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B-70 AIRCRAFT STUDY
FINAL REPORT
Volume III

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[redacted]

Space Division
North American Rockwell

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SUBSYSTEM: AIRFRAME STRUCTURE WBS CODE 1.1

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SUBSYSTEM: AIRFRAME STRUCTURE

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TECHNICAL DESCRIPTION

SUBSYSTEM: AIRFRAME STRUCTURE WBS CODE: 1.1

DESCRIPTION/FUNCTION

The airframe structure subsystem consisted of the forward fuselage, intermediate fuselage, aft fuselage, horizontal stabilizer (canard) and flaps, wings, vertical stabilizers and the structural provisions therein for the other air vehicle subsystems. All sections of the fuselage were permanently attached to each other, and major bulkheads and frames were located in the structure as required for structural integrity and compartmentation. Minor frames were spaced between major bulkheads and frames while ballast was installed as necessary to maintain aerodynamically acceptable C.G. limits and so located as to maintain proper structural and dynamic responses. The wing root section (stub) was an integral part of the fuselage with the main wing panels permanently welded to this root section. The movable vertical stabilizers were supported on the aft fuselage with the horizontal stabilizer attached to the forward fuselage.

The following summary descriptions define the breakdown of the airframe structure subsystem.

Section	Stations
Forward Fuselage	FS-0 to FS-857.5
Intermediate Fuselage	
Upper Section	FS-857.5 to FS-1838 above FRP
Forward Lower Section	Forward of FS-1521 bounded by the wing fuselage joint
Aft Lower Section	FS-1521 to FS-2028.5 below FRP between wing fuselage joints plus a portion of upper fuselage from FS-1838 to FS-2028.5
Aft Fuselage	FS-2028.5 to FS-2276.8 between the fuselage wing joints
Wings (LH & RH)	In-board wings and folding wing tips
Horizontal Stabilizer	Leading edge to flap hinge fittings plus the flaps
Vertical Stabilizers (LH & RH)	Fuselage mold line to the stabilizer hinge line plus the movable stabilizers (rudders).

Each of the above major structure sections are discussed in detail in subsequent paragraphs as well as being identified by its WBS code. The "General Arrangement" drawing 267-000001 and the "In-board Profile" drawing 267-000003 are enclosed to present the interrelationship of the structure sections. These two drawings should also be used as an aid in determining specific definitions and locations for all of the air vehicle subsystems and major assemblies.

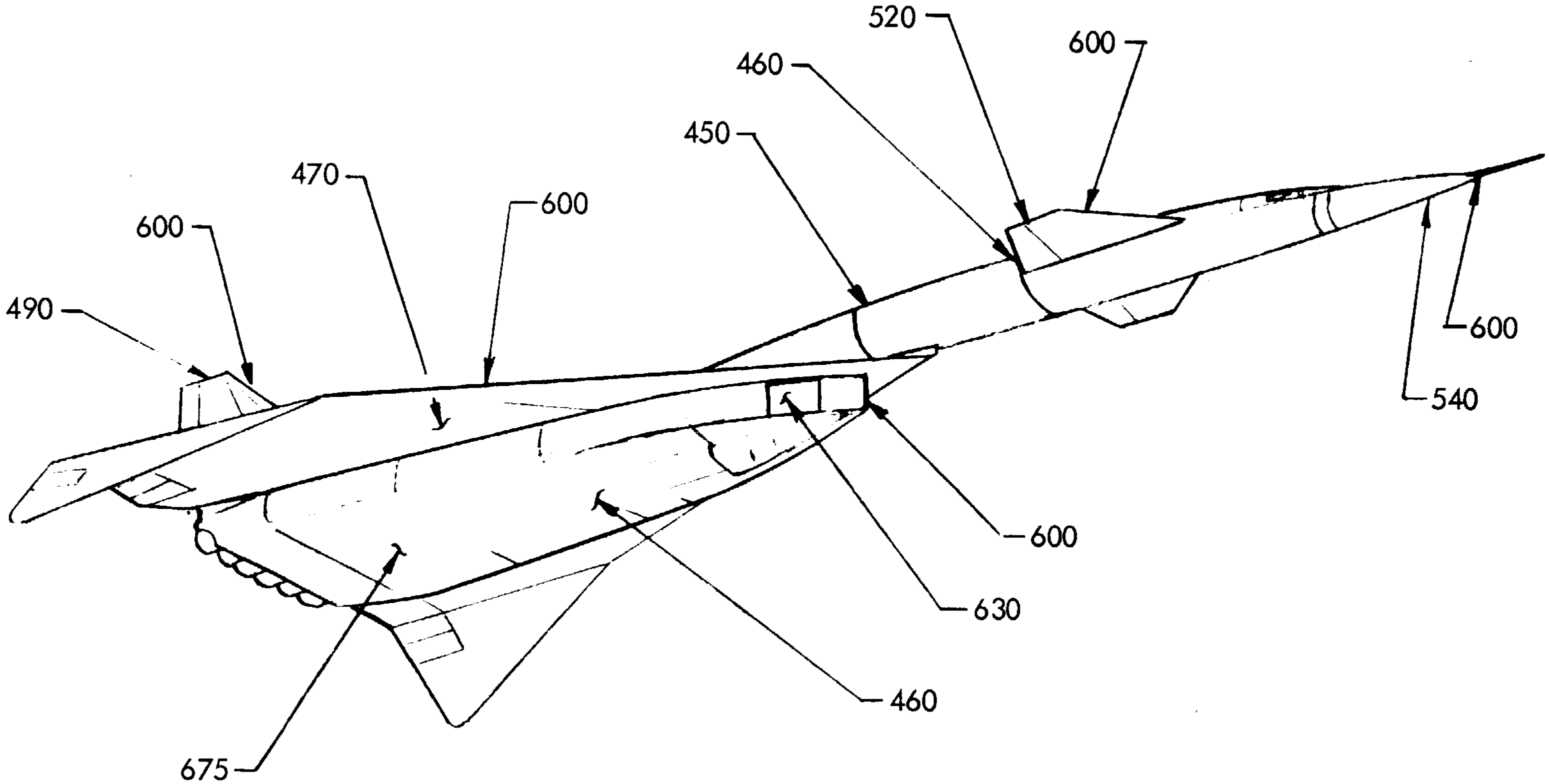
The requirement for sustained cruise at Mach 3 created a unique temperature environment for the B-70 airframe structure. The scope of effort for the structural design was well beyond the available knowledge requiring new materials, new types and methods of construction, and broadly expanded analysis methods based on large utilization of high speed computers. As shown by Exhibit 1, page III-12, the majority of the airframe structure had to carry flight loads at a structural temperature above 475°F with some leading edges as high as 630°F and some engine compartment structure as high as 1000°F. At these temperatures, the structure had to carry the loads produced by maneuvering and gusts as well as the loads caused by speed and air vehicle weight.

