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B-70 AIRCRAFT STUDY
FINAL REPORT
Volume IV

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Volume 4

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: AIR INDUCTION **WBS CODE 1.5**

WBS LEVELS
4 5 6 7 8

1.5 AIR INDUCTION SUBSYSTEM

1.5.1 Inlet System

1.5.1.1 Fixed Wedge

1.5.1.2 External Ramp

Ramp Panel
Panel Seals
Hydraulic Actuator
Actuator Mechanism
Position Sensors
Panel Hinges
Limit Switches
Panel Stops

1.5.1.3 Internal Ramp

Bleed Panel
Panel Seals
Panel Hinges

1.5.1.4 Throat Ramp

Bleed Panel
Panel Seals
Hydraulic Actuators
Electric Trim Motor
Panel Hinges
Servo Valves

1.5.1.5 Rear Ramp

Bleed Panel
Panel Seals
Panel Rotation Hinge
Panel Sliding Hinge

1.5.1.6 Duct Dividers

1.5.1.7 Inlet Lip

1.5.1.8 Throat Section

SUBSYSTEM: AIR INDUCTION WBS CODE 1.5

WBS LEVELS
4 5 6 7 8

1.5.1.9 Diffuser Section

1.5.1.10 Bypass Plenum

1.5.2 Bypass Section

1.5.2.1 Bypass Plenum

1.5.2.2 Main Doors

Door Panels
Door Seals
Hydraulic Actuator
Actuator Mechanism
Shock Limit Motor
Door Position Sensors
Bungee Override
Servo Valves

1.5.2.3 Trim Doors

Door Panels
Door Seals
Hydraulic Actuators
Master Cylinder
Door Position Sensors
Trim Actuator
Actuation Mechanism
Servo Valves
Rate Bungee

1.5.3 Air Induction Control System

1.5.3.1 Shock Position Sensors

1.5.3.2 Shock Limit Sensors

1.5.3.3 Buzz Sensor Units

Pressure Level Sensor
Pressure Cycle Sensor

1.5.3.4 Central Air Data Sensor

1.5.3.5 Unstart Sensor

SUBSYSTEM: AIR INDUCTION WBS CODE 1.5

WBS LEVELS
4 5 6 7 8

1.5.3.6 Overpressure Sensor

1.5.3.7 Automatic Controller

Hydraulic Filters
Signal Conditioning
Analog Drive Assembly
Functional Switches
Hydraulic Control Valving
Electrical Distribution
System Monitors
Limit Switches
Override Controls
Pneumatic Valving
C&D Communications
Time Delay Relays
Hydraulic Rate Control Valving

1.5.3.8 Local Mach Unit

Mach Sensor
Servo Switch Monitor

1.5.3.9 Mechanical Follow-up and Trim

1.5.4 Controls and Displays

1.5.4.1 Control Panel

Throat Deviation Indicators
Throat Position Digital Indicators
Pressure Ratio Indicators
Buzz/Reset Lights
AICS Mode Override Switches

1.5.4.2 Co-Pilot Control Box

Mode Switches
Throat Control Knobs
By-Pass Control Knobs

1.5.4.3 Annunciator Panel

Unstart Lights
Shock Limit Lights
Bypass Door Open Lights
Buzz Lights

SUBSYSTEM: AIR INDUCTION WBS CODE 1.5

WBS LEVELS
4 5 6 7 8

1.5.5 Boundary Layer Control System

1.5.5.1 Bleed Chambers

Delta "P" Valves
Check Valves

1.5.5.2 BLC Ducting

1.5.5.3 External Gutter

1.5.5.4 Exhaust Porting

Reverse Flow Door

1.5.6 Ground Tests

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Subsonic Tests
Tri-sonic Tests
Full Scale Tests

1.5.6.2 Flight Simulator

1.5.6.3 Mockups

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1.5.6.5 Wind Tunnel

TECHNICAL DESCRIPTION

SUBSYSTEM: AIR INDUCTION SUBSYSTEM WBS CODE: 1.5

The B-70 Air Induction Subsystem (AIS) consisted of two internal-external compression multiple shock inlet duct systems, symmetrical about the centerline of the air vehicle and completely independent mechanically. Each system governed the air supply to three engines and consisted of a rectangular variable geometry "inlet", transition ducting between the inlet and the engines, a variable area bypass located immediately upstream of the engines, an inlet boundary layer air-bleed system (BLC), and an air induction control system (AICS) with its associated controls and displays. Each of the two inlets were located in the fuselage underslung after body and utilized both internal and external shock compression. On the XB-70, three fixed external ramps were provided per inlet with the required internal geometry obtained from three variable throat panels. Two splitters were provided in the main ducts, each of which supplied air to one engine. All movable panels and doors of the inlet duct systems were actuated by hydraulic actuators. Exhibit 1, Page IV-8, presents a plan view of the AIS depicting the relationship of the inlet in the fuselage underslung after body, the fixed ramps, the hinged variable panels, and the bypass doors which bypassed the air from a plenum surrounding the main duct just forward of the engines. The view shown is that of the RS-70 inlet with four variable throat panels and two fixed ramps. Since the forward throat panel was a two position panel for take-off performance only (being retracted for take-off and extended shortly thereafter), it was permanently fixed at its extended position on the XB-70 with no impact on inflight inlet performance.

Note: Throughout the balance of this section the descriptions apply to one inlet duct system, unless otherwise noted.

The AIS of the B-70 was a multi-shock, variable area, convergent-divergent inlet with essentially four regimes of operation as depicted by Exhibit 2, Page IV-9. During take-off and low subsonic flight (up to local Mach number 0.6), the bypass doors were closed and the throat panels fully retracted to provide maximum air capture area. At high subsonic-low supersonic speeds (up to local Mach number 1.1), the bypass doors were still closed while the throat panels moved from the maximum width of 48 inches to approximately 46 inches. (Note: Throat width is sometimes identified as throat height.) At the intermediate supersonic speeds (up to local Mach number 1.8), the bypass doors were opened a fixed increment while the throat panels had scheduled to an approximate width of 41 inches. Above local Mach number 1.8 and at high supersonic speeds, the bypass doors were modulated for terminal shock control while the throat panels were scheduled as a function of local Mach number to a minimum width of approximately 21 inches.

WBS CODE: 1.5

To maintain efficiency throughout the wide range of operating conditions from take-off to Mach 3 cruise, the variable geometry features of the B-70 AIS provided continuous match of inlet and engines for maximum inlet recovery and engine thrust. As previously stated, for take-off, the inlet was at maximum air capture area with the bypass doors closed to provide the volume of air demanded by the engines. At low supersonic speeds, oblique shocks formed on the external ramps for efficient deceleration of the external supersonic air flow to the subsonic speed demanded by the engines. The terminal normal shock was outside the inlet since the internal area contraction was too great to swallow the normal shock at the low supersonic approach speeds. Under these conditions, the bypass doors were opened about 10° to spill the excess inlet airflow, insure inlet stability, and decrease inlet drag. As the flight speed increased, the external normal shock was swallowed and the inlet was said to be "started". At Mach 3 cruise, the external shocks decelerated the flow to about Mach 2.3 at the cowl lip with the internal oblique shocks further reducing the flow velocity to about 1.3 Mach at the inlet throat. This oblique shock network contracted the air flow area to $\frac{1}{4}$ the free stream area and multiplied the static pressure many times. The normal shock (terminal shock) increased the static pressure by a factor of 2 while the subsonic diffuser raised the pressure to its highest level at the face of the engine. The B-70 AIS, at Mach 3 cruise, had a compression ratio approximately ten times that of the engine.

Exhibit 3, Page IV-10, presents a plan view of the B-70 inlet showing the shock patterns formed at air vehicle Mach 3. This exhibit also shows the compression ratio (to free stream static) along the different stations of the inlet and for the diffuser section. The porous panels noted were part of the boundary layer control (BLC) which bled off the turbulent skin layer to reduce inlet drag and to provide increase stability to the terminal shock. Exhibit 4, Page IV-11, presents a graph showing the pressure recovery of the AIS as estimated and as obtained in flight on air vehicle No. 1 early in the Flight Test Program. Exhibit 5, Page IV-12, presents a chart showing the allowable pressure distortion at the engine face and the distortion data obtained in flight. As indicated, the B-70 AIS provided the volume of air demanded by the engines at minimum distortion.

VARIABLE GEOMETRY INLET

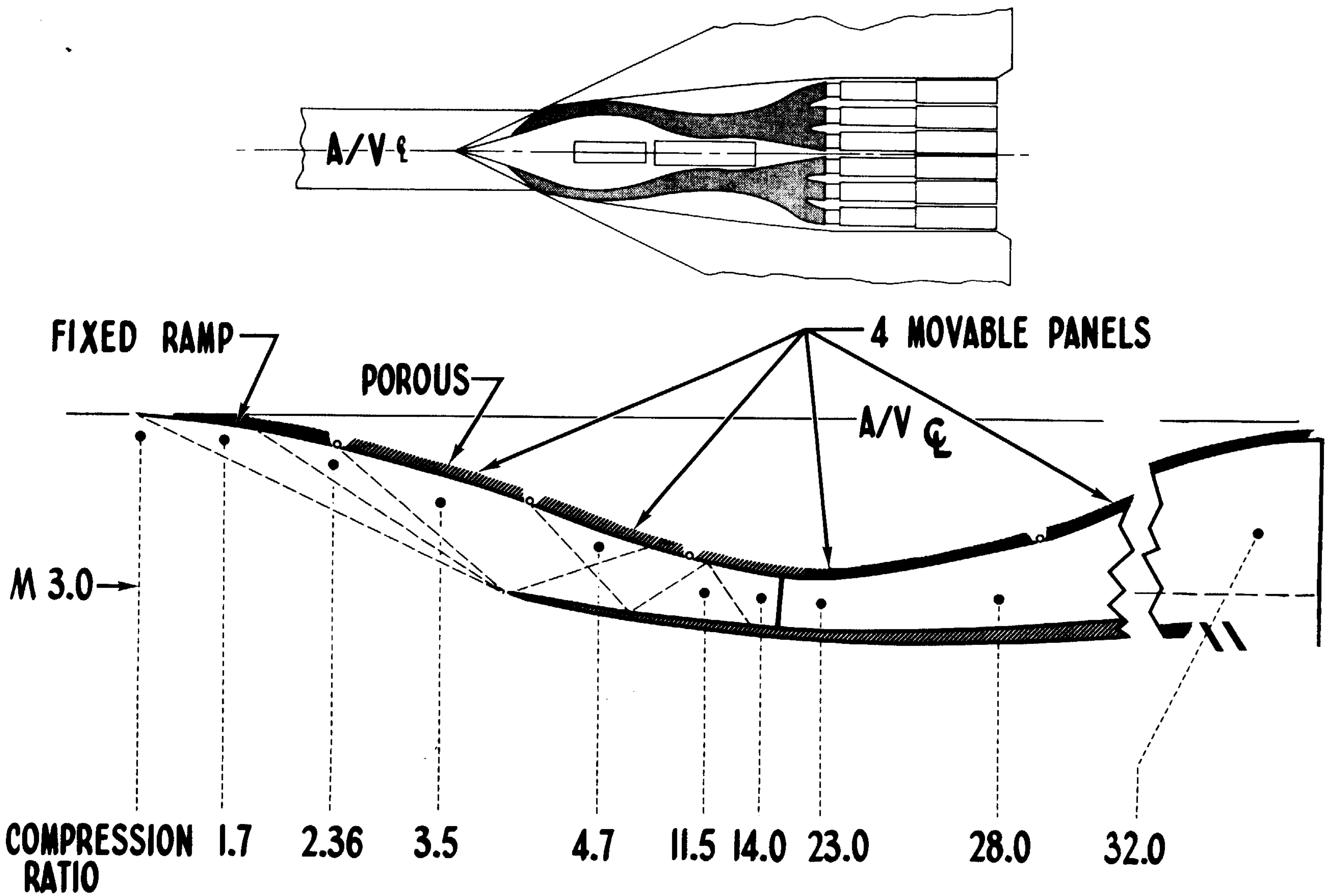
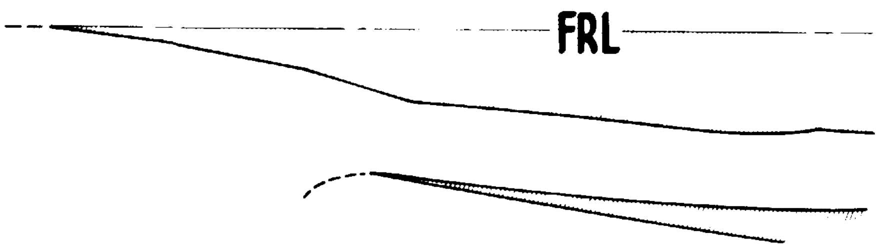


EXHIBIT 1

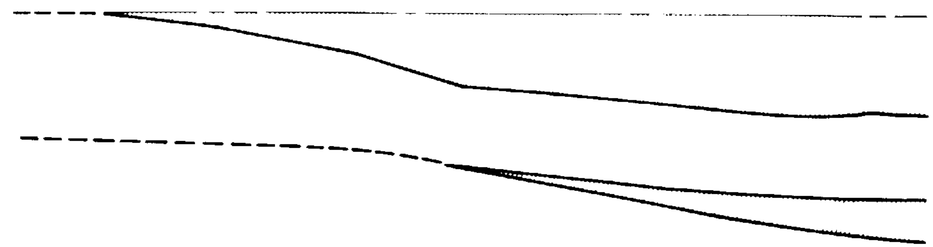
MODES OF OPERATION

TAKEOFF



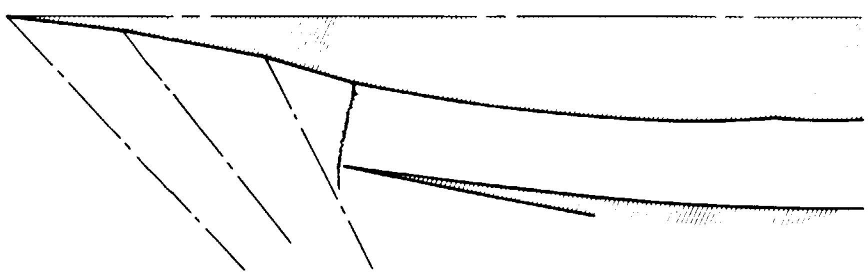
THROAT: MAXIMUM
BYPASS: CLOSED

HIGH SUBSONIC - LOW SUPERSONIC



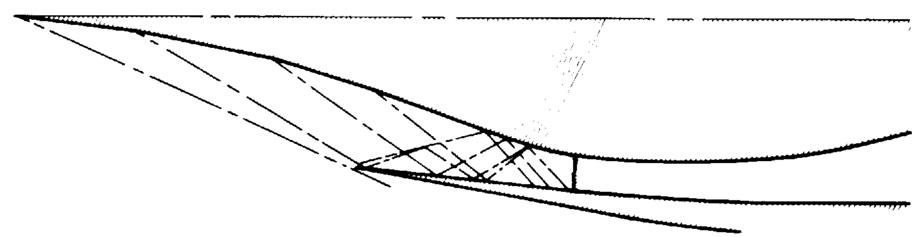
THROAT: NEAR MAXIMUM
BYPASS CLOSED

INTERMEDIATE SUPERSONIC



THROAT: NEAR MAXIMUM
BYPASS: $f(M_A, M_{DE})$

HIGH SUPERSONIC



THROAT $f(M_A)$
BYPASS: VARIES TO POSITION SHOCK

VARIABLE GEOMETRY INLET

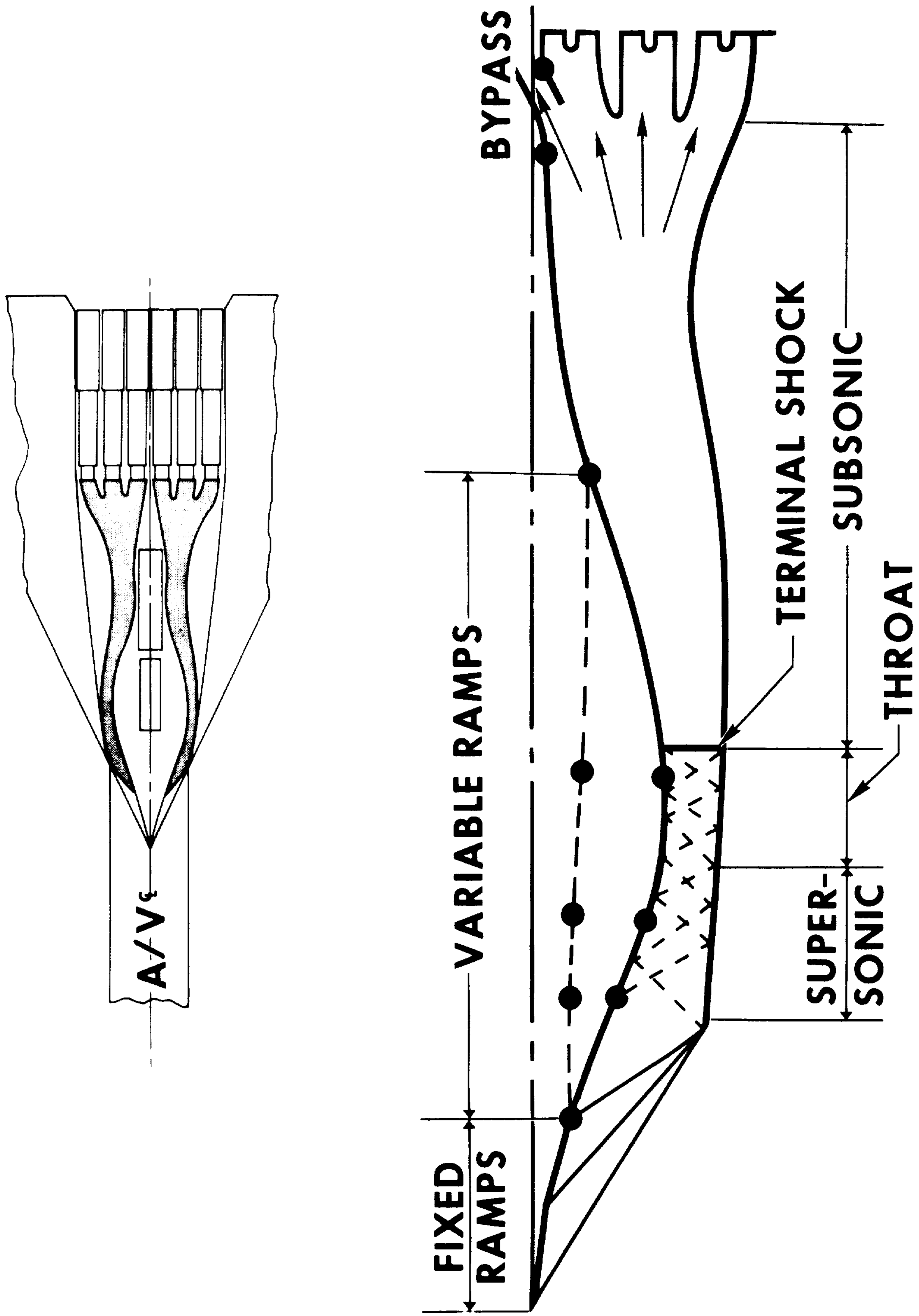


EXHIBIT 3

PRESSURE RECOVERY

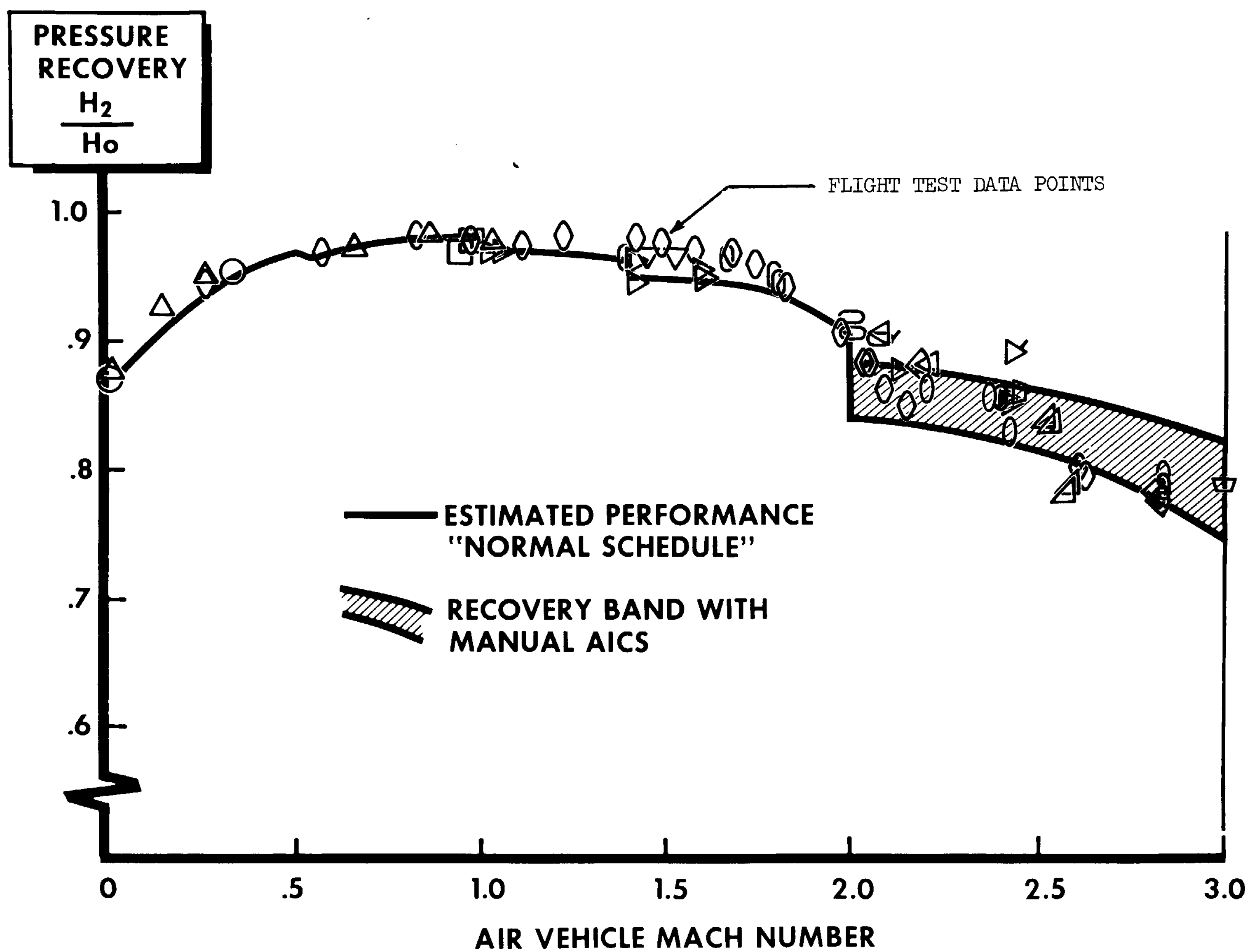


EXHIBIT 4

ENGINE FACE TOTAL PRESSURE DISTORTION

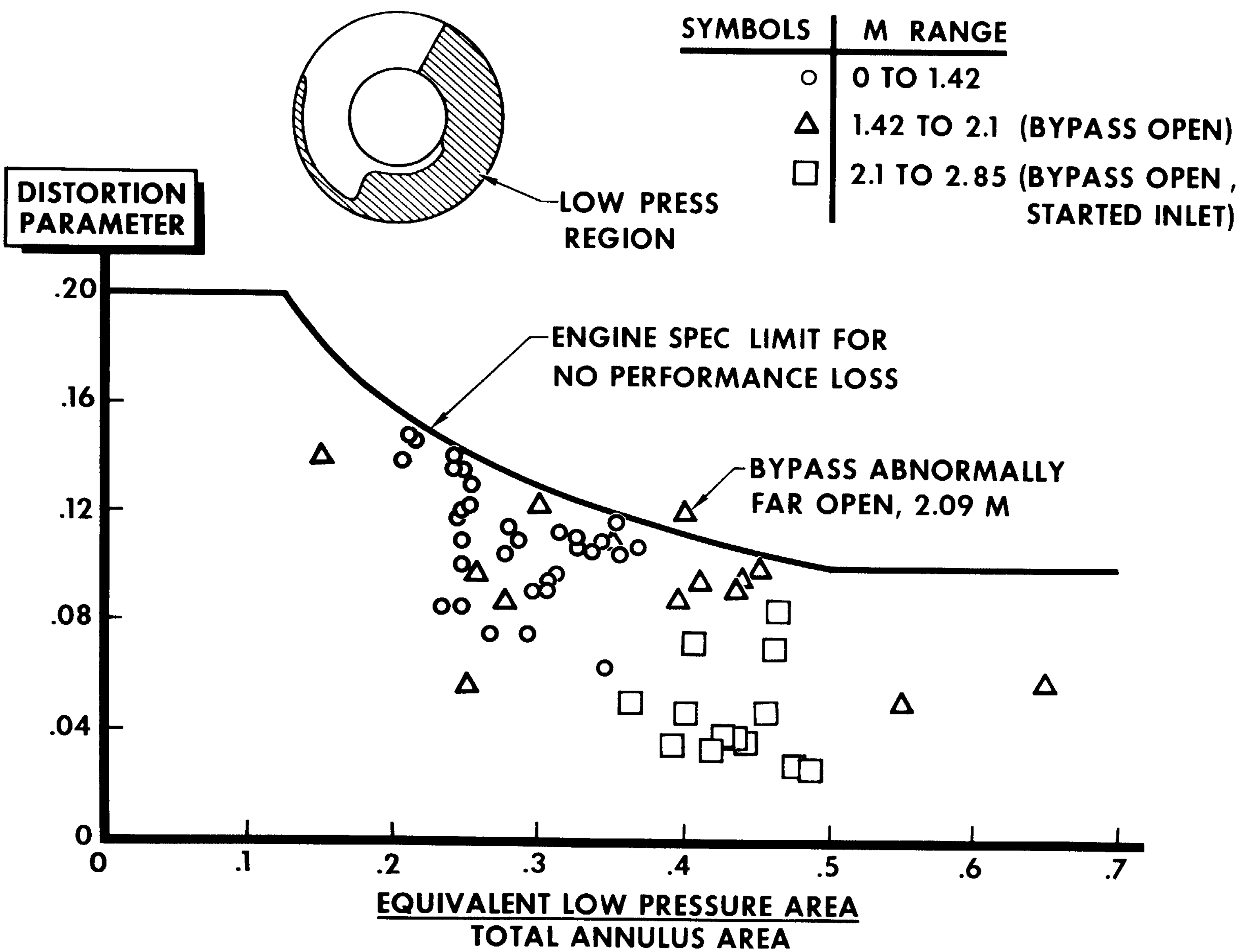


EXHIBIT 5

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: AIR INDUCTION SUBSYSTEM WBS CODE: 1.5

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT (PER AIR VEHICLE)	POUNDS	7638	-	-	*16,185	*15,686
MAJOR SUBSYSTEMS (PER AIR VEHICLE)	TYPE/NO.	INLET CONT /2 BYPASS CONT /2 BLC, /2 CONT. & DISPLAYS /2 SUBSYSTEMS /2 (BUZZ, UNSTART, SHOCK, P/R)	→	→	→	→
POWER SOURCE	SPECIFY	DUAL 4000 psi HYD 400 H_2, 115 VAC Electric	→	→	→	→
TEMPERATURE - DESIGN RANGE	DEGREES F					
AIRFRAME		-65 to 630	→	→	→	→
EQUIPMENT		-65 to 450	→	→	→	→
SPEED - DESIGN RANGE	MACH NO.	3.0 +	→	→	→	→
ALTITUDE - MAX DESIGN	FEET					
AIR VEHICLE		110,000	100,000	90,000	→	→
EQUIPMENT		100,000	90,000	90,000	→	→
PRESSURE RECOVERY - STATIC	PERCENT	87	87	87	87	89

* INCLUDES 4000 LBS FOR WEAPON'S BAY AICS PACKAGE

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: AIR INDUCTION SUBSYSTEM WBS CODE: 1.5

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
PRESSURE RECOVERY - CRUISE	PERCENT					
MACH NO. 3.0		80% NORM 85% HI	- -	- -	76% MAN -	81% NORM 85% HI
MACH NO. 2.0		91% →				→
MACH NO. 1.0		96% →				→
MACH NO. LESS THAN 1.0		94.5% →				→
SHOCK PATTERNS	SPECIFY					
LESS THAN MACH 2.0		EXTERNAL OBLIQUE →				→
ABOVE MACH 2.0		EXTERNAL OBLIQUE WITH MULTIPLE INTERNAL →				→
OPERATIONAL MODES	SPECIFY	AUTO, - STANDBY	AUTO, - STANDBY	AUTO (M_a) - STANDBY	AUTO (M_o) MANUAL STANDBY	AUTO (M_a) - STANDBY
FUNCTIONAL PROTECTION	SPECIFY	UNSTART DETECTION AUTO RESTART BUZZ DETECTION AUTO ELIMIN.		AUTO RESTART AUTO BUZZ PROTECTION -	MANUAL RESTART MANUAL BUZZ ELIMIN.	AUTO RESTART AUTO BUSS PROTECTION -
HEAT SINK	TYPE	ELECTRONIC WATER/GLYCOL	EQUIP. BAY	LN_2 ENVIRONMENTAL PACKAGE WATER GLYCOL (ACTUATORS) WATER JACKET (PRESS. RATIO)		→

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: **AIR INDUCTION SUBSYSTEM** WBS CODE: 1.5

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
RELIABILITY FACTOR	NONE	-	-	-	.99513	.99571
MTBF	NO. OF HR	-	-	-	358	407

TECHNICAL DESCRIPTION

SUBSYSTEM: AIR INDUCTION SUBSYSTEM WBS CODE: 1.5

MAJOR ASSEMBLY: INLET SYSTEM WBS CODE: 1.5.1

The inlet system of the B-70 was designed to capture the free stream air, decelerate and compress the air efficiently and deliver the air to the engine at the volume demanded and at minimum distortion. The inlet system also supplied air for engine compartment cooling, drag chute compartment cooling, and for the reduction of boat-tail drag (increased the base pressures). As depicted by previous exhibits, the inlet system consisted of a forward fixed wedge, a fixed ramp, a fixed porous throat panel, three variable throat panels (2 porous), a diffuser section, a bypass plenum, two duct splitters and the hydraulic actuators, mechanisms, sensors, and valving necessary for the actuation of the movable components. The hydraulic and electrical power required for actuation was supplied by the Secondary Power Subsystem: WBS 1.4.

The lower half of Exhibit 6, Page IV-18, presents a schematic of the components and mechanisms incorporated for the actuation of the throat panels. The master cylinder was controlled by a electro-hydraulic valve driven by signals from the AICS for all normal throat operations. The electrical actuator was positioned by a crew controlled three position switch (momentary "INCR" or "DECR") of the AICS Standby System. The top bungee provided a pivot point for the master cylinder or electrical actuator operation while the two lower bungees provided rate controlled follow-up for the servo valves of the throat panel two hydraulic actuators.

The prime function of the electrical actuator was to provide the capability of safely decelerating (and landing) from Mach 3 cruise after a master cylinder and/or normal AICS mode failure. As indicated by the throat panel linkage, the positioning capability of the throat panels by the standby electrical actuator depended on the master cylinder position. The control range of the electrical actuator was as follows:

Master Cylinder Position	Elect. Actuator Control Range
1. Maximum throat (48 $\frac{1}{4}$ inches)	From 48 $\frac{1}{4}$ to 32.8 inches
2. For 40 inch throat	From 48 $\frac{1}{4}$ to 25 inches
3. Minimum throat (20.5 inches)	From 20.5 to 41.6 inches

Hydraulic power for the electro-hydraulic servo valve and master cylinder (single systems) was provided by the hydraulic utility system #1 (L.H. engines). The throat panel hydraulic actuators were tandem (dual actuators) and were powered by the #1 and #2 utility hydraulic systems. Since the electrical actuator was driven by two motors with each motor energized by an independent electrical system, standby throat operation capability was provided by two independent electrical and two independent hydraulic systems.

In the immediate area forward of the engines (around the duct splitters), the total circumference of the duct wall was perforated which allowed air to pass into a plenum identified as the bypass plenum. This plenum provided two major functions: (1) to supply cooling air for Regime II cooling of the engine compartments, and (2) to collect excess captured inlet air flow to be exhausted by the variable area bypass doors. Description of engine compartment cooling may be found under Propulsion Subsystem (WBS 1.3) while subsequent paragraphs describe the bypass door operation.

Air Induction System Schematic
Throat and Bypass Doors Mechanical Hook-Up

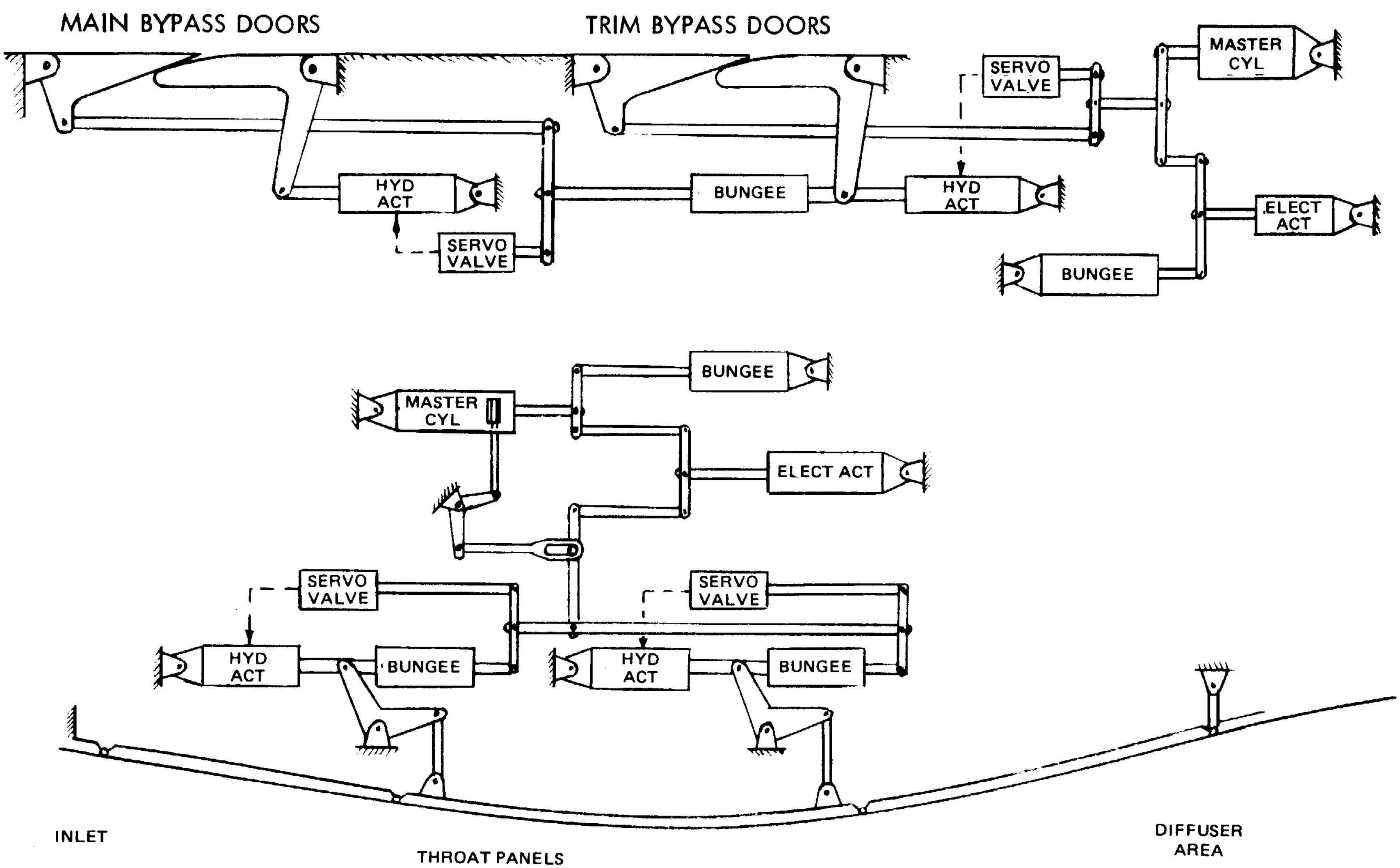


EXHIBIT 6

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: INLET SUBSYSTEM WBS CODE: 1.5.1

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	POUNDS	5486	NOT AVAILABLE	NOT AVAILABLE	3372	3462
ENGINES PER INLET	NUMBER	3	→	→	→	→
CAPTURE AREA	$INCHES^2$	5600	→	→	→	→
RAMPS (EACH INLET)	TYPE/NO.	1- FIXED 7° 1- EXTERN. 12° 4- VARIABLE 1- AUX. INLET		1 - FIXED 7° 1 - EXTERN 12° 3 - VARIABLE 1 - FIXED AUX. INLET 1 - FIXED VARIABLE		→
SEALS (AERODYNAMIC)	TYPE	METALLIC ST. STEEL SLIDING SEALS		→	→	→
LENGTH	INCHES	935	→	→	→	→
HEIGHT (AT THROAT)	INCHES	65.3	→	→	→	→
WIDTH (STATIC): HT. AT THROAT	INCHES	19.5 to 48.25	19.5 to 48.25	20.5 to 48.24	→	→
THROAT AREA VARIATION	$INCHES^2$	1272 to 3145	1272 to 3145	1370 to 3145	→	→
ACTUATION POWER	TYPE	HYD. ACTUATORS 4000 psi	→	→	→	→
SPEED - DESIGN RANGE	MACH NO.	3.0 +	→	→	→	→

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: INLET SUBSYSTEM WBS CODE: 1.5.1

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
ALTITUDE - MAX DESIGN	FEET	100,000	90,000 →			→
PRESSURE RECOVERY - STATIC	PERCENT	87	87	87	87	89
PRESSURE RECOVERY - CRUISE	PERCENT					
MACH LESS THAN 1.0		94.5 →				→
MACH 1.0		96 →				→
MACH 2.0		91 →				→
MACH 3.0		80 NORM 85 HIGH →	81 NORM	81 NORM	76	81 NORM →
SHOCK PATTERNS	SPECIFY					
LESS THAN MACH 2.0		EXTERNAL OBLIQUE →				→
ABOVE MACH 2.0		EXTERNAL OBLIQUE WITH MULTIPLE INTERNAL →				→
HEAT SINK	TYPE	STANDBY ACTUATORS - WATER GLYCOL ELECTRONICS - LH_2 →				→
RELIABILITY FACTOR	NONE	-	-	-	.99513	.99571
MTBF	No. OF HR.	-	-	-	358	407

TECHNICAL DESCRIPTION

SUBSYSTEM: AIR INDUCTION SUBSYSTEM — WBS CODE: 1.5

MAJOR ASSEMBLY: BYPASS SYSTEM — WBS CODE: 1.5.2

The bypass systems of the B-70 AIS were designed to maintain inlet duct-engine compatibility at maximum inlet duct recovery throughout the B-70 flight regime. At supersonic speeds, the position of the normal shock essentially determined the inlet duct efficiency as related to pressure recovery, engine face distortion and inlet stability for both the "started" and "unstarted" regimes of operation. In the "unstarted" speed range, the normal shock was positioned externally near the cowl lip of the inlet to minimize captured air flow spillage behind the shock. For the "started" speed regime, since a normal shock cannot be held on a converging slope, the shock was "swallowed" and maintained on the divergent slope of the inlet throat. The closer the normal shock was maintained to the minimum area of the throat, the higher the pressure recovery of the inlet (it also required tighter shock control).

As previously stated, the engine was a constant volume demand pump while the inlet was a mass air flow device. The equalizer between the two was the normal shock phenomenon which varied the pressure recovery of the inlet. The control of the normal shock was accomplished by varying the excess air flow captured by the inlet. For a constant volume demand, a decreased bypass door area decreased the excess airflow and the normal shock moved forward; an increase in bypass area increased mass flow and the normal shock moved aft. Since inlet-engine match was determined by the normal shock positioning, it was used as the basic control of bypass door operation. The pre-determined desired position of the normal shock was controlled by the AICS which sensed the shock position by pressure taps and signaled for an increased or decreased bypass area.

The bypass system for one inlet duct was comprised of one pair of trimmer doors, two pairs of main doors, and the hydraulic actuators, mechanisms, sensors, and valving necessary for the actuation of the movable components. The bypass doors were located on the upper mold line of the wing directly over the bypass plenum as depicted by Exhibit 7, Page IV-23. Each pair of doors consisted of two panels of which one opened outward and the other inward to provide variable area nozzle conditions during the initial opening of the doors. The electrical and hydraulic power required for actuation and control of the doors was supplied by the Secondary Power Subsystem: WBS 1.4

WBS CODE: 1.5.2

The top half of Exhibit 6, Page IV-18, presents a schematic of the controlling mechanism for the pair of trimmer doors and one set of main doors (the other set of main doors were in parallel). Exhibit 8, Page IV-24, presents a picture of the bypass master cylinder and the dual motor electrical actuator installation. As with the throat control, normal operation of the bypass doors was through the master cylinder which was controlled by an electro-hydraulic valve driven by signals from the AICS. The electrical actuator, which had full authority as backup control for the doors, was positioned by a crew controlled three position switch (momentary "INCR" or "DECR") of the AICS Standby System. The bungee on the right of the exhibit provided the pivot point for master cylinder or electrical actuator control movements. The trimmer doors operated at a rate of approximately 400 square inches per second and were powered by a dual tandem hydraulic actuator. The primary or main doors normally operated at a rate of approximately 16 square inches per second and were also powered by dual tandem hydraulic actuators. As noted by the schematic, the main doors were slaved to the trimmer doors with the difference in travel rate absorbed by a bungee. With this arrangement, the high rate trimmer doors provided the necessary bypass for "fine-tuning" shock control while the large - low rate primary doors provided gross shock control.

Air Induction Schematic
Bypass Doors

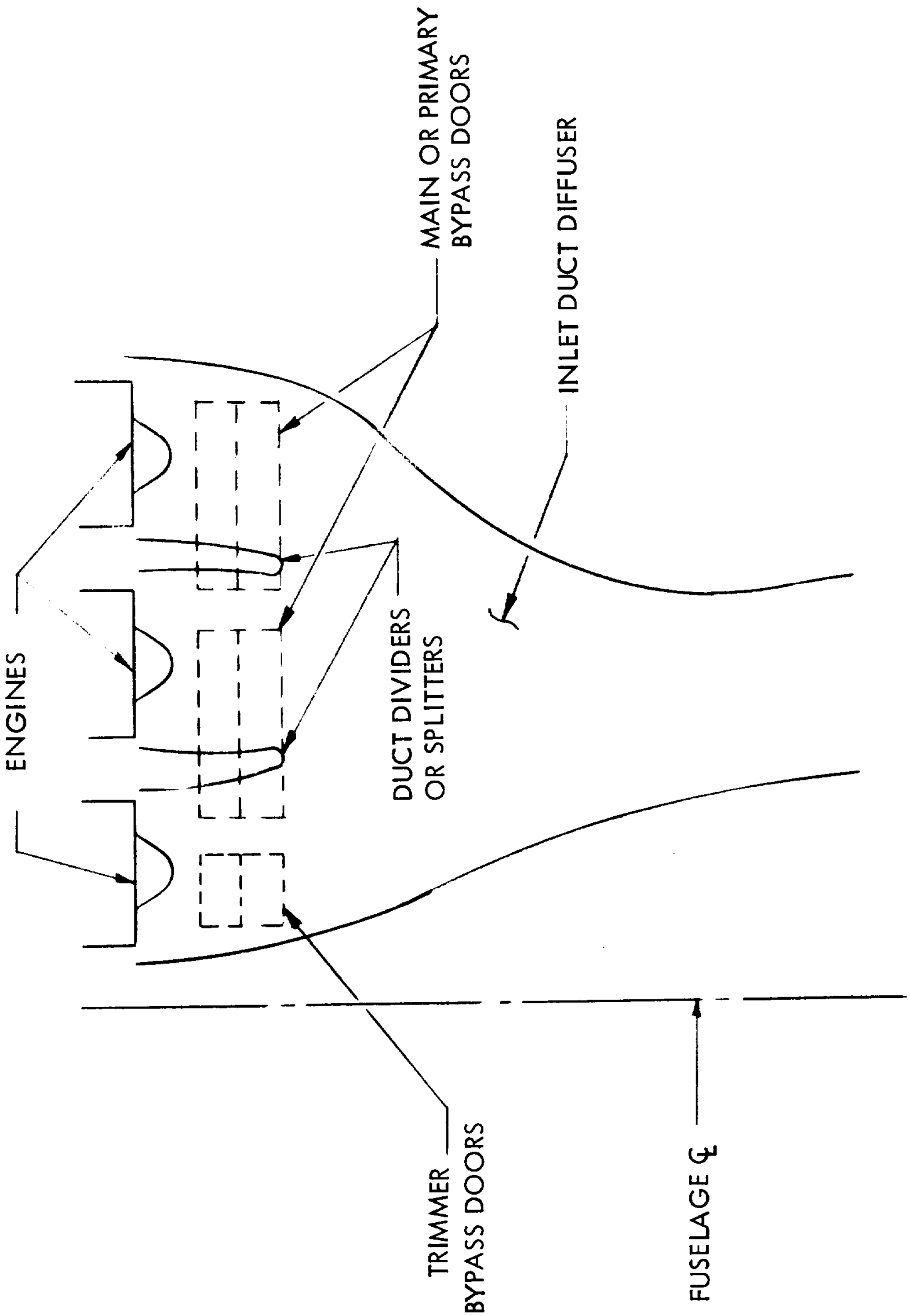
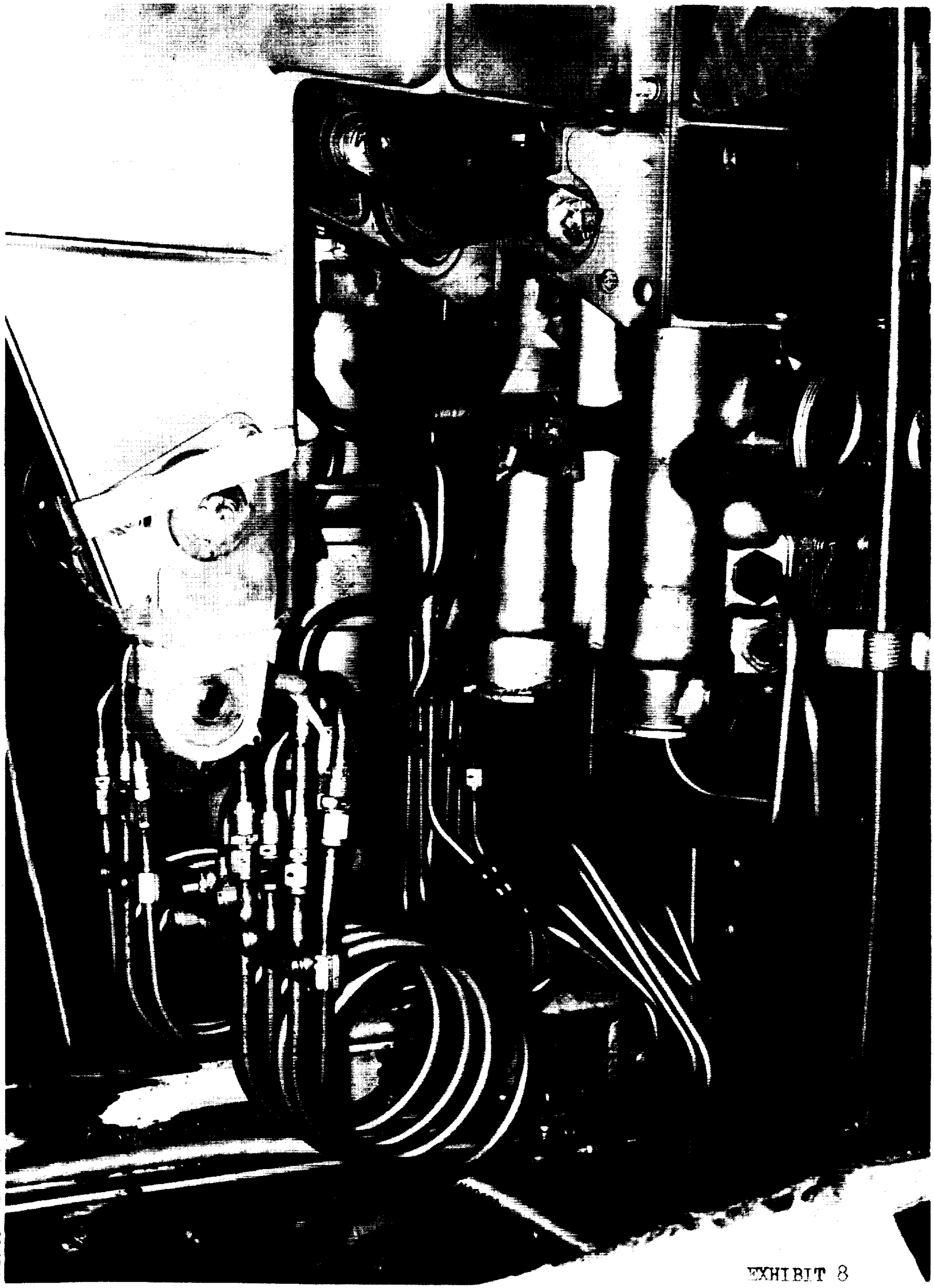


EXHIBIT 7



Bypass Master Cylinder and Trim Actuator

4-29-63 278-58-34D

EXHIBIT 8

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: BYPASS SUBSYSTEM WBS CODE: 1.5.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	POUNDS	1648	1648	3055	3055	3124
EXHAUST AREA - MAX	$INCHES^2$	2410	2410	2380	2380	2380
DOORS	TYPE/NO.	PAIRS - CONVERGENT/DIVERGENT TRIMMER DOORS (1 EACH INLET) PRIMARY DOORS (2 EACH INLET) →				
DOOR LENGTH (EACH INLET)	INCHES	221	221	221	221	221
DOOR WIDTH (EFFECTIVE)	INCHES	10.9 →				
SEAL (AERODYNAMIC)	TYPE	METALLIC ST. STEEL →				
ACTUATION POWER	TYPE	4000 PSI HYDRAULIC →				
SPEED - DESIGN RANGE	MACH NO.	3.0 + →				
ALTITUDE - MAX DESIGN	FEET	100,000	90,000 →			
HEAT SINK	TYPE	(SEE AIS) →				
RELIABILITY FACTOR	NONE	-	-	-	.99513	.99571
MTBF	NO. OF HR	-	-	-	358	407

TECHNICAL DESCRIPTION

SUBSYSTEM: AIR INDUCTION SUBSYSTEM — WBS CODE: 1.5

MAJOR ASSEMBLY: AIR INDUCTION CONTROL SYSTEM — WBS CODE: 1.5.3

Each inlet duct system of the B-70 AIS was controlled by an Air Induction Control System (AICS). The function of the AICS was to position the throat panels and bypass doors as required to maintain high total pressure recovery, minimum inlet drag, stable inlet airflow and provide matching of inlet mass flow to engine volume demand. The AICS essentially consisted of the automatic electro-hydraulic system, the override functions and the backup or standby system. For control of the inlet duct system, the AICS used pneumatic signals from one local Mach (Ma) transducer, one pressure ratio transducer, two buzz sensors, two unstart sensors, movable surface positions, and included signals as selected by the crew for normal performance, high performance, low performance, and standby operation. Exhibit 9, Page IV-29, presents a general diagram of the AICS showing by block diagram the functions and control interfaces of the AICS.

The automatic electro-hydraulic functions of the AICS utilized the various pressures and pressure ratios sensed at predetermined locations in the inlet duct system and positioned the movable components per predetermined throat and bypass schedules. Exhibit 10, Page IV-30, presents the schedules for the throat panels and bypass area as a function of Ma and shock position, respectively. As noted, during take-off, landing, and at speeds below Ma 0.6, the throat panels were full retracted and the bypass doors closed. For these flight conditions, the performance mode switch was in the standby position which shut off hydraulic pressure to the electro-hydraulic servo valves and positioned these servo valves pressure ports to hydraulic return. In this configuration, it required two distinct signals, a 0.6 Ma and an "Auto" mode selection, before the master cylinders could become operative and shift positions during this critical flight regime. At a MA of 0.6, the AICS mode switch was placed in the "Auto" position by the crew which connected the electro-hydraulic servo valves to hydraulic system pressure so that the master cylinders were operative for automatic positioning control.

For flight speeds above Ma of 0.6, the normal performance mode of operation was selected by the crew which scheduled the throat and bypass as indicated including an automatic inlet "start" at Ma 1.86 (air vehicle Mach 2). The low performance mode could be selected by the crew if severe downstreams transients were anticipated, such as an engine shutdown. The high performance mode was selected for stabilized flight conditions only at high supersonic speeds.

WBS CODE: 1.5.3

The restart control function, which was an override function in the "Auto" mode, was armed at Ma 1.86 by signals from either of the two inlets local mach transducers. Upon detection of an unstart by the unstart sensors, signals were directed to the cockpit to illuminate the unstart warning lights and the AICS reset light-switch. Simultaneously, signals were transmitted which opened the throat plus 8 inches, selected a downstream shock position control, and switched the opening rate of the main bypass doors to maximum for a period of 2 seconds (after which normal rate was resumed). After restarting, the unstart warning lights went out but the AICS reset switch remained illuminated to indicate the throat panel at plus 8 inches schedule and the shock on downstream control. This inlet duct configuration was maintained until the control system was returned to the original operational mode by manually depressing the AICS reset switch.

Each duct had two unstart detection systems which were independent except for the common duct pressure sources. Each system received two pressure signals from the duct. When the normal shock was at its scheduled position in the duct, the ratio of the two pressures was a given valve. With expulsion of the normal shock from the duct, the ratio became a higher valve which initiated the restart function.

Exhibit 11, Page IV-31, presents a composite graph of normal inlet starting and unstarting during a slow acceleration and deceleration through air vehicle Mach 2 (Ma = 1.86). Since this was the Mach range for normal starting (nearly a natural phenomenon during air vehicle acceleration), reaction of inlet pressures were very slow when compared to that presented by Exhibit 12, Page IV-32. This exhibit shows the rapid reaction (pressure recovery parameter) of a typical inlet unstart and restart at high supersonic speeds. As indicated by the pressure recovery parameter, there were two (plus) duct pressure cycles during the restart which was not uncommon at high mach numbers. However, six or more pressure cycles was classified as "duct buzz" which could occur very rapidly if the condition that caused the unstart prevented a satisfactory restart.

The buzz control system was armed at all times in the "Auto" mode and was an overriding function. Each duct had two independent buzz detection systems located in the duct diffuser area. When variations in the sensed pressure were of a magnitude and rate considered detrimental to structure and/or engine, the overriding buzz control function was initiated. Upon buzz detection, signals were directed to the cockpit to illuminate the buzz warning lights and the AICS reset switch. Simultaneously, signals were transmitted which selected the downstream shock position for bypass door control and switched operating rate of the main doors to maximum for a period of two seconds. After the elimination of the buzz signal, the buzz warning lights went out but the AICS reset remained illuminated to indicate the inlet was still on downstream shock control. As with the unstart, this configuration was maintained until the AICS reset switch was manually depressed.

WBS CODE: 1.5.3

The electro-hydraulic automatic functions of the AICS had a single system for the control of the throat panels and bypass doors. However, the backup or standby control had dual systems for the recovery of an unwanted duct configuration caused by an automatic system failure. The standby control also provided pilot control of the AICS during emergency flight conditions, such as an encapsulated deceleration and descent from high altitude supersonic cruise. The standby control of the AICS was provided via electrical actuators which positioned the power actuators control linkages as shown by Exhibit 6, Page IV-18. The electrical actuators, which were energized by switches on the copilot's panel or by either capsule control, were each driven by two motors with each motor energized by an independent electrical system.

For "Standby" control, the actuators could be energized individually to obtain the desired throat panel and/or bypass door position. For "Emergency" control, the three position switches energized the throat panel and bypass door actuators (on one inlet) simultaneously to drive the bypass doors full open and the throat to 39 inches. Simultaneously, the hydraulic power to the electro-hydraulic master cylinders was cut off, causing the cylinders to hold their position. To increase the margin to unstart in this mode, the performance selector switch had to be placed in the "low" performance position prior to movement of the mode switch to the "Emergency" position. The momentary closing of the thrust control switch in either the pilot or copilot capsule also drove the throat panels and bypass doors to the positions noted above.

Air Induction Control System
General Diagram

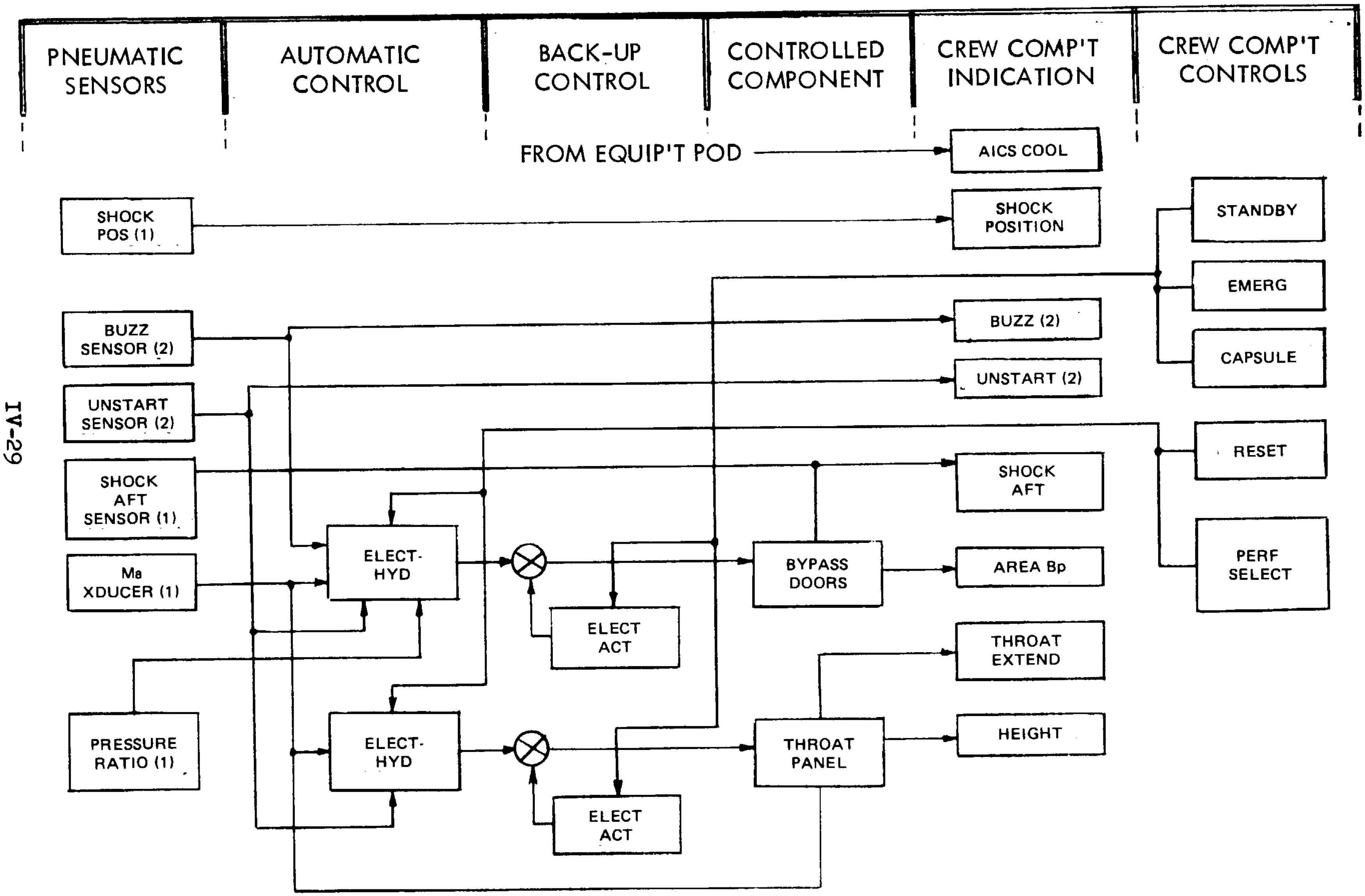


EXHIBIT 9

Air Induction System
Operation of Variable Members

LOCAL MACH RANGE	THROAT PANEL	BYPASS
0 TO 0.6	FULL RETRACTED (MAX THROAT AREA)	FULL CLOSED
0.6 TO 1.1	POSITIONED AS A SCHEDULED FUNCTION OF LOCAL MACH	
1.1 TO 1.8		OPENED A FIXED INCREMENT
1.8 TO MAX.		MODULATED FOR SHOCK CONTROL

THROAT PANEL SCHEDULE

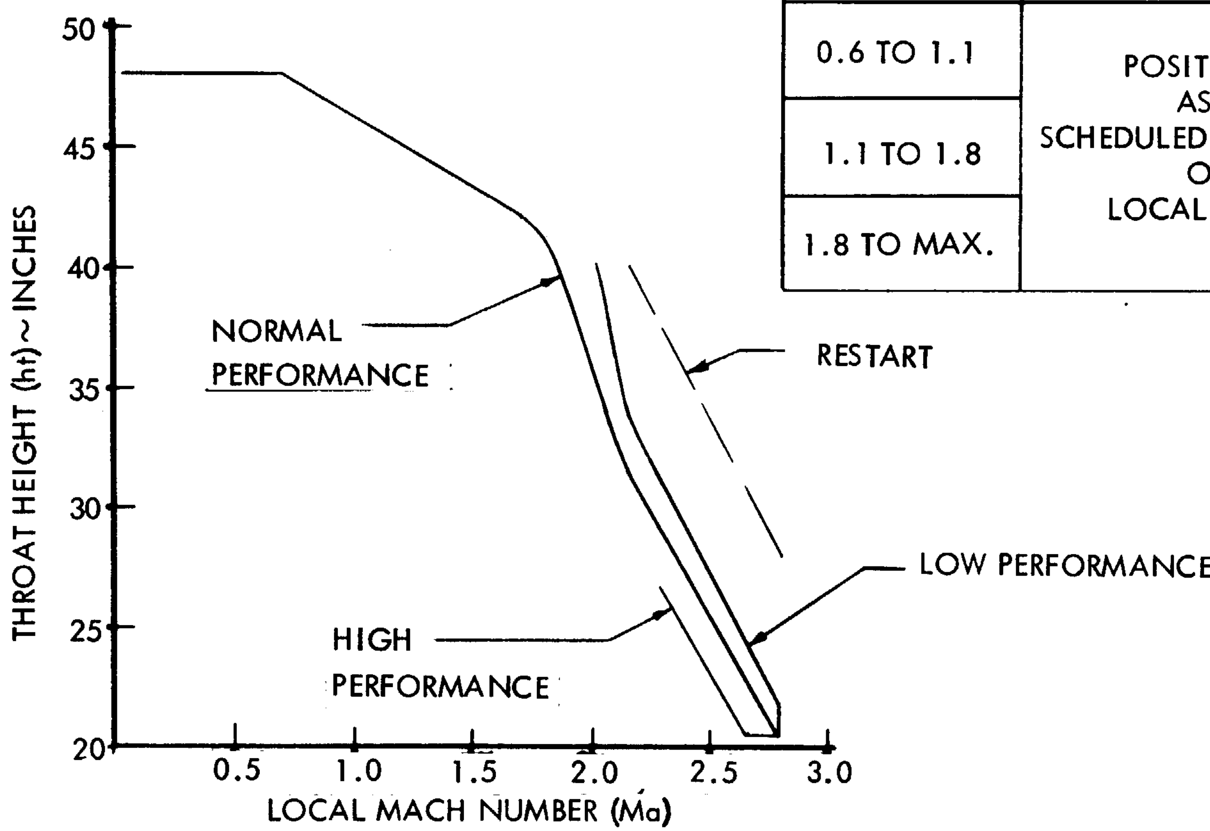
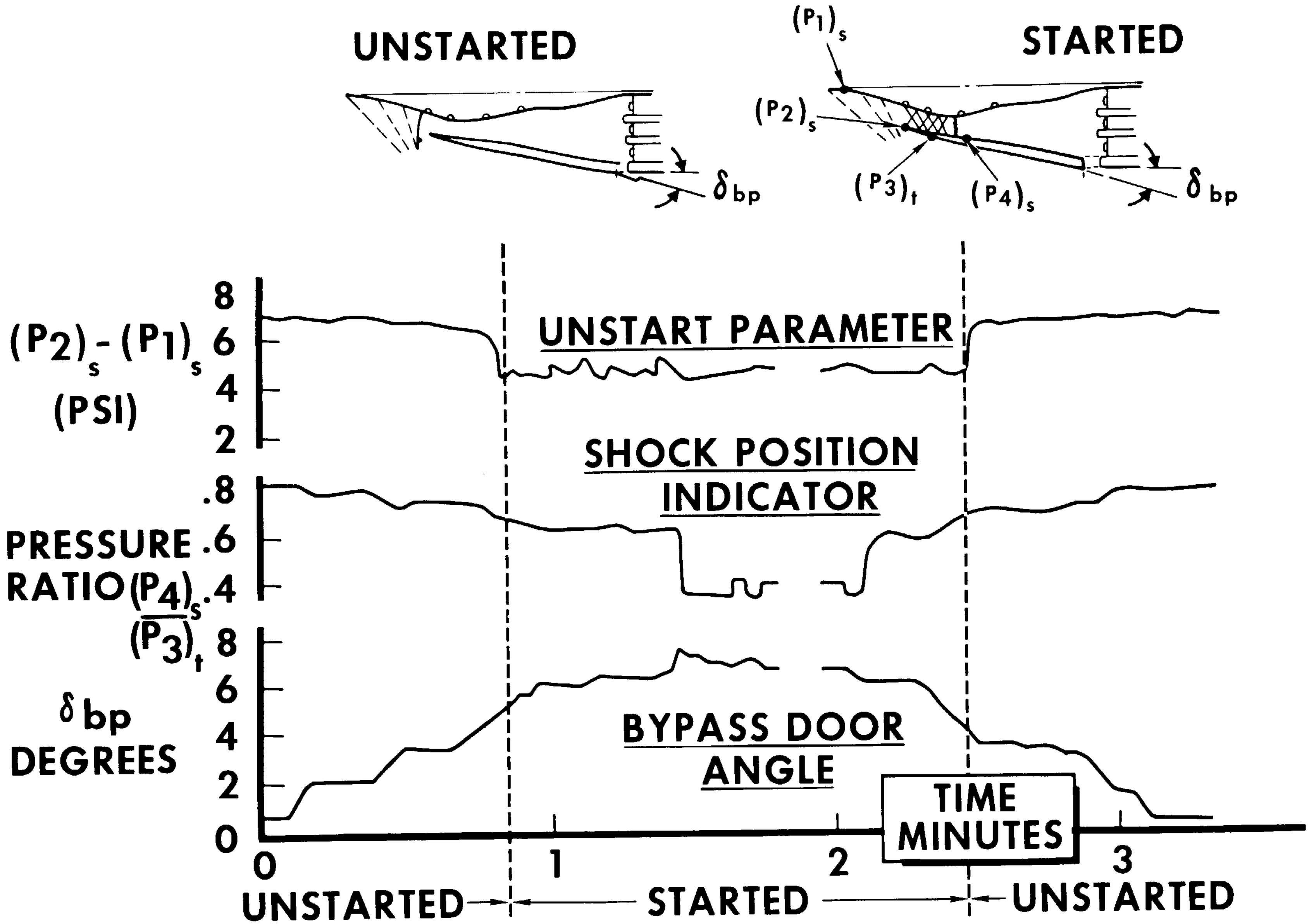


EXHIBIT 1C

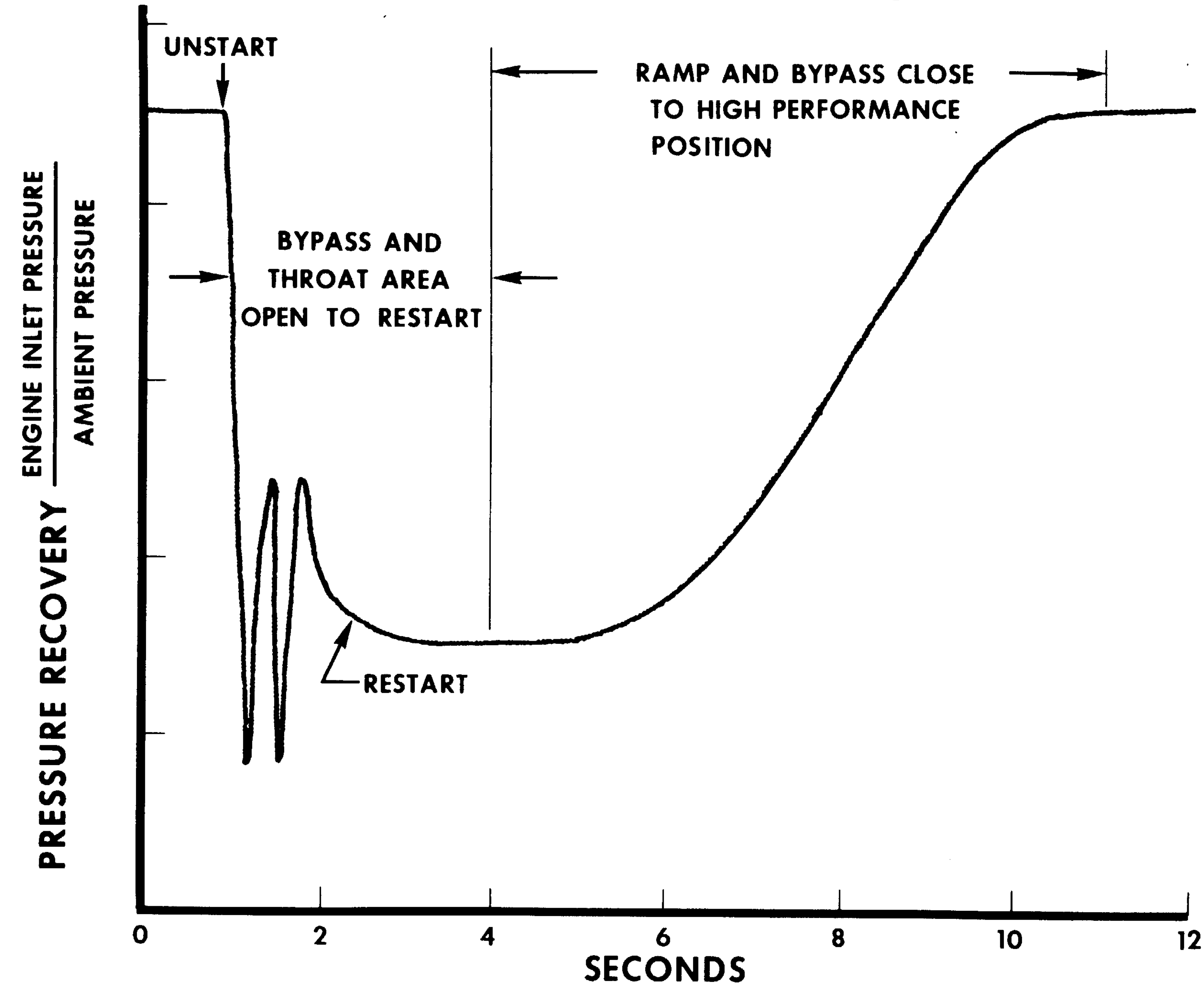
INLET START AND UNSTART CYCLE (M 2.0)



SD72-SH-0003

EXHIBIT 11

TYPICAL B-70 INLET UNSTART AND RESTART



Space Division
North American Rockwell

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: AIR INDUCTION CONTROL SUBSYSTEM WBS CODE: 1.5.3

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	POUNDS	PART OF ELECT. EQUIPMENT BAY WEIGHT		1411	1411	915
SENSORS	TYPE/NO.	MACH (2) SHOCK P/R (2) SHOCK POS (2) UNSTART (4) BUZZ (4)	→	→	→	→
CONTROL MODES	TYPE/NO.	AUTO/2 EACH THROAT & BYPASS STANDBY/2 EA. THROAT 2 BYPASS		- AUTO STANDBY	AUTO MANUAL STANDBY	AUTO STANDBY
OVERRIDE FUNCTIONS	TYPE/NO.	UNSTART DETECTION (4) RESTART CAPABILITY (2) EMERG. DESCENT (2) EMERG. CONT. (1)		MAN. RESTART BUZZ MAN. EMERG. DESCENT	→	AUTO RESTART AUTO BUSS PROTECT EMERG. DESCENT EMERG. CONT.
SPEED - DESIGN RANGE	MACH NO.	3.0 +	→	→	→	→
ALTITUDE - MAX DESIGN	FEET	100,000	90,000	→	→	→
CONTROL POWER	SPECIFY	DUAL HYDRAULIC 4000 PSI 400 H_z ELECT. 115V		→	→	→

WBS IDENTIFICATION: AIR INDUCTION CONTROL SUBSYSTEM WBS CODE: 1.5.3

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
CONTROL PARAMETERS	TYPE/NO.	MA/2 UNSTART/4 SHOCK POS/6 BUZZ/4 SHOCK AFT/2 DIFFERENTIAL LOCAL MACH (MA)/2	→	-	A/V MACH IN LIEU OF M_a	M_a/2 UNSTART/4 SHOCK POS/6 BUZZ/4 SHOCK AFT/2 DIFF. MA/2
ACCURACY	-	-	-	-	-	-
THROAT CONTROL	PERCENT FS	1.4	→	→	→	→
BYPASS CONTROL	PERCENT FS	1.5	→	→	→	→
FREQUENCY RESPONSE	HERTZ	3 to 6	→	→	→	→
RESOLUTION	$INCHES^2$	-	-	-	-	-
BYPASS		10	→	→	→	→
THROAT		13	→	→	→	→
TEMPERATURE - DESIGN RANGE	DEGREES F	630°F INLET STRUCTURE 550°F SENSORS -65° TO 450°F SYSTEM		→	→	→
HEAT SINK	TYPE	ELECTRONIC EQUIP. BAY WATER/GLYCOL		WEAPONS BAY AICS PACKAGE: LN_2 WATER/GLYCOL FOR ACTUATORS WATER JACKET FOR PRESS RATIO'S		

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: AIR INDUCTION CONTROL SUBSYSTEM WBS CODE: 1.5.3

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
RELIABILITY FACTOR	NONE	-	-	-	.99513	.99571
MTBF	NO. OF HR	-	-	-	358	407

TECHNICAL DESCRIPTION

SUBSYSTEM: AIR INDUCTION SUBSYSTEM WBS CODE: 1.5

MAJOR ASSEMBLY: CONTROLS AND DISPLAYS WBS CODE: 1.5.4

Air Induction Control System indications were provided in the cockpit at the copilot's station for standby control and for monitoring the automatic control functions. Exhibit 13, Page IV-37, presents the basic layout for the AICS controls and displays on the copilot's instrument panel which contained the AICS switches shown in the layout of Exhibit 14, Page IV-38. The AICS warning lights were located with the other subsystem warning lights in the annunciator panels which made up the forward section of the center aisle console.

The "Throat Mach Schedule" and "Bypass Area" were digital readouts in terms of air vehicle mach number and total bypass area in square inches, respectively. These indicators were used primarily for monitoring the automatic control and override functions. However, on standby control, these indicators were used in conjunction with switch operation for correct positioning of the throat and bypass doors. The "Shock Position" indicator was a dial-pointer display showing the location of the terminal normal shock in the inlet. The pointer of the instrument was positioned by a sensor which provided a signal that was a function of the ratio of a total pressure sensed at FS 1292 and a static pressure sensed at FS 1383. The "Pressure Ratio" dial indicated the duct efficiency and was essentially a monitoring indicator.

The "Buzz" and "Unstart" warning lights were provided to indicate the presence of these abnormal inlet conditions. Both the buzz and unstart indicating systems were completely dual and provided indication in all AICS control modes. As previously stated, the unstart was armed at Ma 1.86 or above while the buzz system was available at all mach numbers. A "Shock Aft" warning light was provided to indicate the shock was aft of a predetermined limit during the started inlet regime. It was also utilized to indicate that the bypass doors were not fully closed at low air vehicle speeds. The aft shock was sensed by a sensor whose output was an electrical signal as a function of pneumatic pressure ratios sensed at FS 1292 and FS 1443. A "Throat Extended" warning light was provided to inform the flight crew if the throat panels were positioned at 39 inches or less when the air vehicle speed was below Ma 1.1. The "AICS Cool" indicator light was discussed under ECS: WBS 1.2.

AICS Controls

Copilot Panel

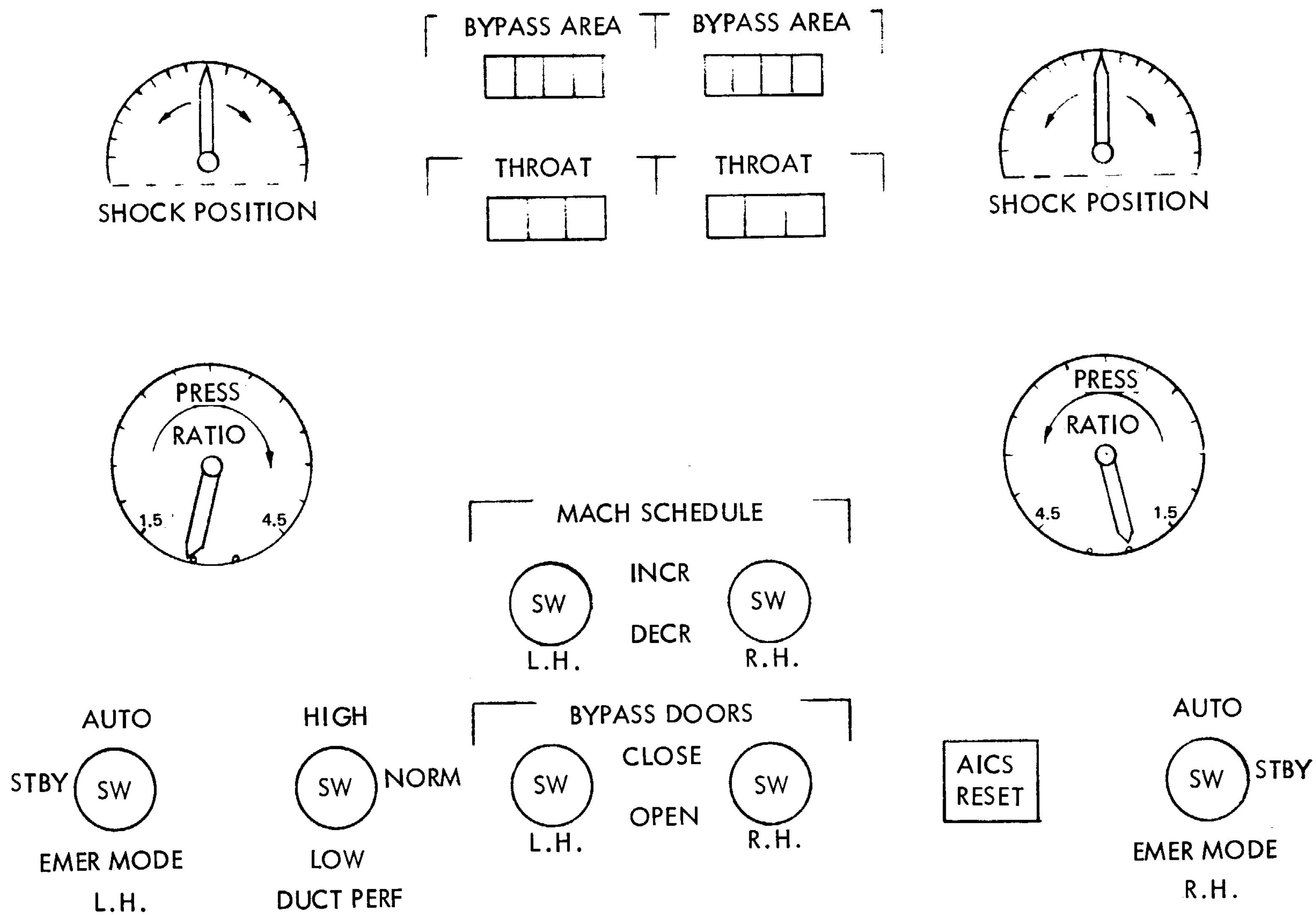
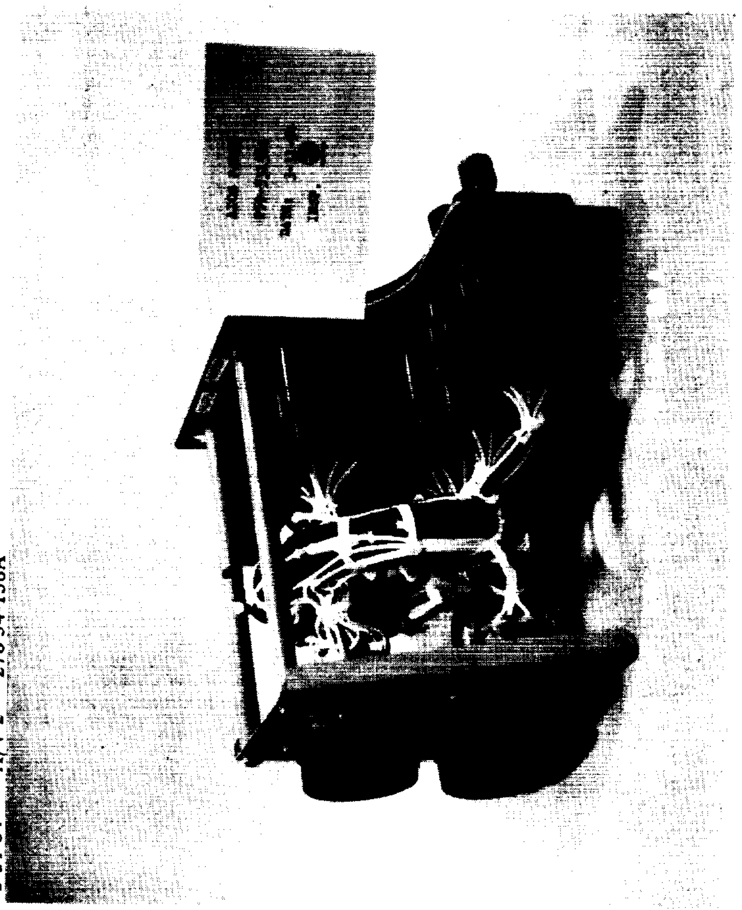
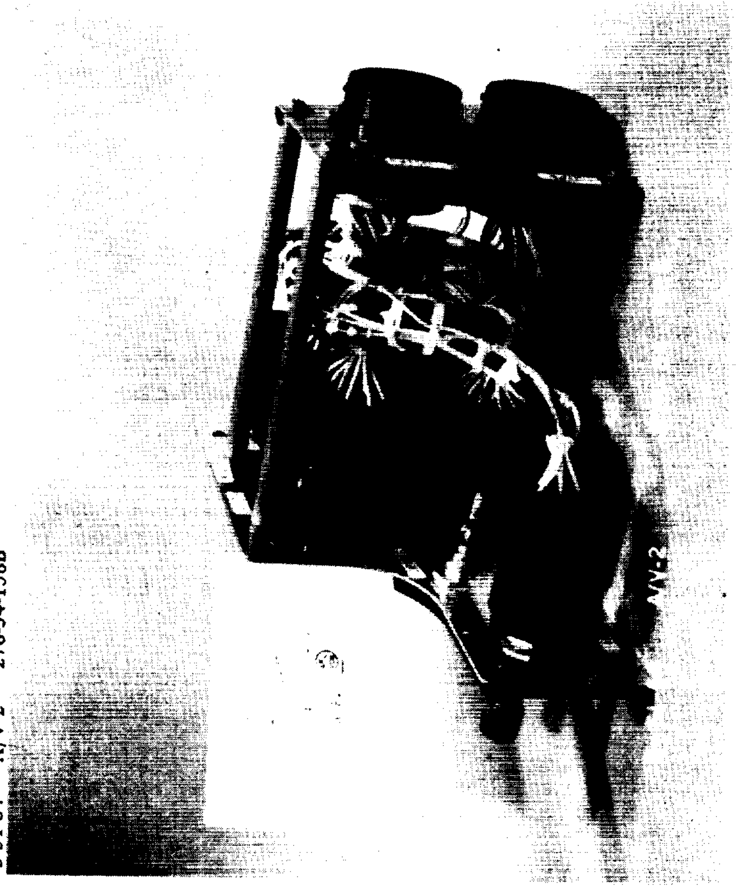


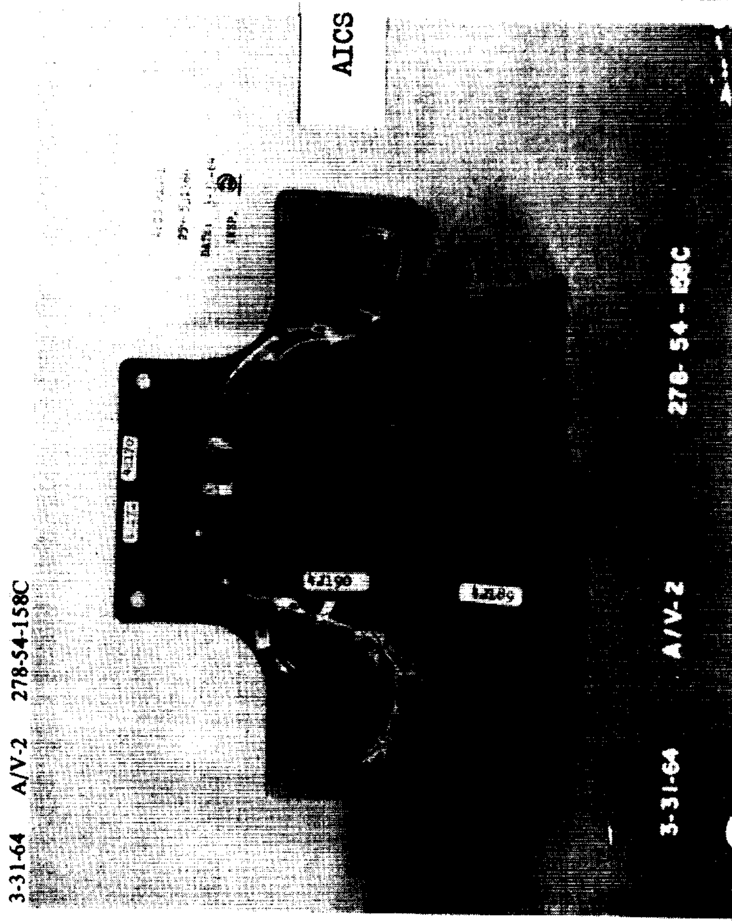
EXHIBIT 13



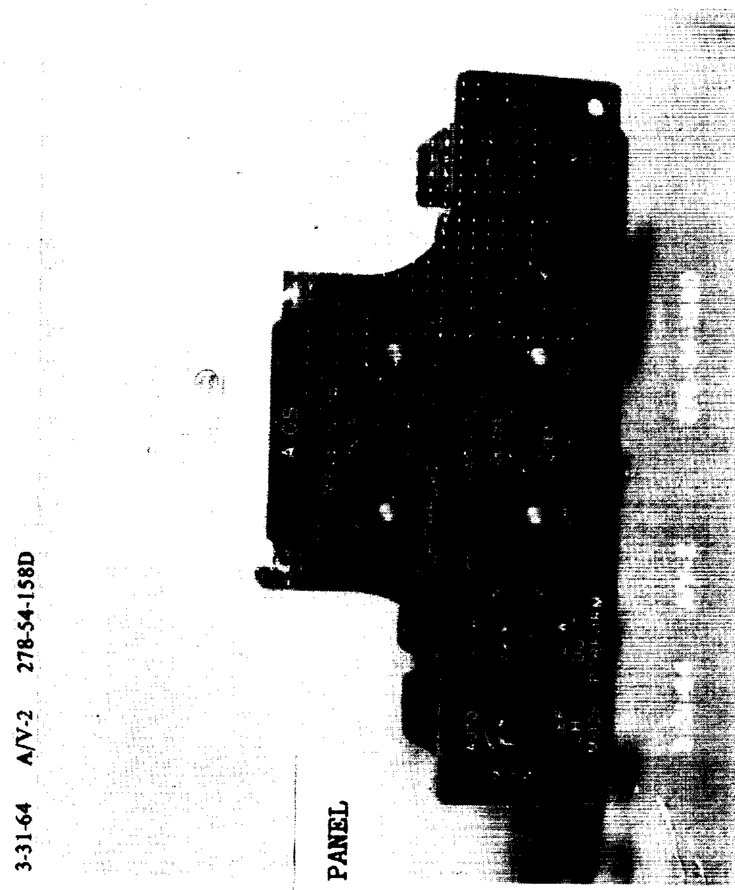
3-31-64 A/V-2 278-54-158A



3-31-64 A/V-2 278-54-158B



3-31-64 A/V-2 278-54-158C



3-31-64 A/V-2 278-54-158D

AICS PANEL

EXHIBIT 14

Space Division
North American Rockwell

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: CONTROLS AND DISPLAYS WBS CODE: 1.5.4

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	POUNDS	-	-	-	3938	3971
INDICATORS	NUMBER	INTEGRATED 2 - THROAT MACH NO. 2 - BYPASS AREA 2 - SHOCK POSITION 2 - PRESS RATIO	→	→	→	→
FUNCTIONAL LIGHTS	NUMBER	16	4 - BUZZ CAUTION LT 4 - UNSTART 2 - THROAT EXTEND 2 - BYPASS OPEN		2 - THROAT IND. 2 - AICS COOL	
MODE SWITCHES	NUMBER	12	1 - POWER 1 - DUCT PERF 2 - AUTO/MAN THROAT 2 - AUTO/MAN BYPASS 2 - STBY THROAT 2 - STBY BYPASS 2 - PRI/ALT POWER		AUTO MAN STBY	AUTO STBY
MANUAL CONTROLS	NUMBER	-	-	-	2 (EA) 2 - THROAT 2 - BYPASS	2 (EA) 2 - STBY THROAT 2 - STBY BYPASS

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: CONTROLS & DISPLAYS WBS CODE: 1.5.4

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
INDICATOR ACCURACIES	PERCENT OF FS					
THROAT		2.8	→	→	→	→
BYPASS		2.3	→	→	→	→
SHOCK		1.4	→	→	→	→
INDICATORS RESOLUTIONS	PERCENT OF FS					
THROAT		1.5	→	→	→	→
BYPASS		1.5	→	→	→	→
SHOCK		2.5	→	→	→	→
INDICATOR FREQUENCY RESPONSE	HERTZ	3 to 4	→	→	→	→
TEMPERATURE - DESIGN RANGE	DEGREES F	32 to 160	→	→	→	→
RELIABILITY FACTOR	NONE	-	-	-	.99513	.99571
MTBF	NO. OF HR	-	-	-	358	407

TECHNICAL DESCRIPTION

SUBSYSTEM: AIR INDUCTION SUBSYSTEM WBS CODE: 1.5

MAJOR ASSEMBLY: BOUNDARY LAYER CONTROL WBS CODE: 1.5.5

The Boundary Layer Control System (BLC) was incorporated in the B-70 to remove the boundary layer air from three major areas. BLC ducting was provided between each engine air inlet and the lower wing surface to remove the boundary layer air formed under the wing forward of the inlets. This air discharged overboard through an exit on the top surface of the wing. Porous surfaces were provided on the four walls of each inlet forward of the throat to remove the boundary layer formed along these inlet surfaces. This air was bled into compartments (chamber I & II) and then ducted to exits located underneath the air vehicle below the bleed chambers. The walls of the inlet throat area were also porous and this boundary layer air was bled into compartments or chambers III, IV & V. The air from chamber III (air from chamber IV passed into chamber III through check valves) was ducted aft to the engine compartments where valving either directed the air to the base area or for engine compartment cooling (Regime III cooling; see Propulsion: WBS 1.3). The air from chamber V was ducted to the same exits as for chambers I & II.

The BLC performed a major function in the control of the inlet normal shock, increased inlet duct recovery, and reduced inlet drag. The boundary air ducted aft also increased the base area pressures and reduced the boat tail drag. The reduction in inlet drag was realized because the turbulent boundary layer air was removed from the surfaces and provided in airflow that was more laminar. The increased inlet duct recovery was due to increased efficiency in normal shock control and a larger inlet airflow capture area (relatively) due to the BLC bleed reduction of boundary layer thickness.

The increased efficiency of inlet normal shock control during the inlet "started" regime of operation is graphically shown by Exhibit 15, Page IV-42. The two pictorial presentations show an inlet throat with and without BLC bleed. Without porous bleed, in addition to a thick boundary layer, the normal shock impingements spread and creeps forward in the lower static pressures. The phenomenon of shock impingement creep and the build up of boundary layer reduces the effective total pressure area and the normal shock moves forward due to the high static pressure downstream. Once the normal shock passes the minimum throat area, it is expelled completely out of the inlet since a normal shock can not be held on a convergent surface. As shown by the presentation, an inlet with BLC bleed has a thinner boundary layer and the shock impingements are bled off which result in a stable shock and a high effective total pressure.

Air Induction System
With and Without BLC

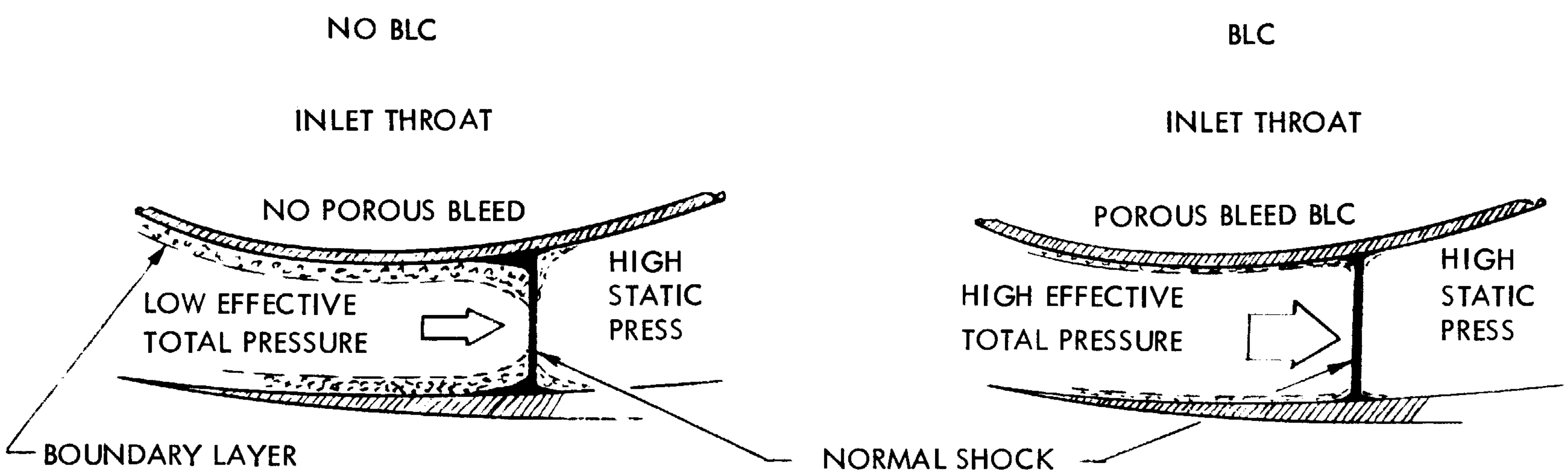


EXHIBIT 15

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: BOUNDARY LAYER CONTROL   WBS CODE: 1.5.5

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	POUNDS	504	504	700	700	709
NUMBER OF CHAMBERS	NUMBER	5 EA. INLET →				
BLEED PANELS	NUMBER	5 EA. INLET →				
EXTERNAL CONTROL	SPECIFY	SECONDARY REGIME III	AIR-ENGINE NOZZLES COOLING →			
PRESSURE	PSI	8.8 DELTA →				
TEMPERATURE - DESIGN RANGE	DEGREES F	- 65 to 630 →				
SPEED - DESIGN RANGE	MACH NO.	3.0 + →				
ALTITUDE - MAX DESIGN	FEET	100,000	90,000 →			
SEALS (AERODYNAMIC)	TYPE	METALLIC →				
RELIABILITY FACTOR	NONE	-	-	-	.99513	.99571
MTBF	NO. OF HR	-	-	-	358	407

TECHNICAL DESCRIPTION

SUBSYSTEM: AIR INDUCTION SUBSYSTEM — WBS CODE: 1.5

MAJOR ASSEMBLY: GROUND TESTS — WBS CODE: 1.5.6

The major effort expended on ground tests of the Air Induction System was wind tunnel testing. This testing effort involved eleven different models (scaled) and two unscaled assemblies for a total of 5,235 charged tunnel hours. The test units and their scale were as follows:

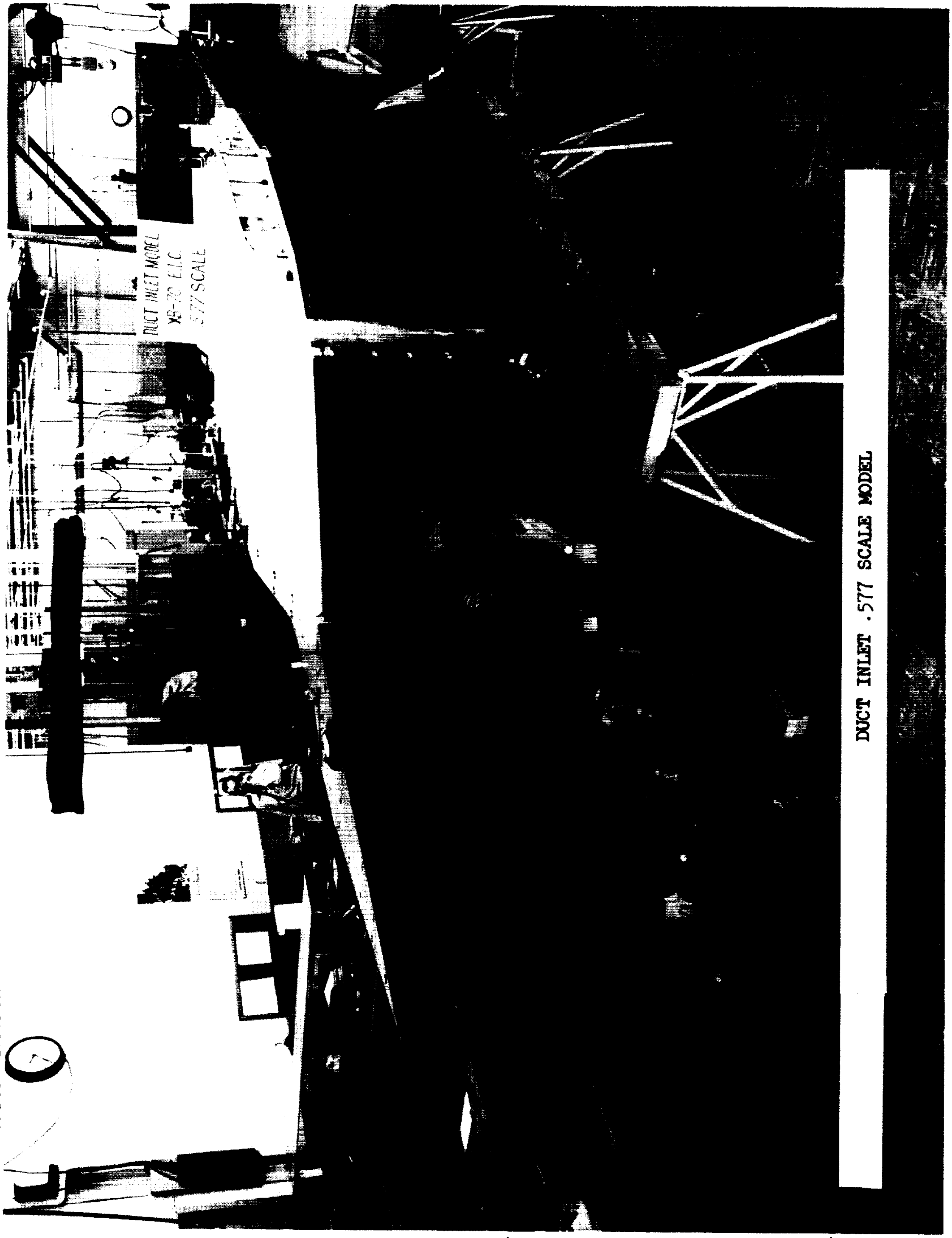
Models	Scale
1. Preliminary Inlet Duct Research	.04
2. Preliminary Inlet Duct Research	.05
3. Infinitely Variable Duct	None
4. Base Pressure	.04
5. Base Pressure	.045
6. Porous Material Research	None
7. Supersonic Diffuser	.04
8. Inlet Control	.10
9. Inlet Control	.25
10. Inlet Control (HSD)	.04
11. Inlet, Inlet-Engine	.577
12. Inlet Force	.04
13. Inlet Duct - I	.05
14. Inlet Duct - III	.05
15. Inlet Duct - IIIR	.05

WBS CODE: 1.5.6

The wind tunnel tests were conducted to establish and confirm the basic inlet geometry and to verify the control of the inlet as well as the compatibility of the inlet with the engines. The tests included 3,138 actual test hours on the .04 scale models for basic inlet geometry and 717 test hours on the .25 model in the 10 ft supersonic tunnel of Lewis Propulsion Laboratory for inlet recovery, inlet control parameters, BLC, and dynamic response. The tests conducted on the .577 model at AEDC for inlet-engine compatibility, required 560 test hours and included extensive engine operation up to Mach 3.0. In addition, 245 hours of testing were conducted utilizing the .10 scale model of the full inlet configuration, i.e., both inlets and incorporating air vehicle features, to verify control parameters and the air induction system.

Exhibit 16, Page IV-46, presents a picture of the .577 scaled model of one inlet duct system. This model was 1/3 area scale of the air vehicle or full scale for one engine. Exhibit 17, Page IV-47, presents the .577 test results. Also shown on the graph is the .25 scale tests and depicts the close agreement between the estimated match (inlet/engine) and the test results of the two models.

Other ground tests conducted on the AIS, in addition to that performed by subcontractors on the buzz, unstart, and local Mach sensors/transducers, included a "breadboard" mockup of the control system. These tests were conducted to establish circuitry, power levels, accuracy, resolution, and frequency response requirements of the control system hardware. The inlet parameters were also incorporated into the computer system of the Flight Control Simulator. This provided excellent crew training and early evaluation of system control layout, system responses, and air vehicle re-actions.



DUCT INLET .577 SCALE MODEL

XB-70 INLET DEVELOPMENT
.577 SCALE TEST RESULTS

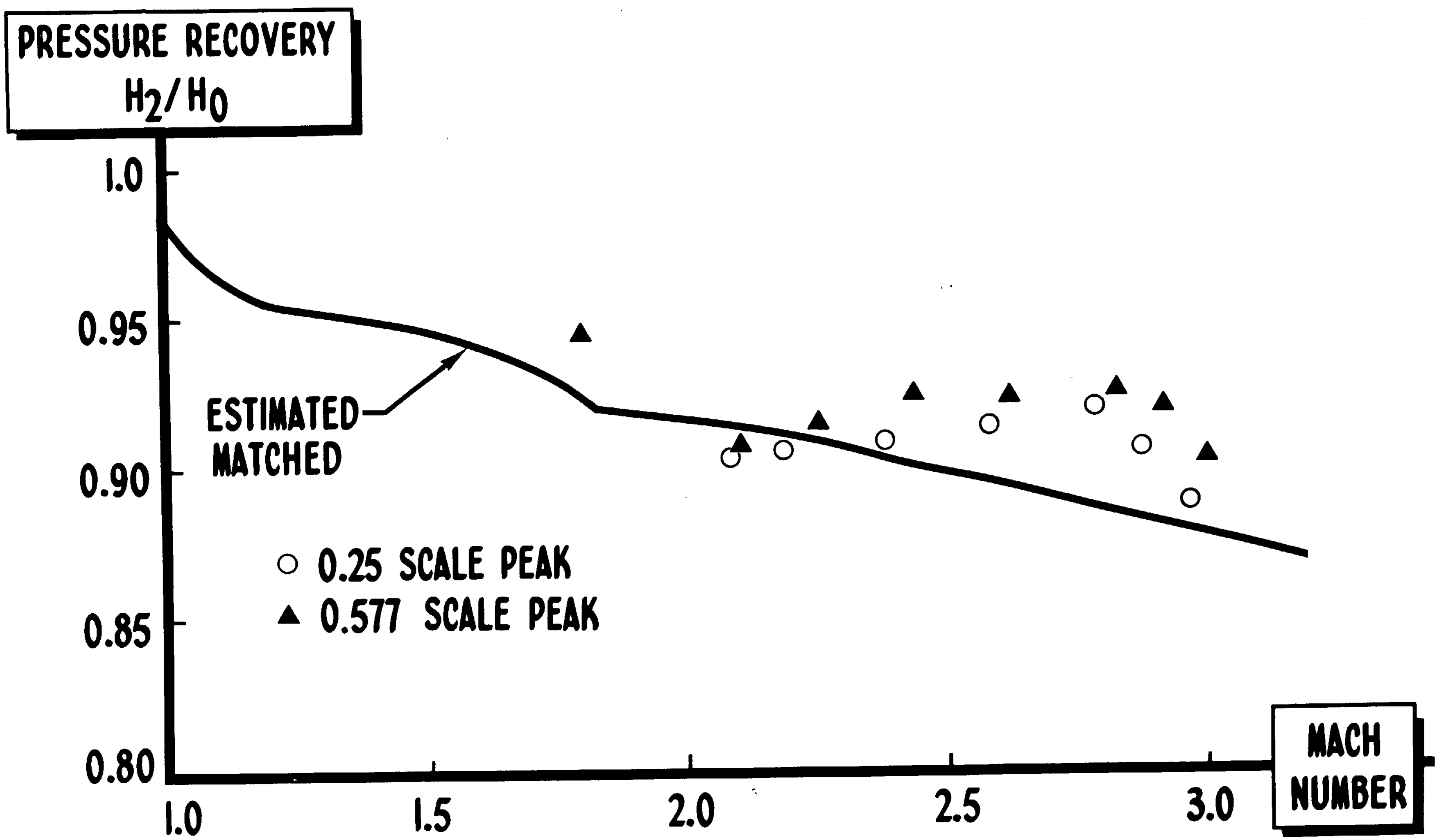


EXHIBIT 17

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: GROUND TESTS   WBS CODE: 1.5.6

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
MAJOR ASSEMBLIES	TYPE/NO.	SYSTEM BREADBOARD COMPONENT AIRWORTHINESS, QUAL. TEST			→	→
MODELS	TYPE/NO.	AEDC WIND TUNNEL	→	→	→	→
MOCKUPS	TYPE/NO.	A/V - CONTROLS & DISPLAYS		→	→	→
FACILITIES	TYPE/NO.	DEVELOPMENT LABS AICS SIMULATOR (TRAINER)		→	→	→
TESTS	TYPE/NO	DEVELOPMENT TESTING DYNAMIC TESTS, FREQ. RESPONSE		→	→	→
ACCURACY (DATA)	PERCENT OF FS	-	.5 to 1.5	→	→	→
FREQUENCY RESPONSE (DATA)	HERTZ	0.1 TO 10.0 Hz 0.1 TO 3.0 Hz - THROAT MASTER CYL 0.1 TO 3.0 Hz - LOCAL MACH X'DUCER 0.1 TO 6.0 Hz - TRIMMER CYL BYPASS 0.1 TO 6.0 Hz - BYPASS MASTER CYL			→	→
RESOLUTION (DATA)	PERCENT OF FS	-	1.5	→	→	→
SPEED RANGES	MACH NO.	0 TO M. 3.0	→	→	→	→
TEMPERATURE RANGES	DEGREES F	-65°F TO 450°F	→	→	→	→

TECHNICAL DRIVER

SUBSYSTEM: AIR INDUCTION SUBSYSTEM WBS CODE: 1.5

DRIVERS: BYPASS SYSTEM WBS CODE: 1.5.2
BYPASS DOORS WARPING/SEALING

The bypass doors were designed to provide convergent-divergent area nozzles for the initial opening. This was accomplished by shape and by opening one door panel outward and the other panel inward: see Exhibit 6, Page IV-18. The door panels, especially the mains, were long and narrow which inherently resulted in door sealing and warping problems. (This design was necessary since the doors were located on the wing mold line and deflective surfaces had to be kept to a minimum.)

After considerable effort fitting the doors prior to flight, it was found that air loads, with the working loads, warped the doors and resulted in poor sealing at low speeds. Warped doors had little impact on system operation at supersonic speeds since shock control was a function of airflow area not door position and also, the inlet duct pressures were higher than ambient. However, at low speeds where the inlet duct pressures were less than ambient, the warped doors (poor sealing) resulted in reverse airflow causing some engine face pressure distortion.

Although rework to the doors were made to strengthen the torsional modes, complete satisfactory operation was not achieved. This was due mainly to the nature of the Flight Test Program and its objectives; within these program goals the bypass doors were satisfactory. Exhibit 6, Page IV-18, and Exhibit 7, Page IV-23, present schematics of the bypass doors.

TECHNICAL DRIVER

SUBSYSTEM: AIR INDUCTION SUBSYSTEM WBS CODE: 1.5

DRIVERS: AIR INDUCTION CONTROL SYSTEM WBS CODE: 1.5.3

At the onset, the Air Induction Control System (AICS) was a dual electro-mechanical system with the control packaged for installation in the electronic equipment bay. In the second quarter of 1962, a review of the control unit development program was conducted with the subcontractor to negotiate late changes (as a result of wind tunnel tests) and possible rescheduling. In June, 1962, due to the technical and scheduling problems encountered during the program review, the AICS subcontractor was terminated and the development effort of the control unit was assumed by North American Rockwell (NR).

The NR system established was a single electro-hydraulic automatic system with dual standby capabilities and utilized pneumatic and electronic techniques compatible with the established mechanical and hydraulic actuation mechanism. To facilitate design, packaging of the hardware was not to be a restraint with that equipment requiring environmental control installed in a package located in the weapons bay. This AICS package had its own ECS (see ECS: WBS 1.2) and was similar to the Flight Test Instrumentation Package located in the forward part of the weapons bay.

Since the NR design was started late and due to the complexity inherent in an automatic system development, it was decided that an interim manual system with automatic functions would be installed in air vehicle No. 1 prior to flight and retrofitted later with the full automatic system. The full automatic system was incorporated in air vehicle No. 2 prior to its first flight. This scheduling problem essentially put two AICS designs in development, however, the interim system development was mostly involved with the integration of "off-the-shelf" hardware. It differed mainly in that the buzz and restart functions were copilot initiated, the throat was scheduled by air vehicle Mach number biased by a manual copilot control, and the bypass doors were manually controlled by the copilot for shock control. The copilot manual controls for the interim system were located on a horizontal plate attached to the copilot's flight control column. Extensive training was required on the flight control simulator to train the crew in the use of the interim system.

TECHNICAL DRIVER

SUBSYSTEM: AIR INDUCTION SYSTEM WBS CODE: 1.5

DRIVERS: AIR INDUCTION CONTROL SYSTEM SENSORS AND TRANSDUCERS WBS CODE: 1.5.3

The B-70 requirements for the Air Induction Control System (AICS) dictated the development of extremely accurate high temperature sensors and transducers. The high temperature requirement in itself did not present a particular difficult problem, however, obtaining the desired accuracy at high temperature necessitated an extensive research and development program with some schedule impacts in delivery.

The initial problems encountered with the development of the buzz and unstart sensors was the late delivery of Statham transducers which were the heart of the basic sensors. The late delivery of the pressure transducers was caused by unsatisfactory signal to noise ratios. Although further development showed the high noise level to be caused by strain wire attachment techniques, it continued to plague the flight test program in specific sensor instances.

In addition to the noise problem, the local Mach transducer had an undesirable "dead band" at the Mach 3 end. This phenomenon appeared as drop-off in throat scheduling after the air vehicle had experienced slight yaws which changed the local Mach at the inlet. This small dead band at the Mach 3 end of the schedule was not satisfactorily solved during the flight test program. The impact of the condition was minimized by the copilot's inflight trimming of the throat with the standby electrical actuators.

The buzz sensor was a complex dual pressure sensing device. The sensor was designed for a bleed type bypass which was maintained as a reference point for inlet pressure levels. It also imposed on this reference point the dynamic pressure cycles during inlet dynamic conditions. The design requirement was for the sensor to provide a signal when six or more pressure cycles occurred with a given amplitude above a pre-determined inlet duct pressure level schedule. In addition to the previously mentioned noise problem, the development effort centered around determining the correct air passages and their required flows. Although the majority of buzz sensors were satisfactory, repeatability was below standard and several false inflight buzz signals did occur during the flight test program.

DEVELOPMENT DATA SUMMARY

WBS TITLE: AIR INDUCTION SUBSYSTEM WBS CODE: 1.5

STATE-OF-THE-ART RATING: 4 (See Remarks)

PERCENT DEVELOPED MATRIX:

	PRIOR TO FLIGHT		FLIGHT TEST
	CONFIGURATION	GROUND TEST	
PROGRAM LEVEL	40% (AV1) 80% (AV2)	76%	29%
EFFORT TO GO	82% (AV1) 44% (AV2)	49%	89%

GROUND TESTS

TYPE OF TEST	NUMBER OF UNITS	TEST HOURS
CONFIGURATION RESEARCH (1) (2)	10	2,700
DESIGN FEASIBILITY	-	-
DESIGN VERIFICATION (1) (2)	18	3,905
AIRWORTHINESS	15	2,500
QUALIFICATION (1)	-	-
OTHER	-	-
TOTAL	43	9,105

REMARKS:

(1) Does not include actuator testing by the Hydraulic Group WBS 1.4.1

(2) Does not include the following wind tunnel tests:

1.	Preliminary Inlet Duct Research	.04 scale
2.	Preliminary Inlet Duct Research	.05 scale
3.	Infinitely Variable Duct	no scale
4.	Base Pressure	.04 scale
5.	Base Pressure	.045 scale
6.	Porous Material Research	no scale
7.	Supersonic Diffuser	.04 scale
8.	Inlet Control	.10 scale
9.	Inlet Control	.25 scale
10.	Inlet Control (HSD)	.04 scale
11.	Inlet, Inlet/Engine	.577 scale
12.	Inlet Force	.04 scale
13.	Inlet Duct - I	.05 scale
14.	Inlet Duct - III	.05 scale
15.	Inlet Duct - III R	.05 scale

WBS 1.5 AIR INDUCTION SUBSYSTEM

State of the Art:

The Air Induction Subsystem was assigned an overall state-of-the-art rating of 4 based on definitions established using AFSCM173-1 (11-28-67) as a guide. This rating was determined by comparing the RS-70 requirements with the existing capabilities at the RS-70 time period using state-of-the-art criteria discussed in subsequent paragraphs. The RS-70 configuration was selected for the comparison since it was the production configuration defined. This selection is considered valid since the development status at "out-the-door" and at program "end" is also based on the scheduled production configuration.

The definitions used in determining the state-of-the art ratings are described below. For ratings 3, 4, and 5, the following B-70 design criteria was used as an aid for rating selection.

A. High temperature application

B. High pressure/load/acoustics/etc., application

C. Light-weight/special materials/unique processes

Rating	Description
1	The item was off-the-shelf commercial item or a standard military issue which was installed "as-is."
2	The item was off-the-shelf commercial item or a standard military issue which required only a physical modification for installation.
3	The item was considered within the state of the art but had no commercial or military counterpart. As an aid, the item was existing but required modification to be compatible with one of the design criteria. Also, any new design or process has a rating of at least 3.
4	The item was slightly beyond the state of the art, and some development was required. As an aid, the item was based on an existing concept but required modification to be compatible with two of the design criteria. Also, any new design or process required to be compatible with one of the design criteria will be rated 4.
5	The item was substantially beyond the existing state of the art and required major development work. As an aid, any new design or process required to be compatible with two of the design criteria will be rated 5.

At the onset of the RS-70, the Air Induction Control System (AICS) of the Air Induction Subsystem (AIS) was a total subcontractor effort and was comprised of a dual electromechanical automatic control with a single manual backup system. This system was cancelled and an NR system implemented which was a single electrohydraulic automatic control with dual manual backup. It is the opinion of the AICS Design Group that the NR system would have been satisfactory as a production configuration if repackaged and given time for full development. The AIS with the NR AICS is the overall subsystem that was assigned a state-of-the-art rating of 4 based on the established ground rules and the Design Group's declaration. It should be noted that the dual electromechanical automatic control system, if used in this appraisal, would have been assigned a state-of-the-art rating of 5.

Percent Developed:

The AIS development status percent comparisons of the XB-70 configuration to that scheduled for the RS-70, were made at two development stages; one at prior to flight or "out-the-door" of the No. 1 air vehicle and the other for the flight test programs. The same methodology developed and verified for the Airframe Structures Subsystem (WBS 1.1) percent comparisons was applied in the analyses of the AIS status. The analysis for the AIS was slightly more complex than that for the structures since three configurations are involved. The first system was the fully automatic dual electromechanical AICS upon which considerable development effort was expended before cancellation. However, the basic design criteria established during the initial phase was valid and applied in the design of the NR system. The NR AIS configuration for the No. 1 XB-70 was different than that for Air Vehicle No. 2 which had the NR fully automatic AICS. The No.1 XB-70 had an interim AICS which was manual with automatic features and was the configuration used in the percent comparisons at time of "out-the-door." For the comparisons made of the flight test programs, consideration had to be given to the fact that the XB-70 test program involved two AICS configurations. For the ground test programs, the No. 1 XB-70 configuration did not have to be considered since all effort was directed toward a fully automatic system development and the interim system was only installed due to a scheduling problem.

The fully automatic AIS installed in XB-70 No. 2 was assessed at 80% of a production level status, being downgraded essentially due to the packaging employed (electronics installed in large ECS package in weapons bay instead of the avionics bay of the air vehicle). The No. 1 XB-70 had the same packaging employed but also had the pilot in the control loop to bias control scheduling and to perform the "unstart" and "buzz" override functions. Since these functions that were performed by the pilot were a major part of the AICS, the No. 1 air vehicle was assessed as being approximately 50% of the fully automatic system installed in XB-70 No. 2. This analysis then shows that at the tine of "out-the-door" the XB-70 configuration represented 40% of that planned for the RS-70.

To determine what expenditures would have been required to attain a first air vehicle production level status, the same curve used for the Structures Subsystem was utilized for the AIS; Exhibit 18, Page IV-57. Entering the exhibit on the left hand side at 40%, across to the curve and then down to the bottom scale, it shows that 82% more effort would have been required for a No. 1 RS-70 AIS configuration, excluding ground test effort. In regard to the ground test effort, the ground tests scheduled for the RS-70 at time of "out-the-door" was approximately 17,900 test hours not including the Hydraulic Design Group effort on actuators. Comparing this test effort with the 9,105 test hours expended on the XB-70 AIS, it shows that the testing level or verification level of the XB-70 to be approximately 51% of that planned for the RS-70 AIS at the prior to flight time period. This shows that 49% more testing effort was required to attain the production level status for a No. 1 air vehicle at the "out-the-door" time period. Entering Exhibit 18, Page IV-57, on the bottom scale at 51%, it shows that the No. 1 XB-70 was at a confidence level of approximately 76% prior to first flight.

The XB-70 flight test program for the AIS was established at 19% of a production level status as presented by Exhibit 13, page II-23, under Air Vehicle: WBS 1.0. This would indicate that 81% more flight testing effort than expended would be required for a production level effort. However, not only were two different configurations flown (air vehicles No. 1 and No. 2) during the flight test program, the flight envelope explored was 80% of the RS-70 envelope including "g's," yaws, rolls, etc; see Exhibit 14, page II-24, under Air Vehicle: WBS 1.0. Since the 19% flight effort established was based on a direct comparison of equivalent test hours, the effort expended must be adjusted to reflect the two different configurations flown and the envelope explored. Throughout the XB-70 flight test program, the test conditions were scheduled between air vehicles No. 1 and No. 2 so as to minimize the impact of the interim AICS in air vehicle No. 1. Based on this control scheduling, the AIS equivalent test hours were weighted at 80%. Since approximately one half of the total AIS test hours (9.5%) were flown on air vehicle No. 1, the equivalent flight test hours were reduced from 19% to 17% (80% x 9.5% + 9.5%). This 17% was used as the base in the calculations performed to reflect the XB-70 flight envelope impact in the following paragraph.

As previously established for the Airframe Structures Subsystem (WBS 1.1), the first 80% of the flight envelope requires only 60% of the total effort compared to the last 20% of the envelope which requires 40% of the total effort. For the AIS, this 2 to 3 ratio was directly applicable since all of the test hours were flown in the first 80% of the flight envelope. Using this ratio as a weight factor so that direct comparison can be made based on the RS-70 flight envelope, the flight test effort expended on the XB-70 was adjusted by the equation 2:3:: x :17%. Based on this equation, the total flight test effort remaining to attain a production level status for the AIS would be 40% + 60% - (2 x 17 ÷ 3) or 89% (where 40% is that effort required for the last 20% of the flight envelope).

In summary, the prior to flight status comparisons are: (1) the XB-70 No. 1 AIS was 40% of an RS-70 AIS and would require 82% more expenditure for configuration and 49% more ground testing effort; and (2), the XB-70 AIS flight test program was 11% of the planned RS-70 program effort with 89% more effort required to attain the production level status. All of the above comparisons are based on tooling, test articles, GSE, etc., being at the RS 70 or production level in both numbers and fidelity. Exhibit 18, Page IV-57, presents a graph showing the AIS percent comparisons.

NOTE: THE USE OF THE "EFFORT TO GO" PERCENTAGES FOR COST DETERMINATION SHOULD NOT BE APPLIED WITHOUT CONSULTING SECTION IV-8, VOLUME I, PAGE 310 FOR APPLICATION CONSIDERATIONS.

AIR INDUCTION SUBSYSTEM DEVELOPMENT STATUS
PERCENT COMPARISONS BASED ON RS-70 (UNITY)

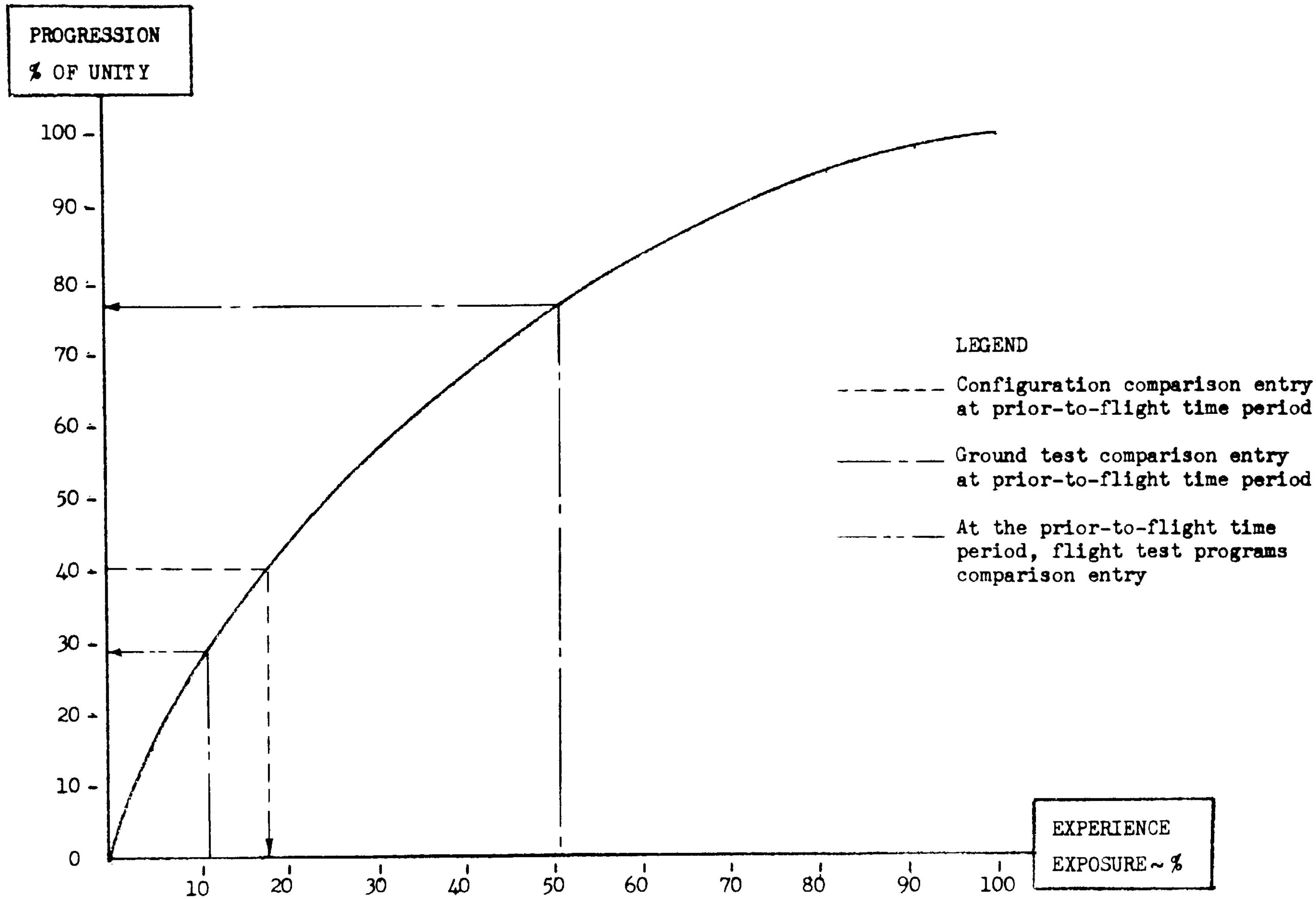
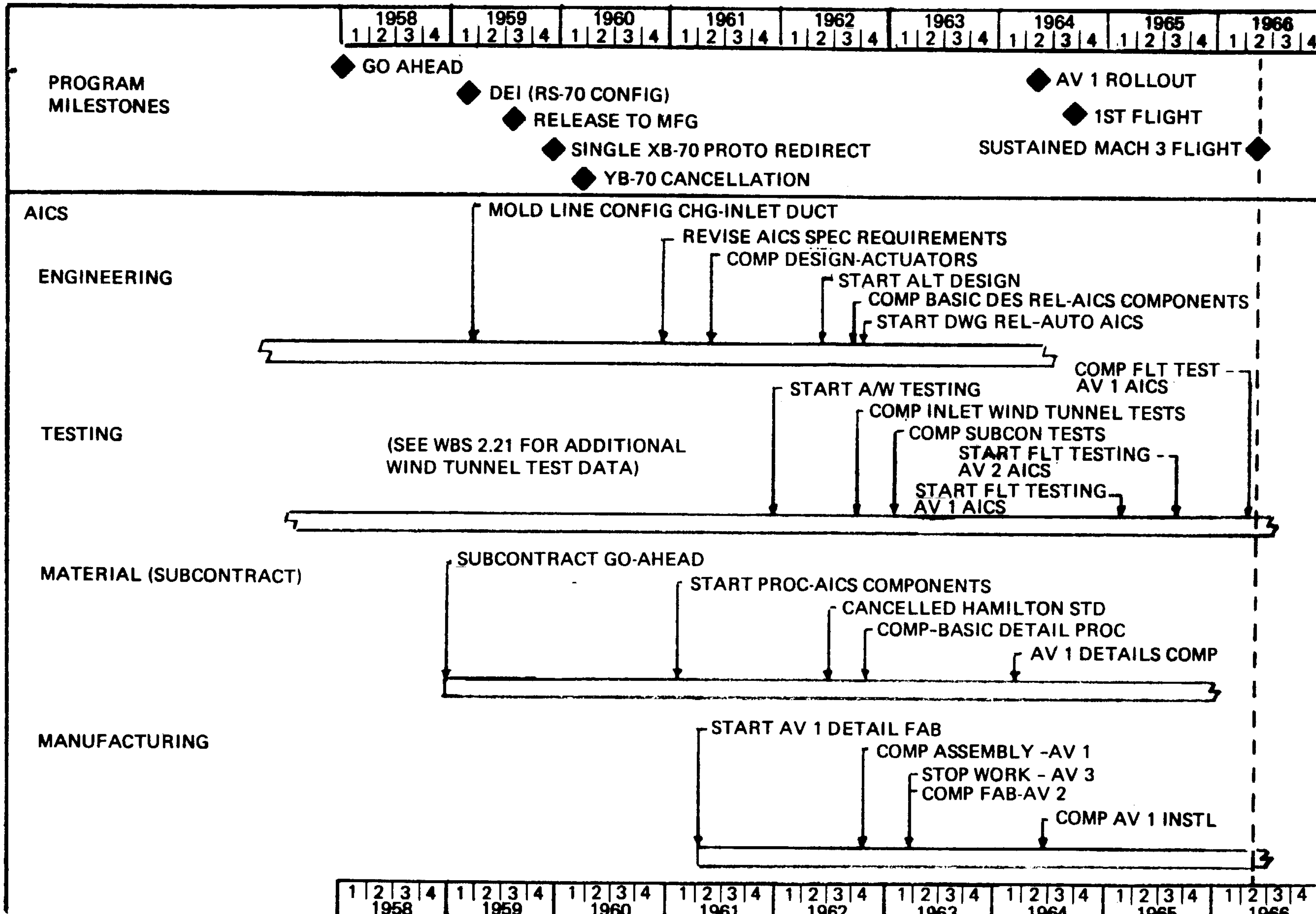


EXHIBIT 18

AIR INDUCTION SUBSYSTEM DEVELOPMENT SUMMARY

WBS 1.5



DEVELOPMENT SUMMARY
TABULATION OF DATES

SUBSYSTEM: AIR INDUCTION WBS CODE: 1.5

ENGINEERING

Mold Line Configuration Change - Inlet Duct	3-20-59
Revise AICS Spec Requirements	12-16-60
Complete Design-Actuators	5-26-61
Start NR AICS System Design	6-01-62
Complete Basic Design AICS Components	9-17-62
Start Drawing Release - Automatic AICS System	10-05-62

TESTING

Start A/W & Accept. Testing AICS Component AV #1	12-20-61
Complete Wind Tunnel Tests (Scale Inlet/Engine)	9-27-62
Complete Sub/Cont. Testing AICS Components AV #1	1-11-63
Start Flight Testing AV #1 AICS (Flight #5)	2-16-65
Start Flight Testing AV #2 AICS (Flight #5)	9-17-65
Complete Flight Testing AV #1 AICS (Flight #49)	5-09-66

MATERIALS (SUBCONTRACT)

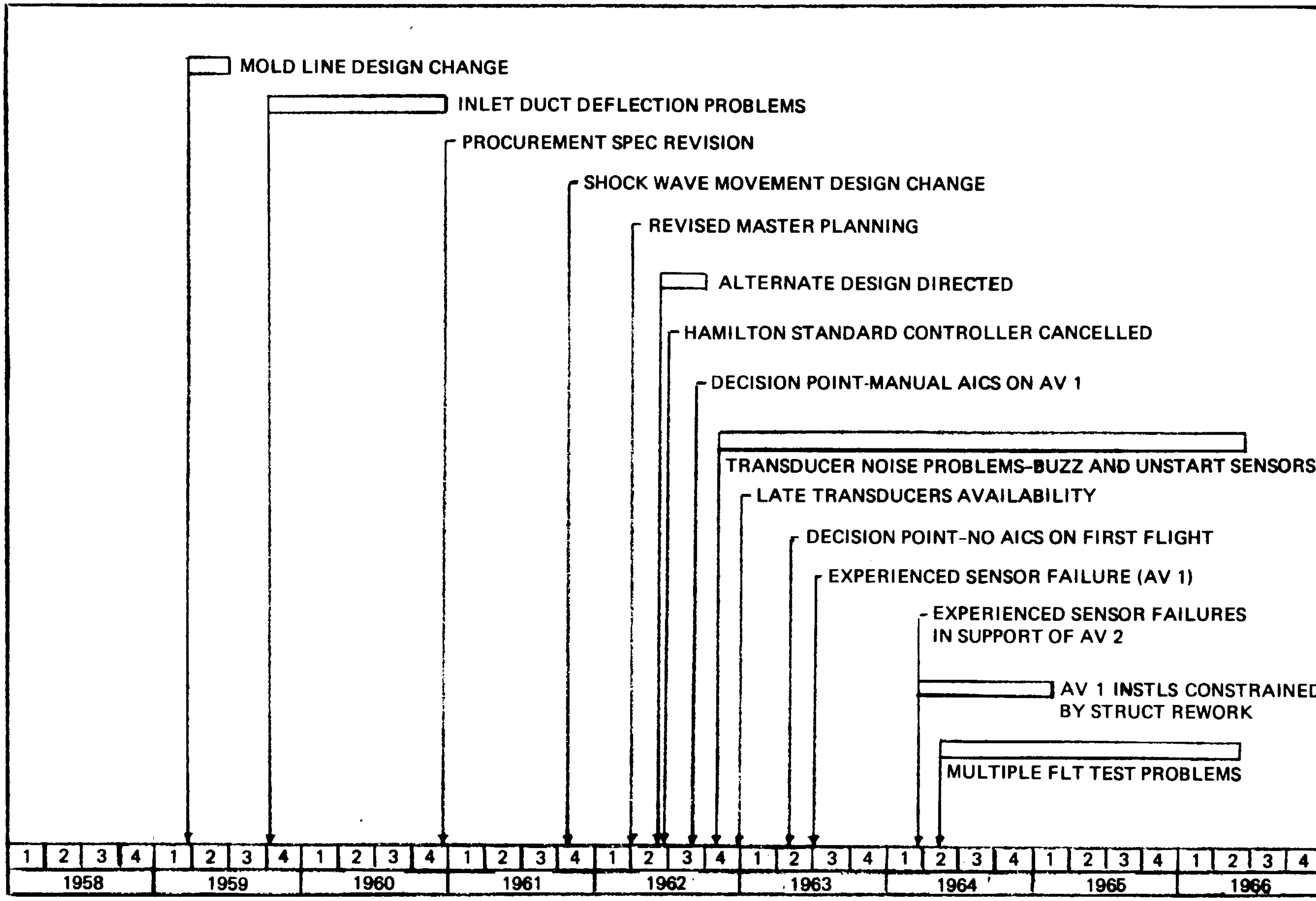
Initial Subcontract Go-Ahead	12-12-58
Start Procurement AICS Components	1-27-61
Cancel Hamilton Standard Controller	6-22-62
Complete Basic Detail Procurement	10-23-62
Receive Subcontract Items AV #1 AICS at NAA	3-14-64

MANUFACTURING

Start AV #1 Detail Fabrication	4-28-61
Complete Fabrication & Assembly AV #1 (Excluding Sensors)	10-23-62
Stop Work AV #3	3-06-64
Complete Fabrication AV #2	3-19-64
Complete AV #1 Installations	6-16-64

AIR INDUCTION SUBSYSTEM
DESIGN / PROGRAMMATIC IMPACTS

WBS 1.5



DESIGN/PROGRAMMATIC NARRATIVE

SUBSYSTEM: AIR INDUCTION CONTROL WBS CODE: 1.5

3-20-59 to 6-30-59

Configuration changes affecting the mold line were made to the wing and duct inlet. Engineering authorization for fabrication in the duct area structure was delayed until July 1, 1959.

10-2-59 to 12-16-60

A problem was experienced in regard to duct deflection out of tolerance condition which resulted in a stop work on tooling. Problems ultimately resulted in revisions to AICS specifications on December 16, 1960, thus delaying submittal of firm design information to subcontractors.

12-16-60

Revision to AICS procurement specifications as a result of design changes to the inlet ducts.

10-19-61

Engineering (NAA) incorporated a change to the AICS system to preclude shock wave movement out of one engine air intake duct due to improper aperture control. The condition could cause yaw and jeopardize safety of the air vehicle.

WBS CODE: 1.5

6-22-62

A decision was reached by NAA Management to cancel the Hamilton Standard AICS controller. This caused removal of parts already installed in AV #1. An alternate design release was currently under way at NAA for the AICS. It was decided to install the modified manual AICS on a mode basis.

8-31-62

A decision was reached to install the improved manual AICS prior to the first flight of AV #1. The improved system required honeycomb panel rework, installation of eight, two-inch conduits; considerable wiring which ranged from the instrument panel to the weapons bay; and numerous long leadtime purchased items. Fabrication of an equipment package similar to that used for instrumentation was also required. Further air vehicle modification was required for the second system along with the addition of more purchased components consisting of synchros, electrohydraulic valves, and instrument panel controls. These systems affected AV #1 only.

10-31-62 to 6-8-66

Problems with Buzz and Unstart Sensors from Marquardt started with late availability of Statham Transducers. Noise level problems with the sensors developed and were thought to be caused by method of strain wire attachment to transducers. This problem continued, i.e., with sensor noise and unstarts, until the conclusion of the flight test program on AV #2. A more detailed description of the problems experienced will be reflected under the flight test area of this report.

12-31-62

Late unavailability of Statham transducers impacts delivery of Buzz and Unstart Sensors to NAA.

5-1-63

A decision was reached not to install the AICS in AV #1 until after first flight.

WBS CODE: 1.5

7-1-63

The first half shipset of sensors failed at NAA during system checkout on AV #1 and were returned to the subcontractor for analysis and repair.

3-14-64

All AV #1 AICS hardware had been received at NAA; however, problems were still being experienced with sensors at the subcontractor for AV #2.

3-27-64 to 2-17-65

Structure problems were encountered on AV #1 which actually impeded completion of installation, operations and checkout of the AICS. At this point, the AICS was not the driving factor but structure problems were. Though these problems are too numerous to mention, selected areas are defined for reference purposes as follows:

1. Door sealing and warping.
2. Sealing problems.
3. Bracket changes for the sensors.
4. Inlet ramp rigging delayed until completion of structure work.
5. Interference problems with AICS bypass doors.
6. Closeout of doors held up for structure repairs.

5-11-64 to 6-8-66

Flight test records indicate that the AICS for AV #1 was generally satisfactory in operation. This statement should be qualified to indicate satisfactory operation for a development aircraft. The Buzz and Unstart Sensor reliability was unsatisfactory but did not prove to be as problematical as for AV System #2.

The fully automatic AICS for AV #2 was generally satisfactory in operation but was classified in the "not completely developed" category due to the following problem areas that needed refinement:

1. There was local mach scheduling drop-off at high mach numbers. This resulted in improper throat scheduling at high speed and contributed to several inadvertent unstarts. **This did not necessarily occur in straight flight but when the aircraft yawed.**

WBS CODE: 1.5

2. The improper throat schedules as noted above were the major cause of unstarts or the inability of the Automatic Shock Control to prevent unstarts. One of the major goals was the development of the AICS to prevent inadvertent unstarts.

3. The component reliability of the AICS was not as good as desired. In particular, the Buzz and Unstart Sensors were unsatisfactory. The electronics in general, Buzz and Mach logic computer, Buzz and Unstart power supplies, valve driver and throat deviation control, and the associated computer modules were subject to malfunctions and failures.

COST DEFINITION

SUBSYSTEM: AIR INDUCTION WBS CODE: 1.5

Total costs of $19,060,408 presented in this WBS item include all identifiable expenditures to design, develop, ground test, fabricate and assemble all components, assemblies and developmental test hardware within the Air Induction Subsystem as defined by the WBS. Total expenditures include the following items:

a) Development of subsystem specification requirements.
b) Subsystem installation and integration design.
c) Vendor coordination.
d) In-house ground testing including the design and fabrication of models, mockups and simulators.
e) Subcontracted hardware including the supplier costs for engineering, manufacturing, tooling and testing.
f) In-house and subcontracted wind tunnel tests.

Specifically excluded from the expenditures are:

g) Fabrication and assembly of the structural items of the inlet system (WBS 1.5.1) and the bypass system (WBS 1.5.2). These costs are included in the production costs of the intermediate fuselage (WBS 1.1.5). The costs can not be segregated from the intermediate fuselage.
h) Fabrication of subsystem provisions (shelves, brackets, clips, clamps, wire harnesses, etc.).
i) Miscellaneous purchased parts and installation materials. This includes the fabrication and purchased parts of the Air Induction Control System (WBS 1.5.3) returned in-house after the cancellation of Hamilton Standard. (See Subcontractor Data Sheet, page IV-68.
j) Installation of the subsystem equipment into the vehicles.
k) Subsystem, vehicle and preflight checkout.
l) Government furnished wind tunnel testing.

Costs for items h) through k) are contained in WBS 1.12 (Volume IV, page 647). Internal accounting procedures and the resultant cost reports do not provide a basis for establishing expenditures for these items by individual subsystems. Therefore, all costs are collected and reported in one WBS item. Refer to WBS 1.12 for additional information.

Detail of the recorded costs associated with this subsystem is provided by Element of Cost (EOC) and Subdivision of Work (SOW). Section III of Volume I provides a detail definition of these items. Further segregation of the cost data is provided by the WBS. All cost data is displayed at

WBS CODE: 1.5

WBS level 5 (Air Induction Subsystem WBS 1.5) with the exception of in-house ground testing (WBS 1.5.6). Cost data can be located on the following pages:

		Cost Breakdown	Time-Phased Detail
WBS 1.5	$12,999,030	page IV-70	page IV-71
WBS 1.5.6 Ground Tests	6,061,378	page IV-70	page IV-85
Total WBS 1.5	$19,060,408	page IV-70	page IV-94

A summary of the subcontractor recorded cost data is provided on page IV-68. Contractual arrangements, delivery dates, costs by supplier, quantity of hardware delivered and other pertinent data is provided. Cost data includes the supplier expenditures for engineering, production, tooling and testing (where identifiable) performed at the supplier's facility. Refer to the subcontracting Element of Cost definition (Volume I, page I-26) for additional explanation.

As an aid in the definition and evaluation of the in-house engineering costs associated with this subsystem, a matrix of engineering hours has been developed. This matrix, displayed below, is a summary of all the in-house engineering groups that provided support to the design and development of the Air Induction Subsystem.

Group No.	Title	Hours Expended
4	Fluid Power System	76,006
6	Controls System	32,411
14	Wind Tunnel Models	261,674
55	Flight Control Analysis	64,054
96	Wind Tunnel Projects	24,696
99	Auxiliary Control System	107,818
132	Thermodynamics	36,131
134	Wind Tunnel Projects	24,499
155	Propulsion Sciences	3,406
	Total Engineering Hours	630,695

WBS 1.5	319,826 hours (page IV-70)
WBS 1.5.6	310,869 hours (page IV-70)
	630,695 hours

Ground testing activities associated with the development of the Air Induction Subsystem have been identified and the costs assigned to WBS 1.5.6 (page IV-85). These costs reflect the in-house expenditures only.

WBS CODE: 1.5

Testing activities performed by the subcontractors where identified are included under WBS 1.5, Test/QC Subdivision of Work and the Subcontracting Element of Cost. The following is a summary of the major in-house test activities identified to this subsystem.

Description	Recorded Costs
Wind Tunnel Models	$2,276,514
.577 Scale Inlet Duct Model	1,355,925
.10 Inlet and Ramp Flutter Model	607,976
Airworthiness Testing of #2AICS Panel Actuators	241,590
AICS Breadboard & Development Testing	207,737
.25 Inlet Control Model	150,541
AICS Airworthiness Testing	109,161
AICS Airworthiness Testing of Components	106,728
Airworthiness Testing of #AICS Bypass Actuator	92,942
Ramps-Air Induction System - Fatigue Test	66,924
Bypass Trimmer Actuator Cylinder	60,725
Bypass Manual Door Actuator	52,094
AICS Buzz and Unstart Sensors	21,337
Bypass Shock Limiter Cylinder	17,704
AICS Breadboard	17,499
Various	538,470
Costs (Less MPC & G&A)	$5,923,867
Material Procurement Cost	52,977
General and Administrative	84,534
Total Cost WBS 1.5.6	$6,061,378

SUBCONTRACTOR MATRIX

Subsystem: Air Induction

WBS Code: 1.5

SUBCONTRACTOR	ENGINEERING	PROD	TOOLING	TEST	TOTAL
Hamilton Standard	6,120,046	1,151,980	31,404	-	7,303,430
Marquardt	872,077	702,590	-	144,733	1,719,400
Statham	49,361	138,865	-	90,775	279,001
TOTAL	7,041,484	1,993,435	31,404	235,508	9,301,831

HAMILTON STANDARD was selected to produce the B-70 Air Induction Control System. Two letter contracts were awarded to Hamilton Standard for this effort:

L961-G-600108	February 19, 1959 - December 22, 1959
LOE1-X2-600215	August 24, 1960 - June 21, 1962

The Statement of Work for the two purchase orders directed the subcontractor to conduct analytical, design, and other necessary studies leading to the selection, optimization, and definition of an Air Induction System compatible with the B-70 Weapon System and NR Specification NA58-532 and NR Specification NA58-228.

Purchase Order 600108 was in the early stages of design and development when the contract was terminated on December 22, 1959 for the convenience of the Government. A total of 718 drawings were produced, 1600 pieces of experimental hardware were in process, and 55 fixtures had been fabricated at the time of termination.

A 1/25 scale model of the B-70 air inlet was completed and installed in the 17 inch by 17 inch United Aircraft wind tunnel. Testing was started on June 17, 1959 to determine the control characteristics for angle of attack and yaw changes in the higher flight speed regimes. A total of 170 test hours were conducted on the system before the contract was terminated. The cost of the test effort was not segregated by the subcontractor and is therefore included in the Engineering cost for Hamilton Standard.

When the B-70 program was reinstated, Letter Contract 600215 was awarded to Hamilton Standard to continue the Air Induction Control System. The Statement of Work called for the subcontractor to design, develop, fabricate, test, package and deliver the Air Induction Control System.

Purchase Order 600215 was terminated for convenience by NR on June 21, 1962 due to the magnitude of unresolved technical problems and their estimated cost and schedule impact on the program. The required system performance was beyond the current state-of-the-art. It was determined that 59.2% of the effort was completed at the time of termination.

MARQUARDT was selected to produce the Duct Buzz and Inlet Unstart Sensors for the Air Induction System of the XB-70.

Letter Contract L2E1-YJ.-600416 was awarded to Marquardt on August 1, 1962 and terminated March 6, 1964.

The Statement of Work called for the subcontractor to design, develop, fabricate, test, package, and deliver the Duct Buzz and Inlet Unstart Sensors including Power Supplies and data for the XB-70 Air Vehicles 1, 2, and 3. The negotiated schedule called for the airworthiness test report by December 1, 1962 and hardware delivery from November 26, 1962 through Febiryary 1, 1963. Air Vehicle 3 was 50% complete at time of termination.

The residual inventory identified to Purchase Order 600416 was co-mingled with the residual inventory from Purchase Order L3E1-X0-600540 which was issued for spare parts. The inventory was shipped to NR for spare parts requirement except items which were considered to be of no potential use. The usable tooling was delivered to NR for storage and disposal. All proceeds were credited to the above contract.

The final cost of spares contract 600450 was $72,775.

STATHAM was awarded Letter Contract L3E1-X0-600543 for High Temperature Transducers for the Air Induction Control System for the XB-70 Air Vehicles 1 and 2 on August 7, 1963 and closed August 6, 1964.

The Statement of Work called for Statham Instruments to perform research, development, testing, and related engineering studies in connection with material and fabrication processes to manufacture the required transducers for Air Vehicles 1 and 2.

The principal effort in this program was the improvement goal of optimizing the strain wire, strain wire attachment method, insulators, diaphram material, and compensating resistor stabilization.

Certain items of residual inventory were retained by Statham in the amount of $3,447. The remaining inventory was delivered to NR for dispostion, and the proceeds credited to the appropriate contract.

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
AIR INDUCTION SUBSYSTEM

	6-M ASSY 0 HOURS DOLLARS	6-M ASSY 06 HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	319826	310869	630695
LABOR AT $ 4.931	1656085	1454077	3110162
ENGR BURDEN AT $ 4.282	1477416	1223199	2700615
SHOP SUPPORT		151065	151065
LABOR AT $ 3.113		470196	470196
TEST/QC		10036	10036
LABOR AT $ 3.115		31264	31264
MFG BURDEN AT $ 3.908		629614	629614
ENGR MATERIAL		546226	546226
SUBCONTRACT	9301831		9301831
MPC	359906	52977	412883
WIND TUNNEL		124317 8	1243178
OTHER COST		326113	326113
SUB-TOTAL	12795238	5976844	18772082
GEN & ADMIN	203792	84534	288326
TOTAL COST	12999030	6061378	19060408

SUBDIVISION OF WORK
COST DETAIL - SEE PAGE IV-71 IV-85 IV-94

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
6-MAJ ASSY 0

AIR INDUCTION SUBSYSTEM

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOOLING AND STE HOURS DOLLARS	TEST /OC HOURS DOLLARS
DESIGN/ENGINEERING	319826			
LABOR AT $ 5.178	1656085			
ENGR BURDEN AT $ 4.619	1477416			
SUBCONTRACT	7041484	1993435	31404	235508
MPC	249370	90243	1088	19205
SUB-TOTAL	10424355	2083678	32492	254713
GEN & ADMIN	165151	33367	480	4794
TOTAL COST	10589506	2117045	32972	259507
TIME-PHASED COST DETAIL - SEE PAGE	IV-73	IV-77	IV-78	IV-79

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
6-MAJ ASSY 0

AIR INDUCTION SUBSYSTEM

	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	319826
LABOR AT $ 5.178	1656085
ENGR BURDEN AT $ 4.619	1477416
SUBCONTRACT	9301831
MPC	359906

SUB-TOTAL	12795238
GEN & ADMIN	203792

TOTAL COST	12999030

TIME-PHASED COST DETAIL - SEE PAGE IV-81

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 05 AIR INDUCTION SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	3.0	563	4.668	2628	2561	5189
Q-2 58						
Q-3 58	36.0	6170	4.327	26699	24231	50930
Q-4 58						
Q-1 59	49.5	8406	4.359	36638	28866	65504
Q-2 59						
Q-3 59	57.0	10159	4.246	43136	36366	79502
Q-4 59						
Q-1 60	160.5	27893	4.558	127123	102668	229791
Q-2 60						
Q-3 60	211.5	35427	4.680	165808	127830	293638
Q-4 60						
Q-1 61	268.5	45876	4.761	218424	153063	371487
Q-2 61						
Q-3 61	135.0	24591	5.172	127191	113203	240394
Q-4 61						
Q-1 62	153.0	26149	5.414	141568	119814	261382
Q-2 62						
Q-3 62	181.5	30478	5.359	163345	152911	316256
Q-4 62						
Q-1 63	180.0	30662	5.598	171647	164500	336147
Q-2 63						
Q-3 63	153.0	25619	5.632	144287	145006	289293
Q-4 63						
Q-1 64	120.0	20496	5.800	118880	129469	248349
Q-2 64						
Q-3 64	106.5	18658	5.817	108539	118739	227278
Q-4 64						
Q-1 65	39.0	6717	6.844	45968	44312	90280

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 05 **AIR INDUCTION SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-2 65						
Q-3 65	12.0	1962	7.240	14204	13877	28081
TOTAL	1866.0	319826		1656085	1477416	3133501

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05 AIR INDUCTION SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-1 58	3.0	563	4.668	2628	2561	5189	
Q-2 58							
Q-3 58	36.0	6170	4.327	26699	24231	50930	
Q-4 58							
Q-1 59	49.5	8406	4.359	36638	28866	65504	65441
Q-2 59							
Q-3 59	57.0	10159	4.246	43136	36366	79502	933030
Q-4 59							
Q-1 60	160.5	27893	4.558	127123	102668	229791	680229
Q-2 60							
Q-3 60	211.5	35427	4.680	165808	127830	293638	242842
Q-4 60							
Q-1 61	268.5	45876	4.761	218424	153063	371487	825792
Q-2 61							
Q-3 61	135.0	24591	5.172	127191	113203	240394	736562
Q-4 61							
Q-1 62	153.0	26149	5.414	141568	119814	261382	1416569
Q-2 62							
Q-3 62	181.5	30478	5.359	163345	152911	316256	1416568
Q-4 62							
Q-1 63	180.0	30662	5.598	171647	164500	336147	595101
Q-2 63							
Q-3 63	153.0	25619	5.632	144287	145006	289293	99055
Q-4 63							
Q-1 64	120.0	20496	5.800	118880	129469	248349	30295
Q-2 64							
Q-3 64	106.5	18658	5.817	108539	118739	227278	
Q-4 64							
Q-1 65	39.0	6717	6.844	45968	44312	90280	
Q-2 65							
Q-3 65	12.0	1962	7.240	14204	13877	28081	
TOTAL	1866.0	319826		1656085	1477416	3133501	7041484

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05 AIR INDUCTION SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 58		5189		5189
Q-2 58				
Q-3 58		50930		50930
Q-4 58				
Q-1 59	1734	132679		132679
Q-2 59				
Q-3 59	25495	1038027		1038027
Q-4 59				
Q-1 60	40357	950377	18108	968485
Q-2 60				
Q-3 60	14408	550888	10496	561384
Q-4 60				
Q-1 61	23659	1220938	22689	1243627
Q-2 61				
Q-3 61	21103	998059	18547	1016606
Q-4 61				
Q-1 62	45021	1722972	28920	1751892
Q-2 62				
Q-3 62	44980	1777804	29840	1807644
Q-4 62				
Q-1 63	25270	956518	15993	972511
Q-2 63				
Q-3 63	3183	391531	6546	398077
Q-4 63				
Q-1 64	4160	282804	6018	288822
Q-2 64				
Q-3 64		227278	4836	232114
Q-4 64				
Q-1 65		90280	2409	92689
Q-2 65				
Q-3 65		28081	749	28830
TOTAL	249370	10424355	165151	10589506

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
6-MAJ ASSY 0
SUBD OF WORK PRODUCTION

AIR INDUCTION SUBSYSTEM

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 59	13396	355	13751		13751
Q-2 59					
Q-3 59	189018	5164	194182		194182
Q-4 59					
Q-1 60	137266	8143	145409	2770	148179
Q-2 60					
Q-3 60	43459	2578	46037	877	46914
Q-4 60					
Q-1 61	151799	4062	155861	2896	158757
Q-2 61					
Q-3 61	134883	3864	138747	2578	141325
Q-4 61					
Q-1 62	297342	9450	306792	5150	311942
Q-2 62					
Q-3 62	298641	9482	308123	5172	313295
Q-4 62					
Q-1 63	395086	16776	411862	6886	418748
Q-2 63					
Q-3 63	145453	4674	150127	2510	152637
Q-4 63					
Q-1 64	187092	25695	212787	4528	217315
TOTAL	1993435	90243	2083678	33367	2117045

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05 AIR INDUCTION SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK TOOLING AND STE

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 59 Q-2 59	341	9	350		350
Q-3 59 Q-4 59	4867	132	4999		4999
Q-1 60 Q-2 60	3549	210	3759	72	3831
Q-3 60 Q-4 60	1274	75	1349	26	1375
Q-1 61 Q-2 61	4320	123	4443	83	4526
Q-3 61 Q-4 61	3860	110	3970	74	4044
Q-1 62 Q-2 62	7050	224	7274	122	7396
Q-3 62 Q-4 62	5790	183	5973	100	6073
Q-1 63 Q-2 63	30	1	31		31
Q-3 63 Q-4 63	208	6	214		214
Q-1 64	115	15	130	3	133
TOTAL	31404	1088	32492	480	32972

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05 AIR INDUCTION SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK TEST/QC

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-1 62							9838
Q-2 62							
Q-3 62							9801
Q-4 62							
Q-1 63							73413
Q-2 63							
Q-3 63							38968
Q-4 63							
Q-1 64							103488
TOTAL							235508

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05 **AIR INDUCTION SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK TEST/QC

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 60				
Q-2 60				
Q-3 60				
Q-4 60				
Q-1 61				
Q-2 61				
Q-3 61				
Q-4 61				
Q-1 62	312	10150	170	10320
Q-2 62				
Q-3 62	311	10112	169	10281
Q-4 62				
Q-1 63	3117	76530	1280	77810
Q-2 63				
Q-3 63	1252	40220	671	40891
Q-4 63				
Q-1 64	14213	117701	2504	120205
TOTAL	19205	254713	4794	259507

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 05 **AIR INDUCTION SUBSYSTEM**
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	3.0	563	4.668	2628	2561	5189
Q-2 58						
Q-3 58	36.0	6170	4.327	26699	24231	50930
Q-4 58						
Q-1 59	49.5	8406	4.359	36638	28866	65504
Q-2 59						
Q-3 59	57.0	10159	4.246	43136	36366	79502
Q-4 59						
Q-1 60	160.5	27893	4.558	127123	102668	229791
Q-2 60						
Q-3 60	211.5	35427	4.680	165808	127830	293638
Q-4 60						
Q-1 61	268.5	45876	4.761	218424	153063	371487
Q-2 61						
Q-3 61	135.0	24591	5.172	127191	113203	240394
Q-4 61						
Q-1 62	153.0	26149	5.414	141568	119814	261382
Q-2 62						
Q-3 62	181.5	30478	5.359	163345	152911	316256
Q-4 62						
Q-1 63	180.0	30662	5.598	171647	164500	336147
Q-2 63						
Q-3 63	153.0	25619	5.632	144287	145006	289293
Q-4 63						
Q-1 64	120.0	20496	5.800	118880	129469	248349
Q-2 64						
Q-3 64	106.5	18658	5.817	108539	118739	227278
Q-4 64						
Q-1 65	39.0	6717	6.844	45968	44312	90280
Q-2 65						

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 05 **AIR INDUCTION SUBSYSTEM**
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	12.0	1962	7.240	14204	13877	28081
TOTAL	1866.0	319826		1656085	1477416	3133501

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
DATA PREPARED UNDER
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
6-MAJ ASSY 0

AIR INDUCTION SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-1 58	3.0	563	4.668	2628	2561	5189	
Q-2 58							
Q-3 58	36.0	6170	4.327	26699	24231	50930	
Q-4 58							
Q-1 59	49.5	8406	4.359	36638	28866	65504	79178
Q-2 59							
Q-3 59	57.0	10159	4.246	43136	36366	79502	1126915
Q-4 59							
Q-1 60	160.5	27893	4.558	127123	102668	229791	821044
Q-2 60							
Q-3 60	211.5	35427	4.680	165808	127830	293638	287575
Q-4 60							
Q-1 61	268.5	45876	4.761	218424	153063	371487	981911
Q-2 61							
Q-3 61	135.0	24591	5.172	127191	113203	240394	875305
Q-4 61							
Q-1 62	153.0	26149	5.414	141568	119814	261382	1730799
Q-2 62							
Q-3 62	181.5	30478	5.359	163345	152911	316256	1730800
Q-4 62							
Q-1 63	180.0	30662	5.598	171647	164500	336147	1063630
Q-2 63							
Q-3 63	153.0	25619	5.632	144287	145006	289293	283684
Q-4 63							
Q-1 64	120.0	20496	5.800	118880	129469	248349	320990
Q-2 64							
Q-3 64	106.5	18658	5.817	108539	118739	227278	
Q-4 64							
Q-1 65	39.0	6717	6.844	45968	44312	90280	
Q-2 65							
Q-3 65	12.0	1962	7.240	14204	13877	28081	
TOTAL	1866.0	319826		1656085	1477416	3133501	9301831

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
6-MAJ ASSY 0

AIR INDUCTION SUBSYSTEM

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 58		5189		5189
Q-2 58				
Q-3 58		50930		50930
Q-4 58				
Q-1 59	2098	146780		146780
Q-2 59				
Q-3 59	30791	1237208		1237208
Q-4 59				
Q-1 60	48710	1099545	20950	1120495
Q-2 60				
Q-3 60	17061	598274	11399	609673
Q-4 60				
Q-1 61	27844	1381242	25668	1406910
Q-2 61				
Q-3 61	25077	1140776	21199	1161975
Q-4 61				
Q-1 62	55007	2047188	34362	2081550
Q-2 62				
Q-3 62	54956	2102012	35281	2137293
Q-4 62				
Q-1 63	45164	1444941	24159	1469100
Q-2 63				
Q-3 63	9115	582092	9727	591819
Q-4 63				
Q-1 64	44083	613422	13053	626475
Q-2 64				
Q-3 64		227278	4836	232114
Q-4 64				
Q-1 65		90280	2409	92689
Q-2 65				
Q-3 65		28081	749	28830
TOTAL	359906	12795238	203792	12999030

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
6-MAJ ASSY 06
AIR INDUCTION GROUND TESTS

	TEST /QC HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	310869	310869
LABOR AT $ 4.677	1454077	1454077
ENGR BURDEN AT $ 3.935	1223199	1223199
SHOP SUPPORT	151065	151065
LABOR AT $ 3.113	470196	470196
TEST/QC	10036	10036
LABOR AT $ 3.115	31264	31264
MFG BURDEN AT $ 3.908	629614	629614
ENGR MATERIAL	546226	546226
MPC	52977	52977
WIND TUNNEL	1243178	1243178
OTHER COST	326113	326113
SUB-TOTAL	5976844	5976844
GEN & ADMIN	84534	84534
TOTAL COST	6061378	6061378
TIME-PHASED COST DETAIL - SEE PAGE	IV-86	IV-86

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 05 AIR INDUCTION GROUND TESTS
6-MAJ ASSY 06
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	42.0	7153	4.378	31314	32546	63860
Q-2 58						
Q-3 58	160.5	26851	4.152	111473	105090	216563
Q-4 58						
Q-1 59	196.5	33500	4.170	139698	114973	254671
Q-2 59						
Q-3 59	147.0	25743	4.101	105565	92521	198086
Q-4 59						
Q-1 60	301.5	52177	4.521	235877	190853	426730
Q-2 60						
Q-3 60	237.0	39923	4.596	183471	144184	327655
Q-4 60						
Q-1 61	195.5	34060	4.677	159282	113580	272862
Q-2 61						
Q-3 61	144.0	26230	5.072	133042	116958	250000
Q-4 61						
Q-1 62	198.0	33725	5.423	182899	152716	335615
Q-2 62						
Q-3 62	117.0	19768	5.366	106077	97031	203108
Q-4 62						
Q-1 63	61.5	10388	5.554	57691	54457	112148
Q-2 63						
Q-3 63	3.0	392	5.000	1960	2235	4195
Q-4 63						
Q-1 64	3.0	438	4.893	2143	2631	4774
Q-2 64						
Q-3 64		50	5.840	292	321	613
Q-4 64						
Q-1 65	1.5	381	6.992	2664	2512	5176

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 05 AIR INDUCTION GROUND TESTS
6-MAJ ASSY 06
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-2 65						
Q-3 65		90	6.989	629	591	1220
Q-4 65						
Q-1 66						
TOTAL	1812.0	310869		1454077	1223199	2677276

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPENC.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 05 AIR INDUCTION GROUND TESTS
6-MAJ ASSY 06
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 59	7.5	1286	3.171	4078	3941	8019
Q-2 59						
Q-3 59						
Q-4 59					30	30
Q-1 60	15.0	2592	3.029	7852	8502	16354
Q-2 60						
Q-3 60	58.5	9713	3.178	30864	31920	62784
Q-4 60						
Q-1 61	49.5	8446	3.188	26925	28532	55457
Q-2 61						
Q-3 61	100.5	18172	2.995	54428	69488	123916
Q-4 61						
Q-1 62	279.0	47626	3.148	149907	182945	332852
Q-2 62						
Q-3 62	142.5	23964	3.146	75385	100661	176046
Q-4 62						
Q-1 63	76.5	13115	3.092	40554	63831	104385
Q-2 63						
Q-3 63	129.0	21731	3.043	66122	118105	184227
Q-4 63						
Q-1 64	10.5	1743	3.122	5441	9172	14613
Q-2 64						
Q-3 64	10.5	1741	3.125	5440	9169	14609
Q-4 64						
Q-1 65	4.5	655	3.418	2239	2322	4561
Q-2 65						
Q-3 65	1.5	262	3.420	896	629	1525
Q-4 65						
Q-1 66		19	3.421	65	367	432
TOTAL	885.0	151065		470196	629614	1099810

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	TEST/QC	
4-SYSTEM	1	
5-SUBSYSTEM	05	AIR INDUCTION GROUND TESTS
6-MAJ ASSY	06	
SUBD OF WORK	TEST/QC	

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 59		2	2.000	4		4
Q-2 59						
Q-3 59						
Q-4 59						
Q-1 60		34	3.059	104		104
Q-2 60						
Q-3 60	1.5	136	3.654	497		497
Q-4 60						
Q-1 61	3.0	386	3.187	1230		1230
Q-2 61						
Q-3 61	7.5	1267	2.954	3743		3743
Q-4 61						
Q-1 62	15.0	2562	3.074	7875		7875
Q-2 62						
Q-3 62	7.5	1174	3.221	3782		3782
Q-4 62						
Q-1 63	10.5	1838	3.077	5655		5655
Q-2 63						
Q-3 63	13.5	2179	3.132	6825		6825
Q-4 63						
Q-1 64	1.5	227	3.339	758		758
Q-2 64						
Q-3 64	1.5	227	3.339	758		758
Q-4 64						
Q-1 65		3	8.000	24		24
Q-2 65						
Q-3 65		1	9.000	9		9
TOTAL	61.5	10036		31264		31264

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
6-MAJ ASSY 06
AIR INDUCTION GROUND TESTS

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	42.0	7153	4.378	31314	32546	63860	
Q-2 58							
Q-3 58	160.5	26851	4.152	111473	105090	216563	
Q-4 58							
Q-1 59	204.0	34788	4.133	143780	118914	262694	428
Q-2 59							
Q-3 59	147.0	25743	4.101	105565	92551	198116	
Q-4 59							
Q-1 60	316.5	54803	4.449	243833	199355	443188	189
Q-2 60							
Q-3 60	297.0	49772	4.316	214832	176104	390936	13102
Q-4 60							
Q-1 61	252.0	42892	4.370	187437	142112	329549	52777
Q-2 61							
Q-3 61	252.0	45669	4.187	191213	186446	377659	103089
Q-4 61							
Q-1 62	492.0	83913	4.060	340681	335661	676342	164090
Q-2 62							
Q-3 62	267.0	44906	4.125	185244	197692	382936	72663
Q-4 62							
Q-1 63	148.5	25341	4.100	103900	118288	222188	72039
Q-2 63							
Q-3 63	145.5	24302	3.082	74907	120340	195247	26249
Q-4 63							
Q-1 64	15.0	2408	3.464	8342	11803	20145	22396
Q-2 64							
Q-3 64	12.0	2018	3.216	6490	9490	15980	22310
Q-4 64							
Q-1 65	6.0	1039	4.742	4927	4834	9761	-2174
Q-2 65							
Q-3 65	1.5	353	4.346	1534	1220	2754	-870

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
6-MAJ ASSY 06
AIR INDUCTION GROUND TESTS

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-4 65							
Q-1 66		19	3.421	65	367	432	-62
TOTAL	2758.5	471970		1955537	1852813	3808350	546226

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
6-MAJ ASSY 06
AIR INDUCTION GROUND TESTS

	MPC	WIND TUNNEL	OTHER COST	TOTAL O/C $	SUB TOTAL	G & A	TOTAL COST
Q-1 58		17037		17037	80897		80897
Q-2 58							
Q-3 58		110870		110870	327433		327433
Q-4 58							
Q-1 59	36	177104		177104	440262		440262
Q-2 59							
Q-3 59		201828		201828	399544		399544
Q-4 59							
Q-1 60	24	182582		182582	625983	11927	637910
Q-2 60							
Q-3 60	1723	165266		165266	571027	10880	581907
Q-4 60							
Q-1 61	4460	133435		133435	520221	9667	529888
Q-2 61							
Q-3 61	8711	99635	4574	104209	593668	11032	604700
Q-4 61							
Q-1 62	12930	64343	39674	104017	957379	16070	973449
Q-2 62							
Q-3 62	5726	30245	92708	122953	584278	9807	594085
Q-4 62							
Q-1 63	7096	31133	8418	39551	340874	5699	346573
Q-2 63							
Q-3 63	2586	29699	180649	210348	434430	7264	441694
Q-4 63							
Q-1 64	2387	1	24	25	44953	957	45910
Q-2 64							
Q-3 64	8116	-1	23	22	46428	988	47416
Q-4 64							
Q-1 65	-650	1	30	31	6968	186	7154
Q-2 65							
Q-3 65	-155		12	12	1741	46	1787

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
AIR INDUCTION SUBSYSTEM

	DESIGN /ENGR HOURS DOLLARS	PROP HOURS DOLLARS	TOOLING AND STE HOURS DOLLARS	TEST /QC HOURS DOLLARS
DESIGN/ENGINEERING	319826			310869
LABOR AT $ 4.931	1656085			1454077
ENGR BURDEN AT $ 4.282	1477416			1223199
SHOP SUPPORT				151065
LABOR AT $ 3.113				470196
TEST/QC				10036
LABOR AT $ 3.115				31264
MFG BURDEN AT $ 3.908				629614
ENGR MATERIAL				546226
SUBCONTRACT	7041484	1993435	31404	235568
MPC	249370	90243	1088	72122
WIND TUNNEL				1243178
OTHER COST				326113
SUB-TOTAL	10424355	2083678	32492	6231557
GEN & ADMIN	165151	33367	480	89328
TOTAL COST	10589506	2117045	32972	6320885

TIME-PHASED COST DETAIL - SEE PAGE	IV-96	IV-100	IV-101	IV-102

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NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
6-MAJ ASSY 06
AIR INDUCTION GROUND TESTS

	MPC	WIND TUNNEL	OTHER COST	TOTAL O/C $	SUB TOTAL	G & A	TOTAL COST
Q-4 65							
Q-1 66	-13		1	1	358	11	369
TOTAL	52977	1243178	326113	1569291	5976844	84534	6061378

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
DATA PREPARED UNDER
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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
AIR INDUCTION SUBSYSTEM

		TOTAL HOURS DOLLARS
DESIGN/ENGINEERING		630695
LABOR AT $ 4.931		3110162
ENGR BURDEN	AT $ 4.282	2700515
SHOP SUPPORT		151065
LABOR AT $ 3.113		470196
TEST/QC		10036
LABOR AT $ 3.115		31254
MFG BURDEN	AT $ 3.908	629514
ENGR MATERIAL		546226
SUBCONTRACT		9301831
MPC		412883
WIND TUNNEL		1243178
OTHER COST		326113
SUB-TOTAL		18772082
GEN & ADMIN		288326
TOTAL COST		19060408

TIME-PHASED COST
DETAIL - SEE PAGE IV-112

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 05 **AIR INDUCTION SUBSYSTEM**
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58 Q-2 58	3.0	563	4.668	2628	2561	5189
Q-3 58 Q-4 58	36.0	6170	4.327	26699	24231	50930
Q-1 59 Q-2 59	49.5	8406	4.359	36638	28865	65504
Q-3 59 Q-4 59	57.0	10159	4.246	43136	36366	79502
Q-1 60 Q-2 60	160.5	27893	4.558	127123	102668	229791
Q-3 60 Q-4 60	211.5	35427	4.680	165808	127830	293638
Q-1 61 Q-2 61	268.5	45876	4.761	218424	153063	371487
Q-3 61 Q-4 61	135.0	24591	5.172	127191	113203	240394
Q-1 62 Q-2 62	153.0	26149	5.414	141568	119814	261382
Q-3 62 Q-4 62	181.5	30478	5.359	163345	152911	316256
Q-1 63 Q-2 63	180.0	30662	5.598	171647	164500	336147
Q-3 63 Q-4 63	153.0	25619	5.632	144287	145006	289293
Q-1 64 Q-2 64	120.0	20496	5.800	118880	129469	248349
Q-3 64 Q-4 64	106.5	18653	5.817	108539	118739	227278
Q-1 65 Q-2 65	39.0	6717	6.844	45968	44312	90280

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 05 **AIR INDUCTION SUBSYSTEM**
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	12.0	1962	7.240	14204	13877	28081
TOTAL	1866.C	319826		1656085	1477416	3133501

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05 **AIR INDUCTION SUBSYSTEM**
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-1 58	3.0	563	4.668	2628	2561	5189	
Q-2 58							
Q-3 58	36.0	6170	4.327	26699	24231	50930	
Q-4 58							
Q-1 59	49.5	8406	4.359	36638	28866	65504	65441
Q-2 59							
Q-3 59	57.0	10159	4.246	43136	36366	79502	933030
Q-4 59							
Q-1 60	160.5	27893	4.558	127123	102668	229791	680229
Q-2 60							
Q-3 60	211.5	35427	4.680	165808	127830	293638	242842
Q-4 60							
Q-1 61	268.5	45876	4.761	218424	153063	371487	825792
Q-2 61							
Q-3 61	135.0	24591	5.172	127191	113203	240394	736562
Q-4 61							
Q-1 62	153.0	26149	5.414	141568	119814	261382	1416569
Q-2 62							
Q-3 62	181.5	30478	5.359	163345	152911	316256	1416568
Q-4 62							
Q-1 63	180.0	30662	5.598	171647	164500	336147	595101
Q-2 63							
Q-3 63	153.0	25619	5.632	144287	145006	289293	99055
Q-4 63							
Q-1 64	120.0	20496	5.800	118880	129469	248349	30295
Q-2 64							
Q-3 64	106.5	18658	5.817	108539	118739	227278	
Q-4 64							
Q-1 65	39.0	6717	6.844	45968	44312	90280	
Q-2 65							
Q-3 65	12.0	1962	7.240	14204	13877	28081	
TOTAL	1866.0	319826		1656085	1477416	3133501	7041484

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
SUBD OF WORK DESIGN/ENGINEERING

AIR INDUCTION SUBSYSTEM

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 58		5189		5189
Q-2 58				
Q-3 58		50930		50930
Q-4 58				
Q-1 59	1734	132679		132679
Q-2 59				
Q-3 59	25495	1038027		1038027
Q-4 59				
Q-1 60	40357	950377	18108	968485
Q-2 60				
Q-3 60	14408	550888	10496	561384
Q-4 60				
Q-1 61	23659	1220938	22689	1243627
Q-2 61				
Q-3 61	21103	998059	18547	1016606
Q-4 61				
Q-1 62	45021	1722972	28920	1751892
Q-2 62				
Q-3 62	44980	1777804	29840	1807644
Q-4 62				
Q-1 63	25270	956518	15993	972511
Q-2 63				
Q-3 63	3183	391531	6546	398077
Q-4 63				
Q-1 64	4160	282804	6018	288822
Q-2 64				
Q-3 64		227278	4836	232114
Q-4 64				
Q-1 65		90280	2409	92689
Q-2 65				
Q-3 65		28081	749	28830
TOTAL	249370	10424355	165151	10589506

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05 AIR INDUCTION SUBSYSTEM
SUBD OF WORK PRODUCTION

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 59	13396	355	13751		13751
Q-2 59					
Q-3 59	189018	5164	194182		194182
Q-4 59					
Q-1 60	137266	8143	145409	2770	148179
Q-2 60					
Q-3 60	43459	2578	46037	877	46914
Q-4 60					
Q-1 61	151799	4062	155861	2896	158757
Q-2 61					
Q-3 61	134883	3864	138747	2578	141325
Q-4 61					
Q-1 62	297342	9450	306792	5150	311942
Q-2 62					
Q-3 62	298641	9482	308123	5172	313295
Q-4 62					
Q-1 63	395086	16776	411862	6886	418748
Q-2 63					
Q-3 63	145453	4674	150127	2510	152637
Q-4 63					
Q-1 64	187092	25695	212787	4528	217315
TOTAL	1993435	90243	2083678	33367	2117045

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05 **AIR INDUCTION SUBSYSTEM**
SUBD OF WORK TOOLING AND STE

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 59	341	9	350		350
Q-2 59					
Q-3 59	4867	132	4999		4999
Q-4 59					
Q-1 60	3549	210	3759	72	3831
Q-2 60					
Q-3 60	1274	75	1349	26	1375
Q-4 60					
Q-1 61	4320	123	4443	83	4526
Q-2 61					
Q-3 61	3860	110	3970	74	4044
Q-4 61					
Q-1 62	7050	224	7274	122	7396
Q-2 62					
Q-3 62	5790	183	5973	100	6073
Q-4 62					
Q-1 63	30	1	31		31
Q-2 63					
Q-3 63	208	6	214		214
Q-4 63					
Q-1 64	115	15	130	3	133
TOTAL	31404	1088	32492	480	32972

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 05 AIR INDUCTION SUBSYSTEM
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	42.0	7153	4.378	31314	32546	63860
Q-2 58						
Q-3 58	160.5	26851	4.152	111473	105090	216563
Q-4 58						
Q-1 59	196.5	33500	4.170	139698	114973	254671
Q-2 59						
Q-3 59	147.0	25743	4.101	105565	92521	198086
Q-4 59						
Q-1 60	301.5	52177	4.521	235877	190853	426730
Q-2 60						
Q-3 60	237.0	39923	4.596	183471	144184	327655
Q-4 60						
Q-1 61	199.5	34060	4.677	159282	113580	272862
Q-2 61						
Q-3 61	144.0	26230	5.072	133042	116958	250000
Q-4 61						
Q-1 62	198.0	33725	5.423	182899	152716	335615
Q-2 62						
Q-3 62	117.0	19768	5.366	106077	97031	203108
Q-4 62						
Q-1 63	61.5	10388	5.554	57691	54457	112148
Q-2 63						
Q-3 63	3.0	392	5.000	1960	2235	4195
Q-4 63						
Q-1 64	3.0	438	4.893	2143	2631	4774
Q-2 64						
Q-3 64		50	5.840	292	321	613
Q-4 64						
Q-1 65	1.5	381	6.992	2664	2512	5176
Q-2 65						

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 05 **AIR INDUCTION SUBSYSTEM**
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65		90	6.989	629	591	1220
Q-4 65						
Q-1 66						
TOTAL	1812.0	310869		1454077	1223199	2677276

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 05 AIR INDUCTION SUBSYSTEM
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 59	7.5	1286	3.171	4078	3941	8019
Q-2 59						
Q-3 59						
Q-4 59					30	30
Q-1 60	15.0	2592	3.029	7852	8502	16354
Q-2 60						
Q-3 60	58.5	9713	3.178	30864	31920	62784
Q-4 60						
Q-1 61	49.5	8446	3.188	26925	28532	55457
Q-2 61						
Q-3 61	100.5	18172	2.995	54428	69488	123916
Q-4 61						
Q-1 62	279.0	47626	3.148	149907	182945	332852
Q-2 62						
Q-3 62	142.5	23964	3.146	75385	100661	176046
Q-4 62						
Q-1 63	76.5	13115	3.092	40554	63831	104385
Q-2 63						
Q-3 63	129.0	21731	3.043	66122	118105	184227
Q-4 63						
Q-1 64	10.5	1743	3.122	5441	9172	14613
Q-2 64						
Q-3 64	10.5	1741	3.125	5440	9169	14609
Q-4 64						
Q-1 65	4.5	655	3.418	2239	2322	4561
Q-2 65						
Q-3 65	1.5	262	3.420	896	629	1525
Q-4 65						
Q-1 66		19	3.421	65	367	432
TOTAL	885.0	151065		470196	629614	1099810

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 05
SUBD OF WORK TEST/QC

AIR INDUCTION SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 59		2	2.000	4		4
Q-2 59						
Q-3 59						
Q-4 59						
Q-1 60		34	3.059	104		104
Q-2 60						
Q-3 60	1.5	136	3.654	497		497
Q-4 60						
Q-1 61	3.0	386	3.187	1230		1230
Q-2 61						
Q-3 61	7.5	1267	2.954	3743		3743
Q-4 61						
Q-1 62	15.0	2562	3.074	7875		7875
Q-2 62						
Q-3 62	7.5	1174	3.221	3782		3782
Q-4 62						
Q-1 63	10.5	1838	3.077	5655		5655
Q-2 63						
Q-3 63	13.5	2179	3.132	6825		6825
Q-4 63						
Q-1 64	1.5	227	3.339	758		758
Q-2 64						
Q-3 64	1.5	227	3.339	758		758
Q-4 64						
Q-1 65		3	8.000	24		24
Q-2 65						
Q-3 65		1	9.000	9		9
TOTAL	61.5	10036		31264		31264

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
SUBD OF WORK TEST/QC

AIR INDUCTION SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	42.0	7153	4.378	31314	32546	63860	
Q-2 58							
Q-3 58	160.5	26851	4.152	111473	105090	216563	
Q-4 58							
Q-1 59	204.0	34788	4.133	143780	118914	262694	428
Q-2 59							
Q-3 59	147.0	25743	4.101	105565	92551	198116	
Q-4 59							
Q-1 60	316.5	54803	4.449	243833	199355	443188	189
Q-2 60							
Q-3 60	297.0	49772	4.316	214832	176104	390936	13102
Q-4 60							
Q-1 61	252.0	42892	4.370	187437	142112	329549	52777
Q-2 61							
Q-3 61	252.0	45669	4.187	191213	186446	377659	103089
Q-4 61							
Q-1 62	492.0	83913	4.060	340631	335661	676342	164090
Q-2 62							
Q-3 62	267.0	44906	4.125	185244	197692	382936	72663
Q-4 62							
Q-1 63	148.5	25341	4.100	103900	118288	222188	72039
Q-2 63							
Q-3 63	145.5	24302	3.082	74907	120340	195247	26249
Q-4 63							
Q-1 64	15.0	2408	3.464	8342	11803	20145	22396
Q-2 64							
Q-3 64	12.0	2018	3.216	6490	9490	15980	22310
Q-4 64							
Q-1 65	6.0	1039	4.742	4927	4834	9761	-2174
Q-2 65							
Q-3 65	1.5	353	4.346	1534	1220	2754	-870
Q-4 65							

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
SUBD OF WORK TEST/QC

AIR INDUCTION SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66		19	3.421	65	367	432	-62
TOTAL	2758.5	471970		1955537	1852813	3808350	546226

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B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
SUBD OF WORK TEST/QC

AIR INDUCTION SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	WIND TUNNEL	OTHER COST	TOTAL C/C $	SUB TOTAL
Q-1 58				17037		17037	80897
Q-2 58							
Q-3 58				110870		110870	327433
Q-4 58							
Q-1 59		428	36	177104		177104	440262
Q-2 59							
Q-3 59				201828		201828	399944
Q-4 59							
Q-1 60		189	24	182582		182582	625983
Q-2 60							
Q-3 60		13102	1723	165266		165266	571027
Q-4 60							
Q-1 61		52777	4460	133435		133435	520221
Q-2 61							
Q-3 61		103039	8711	99635	4574	104209	593668
Q-4 61							
Q-1 62	9838	173928	13242	64343	39674	104017	967529
Q-2 62							
Q-3 62	9801	82464	6037	30245	92708	122953	594390
Q-4 62							
Q-1 63	73413	145452	10213	31133	8418	39551	417404
Q-2 63							
Q-3 63	38968	65217	3838	29699	180649	210348	474650
Q-4 63							
Q-1 64	103488	125884	16600	1	24	25	162654
Q-2 64							
Q-3 64		22310	8116	-1	23	22	46428
Q-4 64							
Q-1 65		-2174	-650	1	30	31	6968
Q-2 65							
Q-3 65		-870	-155		12	12	1741
Q-4 65							

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1 AIR INDUCTION SUBSYSTEM
5-SUBSYSTEM 05
SUBD OF WORK TEST/QC

	SUBC	TOTAL MATERIAL	MPC	WIND TUNNEL	OTHER COST	TOTAL O/C $	SUB TOTAL
Q-1 66		-62	-13		1	1	358
TOTAL	235508	781734	72182	1243178	326113	1569291	6231557

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
SUBD OF WORK TEST/QC

AIR INDUCTION SUBSYSTEM

	G & A	TOTAL COST
Q-1 58		80897
Q-2 58		
Q-3 58		327433
Q-4 58		
Q-1 59		440262
Q-2 59		
Q-3 59		399944
Q-4 59		
Q-1 60	12097	638030
Q-2 60		
Q-3 60	11049	582076
Q-4 60		
Q-1 61	10947	531168
Q-2 61		
Q-3 61	11703	605371
Q-4 61		
Q-1 62	18574	986103
Q-2 62		
Q-3 62	9807	604197
Q-4 62		
Q-1 63	5699	423103
Q-2 63		
Q-3 63	7264	481914
Q-4 63		
Q-1 64	957	163611
Q-2 64		
Q-3 64	988	47416
Q-4 64		
Q-1 65	186	7154
Q-2 65		
Q-3 65	46	1737
Q-4 65		

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
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B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05 AIR INDUCTION SUBSYSTEM
SUBD OF WORK TEST/QC

	G & A	TOTAL COST
Q-1 66	11	369
TOTAL	89328	6320885

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 05
AIR INDUCTION SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	46.5	7716	4.399	33942	35107	69049
Q-2 58						
Q-3 58	196.5	33021	4.184	138172	129321	267493
Q-4 58						
Q-1 59	246.0	41906	4.208	176336	143839	320175
Q-2 59						
Q-3 59	204.0	35902	4.142	148701	128887	277588
Q-4 59						
Q-1 60	462.0	80070	4.534	363000	293521	656521
Q-2 60						
Q-3 60	448.5	75350	4.635	349279	272014	621293
Q-4 60						
Q-1 61	468.0	79936	4.725	377706	266643	644349
Q-2 61						
Q-3 61	280.5	50821	5.121	260233	230161	490394
Q-4 61						
Q-1 62	351.0	59874	5.419	324467	272530	596997
Q-2 62						
Q-3 62	298.5	50246	5.362	269422	249942	519364
Q-4 62						
Q-1 63	240.0	41050	5.587	229338	218957	448295
Q-2 63						
Q-3 63	154.5	26011	5.623	146247	147241	293488
Q-4 63						
Q-1 64	123.0	20934	5.781	121023	132100	253123
Q-2 64						
Q-3 64	106.5	18708	5.817	108831	119060	227891
Q-4 64						
Q-1 65	40.5	7098	6.852	48632	46824	95456
Q-2 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 05
AIR INDUCTION SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	12.0	2052	7.229	14833	14468	29301
Q-4 65						
Q-1 66						
TOTAL	3678.0	630695		3110162	2700615	5810777

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 05
AIR INDUCTION SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 59	7.5	1286	3.171	4078	3941	8019
Q-2 59						
Q-3 59						
Q-4 59					30	30
Q-1 60	15.0	2592	3.029	7852	8502	16354
Q-2 60						
Q-3 60	58.5	9713	3.178	30864	31920	62784
Q-4 60						
Q-1 61	49.5	8446	3.188	26925	28532	55457
Q-2 61						
Q-3 61	100.5	18172	2.995	54428	69488	123916
Q-4 61						
Q-1 62	279.0	47626	3.148	149907	182945	332852
Q-2 62						
Q-3 62	142.5	23964	3.146	75385	100661	176046
Q-4 62						
Q-1 63	76.5	13115	3.092	40554	63831	104385
Q-2 63						
Q-3 63	129.0	21731	3.043	66122	118105	184227
Q-4 63						
Q-1 64	10.5	1743	3.122	5441	9172	14613
Q-2 64						
Q-3 64	10.5	1741	3.125	5440	9169	14609
Q-4 64						
Q-1 65	4.5	655	3.418	2239	2322	4561
Q-2 65						
Q-3 65	1.5	262	3.420	896	629	1525
Q-4 65						
Q-1 66		19	3.421	65	367	432
TOTAL	885.0	151065		470196	629614	1099810

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 05
AIR INDUCTION SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 59		2	2.000	4		4
Q-2 59						
Q-3 59						
Q-4 59						
Q-1 60		34	3.059	104		104
Q-2 60						
Q-3 60	1.5	136	3.654	497		497
Q-4 60						
Q-1 61	3.0	386	3.187	1230		1230
Q-2 61						
Q-3 61	7.5	1267	2.954	3743		3743
Q-4 61						
Q-1 62	15.0	2562	3.074	7875		7875
Q-2 62						
Q-3 62	7.5	1174	3.221	3782		3782
Q-4 62						
Q-1 63	10.5	1838	3.077	5655		5655
Q-2 63						
Q-3 63	13.5	2179	3.132	6825		6825
Q-4 63						
Q-1 64	1.5	227	3.339	758		758
Q-2 64						
Q-3 64	1.5	227	3.339	758		758
Q-4 64						
Q-1 65		3	8.000	24		24
Q-2 65						
Q-3 65		1	9.000	9		9
TOTAL	61.5	10036		31264		31264

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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
AIR INDUCTION SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	46.5	7716	4.399	33942	35107	69049	
Q-2 58							
Q-3 58	196.5	33021	4.184	138172	129321	267493	
Q-4 58							
Q-1 59	253.5	43194	4.177	180418	147780	328198	428
Q-2 59							
Q-3 59	204.0	35902	4.142	148701	128917	277618	
Q-4 59							
Q-1 60	477.0	82696	4.486	370956	302023	672979	189
Q-2 60							
Q-3 60	508.5	85199	4.468	380640	303934	684574	13102
Q-4 60							
Q-1 61	520.5	88768	4.572	405861	295175	701036	52777
Q-2 61							
Q-3 61	388.5	70260	4.532	318404	299649	618053	103089
Q-4 61							
Q-1 62	645.0	110062	4.382	482249	455475	937724	164090
Q-2 62							
Q-3 62	448.5	75384	4.624	348589	350603	699192	72663
Q-4 62							
Q-1 63	327.0	56003	4.920	275547	282788	558335	72039
Q-2 63							
Q-3 63	297.0	49921	4.391	219194	265346	484540	26249
Q-4 63							
Q-1 64	135.0	22904	5.555	127222	141272	268494	22396
Q-2 64							
Q-3 64	118.5	20676	5.563	115029	128229	243258	22310
Q-4 64							
Q-1 65	45.0	7756	6.562	50895	49146	100041	-2174
Q-2 65							
Q-3 65	13.5	2315	6.798	15738	15097	30835	-870
Q-4 65							

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
AIR INDUCTION SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66		19	3.421	65	367	432	-62
TOTAL	4624.5	791796		3611622	3330229	6941851	546226

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
AIR INDUCTION SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	WIND TUNNEL	OTHER COST	TOTAL O/C $	SUB TOTAL
Q-1 58				17037		17037	86086
Q-2 58							
Q-3 58				110870		110870	378363
Q-4 58							
Q-1 59	79178	79606	2134	177104		177104	587042
Q-2 59							
Q-3 59	1126915	1126915	30791	201828		201828	1637152
Q-4 59							
Q-1 60	821044	821233	48734	182582		182582	1725528
Q-2 60							
Q-3 60	287575	300677	18784	165266		165266	1169301
Q-4 60							
Q-1 61	981911	1034688	32304	133435		133435	1901463
Q-2 61							
Q-3 61	875305	978394	33788	99635	4574	104209	1734444
Q-4 61							
Q-1 62	1730799	1894889	67937	64343	39674	104017	3004567
Q-2 62							
Q-3 62	1730800	1803463	60682	30245	92708	122953	2686290
Q-4 62							
Q-1 63	1063630	1135669	52260	31133	8418	39551	1785815
Q-2 63							
Q-3 63	283684	309933	11701	29699	180649	210348	1016522
Q-4 63							
Q-1 64	320990	343386	46470	1	24	25	658375
Q-2 64							
Q-3 64		22310	8116	-1	23	22	273706
Q-4 64							
Q-1 65		-2174	-650	1	30	31	97248
Q-2 65							
Q-3 65		-870	-155		12	12	29822
Q-4 65							

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B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
AIR INDUCTION SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	WIND TUNNEL	CTHER CCST	TOTAL C/C $	SUB TOTAL
Q-1 66		-62	-13		1	1	358
TOTAL	9301831	9848057	412883	1243178	326113	1569291	18772082

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B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
AIR INDUCTION SUBSYSTEM

	G & A	TOTAL COST
Q-1 58		86086
Q-2 58		
Q-3 58		378363
Q-4 58		
Q-1 59		587042
Q-2 59		
Q-3 59		1637152
Q-4 59		
Q-1 60	32877	1758405
Q-2 60		
Q-3 60	22279	1191580
Q-4 60		
Q-1 61	35335	1936798
Q-2 61		
Q-3 61	32231	1766675
Q-4 61		
Q-1 62	50432	3054999
Q-2 62		
Q-3 62	45088	2731378
Q-4 62		
Q-1 63	29858	1815673
Q-2 63		
Q-3 63	16991	1033513
Q-4 63		
Q-1 64	14010	672385
Q-2 64		
Q-3 64	5824	279530
Q-4 64		
Q-1 65	2595	99843
Q-2 65		
Q-3 65	795	30617
Q-4 65		

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B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 05
AIR INDUCTION SUBSYSTEM

	G & A	TOTAL COST
Q-1 66	11	369
TOTAL	288326	19060408

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WORK BREAKDOWN STRUCTURE

SUBSYSTEM: FLIGHT CONTROL

WBS CODE: 1.6

WBS LEVELS
4 5 6 7 8

1.6 FLIGHT CONTROL SUBSYSTEM

1.6.1 Primary Flight Control

1.6.1.1 Crew Station Control

Control Wheels
Control Columns
Storage Bungee
Storage Thrusters
Rudder Pedals
Pedal Adjusters
Longitudinal Bobweight
Lateral Bobweight
Forward Pitch Feel Bungee
Aft Pitch Feel Bungee
Forward Roll Feel Bungee
Aft Roll Feel Bungee
Yaw Feel Bungee
Emergency FACS disengage
Gearing Train
Brake Pedals
Nose Wheel Steering
Longitudinal Position Trim Wheel

1.6.1.2 Elevon Control

Outboard Actuators
Outboard Actuator Mechanism Drivers
Roll Master Actuator
Pitch Master Actuator
Pitch Override Bungee
Roll Override Bungee
Centering Bungee
Fold Interlock
Elevon Actuator Mechanism
Aero Sealing
Elevon Hinges
Position Sensors
Elevon Stops

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: FLIGHT CONTROL

WBS CODE: 1.6

WBS LEVELS

4 5 6 7 8

1.6.1.3 Yaw Control

Gearing Changer
Yaw Override Bungee
Vertical Stabilizer Actuator
Stabilizer Position Sensors
Centering Bungee
Hydraulic Interconnecting Valving

1.6.1.4 Cable System

Forward Tension Regulator
Forward Bellows Seals
Forward Tension/Grad Bungee
Forward Pulleys
Forward Guides
Aft Tension Regulator
Aft Bellows Seals
Aft Tension/Grad Bungee
Aft Pulleys
Aft Guides

1.6.1.5 Ancillary Control

Electrical Actuator Bungees
Electronics
Positioner Assys
Servo Valves

1.6.2 Secondary Flight Control

1.6.2.1 Pitch Trim Actuators

Linear Guarded Transducers
Servo Position Transmitters
Position Sensors

1.6.2.2 Roll Trim Actuators

Linear Guarded Transducers
Servo Position Transmitters
Position Sensors

1.6.2.3 Standby Trim Electronics

Servo Position Transmitters
Trim Switch

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: FLIGHT CONTROL WBS CODE: 1.6

WBS LEVELS
4 5 6 7 8

1.6.2.4 Yaw Trim Actuators

Linear Guarded Transducers
Servo Position Transmitters
Position Sensors

1.6.2.5 Horizontal Pitch Trim Actuators

Linear Guarded Transducer
Servo Position Transmitters
Position Sensors

1.6.2.6 Flap Actuator

Position Sensors
Limit Switches
Flap Stops
Servo Position Transmitters

1.6.2.7 Roll Primary Trim Switch Assy

1.6.2.8 Pitch Primary Trim Switch Assy

1.6.2.9 Trim For Take-Off

Push Button Control Assy
Position Switches
Position Summation Unit
Oleo Disengage Switch

1.6.2.10 Wing Tip Fold Actuation

Hydraulic Motors
Position Sensors
Position Summation Unit
Limit Switches
Gear Trains
Motor Interconnects
Hinges
Hydraulic Flow Regulators

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: FLIGHT CONTROL WBS CODE: 1.6

WBS LEVELS
4 5 6 7 8

1.6.3 Flight Augmentation Control System

1.6.3.1 FACS Panel

Mode Selector Switches
Engage/Disengage Switch
Trim for Take-Off Light
FACS Engage Light
Lateral Bobweight Switch

1.6.3.2 FACS Computer

Stabilization Generator
Input Control
System Monitors
Rate Limiter
Command Output
Signal Conditioning
Power Supply

1.6.3.3 Linear Displacement Transducer

1.6.3.4 Linear Guarded Transducer

1.6.3.5 Rotary Pitch Trim Transducer

1.6.3.6 Pitch Augmentation Servo Actuator

1.6.3.7 Roll Augmentation Servo Actuator

1.6.3.8 Yaw Augmentation Servo Actuator

1.6.4 Ground Tests

1.6.4.1 Flight Control Simulator

1.6.4.2 Test Beds

1.6.4.3 Mockups

1.6.4.4 Wind Tunnel

TECHNICAL DESCRIPTION

SUBSYSTEM: FLIGHT CONTROL WBS CODE: 1.6

The B-70 control surfaces, developed to provide long-range supersonic cruise capability, featured a thin low aspect ratio delta-wing with folding tips, elevon surfaces for combined pitch-roll maneuvering, twin vertical stabilizers with rudders, and a movable canard-type horizontal stabilizer with trailing edge flaps. Exhibit 1, page IV-131, presents the various aerodynamic surfaces of the B-70 used for control of the air vehicle. The folding wing tips (three positions) offered the advantages of providing satisfactory directional stability without the necessity of using large vertical stabilizers and resulted in less drag and lower control power requirements. As discussed under Wing Structures (WBS 1.1.2), the folding wing tips also minimized supersonic speed trim drag due to reduced longitudinal stability caused by the forward shift in the aerodynamic load centroid.

The elevons, which consisted of six segmented surfaces on each wing, provided pitch control through symmetrical movement and roll control through differential movement. The elevons were segmented to minimize the effects of wing spanwise bending with the two outboard segments (wing fold portion) returned to neutral when the tips were folded. Exhibit 2, page IV-132, presents an elevon compartment showing three elevon segments. The yaw control was provided by twin canted-hinge rudders that were actuated in unison. The twin rudder configuration was chosen over a conventional design due to an overall system weight savings. Flaps were provided on the canard type horizontal stabilizer for use during takeoffs and landings. As discussed under Horizontal Stabilizer Structures (WBS 1.1.1), the nose-up pitching moment of the horizontal stabilizer flaps was balanced by positive lift and the nose-down movement of the elevons resulted in increased overall lift for a given attitude. This phenomenon reduced the angle-of-attack (relatively) for landing approaches and increased the visibility.

The selection of the systems for the control of the B-70 aerodynamics surfaces was based largely upon specific airframe and aerodynamic characteristics. The aerodynamic characteristics indicated the functions which had to be provided by the control system to obtain optimum flying qualities while the airframe dictated the methods of accomplishing the function. The dynamic stability, surface effectiveness, and speed stability were the aerodynamic characteristics which influenced selection while air vehicle length, flexibility, and surface configuration were airframe characteristics which had to be considered. In addition, the air vehicle mission, as related to vulnerability, survivability, and pilot work load, also influenced the selection of control systems.

The unaugmented damping and response characteristics of the B-70 were adequate to perform the mission. However, in the pitch axis, both pitch rate and normal acceleration were sensed and surfaces moved accordingly to improve the dynamic longitudinal stability. In roll and yaw axes, roll rate and yaw rate only were sensed to generate damping signals. In addition, altitude scheduling was used in the pitch and yaw axes to compensate for variations in damping.

The forward horizontal stabilizer was simultaneously operated with the elevons for pitch control to provide essentially a constant effectivity over the entire speed range. The forward horizontal stabilizer effectivity increased in the high speed range and compensated for the deterioration in elevon effectivity. Conversely, during low speed flight, elevon effectiveness compensated for the deterioration in the canard effectivity. In roll, the pilot wheel force and roll rate were combined to obtain a roll rate command loop while in the yaw axis, pedal-to-surface gearing was modified by the landing gear position to compensate for the variation in rudder effectiveness. Large pitch and roll surface movements were utilized to provide damping and control sensitivity compensation. Since the hardover failure of a large authority servo was unsafe, the holding capability of dual tandem actuators under failure conditions were utilized to provide safety. In yaw, limited authority servos provided satisfactory performance and fail safety over the flight range. The flight control systems were designed to have sufficiently fine resolution and small amplitude controllability to provide adequate control at high effectiveness flight conditions encountered during the B-70 mission.

The extreme length of the B-70 necessitated special design features in the flight control systems. For minimum friction felt by the pilot and minimum freeplay by the differential servo operating loop, master cylinders were provided in the pitch and roll control systems. The master cylinder also provided a ground point for augmentation inputs. The B-70 flexibility was another factor in the design of the flight control. The cable routing and effective system balance were designed to minimize the induced surface motions due to fuselage vibration and flextures. Surface actuators and augmentation servos were selected with natural frequencies and maximum rates which would not excite fuselage natural modes of oscillation. Augmentation sensors were located at a point along the fuselage where the combined fuselage bending and air vehicle motions experienced by the sensors resulted in optimum damping. The selection of gains and provisions of adequate filtering were required to insure stability of the higher order flexible modes.

The Flight Control Subsystem of the B-70 consisted of the Primary, Secondary, and Flight Augmentation Control Systems. The Primary Flight Control System (PFCS) was the mechanical and hydromechanical connection from the pilot's control to the control surfaces. The Secondary Flight Control System (SFCS) was the pitch, roll, and yaw trim control, the flap control, and the wing folding control. The Flight Augmentation Control System (FACS) was the electronic system containing air vehicle response sensors and hydromechanical servos which, operating through the PFCS, provided augmentation and damping functions to the air vehicle. Each of these systems are discussed in subsequent paragraphs as identified by the WBS.

FLIGHT CONTROLS
PRIMARY & SECONDARY

- PRIMARY
  - CANARD, ELEVONS & VERTICAL STABILIZERS
    - PITCH, ROLL & YAW CONTROL
    - PRIMARY HYDRAULIC SYSTEMS 1 & 2
- SECONDARY
  - CANARD, ELEVONS & VERTICAL STABILIZERS
    - PITCH & ROLL STAND-BY TRIM & YAW NORMAL TRIM
    - UTILITY HYDRAULIC SYSTEMS 1 & 2
  - FLAPS
    - LIFT FOR TAKE-OFF & BRAKING FOR LANDING
    - UTILITY HYDRAULIC SYSTEMS 1 & 2
  - WING FOLD TIP
    - MACH 3 FLIGHT STABILITY
    - PRIMARY HYDRAULIC SYSTEMS 1 & 2

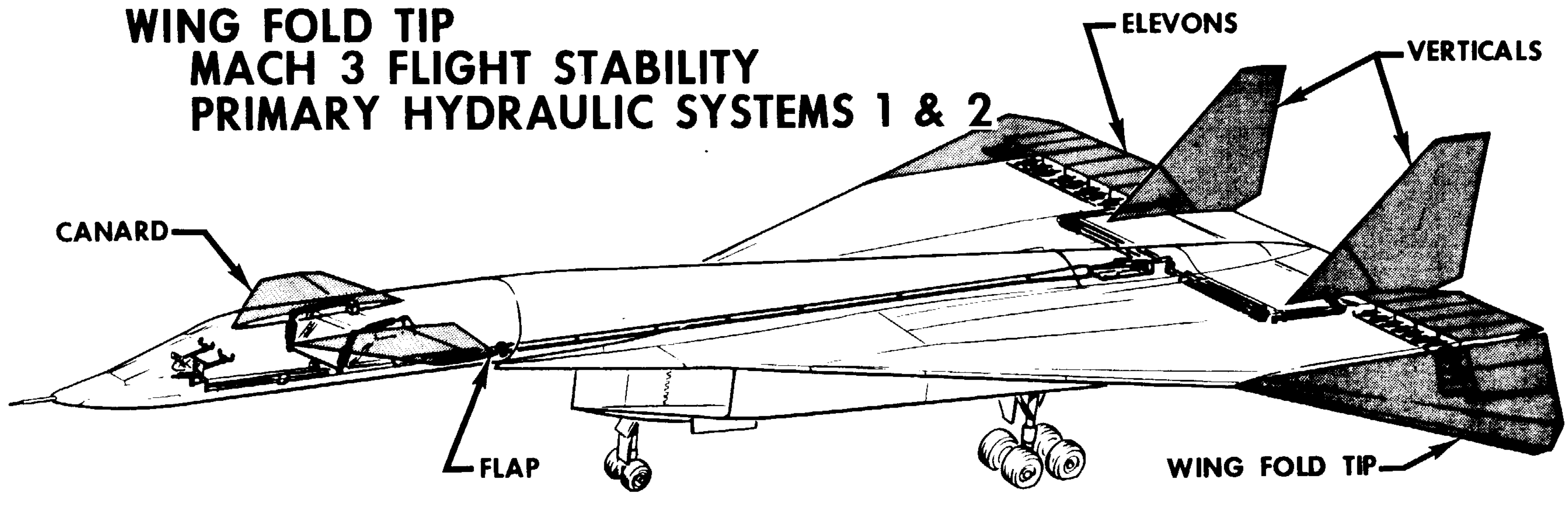


EXHIBIT 1

EXHIBIT 2

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: FLIGHT CONTROL SUBSYSTEM WBS CODE: 1.6

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	POUNDS	7751	NOT AVAIL	NOT AVAIL	7610	7705
MAJOR SUBSYSTEM	TYPE	PRIMARY SECONDARY FACS AFCS	PRIMARY → SECONDARY → FACS → -	→ → → -	→ → → -	→ → → -
POWER SOURCE	SPECIFY	HYDRAULIC 4000 PSI ELECTRIC-AC 400 CPS	→	→	→	→
TEMPERATURE - DESIGN RANGE	DEGREES F	-65 TO 630 (SKIN)	→	→	→	→
SPEED - MAX DESIGN	MACH NO.	3	→	→	→	→
ALTITUDE - MAX DESIGN	FEET	110,000	80,000	→	→	→
AIR LOADS (Q) - MAX DESIGN	POUNDS/FT^2	1,550	→	→	→	→
RELIABILITY FACTOR	NONE	.99813	→	→	→	→
MTBF	NO. OF HR	935	→	→	→	→

TECHNICAL DESCRIPTION

SUBSYSTEM: FLIGHT CONTROL WBS CODE: 1.6

MAJOR ASSEMBLY: PRIMARY FLIGHT CONTROL SYSTEM WBS CODE: 1.6.1

The Primary Flight Control System (PFCS) consisted of mechanical and hydro-mechanical components extending from the pilot's controls to and including the hydraulic actuators which powered the aerodynamic surfaces. The PFCS also incorporated provisions for receiving inputs from the Flight Augmentation Control System (FACS) servocylinders and for displacement of the neutral (zero force) position by the Secondary Flight Control System (SFCS). Full control of the air vehicle throughout its entire flight envelope was provided placing no restrictions on the air vehicle with respect to allowable or attainable limits of altitude, speed, range, rate of climb, normal acceleration, and environment operating conditions.

The PFCS pitch and roll control components consisted essentially of inter-connected control columns and associated wheels, feel system, cable system, mechanical mixer, pitch and roll master cylinders, horizontal stabilizer surface actuators, elevon surface actuators, override bungees, and an elevon control fold mechanism. The control column and wheel for the pilot and copilot were interconnected and moved in unison. The wheel was a twin-grip, two-spoke, cast magnesium structure. Integrally attached to the wheel was a rotary transmitter, two push button switches, a rocker arm switch, and internal wiring. A special pilot's control wheel was provided for flight testing purposes and contained, in addition to the above, an instrumentation record switch, event marker, and force measuring instrumentation for pitch and roll. The control wheel attached to the control column by means of a shaft which was in turn connected to a lower offset control column shaft by means of a gear drive. A ball bearing assembly arrangement within the control column permitted linear movement of the control column shaft and transmitted rotary motion of the control column shaft. Each control column had its individual column stowage mechanism. Stowage was accomplished either manually or automatically and the mechanism consisted of a locking device, a manual plunger integral with the column support assembly, a thruster and an engagement mechanism. Exhibit 3, page IV-139, and Exhibit 4, page IV-140, present views of the cockpit showing the control columns and wheels.

In the pitch system, artificial feel was provided by a dynamic pressure bellows with contribution toward feel from an overcenter spring, a hydraulic damper, and a bobweight. In the roll system, artificial feel was provided by a single-acting overcenter, compression spring type feel bungee. The artificial feel for the yaw system was provided by a double-acting spring type feel bungee.

The cables used throughout the pitch and roll systems were steel clad (stainless steel tubing swaged over stainless steel cable) with the exception of the cross ship cables between the horizontal stabilizer actuators, which were bare stainless steel flexible cables. At approximately ten foot intervals in the forward cable system, each control cable was supported by a three-roller carriage running in a limited length cylindrical tube. Six such cylindrical tubes were in turn commonly affixed to a guided carriage which could be withdrawn from the aft end of the integral control tunnel that extended through the fuel cells. Spaced equally between the cable supports in the forward cable system were control cable fairleads affixed to each of nine guided carriages. Forward of the control tunnel the cable fairleads were interspaced between the supports and seals. The cable seal was a round shaft positioned within a cylindrical spacer with a minimum of radial clearance. The close dimensionally controlled radial clearance between the shaft and the spacer resulted in a controlled leakage through the seals. The cable tension regulator consisted of three separate four-bar parallelogram linkages supported by an idler bell crank. Primary flight commands were transmitted through each respective parallelogram linkage; cable tension regulation provided by compression bungees was transmitted through the rotatable idler bell crank.

The mechanical mixer was a four-bar parallelogram linkage supported by an idler bell crank. Roll commands were transmitted through the parallelogram linkage while the pitch commands were transmitted through the idler bell crank. The pitch and roll master cylinders were of the stationary, dual tandem, hydraulically unbalanced type supplied simultaneously by primary hydraulic systems No. 1 and No. 2. The dual servo valve was mounted on the cylinder and was controlled by an external follow-up linkage. The horizontal stabilizer actuators were of the dual tandem, unbalanced type controlled by an external follow-up linkage. Exhibit 5, page IV-141 presents a view showing part of the mixer bay.

Each elevon segment was actuated by two single system hydraulically balanced actuators. Power to one actuator per segment was supplied by primary hydraulic system No. 1 while the other actuator was supplied by primary hydraulic system No. 2. The inboard elevon segment actuators in each wing received inputs from the pitch and roll control systems. The actuators of the remaining elevon segments were controlled from the output side of the outboard actuator of the inboard elevon segment. Each actuator had a single servo valve and was controlled by an external follow-up linkage. The actuator valves were linked together through the input control linkage so that simultaneous movement of all actuators in each wing was effected. Exhibit 6, page IV-142, presents a view showing an elevon compartment and the elevon actuators. The elevon control mechanism at the wing tip fold consisted of a linkage which provided the function of disengaging and centering the outboard elevon linkage during the wing folding operation. This was essentially two bell cranks double acting type utilizing a single compression spring. Each override bungee had a preload sufficient to produce an unjamming force on any servo valve spool within the respective system.

The manual pitch and roll inputs were transmitted from the control column and wheel through mechanical elements and master cylinders to full-powered irreversible surface actuators. From the control wheel to the mechanical mixer the manual pitch and roll inputs were separated. From the mixer to the surface actuators the input motion was either pitch or roll or a combination of both. The pitch differential servo and pitch master cylinder combined outputs exceeded available surface travel. This excess travel, when it occurred, was absorbed by the pitch override bungee. The roll override bungee provided the same function in the roll axis, however, its preload was lower that the pitch override bungee to prevent reduction of pitch commands through roll inputs. The cable supports maintained cable alignment and prevented excessive catenary sag of the control cables. The three-roller carriage was constructed so that minimum of control system friction was obtained. In the event of loss of cable rig, the fairleads afforded push-pull transmission of pilot commands to overcome the normal operating loads of the control valves. The cable tnesion regulator allowed independent pitch, roll, and yaw primary flight control operation while maintaining cable tension in all axes. The regulator compensated not only for the effect of changes in temperature (-65°F to 450°F), but also for deflection of structure under air loading. Motion of the regulator did not induce primary flight control commands.

The mechanical mixer was capable of receiving roll command inputs or pitch command inputs individually or simultaneously and issuing outputs to cause elevon controls to move differentially for roll or symmetrically for pitch commands. Stops were located at the mechanical mixer parallelogram linkage to limit roll motion while the linkage connected to the idler bell crank had stops to limit the pitch motion.

The portion of the PFCS which provided manual control to the rudders was referred to as yaw control. The yaw control consisted essentially of pilot and copilot interconnected rudder pedals, cable system, yaw gearing changer system, yaw override bungee, and rudder actuators. The rudder pedals were of rectangular cast lattice construction with adequate width to accommodate a heavily-booted foot and at a height such that braking pressure could be applied by the most desirable portion of the foot. The pedals were pivoted about the lower edge and suspended from a set of links which provided essentially straight line motion of the pedal. Angular altitude of the pedal was dictated by the brake rod bungee. A rotary pedal position adjustment knob, actuation of which adjusted both pedals simultaneously, was provided on the pedal support structure at the centerline of each crew station.

The yaw gearing changer system consisted of a changer actuator and connecting linkages. The actuator was a dual-tandem, unbalanced, hydraulic actuator with an integral valve that was operated by landing gear pressure. Built-in flow restrictors slowed the shifting of pedal-to-surface gearing to an operating time of 5 to 10 seconds. The changer linkage was essentially a four bar linkage whose input link had a fixed pivot and whose movable output link pivot was positioned by the actuator. A change in position of the movable pivot resulted in a change of gearing between input and output arms of the changer. Stops on the input arm of the changer provided limits for the combined yaw command inputs of the pedals and the FACS servocylinders. Such yaw input commands were accordingly transmitted through the changer linkage and were modified only when the landing gear was up and a resulting change in gearing of the input and output arms of the changer linkage had been made. Each rudder was actuated by a dual tandem, unbalanced, hydraulic actuator with a dual servo valve controlled by an external follow-up linkage. Power to the actuators was supplied simultaneously by primary hydraulic systems No. 1 and No. 2.

Pedal deflections for yaw control were transmitted through mechanical elements directly to the control valves on the rudder actuators. The inputs could be modified by motion of the FACS yaw servocylinders. The yaw control pedals provided for the pilot and copilot were interlinked in the cockpit region so that operation of one pedal resulted in movement of all pedals in the applicable direction. Travel was essentially linear and parallel to the cabin floor. Angular altitude of the pedal varied throughout the range of travel to afford a relaxed ankle position. The air vehicle wheel braking utilizes electrical control consisting of dual linear potentiometers that were integral with the brake feel bungees.

The ancillary control was an electrical control which operated in parallel with the mechanical portions of the PFCS aft of the master cylinders in the pitch and roll axes. The ancillary system consisted of two separate control channels, one for operating in parallel with the right-hand elevon cable system and the other operated in parallel with the left-hand elevon cable system. Each channel was composed of a valve driver, a servocylinder, an override bungee, and linear displacement transducers. The valve drivers were transistorized and packaged or printed circuit boards of modular form. The electronics were located in the FACS yaw-roll computer. The servocylinder was composed of a single-piston, rotary-output, balanced, hydraulic cylinder and a four way electro-mechanical servovalve. The ancillary servocylinder was mounted directly on the inboard elevon surface actuator and received hydraulic power through face seals in its mounting. The ancillary control utilized eight rectilinear, variable-permeance transducers to indicate the shaft position of the pitch and roll master cylinders, pitch and roll differential servos, and the ancillary actuators. The ancillary override bungee was a double-acting, preloaded compression spring which tied the ancillary servocylinder output to the mechanical portion of the PFCS.

For roll commands, the right hand and left hand ancillary actuators were driven differentially by the transducer outputs produced by shaft displacement of the roll master cylinder and/or roll differential servocylinder. Master cylinder and differential servo position were sensed by dualized linear transducers which were shared with the FACS roll axis. Excitation of each channel of FACS was 180 electrical degrees out of phase with each other. Thus a given roll input produced two singles equal in magnitude but 180 degrees apart. Outputs of the roll master cylinder and differential servo in one channel were fed to the right hand ancillary valve driver, and those in the other channel to the left hand ancillary valve driver. Consequently, since the ancillary valve drivers utilized a common reference supply, and the control valves were connected in the same manner, the 180 degree shift in signal phase caused the ancillary servo cylinders to drive in opposite directions to operate the surfaces as ailerons. For pitch commands, a pitch master cylinder position transducer and a pitch differential servo position transducer, which was independent of the FACS pitch axis, were electronically summed. The resultant output signal controlled both ancillary valve drivers. Since the signal to both valve drivers were identical in both magnitude and phase, the ancillary actuators were driven in unison to operate the surfaces as elevators. For normal operation the ancillary control operated in unison with the PFS and only assumed control if the mechanical portion became disconnected.

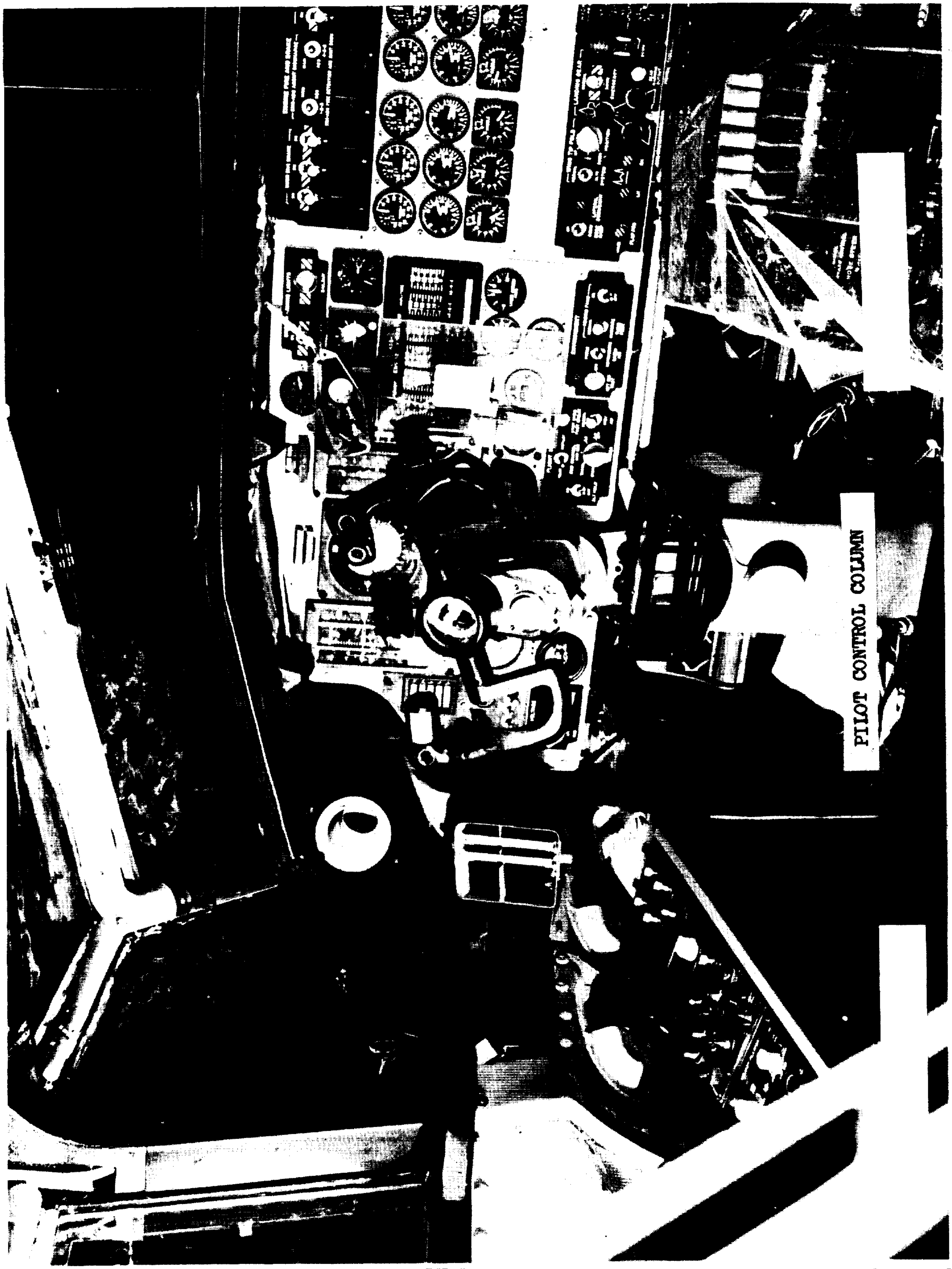
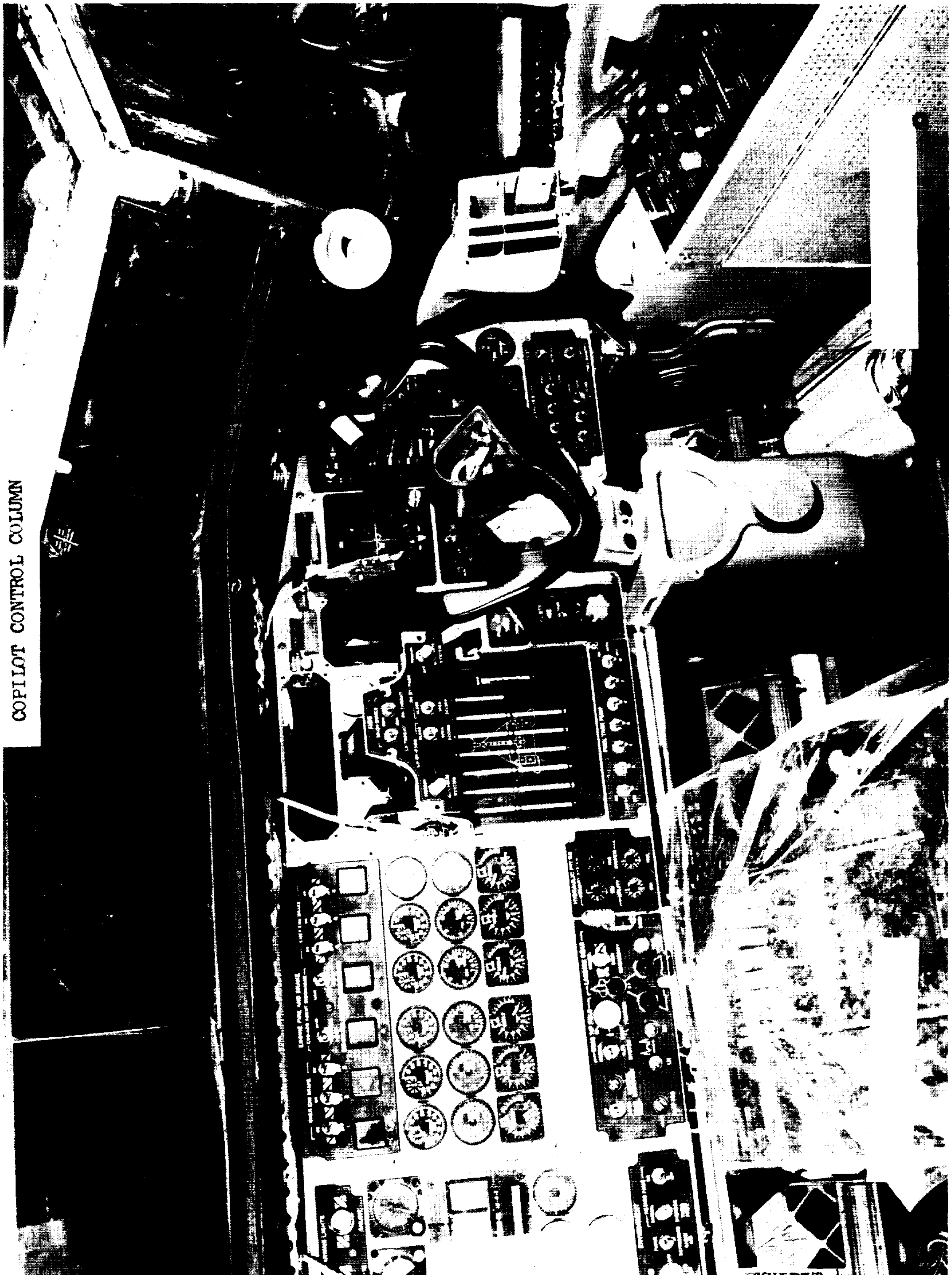


EXHIBIT 3



COPILOT CONTROL COLUMN

EXHIBIT 4

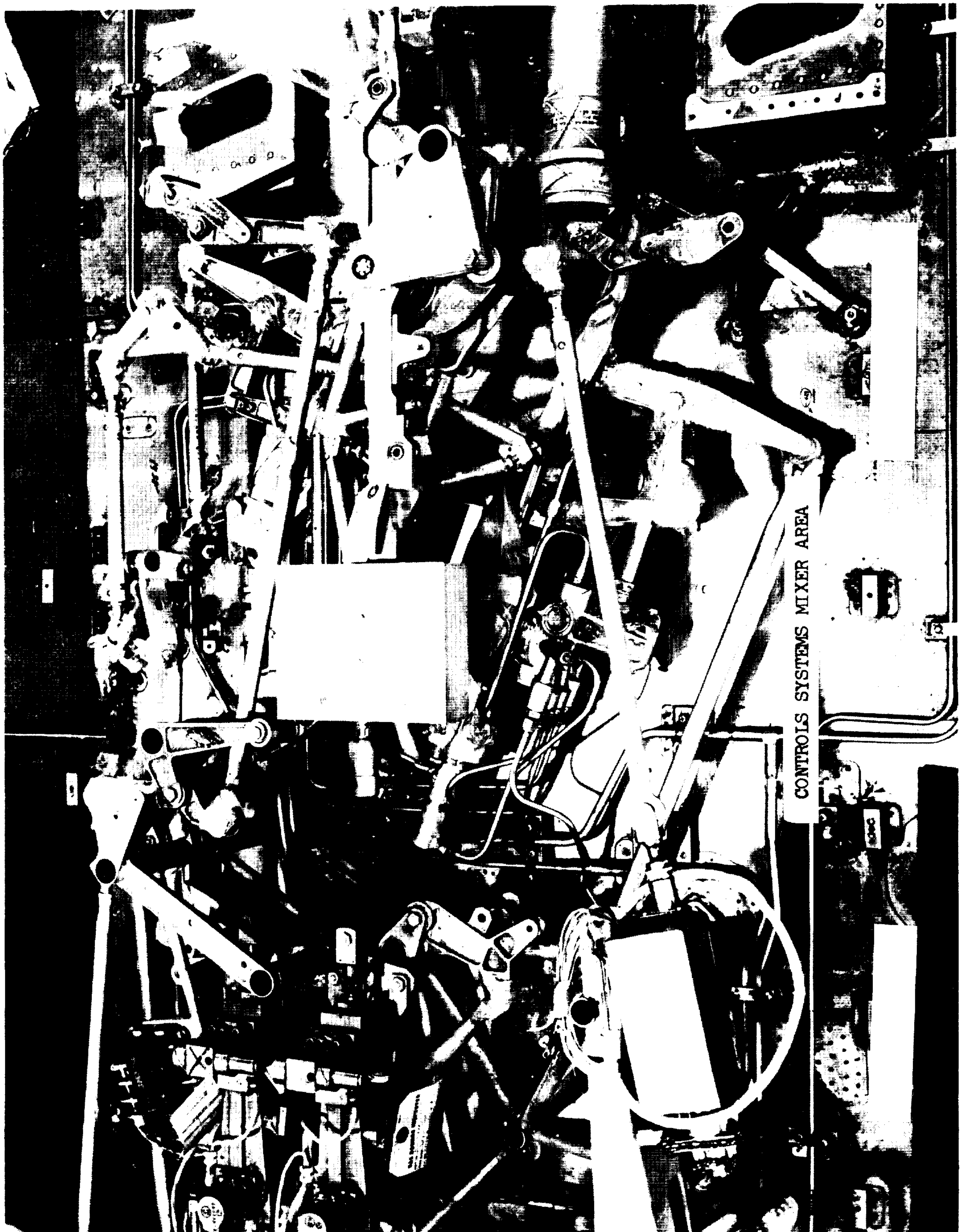


EXHIBIT 5


ELEVON ACTUATORS
EXHIBIT 6

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: PRIMARY FLIGHT CONTROL WBS CODE: 1.6.1

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	POUNDS	4,236	NOT AVAIL	NOT AVAIL	4,433	4,502
CREW CONTROL STATIONS	NUMBER	2	→	→	→	→
CREW LATERAL CONTROL	TYPE	WHEEL	→	→	→	→
CREW LONGITUDINAL CONTROL	TYPE	COLUMN	→	→	→	→
CREW YAW CONTROL	TYPE	PEDALS	→	→	→	→
FEEL FORCE	TYPE	ARTIFICIAL BOBWEIGHT	→	→	→	→
"G" GRADIENT FORCE	LBS/"G"	45 CONSTANT	45 CONSTANT	35 TO 45	→	→
WHEEL TRAVEL	DEGREES	± 90°	→	→	→	→
COLUMN TRAVEL	LINEAR/EQUIV.-DEGREES	9.625 INCHES 27 DEGREES	→	→	→	→
PRIMARY CONTROL TRANSMISSION	TYPE	LOCKCLAD CABLE AND LINKAGE PILOT ASSISTED	→	→	→	→
BACK-UP CONTROL TRANSMISSION	TYPE	DUAL MECH. FACS ELECT	→	→	→	→

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: PRIMARY FLIGHT CONTROL WBS CODE: 1.6.1

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
CABLE LENGTH	FEET	FWD 130 AFT 33	→	→	→	→
CABLE DIAMETER	INCHES	1/8 DIA (.201 DIA CLAD) STAINLESS	→	→	→	→
CONTROL SURFACES	TYPE/NO.	ELEVON/12 RUDDER/2 STABILIZER/1	→	→	→	→
CONTROL SURFACE AREAS	$FEET^2$	ELEVONS 396 RUDDER 468 STABILIZER 415	→	→	→	→
RUDDER TRAVEL (GEAR DOWN)	DEGREES	$\pm$ 12	→	→	→	→
RUDDER TRAVEL (GEAR UP)	DEGREES	$\pm$ 3	→	→	→	→
POWER SOURCE	SPECIFY	DUAL HYD. 4000 PSI	→	→	→	→
MAX TRAVEL RATE - PITCH	DEGREES/SEC	28 (SURF)	→	→	→	→
MAX TRAVEL RATE - ROLL	DEGREES/SEC	SURFACE DIFFERENTIAL 56	→	→	→	→

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: PRIMARY FLIGHT CONTROL WBS CODE: 1.6.1

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
MAX TRAVEL RATE - YAW	DEGREES/SEC	12 (SURF.) →	→	→	→	→
TEMPERATURE - DESIGN RANGE	DEGREES F	630 (SKIN) →	→	→	→	→
ACTUATORS	TYPE/NO.	SINGLE BAL/ 24 DUAL UNBAL/ 4 →	→	→	→	→
ACTUATOR SEALS	TYPE	METAL →	→	→	→	→
ACTUATOR WORKING PRESSURE	PSI	4000 PSI →	→	→	→	→
HYD FLOW REQUIRED - DESIGN MAX	GPM	88.2 EACH OF SIX PUMPS →	→	→	→	→
ELEC PWR REQUIRED - DESIGN MAX	AMPS, VOLTS	660	660	660	750	750
RELIABILITY FACTOR	NONE	.99990 →	→	→	→	→
MTBF	NO. OR HR.	17500 HR →	→	→	→	→

TECHNICAL DESCRIPTION

SUBSYSTEM: FLIGHT CONTROL WBS CODE: 1.6

MAJOR ASSEMBLY: SECONDARY FLIGHT CONTROL WBS CODE: 1.6.2

The secondary flight control system (SFCS) consisted of those components required to provide the functions of trim in the pitch, roll, and yaw axes and operation of the flaps and wing folding tips.

Two linear electro-mechanical pitch trim actuators were utilized. They consisted of 115V 3-phase motor and associated gearing. A linear position transducer was mounted on the primary pitch trim actuator to indicate actuator shaft position. There were two modes of pitch trim, namely primary trim and standby trim. Primary trim,controlled by a knob on each control wheel,was proportional to the knob rotation. Standby trim,controlled by a three position switch,was accomplished by actuation of the momentary switch until the desired trim position was attained. The controls for actuating standby trim and located on the FACS panel are shown in Exhibit 7, page IV-147.

There were two means provided for establishing lateral trim. The controls were located on the center aisle console. A primary roll trim knob was used to provide position trim and a three-position switch was used to provide standby (rate) trim. The knob operation provided an output through the flight augmentation control system (FACS) to reposition the elevons.

The control for directional trim was provided by a three-position switch on the center aisle console. This control, when operated, caused the trim actuator to move at a fixed rate which repositioned the zero force point of the directional control feel bungee.

A trim for the takeoff (TTO) push button was mounted on the FACS control panel to provide the pilot with a quick and easy method of positioning the primary surfaces for takeoff. Pressing and holding the TTO would automatically position all the air vehicle primary control surfaces to their respective takeoff positions. The TTO button would illuminate when all surfaces were properly positioned for takeoff and the flaps were lowered.

FLIGHT AUGMENTATION CONTROL PANEL

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: SECONDARY FLIGHT CONTROL WBS CODE: 1.6.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	POUNDS	3145	NOT AVAIL	NOT AVAIL	2818	2842
CREW CONTROL STATIONS	NUMBER	2				
ELEVON TRIM TRAVEL - PITCH	DEGREES	25 UP 15 DN	25 UP 15 DN	25 UP 15 DN	25 UP 15 ND	20 UP 20 DN
ELEVON TRIM TRAVEL - DIFF	DEGREES	$\pm 7.5^{\circ}$	→	→	→	→
STAND-BY TRIM TRAVEL	DEGREES	25 UP 15 DN	25 UP 15DN	25 UP 15 DN	25 UP 15 DN	20 UP 20 DN
PITCH TRIM MOTORS	TYPE/NO.	ELECTRO-MECHANICAL 2 REQ. 115 VAC 3 PH.	→	→	→	→
ROLL TRIM MOTORS	TYPE/NO.	ELECTRO-MECHANICAL 2 REQ. 115 VAC 3 PH	→	→	→	→
YAW TRIM TRAVEL	DEGREES	FLAPS UP $\pm$ 5.6 FLAPS DN $\pm$ 1.4	→	→	→	→
YAW TRIM MOTOR	TYPE/NO.	ELECTRO-MECH 115 VAC 3 PH	→	→	→	→

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: SECONDARY FLIGHT CONTROL　　WBS CODE: 1.6.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
TRIM ACTUATORS	TYPE/NO.	ELECTRO-MECH 4 REQ.				
PITCH TRIM ELEC POWER REQUIRED	AMPS, VOLTS	200 VA				
ROLL TRIM ELEC POWER REQUIRED	AMPS, VOLTS	200 VA				
YAW TRIM ELEC POWER REQUIRED	AMPS, VOLTS	200 VA				
PITCH TRIM MAX RATE	DEGRESS PER SECOND	1.5 STANDBY				
ROLL TRIM MAX RATE	DEGREES PER SECOND	2.0 DIFF STANDBY				
YAW TRIM MAX RATE	DEGREES PER SECOND	1 GEAR UP 4 GEAR DN				
TRIM SIGNAL TRANSMISSION	TYPE	ELECTRICAL ANALOG				
TEMPERATURE - DESIGN RANGE	DEGREES F	-65 TO 475				
FLAPS POSITION MOTOR	TYPE/NO	LINEAR HYDRAULIC ACTUATOR				
FLAP POSITION TRAVEL	DEGREES	20				

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: SECONDARY FLIGHT CONTROL WBS CODE: 1.6.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
FLAP ACTUATOR	TYPE/NO.	TANDEM UNBALANCED 2 REQ.	→	→	→	→
TRIM POSITION SENSORS	TYPE/NO.	LINEAR ELECT (LVDT) 8 REQ.	→	→	→	→
WING-TIP FOLD TRAVEL - MAX	DEGREES	70 @ 1.04°/SEC	70 @ 1.04°/SEC	65 @ 1.04°/SEC	→	→
WING TIP FOLD TRAVEL - INTERMED	DEGREES	25	→	→	→	→
WING-TIP FOLD ACTUATOR	TYPE/NO.	HYD. MOTORS-EPICYCLIC GEARING MECHANICAL ONE PER	→	→	→	→
WING-TIP FOLD GEARING RATIO	NONE	31812 TO 1	→	→	→	→
WING-TIP FOLD POS SENSORS	TYPE/NO.	ROTARY SYNCHRO ELECTRICAL 2 REQ.	→	→	→	→
HYD PRESS. - WING-TIP FOLD	PSI	4000 PSI	→	→	→	→
HYD FLOW - WING-TIP FOLD	GPM	33.4	→	→	→	→

* LINEAR VELOCITY DISPLACEMENT TRANSDUCER

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: SECONDARY FLIGHT CONTROL WBS CODE: 1.6.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
ELEVON TRIM RESOLUTION - T.O.	DEGREES	± 0.1 →				
ROLL TRIM CENTERING - T.O.	DEGREES	± 0.1 →				
YAW TRIM CENTERING - T.O.	DEGREES	± 0.1 →				
HORIZ STAB. RESOLUTION - T.O.	DEGREES	± 0.05 →				
TRIM FOR TAKEOFF CONTROL	TYPE	SINGLE POINT THROUGH FACS →				
PITCH TRIM CONTROLS	TYPE/NO.	POSITION WITH RATE STANDBY (DUAL) →				
ROLL TRIM CONTROLS	TYPE/NO.	POSITION (DUAL) →				
YAW TRIM CONTROLS	TYPE/NO.	RATE (SINGLE) →				
RELIABILITY FACTOR	NONE	-	-	.99823	.99823	.99823
MTBF	NO. OF HR.	-	-	988	988	988

TECHNICAL DESCRIPTION

SUBSYSTEM: FLIGHT CONTROL WBS CODE: 1.6

MAJOR ASSEMBLY: FLIGHT AUGMENTATION CONTROL SYSTEM (FACS) WBS CODE: 1.6.3

The FACS augments basic air vehicle control characteristics in three axes to provide improved manual control and maneuverability throughout the flight envelope. The functions of the FACS were dynamic stability augmentation, maneuver control augmentation, speed stability augmentation, primary roll trim and trim for take-off.

The FACS was designed as an electrical control system operating in parallel with the mechanical primary flight control system to enhance flight control performance of the air vehicle. The FACS was designed to transform pilot inputs and air vehicle motion into electrical signals which drive the air vehicle surfaces through the differential servocylinders to produce the desired damping, maneuver control, and trim characteristics. In each axis the FACS servocylinder, controlled by these signals, was in effect series-mounted with respect to the mechanical primary flight control system and was free to add or subtract from pilot inputs to the mechanical system.

The FACS pitch axis was designed to transform pilot column deflection and air vehicle motion about the pitch axis into displacements of the pitch servocylinder. The column and air vehicle motion inputs were sensed independently by two identical channels of transducers and electronics, and the resultant electrical signals then fed into separate servo valves on the pitch servocylinder. The servocylinder shaft displacement commanded by these signals then would drive the mechanical control system linkages.

The FACS roll axis was designed to transform pilot wheel rotation, primary trim inputs, and air vehicle motion about the air vehicle roll axis into displacements of the roll servocylinder. The wheel and air vehicle motion inputs were sensed independently by two identical channels of transducers and electronics, and the resultant electrical signals fed into separate servovalves on the roll servocylinder. The servocylinder shaft displacement commanded by these signals then would drive the mechanical control system linkages.

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: FLIGHT AUGMENTATION CONTROL SUBSYSTEM (FACS) WBS CODE: 1.6.3

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	POUNDS	370	NOT AVAIL	NOT AVAIL	359	361
CREW CONTROL STATIONS	NUMBER	2 →	→	→	→	→
CONTROL PARAMETERS	TYPE					
PITCH		TRIM POS COLUMN POS RATE ACCELERATION SERVO POS FLOW INTEG	→	→	→	→
ROLL		TRIM COMMAND WHEEL POS RATE SERVO POS FLOW INTEG	→	→	→	→
YAW		RATE SERVO POS	→	→	→	→
FREQUENCY RESPONSE - PITCH	HERTZ	10	10	SHAPED TO 1.6 →	→	→
FREQUENCY RESPONSE - ROLL	HERTZ	10 →	→	→	→	→
FREQUENCY RESPONSE - YAW	HERTZ	10 →	→	→	→	→

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: FLIGHT AUGMENTATION CONTROL SUBSYSTEM (FACS) WBS CODE: 1.6.3

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
PITCH SERVO	TYPE/NO.	TANDEM UNBALANCED 1	→	→	→	→
ROLL SERVO	TYPE/NO.	TANDEM UNBALANCED 1	→	→	→	→
YAW SERVO	TYPE/NO.	SINGLE BALANCED 2	→	→	→	→
POWER SOURCE	TYPE	4000 PSI 400 CPS.AC	→	→	→	→
HYDRAULIC FLOW DEMAND - MAX	GPM	5.4	→	→	→	→
ELEC POWER DEMAND - MAX	AMPS, VOLTS	660 VA	→	→	→	→
NORMAL ACCELEROMETER	TYPE/NO.	FLUID DAMPED PENDULOUS MASS, A.C. PICKOFF	→	→	→	→
NORMAL ACCEL FREQ RESPONSE	HERTZ	16 OR LESS	→	→	→	→
NORMAL ACCELERATION RANGE	$FEET/SEC^2$	+128 TO -32	→	→	→	→

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: FLIGHT AUGMENTATION CONTROL SUBSYSTEM (FACS) WBS CODE: 1.6.3

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
PITCH RATE GYRO	TYPE	FLUID DAMPED AC PICKOFF	→	→	→	→
PITCH RATE GYRO FREQ RESPONSE	HERTZ	ABOVE 30	→	→	→	→
PITCH RATE GYRO HYSTERESIS	% OF FS	0.3	→	→	→	→
PITCH RATE GYRO LINEARITY	% OF FS	0.3	→	→	→	→
ROLL RATE GYRO	TYPE	FLUID DAMPED AC PICKOFF	→	→	→	→
ROLL RATE GYRO FREQ RESPONSE	HERTZ	ABOVE 30	→	→	→	→
ROLL RATE GYRO HYSTERESIS	% OF FS	0.3	→	→	→	→
ROLL RATE GYRO LINEARITY	% OF FS	0.3	→	→	→	→
YAW RATE GYRO	TYPE	FLUID DAMPED AC PICKOFF	→	→	→	→
YAW RATE GYRO FREQ RESPONSE	HERTZ	ABOVE 30	→	→	→	→
YAW RATE GYRO HYSTERESIS	% OF FS	0.3	→	→	→	→
YAW RATE GYRO LINEARITY	% OF FS	0.3	→	→	→	→
PITCH MAX RATE LIMITING	DEGREES/SEC	28	→	→	→	→

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: FLIGHT AUGMENTATION CONTROL SUBSYSTEM (FACS) WBS CODE: 1.6.3

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
ROLL MAX RATE LIMITING	DEGREES/SEC	56 DIFFERENTIAL	→	→	→	→
YAW MAX RATE LIMITING	DEGREES/SEC	12	→	→	→	→
PITCH MAX DISPLACEMENT	DEGREES	40	40	40	20	20
ROLL MAX DISPLACEMENT	DEGREES	30	→	→	→	→
YAW MAX DISPLACEMENT	DEGREES	GEAR UP = 1 GEAR DN = 4	→	→	→	→
LINEAR DISPLACEMENT XDUCERS	TYPE/NO.	LVDT * 6	→	→	→	→
LINEAR GUARDED XDUCERS	TYPE/NO.	LVDT * 13	→	→	→	→
ROTARY PITCH TRIM XDUCERS	TYPE/NO.	CONTROL TRANSFORMER 2	→	→	→	→
NUMBER OF DISPLAYS	NUMBER	3	→	→	→	→
NUMBER OF CONTROLS	NUMBER	3	→	→	→	→
EMERGENCY DISENGAGE	TYPE	ON-OFF ELECTRICAL SWITCH	→	→	→	→

*LINEAR VELOCITY DISPLACEMENT TRANSDUCERS

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: FLIGHT AUGMENTATION CONTROL SUBSYSTEM (FACS) WBS CODE: 1.6.3

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
RELIABILITY FACTOR	NONE			.999985	.999985	.999985
MTBF	NO. OF HR			117,450	117,450	117,450

TECHNICAL DESCRIPTION

SUBSYSTEM: FLIGHT CONTROL WBS CODE: 1.6

MAJOR ASSEMBLY: GROUND TESTS WBS CODE: 1.6.4

To provide an efficient means of complete system development and to accurately demonstrate in-flight performance and safety prior to flight, a full scale functional mockup of the B-70 flight control system was designed and built. This flight control system simulator was designed to: (1) verify system design, (2) evaluate system performance including actual representation of system non-linearities which were difficult to describe for system analysis, (3) demonstrate compatible subsystem integration, (4) provide system familiarization for flight maintenance crews, and (5) to some degree, demonstrate reliability and isolate potential reliability problems. The simulator consisted of those systems and components normally used in aircraft control.