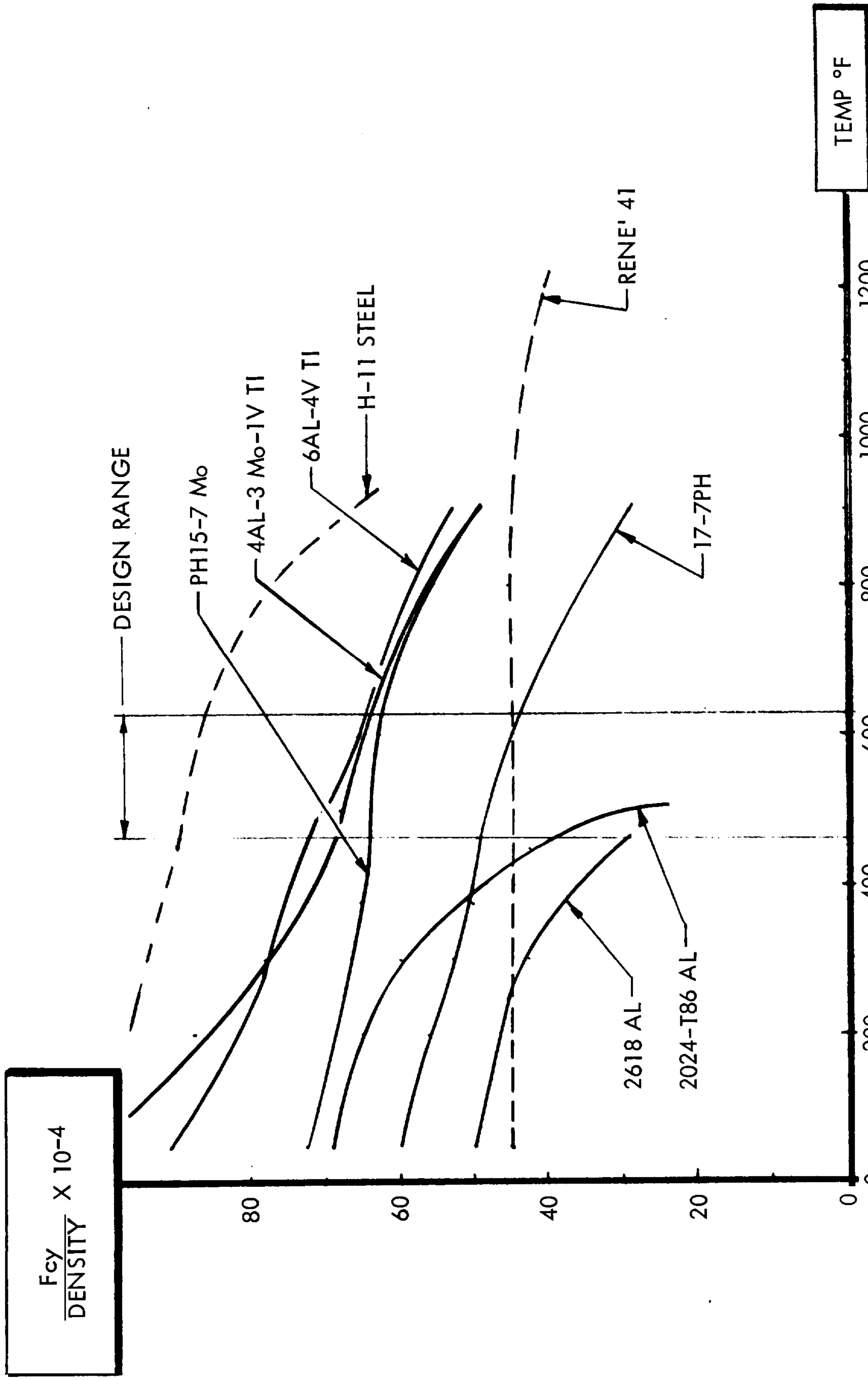
The selection of structural materials was one of the most critical factors in achieving the required high altitude, high speed, and long range performance. The long exposure of the airframe structure to temperatures from 450°F to 630°F required materials that would retain a high strength/weight ratio, i.e., the highest load-carrying capability at the lowest possible weight. Exhibit 2, page III-13, depicts the variations in a representative material efficiency parameter with increasing temperature for a number of structure materials that were investigated. As shown, the corrosion resistant steel alloys, titanium alloys, and H-11 tool steel exhibited good strength characteristics in the design temperature range. These materials were used extensively in the airframe structure subsystem sections as shown by Exhibit 3, page III-14. The values shown are percent of the total basic structure weight which for titanium was slightly over 12,000 lbs., nearly 23,000 lbs. for H-11 steel, and approximately 93,000 lbs. for PH15-7MO steel. The construction and use of these materials in each major assembly are discussed in more detail under each end item.

In addition to the function of high temperature load carrying, the airframe structure was required to have good insulating properties to prevent the aerodynamic heating from raising the integral fuel temperature which would have reduced its value as a heat sink and/or raised its value above the 300°F limit for engine supply. This insulation property was achieved on the B-70 by use of PH15-7MO stainless steel honeycomb sandwich constructed panels representing a total area of approximately 25,000 sq. ft. The detail construction of a honeycomb panel is presented by Exhibit 4, page III-15.

The stiffness of the honeycomb panel was also an important functional factor. High speed and long range performance of the B-70 was achieved through aerodynamic as well as structural efficiency. This aerodynamic efficiency was realized due to the minimized drag of the smooth surfaces exposed to the airflow on the air vehicle exterior and on the engine air inlets. The stiff panels maintained mold line contour under high pressures enhancing air flow characteristics thus minimizing the boundary layer and the associated drag. The honeycomb panel was also more resistant to the transfer of sonic noise and to sonic fatigue caused by the sound pressures developed during high speed flight and from the noise generated by the engines. Other unique and important aerodynamic features incorporated into the construction of the airframe structure subsystem are discussed under each of its major assemblies.

PEAK EXTERNAL SKIN TEMPERATURES
DEGREES FAHRENHEIT

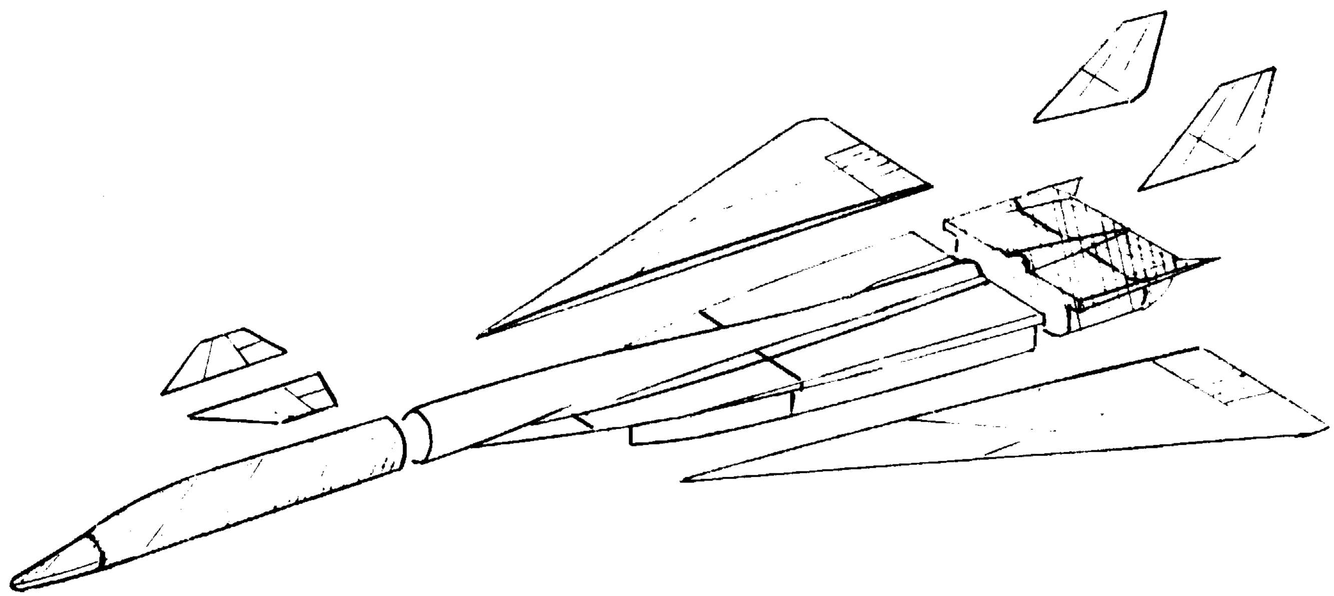




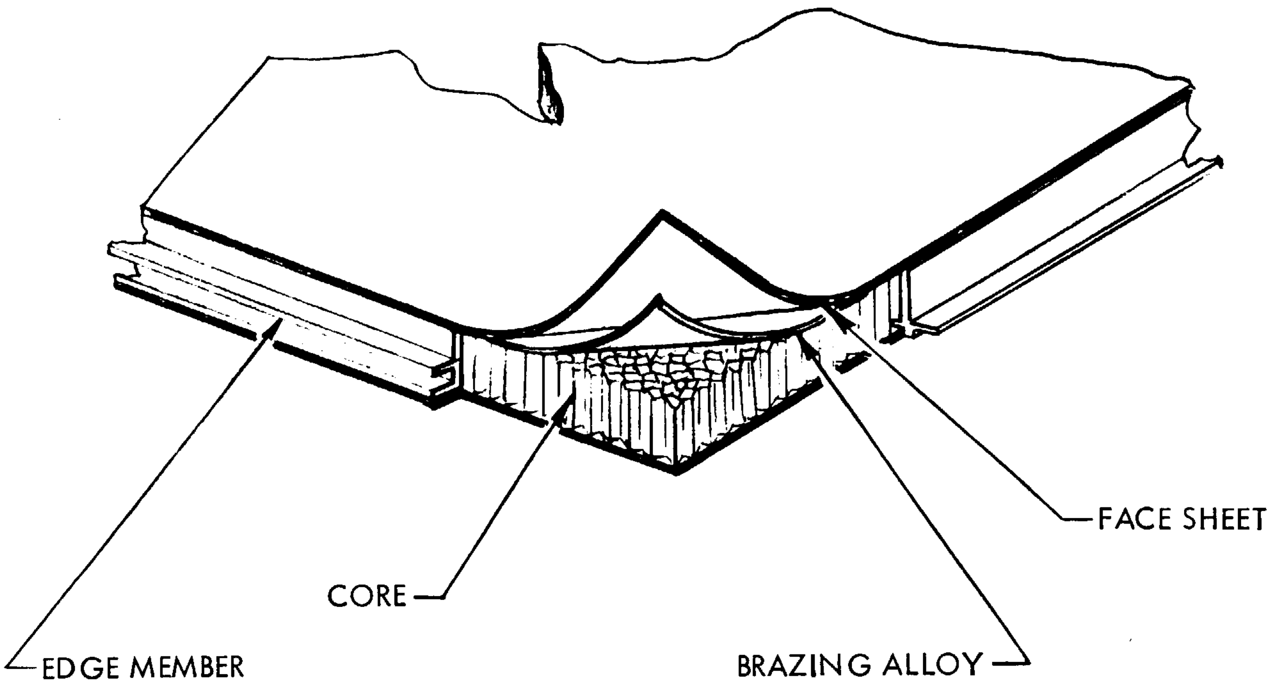
MATERIALS COMPARISON

B-70 STRUCTURE MATERIALS

☐ (plain)	PH15-7Mo	68%	(≅ 93,000 LBS)
	355 CRES	4%	(≅ 5,500 LBS)
(hatched)	TITANIUM	9%	(≅ 12,000 LBS)
(cross-hatched)	H-11 STEEL	17%	(≅ 23,000 LBS)
	RENE' 41	2%	(≅ 3,000 LBS)



HONEYCOMB PANEL CONSTRUCTION



TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: AIRFRAME STRUCTURES SUBSYSTEM WBS CODE: 1.1

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	Pounds	89,022	TBD	TBD	124,203	125,422
CONSTRUCTION	Type		- - - Permanently attached - - - Riveted and Welded			
MATERIALS	Type	PH15-7Mo Steel, 4Al-3Mo-1V Titanium, 6Al-4V Titanium, H-11 Tool Steel, and Rene 41				
HEIGHT (TIP OF VERT)	Feet	30.71	30.71	30.71	30.71	30.71
LENGTH (LESS NOSE BOOM)	Feet	185.75	185.75	185.75	185.75	185.75
SPAN (STATIC)	Feet	105.0	105.0	105.0	105.0	105.0
"G" - DESIGN LOADS	"Gs"	±2.0	± 2.0	± 2.0	± 2.0	± 2.0
"Q" - DESIGN AIR LOADS	Pounds/Ft^2	1388	1388	1388	1388	1388
TEMPERATURE ~ GENERAL	Degrees F	-65 to 630	-65 to 630	-65 to 630	-65 to 630	- 65 to 630
MAJOR ASSEMBLIES	Type/No.	(1)Forward fuselage, (1) Intermediate Fuselage, (1) Aft Fuselage, (2) Horizontal Stab. Panels, (2) Vert. Stab. Panels, (2) Wing Panels, (2) Wing Fold Tips				
JOINING MAJOR ASSEMBLIES	Type	All fuselage sections and wing panels one welded assembly. Horz & vert stab and wing fold tips mechanically attached.				
INTERNAL FUEL (TOTAL)	Gallons	53,098	46,503	46,503	43,171	45,971
WEIGHT (DDORS, FAIRINGS, PAINT, ETC.)	Pounds	2109	TBD	TBD	1927	2097

TECHNICAL DRIVER

WBS ITEM: AIRFRAME STRUCTURE SUBSYSTEM WBS CODE: 1.1

DRIVER: HONEYCOMB PANELS: DESIGN & FABRICATION

GENERAL

When the B-70 design was initiated and the performance requirements analyzed, it was evident that the structural weight had to be at a minimum to achieve the long range requirements. The two basic factors involved in attaining structural efficiency were the selection of materials to be used and the detail type of construction. Early in the design stage, a comprehensive study was performed to determine the best choice for the two factors, and before the study was completed, tests had been conducted on more than 6000 specimens ranging from small elements to large complex assemblies.

Because of the operating environment of the B-70, material selection for the structures development program was limited to those materials which would not lose their strength at high temperatures. Strength-weight comparison studies (Reference Exhibit 2, page III-13) indicated that corrosion resistant steel alloys, titanium alloys, and tool steels were the most promising. Since these were all high strength materials, the sheet gauges required to sustain a given load could be relatively thin thereby reducing weight. With the basic materials selected, the testing program continued using each of these materials to determine the efficiency of different methods of construction, including conventional structural arrangements and sandwich panel constructions. Conventional sheet metal skins, reinforced plates of various constructions, and sandwich or composite panels were designed, fabricated and evaluated. The results showed that the sandwich panel construction was superior for most of the structural areas due to the good insulating properties and the stability against buckling furnished by the continuous support of the sandwich core to the thin gauged high strength materials. See Exhibit 6, page III-22, for thermal efficiency comparison of conventional construction versus sandwich panel construction.

The structure development program at this point was directed toward investigating the merits of different types of sandwich with early results showing that only two types warranted extensive study: honeycomb sandwich and corrugated core sandwich. During this phase it was also determined that adhesive bonding could not be used due to the high temperatures involved, so the face sheets were brazed to the honeycomb and spot welded to the corrugation.

The heat treatable corrosion resistant steel, PH15-7MO, was selected as the best material for both the honeycomb and corrugation. The tool steels were eliminated due to weight and difficulties with corrosion preventive coatings and other processing problems. Titanium was also eliminated since the best titanium alloys could not be brazed and heat treated in the same operation or bent to the sharp angles required for an efficient corrugation. After extensive testing of both types of sandwich construction, it was concluded that honeycomb sandwich was superior for the required application. A significant factor influencing this decision was the ability of honeycomb to carry loads equally well in all directions which minimizes the single failure criticality for structures. Also, as shown by Exhibit 5, page III-21, the thermal conductance for honeycomb was lower than that for corrugation panels. Other advantages of the honeycomb panels, such as aerodynamic smoothness and resistance to sonic fatigue, are discussed under Airframe Structures.

DISCUSSION

The early design concept for honeycomb panels required most of the components to be individually machined to the desired configuration and for the face sheets to consist of many separate details which were joined by welding or brazing. This approach created warpage and distortion that in turn resulted in panel assembly and sealing problems. It was determined during this period that even the machine cutter marks were sufficient to cause brazing voids resulting in subsequent sealing difficulties. These problem areas were solved by requiring chemical milling in place of machine milling which also allowed the face sheets to be made from one large integral sheet. The chem-milling eliminated warpage and the one piece chem-milled face sheets eliminated faying surfaces for braze bonding which were a major cause of panel leaks.

Prior to the B-70 program, silver-manganese braze alloy was the only production alloy available for brazing steel sandwich. During the initial panel development phase it was determined that this brazing alloy had many weaknesses, among them, crevice corrosion. This resulted in a program being initiated to formulate a new brazing alloy with the following exacting requirements:

(1) Provide adequate fillets for core to face bond.

(2) Flow uniformly along the core nodes to boost column strength.

(3) Possess low thermal conductance so that the insulating property of the sandwich panel was not impaired.

(4) Remain in place on curved panels rather than flow to the low points.

(5) Produce a braze at a temperature compatible with the heat treating cycle of PH15-7MO steel.

The alloy developed was a silver base (84.6%) alloy which brazed at 1725°F. Indium (5.5%) was added to reduce the high thermal conductivity that is a characteristic of silver. Palladium (2.2%) was added to raise the brazing temperature so it would be compatible with the first stage of heat treatment of the PH15-7MO steel. The alloy also contained 0.2% lithium for self-fluxing and 7.5% copper. To control alloy drainage in curved panels, a nickel dispersion (20% by volume) was added to the braze. Exhibit 7, page III-23, presents the results of the brazing alloy development program showing the strength/insulation comparison of the old and new braze alloys with and without node flow.

The original honeycomb panel design called for submill (0.00075) foil gauge honeycomb core, 0.004 face sheets, and a core to face sheet fit within a tolerance of four thousandths of an inch. Since core foil material was not available at the mills, core gauge reduction was attempted by chem-milling but was not successful due to uneven removal of material. The combination of this unevenness and the foil gauge resulted in core crushing during brazing. Also, the chem-milling caused subsequent intergrannular corrosion within the core. The use of the thin face sheets caused "pillowing" (small dimples over each cell opening) and skin wrinkles. These two problem areas were corrected by redesign which required a 0.001 foil gauge core and face sheets of 0.007. At the onset, inspection of core/face sheet fit was by individual measurements relating the core to the related steps and pockets in the face sheet. This method of inspection failed to produce the guaranteed tolerance fit and resulted in mismatched areas causing voids. This problem of measurement was solved by developing the use of a tape check whereby the impact of core against face sheets were accurately gauged.

There were many detailed components in a single panel and, at the onset, these parts were held in position by welding strip material. This method was unsatisfactory in that it permitted thermo movement and mismatch. Development in this area resulted in the use of tooling tabs and pins, plus insertion of tubular sleeves welded to the face sheet. This method of holding parts gave good dimensional control for better fit in assembly.