The simulation effort in the development of the flight control was continuous beginning at initiation of preliminary analysis and ending at completion of flight test support. The initial simulations utilized were comprised of complete analog representations of pilot, control system and aerodynamics. As the system development progressed and experimental or actual equipment became available, the analoged simulations of the control loop were replaced by their real counterparts with the complete system available and in operation before flight.

The flight control system simulator permitted complete pilot evaluation of the system throughout the mission of the B-70 while in a realistic environment. The development phase emphasized the testing associated with system performance and the effects of component characteristics.

The flight control simulator provided a complete air vehicle control installation, within practical limits, for development testing. This generally included all major cockpit controls and displays, all significant control linkages which affect control or feel, all surface actuators and hydraulic and electrical power similar to that provided in the actual aircraft. Air vehicle hardware and components fabricated to production drawings were used wherever possible.

The pilot's forward view was the same as that in the air vehicle. Optical displays external to the simulator were provided to indicate particular phases of flight.

The development program was established as three phases. Phase I was classified as Evaluation and Finalization of overall system requirements and components effecting feel characteristics and handling qualities. Phase II covered evaluation of preliminary control configuration for design verification and integration compatibility. Phase III covered evaluation and verification of final control configuration, demonstration of flight control and safety prior to flight.

WBS CODE: 1.6.4

The development test program for both the Primary and Secondary Flight Control Systems consisted of operational tests, design verification system parameter evaluation, system parameter optimization and subsystem integration tests. Operational tests consisted of the normal tests performed during simulator buildup and were to assure proper component fit, acceptable buildup tolerances and adequate design margins. Design verification testing included the Force and Displacement characteristics tests, Dynamic characteristics tests and Trim characteristic tests. The force and displacement characteristics tests determined the force and displacement relationship between the control column, wheel, pedal, feel bungee, "q" bellows master cylinders. Surface actuators outputs column force vs. rate characteristics were also checked. These data were used to verify displacement characteristics such as gradient, authority, linearity, freeplay, backlash, hysteresis, resolution, centering and cable stretch. The force characteristics verified were force gradient, linearity, friction, preload breakout unbalance and elasticity of spring constants.

In the system parameter evaluation the parameters of interest were control and trim gradients throughout the entire flight envelope and were evaluated with respect to pilot physical tolerances and control characteristics such as sensitivity, overcontrol, and induced oscillations. System parameter optimization involved displacement gradient, bungee location and gradient, preload and friction. The cable failure tests were used to determine the adequacy of backup provisions of the forward and aft cable system and the effect of intentional cable failures on static and dynamic system characteristics.

The development tests for the Flight Augmented Control System (FACS) consisted of design verification, performance evaluation and system optimization tests. The design verification tests verified the installation and operation of the FACS electronics, servo-actuators and transducers. Performance characteristic tests were conducted to evaluate the controllability and adequacy of the system under normal and failed conditions.

Flight instruments, both experimental and prototype flight instruments, were installed as an integral part of the cockpit of the flight control simulator. The instrument system was subjected to a performance evaluation of all instruments and mission analyses for complete instruments system adequacy.

Hydraulic power supplied to the flight simulator came from actual air vehicle system components. System design parameters such as pressure, flow, response, temperature, service life, vibrations, fluid compressibility and surge characteristics were verified. Characteristics of the individual pumps, various combinations of redundancy, and master slave arrangements were evaluated. Additional effort included verifying the Braking and Steering Subsystem and pilot familiarization and training.

The simulator complex, control console and cabin simulator are shown in Exhibits 8 through 12. Reports indicate that effort expended as of February 1962 was 3352 hours, 4416 hours as of June 1962 and 5174 hours through November 1962. Within the total hours there were 1822 hours of testing of the primary (PFCS) and secondary flight control systems (SFCS), 1333 hours of flight augmentation control system (FACS) testing, 672 hours of flying qualities evaluation and 500 hours of flight display evaluation which resulted in approximately 500 hours of "flight time" on the simulator. Through July 1964 an accumulative test time of 7800 hours had been accomplished consisting of 2600 hours on the PFCS and SFCS, 2350 hours on the FACS, 1300 hours on flying qualities, 1050 hours miscellaneous and 500 hours on flight display. These test categories consisted of the following:

PFCS and SFCS - Static and dynamic performance characteristics, fail safety, overall system operation for handling qualities investigations.

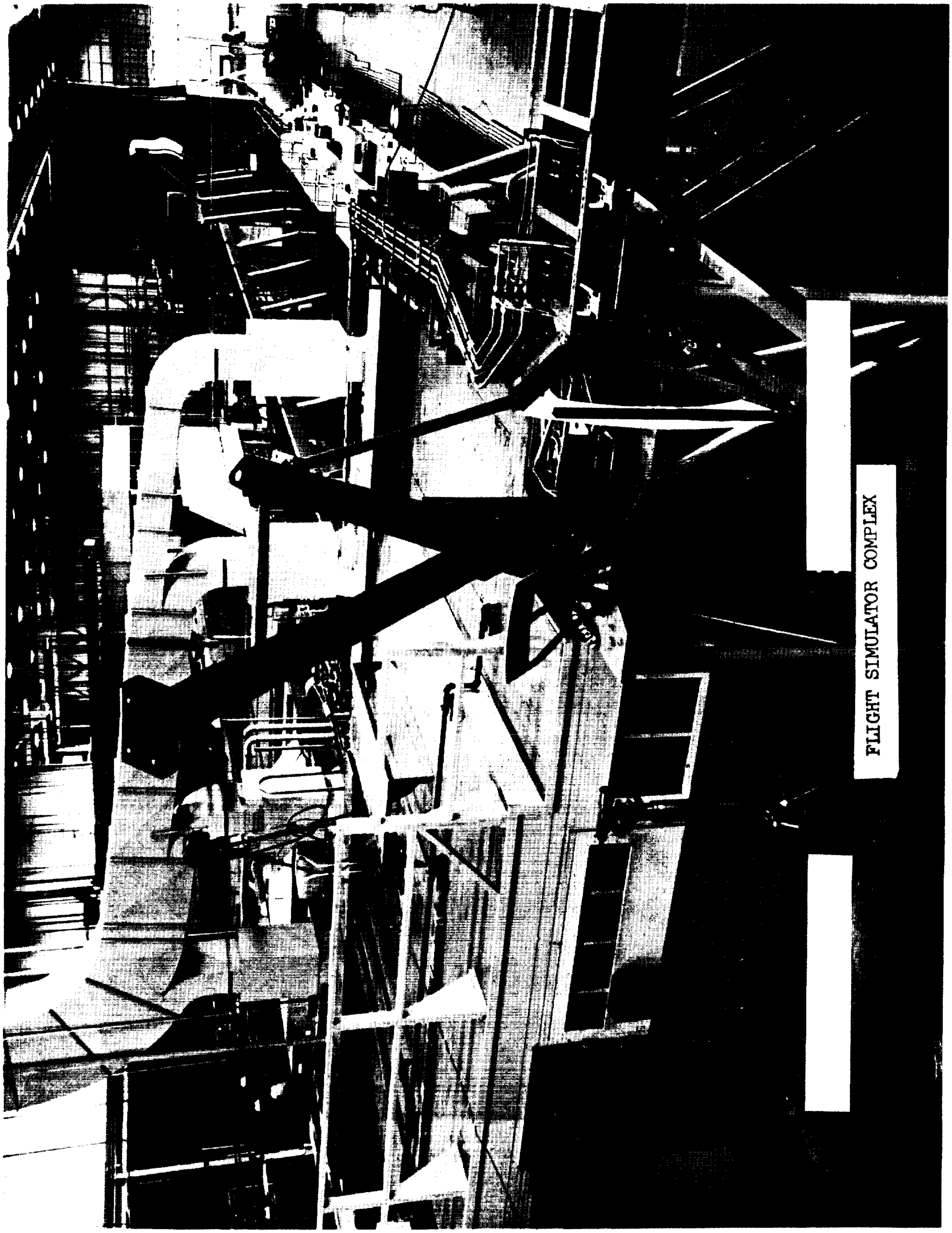
FACS - Performance, fail safety, overall operation for handling qualities investigations.

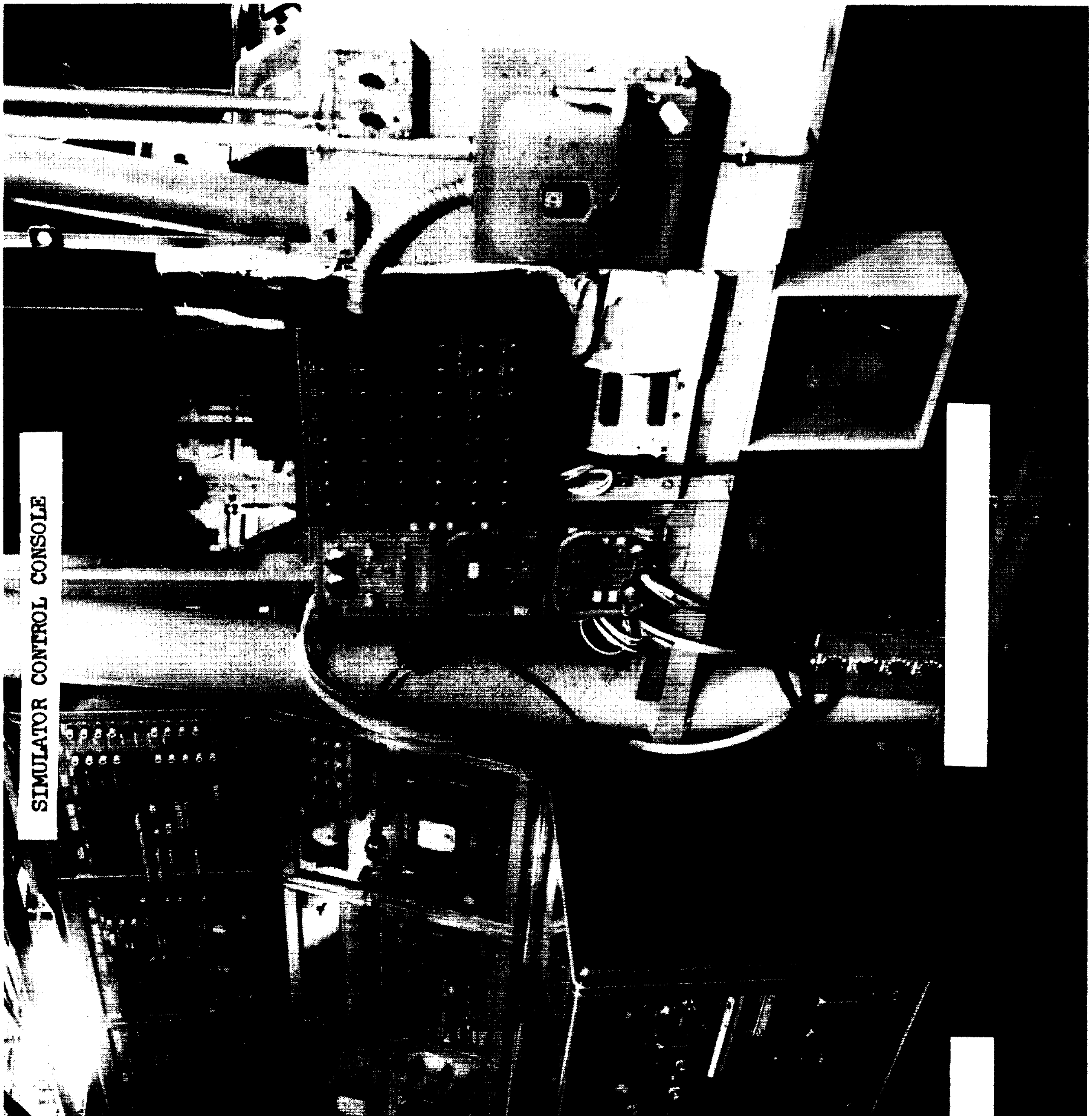
Flying Qualities - Landing, first flight missions, trimability, accelerated stability, speed stability, dynamic stability, inlet instant, flap transients.

Flight Display - Controllability of air vehicle during instrument flying.

Miscellaneous - Throttle control, hydraulic system performance.

Cumulative "flight time" through July 1964 was 758 hours with 382 hours for test pilots and 376 hours for engineers. "Flight time" was defined as simulator operation time with a pilot at the controls performing maneuvers for handling qualities or control equipment evaluation, or flying mission profiles.


FLIGHT SIMULATOR COMPLEX



SIMULATOR CONTROL CONSOLE

EXHIBIT 9

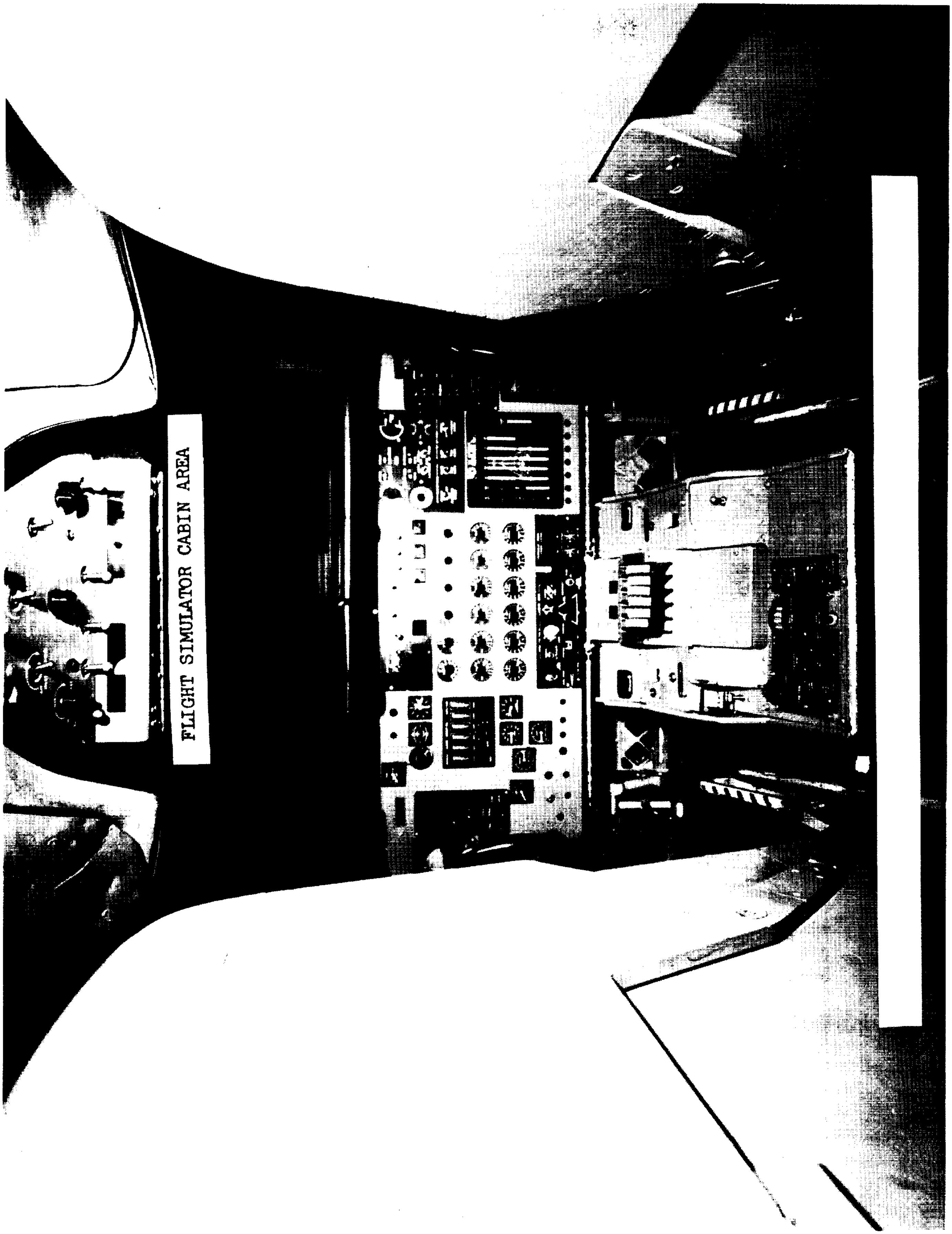
FLIGHT SIMULATOR (CABIN)

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH

FLIGHT SIMULATOR CABIN AREA

EXHIBIT 11

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH



TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: GROUND TESTS WBS CODE: 1.6.4

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
MAJOR ASSEMBLIES	TYPE/NO.	X-Y PLOTTER STRIP RECORDER	→	→	→	→
MOCKUPS/BREADBOARDS	TYPE/NO.	WOOD (1) BREADBOARD (3) HOT MOCKUP (1)	→	→	→	→
MODELS	TYPE/NO.	NONE	→	→	→	→
TEST BEDS	TYPE/NO.	FULL SCALE SIMULATOR 1	→	→	→	→
TESTS	TYPE/NO.	DYNAMIC AND STATIC 24	→	→	→	→
MEASUREMENTS (DATA)	TYPE	POSITION RATE FORCE	→	→	→	→
ACCURACY (DATA)	% OF FS	0.5	→	→	→	→
FREQUENCY RESPONSE (DATA)	HERTZ	UP TO 30	→	→	→	→
RESOLUTION (DATA)	% OF FS	0.5 TO 2.0	→	→	→	→
SPEED TEST RANGE	MACH NO.	TO 3.0	→	→	→	→
ALTITUDE TEST RANGE	FEET	TO 80,000	→	→	→	→

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: GROUND TESTS   WBS CODE: 1.6.4

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
TEMPERATURE TEST RANGE	DEGREES F	70	→	→	→	→
DYNAMIC INPUT TEST RANGE	HERTZ	3 TO 10	→	→	→	→
ACCELERATION INPUT TEST RANGE	$FEET/SEC^2$	128 TO - 32	→	→	→	→

DEVELOPMENT DATA SUMMARY

WBS TITLE: FLIGHT CONTROL SUBSYSTEM WBS CODE: 1.6

STATE-OF-THE-ART RATING: 4 (See Remarks)

PERCENT DEVELOPED MATRIX:

	PRIOR TO FLIGHT		FLIGHT TEST
	CONFIGURATION	GROUND TEST	
PROGRAM LEVEL	95%	85%	20%
EFFORT TO GO	18%	37%	93%

GROUND TESTS (1)

TYPE OF TEST	NUMBER OF UNITS	TEST HOURS
CONFIGURATION RESEARCH	-	-
DESIGN FEASIBILITY	10	500
DESIGN VERIFICATION (2)	22	24,950
AIRWORTHINESS (2)	32	10,350
QUALIFICATION (3)	60	600
OTHER	-	-
TOTAL	124	36,400

REMARKS:

(1) Hydraulic actuators and electrical solenoid development testing not included: See WBS 1.4, Secondary Power Subsystem.

(2) Includes full scale Flight Simulator operational tests.

(3) Test hours shown were for vibration and acoustics tests.

State of the Art:

The Flight Control Subsystem was assigned an overall state-of-the art rating of 4 based on definitions established using AFSCM173-1 (11-28-67) as a guide. This rating was determined by comparing the RS-70 requirements with the existing capabilities at the RS-70 time period using state-of-the-art criteria discussed in subsequent paragraphs. The RS-70 configuration was selected for the comparison since it was the production configuration defined. This selection is considered valid since the development atatus at "out-the-door" and at program "end" is also based on the scheduled production configuration.

The definitions used in determining the state-of-the-art ratings are described below. For ratings 3, 4, and 5, the following B-70 design criteria was used as an aid for rating selection.

A. High temperature application

B. High pressure/load/acoustics/etc., application

C. Light-weight/special materials/unique processes

Rating	Description
1	The item was off-the-shelf commercial item or a standard military issue which was installed "as-is."
2	The item was off-the-shelf commercial item or a standard military issue which required only a physical modification for installation.
3	The item was considered within the state of the art but had no commercial or military counterpart. As an aid, the item was existing but required modification to be compatible with <u>one</u> of the design criteria. Also, any new design or process has a rating of at least 3.
4	The item was slightly beyond the state of the art, and some development was required. As an aid, the item was based on an existing concept but required modification to be compatible with <u>two</u> of the design criteria. Also, any new design or process required to be compatible with <u>one</u> of the design criteria will be rated 4.
5	The item was substantially beyond the existing state of the art and required major development work. As an aid, any new design or process required to be compatible with <u>two</u> of the of the design criteria will be rated 5.

The Flight Control Subsystem planned for the RS-70 was essentially the same as installed in the XB-70 except for the "hold" functions, identified as: altitude hold, Mach hold, attitude, and "station keeping" (position hold function for inflight refueling). The "hold" functions, which were automatic functions in the simplest form, were to receive their control signals from the Bombing and Navigation Stable Platform and were to supplement the pilot's tasks to relieve fatigue. In the assessment of the RS-70 configuration, based only on its functional requirements, the Flight Control Subsystem was assigned a state-of-the-art rating of 3. However, the design of the subsystem was impacted by the high temperature and acoustic environments, size of the air vehicle, and the large structural deflections inherent with the B-70 type design. Based on these design factors, the state-of-the-art rating was upgraded and assigned a rating of 4.

Percent Developed:

The development status percent comparisons of the XB-70 Flight Control Subsystem to that scheduled for the RS-70, were made at two development stages; one at prior to flight or "out-the-door" of the No. 1 air vehicle, and the other for the flight test programs. The same methodology developed and verified for the Airframe Structures Subsystem (WBS 1.1) percent comparisons was applied in the analyses of the Flight Control Subsystem status. As noted above, the XB-70 configuration lacked only the "hold" functions of the planned RS-70 configuration which were automatic functions in the simplest form. Based on this, the XB-70 configuration at the time of "out-the-door" was assessed as being 95% representative of that planned for the RS-70 for the same time period. To determine what expenditure would have been required to attain a first air vehicle production level status, the same curve used for the Structures Subsystem was utilized for the Flight Control Subsystem, Exhibit 13, page IV-172. Entering the exhibit on the left hand side at 95%, acorss to the curve and then down to the bottom scale, it shows that 18% more effort would have been required for a No. 1 RS-70 Flight Control Subsystem, excluding ground test effort. In regard to the ground test effort, the ground tests scheduled for the RS-70 at time of "out-the-door" was apprximately 57,600 test hours not including the hydraulic and electrical design test hours noted under "Remarks" or subcontractor effort. Comparing this scheduled test effort with the 36,400 test hours expended, it shows that the testing level or verification level of the XB-70 to be approximately 63% of that planned for the RS-70 at the time of "out-the-door." This shows that 37% more testing effort was required to attain the production level status for the No. 1 air vehicle prior to flight. Entering Exhibit 13, page IV-172, on the bottom scale at 63%, it shows that the No. 1 XB-70 was at a confidence level of approximately 85% for the flight controls prior to flight. The XB-70 flight test program for the Flight Control Subsystem was established at 11% of a production level status as presented by Exhibit 13, page II-23, under Air Vehicle: WBS 1.0. However, this percentage was obtained based on a direct comparison of equivalent test hours and must be adjusted to reflect the flight envelope flown during the XB-70 program. As previously established for the AirFrame Structures Subsystem (WBS 1.1), the first 80% of the flight envelope requires only 60% of the total effort compared to the last 20% of the envelope which requires 40% of the total effort. For the Flight Control Subsystem, this 2 to 3 ratio was directly applicable since all of the test hours were flown in the first 80% of the flight envelope. Using this ratio as a weight factor so that direct comparison can be made based on the RS-70 flight envelope, the flight test effort expended on the XB-70 was adjusted by the equation 2:3:: X:11%. Based on this equation, the total flight test effort remaining to attain a production level status for the Flight Control Subsystem would be 40% + 60% - (2 x 11 ÷ 3) or 93% (where 40% is that effort required for the last 20% of the flight envelope).

In summary, the prior to flight status comparisons are: (1) the XB-70 No. 1 Flight Control Subsystem was 95% of an RS-70 system and would have required 18% more expenditure for configuration and 37% more ground testing effort; and (2), the XB-70 Flight Control Subsystem flight test program was 7% of the planned RS-70 program effort and would have required 93% more flight test effort to attain a production level status. All of the above comparisons are based on tooling, test articles, GSE, etc., being at the RS-70 or production level in both numbers and fidelity. Exhibit 13, page IV-172, presents a graph showing the percent comparisons.

NOTE: THE USE OF THE "EFFORT TO GO" PERCENTAGES FOR COST DETERMINATION SHOULD NOT BE APPLIED WITHOUT CONSULTING SECTION IV-8, VOLUME I, PAGE I-310 FOR APPLICATION CONSIDERATIONS.

XB-70 FLIGHT CONTROL SUBSYSTEM DEVELOPMENT STATUS
PERCENT COMPARISON TO RS-70 (UNITY)

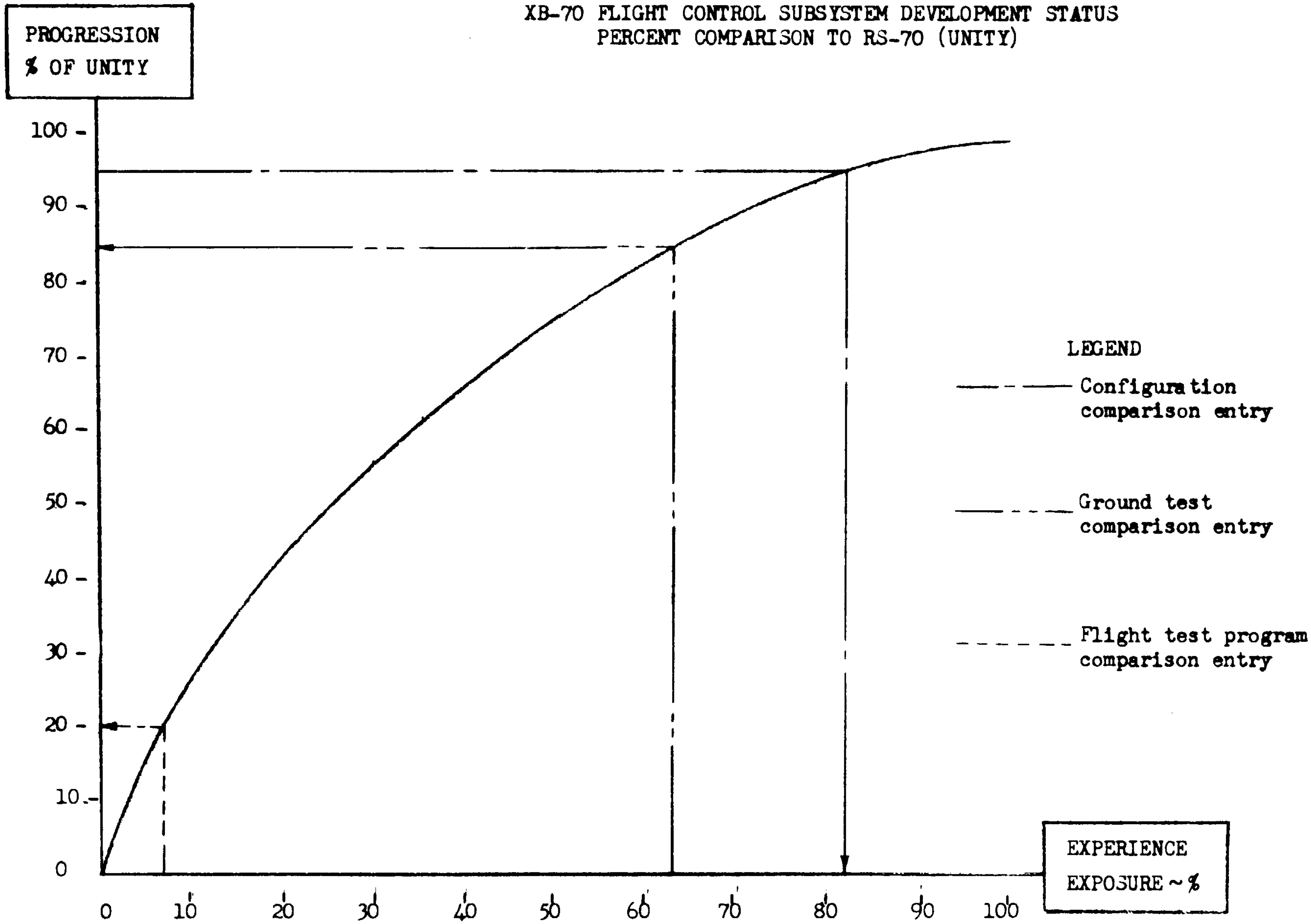
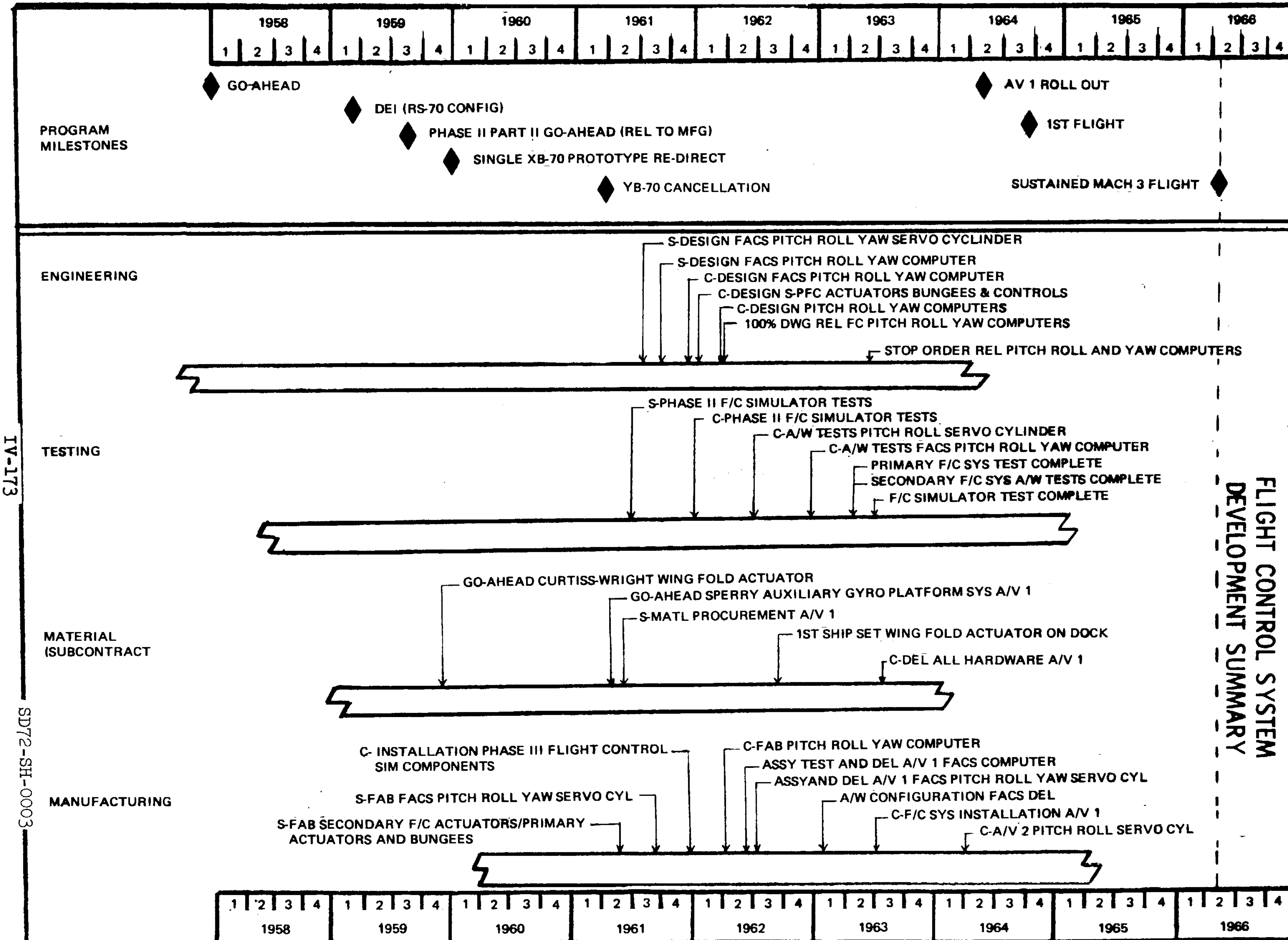


EXHIBIT 13

WBS 1.6


FLIGHT CONTROL SYSTEM
DEVELOPMENT SUMMARY
1958
1959
1960
1961
1962
1963
1964
1965
1966
PROGRAM MILESTONES
GO-AHEAD
DEI (RS-70 CONFIG)
PHASE II PART II GO-AHEAD (REL TO MFG)
SINGLE XB-70 PROTOTYPE RE-DIRECT
YB-70 CANCELLATION
AV 1 ROLL OUT
1ST FLIGHT
SUSTAINED MACH 3 FLIGHT
ENGINEERING
S-DESIGN FACS PITCH ROLL YAW SERVO CYCLINDER
S-DESIGN FACS PITCH ROLL YAW COMPUTER
C-DESIGN FACS PITCH ROLL YAW COMPUTER
C-DESIGN S-PFC ACTUATORS BUNGEES & CONTROLS
C-DESIGN PITCH ROLL YAW COMPUTERS
100% DWG REL FC PITCH ROLL YAW COMPUTERS
STOP ORDER REL PITCH ROLL AND YAW COMPUTERS
TESTING
S-PHASE II F/C SIMULATOR TESTS
C-PHASE II F/C SIMULATOR TESTS
C-A/W TESTS PITCH ROLL SERVO CYLINDER
C-A/W TESTS FACS PITCH ROLL YAW COMPUTER
PRIMARY F/C SYS TEST COMPLETE
SECONDARY F/C SYS A/W TESTS COMPLETE
F/C SIMULATOR TEST COMPLETE
MATERIAL (SUBCONTRACT
GO-AHEAD CURTISS-WRIGHT WING FOLD ACTUATOR
GO-AHEAD SPERRY AUXILIARY GYRO PLATFORM SYS A/V 1
S-MATL PROCUREMENT A/V 1
1ST SHIP SET WING FOLD ACTUATOR ON DOCK
C-DEL ALL HARDWARE A/V 1
MANUFACTURING
C- INSTALLATION PHASE III FLIGHT CONTROL SIM COMPONENTS
S-FAB FACS PITCH ROLL YAW SERVO CYL
S-FAB SECONDARY F/C ACTUATORS/PRIMARY ACTUATORS AND BUNGEES
C-FAB PITCH ROLL YAW COMPUTER
ASSY TEST AND DEL A/V 1 FACS COMPUTER
ASSYAND DEL A/V 1 FACS PITCH ROLL YAW SERVO CYL
A/W CONFIGURATION FACS DEL
C-F/C SYS INSTALLATION A/V 1
C-A/V 2 PITCH ROLL SERVO CYL

DEVELOPMENT SUMMARY
TABULATION OF DATES

Subsystem: Flight Control — WBS 1.6

Engineering

Start Design FACS Pitch Roll Yaw Servo Clyinder	8-28-61
Start Design FACS Pitch Roll Yaw Computer	9-1-61
Complete Design FACS Pitch Roll Yaw Computer	11-10-61
Complete Redesign Secondary-Prime F/C Actuators Bungees and Controls	1-19-62
Complete redesign Pitch Roll Yaw Computers	3-1-62
Complete 100% Drawing Release for Pitch Roll Yaw Computer	3-23-62
Stop Order Release Pitch Roll Yaw Computers	6-7-63

Testing

Start Phase II Flight Control Simulator	6-61
Complete Phase II Flight Control Simulator	1-72
Complete A/W Tests Pitch Roll Servo Cylinder	6-62
Complete A/W Tests Pitch Roll Yaw Computer	12-21-62
Complete Primary Flight Control System Test	5-62
Complete Secondary Flight Control System A/W Test	5-62
Complete Flight Control Simulator Test	6-63

Material (Subcontract)

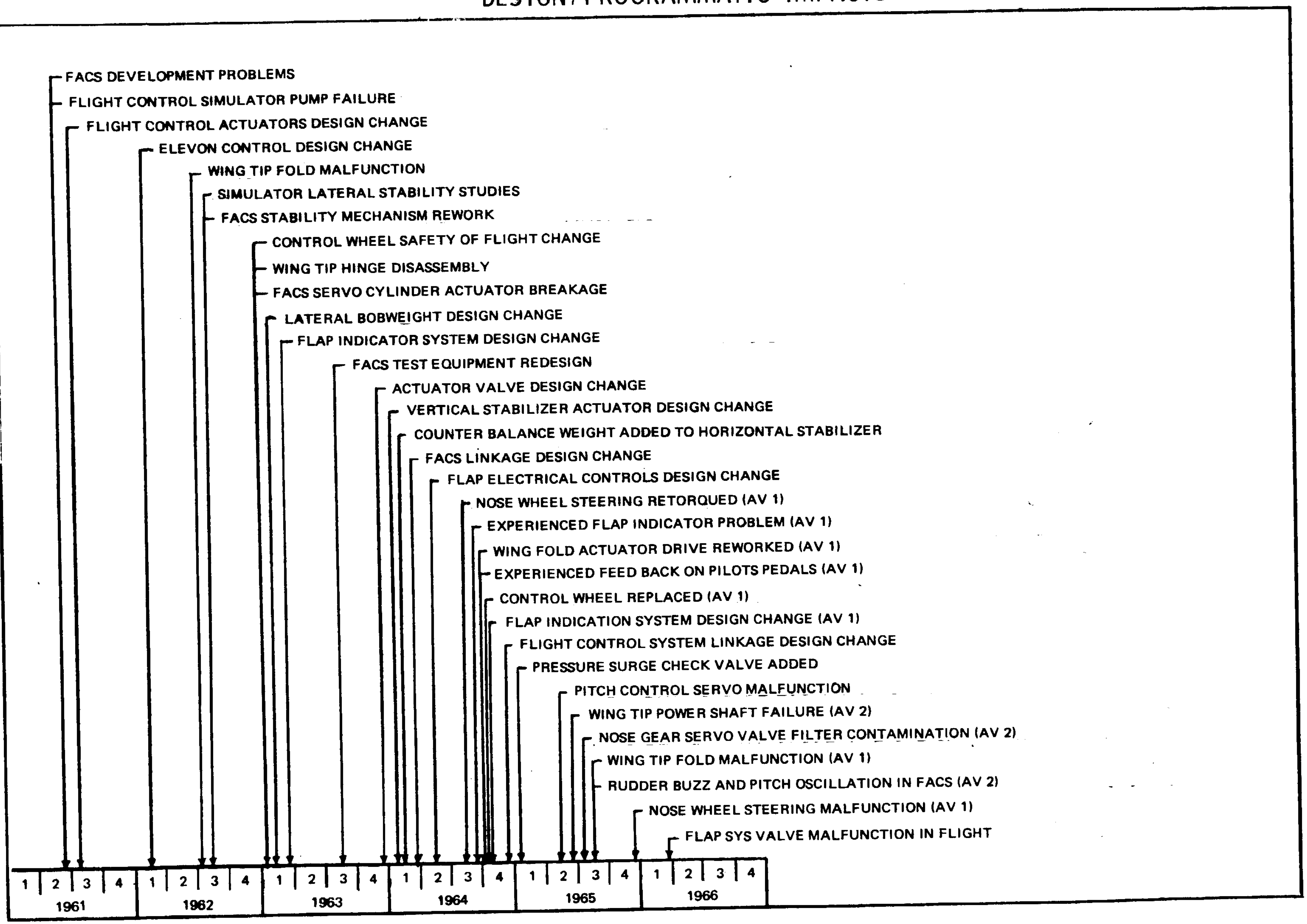
Go-Ahead Curtiss-Wright Wing Fold Actuators	12-8-59
Go-Ahead Sperry Auxiliary Gyro Platform System, Air Vehicle No. 1	5-5-61
Start Material Procurement, Air Vehicle No. 1	6-30-61
First Shipset Wing Fold Actuators on Dock	9-2-62
Complete Delivery All Hardware, Air Vehicle No. 1	8-1-63

Manufacturing

Start Fabrication Secondary F/C Actuators/Primary F/C Actuators and Bungees	5-26-61
Start Fabrication FACS Pitch Roll Yaw Servo Clyinders	9-15-61
Complete Installation Phase III F/C Simulator Components	12-26-61
Complete Fabrication Pitch Roll Yaw Computers	4-16-62
Assembly, Test and Delivery, Air Vehicle No. 1 FACS Computer	6-8-62
Assembly, Delivery Air Vehicle No. 1 FACS Pitch Roll Yaw Servo Cylinder	7-14-62
Delivery A/W Configuration FACS Cylinders and Computers	1-30-63
Complete F/C System Installations, Air Vehicle No. 1	7-63
Complete Air Vehicle No. 2 Pitch-Roll Servo Cylinder	4-64

FLIGHT CONTROL SYSTEM
DESIGN/PROGRAMMATIC IMPACTS

WBS 1.6



DESIGN/PROGRAMMATIC IMPACTS

Subsystem: Flight Control WBS 1.6

June 1961
Development problems were encountered in the FACS during development tests. Failures caused delays to delivery of acceptable units due to design changes/rework.

During Phase II testing on the Flight Control Simulator, failure of the purchased hydraulic pumps was encountered. The pumps were returned to the supplier (Vickers) for repair and recycle.

July 1961
Due to problems encountered during Flight Control Simulator tests, the 18 actuators required rework. The rework was due to design changes of the hydraulic barrier seal. Approximately 70 seals were scrapped and replaced.

February 1962
Design changes to the Elevon Control System due to operational tests on the Flight Control Simulator and airworthiness tests and checkout; data showed a high friction rate (three to four times above basic design requirements) in valves and actuators.

July 1962
Delays were experienced when wing tip fold hydraulic package was found to be defective and was returned to the supplier for rework/repairs.

August 1962
Studies were conducted as the result of lateral stability problems discovered during F/C simulator testing. Studies were conducted to revise Air Vehicle No. 1 Control System in order to improve lateral directional control and add 5 degrees dihedral to Air Vehicle No. 2 and Air Vehicle No. 3 wing.

August 1962
Speed Stability. Analysis showed that there was a probability of flight control reversal between Mach .8 and 1.1. Engineering released an EWA to revise the FACS speed stability mechanism. This required design and fabrication of electrical control amplifiers and the addition of a "black box." Changes were incorporated prior to first flight.

January 1963
A "safety of flight" EWA was released to lower the pilot's control wheel due to inadequate clearance between the wheels and instrument panel shroud. Rework was accomplished.

January 1963

The wing tip fold actuator power hinge was disassembled and cleaned as the result of oil being added by mistake. Replacement of the speed reducer housings on the wing fold hydraulic package due to failure of parts during airworthiness vibration tests was made.

The horizontal stabilizer actuator broke during tests and scored the servo cylinder barrel. Safety of flight changes were incorporated into Air Vehicle No. 1 prior to first flight. Some delays were encountered with delivery of pitch and roll servo cylinders to Palmdale due to acceptance testing delays.

February 1963

Design change was released for a new centering spring for the lateral bobweight, and rework was accomplished.

March 1963

Design change to the flap indicator position system. Due to problems encountered during airworthiness tests, the change was made to show when both flaps are in position.

August 1963

FACS test equipment redesign was necessary for the pitch computer and auxiliary function computer. Redesign and modification of the yaw, roll and auxiliary computers was necessary due to speed stability (Reference EWA-191).

December 1963

Design change released (reference EWA 259-206) yaw control to change the valve input linkage of the vertical stabilizer actuators. Excessive friction in the actuator valve was affecting pilot control. Fabrication of a new bellcrank support, link bellcrank and retainers was required.

January 1964

Failure during yaw control system tests on the Flight Control Simulator. Oscillation occurred when a pulse excited the system. An EWA was released to revise the vertical stabilizer actuator override bungee balance weight (EWA 259-209).

February 1964

Engineering EWA-211 was released to install a counter balance weight to each horizontal linkage to dampen out oscillation; change authorized as the result of flight control analysis.

March 1964

Redesign of the FACS pitch and roll servo attachment (EWA-210) on Air Vehicle No. 1 and No. 2 input linkage to correct FACS pitch and roll servo centering problem. Simulator tests showed some improvements. The design changes were the result of problems at Autonetics in obtaining consistent recentering at high temperatures. The new design separated the servo centering mechanism by adding linkage arms and modifying existing bellcranks and supports.

May 1964
Redesign of Air Vehicle No. 1 Flap Electrical Control System (reference EWA-182) revised the system to prevent flap flutter and power loss during switching of electrical systems.

August 1964
During taxi runs, problems were encountered with nose wheel steering. The system was checked out using hydraulic and electrical power and cockpit controls. The steering torque was measured and retorqued prior to the next taxi run.

September 1964
First Flight. The flap indicator changed to a "barber pole" indication just above 8000 feet, even though the flap handle had not been removed from the down position. The flaps appeared okay to the chase plane.

October 1964
The flap indicator stuck in a "barber pole" position and the primary pitch trim was intermittently inoperative. Air Vehicle No. 2 wing fold actuator drive assembly was reworked by machining the lip to match the inside diameter of the snap ring. Curtiss Wright was responsible for the rework.

Air Vehicle No. 1, Flight No. 3. With the landing gear lowered, and yaw damper on, feedback through the rudder pedals was sufficient to "knock" the pilot's feet off the pedals. Prior to fourth flight, the wing fold actuator system Hayden microswitches were replaced.

On October 20, the Air Vehicle No. 1 pilot's control wheel was removed and replaced with Air Vehicle No. 2's pilot wheel in order to improve pitch and roll sensitivity.

November 1964
Air Vehicle No. engineering (EWA-182) change incorporated to the flap system position and pressure indication system.

December 1964
EWA 249, 250, and 281-8, Flight Control System Linkage Revision. Implemented to provide an overcenter linkage mechanism for the horizontal stabilizer and to the flap under connecting linkage to prevent loads in the horizontal stabilizer to flap interconnector linkage. A design study was conducted to move the bobweight to the aft mechanism compartment forward of the pitch master cylinder at fuselage station 1912.5. The change was to eliminate the excitation caused by symmetrical strut bending mode experienced at the present location fuselage station 391.

January 1965

Design change was released (EWA 254) and implemented for the Air Vehicle No. 1 elevon actuators. The design change involved revision of the rod seal return lines on the elevon actuators due to failures caused by pressure surges entering and rupturing the lines. The change provided a new ball check valve and seal to the nearest trunk line on each elevon actuator to reduce surges.

May 1965

Malfunctions in flight of the flight control pitch augmentation servo necessitated modification by the addition of stops to the pitch servo, to prevent recurrence in flight.

June 1965

Failure of Air Vehicle No. 2 wing tip power shaft necessitated the removal and torque of all the shafts. Failure was attributed to a poor braze attachment between the shaft and splined fitting. A replacement part from Curtiss Wright was installed in the airplane.

July 1965

Damage to the nose gear drag link trunnion fitting occurred to Air Vehicle No. 2 during a "hard right" steering condition, while taxiing to the parking area. Investigation revealed that the servo valve filter was clogged with contamination. This condition would permit fluid to bypass the filter and contaminate the valve. Duplication of a hard right condition was simulated in the laboratory with a clogged filter. Engineering EWA was released authorizing the use of an Air Vehicle No. 3 surplus part for use on Air Vehicle No. 2. Air Vehicle No. 1 filter inspection was also conducted for contamination.

August 1965

Wing fold tip malfunction during preflight on Air Vehicle No. 1, causing flight to be cancelled. Troubleshooting revealed faulty relays which were removed and replaced.

During Flight No. 3, Air Vehicle No. 2 rudder buzz and pitch oscillation occurred in the FACS. Recalibration of instruments and bench check of FACS yaw and roll computer was accomplished.

December 1965

The nose wheel steering malfunctioned after landing of Flight No. 27, Air Vehicle No. 1, which necessitated towing the airplane to the run pad.

March 1966

Flight No. 35, on March 3. Shortly after takeoff the flap system malfunctioned and an alternate flight of subsonic testing was followed. Prior to Flight No. 36, the flap valves were removed and replaced.

COST DEFINITION

SUBSYSTEM: FLIGHT CONTROL WBS CODE: 1.6

Total costs presented in this WBS item include all identifiable expenditures to design, develop, ground test, fabricate and assemble all components, assemblies and developmental test hardware within the Flight Control Subsystem as defined by the WBS. Total costs of $24,435,028 include the following items:

a) Developing subsystem specification requirements.
b) Subsystem installation and integration design.
c) Vendor coordination.
d) In-house ground testing including design and fabrication of models, mockups and simulators.
e) Subcontracted hardware including the suppliers costs for engineering, manufacturing, tooling and testing.

Excluded from the cost displayed for this subsystem are the in-house costs associated with the:

f) Fabrication of subsystem provisions.
g) Miscellaneous purchased parts and installation materials.
h) Installation of the subsystem into the vehicles.
i) Subsystem, vehicle and preflight checkouts.

Costs for items f) through i) are contained in WBS 1.12 (Volume IV, page 647). Internal accounting procedures and the resultant cost reports do not provide a basis for establishing expenditures for these items by individual subsystems. Therefore, all costs are collected and reported in one WBS item. Refer to WBS 1.12 for additional information.

Detail of the recorded costs associated with this subsystem is provided by Element of Cost (EOC) and Subdivision of Work (SOW). Section III of Volume I provides a detail definition of these items. Further segregation of the cost data is provided by the WBS. All cost data is displayed at WBS level 5 (Flight Control Subsystem WBS 1.6) with the exception of in-house ground testing (WBS 1.6.4). Cost data can be located on the following pages:

		Cost Breakdown	Time-Phased Detail
WBS 1.6	$18,407,365	page IV-184	page IV-185
WBS 1.6.4 Ground Tests	6,027,663	page IV-184	page IV-205
Total WBS 1.6	$24,435,028	page IV-184	page IV-216

A summary of the subcontractor recorded cost data is provided on page IV-183. Contractual arrangements, delivery dates, costs by supplier, quantity of hardware delivered and other pertinent data is provided. Cost data includes the supplier expenditures for engineering, production, tooling

WBS CODE: 1.6

and testing (where identifiable) performed at the supplier's facility. Refer to the subcontracting Element of Cost definition (Volume I, page I-26) for additional explanation.

As an aid in the definition and evaluation of the in-house engineering costs associated with this subsystem, a matrix of engineering hours has been developed. This matrix, displayed below, is a summary of all the in-house engineering groups that provided support to the design and development of the Flight Control Subsystem.

Group No.	Title	Hours Expended
4	Fluid Power Systems	18,277
6	Controls System	184,732
10	Structural Analysis	8,204
12	Checking	16,410
34	Structural Projects	35,779
48	Communication and Indicating System	73,369
49	Avionics Integration and Control	31,721
55	Flight Controls Analysis	231,404
57	Engineering Specifications	34,440
64	Design Support	7,576
75	Non-Metallics	11,816
94	Flight Simulation	178,540
95	Electrical System Design	26,992
97	Laboratory Services	39,404
99	Auxiliary Control System	89,739
109	Hydraulics Lab	60,007
125	Electrical System Equipment	35,979
	Miscellaneous	45,766
	Total Hours	1,130,155

WBS 1.6	1,041,371 hours	(page IV-184)
WBS 1.6.4	88,784 hours	(page IV-184)
	1,130,155 hours	

Ground testing activities associated with the development of the Flight Control Subsystem have been identified and the costs assigned to WBS 1.6.4 (page IV-205). These costs reflect the in-house expenditures only. Testing activities performed by the subcontractors where identified are included under WBS 1.6, Test/QC Subdivision of Work and the subcontracting Element of Cost. The following is a summary of the major in-house test activities identified to this subsystem.

WBS CODE: 1.6

Description	Recorded Costs
Flight Simulator - Phase III	$1,326,288
Flight Simulator - Phase II	1,056,070
Flight Control Simulator	955,668
Fabrication of Actuators for Airworthiness Tests	620,152
Fabrication of Parts for Airworthiness Testing	171,785
Flight Control System Component Tests	116,592
Vertical Stabilizer Actuator Test	87,526
Horizontal Stabilizer Actuator Test	84,235
Flight Control Actuator Parts Test	79,912
Flap Actuator Test	52,804
Inboard Elevon Actuator Test	50,120
Electrical Equipment Lab Tests	46,377
Minimum Airworthiness Test of Hydraulic Pitch Control Feel Damper	30,265
Various	1,123,446
Costs (less MPC & G&A)	5,801,240
Material Procurement Costs	122,342
General and Administrative	104,081
Total Cost WBS 1.6.4	$6,027,663

SUBCONTRACTOR MATRIX

Subsystem: Flight Control

WBS Code: 1.6

SUBCONTRACTOR	ENGINEERING	PROD	TOOLING	TEST	TOTAL
Curtis Wright	2,188,837	4,768,647	467,552	-	7,425,036

CURTIS WRIGHT was selected to produce the Wingtip Fold Actuating Subsystem for the B-70. Letter Contract LOJ1-XZ-600204 was awarded to Curtis Wright on March 28, 1960 for this effort and completed March 6, 1964.

The Statement of Work called for the subcontractor to provide designs, development, fabrication, testing, and packaging effort required to produce the Wingtip Fold Actuating Subsystem for Air Vehicles 1, 2, and 3.

The design, development and fabrication of hardware for Air Vehicles 1 and 2 was completed prior to termination of the contract. Air Vehicle 3 was 81% complete on March 28, 1960, the date of termination.

The residual hardware not utilized for flight spares was delivered to NR with the special tooling for salvage and the proceeds credited to the contract.

NORTH AMERICAN ROCKWELL CORP.
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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
FLIGHT CONTROL SUBSYSTEM

	6-M ASSY 0 HOURS DOLLARS	6-M ASSY 04 HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	1041371	88784	1130155
LABOR AT $ 4.926	5210925	356088	5567013
ENGR BURDEN AT $ 4.529	4720843	397278	5118121
SHOP SUPPORT	27592	545765	573357
LABOR AT $ 2.987	78582	1634165	1712747
TEST/QC	309	33784	34093
LABOR AT $ 3.230	1264	108870	110134
MFG BURDEN AT $ 3.676	104151	2128551	2232702
ENGR MATERIAL	6715	1166739	1173454
SUBCONTRACT	7425036		7425036
MPC	304782	122342	427124
OTHER COST	248415	9549	257964
SUB-TOTAL	18100713	5923582	24024295
GEN & ADMIN	306652	104081	410733
TOTAL COST	18407365	6027663	24435028

SUBDIVISION OF WORK
COST DETAIL - SEE PAGE IV-185 IV-205 IV-216

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
6-MAJ ASSY 0

FLIGHT CONTROL SUBSYSTEM

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOOLING AND STE HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	1041371			1041371
LABOR AT $ 5.004	5210925			5210925
ENGR BURDEN AT $ 4.533	4720843			4720843
SHOP SUPPORT	27592			27592
LABOR AT $ 2.848	78582			78582
TEST/QC	309			309
LABOR AT $ 4.091	1264			1264
MFG BURDEN AT $ 3.733	104151			104151
ENGR MATERIAL	6715			6715
SUBCONTRACT	2188837	4768647	467552	7425036
MPC	96706	188630	19446	304782
OTHER COST	248415			248415
SUB-TOTAL	12656438	4957277	486998	18100713
GEN & ADMIN	206000	91893	8759	306652
TOTAL COST	12862438	5049170	495757	18407365

TIME-PHASED COST DETAIL - SEE PAGE	IV-186	IV-194	IV-196	IV-197

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	40.5	6891	4.800	33076	31352	64428
Q-2 58						
Q-3 58	198.0	33360	4.469	149077	131368	280445
Q-4 58						
Q-1 59	231.0	39382	4.537	178659	135264	313923
Q-2 59						
Q-3 59	479.5	84379	4.334	365662	301488	667150
Q-4 59						
Q-1 60	588.0	101943	4.658	474885	382234	857119
Q-2 60						
Q-3 60	592.5	99616	4.808	478995	370123	849118
Q-4 60						
Q-1 61	769.0	131185	4.728	620302	446983	1067285
Q-2 61						
Q-3 61	484.5	87832	4.992	438420	408087	846507
Q-4 61						
Q-1 62	580.5	99064	5.218	516960	457046	974006
Q-2 62						
Q-3 62	534.0	89740	5.135	460856	461039	921895
Q-4 62						
Q-1 63	435.0	74289	5.492	407999	403202	811201
Q-2 63						
Q-3 63	400.0	67198	5.479	368192	385318	753510
Q-4 63						
Q-1 64	319.5	54571	5.574	304155	344978	649133
Q-2 64						
Q-3 64	294.0	51666	5.600	289326	329457	618783
Q-4 64						
Q-1 65	82.5	14346	6.183	88704	95044	183748

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 06 FLIGHT CONTROL SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-2 65						
Q-3 65	24.0	4106	7.953	32654	35026	67680
Q-4 65						
Q-1 66	10.5	1803	1.666	3003	2834	5837
TOTAL	6063.0	1041371		5210925	4720843	9931768

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 59		40	2.025	81	148	229
Q-2 59						
Q-3 59	13.5	2320	2.809	6516	8194	14710
Q-4 59						
Q-1 60	25.5	4456	3.112	13868	17528	31396
Q-2 60						
Q-3 60	57.0	9525	2.875	27383	35792	63175
Q-4 60						
Q-1 61	51.0	8666	2.694	23350	30665	54015
Q-2 61						
Q-3 61	12.0	2307	2.840	6553	10502	17055
Q-4 61						
Q-1 62		93	3.172	295	424	719
Q-2 62						
Q-3 62		-40	.150	-6	-184	-190
Q-4 62						
Q-1 63		73	3.000	219	294	513
Q-2 63						
Q-3 63		-31	7.548	-234	-134	-368
Q-4 63						
Q-1 64		115	3.052	351	564	915
Q-2 64						
Q-3 64		68	3.029	206	358	564
TOTAL	159.0	27592		78582	104151	182733

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 06 FLIGHT CONTROL SUBSYSTEM
6-MAJ ASSY 0
SUBD CF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 59		18	2.889	52		52
Q-4 59						
Q-1 60		64	3.438	220		220
Q-2 60						
Q-3 60	1.5	194	4.407	855		855
Q-4 60						
Q-1 61		21	4.810	101		101
Q-2 61						
Q-3 61		6	2.500	15		15
Q-4 61						
Q-1 62						
Q-2 62						
Q-3 62						
Q-4 62						
Q-1 63						
Q-2 63						
Q-3 63						
Q-4 63						
Q-1 64		1	2.000	2		2
Q-2 64						
Q-3 64		5	3.600	18		18
Q-4 64						
Q-1 65				1		1
TOTAL	1.5	309		1264		1264

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	40.5	6891	4.800	33076	31352	64428	
Q-2 58							
Q-3 58	198.0	33360	4.469	149077	131368	280445	
Q-4 58							
Q-1 59	231.0	39422	4.534	178740	135412	314152	
Q-2 59							
Q-3 59	493.0	86717	4.292	372230	309682	681912	1054
Q-4 59							
Q-1 60	613.5	106463	4.593	488973	399762	888735	1102
Q-2 60							
Q-3 60	651.0	109335	4.639	507233	405915	913148	1281
Q-4 60							
Q-1 61	820.0	139872	4.602	643753	477648	1121401	761
Q-2 61							
Q-3 61	496.5	90145	4.936	444988	418589	863577	193
Q-4 61							
Q-1 62	580.5	99157	5.217	517255	457470	974725	88
Q-2 62							
Q-3 62	534.0	89700	5.138	460850	460855	921705	51
Q-4 62							
Q-1 63	435.0	74362	5.490	408218	403496	811714	120
Q-2 63							
Q-3 63	400.0	67167	5.478	367958	385184	753142	1812
Q-4 63							
Q-1 64	319.5	54687	5.568	304508	345542	650050	79
Q-2 64							
Q-3 64	294.0	51739	5.596	289550	329815	619365	174
Q-4 64							
Q-1 65	82.5	14346	6.183	83705	95044	183749	
Q-2 65							
Q-3 65	24.0	4106	7.953	32654	35026	67680	

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-4 65							
Q-1 66	10.5	1803	1.666	3003	2834	5837	
TOTAL	6223.5	1069272		5290771	4824994	10115765	6715

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58				3433	67861		67861
Q-2 58							
Q-3 58				4486	284931		284931
Q-4 58							
Q-1 59				5137	319239		319289
Q-2 59							
Q-3 59	137905	138959	3857	14883	839611		839611
Q-4 59							
Q-1 60	87905	89007	5360	23033	1006185	19171	1025356
Q-2 60							
Q-3 60	352646	353927	21091	25159	1313325	25023	1338348
Q-4 60							
Q-1 61	372425	373186	10734	19807	1525128	28341	1553469
Q-2 61							
Q-3 61	112999	113192	3253	17605	997627	18539	1016166
Q-4 61							
Q-1 62	340167	340255	10818	13326	1339124	22477	1361601
Q-2 62							
Q-3 62	340166	340217	10819	18651	1291392	21676	1313068
Q-4 62							
Q-1 63	280355	280475	11916	26319	1130424	18901	1149325
Q-2 63							
Q-3 63	37558	39370	1385	24568	818465	13685	832150
Q-4 63							
Q-1 64	126711	126790	17410	17029	811279	17262	828541
Q-2 64							
Q-3 64		174	63	13947	633549	13481	647030
Q-4 64							
Q-1 65				14687	198436	5294	203730
Q-2 65							
Q-3 65				5875	73555	1962	75517

C-3.

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

FLIGHT CONTROL SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-4 65							
Q-1 66				420	6257	188	6445
TOTAL	2188837	2195552	96706	248415	12656438	206000	12862438

[redacted]

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK PRODUCTION

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-3 59							
Q-4 59							24595
Q-1 60							
Q-2 60							64120
Q-3 60							
Q-4 60							217831
Q-1 61							
Q-2 61							1129142
Q-3 61							
Q-4 61							881846
Q-1 62							
Q-2 62							741028
Q-3 62							
Q-4 62							741027
Q-1 63							
Q-2 63							610732
Q-3 63							
Q-4 63							81818
Q-1 64							276458
TOTAL							4768647

[redacted]

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK PRODUCTION

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-3 59	672	25267		25267
Q-4 59				
Q-1 60	3804	67924	1294	69218
Q-2 60				
Q-3 60	12927	230808	4398	235206
Q-4 60				
Q-1 61	32351	1161493	21584	1183077
Q-2 61				
Q-3 61	25265	907111	16857	923968
Q-4 61				
Q-1 62	23551	764579	12833	777412
Q-2 62				
Q-3 62	23529	764556	12833	777389
Q-4 62				
Q-1 63	25934	636666	13989	650655
Q-2 63				
Q-3 63	2629	84447	1415	85862
Q-4 63				
Q-1 64	37968	314426	6690	321116
TOTAL	188630	4957277	91893	5049170

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
6-MAJ ASSY 0
SUBD CF WORK TOOLING AND STE

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 60	10475	621	11096	211	11307
Q-2 60					
Q-3 60	49033	2909	51942	990	52932
Q-4 60					
Q-1 61	100958	2892	103850	1930	105780
Q-2 61					
Q-3 61	66890	1916	68806	1278	70084
Q-4 61					
Q-1 62	72694	2310	75004	1259	76263
Q-2 62					
Q-3 62	72696	2308	75004	1259	76263
Q-4 62					
Q-1 63	59913	2544	62457	1044	63501
Q-2 63					
Q-3 63	8026	257	8283	138	8421
Q-4 63					
Q-1 64	26867	3689	30556	650	31206
TOTAL	467552	19446	486998	8759	495757

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	40.5	6891	4.800	33076	31352	64428
Q-2 58						
Q-3 58	198.0	33360	4.469	149077	131368	280445
Q-4 58						
Q-1 59	231.0	39382	4.537	178659	135264	313923
Q-2 59						
Q-3 59	479.5	84379	4.334	365662	301488	667150
Q-4 59						
Q-1 60	588.0	101943	4.658	474885	382234	857119
Q-2 60						
Q-3 60	592.5	99616	4.808	478995	370123	849118
Q-4 60						
Q-1 61	769.0	131185	4.728	620302	446983	1067285
Q-2 61						
Q-3 61	484.5	87832	4.992	438420	408087	846507
Q-4 61						
Q-1 62	580.5	99064	5.218	516960	457046	974006
Q-2 62						
Q-3 62	534.0	89740	5.135	460856	461039	921895
Q-4 62						
Q-1 63	435.0	74289	5.492	407999	403202	811201
Q-2 63						
Q-3 63	400.0	67198	5.479	368192	385318	753510
Q-4 63						
Q-1 64	319.5	54571	5.574	304155	344978	649133
Q-2 64						
Q-3 64	294.0	51666	5.600	289326	329457	618783
Q-4 64						
Q-1 65	82.5	14346	6.183	88704	95044	183748
Q-2 65						

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	24.0	4106	7.953	32654	35026	67680
Q-4 65						
Q-1 66	10.5	1803	1.666	3003	2834	5837
TOTAL	6063.0	1041371		5210925	4720843	9931768

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 59		40	2.025	81	148	229
Q-2 59						
Q-3 59	13.5	2320	2.809	6516	8194	14710
Q-4 59						
Q-1 60	25.5	4456	3.112	13868	17528	31396
Q-2 60						
Q-3 60	57.0	9525	2.875	27383	35792	63175
Q-4 60						
Q-1 61	51.0	8666	2.694	23350	30665	54015
Q-2 61						
Q-3 61	12.0	2307	2.840	6553	10502	17055
Q-4 61						
Q-1 62		93	3.172	295	424	719
Q-2 62						
Q-3 62		-40	.150	-6	-184	-190
Q-4 62						
Q-1 63		73	3.000	219	294	513
Q-2 63						
Q-3 63		-31	7.548	-234	-134	-368
Q-4 63						
Q-1 64		115	3.052	351	564	915
Q-2 64						
Q-3 64		68	3.029	206	358	564
TOTAL	159.0	27592		78582	104151	182733

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	TEST/QC	
4-SYSTEM	1	
5-SUBSYSTEM	06	**FLIGHT CONTROL SUBSYSTEM**
6-MAJ ASSY	0	

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 59		18	2.889	52		52
Q-4 59						
Q-1 60		64	3.438	220		220
Q-2 60						
Q-3 60	1.5	194	4.407	855		855
Q-4 60						
Q-1 61		21	4.810	101		101
Q-2 61						
Q-3 61		6	2.500	15		15
Q-4 61						
Q-1 62						
Q-2 62						
Q-3 62						
Q-4 62						
Q-1 63						
Q-2 63						
Q-3 63						
Q-4 63						
Q-1 64		1	2.000	2		2
Q-2 64						
Q-3 64		5	3.600	18		18
Q-4 64						
Q-1 65				1		1
TOTAL	1.5	309		1264		1264

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
6-MAJ ASSY 0

FLIGHT CONTROL SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	40.5	6891	4.800	33076	31352	64428	
Q-2 58							
Q-3 58	198.0	33360	4.469	149077	131368	280445	
Q-4 58							
Q-1 59	231.0	39422	4.534	178740	135412	314152	
Q-2 59							
Q-3 59	493.0	86717	4.292	372230	309682	681912	1054
Q-4 59							
Q-1 60	613.5	106463	4.593	488973	399762	888735	1102
Q-2 60							
Q-3 60	651.0	109335	4.639	507233	405915	913148	1281
Q-4 60							
Q-1 61	820.0	139872	4.602	643753	477648	1121401	761
Q-2 61							
Q-3 61	496.5	90145	4.936	444988	418589	863577	193
Q-4 61							
Q-1 62	580.5	99157	5.217	517255	457470	974725	88
Q-2 62							
Q-3 62	534.0	89700	5.138	460850	460855	921705	51
Q-4 62							
Q-1 63	435.0	74362	5.490	408218	403496	811714	120
Q-2 63							
Q-3 63	400.0	67167	5.478	367958	385184	753142	1812
Q-4 63							
Q-1 64	319.5	54687	5.568	304508	345542	650050	79
Q-2 64							
Q-3 64	294.0	51739	5.596	289550	329815	619365	174
Q-4 64							
Q-1 65	82.5	14346	6.183	88705	95044	183749	
Q-2 65							
Q-3 65	24.0	4106	7.953	32654	35026	67680	
Q-4 65							

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
6-MAJ ASSY 0

FLIGHT CONTROL SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66	10.5	1803	1.666	3003	2834	5837	
TOTAL	6223.5	1069272		5290771	4824994	10115765	6715

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
6-MAJ ASSY 0

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58				3433	67861		67861
Q-2 58							
Q-3 58				4486	284931		284931
Q-4 58							
Q-1 59				5137	319289		319289
Q-2 59							
Q-3 59	162500	163554	4529	14883	864878		864878
Q-4 59							
Q-1 60	162500	163602	9785	23083	1085205	20676	1105881
Q-2 60							
Q-3 60	619560	620841	36927	25159	1596075	30411	1626486
Q-4 60							
Q-1 61	1602525	1603286	45977	19807	2790471	51855	2842326
Q-2 61							
Q-3 61	1061735	1061928	30434	17605	1973544	36674	2010218
Q-4 61							
Q-1 62	1153889	1153977	36679	13326	2178707	36569	2215276
Q-2 62							
Q-3 62	1153889	1153940	36656	18651	2130952	35768	2166720
Q-4 62							
Q-1 63	951000	951120	40394	26319	1829547	33934	1863481
Q-2 63							
Q-3 63	127402	129214	4271	24568	911195	15238	926433
Q-4 63							
Q-1 64	430036	430115	59067	17029	1156261	24602	1180863
Q-2 64							
Q-3 64		174	63	13947	633549	13481	647030
Q-4 64							
Q-1 65				14687	198436	5294	203730
Q-2 65							
Q-3 65				5875	73555	1962	75517
Q-4 65							

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
6-MAJ ASSY 0

FLIGHT CONTROL SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 66				420	6257	188	6445
TOTAL	7425036	7431751	304782	248415	18100713	306652	18407365

NORTH AMERICAN ROCKWELL CORP.
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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
6-MAJ ASSY 04
FLIGHT CONTROL GROUND TESTS

	TEST /QC HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	88784	88784
LABOR AT $ 4.011	356088	356088
ENGR BURDEN AT $ 4.475	397278	397278
SHOP SUPPORT	545765	545765
LABOR AT $ 2.994	1634165	1634165
TEST/QC	33784	33784
LABOR AT $ 3.223	108870	108870
MFG BURDEN AT $ 3.673	2128551	2128551
ENGR MATERIAL	1166739	1166739
MPC	122342	122342
OTHER COST	9549	9549
SUB-TOTAL	5923582	5923582
GEN & ADMIN	104081	104081
TOTAL COST	6027663	6027663
TIME-PHASED COST DETAIL - SEE PAGE	IV-206	IV-206

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 06 FLIGHT CONTROL GROUND TESTS
6-MAJ ASSY 04
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58						
Q-2 58						
Q-3 58						
Q-4 58						
Q-1 59						
Q-2 59						
Q-3 59						
Q-4 59						
Q-1 60						
Q-2 60						
Q-3 60	73.5	12334	3.917	48314	45972	94286
Q-4 60						
Q-1 61	82.5	14193	3.996	56717	48446	105163
Q-2 61						
Q-3 61	70.5	12794	3.917	50110	56599	106709
Q-4 61						
Q-1 62	73.0	12418	4.113	51070	55208	106278
Q-2 62						
Q-3 62	135.0	22785	2.976	67812	82072	149884
Q-4 62						
Q-1 63	42.0	7121	7.309	52047	71025	123072
Q-2 63						
Q-3 63	19.5	3389	4.402	14919	20956	35875
Q-4 63						
Q-1 64	9.0	1479	3.853	5699	6271	11970
Q-2 64						
Q-3 64	9.0	1469	3.849	5654	6224	11878
Q-4 64						
Q-1 65	3.0	561	4.674	2622	3153	5775

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 06 FLIGHT CONTROL GROUND TESTS
6-MAJ ASSY 04
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-2 65						
Q-3 65	1.5	225	4.667	1050	1262	2312
Q-4 65						
Q-1 66		16	4.625	74	90	164
TOTAL	518.5	88784		356088	397278	753366

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL GROUND TESTS**
6-MAJ ASSY 04
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	1.0	127	2.551	324	557	881
Q-4 58						
Q-1 59	3.0	565	2.750	1554	2147	3701
Q-2 59						
Q-3 59	177.0	31100	2.981	92702	118620	211322
Q-4 59						
Q-1 60	418.5	72640	2.912	211514	286481	497995
Q-2 60						
Q-3 60	378.0	63453	2.878	182637	220167	402804
Q-4 60						
Q-1 61	700.5	119602	2.950	352834	415685	768519
Q-2 61						
Q-3 61	649.5	117666	3.040	357725	477999	835724
Q-4 61						
Q-1 62	350.5	59781	3.040	181743	220688	402431
Q-2 62						
Q-3 62	280.5	47019	3.074	144547	196076	340623
Q-4 62						
Q-1 63	9.0	1531	4.651	7120	13771	20891
Q-2 63						
Q-3 63	102.0	17048	2.962	50499	96014	146513
Q-4 63						
Q-1 64	40.5	6841	2.578	17639	31979	49618
Q-2 64						
Q-3 64	22.5	4048	4.544	18393	31180	49573
Q-4 64						
Q-1 65	18.0	3041	3.439	10457	12034	22491
Q-2 65						
Q-3 65	7.5	1216	3.436	4178	4809	8987

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 06 FLIGHT CONTROL GROUND TESTS
6-MAJ ASSY 04
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-4 65						
Q-1 66		87	3.437	299	344	643
TOTAL	3158.0	545765		1634165	2128551	3762716

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	TEST/QC	
4-SYSTEM	1	
5-SUBSYSTEM	06	**FLIGHT CONTROL GROUND TESTS**
6-MAJ ASSY	04	
SUBD OF WORK	TEST/QC	

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		26	3.231	84		84
Q-4 58						
Q-1 59		29	2.897	84		84
Q-2 59						
Q-3 59	3.0	644	2.887	1859		1859
Q-4 59						
Q-1 60	18.0	3149	3.100	9762		9762
Q-2 60						
Q-3 60	24.0	4082	3.226	13170		13170
Q-4 60						
Q-1 61	46.5	8047	3.196	25721		25721
Q-2 61						
Q-3 61	51.0	9303	3.320	30890		30890
Q-4 61						
Q-1 62	24.0	4184	3.264	13658		13658
Q-2 62						
Q-3 62	18.0	3127	3.130	9786		9786
Q-4 62						
Q-1 63	1.5	379	4.364	1654		1654
Q-2 63						
Q-3 63	-6.0	-1104	2.722	-3005		-3005
Q-4 63						
Q-1 64	7.5	1359	3.051	4146		4146
Q-2 64						
Q-3 64	7.5	1358	3.054	4147		4147
Q-4 64						
Q-1 65	-3.0	-559	3.864	-2160		-2160
Q-2 65						
Q-3 65	-1.5	-224	3.857	-864		-864

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	TEST/QC	
4-SYSTEM	1	
5-SUBSYSTEM	06	FLIGHT CONTROL GROUND TESTS
6-MAJ ASSY	04	
SUBD OF WORK	TEST/QC	

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-4 65						
Q-1 66		-16	3.875	-62		-62
TOTAL	190.5	33784		108870		108870

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
6-MAJ ASSY 04
FLIGHT CONTROL GROUND TESTS

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58							
Q-2 58							
Q-3 58	1.0	153	2.667	408	557	965	196
Q-4 58							
Q-1 59	3.0	594	2.758	1638	2147	3785	1138
Q-2 59							
Q-3 59	180.0	31744	2.979	94561	118620	213181	15372
Q-4 59							
Q-1 60	436.5	75789	2.920	221276	286481	507757	20774
Q-2 60							
Q-3 60	475.5	79869	3.057	244121	266139	510260	216466
Q-4 60							
Q-1 61	829.5	141842	3.069	435272	464131	899403	70117
Q-2 61							
Q-3 61	771.0	139763	3.139	438725	534598	973323	397177
Q-4 61							
Q-1 62	447.5	76383	3.227	246471	275896	522367	76118
Q-2 62							
Q-3 62	433.5	72931	3.046	222145	278148	500293	128791
Q-4 62							
Q-1 63	52.5	9031	6.735	60821	84796	145617	149796
Q-2 63							
Q-3 63	115.5	19333	3.228	62413	116970	179383	16421
Q-4 63							
Q-1 64	57.0	9679	2.840	27484	38250	65734	32874
Q-2 64							
Q-3 64	39.0	6875	4.101	28194	37404	65598	32845
Q-4 64							
Q-1 65	18.0	3043	3.588	10919	15187	26106	6057
Q-2 65							
Q-3 65	7.5	1217	3.586	4364	6071	10435	2422

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
6-MAJ ASSY 04
FLIGHT CONTROL GROUND TESTS

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-4 65							
Q-1 66		87	3.575	311	434	745	175
TOTAL	3867.0	668333		2099123	2525829	4624952	1166739

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
6-MAJ ASSY 04
FLIGHT CONTROL GROUND TESTS

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58		10	10		10
Q-2 58					
Q-3 58	11	-10	1162		1162
Q-4 58					
Q-1 59	96		5019		5019
Q-2 59					
Q-3 59	1302		229855		229855
Q-4 59					
Q-1 60	2731		531262	10122	541384
Q-2 60					
Q-3 60	28465		755191	14389	769580
Q-4 60					
Q-1 61	5925		975445	18127	993572
Q-2 61					
Q-3 61	33561	8506	1412567	26250	1438817
Q-4 61					
Q-1 62	5998	1127	605610	10165	615775
Q-2 62					
Q-3 62	10149	2180	641413	10766	652179
Q-4 62					
Q-1 63	14754	-1905	308262	5154	313416
Q-2 63					
Q-3 63	1617	-640	196781	3290	200071
Q-4 63					
Q-1 64	3504	88	102200	2175	104375
Q-2 64					
Q-3 64	11949	87	110479	2351	112830
Q-4 64					
Q-1 65	1812	74	34049	908	34957
Q-2 65					
Q-3 65	432	30	13319	355	13674

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
6-MAJ ASSY 04
FLIGHT CONTROL GROUND TESTS

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-4 65					
Q-1 66	36	2	958	29	987
TOTAL	122342	9549	5923582	104081	6027663

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
FLIGHT CONTROL SUBSYSTEM

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOOLING AND STE HOURS DOLLARS	TEST /QC HOURS DOLLARS
DESIGN/ENGINEERING	1041371			88784
LABOR AT $ 4.926	5210925			356088
ENGR BURDEN AT $ 4.529	4720843			397278
SHOP SUPPORT	27592			545765
LABOR AT $ 2.987	78582			1634165
TEST/QC	309			33784
LABOR AT $ 3.230	1264			108870
MFG BURDEN AT $ 3.676	104151			2128551
ENGR MATERIAL	6715			1166739
SUBCONTRACT	2188837	4768647	467552	
MPC	96706	188630	19446	122342
OTHER COST	248415			9549
SUB-TOTAL	12656438	4957277	486998	5923582
GEN & ADMIN	206000	91893	8759	104081
TOTAL COST	12862438	5049170	495757	6027663
TIME-PHASED COST DETAIL - SEE PAGE	IV-218	IV-226	IV-228	IV-229

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
FLIGHT CONTROL SUBSYSTEM

			TOTAL HOURS DOLLARS
DESIGN/ENGINEERING			1130155
LABOR AT $ 4.926			5567013
ENGR BURDEN	AT $	4.529	5118121
SHOP SUPPORT			573357
LABOR AT $ 2.987			1712747
TEST/QC			34093
LABOR AT $ 3.230			110134
MFG BURDEN	AT $	3.676	2232702
ENGR MATERIAL			1173454
SUBCONTRACT			7425036
MPC			427124
OTHER COST			257964
SUB-TOTAL			24024295
GEN & ADMIN			410733
TOTAL COST			24435028

TIME-PHASED COST
DETAIL - SEE PAGE IV-239

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 06
SUBD OF WORK DESIGN/ENGINEERING

FLIGHT CONTROL SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	40.5	6891	4.800	33076	31352	64428
Q-2 58						
Q-3 58	198.0	33360	4.469	149077	131368	280445
Q-4 58						
Q-1 59	231.0	39382	4.537	178659	135264	313923
Q-2 59						
Q-3 59	479.5	84379	4.334	365662	301488	667150
Q-4 59						
Q-1 60	588.0	101943	4.658	474885	382234	857119
Q-2 60						
Q-3 60	592.5	99616	4.808	478995	370123	849118
Q-4 60						
Q-1 61	769.0	131185	4.728	620302	446983	1067285
Q-2 61						
Q-3 61	484.5	87832	4.992	438420	408087	846507
Q-4 61						
Q-1 62	580.5	99064	5.218	516960	457046	974006
Q-2 62						
Q-3 62	534.0	89740	5.135	460856	461039	921895
Q-4 62						
Q-1 63	435.0	74289	5.492	407999	403202	811201
Q-2 63						
Q-3 63	400.0	67198	5.479	368192	385318	753510
Q-4 63						
Q-1 64	319.5	54571	5.574	304155	344978	649133
Q-2 64						
Q-3 64	294.0	51666	5.600	289326	329457	618783
Q-4 64						
Q-1 65	82.5	14346	6.183	88704	95044	183748
Q-2 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 06 FLIGHT CONTROL SUBSYSTEM
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	24.0	4106	7.953	32654	35026	67680
Q-4 65						
Q-1 66	10.5	1803	1.666	3003	2834	5837
TOTAL	6063.0	1041371		5210925	4720843	9931768

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 59		40	2.025	81	148	229
Q-2 59						
Q-3 59	13.5	2320	2.809	6516	8194	14710
Q-4 59						
Q-1 60	25.5	4456	3.112	13868	17528	31396
Q-2 60						
Q-3 60	57.0	9525	2.875	27383	35792	63175
Q-4 60						
Q-1 61	51.0	8666	2.694	23350	30665	54015
Q-2 61						
Q-3 61	12.0	2307	2.840	6553	10502	17055
Q-4 61						
Q-1 62		93	3.172	295	424	719
Q-2 62						
Q-3 62		-40	.150	-6	-184	-190
Q-4 62						
Q-1 63		73	3.000	219	294	513
Q-2 63						
Q-3 63		-31	7.548	-234	-134	-368
Q-4 63						
Q-1 64		115	3.052	351	564	915
Q-2 64						
Q-3 64		68	3.029	206	358	564
TOTAL	159.0	27592		78582	104151	182733

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1 FLIGHT CONTROL SUBSYSTEM
5-SUBSYSTEM 06
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 59		18	2.889	52		52
Q-4 59						
Q-1 60		64	3.438	220		220
Q-2 60						
Q-3 60	1.5	194	4.407	855		855
Q-4 60						
Q-1 61		21	4.810	101		101
Q-2 61						
Q-3 61		6	2.500	15		15
Q-4 61						
Q-1 62						
Q-2 62						
Q-3 62						
Q-4 62						
Q-1 63						
Q-2 63						
Q-3 63						
Q-4 63						
Q-1 64		1	2.000	2		2
Q-2 64						
Q-3 64		5	3.600	18		18
Q-4 64						
Q-1 65				1		1
TOTAL	1.5	309		1264		1264

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	40.5	6891	4.800	33076	31352	64428	
Q-2 58							
Q-3 58	198.0	33360	4.469	149077	131368	280445	
Q-4 58							
Q-1 59	231.0	39422	4.534	173740	135412	314152	
Q-2 59							
Q-3 59	493.0	86717	4.292	372230	309682	681912	1054
Q-4 59							
Q-1 60	613.5	106463	4.593	488973	399762	888735	1102
Q-2 60							
Q-3 60	651.0	109335	4.639	507233	405915	913148	1281
Q-4 60							
Q-1 61	820.0	139872	4.602	643753	477648	1121401	761
Q-2 61							
Q-3 61	496.5	90145	4.936	444988	418589	863577	193
Q-4 61							
Q-1 62	580.5	99157	5.217	517255	457470	974725	88
Q-2 62							
Q-3 62	534.0	89700	5.138	460850	460855	921705	51
Q-4 62							
Q-1 63	435.0	74362	5.490	408218	403496	811714	120
Q-2 63							
Q-3 63	400.0	67167	5.478	367958	385184	753142	1812
Q-4 63							
Q-1 64	319.5	54687	5.568	304508	345542	650050	79
Q-2 64							
Q-3 64	294.0	51739	5.596	289550	329815	619365	174
Q-4 64							
Q-1 65	82.5	14346	6.183	88705	95044	183749	
Q-2 65							
Q-3 65	24.0	4106	7.953	32654	35026	67680	
Q-4 65							

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
SUBD OF WORK DESIGN/ENGINEERING

FLIGHT CONTROL SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66	10.5	1803	1.666	3003	2834	5837	
TOTAL	6223.5	1069272		5290771	4824994	10115765	6715

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
SUBD OF WORK DESIGN/ENGINEERING

FLIGHT CONTROL SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58				3433	67861		67861
Q-2 58							
Q-3 58				4486	284931		284931
Q-4 58							
Q-1 59				5137	319289		319289
Q-2 59							
Q-3 59	137905	138959	3857	14883	839611		839611
Q-4 59							
Q-1 60	87905	89007	5360	23083	1006185	19171	1025356
Q-2 60							
Q-3 60	352646	353927	21091	25159	1313325	25023	1338348
Q-4 60							
Q-1 61	372425	373186	10734	19807	1525128	28341	1553469
Q-2 61							
Q-3 61	112999	113192	3253	17605	957627	13539	1016166
Q-4 61							
Q-1 62	340167	340255	10818	13326	1339124	22477	1361601
Q-2 62							
Q-3 62	340166	340217	10819	18651	1291392	21676	1313068
Q-4 62							
Q-1 63	280355	280475	11916	26319	1130424	18901	1149325
Q-2 63							
Q-3 63	37558	39370	1385	24568	818465	13685	832150
Q-4 63							
Q-1 64	126711	126790	17410	17029	811279	17262	828541
Q-2 64							
Q-3 64		174	63	13947	633549	13481	647030
Q-4 64							
Q-1 65				14687	198436	5294	203730
Q-2 65							
Q-3 65				5875	73555	1962	75517
Q-4 65							

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1 **FLIGHT CONTROL SUBSYSTEM**
5-SUBSYSTEM 06
SUBD OF WORK DESIGN/ENGINEERING

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 66				420	6257	188	6445
TOTAL	2183837	2195552	96706	248415	12656438	206000	12862438

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
SUBD OF WORK PRODUCTION

FLIGHT CONTROL SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-3 59							24595
Q-4 59							
Q-1 60							64120
Q-2 60							
Q-3 60							217881
Q-4 60							
Q-1 61							1129142
Q-2 61							
Q-3 61							881346
Q-4 61							
Q-1 62							741028
Q-2 62							
Q-3 62							741027
Q-4 62							
Q-1 63							610732
Q-2 63							
Q-3 63							81818
Q-4 63							
Q-1 64							276458
TOTAL							4768647

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
SUBD OF WORK PRODUCTION

FLIGHT CONTROL SUBSYSTEM

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-3 59	672	25267		25267
Q-4 59				
Q-1 60	3804	67924	1294	69218
Q-2 60				
Q-3 60	12927	230808	4398	235206
Q-4 60				
Q-1 61	32351	1161493	21584	1183077
Q-2 61				
Q-3 61	25265	907111	16857	923968
Q-4 61				
Q-1 62	23551	764579	12833	777412
Q-2 62				
Q-3 62	23529	764556	12833	777389
Q-4 62				
Q-1 63	25934	636666	13989	650655
Q-2 63				
Q-3 63	2629	84447	1415	85862
Q-4 63				
Q-1 64	37968	314426	6690	321116
TOTAL	188630	4957277	91893	5049170

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
SUBD OF WORK TOOLING AND STE

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 60	10475	621	11096	211	11307
Q-2 60					
Q-3 60	49033	2909	51942	990	52932
Q-4 60					
Q-1 61	100958	2892	103850	1930	105780
Q-2 61					
Q-3 61	66890	1916	68806	1278	70084
Q-4 61					
Q-1 62	72694	2310	75004	1259	76263
Q-2 62					
Q-3 62	72696	2308	75004	1259	76263
Q-4 62					
Q-1 63	59913	2544	62457	1044	63501
Q-2 63					
Q-3 63	8026	257	8283	138	8421
Q-4 63					
Q-1 64	26867	3689	30556	650	31206
TOTAL	467552	19446	486998	8759	495757

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58						
Q-2 58						
Q-3 58						
Q-4 58						
Q-1 59						
Q-2 59						
Q-3 59						
Q-4 59						
Q-1 60						
Q-2 60						
Q-3 60	73.5	12334	3.917	48314	45972	94286
Q-4 60						
Q-1 61	82.5	14193	3.996	56717	48446	105163
Q-2 61						
Q-3 61	70.5	12794	3.917	50110	56599	106709
Q-4 61						
Q-1 62	73.0	12418	4.113	51070	55208	106278
Q-2 62						
Q-3 62	135.0	22785	2.976	67812	82072	149884
Q-4 62						
Q-1 63	42.0	7121	7.309	52047	71025	123072
Q-2 63						
Q-3 63	19.5	3389	4.402	14919	20956	35875
Q-4 63						
Q-1 64	9.0	1479	3.853	5699	6271	11970
Q-2 64						
Q-3 64	9.0	1469	3.849	5654	6224	11878
Q-4 64						
Q-1 65	3.0	561	4.674	2622	3153	5775
Q-2 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	1.5	225	4.667	1050	1262	2312
Q-4 65						
Q-1 66		16	4.625	74	90	164
TOTAL	518.5	88784		356088	397278	753366

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	1.0	127	2.551	324	557	881
Q-4 58						
Q-1 59	3.0	565	2.750	1554	2147	3701
Q-2 59						
Q-3 59	177.0	31100	2.981	92702	118620	211322
Q-4 59						
Q-1 60	418.5	72640	2.912	211514	286481	497995
Q-2 60						
Q-3 60	378.0	63453	2.878	182637	220167	402804
Q-4 60						
Q-1 61	700.5	119602	2.950	352834	415685	768519
Q-2 61						
Q-3 61	649.5	117666	3.040	357725	477999	835724
Q-4 61						
Q-1 62	350.5	59781	3.040	181743	220688	402431
Q-2 62						
Q-3 62	280.5	47019	3.074	144547	196076	340623
Q-4 62						
Q-1 63	9.0	1531	4.651	7120	13771	20891
Q-2 63						
Q-3 63	102.0	17048	2.962	50499	96014	146513
Q-4 63						
Q-1 64	40.5	6841	2.578	17639	31979	49618
Q-2 64						
Q-3 64	22.5	4048	4.544	18393	31180	49573
Q-4 64						
Q-1 65	18.0	3041	3.439	10457	12034	22491
Q-2 65						
Q-3 65	7.5	1216	3.436	4178	4809	8987
Q-4 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 66		87	3.437	299	344	643
TOTAL	3158.0	545765		1634165	2128551	3762716

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		26	3.231	84		84
Q-4 58						
Q-1 59		29	2.897	84		84
Q-2 59						
Q-3 59	3.0	644	2.887	1859		1859
Q-4 59						
Q-1 60	18.0	3149	3.100	9762		9762
Q-2 60						
Q-3 60	24.0	4082	3.226	13170		13170
Q-4 60						
Q-1 61	46.5	8047	3.196	25721		25721
Q-2 61						
Q-3 61	51.0	9303	3.320	30890		30890
Q-4 61						
Q-1 62	24.0	4184	3.264	13658		13658
Q-2 62						
Q-3 62	18.0	3127	3.130	9786		9786
Q-4 62						
Q-1 63	1.5	379	4.364	1654		1654
Q-2 63						
Q-3 63	-6.0	-1104	2.722	-3005		-3005
Q-4 63						
Q-1 64	7.5	1359	3.051	4146		4146
Q-2 64						
Q-3 64	7.5	1358	3.054	4147		4147
Q-4 64						
Q-1 65	-3.0	-559	3.864	-2160		-2160
Q-2 65						
Q-3 65	-1.5	-224	3.857	-864		-864
Q-4 65						

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 06
SUBD OF WORK TEST/QC

FLIGHT CONTROL SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 66		-16	3.875	-62		-62
TOTAL	190.5	33784		108870		108870

C S.

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
SUBD OF WORK TEST/QC

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58							
Q-2 58							
Q-3 58	1.0	153	2.667	408	557	965	196
Q-4 58							
Q-1 59	3.0	594	2.758	1638	2147	3785	1138
Q-2 59							
Q-3 59	180.0	31744	2.979	94561	118620	213181	15372
Q-4 59							
Q-1 60	436.5	75789	2.920	221276	286481	507757	20774
Q-2 60							
Q-3 60	475.5	79869	3.057	244121	266139	510260	216466
Q-4 60							
Q-1 61	825.5	141842	3.069	435272	464131	899403	70117
Q-2 61							
Q-3 61	771.0	139763	3.139	438725	534598	973323	397177
Q-4 61							
Q-1 62	447.5	76383	3.227	246471	275896	522367	76118
Q-2 62							
Q-3 62	433.5	72931	3.046	222145	278148	500293	128791
Q-4 62							
Q-1 63	52.5	9031	6.735	60821	84796	145617	149796
Q-2 63							
Q-3 63	115.5	19333	3.228	62413	116970	179383	16421
Q-4 63							
Q-1 64	57.0	9679	2.840	27484	38250	65734	32874
Q-2 64							
Q-3 64	39.0	6875	4.101	28194	37404	65598	32845
Q-4 64							
Q-1 65	18.0	3043	3.588	10919	15187	26106	6057
Q-2 65							
Q-3 65	7.5	1217	3.586	4364	6071	10435	2422
Q-4 65							

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
SUBD OF WORK TEST/QC

FLIGHT CONTROL SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66		87	3.575	311	434	745	175
TOTAL	3867.0	668333		2099123	2525829	4624952	1166739

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
SUBD OF WORK TEST/QC

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58		10	10		10
Q-2 58					
Q-3 58	11	-10	1162		1162
Q-4 58					
Q-1 59	96		5019		5019
Q-2 59					
Q-3 59	1302		229855		229855
Q-4 59					
Q-1 60	2731		531262	10122	541384
Q-2 60					
Q-3 60	28465		755191	14389	769580
Q-4 60					
Q-1 61	5925		975445	18127	993572
Q-2 61					
Q-3 61	33561	8506	1412567	26250	1438817
Q-4 61					
Q-1 62	5998	1127	605610	10165	615775
Q-2 62					
Q-3 62	10149	2180	641413	10766	652179
Q-4 62					
Q-1 63	14754	-1905	308262	5154	313416
Q-2 63					
Q-3 63	1617	-640	196781	3290	200071
Q-4 63					
Q-1 64	3504	88	102200	2175	104375
Q-2 64					
Q-3 64	11949	87	110479	2351	112830
Q-4 64					
Q-1 65	1812	74	34049	908	34957
Q-2 65					
Q-3 65	432	30	13319	355	13674
Q-4 65					

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06 **FLIGHT CONTROL SUBSYSTEM**
SUBD OF WORK TEST/QC

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 66	36	2	958	29	987
TOTAL	122342	9549	5923582	104081	6027663

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 06
FLIGHT CONTROL SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	40.5	6891	4.800	33076	31352	64428
Q-2 58						
Q-3 58	198.0	33360	4.469	149077	131368	280445
Q-4 58						
Q-1 59	231.0	39382	4.537	178659	135264	313923
Q-2 59						
Q-3 59	479.5	84379	4.334	365662	301488	667150
Q-4 59						
Q-1 60	588.0	101943	4.658	474885	382234	857119
Q-2 60						
Q-3 60	666.0	111950	4.710	527309	416095	943404
Q-4 60						
Q-1 61	852.0	145378	4.657	677019	495429	1172448
Q-2 61						
Q-3 61	555.0	100626	4.855	488530	464686	953216
Q-4 61						
Q-1 62	653.5	111482	5.095	568030	512254	1080284
Q-2 62						
Q-3 62	670.0	112525	4.698	528668	543111	1071779
Q-4 62						
Q-1 63	477.0	81410	5.651	460046	474227	934273
Q-2 63						
Q-3 63	420.0	70587	5.428	383111	406274	789385
Q-4 63						
Q-1 64	328.5	56050	5.528	309854	351249	661103
Q-2 64						
Q-3 64	301.5	53135	5.552	294980	335681	630661
Q-4 64						
Q-1 65	85.5	14907	6.126	91326	98197	189523
Q-2 65						

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 06
FLIGHT CONTROL SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	25.5	4331	7.782	33704	36288	69992
Q-4 65						
Q-1 66	10.5	1819	1.692	3077	2924	6001
TOTAL	6582.C	1130155		5567C13	5118121	10685134

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 06
FLIGHT CONTROL SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	1.0	127	2.551	324	557	881
Q-4 58						
Q-1 59	3.0	605	2.702	1635	2295	3930
Q-2 59						
Q-3 59	190.5	33420	2.969	99218	126814	226032
Q-4 59						
Q-1 60	445.0	77096	2.923	225382	304009	529391
Q-2 60						
Q-3 60	435.0	72978	2.878	210020	255959	465979
Q-4 60						
Q-1 61	751.5	128268	2.933	376184	446350	822534
Q-2 61						
Q-3 61	661.5	119973	3.036	364278	488501	852779
Q-4 61						
Q-1 62	351.0	59874	3.040	182038	221112	403150
Q-2 62						
Q-3 62	279.0	46979	3.077	144541	195892	340433
Q-4 62						
Q-1 63	9.0	1604	4.575	7339	14065	21404
Q-2 63						
Q-3 63	101.5	17017	2.954	50265	95880	146145
Q-4 63						
Q-1 64	40.5	6956	2.586	17990	32543	50533
Q-2 64						
Q-3 64	24.0	4116	4.519	18599	31538	50137
Q-4 64						
Q-1 65	18.0	3041	3.439	10457	12034	22491
Q-2 65						
Q-3 65	7.5	1216	3.436	4178	4809	8987
Q-4 65						

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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 06
FLIGHT CONTROL SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 66		87	3.437	299	344	643
TOTAL	3318.0	573357		1712747	2232702	3945449

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 06
FLIGHT CONTROL SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		26	3.231	84		84
Q-4 58						
Q-1 59		29	2.897	84		84
Q-2 59						
Q-3 59	4.5	662	2.887	1911		1911
Q-4 59						
Q-1 60	18.0	3213	3.107	9982		9982
Q-2 60						
Q-3 60	25.5	4276	3.280	14025		14025
Q-4 60						
Q-1 61	48.0	8068	3.201	25822		25822
Q-2 61						
Q-3 61	51.0	9309	3.320	30905		30905
Q-4 61						
Q-1 62	24.0	4184	3.264	13658		13658
Q-2 62						
Q-3 62	18.0	3127	3.130	9786		9786
Q-4 62						
Q-1 63	1.5	379	4.364	1654		1654
Q-2 63						
Q-3 63	-6.0	-1104	2.722	-3005		-3005
Q-4 63						
Q-1 64	7.5	1360	3.050	4148		4148
Q-2 64						
Q-3 64	7.5	1363	3.056	4165		4165
Q-4 64						
Q-1 65	-3.0	-559	3.862	-2159		-2159
Q-2 65						
Q-3 65	-1.5	-224	3.857	-864		-864
Q-4 65						

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 06
FLIGHT CONTROL SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 66		-16	3.875	-62		-62
TOTAL	195.0	34093		110134		110134

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
FLIGHT CONTROL SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	40.5	6891	4.800	33076	31352	64428	
Q-2 58							
Q-3 58	199.0	33513	4.461	149485	131925	281410	196
Q-4 58							
Q-1 59	234.0	40016	4.508	180378	137559	317937	1138
Q-2 59							
Q-3 59	674.5	118461	3.940	466791	428302	895093	16426
Q-4 59							
Q-1 60	1051.0	182252	3.897	710249	686243	1396492	21876
Q-2 60							
Q-3 60	1126.5	189204	3.971	751354	672054	1423408	217747
Q-4 60							
Q-1 61	1651.5	281714	3.830	1079025	941779	2020804	70878
Q-2 61							
Q-3 61	1267.5	229908	3.844	883713	953187	1836900	397370
Q-4 61							
Q-1 62	1028.5	175540	4.351	763726	733366	1497092	76206
Q-2 62							
Q-3 62	967.0	162631	4.200	682995	739003	1421998	128842
Q-4 62							
Q-1 63	487.5	83393	5.624	469039	488292	957331	149916
Q-2 63							
Q-3 63	515.5	86500	4.975	430371	502154	932525	18233
Q-4 63							
Q-1 64	376.5	64366	5.158	331992	383792	715784	32953
Q-2 64							
Q-3 64	333.0	58614	5.421	317744	367219	684963	33019
Q-4 64							
Q-1 65	100.5	17389	5.729	99624	110231	209855	6057
Q-2 65							
Q-3 65	31.5	5323	6.954	37018	41097	78115	2422
Q-4 65							

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
FLIGHT CONTROL SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66	10.5	1890	1.753	3314	3268	6582	175
TOTAL	10095.0	1737605		7389894	7350823	14740717	1173454

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
FLIGHT CONTROL SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58				3443	67871		67871
Q-2 58							
Q-3 58		196	11	4476	286093		286093
Q-4 58							
Q-1 59		1138	96	5137	324308		324308
Q-2 59							
Q-3 59	162500	178926	5831	14883	1094733		1094733
Q-4 59							
Q-1 60	162500	184376	12516	23083	1616467	30798	1647265
Q-2 60							
Q-3 60	619560	837307	65392	25159	2351266	44800	2396066
Q-4 60							
Q-1 61	1602525	1673403	51902	19807	3765916	69982	3835898
Q-2 61							
Q-3 61	1061735	1459105	63995	26111	3386111	62924	3449035
Q-4 61							
Q-1 62	1153889	1230095	42677	14453	2784317	46734	2831051
Q-2 62							
Q-3 62	1153889	1282731	46805	20831	2772365	46534	2818899
Q-4 62							
Q-1 63	951000	1100916	55148	24414	2137809	39088	2176897
Q-2 63							
Q-3 63	127402	145635	5898	23928	1107976	18528	1126504
Q-4 63							
Q-1 64	430036	462989	62571	17117	1258461	26777	1285238
Q-2 64							
Q-3 64		33019	12012	14034	744028	15832	759860
Q-4 64							
Q-1 65		6057	1812	14761	232485	6202	238687
Q-2 65							
Q-3 65		2422	432	5905	86874	2317	89191
Q-4 65							

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B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 06
FLIGHT CONTROL SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 66		175	36	422	7215	217	7432
TOTAL	7425036	8598490	427124	257964	24024295	410733	24435028

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WORK BREAKDOWN STRUCTURE

SUBSYSTEM: PERSONNEL ACCOMMODATION & ESCAPE WBS CODE: 1.7

WBS LEVELS
4 5 6 7 8

1.7 PERSONNEL ACCOMODATION AND ESCAPE SUBSYSTEM

1.7.1 Personnel Equipment

1.7.1.1 Aircrew Helmet (GFE)

Microphones
Headsets

1.7.1.2 Oxygen Mask (GFE)

1.7.1.3 Flight Suit (GFE)

1.7.1.4 Pressure Suit (GFE)

1.7.1.5 Relief System (GFE)

1.7.1.6 Data Case

1.7.1.7 Thermal Underwear (GFE)

1.7.1.8 Mae West (GFE)

1.7.1.9 Flash Light

1.7.2 LO_2 Subsystem

1.7.2.1 Converters (GFE)

1.7.2.2 Check Valves (GFE)

1.7.2.3 Heat Exchanger

1.7.2.4 Flex Hoses

1.7.2.5 Quick Disconnects (GFE)

1.7.2.6 Quantity Probes

1.7.2.7 Pressure Suit Regulator

1.7.2.8 Capsule O_2 Cylinder (GFE)

1.7.2.9 O_2 Pressure Regulator (GFE)

1.7.2.10 Portable O_2 Cylinder

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: PERSONNEL ACCOMMODATION & ESCAPE WBS CODE: 1.7

WBS LEVELS
4 5 6 7 8

1.7.2.11 O_2 Filter Assy

1.7.2.12 O_2 Control Panel

Quantity Indicator (GFE)
Mode Switch (GFE)
Function Indicator
Test Circuitry

1.7.3 Crew Station Accommodations

1.7.3.1 Controls and Displays

1.7.3.2 Fire Extinguishing Cylinder (GFE)

1.7.3.3 Relief Container (GFE)

1.7.3.4 Emergency Ax

1.7.3.5 Escape Reels

1.7.3.6 Safety Pins

1.7.3.7 Streamers

1.7.3.8 ILS Chart Holder

1.7.3.9 Map Case

1.7.3.10 Data Holder

1.7.3.11 Sun Visors

1.7.3.12 Seat Adjusters

Vertical Motor
Longitudinal Motor
Actuators
Switches
Sensors

1.7.4 Escape Subsystem

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: PERSONNEL ACCOMMODATION & ESCAPE WBS CODE: 1.7

WBS LEVELS

4 5 6 7 8

1.7.4.1 Encapsulated Seat

Upper Door
Lower Door
Shell Assembly
Rotary Thrusters
Foot Positioners
Seal Assembly
Initiators
Door Hinges
A/V Descent Control

1.7.4.2 Seat Ejection

Restraint Harness
Inertial Reels
Reel Power Take-up Assembly
Seal Retract Actuator
Parachute Container
Parachute Container Lid
Parachute Container Lid Actuator
Aneroid Control Unit
Parachute
Manual Chute Control
Chute Cutter
Retraction Thruster
Gas Flow Check Valves
Rocket Catapult
Propellants
Pressure Controller
Relief Vent
Altimeter
Chute Release Mechanism
Impact Attenuators
Attenuator/Door Interlock
Stabilization Booms
Boom Thrusters
Stabilizer Chutes
Door Closure Thrusters
Gas Generators
Door Close Sensor
Sequence Valving
Hatch Initiators
Hatch Boosters
Hatch Removers
Catapult Rails

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: PERSONNEL ACCOMMODATION & ESCAPE   WBS CODE: 1.7

WBS LEVELS
4 5 6 7 8

1.7.4.3 Control Column Stowage

Thruster
Initiator
Gas Generator

1.7.4.4 Ejection Control and Display

Hand Grips
Triggers
Encapsulation display
Ejection Display

1.7.4.5 Survival Equipment (GFE)

Stowed Kits
Radio Beacon
Chaff Dispenser

1.7.5 Aft Escape Hatch

1.7.5.1 Ejection System

"Tee" Handle Controls
Cabling
Initiators
Booster
Hatch Remover
External Initiation

1.7.5.2 Manual Removal

Release Handle
Cabling
Locking Mechanism

1.7.6 Development Tests

1.7.6.1 Wind Tunnel

1.7.6.2 Rate of Descent

1.7.6.3 Chute Integrity

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: PERSONNEL ACCOMMODATION & ESCAPE

WBS CODE: 1.7

WBS LEVELS 4 5 6 7 8	
1.7.6.4	Low Altitude Drops
1.7.6.5	Catapult Static Fire
1.7.6.6	Shell Altitude Ejection
1.7.6.7	Static Sled Ejection
1.7.6.8	Impact Tests
1.7.6.9	Hi-speed Sled Ejection
1.7.6.10	Floatation Tests
1.7.6.11	Cartridge Tests
1.7.6.12	Sled Deceleration Tests
1.7.6.13	Centrifuge Tests
1.7.6.14	B-58 Rocket Ejection
1.7.6.15	Simian Ejections
1.7.6.16	Human Ejections
1.7.6.17	Flight Simulator
1.7.6.18	Mockups

TECHNICAL DESCRIPTION

SUBSYSTEM: PERSONNEL ACCOMMODATIONS AND ESCAPE — WBS CODE: 1.7

The Personnel Accommodations and Escape Subsystem consisted essentially of equipment, furnishings, the efficient arrangement of controls and displays for normal and emergency operation of the air vehicle, and an escape system for the survival of each crewman in the event the air vehicle had to be abandoned. The XB-70A side-by-side, pilot-copilot configuration essentially conformed to the standard cockpit of Specification MIL-STD-203. Complete duality of flight controls and flight instruments permitted control of the air vehicle from either station which also had backup flight instruments, such as altimeters and airspeed indicators. Exhibit 1, page IV-256, presents a view looking forward of the No. 1 XB-70 cockpit showing the arrangement of the controls and displays which are identified in Crew Accommodations: WBS 1.7.3.

The "shirt-sleeve" environment requirement for the B-70 necessitated a number of advances in the state-of-the-art for the emergency and escape operational functions. The "shirt-sleeve" environment concept freed the crew of inhibiting clothing, such as, pressure suits, ventilation garments, exposure suits, life vests, etc., and enhanced their efficiency through better communications, vision, comfort and mobility. However, these improvements for crew efficiency impacted the survival systems due to the unimpaired survival requirements for the crew without protective clothing for an undelayed escape regardless of altitude and Mach number. The encapsulated seat approach was selected in order to accomplish the objectives of "shirt-sleeve" operations and yet furnish both a pressurized retreat within the cabin and an exit device for abandonment of the air vehicle.

The escape system consisted primarily of an escape capsule for each crew member, escape hatches, rocket catapults, and the necessary controls and actuating devices for safe ejection within the escape envelope shown by Exhibit 2, page IV-257. The escape capsule is shown by Exhibits 3, 4, 5, on pages IV-258, IV-259, and IV-260, respectively. During ejection, the resultant acceleration, applied to the center of gravity of the ejected mass, was limited to 30g's and the acceleration forces in the direction seat-to-head and parallel to the backrest was limited to 24g's. The escape capsule catapult was designed to provide a 300-foot runway clearance at a 90 knot airspeed.

In addition to the items discussed above, the Personnel Accommodations and Escape Subsystem included a breathing oxygen system for normal flight and emergency descent, rescue and survival equipment, suit pressurization and ventilation (for flight test), and miscellaneous furnishings.

CONTROLS & DISPLAYS ARRANGEMENT

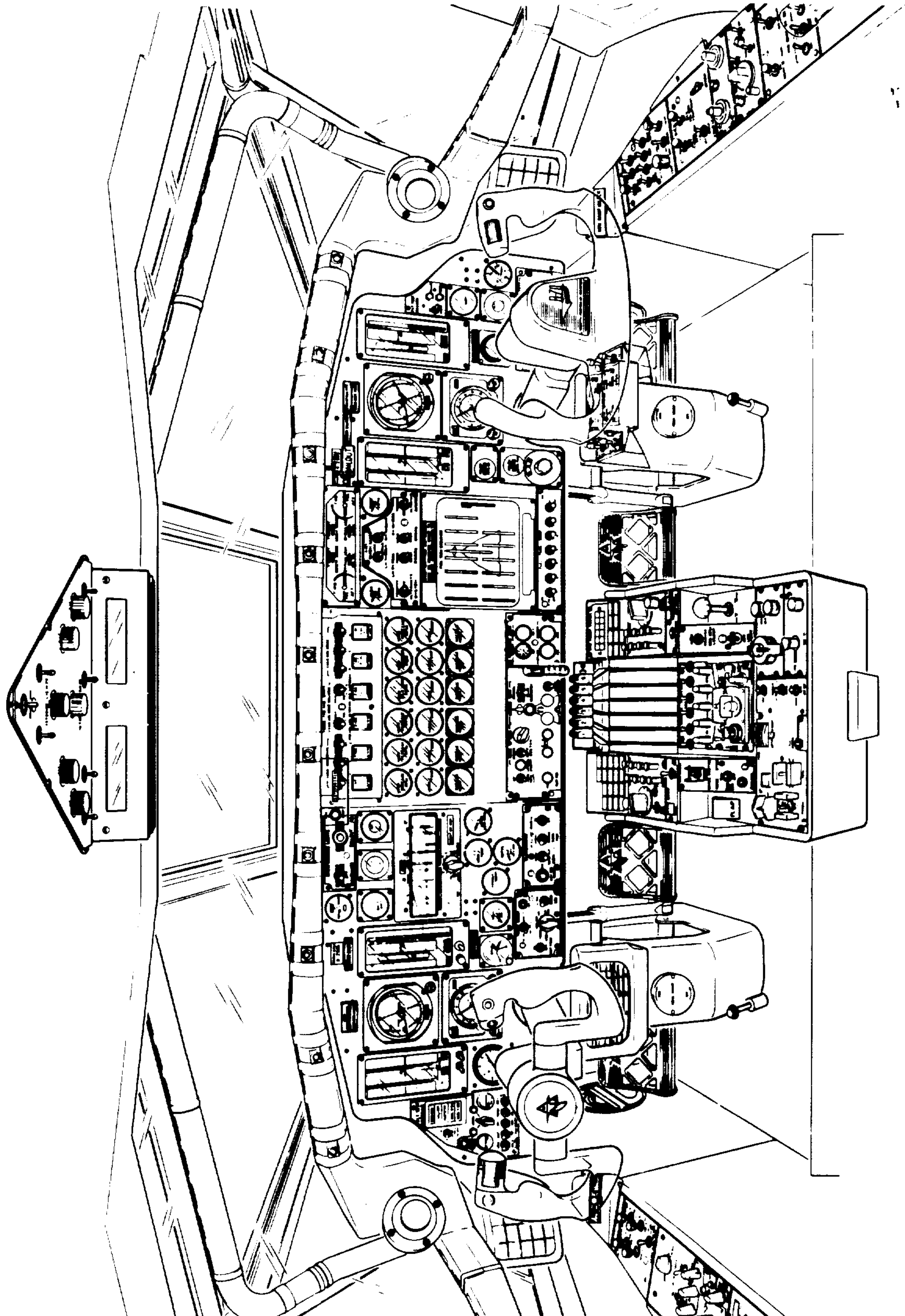


EXHIBIT 1

Escape Envelope

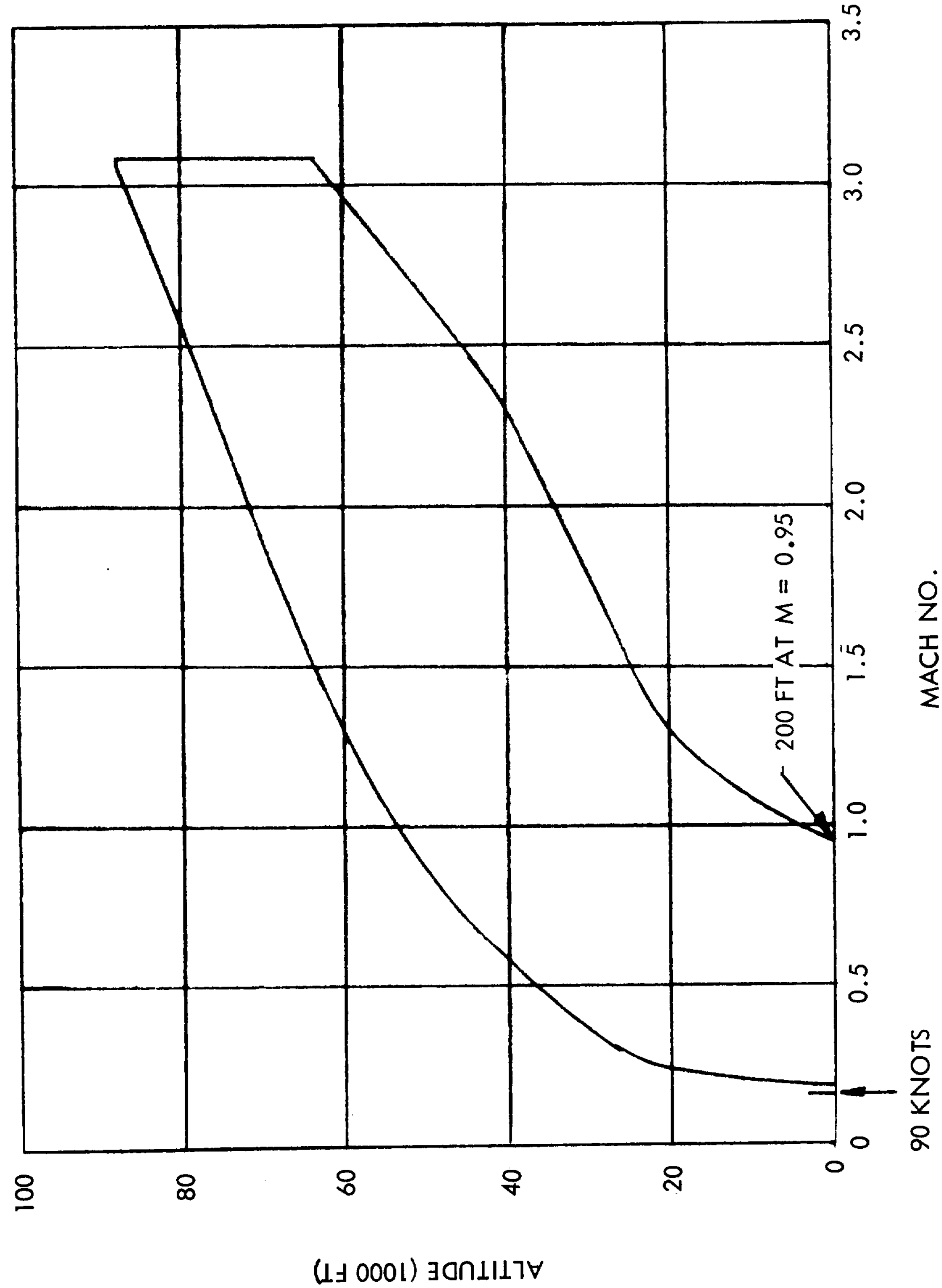
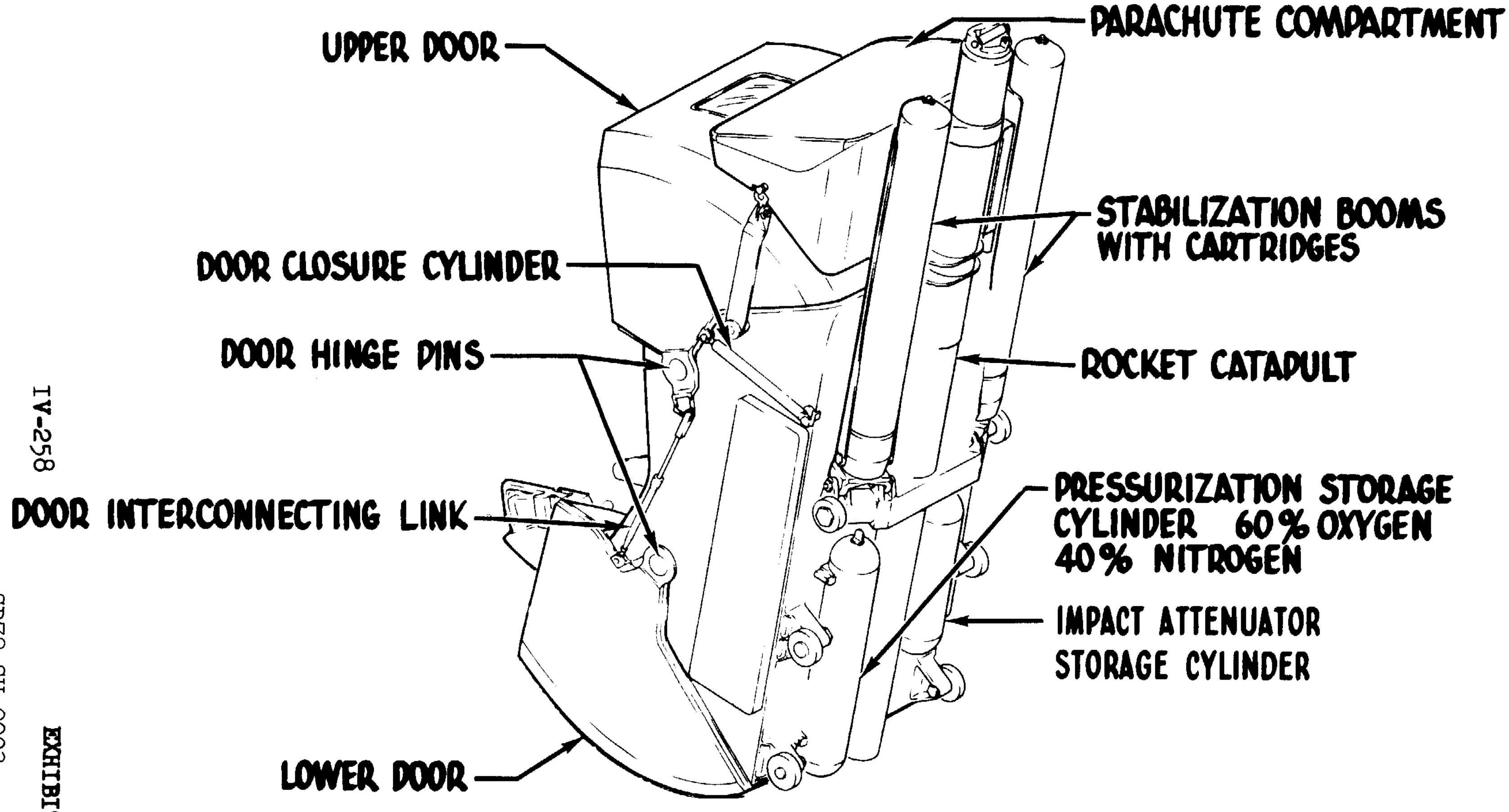
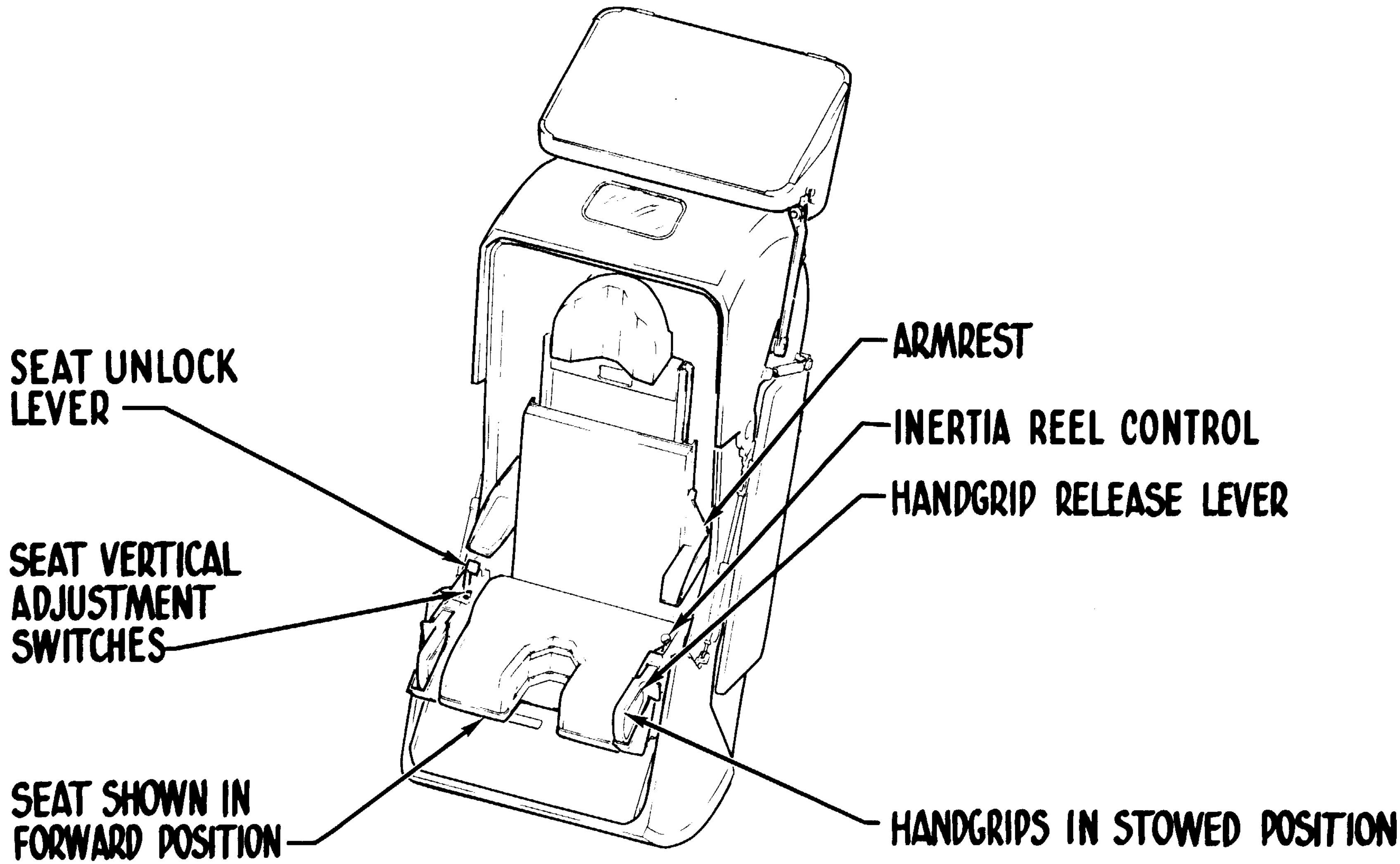


EXHIBIT 2

ENCAPSULATED SEAT ARRANGEMENT
REAR OF CAPSULE



ENCAPSULATED SEAT ARRANGEMENT
FRONT OF CAPSULE



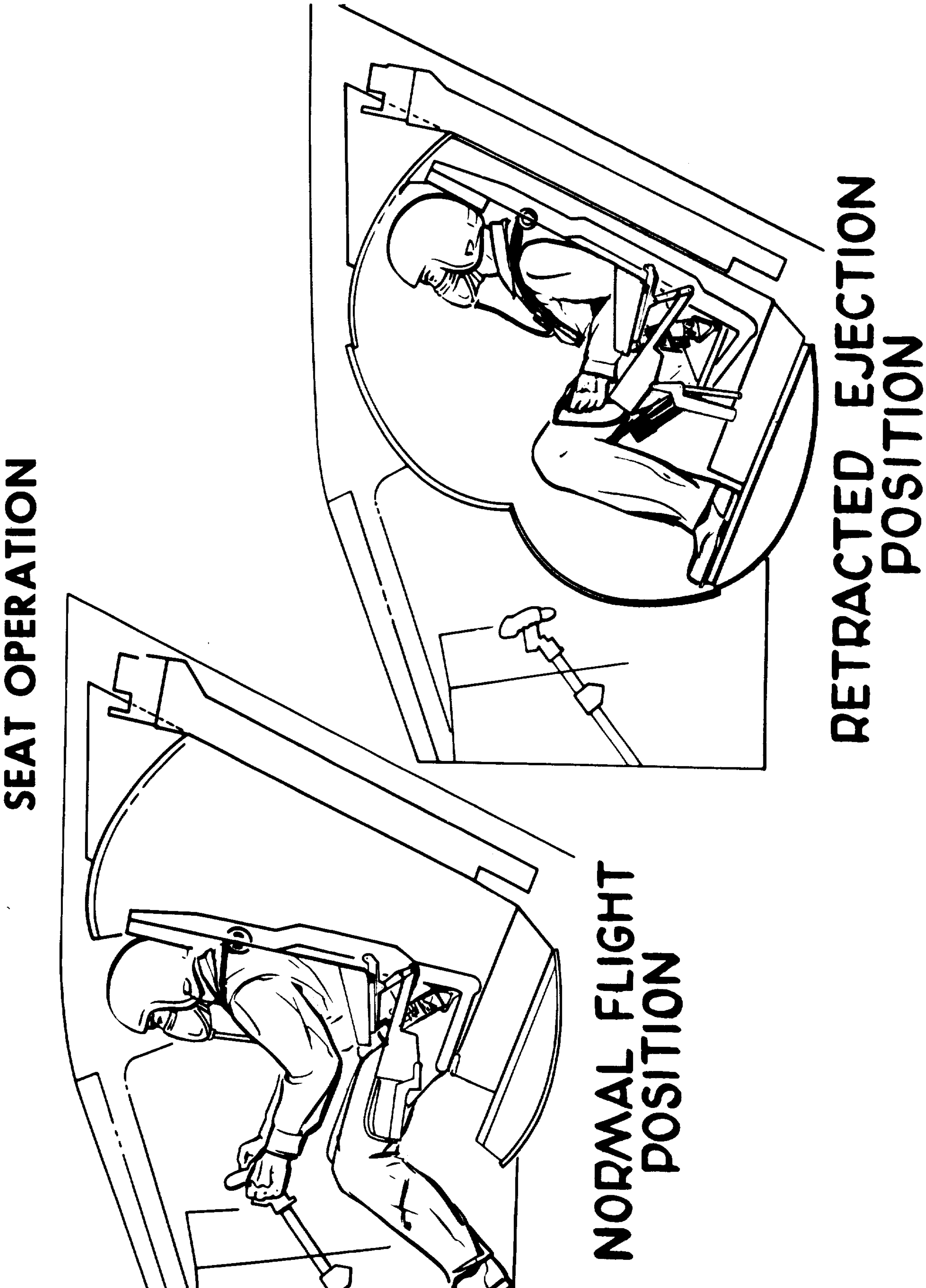

SEAT OPERATION
NORMAL FLIGHT POSITION
RETRACTED EJECTION POSITION

EXHIBIT 5

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: PERSONNEL ACCOMMODATIONS AND ESCAPE SUBSYSTEM WBS CODE: 1.7

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
MAJOR FUNCTIONAL EQUIPMENT	SPECIFY	ACCOMMODATIONS → LIFE SUPPORT → ESCAPE → CONTROLS AND DISPLAYS →				
CREW STATIONS	NUMBER	4	2	2	2	2
PILOT	NUMBER	1	1	1	1	1
COPILOT	NUMBER	1	1	1	1	1
BOMB/NAV. OPERATOR	NUMBER	1	NONE →			
DEF. OPERATOR	NUMBER	1	NONE →			
SYSTEM INDICATORS	NUMBER	57	71	77	74	71
EVENT DISPLAYS	NUMBER	30	9	14	21	21
SYSTEM CONTROLS	NUMBER	11	14	18	21	24
TOGGLE SWITCHES	NUMBER	119	94	107	125	140
PUSH BUTTONS	NUMBER	215	27	32	32	31
SELECTOR SWITCHES	NUMBER	119	93	94	85	88
CIRCUIT BREAKERS	NUMBER	(NONE IN CREW COMPARTMENT) →				

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: PERSONNEL ACCOMMODATIONS AND ESCAPE SUBSYSTEM WBS CODE: 1.7

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
CAUTION AND WARNING LIGHTS	NUMBER	102	60	76	83	83
MINIMUM EJECTION ALTITUDE	FEET	ZERO	ZERO	ZERO	ZERO	ZERO
MINIMUM EJECTION SPEED	KIAS	90	90	90	90	90
MAXIMUM EJECTION ALTITUDE	FEET	100,000	100,000	100,000	100,000	100,000
MAXIMUM EJECTION SPEED	MACH NO.	3.1	3.1	3.1	3.1	3.1
TEMPERATURE DESIGN RANGE	-	-	-	-	-	-
ESCAPE SYSTEM	DEGREES F	-65 TO 630	-65 TO 630	-65 TO 630	-65 TO 630	-65 TO 630
CREW AMBIENT	" "	50 TO 120	50 TO 120	50 TO 120	50 TO 120	50 TO 120
TOTAL COMPARTMENTATION VOLUME	$FEET^3$ *	1000	1000	1000	1000	1000

*INCLUDES CABIN, EQUIP. BAY, AND UNDERFLOOR AREA

TECHNICAL DESCRIPTION

SUBSYSTEM: PERSONNEL ACCOMMODATION & ESCAPE — WBS CODE: 1.7

MAJOR ASSEMBLY: PERSONNEL EQUIPMENT — WBS CODE: 1.7.1

Personnel equipment was primarily Government Furnished Equipment. See WBS listing on Page IV-250 for details.

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: PERSONNEL EQUIPMENT WBS CODE: 1.7.1

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
NUMBER OF CREW MEMBERS	NUMBER	4	2	2	2	2
CREW HELMET	TYPE	LIGHT WEIGHT SPECIAL	PRESS SUIT	PRESS SUIT	PRESS SUIT	PRESS SUIT
CREW OXYGEN MASK	TYPE	LIGHT WEIGHT WITH RATE SUSPENSION	PRESS SUIT HELMET	PRESS SUIT HELMET	PRESS SUIT HELMET	PRESS SUIT HELMET
FLIGHT SUIT	TYPE	SPECIAL SUMMER TYPE	PRESS SUIT	PRESS SUIT	PRESS SUIT	PRESS SUIT
PRESSURE SUIT	TYPE	NONE	A/P 22S-2	A/P 22S-2	A/P 22S-2	A/P 22S-2

TECHNICAL DESCRIPTION

SUBSYSTEM: PERSONNEL ACCOMMODATION & ESCAPE WBS CODE: 1.7

MAJOR ASSEMBLY: LIQUID OXYGEN SUBSYSTEM WBS CODE: 1.7.2

A liquid oxygen subsystem was provided to supply breathing oxygen for the crewmen during normal flight. Two 10-liter liquid oxygen converters were positioned within a closed compartment just inboard and aft of the main entrance door of the air vehicle. An oxygen quantity indicator was located on the main instrument panel with a quantity indicator test button located immediately below the indicator. Oxygen flow to the crewman was regulated by regulators in the personal equipment worn by the crewman. Connection to the oxygen subsystem from the personal equipment (oxygen mask and regulator or the pressure suit) was provided by a quick-disconnect fitting on a hose attached to the forward edge of each seat. The liquid oxygen converters were capable of being quickly disconnected from the air vehicle for ground servicing.

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: LIQUID OXYGEN SYSTEM WBS CODE: 1.7.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
LOX QUANTITY	POUNDS	50.8	50.8	50.8	50.8	50.8
LOX CONVERTER	TYPE	QUICK REMOVABLE	GCU-18/A MIL-C-27423B	GCU-18/A MIL-C-27423B	GCU-18/A MIL-C-27423B	GCU-18/A MIL-C-27423B
HEAT SINK	SPECIFY	AMBIENT AIR IN CABIN	AMBIENT AIR IN CABIN	AMBIENT AIR IN CABIN	AMBIENT AIR IN CABIN	AMBIENT AIR IN CABIN
HEAT EXCHANGER	TYPE	ALUMINUM TUBING	ALUMINUM TUBING	ALUMINUM TUBING	ALUMINUM TUBING	ALUMINUM TUBING
LOX SUPPLY REGULATORS	TYPE	MASK MOUNTED BREATHING	PART OF PRESS SUIT	PART OF PRESS SUIT	PART OF PRESS SUIT	PART OF PRESS SUIT
LOX SUPPLY PRESSURE	PSI	70	70	70	70	70
LOX SUPPLY TEMPERATURE	DEGREES F	60°	60°	60°	60°	60°
PORTABLE O_2 QUANTITY	POUNDS	1.6	0.8	0.8	0.8	0.8
PORTABLE O_2 PRESSURE	PSI	1800	1800	1800	1800	1800
PORTABLE O_2 PRESS REGULATOR	TYPE	1800 TO 70 PSI REDUCER	1800 TO 70 PSI REDUCER	1800 TO 70 PSI REDUCER	1800 TO 70 PSI REDUCER	1800 TO 70 PSI REDUCER
PRESSURE SUIT REGULATION	PSI	70	70	70	70	70

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: LIQUID OXYGEN SYSTEM WBS CODE: 1.7.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
MTBF	NO. OF HR.	500	500	500	500	500

TECHNICAL DESCRIPTION

SUBSYSTEM: PERSONNEL ACCOMMODATIONS AND ESCAPE — WBS CODE: 1.7

MAJOR ASSEMBLY: CREW STATION ACCOMMODATIONS — WBS CODE: 1.7.3

The XB-70 pilot-copilot side-by-side crew station configuration provided the capability of air vehicle control from either station. Exhibit 1, page IV-256, presents the cockpit layout showing the arrangements of the instrument panels and associated controls and displays. The engine controls consisted of engine brake, fire warning and shutdown, tachometer, exhaust gas temperature, nozzle opening, primary throttle, and alternate throttle which were essentially in the center and available to both crewmen. Also located between the pilots was the standby trim, primary roll trim (primary pitch trim was on each control wheel), UHF No. 1, TACAN, ILS, intercom, flaps, drag chute, landing gear, wingtip fold, nose steering, brakes, and caution lights.

The overhead panel had switches for interior and exterior lights and the electrical generators. The copilot had the fuel system controls comprised of: total quantity, tank selection quantity, fuel sequencing, fuel transfer, and refueling valves. The copilot also had the air induction system controls and controls for environment, personnel equipment, IFF, SIF, fire detector test, and utility light. The pilot's side console had the following controls: augmentation power, personnel equipment, UHF No. 2, gyro platform, standby secondary nozzle, and utility light.

In addition to the crew station provisions noted above, other various equipment items were provided for the comfort and safety of the crew. These miscellaneous items included a fire extinguisher, relief container, portable oxygen unit, escape ropes, maintenance and flight status safety pins and streamers, combination map case and flight data card holder, sun visors, frequency card holders, and an emergency axe holder. The relief container had a one-pint capacity and along with the portable oxygen unit was located in a holder on the cockpit floor immediately aft of the center aisle control pedestal. The escape ropes were provided in canvas containers mounted on the bulkhead above and forward of the main entrance door. The ropes, with their descent devices, permitted the crew to leave the air vehicle in the event ladders or stands were not available.

The flight status safety pins and the "Remove Before Flight" streamers were stowed on a roller in the headrests of the seats. The safety pin was inserted in the right-hand grip of the seat following flight to inactivate the seat ejection system. The maintenance safety pins were used to deactivate the various initiators during maintenance activities.

The flight test instrumentation controls and displays are identified and discussed under Test Instrumentation Subsystem, WBS 1.11.

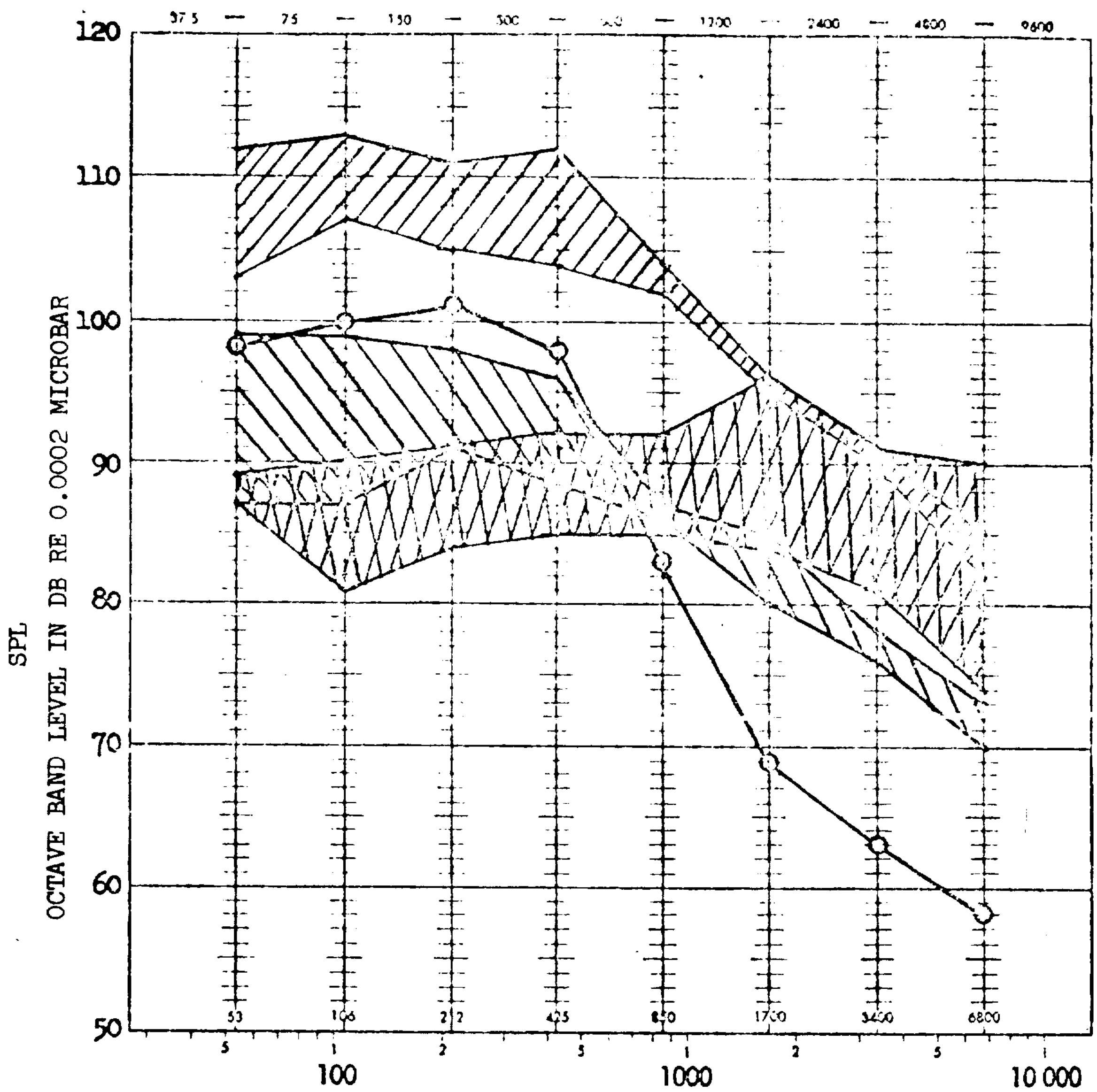
TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: CREW STA. ACCOMMODATIONS WBS CODE: 1.7.3

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
GROUND ESCAPE	SPECIFY	ONE ROPE	ONE ROPE	ONE ROPE	TWO "SKY GENIES" DESCENT DEVICES	TWO "SKY GENIES" DESCENT DEVICES
NOISE LEVEL	DB	NOT AVAILABLE	NOT AVAILABLE	SEE EXHIBITS 6, 7, AND 8, ON PAGES IV-270, IV-271, AND IV-272.		
SEAT ADJUSTMENT - VERTICAL	INCHES	5.0	5.0	5.0	5.0	5.0

TECHNICAL CHARACTERISTICS WBS CODE: 1.7.3

OCTAVE PASS BANDS IN CYCLES PER SECOND



FREQUENCY IN CYCLES PER SECOND

XB-70 INTERNAL CABIN NOISE LEVELS

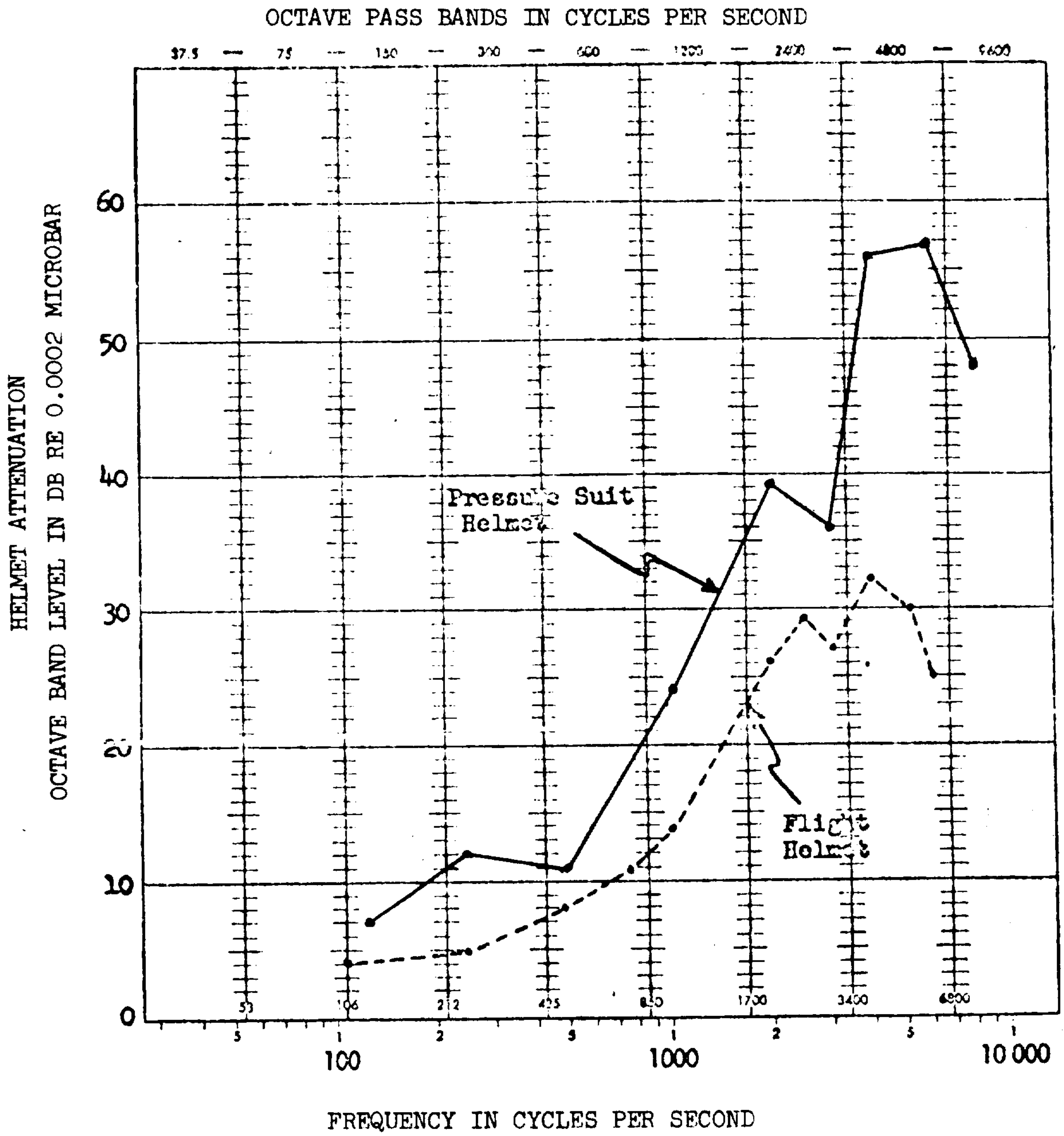
//// Boundary Layer Noise Maximum q Conditions Mach 0.95 at Sea Level and Mach 2.17 at 40,000 ft.

\\\\ Boundary Layer Noise Cruise Condition Mach 3.0 at 65,000 ft. and 86,000 ft.

XXXX Environmental System (ECS)

-⊙- Engine Noise During Takeoff at Maximum Power (Component SPL's to be Summed Logarithmically)

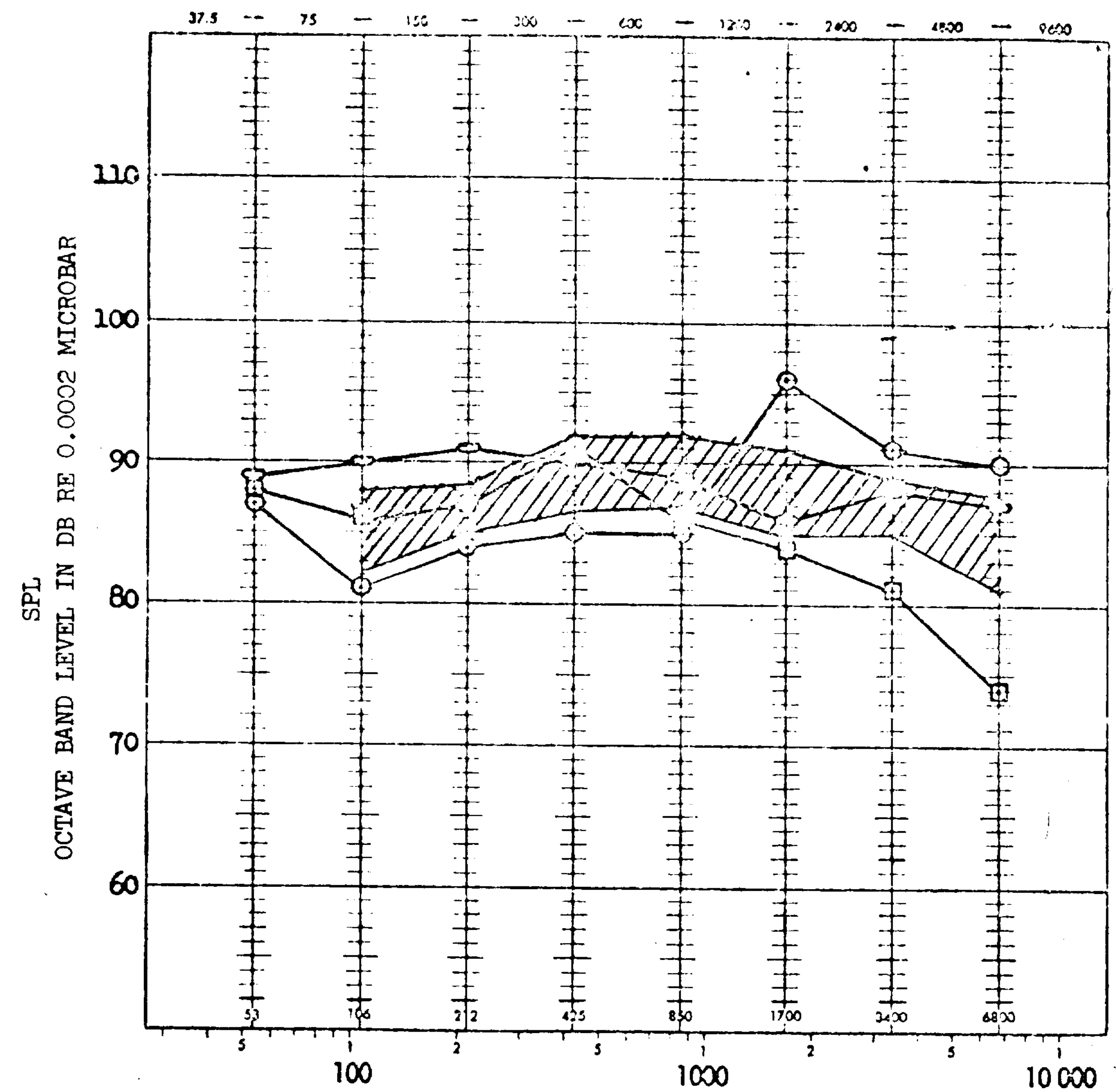
EXHIBIT 6



HELMET ATTENUATION - XB-70 CREW MEMBERS

EXHIBIT 7

OCTAVE PASS BANDS IN CYCLES PER SECOND



FREQUENCY IN CYCLES PER SECOND

XB-70 CABIN ENVIRONMENTAL SYSTEM (ECS) NOISE LEVELS

- ---- Mil. Spec. 8806 Normal Cruise
- ⊙ Thermal Simulator - Hot
- ⊡ Thermal Simulator - Cold
- ⬭ F-108 ECS Estimates by Hamilton Standard
- ▨ B-47 Airconditioning Equipment Noise (Ref. WADC TR 53-522)

TECHNICAL DESCRIPTION

SUBSYSTEM: PERSONNEL ACCOMMODATION & ESCAPE WBS CODE: 1.7

MAJOR ASSEMBLY: ESCAPE WBS CODE: 1.7.4

Each pilot's seat was enclosed in a capsule shell of bonded aluminum honeycomb construction. The encapsulated seat furnished the crew member with a secondary pressure environment in the event of cabin decompression, and adequate protection from adverse effects of windblast, accelerations, and low atmospheric pressure during ejection from a disabled air vehicle. The capsule internal pressure increased to 5 psi within 12 seconds after the capsule doors were closed. The pressure level was designed to remain between 5 and 9.5 psia during ejection and descent. The pressurization medium was 60 percent oxygen and 40 percent nitrogen. The encapsulation subsystem consisted of a seat retraction thruster, door closure thrusters, initiators, foot positioning sensing pedals, actuation controls, the capsule doors and the seat mechanism. The encapsulation subsystem provided for emergency encapsulation of the crew members. During the encapsulation sequences, the system unlocked the seat, translated it aft into the capsule shell and locked into position. The capsule doors then moved to the closed position. The encapsulation sequence could be initiated by raising either hand grip which would initiate seat retraction and arm the door closure ballistics. Actuation of foot pedals in the capsule was designed to actuate the door closure thrusters. Seat retraction and door closure could also be accomplished manually.

The capsule seat system consisted of the capsule seat assembly, the seat vertical adjustment actuator, the restraint harness and inertia reel. The seat assembly included armrests, the headrest and controls for seat adjustment, inertia reel locking and unlocking, encapsulation and ejection.

Propellant actuated devices were used in the capsule escape system. These included initiators, the seat retraction thruster, rocket catapult, door closure thrusters, stabilization booms, inertia reel power-takeup, and control column stowage thruster.

There were a total of 59 initiators employed for the emergency escape system.

Each capsule contained 23 initiators (explosive devices) and 13 were used for hatch jettison and capsule rocket catapult actuation and sequencing.

WBS CODE: 1.7.4

A seat retraction thruster was located aft of and attached to the undersurface of the two seats. The thruster was actuated when the seat handgrips were raised to initiate the encapsulation sequence. After operation of the thruster, the propellant gases, which are retained in the mechanism, by-pass the thruster piston making it possible to extend the seat for resumption of manual operation of the air vehicle. The seat and thruster design is such that the seat may be manually retracted or extended without affecting subsequent functioning of the thruster by propellant actuation.

The capsule doors were closed by gas operated thrusters as a final step in the encapsulating system. The thrusters were powered by gas from an initiator. The design would permit manual operation of the doors without affecting gas operation of the thruster.

Provisions were incorporated in the capsule which permitted limited control of the descent of the air vehicle. Electrical switches and circuits were provided by which the crewman could reduce engine thrust, and orient the vehicle by altering the pitch and roll trim control surfaces.

A rocket catapult (see Exhibit 3, Page IV-258) was used to eject the capsules from the air vehicle. The catapult was a two-stage telescoping ejector. The catapult charge was designed to propel the capsule up the ejection rails until tube separation occurs. Just before tube separation, rocket motor ignition was programmed to occur and thrust the capsule through a trajectory sufficient for parachute deployment.

Two telescoping stabilization booms were located on the back of each capsule. (Refer to Exhibit 3, Page IV-258) A self-contained propellant charge was provided in each boom. As the capsule moved up the rails during ejection, initiators mounted on the back of the capsule were designed to fire thereby actuating the charge in the booms. The booms then became unlocked and rotated away from the back of the capsule, and extended to 116 inches. Deploy stabilization parachutes stowed in the boom end-compartments then were released to stabilize the capsule in pitch and yaw after ejection.

Incorporated in the capsule was an inertia reel which was a lightly spring-powered takeup device for retracting the crew restraint harness. The reel was designed to lock mechanically when the pilot's body moved forward with an acceleration of 2g to 3g. The reel contained a power-takeup unit which was a cartridge-actuated device initiated by gas pressure. During the encapsulation sequence, the initiator gas flow which activated the seat retraction thruster also was designed to initiate the cartridge in the power-takeup unit resulting in retracting the restraint harness (and the crew members). Another event which occurred in the encapsulating sequence was the stowage of the control column so as to prevent interference with the closing capsule doors (see Exhibit 5, Page IV-260). The control column thruster was designed to be activated by gas pressure from an integral cartridge. Actuation resulted in disconnection of the control column and forward movement so it was stowed against the instrument panel.

WBS CODE: 1.7.4

The capsule was provided with breathing oxygen, a pressurization system, a recovery system and an impact attenuation system.

The emergency supply of oxygen for descent after ejection of the capsule was supplied by 1800 psi oxygen contained in a 205 cubic inch bottle installed beneath the seat. The emergency oxygen supply was designed to be automatically activated as the capsule ascended the ejection rails by a tripping mechanism. The crewman could also manually activate the system by pulling an oxygen control handle located under the seat.

The capsule interior was also pressurized automatically when the capsule doors closed. The pressurization source was a gas mixture of 60 percent oxygen and 40 percent nitrogen (by volume) contained in four cylinders with a total capacity of 376 cubic inches. The capsule internal pressure was maintained at a minimum pressure of 5 psia. A relief valve was also provided to protect the capsule against over pressurization. The valve also permitted the entrance of outside air when outside pressure exceeded interior pressure by 0.5 psia.

The recovery parachute subsystem was designed as a fully automatic high altitude system for controlled descent of the encapsulated aircrew member after ejection. The main parachute was designed to provide a sea level rate of descent of 29 feet per second maximum and limit oscillations to $\pm$ 15 degrees. The system was capable of deployment at 410 knots at an altitude of 15,000 feet. The subsystem was composed of the main recovery parachute, the pilot chute, and the deployment sequencing systems, all packed in a container in the top of the escape capsule (see Exhibit 3, Page IV-258). During descent, the sequencing system was also designed to actuate the impact attenuator system. This system was installed in the bottom of the capsule shell to reduce impact forces when the capsule struck the ground. The attenuator consisted of a neoprene impregnated nylon cloth bladder which was inflated by gas stored in a cylinder mounted on the lower aft surface of the capsule. The impact attenuation was accomplished by controlled deflation of the bladder through four blowout orifices which activated upon impact.

Extensive survival equipment was provided either within or attached to the capsule. In addition to personal survival gear, a chaff dispenser was incorporated which actuated automatically during descent to assist in providing a radar fix for subsequent rescue. An emergency radio beacon assembly was also provided to transmit distress signals during descent. This radio beacon was actuated as part of the automatic ejection sequence.

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: ESCAPE SYSTEM WBS CODE: 1.7.4

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
CAPSULES	NUMBER	4	2	2	2	2
LENGTH	INCHES	79.375 →				
WIDTH	"	24.0 →				
HEIGHT	"	40.12 →				
ENCAPSULATION CONTROLS	TYPE	MANUAL →				
		BALLISTIC →				
ENCAPSULATION TIME (BALLASTIC)	SECONDS	MAX = 0.5 →				
ENCAPSULATION INITIATORS	TYPE	MECHANICALLY ACTUATED (ORDNANCE ENGR. ASSOC.)				
MINIMUM EJECTION SPEED	KIAS	90	90	90	90	90
MINIMUM EJECTION ALTITUDE	FEET	ZERO	ZERO	ZERO	ZERO	ZERO
MAXIMUM EJECTION SPEED	MACH NO.	3.1	3.1	3.1	3.1	3.1
MAXIMUM EJECTION ALTITUDE	FEET	100,000	100,000	100,000	100,000	100,000
LIFT OR CARRY WEIGHT	POUNDS	NOT AVAIL	NOT AVAIL	664	664	664
ROCKET CATAPULT	TYPE	-	-	(ROCKET POWER: 1720-12)		
CATAPULT THRUST LEVEL	POUNDS	-	-	12,000 AT 70°F		
ROCKET PROPELLANT	TYPE	SOLID	SOLID	SOLID	SOLID	SOLID
ACCELERATION: CATAPULT	FT/SEC^2	20	20	20	20	20
BOOM THRUSTERS	TYPE/NO.	-	-	GAS GENERATOR TYPE (SELF CONTAINED PROPELLANT) 2 PER CAPSULE (PACIFIC DIV.-HOUSTON: 59252-001)		
MAIN PARACHUTES	TYPE/NO	34.5 FT. - SOLID - 10% EXTENDED SKIRT/1				
MAIN CHUTE DEPLOY ALTITUDE	FEET	15,000	15,000	15,000	15,000	15,000
MAIN CHUTE RELEASE	TYPE	MECH. INITIATOR →				

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: ESCAPE SYSTEM WBS CODE: 1.7.4

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
HATCH INITIATORS	TYPE	EJECTION INITIATORS CONNECTED TO PRESSURE ACTUATED INITIATOR WHICH BOOSTED SYSTEM PRESSURE TO HATCH REMOVER.				
HATCH BOOSTERS	TYPE	PRESS. ACTUATED CARTRIDGE (MODEL NO. 960100)				
HATCH BOOSTER THRUST	POUNDS	-	-	13,100 MAX 9,300 MIN.	→	→
HATCH REMOVERS	TYPE	CARTRIDGE ACTUATED (MODEL NO. 960100)				
SEQUENCE VALVING	TYPES	MECHANICAL SENSING (SINGLE & DOUBLE CHECK) TRIPPERS, BALLISTICALLY ACTIVATED, TIME DELAYS, AND ANEROID CONTROLLED.				
IMPACT ATTENUATORS	TYPE	INFLATABLE BLADDER (BF GOODRICH: 4A-1263)				
THERMAL IMPACT LOADS						
RATE OF DESCENT	FEET/SEC	-	-	28	28	28
DECELERATION LOAD	"Gs"			15	15	15
RESTRAINT HARNESS	TYPE	TORSO - HIP RESTRAINT HARNESS ATTACHED AT TWO FITTINGS, LAP BELT & SHOULDER HARNESS FROM PACIFIC SCIENTIFIC CO. (1101152-0)				
CONTROL COLUMN THRUSTER	TYPE	PRESSURE ACTUATED CARTRIDGE (US FLARE D-5308)				
CONTROL COLUMN THRUSTER THRUST	POUNDS	-	-	250	250	250
STOWED SURVIVAL KITS	NUMBER	3	3	3	3	3
STOWED SURVIVAL RADIO	TYPE	EMERGENCY RADIO BEACON SYSTEM (NR)				
STOWED RADAR AID	TYPE	GFP CHAFF BUNDLE: RR-94/AL 5895-620-57364				
STOWED LIFE	DAYS	-	-	1068	1068	1068

TECHNICAL DESCRIPTION

SUBSYSTEM: PERSONNEL ACCOMMODATION & ESCAPE WBS CODE: 1.7

MAJOR ASSEMBLY: AFT ESCAPE HATCH WBS CODE: 1.7.5

There were four escape hatches provided in the air vehicle. Two forward hatches were located above the pilot's and copilot's escape capsules. These hatches were jettisoned as part of the ejection sequence. Aft of these hatches there were two additional hatches. The left-hand hatch was subsequently fastened closed. The right-hand aft escape hatch was intended to be used for emergency ground escape in the event the main entrance door was inoperable. The hatch was jettisoned from inside the air vehicle by means of either of two "Tee" handles. One handle was located on the pilot's left console, the other was located on a bulkhead below the escape hatch. Pulling these handles would fire an initiator resulting in ejection of the hatch. The hatch was also designed to be removed manually by unlocking the hatch locks and then lifting and removing the hatch.

Space Division
North American Rockwell

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: AFT ESCAPE HATCH WBS CODE: 1.7.5

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
ESCAPE HATCHES	NUMBER	4	4	3	3	3
HATCH INITIATORS	TYPE/NO.	3 - MECHANICAL INITIATORS (2037-01A)				
HATCH BOOSTER	TYPE	PRESSURE ACTUATED (MODEL NO. 960100)				
BOOSTER THRUST	POUNDS	-	-	13,100 (MAX); 9,300 (MIN)		
HATCH REMOVER	TYPE	CARTRIDGE ACTUATED (MODEL NO. 960100)				
EJECTION CONTROLS	SPECIFY	TEE HANDLE ON INSTRUMENT PANEL TEE " IN AISLE ROOF TEE " ON RH SIDE OF AISLE ALSO CONNECTED TO AN EXTERIOR HANDLE NEAR DOOR				

TECHNICAL DESCRIPTION

SUBSYSTEM: PERSONNEL ACCOMMODATION & ESCAPE SUBSYSTEM WBS CODE: 1.7

MAJOR ASSEMBLY: DEVELOPMENT TESTS WBS CODE: 1.7.6

Wind tunnel evaluation of the capsule included testing of a 0.08 scale model both when isolated and when in proximity of the air vehicle.

From April through November 1959, recovery parachute evaluation at the Joint Parachute Test Facility, El Centro, California, consisted of a total of fifty-two rate of descent and structural integrity tests. By May, 1960, five capsule aerial drops had been performed at 130 knots using a C-130 and twelve ejections at 200 to 380 knots at an altitude of 40,000 feet using a B-47. Ejection tests were also performed at speeds of Mach 0.8 at 21,000 feet altitude and mach 1.6 at 38,000 feet. Sled tests were accomplished at both HurricaneMesa, Utah and at Edwards Air Force Base.

In addition, there were development tests demonstrating operational integrity, structural capability, flotation characteristics and impact resistance. The overall test program is depicted in Exhibits 9, Page IV-282, through 12, Page IV-285 respectively.

ESCAPE SYSTEM TEST SUMMARY

TEST UNITS FABRICATED:

Research Models and Mockups	8 UNITS
DEI Operational Mockup	1 "
Fwd. Fuselage/Capsule Mockups	2 "
"A" Weighted Shells: For aerials, floatation and impact tests	8 "
"B" Weighted Shells: For sled tests	3 "
"X" Test Capsules: For static loading structural tests	3 "
"T" Test Capsules: For altitude/pressure chamber tests	3 "
Recovery Chutes: For aerial tests	10 "
Escape Hatches: For static firings	4 "
TOTAL	42 UNITS

TESTS PERFORMED:

Wind Tunnel	3 UNITS	473 HOURS
Operational Evaluations	3 "	400 "
C-130 Test Bed: 5 aerial ejections	2 "	9 "
B-47 Test Bed: 12 aerial ejections	5 "	20 "
B-58 Test Bed: 2 aerial ejections	1 "	4 "
Sled Tests: 11 ejections at max. KEAS	2 "	330 "
Zero Airspeed - Capsule: 2 ground level ejections	1 "	60 "
Capsule Landings: 17 impacts with dummy and humans (concrete and water)	5 "	340 "
Zero Airspeed - Hatches: 4 ground level ejections	4 "	80 "
Recovery Parachute: 52 aerial tests	10 "	87 "
Altitude Chamber: 18 tests with dummy, simian, and humans	3 "	360 "
Structural Tests: 36 static loadings	3 "	720 "
TOTALS	42 UNITS	2883 HOURS

GROUND AND LABORATORY TESTS

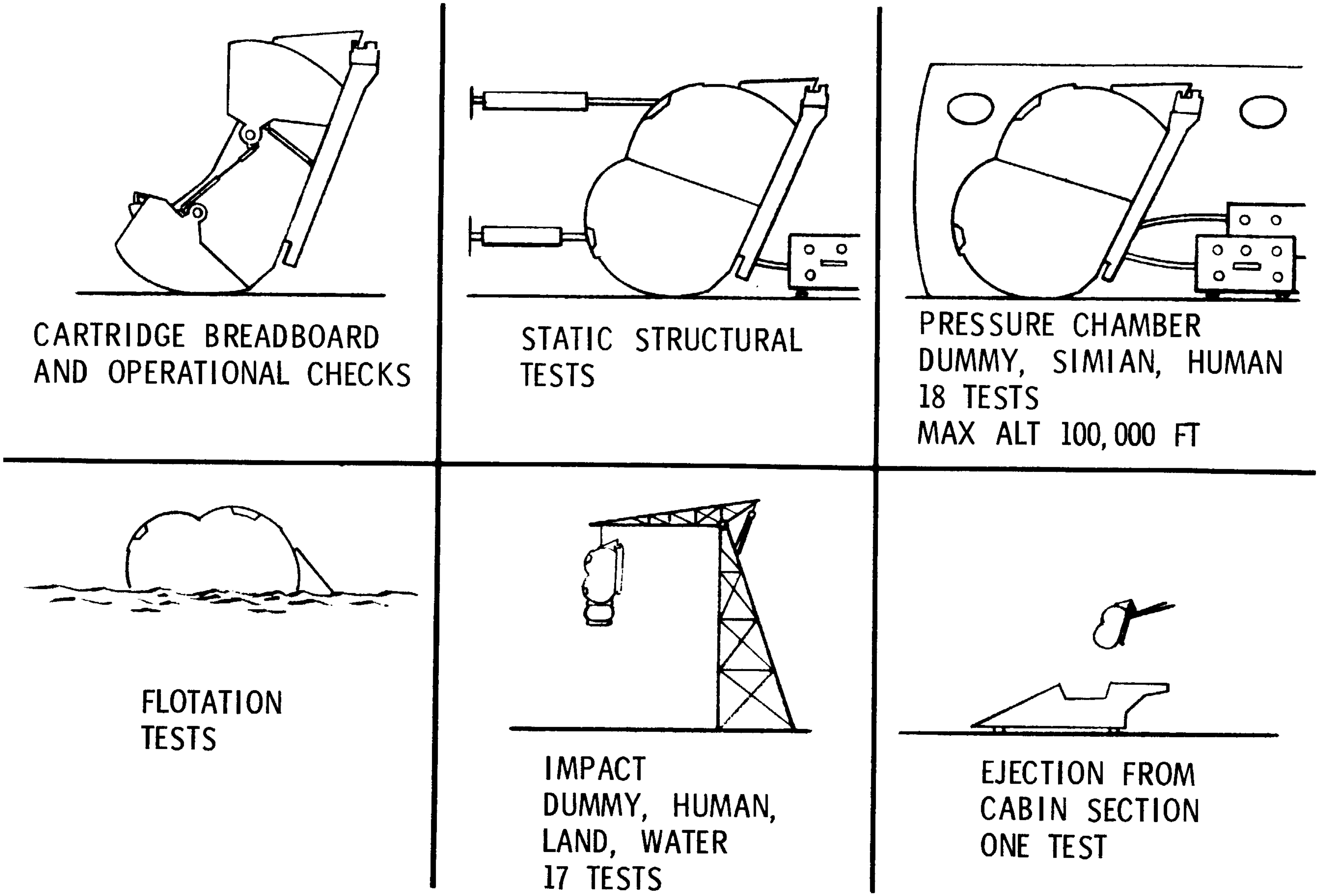
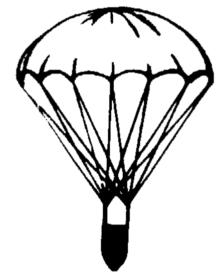
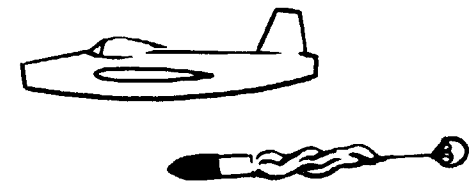


EXHIBIT 9

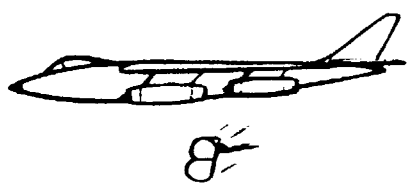
AERIAL TESTS



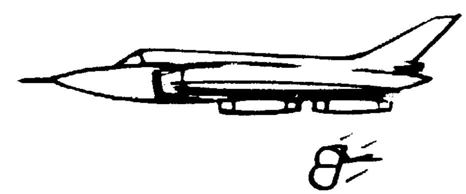
- RATE-OF-DESCENT TESTS
  24 SUCCESSFUL TESTS
- DEVELOPED ACCEPTABLE CAPSULE RATE-OF-DESCENT



- PARACHUTE STRUCTURAL TESTS
  28 TESTS
  2 FAILURES
- VERIFIED STRUCTURAL INTEGRITY OF PARACHUTE



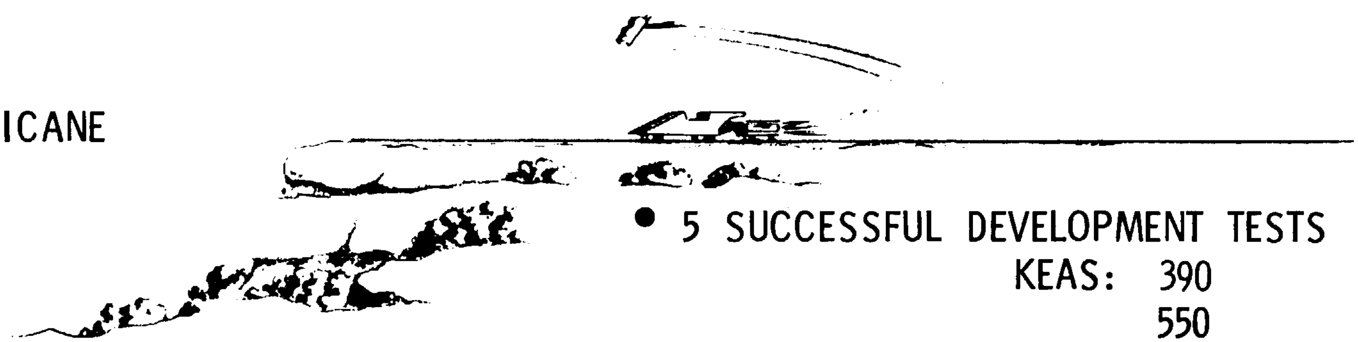
- LOW & HIGH-ALT CAPSULE DROPS FROM C-130 & B-47
  17 TESTS
  1 FAILURE AT -89°F
- VERIFIED CAPSULE STABILITY & RECOVERY PARACHUTE PERFORMANCE



- EJECTIONS FROM B-58
  2 SUCCESSFUL TESTS
  M 0.8 AT 21,000 FT
  M 1.6 AT 38,000 FT
- VERIFIED HIGH MACH NO. PERFORMANCE

SLED TESTS

HURRICANE
MESA



- 5 SUCCESSFUL DEVELOPMENT TESTS
  KEAS: 390
  550
  550
  650
  650
- VERIFIED HIGH-q PERFORMANCE

EAFB

- 5 QUALIFICATION TESTS
  ONE FAILURE
  KEAS: 90
  660
  660
  550
  640
- VERIFIED INTEGRATED PERFORMANCE OF ALL SYSTEMS
- ONE 90 KEAS DEVELOPMENT TEST (SUCCESSFUL)
- VERIFIED INTEGRATION OF CAPSULE, CATAPULT & RECOVERY PARACHUTE

ADDITIONAL TESTS

• WIND TUNNEL	473 HOURS
• STABILIZATION BOOM FIRINGS	134 TESTS
• HARNESS REEL CARTRIDGE FIRINGS	91
• SEAT RETRACTION THRUSTER FIRINGS	44
• INITIATOR FIRINGS	1064
• IMPACT ATTENUATOR IMPACT TESTS	55
• CARTRIDGE DEVICE BREADBOARD TESTS	149

TECHNICAL INNOVATIONS

TITLE: PERSONNEL ACCOMMODATION/ESCAPE SUBSYSTEM WBS CODE: 1.7

During the development of the B-70, the state-of-the-art was advanced significantly in the area of personnel escape and protection. The major advancements achieved are summarized in the following paragraphs.

Note: Since the items discussed did not impact subsystem or air vehicle schedules, the term Technical Innovation is used in place of Technical Drivers.

1. Capsule Concept:
The crew escape requirements for the B-70 air vehicle necessitated a number of state-of-the-art advances since unimpaired survival of the crew was required under conditions of (1) complete freedom from inhibiting clothing, (2) undelayed escape regardless of altitude. To attain these objectives, it was necessary to employ a protective cocoon or capsule which could be ejected from the air vehicle and serve as a vehicle during the crewman's descent to earth.

2. Stabilization Booms:
To assure that the capsule would descend in a predictable manner, two booms were attached to the capsule framework. These booms were of telescoping design and upon actuation extended to 116 inches and rotated outwarded. From the upper end of each boom, parachutes are released which stabilize the capsule from tumbling and excessive oscillation.

3. Descent Control:
In the event of cabin damage or loss of the oxygen breathing system, the capsule was designed to serve as a temporary protective area for the pilot and copilot. Controls were provided in the capsule by which the engine thrust could be reduced and the air vehicle could be put in a descent orientation by adjusting the trim surfaces. Upon reaching a safe altitude, the crew would leave the capsules and resume normal air vehicle control.

Space Division
North American Rockwell

DEVELOPMENT DATA SUMMARY

WBS TITLE: PERSONNEL ACCOMM. & ESCAPE SUBSYSTEM WBS CODE: 1.7

STATE-OF-THE-ART RATING: 4 (See remarks)

PERCENT DEVELOPED MATRIX:

	PRIOR TO FLIGHT		FLIGHT TEST
	CONFIGURATION	GROUND TEST	
PROGRAM LEVEL	68%	85%	20%
EFFORT TO GO	54%	37%	93%

GROUND TESTS

TYPE OF TEST		NUMBER OF UNITS	TEST HOURS
CONFIGURATION RESEARCH	(1) (2)	12	1322
DESIGN FEASIBILITY	(1) (2)	11	240
DESIGN VERIFICATION	(1) (2)	11	1233
AIRWORTHINESS	(1) (2)	24	2031
QUALIFICATION		-	-
OTHER	(2)	3	400
TOTAL		61	5226

REMARKS:

(1) Includes following Personnel Accommodations Testing

Item	Units	Test Hours
Flight Displays	2	500
Crew Training	2	382
Lighted Panels (Blue/White edge light)	3	300
Shock Mounting: Instrument Panels	6	321
Ground Escape Devices	4	40
Pressure Suit Cooling (Liquid Air)	2	800
	19	2343

(2) Includes Escape System Tests as presented on page IV-281.

WBS CODE: 1.7

State-of-the-Art

The Personnel Accommodations and Escape Subsystem was assigned an overall state-of-the-art rating of 4 based on definitions established using AFSCM 173-1 (11-28-67) as a guide. This rating was determined by comparing the RS-70 requirements with the existing capabilities at the RS-70 time period using state-of-the-art criteria discussed in subsequent paragraphs. The RS-70 configuration was selected for the comparison since it was the production configuration defined. This selection is considered valid since the development status at "out-the-door" and at program "end" is also based on the scheduled production configuration.

The definitions used in determining the state-of-the-art ratings are described below. For ratings 3, 4, and 5, the following B-70 design criteria was used as an aid for rating selection:

A. High temperature application
B. High pressure/load/acoustics/etc., application
C. Light-weight/special materials/unique processes

Rating	Description
1	The item was off-the-shelf commercial item or a standard military issue which was installed "as-is".
2	The item was off-the-shelf commercial item or a standard military issue which required only a physical modification for installation.
3	The item was considered within the state-of-the-art but had no commercial or military counterpart. As an aid, the item was existing, but required modification to be compatible with one of the design criteria. Also, any new design or process has a rating of at least 3.
4	The item was slightly beyond the state-of-the-art, and some development was required. As an aid, the item was based on an existing concept but required modification to be compatible with two of the design criteria. Also, any new design or process required to be compatible with one of the design criteria will be rated 4.
5	The item was substantially beyond the existing state-of-the-art and required major development work. As an aid, any new design or process required to be compatible with two of the design criteria will be rated 5.

WBS CODE: 1.7

State-of-the-Art:

To arrive at the state-of-the-art rating of 4 for the overall RS-70 Personnel Accommodations and Escape Subsystem, an assessment was made in each of two areas: (1) the escape system design, and (2) all other design requirements for the subsystem. The escape system was considered a major advancement in the state-of-the-art for manned aircraft and was assigned a rating of 5. This rating was based on the extreme requirements to provide unimpaired survival for a "shirt-sleeved" crewman over land or water, for low to high "Q's", low to high temperatures, and zero to high altitude. The encapsulation concept developed not only provided a controlled environment for the crewman within the cabin for emergencies, it was also the device utilized for abandoning the aircraft. This concept, which allowed "shirt-sleeve" operation (no pressure suits, no mae wests, no parachutes, etc.), provided the crewman with maximum mobility and increased vision for the performance of his tasks. All other design requirements for the overall subsystem was assigned a state-of-the-art rating of 3 since these requirements were complex only in the provisioning designs for the four crewman. Combining the two ratings, the overall Personnel Accommodations and Escape Subsystem was assigned a state-of-the-art rating of 4.

Percent Developed:

The Personnel Accommodations and Escape Subsystem development status percent comparisons of the XB-70 configuration to that scheduled for the RS-70 were made at two development stages; one at prior to flight or at the time period of "out-the-door" of the No. 1 air vehicle and the other for the flight test programs. The same methodology developed and verified for the Airframe Structures Subsystem (WBS 1.1) percent comparisons was applied in the analysis of this subsystem. The analysis was performed to establish a status level for the overall subsystem; however, to achieve this goal, the two major areas were assessed (as with the state-of-the-art analysis) as presented in the following paragraphs.

The escape system configuration was assessed as 95 percent representative of its RS-70 counterpart being downgraded mainly due to the two crew stations instead of four. The additional two crew stations impacted the escape system due mainly to the sequencing circuitry for ejection required with the aft stations. This impact would be for air vehicle wiring and would not impact the individual capsule operation after the programmed ejection was initiated. The remaining configuration of the Personnel Accommodation and Escape Subsystem was assessed as being 40 percent representative of the RS-70 configuration. This downgrading was also due to the lack of the aft two stations, plus a ten percent downgrading for the pilot and copilot stations which were below the standard planned for the RS-70. To establish what effort would have been required to allow a No. 1 air vehicle production level status for the two major design areas, the same curve used for the structures analyses was utilized for the Personnel Accommodations and Escape Subsystem, Exhibit 13, page IV-293. Entering this exhibit on the left-hand scale at 95 percent and at 40 percent, the bottom scale shows that 20 percent and 82 percent more effort would have been required for a No. 1 RS-70 escape system and the remaining configuration, respectively. Combining the 95 percent and 40 percent for a composite percentage resulted in the XB-70 Personnel Accommodations and Escape Subsystem being assessed as 68 percent representative of the RS-70 configuration at the time period of "out-the-door" for the No. 1 air vehicle. Entering Exhibit 13, page IV-293, on the left-hand scale at 68 percent, the bottom scale shows that 58 percent more effort would be required to attain a No. 1 air vehicle production level status for the overall subsystem. Comparing this percentage with the average of effort remaining of the two major areas (20% + 82% ÷ 2 = 51%) shows a 7 percent spread in effort remaining. This is due to the complexity curve showing a larger impact for the crew station provisioning than for the escape system. To provide a single percentage remaining, the difference between the two was taken or 54 percent. In summary, for the "out-the-door" time period, the Personnel Accommodations and Escape Subsystem of the XB-70 was 68 percent representative of the RS-70 configuration and 54 percent more effort would be required to attain a production level status, excluding ground testing.

To determine the ground testing status, a comparison was made of the ground test hours expended on the XB-70 to that scheduled for the RS-70 at the time of "out-the-door" for each of the two major areas. It should be noted that for the escape system there was no prime air vehicle flight testing, only test beds and these flight test hours are included as part of the total prior-to-flight testing effort. For the escape system status prior to flight, the RS-70 had 3600 test hours scheduled compared to the 2883 test hours expended on the XB-70 program. This shows that the XB-70 prior to flight testing effort was 80 percent of that planned for the RS-70 or that 20 percent more testing effort would be required to attain a production level status for the escape system. This testing effort remaining would be essentially for sled testing of sequencing and for water endurance tests with the capsule under sea conditions. Entering Exhibit 13, page IV-293, on the bottom scale at 80 percent, it shows that the escape system was at a program confidence level of 95 percent, the same as for configuration. For the remaining configuration of the overall subsystem, the RS-70 had 4700 ground test hours scheduled compared to the 2343 test hours expended on the XB-70 program. This shows that the XB-70 prior to flight testing effort was 50 percent of that planned for the RS-70 or that 50 percent more testing effort would be required to attain a production level status for the crew station provisioning. Entering Exhibit 13, page IV-293, on the bottom scale at 50 percent, it shows that the crew station provisioning was at a program confidence level of 75 percent (off the left-hand scale) prior to flight.

To establish a composite percentage for the Personnel Accommodations and Escape "out-the-door" testing level status, the above 75 percent and the escape system 95 percent are averaged for an overall subsystem program confidence level of 85 percent. Entering Exhibit 13, page IV-293, at 85 percent on the left-hand scale, the bottom scale shows that 37 percent more testing effort would be required to attain a production level status at the prior-to-flight time period. The averaging of test effort remaining for the two major areas (20% + 70% ÷ 2) shows 35 percent or a spread in the two methods of analysis of 2 percent. For the overall subsystem, the difference was split and the ground test effort remaining assessed at 36 percent.

The XB-70 flight test program for the Personnel Accommodations and Escape Subsystem was established at 61 percent of a production level status as presented by Exhibit 13, page II-23, under Air Vehicle: WBS 1.0. However, this percentage was based on the direct comparison of equivalent flight test hours with no adjustment for envelope flown or for the escape system test bed programs which were part of the total effort at the "out-the-door" time period. Since no prime air vehicle flight testing was scheduled on the RS-70 or expended on the XB-70 for the escape system, the flight test program comparison was for personnel accommodations or crew station provisioning only. Based on this ground rule, the flight test program comparisons must be made between the 15 hours of the XB-70 program and the 155 hours scheduled for the RS-70. This shows that, based on equivalent flight test hours only, the XB-70 program was 10 percent of that planned for the RS-70.

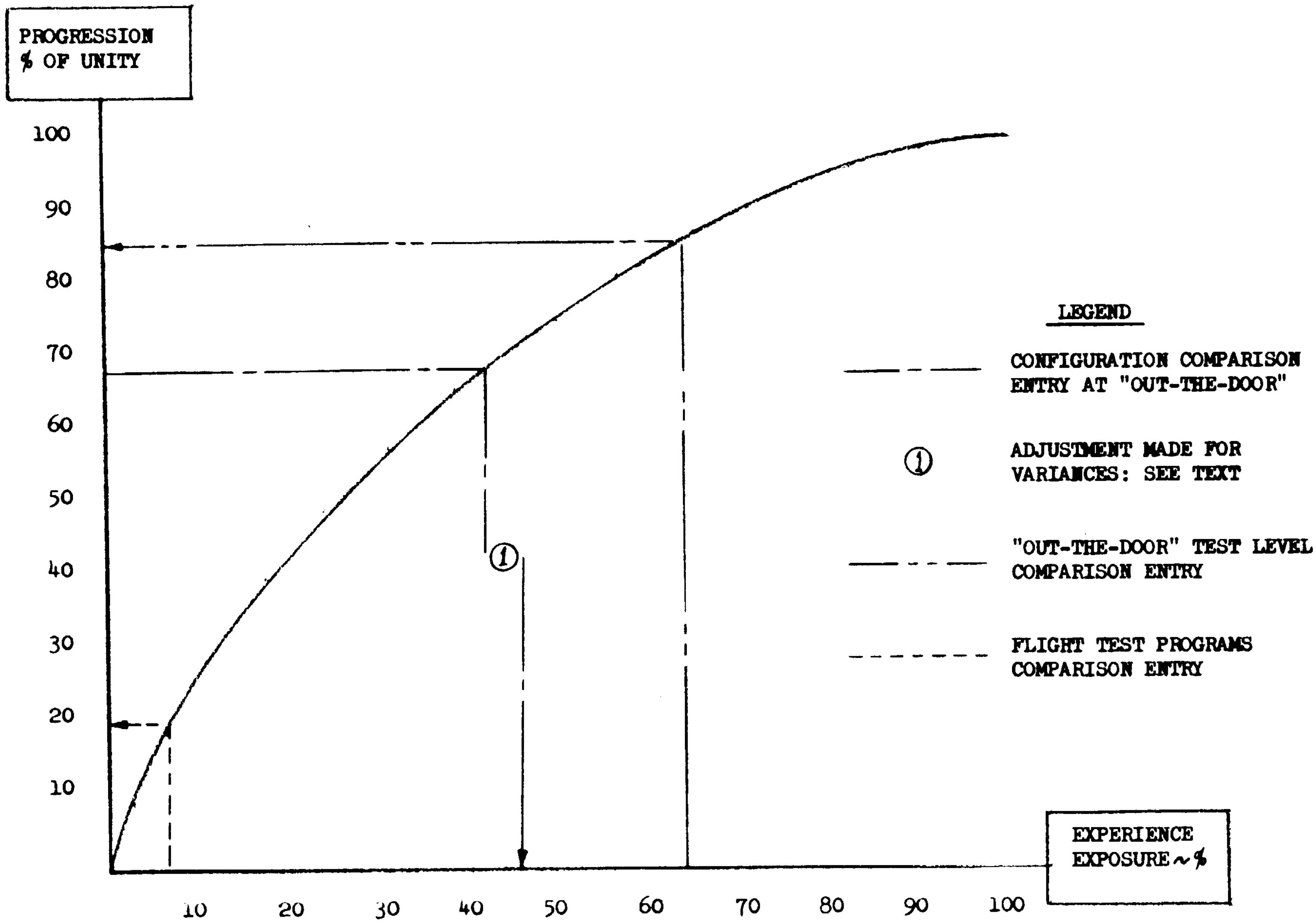
As previously stated, an adjustment must be made for the envelope flown; however, no adjustment was required for the configuration flown since the comparisons are for basic air vehicle only and the configuration down-grading was due mainly to the military subsystem stations. The XB-70 flight envelope explored was 80 percent of the RS-70 envelope as shown by Exhibit 14, page II-24, under Air Vehicle: WBS 1.0. As previously established for the Airframe Structures Subsystem (WBS: 1.1), the first 80 percent of the flight envelope requires only 60 percent of the total effort compared to the last 20 percent of the envelope which requires 40 percent of the total effort. For the Personnel Accommodations and Escape Subsystem, this 2 to 3 ratio was directly applicable since all of the test hours were obtained in the first 80 percent of the flight envelope. Using this ratio as a weight factor so that direct comparisons can be made based on the RS-70 flight envelope, the XB-70 flight test effort expended was adjusted by the equation 2:3::X:10%. Using this equation, the total flight test effort remaining to attain a production level status would be 40 percent + 60 percent - (2 x 10 ÷ 3) or 93 percent (where the 40 percent is that effort required for the last 20 percent of the flight envelope). Entering Exhibit 13, page IV-293, at seven percent on the bottom scale. the left-hand scale shows that the XB-70 flight test program attained a production program confidence level of 20 percent.

WBS CODE: 1.7

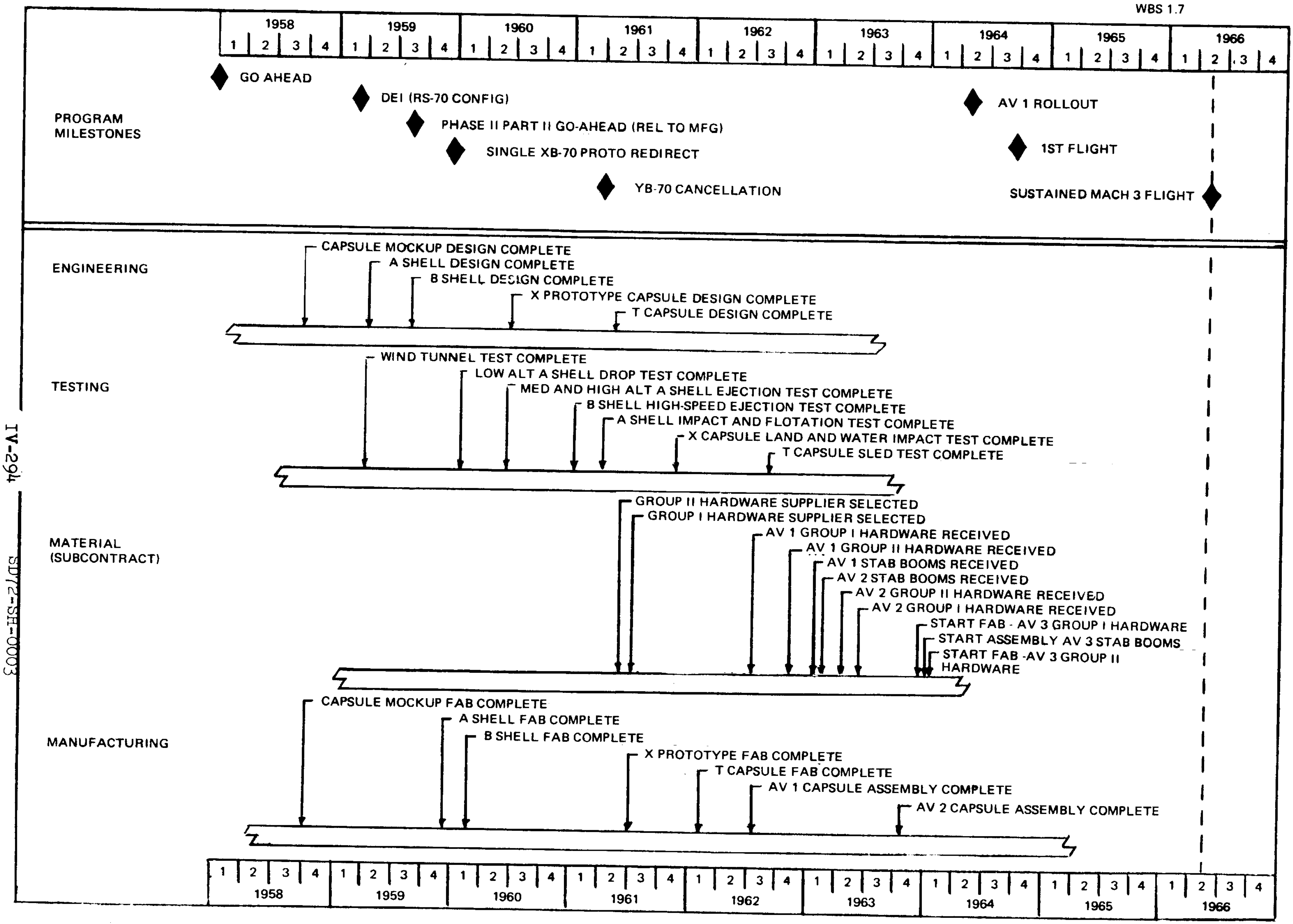
Exhibit 13, page IV-293, presents a graph showing the Personnel Accommodations and Escape Subsystem comparisons. It should be noted, all comparisons are based on tooling, test articles, GSE, etc., being at the RS-70 or production level in both number and fidelity.

NOTE: THE USE OF THE "EFFORT TO GO" PERCENTAGES FOR COST DETERMINATION SHOULD NOT BE APPLIED WITHOUT CONSULTING SECTION IV-8, VOLUME I, PAGE 310 FOR APPLICATION CONSIDERATIONS.

XB-70 PERSONNEL ACCOMMODATIONS & ESCAPE SUBSYSTEM DEVELOPMENT STATUS
PERCENT COMPARISONS TO RS-70 (UNITY)



PERSONNEL ACCOMMODATIONS AND ESCAPE SUBSYSTEM DEVELOPMENT SUMMARY



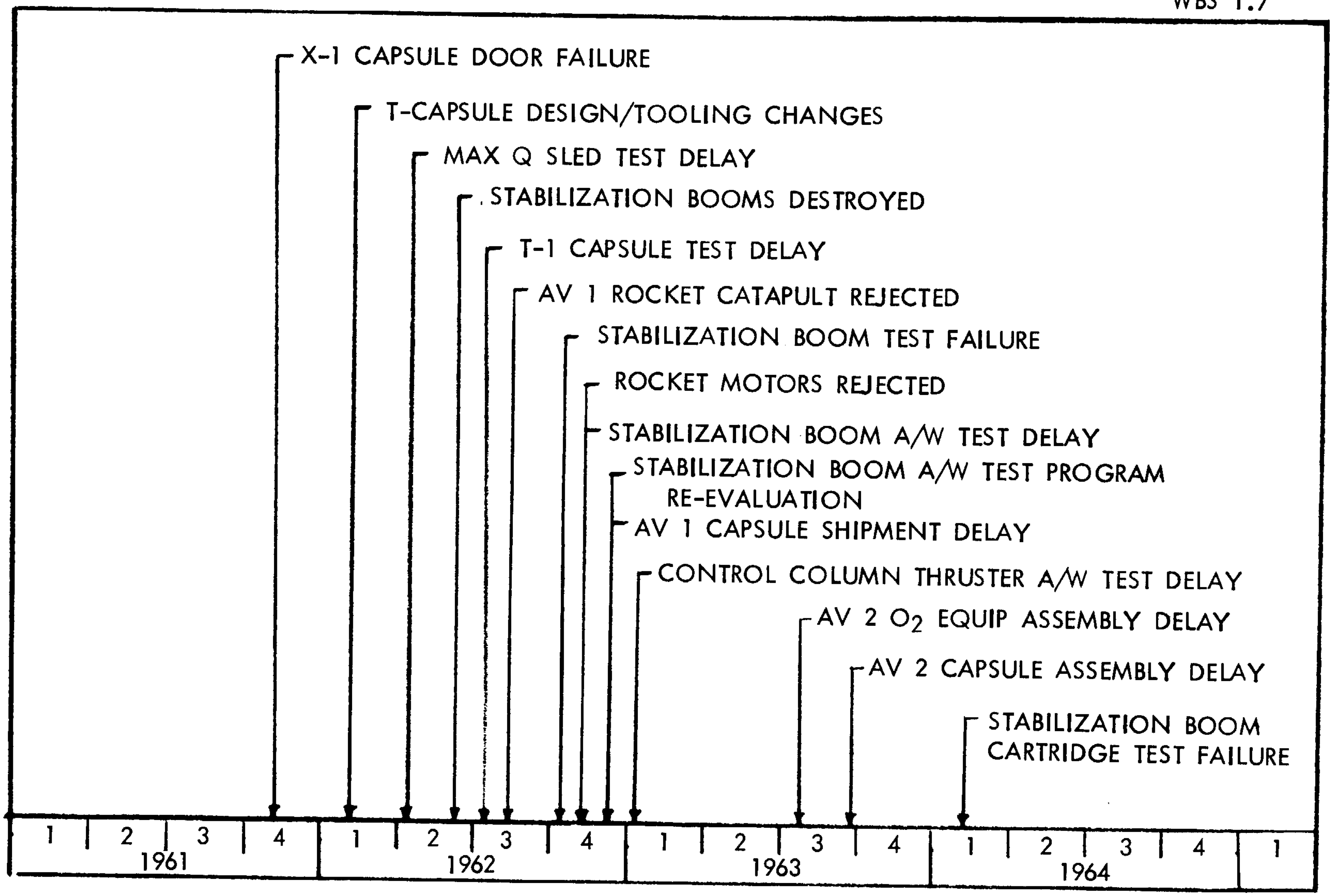
DEVELOPMENT SUMMARY
TABULATION OF DATES

Subsystem: Personnel Accommodation and Escape Subsystem	WBS 1.7
Engineering	
Capsule Mockup Design Completed	9-15-58
"A" Shell Design Complete	4-7-59
"B" Shell Design Complete	8-8-59
"X" Prototype Design Complete	6-4-60
"T" Capsule Design Complete	5-12-61
Testing	
Wind Tunnel Test Complete	4-1-59
Low Altitude "A" Shell Drop Test Complete	1-15-60
Medium and High Altitude "A" Shell Ejection Test Complete	6-1-60
High Speed "B" Shell Sled Ejection Test Complete	2-1-61
"A" Shell Flotation and Impact Test Complete	4-1-61
"X" Capsule Land and Water Impact Test Complete	11-1-61
"T" Capsule Maximum Sled Test Complete	8-15-62
Material (Subcontract)	
Group II Hardware Supplier Selected	6-1-61
Group I Hardware Supplier Selected	7-7-61
Air Vehicle No. 1 Group I Hardware Received	8-26-62
Air Vehicle No. 1 Group II Hardware Received	11-9-62
Air Vehicle No. 1 Stabiliation Booms Received	2-7-63
Air Vehicle No. 2 Stabiliation Booms Received	3-7-63
Air Vehicle No. 2 Group II Hardware Received	4-22-63
Air Vehicle No. 2 Group I Hardware Received	6-4-63
Start Fabrication Air Vehicle No. 3 Group I Hardware	12-20-63
Start Assembly Air Vehicle No. 3 Stabilization Booms	1-3-64
Start Fabrication Air Vehicle No. 3 Group II Hardware	1-31-64
Manufacturing	
Capsule Mockup Fabrication Complete	11-1-58
"A" Shell Fabrication Complete	12-15-59
"B" Shell Fabrication Complete	2-15-60
"X" Prototype Fabrication Complete	7-1-61
"T" Capsule Fabrication Complete	2-23-62
Air Vehicle No. 1 Capsule Assembly Complete	9-21-62
Air Vehicle No. 2 Capsule Assembly Complete	12-7-63

PERSONNEL ACCOMMODATION AND ESCAPE SUBSYSTEM

DESIGN/PROGRAMMATIC IMPACTS

WBS 1.7



DESIGN/PROGRAMMATIC IMPACTS

Subsystem: Personnel Accommodation and Escape Subsystem WBS 1.7

11-3-61
Completion of structural static test of X-1 capsule was delayed due to lower door failure and cracks during 100% ultimate internal pressure.

2-7-62
Assembly of "T" capsules was extended due to a combination of engineering and tooling changes and late receival of equipment.

4-6-62
Maximum "Q" sled tests were delayed due to modification of instrumentation and mechanical elements.

6-7-62
An explosion and fire occurred at the Pacific Division of Houston-Fearless Corporation. Four escape capsule stabilization booms and one spare trunnion were destroyed.

7-6-62
The completion of two T-1 aerial ejection tests were delayed due to non-availability of a functional B-58 test bed airplane.

8-7-62
Due to excessive voids in the rocket propellant found by X-ray inspection, Air Vehicle No. 1 rocket catapult was returned to the supplier.

10-8-62
Stabilization booms A/W test failed during test stand vibration test.

11-7-62
Some of the rocket motors were rejected for out-of-tolerance conditions necessitating remachining of the rocket nozzles.

12-7-62
Upon final check prior to shipment of two capsules to Palmdale the seal regulator would not allow the seal to deflate on one capsule. The regulator was returned to the supplier for repair.

1-7-63
Completion of control column thruster A/W testing was delayed due to marginal cartridge ignition. Investigations indicated changes to the prime-igniter and cartride closure disc retention were required.

7-31-63
Air Vehicle No. 2 oxygen equipment assembly comprising the heat exchanger was delayed due to material shortages.

9-27-63
The start of Air Vehicle No. 2 capsule assembly was delayed due to window fitting scrappage resulting in remachining and approximately four weeks rework.

2-7-64
Stabilization booms for Air Vehicle No. 3 experienced a cartridge test failure during hot fire testing at the supplier.

COST DEFINITION

SUBSYSTEM: PERSONNEL ACCOMMODATION AND ESCAPE SYSTEM WBS CODE: 1.7

Total costs presented in this WBS item include all identifiable expenditures to design, develop, ground test, fabricate and assembly all components, assemblies and developmental test hardware within the Personnel Accommodation and Escape Subsystem as defined by the WBS except for those items supplied to North American as Government Furnished Equipment (GFE). The GFE items are:

a) LO_2 System Converters (WBS 1.7.2)
   Check Valves
   Quick Disconnects
   Capsule O_2 Cylinder
   O_2 Pressure Regulator
   Quantity Indicator
   Mode Switch

b) Fire Extinguisher Cylinder (WBS 1.7.3.2)

c) Relief Container (WBS 1.7.3.3)

d) Survival Equipment (WBS 1.7.4.5)

Total costs of $12,557,555 include the following items:

a) developing subsystem specification requirements

b) subsystem installation and integration design

c) vendor coordination

d) in-house ground testing including design and fabrication of models, mockups and simulators

e) subcontracted hardware including the supplier's costs for engineering, manufacturing, tooling and testing.

Excluded from the cost displayed for this subsystem are the in-house costs associated with the:

f) fabrication of subsystem provisions (brackets, racks, wire harnesses, shelves, supports, etc.)

g) miscellaneous purchased parts and installation materials

h) installation of the subsystem into the vehicles

i) subsystem, vehicle and preflight checkouts

j) GFE items

Costs for items (f) through (i) are contained in WBS 1.12 (Volume IV, page 647). Internal accounting procedures and the resultant cost reports do not provide a basis for establishing expenditures for these items by individual subsystems. Therefore, all costs are collected and reported in one WBS item. Refer to WBS 1.12 for additional information.

Detail of the recorded costs associated with this subsystem is provided by Element of Cost (EOC) and Subdivision of Work (SDW). Section III of Volume I provides a detail definition of these items. Further segregation of the cost data is provided by the WBS. All cost data is displayed at WBS level 5 (Personnel Accommodation and Escape Subsystem, WBS 1.7) with the exception of in-house ground testing (WBS 1.7.6). Cost data can be located on the following pages:

		Cost Breakdown	Time-Phased Detail
WBS 1.7	$7,330,611	page IV-304	page IV-305
WBS 1.7.6 Ground Tests	5,226,944	page IV-304	page IV-328
Total WBS 1.7	$12,557,555	page IV-304	page IV-336

A summary of the subcontractor recorded cost data is provided on page IV-302 Contractual arrangements, delivery dates, costs by supplier, quantity of hardware delivered and other pertinent data is provided. Cost data includes the supplier expenditures for engineering, production, tooling and testing (where identifiable) performed at the supplier's facility. Refer to the Subcontracting Element of Cost definition (Volume I, page I-26) for additional explanation.

As an aid in the definition and evaluation of the in-house engineering costs associated with this subsystem, a matrix of engineering hours has been developed. This matrix, displayed below, is a summary of all the in-house engineering groups that provided support to the design and development of the Personnel Accommodation and Escape Subsystem.

Group No.	Title	Hours Expended
3	Electrical and Avionics Installation	2,602
11	Weight Control	1,925
12	Checking	8,084
34	Structural Projects	2,132
40	Wing and Empennage Structures	9,676
47	Human Factors and Cockpit Displays	416,139
57	Engineering Specifications	11,611
64	Design Support	1,579
67	Structural Test Laboratory	4,118
74	Flight Test Instrumentation	4,881

Group No.	Title	Hours Expended
94	Flight Simulation	3,810
95	Electrical Systems Design	3,895
97	Laboratory Services	6,334
110	Electrical Power Laboratory	14,310
114	Flight Test Instrumentation Development	1,990
125	Electrical System Equipment	4,200
146	Thermodynamics Laboratory	5,657
150	Life Sciences	13,406
	Miscellaneous	9,775
	Total Engineering Hours	526,124

WBS 1.7	489,801 hours	(page IV-304)
WBS 1.7.6	36,323 hours	(page IV-304)
	526,124 hours	

Ground testing activities associates with the development of the Personnel Accommodation and Escape Subsystem have been identified and the costs assigned to WBS 1.7.6 (Page IV-328). These costs reflect the in-house expenditures only. Testing activities performed by the subcontractor where identified are included under WBS 1.7 Test/QC Subdivision of Work and the Subcontracting Element of Cost. The following is a summary of the major in-house test activities identified to this subsystem.

DESCRIPTION	RECORDED COSTS
Escape Capsule Tests	$1,746,638
Escape System Test Sled	898,863
Modification and Repair of Test Capsules	417,480
Weighted Shells - Escape Capsules	302,773
Modification and Repair of Weighted Shells after Test	85,108
Encapsulated Seat-Operational Tests	73,635
Encapsulated Seat-Sled Test	67,644
Encapsulated Seat-Pressurization Tests	60,700
Encapsulated Seat-Zero Speed Ejection	53,800
Structural Tests - Escape Capsule	47,659
Encapsulated Seat "T" Ejections from B-58 Pad	41,246
Air Force Test Sled Adapter	24,712
Various	1,224,020
Costs (less MPC & G&A)	$5,044,278
Material Procurement Cost	99,770
General and Administration	82,896
Total Cost WBS 1.7.6	$5,226,944

SUBCONTRACTOR MATRIX

Subsystem: Personnel Accommodations and Escape WBS Code: 1.7

SUBCONTRACTOR	ENGINEERING	PROD	TOOLING	TEST	TOTAL
Houston-Fearless	177,899	709,810	-	-	887,709
Rocket Power	8,873	139,137	58,354	59,258	265,622
TOTAL	186,772	848,947	58,354	59,258	1,153,331

HOUSTON FEARLESS was awarded Letter Contract LOF1-VJ-600209 for the Ballistic Stabilization Booms on May 28, 1963.

The Statement of Work required the subcontractor to provide design, development, engineering test, manufacturing and other effort necessary to produce the Ballistic Stabilization Booms per NR specification NA5-4309-1G for Air Vehicles 1, 2, and 3.

The program required fabrication of 22 sled test boom assemblies, 10 development units, 12 prototypes, 6 qualification test specimens to support the Airworthiness Test Program, 8 complete Air Vehicle Boom Assemblies, and qualification test specimens to support the Acceptance Test Program.

The Ballistic Stabilization Booms are extremely critical to the safe recovery of the B-70 airmen ejected in the Escape Capsule-Man combination. The primary purpose of the Boom is to dampen erratic Pitch, Roll, and Yaw effects of the Escape Capsule during the time period between capsule ejection and until the recovery parachute takes effect.

NR conducted test sled firings at Hurricane Mesa test site to determine the reliability of the boom assemblies. These tests resulted in design changes which ultimately produced a satisfactory product.

The cost of the test effort was not segregated by the subcontractor and is therefore included in the Engineering cost for Houston-Fearless.

Residual inventory was shipped to NR on June 6, 1963, and special tooling was received in Government Stores on July 22, 1963. The proceeds were credited to the purchase order.

ROCKET POWER was selected to produce the Ballistic Rocket Catapult. Purchase Order LOF1-XZ-60023 was issued June 25, 1959 for this effort. The qualification test report was scheduled for June 28, 1960 and the contract was completed in November 1962.

The Statement of Work called for the subcontractor to provide design, development, test and fabrication of the Ballistic Rocket Catapult for the B-70 program.

WBS CODE: 1.7

Rocket Power was awarded the fixed price purchase order L961-X-316 to develop a ballistic rocket catapult for the F-108 and the B-70. Cancellation of the F-108 program in September 1959 revealed that the fixed price contract then in effect was not a satisfactory framework to develop the item. Design and test problems were of such complexity that a cost-plus-fixed-fee contract was determined to be the most practical basis for completing the program.

Tooling was retained for follow-on replacement units. Residual inventory was disposed of and proceeds applied to the base contract.

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SPACE DIVISION
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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07
PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM

	6-M ASSY 0 HOURS DOLLARS	6-M ASSY 06 HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	489801	36323	526124
LABOR AT $ 4.904	2434838	145426	2580264
ENGR BURDEN AT $ 4.515	2213214	162077	2375291
SHOP SUPPORT	1521	508528	510049
LABOR AT $ 3.158	4249	1606697	1610946
TEST/QC	397	20869	21266
LABOR AT $ 3.103	1598	64385	65983
MFG BURDEN AT $ 3.638	9452	1923417	1932869
ENGR MATERIAL	14492	951601	966093
SUBCONTRACT	1153331		1153331
MPC	46637	99770	146407
OTHER COST	47395	22531	69926
SUB-TOTAL	5925206	4975904	10901110
GEN & ADMIN	117845	82896	200741
IDWA	1287560	168144	1455704
TOTAL COST	7330611	5226944	12557555

SUBDIVISION OF WORK
COST DETAIL - SEE PAGE IV-305 IV-328 IV-336

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07 **PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM**
6-MAJ ASSY 0

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOOLING AND STE HOURS DOLLARS	TEST /QC HOURS DOLLARS
DESIGN/ENGINEERING	489801			
LABOR AT $ 4.971	2434838			
ENGR BURDEN AT $ 4.519	2213214			
SHOP SUPPORT	1521			
LABOR AT $ 2.794	4249			
TEST/QC	397			
LABOR AT $ 4.025	1598			
MFG BURDEN AT $ 4.928	9452			
ENGR MATERIAL	14492			
SUBCONTRACT	186772	848947	58354	59258
MPC	10606	31403	2445	2183
OTHER COST	47395			
SUB-TOTAL	4922616	880350	60799	61441
GEN & ADMIN	75803	39806	1139	1097
IOWA		1287560		
TOTAL COST	4998419	2207716	61938	62538
TIME-PHASED COST DETAIL - SEE PAGE	IV-307	IV-315	IV-316	IV-317

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07
6-MAJ ASSY 0

PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM

	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	489801
LABOR AT \$ 4.971	2434838
ENGR BURDEN AT \$ 4.519	2213214
SHOP SUPPORT	1521
LABOR AT \$ 2.794	4249
TEST/QC	397
LABOR AT \$ 4.025	1598
MFG BURDEN AT \$ 4.928	9452
ENGR MATERIAL	14492
SUBCONTRACT	1153331
MPC	46637
OTHER COST	47395
SUB-TOTAL	5925206
GEN & ADMIN	117845
IDWA	1287560
TOTAL COST	7330611

TIME-PHASED COST DETAIL - SEE PAGE IV-318

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 07 PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	9.0	1613	4.725	7621	7339	14960
Q-2 58						
Q-3 58	117.0	19585	4.318	84562	76719	161281
Q-4 58						
Q-1 59	169.5	28988	4.316	125098	99850	224948
Q-2 59						
Q-3 59	287.5	50578	4.056	205163	180594	385757
Q-4 59						
Q-1 60	390.0	67676	4.519	305805	248813	554618
Q-2 60						
Q-3 60	319.0	53563	4.893	262106	198555	460661
Q-4 60						
Q-1 61	444.0	75713	4.764	360714	380311	741025
Q-2 61						
Q-3 61	312.0	56573	5.069	286787	284461	571248
Q-4 61						
Q-1 62	226.5	38608	5.305	204812	178159	382971
Q-2 62						
Q-3 62	187.5	31501	5.208	164049	162873	326922
Q-4 62						
Q-1 63	138.0	23602	6.088	143682	128067	271749
Q-2 63						
Q-3 63	97.0	16246	6.332	102871	94891	197762
Q-4 63						
Q-1 64	86.5	14726	6.990	102932	97930	200862
Q-2 64						
Q-3 64	43.5	7620	6.995	53304	53463	106767
Q-4 64						
Q-1 65	12.0	2149	7.894	16964	14180	31144

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	DESIGN/ENGINEERING	
4-SYSTEM	1	
5-SUBSYSTEM	07	**PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM**
6-MAJ ASSY	0	
SUBD OF WORK	DESIGN/ENGINEERING	

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-2 65						
Q-3 65	6.0	992	7.889	7326	6561	14386
Q-4 65						
Q-1 66		68	7.971	542	449	991
TOTAL	2845.0	489801		2434835	2213214	4648052

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 07 **PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		8	2.875	23	28	51
Q-2 58						
Q-3 58		30	4.467	134	139	273
Q-4 58						
Q-1 59						
Q-2 59						
Q-3 59	21.0	3819	2.804	10707	15158	25865
Q-4 59						
Q-1 60	-15.0	-2542	2.829	-7191	-6863	-14054
Q-2 60						
Q-3 60		62	2.516	156	175	331
Q-4 60						
Q-1 61		92	2.761	254	380	634
Q-2 61						
Q-3 61		1	1.000	1	2	3
Q-4 61						
Q-1 62	1.5	221	3.751	829	1016	1845
Q-2 62						
Q-3 62	-1.5	-214	3.757	-804	-985	-1789
Q-4 62						
Q-1 63		31	3.226	100	124	224
Q-2 63						
Q-3 63		13	3.077	40	278	318
TOTAL	6.0	1521		4249	9452	13701

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 07 **PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		9	2.000	18		18
Q-4 58						
Q-1 59		-1				
Q-2 59						
Q-3 59		91	2.857	260		260
Q-4 59						
Q-1 60	1.5	211	4.545	959		959
Q-2 60						
Q-3 60		24	4.625	111		111
Q-4 60						
Q-1 61		16	5.375	86		86
Q-2 61						
Q-3 61						
Q-4 61						
Q-1 62						
Q-2 62						
Q-3 62		1	1.000	1		1
Q-4 62						
Q-1 63						
Q-2 63						
Q-3 63		47	3.468	163		163
Q-4 63						
Q-1 64		-1				
TOTAL	1.5	397		1598		1598

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	9.0	1621	4.716	7644	7367	15011	22
Q-2 58							
Q-3 58	117.0	19624	4.317	84714	76858	161572	75
Q-4 58							
Q-1 59	169.5	28987	4.316	125098	99850	224948	12
Q-2 59							
Q-3 59	308.5	54488	3.967	216130	195752	411882	1031
Q-4 59							
Q-1 60	376.5	65345	4.584	299573	241950	541523	308
Q-2 60							
Q-3 60	319.0	53649	4.891	262373	198730	461103	499
Q-4 60							
Q-1 61	444.0	75821	4.762	361054	380691	741745	191
Q-2 61							
Q-3 61	312.0	56574	5.069	286788	284463	571251	-9
Q-4 61							
Q-1 62	228.0	38829	5.296	205641	179175	384816	
Q-2 62							
Q-3 62	186.0	31288	5.218	163246	161888	325134	10172
Q-4 62							
Q-1 63	138.0	23633	6.084	143782	128191	271973	58
Q-2 63							
Q-3 63	97.0	16306	6.321	103074	95169	198243	1434
Q-4 63							
Q-1 64	86.5	14725	6.990	102932	97930	200862	-90
Q-2 64							
Q-3 64	43.5	7620	6.995	53304	53463	106767	789
Q-4 64							
Q-1 65	12.0	2149	7.894	16964	14180	31144	
Q-2 65							
Q-3 65	6.0	992	7.889	7826	6560	14386	

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07 **PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-4 65							
Q-1 66		68	7.971	542	449	991	
TOTAL	2852.6	491719		2440685	2222666	4663351	14492

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07 PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM
6-MAJ ASSY C
SUBD OF WORK DESIGN/ENGINEERING

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58		22	1	308	15342		15342
Q-2 58							
Q-3 58		75	4		161651		161651
Q-4 58							
Q-1 59		12	1		224961		224961
Q-2 59							
Q-3 59		1031	87		413000		413000
Q-4 59							
Q-1 60	92679	92987	5538	11302	651350	12410	663760
Q-2 60							
Q-3 60	20110	20609	1258	7528	490498	9345	499843
Q-4 60							
Q-1 61	14499	14690	431	18571	775437	14410	789847
Q-2 61							
Q-3 61	8478	8469	241	572	580533	10788	591321
Q-4 61							
Q-1 62	10352	10352	329	1294	396791	6660	403451
Q-2 62							
Q-3 62	17358	27530	1352	4578	358594	6019	364613
Q-4 62							
Q-1 63	18645	18703	797	118	291591	4875	296466
Q-2 63							
Q-3 63	4651	6085	290	836	205454	3435	208889
Q-4 63							
Q-1 64		-90	-10	1000	201762	4293	206055
Q-2 64							
Q-3 64		789	287	1000	108843	2316	111159
Q-4 64							
Q-1 65				202	31346	836	32182
Q-2 65							
Q-3 65				81	14467	386	14853

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07 PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-4 65							
Q-1 66				5	996	30	1026
TOTAL	186772	201264	10606	47395	4922616	75803	4998419

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07 PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK PRODUCTION

	SUBC	MPC	SUB TOTAL	G & A	IDWA	TOTAL COST
Q-1 60	70600	4188	74788	1425		76213
Q-2 60						
Q-3 60	107618	6385	114003	2552	19966	136521
Q-4 60						
Q-1 61	344469	9869	354338	17696	597916	969950
Q-2 61						
Q-3 61	19383	412	19795	12812	669678	702285
Q-4 61						
Q-1 62	102968	3272	106240	1783		108023
Q-2 62						
Q-3 62	110969	3523	114492	1922		116414
Q-4 62						
Q-1 63	74391	3158	77549	1296		78845
Q-2 63						
Q-3 63	18549	596	19145	320		19465
TOTAL	848947	31403	880350	39806	1287560	2207716

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07 **PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK TOOLING AND STE

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-3 60	25052	1486	26538	506	27044
Q-4 60					
Q-1 61	27160	778	27938	519	28457
Q-2 61					
Q-3 61	4107	117	4224	78	4302
Q-4 61					
Q-1 62	1019	32	1051	18	1069
Q-2 62					
Q-3 62	1016	32	1048	18	1066
TOTAL	58354	2445	60799	1139	61938

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07 PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK TEST/QC

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-3 60	10500	622	11122	212	11334
Q-4 60					
Q-1 61	3535	101	3636	68	3704
Q-2 61					
Q-3 61	18156	520	18676	347	19023
Q-4 61					
Q-1 62	16035	590	16625	279	16904
Q-2 62					
Q-3 62	11032	350	11382	191	11573
TOTAL	59258	2183	61441	1097	62538

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 07 **PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM**
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	9.0	1613	4.725	7621	7339	14960
Q-2 58						
Q-3 58	117.0	19585	4.318	84562	76719	161281
Q-4 58						
Q-1 59	169.5	28988	4.316	125098	99850	224948
Q-2 59						
Q-3 59	287.5	50578	4.056	205163	180594	385757
Q-4 59						
Q-1 60	390.0	67676	4.519	305805	248813	554618
Q-2 60						
Q-3 60	319.0	53563	4.893	262106	198555	460661
Q-4 60						
Q-1 61	444.0	75713	4.764	360714	380311	741025
Q-2 61						
Q-3 61	312.0	56573	5.069	286787	284461	571248
Q-4 61						
Q-1 62	226.5	38608	5.305	204812	178159	382971
Q-2 62						
Q-3 62	187.5	31501	5.208	164049	162873	326922
Q-4 62						
Q-1 63	138.0	23602	6.088	143682	128067	271749
Q-2 63						
Q-3 63	97.0	16246	6.332	102871	94891	197762
Q-4 63						
Q-1 64	86.5	14726	6.990	102932	97930	200862
Q-2 64						
Q-3 64	43.5	7620	6.995	53304	53463	106767
Q-4 64						
Q-1 65	12.0	2149	7.894	16964	14180	31144
Q-2 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 07 **PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM**
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	6.0	992	7.889	7826	6560	14386
Q-4 65						
Q-1 66		68	7.971	542	449	991
TOTAL	2845.0	489801		2434838	2213214	4648052

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 07 **PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM**
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		8	2.875	23	28	51
Q-2 58						
Q-3 58		30	4.467	134	139	273
Q-4 58						
Q-1 59						
Q-2 59						
Q-3 59	21.0	3819	2.804	10707	15158	25865
Q-4 59						
Q-1 60	-15.0	-2542	2.829	-7191	-6863	-14054
Q-2 60						
Q-3 60		62	2.516	156	175	331
Q-4 60						
Q-1 61		92	2.761	254	380	634
Q-2 61						
Q-3 61		1	1.000	1	2	3
Q-4 61						
Q-1 62	1.5	221	3.751	829	1016	1845
Q-2 62						
Q-3 62	-1.5	-214	3.757	-804	-985	-1789
Q-4 62						
Q-1 63		31	3.226	100	124	224
Q-2 63						
Q-3 63		13	3.077	40	278	318
TOTAL	6.0	1521		4249	9452	13701

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 07 **PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM**
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		9	2.000	18		18
Q-4 58						
Q-1 59		-1				
Q-2 59						
Q-3 59		91	2.857	260		260
Q-4 59						
Q-1 60	1.5	211	4.545	959		959
Q-2 60						
Q-3 60		24	4.625	111		111
Q-4 60						
Q-1 61		16	5.375	86		86
Q-2 61						
Q-3 61						
Q-4 61						
Q-1 62						
Q-2 62						
Q-3 62		1	1.000	1		1
Q-4 62						
Q-1 63						
Q-2 63						
Q-3 63		47	3.468	163		163
Q-4 63						
Q-1 64		-1				
TOTAL	1.5	397		1598		1598

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07
6-MAJ ASSY 0

PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	9.0	1621	4.716	7644	7367	15011	22
Q-2 58							
Q-3 58	117.0	19624	4.317	84714	76858	161572	75
Q-4 58							
Q-1 59	169.5	28987	4.316	125098	99850	224948	12
Q-2 59							
Q-3 59	308.5	54488	3.967	216130	195752	411882	1031
Q-4 59							
Q-1 60	376.5	65345	4.584	299573	241950	541523	308
Q-2 60							
Q-3 60	319.0	53649	4.891	262373	198730	461103	499
Q-4 60							
Q-1 61	444.0	75821	4.762	361054	380691	741745	191
Q-2 61							
Q-3 61	312.0	56574	5.069	286788	284463	571251	-9
Q-4 61							
Q-1 62	228.0	38829	5.296	205641	179175	384816	
Q-2 62							
Q-3 62	186.0	31288	5.218	163246	161888	325134	10172
Q-4 62							
Q-1 63	138.0	23633	6.084	143782	128191	271973	58
Q-2 63							
Q-3 63	97.0	16306	6.321	103074	95169	198243	1434
Q-4 63							
Q-1 64	86.5	14725	6.990	102932	97930	200862	-90
Q-2 64							
Q-3 64	43.5	7620	6.995	53304	53463	106767	789
Q-4 64							
Q-1 65	12.0	2149	7.894	16964	14130	31144	
Q-2 65							
Q-3 65	6.0	992	7.889	7826	6560	14386	
Q-4 65							

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07
6-MAJ ASSY 0

PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66		68	7.971	542	449	991	
TOTAL	2852.5	491719		2440685	2222666	4663351	14492

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07 **PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM**
6-MAJ ASSY 0

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	IDWA
Q-1 58		22	1	308	15342		
Q-2 58							
Q-3 58		75	4		161651		
Q-4 58							
Q-1 59		12	1		224961		
Q-2 59							
Q-3 59		1031	87		413000		
Q-4 59							
Q-1 60	163279	163587	9726	11302	726138	13835	
Q-2 60							
Q-3 60	163280	163779	9751	7528	642161	12615	19966
Q-4 60							
Q-1 61	389663	389854	11179	18571	1161349	32693	597916
Q-2 61							
Q-3 61	50124	50115	1290	572	623228	24025	669678
Q-4 61							
Q-1 62	130374	130374	4223	1294	520707	8740	
Q-2 62							
Q-3 62	140375	150547	5257	4578	485516	8150	
Q-4 62							
Q-1 63	93036	93094	3955	118	369140	6171	
Q-2 63							
Q-3 63	23200	24634	886	836	224599	3755	
Q-4 63							
Q-1 64		-90	-10	1000	201762	4293	
Q-2 64							
Q-3 64		789	287	1000	108843	2316	
Q-4 64							
Q-1 65				202	31346	836	
Q-2 65							
Q-3 65				81	14467	386	
Q-4 65							

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07 **PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM**
6-MAJ ASSY 0

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	IDWA
Q-1 66				5	996	30	
TOTAL	1153331	1167823	46637	47395	5925206	117845	1287560

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07 PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM
6-MAJ ASSY 0

	TOTAL COST
Q-1 58	15342
Q-2 58	
Q-3 58	161651
Q-4 58	
Q-1 59	224961
Q-2 59	
Q-3 59	413000
Q-4 59	
Q-1 60	739973
Q-2 60	
Q-3 60	674742
Q-4 60	
Q-1 61	1791958
Q-2 61	
Q-3 61	1316931
Q-4 61	
Q-1 62	529447
Q-2 62	
Q-3 62	493666
Q-4 62	
Q-1 63	375311
Q-2 63	
Q-3 63	228354
Q-4 63	
Q-1 64	206055
Q-2 64	
Q-3 64	111159
Q-4 64	
Q-1 65	32182
Q-2 65	
Q-3 65	14853
Q-4 65	

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNCER
NASA CONTRACT NAS9-12100

APRIL 1972

TIMF PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07 **PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM**
6-MAJ ASSY 0

	TOTAL COST
Q-1 66	1026
TOTAL	7330611

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
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APRIL 1972

COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07
6-MAJ ASSY 06
PERSONNEL ACCOMM AND ESCAPE GROUND TESTS

	TEST /QC HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	36323	36323
LABOR AT $ 4.004	145426	145426
ENGR BURDEN AT $ 4.462	162077	162077
SHOP SUPPORT	508528	508528
LABOR AT $ 3.160	1606697	1606697
TEST/QC	20859	20859
LABOR AT $ 3.085	64385	64385
MFG BURDEN AT $ 3.633	1923417	1923417
ENGR MATERIAL	951601	951601
MPC	99770	99770
OTHER COST	22531	22531
SUB-TOTAL	4975904	4975904
GEN & ADMIN	82896	82896
IOWA	168144	168144
TOTAL COST	5226944	5226944

TIME-PHASED COST DETAIL - SEE PAGE IV-329 IV-329

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SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 07 PERSONNEL ACCOMM AND ESCAPE GROUND TESTS
6-MAJ ASSY 06
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 60		52	3.769	196	196	392
Q-2 60						
Q-3 60	24.0	4017	3.688	14814	14650	29464
Q-4 60						
Q-1 61	9.0	1516	5.093	7721	4064	11785
Q-2 61						
Q-3 61	73.5	13338	3.735	49812	51807	101619
Q-4 61						
Q-1 62	48.0	8109	4.585	37179	43038	80217
Q-2 62						
Q-3 62	43.5	7244	3.912	28335	38707	67042
Q-4 62						
Q-1 63	6.0	1056	3.765	3976	5483	9459
Q-2 63						
Q-3 63	3.0	527	3.330	1755	-1188	567
Q-4 63						
Q-1 64	1.5	243	3.506	852	4448	5300
Q-2 64						
Q-3 64		29	4.207	122	206	328
Q-4 64						
Q-1 65	1.5	135	3.281	443	445	888
Q-2 65						
Q-3 65		54	3.296	178	178	356
Q-4 65						
Q-1 66		3	14.333	43	43	86
TOTAL	210.0	36323		145426	162077	307503

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 07 PERSONNEL ACCOMM AND ESCAPE GROUND TESTS
6-MAJ ASSY 06
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	76.5	12858	2.720	34979	46863	81842
Q-4 58						
Q-1 59	289.5	49514	2.922	144663	179854	324517
Q-2 59						
Q-3 59	94.5	16759	2.808	47053	72074	119127
Q-4 59						
Q-1 60	303.0	52483	2.933	153945	165457	319402
Q-2 60						
Q-3 60	166.5	27957	2.918	81579	96097	177676
Q-4 60						
Q-1 61	1012.5	172823	2.983	515586	559565	1075151
Q-2 61						
Q-3 61	409.5	74272	3.105	230622	305626	536248
Q-4 61						
Q-1 62	433.5	73882	4.234	312800	358728	671528
Q-2 62						
Q-3 62	156.0	26172	2.985	78113	108603	186716
Q-4 62						
Q-1 63	10.5	1685	4.160	7009	6863	13872
Q-2 63						
Q-3 63		44	2.977	131	23285	23416
Q-4 63						
Q-1 64	1.5	194	1.933	375	668	1043
Q-2 64						
Q-3 64		44	1.817	-80	-91	-171
Q-4 64						
Q-1 65		-112	.491	-55	-124	-179
Q-2 65						
Q-3 65		-44	.477	-21	-49	-70

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
DATA PREPARED UNDER
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 07 PERSONNEL ACCOMM AND ESCAPE GROUND TESTS
6-MAJ ASSY 06
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-4 65						
Q-1 66		-3	.667	-2	-2	-4
TOTAL	2953.5	508528		1606697	1923417	3530114

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 07 PERSONNEL ACCOMM AND ESCAPE GROUND TESTS
6-MAJ ASSY 06
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	1.5	225	4.289	965		965
Q-4 58						
Q-1 59	4.5	744	3.094	2302		2302
Q-2 59						
Q-3 59	3.0	441	3.522	1553		1553
Q-4 59						
Q-1 60	13.5	2333	3.012	7028		7028
Q-2 60						
Q-3 60	15.0	2468	3.615	8922		8922
Q-4 60						
Q-1 61	37.5	6498	2.777	18044		18044
Q-2 61						
Q-3 61	19.5	3562	3.077	10962		10962
Q-4 61						
Q-1 62	18.0	3106	3.217	9992		9992
Q-2 62						
Q-3 62	9.0	1403	3.087	4331		4331
Q-4 62						
Q-1 63		58	3.052	177		177
Q-2 63						
Q-3 63		24	3.750	90		90
Q-4 63						
Q-1 64	1.5	162	.105	17		17
Q-2 64						
Q-3 64	1.5	157				
Q-4 64						
Q-1 65	-1.5	-218	. 8	2		2
Q-2 65						
Q-3 65		-87				

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1 PERSONNEL ACCOMM AND ESCAPE GROUND TESTS
5-SUBSYSTEM 07
6-MAJ ASSY 06
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-4 65						
Q-1 66		-7				
TOTAL	123.0	20869		64385		64385

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07
6-MAJ ASSY 06
PERSONNEL ACCOMM AND ESCAPE GROUND TESTS

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-3 58 Q-4 58	78.0	13083	2.747	35944	46863	82807	11585
Q-1 59 Q-2 59	294.0	50258	2.924	146965	179854	326819	34002
Q-3 59 Q-4 59	97.5	17200	2.826	48606	72074	120680	13952
Q-1 60 Q-2 60	316.5	54868	2.937	161169	165653	326822	108958
Q-3 60 Q-4 60	205.5	34442	3.058	105315	110747	216062	251811
Q-1 61 Q-2 61	1059.0	180837	2.994	541351	563629	1104980	174683
Q-3 61 Q-4 61	502.5	91172	3.196	291396	357433	648829	147295
Q-1 62 Q-2 62	499.5	85097	4.230	359971	401766	761737	120874
Q-3 62 Q-4 62	208.5	34819	3.182	110779	147310	258089	66028
Q-1 63 Q-2 63	16.5	2799	3.988	11162	12346	23508	2759
Q-3 63 Q-4 63	3.0	595	3.321	1976	22097	24073	-590
Q-1 64 Q-2 64	4.5	599	2.077	1244	5116	6360	7222
Q-3 64 Q-4 64	1.5	230	.183	42	115	157	12787
Q-1 65 Q-2 65		-195	1.999	390	321	711	165
Q-3 65 Q-4 65		-77	2.038	157	129	286	66
Q-1 66		-7	5.856	41	41	82	4
TOTAL	3286.5	565720		1816508	2085494	3902002	951601

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07
6-MAJ ASSY 06
PERSONNEL ACCOMM AND ESCAPE GROUND TESTS

	MPC	OTHER COST	SUB TOTAL	G & A	IDWA	TOTAL COST
Q-3 58	634		95026			95026
Q-4 58						
Q-1 59	2880		363701			363701
Q-2 59						
Q-3 59	1182		135814			135814
Q-4 59						
Q-1 60	14328		450108	8576		458684
Q-2 60						
Q-3 60	33113		500986	9597	2717	513300
Q-4 60						
Q-1 61	14761	240	1294664	26333	122391	1443388
Q-2 61						
Q-3 61	12446	5494	814064	15927	43036	873027
Q-4 61						
Q-1 62	9525	5989	898125	15075		913200
Q-2 62						
Q-3 62	5203	3102	332422	5580		338002
Q-4 62						
Q-1 63	272	-2367	24172	404		24576
Q-2 63						
Q-3 63	-58	-2822	20603	344		20947
Q-4 63						
Q-1 64	770	2	14354	305		14659
Q-2 64						
Q-3 64	4652	2	17598	374		17972
Q-4 64						
Q-1 65	49	9024	9949	265		10214
Q-2 65						
Q-3 65	12	3609	3973	106		4079
Q-4 65						
Q-1 66	1	258	345	10		355
TOTAL	99770	22531	4975904	82896	168144	5226944

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07
PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOOLING AND STE HOURS DOLLARS	TEST /QC HOURS DOLLARS
DESIGN/ENGINEERING	489801			36323
LABOR AT $ 4.904	2434838			145426
ENGR BURDEN AT $ 4.515	2213214			162077
SHOP SUPPORT	1521			508528
LABOR AT $ 3.158	4249			1606697
TEST/QC	397			20869
LABOR AT $ 3.103	1598			64385
MFG BURDEN AT $ 3.638	9452			1923417
ENGR MATERIAL	14492			951601
SUBCONTRACT	186772	848947	58354	59258
MPC	10606	31403	2445	101953
OTHER COST	47395			22531
SUB-TOTAL	4922616	880350	60799	5037345
GEN & ADMIN	75803	39806	1139	83993
IOWA		1287560		168144
TOTAL COST	4998419	2207716	61938	5289482
TIME-PHASED COST DETAIL - SEE PAGE	IV-338	IV-346	IV-347	IV-348

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07
PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM

	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	526124
LABOR AT $ 4.904	2580264
ENGR BURDEN AT $ 4.515	2375291
SHOP SUPPORT	510049
LABOR AT $ 3.158	1610946
TEST/QC	21266
LABOR AT $ 3.103	65983
MFG BURDEN AT $ 3.638	1932869
ENGR MATERIAL	966093
SUBCONTRACT	1153331
MPC	146407
OTHER COST	69926
SUB-TOTAL	10901110
GEN & ADMIN	200741
IOWA	1455704
TOTAL COST	12557555

TIME-PHASED COST
DETAIL - SEE PAGE IV-356

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 07 PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	9.0	1613	4.725	7621	7339	14960
Q-2 58						
Q-3 58	117.0	19585	4.318	84562	76719	161281
Q-4 58						
Q-1 59	169.5	28988	4.316	125098	99850	224948
Q-2 59						
Q-3 59	287.5	50578	4.056	205163	180594	385757
Q-4 59						
Q-1 60	390.0	67676	4.519	305805	248813	554618
Q-2 60						
Q-3 60	319.0	53563	4.893	262106	198555	460661
Q-4 60						
Q-1 61	444.0	75713	4.764	360714	380311	741025
Q-2 61						
Q-3 61	312.0	56573	5.069	286787	284461	571248
Q-4 61						
Q-1 62	226.5	38608	5.305	204812	178159	382971
Q-2 62						
Q-3 62	187.5	31501	5.208	164049	162873	326922
Q-4 62						
Q-1 63	138.0	23602	6.088	143682	128067	271749
Q-2 63						
Q-3 63	97.0	16246	6.332	102871	94891	197762
Q-4 63						
Q-1 64	86.5	14726	6.990	102932	97930	200862
Q-2 64						
Q-3 64	43.5	7620	6.995	53304	53463	106767
Q-4 64						
Q-1 65	12.0	2149	7.894	16964	14180	31144
Q-2 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING

4-SYSTEM 1 PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM
5-SUBSYSTEM 07
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	6.0	992	7.889	7826	6560	14386
Q-4 65						
Q-1 66		68	7.971	542	449	991
TOTAL	2845.0	489801		2434838	2213214	4648052

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 07 PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		8	2.875	23	28	51
Q-2 58						
Q-3 58		30	4.467	134	139	273
Q-4 58						
Q-1 59						
Q-2 59						
Q-3 59	21.0	3819	2.804	10707	15158	25865
Q-4 59						
Q-1 60	-15.0	-2542	2.829	-7191	-6863	-14054
Q-2 60						
Q-3 60		62	2.516	156	175	331
Q-4 60						
Q-1 61		92	2.761	254	380	634
Q-2 61						
Q-3 61		1	1.000	1	2	3
Q-4 61						
Q-1 62	1.5	221	3.751	829	1016	1845
Q-2 62						
Q-3 62	-1.5	-214	3.757	-804	-985	-1789
Q-4 62						
Q-1 63		31	3.226	100	124	224
Q-2 63						
Q-3 63		13	3.077	40	278	318
TOTAL	6.0	1521		4249	9452	13701

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 07 PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		9	2.000	18		18
Q-4 58						
Q-1 59		-1				
Q-2 59						
Q-3 59		91	2.857	260		260
Q-4 59						
Q-1 60	1.5	211	4.545	959		959
Q-2 60						
Q-3 60		24	4.625	111		111
Q-4 60						
Q-1 61		16	5.375	86		86
Q-2 61						
Q-3 61						
Q-4 61						
Q-1 62						
Q-2 62						
Q-3 62		1	1.000	1		1
Q-4 62						
Q-1 63						
Q-2 63						
Q-3 63		47	3.468	163		163
Q-4 63						
Q-1 64		-1				
TOTAL	1.5	397		1598		1598

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07 PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	9.0	1621	4.716	7644	7367	15011	22
Q-2 58							
Q-3 58	117.0	19624	4.317	84714	76858	161572	75
Q-4 58							
Q-1 59	169.5	28987	4.316	125098	99850	224948	12
Q-2 59							
Q-3 59	308.5	54488	3.967	216130	195752	411882	1031
Q-4 59							
Q-1 60	376.5	65345	4.584	299573	241950	541523	308
Q-2 60							
Q-3 60	319.0	53649	4.891	262373	198730	461103	499
Q-4 60							
Q-1 61	444.0	75821	4.762	361054	380691	741745	191
Q-2 61							
Q-3 61	312.0	56574	5.069	286788	284463	571251	-9
Q-4 61							
Q-1 62	228.0	38829	5.296	205641	179175	384816	
Q-2 62							
Q-3 62	186.0	31288	5.218	163246	161888	325134	10172
Q-4 62							
Q-1 63	138.0	23633	6.084	143782	128191	271973	58
Q-2 63							
Q-3 63	97.0	16306	6.321	103074	95169	198243	1434
Q-4 63							
Q-1 64	86.5	14725	6.990	102932	97930	200862	-90
Q-2 64							
Q-3 64	43.5	7620	6.995	53304	53463	106767	789
Q-4 64							
Q-1 65	12.0	2149	7.894	16964	14180	31144	
Q-2 65							
Q-3 65	6.0	992	7.889	7826	6560	14386	
Q-4 65							

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B-70 AIRCRAFT STUDY

4-SYSTEM 1 PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM
5-SUBSYSTEM 07
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66		68	7.971	542	449	991	
TOTAL	2852.5	491719		2440685	2222666	4663351	14492

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07 **PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM**
SUBD OF WORK DESIGN/ENGINEERING

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58		22	1	308	15342		15342
Q-2 58							
Q-3 58		75	4		161651		161651
Q-4 58							
Q-1 59		12	1		224961		224961
Q-2 59							
Q-3 59		1031	87		413000		413000
Q-4 59							
Q-1 60	92679	92937	5538	11302	651350	12410	663760
Q-2 60							
Q-3 60	20110	20609	1258	7528	490498	9345	499843
Q-4 60							
Q-1 61	14499	14690	431	13571	775437	14410	789847
Q-2 61							
Q-3 61	8478	8469	241	572	580533	10788	591321
Q-4 61							
Q-1 62	10352	10352	329	1294	396791	6660	403451
Q-2 62							
Q-3 62	17358	27530	1352	4578	358594	6019	364613
Q-4 62							
Q-1 63	18645	18703	797	118	291591	4875	296466
Q-2 63							
Q-3 63	4651	6085	290	836	205454	3435	208889
Q-4 63							
Q-1 64		-90	-10	1000	201762	4293	206055
Q-2 64							
Q-3 64		789	287	1000	108843	2316	111159
Q-4 64							
Q-1 65				202	31346	836	32182
Q-2 65							
Q-3 65				81	14467	386	14853
Q-4 65							

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1 PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM
5-SUBSYSTEM 07
SUBD OF WORK DESIGN/ENGINEERING

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 66				5	996	30	1026
TOTAL	186772	201264	10606	47395	4922616	75803	4998419

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07 **PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM**
SUBD OF WORK PRODUCTION

	SUBC	MPC	SUB TOTAL	G & A	IDWA	TOTAL COST
Q-1 60	70600	4188	74788	1425		76213
Q-2 60						
Q-3 60	107618	6385	114003	2552	19966	136521
Q-4 60						
Q-1 61	344469	9869	354338	17696	597916	969950
Q-2 61						
Q-3 61	19383	412	19795	12812	669678	702285
Q-4 61						
Q-1 62	102968	3272	106240	1783		108023
Q-2 62						
Q-3 62	110969	3523	114492	1922		116414
Q-4 62						
Q-1 63	74391	3158	77549	1296		78845
Q-2 63						
Q-3 63	18549	596	19145	320		19465
TOTAL	848947	31403	880350	39806	1287560	2207716

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B-70 AIRCRAFT STUDY

4-SYSTEM 1 PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM
5-SUBSYSTEM 07
SUBD OF WORK TOOLING AND STE

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-3 60	25052	1486	26538	506	27044
Q-4 60					
Q-1 61	27160	778	27938	519	28457
Q-2 61					
Q-3 61	4107	117	4224	78	4302
Q-4 61					
Q-1 62	1019	32	1051	18	1069
Q-2 62					
Q-3 62	1016	32	1048	18	1066
TOTAL	58354	2445	60799	1139	61938