Basically, the process of brazing a honeycomb panel consisted of:

(1) Preparing the basic components (core, face sheets, brazing foil, and close-out edge members)

(2) Assembling these elements under surgically clean conditions

(3) Placing the assembly in an air-tight steel container, called a retort, which was then evacuated and subsequently filled with an inert gas (argon)

(4) Placing the retort containing the panel into a heat source for the actual brazing process

Four brazing methods were explored, namely, luminous wall furnace, die quench, salt bath, and electric blanket. Of these four, the electric blanket brazing was the most advanced during the B-70 development, was considered the most efficient, and was used in fabricating most of the panels. The electric blanket brazing was an integrated procedure that provided for brazing, transforming, and heat aging in one continuous operation. The brazing tool was made of glass rock cement and foam block supported by a steel frame. The glass rock cement was cast against a master model to provide proper dimensional control. The development of this glass rock material, which was extremely stable under rapid and wide changes in temperature was considered the significant technological breakthrough that made electric blanket brazing possible.

The electric blanket brazing tool held the honeycomb panel in its retort between the upper and lower tool sections of glass rock brick and cement. The glass rock contained cored passages and cooling grooves in the face of the tool next to the panel for passage of compressed air and vaporized liquid nitrogen. Heat was provided by one-inch wide strips of inconel laid against the contoured face of the glass rock tool. Insulation between the heating elements and the panel retort was provided by refrasil bats. This major development item, the electric brazing tool, provided uniform and controllable heating/cooling, had low power requirements, and the ability to braze and heat treat in one fixture in a continuous operation without moving the panel. Exhibit 8, page III-24, presents a cross sectional view of a typical electric blanket brazing tool and a graph showing the brazing cycle of a PH15-7MO steel honeycomb panel. Exhibits 9, 10, and 11, pages III-25, III-26, and III-27 display significant honeycomb panel milestones and summarization of total panels delivered