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 07 PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 60		52	3.769	196	196	392
Q-2 60						
Q-3 60	24.0	4017	3.688	14814	14650	29464
Q-4 60						
Q-1 61	9.0	1516	5.093	7721	4064	11785
Q-2 61						
Q-3 61	73.5	13338	3.735	49812	51807	101619
Q-4 61						
Q-1 62	48.0	8109	4.585	37179	43038	80217
Q-2 62						
Q-3 62	43.5	7244	3.912	23335	38707	67042
Q-4 62						
Q-1 63	6.0	1056	3.765	3976	5483	9459
Q-2 63						
Q-3 63	3.0	527	3.330	1755	-1188	567
Q-4 63						
Q-1 64	1.5	243	3.506	852	4448	5300
Q-2 64						
Q-3 64		29	4.207	122	206	328
Q-4 64						
Q-1 65	1.5	135	3.281	443	445	888
Q-2 65						
Q-3 65		54	3.296	178	178	356
Q-4 65						
Q-1 66		3	14.333	43	43	86
TOTAL	210.0	36323		145426	162077	307503

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B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 07 PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	76.5	12858	2.720	34979	46863	81842
Q-4 58						
Q-1 59	289.5	49514	2.922	144663	179854	324517
Q-2 59						
Q-3 59	94.5	16759	2.808	47053	72074	119127
Q-4 59						
Q-1 60	303.0	52483	2.933	153945	165457	319402
Q-2 60						
Q-3 60	166.5	27957	2.918	81579	96097	177676
Q-4 60						
Q-1 61	1012.5	172823	2.983	515586	559565	1075151
Q-2 61						
Q-3 61	409.5	74272	3.105	230622	305626	536248
Q-4 61						
Q-1 62	433.5	73882	4.234	312800	358728	671528
Q-2 62						
Q-3 62	156.0	26172	2.985	78113	108603	186716
Q-4 62						
Q-1 63	10.5	1685	4.160	7009	6863	13872
Q-2 63						
Q-3 63		44	2.977	131	23285	23416
Q-4 63						
Q-1 64	1.5	194	1.933	375	668	1043
Q-2 64						
Q-3 64		44	1.817	-80	-91	-171
Q-4 64						
Q-1 65		-112	.491	-55	-124	-179
Q-2 65						
Q-3 65		-44	.477	-21	-49	-70
Q-4 65						

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B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 07 **PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM**
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 66		-3	.667	-2	-2	-4
TOTAL	2953.5	508528		1606697	1923417	3530114

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1 **PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM**
5-SUBSYSTEM 07
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	1.5	225	4.289	965		965
Q-4 58						
Q-1 59	4.5	744	3.094	2302		2302
Q-2 59						
Q-3 59	3.0	441	3.522	1553		1553
Q-4 59						
Q-1 60	13.5	2333	3.012	7028		7028
Q-2 60						
Q-3 60	15.0	2468	3.615	8922		8922
Q-4 60						
Q-1 61	37.5	6498	2.777	18044		18044
Q-2 61						
Q-3 61	19.5	3562	3.077	10962		10962
Q-4 61						
Q-1 62	18.0	3106	3.217	9992		9992
Q-2 62						
Q-3 62	9.0	1403	3.087	4331		4331
Q-4 62						
Q-1 63		58	3.052	177		177
Q-2 63						
Q-3 63		24	3.750	90		90
Q-4 63						
Q-1 64	1.5	162	.105	17		17
Q-2 64						
Q-3 64	1.5	157				
Q-4 64						
Q-1 65	-1.5	-218	. 8	2		2
Q-2 65						
Q-3 65		-87				
Q-4 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 07 **PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM**
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 66		-7				
TOTAL	123.0	20869		64385		64385

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1 PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM
5-SUBSYSTEM 07
SUBD OF WORK TEST/QC

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-3 58	78.0	13083	2.747	35944	46863	82807	11585
Q-4 58							
Q-1 59	294.0	50258	2.924	146965	179854	326819	34002
Q-2 59							
Q-3 59	97.5	17200	2.826	48606	72074	120680	13952
Q-4 59							
Q-1 60	316.5	54868	2.937	161169	165653	326822	108958
Q-2 60							
Q-3 60	205.5	34442	3.058	105315	110747	216062	251811
Q-4 60							
Q-1 61	1059.0	180837	2.994	541351	563629	1104980	174683
Q-2 61							
Q-3 61	502.5	91172	3.196	291396	357433	648829	147295
Q-4 61							
Q-1 62	499.5	85097	4.230	359971	401766	761737	120874
Q-2 62							
Q-3 62	208.5	34819	3.182	110779	147310	258089	66028
Q-4 62							
Q-1 63	16.5	2799	3.988	11162	12346	23508	2759
Q-2 63							
Q-3 63	3.0	595	3.321	1976	22097	24073	-590
Q-4 63							
Q-1 64	4.5	599	2.077	1244	5116	6360	7222
Q-2 64							
Q-3 64	1.5	230	.183	42	115	157	12787
Q-4 64							
Q-1 65		-195	1.999	390	321	711	165
Q-2 65							
Q-3 65		-77	2.038	157	129	286	66
Q-4 65							
Q-1 66		-7	5.856	41	41	82	4
TOTAL	3286.5	565720		1816508	2085494	3902002	951601

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B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07 **PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM**
SUBD OF WORK TEST/QC

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	IDWA
Q-3 58		11585	634		95026		
Q-4 58							
Q-1 59		34002	2880		363701		
Q-2 59							
Q-3 59		13952	1182		135814		
Q-4 59							
Q-1 60		108958	14328		450108	8576	
Q-2 60							
Q-3 60	10500	262311	33735		512108	9809	2717
Q-4 60							
Q-1 61	3535	178218	14862	240	1298300	26401	122391
Q-2 61							
Q-3 61	18156	165451	12966	5494	332740	16274	43036
Q-4 61							
Q-1 62	16035	136909	10115	5989	914750	15354	
Q-2 62							
Q-3 62	11032	77060	5553	3102	343804	5771	
Q-4 62							
Q-1 63		2759	272	-2367	24172	404	
Q-2 63							
Q-3 63		-590	-58	-2822	20603	344	
Q-4 63							
Q-1 64		7222	770	2	14354	305	
Q-2 64							
Q-3 64		12787	4652	2	17598	374	
Q-4 64							
Q-1 65		165	49	9024	9949	265	
Q-2 65							
Q-3 65		66	12	3609	3973	106	
Q-4 65							
Q-1 66		4	1	258	345	10	
TOTAL	59258	1010859	101953	22531	5037345	83993	168144

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B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07 PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM
SUBD OF WORK TEST/QC

	TOTAL COST
Q-3 58	95026
Q-4 58	
Q-1 59	363701
Q-2 59	
Q-3 59	135814
Q-4 59	
Q-1 60	458684
Q-2 60	
Q-3 60	524634
Q-4 60	
Q-1 61	1447092
Q-2 61	
Q-3 61	892050
Q-4 61	
Q-1 62	930104
Q-2 62	
Q-3 62	349575
Q-4 62	
Q-1 63	24576
Q-2 63	
Q-3 63	20947
Q-4 63	
Q-1 64	14659
Q-2 64	
Q-3 64	17972
Q-4 64	
Q-1 65	10214
Q-2 65	
Q-3 65	4079
Q-4 65	
Q-1 66	355
TOTAL	5289482

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 07
PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58 Q-2 58	9.0	1613	4.725	7621	7339	14960
Q-3 58 Q-4 58	117.0	19585	4.318	84562	76719	161281
Q-1 59 Q-2 59	169.5	28988	4.316	125098	99850	224948
Q-3 59 Q-4 59	287.5	50578	4.056	205163	180594	385757
Q-1 60 Q-2 60	391.0	67728	4.518	306001	249009	555010
Q-3 60 Q-4 60	343.0	57580	4.809	276920	213205	490125
Q-1 61 Q-2 61	453.0	77229	4.771	368435	384375	752810
Q-3 61 Q-4 61	385.5	69911	4.815	336599	336268	672867
Q-1 62 Q-2 62	274.0	46717	5.180	241991	221197	463188
Q-3 62 Q-4 62	231.0	38745	4.965	192384	201580	393964
Q-1 63 Q-2 63	144.0	24658	5.988	147658	133550	281208
Q-3 63 Q-4 63	100.0	16773	6.238	104626	93703	198329
Q-1 64 Q-2 64	88.0	14969	6.933	103784	102378	206162
Q-3 64 Q-4 64	43.5	7649	6.985	53426	53669	107095
Q-1 65 Q-2 65	13.5	2284	7.621	17407	14625	32032

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 07
PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	6.0	1046	7.652	8004	6738	14742
Q-4 65						
Q-1 66		71	8.239	585	492	1077
TOTAL	3055.5	526124		2580264	2375291	4955555

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 07
PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		8	2.875	23	28	51
Q-2 58						
Q-3 58	76.5	12888	2.724	35113	47002	82115
Q-4 58						
Q-1 59	289.5	49514	2.922	144663	179854	324517
Q-2 59						
Q-3 59	117.0	20578	2.807	57760	87232	144992
Q-4 59						
Q-1 60	283.0	49941	2.939	146754	158594	305348
Q-2 60						
Q-3 60	166.5	28019	2.917	81735	96272	178007
Q-4 60						
Q-1 61	1012.5	172915	2.983	515840	559945	1075785
Q-2 61						
Q-3 61	409.5	74273	3.105	230623	305628	536251
Q-4 61						
Q-1 62	434.5	74103	4.232	313629	359744	673373
Q-2 62						
Q-3 62	154.5	25958	2.978	77309	107618	184927
Q-4 62						
Q-1 63	10.5	1716	4.143	7109	6987	14096
Q-2 63						
Q-3 63		57	3.000	171	23563	23734
Q-4 63						
Q-1 64	1.5	194	1.933	375	668	1043
Q-2 64						
Q-3 64		44	1.817	-80	-91	-171
Q-4 64						
Q-1 65		-112	.491	-55	-124	-179
Q-2 65						

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B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 07
PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65		-44	.477	-21	-49	-70
Q-4 65						
Q-1 66		-3	.667	-2	-2	-4
TOTAL	2960.5	510049		1610946	1932869	3543815

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B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 07
PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58 Q-4 58	1.5	234	4.201	983		983
Q-1 59 Q-2 59	4.5	743	3.098	2302		2302
Q-3 59 Q-4 59	3.0	532	3.408	1813		1813
Q-1 60 Q-2 60	15.0	2544	3.140	7987		7987
Q-3 60 Q-4 60	15.0	2492	3.625	9033		9033
Q-1 61 Q-2 61	37.5	6514	2.783	18130		18130
Q-3 61 Q-4 61	19.5	3562	3.077	10962		10962
Q-1 62 Q-2 62	18.0	3106	3.217	9992		9992
Q-3 62 Q-4 62	9.0	1404	3.085	4332		4332
Q-1 63 Q-2 63		58	3.052	177		177
Q-3 63 Q-4 63		71	3.563	253		253
Q-1 64 Q-2 64	1.5	161	.106	17		17
Q-3 64 Q-4 64	1.5	157				
Q-1 65 Q-2 65	-1.5	-218	. 8	2		2
Q-3 65 Q-4 65		-87				

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 07
PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 66		-7				
TOTAL	124.5	21266		65983		65983

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07
PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	9.0	1621	4.716	7644	7367	15011	22
Q-2 58							
Q-3 58	195.0	32707	3.689	120658	123721	244379	11660
Q-4 58							
Q-1 59	463.5	79245	3.433	272063	279704	551767	34014
Q-2 59							
Q-3 59	407.5	71688	3.693	264736	267826	532562	14983
Q-4 59							
Q-1 60	694.0	120213	3.833	460742	407603	868345	109266
Q-2 60							
Q-3 60	524.5	88091	4.174	367688	309477	677165	252310
Q-4 60							
Q-1 61	1503.0	256658	3.516	902405	944320	1846725	174874
Q-2 61							
Q-3 61	814.5	147746	3.913	578184	641896	1220080	147286
Q-4 61							
Q-1 62	726.5	123926	4.564	565612	580941	1146553	120874
Q-2 62							
Q-3 62	394.5	66107	4.145	274025	309198	583223	76200
Q-4 62							
Q-1 63	154.5	26432	5.862	154944	140537	295481	2817
Q-2 63							
Q-3 63	100.0	16901	6.216	105050	117266	222316	844
Q-4 63							
Q-1 64	91.0	15324	6.798	104176	103046	207222	7132
Q-2 64							
Q-3 64	45.0	7850	6.796	53346	53578	106924	13576
Q-4 64							
Q-1 65	12.0	1954	8.881	17354	14501	31855	165
Q-2 65							
Q-3 65	6.0	915	8.725	7983	6689	14672	66
Q-4 65							

NORTH AMERICAN ROCKWELL CORP.
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B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07
PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66		61	9.557	583	490	1073	4
TOTAL	6140.5	1057439		4257193	4308160	8565353	966093

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07
PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	IOWA
Q-1 58		22	1	308	15342		
Q-2 58							
Q-3 58		11660	638		256677		
Q-4 58							
Q-1 59		34014	2881		588662		
Q-2 59							
Q-3 59		14983	1269		548814		
Q-4 59							
Q-1 60	163279	272545	24054	11302	1176246	22411	
Q-2 60							
Q-3 60	163280	415590	42864	7528	1143147	22212	22683
Q-4 60							
Q-1 61	389663	564537	25940	18811	2456013	59026	720307
Q-2 61							
Q-3 61	50124	197410	13736	6066	1437292	39952	712714
Q-4 61							
Q-1 62	130374	251248	13748	7283	1418832	23815	
Q-2 62							
Q-3 62	140375	216575	10460	7680	817938	13730	
Q-4 62							
Q-1 63	93036	95853	4227	-2249	393312	6575	
Q-2 63							
Q-3 63	23200	24044	828	-1986	245202	4099	
Q-4 63							
Q-1 64		7132	760	1002	216116	4598	
Q-2 64							
Q-3 64		13576	4939	1002	126441	2690	
Q-4 64							
Q-1 65		165	49	9226	41295	1101	
Q-2 65							
Q-3 65		66	12	3690	18440	492	
Q-4 65							

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B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07
PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	IDWA
Q-1 66		4	1	263	1341	40	
TOTAL	1153331	2119424	146407	69926	10901110	200741	1455704

NORTH AMERICAN ROCKWELL CORP.
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B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07
PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM

	TOTAL COST
Q-1 58	15342
Q-2 58	
Q-3 58	256677
Q-4 58	
Q-1 59	588662
Q-2 59	
Q-3 59	548814
Q-4 59	
Q-1 60	1198657
Q-2 60	
Q-3 60	1188042
Q-4 60	
Q-1 61	3235346
Q-2 61	
Q-3 61	2189958
Q-4 61	
Q-1 62	1442647
Q-2 62	
Q-3 62	831668
Q-4 62	
Q-1 63	399887
Q-2 63	
Q-3 63	249301
Q-4 63	
Q-1 64	220714
Q-2 64	
Q-3 64	129131
Q-4 64	
Q-1 65	42396
Q-2 65	
Q-3 65	18932
Q-4 65	

NORTH AMERICAN ROCKWELL CORP.
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NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 07
PERSONNEL ACCOMM AND ESCAPE SUBSYSTEM

	TOTAL COST
Q-1 66	1381
TOTAL	12557555

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WORK BREAKDOWN STRUCTURE

SUBSYSTEM: ALIGHTING AND ARRESTING WBS CODE 1.8

WBS LEVEL
4 5 6 7 8

1.8 ALIGHTING AND ARRESTING SUBSYSTEM

1.8.1 Main Landing Gear

1.8.1.1 Shock Strut

Pressure Relief Valve
Seals
Scissors

1.8.1.2 Bogie Rotate Actuator

Down Lock Pin
Up Lock Latch
Rotate Flow Control Valve
Rotate Actuator Transfer Valve
Rotate Lock Transfer Valve
Beam

1.8.1.3 Brake System

Disc Cartridge
Actuator
Control Valve
Torque Sensor
Wheel Load Sensor
Wheel Speed Sensor

1.8.1.4 Reference Wheel Assembly

Wheel Speed Sensor
Wheel Shock Strut
Wheel
Tire

1.8.1.5 Bogie Fold and Pitch Control Assembly

Control Valves
Control Manifold

1.8.1.6 Main Gear Door Actuator Mechanism

Door Locks
Door Position Sensor

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: ALIGHTING AND ARRESTING

WBS CODE 1.8

WBS LEVEL
4 5 6 7 8

1.8.1.7 Brake Control Unit

1.8.1.8 Brake Pedal Position Valving

1.8.1.9 Main Gear Wheel

1.8.1.10 Main Gear Tires

1.8.1.11 Tire Temperature Sensor

1.8.1.12 Gear Uplock Assembly

1.8.1.13 Electrical Emergency Ext. Control

1.8.2 Nose Gear

1.8.2.1 Shock Strut

Pressure Relief Valve
Seals
Scissors

1.8.2.2 Nose Gear Steering

Actuator
Valve Manifold Assembly
Control Valve
Position Output Transducer
Position Input Transducer

1.8.2.3 Nose Gear Wheel

1.8.2.4 Nose Gear Tire

1.8.2.5 Nose Gear Door Actuator Mechanism

Door Locks
Door Position Sensor

1.8.2.6 Gear Up Lock Assy

1.8.2.7 Electronic Emergency Ext. Control

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: ALIGHTING AND ARRESTING WBS CODE 1.8

WBS LEVEL
4 5 6 7 8

1.8.3 Drag Chute Subsystem

1.8.3.1 Compartment Door Actuation

Actuators
Locking Mechanism

1.8.3.2 Chute Release Mechanism

Hook Lock Actuator
Control Cabling
Servo Valve

1.8.3.3 Drag Chute

1.8.3.4 Over Temperature Detector

1.8.4 Controls and Displays

1.8.4.1 Gear Indicator Panel

1.8.4.2 Gear Control Handle

1.8.4.3 Drag Chute Control "Tee"

1.8.5 Ground Tests

1.8.5.1 Mockups

1.8.5.2 Simulators

1.8.5.3 Mission Hydrostatic Tests

1.8.5.4 Wind Tunnel

TECHNICAL DESCRIPTION

SUBSYSTEM: ALIGHTING AND ARRESTING WBS CODE: 1.8

The Alighting and Arresting Subsystem of the B-70 consisted of a conventional tricycle landing gear arrangement and a drag chute system to reduce the landing roll. The landing gear system was composed of two main landing gears and a nose gear which retracted aft into the fuselage and were enclosed by contoured doors. Each main gear assembly consisted of a shock strut, bracing, actuators, and bogie beam on which were mounted four wheels and tires, two brakes with steel heat sinks, plus a small fifth wheel to sense braking action. The nose gear assembly was composed of a shock strut, bracing, actuators, two wheels with tires, and a steering unit. Exhibit 1, page IV-374, presents a series of pictures of the landing gear and checkout criteria.

The drag chute system was installed in the upper aft fuselage and consisted of three 28-foot diameter ring slot drag chutes. Each drag chute was installed in individual deployment bags in the drag chute compartment with individual canopy risers attached to a trunnion assembly which was hooked to the air vehicle structure. Exhibit 2, page IV-375, presents an overview showing the drag chute system installation.

The landing gear shock struts and bogie beams of the B-70 pioneered the use of high heat treat, high temperature H-11 tool steel for aircraft use. (See Technical Driver: Use of H-11 Tool Steel under Airframe Structures Subsystem, WBS 1.1) The gear assembly was in the heat treat range of 280 to 300,000 psi and would withstand stowage for extended periods of temperatures as high as 650° F without becoming annealed. The tires of the gear assembly were also an advancement in the state-of-the-art. The tires had higher load ratings than ever before achieved within the envelope of 40 x 17.5 and operated at greater speeds than ever before used on heavy aircraft.

The brake control system of the B-70 was a new concept of fully automatic regulation of braking the air vehicle upon a given input command by the pilot. The braking torque on each of the four brakes was individually and automatically controlled to provide maximum retarding force, regardless of runway conditions, without skidding the tires. The braking system was not of the conventional anti-skid ("On"-"Off") type but a much more refined type of control which utilized a "fifth wheel" to provide a true ground speed reference.

The Alighting and Arresting Subsystem is described in detail along with the functional interfaces in subsequent paragraphs as identified by the WBS.

LANDING GEAR

- HYDRAULIC OPERATING SYSTEMS (INCLUDING 27 ACTUATORS)
  - CHECK OUT
    - STEERING, BRAKING, & ANTI-SKID
    - CYCLING
      - RETRACT 18 SECONDS
      - EXTEND 20 SECONDS
- ELECTRICAL & ELECTRONIC
  - CHECK OUT
    - STEERING & BRAKE CONTROLS COCKPIT
    - TIRE & BRAKE HEAT SENSING SUBSYSTEM
    - ANTI-SKID SUBSYSTEM

NOSE GEAR

MAIN GEAR

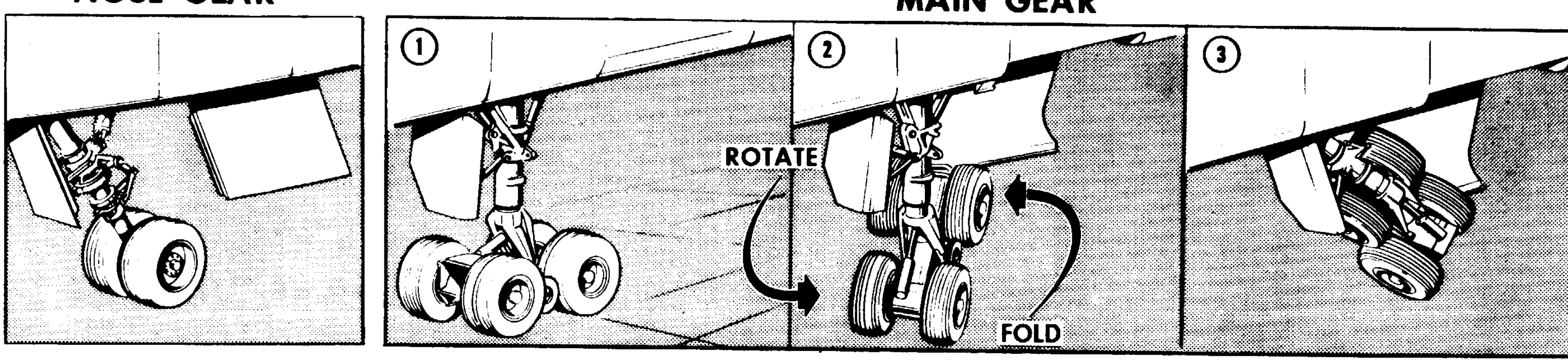
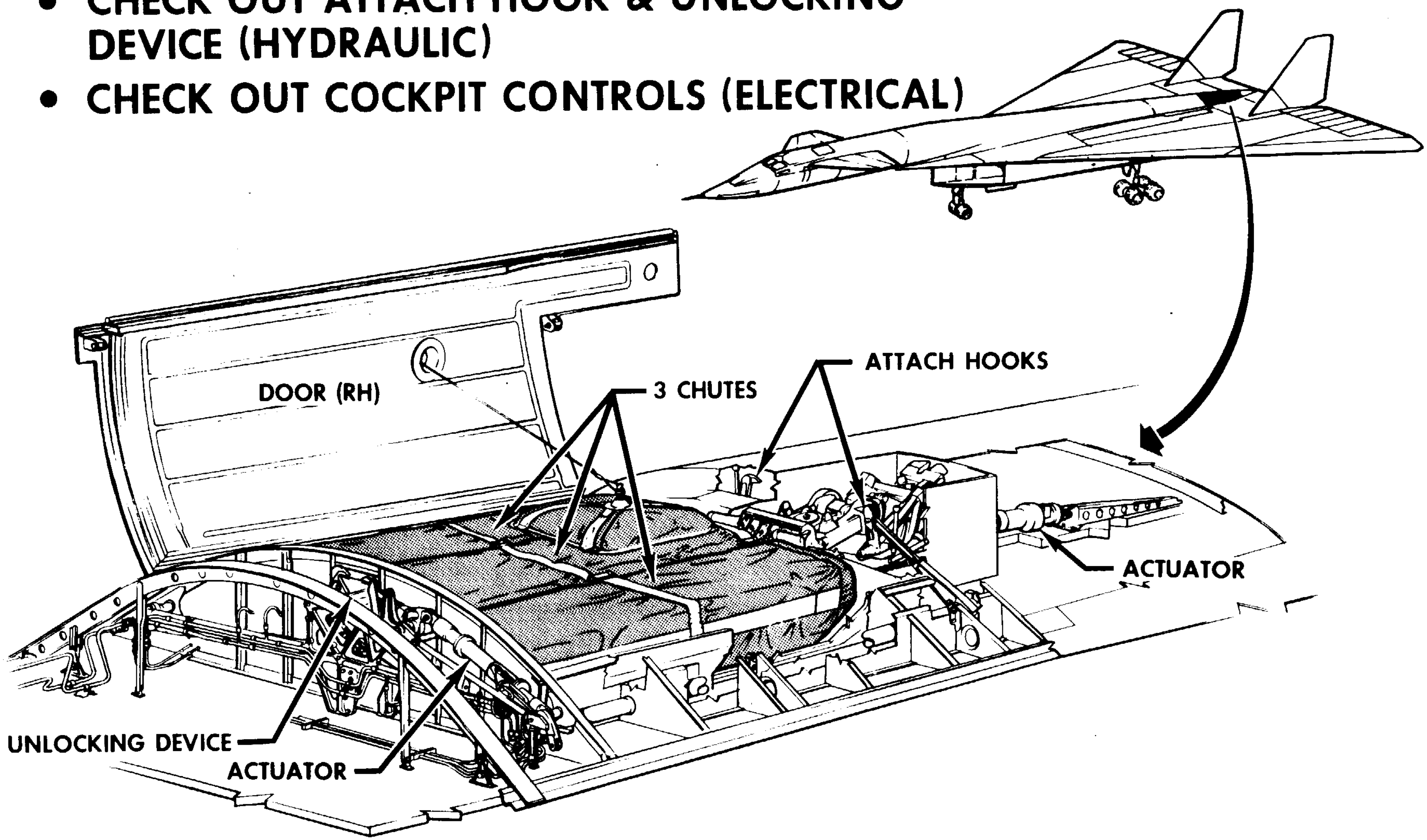


EXHIBIT 1

DRAG CHUTE

- CYCLE DOORS (HYDRAULIC)
- CHECK OUT ATTACH HOOK & UNLOCKING DEVICE (HYDRAULIC)
- CHECK OUT COCKPIT CONTROLS (ELECTRICAL)



TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: ALIGHTING AND ARRESTING SUBSYSTEM WBS CODE: 1.8

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
MAJOR ASSEMBLIES	NO./TYPE	2 -	MAIN LANDING GEAR SYSTEM →	→	→	→
		1 -	NOSE GEAR SYSTEM →	→	→	→
		1 -	DRAG CHUTE SYSTEM (3 CHUTES) →	→	→	→
		1 -	CONTROLS AND DISPLAY SYSTEM →	→	→	→
WEIGHT	POUNDS	17,008	NOT AVAILABLE		19,472	20,173
ALIGHTING GEAR	TYPE	TRICYCLE	TRICYCLE	TRICYCLE	TRICYCLE	TRICYCLE
MAXIMUM STATIC LOAD	POUNDS	561,609	562,609	562,609	562,609	562,609
MAXIMUM TAKE-OFF LOAD	POUNDS	554,609	NOT AVAILABLE		519,878	542,029
MAXIMUM LANDING WEIGHT	POUNDS	537,000	"	"	537,000	537,000
BRAKES	NO./TYPE	MULTIPLE FRICTION DISCS: HYDRAULICALLY OPERATED				
BRAKE ENERGY (MAXIMUM)	FEET/POUNDS	-	174,000,000	174,000,000	174,000,000	174,000,000
DRAG CHUTES	NO./SIZE	3 - 28 FT DIA	→	→	3 - 28 FT. DIA	
CHUTE DEPLOY (MAXIMUM SPEED)	KIAS	-	-	220	220	220
" " (MINIMUM SPEED)	KIAS	-	-	100	100	100
" DRAG (MAXIMUM LOAD)	POUNDS	-	-	166,000	166,000	166,000
RELIABILITY FACTOR	NONE	-	-	0.99924	0.99924	0.99924
MTBF	HOURS	-	-	2304	2304	2304

Space Division
North American Rockwell

TECHNICAL DESCRIPTION

SUBSYSTEM: ALIGHTING AND ARRESTING WBS CODE: 1.8

MAJOR ASSEMBLY: MAIN LANDING GEAR WBS CODE: 1.8.1

Exhibit 3, page IV-379, presents a picture looking forward under the air vehicle showing the conventional tricycle landing gear installation. As shown, each main landing gear assembly had a shock strut assembly with an attached bogie beam on which were mounted four wheels, four tires, two tandem brake assemblies, and a fifth wheel for ground speed reference. The shock strut assembly was a modified metering pin air-oil shock absorbing type with provisions incorporated for attachment of the bogie beam, actuators, doors and braces. All basic structural members were fabricated of H-11 tool steel with a heat treat of 280,000 to 300,000 psi. Exhibit 4, page IV-380 presents the total main gear assembly while Exhibit 5, page IV-381, shows the upper end of the strut assembly with its braces, main actuator, and air vehicle attachment configuration.

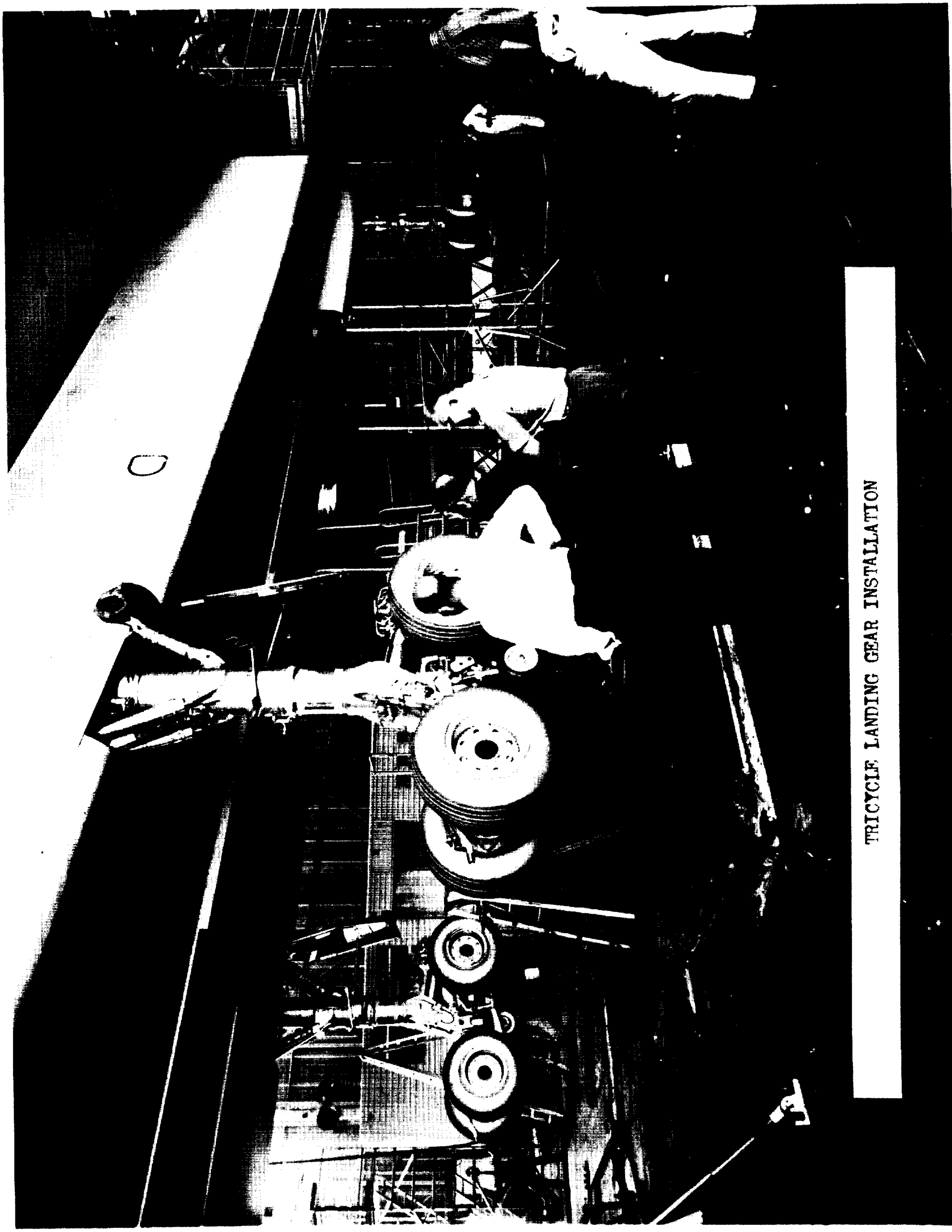
As shown by previous exhibits, the bogie beam was attached to the bottom of the main gear shock strut and provided axles on which the four wheels were mounted in a dual tandem configuration. The bogie beam also incorporated provisions for the brake control sensing "fifth wheel." Exhibit 6, page IV-382 , presents a bogie beam in the build-up stage while Exhibit 7 page IV-383 , and Exhibit 8, page IV-384, show the bogie beam with the wheel assemblies installed. The design of the bogie beam was such that sufficient motion was provided to permit flat tires or wheels on either axle to maintain contact with the runway. Each end of the bogie beam incorporated provisions for jacking up that gear with the air vehicle at maximum taxi weight. Provisions for towing and restraining were also incorporated and each bogie beam assembly had skid plates attached to the forward and aft underside to protect the beam from damage such as would occur due to blown tires.

Each main gear strut incorporated a hook to receive and lock the bogie beam roller at the completion of the bogie fold and rotate cycle. Exhibit 9, page IV-385 , presents a picture of the main gear being retracted showing the gear doors extended and the bogie folded and rotated. The hook was held in the locked position by a compression bungee to prevent unfolding of the beam during retraction. During extension of the gear, rotation of the bogie beam automatically disengaged the roller from the hook so that the bogie could be unfolded. The folding and unfolding of the bogie beam was accomplished by an actuator which also dampened landing roll pitch oscillations and provided partial compensations for moments due to braking torque.

The wheels, which were fabricated of steel, mounted silver painted 40 x 17.50-18 ply tires. Each pair of wheels were co-rotating and each wheel assembly contained provisions for tire inflation and deflation. A pressure gage, filler valve, and thermal release unit was attached to each wheel with a counterbalance weight containing a pressure relief valve attached to the opposite side of the wheel rim. The pressure gage had a dial range of 600 psi with markings for the allowable pressure range of 350 to 525 psi. The pressure relief devices incorporated in each wheel automatically bled off tire pressures that excluded a safety margin well below tire burst pressure. The 40 x 17.50-18 ply tires were extra-high pressure, Type III tubeless tires, inflated with gaseous nitrogen, and designed to withstand an environment of 360° F. The same tire was used for the main gear and nose gear installations.

The braking system consisted of the main power brakes, the braking control unit (computer), and the crew brake pedal assembly along with the fifth wheel, plumbing, sensors, valving and associated electrical controls. Each main landing gear assembly had full power brakes with steel heat sink type discs as shown by Exhibit 10, page IV-386. As indicated by the exhibit, one brake assembly was provided for each pair of co-rotating wheels. The full power braking system of the B-70 was a dual system including the pilot input device, electronic control unit, pressure control unit and sensing units.

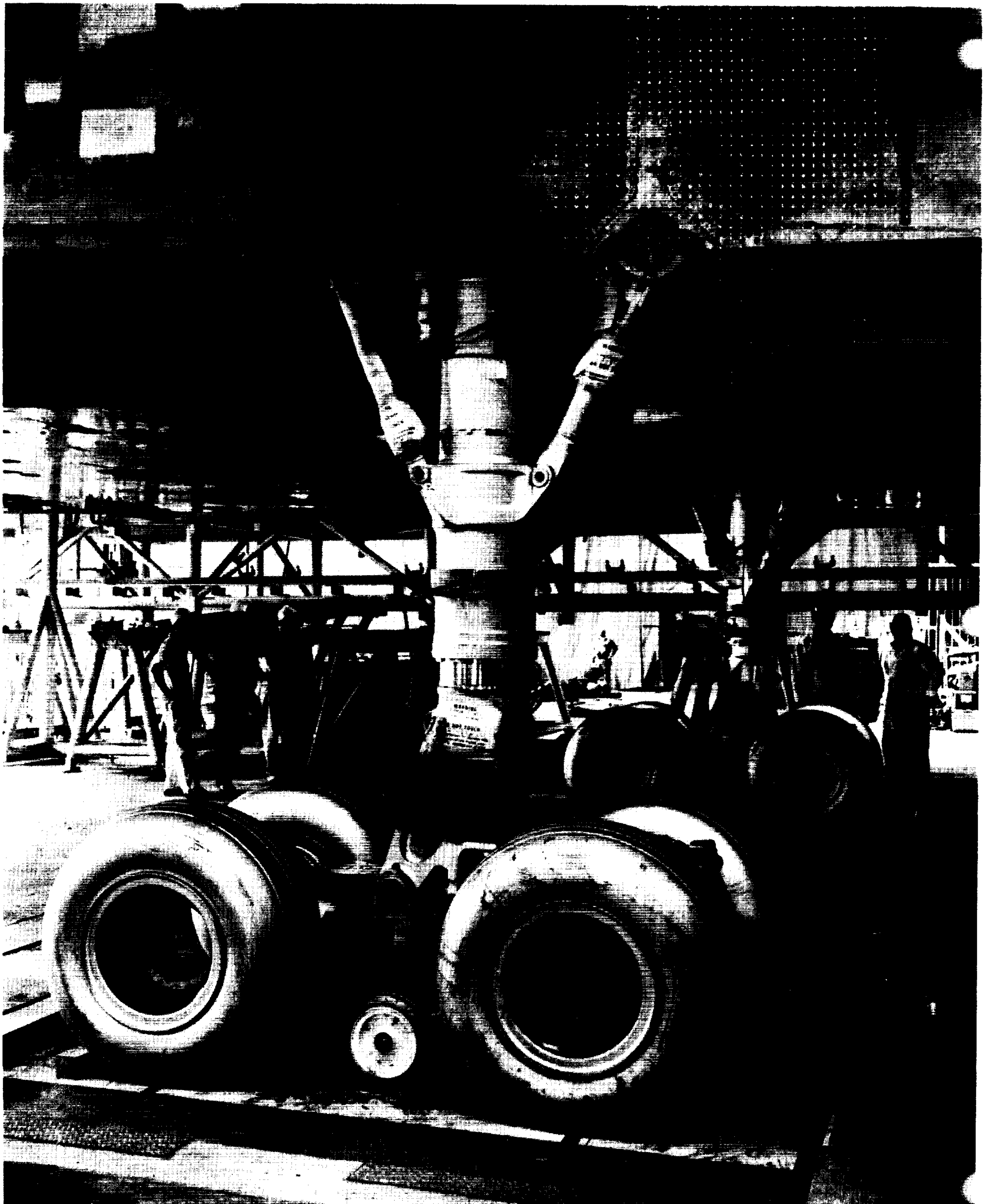
The concept of skid control governed the control function of the automatic brake system. The reference wheel, located between the two outboard main wheels on the landing gear bogie, provided a ground speed signal that was compared with brake wheel speed by the electronic control unit. The pilot's application of braking power on the foot pedals was sensed by brake torque sensors which was also provided as an input to the electronic control box. The control modulated the pilot input and brake torque output to prevent exceeding a value consistent with usable ground coefficients of braking. As a backup to the automatic system, a manual brake control was provided and was engaged by crew selection. In the manual mode, the pilot's application of braking power on the foot pedal provided an electrical input directly to the brake servo valves which resulted in braking torque being applied. In the manual mode, all automatic brake control features were bypassed requiring pilot technique to prevent tire skidding.



TRICYCLE LANDING GEAR INSTALLATION

EXHIBIT 3

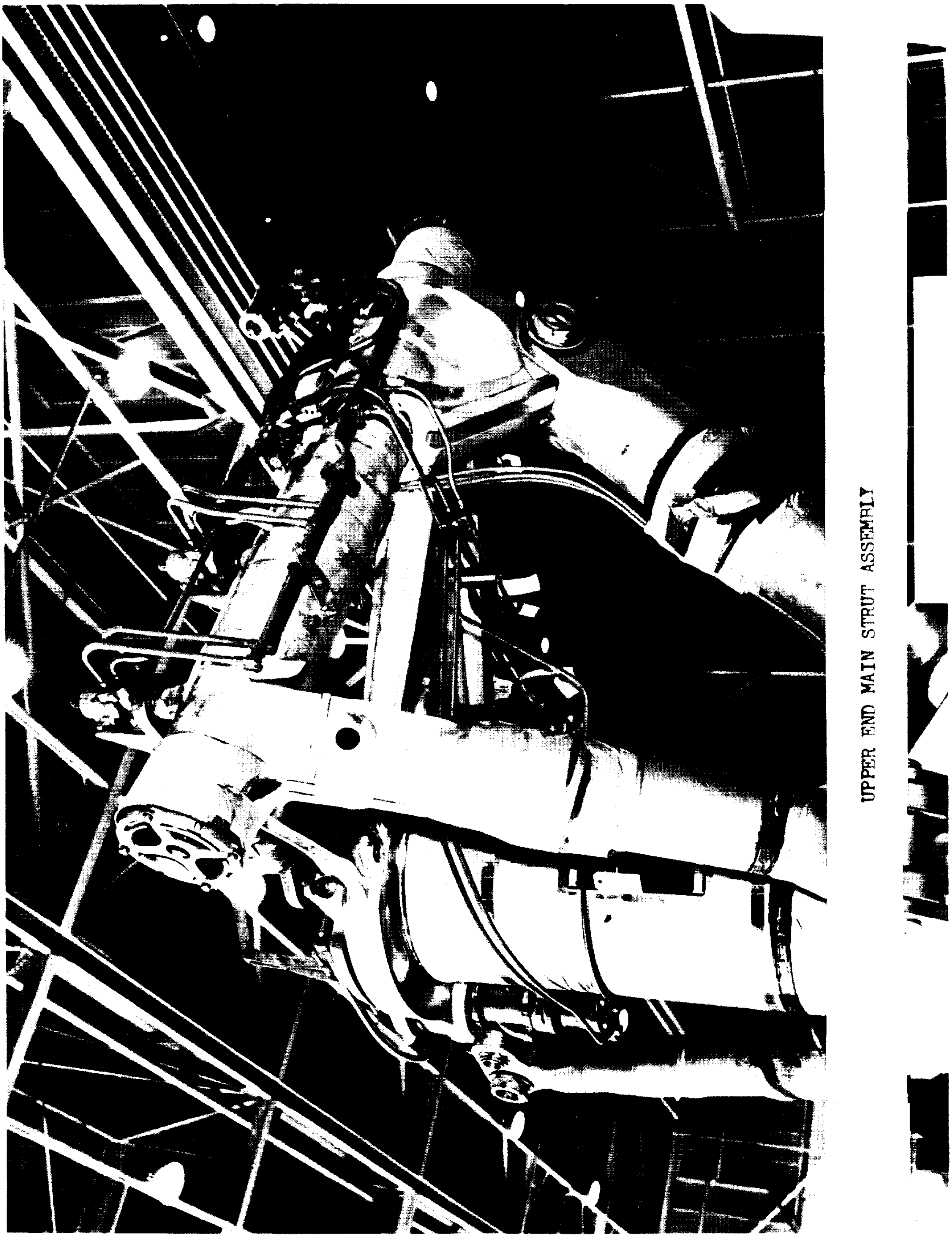
ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH



MAIN GEAR ASSEMBLY

EXHIBIT 4

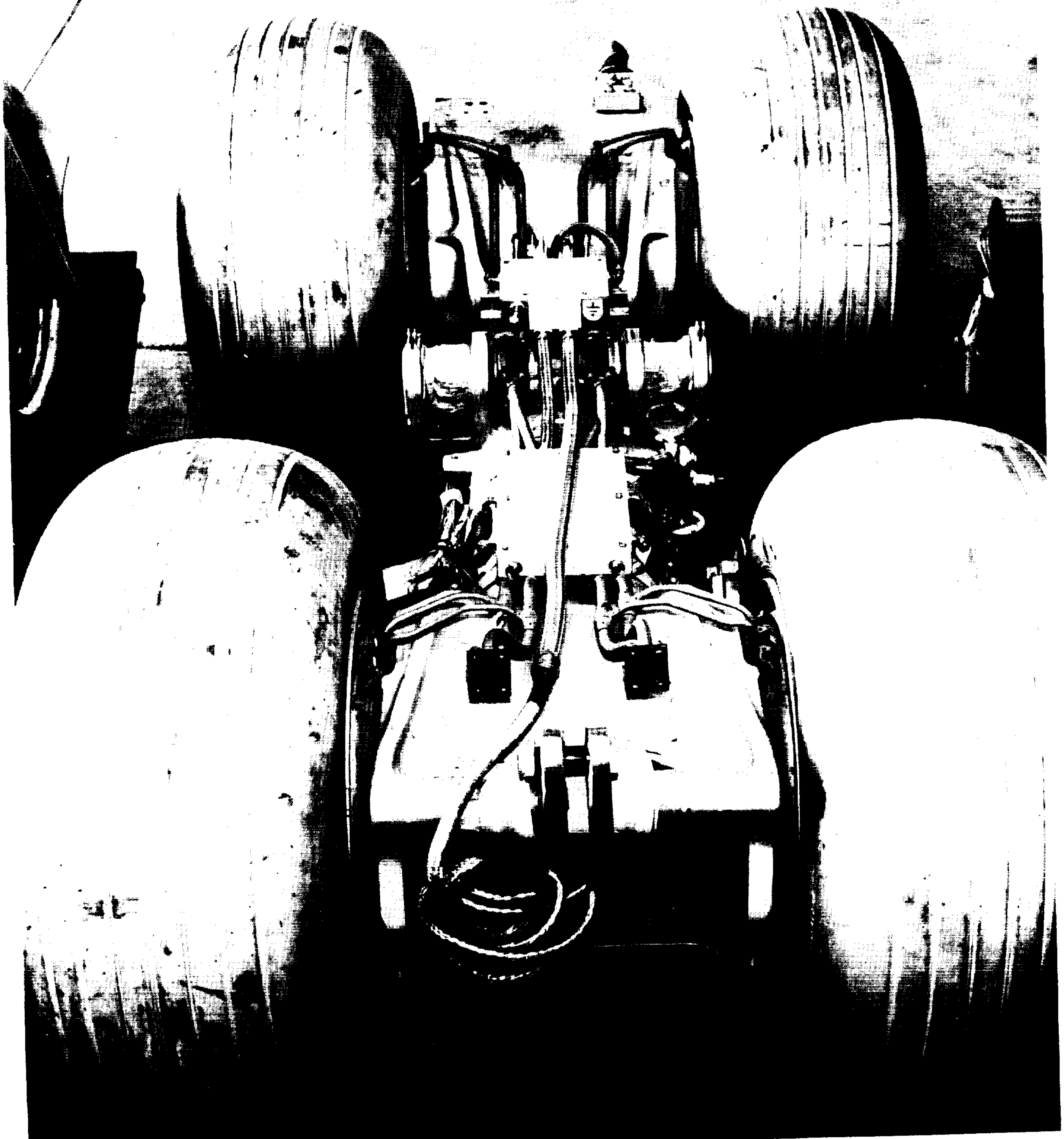
ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH



UPPER END MAIN STRUT ASSEMBLY

EXHIBIT 5

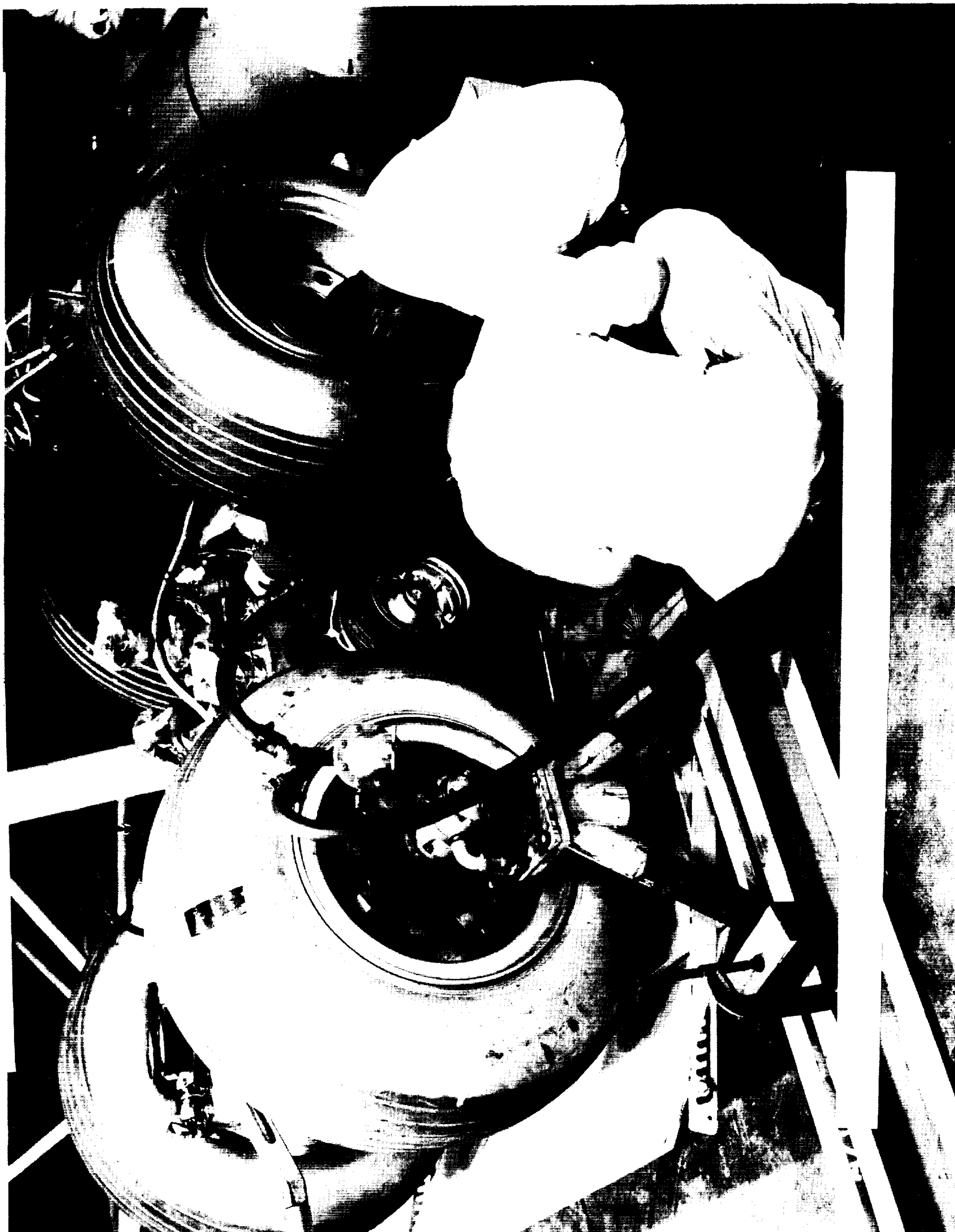
EXHIBIT 6

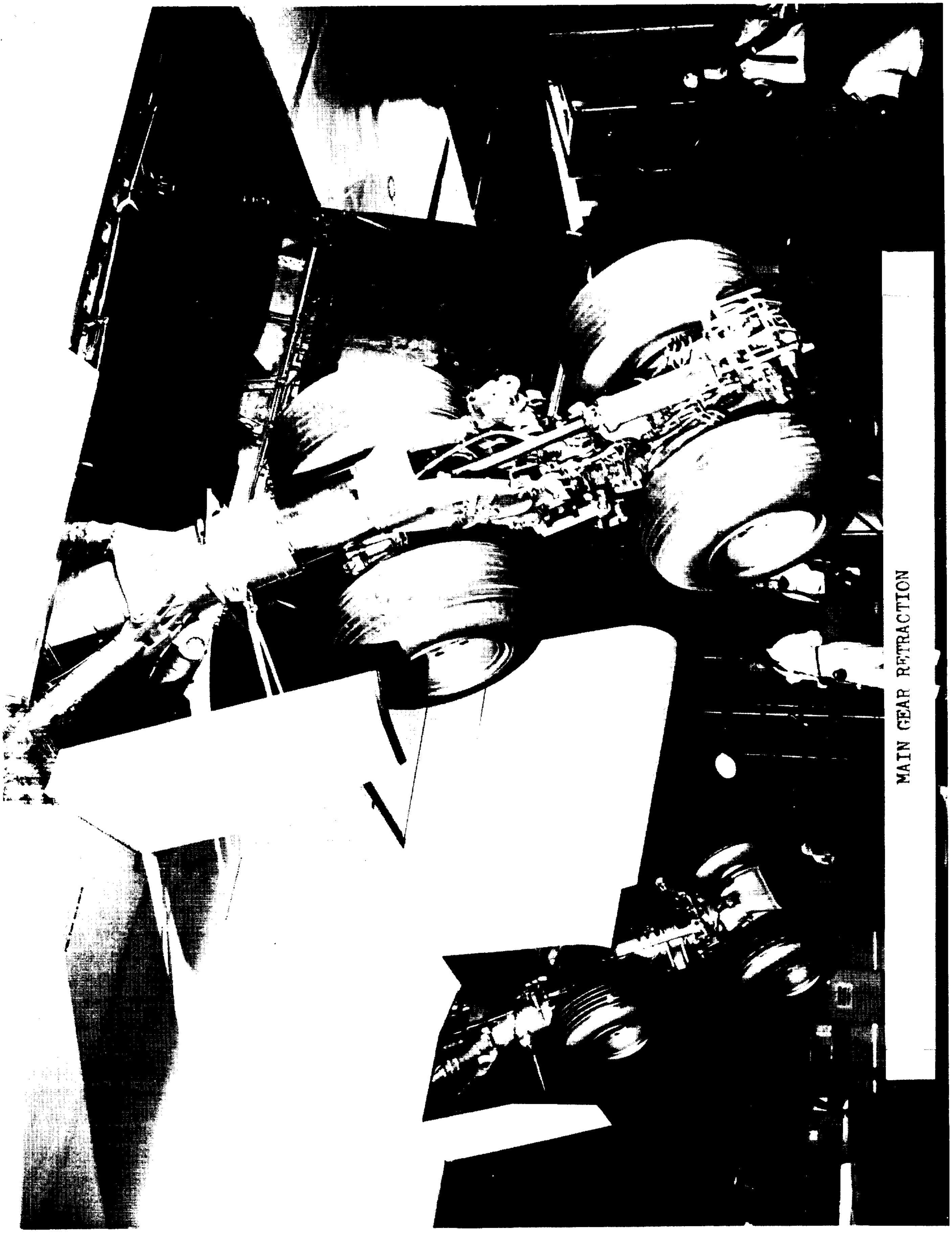


BOGIE BEAM AND WHEEL ASSEMBLY

EXHIBIT 7

BOGIE BEAM / WHEEL ASSEMBLY WITH 5TH WHEEL





MAIN GEAR RETRACTION

EXHIBIT 9

XB-70 BRAKE CONFIGURATIONS

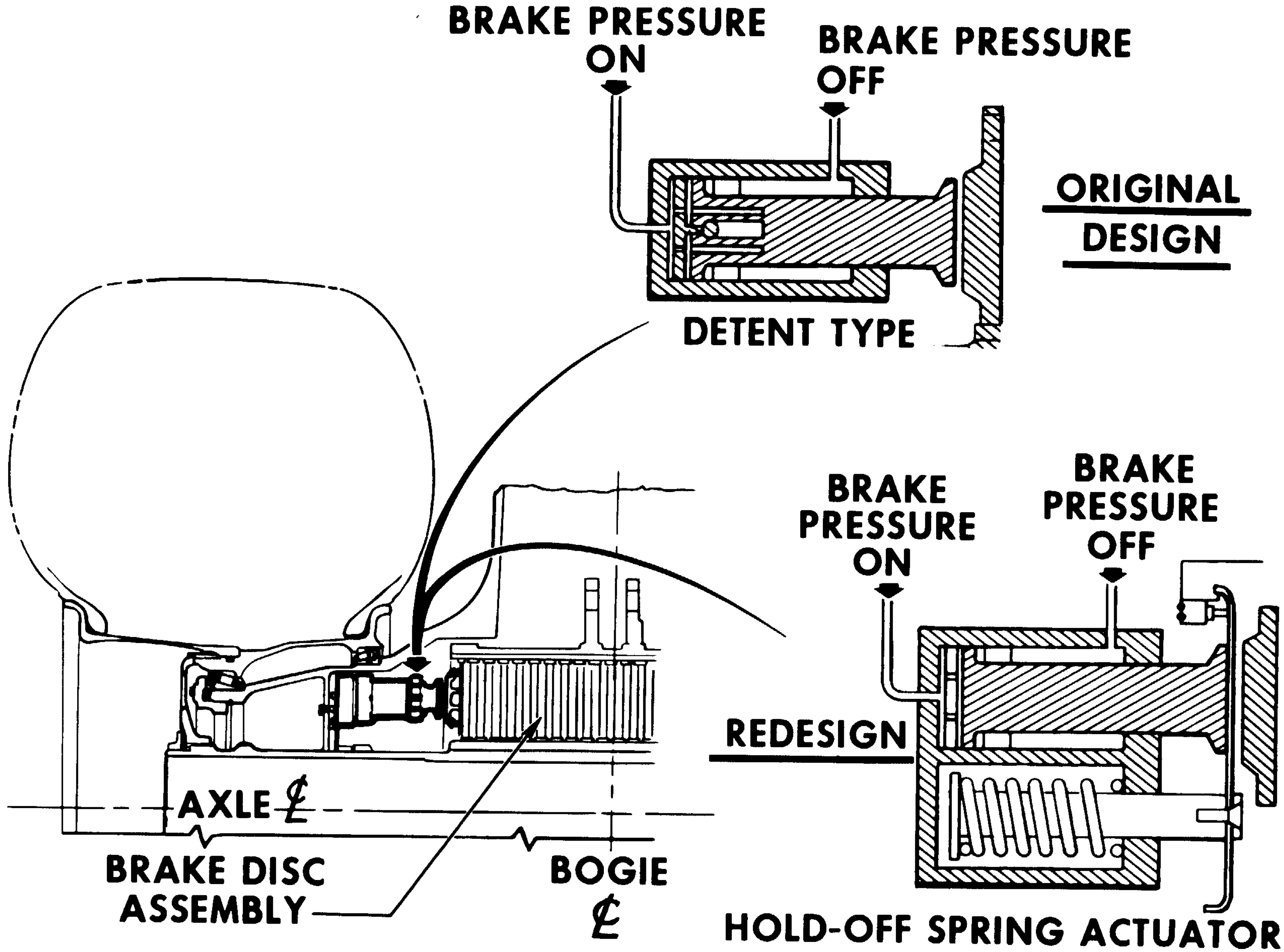


EXHIBIT 10

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: MAIN LANDING GEAR   WBS CODE: 1.8.1

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	POUNDS	13,049	NOT AVAILABLE		14,209	14,649
STATIC LOAD (MAXIMUM TAXI)	POUNDS	238,689	-	-	238,689	238,689
TIRES	TYPE/NO.	-	TYPE III, EHP TUBELESS/8 →			→
TIRE PRESSURE (MAXIMUM	PSI	320	320	320	320	425
THERMAL CYCLES (TIRES)	QUANTITY	9 @ 360°F FOR 4.5 HRS	-	9 @ 300°F FOR 3.3 HRS	→	→
TIRE SIZE	INCHES	40 x 17.5 x 18 →				→
WHEEL	TYPE/NO.	FORGED STEEL/8 →				→
WHEEL SIZE	INCHES	40 x 17.5 →				→
WHEEL ARRANGEMENT	SPECIFY	TWIN TANDEM →				→
BRAKES	TYPE/NO.	STEEL HEAT SINK/4 →				→
BRAKE DISCS	QUANTITY	-	20	20	20	20
BRAKE STATORS	"	-	21	21	21	21
BRAKE LINING	SPECIFY	-	-	Sintered Iron Composition		
BRAKE CAPACITY (MAXIMUM)	FEET/POUNDS	-	174 x 10^6	174 x 10^6	174 x 10^6	174 x 10^6
BRAKE CONTROL	SPECIFY	-	DUAL FULL POWER AUTOMATIC →			→
" CONTROL PARAMETERS	"	-	-	GROUND SPEED, WHEEL SPEED, TORQUE		
" " FREQ. RESPONSE	HERTZ	-	-	40	40	40
" ACTUATORS	TYPE/NO.	-	HYDRAULICALLY ACTUATED/12 →			→
" " FREQ. RESPONSE	HERTZ	-	-	20	20	20
" TORQUE SENSORS	TYPE	-	-	AC, FREQUENCY MODULATED →		→
BRAKE WHEEL SPEED SENSORS	TYPE	-	-	AC, FREQUENCY MODULATED →		→
" REF. WHEEL SPEED SENSOR	TYPE	-	-	"	"	→
WHEEL SPEED SENSOR FREQ. RESPONSE	HERTZ	-	-	40	40	40

C-5

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: MAIN LANDING GEAR WBS CODE: 1.8.1

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
TORQUE SENSOR FREQ. RESPONSE	HERTZ	-	-	40	40	40
TORQUE SENSOR HYSTERESIS	% FS	-	-	1	1	1
REFERENCE WHEEL SIZE	INCHES	-	-	14 x 4.5		
REFERENCE WHEEL TIRE SIZE	INCHES	-	-	14 x 4.5 x 8 (TUBELESS)	→	→
TEMPERATURE (DESIGN RANGE)	DEGREES F	450	450	450	450	450
BOGIE BEAM STRUCTURE	TYPE	-	H-11 STEEL FORGING: MECHANICAL	→	→	→
BOGIE ROTATE ACTUATOR	TYPE/NO.	-	HYDRAULIC CYLINDER/2 PER GEAR	→	→	→
" " " SEALS	TYPE	-	-	METAL	METAL	METAL
" " " PRESSURE	PSI	4,000	4,000	4,000	4,000	4,000
BOGIE FOLD AND PITCH ACTUATOR	TYPE	HYDRAULIC CYLINDER	→	→	→	→
BOGIE ROTATE TRAVEL	DEGREES	-	79.67	79.67	79.67	79.67
BOGIE FOLD TRAVEL	DEGREES	-	98	98	98	98
MAIN GEAR SHOCK STRUT	TYPE	AIR OIL	→	→	→	→
SHOCK STRUT TRAVEL	INCHES	-	13.75	13.75	13.75	13.75
SHOCK STRUT PRESSURE (MAX)	PSI	-	1800	1800	1800	1800
SHOCK STRUT SEALS	TYPE/NO.	-	"U" CAP: (1) STATIC, (1) DYNAMIC			
SHOCK STRUT ACTUATOR	TYPE/NO.	(1) HYDRAULIC CYLINDER FOR RETRACTION & EXTENSION				
SHOCK STRUT ACTUATOR SEALS	TYPE	-	METAL	METAL	METAL	METAL
MAIN GEAR DOOR ACTUATORS	TYPE/NO.	HYDRAULIC, 2 PER GEAR	→	→	→	→
" " DOOR LOCKS	TYPE/NO.	HYDRAULIC, 1 PER GEAR	→	→	→	→
" " LOCKS	TYPE/NO.	HYDRAULIC, 1 PER YEAR	→	→	→	→

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: MAIN LANDING GEAR WBS CODE: 1.8.1

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
MAIN GEAR SEQUENCING	TYPE	-	ELECTRO-HYDRAULIC, MECHANICAL ⟵⟶			
RELIABILITY FACTOR	NONE	-	-	0.99989	0.99989	0.99989
MTBF	HOURS	-	0	16,129	16,129	16,129

TECHNICAL DESCRIPTION

SUBSYSTEM: ALIGHTING AND ARRESTING WBS CODE: 1.8

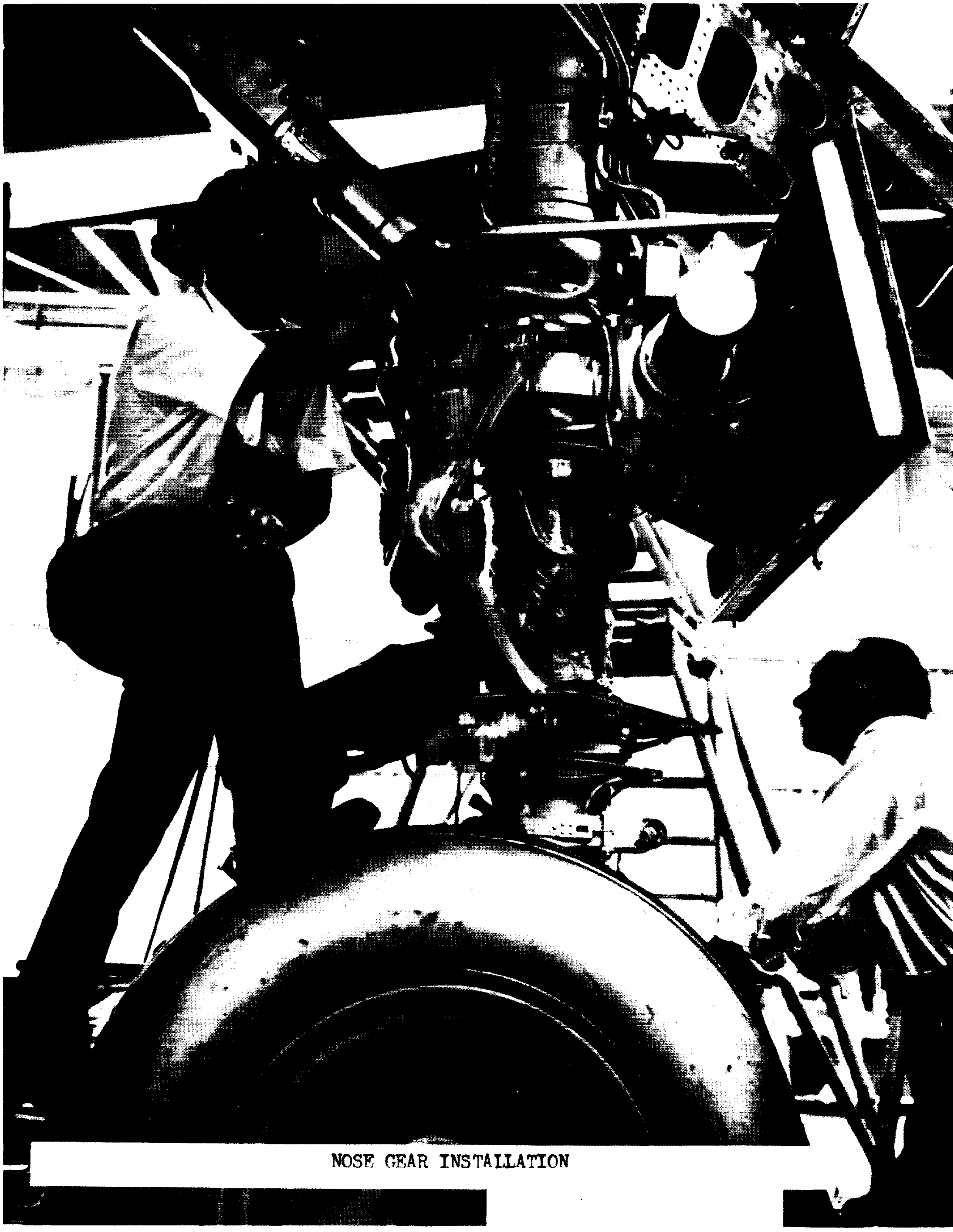
MAJOR ASSEMBLY: NOSE LANDING GEAR WBS CODE: 1.8.2

The nose landing gear assembly consisted of a shock strut, wheels, tires, and a steering unit mounted on the shock strut along with braces, actuators, doors, plumbing, valving and electrical control devices. Exhibit 11, page IV-391 , presents a view of the nose gear installation showing the nose gear actuator at upper right, the steering unit centered behind the small door, strut scissors in the foreground, and the two co-rotating wheels. The wheels, tires, pressure gage, and counterbalance installations of the nose gear were identical to the main landing gear installations.

The shock strut was a conventional air-oil shock absorbing type with the main structural elements fabricated of H-11 tool steel. Exhibit 12, page IV-392 , presents the nose gear strut in the build-up phase, while Exhibit 13, page IV-393, shows just the nose gear strut installed in the air vehicle. As indicated by the exhibits, the lower strut segment incorporated a member for mounting an axle for two co-rotating wheels. The strut was so designed that it automatically centered the wheels when the wheels were not in contact with the ground. The strut incorporated provisions for jacking up the nose gear at maximum air vehicle taxi weight. Provisions were also provided for towing the air vehicle and for mooring.

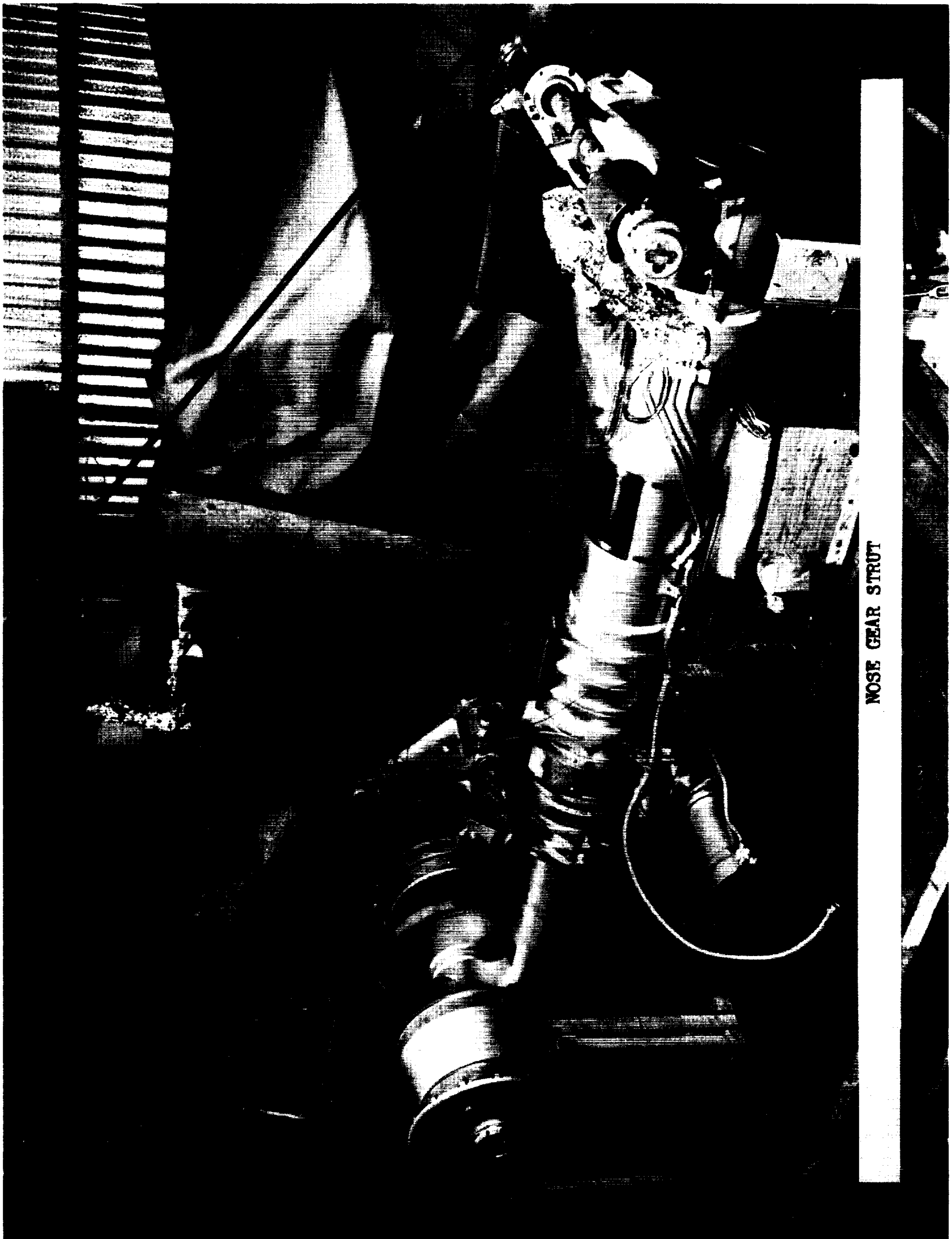
The nose wheel steering unit was hydraulically powered and was controlled electrically by the pilot's directional control foot pedals (rudder pedals). The B-70 nose wheel steering control system was engaged and disengaged by the selector switch on the landing gear control panel and was also automatically disengaged when the gear lifted off of the runway. The steering actuator had the authority to rotate the nose wheels 58 degrees each side of center.

A new concept in nose wheel steering control, consisting of complete fail-safety provisions, was incorporated in the B-70 steering control system. Previous systems were capable of detecting hard-over failures only after the failure occurred and were often "fooled" by a pilot's large abrupt inputs resulting in disengagement when control was critical. In contrast, the B-70 system was designed to detect the failure before a hard-over condition materialized. In addition, the electrical circuit was such that large abrupt pilot demands were not sensed as a failure. In aircraft the size and configuration of the B-70, where hard-over failures or lack of steering could result in severe damage or loss of the aircraft, the fail-safety protection offered by the nose wheel steering design was essential.



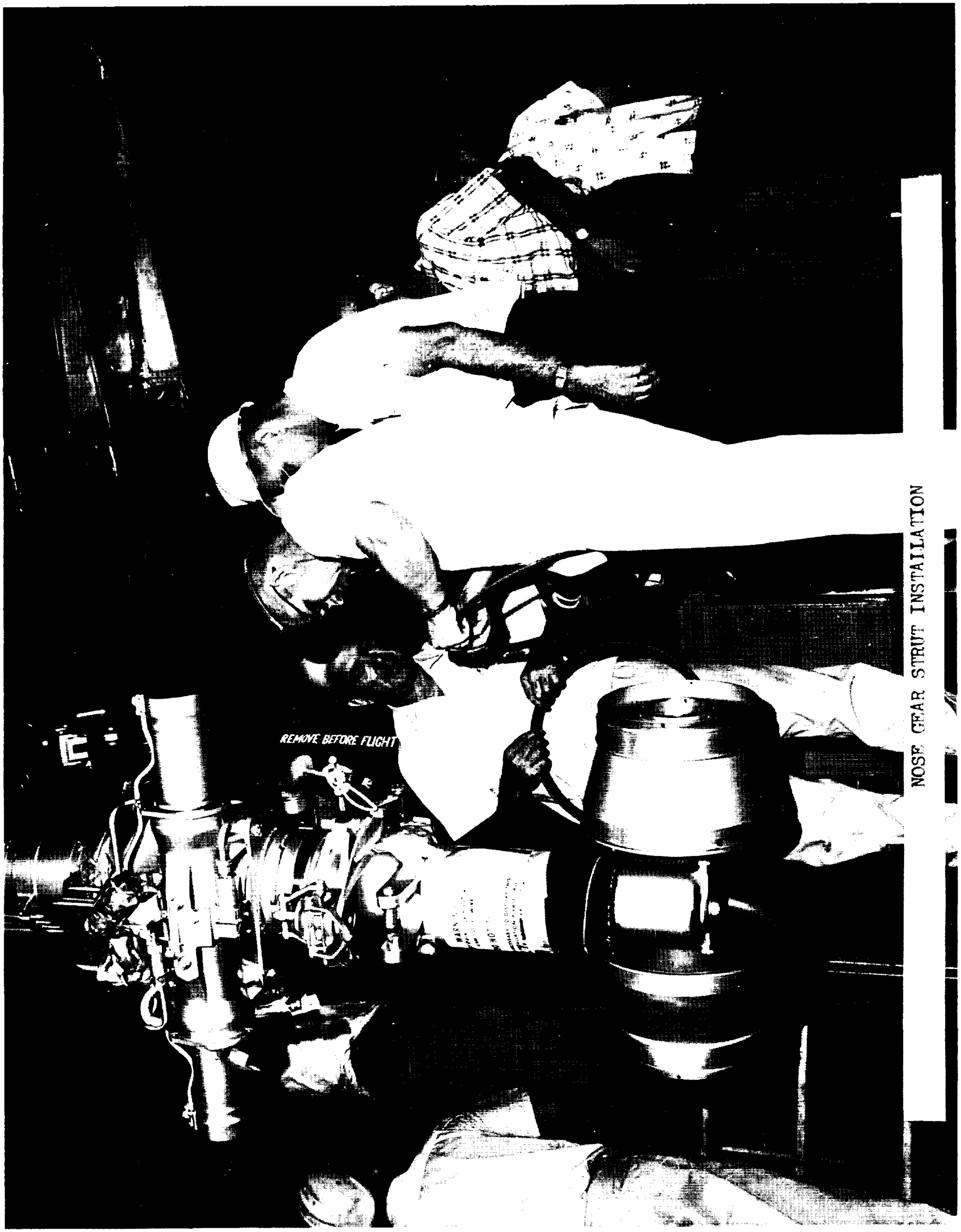
NOSE GEAR INSTALLATION

EXHIBIT 11



NOSE GEAR STRUT

EXHIBIT 12



NOSE GEAR STRUT INSTALLATION

EXHIBIT 13

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: NOSE GEAR WBS CODE: 1.8.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	LBS	1794	NOT AVAILABLE		1978	1988
STATIC LOAD (MAX)	LBS.	96,062 (@ MAX LANDING WT)	→	→	→	→
TIRES	TYPE/NO.	TYPE VIII E.H.P. TUBE-LESS/2	→	→	→	→
TIRE PRESSURE (MAX WT)	PSI	320	320	320	425	425
THERMAL CYCLES	NO.	9- @ 360 F FOR 4 ½ HRS EACH	←	←	9- @ 300F FOR 3.3 HRS EACH	→
TIRE SIZE	INCHES	40 x 17.5 x 18 (38 PLY RATING) TUBE-LESS	→	→	→	→
WHEEL	TYPE	FORGED STEEL	→	→	→	→
WHEEL SIZE	INCHES	40 x 17.5-18 RIM DIAMETER	→	→	→	→
SHOCK STRUT	TYPE	AIR/OIL	→	→	→	→
SHOCK STRUT TRAVEL (MAX)	INCHES	14.25	→	→	→	→

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: NOSE GEAR WBS CODE: 1.8.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
SHOCK STRUT PRESSURE @ MAX WT.	PSI	1900	→	→	→	→
SHOCK STRUT SEALS	TYPE	1 - STATIC 1 - DYNAMIC (BOTH U CAP TYPE)	→	→	→	→
STRUT ACTUATORS	TYPE	HYDRAULIC CYLINDER	→	→	→	→
STRUT ACTUATOR SEALS	TYPE	METAL	→	→	→	→
NOSE GEAR STEERING	TYPE	HYDRAULIC	→	→	→	→
NOSE GEAR STEERING ACTUATOR	TYPE	HYDRAULIC CYLINDER WITH RACK AND PINION	→	→	→	→
STEERING POSITION INPUT TRANSDUCER	TYPE	VARIABLE ELECTRICAL RESISTANCE	→	→	→	→
STEERING POSITION OUTPUT TRANSDUCER	TYPE	VARIABLE ELECTRICAL RESISTANCE	→	→	→	→
STEERING SYSTEM FREQUENCY RESPONSE	HERTZ	20	→	→	→	→

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: NOSE GEAR WBS CODE: 1.8.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
STEERING SYSTEM HYSTERESIS	PERCENT OF F.S.	1	→	→	→	→
STEERING SYSTEM TRAVEL	DEGREES	± 58	→	→	→	→
TEMPERATURE (DESIGN RANGE)	DEGREES F	550 - STRUCTURAL 450 - HYDRAULIC	→	→	→	→
NOSE GEAR STRUCTURE	TYPE	SEMI-CANTI-LEVERED	→	→	→	→
RELIABILITY	DNA	0.999978	→	→	→	→
MTBF	HOURS	80,000	→	→	→	→

TECHNICAL DESCRIPTION

SUBSYSTEM: ALIGHTING AND ARRESTING WBS CODE: 1.8

MAJOR ASSEMBLY: DRAG CHUTE SYSTEM WBS CODE: 1.8.3

As previously stated, the drag chute system was installed in the upper aft fuselage and consisted of three 28 foot diameter ring slot chutes and associated risers with each chute packed in individual deployment bags. Attached to each main chute was a pilot chute and an extraction chute to provide the extraction force. The individual main risers of each main chute assembly were individually attached to a trunnion assembly which also functioned as the drag chute release mechanism. Exhibit 14, page IV-398, presents the drag chute compartment (looking forward) with the compartment doors open and the trunnion assembly installed. Exhibit 15, page IV-399, presents the trunnion assembly which was attached to the air vehicle structure and functioned as both the main chute restraint and chute release mechanism.

Exhibit 16, page IV-400, shows the drag chute assembly at its initial installation phase with the chute supported over the compartment and the chute attach hook initially engaged in the trunnion. In Exhibit 17, page IV-401 , the chute attach hook is being rotated forward to its stowed position. For drag chute deployment the hooks of the trunnion, shown engaged to the chute hook assembly, rotate aft to provide solid attachment. Exhibit 18, page IV-402, shows the chutes installed with the pilot chute lanyard attached to the compartment right hand door. As indicated by the exhibit, if the doors were inadvertently opened in flight, the chute hook assembly would slip out of the trunnion hooks and the chutes would be automatically jettisoned.

DRAG CHUTE COMPARTMENT

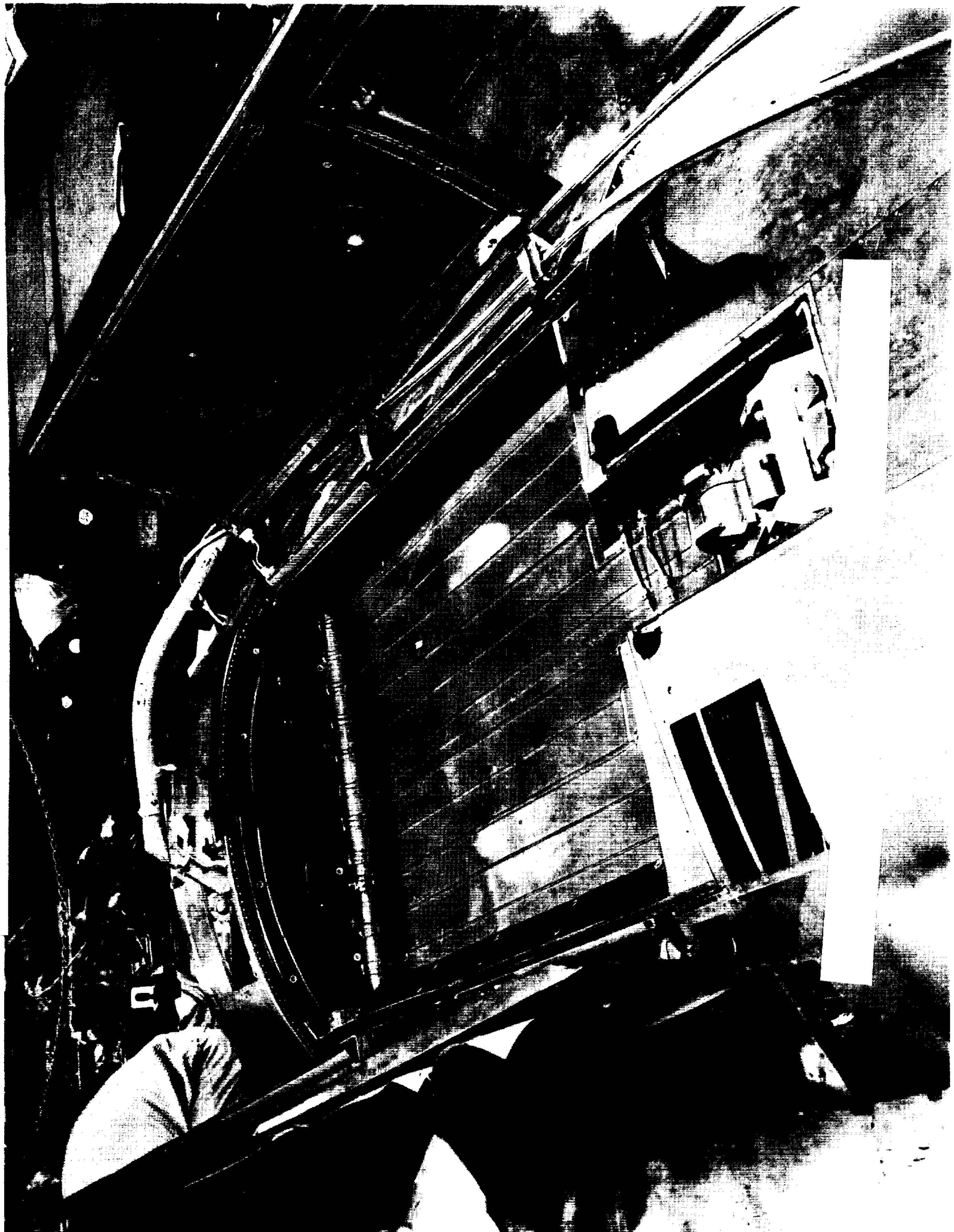
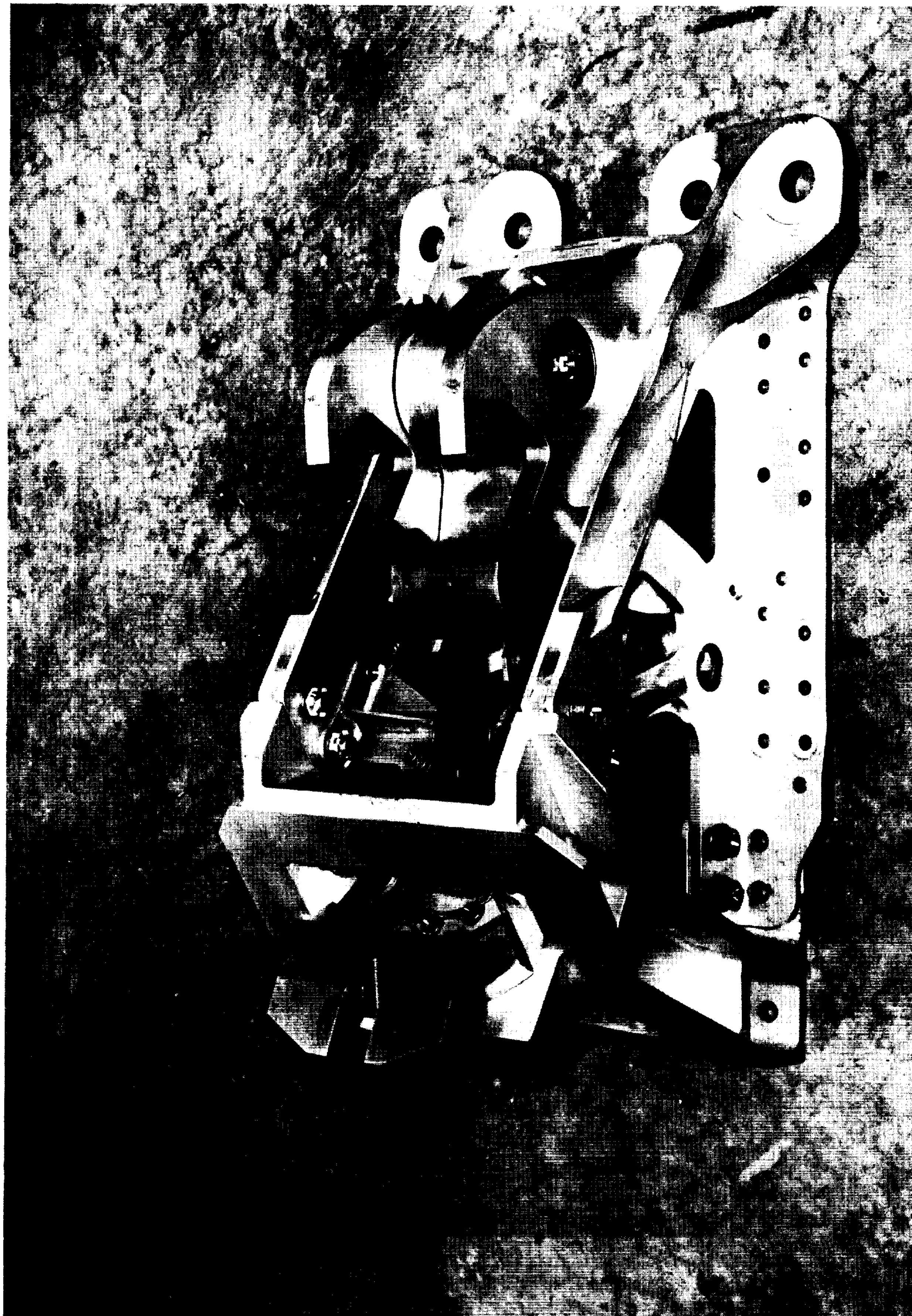


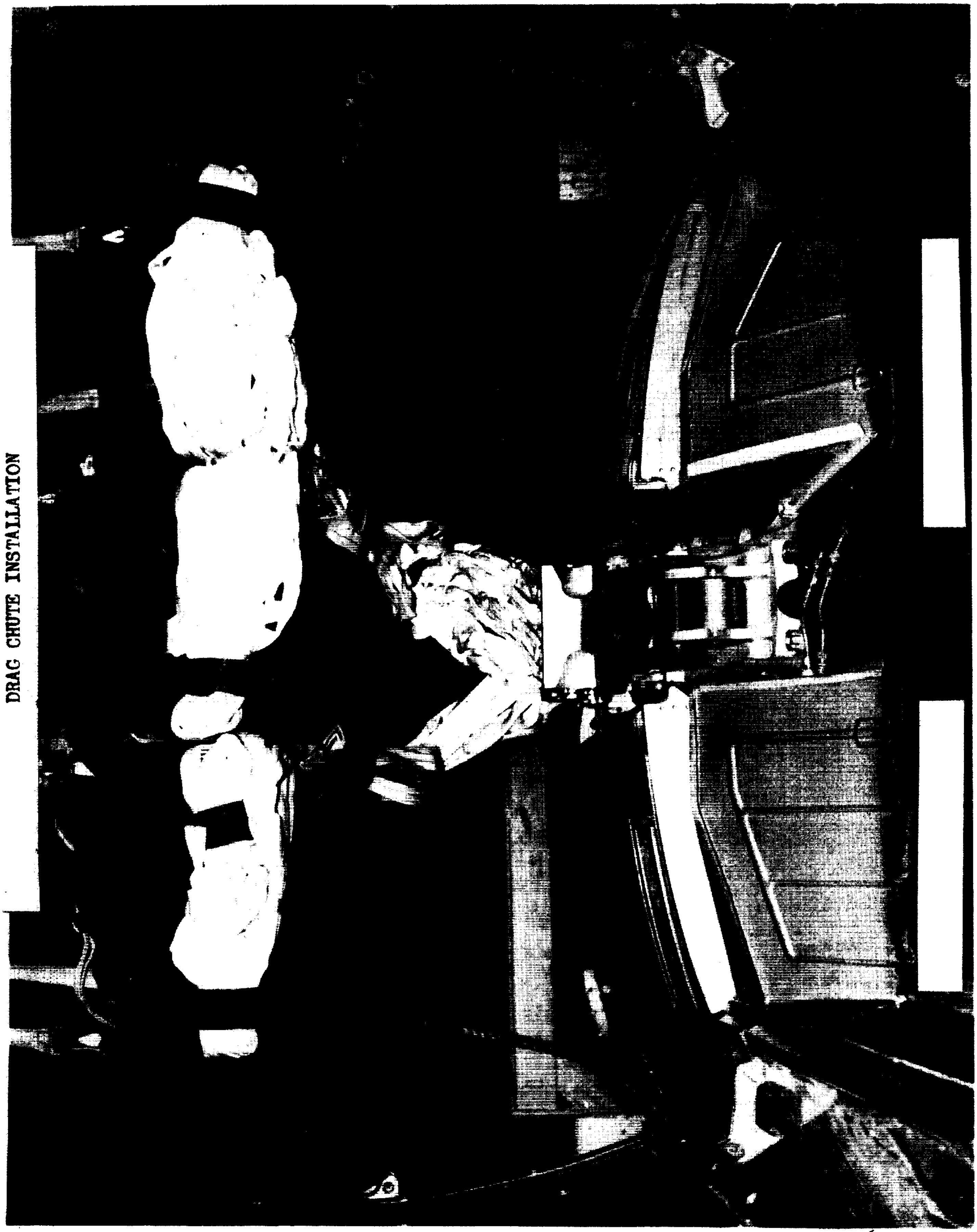
EXHIBIT 14

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH



DRAG CHUTE ATTACH AND RELEASE MECHANISM

EXHIBIT 15

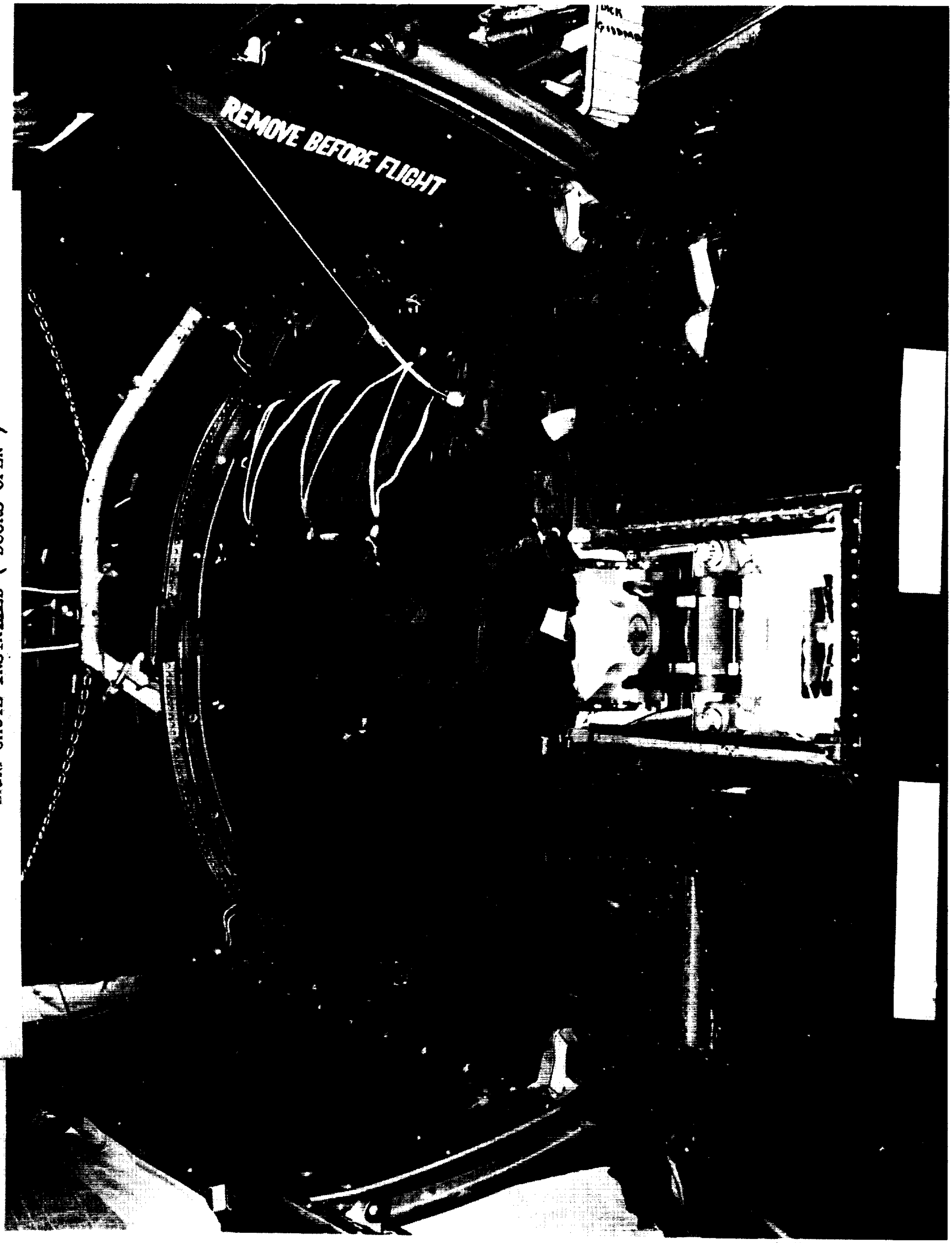


DRAG CHUTE INSTALLATION

EXHIBIT 16

DRAG CHUTE INSTALLATION

EXHIBIT 17



DRAG CHUTE INSTALLED (DOORS OPEN)

EXHIBIT 18

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: DRAG CHUTE SUBSYSTEM WBS CODE: 1.8.3

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	LBS.	460	NOT AVAILABLE	NOT AVAILABLE	516	512
DRAG CHUTES	TYPE/NO	28 FT DIA RING SLOT 3	→	→	→	→
DRAG CHUTE DEPLOY (MAX SPEED)	KIAS	220	→	→	→	→
DRAG CHUTE DEPLOY (MIN SPEED)	KIAS	100	→	→	→	→
DRAG LOAD (MAX DESIGN)	LBS.	166,000	→	→	→	→
COMPARTMENT DOOR (ACTUATION)	TYPE	HYDRAULIC	→	→	→	→

TECHNICAL DESCRIPTION

SUBSYSTEM: ALIGHTING AND ARRESTING — WBS CODE: 1.8

MAJOR ASSEMBLY: CONTROLS AND DISPLAYS — WBS CODE: 1.8.4

The Alighting and Arresting Subsystem Controls and Displays were essentially grouped into four areas: (1) the extension and retraction of the landing gear, (2) the control of the braking system, (3) nose wheel steering control, and (4) drag chute operation. Exhibit 19, page IV-407, depicts the landing gear control panel which was located on the main instrument panel in the lower center section and convenient to both the pilot and copilot. This panel included the landing gear control handle, emergency switch, position indicators and the audible warning cutout switch. As shown, the control handle was a plastic knob in the shape of a tire and was moved up for retraction and down for extension of the landing gear. The emergency gear extension switch was provided to override the normal electrically controlled hydraulic system sequencing and provide gear extension using the hydromechanical sequencing which always worked in parallel with the electrical system. The landing indicating system consisted of one green light for each retractable landing gear assembly and one red light in the plastic knob of the landing gear control handle. The red light illuminated when any gear was not in the position indicated by the position of the control handle, i.e., handle up but any gear not up and locked. The red light also remained illuminated if any gear door was not up-and-locked with the gear control handle either up or down. The audible warning signal assembly was installed at the pilot's station and the signal was audible in both headsets. The signal was initiated when the landing gear was in any position other than down-and-locked and (1) the air vehicle was below a predetermined altitude and airspeed and (2) the engine throttles were not in the afterburner position. The pilot-operated cutout switch on the panel permitted the pilot to discontinue the audible signal.

An emergency manual control handle was provided on the overhead panel in the cockpit and in the electronics bay. Either handle could be used to extend the landing gear by either hydraulic utility system No. 1 or No. 2 without changing electrical sequencing. This provided (combinations of manual handle and emergency switch) four methods of extending the landing gear. In addition, since the nose gear had to be down and locked for any abnormal gear configured landing, an emergency nose gear manual control handle was provided on the cockpit overhead panel. This handle could be used to extend the nose gear through a system separately supplied by the hydraulic replenishing reservoir system without electrical sequencing. Manual switches were also provided in the electronics equipment bay to override the normal main and nose gear "door open" function limit switches and the utility No. 1 bogie power valve. This system was for the condition of doors not opening for gear extension, and it provided another backup to get the doors opened with subsequent hydromechanical sequencing.

WBS CODE: 1.8.4

A second landing gear control panel was located on the left side of the center aisle pedestal and provided the following functions.

(1) Manual and automatic brake selector switch for pilot selection of braking control mode.

(2) Nose gear steering control selector switch with positions for take-off and landing, taxi, and off (In the take-off and landing position, the steering was armed but not engaged).

(3) A brake system test switch to test for dual hydraulic pressure and computer "on-line".

(4) A brake hold pushbutton switch for extended non-taxi conditions. The hold function was disengaged by depressing the brake pedals.

(5) A nose gear steering engage switch for engaging the steering control when selector was other than off (item 2).

(6) A second brake selector switch which permitted the selection of either the front or rear brakes only.

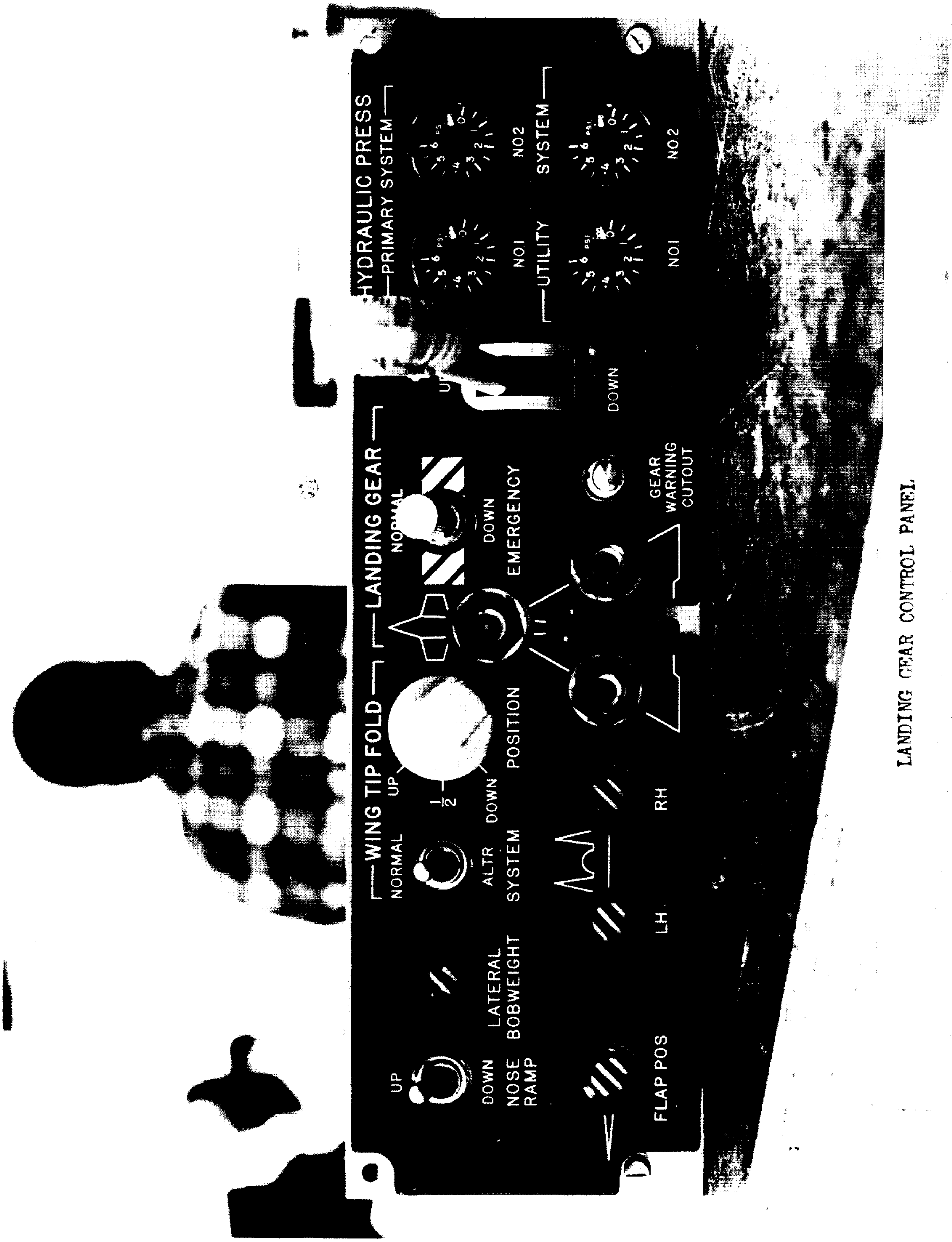
(7) A brake control caution light which indicated a malfunction of the brake computer.

A "Tire Overheat" caution light was provided on the left upper surface of the center aisle pedestal caution light panel. The heart of this system was the heat sensors which were installed in all wheel wells and which made contact with the tire when the landing gear was retracted. When the tire temperature approached the high temperature limit, but below the actuation of the thermal pressure relief devices installed on the wheels, the caution light illuminated. This alerted the pilot to initiate corrective action to prevent the actuation of the thermal pressure relief devices which would result in subsequent landing with low pressure or flat tires.

A drag chute control panel was located on the right aft section of the center aisle pedestal. The knob of the control handle was shaped like a chute canopy and was a two-position switch that was level locked in both positions. An aft movement of the handle electrically activated the hydraulic system to open the chute compartment doors and engage the hook mechanism with the drag chute trunnion assembly. A forward movement of the drag chute control handle electrically activated the hydraulic system to disengage the hook mechanism from the drag chute trunnion assembly. This allowed the drag chute assembly to disengage from the air vehicle. Jettisoning of the drag chutes had to be accomplished at a speed no slower than 60KIAS to ensure that the trunnion assembly would clear the aft fuselage.

WBS CODE: 1.8.4

A "Drag Chute Overheat" caution light was provided on the left upper surface of the center aisle pedestal caution light panel. A sensor was installed in the drag chute compartment to indicate the compartment temperature and had a setting of 255° F ± 5° F. If the caution light illuminated, it alerted the pilot that the landing might be without drag chutes.



LANDING GEAR CONTROL PANEL

TECHNICAL DRIVER

SUBSYSTEM: ALIGHTING AND ARRESTING WBS CODE: 1.8

DRIVER: LANDING GEAR SEQUENCE SWITCHES

The landing gear system required high temperature switches in the sequencing and indicating portions of both the main and nose gear assemblies. The airworthiness testing of the new developed switches was scheduled for completion by mid 1962. However, development problems were encountered which involved the bellows type seal that was designed to isolate the contact portion from the actuating elements of the switch. To minimize the impact of the schedule slippage, low temperature substitute switches were installed for initial system checkout.

An analysis of data obtained during development tests showed that the original bellows design was too stiff which resulted in unsatisfactory actuating loads and caused seal leakage. The bellows were redesigned by the subcontractor, new tests parts fabricated, and the testing of the switches continued. However, torque valves were still high, and case seal leakage was still experienced.

By the second quarter of 1963, it appeared that all major development problems had been solved; however, leakage from the static case seal was still being experienced in attempted airworthiness tests. In addition, the high torque valves that were accepted required that all switch installations be evaluated to determine if adequate return spring forces were available. This review showed that the main gear door opened, door locked, and door closed switch springs forces were marginal and required redesign to ensure satisfactory operation with the higher torque switches.

By mid 1963, the development effort by Controls Company of America had not produced a satisfactory hermetically sealed case. At this time, NR sent a special team to the subcontractor to initiate a development program of hermetically sealing the cases by welding which the subcontractor had attempted unsuccessfully. Due to these problems and schedule impacts, the 350° switches were authorized for the initial flights which would not exceed the limit temperature. In addition, a second substitute switch which had limited high temperature capability was purchased in sufficient quantities to support the higher mach flights and for spares. This switch had a 600° F rating but was limited to 25 flight hours which impacted landing gear maintenance during the first half of the flight test program.

TECHNICAL DRIVER

SUBSYSTEM: ALIGHTING AND ARRESTING WBS CODE: 1.8

MAJOR ASSEMBLY: MAIN LANDING GEAR: TIRES WBS CODE: 1.8.1

The basic requirements of the B-70 mission and air vehicle configuration dictated that tires be capable of supporting 62,500 lbs/tire while operating at ground speeds of 288 mph, exert surface loads and stresses compatible with existing SAC hangar floors and runways, and be capable of withstanding 4½ hours of high mach-high temperature environment. An industry study conducted showed that the B-52 tires were the most advanced product at that time; however, these tires fell way short of the B-70 requirements. As a result of this study, a tire development program was initiated with the final product representing a very significant advancement in the state-of-the-art of tires.

The space allotted for stowing the tire dictated that the tire be no larger than 40 inches in diameter and 17.5 inches wide. In addition, as a weight control measure, the cooling requirements of the tire, in its stowed position, had to be minimized. In this regard, a weight-cooling requirement trade-off study showed that a tire compartment environment such that the tire could be at 360° F for approximately 4½ hours would be compatible with the other environment loadings of the B-70. This temperature goal for the tires was very demanding, since this temperature was very close to the reversion and deterioration temperatures of the rubber and nylon materials, respectively, used in tires. The tire life for the B-70 was established as eight thermal cycles with a compatible tread life. (The wheel life for the B-70 was established as 1000 miles but was reduced to 800 miles for the XB-70 and was accepted with bearing life waivers after 500 miles was demonstrated.)

The initial problems encountered in the tire development was with Aeronautical Systems Division (ASD) facilities where the oven wheel rotation equipment subjected tires to temperatures up to 500° F. A complete redesign of the rotation equipment from a tire tread friction wheel to a wheel drive still exposed the test tires up to 400° F. However, these damaged tires were not completely lost, since a study of the sidewall and tread blisters was performed followed by a burst test after which a cord depth of strength loss analysis was conducted. Subsequent modification of the oven facilities provided temperatures that were satisfactory during tire testing.

The XB-70 tires essentially met all of the B-70 requirements, and when compared to the B-52 tire, they were 28% smaller in diameter and rotated 63% faster while carrying 83% more load per lb. of tire. They weighed 55% less and were exposed to stowage temperatures approximately 250% higher. The tires were 18 ply with a special cord-tread configuration including a "special" covered sidewall or outer layer that was built into the tire to reflect or repel heat.

TECHNICAL DRIVER

SUBSYSTEM: ALIGHTING AND ARRESTING WBS CODE: 1.8

MAJOR ASSEMBLY: MAIN LANDING GEAR AUTOMATIC BRAKE CONTROL WBS CODE: 1.8.1

GENERAL

A major advancement in the state-of-the-art was achieved in automatic braking control during the development of the B-70. The dual full power brake control system, which was hydraulically powered and electrically controlled, provided full automatic control upon pilot demand for maximum braking. The braking torque on each of the four brakes was individually and automatically controlled to provide maximum retarding force regardless of runway conditions. The control was provided by means of a four channel electronics computer in combination with sensing devices located on the main wheels and brakes, plus an additional "fifth" wheel located on each main gear bogie which sensed relative ground velocity of the main wheels. In this highly adaptive method of brake control, actual tire slippage and ground retarding forces were continuously computed and compared to determine the "peak" braking forces which could be tolerated by tire to runway coefficient of friction and this information fed electrically to the electro-hydraulic servo valves which controlled hydraulic pressure to the brakes. This braking system differred from previous "anti-skid" systems, which operated in an "On-Off" manner in response to tire skid, in that brake torque was continuously regulated to maintain operation at an optimum level as demanded by the pilot.

The ability of the B-70 system to provide the intended functions was demonstrated on the 192 inch dynamometer at ASD (Aeronautical Systems Division) utilizing actual air vehicle hardware. The development tests were concluded by demonstrating 50 consecutive max design landings under full automatic control without a single malfunction or skid. The data obtained during each stop showed deceleration rates exceeded specification requirements by a substantial margin.

The development of the braking system, in addition to the pilot control and computer, involved the selection of material for the linings within the wheel brake assemblies which incorporated steel heat sink type discs. The lining had to be compatible with the overall system, in that it not only had long wear characteristics, but that it provided the required coefficient of friction without "rough," "grabby," or "chattering" characteristics.

WBS CODE: 1.8.1

DISCUSSION

During the initial stages of brake tests, several "rough" brake operations were experienced which analysis showed to be caused by the brake lining coefficient of friction being too high. Based on this study, the lining coefficient of friction was reduced from 2.0 to 1.5. After this basic coefficient change for linings, tests continued on many types of lining material with final choice being either an iron-base lining or a copper-base lining. During these tests, two other problems became evident. One was a ripple in the angular rotation signal, and the other was the physical arrangement of the brake test setup.

Although the angular rotation signal output ripple represented a very small percentage (one percent) of the difference between the angular velocity signal of the driver and the driven elements of the sensor, it was sufficient to prevent normal automatic brake control. Detailed analysis disclosed that the ripple in the sensor signal was due to slight eccentricity between the axis of rotation of the driver and the driven elements caused by deflection of the axle under load. To correct the problem, it was decided to add a floating element between the driver and driven portions of the sensor which employed essentially a slotted pin drive to assure precise angular alignment of the two elements.

The problem with the brake test setup was the manner in which the "fifth" wheel was mounted. In the original dynamometer installation of the brake control system, the speed reference wheel was mounted on the dynamometer base structure rather than the bogie beam with the braked wheel. This installation, since flexing and vibration of the bogie beam and axle occurred during braking, caused a discrepancy between the speed sensed by the reference wheel and the actual speed of the braked wheel. The problem was corrected by mounting the fifth wheel to the bogie per the air vehicle configuration.

Signal "noises" were also encountered during the automatic brake control development. One was the excessive "noise" from the braked wheel speed sensor mechanism which was sufficient under some conditions that the "slope logic" circuit operation was compromised. The final fix for this was to desensitize the "slope logic" circuit below the desired optimum level, which in effect placed the major dependence for brake control on the slip control circuit at high speeds. Another problem experienced was brake "noise" due to vibrations set up by the relief slots in the brake discs at low taxi speeds (below 25 knots). This noise caused some loss of performance at the low speed conditions and required a reduction of feedback gain. This low taxi speed chatter was never completely resolved and occurred during the flight test program. In most instances, the "chatter" condition could be minimized by the pilot (if taxi conditions allowed) with intermittent-light application of brakes.

DEVELOPMENT DATA SUMMARY

WBS TITLE: **ALIGHTING AND ARRESTING SUBSYSTEM** WBS CODE: 1.8

STATE-OF-THE-ART RATING: 5 (See Remarks)

PERCENT DEVELOPED **MATRIX:**

	PRIOR TO FLIGHT		FLIGHT TEST
	CONFIGURATION	GROUND TEST	
PROGRAM LEVEL	95%	90%	32%
EFFORT TO GO	18%	29%	87%

GROUND TESTS

TYPE OF TEST	NUMBER OF UNITS	TEST HOURS
CONFIGURATION RESEARCH		
DESIGN FEASIBILITY		
DESIGN VERIFICATION		
AIRWORTHINESS		
QUALIFICATION		
OTHER		
TOTAL		

REMARKS:

(1) Essentially all alighting and arresting subsystem ground testing was performed by Cleveland Pneumatic Tool Company and their subtier subcontractors. The detail breakdown of the responsibilities are presented under major subcontractor data, page IV-428. The NR effort consisted mainly of installations, checkout, preflight and structural calibrations. The gear calibrations were included under structural ground testing (WBS: 1.1).

C 8.

WBS CODE: 1.8

State-of-the Art

The Alighting and Arresting Subsystem was assigned an overall state-of-the-art rating of 5 based on definitions established using AFSCM 173-1 (11-28-67) as a guide. This rating was determined by comparing the RS-70 requirements with the existing capabilities at the RS-70 time period using state-of-the-art criteria discussed in subsequent paragraphs. The RS-70 configuration was selected for the comparison since it was the production configuration defined. This selection is considered valid since the development status at "out-the-door" and at program "end" is also based on the scheduled production configuration.

The definitions used in determining the state-of-the-art ratings are described below. For ratings 3, 4, and 5, the following B-70 design criteria was used as an aid for rating selection.

A. High temperature application
B. High pressure/load/acoustics/etc., application
C. Light-weight/special materials/unique processes

Rating	Description
1	The item was off-the-shelf commercial item or a standard military issue which was installed "as-is".
2	The item was off-the-shelf commercial item or a standard military issue which required only a physical modification for installation.
3	The item was considered within the state-of-the-art but had no commercial or military counterpart. As an aid, the item was existing but required modification to be compatible with one of the design criteria. Also, any new design or process has a rating of at least 3.
4	The item was slightly beyond the state-of-the-art, and some development was required. As an aid, the item was based on an existing concept but required modification to be compatible with two of the design criteria. Also, any new design or process required to be compatible with one of the design criteria will be rated 4.
5	The item was substantially beyond the existing state-of-the-art and required major development work. As an aid, any new design or process required to be compatible with two of the design criteria will be rated 5.

WBS CODE: 1.8

The Alighting and Arresting Subsystem was comprised essentially of the landing gear system and the deceleration or drag chute system. In the analysis performed to establish a state-of-the-art rating, the drag chute system was not considered since it relatively represented only a fraction of the total effort required for the overall subsystem. The landing gear system development, described under Technical Descriptions with the special design areas defined under Technical Drivers, was considered a major advancement in the state-of-the-art for manned aircraft. Although the tricycle gear arrangement was an existing concept, the design of the gear system was required to meet all three of the B-70 design criteria: high temperature and acoustic environment, high pressures and structural loading, and light weight. To meet the B-70 design criteria, the gear, brakes and actuator mechanisms were fabricated of H-11 tool steel which imposed new manufacturing techniques and processes. The tires developed were also a major advancement in the state-of-the-art as related to temperature, loading versus size, and arrangement for low footprint loading. Based on the ground rules established, the subsystem was assigned a state-of-the-art rating of 5.

Percent Developed

The Alighting and Arresting Subsystem percent comparisons of the XB-70 configuration to that scheduled for the RS-70 were made at two stages of development; one at prior-to-flight or "out-the-door" of the No. 1 air vehicle, and the other for the flight test programs. For the "out-the-door" time period, a percentage was established for the configuration status and also for the level of ground testing achieved. The Alighting and Arresting Subsystem configuration of the XB-70 was assessed as 95% representative of its RS-70 counterpart while the ground testing status was assessed at a program confidence level of 90%. It was the opinion of the Design Group that additional testing was required in specific areas to reduce the maintenance requirements. In addition, the co-rotating wheels/bogie main gear arrangement required more design effort due to the undesirable single axle failure mode. To establish what effort would be required to attain a No. 1 air vehicle production level prior-to-flight status, the same curve used for the structures analysis was utilized for the Alighting and Arresting Subsystem; Exhibit 20, page IV-416. Entering this exhibit on the left-hand scale at 95% and 90%, it shows on the bottom scale that 18% and 29% more effort was required for the configuration and the ground testing, respectively.

The flight test program comparisons, presented by Exhibit 13, **page II-23**, under Air Vehicle (WBS: 1.0), shows that during the XB-70 flight test program, the Alighting and Arresting Subsystem had an equivalent test hour total equal to 19 percent of that scheduled for the RS-70. However, this was an across-the-board comparison of equivalent test hours and did not reflect the testing envelopes of the two flight test programs. Although design loads for the Alighting and Arresting Subsystem were attained during the XB-70 flight test program, maximum performance landings and aborted take-offs were not scheduled and did not occur. In addition, the effect on directional control and braking of wet and icy runways was not determined, as well as the impact of hydroplaning with excessive water. Based on program comparisons, the Alighting and Arresting Subsystem XB-70 Flight test program was assessed as being approximately 80 percent of the test envelope scheduled for the RS-70. Since all of the XB-70 effort occurred within this less demanding envelope, an adjustment had to be made to the test hours obtained before the two flight test programs could be compared. The same weight factor established for the Structures Subsystem (WBS: 1.1) was applied in the analysis of the Alighting and Arresting Subsystem flight test effort; that is, the first 80 percent of the test envelope requires only 60 percent of the total effort while the last 20 percent of the envelope requires 40 percent. Using this weight factor, the equation 2:3::X:19% was generated for the XB-70 test effort adjustment. With this equation, the flight test effort remaining to attain a production level status would be stated as 40% + 60% - (2 X 19 ÷ 3) or 87 percent, where the 40 percent is that effort required for the last 20 percent of the envelope. It should be noted that all of the comparisons conducted on the Alighting and Arresting Subsystem are based on test articles, tooling, GSE, etc., being at the RS-70 level in both numbers and fidelity. Exhibit 20, page IV-416, presents a graph of the comparisons made for the Alighting and Arresting Subsystem.

NOTE: THE USE OF THE "EFFORT TO GO" PERCENTAGES FOR COST DETERMINATION SHOULD NOT BE APPLIED WITHOUT CONSULTING SECTION IV-8, VOLUME I, PAGE 310 FOR APPLICATION CONSIDERATIONS.

ALIGHTING AND ARRESTING SUBSYSTEM DEVELOPMENT STATUS
PERCENT COMPARISONS BASED ON RS-70 (UNITY)

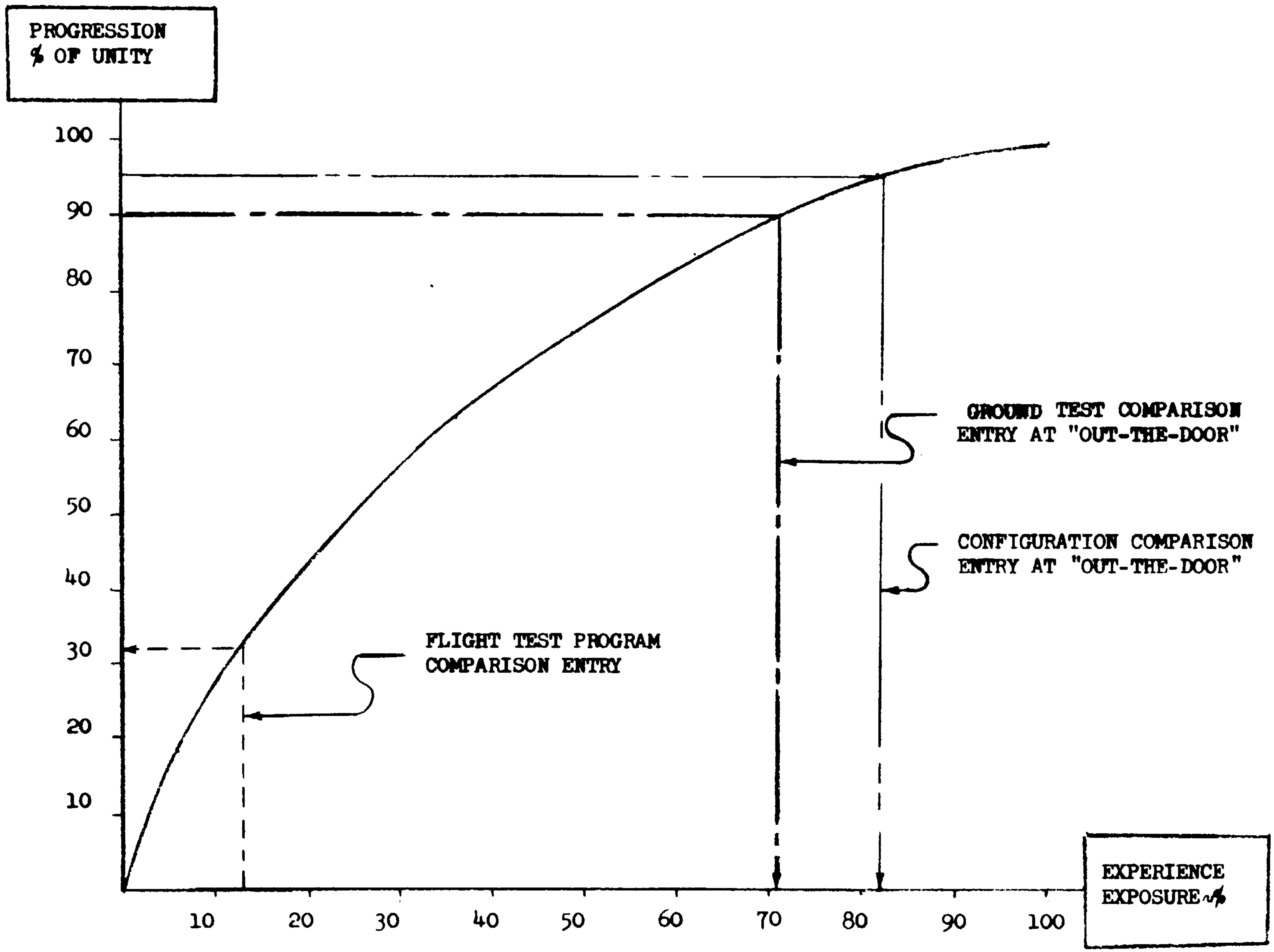
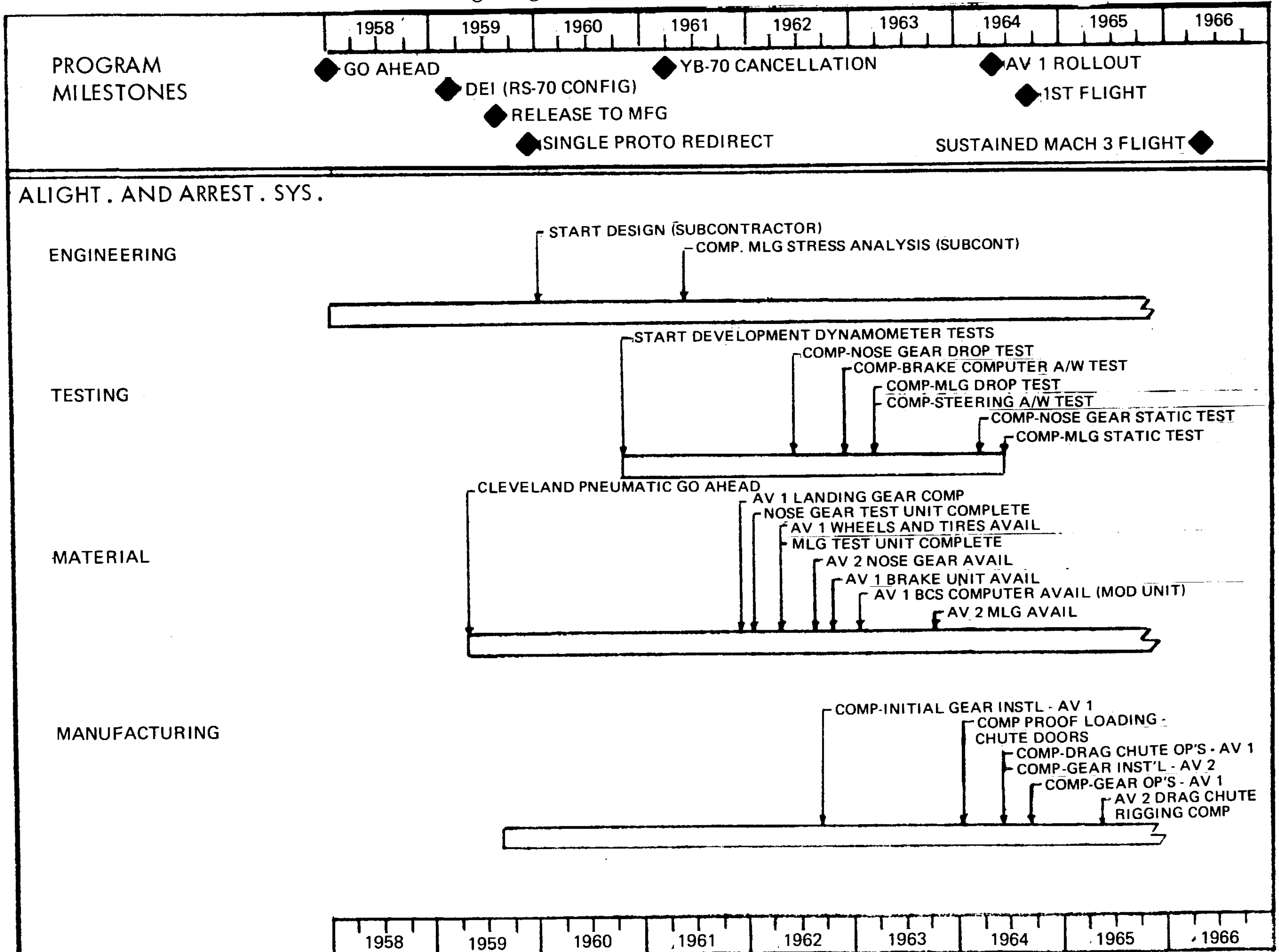


EXHIBIT 20

Development Summary
Alighting and Arresting Subsystem

WBS 1.8



DEVELOPMENT SUMMARY
TABULATION OF DATES

SUBSYSTEM: ALIGHTING & ARRESTING WBS CODE: 1.8

ENGINEERING:

Start Design - Subcontractor	Jan. 1,	1960
Comp MLG Stress Analysis - Subcontractor	May 19,	1961

Testing

Start Dev. Dynamometer Tests	Oct	21,	1960
Compl. Brake Computer A/W Test	Nov	21,	1962
Compl. MLG Drop Test	Mar	1,	1963
Compl. Fail Safe Steering A/W Test A/V #1	Mar	8,	1963
Compl. N.L.G. Phase I Proof Load Static Tests A/V #1	Mar		1964
Compl. L.H. Main Gear Door Static Proof Load Testing	Jun		1964

Material

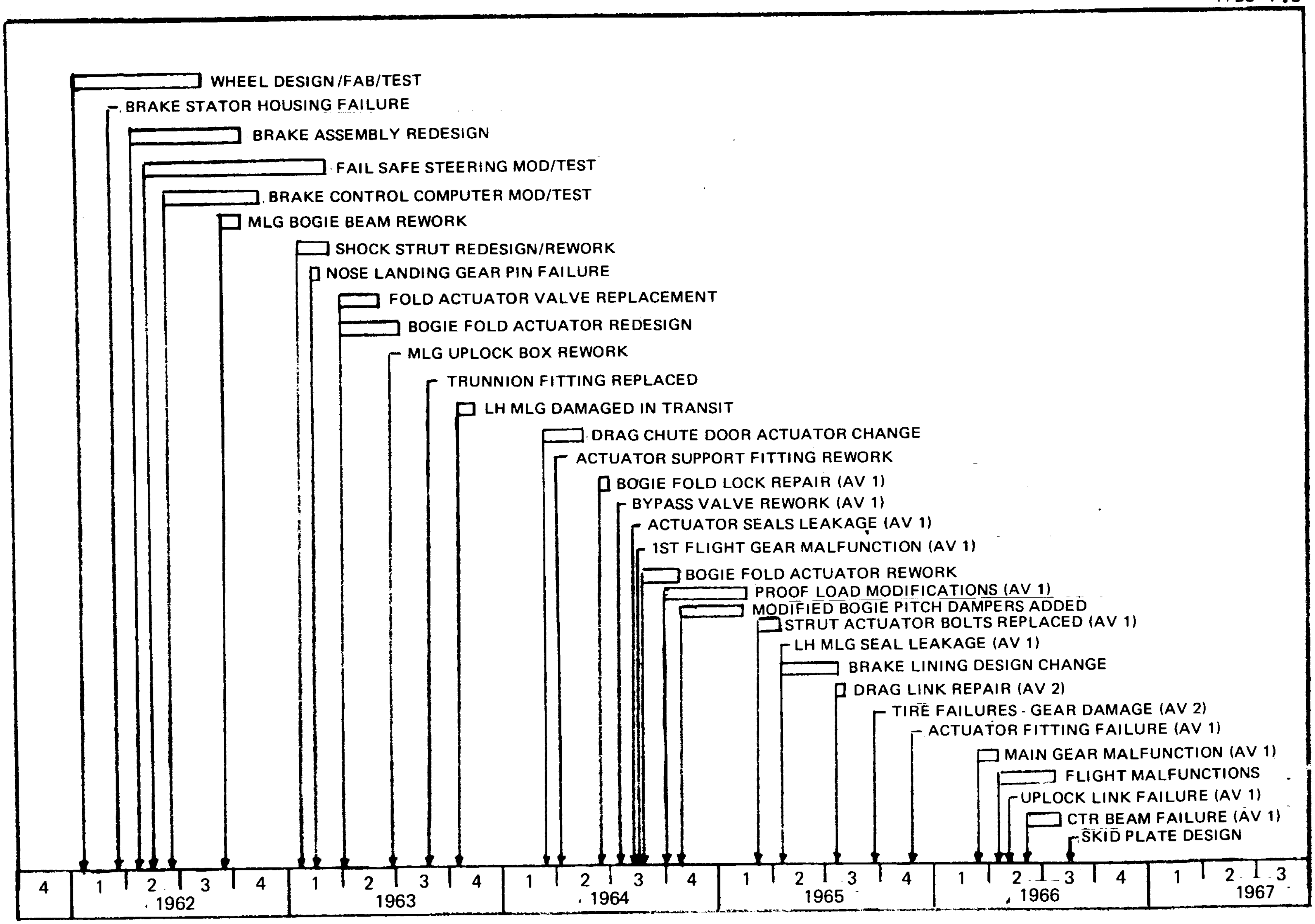
Cleveland Pneumatic Go-Ahead	Apr	10,	1959
Nose L.G. Complete on Dock A/V #1	Nov	27,	1961
MLG Complete on Dock A/V #1	Dec		1961
Complete Assembly, Nose Gear (Drop Test)	Jan		1962
Rec. Wheels & Tires A/V #1	Apr		1962
Compl. Assembly MLG L.H. (Drop Test)	Apr	10,	1962
Compl. Refurbish Drop Test Nose Gear & Receive for A/V #2	Aug		1962
Brake Unit on Dock A/V #1	Oct		1962
Modified BCS Computer A/V #1	Jan		1963
MLG Complete on Dock A/V #2	Oct		1963

Manufacturing

Complete - Initial Gear Installation (A/V #1)	Sep	15,	1962
Complete - Chute Doors Proof Loading	Jan		1964
Complete - Drag Chute Operations (A/V #1)	Jun	8,	1964
Complete - Gear Installation (A/V #2)	Jun		1964
Complete - Gear Operations (A/V #1)	Sep	18,	1964
Complete - Drag Chute Rigging (A/V #2)	May	14,	1965

Design/Programmatic Impacts
Alighting and Arresting Subsystem

WBS 1.8



DESIGN/PROGRAMMATIC IMPACTS

SUBSYSTEM: ALIGHTING & ARRESTING WBS CODE: 1.8

22 Jan - 14 Aug 1962	- Wheels and locknuts were being redesigned, fabricated and air worthiness tested.
March 1962	- Brake delivery delayed due to cracked lugs on brake stator housing. Immediate action was to weld lugs to stator. Concurrently with rework a backup program was implemented by the sub-contractor to procure closed die, integral lug, H 11 Stator housing forgings.
22 Apr - 26 Oct 62	- Brake assembly was redesigned and fabricated.
19 May 62 - 8 Mar 1963	- Fail safe steering was redesigned, fabricated and air worthiness tested.
15 June 62 - Nov 1962	- Brake control computer was redesigned, fabricated and airworthiness tested.
15 Sept - Oct 1962	- During the main landing gear fold and rotation tests, being conducted under hydraulic pressure, the bogie H 11 casting on the LH gear was cracked at the uplatch roller arm attachment point. Repair of the MLG bagie beam and rework of both hands of the lock arm was required and completed.
20 Jan - 8 March 1963	- Redesigned and reworked the shock strut to add ring groove and piston ring.
15 Feb - 1 March 1963	- Reworked nose landing gear due to failure experienced during airworthiness test, of the actuating cylinder attachment pin A/V #1.
1 April - 10 June 1963	- Due to relief valve malfunction, the LH bogie fold actuator for A/V #2 failed during acceptance tests. Consequently CPI was required to install new valves in A/V #1 actuators.
1 April - July 1963	- A failure occurred during rupture testing of the bogie fold actuator which required redesign and fabrication of the retainment nut and cap end. RH and LH bogie fold actuators, reworked to incorporate design changes, were received and installed in A/V #1.

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28 June - 5 July 1963	-	Rework of the main landing gear uplock box required due to negative stress margin (81%) due to a combination of gear retraction snubbing loads and wing bending loads.
30 Aug - 9 Sept 1963	-	Replaced one nose landing gear trunnion fitting on A/V #1 due to cracks and distortions that occurred after weld rework. Engineering simplified design to reduce machining.
18 Oct - 15 Nov 1963	-	The L H landing gear was damaged during railroad transit to NAA. Rail car bumping apparently caused wire tie downs to break allowing gear to shift. Tires were badly chaffed and declared unusable. Other components were also damaged. No structural damage to the main strut and bogie beam assembly.
13 March - 8 June 1964	-	Operational test on A/V #1 showed drag chute door operational speed so excessive that it could cause structural damage. Actuator change to decelerate action was accomplished on the Drag Chute and operations completed 8 June.
3 April - 10 April 1964	-	During cycling of A/V #1 RH main landing gear down lock H 11 support fitting failed due to cracks induced by weld beef up. The first reworked part was delivered to Engineering Structure Lab for destruction testing. During test one of the supporting components failed. Previously (6 April) B-70 Management decided to make one set of substitute parts of 4340 steel as a backup. On 9 April the fitting completed the 500 cycles of limit load followed by one ultimate load application without failure.
18 June - 2 July 1964	-	Due to erratic operations of the landing gear on A/V #1, the emergency landing gear 4 position valves required rework to reduce surge effort. Engineering was released on 18 June for valve rework. In addition new lines, restrictors and check valves were added to the hydraulic installation. Additional rework was required due to thread strippage of the arm attach bolt on the bogie beam. The thread stripping was due to extreme force action during operations. The bolt was redesigned and the method of rotate sequencing was revised. On July 1, the RH bogie fold lock arm failed on A/V #1 during operations. The A/V #2 part was installed on A/V #1 to continue operations. Cleveland Pneumatic (CPI),

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the gear supplier was on strike at this time. A beefed-up part made from 4340 steel was designed at NAA, approved by CPI, to be made locally to support A/V #1, #2 and spare.

10 July - 24 July 1964 - Engineering released landing gear valve and structure rework drawings for emergency bypass valve. Structure rework was required to facilitate the installation of reworked valve on A/V #1.

10 Aug - 11 Sept 1964 - Completed installation of new 10 port valves and brake computer modification/installation on A/V #1. During taxi tests the LH brakes were smoking due to brake actuator leakage. Viton seals were installed on all brake actuators.

21 Sept - 25 Sept 1964 - During the first flight of A/V #1 the landing gear remained down locked position. During landing non rotation of the LH gear wheels resulted in a fire at the wheel area. The MLG in flight malfunction was traced to one of the switches on the rotate pin. The switch was replaced. Bogie replacement due to damage from the wheel fire was completed.

28 Sept - 23 Oct 1964 - The bogie fold actuator was reworked and the LH and RH MLG support tee repaired.
During flight the gear was extended on emergency Manual #1. The RH was slower than the LH side. The RH side also started to rotate and unfold prior to strut full down. Replacement of the LH bogie pitch dampers resolved the problem. Redesign of the bogie fold and pitch compensator, main landing gear valves, MLG bogie beam skid, MLG brake seals and revised MLG door lock switch mechanism. Rework was accomplished during proof load phase.

Removed and replaced thirty-two H 18 switches with modified H 18 switches.
Removed and replaced nose gear strut relief valve.
Removed and returned to Parker, for rework, seven main landing gear control valves. (A/V #1).
Wheel bearing rework on A/V #1 and #2. Damaged wheel bearings were found on A/V #1. Analysis indicated deficient wheel bearings received from the supplier.

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Per EWA 259-241, Engineering was issued to modify brake control system to improve control and brake chatter tendancy. (A/V #1 and #2).

Reworked main and nose gear door and strut control selector valves (EWA 259-233) on A/V #1. Structural rework was required.

31 Oct 64 - 9 Feb 1965 - Modified bogie pitch dampers were installed on A/V #1 and gear operations completed.

A/V #1 Bogie fold and pitch compensation assembly valve packs were reworked in house to improve reliability. (EWA 59-223).

5 March - 9 April 1965 - The head of the bolt connecting the RH main gear strut actuator to the structure was broken off during flight 9 of A/V #1, a recurrence of the problem encountered on Flight #7. Redesigned strut actuator attach bolts were installed complete 9 April.

16 April - 23 July 1965 - Three phase program for development and air-worthiness testing of a new brake lining to eliminate chatter.

20 April - 26 April 1965 - A/V #1 - Two cycles were required to retract gear. The LH main strut required rework due to a leaking seal. The strut control valve on the RH gear was also replaced.

19 July - 30 July 1965 - After landing from first flight (A/V #2) and while taxiing, the nose wheel went hard right. Inspection revealed drag link trunnion fitting failure. Repair completed 30 July.

24 Sept - 27 Sept 1965 - The sixth A/V #2 flight was aborted due to power roll back. While taxiing back to the pad tires #7 and #8 blew out. Inspection revealed that the remaining eight tires required replacement. The blowout resulted in damage to the brake junction box, on top of the bogie, and wiring on the LH gear.

24 Nov - 29 Nov 1965 - Main gear actuator fitting failure on A/V #1 resulted from cracked fitting. The fitting was replaced and gear operations completed 29 April.

14 March - 18 April 1966 - A/V #1 Flight #37, 14 March 1966. - When the landing gear was lowered the nose and LH main gear extended normally and showed down and locked. The RH gear extended very abruptly when the strut actuator attach fitting failed and showed unsafe in the cockpit. The fitting failure caused damage to the lines in the wheel well, resulting in the loss of U1 and U2 hydraulic systems. The loss of hydraulic power caused both bogies to drift to the upright position. The airplane was landed and after touch down the RH bogie unfolded to the normal position but the RH remained vertical. The roll out was made on four RH wheels and the front two wheels of the LH bogie. The airplane was jacked on the lakebed, the LH bogie unfolded and the RH gear locked down and was towed to the hangar. Repairs were completed 16 March.

On 11 April the A/V #1 flight was aborted due to tire failure during takeoff. the flight was rescheduled to 13 April and accomplished. Post flight inspection, however, revealed damage to the LH main gear bogie. The hot damper lugs had snapped off and a crack propogated approximately 8 inches into the bogie beam. The beam was replaced with a spare which was available in LSS inventory.

19 April - 26 July 1966 - (A/V #1) Nose Gear failed to retract after take-off on 19 April. The nose gear sink rate arm, in the unlatched position, had prevented gear retraction. At post flight the sink rate arm (NASA instrumentation) was removed and the gear successfully operated.

(A/V #2) When the nose gear retracted, the door jammed and cut the LH tire, resulting in nose gear hanging up partially retracted. Numerous attempts to lower the gear failed until the Co-Pilot, following ground instructions, shorted across two circuits in the EE bay. The gear lowered when electrical emergency down was selected. When the airplane landed the brakes were locked and caused six main gear tires to blow out and damaged both bogies. Cause was a crimped wire in a junction box on the RH forward bogie which shorted and blew the circuit breaker. Structure damage was completed and A/V #2 readied for the next flight on 19 May. Bogie beam repair was completed on 26 Jul 1966.

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5 May - 9 May 1966

A/V #1

- Red light on first retraction. Gear was re-cycled and on this second retraction attempt, the nose gear gear retracted but the main gear folded and rotated without retraction. Malfunction was due to broken main gear uplock linkage. Up-lock linkage repaired for subsequent flight on 9 June. On the June 9 flight the gear retracted normally. Upon re-cycling the nose gear extended but the main gear did not. The electrical emergency system was used to extend the gear. Malfunction was caused by a failed ground safety relay.

4 June - 2 Aug 1966

A/V #1

- While the rear wheels were being jacked, as a part of the proof load test, (4 June) the center beam failed fore and aft of the strut attach point permitting the strut to penetrate into the run pad. The Manufacturing repair effort was completed 19 July. Structures Lab. completed proof loading 25 July. Magnaflux and pen-stripe inspection was successfully completed and Air Force permission was received for reinstallation on A/V #1, 2 August 1966.

15 Aug 1966

- Directorate of Research Vehicle (XB-70) requested that the bogie skid plates be redesigned. Original plates contained 307 cubic inches of metal, below the fastening point. DRV requested a minimum of 400 cubic inches. Designed, fabricated and delivered as of 15 Aug. 1966.

COST DEFINITIONS

SUBSYSTEM: ALIGHTING AND ARRESTING WBS CODE: 1.8

Total costs presented in this WBS item include all identifiable expenditures to design, develop, ground test, fabricate and assemble all components, assemblies and developmental test hardware within the Alighting and Arresting Subsystem as defined by the WBS. Total costs of $17,259,216 include the following items:

a) developing subsystem specification requirements

b) subsystem installation and integration design

c) vendor coordination

d) in-house ground testing including design and fabrication of models, mockups and simulators

e) subcontracted hardware including the supplier's costs for engineering, manufacturing, tooling and testing.

Excluded from the cost displayed for this subsystem are the in-house costs associated with the:

f) fabrication of subsystem provisions (brackets, racks, wire harnesses, shelves, supports, etc.).

g) miscellaneous purchased parts and installation materials

h) installation of the subsystem into the vehicles

i) subsystem, vehicle and preflight checkouts

Costs for items (f) through (i) are contained in WBS 1.12 (Volume IV, page IV-647). Internal accounting procedures and the resultant cost reports do not provide a basis for establishing expenditures for these items by individual subsystems. Therefore all costs are collected and reported in one WBS item. Refer to WBS 1.12 for additional information.

Detail of the recorded costs associated with this subsystem is provided by Element of Cost (EOC) and Subdivision of Work (SDW). Section III of Volume I provides a detail definition of these items. Further segregation of the cost data is provided by the WBS. All cost data is displayed at WBS level 5 (Alighting and Arresting Subsystem, WBS 1.8) with the exception of in-house ground testing (WBS 1.8.5). Cost data can be located on the following pages.

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		Cost Breakdown	Time-Phased Detail
WBS 1.8	$17,147,634	Page IV-429	Page IV-430
WBS 1.8.5 Ground Tests	111,582	Page IV-429	Page IV-441
Total WBS 1.8	$17,259,216	Page IV-429	Page IV-447

A summary of the subcontractor recorded cost data is provided on page IV-428. Contractual arrangements, delivery dates, costs by supplier, quantity of hardware delivered and other pertinent data is provided. Cost data includes the supplier expenditures for engineering, production, tooling and testing (where identifiable) performed at the supplier's facility. Refer to the Subcontracting Element of Cost (EOC) definition (Volume I, page I-26) for additional explanation.

Ground testing activities associated with the development of the Alighting and Arresting Subsystem have been identified and the costs assigned to WBS 1.8.5 (page IV-441). These costs reflect the in-house expenditures only. Testing activities performed by the subcontractors where identified are included under WBS 1.8, Test/QC Subdivision of Work and the Subcontracting Element of Cost. The following is a summary of the major in-house test activities identified to this subsystem.

Description	Recorded Costs
Airworthiness Retest of Nose Landing Gear Actuator	$ 40,521
Airworthiness Retest of Main Landing Gear Cylinder	28,256
Airworthiness Retest of Main Landing Gear Door Actuator	19,122
Main Landing Gear Mockup	6,004
Nose Landing Gear Mockup	3,117
Various	12,133
Costs (less MPC and G&A)	$109,153
Material Procurement Cost	574
General and Administrative	1,855
Total Costs WBS 1.8.5	$111,582*

* Calibration of the Landing Gear is included in the Structural Ground Test, WBS item 1.1.8.

SUBCONTRACTOR MATRIX

Subsystem: Alighting and Arresting WBS Code: 1.8

SUBCONTRACTOR	ENGINEERING	PROD	TOOLING	TEST	TOTAL
Cleveland Pneumatic	1,933,284	10,567,577	1,851,888	-	14,352,749

CLEVELAND PNEUMATIC was selected to produce the Landing Gear Subsystem for the B-70 Air Vehicle.

Purchase Order L9J1-YZ-600122 was awarded to Cleveland Pneumatic July 10, 1959. The final piece of hardware was completed and delivered to NR on September 13, 1965,

The Statement of Work called for the subcontractor to provide design, development, and test effort necessary to produce and deliver the Landing Gear Subsystem for the B-70 Air Vehicles 1, 2, and 3.

The subsystem consisted of the following assemblies:

1. Brake Control System
2. Brake System
3. Main Wheel Assembly
4. Nose Wheel Assembly
5. Nose Steering Assembly
6. Tires

A considerable portion of the Landing Gear effort was subcontracted to other firms by Cleveland Pneumatic Tool Company. The wheels, tires, and brakes were subcontracted to B. F. Goodrich Company. The Brake Control System was subcontracted to the Instrumentation and Control Division of CPT at Kalamazoo, Michigan, and the Nose Steering System was subcontracted to the National Water Lift Division of CPT at Grand Rapids, Michigan. All of the above effort was in accordance with NR specifications and controlling documentation.

All residual inventories were disposed of, and applicable credits were taken against Purchase Order 600122. The tooling used in the performance of this purchase order was sold on a salvage basis to Cleveland Pneumatic Tool Company.

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM C8
ALIGHTING AND ARRESTING SUBSYSTEM

	6-M ASSY 0 HOURS DOLLARS	6-M ASSY C5 HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	190672	8637	199309
LABOR AT $ 5.010	958868	39620	998488
ENGR BURDEN AT $ 4.387	835257	39118	874375
SHOP SUPPORT		2650	2650
LABOR AT $ 3.502		9280	9280
TEST/QC		301	301
LABOR AT $ 4.229		1273	1273
MFG BURDEN AT $ 3.932		11602	11602
ENGR MATERIAL		8199	8199
SUBCONTRACT	14352749		14352749
MPC	703702	574	704276
OTHER COST		61	61
SUB-TOTAL	16850576	109727	16960303
GEN & ADMIN	297058	1855	298913
TOTAL COST	17147634	111582	17259216

SUBDIVISION OF WORK
COST DETAIL - SEE PAGE IV-430 IV-441 IV-447

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 08
6-MAJ ASSY 0

ALIGHTING AND ARRESTING SUBSYSTEM

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOOLING AND STE HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	190672			190672
LABOR AT $ 5.029	958868			958868
ENGR BURDEN AT $ 4.381	835257			835257
SUBCONTRACT	1933284	10567577	1851888	14352749
MPC	93943	508867	100892	703702
SUB-TOTAL	3821352	11076444	1952780	16850576
GEN & ADMIN	59194	202009	35855	297058
TOTAL COST	3880546	11278453	1988635	17147634
TIME-PHASED COST DETAIL - SEE PAGE	IV-431	IV-435	IV-436	IV-437

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 08 **ALIGHTING AND ARRESTING SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		95	4.674	444	432	876
Q-2 58						
Q-3 58	40.5	6708	4.628	31044	26269	57313
Q-4 58						
Q-1 59	82.5	14041	4.518	63437	48273	111710
Q-2 59						
Q-3 59	70.5	12504	4.346	54342	44877	99219
Q-4 59						
Q-1 60	118.5	20444	4.445	90874	78219	169093
Q-2 60						
Q-3 60	127.5	21535	4.655	100245	80196	180441
Q-4 60						
Q-1 61	174.0	29806	4.827	143874	102562	246436
Q-2 61						
Q-3 61	108.0	19568	4.843	94768	89093	183861
Q-4 61						
Q-1 62	99.0	16780	5.331	89454	77440	166894
Q-2 62						
Q-3 62	75.0	12503	5.415	67704	64315	132019
Q-4 62						
Q-1 63	57.0	9649	6.725	64890	60373	125263
Q-2 63						
Q-3 63	46.5	7755	5.120	39706	39372	79078
Q-4 63						
Q-1 64	37.5	6299	5.922	37303	39633	76936
Q-2 64						
Q-3 64	48.0	8359	5.895	49276	53673	102949
Q-4 64						
Q-1 65	16.5	2765	6.811	18832	18255	37087

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 08 ALIGHTING AND ARRESTING SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-2 65						
Q-3 65	10.5	1861	6.811	12675	12275	24950
TOTAL	1111.5	190672		958868	835257	1794125

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 08 **ALIGHTING AND ARRESTING SUBSYSTEM**
6-MAJ ASSY 0
SUBD CF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-1 58		95	4.674	444	432	876	
Q-2 58							
Q-3 58	40.5	6708	4.628	31044	26269	57313	
Q-4 58							
Q-1 59	82.5	14041	4.518	63437	48273	111710	186371
Q-2 59							
Q-3 59	70.5	12504	4.346	54342	44877	99219	171197
Q-4 59							
Q-1 60	118.5	20444	4.445	90874	78219	169093	450570
Q-2 60							
Q-3 60	127.5	21535	4.655	100245	80196	180441	138598
Q-4 60							
Q-1 61	174.0	29806	4.827	143874	102562	246436	113355
Q-2 61							
Q-3 61	108.0	19568	4.843	94768	89093	183861	172642
Q-4 61							
Q-1 62	99.0	16780	5.331	89454	77440	166894	112215
Q-2 62							
Q-3 62	75.0	12503	5.415	67704	64315	132019	212215
Q-4 62							
Q-1 63	57.0	9649	6.725	64890	60373	125263	165624
Q-2 63							
Q-3 63	46.5	7755	5.120	39706	39372	79078	48177
Q-4 63							
Q-1 64	37.5	6299	5.922	37303	39633	76936	162309
Q-2 64							
Q-3 64	48.0	8359	5.895	49276	53673	102949	
Q-4 64							
Q-1 65	16.5	2765	6.811	18832	18255	37087	
Q-2 65							
Q-3 65	10.5	1861	6.811	12675	12275	24950	
TOTAL	1111.5	190672		958868	835257	1794125	1933284

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 08 ALIGHTING AND ARRESTING SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 58		876		876
Q-2 58				
Q-3 58		57313		57313
Q-4 58				
Q-1 59	4941	303022		303022
Q-2 59				
Q-3 59	4677	275093		275093
Q-4 59				
Q-1 60	26732	646395	12316	658711
Q-2 60				
Q-3 60	8223	327262	6235	333497
Q-4 60				
Q-1 61	3248	363050	6746	369796
Q-2 61				
Q-3 61	4946	361449	6716	368165
Q-4 61				
Q-1 62	3566	282675	4744	287419
Q-2 62				
Q-3 62	6738	350972	5891	356863
Q-4 62				
Q-1 63	7033	297920	4981	302901
Q-2 63				
Q-3 63	1548	128803	2154	130957
Q-4 63				
Q-1 64	22291	261536	5565	267101
Q-2 64				
Q-3 64		102949	2191	105140
Q-4 64				
Q-1 65		37087	989	38076
Q-2 65				
Q-3 65		24950	666	25616
TOTAL	93943	3821352	59194	3880546

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 08 **ALIGHTING AND ARRESTING SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK PRODUCTION

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 59	27317	724	28041		28041
Q-2 59					
Q-3 59	27318	746	28064		28064
Q-4 59					
Q-1 60	1376036	81640	1457676	27773	1485449
Q-2 60					
Q-3 60	1504048	89239	1593287	30357	1623644
Q-4 60					
Q-1 61	1366153	39141	1405294	26116	1431410
Q-2 61					
Q-3 61	1690115	48423	1738538	32307	1770845
Q-4 61					
Q-1 62	1359856	43218	1403074	23550	1426624
Q-2 62					
Q-3 62	1159856	36828	1196684	20086	1216770
Q-4 62					
Q-1 63	905218	38440	943658	15778	959436
Q-2 63					
Q-3 63	263308	8462	271770	4544	276314
Q-4 63					
Q-1 64	888352	122006	1010358	21498	1031856
TOTAL	10567577	508867	11076444	202009	11278453

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 08 ALIGHTING AND ARRESTING SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK TOOLING AND STE

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-3 59	15174	414	15588		15588
Q-4 59					
Q-1 60	775997	46039	822036	15662	837698
Q-2 60					
Q-3 60	128677	7634	136311	2597	138908
Q-4 60					
Q-1 61	104497	2993	107490	1997	109487
Q-2 61					
Q-3 61	161306	4621	165927	3083	169010
Q-4 61					
Q-1 62	103392	3286	106678	1791	108469
Q-2 62					
Q-3 62	203393	6458	209851	3522	213373
Q-4 62					
Q-1 63	158739	6740	165479	2766	168245
Q-2 63					
Q-3 63	46173	1483	47656	797	48453
Q-4 63					
Q-1 64	154540	21224	175764	3640	179404
TOTAL	1851888	100892	1952780	35855	1988635

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 08 **ALIGHTING AND ARRESTING SUBSYSTEM**
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		95	4.674	444	432	876
Q-2 58						
Q-3 58	40.5	6708	4.628	31044	26269	57313
Q-4 58						
Q-1 59	82.5	14041	4.518	63437	48273	111710
Q-2 59						
Q-3 59	70.5	12504	4.346	54342	44877	99219
Q-4 59						
Q-1 60	118.5	20444	4.445	90874	78219	169093
Q-2 60						
Q-3 60	127.5	21535	4.555	100245	80196	180441
Q-4 60						
Q-1 61	174.0	29806	4.827	143874	102562	246436
Q-2 61						
Q-3 61	108.0	19568	4.843	94768	89093	183861
Q-4 61						
Q-1 62	99.0	16780	5.331	89454	77440	166894
Q-2 62						
Q-3 62	75.0	12503	5.415	67704	64315	132019
Q-4 62						
Q-1 63	57.0	9649	6.725	64890	60373	125263
Q-2 63						
Q-3 63	46.5	7755	5.120	39706	39372	79078
Q-4 63						
Q-1 64	37.5	6299	5.922	37303	39633	76936
Q-2 64						
Q-3 64	48.0	8359	5.895	49276	53673	102949
Q-4 64						
Q-1 65	16.5	2765	6.811	18832	18255	37087
Q-2 65						

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING

4-SYSTEM 1
5-SUBSYSTEM 08 **ALIGHTING AND ARRESTING SUBSYSTEM**
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	10.5	1861	6.811	12675	12275	24950
TOTAL	1111.5	190672		958868	835257	1794125

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 08 **ALIGHTING AND ARRESTING SUBSYSTEM**
6-MAJ ASSY 0

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-1 58		95	4.674	444	432	876	
Q-2 58							
Q-3 58	40.5	6708	4.628	31044	26269	57313	
Q-4 58							
Q-1 59	82.5	14041	4.518	63437	48273	111710	213688
Q-2 59							
Q-3 59	70.5	12504	4.346	54342	44877	99219	213699
Q-4 59							
Q-1 60	118.5	20444	4.445	90874	78219	169093	2602603
Q-2 60							
Q-3 60	127.5	21535	4.655	100245	80196	180441	1771323
Q-4 60							
Q-1 61	174.0	29806	4.827	143874	102562	246436	1584016
Q-2 61							
Q-3 61	108.0	19568	4.843	94768	89093	183861	2024063
Q-4 61							
Q-1 62	99.0	16780	5.331	89454	77440	166894	1575463
Q-2 62							
Q-3 62	75.0	12503	5.415	67704	64315	132019	1575464
Q-4 62							
Q-1 63	57.0	9649	6.725	64890	60373	125263	1229581
Q-2 63							
Q-3 63	46.5	7755	5.120	39706	39372	79078	357658
Q-4 63							
Q-1 64	37.5	6299	5.922	37303	39633	76936	1205201
Q-2 64							
Q-3 64	48.0	8359	5.895	49276	53673	102949	
Q-4 64							
Q-1 65	16.5	2765	6.811	18832	18255	37087	
Q-2 65							
Q-3 65	10.5	1861	6.811	12675	12275	24950	
TOTAL	1111.5	190672		958868	835257	1794125	14352749

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 08 ALIGHTING AND ARRESTING SUBSYSTEM
6-MAJ ASSY 0

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 58		876		876
Q-2 58				
Q-3 58		57313		57313
Q-4 58				
Q-1 59	5665	331063		331063
Q-2 59				
Q-3 59	5837	318745		318745
Q-4 59				
Q-1 60	154411	2926107	55751	2981858
Q-2 60				
Q-3 60	105096	2056860	39189	2096049
Q-4 60				
Q-1 61	45382	1875834	34859	1910693
Q-2 61				
Q-3 61	57990	2265914	42106	2308020
Q-4 61				
Q-1 62	50070	1792427	30085	1822512
Q-2 62				
Q-3 62	50024	1757507	29499	1787006
Q-4 62				
Q-1 63	52213	1407057	23525	1430582
Q-2 63				
Q-3 63	11493	448229	7495	455724
Q-4 63				
Q-1 64	165521	1447658	30703	1478361
Q-2 64				
Q-3 64		102949	2191	105140
Q-4 64				
Q-1 65		37087	989	38076
Q-2 65				
Q-3 65		24950	666	25616
TOTAL	703702	16850576	297058	17147634

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 08
6-MAJ ASSY 05
ALIGHTING AND ARRESTING GROUND TESTS

	TEST /QC HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	8637	8637
LABOR AT $ 4.587	39620	39620
ENGR BURDEN AT $ 4.529	39118	39118
SHOP SUPPORT	2650	2650
LABOR AT $ 3.502	9280	9280
TEST/QC	301	301
LABOR AT $ 4.229	1273	1273
MFG BURDEN AT $ 3.932	11602	11602
ENGR MATERIAL	8199	8199
MPC	574	574
OTHER COST	61	61
SUB-TOTAL	109727	109727
GEN & ADMIN	1855	1855
TOTAL COST	111582	111582

TIME-PHASED COST DETAIL - SEE PAGE IV-442

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 08 ALIGHTING AND ARRESTING GROUND TESTS
6-MAJ ASSY 05
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 61	4.5	865	8.713	7537		7537
Q-2 61						
Q-3 61		118	7.814	922	407	1329
Q-4 61						
Q-1 62	6.0	969	3.998	3874	4474	8348
Q-2 62						
Q-3 62	28.5	4727	4.052	19152	23150	42302
Q-4 62						
Q-1 63	12.0	1952	4.134	8070	10739	18809
Q-2 63						
Q-3 63		4	16.000	64	347	411
Q-4 63						
Q-1 64		1			-1	-1
Q-2 64						
Q-3 64		1				
Q-4 64						
Q-1 65				1	2	3
TOTAL	51.0	8637		39620	39118	78738

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 08 **ALIGHTING AND ARRESTING GROUND TESTS**
6-MAJ ASSY 05
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 59		1	3.000	3	4	7
Q-2 59						
Q-3 59						
Q-4 59						
Q-1 60		29	2.724	79		79
Q-2 60						
Q-3 60						
Q-4 60						
Q-1 61		108	3.167	342	275	617
Q-2 61						
Q-3 61		78	3.051	238	317	555
Q-4 61						
Q-1 62		90	3.033	273	346	619
Q-2 62						
Q-3 62	9.0	1615	3.797	6132	7129	13261
Q-4 62						
Q-1 63	4.5	861	3.105	2673	3741	6414
Q-2 63						
Q-3 63		-72	3.556	-256	-6	-262
Q-4 63						
Q-1 64				1	-3	-2
Q-2 64						
Q-3 64		-1	.999	1	-3	-2
Q-4 64						
Q-1 65		-41	3.537	-145	-139	-284
Q-2 65						
Q-3 65		-17	3.353	-57	-56	-113
Q-4 65						
Q-1 66		-1	4.000	-4	-3	-7
TOTAL	13.5	2650		9280	11602	20882

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 08 **ALIGHTING AND ARRESTING GROUND TESTS**
6-MAJ ASSY 05
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 61		10	4.700	47		47
Q-2 61						
Q-3 61		10	3.100	31		31
Q-4 61						
Q-1 62		3	2.667	8		8
Q-2 62						
Q-3 62	1.5	200	4.420	884		884
Q-4 62						
Q-1 63		78	3.885	303		303
Q-2 63						
Q-3 63						
TOTAL	1.5	301		1273		1273

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 08
6-MAJ ASSY 05
ALIGHTING AND ARRESTING GROUND TESTS

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 59		1	3.000	3	4	7	
Q-2 59							
Q-3 59							
Q-4 59							
Q-1 60		29	2.724	79		79	
Q-2 60							
Q-3 60							-1588
Q-4 60							
Q-1 61	4.5	983	8.063	7926	275	8201	20
Q-2 61							
Q-3 61		206	5.782	1191	724	1915	1025
Q-4 61							
Q-1 62	6.0	1062	3.912	4155	4820	8975	6479
Q-2 62							
Q-3 62	39.0	6542	4.000	26168	30279	56447	2301
Q-4 62							
Q-1 63	16.5	2891	3.821	11046	14480	25526	665
Q-2 63							
Q-3 63		-68	2.824	-192	341	149	-702
Q-4 63							
Q-1 64		1	1.000	1	-4	-3	-110
Q-2 64							
Q-3 64				1	-3	-2	-111
Q-4 64							
Q-1 65		-41	3.512	-144	-137	-281	154
Q-2 65							
Q-3 65		-17	3.353	-57	-56	-113	62
Q-4 65							
Q-1 66		-1	4.000	-4	-3	-7	4
TOTAL	66.0	11588		50173	50720	100893	8199

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 08
6-MAJ ASSY 05
ALIGHTING AND ARRESTING GROUND TESTS

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 59			7		7
Q-2 59					
Q-3 59					
Q-4 59					
Q-1 60			79	2	81
Q-2 60					
Q-3 60	-209		-1797	-34	-1831
Q-4 60					
Q-1 61	2		8223	153	8376
Q-2 61					
Q-3 61	87	18	3045	57	3102
Q-4 61					
Q-1 62	510	3	15967	268	16235
Q-2 62					
Q-3 62	181	7	58936	989	59925
Q-4 62					
Q-1 63	66		26257	439	26696
Q-2 63					
Q-3 63	-69	27	-595	-10	-605
Q-4 63					
Q-1 64	-12	2	-123	-3	-126
Q-2 64					
Q-3 64	-40	1	-152	-3	-155
Q-4 64					
Q-1 65	46	1	-80	-2	-82
Q-2 65					
Q-3 65	11	1	-39	-1	-40
Q-4 65					
Q-1 66	1	1	-1		-1
TOTAL	574	61	109727	1855	111582

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 08
ALIGHTING AND ARRESTING SUBSYSTEM

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOOLING AND STE HOURS DOLLARS	TEST /QC HOURS DOLLARS
DESIGN/ENGINEERING	190672			8637
LABOR AT $ 5.010	958868			39620
ENGR BURDEN AT $ 4.387	835257			39118
SHOP SUPPORT				2650
LABOR AT $ 3.502				9280
TEST/QC				301
LABOR AT $ 4.229				1273
MFG BURDEN AT $ 3.932				11602
ENGR MATERIAL				3199
SUBCONTRACT	1933284	10567577	1851888	
MPC	93943	508867	100892	574
OTHER COST				61
SUB-TOTAL	3821352	11076444	1952780	109727
GEN & ADMIN	59194	202009	35855	1855
TOTAL COST	3880546	11278453	1988635	111582
TIME-PHASED COST DETAIL - SEE PAGE	IV-449	IV-453	IV-454	IV-455

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 08
ALIGHTING AND ARRESTING SUBSYSTEM

			TOTAL HOURS DOLLARS
DESIGN/ENGINEERING			199309
LABOR AT $ 5.010			998488
ENGR BURDEN	AT $	4.387	874375
SHOP SUPPORT			2650
LABOR AT $ 3.502			9280
TEST/QC			301
LABOR AT $ 4.229			1273
MFG BURDEN	AT $	3.932	11602
ENGR MATERIAL			8199
SUBCONTRACT			14352749
MPC			704276
OTHER COST			61
SUB-TOTAL			16960303
GEN & ADMIN			298913
TOTAL COST			17259216

TIME-PHASED COST
DETAIL - SEE PAGE IV-460

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 08 **ALIGHTING AND ARRESTING SUBSYSTEM**
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		95	4.674	444	432	876
Q-2 58						
Q-3 58	40.5	6708	4.628	31044	26269	57313
Q-4 58						
Q-1 59	82.5	14041	4.518	63437	48273	111710
Q-2 59						
Q-3 59	70.5	12504	4.346	54342	44877	99219
Q-4 59						
Q-1 60	118.5	20444	4.445	90874	78219	169093
Q-2 60						
Q-3 60	127.5	21535	4.655	100245	80196	180441
Q-4 60						
Q-1 61	174.0	29806	4.827	143874	102562	246436
Q-2 61						
Q-3 61	108.0	19568	4.843	94768	89093	183861
Q-4 61						
Q-1 62	99.0	16780	5.331	89454	77440	166894
Q-2 62						
Q-3 62	75.0	12503	5.415	67704	64315	132019
Q-4 62						
Q-1 63	57.0	9649	6.725	64890	60373	125263
Q-2 63						
Q-3 63	46.5	7755	5.120	39706	39372	79078
Q-4 63						
Q-1 64	37.5	6299	5.922	37303	39633	76936
Q-2 64						
Q-3 64	48.0	8359	5.895	49276	53673	102949
Q-4 64						
Q-1 65	16.5	2765	6.811	18832	18255	37087
Q-2 65						

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 08 ALIGHTING AND ARRESTING SUBSYSTEM
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	10.5	1861	6.811	12675	12275	24950
TOTAL	1111.5	190672		958868	835257	1794125

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1 ALIGHTING AND ARRESTING SUBSYSTEM
5-SUBSYSTEM 08
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-1 58		95	4.674	444	432	876	
Q-2 58							
Q-3 58	40.5	6708	4.628	31044	26269	57313	
Q-4 58							
Q-1 59	82.5	14041	4.518	63437	48273	111710	186371
Q-2 59							
Q-3 59	70.5	12504	4.346	54342	44877	99219	171197
Q-4 59							
Q-1 60	118.5	20444	4.445	90874	78219	169093	450570
Q-2 60							
Q-3 60	127.5	21535	4.655	100245	80196	180441	138598
Q-4 60							
Q-1 61	174.0	29806	4.827	143874	102562	246436	113366
Q-2 61							
Q-3 61	108.0	19568	4.843	94768	89093	183861	172642
Q-4 61							
Q-1 62	99.0	16780	5.331	89454	77440	166894	112215
Q-2 62							
Q-3 62	75.0	12503	5.415	67704	64315	132019	212215
Q-4 62							
Q-1 63	57.0	9649	6.725	64890	60373	125263	165624
Q-2 63							
Q-3 63	46.5	7755	5.120	39706	39372	79078	48177
Q-4 63							
Q-1 64	37.5	6299	5.922	37303	39633	76936	162309
Q-2 64							
Q-3 64	48.0	8359	5.395	49276	53673	102949	
Q-4 64							
Q-1 65	16.5	2765	6.811	18832	18255	37087	
Q-2 65							
Q-3 65	10.5	1861	6.811	12675	12275	24950	
TOTAL	1111.5	190672		958868	835257	1794125	1933234

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1 ALIGHTING AND ARRESTING SUBSYSTEM
5-SUBSYSTEM 08
SUBD OF WORK DESIGN/ENGINEERING

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 58		876		876
Q-2 58				
Q-3 58		57313		57313
Q-4 58				
Q-1 59	4941	303022		303022
Q-2 59				
Q-3 59	4677	275093		275093
Q-4 59				
Q-1 60	26732	646395	12316	658711
Q-2 60				
Q-3 60	8223	327262	6235	333497
Q-4 60				
Q-1 61	3248	363050	6746	369796
Q-2 61				
Q-3 61	4946	361449	6716	368165
Q-4 61				
Q-1 62	3566	282675	4744	287419
Q-2 62				
Q-3 62	6738	350972	5891	356863
Q-4 62				
Q-1 63	7033	297920	4981	302901
Q-2 63				
Q-3 63	1548	128803	2154	130957
Q-4 63				
Q-1 64	22291	261536	5565	267101
Q-2 64				
Q-3 64		102949	2191	105140
Q-4 64				
Q-1 65		37087	989	38076
Q-2 65				
Q-3 65		24950	666	25616
TOTAL	93943	3821352	59194	3880546

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1 **ALIGHTING AND ARRESTING SUBSYSTEM**
5-SUBSYSTEM 08
SUBD OF WORK PRODUCTION

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 59	27317	724	28041		28041
Q-2 59					
Q-3 59	27318	746	28064		28064
Q-4 59					
Q-1 60	1376036	81640	1457676	27773	1485449
Q-2 60					
Q-3 60	1504048	89239	1593287	30357	1623644
Q-4 60					
Q-1 61	1366153	39141	1405294	26116	1431410
Q-2 61					
Q-3 61	1690115	48423	1738538	32307	1770845
Q-4 61					
Q-1 62	1359856	43218	1403074	23550	1426624
Q-2 62					
Q-3 62	1159856	36828	1196684	20086	1216770
Q-4 62					
Q-1 63	905218	38440	943658	15778	959436
Q-2 63					
Q-3 63	263308	8462	271770	4544	276314
Q-4 63					
Q-1 64	888352	122006	1010358	21498	1031856
TOTAL	10567577	508867	11076444	202009	11278453

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 08 ALIGHTING AND ARRESTING SUBSYSTEM
SUBD OF WORK TOOLING AND STE

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-3 59	15174	414	15588		15588
Q-4 59					
Q-1 60	775997	46039	822036	15662	837698
Q-2 60					
Q-3 60	128677	7634	136311	2597	138908
Q-4 60					
Q-1 61	104497	2993	107490	1997	109487
Q-2 61					
Q-3 61	161306	4621	165927	3083	169010
Q-4 61					
Q-1 62	103392	3286	106678	1791	108469
Q-2 62					
Q-3 62	203393	6458	209851	3522	213373
Q-4 62					
Q-1 63	158739	6740	165479	2766	168245
Q-2 63					
Q-3 63	46173	1483	47656	797	48453
Q-4 63					
Q-1 64	154540	21224	175764	3640	179404
TOTAL	1851888	100892	1952780	35855	1988635

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 08 **ALIGHTING AND ARRESTING SUBSYSTEM**
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 61	4.5	865	8.713	7537		7537
Q-2 61						
Q-3 61		118	7.814	922	407	1329
Q-4 61						
Q-1 62	6.0	969	3.998	3874	4474	8348
Q-2 62						
Q-3 62	28.5	4727	4.052	19152	23150	42302
Q-4 62						
Q-1 63	12.0	1952	4.134	8070	10739	18809
Q-2 63						
Q-3 63		4	16.000	64	347	411
Q-4 63						
Q-1 64		1			-1	-1
Q-2 64						
Q-3 64		1				
Q-4 64						
Q-1 65				1	2	3
TOTAL	51.0	8637		39620	39118	78738

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 08 ALIGHTING AND ARRESTING SUBSYSTEM
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 59		1	3.000	3	4	7
Q-2 59						
Q-3 59						
Q-4 59						
Q-1 60		29	2.724	79		79
Q-2 60						
Q-3 60						
Q-4 60						
Q-1 61		108	3.167	342	275	617
Q-2 61						
Q-3 61		78	3.051	238	317	555
Q-4 61						
Q-1 62		90	3.033	273	346	619
Q-2 62						
Q-3 62	9.0	1615	3.797	6132	7129	13261
Q-4 62						
Q-1 63	4.5	861	3.105	2673	3741	6414
Q-2 63						
Q-3 63		-72	3.556	-256	-6	-262
Q-4 63						
Q-1 64				1	-3	-2
Q-2 64						
Q-3 64		-1	.999	1	-3	-2
Q-4 64						
Q-1 65		-41	3.537	-145	-139	-284
Q-2 65						
Q-3 65		-17	3.353	-57	-56	-113
Q-4 65						
Q-1 66		-1	4.000	-4	-3	-7
TOTAL	13.5	2650		9280	11602	20882

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 08
SUBD OF WORK TEST/QC

ALIGHTING AND ARRESTING SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 61		10	4.700	47		47
Q-2 61						
Q-3 61		10	3.100	31		31
Q-4 61						
Q-1 62		3	2.667	8		8
Q-2 62						
Q-3 62	1.5	200	4.420	884		884
Q-4 62						
Q-1 63		78	3.885	303		303
Q-2 63						
Q-3 63						
TOTAL	1.5	301		1273		1273

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 08 ALIGHTING AND ARRESTING SUBSYSTEM
SUBD OF WORK TEST/QC

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 59		1	3.000	3	4	7	
Q-2 59							
Q-3 59							
Q-4 59							
Q-1 60		29	2.724	79		79	
Q-2 60							
Q-3 60							-1588
Q-4 60							
Q-1 61	4.5	983	8.063	7926	275	8201	20
Q-2 61							
Q-3 61		206	5.782	1191	724	1915	1025
Q-4 61							
Q-1 62	6.0	1062	3.912	4155	4820	8975	6479
Q-2 62							
Q-3 62	39.0	6542	4.000	26168	30279	56447	2301
Q-4 62							
Q-1 63	16.5	2891	3.821	11046	14480	25526	665
Q-2 63							
Q-3 63		-68	2.824	-192	341	149	-702
Q-4 63							
Q-1 64		1	1.000	1	-4	-3	-110
Q-2 64							
Q-3 64				1	-3	-2	-111
Q-4 64							
Q-1 65		-41	3.512	-144	-137	-281	154
Q-2 65							
Q-3 65		-17	3.353	-57	-56	-113	62
Q-4 65							
Q-1 66		-1	4.000	-4	-3	-7	4
TOTAL	66.0	11588		50173	50720	100893	8199

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 08
SUBD OF WORK TEST/QC

ALIGHTING AND ARRESTING SUBSYSTEM

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 59			7		7
Q-2 59					
Q-3 59					
Q-4 59					
Q-1 60			79	2	81
Q-2 60					
Q-3 60	-209		-1797	-34	-1831
Q-4 60					
Q-1 61	2		8223	153	8376
Q-2 61					
Q-3 61	87	18	3045	57	3102
Q-4 61					
Q-1 62	510	3	15967	268	16235
Q-2 62					
Q-3 62	181	7	58936	989	59925
Q-4 62					
Q-1 63	66		26257	439	26696
Q-2 63					
Q-3 63	-69	27	-595	-10	-605
Q-4 63					
Q-1 64	-12	2	-123	-3	-126
Q-2 64					
Q-3 64	-40	1	-152	-3	-155
Q-4 64					
Q-1 65	46	1	-80	-2	-82
Q-2 65					
Q-3 65	11	1	-39	-1	-40
Q-4 65					
Q-1 66	1	1	-1		-1
TOTAL	574	61	109727	1855	111582

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 08
ALIGHTING AND ARRESTING SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		95	4.674	444	432	876
Q-2 58						
Q-3 58	40.5	6708	4.628	31044	26269	57313
Q-4 58						
Q-1 59	82.5	14041	4.518	63437	48273	111710
Q-2 59						
Q-3 59	70.5	12504	4.346	54342	44877	99219
Q-4 59						
Q-1 60	118.5	20444	4.445	90874	78219	169093
Q-2 60						
Q-3 60	127.5	21535	4.655	100245	80196	180441
Q-4 60						
Q-1 61	180.0	30671	4.937	151411	102562	253973
Q-2 61						
Q-3 61	108.0	19686	4.861	95690	89500	185190
Q-4 61						
Q-1 62	103.5	17749	5.258	93328	81914	175242
Q-2 62						
Q-3 62	102.0	17230	5.041	86856	87465	174321
Q-4 62						
Q-1 63	67.5	11601	6.289	72960	71112	144072
Q-2 63						
Q-3 63	46.5	7759	5.126	39770	39719	79489
Q-4 63						
Q-1 64	37.5	6300	5.921	37303	39632	76935
Q-2 64						
Q-3 64	48.0	8360	5.894	49276	53673	102949
Q-4 64						
Q-1 65	16.5	2765	6.811	18833	18257	37090
Q-2 65						

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 08
ALIGHTING AND ARRESTING SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	10.5	1861	6.811	12675	12275	24950
TOTAL	1159.5	199309		998438	874375	1872863

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 08
ALIGHTING AND ARRESTING SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 59		1	3.000	3	4	7
Q-2 59						
Q-3 59						
Q-4 59						
Q-1 60		29	2.724	79		79
Q-2 60						
Q-3 60						
Q-4 60						
Q-1 61		108	3.167	342	275	617
Q-2 61						
Q-3 61		78	3.051	238	317	555
Q-4 61						
Q-1 62		90	3.033	273	346	619
Q-2 62						
Q-3 62	9.0	1615	3.797	6132	7129	13261
Q-4 62						
Q-1 63	4.5	861	3.105	2673	3741	6414
Q-2 63						
Q-3 63		-72	3.556	-256	-6	-262
Q-4 63						
Q-1 64				1	-3	-2
Q-2 64						
Q-3 64		-1	.999	1	-3	-2
Q-4 64						
Q-1 65		-41	3.537	-145	-139	-284
Q-2 65						
Q-3 65		-17	3.353	-57	-56	-113
Q-4 65						
Q-1 66		-1	4.000	-4	-3	-7
TOTAL	13.5	2650		9280	11602	20882

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 08
ALIGHTING AND ARRESTING SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 61		10	4.700	47		47
Q-2 61						
Q-3 61		10	3.100	31		31
Q-4 61						
Q-1 62		3	2.667	8		8
Q-2 62						
Q-3 62	1.5	200	4.420	884		884
Q-4 62						
Q-1 63		78	3.885	303		303
Q-2 63						
Q-3 63						
TOTAL	1.5	301		1273		1273

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 08
ALIGHTING AND ARRESTING SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58		95	4.674	444	432	876	
Q-2 58							
Q-3 58	40.5	6708	4.628	31044	26269	57313	
Q-4 58							
Q-1 59	82.5	14042	4.518	63440	48277	111717	
Q-2 59							
Q-3 59	70.5	12504	4.346	54342	44877	99219	
Q-4 59							
Q-1 60	118.5	20473	4.443	90953	78219	169172	
Q-2 60							
Q-3 60	127.5	21535	4.655	100245	80196	180441	-1588
Q-4 60							
Q-1 61	180.0	30789	4.930	151800	102837	254637	20
Q-2 61							
Q-3 61	108.0	19774	4.853	95959	89817	185776	1025
Q-4 61							
Q-1 62	103.5	17842	5.247	93609	82260	175869	6479
Q-2 62							
Q-3 62	112.5	19045	4.929	93872	94594	188466	2301
Q-4 62							
Q-1 63	72.0	12540	6.056	75936	74853	150789	665
Q-2 63							
Q-3 63	46.5	7687	5.140	39514	39713	79227	-702
Q-4 63							
Q-1 64	37.5	6300	5.921	37304	39629	76933	-110
Q-2 64							
Q-3 64	48.0	8359	5.895	49277	53670	102947	-111
Q-4 64							
Q-1 65	16.5	2724	6.860	18688	18118	36806	154
Q-2 65							
Q-3 65	10.5	1844	6.843	12618	12219	24837	62
Q-4 65							

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APRIL 1972

TIME PHASED EXPEND.
B-7C AIRCRAFT STUCY

4-SYSTEM 1
5-SUBSYSTEM 08
ALIGHTING AND ARRESTING SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATI
C-1 66		-1	4.00C	-4	-3	-7	4
TOTAL	1174.5	2C2260		1009041	885977	1895018	8199

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 08
ALIGHTING AND ARRESTING SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58					876		876
Q-2 58							
Q-3 58					57313		57313
Q-4 58							
Q-1 59	213688	213688	5665		331070		331070
Q-2 59							
Q-3 59	213689	213689	5837		318745		318745
Q-4 59							
Q-1 60	2602603	2602603	154411		2926186	55753	2981939
Q-2 60							
Q-3 60	1771323	1769735	104887		2055063	39155	2094218
Q-4 60							
Q-1 61	1584016	1584036	45384		1884057	35012	1919069
Q-2 61							
Q-3 61	2024063	2025088	58077	18	2268959	42163	2311122
Q-4 61							
Q-1 62	1575463	1581942	50580	3	1808394	30353	1838747
Q-2 62							
Q-3 62	1575464	1577765	50205	7	1816443	30488	1846931
Q-4 62							
Q-1 63	1229581	1230246	52279		1433314	23964	1457278
Q-2 63							
Q-3 63	357658	356956	11424	27	447634	7485	455119
Q-4 63							
Q-1 64	1205201	1205091	165509	2	1447535	30700	1478235
Q-2 64							
Q-3 64		-111	-40	1	102797	2188	104985
Q-4 64							
Q-1 65		154	46	1	37007	987	37994
Q-2 65							
Q-3 65		62	11	1	24911	665	25576
Q-4 65							

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NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 08
ALIGHTING AND ARRESTING SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 66		4	1	1	-1		-1
TOTAL	14352749	14360948	704276	61	16960303	298913	17259216

TABLE OF CONTENTS

SUBSYSTEM: MISSION AND TRAFFIC CONTROL WBS CODE: 1.9

TITLE		PAGE
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TECHNICAL DESCRIPTIONS		IV-472
WBS 1.9	Mission & Traffic Control Subsystem	IV-472
WBS 1.9.1	Communications Equipment	IV-473
WBS 1.9.2	Navigation Aids Equipment	IV-476
WBS 1.9.3	Identification Equipment	IV-477
DEVELOPMENT MILESTONES		IV-478
COST SUMMARY		IV-480
Cost Definition		IV-480
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Detail Cost Data		IV-484

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: MISSION AND TRAFFIC CONTROL WBS CODE: 1.9

WBS LEVELS
4 5 6 7 8

1.9 MISSION AND TRAFFIC CONTROL SUBSYSTEM

1.9.1 Communications Equipment

1.9.1.1 Command Radio Group

Receivers/Transmitters (GFE)
Control Unit (GFE)
Antenna Selector Unit (GFE)
Antennas
RF Transmission Lines
RF Transmission Lines Switch (GFE)

1.9.1.2 Intercommunications Group

Intercom Set (GFE)
Communications Control (GFE)
Ground Intercom Control (GFE)
Crew Extension Assembly

1.9.2 Navigation Aids Equipment

1.9.2.1 Instrument Approach Equipment

Glide Slope Receiver (GFE)
Localizer Receiver (GFE)
Control Assembly (GFE)
Antennas
Marker Beacon Receiver (GFE)

1.9.2.2 TACAN

Receiver/Transmitter (GFE)
Control Indicator Assembly (GFE)
Antenna Selector Unit (GFE)
Antennas
RF Transmission Lines
RF Transmission Line Switch (GFE)

1.9.3 Identification Equipment

1.9.3.1 Receiver/Transmitter (GFE)

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: MISSION AND TRAFFIC CONTROL WBS CODE: 1.9

WBS LEVELS
4 5 6 7 8

1.9.3.2 IFF Control Assembly (GFE)

Receiver/Transmitter Control
Coder/Decoder Control

1.9.3.3 Antennas

Upper
Lower

1.9.3.4 Antenna Lobing Switch (GFE)

1.9.3.5 RF Transmission Lines

1.9.3.6 RF Transmission Switch

1.9.4 Portable Tape Recoder

1.9.5 Ground Tests

1.9.5.1 Models

1.9.5.2 Mockups

1.9.5.3 Antenna Test

TECHNICAL DESCRIPTION

SUBSYSTEM: MISSION TRAFFIC CONTROL SUBSYSTEM (MTCS) WBS CODE: 1.9

This subsystem included the communication equipment, navigation aids equipment, and identification equipment.

The MTCS was essentially provided as GFE (Government Furnished Equipment) and therefore no technical drivers, percentage of accomplishment and state-of-the-art assessment will be provided. Although the MTCS was GFE, effort was involved in the installation and integration activities.

TECHNICAL DESCRIPTION

SUBSYSTEM: MISSION TRAFFIC CONTROL SUBSYSTEM (MTCS) WBS CODE: 1.9

MAJOR ASSEMBLY: COMMUNICATIONS EQUIPMENT WBS CODE: 1.9.1

The UHF Receiver - Transmitter Group was airborne radio communication equipment capable of being operated on 3500 discrete frequency channels in the frequency band of 225.0 to 399.95 megacycles. The equipment normally transmitted and received amplitude - modulated signals with a minimum transmitted carrier power output of 30 watts. Receiver sensitivity was 3 microvolts open circuit and had a signal-to-noise ratio of 10 decibels. A remote control panel provided control of all receiver-transmitter functions. Five rotary switches permitted manual selection of any of the 3500 frequency channels in 0.05 megacycle steps. Any 20 channels could be preset on a memory drum in the panel. A MANUAL-PRESET-GUARD control enabled the receiver-transmitter to be tuned to a manually set channel, a preset channel on the preset guard channel. An 11-position switch (PWR) controlled the transmitter power attenuator in the transmitter, permitting power output reduction of up to 80 decibels in approximately 9 decibel increments.

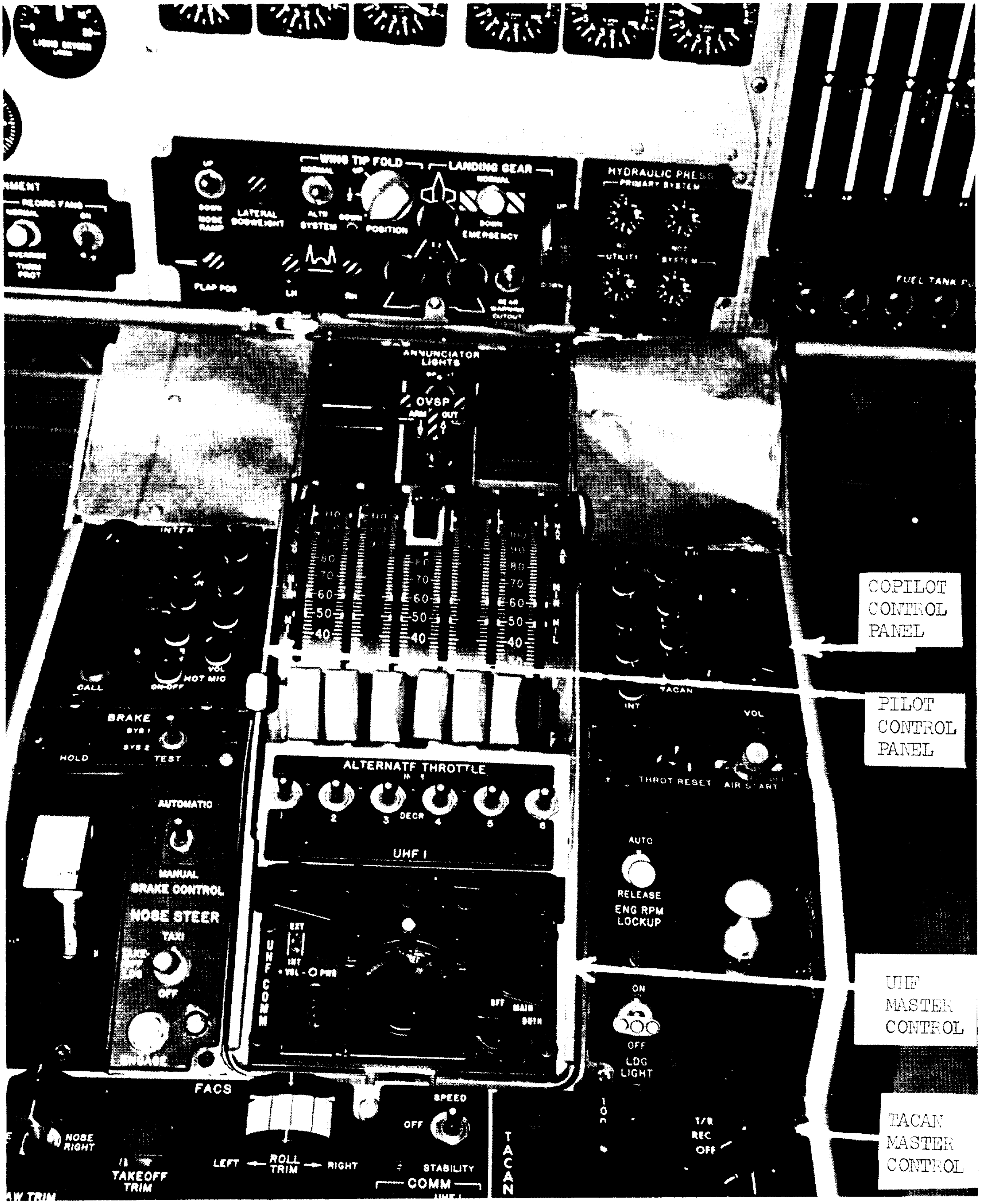
An antenna selector assembly was provided which through electronic circuitry switched between the two air vehicle antenna at a rate of 70 cycles per minute. When either antenna received a sufficiently strong signal level the cycling ceased and the selector assembly would hold on that antenna. In the event signal reception was lost the cycling would resume. A selector switch was also provided for manual selection of either the upper or lower antenna if desired.

Each crew member was provided with equipment for monitoring, receiving and initiating internal and external communications with respect to the air vehicle. Located on the face of the control panel (See Exhibit 1) were seven push-pull type monitoring switches ganged to individual volume controls which provided the facility for monitoring and individual level adjustment of specific inputs. Five of the seven switches selected UHF-1, UHF-2, Intercom (INT), marker Beacon (MKR BCN), Instrument Landing System (ILS), and TACAN. The two other switches selected HOT MIC ON-OFF and HOT MIC VOL control. A six-position rotary selector switch enabled transmission over the interphone line or operation and modulation of the UHF radio transmitters. For emergency communication between crew stations, a momentary contact CALL pushbutton was provided. When a CALL signal was initiated existing monitored signals were overridden. The landing gear unsafe warning signal was also directed through this communication equipment. To provide in-flight intercommunication capability between the cockpit and the equipment bay an extension cord was stowed in the equipment bay area.

Intercommunication system, when integrated with TACAN equipment, instrument landing system equipment and the UHF communications equipment comprised a complete communication system which provided intercommunication within the aircraft, communication beyond the aircraft by means of radio equipment, and monitoring any combination of radio and navigation receivers. Transmission was initiated through the use of the push-to-talk switch located on each control wheel and at the forward side of the equipment rack. The two modes of transmission were intercrew communications and radio transmission.

The ground intercom control consisted of a manually operated toggle switch located on the copilots side console plus a relay located in the electronic equipment bay. The switch positions were ground intercom (GND INTERCOM) -off-ground power intercom (GND POWER INTERCOM). In the off position the ground intercom isolation amplifiers are disabled and the electrical connections to the remote outlets are opened. In the GND INTERCOM position the amplifiers are activated and connections again completed to the remote outlets, enabling full use of the remote outlets, with ground equipment and with a single microphone. In the ground power intercom (GND POWER INTERCOM) position the air vehicle intercom system was able to utilize 28 vdc power provided by the ground maintenance intercom power supply. This mode is used immediately following engine shutdown and prior to attachment of the normal ground power units.

A "hand free" mode of intercommunication was automatically selected when any one of the following conditions occurred in flight: bailout warning relay actuated, encapsulate warning relay activated, or one or all escape capsules are closed. Contained within the escape capsules were personnel lead disconnects for microphone and headset connections plus an additional microphone button redundant to the normally used microphone button, and which was available for use during encapsulation to initiate radio transmission.



CABIN CENTER CONSOLE

TECHNICAL DESCRIPTION

SUBSYSTEM: MISSION TRAFFIC CONTROL SUBSYSTEM (MTCS) WBS CODE: 1.9

MAJOR ASSEMBLY: NAVIGATION AIDS EQUIPMENT WBS CODE: 1.9.2

The instrument landing system (ILS) equipment consisted of a 20 channel glide slope and localizer and a single-frequency marker beacon receiving set to provide the pilot and copilot with vertical and lateral guidance for landing when the system control was turned on and set for a desired localizer frequency, the correct glide slope frequency was automatically selected.

The TACAN receiver-transmitter contained the receiver, transmitter, azimuth and range circuits. In operation the receiver-transmitter continuously received from a selected surface beacon, random generated, paired pulse, amplitude modulated signals. Multiplexed with the filler signal were the precisely regulated paired pulse signals for reference bearing, variable bearing, station identification and distance reply. The distance signal was a reply to an interrogation signal initially generated and transmitted by the receiver-transmitter plus a 50-microsecond fixed delay at the beacon. The time lapse from interrogration to reply formed the basis for computation of the slant range distance from the aircraft to the surface beacon. The bearing information was determined by measuring the phase difference between the variable and reference bearing signals transmitted by the ground beacon. The reference signal phase remained constant for all points around the beacon. The variable signal phase varied as the aircraft bearing varied to the ground beacon. The control panel for the TACAN system was designed with a selector switch, channel knob and volume control. With the selector positioned at "OFF" all power was removed; at position "REC" only bearing information was provided; in the "T/R" position the transmitter became actuated and both bearing and range information received.

The air vehicle was provided with two anntenas which worked in conjunction with an automatic antenna selector which switched between the two antennas at a 70 cycle per minute rate. When either antenna received a sufficiently strong signal the selector would hold on that antenna. If the signal becomes weak the cycling would resume. This assured signal reception which might otherwise be obscured by the air vehicle configuration.

The TACAN system, when tuned to and operated in conjunction with a surface beacon, was designed to provide polar coordinate information with respect to a known geographical location which may be used for terminal or cross-country navigation.

TECHNICAL DESCRIPTION

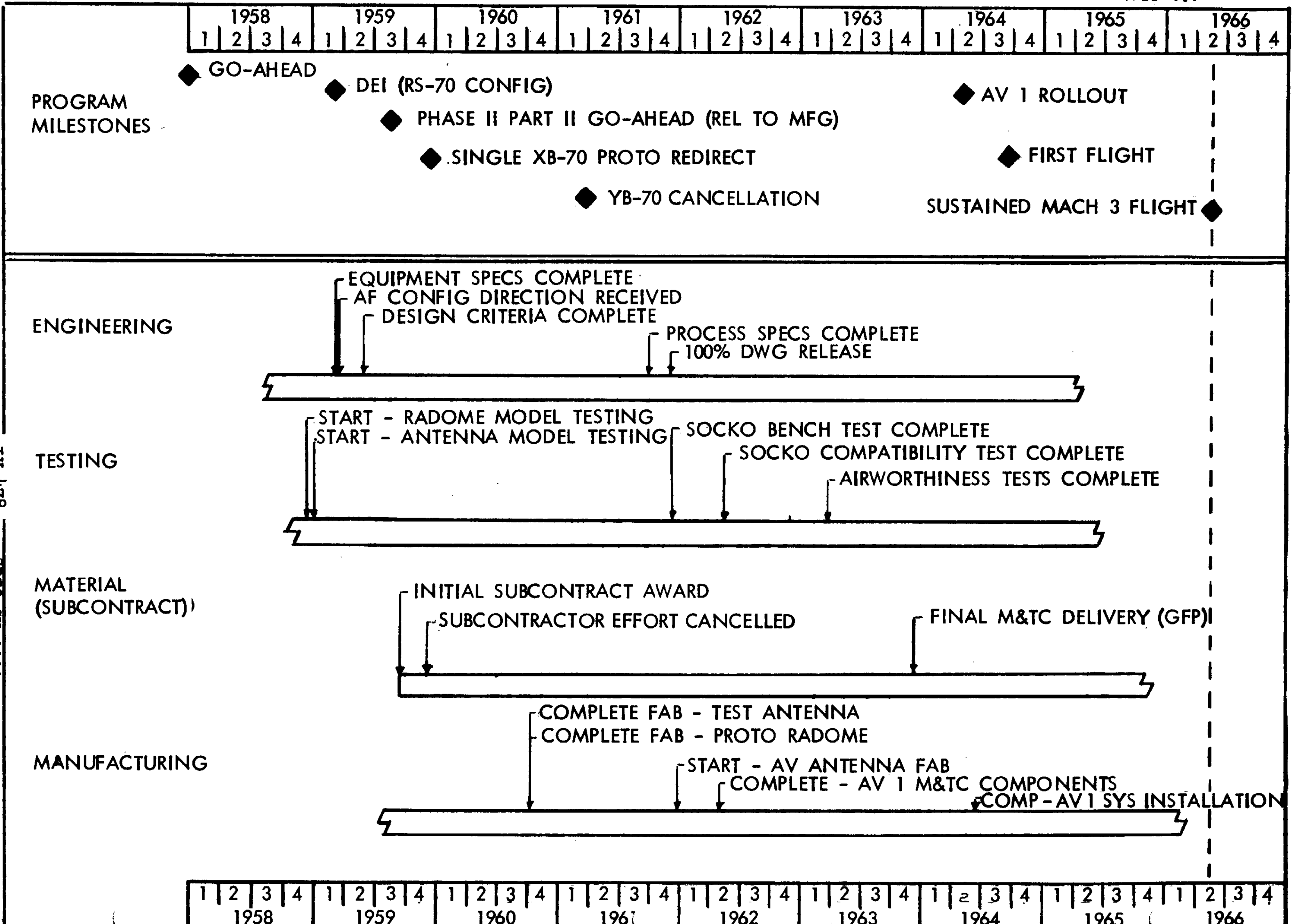
SUBSYSTEM: MISSION TRAFFIC CONTROL SUBSYSTEM (MTCS) WBS CODE: 1.9

MAJOR ASSEMBLY: IDENTIFICATION EQUIPMENT (IFF) WBS CODE: 1.9.3

The identification equipment consisted of a receiver-transmitter, antenna and antenna switching unit. The receiver-transmitter were designed to receive interrogation signals, process these signals through a coder-decoder circuitry and generate preselected reply signals in accordance with associated coder-decoder control settings. The transmit reply frequency was 1090 megacycle. The receiver frequency was 1030 megacycle. Front panel controls include adjustments for transmitter tuning, normal sensitivity, low sensitivity, and Mode 2 code selection. On the same panel an operation time totalizer and go-no-go self-test provision were also provided. The control panel also contained a rotary selector master switch with "OFF", "STANDBY", "LOW", "NORM", and "EMERGENCY" positions. In addition there was a Mode 2 toggle switch, Mode 3 toggle switch and an I/P (identification of position) toggle switch. There were also rotary selector switches designated Mode 1 and Mode 3 which, by their setting, established the frequency range between 960 to 1220 megacycles. Two of these antennas were incorporated in the air vehicle and operated in conjunction with an antenna lobing unit which provided signal reception and transmission which might otherwise be obscured by air vehicle attitude.

MISSION AND TRAFFIC CONTROL DEVELOPMENT SUMMARY

WBS 1.9



DEVELOPMENT SUMMARY
TABULATION OF DATES

Subsystem: Mission and Traffic Control	WBS 1.9
Engineering	
Equipment Specifications Complete	2-28-59
Air Force Configuration Direction Received	3-2-59
Design Criteria Complete	5-31-59
Process Specifications Complete	9-30-61
100% Drawing Release	12-2-61
Testing	
Start - Radome Model Testing	12-1-58
Start - Antenna Model Testing	1-1-59
Complete - SOCKO Bench Testing	12-15-61
Complete - SOCKO Compatibility Testing	5-15-62
Complete - Airworthiness Testing	3-22-63
Material	
Initial Subcontract Awarded	9-3-59
Subcontractor Effort Cancelled	12-3-59
Final M&TC Delivery (GFE)	12-6-63
Manufacturing	
Complete - Prototype Radome Fabrication	9-30-60
Complete - Test Antenna Fabrication	9-30-60
Start - Air Vehicle Antenna Fabrication	12-29-61
Complete - Air Vehicle No. 1 M&TC Components	4-27-62
Complete - Air Vehicle No. 1 System Installation	6-10-64

COST DEFINITION

SUBSYSTEM: MISSION AND TRAFFIC CONTROL WBS CODE: 1.9

Total costs presented in this WBS item include all identifiable expenditures to design, develop, ground test, fabricate and assemble all components, assemblies and developmental test hardware within the Mission and Traffic Control (M&TC) subsystem as defined by the WBS except for those items supplied to North American Rockwell as Government Furnished Equipment. The GFE items are:

a) 1.9.1.1 Command Radio Group
   Receivers/Transmitters
   Control Unit
   Antenna Selector Unit
   RF Transmission Line Switches

b) 1.9.1.2 Intercommunications Group
   Communications Control
   Ground Intercom Control
   Intercom Set

c) 1.9.2.1 Instrument Approach Equipment
   Glide Slope Receiver
   Localizer Receiver
   Control Assembly
   Marker Beacon Receiver

d) TACAN
   Receiver/Transmitter
   Control Indicator Assembly
   Antenna Selector Unit
   RF Transmission Line Switches

e) 1.9.3.1 Receiver/Transmitter

f) 1.9.3.2 IFF Control Assembly

g) 1.9.3.4 Antenna Lobing Switch

Total cost of $3,770,766 includes the following items:

1) developing subsystem specification requirements

2) subsystem installation and integration design

3) vendor coordination

4) in-house ground testing including design and development of models, mockups and simulators

5) subcontracted hardware including the supplier's cost for engineering, manufacturing, tooling and testing. (Suppliers terminated; equipment furnished as GFE.)

Excluded from the cost displayed for this subsystem are the in-house costs associated with the:

h) fabrication of subsystem provisions (brackets, racks, wire harnesses, shelves, supports, etc.)

i) miscellaneous purchased parts and installation materials

j) installation of the subsystem into the vehicles

k) subsystem, vehicle and preflight checkouts

l) GFE items

Costs for items (h) through (k) are contained in WBS 1.12 (Volume IV, page IV-647). Internal accounting procedures and the resultant cost reports do not provide a basis for establishing expenditures for these items by individual subsystems. Therefore, all costs are collected and reported in one WBS item. Refer to WBS 1.12 for additional information.

Detail of the recorded costs associated with this subsystem is provided by Element of Cost (EOC) and Subdivision of Work (SDW). Section III of Volume I provides a detail definition of these items. Further segregation of the cost data is provided by the WBS. All cost data is displayed at WBS level 5 (Mission and Traffic Control Subsystem, WBS 1.9) with the exception of in-house ground testing (WBS 1.9.5). Cost data can be located on the following pages:

		Cost Breakdown	Time-Phased Detail
WBS 1.9	$3,421,495	Page IV-484	Page IV-485
WBS 1.9.5 Ground Tests	$ 349,271	Page IV-484	Page IV-504
Total WBS 1.9	$3,770,766	Page IV-484	Page IV-511

A summary of the subcontractor recorded cost data is provided on page IV-483. Contractual arrangements, delivery dates, costs by supplier, quantity of hardware delivered and other pertinent data are provided. Cost data includes the supplier expenditures for engineering, production, tooling and testing (where identifiable) performed at the supplier's facility. Refer to the Subcontracting Element of Cost definition (Volume I, page I-26) for additional explanation.

As an aid in the definition and evaluation of the in-house engineering costs associated with this subsystem, a matrix of engineering hours has been developed. This matrix, displayed below, is a summary of all the in-house engineering groups that provided support to the design and development of the Mission and Traffic Control Subsystem.

WBS 1.9

Group No.	Title	Hours Expended
30	Numerical Design	3,907
48	Communication and Indicating System	75,340
49	Avionics Integration and Control	15,355
57	Engineering Specifications	17,726
75	Non-Metallics	3,068
86	Electronic Integration	24,025
95	Electrical System Design	11,315
97	Laboratory Services	5,078
110	Electrical Power Laboratory	38,493
125	Electrical System Equipment	1,507
	Miscellaneous	17,494
	Total	213,308 Hours

WBS 1.9	196,472	Hours	(page IV-484)
WBS 1.9.5	16,836	Hours	(page IV-484)
	213,308	Hours	(page IV-484)

Ground testing activities associated with the development of the Mission and Traffic Control Subsystem have been identified and the costs assigned to WBS 1.9.5 (page IV-504).These costs reflect the in-house expenditures only. Testing activities performed by the subcontractors where identified are included under WBS 1.9, Test/QC Subdivision of Work and the Subcontracting Element of Cost. The following is a summary of the major in-house test activities identified to this subsystem.

Description	Recorded Costs
Basic Recording Equipment - Air Vehicle No. 1	60,632
Impedance Model	53,744
Testing and Techniques Required to Reduce Radar Back Scatter	48,772
Radiation Pattern Tests - UHF Communications and Telemetry Antennas	11,073
High Frequency Tail Cap Antenna High Voltage Corona and Breakdown	10,473
Radiation Pattern Tests - Localize Glide Slope Antenna	9,197
Various	138,524
Costs (less MPC and G&A)	$332,415
Material Procurement Cost	11,249
General & Administrative	5,607
Total Cost WBS 1.9.5	$349,271

SUBCONTRACTOR MATRIX

Subsystem: Mission and Traffic Control WBS Code: 1.9

SUBCONTRACTOR	ENGINEERING	PROD	TOOLING	TEST	TOTAL
Motorola	968,890	122,940	-	382,356	1,474,186
Zenith Plastic	27,675	3,509	-	-	31,184
TOTAL	996,565	126,449		382,356	1,505,370

MOTOROLA was selected to produce the Mission and Traffic Control Subsystem Group and the Mission and Traffic Control Antenna Subsystem Group for the B-70.

Two contracts were awarded to Motorola for this effort:

L961-GX-600129	September 15, 1959 - December 3, 1959
L1E1-YX-600301	October 27, 1960 - - March 31, 1961

The Statement of Work required the subcontractor to provide design, development, test, production and related support necessary to produce the Mission and Traffic Control System for the B-70 Air Vehicle per NR specification.

The supplier was in the early design and development phase when Contract 600129 was terminated on December 3, 1959 for the convenience of the Government. The substantial portion of the work accomplished was in the managing and planning effort of the development and fabrication tasks, both within Motorola and at their subcontractors. The contract was 47.5% complete at the time of termination.

When the B-70 Program was reinstated in 1960, Motorola was awarded Letter Contract 600301 for the continuation of the Mission and Traffic Control Subsystem on October 27, 1960. The contract was 62.6% complete on March 31, 1961, the date the contract was terminated for the convenience of the Government. The substantial portion of the effort completed was in the engineering, management, and support areas.

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09
MISSION AND TRAFFIC CONTROL SUBSYSTEM

	6-M ASSY 0 HOURS DOLLARS	6-M ASSY 05 HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	196472	16836	213308
LABOR AT $ 4.666	928712	66538	995250
ENGR BURDEN AT $ 4.260	843906	64688	908594
SHOP SUPPORT	1427	14796	16223
LABOR AT $ 2.926	4213	43260	47473
TEST/QC	68	703	771
LABOR AT $ 3.394	200	2417	2617
MFG BURDEN AT $ 3.699	5676	57184	62860
ENGR MATERIAL	245	98212	98457
SUBCONTRACT	1505370		1505370
MPC	74289	11249	85538
OTHER COST	9041	116	9157
SUB-TOTAL	3371652	343664	3715316
GEN & ADMIN	49843	5607	55450
TOTAL COST	3421495	349271	3770766

SUBDIVISION OF WORK
COST DETAIL - SEE PAGE IV-485 IV-504 IV-511

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
6-MAJ ASSY 0

		DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TEST /QC HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING		196472			196472
LABOR AT $ 4.727		928712			928712
ENGR BURDEN	AT $ 4.295	843906			843906
SHOP SUPPORT		1427			1427
LABOR AT $ 2.952		4213			4213
TEST/QC		68			68
LABOR AT $ 2.941		200			200
MFG BURDEN	AT $ 3.797	5676			5676
ENGR MATERIAL		245			245
SUBCONTRACT		996565	126449	382356	1505370
MPC		51860	6235	16194	74289
OTHER COST		9041			9041
SUB-TOTAL		2840418	132684	398550	3371652
GEN & ADMIN		39919	2431	7493	49843
TOTAL COST		2880337	135115	406043	3421495
TIME-PHASED COST DETAIL - SEE PAGE		IV-486	IV-494	IV-495	IV-496

a-6.

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 09 MISSION AND TRAFFIC CONTROL SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	15.0	2605	4.382	11415	11852	23267
Q-2 58						
Q-3 58	99.0	16556	4.261	70537	65031	135568
Q-4 58						
Q-1 59	124.5	21353	4.132	88221	73551	161772
Q-2 59						
Q-3 59	168.0	29494	4.008	118219	106203	224422
Q-4 59						
Q-1 60	116.5	20143	4.606	92783	75259	168042
Q-2 60						
Q-3 60	54.0	9055	4.945	44778	33435	78213
Q-4 60						
Q-1 61	120.0	20484	4.580	93819	68809	162628
Q-2 61						
Q-3 61	76.0	13750	5.034	69216	68827	138043
Q-4 61						
Q-1 62	85.5	14673	5.333	78248	67719	145967
Q-2 62						
Q-3 62	94.5	15807	5.275	83387	80146	163533
Q-4 62						
Q-1 63	61.5	10453	5.727	59867	56814	116681
Q-2 63						
Q-3 63	52.0	8710	5.225	45510	50125	95635
Q-4 63						
Q-1 64	39.5	6765	8.219	55599	42213	97812
Q-2 64						
Q-3 64	31.5	5485	1.574	8635	36406	45041
Q-4 64						
Q-1 65	4.5	745	7.447	5548	4919	10467

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NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-2 65						
Q-3 65	1.5	367	7.452	2735	2424	5159
Q-4 65						
Q-1 66		27	7.222	195	173	368
TOTAL	1143.5	196472		928712	843906	1772618

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 09 MISSION AND TRAFFIC CONTROL SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58					123	123
Q-4 58						
Q-1 59						
Q-2 59						
Q-3 59	1.5	138	3.645	503	482	985
Q-4 59						
Q-1 60	7.5	1268	2.865	3633	5246	8879
Q-2 60						
Q-3 60		21	3.667	77	-175	-98
Q-4 60						
Q-1 61						
Q-2 61						
Q-3 61						
Q-4 61						
Q-1 62		3	3.000	9	14	23
Q-2 62						
Q-3 62		-3	3.000	-9	-14	-23
TOTAL	9.0	1427		4213	5676	9889

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		34	2.971	101		101
Q-4 58						
Q-1 59						
Q-2 59						
Q-3 59		4	3.250	13		13
Q-4 59						
Q-1 60		30	2.867	86		86
TOTAL		68		200		200

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09 MISSION AND TRAFFIC CONTROL SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	15.0	2605	4.382	11415	11852	23267	
Q-2 58							
Q-3 58	99.0	16590	4.258	70638	65154	135792	
Q-4 58							
Q-1 59	124.5	21353	4.132	88221	73551	161772	
Q-2 59							
Q-3 59	169.5	29636	4.006	118735	106685	225420	240
Q-4 59							
Q-1 60	124.0	21441	4.501	96502	80505	177007	-15
Q-2 60							
Q-3 60	54.0	9076	4.942	44855	33260	78115	20
Q-4 60							
Q-1 61	120.0	20484	4.580	93819	68809	162628	
Q-2 61							
Q-3 61	76.0	13750	5.034	69216	68827	138043	
Q-4 61							
Q-1 62	85.5	14676	5.332	78257	67733	145990	
Q-2 62							
Q-3 62	94.5	15804	5.276	83378	80132	163510	
Q-4 62							
Q-1 63	61.5	10453	5.727	59867	56814	116681	
Q-2 63							
Q-3 63	52.0	8710	5.225	45510	50125	95635	
Q-4 63							
Q-1 64	39.5	6765	8.219	55599	42213	97812	
Q-2 64							
Q-3 64	31.5	5485	1.574	8635	36406	45041	
Q-4 64							
Q-1 65	4.5	745	7.447	5548	4919	10467	
Q-2 65							
Q-3 65	1.5	367	7.452	2735	2424	5159	

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

MISSION AND TRAFFIC CONTROL SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-4 65							
Q-1 66		27	7.222	195	173	368	
TOTAL	1152.5	197967		933125	849582	1782707	245

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09 MISSION AND TRAFFIC CONTROL SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58				264	23531		23531
Q-2 58							
Q-3 58				16	135808		135808
Q-4 58							
Q-1 59	22308	22308	591		184671		184671
Q-2 59							
Q-3 59	22308	22548	641		248609		248609
Q-4 59							
Q-1 60	558349	558334	33124	2938	771403	14698	786101
Q-2 60							
Q-3 60	202935	202955	12042	1222	294334	5608	299942
Q-4 60							
Q-1 61	136972	136972	3924	2885	306409	5694	312103
Q-2 61							
Q-3 61	53693	53693	1538	935	194209	3608	197817
Q-4 61							
Q-1 62				58	146048	2451	148499
Q-2 62							
Q-3 62				269	163779	2749	166528
Q-4 62							
Q-1 63				422	117103	1958	119061
Q-2 63							
Q-3 63				-1	95634	1599	97233
Q-4 63							
Q-1 64				17	97829	167	97996
Q-2 64							
Q-3 64				16	45057	959	46016
Q-4 64							
Q-1 65					10467	279	10746
Q-2 65							
Q-3 65					5159	138	5297

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-4 65							
Q-1 66					368	11	379
TOTAL	996565	996810	51360	9041	2840418	39919	2880337

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09 MISSION AND TRAFFIC CONTROL SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK PRODUCTION

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 59	2046	54	2100		2100
Q-2 59					
Q-3 59	2046	55	2101		2101
Q-4 59					
Q-1 60	59728	3543	63271	1206	64477
Q-2 60					
Q-3 60	25750	1527	27277	520	27797
Q-4 60					
Q-1 61	30069	861	30930	575	31505
Q-2 61					
Q-3 61	6810	195	7005	130	7135
TOTAL	126449	6235	132684	2431	135115

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK TEST/QC

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 60	92981	5516	98497	1877	100374
Q-2 60					
Q-3 60	77863	4619	82482	1572	84054
Q-4 60					
Q-1 61	190923	5470	196393	3650	200043
Q-2 61					
Q-3 61	20589	589	21178	394	21572
TOTAL	382356	16194	398550	7493	406043

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 09 MISSION AND TRAFFIC CONTROL SUBSYSTEM
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	15.0	2605	4.382	11415	11852	23267
Q-2 58						
Q-3 58	99.0	16556	4.261	70537	65031	135568
Q-4 58						
Q-1 59	124.5	21353	4.132	88221	73551	161772
Q-2 59						
Q-3 59	168.0	29494	4.008	118219	106203	224422
Q-4 59						
Q-1 60	116.5	20143	4.606	92783	75259	168042
Q-2 60						
Q-3 60	54.0	9055	4.945	44778	33435	78213
Q-4 60						
Q-1 61	120.0	20484	4.580	93819	68809	162628
Q-2 61						
Q-3 61	76.0	13750	5.034	69216	68827	138043
Q-4 61						
Q-1 62	85.5	14673	5.333	78248	67719	145967
Q-2 62						
Q-3 62	94.5	15807	5.275	83387	80146	163533
Q-4 62						
Q-1 63	61.5	10453	5.727	59867	56814	116681
Q-2 63						
Q-3 63	52.0	8710	5.225	45510	50125	95635
Q-4 63						
Q-1 64	39.5	6765	8.219	55599	42213	97812
Q-2 64						
Q-3 64	31.5	5485	1.574	8635	36406	45041
Q-4 64						
Q-1 65	4.5	745	7.447	5548	4919	10467
Q-2 65						

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	1.5	367	7.452	2735	2424	5159
Q-4 65						
Q-1 66		27	7.222	195	173	368
TOTAL	1143.5	196472		928712	843906	1772618

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58					123	123
Q-4 58						
Q-1 59						
Q-2 59						
Q-3 59	1.5	138	3.645	503	482	985
Q-4 59						
Q-1 60	7.5	1268	2.865	3633	5246	8879
Q-2 60						
Q-3 60		21	3.667	77	-175	-98
Q-4 60						
Q-1 61						
Q-2 61						
Q-3 61						
Q-4 61						
Q-1 62		3	3.000	9	14	23
Q-2 62						
Q-3 62		-3	3.000	-9	-14	-23
TOTAL	9.0	1427		4213	5676	9889

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	TEST/QC	
4-SYSTEM	1	
5-SUBSYSTEM	09	**MISSION AND TRAFFIC CONTROL SUBSYSTEM**
6-MAJ ASSY	0	

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		34	2.971	101		101
Q-4 58						
Q-1 59						
Q-2 59						
Q-3 59		4	3.250	13		13
Q-4 59						
Q-1 60		30	2.867	86		86
TOTAL		68		200		200

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
6-MAJ ASSY 0

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	15.0	2605	4.382	11415	11852	23267	
Q-2 58							
Q-3 58	99.0	16590	4.258	70638	65154	135792	
Q-4 58							
Q-1 59	124.5	21353	4.132	88221	73551	161772	
Q-2 59							
Q-3 59	169.5	29636	4.006	118735	106635	225420	240
Q-4 59							
Q-1 60	124.0	21441	4.501	96502	80505	177007	-15
Q-2 60							
Q-3 60	54.0	9076	4.942	44855	33260	78115	20
Q-4 60							
Q-1 61	120.0	20484	4.580	93819	68809	162628	
Q-2 61							
Q-3 61	76.0	13750	5.034	69216	68827	138043	
Q-4 61							
Q-1 62	85.5	14676	5.332	78257	67733	145990	
Q-2 62							
Q-3 62	94.5	15804	5.276	83378	80132	163510	
Q-4 62							
Q-1 63	61.5	10453	5.727	59867	56814	116681	
Q-2 63							
Q-3 63	52.0	8710	5.225	45510	50125	95635	
Q-4 63							
Q-1 64	39.5	6765	8.219	55599	42213	97812	
Q-2 64							
Q-3 64	31.5	5485	1.574	8635	36406	45041	
Q-4 64							
Q-1 65	4.5	745	7.447	5548	4919	10467	
Q-2 65							
Q-3 65	1.5	367	7.452	2735	2424	5159	
Q-4 65							

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
6-MAJ ASSY 0

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66		27	7.222	195	173	368	
TOTAL	1152.5	197967		933125	849582	1782707	245

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09 MISSION AND TRAFFIC CONTROL SUBSYSTEM
6-MAJ ASSY 0

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58				264	23531		23531
Q-2 58							
Q-3 58				16	135808		135808
Q-4 58							
Q-1 59	24354	24354	645		186771		186771
Q-2 59							
Q-3 59	24354	24594	696		250710		250710
Q-4 59							
Q-1 60	711058	711043	42183	2938	933171	17781	950952
Q-2 60							
Q-3 60	306548	306568	18188	1222	404093	7700	411793
Q-4 60							
Q-1 61	357964	357964	10255	2885	533732	9919	543651
Q-2 61							
Q-3 61	81092	81092	2322	935	222392	4132	226524
Q-4 61							
Q-1 62				58	146048	2451	148499
Q-2 62							
Q-3 62				269	163779	2749	166528
Q-4 62							
Q-1 63				422	117103	1958	119061
Q-2 63							
Q-3 63				-1	95634	1599	97233
Q-4 63							
Q-1 64				17	97829	167	97996
Q-2 64							
Q-3 64				16	45057	959	46016
Q-4 64							
Q-1 65					10467	279	10746
Q-2 65							
Q-3 65					5159	138	5297
Q-4 65							

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09 MISSION AND TRAFFIC CONTROL SUBSYSTEM
6-MAJ ASSY 0

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 66					368	11	379
TOTAL	1505370	1505615	74289	9041	3371652	49843	3421495

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09
6-MAJ ASSY 05
MISSION AND TRAFFIC CONTROL GROUND TESTS

	TEST /QC HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	16836	16836
LABOR AT $ 3.952	66538	66538
ENGR BURDEN AT $ 3.842	64688	64688
SHOP SUPPORT	14796	14796
LABOR AT $ 2.924	43260	43260
TEST/QC	703	703
LABOR AT $ 3.438	2417	2417
MFG BURDEN AT $ 3.690	57184	57184
ENGR MATERIAL	98212	98212
MPC	11249	11249
OTHER COST	116	116
SUB-TOTAL	343664	343664
GEN & ADMIN	5607	5607
TOTAL COST	349271	349271

TIME-PHASED COST
DETAIL - SEE PAGE IV-505

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL GROUND TESTS**
6-MAJ ASSY 05
SUBD CF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 60	40.5	6919	4.050	28020	25893	53913
Q-4 60						
Q-1 61	36.0	6069	3.892	23623	20627	44250
Q-2 61						
Q-3 61	15.0	2727	3.795	10349	13236	23585
Q-4 61						
Q-1 62	3.0	505	4.238	2140	2325	4465
Q-2 62						
Q-3 62		66	4.833	319	438	757
Q-4 62						
Q-1 63					3	3
Q-2 63						
Q-3 63	1.5	351	3.954	1388	1470	2858
Q-4 63						
Q-1 64		68	3.500	238	237	475
Q-2 64						
Q-3 64		67	3.537	237	235	472
Q-4 64						
Q-1 65		45	3.489	157	158	315
Q-2 65						
Q-3 65		18	3.444	62	62	124
Q-4 65						
Q-1 66		1	5.000	5	4	9
TOTAL	96.0	16836		66538	64688	131226

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 09
6-MAJ ASSY 05
SUBD OF WORK TEST/QC

MISSION AND TRAFFIC CONTROL GROUND TESTS

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	1.5	250	2.772	693	906	1599
Q-4 58						
Q-1 59	12.0	2136	3.047	6509	7896	14405
Q-2 59						
Q-3 59	18.0	3145	2.837	8922	12876	21798
Q-4 59						
Q-1 60	-1.5	-227	.608	-138	-1495	-1633
Q-2 60						
Q-3 60	6.0	884	2.859	2527	4397	6924
Q-4 60						
Q-1 61	30.0	5009	3.094	15498	17202	32700
Q-2 61						
Q-3 61	10.5	1996	2.770	5529	8869	14398
Q-4 61						
Q-1 62	9.0	1439	2.459	3539	5558	9097
Q-2 62						
Q-3 62	3.0	432	2.602	1124	1903	3027
Q-4 62						
Q-1 63					5	5
Q-2 63						
Q-3 63		2	3.000	6	6	12
Q-4 63						
Q-1 64		8	2.625	21	34	55
Q-2 64						
Q-3 64					1	1
Q-4 64						
Q-1 65		-83	2.675	-222	-226	-448
Q-2 65						
Q-3 65		-78	3.487	-272	-272	-544

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
DATA PREPARED UNDER
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL GROUND TESTS**
6-MAJ ASSY 05
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-4 65						
Q-1 66		-117	4.068	-476	-476	-952
TOTAL	88.5	14796		43260	57184	100444

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	TEST/QC	
4-SYSTEM	1	
5-SUBSYSTEM	09	**MISSION AND TRAFFIC CONTROL GROUND TESTS**
6-MAJ ASSY	05	
SUBD OF WORK	TEST/QC	

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 59		14	3.357	47		47
Q-2 59						
Q-3 59		63	2.889	182		182
Q-4 59						
Q-1 60		5	3.200	16		16
Q-2 60						
Q-3 60	1.5	267	3.547	947		947
Q-4 60						
Q-1 61	1.5	221	2.995	662		662
Q-2 61						
Q-3 61	1.0	135	4.104	554		554
Q-4 61						
Q-1 62		-1	8.999	9		9
Q-2 62						
Q-3 62						
Q-4 62						
Q-1 63						
Q-2 63						
Q-3 63		-1				
Q-4 63						
Q-1 64						
Q-2 64						
Q-3 64						
Q-4 64						
Q-1 65						
TOTAL	4.0	703		2417		2417

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09
6-MAJ ASSY 05
MISSION AND TRAFFIC CONTROL GROUND TESTS

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-3 58	1.5	250	2.772	693	906	1599	93
Q-4 58							
Q-1 59	12.0	2150	3.049	6556	7896	14452	1623
Q-2 59							
Q-3 59	18.0	3208	2.838	9104	12876	21980	852
Q-4 59							
Q-1 60	-1.5	-222	.550	-122	-1495	-1617	208
Q-2 60							
Q-3 60	48.0	8070	3.903	31494	30290	61784	3518
Q-4 60							
Q-1 61	67.5	11299	3.521	39783	37829	77612	37272
Q-2 61							
Q-3 61	26.5	4858	3.382	16432	22105	38537	8813
Q-4 61							
Q-1 62	12.0	1943	2.927	5688	7883	13571	2234
Q-2 62							
Q-3 62	3.0	498	2.898	1443	2341	3784	243
Q-4 62							
Q-1 63					8	8	26193
Q-2 63							
Q-3 63	1.5	352	3.960	1394	1476	2870	3509
Q-4 63							
Q-1 64		76	3.408	259	271	530	4565
Q-2 64							
Q-3 64		67	3.537	237	236	473	6450
Q-4 64							
Q-1 65		-38	1.711	-65	-68	-133	1848
Q-2 65							
Q-3 65		-60	3.500	-210	-210	-420	739
Q-4 65							
Q-1 66		-116	4.060	-471	-472	-943	52
TOTAL	188.5	32335		112215	121872	234087	98212

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09
6-MAJ ASSY 05
MISSION AND TRAFFIC CONTROL GROUND TESTS

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-3 58	5		1697		1697
Q-4 58					
Q-1 59	137		16212		16212
Q-2 59					
Q-3 59	72		22904		22904
Q-4 59					
Q-1 60	27		-1382	-26	-1408
Q-2 60					
Q-3 60	463		65765	1253	67018
Q-4 60					
Q-1 61	3149		118033	2193	120226
Q-2 61					
Q-3 61	745	72	48167	895	49062
Q-4 61					
Q-1 62	176	1	15982	268	16250
Q-2 62					
Q-3 62	19		4046	68	4114
Q-4 62					
Q-1 63	2580		28781	481	29262
Q-2 63					
Q-3 63	346	37	6762	113	6875
Q-4 63					
Q-1 64	487	2	5584	119	5703
Q-2 64					
Q-3 64	2347	1	9271	197	9468
Q-4 64					
Q-1 65	553	2	2270	61	2331
Q-2 65					
Q-3 65	132	1	452	12	464
Q-4 65					
Q-1 66	11		-880	-27	-907
TOTAL	11249	116	343664	5607	349271

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09
MISSION AND TRAFFIC CONTROL SUBSYSTEM

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TEST /QC HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	196472		16836	213308
LABOR AT $ 4.666	928712		66538	995250
ENGR BURDEN AT $ 4.260	843906		64688	908594
SHOP SUPPORT	1427		14796	16223
LABOR AT $ 2.926	4213		43260	47473
TEST/QC	68		703	771
LABOR AT $ 3.394	200		2417	2617
MFG BURDEN AT $ 3.699	5676		57184	62860
ENGR MATERIAL	245		98212	98457
SUBCONTRACT	996565	126449	382356	1505370
MPC	51860	6235	27443	85538
OTHER COST	9041		116	9157
SUB-TOTAL	2840418	132684	742214	3715316
GEN & ADMIN	39919	2431	13100	55450
TOTAL COST	2880337	135115	755314	3770766

TIME-PHASED COST DETAIL - SEE PAGE IV-512 IV-520 IV-521 IV-527

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	15.0	2605	4.382	11415	11852	23267
Q-2 58						
Q-3 58	99.0	16556	4.261	70537	65031	135568
Q-4 58						
Q-1 59	124.5	21353	4.132	88221	73551	161772
Q-2 59						
Q-3 59	168.0	29494	4.008	118219	106203	224422
Q-4 59						
Q-1 60	116.5	20143	4.606	92783	75259	168042
Q-2 60						
Q-3 60	54.0	9055	4.945	44778	33435	78213
Q-4 60						
Q-1 61	120.0	20484	4.580	93819	68809	162628
Q-2 61						
Q-3 61	76.0	13750	5.034	69216	68827	138043
Q-4 61						
Q-1 62	85.5	14673	5.333	78248	67719	145967
Q-2 62						
Q-3 62	94.5	15807	5.275	83387	80146	163533
Q-4 62						
Q-1 63	61.5	10453	5.727	59867	56814	116681
Q-2 63						
Q-3 63	52.0	8710	5.225	45510	50125	95635
Q-4 63						
Q-1 64	39.5	6765	8.219	55599	42213	97812
Q-2 64						
Q-3 64	31.5	5485	1.574	8635	36406	45041
Q-4 64						
Q-1 65	4.5	745	7.447	5548	4919	10467
Q-2 65						

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	1.5	367	7.452	2735	2424	5159
Q-4 65						
Q-1 66		27	7.222	195	173	368
TOTAL	1143.5	196472		928712	843906	1772618

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58					123	123
Q-4 58						
Q-1 59						
Q-2 59						
Q-3 59	1.5	138	3.645	503	482	985
Q-4 59						
Q-1 60	7.5	1268	2.865	3633	5246	8879
Q-2 60						
Q-3 60		21	3.667	77	-175	-98
Q-4 60						
Q-1 61						
Q-2 61						
Q-3 61						
Q-4 61						
Q-1 62		3	3.000	9	14	23
Q-2 62						
Q-3 62		-3	3.000	-9	-14	-23
TOTAL	9.0	1427		4213	5676	9889

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		34	2.971	101		101
Q-4 58						
Q-1 59						
Q-2 59						
Q-3 59		4	3.250	13		13
Q-4 59						
Q-1 60		30	2.867	86		86
TOTAL		68		200		200

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1 MISSION AND TRAFFIC CONTROL SUBSYSTEM
5-SUBSYSTEM 09
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	15.0	2605	4.382	11415	11852	23267	
Q-2 58							
Q-3 58	99.0	16590	4.258	70638	65154	135792	
Q-4 58							
Q-1 59	124.5	21353	4.132	88221	73551	161772	
Q-2 59							
Q-3 59	169.5	29636	4.006	118735	106685	225420	240
Q-4 59							
Q-1 60	124.0	21441	4.501	96502	80505	177007	-15
Q-2 60							
Q-3 60	54.0	9076	4.942	44855	33260	78115	20
Q-4 60							
Q-1 61	120.0	20484	4.580	93819	68809	162628	
Q-2 61							
Q-3 61	76.0	13750	5.034	69216	68827	138043	
Q-4 61							
Q-1 62	85.5	14676	5.332	78257	67733	145990	
Q-2 62							
Q-3 62	94.5	15804	5.276	83378	80132	163510	
Q-4 62							
Q-1 63	61.5	10453	5.727	59867	56814	116681	
Q-2 63							
Q-3 63	52.0	8710	5.225	45510	50125	95635	
Q-4 63							
Q-1 64	39.5	6765	8.219	55599	42213	97812	
Q-2 64							
Q-3 64	31.5	5485	1.574	8635	36406	45041	
Q-4 64							
Q-1 65	4.5	745	7.447	5548	4919	10467	
Q-2 65							
Q-3 65	1.5	367	7.452	2735	2424	5159	
Q-4 65							

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66		27	7.222	195	173	368	
TOTAL	1152.5	197967		933125	849582	1782707	245

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
SUBD OF WORK DESIGN/ENGINEERING

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58				264	23531		23531
Q-2 58							
Q-3 58				16	135808		135808
Q-4 58							
Q-1 59	22308	22308	591		184671		184671
Q-2 59							
Q-3 59	22308	22548	641		248609		248609
Q-4 59							
Q-1 60	558349	558334	33124	2938	771403	14698	786101
Q-2 60							
Q-3 60	202935	202955	12042	1222	294334	5608	299942
Q-4 60							
Q-1 61	136972	136972	3924	2885	306409	5694	312103
Q-2 61							
Q-3 61	53693	53693	1538	935	194209	3608	197817
Q-4 61							
Q-1 62				58	146048	2451	148499
Q-2 62							
Q-3 62				269	163779	2749	166528
Q-4 62							
Q-1 63				422	117103	1958	119061
Q-2 63							
Q-3 63				-1	95634	1599	97233
Q-4 63							
Q-1 64				17	97829	167	97996
Q-2 64							
Q-3 64				16	45057	959	46016
Q-4 64							
Q-1 65					10467	279	10746
Q-2 65							
Q-3 65					5159	138	5297
Q-4 65							

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
SUBD OF WORK DESIGN/ENGINEERING

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 66					368	11	379
TOTAL	996565	996810	51860	9041	2840418	39919	2880337

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09 MISSION AND TRAFFIC CONTROL SUBSYSTEM
SUBD OF WORK PRODUCTION

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 59	2046	54	2100		2100
Q-2 59					
Q-3 59	2046	55	2101		2101
Q-4 59					
Q-1 60	59728	3543	63271	1206	64477
Q-2 60					
Q-3 60	25750	1527	27277	520	27797
Q-4 60					
Q-1 61	30069	861	30930	575	31505
Q-2 61					
Q-3 61	6810	195	7005	130	7135
TOTAL	126449	6235	132684	2431	135115

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 60	40.5	6919	4.050	28020	25893	53913
Q-4 60						
Q-1 61	36.0	6069	3.892	23623	20627	44250
Q-2 61						
Q-3 61	15.0	2727	3.795	10349	13236	23585
Q-4 61						
Q-1 62	3.0	505	4.238	2140	2325	4465
Q-2 62						
Q-3 62		66	4.833	319	438	757
Q-4 62						
Q-1 63					3	3
Q-2 63						
Q-3 63	1.5	351	3.954	1388	1470	2858
Q-4 63						
Q-1 64		68	3.500	238	237	475
Q-2 64						
Q-3 64		67	3.537	237	235	472
Q-4 64						
Q-1 65		45	3.489	157	158	315
Q-2 65						
Q-3 65		18	3.444	62	62	124
Q-4 65						
Q-1 66		1	5.000	5	4	9
TOTAL	96.0	16836		66538	64688	131226

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	1.5	250	2.772	693	906	1599
Q-4 58						
Q-1 59	12.0	2136	3.047	6509	7896	14405
Q-2 59						
Q-3 59	18.0	3145	2.837	8922	12876	21798
Q-4 59						
Q-1 60	-1.5	-227	.608	-138	-1495	-1633
Q-2 60						
Q-3 60	6.0	884	2.859	2527	4397	6924
Q-4 60						
Q-1 61	30.0	5009	3.094	15498	17202	32700
Q-2 61						
Q-3 61	10.5	1996	2.770	5529	8869	14398
Q-4 61						
Q-1 62	9.0	1439	2.459	3539	5558	9097
Q-2 62						
Q-3 62	3.0	432	2.602	1124	1903	3027
Q-4 62						
Q-1 63					5	5
Q-2 63						
Q-3 63		2	3.000	6	6	12
Q-4 63						
Q-1 64		8	2.625	21	34	55
Q-2 64						
Q-3 64					1	1
Q-4 64						
Q-1 65		-83	2.675	-222	-226	-448
Q-2 65						
Q-3 65		-78	3.487	-272	-272	-544
Q-4 65						

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
DATA PREPARED UNDER
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 66		-117	4.068	-476	-476	-952
TOTAL	88.5	14796		43260	57184	100444

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 59		14	3.357	47		47
Q-2 59						
Q-3 59		63	2.889	182		182
Q-4 59						
Q-1 60		5	3.200	16		16
Q-2 60						
Q-3 60	1.5	267	3.547	947		947
Q-4 60						
Q-1 61	1.5	221	2.995	662		662
Q-2 61						
Q-3 61	1.0	135	4.104	554		554
Q-4 61						
Q-1 62		-1	8.999	9		9
Q-2 62						
Q-3 62						
Q-4 62						
Q-1 63						
Q-2 63						
Q-3 63		-1				
Q-4 63						
Q-1 64						
Q-2 64						
Q-3 64						
Q-4 64						
Q-1 65						
TOTAL	4.0	703		2417		2417

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
SUBD OF WORK TEST/QC

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-3 58	1.5	250	2.772	693	906	1599	93
Q-4 58							
Q-1 59	12.0	2150	3.049	6556	7896	14452	1623
Q-2 59							
Q-3 59	18.0	3208	2.838	9104	12876	21980	852
Q-4 59							
Q-1 60	-1.5	-222	.550	-122	-1495	-1617	208
Q-2 60							
Q-3 60	48.0	8070	3.903	31494	30290	61784	3518
Q-4 60							
Q-1 61	67.5	11299	3.521	39783	37829	77612	37272
Q-2 61							
Q-3 61	26.5	4858	3.382	16432	22105	38537	8813
Q-4 61							
Q-1 62	12.0	1943	2.927	5688	7883	13571	2234
Q-2 62							
Q-3 62	3.0	498	2.898	1443	2341	3784	243
Q-4 62							
Q-1 63					8	8	26193
Q-2 63							
Q-3 63	1.5	352	3.960	1394	1476	2870	3509
Q-4 63							
Q-1 64		76	3.408	259	271	530	4565
Q-2 64							
Q-3 64		67	3.537	237	236	473	6450
Q-4 64							
Q-1 65		-38	1.711	-65	-68	-133	1848
Q-2 65							
Q-3 65		-60	3.500	-210	-210	-420	739
Q-4 65							
Q-1 66		-116	4.060	-471	-472	-943	52
TOTAL	188.5	32335		112215	121872	234087	98212

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09 **MISSION AND TRAFFIC CONTROL SUBSYSTEM**
SUBD OF WORK TEST/QC

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-3 58		93	5		1697		1697
Q-4 58							
Q-1 59		1623	137		16212		16212
Q-2 59							
Q-3 59		852	72		22904		22904
Q-4 59							
Q-1 60	92981	93189	5543		97115	1851	98966
Q-2 60							
Q-3 60	77863	81381	5082		148247	2825	151072
Q-4 60							
Q-1 61	190923	228195	8619		314426	5843	320269
Q-2 61							
Q-3 61	20589	29402	1334	72	69345	1289	70634
Q-4 61							
Q-1 62		2234	176	1	15982	268	16250
Q-2 62							
Q-3 62		243	19		4046	68	4114
Q-4 62							
Q-1 63		26193	2580		28781	481	29262
Q-2 63							
Q-3 63		3509	346	37	6762	113	6875
Q-4 63							
Q-1 64		4565	487	2	5584	119	5703
Q-2 64							
Q-3 64		6450	2347	1	9271	197	9468
Q-4 64							
Q-1 65		1848	553	2	2270	61	2331
Q-2 65							
Q-3 65		739	132	1	452	12	464
Q-4 65							
Q-1 66		52	11		-880	-27	-907
TOTAL	382356	480568	27443	116	742214	13100	755314

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 09
MISSION AND TRAFFIC CONTROL SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	15.0	2605	4.382	11415	11852	23267
Q-2 58						
Q-3 58	99.0	16556	4.261	70537	65031	135568
Q-4 58						
Q-1 59	124.5	21353	4.132	88221	73551	161772
Q-2 59						
Q-3 59	168.0	29494	4.008	118219	106203	224422
Q-4 59						
Q-1 60	116.5	20143	4.606	92783	75259	168042
Q-2 60						
Q-3 60	94.5	15974	4.557	72798	59328	132126
Q-4 60						
Q-1 61	156.0	26553	4.423	117442	89436	206878
Q-2 61						
Q-3 61	91.0	16477	4.829	79565	82063	161628
Q-4 61						
Q-1 62	88.5	15178	5.296	80388	70044	150432
Q-2 62						
Q-3 62	94.5	15873	5.273	83706	80584	164290
Q-4 62						
Q-1 63	61.5	10453	5.727	59867	56817	116684
Q-2 63						
Q-3 63	54.0	9061	5.176	46898	51595	98493
Q-4 63						
Q-1 64	40.5	6833	8.172	55837	42450	98287
Q-2 64						
Q-3 64	31.5	5552	1.598	8872	36641	45513
Q-4 64						
Q-1 65	4.5	790	7.222	5705	5077	10782
Q-2 65						

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 09
MISSION AND TRAFFIC CONTROL SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	3.0	385	7.265	2797	2486	5283
Q-4 65						
Q-1 66		28	7.143	200	177	377
TOTAL	1242.5	213308		995250	908594	1903844

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 09
MISSION AND TRAFFIC CONTROL SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	1.5	250	2.772	693	1029	1722
Q-4 58						
Q-1 59	12.0	2136	3.047	6509	7896	14405
Q-2 59						
Q-3 59	18.0	3283	2.871	9425	13358	22783
Q-4 59						
Q-1 60	6.0	1041	3.357	3495	3751	7246
Q-2 60						
Q-3 60	6.0	905	2.877	2604	4222	6826
Q-4 60						
Q-1 61	30.0	5009	3.094	15498	17202	32700
Q-2 61						
Q-3 61	10.5	1996	2.770	5529	8869	14398
Q-4 61						
Q-1 62	9.0	1442	2.460	3548	5572	9120
Q-2 62						
Q-3 62	3.0	429	2.599	1115	1889	3004
Q-4 62						
Q-1 63					5	5
Q-2 63						
Q-3 63		2	3.000	6	6	12
Q-4 63						
Q-1 64		8	2.625	21	34	55
Q-2 64						
Q-3 64					1	1
Q-4 64						
Q-1 65		-83	2.675	-222	-226	-448
Q-2 65						
Q-3 65		-78	3.487	-272	-272	-544
Q-4 65						

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 09
MISSION AND TRAFFIC CONTROL SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 66		-117	4.068	-476	-476	-952
TOTAL	96.0	16223		47473	62860	110333

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 09
MISSION AND TRAFFIC CONTROL SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		34	2.971	101		101
Q-4 58						
Q-1 59		14	3.357	47		47
Q-2 59						
Q-3 59		67	2.910	195		195
Q-4 59						
Q-1 60		35	2.914	102		102
Q-2 60						
Q-3 60	1.5	267	3.547	947		947
Q-4 60						
Q-1 61	1.5	221	2.995	662		662
Q-2 61						
Q-3 61	1.0	135	4.104	554		554
Q-4 61						
Q-1 62		-1	8.999	9		9
Q-2 62						
Q-3 62						
Q-4 62						
Q-1 63						
Q-2 63						
Q-3 63		-1				
Q-4 63						
Q-1 64						
Q-2 64						
Q-3 64						
Q-4 64						
Q-1 65						
TOTAL	4.0	771		2617		2617

C 10.