THERMAL CONDUCTANCE COMPARISON HONEYCOMB VS CORRUGATION SANDWICH CONSTRUCTION

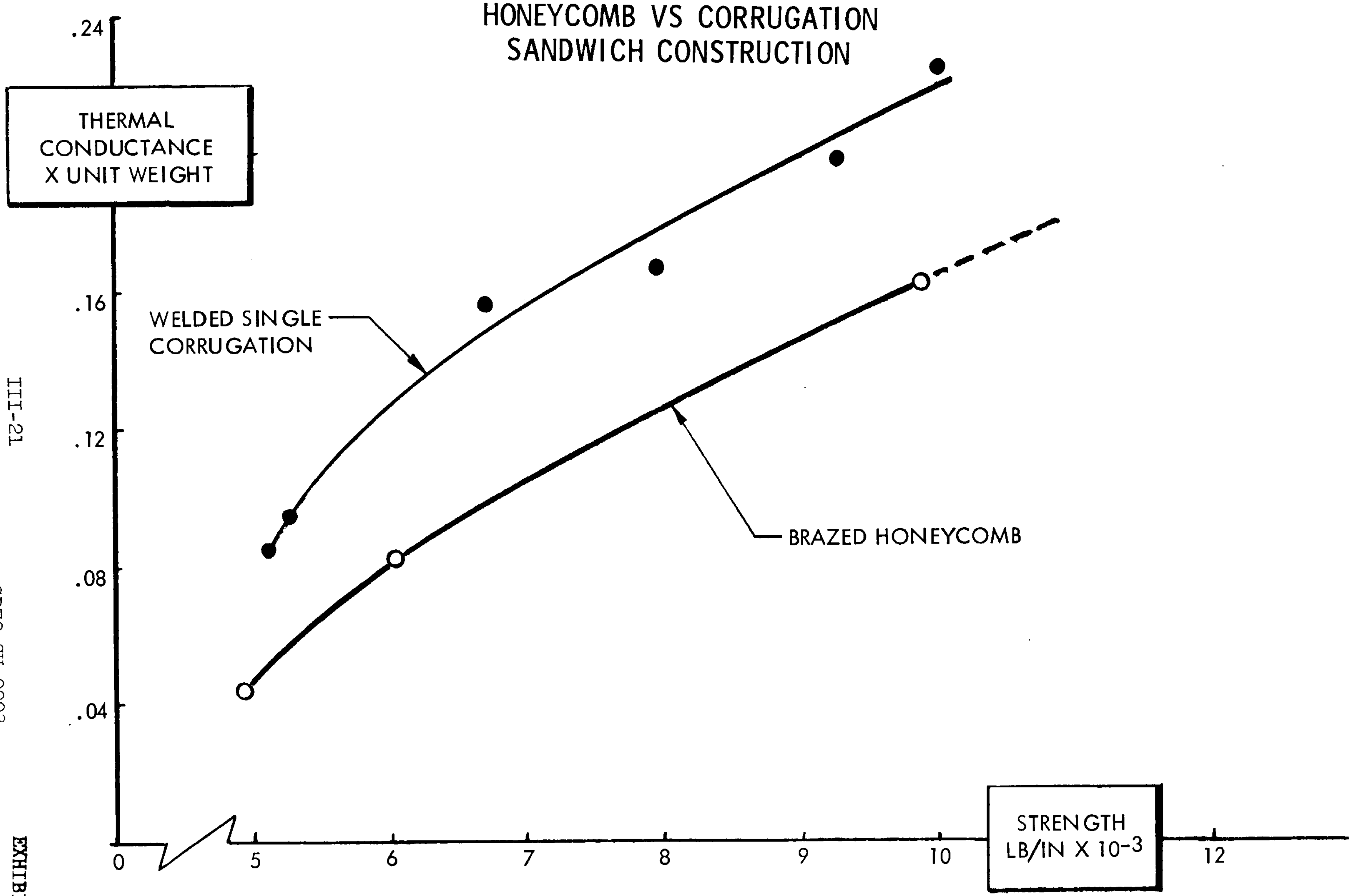


EXHIBIT 5

THERMAL EFFICIENCY OF SANDWICH CONSTRUCTION

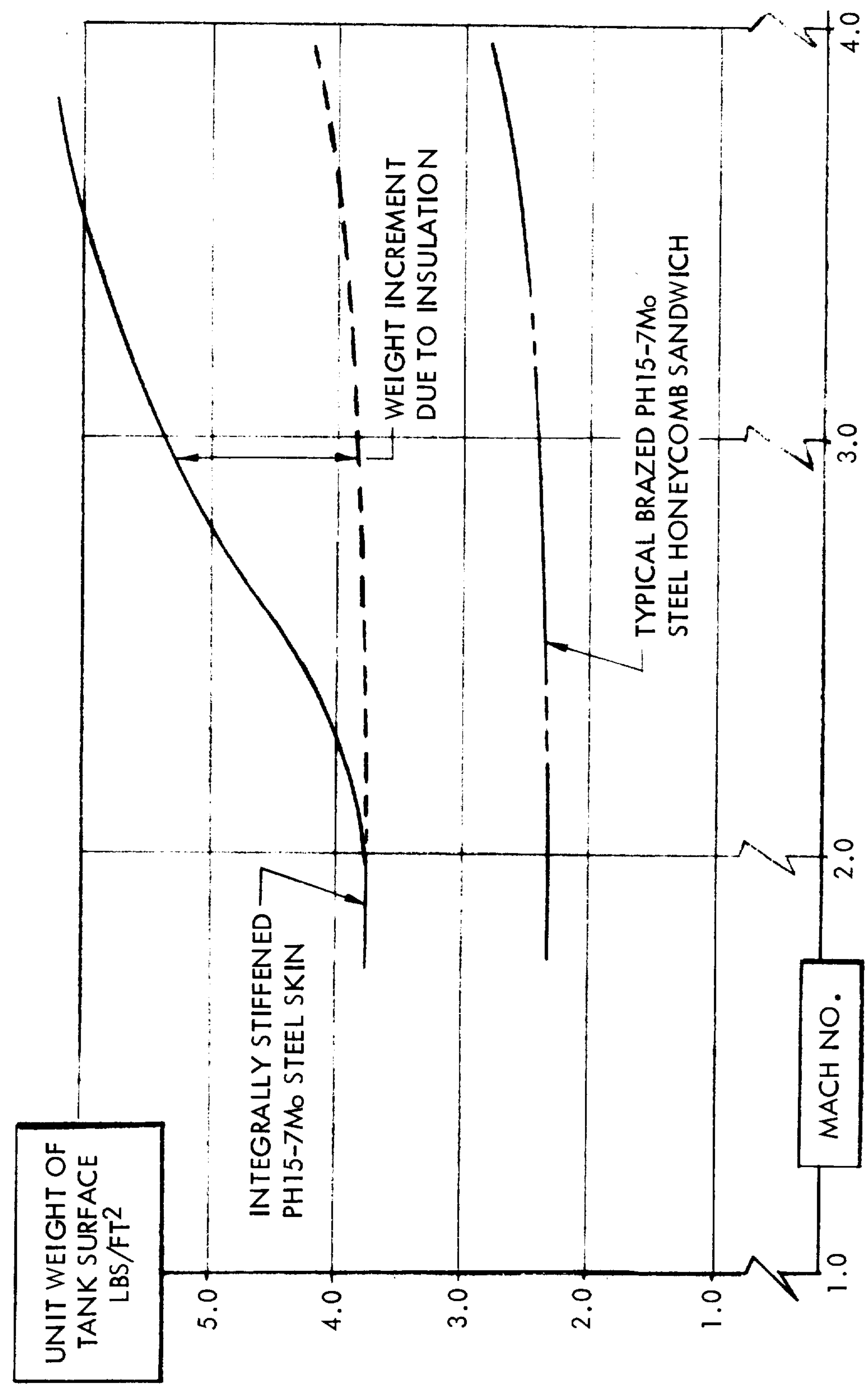


EXHIBIT 6

HONEYCOMB STRUCTURE

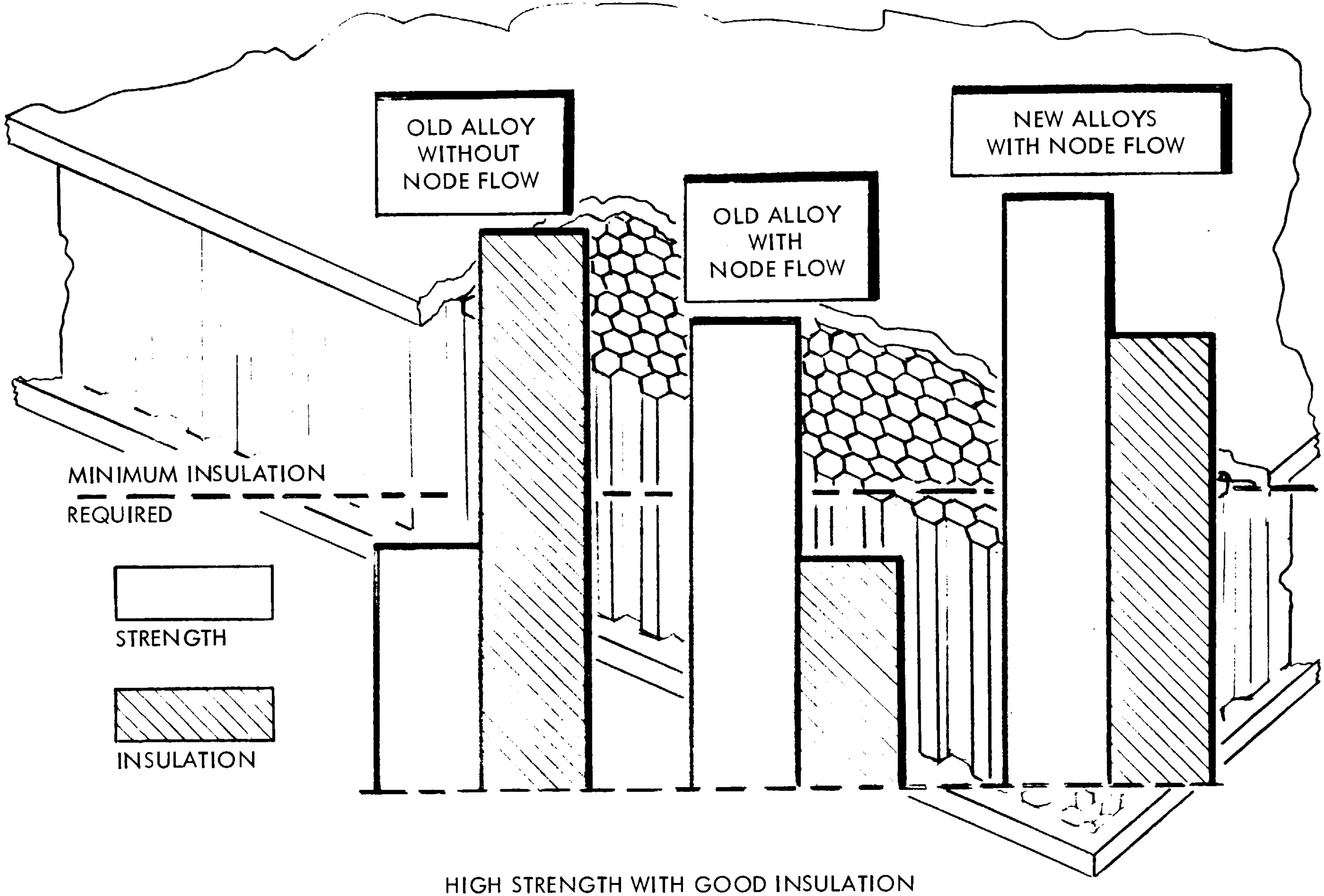
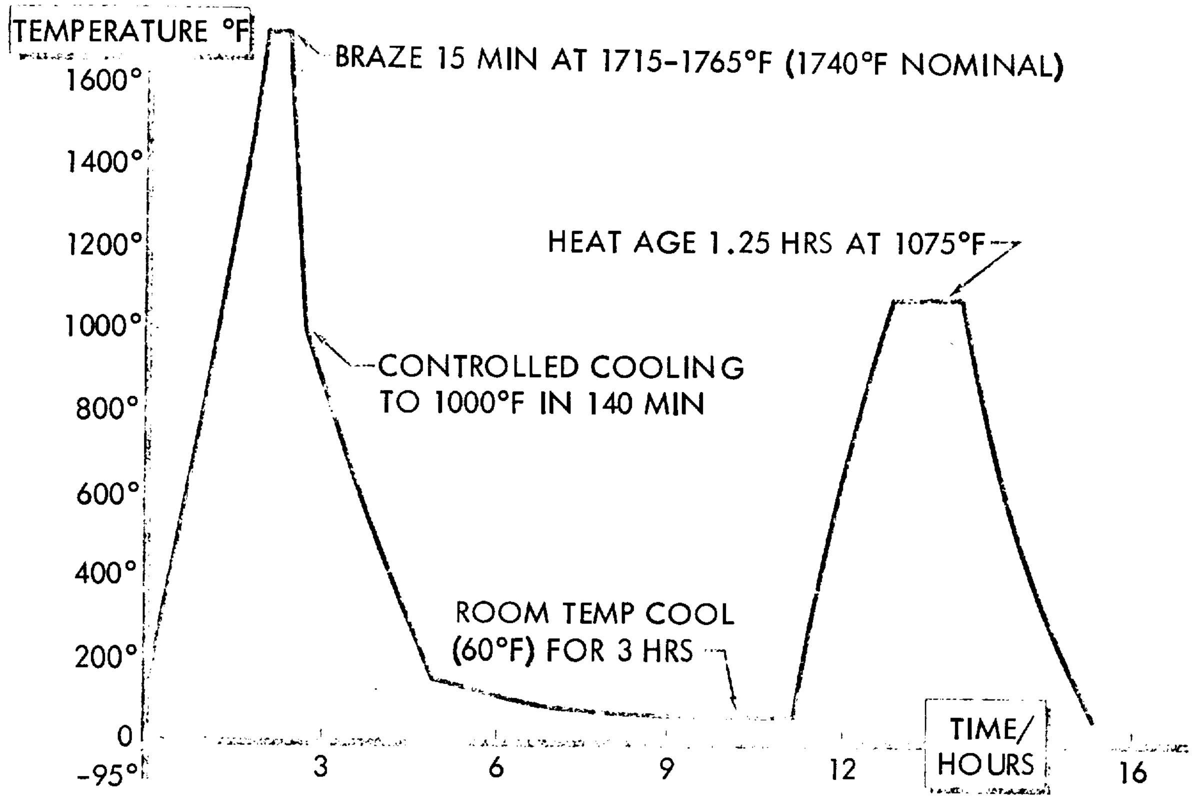
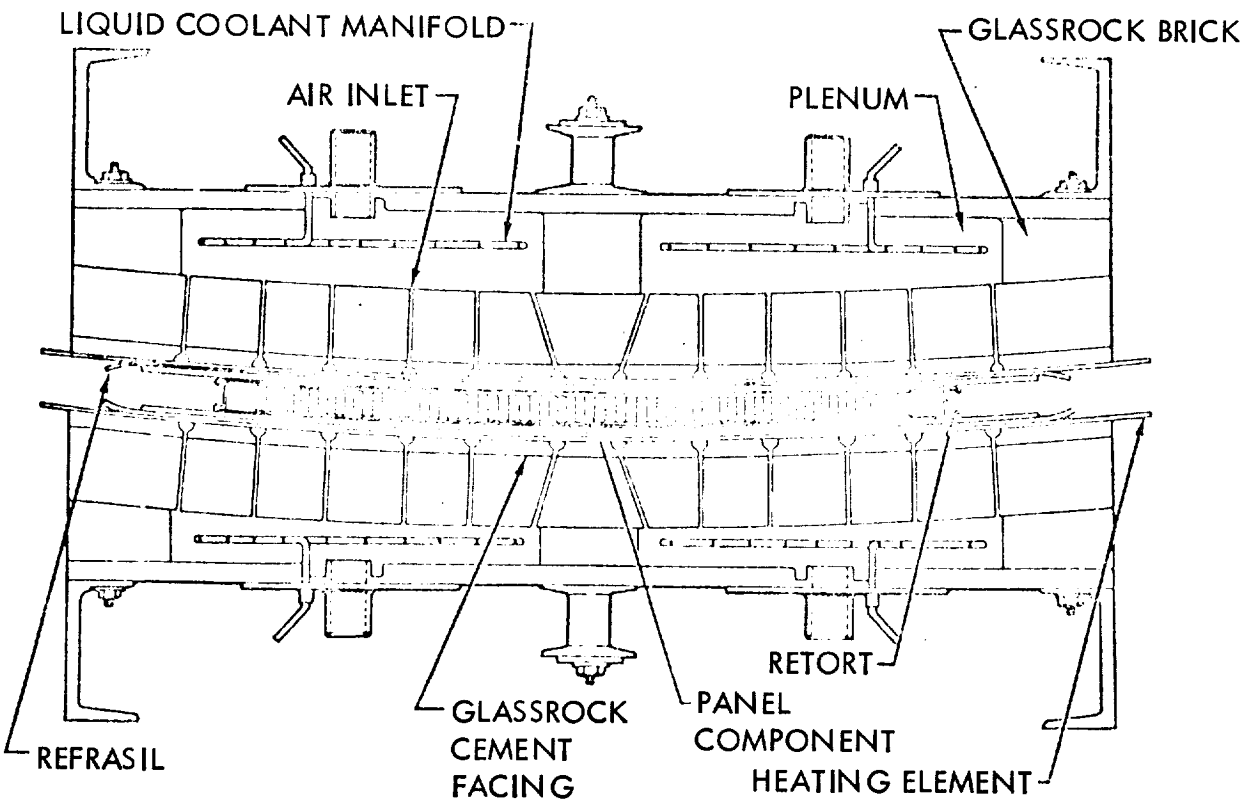