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09
MISSION AND TRAFFIC CONTROL SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	15.0	2605	4.382	11415	11852	23267	
Q-2 58							
Q-3 58	100.5	16840	4.236	71331	66060	137391	93
Q-4 58							
Q-1 59	136.5	23503	4.033	94777	81447	176224	1623
Q-2 59							
Q-3 59	186.0	32844	3.892	127839	119561	247400	1092
Q-4 59							
Q-1 60	122.5	21219	4.542	96380	79010	175390	193
Q-2 60							
Q-3 60	102.0	17146	4.453	76349	63550	139899	3538
Q-4 60							
Q-1 61	187.5	31733	4.204	133602	106638	240240	37272
Q-2 61							
Q-3 61	102.5	18608	4.603	85648	90932	176580	8913
Q-4 61							
Q-1 62	97.5	16619	5.051	83945	75616	159561	2234
Q-2 62							
Q-3 62	97.5	16302	5.203	84821	82473	167294	243
Q-4 62							
Q-1 63	61.5	10453	5.727	59867	56822	116689	26193
Q-2 63							
Q-3 63	54.0	9062	5.176	46904	51601	98505	3509
Q-4 63							
Q-1 64	40.5	6841	8.165	55858	42484	98342	4565
Q-2 64							
Q-3 64	31.5	5552	1.598	8872	36642	45514	6450
Q-4 64							
Q-1 65	4.5	707	7.755	5483	4851	10334	1848
Q-2 65							
Q-3 65	3.0	307	8.225	2525	2214	4739	739
Q-4 65							

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09
MISSION AND TRAFFIC CONTROL SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66		-89	3.101	-276	-299	-575	52
TOTAL	1342.5	230302		1045340	971454	2016794	98457

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09
MISSION AND TRAFFIC CONTROL SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58				264	23531		23531
Q-2 58							
Q-3 58		93	5	16	137505		137505
Q-4 58							
Q-1 59	24354	25977	782		202983		202983
Q-2 59							
Q-3 59	24354	25446	768		273614		273614
Q-4 59							
Q-1 60	711058	711251	42210	2938	931789	17755	949544
Q-2 60							
Q-3 60	306548	310086	18651	1222	469858	8953	478811
Q-4 60							
Q-1 61	357964	395236	13404	2885	651765	12112	663877
Q-2 61							
Q-3 61	81092	89905	3067	1007	270559	5027	275586
Q-4 61							
Q-1 62		2234	176	59	162030	2719	164749
Q-2 62							
Q-3 62		243	19	269	167825	2817	170642
Q-4 62							
Q-1 63		26193	2580	422	145884	2439	148323
Q-2 63							
Q-3 63		3509	346	36	102396	1712	104108
Q-4 63							
Q-1 64		4565	487	19	103413	286	103699
Q-2 64							
Q-3 64		6450	2347	17	54328	1156	55484
Q-4 64							
Q-1 65		1848	553	2	12737	340	13077
Q-2 65							
Q-3 65		739	132	1	5611	150	5761
Q-4 65							

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 09
MISSION AND TRAFFIC CONTROL SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 66		52	11		-512	-16	-528
TOTAL	1505370	1603827	85538	9157	3715316	55450	3770766

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WORK BREAKDOWN STRUCTURE

SUBSYSTEM: FLIGHT INDICATION WBS CODE: 1.10

WBS LEVELS
4 5 6 7 8

1.10 FLIGHT INDICATION SUBSYSTEM

1.10.1 Auxiliary Gyro Platform

1.10.1.1 Gyroscopic Reference Assembly

Gyro Assembly
Gimbal Assembly
Sensors
Slaving Mechanism

1.10.1.2 Computer/Amplifier

1.10.1.3 Remote Deviation Compensator

1.10.1.4 Remote Magnetic Heading Detector

1.10.1.5 Control Panel

Mode Switch
Navigation Input Selectors
Navigation Input Display Units

1.10.2 Flight Instruments

1.10.2.1 Horizon Situation Indicator

1.10.2.2 Attitude Director Indicator

1.10.2.3 Turn Rate Gyro

1.10.2.4 Standby Gyro

Roll Sensors
Pitch Displacement Sensors
Standby Flight Indicator

1.10.2.5 Display Control Panel

Command Control Assembly
Altitude Hold Unit
Reference Assembly Mode Switch Module
Mode Switch Unit
Erection Switch Unit

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: FLIGHT INDICATION WBS CODE: 1.10

WBS LEVELS
4 5 6 7 8

1.10.3 Central Air Data Subsystem (CADS)

1.10.3.1 Pitot Static Installation

Pitot Static Tube
Nose Boom Installation
Pneumatic Lines
Electrical Heater

1.10.3.2 Total Temperature Sensor

1.10.3.3 Total Temperature Indicator

1.10.3.4 CADS Computer

Mach Rate Module
Total Temperature Module
Calibrated Airspeed Module
True Airspeed Module
Output Module
Transducer Section
Monitor Section

1.10.3.5 Normal Accelerometer Sensor

1.10.3.6 Airspeed/Mach/Safe Speed Indicator

Tapes
Tape Driver Unit
Angle-of-Attack Sensor
Command Control Unit
Amplifiers

1.10.3.7 Altitude/Vertical Speed Indicator

Tapes
Tape Driver Unit
Command Readout Indicator
Slew Switch Assembly
Amplifiers

1.10.3.8 DC Power Supply

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: FLIGHT INDICATION

WBS CODE: 1.10

WBS LEVELS

4 5 6 7 8

1.10.3.9 Standby Altitude Indicator

1.10.3.10 Clock

1.10.3.11 Engine Nozzle Standby Control

1.10.3.12 Engine RPM Lock-up Release

1.10.4 Flight Director Computer

1.10.4.1 Roll Channel Section

1.10.4.2 Pitch Channel Section

1.10.5 Ground Tests

1.10.5.1 Mockups

1.10.5.2 Simulators

1.10.5.3 Wind Tunnel

TECHNICAL DESCRIPTION

SUBSYSTEM: FLIGHT INDICATION WBS CODE: 1.10

This system provided the pilot and copilot with continuous information necessary to maintain a desired flight status in terms of altitude, speed and direction. The flight situation indicators were grouped on the left and right sections of the main instrument panel immediately forward of the pilot's and copilot's seats. The complete instrument panel is shown in Exhibit 1, page IV-542, and a close-up of the pilot's instruments is shown in Exhibit 2, page IV-543. The flight indicators received their stimuli from the auxiliary gyro platform, the central air data computer, the flight director computer and other miscellaneous input sources. The integrated inlet duct indicator and controls were mounted on the right-hand instrument panel section for copilot operation only.

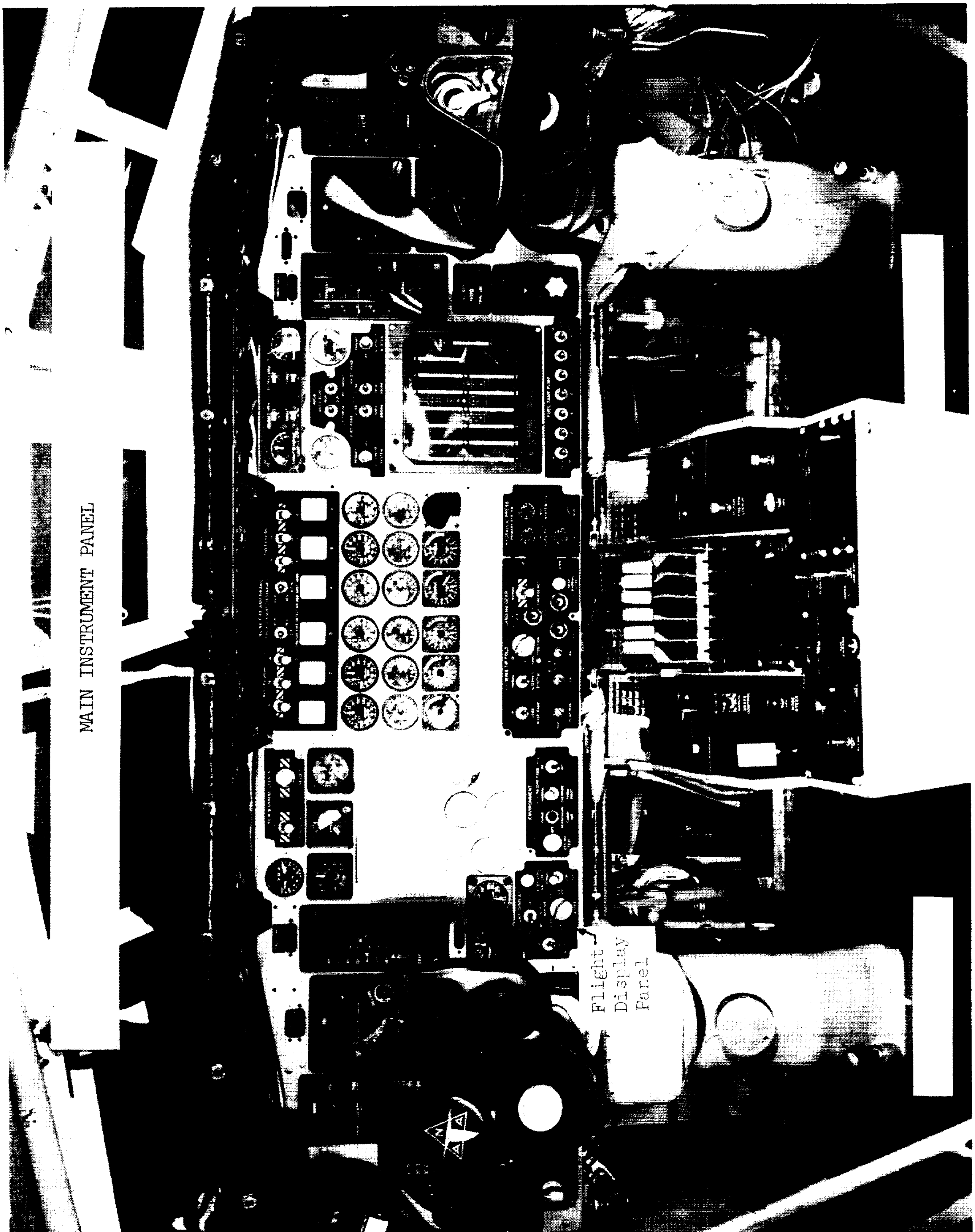
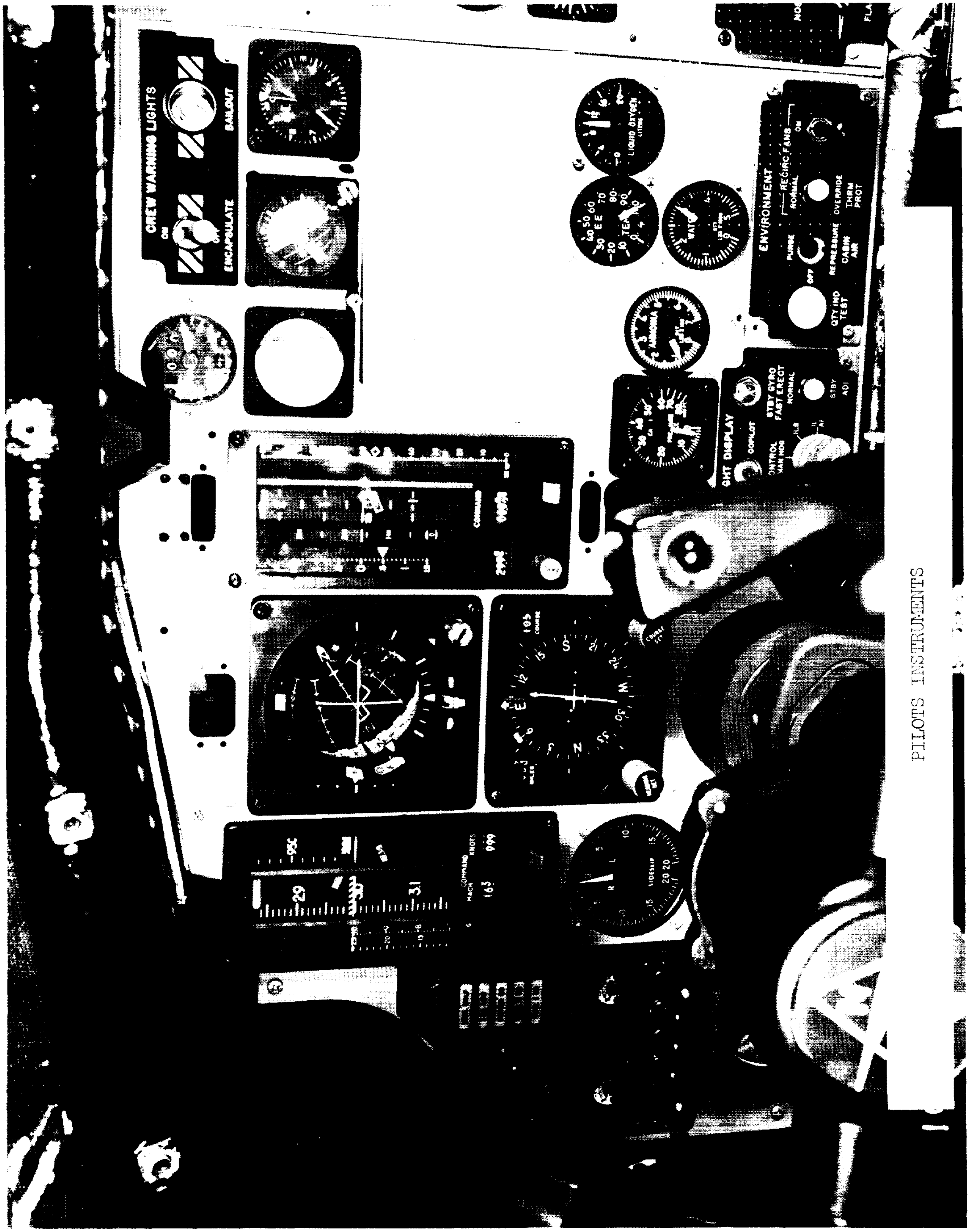


EXHIBIT 1



PILOTS INSTRUMENTS

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: FLIGHT INDICATION SUBSYSTEM WBS CODE: 1.10

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
TOTAL SUBSYSTEM WEIGHT	POUNDS	10,615	665	665	665	661
AUX. GYRO PLATFORM - WEIGHT	POUNDS	(315)	(169)	(169)	(169)	(169)
FLIGHT INSTRUMENTS WEIGHT	POUNDS	(168)	(341)	(341)	(341)	(337)
CENTRAL AIX DATA SYSTEM WEIGHT	POUNDS	(543)	(155)	(155)	(155)	(155)
OFFENSE ELECTRONICS WEIGHT	POUNDS	(2888)	NO	NO	NO	NO
DEFENSE ELECTRONICS WEIGHT	POUNDS	(6216)	NO	NO	NO	NO
WEAPON PLATFORM & RELEASE WEIGHT	POUNDS	(525)	NO	NO	NO	NO
RELIABILITY FACTOR	NONE	NOT AVAILABLE	NOT AVAILABLE	.9999968	.9999968	.9999968
MTBF	HOURS	NOT AVAILABLE	NOT AVAILABLE	549,450	549,450	549,450

( ) Bracketed weights are included in total subsystem weight

TECHNICAL DESCRIPTION

SUBSYSTEM:	FLIGHT INDICATION	WBS CODE:	1.10
MAJOR ASSEMBLY:	AUXILIARY GYRO PLATFORM SUBSYSTEM (AGPS)	WBS CODE:	1.10.1

The AGPS was designed to provide roll and pitch information in the form of three-phase synchro signals to the pilot's and copilot's attitude director indicators for attitude display and to the flight director computer (FDC) for asymptotic steering computations in the pitch and roll channels. In addition, heading information was supplied to the pilot's and copilot's horizontal situation indicators and attitude director indicators for azimuth display. The pilot could select either magnetic, derated magnetic, true north or great circle heading modes of operation.

The gyroscope reference unit computer amplifier and remote deviation compensator were located in the electronic racks aft of the copilot. The remote magnetic heading detector unit was installed in the upper fuselage surface in the aft portion of the crew compartment. The control panel for the AGPS was located on the pilot's left console. The pilot's control panel was provided with controls with which to manually insert values of latitude and magnetic variation to compensate for meridian convergence, earth's rate and bias drift. The gyro, computer amplifier and the pilot's control panel are displayed in Exhibit 3 page IV-546.

GYRO/COMPUTER AMPLIFIER/PILOTS PANEL

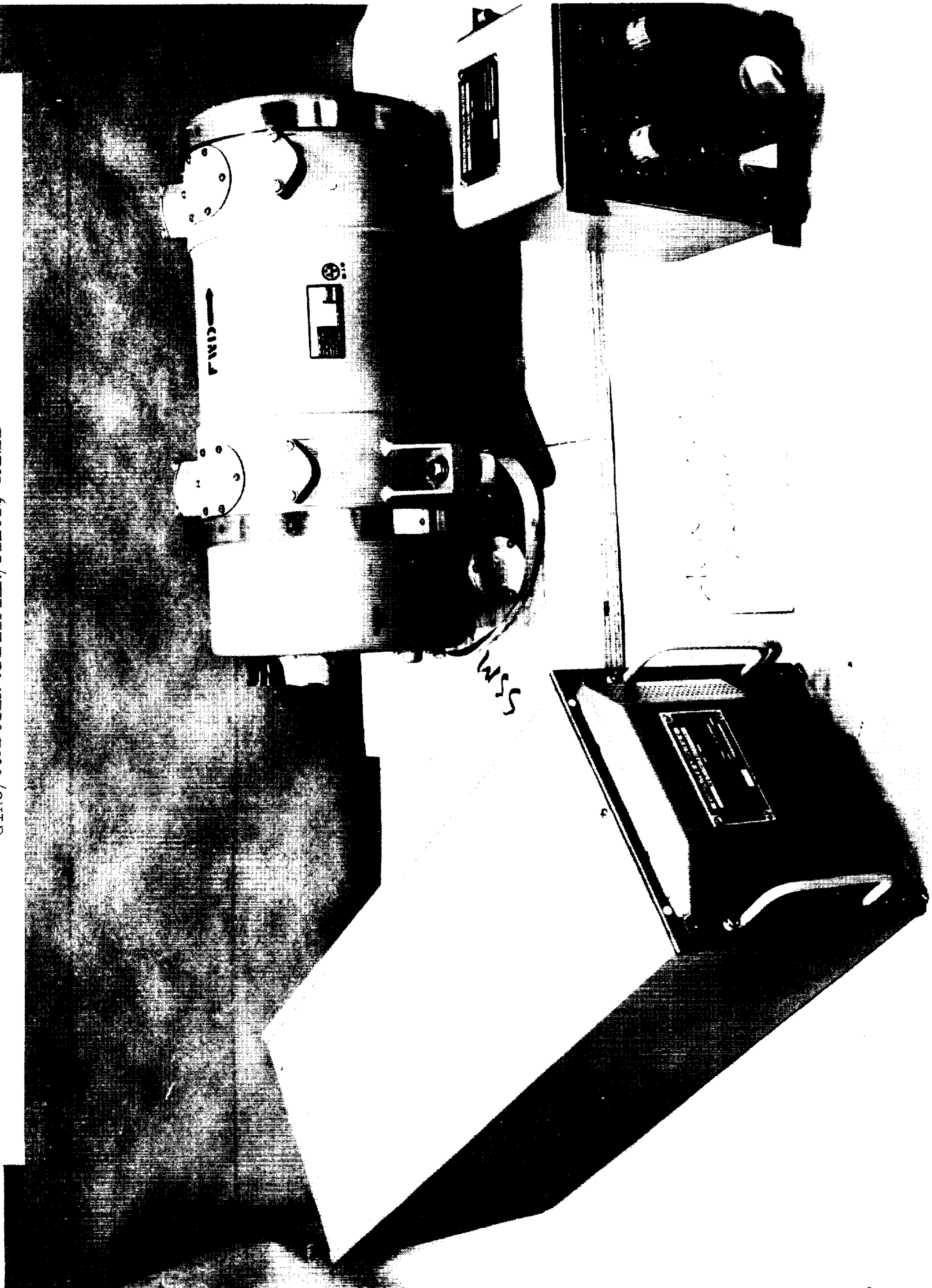


EXHIBIT 3

SDW?-SH-0003

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: AUXILIARY GYRO PLATFORM WBS CODE: 1.10.1

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT (TOTAL SYTEM)	POUNDS	315	169	169	169	169
ATTITUDE RANGE	-	-	-	-	-	-
PITCH	DEGREES	± 60°	± 60	± 60	± 60	± 60
ROLL	DEGREES	± 90	± 90	± 90	± 90	± 90
AZIMUTH	DEGREE	360	360	360	360	360
ATTITUDE RATES	-	-	-	-	-	-
PITCH	DEG/SEC	± 10	± 10	± 10	± 10	± 10
ROLL	DEG/SEC	± 100	± 100	± 100	± 100	± 100
AZIMUTH	DEG/SEC	± 10	± 10	± 10	± 10	± 10
ATTITUDE ACCELERATION	-	-	-	-	-	-
PITCH	DEG/SEC^2	± 20	± 20	± 20	±20	± 20
ROLL	DEG/SEC^2	± 200	± 200	± 200	± 200	± 200
AZIMUTH	DEG/SEC^2	± 20	± 20	± 20	± 20	± 20

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: AUXILIARY GYRO PLATFORM WBS CODE: 1.10.1

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
ATTITUDE ACCURACY	-	-	-	-	-	-
PITCH	ARC MIN	± 21	± 21	± 21	± 21	± 21
ROLL	ARC MIN	± 30	± 30	± 30	± 30	± 30
AZIMUTH (G.C.)	DEG/HR	± .35	± .35	± .35	± .35	± .35
AZIMUTH (TRUE NORTH)	DEG/HR	± .60	± .60	± .60	± .60	± .60
AZIMUTH (MAGNETIC)	DEG/HR	± 4.0	± 4.0	± 4.0	± 4.0	± 4.0
PLATFORM DRIFT	DEG/HR	0.25	0.25	0.25	0.25	0.25
HEADING ALIGNMENT	DEG	± 0.25	± 0.25	± 0.25	± 0.25	± 0.25
RADIO NOISE & INTERFERENCE	MIL-I-26600	-	-	-	-	-
DESIGN OPER. TEMPERATURE	DEF F	+ 32 to +160	+ 32 to +160	+ 32 to +160	+ 32 to +160	+ 32 to +160
PLATFORM COMPENSATION	-	ELECTRICAL	ELECTRICAL	ELECTRICAL	ELECTRICAL	ELECTRICAL
RELIABILITY FACTOR	NONE	NOT AVAILABLE		.999997	.999997	.999997
MTBF	HOURS	NOT AVAILABLE		588,235	588,235	588,235

TECHNICAL DESCRIPTION

SUBSYSTEM: FLIGHT INDICATION — WBS CODE: 1.10

MAJOR ASSEMBLY: FLIGHT INSTRUMENTS — WBS CODE: 1.10.2

Flight instruments were incorporated which provided to the pilots horizontal situation and attitude including heading, pitch and roll, rate of turn, and air vehicle slip. The Horizontal Situation Indicator (HSI) was designed to provide an integrated display of navigation information in the horizontal plane. The displays included:

(a) Great circle, true north, or derated magnetic north as transmitted by the AGPS and selected by the pilot.

(b) Command heading marker as manually selected by the HDG SET knob. Numerical indication of the selected course was also shown in the COURSE window.

(c) Course deviation from selected TACAN radial or localizer course indicated by a course deviation bar displacement relative to course arrow.

(d) Slant range distances to ground TACAN station indicated by the DISTANCE counter.

(e) Relative bearing to a selected TACAN station indicated by a bearing pointer.

The Attitude Director Indication (ADI) was designed to provide an integrated display of navigation information in the vertical and horizontal planes. The display included:

(a) Pitch and roll information from the AGPS or Standby Gyro indicated on the sphere.

(b) Great circle, true north, magnetic north or derated magnetic from the AGPS as selected by the pilot and indicated by azimuth markings on the azimuth axis of the sphere.

(c) Turn rate information from turn rate gyro and indicated by the turn rate needle with slip information indicated by an inclinometer.

(d) Glide slope deviation indicated by the glide slope displacement pointer.

(e) Asymptotic steering to a selected manual heading, TACAN radial course or localizer course indicated by the vertical steering pointer.

WBS CODE: 1.10.2

(f) Asymptotic steering to a glide slope beam or a selected altitude indicated by a horizontal steering pointer.

(g) Steering pointers were biased out of view when not required during specific modes of operation. Warning flags appeared when the computed signals were marginal or unreliable.

The turn rate gyro was designed to provide signals proportional to the rate of turn about the yaw axis. These signals were displayed by the turn rate needle of the attitude director indicator.

A standby roll and pitch displacement gyro and standby indicator was designed and installed to continuously provide pitch and roll information to an indicator on the pilot's flight panel. The gyro also was used to provide roll and pitch signals to the copilot's attitude director indicator in the event signals were not available from the auxiliary gyro platform subsystem.

A flight display control panel was installed on the lower portion of the pilot's flight panel of the main instrument panel. A front and back view of the panel assembly are shown in Exhibits 4, page IV-551, and 5, page IV-552, respectively. Its installation location is shown in Exhibit 1, page IV-542. The various controls provided were as follows:

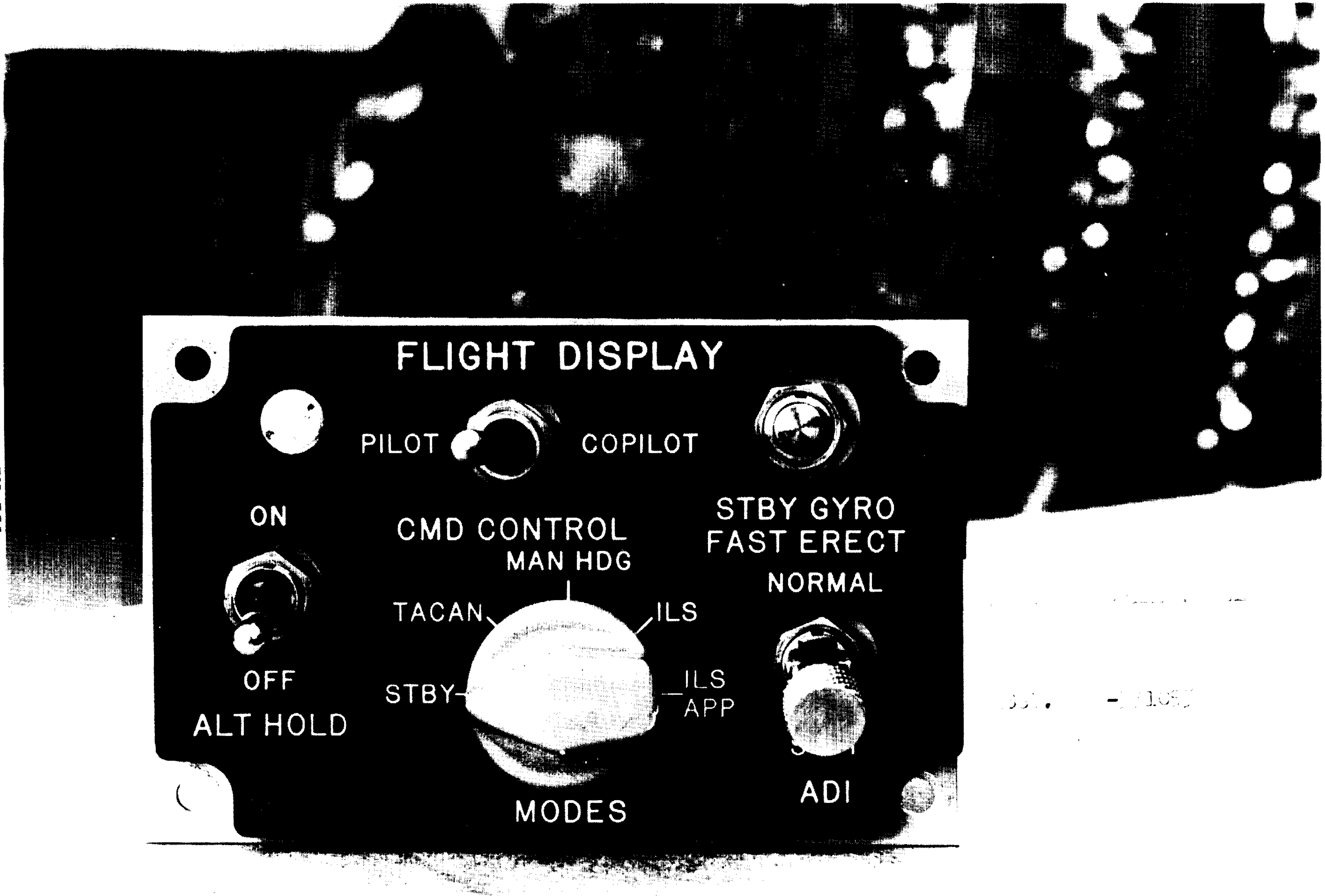
(a) Command control was a simple toggle switch which permits selection of which pilot would have command responsibility for controlling the manual set of command heading course for the horizontal situation indicators and steering information on the attitude director indicators and selection of command altitude, command mach numbers and command airspeed.

(b) A toggle switch was provided for selection of the altitude hold submode operation which maintained the air vehicle in its preset attitude.

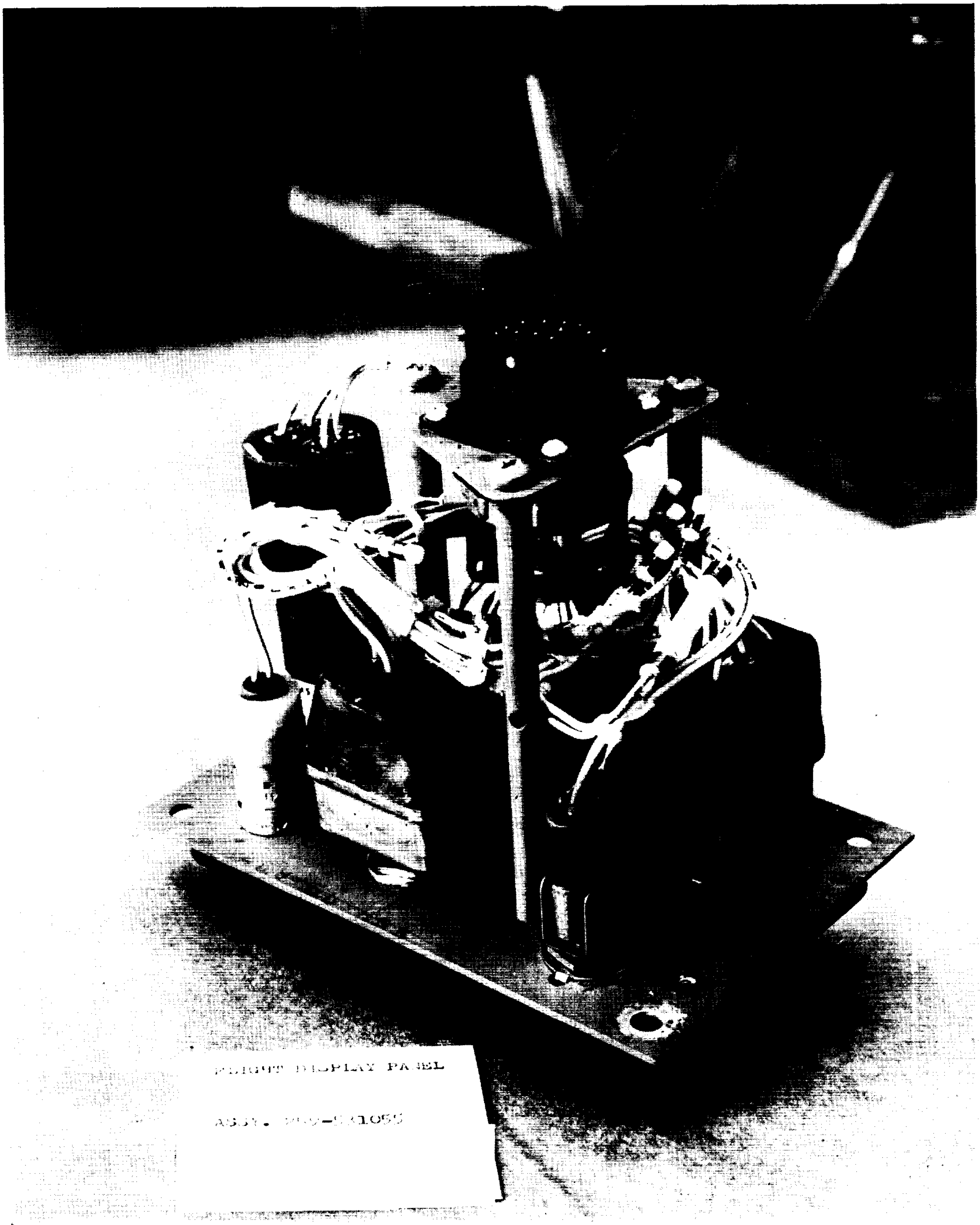
(c) An attitude director indicator switch was designed to permit selection of either the AGPS or the standby gyro as the source of roll and pitch inputs for the various indicators.

(d) A rotary mode selector switch allowed selection of one of five operating modes.

(e) A pushbutton switch was incorporated which upon actuation would fast slave the standby gyro to vertical following a flight maneuver.



FLIGHT DISPLAY PANEL (FRONT VIEW)



FLIGHT DISPLAY PANEL (REAR VIEW)

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: FLIGHT INSTRUMENTS WBS CODE: 1.10.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
RESPONSE TIME						
VERTICAL POINTER	SECONDS	.33	.33	.33	.33	.33
HORIZONTAL POINTER	SECONDS	.33	.33	.33	.33	.33
DISPLACEMENT POINTER	SECONDS	1.15	1.15	1.15	1.15	1.15
LAG (PITCH, ROLL, HEADING)						
AT 20° PER SECOND	DEGREES	.67	.67	.67	.67	.67
AT 90° PER SECOND	DEGREES	3.0	3.0	3.0	3.0	3.0
AT 300° PER SECOND	DEGREES	10.0	10.0	10.0	10.0	10.0
POWER CONSUMPTION	VOLT-AMPERES	28	28	28	28	28
DESIGN OPER. TEMPERATURE	DEGREES F (+)	32 to 160	32 to 160	32 to 160	32 to 160	32 to 160
HORIZONTAL SITUATION INDICATOR	NO.	2	2	2	2	2
WEIGHT (EACH)	POUNDS	9	9	9	9	9
HEADING RANGE	DEGREES	360	360	360	360	360
ACCURACY (GYRO + IND.)						

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: FLIGHT INSTRUMENTS WBS CODE: 1.10.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
TOTAL WEIGHT	POUNDS	168	341	337	341	337
ATTITUDE DIR. INDICATOR	NO.	2	2	2	2	2
WEIGHT (EACH)	POUNDS	8	8	8	8	8
DIMENSIONS	INCHES	8x5x5	8x5x5	8x5x5	8x5x5	8x5x5
ATTITUDE RANGE						
PITCH	DEGREES	± 360	± 360	± 360	± 360	± 360
ROLL	DEGREES	± 360	± 360	± 360	± 360	± 360
HEADING	DEGREES	± 360	± 360	± 360	± 360	± 360
ACCURACY (GYRO & IND.)						
PITCH	DEGREES	1.40	1.40	1.40	1.40	1.40
ROLL	DEGREES	1.53	1.53	1.53	1.53	1.53
HEADING (GYRO & IND.)						
GREAT CIRCLE MODE	DEGREES	.95	.95	.95	.95	.95
TRUE NORTH MODE	DEGREES	4.5	4.5	4.5	4.5	4.5
MAGNETIC NORTH	DEGREES	4.5	4.5	4.5	4.5	4.5

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: FLIGHT INSTRUMENTS WBS CODE: 1.10.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
GREAT CIRCLE MODE	DEGREES	.95	.95	.95	.95	.95
TRUE NORTH MODE	DEGREES	4.5	4.5	4.5	4.5	4.5
MAGNETIC NORTH	DEGREES	4.5	4.5	4.5	4.5	4.5
AIRSPEED - MACH INDICATOR	NO.	2	2	2	2	2
INDICATOR WEIGHT	POUNDS	11.5	11.5	11.5	11.5	11.5
AMPLIFIER WEIGHT	POUNDS	11.5	11.5	11.5	11.5	11.5
DISPLAY RANGE						
AIRSPEED	KNOTS	0 to 1000	0 to 1000	0 to 1000	0 to 1000	0 to 1000
MACH NO.	MACH NO.	.4 to 3.1	.4 to 3.1	.4 to 3.1	.4 to 3.1	.4 to 3.1
ACCELERATION	"g"	-4 to +10	-4 to +10	-4 to +10	-4 to +10	-4 to +10
ANGLE OF ATTACK	DEGREES	-10 to +25	-10 to +25	-10 to +25	-10 to +25	-10 to +25
ACCURACY (TOTAL)						
MACH NO.	MACH NO.	± .025	± .025	± .025	± .025	± .025
AIRSPEED	KNOTS	± 7	± 7	± 7	± 7	± 7
ANGLE OF ATTACH	DEGREES	± 1.0	± 1.0	± 1.0	± 1.0	± 1.0
ACCELERATION	DEGREES	± .170	± .170	± .170	± .170	± .170

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: FLIGHT INSTRUMENTS WBS CODE: 1.10.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
POWER CONSUMPTION	VOLT-AMPERE	150	150	150	150	150
DESIGN OPER. TEMPERATURE	DEGREES F (+)	32 to 160	32 to 160	32 to 160	32 to 160	32 to 160
ALTITUDE - VERT. VEL. INDICATOR	NO.	2	2	2	2	2
WEIGHT (INDICATOR)	POUNDS	11.5	11.5	11.5	11.5	11.5
WEIGHT (AMPLIFIER)	POUNDS	11.5	11.5	11.5	11.5	11.5
DISPLAY RANGE	-	-	-	-	-	-
ALTITUDE	FEET	-1000 to 100,000	-1000 to 80,000	-1000 to 80,000	-1000 to 80,000	-1000 to 80,000
ALTITUDE RATE	FEET/MIN	0 to 40,000	0 to 40,000	0 to 40,000	0 to 40,000	0 to 40,000
ACCURACY						
ALTITUDE (TOTAL)						
AT 20,000 FEET	FEET	± 60	± 60	± 60	± 60	± 60
AT 40,000 FEET	FEET	± 210	± 210	± 210	± 210	± 210
ALTITUDE RATE (TOTAL)						

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: FLIGHT INSTRUMENTS WBS CODE: 1.10.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
AT 2500 FPM	FEET/MIN	± 300	± 300	± 300	± 300	± 300
AT 40,000 FPM	FEET/MIN	± 6000	± 6000	± 6000	± 6000	± 6000
POWER CONSUMPTION	VOLT-AMPERES	150	150	150	150	150
DESIGN OPER. TEMPERATURE	DEGREES F.(+)	32 to 160	32 to 160	32 to 160	32 to 160	32 to 160
RELIABILITY FACTOR	NONE	NOT AVAILABLE	NOT AVAILABLE	.9999968	.9999968	.9999968
MTBF	HOURS	NOT AVAILABLE	NOT AVAILABLE	549,450	549,450	549,450

TECHNICAL DESCRIPTION

SUBSYSTEM: FLIGHT INDICATION WBS CODE: 1.10

MAJOR ASSEMBLY: CENTRAL AIR DATA SUBSYSTEM WBS CODE: 1.10.3

In the B-70 many of the subsystems, such as flight controls, pilot's instruments and radio navigation aids required inputs of air data in the form of airspeed, mach number and altitude. For each of the subsystems to sense, convert and use its own parameters would have unduly complicated and penalized the B-70 from a weight standpoint. Therefore, a Central Air Data Subsystem (CADS) was developed which sensed the air pressure for the conditions of flight and converted this stimuli into electrical signals to supply the needs of all the air vehicle subsystems. Due to the advanced performance of the B-70 and the accuracy to which the pilot was required to know his flight condition, it was necessary to develop computing equipment with a sensing and computing range of about twice that previously required. It was also necessary to overcome the problem of pressure sensing inaccuracies due to the proximity of the air vehicle. This problem is defined as position error. The laboratories at Wright-Patterson Air Force Base developed a probe with an aerodynamic shape which compensated for the presence of the air vehicle and thus minimized the inaccuracies due to position error. The pitot static boom assembly (partially disassembled) is shown in Exhibit 6, page IV-560.

The CADS sensed flight pneumatic and temperature conditions and converted them to analog electrical signals which represented output functions of mach number, airspeed, and altitude which were compatible with the using system requirements.

The air data computer consisted of five basic modules and three transducers which performed the computing and monitoring functions. The five basic modules were:

- Mach number rate module
- Total temperature module
- Calibrated airspeed module
- True airspeed module
- Major output module (altitude, mach number, static pressure, altitude hold and maximum safe mach number outputs)

The output signals from the computer were:

- Mach number
- Altitude rate
- Altitude change
- Calibrated airspeed

WBS CODE: 1.10.3

Maximum safe mach number
Mach number rate
Static pressure
True airspeed

The subsystems receiving these output stimuli were as follows:

USING SYSTEM	TOTALS	
Vertical Scale Indicator	8	
Flight Augmentation Counter	6	
Bomb Navs.	4	(Deleted)
Engine Control	7	
Flight Director Computer	1	
Landing Gear Warning	2	
B-N Displays	4	(Deleted)
Flight Test Instrumentation	6	
Anti-Collision Lighting	1	
AGPS	2	
Spares	6	

The pitot-static tube (reference Exhibit 4, Page IV-560) was installed on a boom mounted to the nose of the air vehicle. The tube was connected to pneumatic lines which transmitted the dynamic and static air pressure effects to the CADS and to the standby pneumatic airspeed and altitude indicators and flight instrumentation. An electrically energized heater was provided to prevent ice accumulation on the pitot static tube.

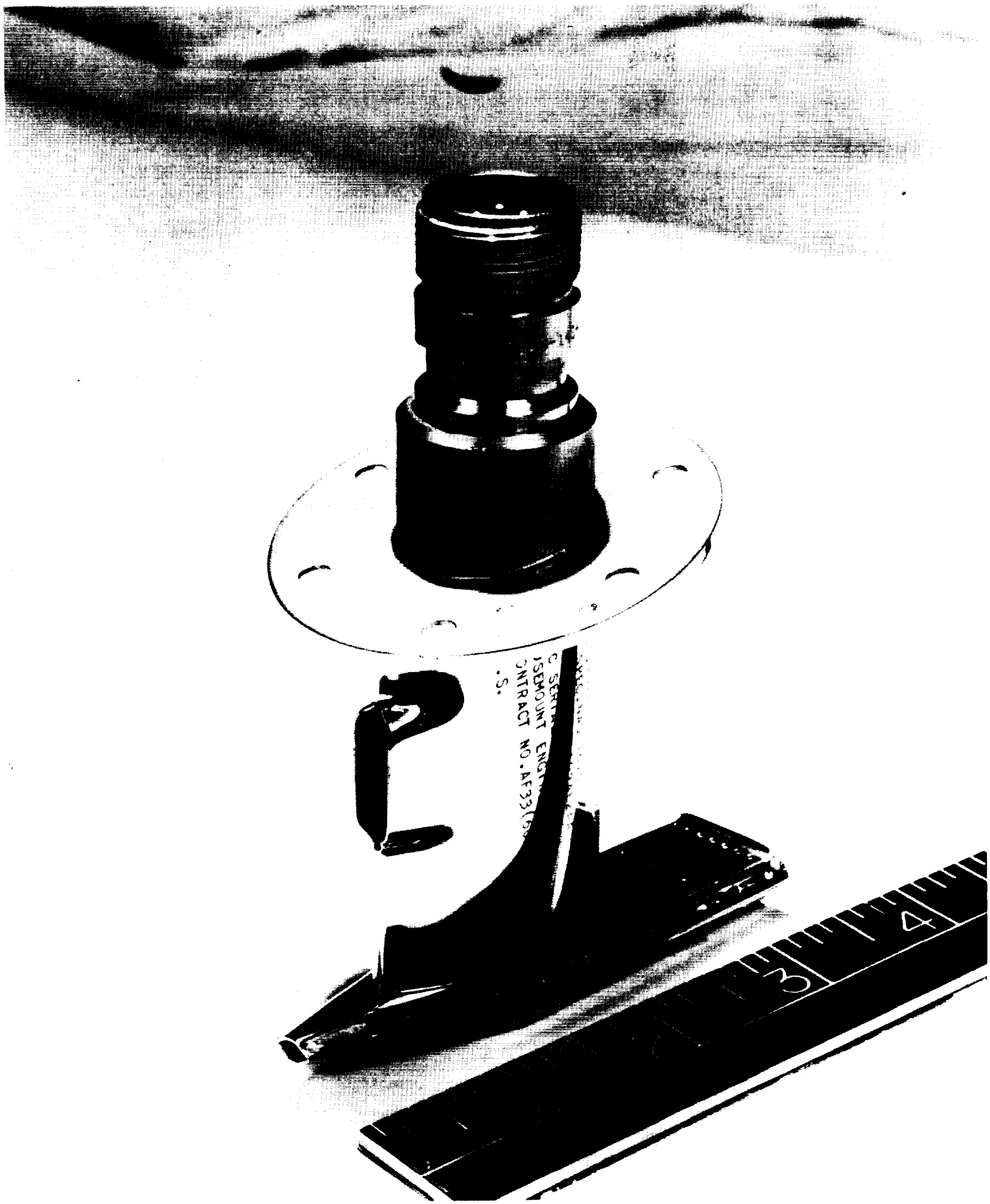
A total temperature sensor was installed below the duct splitter located in the lower aft intermediate fuselage. The sensor element extended into the airstream to sense local temperature conditions. The sensor converted the thermal data into electrical signals which were transmitted to the CADS and to the total temperature indicator located on the pilot's main instrument panel. The total temperature sensor is shown in Exhibit 7, page IV-561.

An indicator was installed to provide mach number, maximum safe mach number and calibrated airspeed. Vertical tapes driven by electrical signals from the CADS provided the indications. An indicator which displayed vertical speed and sensitive, fine and gross altitude by means of a vertical scale was also provided. A DC power supply was installed to furnish excitation for the command functions of the indicators. These command functions initiated by the pilots would actuate counter-type indicators.

A standby altitude indicator was mounted on the main instrument panel. This indicator received pressure variation signals from the static pitot system and provided visual indication of altitude from -1000 to 80,000 feet. An 8-day mechanical clock was also installed on the pilot's and copilot's instrument panel.

PITOT STATIC BOOM ASSEMBLY

EXHIBIT 6



TOTAL TEMPERATURE SENSOR

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: CENTRAL AIR DATA SYSTEM WBS CODE: 1.10.3

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT (TOTAL SYSTEM)	POUNDS	543	155	155	155	155
PRESSURE ALTITUDE (OUTPUT)						
RANGE	FEET ALT.	-1000 to 100,000	-1000 to 100,000	-1000 to 100,000	-1000 to 100,000	-1000 to 100,000
RESOLUTION	PERCENT	5	5	5	5	5
RESPONSE	SECONDS	0.36	0.36	0.36	0.36	0.36
PRESSURE ALTITUDE RATE (OUTPUT)						
RANGE	FEET/MIN	40,000 ASCEND OR DESCEND	40,000 ASCEND OR DESCEND	40,000 ASCEND OR DESCEND	40,000 ASCEND OR DESCEND	40,000 ASCEND OR DESCEND
RESOLUTION	FEET/MIN	25	25	25	25	25
RESPONSE	SECONDS	1.0	1.0	1.0	1.0	1.0
AIRSPEED (OUTPUT)						
RANGE	KNOTS	50 to 750	50 to 750	50 to 750	50 to 750	50 to 750
RSOLUTION	KNOTS	1.0	1.0	1.0	1.0	1.0
DESIGN TEMPERATURE RANGE	DEG F.	+32 to 160	+32 to 160	+32 to 160	+32 to 160	+32 to 160

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: CENTRAL AIR DATA SYSTEM WBS CODE: 1.10.3

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
TEMPERATURE (INPUT)						
RANGE	DEG F	-65 to 315	-65 to 315	-65 to 315	-65 to 315	-65 to 315
SLEW RATE	DEG F/SEC.	10	10	10	10	10
RESPONSE	SECONDS	0.6	0.6	0.6	0.6	0.6
ACCURACY						
ALTITUDE						
AT 20,000 FEET	FEET	± 50	± 50	± 50	± 50	± 50
AT 60,000 FEET	FEET	± 200	± 200	± 200	± 200	± 200
AIRSPEED	KNOTS	5	5	5	5	5
ALTITUDE RATE						
AT 2500 FPM	FEET/MIN	50	50	50	50	50
AT 40,000 FPM	FEET/MIN	2000	2000	2000	2000	2000
MACH NUMBER	MACH NO.	± 0.020	± 0.020	± 0.020	± 0.020	± 0.020

TECHNICAL DESCRIPTION

SUBSYSTEM: FLIGHT INDICATION WBS CODE: 1.10

MAJOR ASSEMBLY: FLIGHT DIRECTOR COMPUTER (FDC) WBS CODE: 1.10.4

The FDC was a two-channel computer, one for roll computations and the other for pitch computations. Input signals to the FDC are obtained from the auxiliary gyro platform subsystem (AGPS), instrument landing subsystem, TACAN, CADS and Horizontal Situation Indicator (HSI). Data outputs include computed vertical and steering signals to the Attitude Director Indicator (ADI) and automatic activation of the ADI horizontal needle when approaching the glide slope in the instrument landing mode.

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: FLIGHT DIRECTOR COMPUTER WBS CODE: 1.10.4

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	POUNDS	12	12	12	12	12
DIMENSIONS						
LENGTH	INCHES	9 5/8	9 5/8	9 5/8	9 5/8	9 5/8
WIDTH	INCHES	5 5/16	5 5/16	5 5/16	5 5/16	5 5/16
HEIGHT	INCHES	7 13/16	7 13/16	7 13/16	7 13/16	7 13/16
NUMBER CHANNELS		ONE	ONE	ONE	ONE	ONE
POWER REQUIRED	VOLT-AMPS	16	16	16	16	16
NUMBER OF INPUTS						
PITCH	-	1	1	1	1	1
ROLL	-	1	1	1	1	1
HEADING	-	1	1	1	1	1
COURSE ERROR	-	1	1	1	1	1
RADIO SIGNAL INPUTS	-	4	4	4	4	4
ATTITUDE HOLD	-	1	1	1	1	1

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: FLIGHT DIRECTOR COMPUTER WBS CODE: 1.10.4

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
NUMBER OF OUTPUT SIGNALS	-	6	6	6	6	6
NUMBER OF OPER. MODES	-	8	8	8	8	8

DEVELOPMENT DATA SUMMARY

WBS TITLE: Flight Indication Subsystem WBS CODE: 1.10

STATE-OF-THE-ART RATING: 3 (See Text on Following 3 Pages)

PERCENT DEVELOPED MATRIX:

	PRIOR TO FLIGHT		FLIGHT TEST
	CONFIGURATION	GROUND TEST	
PROGRAM LEVEL	95%	66%	28%
EFFORT TO GO	18%	60%	90%

GROUND TESTS

TYPE OF TEST	NUMBER OF UNITS	TEST HOURS
CONFIGURATION RESEARCH	-	-
DESIGN FEASIBILITY	-	-
DESIGN VERIFICATION	9	1350
AIRWORTHINESS	26	2240
QUALIFICATION	5	650
OTHER	-	-
TOTAL	40	4240

REMARKS:

WBS CODE: 1.10

State-of-the-Art

The Flight Indications Subsystem was assigned an overall state-of-the-art rating of 3 based on definitions established using AFSCM 173-1 (11-28-67) as a guide. This rating was determined by comparing the RS-70 requirements with the existing capabilities at the RS-70 time period using state-of-the-art criteria discussed in subsequent paragraphs. The RS-70 configuration was selected for the comparison since it was the production configuration defined. This selection is considered valid since the development status at "out-the-door" and at program "end" is also based on the scheduled production configuration.

The definitions used in determining the state-of-the-art ratings are described below. For ratings 3, 4, and 5, the following B-70 design criteria was used as an aid for rating selection.

A. High temperature application
B. High pressure/load/acoustics/etc., application
C. Light-weight/special materials/unique processes

Rating	Description
1	The item was off-the-shelf commercial item or a standard military issue which was installed "as-is".
2	The item was off-the-shelf commercial item or a standard military issue which required only a physical modification for installation.
3	The item was considered within the state-of-the-art but had no commercial or military counterpart. As an aid, the item was existing but required modification to be compatible with one of the design criteria. Also, any new design or process has a rating of at least 3.
4	The item was slightly beyond the state-of-the-art, and some development was required. As an aid, the item was based on an existing concept but required modification to be compatible with two of the design criteria. Also, any new design or process required to be compatible with one of the design criteria will be rated 4.
5	The item was substantially beyond the existing state-of-the-art and required major development work. As an aid, any new design or process required to be compatible with two of the design criteria will be rated 5.

WBS CODE: 1.10

The Flight Indication Subsystem installed in the XB-70 was essentially the same as planned for the RS-70 except for a best climb speed indicator and some downgrading of equipment due to the lack of development effort. In the assessment of the RS-70 flight indication configuration, based only on its functional requirements, the Flight Indication Subsystem was assigned a state-of-the-art rating of 2. However, the Auxiliary Platform and the Central Air Data systems were unique designs for the RS-70 application and were the heart or the major part of the subsystem. Based on the above application and the ground rules established, the state-of-the-art for the Flight Indication Subsystem was upgraded to a rating of 3.

Percent Developed

The development status percent comparisons of the XB-70 Flight Indication Subsystem to that scheduled for the RS-70 were made at two development stages; one at prior-to-flight or "out-the-door" of the No. 1 air vehicle, and the other for the flight test programs. The same methodology developed and verified for the Airframe Structures Subsystem (WBS: 1.1) percent comparisons was applied in the analyses of the Flight Indication Subsystem status. As noted above, the XB-70 configuration was very close to that planned for the RS-70, being short development effort and one indicator. Based on this, the XB-70 Flight Indication Subsystem configuration was assessed as being 95 percent representative of that planned for the RS-70 for the time period of "out-the-door", excluding the ground testing status. To determine what effort would have been required to attain a first air vehicle production level status for the configuration, the same curve used for the structures subsystem was utilized for Flight Indication Subsystem; Exhibit 8, Page IV-571. Entering the exhibit in the left-hand scale at 95 percent, across to the curve and down to the bottom scale, it shows that 18 percent more effort would be required for a No. 1 RS-70 Flight Indication Subsystem, excluding ground testing.

The ground tests scheduled for the RS-70 at time of "out-the-door" was approximately 10,500 test hours. Comparing this scheduled test effort with the 4,240 test hours expended, it shows that the testing level of the XB-70 Flight Indication Subsystem to be approximately 40 percent of that planned for the RS-70 at the "out-the-door" time period. This shows that 60 percent more testing effort was required to attain a No. 1 air vehicle production level status prior to flight. Entering Exhibit 8, Page IV-571, on the bottom scale at 40 percent, the right-hand scale indicates that the No. 1 XB-70 Flight Indication Subsystem was at a confidence level of 66 percent prior-to-flight. In summary, the Flight Indication Subsystem of the XB-70, when compared to the RS-70 at the time of "out-the-door", was at a configuration level of 95 percent with 18 percent more effort required. The confidence level due to ground tests was 66 percent with 60 percent more ground testing required.

WBS CODE: 1.10

The XB-70 flight test program for the Flight Indication Subsystem was established at 15 percent of a production level status as presented by Exhibit 13, Page II-23, under Air Vehicle, WBS: 1.0. However, this percentage was obtained by a direct comparison of equivalent flight test hours and some adjustment must be applied to reflect the flight envelope flown during the XB-70 program. As shown under Air Vehicle (WBS: 1.0), the flight envelope of the XB-70 was approximately 80 percent of the RS-70 envelope. As previously established for Airframe Structures Subsystem (WBS: 1.1), the first 80 percent of the flight envelope requires only 60 percent of the total effort compared to the last 20 percent of the envelope which requires 40 percent of the total effort. For the Flight Indication Subsystem, this 2 to 3 ratio was directly applicable since all of the equivalent test hours were obtained in the first 80 percent of the flight envelope. Using this ratio as a weight factor so that direct comparisons can be made based on the RS-70 flight envelope, the flight test effort expended on the XB-70 was adjusted by the function 2:3::X:15%. Based on this function, the total flight test effort remaining to attain a production level status for the Flight Indication Subsystem would be 40% + 60% - (2 X 15÷3) or 90 percent (where 40 percent is that effort required for the last 20 percent of the flight envelope). Entering Exhibit 8, Page IV-571, on the bottom scale at 10 percent, it shows by the left-hand scale that the XB-70 flight test program attained a confidence level of 28 percent as related to the Flight Indication Subsystem. Exhibit 8, page II-571, presents a summary of the Flight Indication Subsystem comparisons.

NOTE: THE USE OF THE "EFFORT TO GO" PERCENTAGES FOR COST DETERMINATION SHOULD NOT BE APPLIED WITHOUT CONSULTING SECTION IV-7, VOLUME I, PAGE 310 FOR APPLICATION CONSIDERATIONS.

FLIGHT INDICATION SUBSYSTEM DEVELOPMENT STATUS
PERCENT COMPARISON TO RS-70 (UNITY)

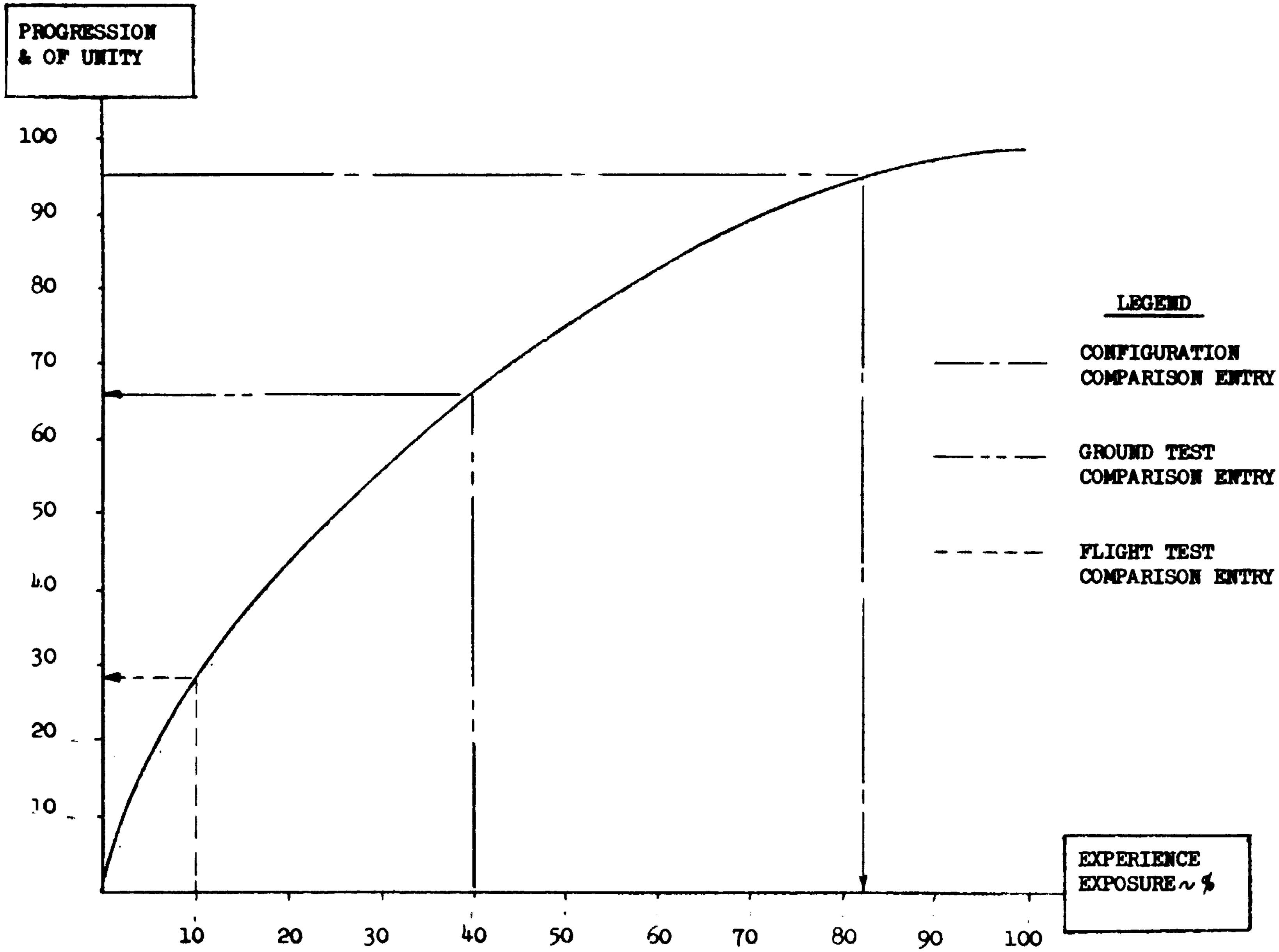
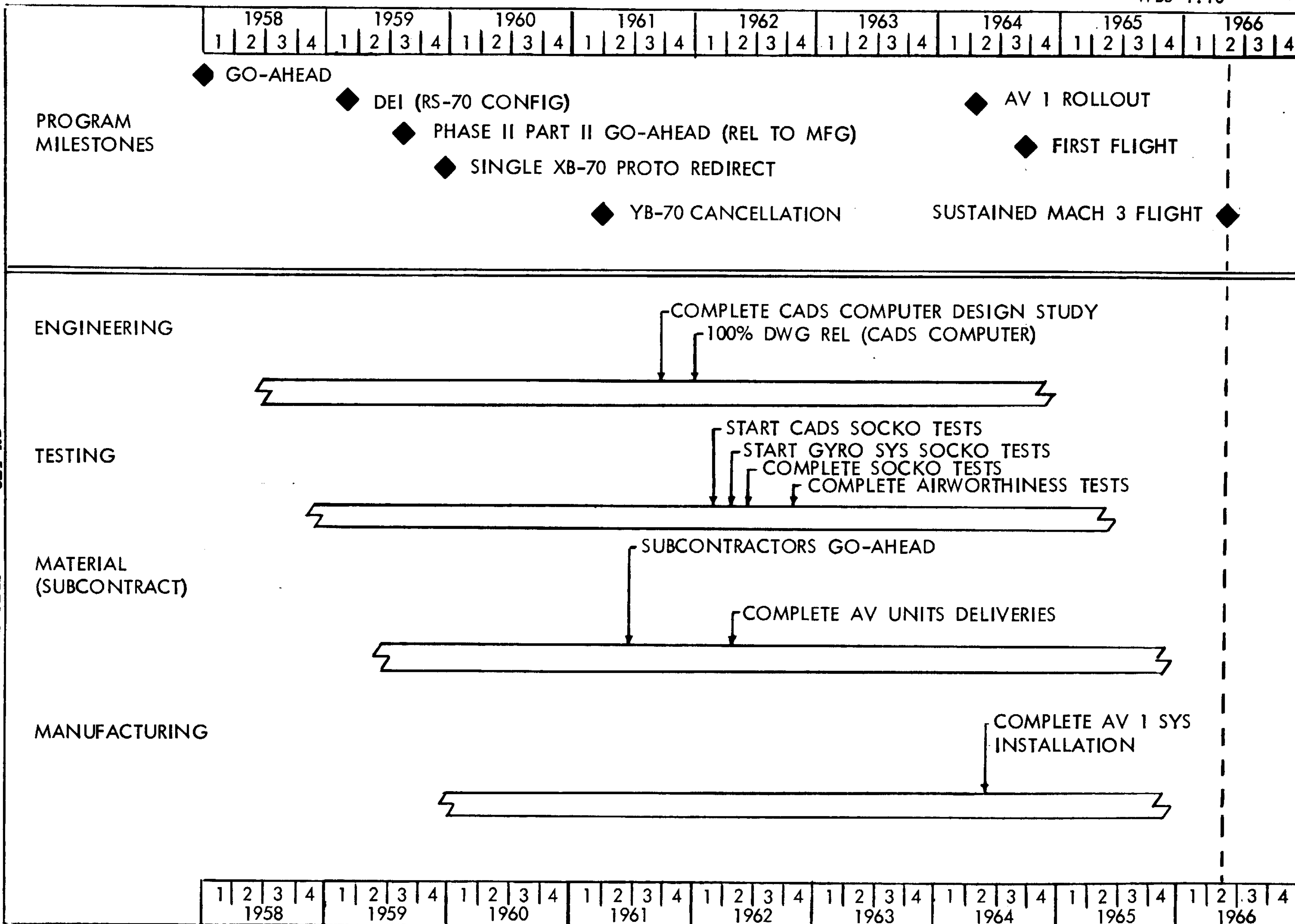


EXHIBIT 8

FLIGHT INDICATION SYSTEM
DEVELOPMENT SUMMARY

WBS 1.10



DEVELOPMENT SUMMARY

TABULATION OF DATES

SUBSYSTEM: FLIGHT INDICATION — WBS CODE 1.10

ENGINEERING	
Complete - CADS Computer Design Study	9-29-61
100% Drawing Release (CADS Computer)	1-01-62
TESTING	
Start - CADS SOCKO Tests	2-28-62
Start - Gyro System SOCKO Tests	4-15-62
Complete - SOCKO Tests	6-01-62
Complete - Airworthiness Tests	10-16-62
MATERIAL	
Subcontractor Go-Ahead	6-15-61
Complete - Air Vehicle Unit Deliveries	5-07-62
MANUFACTURING	
Complete - Air Vehicle No. 1 Syst. Installation	6-10-64

COST DEFINITION

SUBSYSTEM: FLIGHT INDICATION WBS COSE: 1.10

Total cost of $3,292,562 assigned to this subsystem includes only the subcontractor expenditures to design, develop, fabricate, and test the purchased equipment in this subsystem. In-house costs could not be segregated from the other vehicle subsystems. Fabrication of subsystem provisions, miscellaneous purchased parts, installation materials, installation of the subsystem hardware into the vehicles and subsystem, vehicle and preflight checkout of the equipment are accumulated in WBS 1.12 (Volume IV, page 647).

Below is a discussion of the subcontractors supplying equipment.

SUBCONTRACTOR MATRIX

SUBCONTRACTOR	ENGINEERING	PROD	TOOLING	TEST	TOTAL
Sperry Gyroscope	951,973	754,399	-	-	1,706,372
Airesearch	889,707	340,039	-	161,712	1,391,458
TOTAL	1,841,680	1,094,438	-	161,712	3,097,830

<u>SPERRY GYROSCOPE</u> was selected to furnish the Auxiliary Gyro Platform Subsystem and related Support Equipment in accordance with Design Specification NA5-7673. The two purchase orders awarded to Sperry for this effort were:

L961-GX-600123	March 6, 1959 - January 20, 1960
L1E1-YZ-600304	October 31, 1960 - July 10, 1961

The Statement of Work called for the supplier to provide engineering, management, fabrication and other services leading to the design, development, and support of an Auxiliary Gyro Platform for the B-70.

On December 2, 1959 Sperry was directed to reduce the project effort to a minimum. In addition, special studies were authorized relating to the modifications of the AGPS for use on the B-70 test vehicles. By January 20, 1960, the date Purchase Order 600123 was terminated, Sperry had complied with the redirection by reducing personnel to a hard core and completing the special studies as directed.

The second contract awarded to Sperry authorized the engineering and manufacture of twelve complete gyro systems. After proceeding with the program for six months, Sperry was redirected on March 31, 1961 to cease all work associated with the fabrication of hardware, and to maintain design study and planning effort only. Letter Contract 600304 was cancelled in its entirety on July 10, 1961. The total program effort was determined to be all design study and planning effort under the reduced program directed March 31, 1961.

WBS CODE: 1.10

AIRESEARCH was selected to furnish the Central Air Data Subsystem in accordance with NR Specification NA58-232. Two Letter Contracts were awarded to Airesearch for this effort:

L961-GX-600125	May 12, 1959 - December 2, 1959
L1E1-YZ-600303	November 9, 1960 - Nocember 22, 1961

The Statement of Work for each contract called for the subcontractor to provide management, engineering, manufacturing, and other necessary services, including but not limited to analytical and design studies directed toward the design, development, mockup, tooling, fabrication and delivery of the Central Air Data Subsystem for the B-70 Air Vehicle in accordance with NR Specification NA5-7674.

Airesearch was in the early stages of design and development effort on December 2, 1959, when the Contract 600125 was terminated for the convenience of the Government. Work on the Letter Contract 600303 was stopped on May 10, 1961 and terminated in its entirety on November 22, 1961. Airesearch was in the early hardware stage of the program at the time of termination.

The inventory from the above contracts was transferred to spares and shipped to NR for use on the B-70. The balance was disposed of as scrap. The total proceeds were applied to the source contract.

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 10
FLIGHT INDICATION SUBSYSTEM

	6-M ASSY 0 HOURS DOLLARS	TOTAL HOURS DOLLARS
SUBCONTRACT	3097830	3097830
MPC	136403	136403
SUB-TOTAL	3234233	3234233
GEN & ADMIN	58329	58329
TOTAL COST	3292562	3292562

SUBDIVISION OF WORK
COST DETAIL - SEE PAGE IV-577

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 10
6-MAJ ASSY 0

FLIGHT INDICATION SUBSYSTEM

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TEST /QC HOURS DOLLARS	TOTAL HOURS DOLLARS
SUBCONTRACT	1841680	1094438	161712	3097830
MPC	79378	47898	9127	136403
SUB-TOTAL	1921058	1142336	170839	3234233
GEN & ADMIN	26374	19547	12408	58329
TOTAL COST	1947432	1161883	183247	3292562
TIME-PHASED COST DETAIL - SEE PAGE	IV-578	IV-579	IV-580	IV-581

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 10 **FLIGHT INDICATION SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 59	275669	7309	282978		282978
Q-2 59					
Q-3 59	236366	6458	242824		242824
Q-4 59					
Q-1 60	713126	42309	755435	14393	769828
Q-2 60					
Q-3 60	183823	10906	194729	3710	198439
Q-4 60					
Q-1 61	302893	8678	311571	5790	317361
Q-2 61					
Q-3 61	129803	3718	133521	2481	136002
TOTAL	1841680	79378	1921058	26374	1947432

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 10 **FLIGHT INDICATION SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK PRODUCTION

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 59	36144	958	37102		37102
Q-2 59					
Q-3 59	66144	1807	67951		67951
Q-4 59					
Q-1 60	57511	3412	60923	1161	62084
Q-2 60					
Q-3 60	487072	28899	515971	9831	525802
Q-4 60					
Q-1 61	311939	8937	320876	5962	326838
Q-2 61					
Q-3 61	135628	3885	139513	2593	142106
TOTAL	1094438	47898	1142336	19547	1161883

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 10 **FLIGHT INDICATION SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK TEST/QC

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-3 59	9303	254	9557		9557
Q-4 59					
Q-1 60	73221	4344	77565	6132	83697
Q-2 60					
Q-3 60	73687	4372	78059	6171	84230
Q-4 60					
Q-1 61	5501	157	5658	105	5763
TOTAL	161712	9127	170839	12408	183247

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 10
6-MAJ ASSY 0

FLIGHT INDICATION SUBSYSTEM

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 59	311813	8267	320080		320080
Q-2 59					
Q-3 59	311813	8519	320332		320332
Q-4 59					
Q-1 60	843858	50065	893923	21686	915609
Q-2 60					
Q-3 60	744582	44177	788759	19712	808471
Q-4 60					
Q-1 61	620333	17772	638105	11857	649962
Q-2 61					
Q-3 61	265431	7603	273034	5074	278108
TOTAL	3097830	136403	3234233	58329	3292562

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WORK BREAKDOWN STRUCTURE

SUBSYSTEM: TEST INSTRUMENTATION

WBS CODE: 1.11

WBS LEVELS
4 5 6 7 8

1.11 TEST INSTRUMENTATION SUBSYSTEM

1.11.1 Flight Test

1.11.1.1 Transduces

Pressure
Temperature
Strain
Position
Rate Flow
Electrical
Electronic
Acceleration

1.11.1.2 Installation and Routing

Welding
Bonding
Shock Mounting
Wire
Connectors
Routing
References

1.11.1.3 Airborne Data Acquisition

Instrument Package
Multiplexing
Filtering
Communtation
Digitizing
Serial Time Coding
Digital Recorder
Analog Recorder
Telemetry

1.11.1.4 Instrumentation Control

1.11.1.4 Data Recovery Ground Station

Analog Data Reduction
Digital Data Reduction
Time Editing
Data Formats

1.11.2 R&D Ground Tests

TECHNICAL DESCRIPTION

SUBSYSTEM: TEST INSTRUMENTATION SUBSYSTEM WBS CODE: 1.11

The Test Instrumentation Subsystem for the B-70 Program was comprised of two types of data acquisitioning equipment and components: (1), the instrumentation involved directly with data acquisition during ground or flight tests conducted on the air vehicle and/or its installed subsystems; and (2), the instrumentation required for data acquisition in the development and verification of subsystems, major assemblies, and components prior to their installation in the air vehicle. Wherever it was possible, the same transducer or type of transducer was used in the development and flight test programs to provide maximum continuity in data acquisitioning. However, the recording equipment, signal conditioning, multiplexing, etc, were generally not the same with the air vehicle or airborne system having a much greater density and more complex.

Substantial advancements were achieved in the state-of-the-art in concepts and implementation of the data acquisition systems for both the ground development test and flight test programs. For the ground development testing, these achievements were mainly in development of high temperature transducers (strain gages, pressure sensors, accelerometers, etc.,) and in bonding techniques, such as, the application of strain gages to the critical surfaces of H-11 tool steel. The high temperature transducers and installation techniques established for the subsystem development ground test programs were used in implementing the airborne system installations.

In the airborne instrumentation system, the development of "low level" multiplexing or commutation and the dynamic filter were major break throughs for data acquisition. In addition to increasing the signal to noise ratios, these two achievements deleted the requirement for 1000 amplifiers that would have been required for a "high level" multiplexing system. The basic commutation programming of the airborne instrumentation system was also an advancement in the state-of-the-art. The switching, which was solid state, switched both sides of the signal lines at 400 times per second per each master channel with the switch and system sequencing commands derived by dividing down from a master crystal controller clocking oscillator. This design concept facilitated programming and provided "real time" throughout the data acquisition system.

The Test Instrumentation Subsystem was unique, when compared to the other subsystems, in that it existed due to the other subsystems and all requirements were based on the other subsystems criteria. This dependent existence was true for both the ground test programs and the flight test program. Due to this unique existence, the Test Instrumentation Subsystem did not lend itself to the same technical definition breakdown as the other subsystems. To provide an overall description, the technical characteristics of the airborne instrumentation system are included in the narrative description and presented in summary form by exhibits of that section. Also, since by edict the instrumentation requirements for both ground and flight tests did not schedule a subsystems development, no technical drivers existed. However, these were state-of-the-art advancements achieved and these were discussed in the preceeding paragraphs and are also included as part of the narrative descriptions in subsequent paragraphs.

TECHNICAL DESCRIPTION

SUBSYSTEM: TEST INSTRUMENTATION WBS CODE: 1.11

MAJOR ASSEMBLY: FLIGHT TEST INSTRUMENTATION SYSTEM WBS CODE: 1.11.1

The Flight Test Instrumentation System for the XB-70 air vehicle was developed to provide the capability of obtaining data required to establish safety or flight limits, to evaluate subsystem functional operations, and to define gross problem areas within the realm of the various flight test tasks. The airborne instrumentation system also contained provisions for obtaining Supersonic Transport (SST) data and supplemental cockpit instrumentation for special flight monitoring requirements. The primary data acquisition media was magnetic tape recorded in both digital and analog formats. In addition, selected parameters were telemetered to the Ground Station and displayed in real time on chart recorders concurrent with the flight. Exhibit 1, pages IV-597 & IV-598, presents an overall perspective of the XB-70 instrumentation installations and depicts the general locations of the airframe mounted instrumentation components. Exhibit 2, page IV-599, presents a block diagram of the XB-70 airborne instrumentation system.

The high capacity airborne instrumentation system developed for the flight test program, provided the capability of subsystem test sharing during each flight of the XB-70's. As previously discussed under Air Vehicle (WBS: 1.0), the test sharing provided an equivalent test hour total five times actual flight test hours plus the invaluable capability of "looking" at all subsystems for gross problems during the first phase of flight testing. This "gross look" at all subsystems provided early detection of problem areas which resulted in a timely progression of the flight test program.

There were six basic types of parameters recorded by the airborne instrumentation system. They were miscellaneous, acceleration, position, temperature, strain, and pressure. To acquire the parameter data, three sensor or transducer installations were employed. The conventional or normal approach was where the transducer was added at, or near, the point of measurement. The second type was where an air vehicle subsystem configuration had an electrically isolated sensor incorporated as part of the basic configuration and was furnished as an integral part of that subsystem. This avoided the requirement for making a direct electrial connection and afforded maximum isolation and safety. The third type of installation was the direct pick-off method and applied only to the measurement of electrical quantities, such as, voltage, current, frequency or to parameters already existing in electrical form.

In the course of building up the overall data acquisition system it was necessary to meet requirements for data sensors which were capable of operation in high temperature and vibration environments. Much of this equipment was purchased from outside vendors, but sensors for the measurement of linear positions, rotary positions, air flow directions, and high vibration hydraulic pressures were not available. These items, therefore, were designed and developed within the Instrumentation Group. High temperature bonded strain gage and variable reluctance techniques were applied in the construction of these devices. Exhibit 3, Page IV-600, presents several instrumentation data sensors developed for the B-70 program. A review of Exhibit 1, Pages IV-597 & IV-598, will show the general areas of transducer installations and the major routings of the instrumentation wiring from the transducers to the recording media which was mainly located in the instrumentation package.

The instrumentation package was the heart of the airborne data acquisition system. This was a specially designed package which could be lowered out of or raised into the air vehicle forward weapons bay. The equipment section was divided into four areas, three of which were compartmented for installation of modular chassis employing rack and panel connectors. The fourth area contained the tape recording equipment, the program panels, circuit breakers, operational controls and displays for performing preflight and checkout operations. Cooling air, in metered amounts, was forced through each chassis from a self-contained environmental control system which employed liquid nitrogen for cooling and pressurization. Temperature was regulated between limits of 40° and 160°F. Pressure was maintained so that it was never less than that corresponding to 8000 feet altitude. Environmental control provisions were dual, providing back-up operation in the event of an in-flight failure of the system. The instrumentation package was entirely independent of any air vehicle system with the exception of electrical power. Exhibit 4, Page IV-601, present an overall view of the instrumentation package and the air vehicle while Exhibit 5, Page IV-602, present a schematic of the instrumentation package showing the arrangement of the environmental control equipment.

As previously stated, the digital system and analog system were the primary media of data acquisition. The digital system, as shown by block diagram in Exhibit 6, Page IV-603, provided for the recording of approximately 800 channels of quasi-static data with a maximum frequency response of 20 cycles per second for selected channels. A wide variety of parameters were recorded and with the exception of thermocouples, all data channels were individually signal conditioned. The following sub-paragraphs describe the major functions of the digital system.

Multiplexing: A scheme of time multiplexing was employed to sample, digitize, and record each data channel in accordance with a prescribed repetitive pattern. Fifty channels of master commutation received signals sequentially from two pre-digitized data channels and 48 sub-commutators. Four sub-commutation ratios, 4 to 1, 10 to 1, 20 to 1, and 100 to 1 were available.

Filtering: Filtering, to limit the signal frequency spectrum to that which could be recovered from the recorded data at the digitizing rates provided, preceded the signal operation.

Commutation: Commutation was accomplished, at low level, by solid state switches which switched both sides of the signal lines. The switching rate for each master channel was 400 times per second which set the total system and sampling rate at 20,000 times per second. Switch and system sequencing commands were derived by dividing down from a master crystal controlled clocking oscillator. A system time code which was recorded as data, was also generated from this source. Switching was followed by amplification to bring the signal to the ± 3 volt level required by the analog to digital converter. Five sequentially gated amplifiers, each operating at a 20% duty cycle, performed this function.

Digitizing: Digitizing was completed in 15 micro-seconds at a repetition rate of 20,000 times per second. The digital resolution provided was 1 part in 1024, corresponding to conversion into 10 binary bits. The converter was self-clocking, but received its command to digitize from the system programmer.

Recording: Recording of the digitized output was in parallel binary bit format on 16 track 1 inch magnetic tape, as present by Exhibit 7, Page IV-604. Though data words were normally 10 bits in length, the recording system was capable of accepting up to 20 words of 13 bit length as derived from shaft encoders or other externally generated digital inputs. These longer words were recorded on the tape by gating them into the recorder at preset times in the data sampling sequence. Additional bits were also recorded on tracks, not used for data, to provide readout clocking and to indicate lateral parity, commutation frames and cycles, and system operational modes. The packing density on the magnetic tape was 667 words per linear inch with the tape recording speed of 30 inches per second. Two digital tape machines were employed for data acquisitioning. The switchover from the first to the second recorder occurred automatically when tape on the first machine was exhausted. A total of between 48 and 96 minutes of recording time was available depending on the thickness of the tape used; however, during the flight test program a thin tape was used so that the recording time was approximately 96 minutes. Exhibit 8, Page IV-605, presents a summary of the most significant technical characteristics of the digital system.

The analog system, which provided for the acquisition of high frequency data, employed frequency multiplexing to record up to 144 data channels in banks of up to 12 channels per data track on to a 14 track 1 inch magnetic tape. Track 13 was used for tape speed servo control only, and track 14 was used for correlation data only. A functional block diagram of the analog system, including telemetry, is shown in Exhibit 9, Page IV-606. The following subparagraphs described four major functions of the analog data acquisition system.

Frequencies: A 27KC signal was multiplexed with the composite signals of tracks 1 through 12. This signal was compatible with the tape speed compensation system, and was used in data reduction for the correction of wow and flutter. Transistorized, plug-in, subcarrier oscillators using IRIG band frequencies 3 through 14 were used to provide output lines for analog tape recording and telemetry.

Serial Time Code: Serial time code utilizing a 4 millivolt full scale output of a 3.9KC subcarrier oscillator on track 14, appeared in the format shown by Exhibit 10, Page IV-607. This same format was also on track 2 which provided serial time correlation for the telemetry system.

Recording: One analog tape recorder was used with a recording tape speed of 15 inches per second for the acquisitioning of the higher frequency parameters of the airborne system. At this tape speed and with thin tape, 90 minutes of recording time was provided. Exhibit 11, Page IV-608, presents a summary of the analog system's technical characteristics.

In addition to the basic recording equipment in the instrumentation package, the airborne system provided telemetry and other auxillary recording equipment as described in the following sub-paragraphs.

Telemetry: The real time display of 36 selected parameters, via telemetry, for the full duration of the flight, proved useful in monitoring flutter and certain other important parameters. Such monitoring made it possible to follow predicted versus actual flight conditions to guard against exceeding given limitations. It also permitted extensions of the flight envelope during the course of the test. The composite data signals appearing on analog tape tracks #1, #2, and #3 were telemetered to the ground on 3 UHF radio links operating on 228.2, 250.7, and 259.7 MC. These data were displayed on chart recorders, and provided a permanent record of the flight. Correlation with the in-flight records were provided by the analog time code format, and data record start and stop signals.

VGH Recorder: The NASA VGH recorder provided a time history of airspeed, altitude, and normal acceleration. Normal acceleration was measured at both the CG and the Pilot's station. The data were recorded on a 200 foot roll of 70mm photographic paper which advanced at the rate of 2-1/2 feet per hour in a removable recording drum.

Cockpit Camera: A 16mm pulse-operated camera, installed between the Pilot's and Co-Pilot's capsules, was focused on the cockput instrument panel. The field of view included all of the Pilot's engine and flight instruments. The camera was pulsed at two frames per second, and recorded only during the instrumentation recording period.

Pilot's Voice Recorder: A compact, quickly removable tape recorder was installed in the cabin equipment compartment to record flight comments. The recorder was also wired into AIC-18 Audio Bus to record all inter-com conversation, and transmitted or received radio communications. A total of 4-1/2 hours of recording time was available at a recorder speed of 15/16 inch per second.

Landing Gear Camera: A 16mm camera was located in each main landing gear well to record the behavior of the gear at the touchdown point. These cameras operate at 100 frames per second for a 40 second duration.

Sensitive Airspeed and Altitude Recorder: A NASA recorder of the VGH type was used to record sensitive airspeed and altitude. These data were recorded on 70 mm film operating at the rate of 2-1/2 feet per hour.

WBS CODE: 1.11.1

Virbration and Flutter Recorder: An AR-200 recorder utilizing 1 inch magnetic tape was used to record vibration and flutter data in an analog format. The recorder operated at a tape speed of 30 inches per second in conjunction with the analog and digital systems. High frequency accelerometers and microphones were mounted on components and located throughout the air vehicle for use as data sensors.

The airborne instrumentation system had either continuous or automatic sequence recording modes that was selectable by the pilot. Automatic sequencing provided for 4.5 seconds of data recorded out of each successive 15 second period. The recording time was also under the control of the pilot and by this dual arrangement, the pilot was able to record only at those times in the test flight where meaningful data were likely to be obtained. By this pilot function, the pilot performed a first line data editing operation which was further refined during data processing on the ground. In the event of an in-flight emergency, the recording system were automatically started upon encapsulation of the crew.

The control for the operation of the instrumentation system in flight is shown in Exhibit 12, Page IV-609. The pilot's control panel, located at the left hand side of the instrument panel, was the primary control center for the in-flight operation of the instrumentation system. Exhibit 13, page IV-610, presents this control panel showing the instrumentation package warning lights, mode selections, recording time selections, tape remaining, and the manual controls for the package ECS systems. Exhibit 14, Page IV-611, presents the auxiliary controls for the copilot. The correlation counter, as shown by Exhibit 15, Page IV-612, was located above the instrument panel directly in front of the pilot. This permitted time correlation between pilot's visual readings and the magnetic tape recordings. The counter operated directly from the time code generator in the instrumentation package, and ran continuously at a one count per second rate. The engine vibration monitor (EVM) display is shown in detail by Exhibit 16, page IV-613.The normal position for the "Record Selector" was in the "AUTO" position which sequenced the vibration levels of each engine through the analog recording system. This sequencing was accomplished by an EVM commutator which scheduled each engine reading for a 4 second period. The other positions selected that engine for continuous recording.

The high speed airborne instrumentation system recorded an average of 82.5 million data points per flight of which an average of 22.6 million data points were reduced per flight. This large data yield plus an established ground rule of "first" editing within 24 hours, demanded a rapid turn-around for data processing and reduction. To accomplish the massive data processing in the allotted time period, two data reduction stations were developed: one for analog data and one for the digital data. In addition, the Los Angeles Division's IBM facilities were utilized as discussed in a subsequent paragraph.

WBS CODE: 1.11.1

With few exceptions, notably thermocouple (temperature) data, XB-70 parameters were reduced through use of the following general expression:

$$\text{Recorded Value (engineering units)} = (D - Z)\frac{F}{(C - Z)} + b$$

where D = a level recorded for a known (reference) condition
C = Calibrate level
F = Factor (engineering units) associated with the net calibrate step (C - Z)
b = an offset (engineering unit) corresponding to the reference level

F was determined during a physical calibration of the data transducer. C and Z were recorded during the T-9 preflight, and b was measured at the time of the T-9 recording. Because of the many types of measurements recorded, the general expression assumed many forms. For example, Z_v (the level recorded when excitation voltage was removed) was sometimes used instead of Z. Therefore, data channels were categorized into groups, each of which utilized a particular form of the general expression given above. This category list, with identifying numbers appears below. Category numbers were used in the reduction of the pre-flight recording and formed an important part of the IBM processing procedure.

Category	Expression
1	$(D - Z)\frac{F}{C - Z} + b$
2	$(D - Z)\frac{F}{C - Z}$
3	$(D - Z)\frac{F}{C - Z_v} + b$
4	$(D - Z)\frac{F}{C - Z_v}$
5	$(D - Z_v)\frac{F}{C - Z_v} + b$
6	$(D - Z)\ F$
7	$(D - Z)\ F + b$
8	Two states of a switch were indicated by the presence or absence of a bit in a 13 bit digital word.
9	$\frac{D - Z}{C - Z}$ was the ordinate value of a curve. The abscissa was the recorded value.
10	(D - Z) F (Provided high resolution IBM printout)

C. 11

Category	Expression
11	A curve consisting of eight straight line segments, each segment corresponding to 128 counts, approximated the T/C calibration curve to 1^o.
12	Same as 11 except for high range T/Cs.
13	$(D - Z_v) F + b$
14	$(D - Z_v) \frac{F}{C - Z_v}$
15	512 counts indicated one state, 0 indicated the other.
16	$(D - Z) (+F)$ & $(D - Z) (-F)$
17	$D \times \frac{F}{C - Z}$
18	$(D - Z_v)\ F$
21	Revolutions $= \frac{D}{1080}$ (to obtain Bogie Wheel RPM)
24	Test altitude from Aero program. Test A/S from Aero program. Test Mach No. from Aero program.
31	Altitude computed from M1 and M4.
32	A/S computed from M2 and M5.
33	Mach No. computed from M3 and M6.
34	Primary Nozzle Area #1 Engine from X559 Primary Nozzle Area #2 Engine from X560 Primary Nozzle Area #3 Engine from X561 Primary Nozzle Area #4 Engine from X562 Primary Nozzle Area #5 Engine from X563 Primary Nozzle Area #6 Engine from X564
35	Secondary Nozzle Area #1 Engine from X565 and Primary Nozzle Area. Secondary Nozzle Area #2 Engine from X566 and Primary Nozzle Area. Secondary Nozzle Area #3 Engine from X567 and Primary Nozzle Area. Secondary Nozzle Area #4 Engine from X568 and Primary Nozzle Area.

WBS CODE: 1.11.1

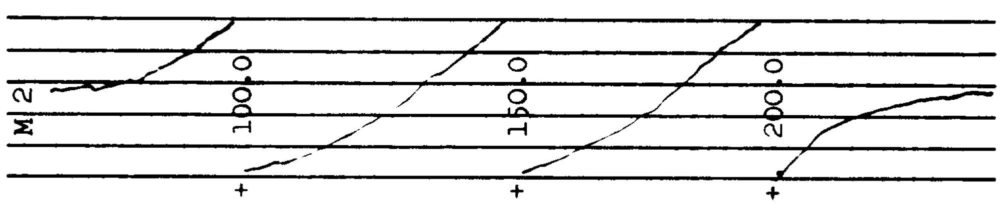
Secondary Nozzle Area #5 Engine from X569 and Primary Nozzle Area.

Secondary Nozzle Area #6 Engine from X570 and Primary Nozzle Area.

Analog data was reduced, without editing, one track (out of 12) at a time for the entire flight tape time. The data signal from the track was input to 12 discriminators or filters. The output of each discriminator was input to a Sanborn direct writing recorder channel for real time, scaled plotting. Three 4 channel Sanborn Recorders were used for plotting as many as 12 parameters per tape track. "Time" from the flight tape was recorded on each Sanborn Recorder. After reduction, the Sanborn plots were identified with parameter numbers and scales. "Time" was translated from the serial code in which it appeared and was written on plots in "hrs-mins-secs" at intervals throughout the data. Exhibit 17, Page IV-614, presents a view of the analog data reduction station while Exhibit 18, Page IV-615, shows by block diagram, the analog data reduction process.

The digital data was reduced by the digital data station or on the IBM 7094 computer. Except for the IBM data, the types of data described below were processed by the digital data station.

Editing Data: Five groups of 15 parameters each were plotted for the entire flight tape time. These plots were used by the various data requestors for editing purposes, i.e., to determine which areas of the flight recording should be requested for detailed data analysis. Editing data was plotted 15 parameters per sheet, each parameter occupying a band of one-half inch. A "Folded scale" scheme provided a full scale data band of about 10 times this amount. This is illustrated below.



M2, Airspeed, is shown increasing from 75 knots to 225 knots. The value of the lower grid line was automatically printed whenever a data transition occurs.

Each sheet containing a 15 parameter group was approximately 50 feet long. The 250 feet of paper from a typical flight was displayed on the walls of an editing data room the morning after a flight had been made.

Litton Transducer Plots: A/Vs #1 and #2 contained, respectively, 4 and 5 Litton pressure transducers which were recorded as 13 bit words with a resolution of 1 part in 8000. Data from the Littons were plotted for the full length of the flight recording. Each pressure was plotted within a 2 inch band, corresponding to a range of 1 psi and a plotting resolution of .005 psi. The folding scale scheme was used to provide full scale range data. All Litton Data from one A/V was plotted on the same sheet.

WBS CODE: 1.11.1

Thermocouple Data: Thermocouple data was plotted in time history form, 4 temperatures were read and plotted once each minute. Each temperature was plotted within a 2 inch band, corresponding to a temperature range of 200°F and a plotting resolution of 1°F. Folded scales were used to provide full scale temperature data.

Unscaled Data: Requests for small amounts of data (1 to 30 parameters) were satisfied by plotting (from 1 to 4 parameters per page) or tabbing up to 18 parameters per page, the unscaled data recorded on the tape. Each point recorded was plotted for the time interval specified. Tab data rates varied from 4 samples per second to recording rate. Plotting resolution was the same as recording resolution (1 in 1000). Since the data was unscaled, the expression for reducing the data to engineering units was provided for each parameters.

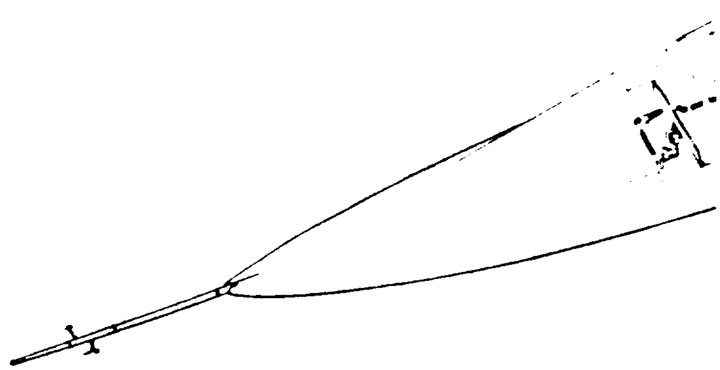
Wheel RPM: Bogie Wheel revolutions (A/V #1) were reduced from a 13 bit counter. The numbers recorded on the flight tape were tabulated and then input to a Recomp II computer which calculated wheel RPM during and after touchdown. This data was plotted by hand.

IBM Data: After editing data had been reviewed, requests for IBM data were received. These requests specified time intervals and the type of data required. Each data type corresponded to a fixed list of parameters. For example, Structures would request Landing Parameters or Flight Parameters; Aero would specify Performance, or Inlet, or Stability, or SST Parameters, or a combination thereof. All requests for IBM data were processed in the same manner, as follows. All data recorded in the time intervals specified was read from the flight tape and written on a half inch tape. This tape was sent to the IBM 7094 Computer with a deck of cards listing the parameters to be reduced. The job instruction sheet specified use of a previously prepared magnetic tape which contained the necessary calibration data for reducing the data on the half inch tape. The half inch tape, the parameter call cards, and the calibration tape were processed, and reduced data was output on 4 magnetic tapes or 5 tapes if tabulated data had been specified. Each of the first 4 tapes contained data from parameters recorded at one of the 4 rates (100, 40, 20, and 4 times per second). These tapes were placed in reserve storage for later use by the requesting group with their IBM analysis programs. When tabulated data had been requested, the contents of the fifth tape was printed.

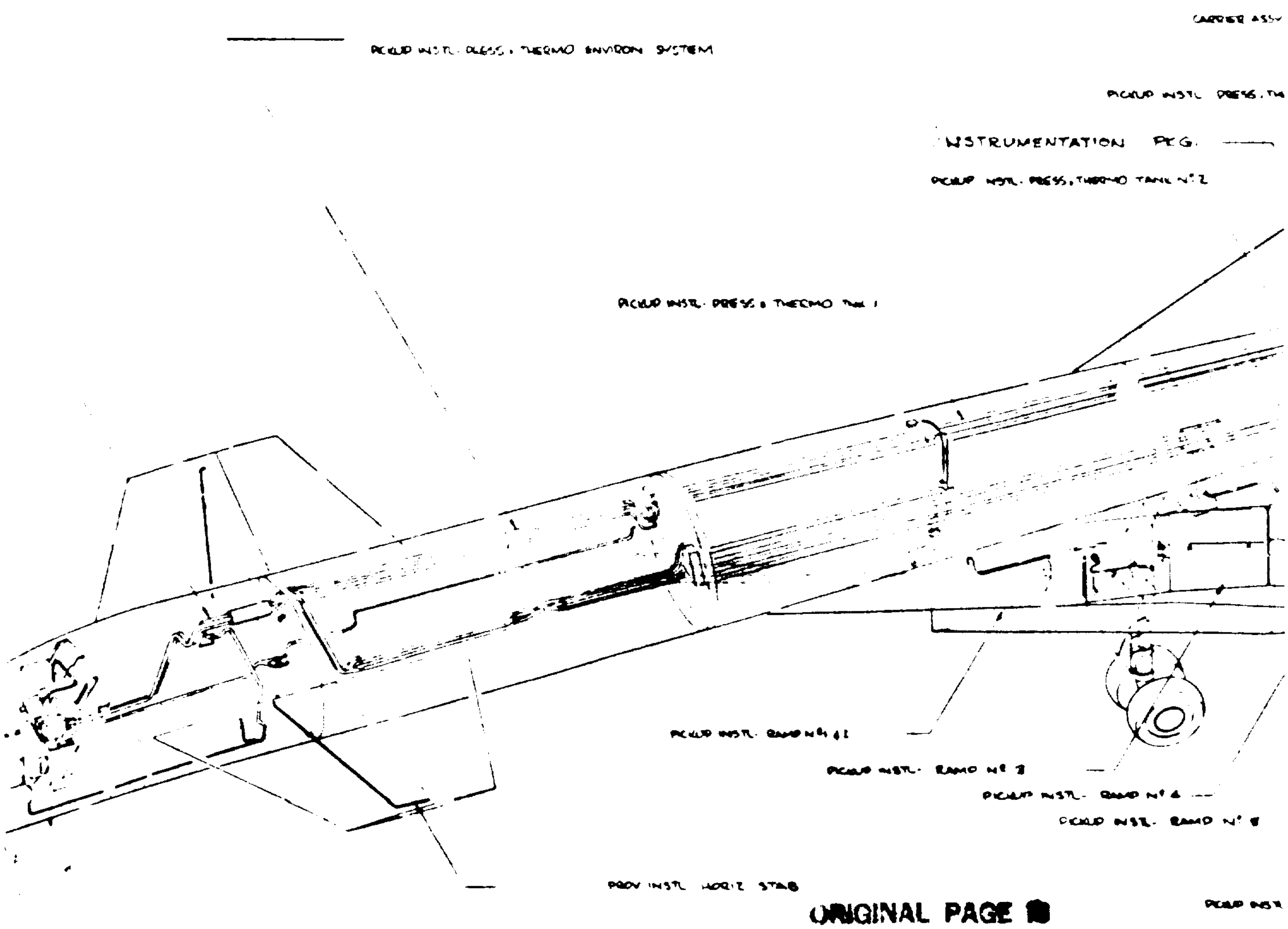
Exhibit 19, Page IV-616, presents a view of the digital data station while Exhibit 20, Page IV-617, shows by block diagram, the digital data reduction process.

FOLDOUT FRAME 1

PICKUP INST- THERMO CREW COMPT
PICKUP INST- THERMO EQUIP COMPT

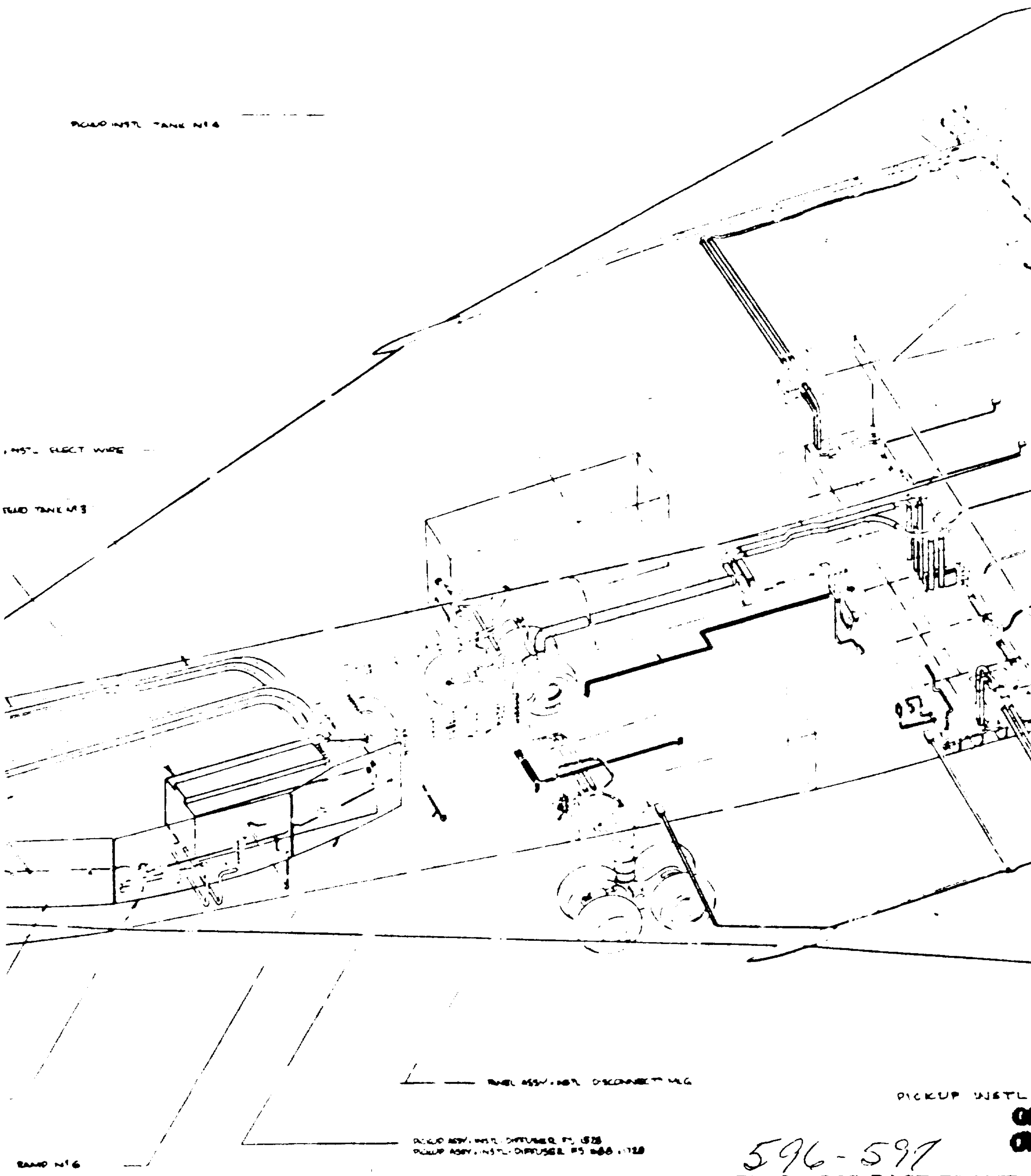


FOLDOUT FRAME 2



ORIGINAL PAGE IS
OF POOR QUALITY

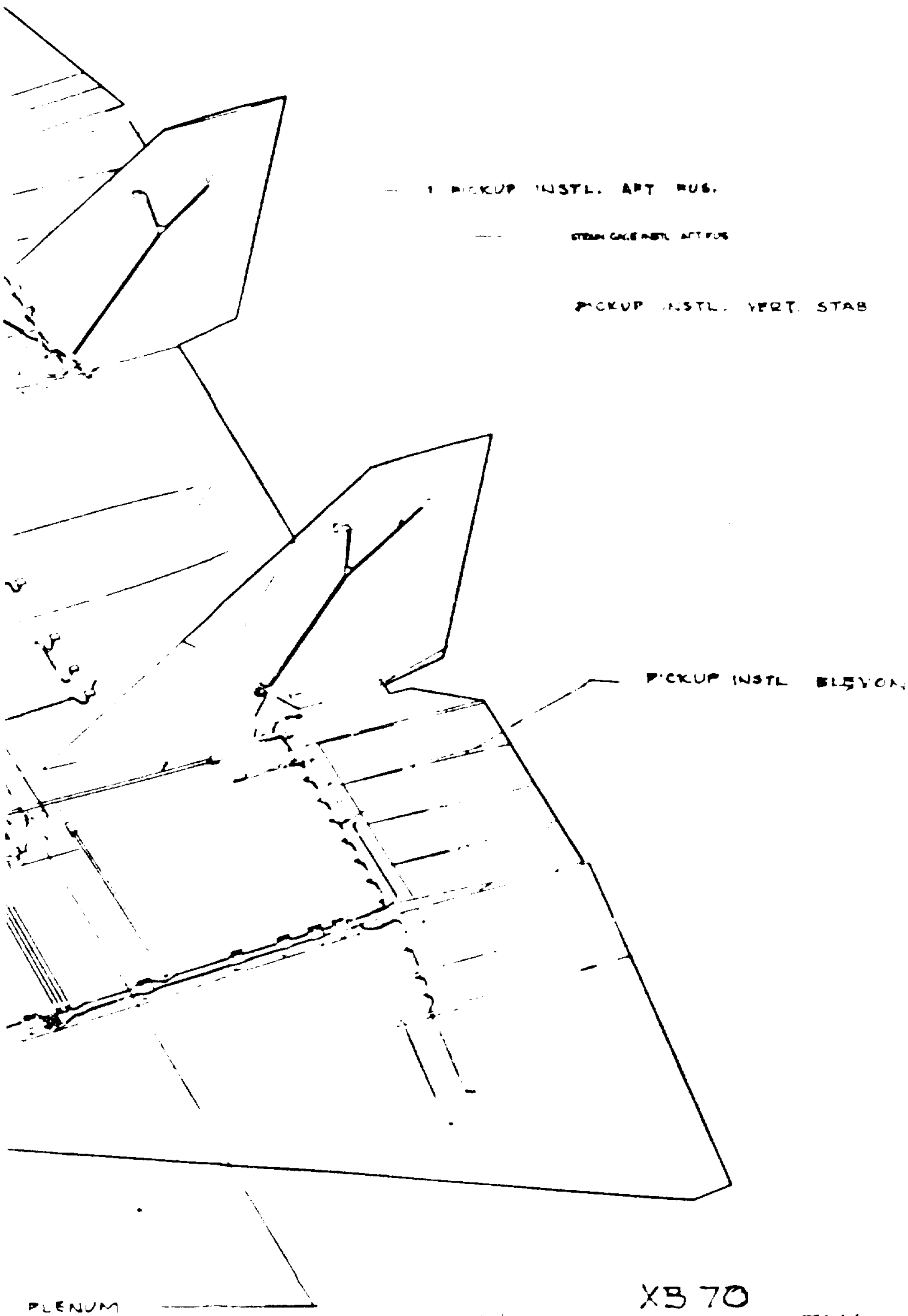
FOLDOUT FRAME 3



596-597

PRECEDING PAGE BLANK N

FOLDOUT FRAME 4



XB 70
INSTRUMENTATION INSTALLATION

EXHIBIT 1

XB-70 AIRBORNE INSTRUMENTATION SYSTEM

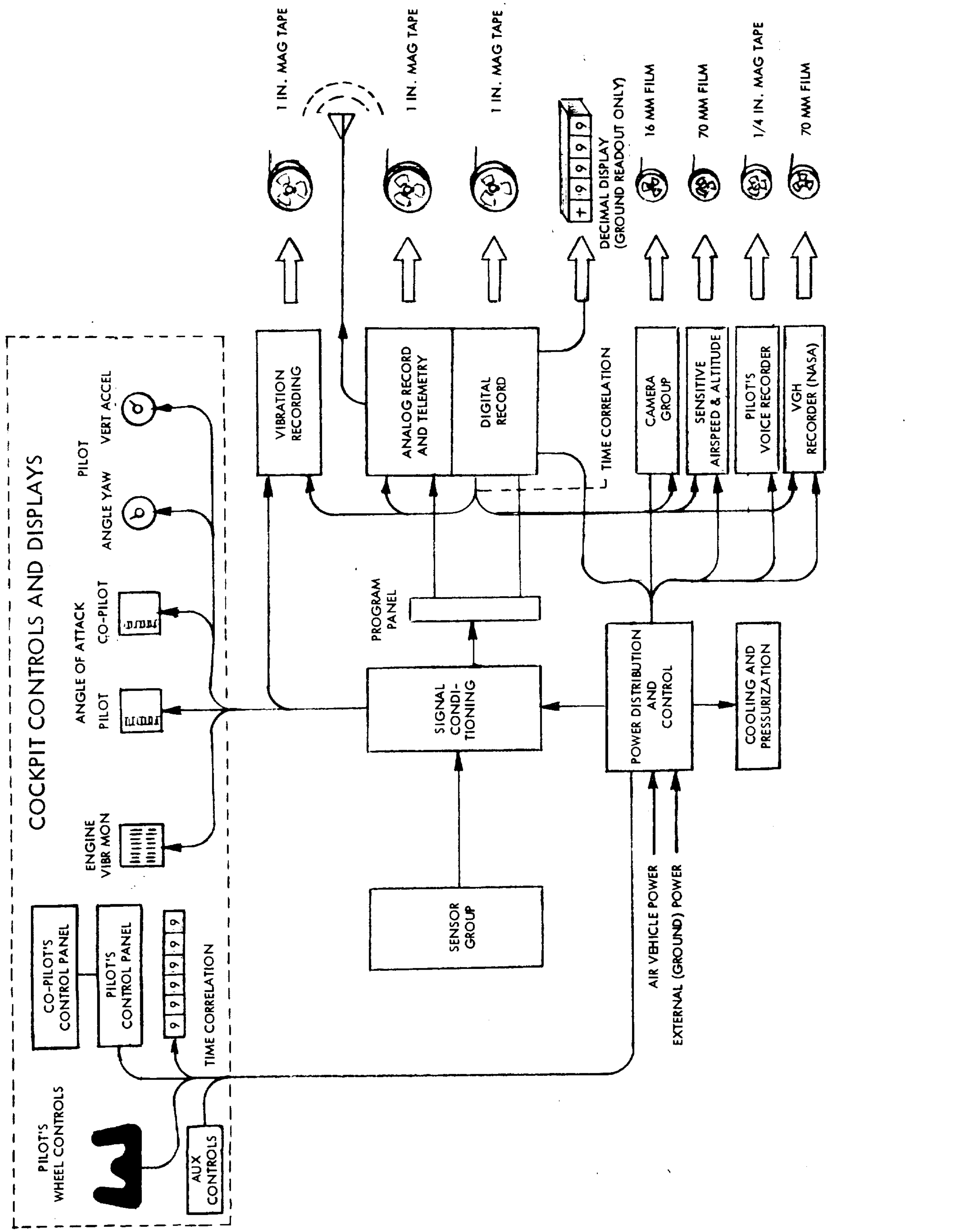


EXHIBIT 2

INSTRUMENTATION DATA SENSORS

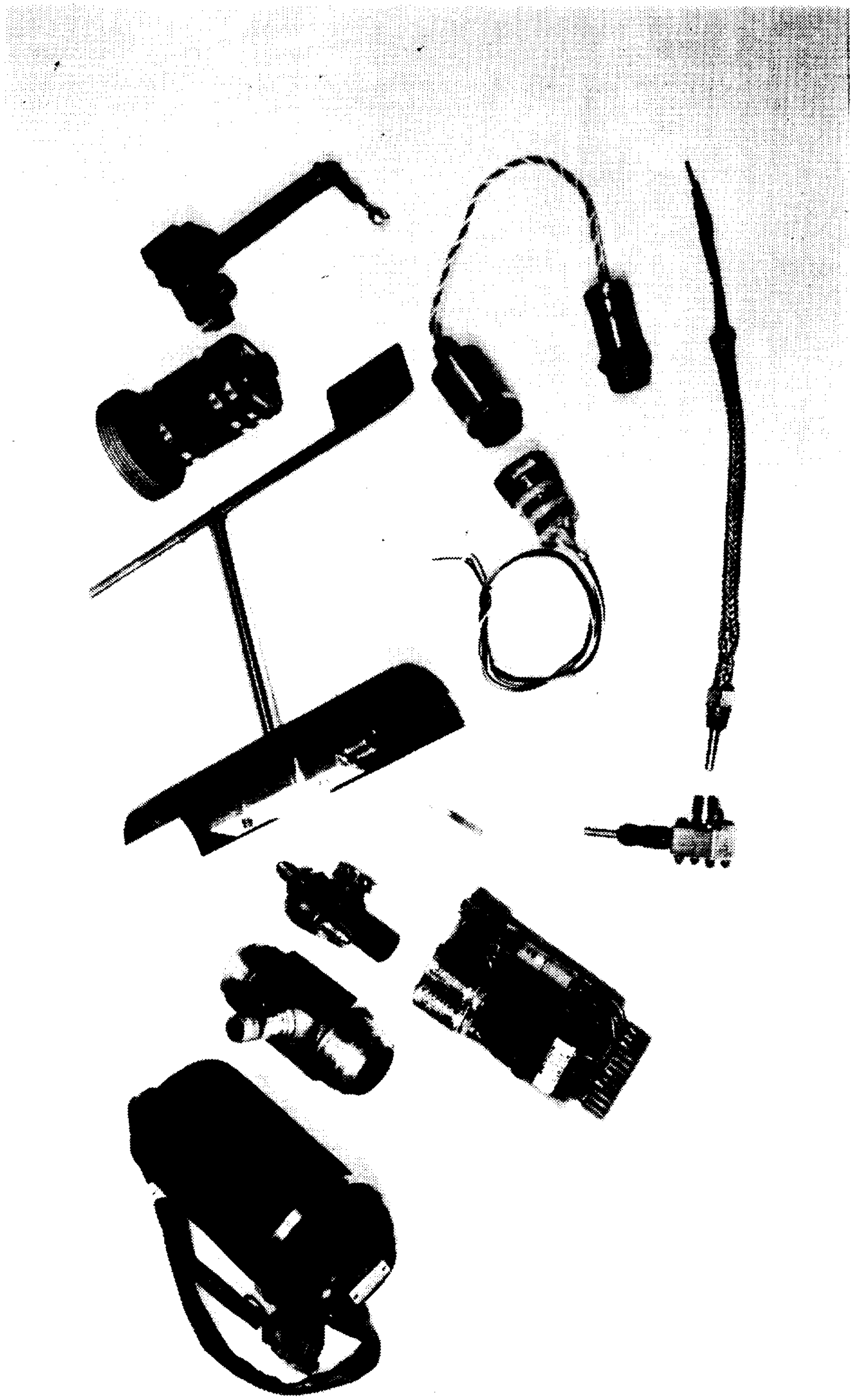
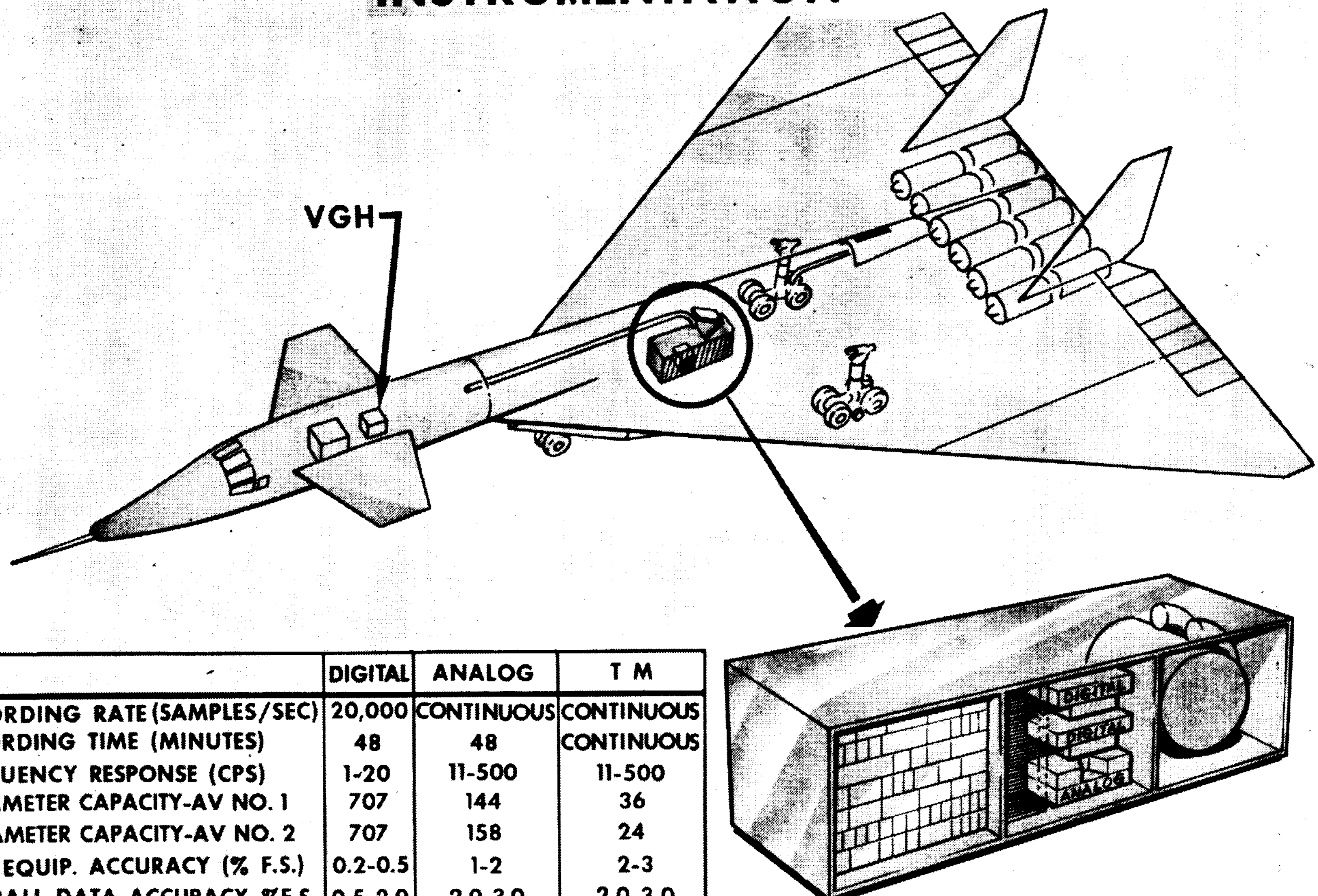


EXHIBIT 3

INSTRUMENTATION



	DIGITAL	ANALOG	T M
RECORDING RATE (SAMPLES/SEC)	20,000	CONTINUOUS	CONTINUOUS
RECORDING TIME (MINUTES)	48	48	CONTINUOUS
FREQUENCY RESPONSE (CPS)	1-20	11-500	11-500
PARAMETER CAPACITY-AV NO. 1	707	144	36
PARAMETER CAPACITY-AV NO. 2	707	158	24
REC. EQUIP. ACCURACY (% F.S.)	0.2-0.5	1-2	2-3
OVERALL DATA ACCURACY %F.S.	0.5-2.0	2.0-3.0	2.0-3.0

TSP63-8431 E

INSTRUMENTATION ENVIRONMENTAL CONTROL EQUIPMENT

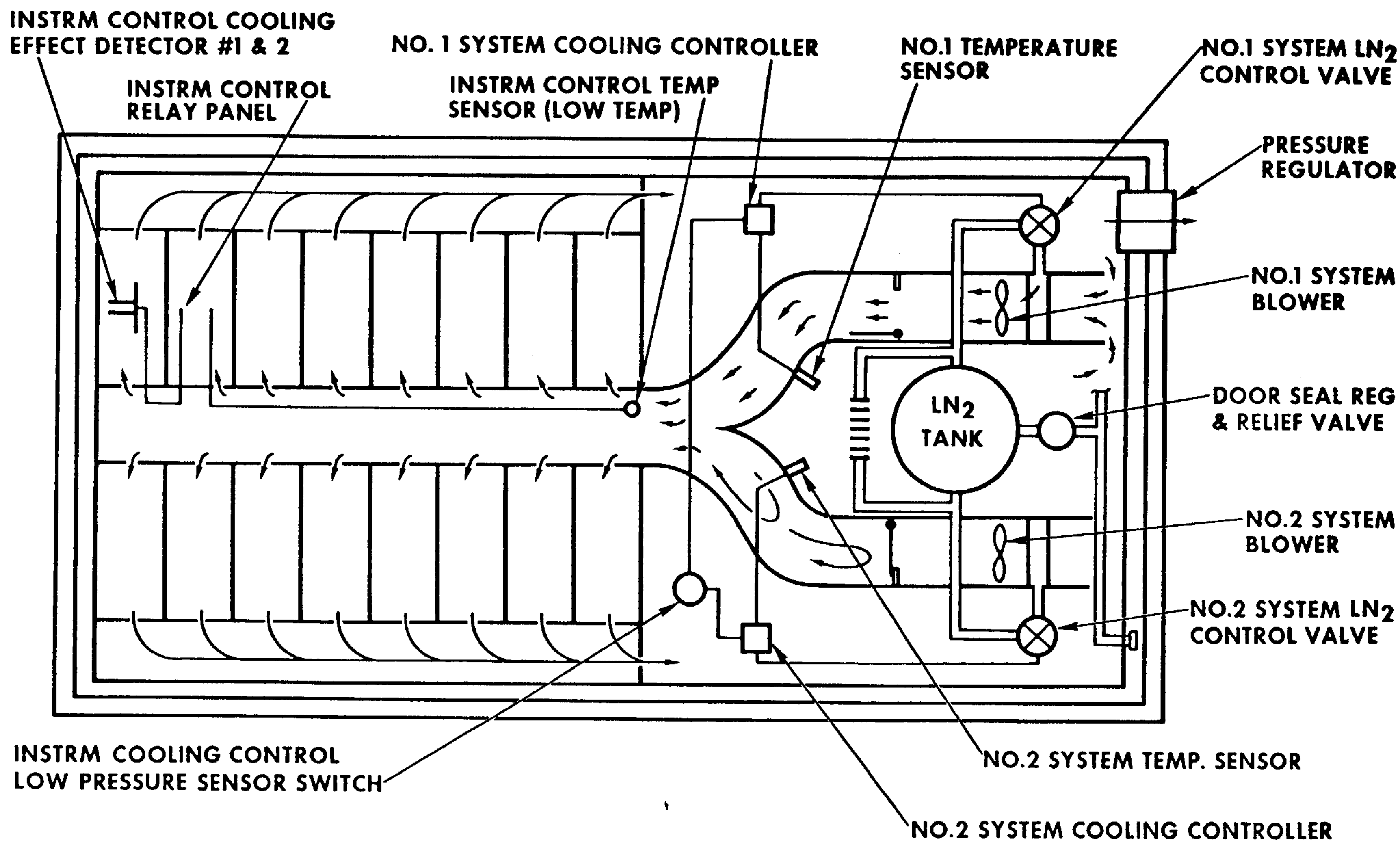


EXHIBIT 5

DIGITAL RECORDING SYSTEM

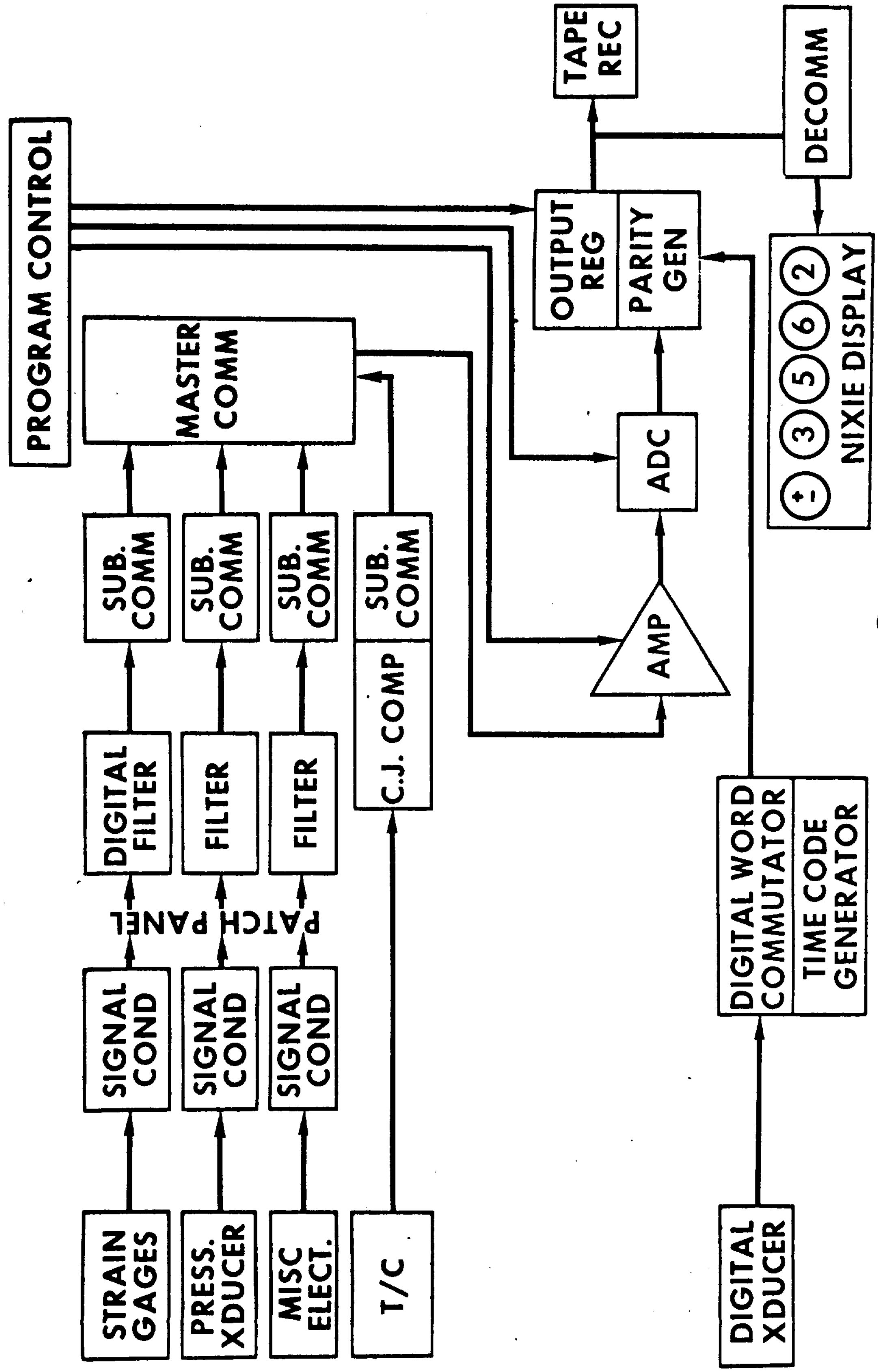
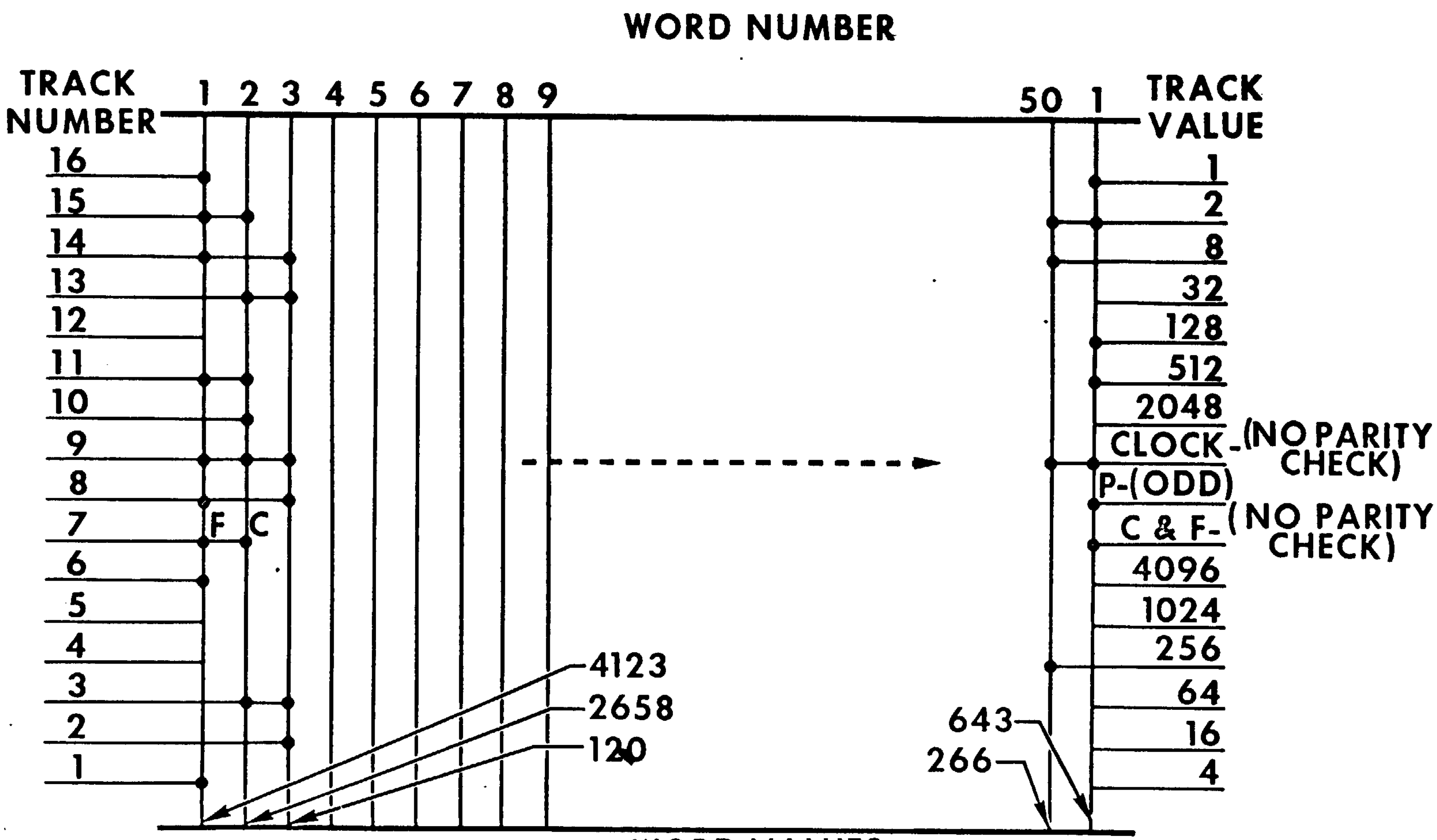


EXHIBIT 6

DIGITAL FLIGHT TAPE FORMAT



ZERO "IDENT."-4096 IN FRAME SLOT 2, SUB-COM. 1
CAL. "IDENT"-2048 IN FRAME SLOT 2, SUB-COM 1.

SUMMARY OF DIGITAL SYSTEM CHARACTERISTICS

RECORDING RESOLUTION	1 IN 1024 STD - 1 IN 8192 DIGITAL
RECORDING ACCURACY	0.3% F.S. TO 0.05% F.S.
TOTAL SAMPLING AND DIGITIZING RATE	20,000 SAMPLES PER SEC.
FREQUENCY RESPONSE	APPROX 1 TO 20 C.P.S.
COMMUTATION RATES	4 SAMPLES/SEC., 400 CHANNELS 20 SAMPLES/SEC., 100 CHANNELS 40 SAMPLES/SEC., 50 CHANNELS 100 SAMPLES/SEC., 136 CHANNELS
PRE-DIGITIZED DATA	20 RECORDINGS/SEC., 20 CHANNELS
TIME CODE	HOURS, MINUTES, SECONDS, AND HUNDREDTHS OF SECONDS - 24 HOURS
RECORDING DURATION	48 TO 94 MINUTES
TAPE PACKING DENSITY	667 DATA WORDS PER INCH
RECORDING MEDIUM	MAGNETIC TAPE, 1 INCH WIDE
RECORDING FORMAT	10 AND 13 BINARY BIT PARALLEL NRZ
CAPACITY	706 PARAMETERS (FIRST AIRPLANE)
SYSTEM DESIGN	SOLID STATE ELECTRONICS

EXHIBIT 8

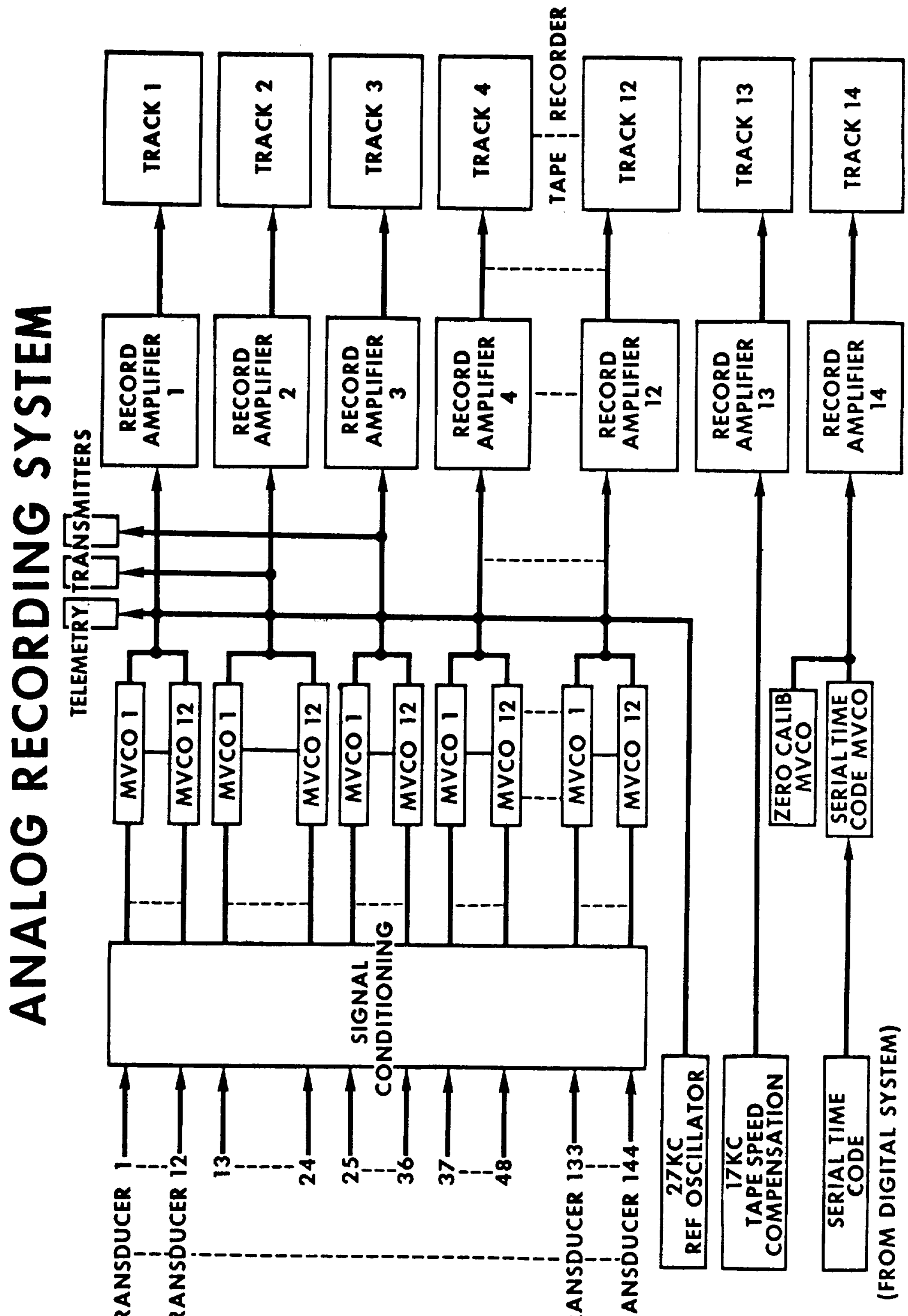
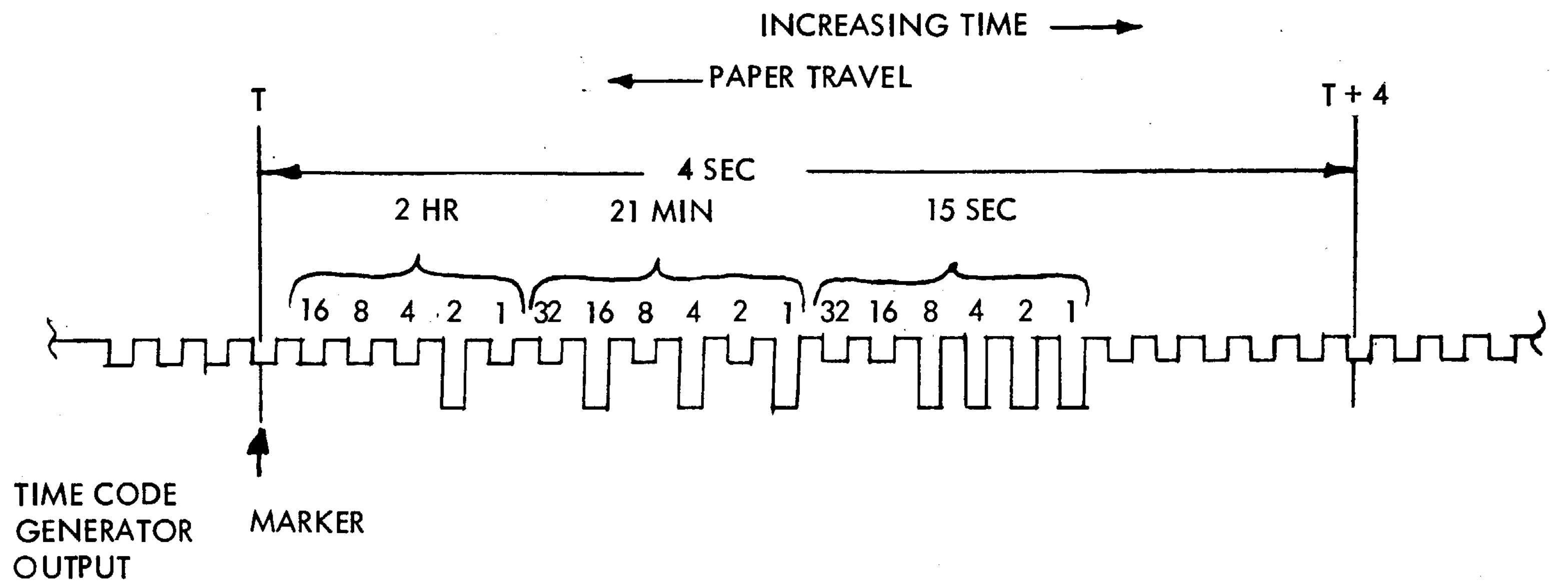

ANALOG RECORDING SYSTEM
TRANSDUCER 1
TRANSDUCER 12
13
24
25
36
37
48
TRANSDUCER 133
TRANSDUCER 144
SIGNAL CONDITIONING
MVCO 1
MVCO 12
TELEMETRY TRANSMITTERS
RECORD AMPLIFIER 1
RECORD AMPLIFIER 2
RECORD AMPLIFIER 3
RECORD AMPLIFIER 4
RECORD AMPLIFIER 12
RECORD AMPLIFIER 13
RECORD AMPLIFIER 14
TRACK 1
TRACK 2
TRACK 3
TRACK 4
TRACK 12
TRACK 13
TRACK 14
TAPE RECORDER
27KC REF OSCILLATOR
17KC TAPE SPEED COMPENSATION
SERIAL TIME CODE
(FROM DIGITAL SYSTEM)
ZERO CALIB MVCO
SERIAL TIME CODE MVCO

EXHIBIT 9



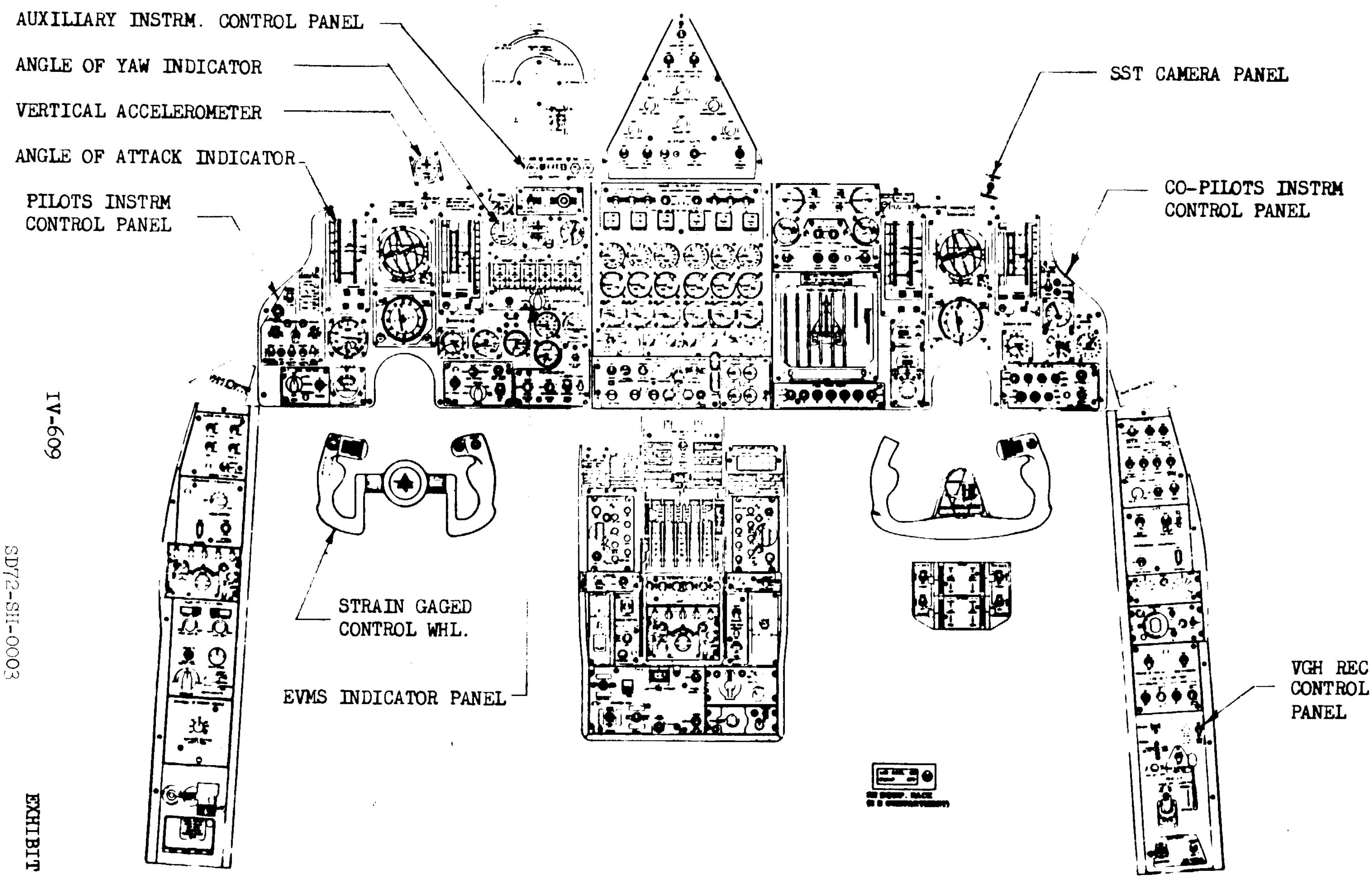
TIME CODE AS RECORDED ON ANALOG TAPE TRACK 14
USING IRIG SUBCARRIER 3.9 Hz

Serial Time Code Format

SUMMARY OF ANALOG SYSTEM CHARACTERISTICS

RECORDING ACCURACY	±3% F.S.
FREQUENCY RESPONSE	0-11 TO 0-330 CPS AT MI = 5
TIME CODE PERIOD/RESOLUTION	24 HR/0.2 SEC
RECORDING TIME	90 MIN FLIGHT, NO.3 M-4901-6800 TAPE
DATA CHANNEL PROVISIONS (POTENTIAL)	A/V 1
RECORDED	144
TELEMETERED	36
BANDS USED	IRIG BANDS 3-14
INPUT SIGNAL	±20 MV
INPUT IMPEDANCE	20K OHMS
FREQUENCY RESPONSE	WITHIN 0.5% BANDWITH DEV ALL CHANNELS TO MI = 5
HARMONIC DISTORTION	LESS THAN 1%
LINEARITY	±0.5% BANDWITH DEV FROM BEST STRAIGHT LINE
STABILITY	±1 OF BANDWITH 30 MIN TO 8 HR AT 25° C
COMMON MODE REJECTION	140 DB AT DC; 100 DB AT 400~
POWER REQUIREMENT	28 VDC ±10 AT 15 MA NOMINAL

XB-70A INSTRUMENT PANELS



PILOTS INSTRUMENTATION CONTROL PANEL

PREPARED BY:	NORTH AMERICAN AVIATION, INC.	PAGE NO. OF
CHECKED BY:	CO-PILOT'S INSTRUMENTATION	REPORT NO.
DATE:	CONTROL PANEL	MODEL NO.

(REF: 259-750722)

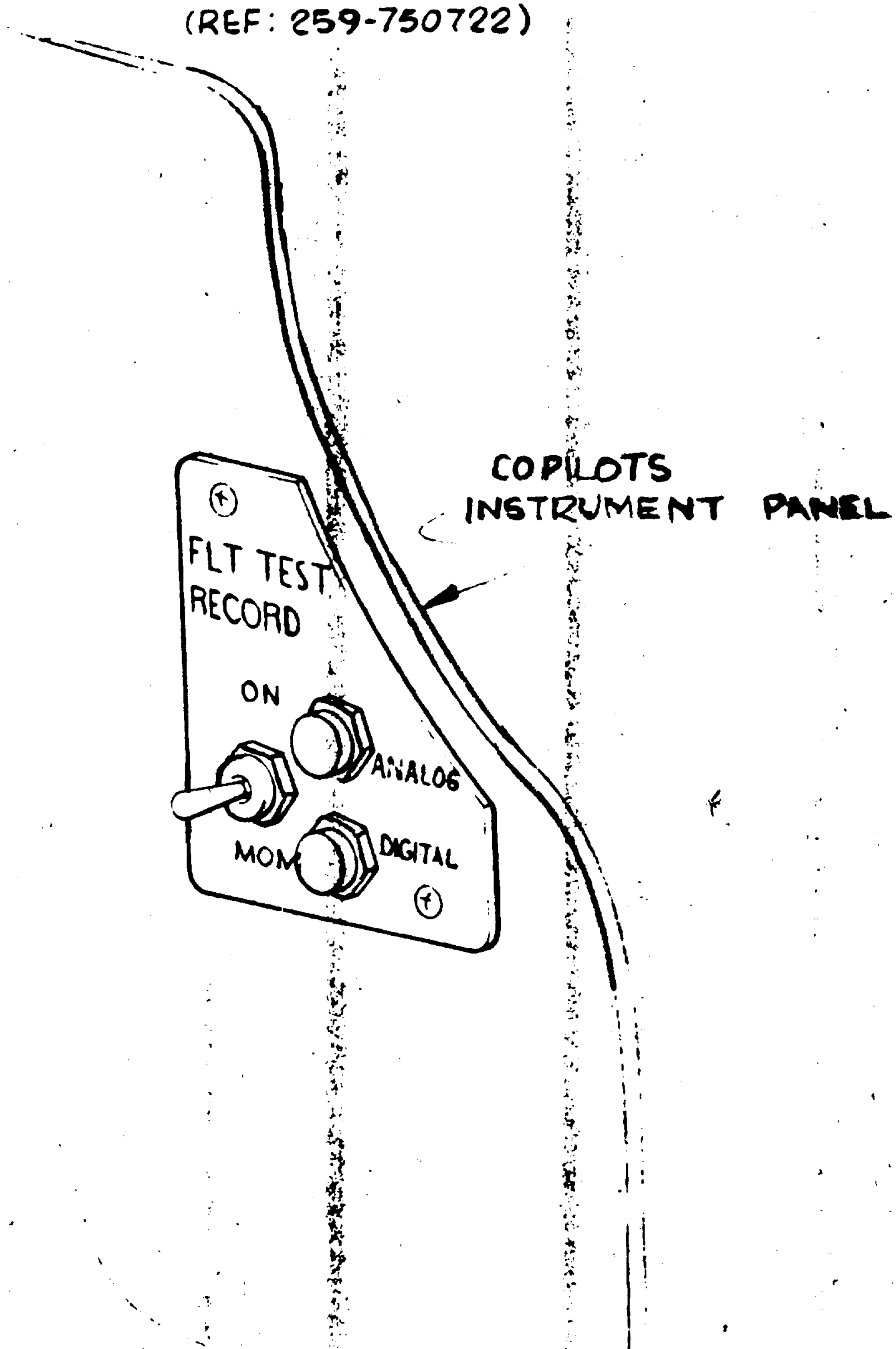


EXHIBIT 14

PREPARED BY:

CHECKED BY:

DATE:

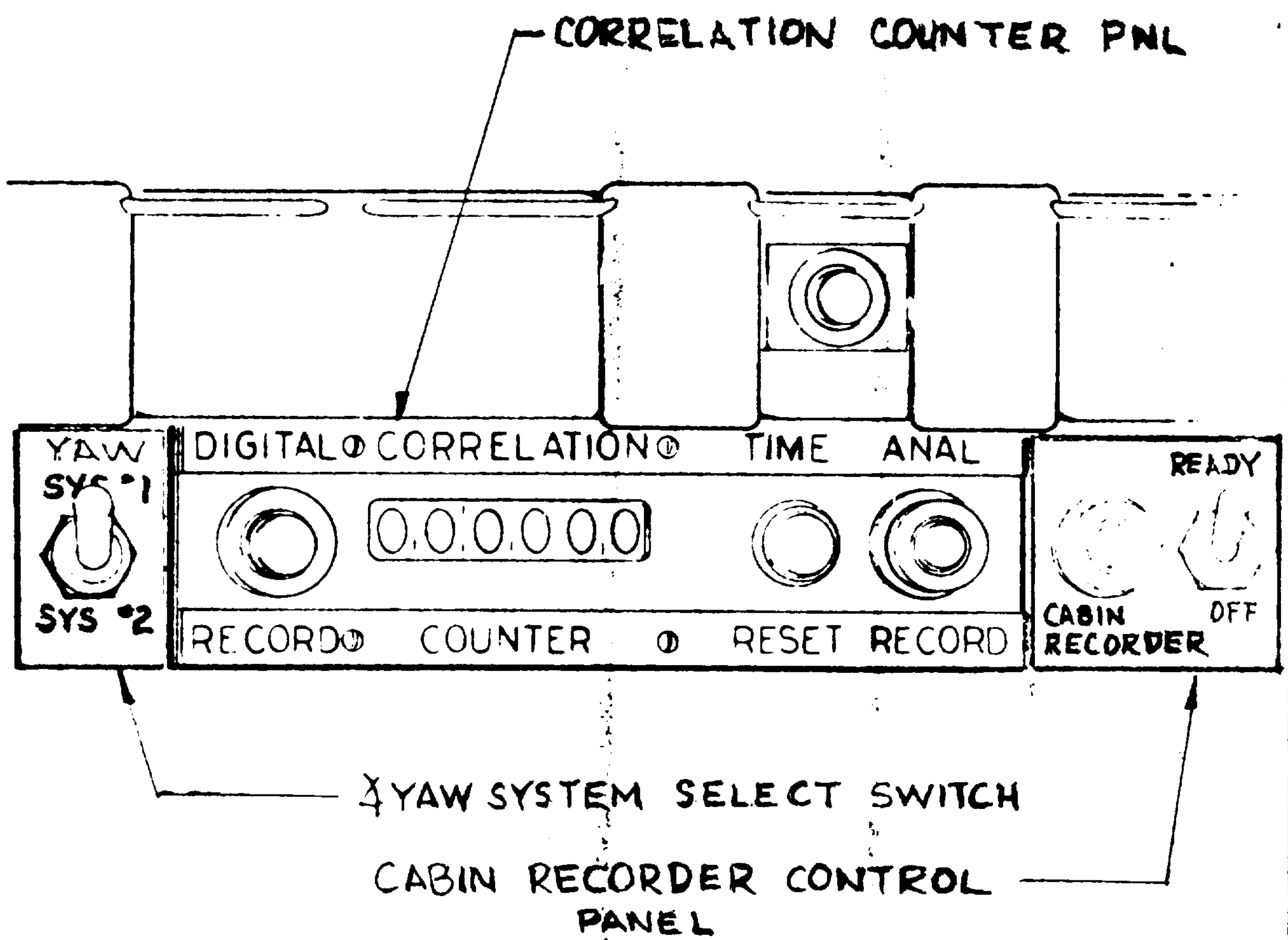
NORTH AMERICAN AVIATION, INC.

AUXILIARY INSTRUMENTATION CONTROL PANEL

PAGE NO OF

REPORT NO

MODEL NO.

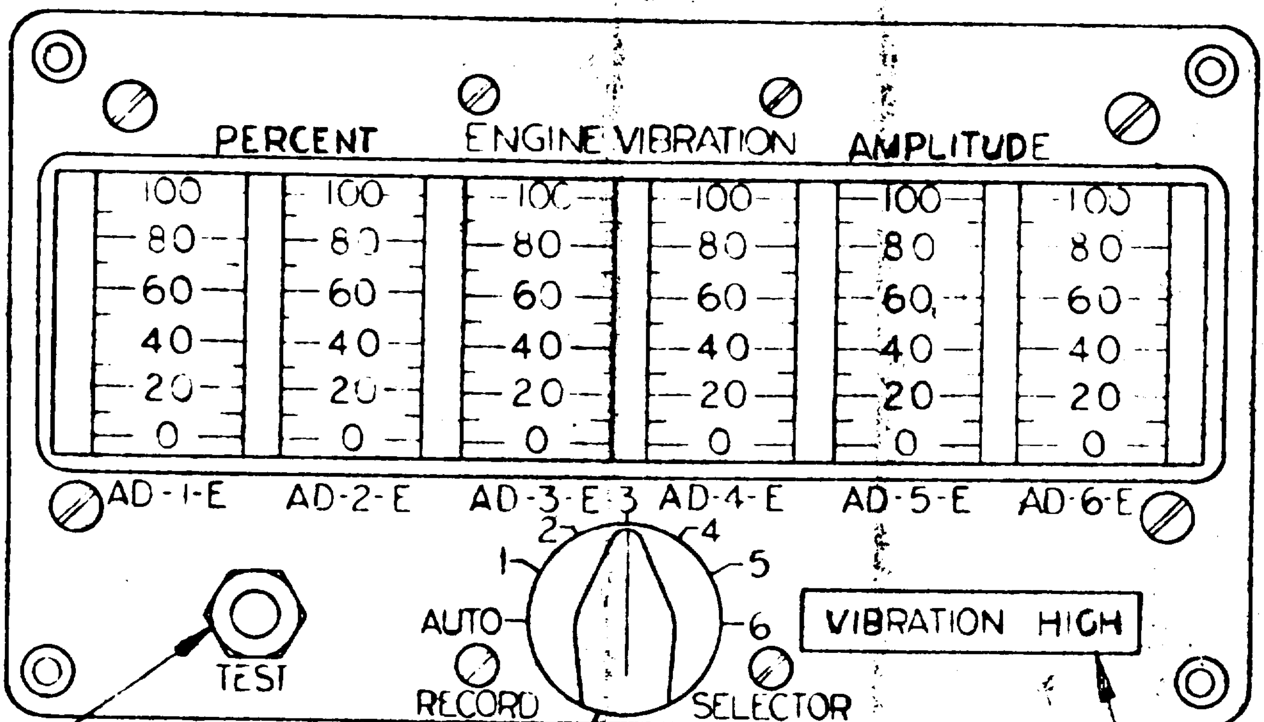


PREPARED BY — NORTH AMERICAN AVIATION, INC. — PAGE NO. OF

CHECKED BY: — REPORT NO.

DATE: — MODEL NO.

PILOT'S ENGINE VIBRATION DISPLAY PANEL



(1) PUSH BUTTON ACTIVATES POINTERS TO APPROX. 70% AMPLITUDE TO CHECK OUT ALL CIRCUITS. WARNING LIGHT (3) SHOULD ILLUMINATE.

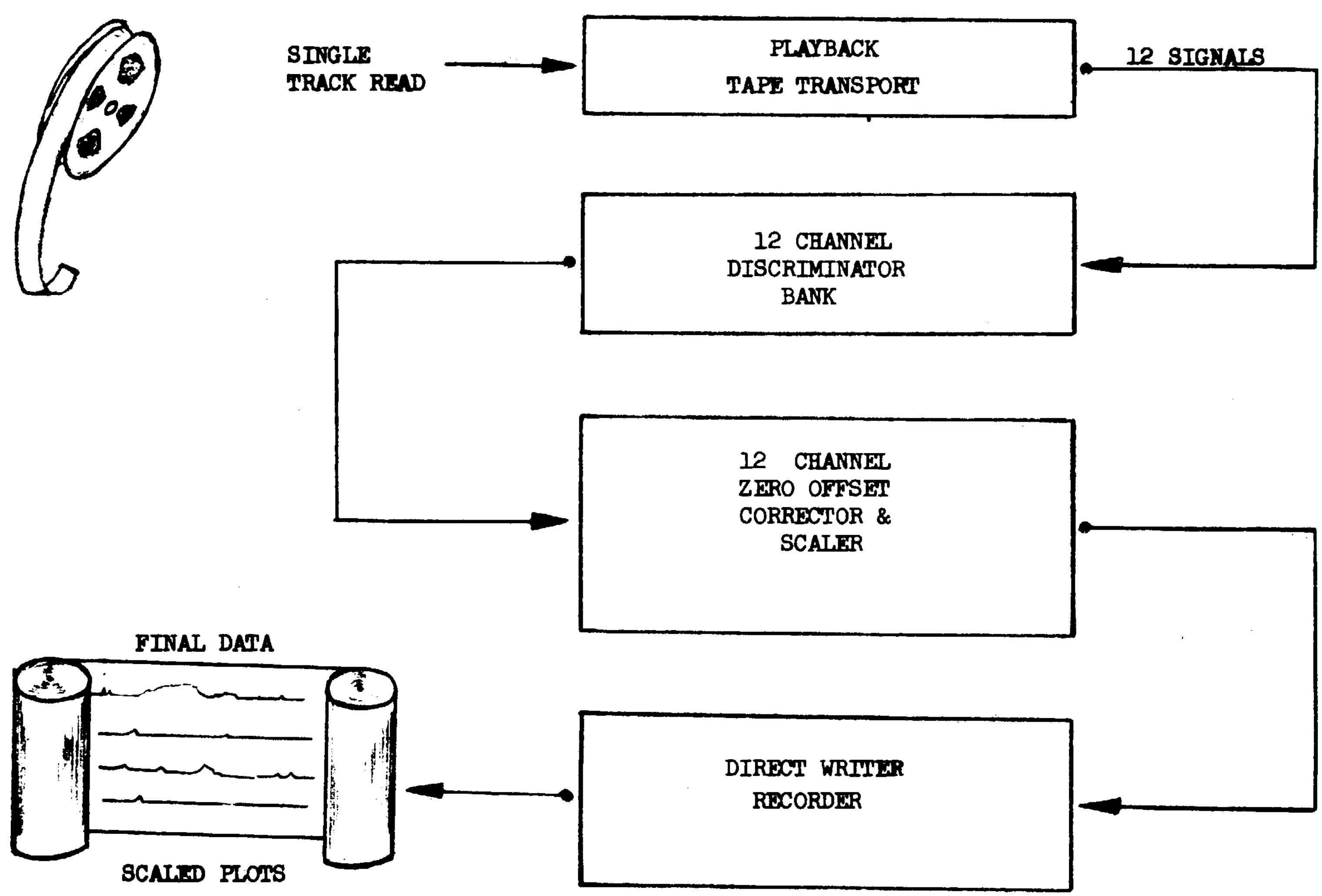
(2) AUTO POSITION SEQUENCES 2 CHANNELS OF DATA FROM EACH POWER UNIT AT FOUR SECOND INTERVALS. CONTINUOUS RECORDING OF ANY POWER UNIT CAN BE SELECTED AT NUMBERED POSITIONS.

(3) WARNING LIGHT ILLUMINATES WHEN ANY VIBRATION AMPLITUDE REACHES 50%.

ANALOG DATA STATION

EXHIBIT 17

ANALOG DATA REDUCTION SYSTEM



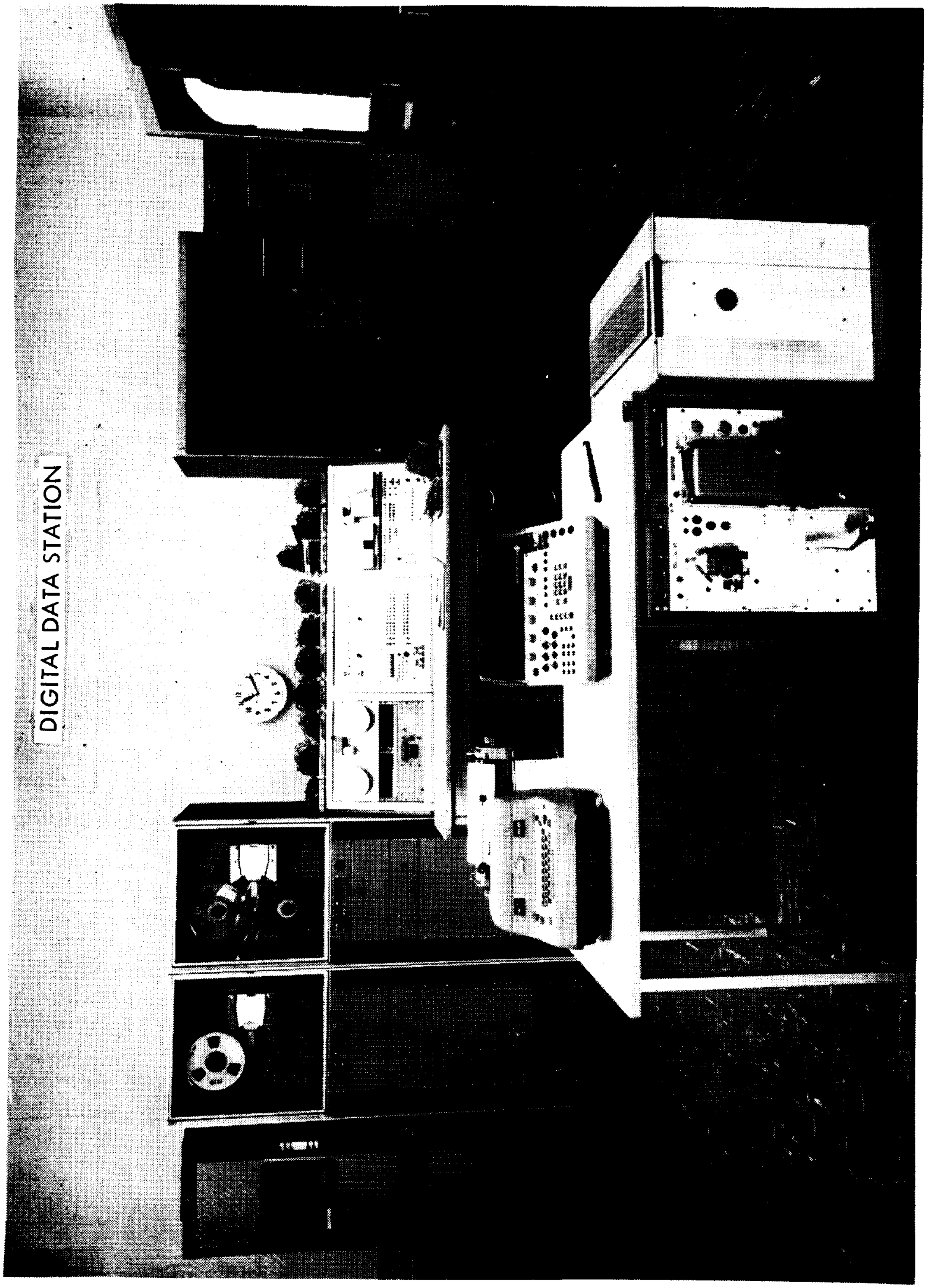


EXHIBIT 19

DIGITAL DATA REDUCTION

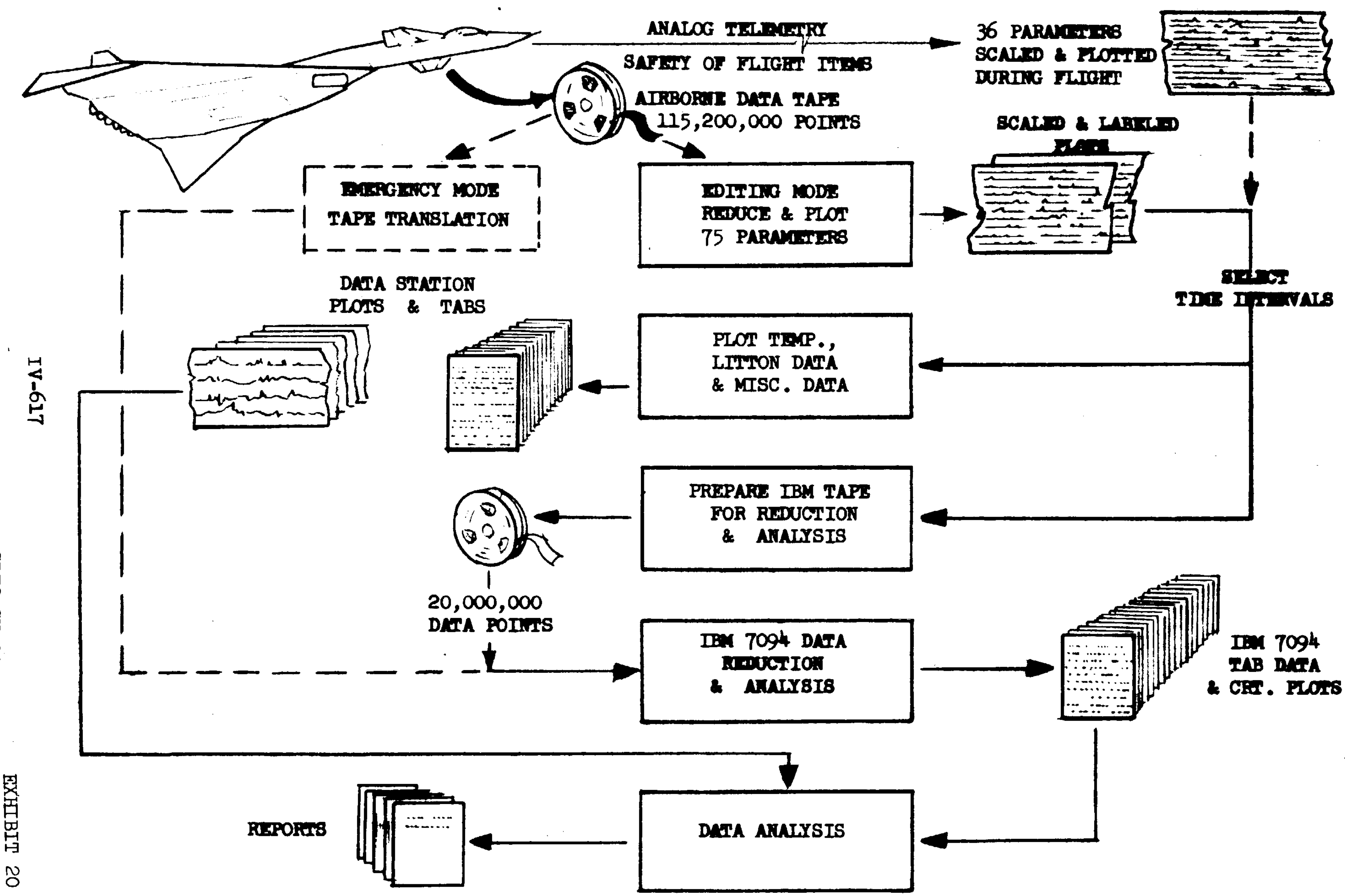


EXHIBIT 20

COST DEFINITION

SUBSYSTEM: TEST INSTRUMENTATION WBS CODE: 1.11

Total costs of $8,937,176 reflect all identifiable expenditures for the design, development, fabrication and/or procurement of all ground and flight test instrumentation as identified by the Work Breakdown Structure. Installation of the instrumentation into the air vehicle structure is included in WBS 1.12.

Instrumentation activities occurring during the flight testing of the two air vehicles are located in WBS 4.41.3, page II-438. These costs would include installation, checkout and modification or repair of the vehicle flight test instrumentation items while the air vehicles were on flight status.

Detail of the recorded costs associated with this subsystem is provided by Element of Cost (EOC) and Subdivision of Work (SDW). Section III of Volume I provides a detail definition of these items.

As an aid in the definition and evaluation of the in-house engineering costs associated with this subsystem, a matrix of engineering hours has been developed. This matrix, displayed below, is a summary of all the in-house engineering groups that provided support to the design and development of test instrumentation.

Group No.	Title	Hours Expended
74	Flight Test Instrumentation	63,115
101	Flight Test Instrumentation Lab-Palmdale	54,535
102	Flight Test Instrumentation Lab - Los Angeles	127,801
104	Test Instrumentation Design	131,220
114	Test Instrumentation Development	119,889
	Various	34,326
	Total Engineering Hrs	530,886

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 11
TEST INSTRUMENTATION SUBSYSTEM

	6-M ASSY 0 HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	530886	530886
LABOR AT $ 5.061	2686991	2686991
ENGR BURDEN AT $ 4.987	2647685	2647685
PRODUCTION	137320	137320
LABOR AT $ 3.272	449311	449311
SHOP SUPPORT	174639	174639
LABOR AT $ 3.385	591227	591227
TEST/QC	19251	19251
LABOR AT $ 3.479	66972	66972
MFG BURDEN AT $ 4.335	1435666	1435666
ENGR MATERIAL	747683	747683
MPC	104605	104605
OTHER COST	48942	48942
SUB-TOTAL	8779082	8779082
GEN & ADMIN	158094	158094
TOTAL COST	8937176	8937176

SUBDIVISION OF WORK
COST DETAIL - SEE PAGE IV-620

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 11 **TEST INSTRUMENTATION SUBSYSTEM**
6-MAJ ASSY 0

		DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TEST /QC HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING		507488		23398	530886
LABOR AT $ 5.061		2590607		96384	2686991
ENGR BURDEN	AT $ 4.987	2544969		102716	2647685
PRODUCTION			137320		137320
LABOR AT $ 3.272			449311		449311
SHOP SUPPORT		117189		57450	174639
LABOR AT $ 3.385		391359		199868	591227
TEST/QC		7178		12073	19251
LABOR AT $ 3.479		24300		42672	66972
MFG BURDEN	AT $ 4.335	525907	601588	308171	1435666
ENGR MATERIAL		84029		663654	747683
MPC		13816		90789	104605
OTHER COST				48942	48942
SUB-TOTAL		6174987	1050899	1553196	8779082
GEN & ADMIN		106719	22846	28529	158094
TOTAL COST		6281706	1073745	1581725	8937176
	TIME-PHASED COST DETAIL - SEE PAGE	IV-621	IV-629	IV-632	IV-637

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 11 TEST INSTRUMENTATION SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	15.0	2536	4.573	11597	11539	23136
Q-2 58						
Q-3 58	58.5	9936	4.289	42616	38702	81318
Q-4 58						
Q-1 59	66.0	11299	4.237	47870	38638	86508
Q-2 59						
Q-3 59	106.5	18638	4.266	79515	68101	147616
Q-4 59						
Q-1 60	96.0	16520	5.306	87655	71524	159179
Q-2 60						
Q-3 60	69.0	11572	4.824	55829	42745	98574
Q-4 60						
Q-1 61	225.0	38315	4.738	181550	133352	314902
Q-2 61						
Q-3 61	240.0	43593	4.988	217431	199919	417350
Q-4 61						
Q-1 62	357.5	61052	5.176	316009	280612	596621
Q-2 62						
Q-3 62	418.5	70405	5.088	358228	356779	715007
Q-4 62						
Q-1 63	420.0	71566	5.466	391198	396231	787429
Q-2 63						
Q-3 63	373.5	62776	5.203	326632	349440	676072
Q-4 63						
Q-1 64	306.0	52320	5.171	270558	317980	588538
Q-2 64						
Q-3 64	96.0	17005	5.557	94503	112290	206793
Q-4 64						
Q-1 65	79.0	13649	5.705	77865	90005	167870

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING

4-SYSTEM 1
5-SUBSYSTEM 11 TEST INSTRUMENTATION SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-2 65						
Q-3 65	36.0	6020	5.064	30486	35988	66474
Q-4 65						
Q-1 66	1.5	246	3.516	865	868	1733
Q-2 66						
Q-3 66		40	5.000	200	256	456
TOTAL	2964.0	507488		2590607	2544969	5135576

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 11 **TEST INSTRUMENTATION SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 62	312.0	52317	3.275	171322	212102	383424
Q-4 62						
Q-1 63	322.5	54982	3.427	188412	238851	427263
Q-2 63						
Q-3 63	25.5	4233	3.353	14193	47776	61969
Q-4 63						
Q-1 64	1.5	310	3.016	935	1519	2454
Q-2 64						
Q-3 64	4.5	908	3.105	2819	4604	7423
Q-4 64						
Q-1 65	10.5	1847	2.881	5322	8739	14061
Q-2 65						
Q-3 65	10.5	1841	3.218	5925	9010	14935
Q-4 65						
Q-1 66	4.5	749	3.239	2426	3370	5796
Q-2 66						
Q-3 66		2	2.500	5	-64	-59
TOTAL	691.5	117189		391359	525907	917266

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 11 **TEST INSTRUMENTATION SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 62	7.5	1278	3.154	4031		4031
Q-4 62						
Q-1 63	22.5	3898	3.479	13560		13560
Q-2 63						
Q-3 63	10.5	1792	3.341	5987		5987
Q-4 63						
Q-1 64		1	4.000	4		4
Q-2 64						
Q-3 64		45	3.244	146		146
Q-4 64						
Q-1 65		7	2.571	18		18
Q-2 65						
Q-3 65		110	3.545	390		390
Q-4 65						
Q-1 66		46	3.500	161		161
Q-2 66						
Q-3 66		1	3.000	3		3
TOTAL	40.5	7178		24300		24300

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 11 TEST INSTRUMENTATION SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	15.0	2536	4.573	11597	11539	23136	
Q-2 58							
Q-3 58	58.5	9936	4.289	42616	38702	81318	
Q-4 58							
Q-1 59	66.0	11299	4.237	47870	38638	86508	
Q-2 59							
Q-3 59	106.5	18638	4.266	79515	68101	147616	
Q-4 59							
Q-1 60	96.0	16520	5.306	87655	71524	159179	
Q-2 60							
Q-3 60	69.0	11572	4.824	55829	42745	98574	
Q-4 60							
Q-1 61	225.0	38315	4.738	181550	133352	314902	
Q-2 61							
Q-3 61	240.0	43593	4.988	217431	199919	417350	
Q-4 61							
Q-1 62	357.5	61052	5.176	316009	280612	596621	
Q-2 62							
Q-3 62	738.0	124000	4.303	533581	568881	1102462	10810
Q-4 62							
Q-1 63	765.0	130446	4.547	593170	635082	1228252	12998
Q-2 63							
Q-3 63	409.5	68801	5.041	346812	397216	744028	11619
Q-4 63							
Q-1 64	307.5	52631	5.158	271497	319499	590996	3373
Q-2 64							
Q-3 64	100.5	17958	5.428	97468	116894	214362	389
Q-4 64							
Q-1 65	89.5	15503	5.367	83205	98744	181949	15286
Q-2 65							
Q-3 65	46.5	7971	4.617	36801	44998	81799	8801

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 11 **TEST INSTRUMENTATION SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-4 65							
Q-1 66	6.0	1041	3.316	3452	4238	7690	17995
Q-2 66							
Q-3 66		43	4.837	208	192	400	2758
TOTAL	3696.0	631855		3006266	3070876	6077142	84029

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 11 TEST INSTRUMENTATION SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 58		23136		23136
Q-2 58				
Q-3 58		81318		81318
Q-4 58				
Q-1 59		86508		86508
Q-2 59				
Q-3 59		147616		147616
Q-4 59				
Q-1 60		159179	3033	162212
Q-2 60				
Q-3 60		98574	1878	100452
Q-4 60				
Q-1 61		314902	5852	320754
Q-2 61				
Q-3 61		417350	7756	425106
Q-4 61				
Q-1 62		596621	10014	606635
Q-2 62				
Q-3 62	852	1114124	18701	1132825
Q-4 62				
Q-1 63	1280	1242530	20775	1263305
Q-2 63				
Q-3 63	1144	756791	12654	769445
Q-4 63				
Q-1 64	360	594729	12655	607384
Q-2 64				
Q-3 64	142	214893	4572	219465
Q-4 64				
Q-1 65	4567	201802	5384	207186
Q-2 65				
Q-3 65	1570	92170	2459	94629

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 11
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

TEST INSTRUMENTATION SUBSYSTEM

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-4 65				
Q-1 66	3732	29417	886	30303
Q-2 66				
Q-3 66	169	3327	100	3427
TOTAL	13816	6174987	106719	6281706

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	PRODUCTION
4-SYSTEM	1
5-SUBSYSTEM	11 TEST INSTRUMENTATION SUBSYSTEM
6-MAJ ASSY	0
SUBD OF WORK	PRODUCTION

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 63	204.0	34352	2.422	83209	188364	271573
Q-4 63						
Q-1 64	310.5	53025	2.458	130334	131617	261951
Q-2 64						
Q-3 64	75.0	13127	7.278	95544	109582	205126
Q-4 64						
Q-1 65	156.0	26917	3.673	98878	127394	226272
Q-2 65						
Q-3 65	58.5	9899	4.177	41346	34528	75874
Q-4 65						
Q-1 66					10096	10096
Q-2 66						
Q-3 66					7	7
TOTAL	804.0	137320		449311	601588	1050899

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 11 **TEST INSTRUMENTATION SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK PRODUCTION

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	G & A
Q-3 63	204.0	34352	2.422	83209	188364	271573	4541
Q-4 63							
Q-1 64	310.5	53025	2.458	130334	131617	261951	5574
Q-2 64							
Q-3 64	75.0	13127	7.278	95544	109582	205126	4366
Q-4 64							
Q-1 65	156.0	26917	3.673	98878	127394	226272	6037
Q-2 65							
Q-3 65	58.5	9899	4.177	41346	34528	75874	2024
Q-4 65							
Q-1 66					10096	10096	304
Q-2 66							
Q-3 66					7	7	
TOTAL	804.0	137320		449311	601588	1050899	22846

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 11 TEST INSTRUMENTATION SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK PRODUCTION

	TOTAL COST
Q-3 63	276114
Q-4 63	
Q-1 64	267525
Q-2 64	
Q-3 64	209492
Q-4 64	
Q-1 65	232309
Q-2 65	
Q-3 65	77898
Q-4 65	
Q-1 66	10400
Q-2 66	
Q-3 66	7
TOTAL	1073745

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 11 TEST INSTRUMENTATION SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 60	4.5	694	12.467	8652	8261	16913
Q-4 60						
Q-1 61	3.0	454	10.761	-4886	-4114	-9000
Q-2 61						
Q-3 61	10.5	1841	5.694	10482	7379	17861
Q-4 61						
Q-1 62	28.5	4972	4.002	19899	23093	42992
Q-2 62						
Q-3 62	-7.5	-1151	6.062	6979	9090	16069
Q-4 62						
Q-1 63	48.0	8075	2.689	21713	23705	45418
Q-2 63						
Q-3 63	16.5	2725	4.852	13222	14655	27877
Q-4 63						
Q-1 64	10.5	1859	3.520	6543	6707	13250
Q-2 64						
Q-3 64	10.5	1813	3.515	6372	6534	12906
Q-4 64						
Q-1 65	9.0	1481	3.502	5186	5184	10370
Q-2 65						
Q-3 65	3.0	592	3.503	2074	2074	4148
Q-4 65						
Q-1 66		43	3.442	148	148	296
TOTAL	136.5	23398		96384	102716	199100

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 11 TEST INSTRUMENTATION SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 60		53	2.755	146	190	336
Q-4 60						
Q-1 61	1.5	192	3.026	581	1041	1622
Q-2 61						
Q-3 61	37.5	6911	3.109	21487	20462	41949
Q-4 61						
Q-1 62	220.5	37595	2.966	111516	141873	253389
Q-2 62						
Q-3 62	60.0	9982	3.001	29960	44765	74725
Q-4 62						
Q-1 63	-3.0	-505	23.429	11832	15668	27500
Q-2 63						
Q-3 63	13.5	2192	9.472	20763	38507	59270
Q-4 63						
Q-1 64	3.0	540	3.498	1889	17752	19641
Q-2 64						
Q-3 64	3.0	451	3.492	1575	9610	11185
Q-4 64						
Q-1 65		33	3.091	102	10670	10772
Q-2 65						
Q-3 65		7	2.714	19	7634	7653
Q-4 65						
Q-1 66		-1	2.000	-2	-1	-3
TOTAL	336.0	57450		199868	308171	508039

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	TEST/QC	
4-SYSTEM	1	
5-SUBSYSTEM	11	**TEST INSTRUMENTATION SUBSYSTEM**
6-MAJ ASSY	0	
SUBD OF WORK	TEST/QC	

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 60		2	2.500	5		5
Q-4 60						
Q-1 61		119	3.168	377		377
Q-2 61						
Q-3 61	1.5	264	3.004	793		793
Q-4 61						
Q-1 62	9.0	1448	3.015	4365		4365
Q-2 62						
Q-3 62	3.0	456	3.011	1373		1373
Q-4 62						
Q-1 63						
Q-2 63						
Q-3 63	6.0	1001	3.247	3250		3250
Q-4 63						
Q-1 64	19.5	3233	3.513	11358		11358
Q-2 64						
Q-3 64	9.0	1681	3.888	6535		6535
Q-4 64						
Q-1 65	13.5	2221	3.600	7995		7995
Q-2 65						
Q-3 65	10.5	1648	4.014	6615		6615
Q-4 65						
Q-1 66				6		6
TOTAL	72.0	12073		42672		42672

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 11
6-MAJ ASSY 0
SUBD OF WORK TEST/QC

TEST INSTRUMENTATION SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-3 60	4.5	749	11.753	8803	8451	17254	78
Q-4 60							
Q-1 61	4.5	765	5.134	-3928	-3073	-7001	2183
Q-2 61							
Q-3 61	49.5	9016	3.634	32762	27841	60603	20011
Q-4 61							
Q-1 62	258.0	44015	3.085	135780	164966	300746	82401
Q-2 62							
Q-3 62	55.5	9287	4.125	38312	53855	92167	230032
Q-4 62							
Q-1 63	45.0	7570	4.431	33545	39373	72918	70076
Q-2 63							
Q-3 63	36.0	5918	6.292	37235	53162	90397	39467
Q-4 63							
Q-1 64	33.0	5632	3.514	19790	24459	44249	73400
Q-2 64							
Q-3 64	22.5	3945	3.671	14482	16144	30626	69618
Q-4 64							
Q-1 65	22.5	3735	3.556	13283	15854	29137	54977
Q-2 65							
Q-3 65	13.5	2247	3.875	8708	9708	18416	19979
Q-4 65							
Q-1 66		42	3.619	152	147	299	1432
TOTAL	544.5	92921		338924	410887	749811	663654

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 11
6-MAJ ASSY 0
SUBD OF WORK TEST/QC

TEST INSTRUMENTATION SUBSYSTEM

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-3 60	10		17342	330	17672
Q-4 60					
Q-1 61	184		-4634	-86	-4720
Q-2 61					
Q-3 61	1692	538	82844	1539	84383
Q-4 61					
Q-1 62	6532	616	390295	6551	396846
Q-2 62					
Q-3 62	18126	132	340457	5714	346171
Q-4 62					
Q-1 63	6902	4269	154165	2578	156743
Q-2 63					
Q-3 63	3838	101571	235323	3935	239258
Q-4 63					
Q-1 64	7824	-61092	64381	1370	65751
Q-2 64					
Q-3 64	25327	2372	128443	2733	131176
Q-4 64					
Q-1 65	16443	25	100582	2684	103266
Q-2 65					
Q-3 65	3564	10	41969	1120	43089
Q-4 65					
Q-1 66	297	1	2029	61	2090
TOTAL	90789	48942	1553196	28529	1581725

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING

4-SYSTEM 1
5-SUBSYSTEM 11 **TEST INSTRUMENTATION SUBSYSTEM**
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	15.0	2536	4.573	11597	11539	23136
Q-2 58						
Q-3 58	58.5	9936	4.289	42616	38702	81318
Q-4 58						
Q-1 59	66.0	11299	4.237	47870	38638	86508
Q-2 59						
Q-3 59	106.5	18638	4.266	79515	68101	147616
Q-4 59						
Q-1 60	96.0	16520	5.306	87655	71524	159179
Q-2 60						
Q-3 60	73.5	12266	5.257	64481	51006	115487
Q-4 60						
Q-1 61	226.5	38769	4.557	176664	129238	305902
Q-2 61						
Q-3 61	250.5	45434	5.016	227913	207298	435211
Q-4 61						
Q-1 62	387.0	66024	5.088	335908	303705	639613
Q-2 62						
Q-3 62	412.5	69254	5.273	365207	365869	731076
Q-4 62						
Q-1 63	466.5	79641	5.185	412911	419936	832847
Q-2 63						
Q-3 63	390.0	65501	5.189	339854	364095	703949
Q-4 63						
Q-1 64	318.0	54179	5.115	277101	324687	601788
Q-2 64						
Q-3 64	106.5	18818	5.361	100875	118824	219699
Q-4 64						
Q-1 65	87.0	15130	5.489	83051	95189	178240
Q-2 65						

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	DESIGN/ENGINEERING	
4-SYSTEM	1	
5-SUBSYSTEM	11	**TEST INSTRUMENTATION SUBSYSTEM**
6-MAJ ASSY	0	

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	39.0	6612	4.924	32560	38062	70622
Q-4 65						
Q-1 66	1.5	289	3.505	1013	1016	2029
Q-2 66						
Q-3 66		40	5.000	200	256	456
TOTAL	3100.5	530886		2636991	2647685	5334676

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

PRODUCTION
4-SYSTEM 1
5-SUBSYSTEM 11 **TEST INSTRUMENTATION SUBSYSTEM**
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 63	204.0	34352	2.422	83209	188364	271573
Q-4 63						
Q-1 64	310.5	53025	2.458	130334	131617	261951
Q-2 64						
Q-3 64	75.0	13127	7.278	95544	109582	205126
Q-4 64						
Q-1 65	156.0	26917	3.673	98878	127394	226272
Q-2 65						
Q-3 65	58.5	9899	4.177	41346	34528	75874
Q-4 65						
Q-1 66					10096	10096
Q-2 66						
Q-3 66					7	7
TOTAL	804.0	137320		449311	601588	1050899

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 11 **TEST INSTRUMENTATION SUBSYSTEM**
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 60		53	2.755	146	190	336
Q-4 60						
Q-1 61	1.5	192	3.026	581	1041	1622
Q-2 61						
Q-3 61	37.5	6911	3.109	21487	20462	41949
Q-4 61						
Q-1 62	220.5	37595	2.966	111516	141873	253389
Q-2 62						
Q-3 62	370.5	62299	3.231	201282	256867	458149
Q-4 62						
Q-1 63	319.5	54477	3.676	200244	254519	454763
Q-2 63						
Q-3 63	38.5	6425	5.441	34956	86283	121239
Q-4 63						
Q-1 64	4.5	850	3.322	2824	19271	22095
Q-2 64						
Q-3 64	7.5	1359	3.233	4394	14214	18608
Q-4 64						
Q-1 65	10.5	1880	2.885	5424	19409	24833
Q-2 65						
Q-3 65	10.5	1848	3.216	5944	16644	22588
Q-4 65						
Q-1 66	4.5	748	3.241	2424	3369	5793
Q-2 66						
Q-3 66		2	2.500	5	-64	-59
TOTAL	1025.5	174639		591227	834078	1425305

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 11 TEST INSTRUMENTATION SUBSYSTEM
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 60		2	2.500	5		5
Q-4 60						
Q-1 61		119	3.168	377		377
Q-2 61						
Q-3 61	1.5	264	3.004	793		793
Q-4 61						
Q-1 62	9.0	1448	3.015	4365		4365
Q-2 62						
Q-3 62	10.5	1734	3.116	5404		5404
Q-4 62						
Q-1 63	22.5	3898	3.479	13560		13560
Q-2 63						
Q-3 63	16.5	2793	3.307	9237		9237
Q-4 63						
Q-1 64	19.5	3234	3.513	11362		11362
Q-2 64						
Q-3 64	10.5	1726	3.871	6681		6681
Q-4 64						
Q-1 65	13.5	2228	3.596	8013		8013
Q-2 65						
Q-3 65	10.5	1758	3.985	7005		7005
Q-4 65						
Q-1 66		46	3.630	167		167
Q-2 66						
Q-3 66		1	3.000	3		3
TOTAL	114.0	19251		66972		66972

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 11
6-MAJ ASSY 0

TEST INSTRUMENTATION SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	15.0	2536	4.573	11597	11539	23136	
Q-2 58							
Q-3 58	58.5	9936	4.289	42616	38702	81318	
Q-4 58							
Q-1 59	66.0	11299	4.237	47870	38638	86508	
Q-2 59							
Q-3 59	106.5	18638	4.266	79515	68101	147616	
Q-4 59							
Q-1 60	96.0	16520	5.306	87655	71524	159179	
Q-2 60							
Q-3 60	73.5	12321	5.246	64632	51196	115828	78
Q-4 60							
Q-1 61	228.0	39080	4.545	177622	130279	307901	2183
Q-2 61							
Q-3 61	289.5	52609	4.756	250193	227760	477953	20011
Q-4 61							
Q-1 62	616.5	105067	4.300	451789	445578	897367	82401
Q-2 62							
Q-3 62	793.5	133287	4.291	571893	622736	1194629	240842
Q-4 62							
Q-1 63	808.5	138016	4.541	626715	674455	1301170	83074
Q-2 63							
Q-3 63	649.0	109071	4.284	467256	638742	1105998	51086
Q-4 63							
Q-1 64	652.5	111288	3.789	421621	475575	897196	76773
Q-2 64							
Q-3 64	199.5	35030	5.923	207494	242620	450114	70007
Q-4 64							
Q-1 65	267.0	46155	4.233	195366	241992	437358	70263
Q-2 65							
Q-3 65	118.5	20117	4.317	86855	89234	176089	28780
Q-4 65							

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 11 **TEST INSTRUMENTATION SUBSYSTEM**
6-MAJ ASSY 0

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66	6.0	1083	3.328	3604	14481	18085	19427
Q-2 66							
Q-3 66		43	4.837	208	199	407	2758
TOTAL	5044.0	862096		3794501	4083351	7877852	747683

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 11 TEST INSTRUMENTATION SUBSYSTEM
6-MAJ ASSY 0

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58			23136		23136
Q-2 58					
Q-3 58			81318		81318
Q-4 58					
Q-1 59			86508		86508
Q-2 59					
Q-3 59			147616		147616
Q-4 59					
Q-1 60			159179	3033	162212
Q-2 60					
Q-3 60	10		115916	2208	118124
Q-4 60					
Q-1 61	184		310268	5766	316034
Q-2 61					
Q-3 61	1692	538	500194	9295	509489
Q-4 61					
Q-1 62	6532	616	986916	16565	1003481
Q-2 62					
Q-3 62	18978	132	1454581	24415	1478996
Q-4 62					
Q-1 63	8182	4269	1396695	23353	1420048
Q-2 63					
Q-3 63	5032	101571	1263687	21130	1284817
Q-4 63					
Q-1 64	8184	-61092	921061	19599	940660
Q-2 64					
Q-3 64	25469	2372	548462	11671	560133
Q-4 64					
Q-1 65	21010	25	528656	14105	542761
Q-2 65					
Q-3 65	5134	10	210013	5603	215616
Q-4 65					

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 11
6-MAJ ASSY 0

TEST INSTRUMENTATION SUBSYSTEM

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 66	4029	1	41542	1251	42793
Q-2 66					
Q-3 66	169		3334	100	3434
TOTAL	104605	48942	8779082	158094	8937176

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TABLE OF CONTENTS

SUBSYSTEM: INSTALLATION, CHECKOUT AND PREFLIGHT WBS CODE 1.12

COST DEFINITION Page IV-648

DETAIL COST DATA Page IV-662

COST DEFINITION

SUBSYSTEM: INSTALLATION, CHECKOUT AND PREFLIGHT WBS CODE: 1.12

Recorded costs assigned to this WBS item include the effort associated with:

a) fabrication of subsystem provisions (brackets, racks, wire harnesses, shelves, supports, etc.). These costs cannot be associated with a particular subsystem without developing a prorating technique. No acceptable method could be developed, therefore, costs were assigned in their entirety to this WBS item.

b) installation of subsystems within the airframe structure. All aircraft subsystems were basically either subcontracted items or furnished as GFE equipment, therefore, no production costs appear in the subsystems. Recorded cost data does not provide a segregation of the installation costs by subsystem. These costs for all subsystems are included in this WBS item.

c) procurement of raw material and miscellaneous purchased parts in support of fabrication (item (a)) and system installation (item (b)) activities. Also included in this item is the purchase of equipment and the fabrication and assembly effort associated with the in-house activities on the Air Induction System. See WBS 1.5 for more detail.

d) system checkout of the installed subsystems to verify installation techniques and procedures.

e) preflight checkout to validate and verify operational parameters.

f) all remaining items described in WBS 4.40, page II-255.

Excluded from this item are:

a) mating of the major sections of the structure (WBS 3.0)

b) flight test operations after first flight of each vehicle (WBS 4.0)

c) special test equipment (WBS 7.0)

d) tooling (WBS 8.0)

Combining of subsystem installation, checkout and preflight activities into one WBS item is the result of the uniqueness of the B-70 program. If the B-70 had been a production program instead of a two-vehicle research and development program, manufacturing checkout and preflight checkout would have been two separate independent activites. However, because of budgetary and schedule constraints, maximum utilization of manufacturing and flight test personnel was essential. Therefore, subsystem installation, checkout and preflight checkout were performed by manufacturing and flight test personnel concurrently. No segregation of activities in this area is available because the same accounting procedures were utilized by all personnel whether performing manufacturing or flight test checkout.

The discussion of the technical problems and the subsystem and program schedule impact occurring during this period are included in the subsystem data. Normal preflight activities, including taxi testing, are discussed in section WBS 4.40.

Exhibits 1 through 4, pages IV-650 through IV-653, display Systems Operational Checkout Lab (SOCKO) facilities and milestones as completed in support of Air Vehicle No. 1. Exhibits 5 through 12, pages IV-654 through IV-661, display typical installations within fuel tanks, wire harnesses/plumbing and systems installations.

SOCKO Lab

EXHIBIT 1

SD77-SH-0003

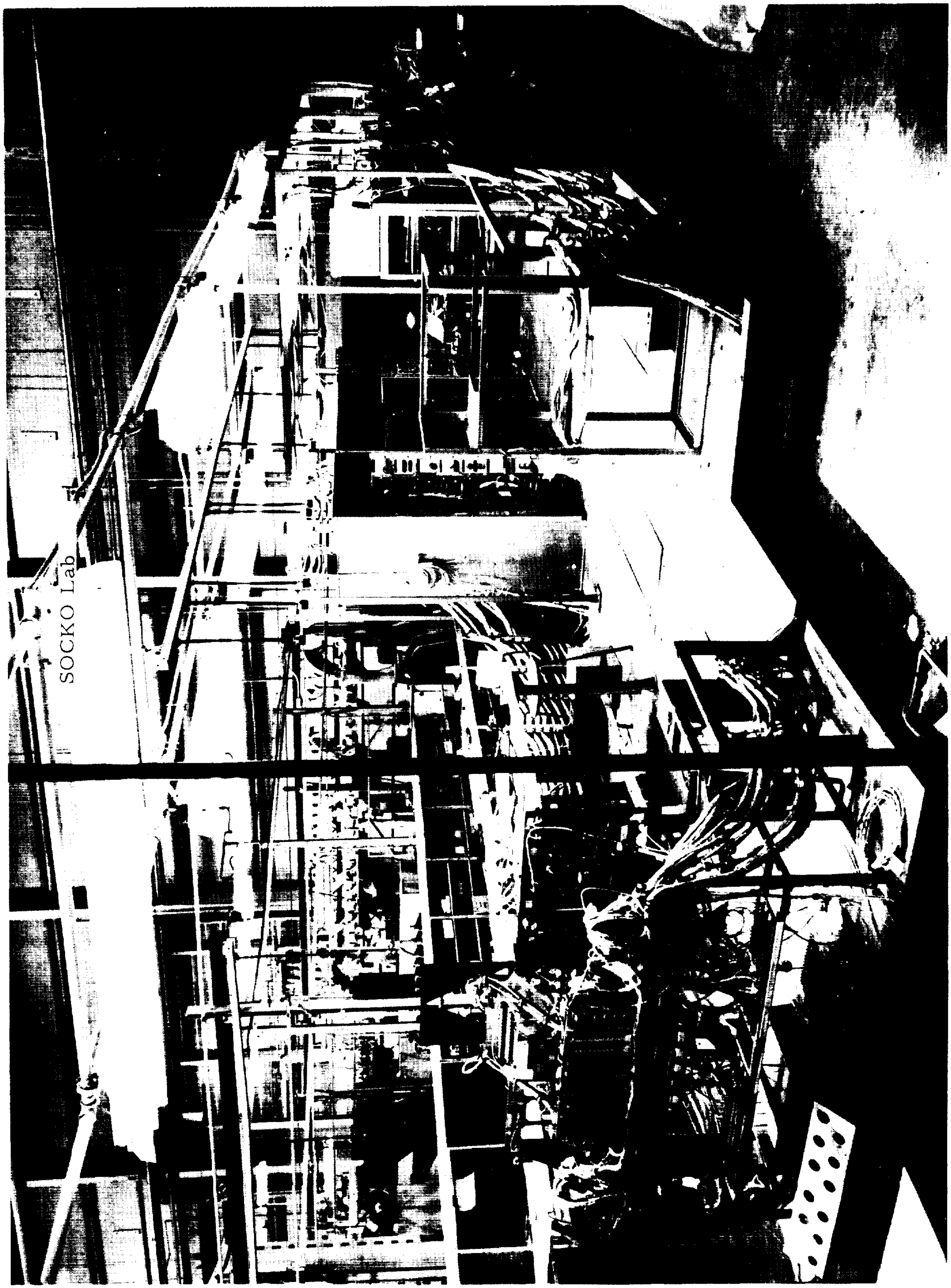
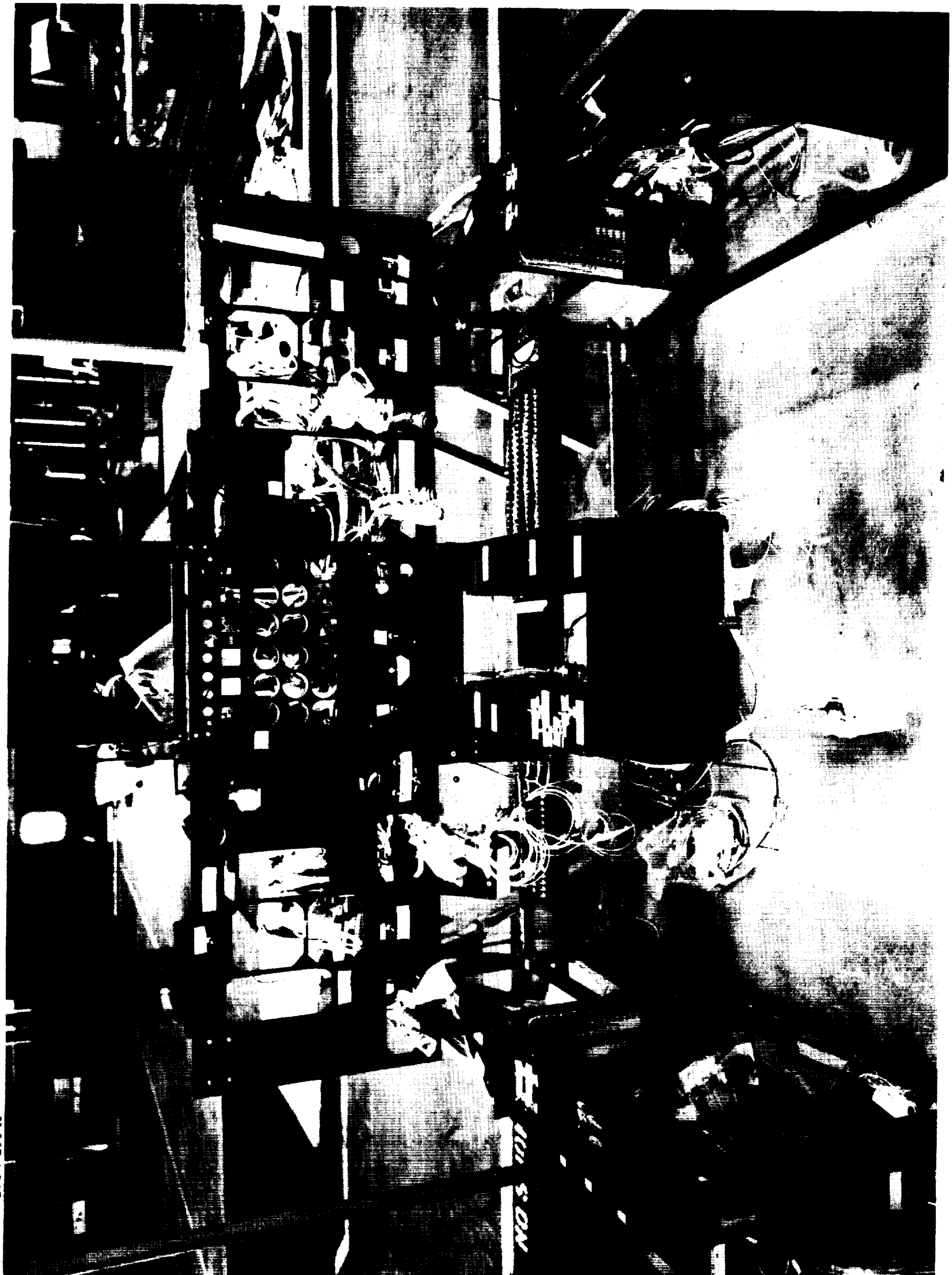


EXHIBIT 2

C 12

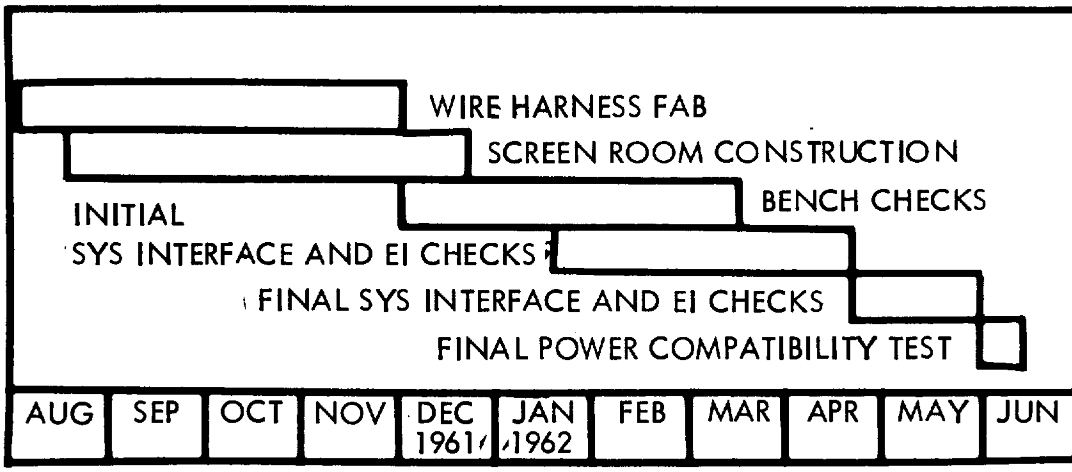
SOCKO Lab

2-3-64 278-7-296-K



Socko Testing

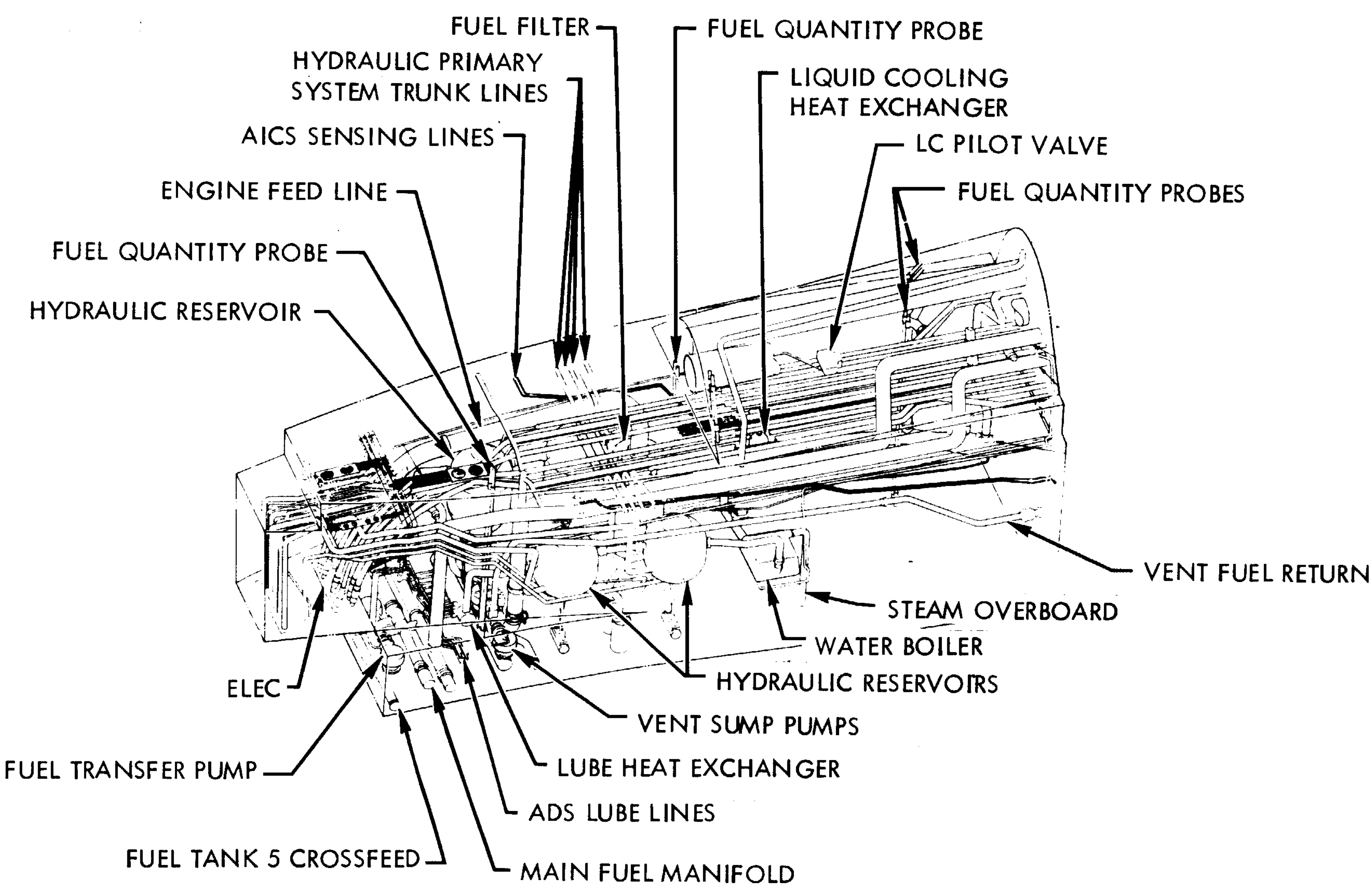
WBS 1.12

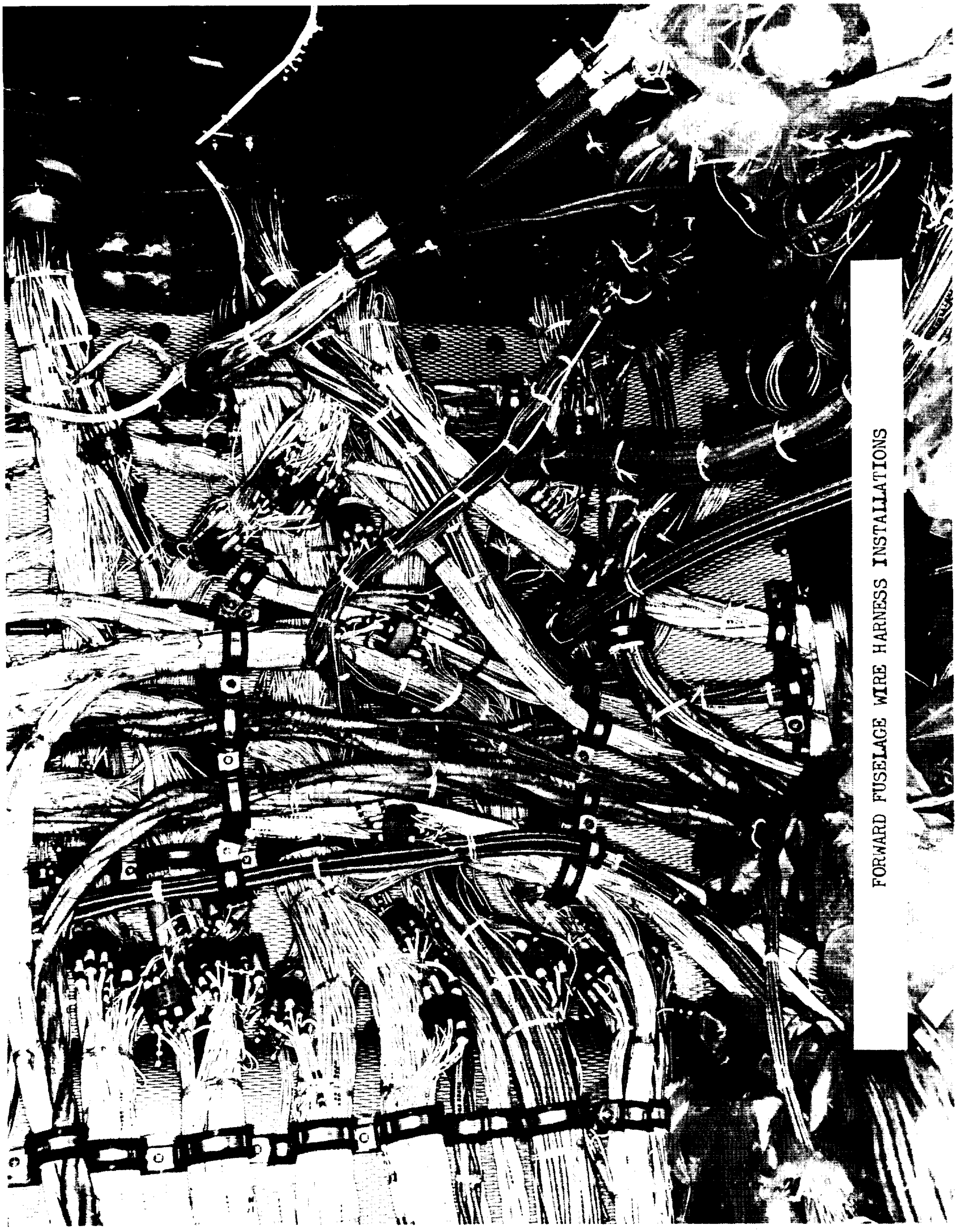


THIS WAS A SYSTEMS OPERATION AND CHECKOUT LABORATORY PROGRAM IN WHICH ALL OF THE ELECTRONIC EQUIPMENT WAS TESTED FOR FUNCTION, MUTUAL COMPATIBILITY, AND INTERACTION. THE PROGRAM WAS SUCCESSFULLY CARRIED OUT ON ACTUAL EQUIPMENT FOR THE FIRST AIR VEHICLE USING AN IDENTICAL AIRCRAFT WIRING CONFIGURATION. THE PROBLEMS SOLVED WERE OF A MINOR NATURE, REQUIRING ONLY CABLE REROUTING AND WIRE SEPARATION FOR THE REDUCTION OF RADIO OR ELECTRICAL INTERFERENCE OR MINOR CHANGES IN CIRCUITRY OR INSTALLATION TO REDUCE INTERACTION.

EXHIBIT 4

FUEL TANK INSTALLATIONS (TYPICAL)
TANK 4




FORWARD FUSELAGE WIRE HARNESS INSTALLATIONS

ENGINE INSTALLATION

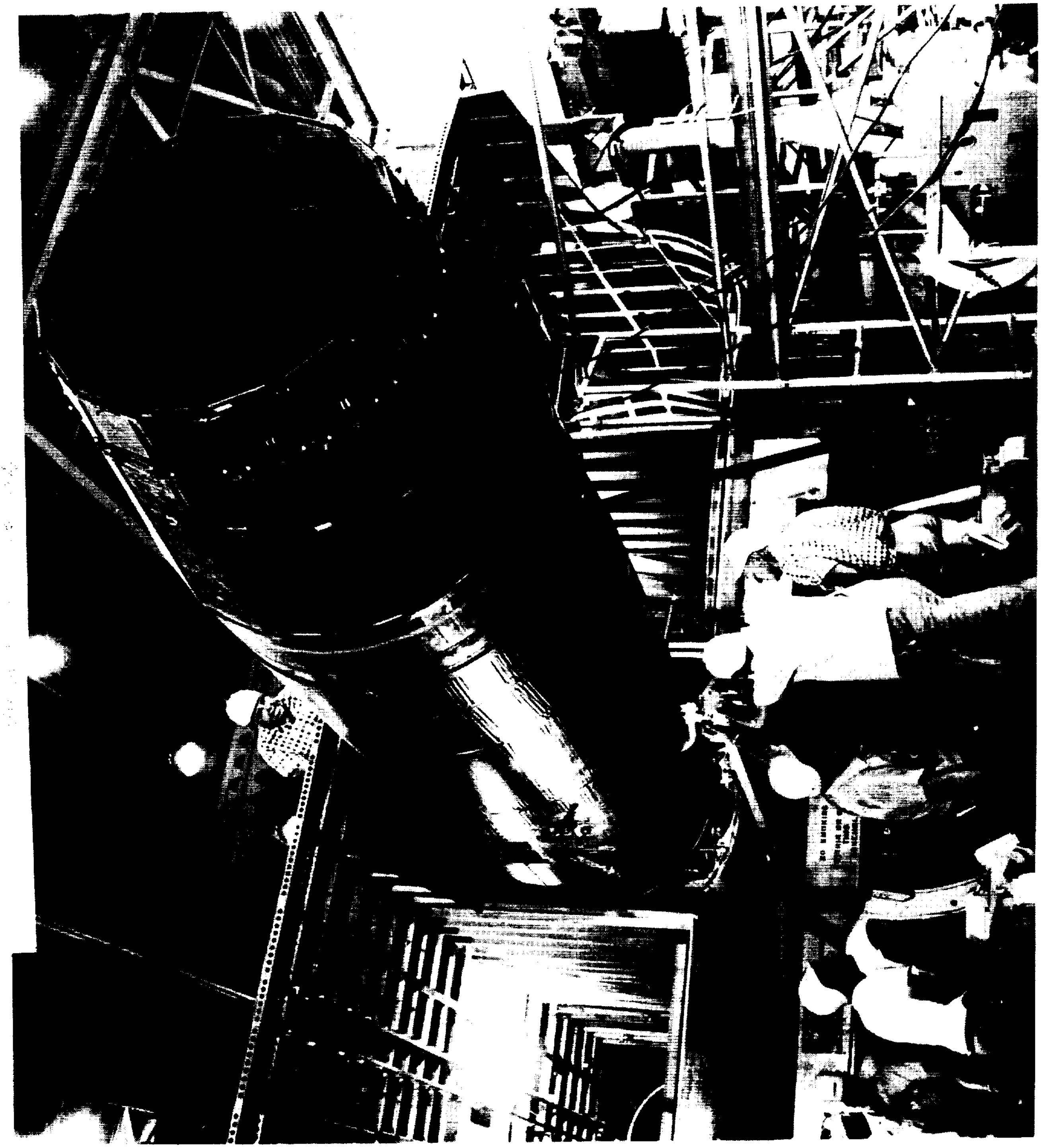
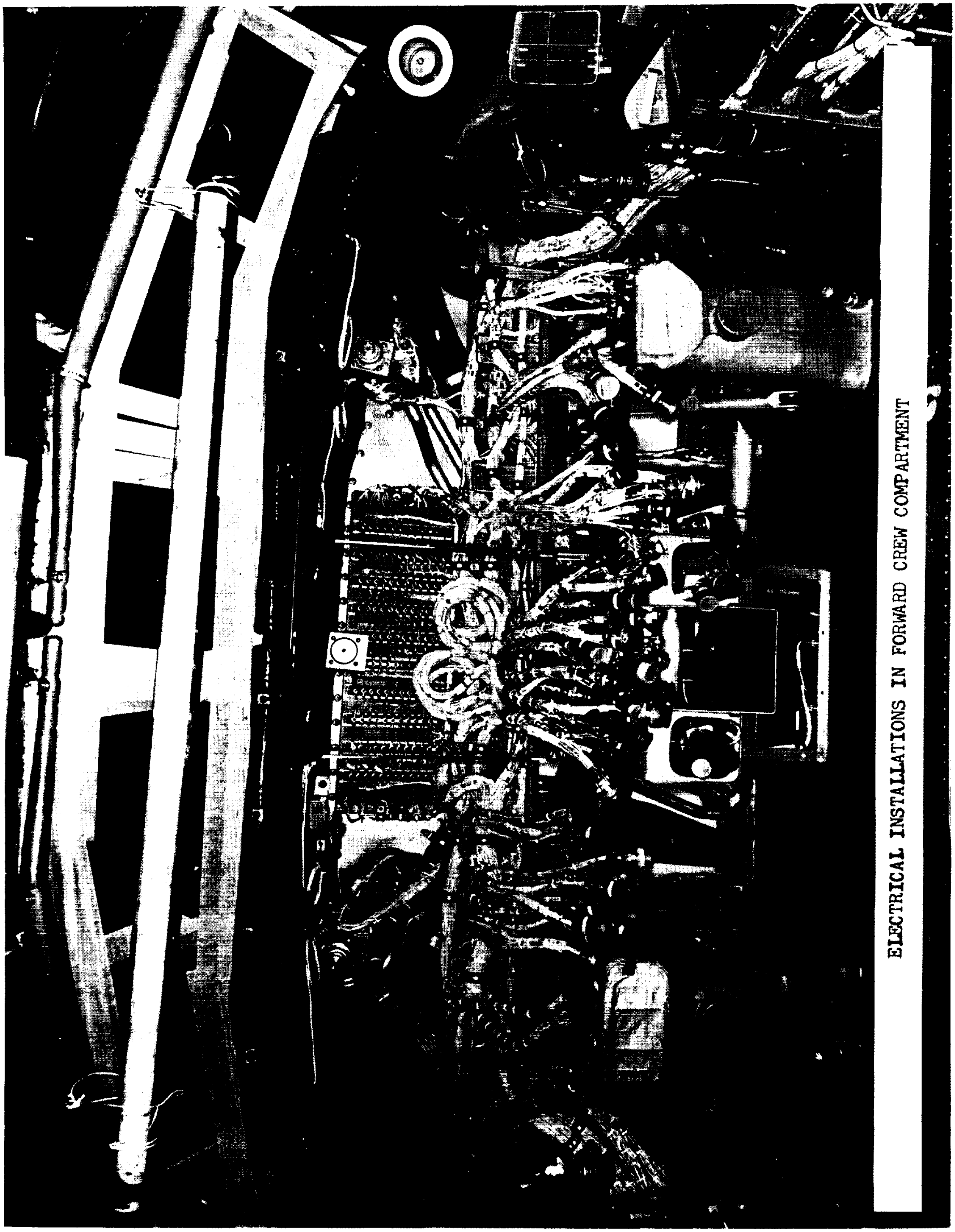
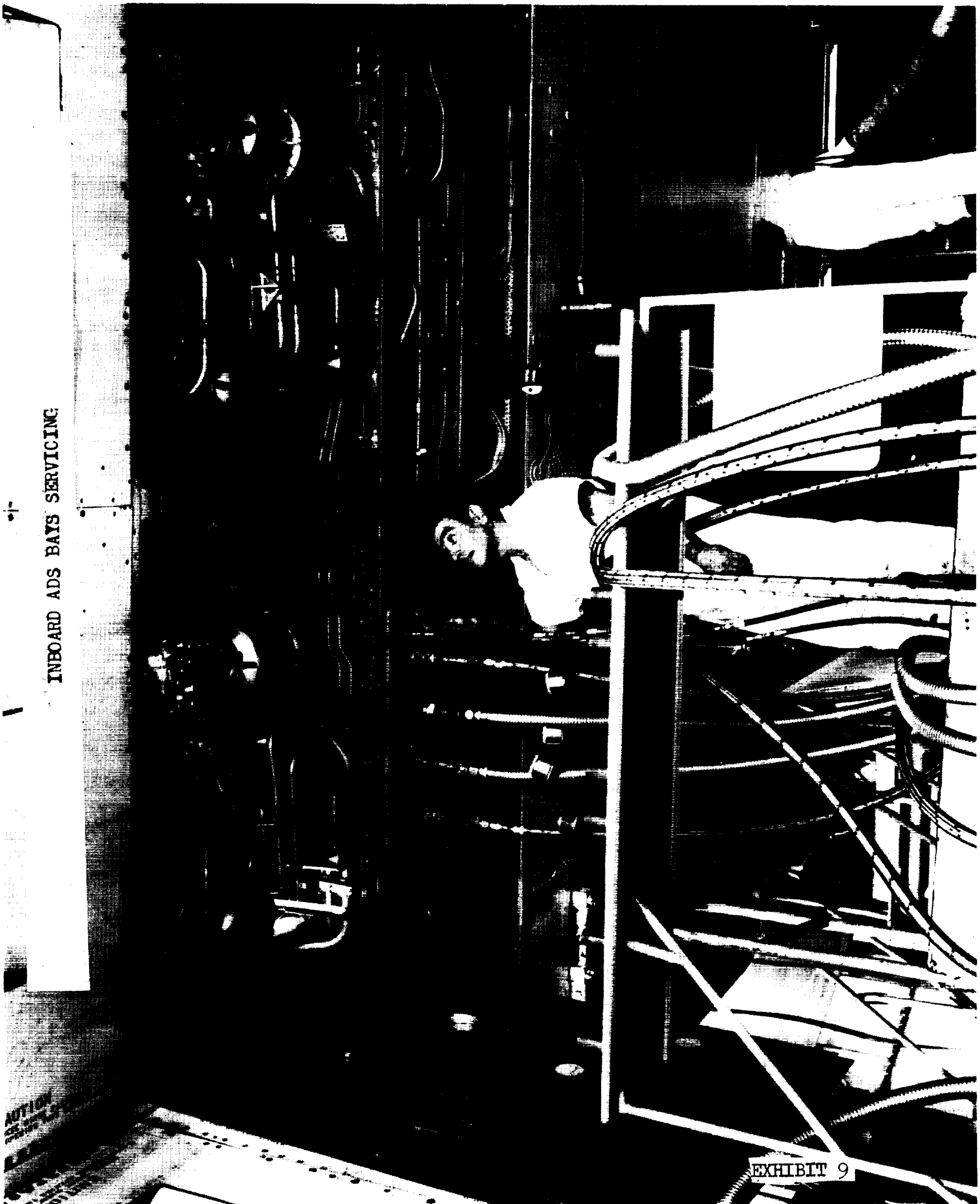


EXHIBIT 7

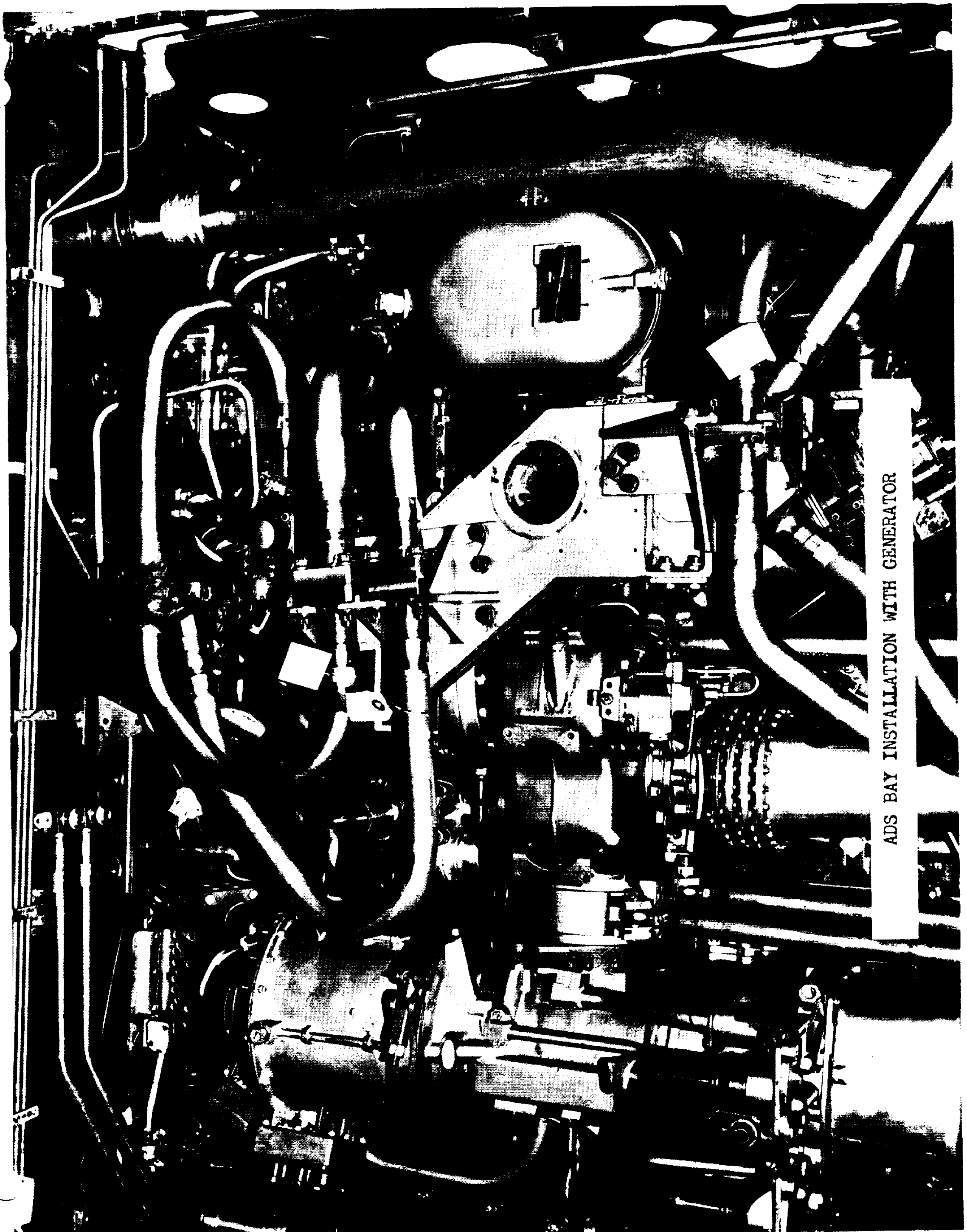


ELECTRICAL INSTALLATIONS IN FORWARD CREW COMPARTMENT



INBOARD ADS BAYS SERVICING

EXHIBIT 9



ADS BAY INSTALLATION WITH GENERATOR

FORWARD FUSELAGE - ENVIRONMENTAL CONTROL SYSTEMS INSTALLATIONS

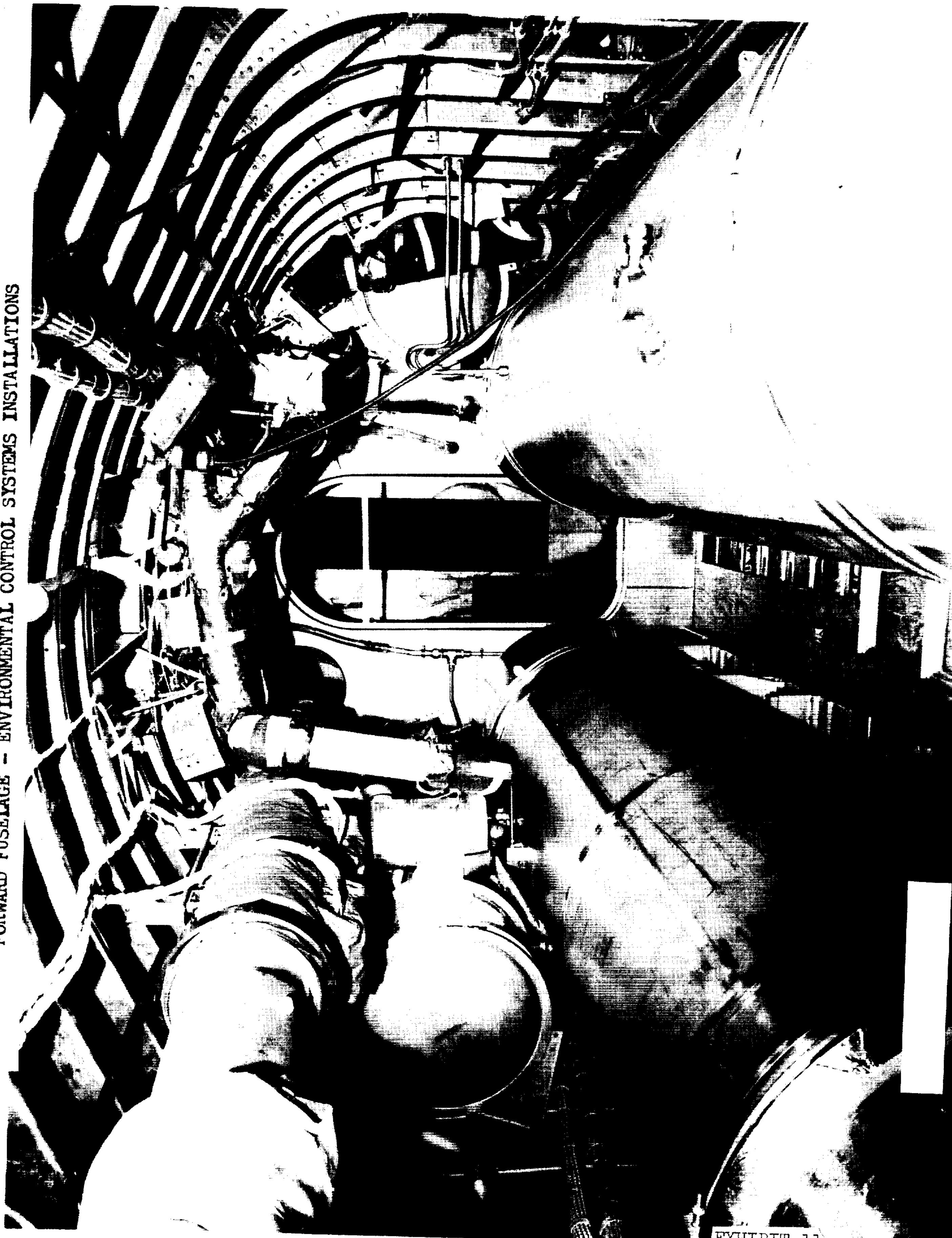


EXHIBIT 11

TUBING INSTALLATIONS IN TOP DECK
OF LOWER AFT INTERMEDIATE FUSELAGE SECTION

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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NASA CONTRACT NAS9-12100

APRIL 1972

COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 12
SUBSYSTEM INSTALLATION AND CHECKOUT

			6-M ASSY 0 HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING			316502	316502
LABOR AT $	6.217		1967649	1967649
ENGR BURDEN	AT $	6.169	1952457	1952457
PRODUCTION			4590814	4590814
LABOR AT $	3.223		14796835	14796835
SHOP SUPPORT			65703	65703
LABOR AT $	3.598		236401	236401
PLANNING			280324	280324
LABOR AT $	3.438		963821	963821
TEST/QC			587203	587203
LABOR AT $	3.637		2135631	2135631
MFG BURDEN	AT $	4.033	22277981	22277981
MFG MATERIAL			9848132	9848132
MPC			1318030	1318030
SUB-TOTAL			55496937	55496937
GEN & ADMIN			1155919	1155919
IOWA			4685745	4685745
TOTAL COST			61338601	61338601

SUBDIVISION OF WORK
COST DETAIL - SEE PAGE IV-663

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 12 SUBSYSTEM INSTALLATION AND CHECKOUT
6-MAJ ASSY 0

	PROD HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	316502	316502
LABOR AT $ 6.217	1967649	1967649
ENGR BURDEN AT $ 6.169	1952457	1952457
PRODUCTION	4590814	4590814
LABOR AT $ 3.223	14796835	14796835
SHOP SUPPORT	65703	65703
LABOR AT $ 3.598	236401	236401
PLANNING	280324	280324
LABOR AT $ 3.438	963821	963821
TEST/QC	587203	587203
LABOR AT $ 3.637	2135631	2135631
MFG BURDEN AT $ 4.033	22277981	22277981
MFG MATERIAL	9848132	9848132
MPC	1318030	1318030
SUB-TOTAL	55496937	55496937
GEN & ADMIN	1155919	1155919
IOWA	4685745	4685745
TOTAL COST	61338601	61338601

TIME-PHASED COST
DETAIL - SEE PAGE IV-664

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	DESIGN/ENGINEERING
4-SYSTEM	1
5-SUBSYSTEM	12 SUBSYSTEM INSTALLATION AND CHECKOUT
6-MAJ ASSY	0
SUBD OF WORK	PRODUCTION

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		8	4.625	37	36	73
Q-2 58						
Q-3 58						
Q-4 58						
Q-1 59	1.5	135	4.215	569	461	1030
Q-2 59						
Q-3 59	13.5	2437	4.259	10379	8932	19311
Q-4 59						
Q-1 60	6.0	1031	4.564	4705	3855	8560
Q-2 60						
Q-3 60						
Q-4 60						
Q-1 61						
Q-2 61						
Q-3 61	1.5	202	5.366	1084	246	1330
Q-4 61						
Q-1 62	9.0	1518	5.023	7625	6209	13834
Q-2 62						
Q-3 62	28.5	4862	4.971	24171	19667	43838
Q-4 62						
Q-1 63	45.0	7701	5.031	38746	39168	77914
Q-2 63						
Q-3 63	49.5	8393	4.468	37500	55614	93114
Q-4 63						
Q-1 64	58.5	9964	4.774	47570	60188	107758
Q-2 64						
Q-3 64	1200.0	211156	5.335	1126515	1320733	2447248
Q-4 64						
Q-1 65	258.0	44827	5.350	239833	291703	531536

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 12 **SUBSYSTEM INSTALLATION AND CHECKOUT**
6-MAJ ASSY 0
SUBD OF WORK PRODUCTION

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-2 65						
Q-3 65	144.0	24169	17.732	428570	145300	573870
Q-4 65						
Q-1 66		99	3.485	345	345	690
TOTAL	1815.0	316502		1967649	1952457	3920106

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

PRODUCTION
4-SYSTEM 1
5-SUBSYSTEM 12 **SUBSYSTEM INSTALLATION AND CHECKOUT**
6-MAJ ASSY 0
SUBD OF WORK PRODUCTION

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 60	3.0	520	5.862	3048	17	3065
Q-2 60						
Q-3 60	4.5	668	4.955	3310	1	3311
Q-4 60						
Q-1 61		1	3.000	3	1	4
Q-2 61						
Q-3 61	933.0	169174	3.150	532898	665682	1198580
Q-4 61						
Q-1 62	3634.5	620314	3.100	1922896	2519877	4442773
Q-2 62						
Q-3 62	5292.0	889022	3.165	2813733	3835791	6649524
Q-4 62						
Q-1 63	3829.5	653638	3.258	2129458	2905412	5034870
Q-2 63						
Q-3 63	4801.5	806685	2.903	2341710	3869539	6211249
Q-4 63						
Q-1 64	2812.5	479999	3.752	1801069	2941595	4742664
Q-2 64						
Q-3 64	3136.5	552086	3.264	1802017	2738544	4540561
Q-4 64						
Q-1 65	1747.5	302789	3.400	1029572	1540408	2569980
Q-2 65						
Q-3 65	690.0	115918	3.598	417121	592154	1009275
TOTAL	26884.5	4590814		14796835	21609021	36405856

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 12 **SUBSYSTEM INSTALLATION AND CHECKOUT**
6-MAJ ASSY 0
SUBD OF WORK PRODUCTION

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 64	261.0	45842	3.628	166336	233354	399690
Q-4 64						
Q-1 65	114.0	19861	3.528	70065	95548	165613
Q-2 65						
Q-3 65					-819	-819
TOTAL	375.0	65703		236401	328083	564484

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

PLANNING
4-SYSTEM 1
5-SUBSYSTEM 12 **SUBSYSTEM INSTALLATION AND CHECKOUT**
6-MAJ ASSY C
SUBD OF WORK PRODUCTION

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 60	160.5	26986	3.066	82728		82728
Q-4 60						
Q-1 61	292.5	49820	3.032	151077	17095	168172
Q-2 61						
Q-3 61	264.0	47744	2.938	140256	21411	161667
Q-4 61						
Q-1 62	255.0	43593	2.983	130048	23034	153082
Q-2 62						
Q-3 62	235.5	39441	2.980	117543	25313	142856
Q-4 62						
Q-1 63						
Q-2 63						
Q-3 63	271.5	45587	5.789	263881	111906	375787
Q-4 63						
Q-1 64	108.0	18448	2.726	50294	94345	144639
Q-2 64						
Q-3 64	34.5	6048	3.284	19862	32728	52590
Q-4 64						
Q-1 65	12.0	2161	3.039	6568	11971	18539
Q-2 65						
Q-3 65	3.0	503	2.994	1506	3058	4564
Q-4 65						
Q-1 66		-7	8.285	58	16	74
TOTAL	1636.5	280324		963821	340877	1304698

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 12 **SUBSYSTEM INSTALLATION AND CHECKOUT**
6-MAJ ASSY 0
SUBD OF WORK PRODUCTION

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 60	1.5	200	5.425	1085		1085
Q-2 60						
Q-3 60						
Q-4 60						
Q-1 61						
Q-2 61						
Q-3 61	123.0	22305	3.283	73230		73230
Q-4 61						
Q-1 62	478.5	81785	3.075	251504		251504
Q-2 62						
Q-3 62	697.5	117214	3.498	410064		410064
Q-4 62						
Q-1 63	505.5	86180	3.615	311558		311558
Q-2 63						
Q-3 63	589.5	99150	4.287	425086		425086
Q-4 63						
Q-1 64	331.5	56643	3.609	204390		204390
Q-2 64						
Q-3 64	385.5	67824	3.621	245581		245581
Q-4 64						
Q-1 65	234.0	40595	3.775	153246		153246
Q-2 65						
Q-3 65	91.5	15306	3.913	59887		59887
TOTAL	3438.0	587203		2135631		2135631

NORTH AMERICAN ROCKWELL CORP.
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 12
SUBSYSTEM INSTALLATION AND CHECKOUT

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58		8	4.625	37	36	73	
Q-2 58							
Q-3 58							
Q-4 58							
Q-1 59	1.5	135	4.215	569	461	1030	
Q-2 59							
Q-3 59	13.5	2437	4.259	10379	8932	19311	
Q-4 59							
Q-1 60	10.5	1751	5.047	8838	3872	12710	
Q-2 60							
Q-3 60	165.0	27654	3.111	86038	1	86039	
Q-4 60							
Q-1 61	292.5	49821	3.032	151080	17096	168176	
Q-2 61							
Q-3 61	1321.5	239425	3.122	747469	687339	1434807	
Q-4 61							
Q-1 62	4377.0	747211	3.094	2312073	2549120	4861193	
Q-2 62							
Q-3 62	6253.5	1050539	3.204	3365511	3880771	7246282	
Q-4 62							
Q-1 63	4380.0	747519	3.317	2479762	2944580	5424342	
Q-2 63							
Q-3 63	5712.0	959815	3.197	3068177	4037059	7105236	
Q-4 63							
Q-1 64	3310.5	565054	3.722	2103323	3096128	5199451	
Q-2 64							
Q-3 64	5017.5	882956	3.806	3360311	4325359	7685670	
Q-4 64							
Q-1 65	2365.5	410233	3.655	1499284	1939630	3438914	
Q-2 65							
Q-3 65	928.5	155896	5.819	907084	739693	1646777	
Q-4 65							

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 12
SUBSYSTEM INSTALLATION AND CHECKOUT

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66		92	4.380	403	361	764	
Q-2 66							
Q-3 66							
TOTAL	34149.0	5840546		20100337	24230438	44330775	

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 12
SUBSYSTEM INSTALLATION AND CHECKOUT

	MFG MATL	TOTAL MATERIAL	MPC	SUB TOTAL	G & A	IDWA	TOTAL COST
Q-1 58				73			73
Q-2 58							
Q-3 58							
Q-4 58							
Q-1 59				1030			1030
Q-2 59							
Q-3 59				19311			19311
Q-4 59							
Q-1 60				12710	242		12952
Q-2 60							
Q-3 60				86039	2131	25832	114002
Q-4 60							
Q-1 61				168176	19146	862112	1049434
Q-2 61							
Q-3 61	314664	314664	26589	1776060	47176	762616	2585852
Q-4 61							
Q-1 62	1153769	1153769	90917	6105879	102487		6208366
Q-2 62							
Q-3 62	1653580	1653580	130302	9030164	151571		9181735
Q-4 62							
Q-1 63	1467317	1467317	144531	7036190	117645		7153835
Q-2 63							
Q-3 63	2217861	2217861	218459	9541556	169228	578537	10289321
Q-4 63							
Q-1 64	1286574	1286574	137149	6623174	189172	2267330	9079676
Q-2 64							
Q-3 64	1100129	1100129	400227	9186026	199305	180726	9566057
Q-4 64							
Q-1 65	409925	409925	122609	3971448	106052	3530	4081030
Q-2 65							
Q-3 65	269109	269109	48009	1963895	52531	5062	2021488
Q-4 65							

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 12
SUBSYSTEM INSTALLATION AND CHECKOUT

	MFG MATL	TOTAL MATERIAL	MPC	SUB TOTAL	G & A	IDWA	TOTAL COST
Q-1 66	5227	5227	1034	7075	213		7288
Q-2 66							
Q-3 66	-30023	-30023	-1846	-31869	-960		-32829
TOTAL	9848132	9848132	1318030	55496937	1155919	4635745	61338601