EXHIBIT 7





CROSS SECTION - ELECTRIC BLANKET BRAZING TOOL

EXHIBIT 8

HONEYCOMB PANEL MILESTONES

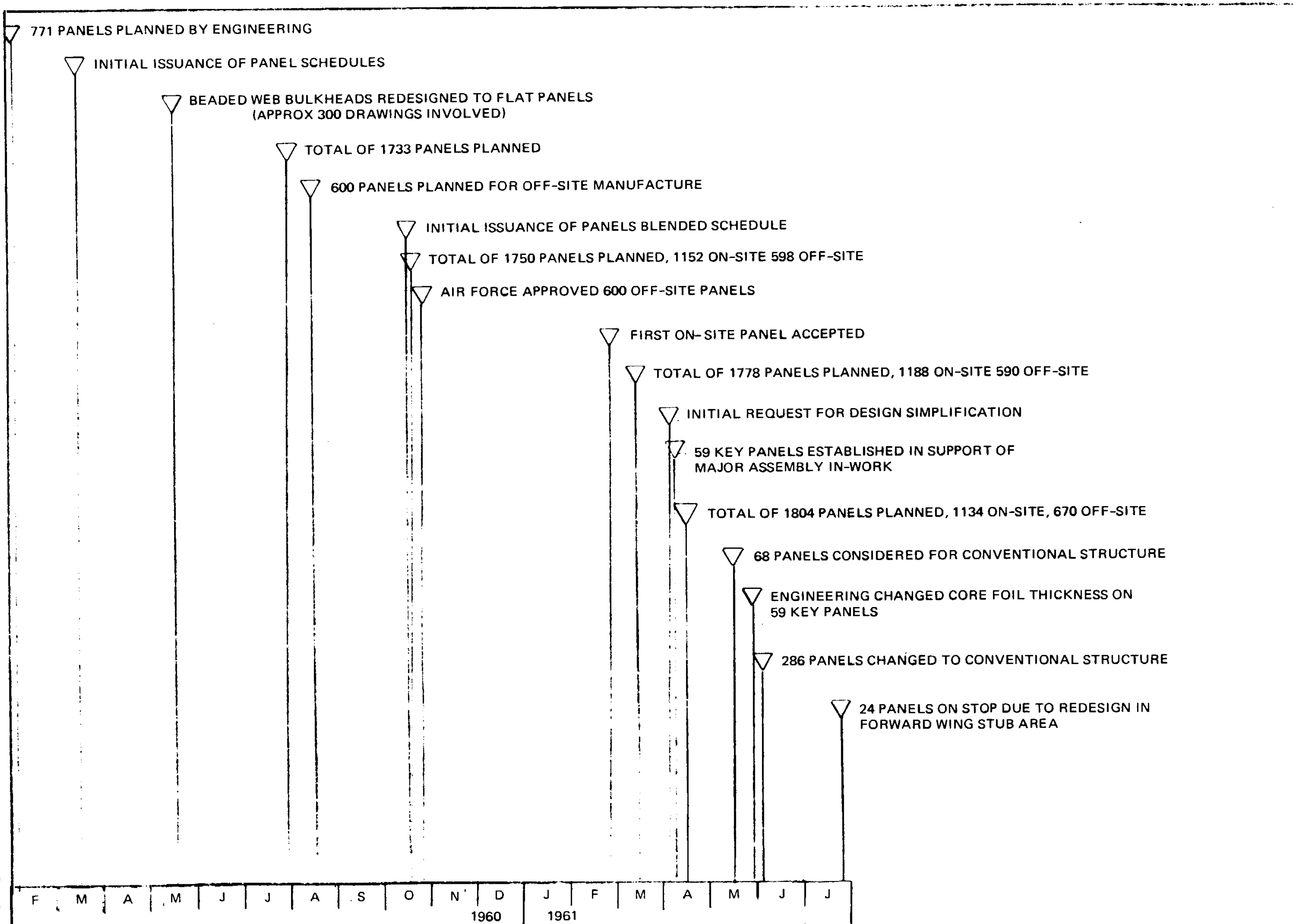


EXHIBIT 9

AIR VEHICLE 1 HONEYCOMB PANEL SUMMARY

	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	1961 DEC	1962 JAN	FEB	MAR
ON-SITE UNIT DELIVERIES														
PANELS MONTHLY	1	17	17	22	30	60	68	81	57	40	209	117	104	8
PANELS CUM	1	18	35	57	87	147	215	296	353	393	602	719	823	831
GROSS SQ FT MO.	1	35	30	46	119	236	332	902	732	652	4755	2308	1845	129
GROSS SQ FT CUM	1	36	66	112	231	467	799	1701	2433	3085	7840	10148	11993	12122
OFF-SITE UNIT DELIVERIES														
PANELS MONTHLY			3	50	70	86	82	85	71	50	88	77	75	2
PANELS CUM			3	53	123	209	291	376	447	497	585	662	737	739
GROSS SQ FT MO.			6	89	163	223	240	402	561	546	1658	2538	3860	91
GROSS SQ FT CUM			6	95	258	481	721	1123	1684	2230	3888	6426	10286	10377

EXHIBIT 10

		TOTAL PANELS		GROSS SQ FEET	
AV NO. 1 REQUIREMENTS COMPLETED MAR '62	ON-SITE	831		12,122	
	OFF-SITE	739		10,377	
			(1570)		(22,499)
AV NO. 2 REQUIREMENTS COMPLETED MAY '64	ON-SITE	1,059		13,483	
	OFF-SITE	205		7,814	
			(1264)		(21,297)
AV NO. 3 CANCELLED MAR '64	ON-SITE	191		3,154	
	OFF-SITE	190		5,312	
			(381)		(8,466)
GRAND TOTAL			3215		52,262

* TOTALS EXCLUDE REMAKES AND REPAIR REQUIREMENTS

HONEYCOMB PANEL SUMMARY

TOTAL PANELS DELIVERED*

EXHIBIT 11

TECHNICAL DRIVER

WBS ITEM: AIRFRAME STRUCTURE SUBSYSTEM WBS CODE: 1.1

DRIVER: APPLICATION OF H-11 TOOL STEEL

GENERAL

The XB-70 contained nearly 23,000 lbs. of parts fabricated from H-11 tool steel heat-treated to a tensile strength of 280,000 to 300,000 psi. The tool steel was used mainly in the fuselage and wing structure, landing gear strut assemblies, and the landing gear mechanism. One of the most spectacular applications of H-11 on the B-70 was the landing gear bogie beam which was precision machined from a 13,000 lb. rough forging. A more extensive and equally advanced application was in the wing center section truss assemblies. These trusses replaced spar webs as shear carrying members in the boundary layer control (BLC) air ducts running through the wing over the engine inlet ducts. To minimize restricting air-flow in the BLC duct, the truss design consisted of straight, thin walled, streamlined tubes welded to cone shaped, turned and formed end fittings. Another application of the tool steel was the double planetary gear train of the self-powered wing fold hinge. It was mandatory that the hinge and its power drive be an integral part of the structure, strong enough to transmit wing loads and, at the same time, stiff enough to prevent flutter. These applications as well as others, such as the main longerons of the fuselage, were fabricated of H-11 tool steel due to its decided advantages in strength and stiffness.

H-11 Low Alloy Die Steel had formerly been used principally in the tool industry because of its high impact strength and hardness. However, it was not a corrosion-resistant steel, and it had to be heat-treated after welding with a very complex heat-treat cycle. In addition, this high strength and high modulus steel was very notch sensitive which demanded all possible precautions be taken to minimize stress concentrations. The use of H-11 steel on the B-70 required nearly 5 years of development to achieve satisfactory forging, fabrication and processing techniques.

DISCUSSION

When the first structural applications were attempted, the H-11 tool steel material cracked during either the heat-treating or subsequent vibration tests. This unsatisfactory condition initiated a development program to establish the necessary configuration and surface finish specifications. In addition to developing heat-treat, process, and raw material forging techniques, suitable high temperature protection processes were developed to keep the tool steel from corroding.

As previously stated, the high strength and high modulus steel was very sensitive to local stress concentrations. During the first phase of the development program it was determined that the stress sensitivity was greatly reduced if the material was vacuum melted by the consumable electrode process. Exhibit 12, page III-30, shows the comparison of the yield strength, elongation, and notch characteristics of air melted versus vacuum melted H-11 steel. It was also established that surface conditions of the material had to be carefully controlled with a very fine surface finish and shot-peening required to ensure maximum resistance to fatigue. In areas which were critical in fatigue, the material had to be free of heat-treat decarburization. For the less critical fatigue areas, only partial decarburization could be allowed and that to a maximum depth of 0.003 inches. To prevent heat-treat decarburization, a coating system was developed. The system was a ceramic formulation which upon exposure to heat formed an oxidation protecting vitreous layer on the substrata and included a binder for good handling characteristics during routine shop utilization. The coating was also self-removing since virtually all of the coating spalled off upon cooling to approximately 700°F.

Since H-11 tool steel was not corrosion-resistant, fabrication and process techniques for corrosion protection had to be developed. This phase of the development program resolved that the protection could be provided in several ways, depending upon function of the part and the service temperature. For temperatures up to 900°F, sprayed aluminum coated with a silicone resin or nickel-zinc electroplate coated with silicone resin was used depending upon the parts function. Where temperatures did not exceed 500°F in service, vacuum deposited cadmium was used to protect the surface.

During the H-11 development program many process limitations were established, such as for threading or grinding, where each process was a potential source of trouble. A few of the limitations were:

1. Threads when made to the MIL-S-7742 configuration, had to be rolled. Acme, Whitworth, or "radius root" threads could be rolled or ground.

2. Welding required pre-heat and post-heat treatments with the part maintained at 600°F during welding. Weldments had to be fully annealed before heat treating.

3. Cold straightening, when applied to heat treated parts, had to be followed by stress-relieving at 925°F for two hours.

4. All burrs, deep scratches, and rough edges had to be removed before the part was heat-treated.

5. Extreme care was required to prevent "checking" during grinding and all grinding had to be followed by stress-relieving at 925°F for two hours.

COMPARISON OF VACUUM MELT VS AIR MELT
H-11 TOOL STEEL STOCK

	AIR MELT		VACUUM MELT	
	MID-RADIUS	CENTER	MID-RADIUS	CENTER
ULTIMATE STRENGTH ~ PSI	290,000	280,000	280,000	288,000
YIELD STRENGTH ~ PSI	245,000	240,000	252,000	250,000
ELONGATION ~ %	4	2.5	8	8
AREA REDUCTION ~ %	10	3	25	24
NOTCH ~ UNNOTCH RATIO (K_t = 3.5)	1.25	1.10	1.30	1.3

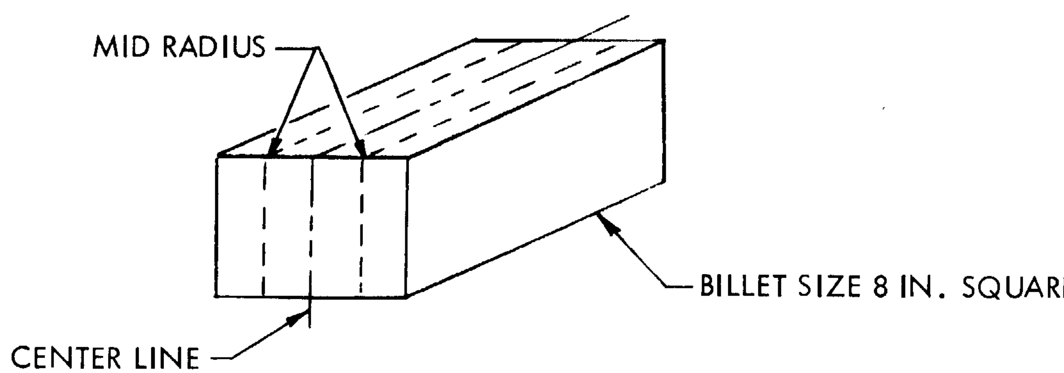


EXHIBIT 12

TECHNICAL DRIVER

WBS TITLE: AIRFRAME STRUCTURE SUBSYSTEM WBS CODE: 1.1
DRIVER: APPLICATION OF TITANIUM

GENERAL

Each XB-70 used approximately 12,000 flyaway pounds of titanium comprising about 23,000 detail parts. (As previously stated, most of the titanium was concentrated in the forward fuselage.) Although this represented the largest and most advanced application of titanium, experience in titanium design and fabrication was actually initiated around 1950 where small amounts of commercially pure titanium were used for such items as fairings. The first use of titanium alloys was around 1953 where 8 Mo type alloy sheet and 4Al-4Mn type forgings were used for primary structure involving the first application of resistance welding. The first use of fusion welding occurred around 1958 where 6Al-4V type alloy pressure vessels and 5Al-2.5 Sn type alloy frame structures were assembled by fusion welding. However, the XB-70 development was the first application of heat treated titanium alloy sheet for airframe structure.

The transition from the lower strength, annealed, commercially pure and 8Mo alloy titanium to that of the high strength, heat-treated 6Al-4V, 4Al-3Mo-1V, and 7Al-4Mo (bar and forgings) alloys required extensive development in fabrication and processing techniques. These alloys were heat-treated to tensile strength levels of 160,000 to 200,000 psi providing the most sophisticated titanium structure ever constructed from heat-treated products of that high a strength level.

DISCUSSION

The product forms used for the B-70 structure were sheet, bar, extensions, and forgings in many sizes and configurations. In each part, the alloys were selected and processed to achieve maximum strength, closely controlled fracture toughness, and close dimensional tolerances. Forming for the production of precision parts in heat-treated materials was developed to a highly refined process involving room temperature forming and hot sizing at about 1200° F in precision metal dies. This was necessary to compensate for the low amount of plasticity and the very high spring-back rate of high strength titanium.

For the assembly of parts, special welding procedures were developed including tungsten inert gas welding in argon-filled chambers and welding without any restricting chamber with the NR "trailing-cup" technique. The trailing-cup method provided a shielding gas shroud for the weld, both during and after the weld, making assembly welds of any length feasible. Another welding process developed was the burn-through welding technique used in the construction of spars and rib sections. (A 6Al-4V sheet, corrugated to form sinusoidal webs, was burn-through welded to 6Al-4V sheet metal caps.) The burn-through welding technique used an automatically controlled TIG torch, following a sine wave pattern, and an argon trailing cup to protect the weldment, both during the molten state and during cool-down of the bead (no chamber or bagging required).

The technology of titanium fabrication was greatly advanced during the XB-70 program by the use of chemical-milling for metal removal, mainly in the achieved high rates of metal removal while holding to very close dimensional tolerances. Removal rates of 4 to 7 miles per minute were used with tolerances of 0.002 to 0.004 achieved for cuts to a depth of 0.200 inches. Like the use of titanium, chemical-milling was not a new process at the onset of the B-70 Program. However, it had been previously limited almost exclusively to aluminum. It should also be noted that the chem-milling development for titanium also resulted in the development of an entire series of etchants for stainless steels, chrome die steels, nickel base alloys, and cobalt base alloys.

TECHNICAL DRIVER

WBS TITLE: AIRFRAME STRUCTURE SUBSYSTEM WBS CODE: 1.1

DRIVER: CONTAMINATION/CORROSION

GENERAL

Although processing controls were maintained at a high level during the XB-70 Program, intergrannular and/or stress corrosion and corrosion due to contamination did occur. Since the corrosions were after-the-fact and were identified downstream, impact to the XB-70 program was experienced. (See Special Chart, page II-117, XB-70 #1: Design/Programmatics). Each instance when corrosion was identified, corrective action was initiated to determine the extent of corrosion, to resolve the existing problem, and to prevent reoccurrence.

DISCUSSION

The design of the original honeycomb panels called for submill foil gauge honeycomb core. Since this 0.00075 foil gauge core was not available at the mills, core gauge reduction was done by chem-milling. Subsequently, it was determined that many panels had internal corrosion in the areas where the core was brazed to the face sheets. Laboratory analysis determined the condition to be intergrannular corrosion caused by the uneven removal of material during the chem-milling process. Corrective action was to redesign the panels using the 0.001 foil gauge core as a minimum. (See write-up of Technical Driver: Honeycomb Panel)

It was originally determined that, for inspection purposes, it was necessary to submerge honeycomb panels in water for ultrasonic inspection and leak tests. This process resulted in subsequent oxidized weld joints in the assembly welds and weld repairs. It also resulted in internal corrosion when water leaked inside the panels. This problem initiated a study to determine if the requirements for ultrasonic inspection could be reduced, if ultrasonic inspection could be accomplished without water submerging panels, and a method of "dry" leak checking. In the interim, for those panels which contained water, small holes were drilled (each node) and heat applied to bake the water out.

As the results of the study, panel leak tests were subsequently conducted by vacuum gas method. This method relied on the high PH value of isopropylamine gas which changed the color of an indicator, such as Bromthymol Blue, from yellow to blue. The surface of the test specimen was coated with the indicator and if gas permeated through a leak channel, the color change immediately indicated and located the leak. Two methods were developed for panel inspection: Magnetic Printing and In-Motion Radiography. The magnetic printing was based on the principle that when a ferromagnetic object was placed in a uniform magnetic field, the lines in that field tended to concentrate more where the section thickness increased. The lines in that field also dispersed and flowed around discontinuities. Using this principle with plastic coatings applied to the panel, permanent records of the inspection were achieved.

Conventional radiography was not suitable for inspection of the braze quality of honeycomb panels since the image of one side became superimposed on the image of the other. The study developed in-motion radiography which alleviated this problem by providing a clear picture of the braze alloy distribution on one side of the panel at a time. This was accomplished by placing the film in intimate contact with the panel side to be inspected and opposite the X-ray source. The panel and film were moved while the x-ray source remained stationary. The panel characteristics being inspected were very close to the film and unaffected by the movement, thus casting a sharp outline. The other side, being some distance from the film, cast only a dim blurred image. The contrast was sufficiently great that, in practice, the reader saw one side clearly and the other not at all.

During repairs to a number of honeycomb panels on air vehicle no. 1, nickel plating solution leaked into the panels and resulted in corrosion of the core, braze alloy, and face sheets. Of the 44 panels suspected of being contaminated, 15 were found to be clean, while the others required either partial or total replacement (See Special Chart, page II-117, XB-70 #1: Design/Programmatics). To repair the corroded panels it was first necessary to determine the extent of damage by analysis and chemical check. Once the corrosion was located, it was stopped with a neutralizing solution, flushed with water, chemically rechecked and then baked dry. Further evaluation of test plugs, which included micro/micro examination and pull tests, was necessary to determine if repairs would consist of installing doublers, replacing all, or replacing part of the panel.

TECHNICAL DRIVER

WBS TITLE: AIRFRAME STRUCTURE SUBSYSTEM WBS CODE: 1.1

DRIVER: FUEL TANK SEALING & MAJOR ASSEMBLY JOINING

GENERAL

Fuel tank sealing and major assembly joining are discussed as a compound technical driver since the single most significant factor that delayed final assembly was the sealing of fuel tanks. The excessive fuel tank leakage encountered during air vehicle no. 1 major assembly was entirely unforeseen. It covered a time span of over 2½ years (not including the Flight Test Program) and delayed wing to fuselage mating for approximately 18 months (See Special Chart, page II-249: Major Airframe Mating). Other conditions that impacted major assembly joining were repair and/or replacement of panels due to corrosion, mismatch due to use of soft tooling, mating-joint variations due to ambient temperature changes, and material growth (pre-load stresses) due to welding temperatures.

The locating of fuel tank leaks and the subsequent tank sealing required considerable developmental effort. Methods established for locating leaks included soap and bubble solutions, dye penetrant solutions, helium sniffers, and temporary sealants which permitted leak checking by area. To solve the sealing problem, 108 sealing compositions were studied with laboratory tests conducted on 32 likely suspects. This investigation established guidelines for tank sealing which consisted of various combinations of the following sealant techniques.

1. Metal to metal brazing or welding was used in basic structural sealing. If pin-hole leaks existed in the braze or weld seal, organic sealant was used unless structural conditions and mission temperatures were beyond established limits. In these instances, AU/GE alloy was used.

2. The organic compound Viton was applied to leaks where mission temperatures would not exceed 500° F. The application of Viton required precise curing cycles up to 22½ hours and heat up to 400° F.

3. DuPont Polyimide Varnish, also an organic compound, was applied to leaks in areas where mission temperatures would exceed 500° F. This application required precise curing cycles up to 28 hours and heat up to 400° F.

DISCUSSION

Mach 3 flight induced temperatures ranging from 450° F to 600° F in some fuel tank areas creating design problems never before encountered in aircraft. Due to the high temperature, an inert gas (nitrogen) was required in the ullage to minimize the potential hazard of fuel vaporization. To prevent fuel leaking to "hot surfaces" and to preserve the limited supply of nitrogen, the fuel tanks had to be liquid and air tight. The design criteria imposed stringent requirements for tank structure integrity and sealing.

WBS: 1.1

The B-70 was designed for fuel stowage in integral tanks only and did not include provisions for bladder cells. The initial sealing development was based upon the selection and improvement of non-metallic materials to meet the high temperature resistance requirements. However, after preliminary examination and test of a great many known and experimentally developed materials, it became apparent that non-metallic materials would not satisfy the design criteria. Probable structural damage if leakage and subsequent ignition occurred, and the limited access to tank areas after assembly dictated the need for a highly reliable sealing method. These conclusions, together with significant improvements in welding and brazing techniques, led to the concept of integral tank sealing by the welding and joining methods used for the structural assembly.

Fusion welds and brazed joints, as structural links, had to be of high quality with joining materials applied homogeneously without voids, discontinuities, or openings. To meet this structural integrity requirement, welded and brazed joints had to be essentially impervious and therefore leakproof. The improvements in fusion welding had supported the B-70 integral tank design. Large unbroken structural sandwich panels were joined and sealed by inert gas shielded arc fusion welding. Tank sections were assembled successively from a given station which provided adequate access for welding, inspection and repair by rewelding without large access doors in the tank walls required. In addition, the fabrication process and the installation process of honeycomb panels resulted in each individual panel being sealed. Based on the above factors, all design studies indicated superior fuel tank structure integrity.

During the XB-70 structural assembly, it became apparent that thin-faced honeycomb panels were prone to handling damage. The repair and associated sealing of the damaged panels presented special processing problems not previously anticipated. The use of brazing and welding methods of sealing the thin gaged structure proved very difficult and resulted in formation of structurally unacceptable wrinkles and buckles. With precise process control, the sealing procedures were used successfully; however, when the brazing and welding procedures were used in areas of limited access or under adverse conditions, panel damage occurred. This unacceptable condition initiated investigations to find a sealing method compatible with the thin gaged structure under the adverse working conditions usually experienced in tank sealing.

As a backup to metallic sealing, elastomeric materials were further investigated. This proceeded from exhaustive literature and industry surveys to laboratory conducted formulation studies of the most promising available high temperature polymers. The most promising sealant materials developed during the studies were based on Viton polymers. The Viton based sealant coatings demonstrated satisfactory life and the ability to seal pin-holes, particularly in joints around structural doublers.

Since the Viton coatings required an elevated temperature cure as high as 400° F, it was necessary to develop the capability to accomplish this cure in the completed tank areas of the air vehicle. Some individual tanks of the B-70 held as much as 8000 gallons of fuel. Facilities and equipment had to be designed and built which were capable of heating the complete tank structure at a controlled rate without developing "hot spots" that would overstress and damage the structure.

During the program to develop honeycomb panel structure repair processes and techniques, the electrodeposition of nickel to reinforce the face sheet was investigated. This development effort resulted in a process, using portable plating equipment and portable plastic cells, which deposited nickel on honeycomb panels or on completed structure. Tests showed the properties of the nickel were high enough to withstand design loads, and the application process did not cause secondary damage to the structure from local thermal stresses. Due to the success of this structural repair process, the use of nickel electrodeposits for sealing was investigated. Tests showed that joints and damaged areas were satisfactorily sealed by this method and that such seals remained effective when subjected to limit load cycling. However, the use of nickel electrodeposits process required extreme care due to the highly corrosive cleaning and plating solution. To minimize this hazard, a conductive nonstructural material was developed for temporary joint sealing. This method of tank sealing had limited use on air vehicle no. 1 but was used extensively on air vehicles no. 2 and no. 3, particularly in areas that mission temperatures exceeded 500° F.

TECHNICAL DRIVER

WBS TITLE: AIRFRAME STRUCTURE SUBSYSTEM WBS CODE: 1.1

DRIVER: STRUCTURAL REPAIRS

GENERAL

The structure repairs considered as a technical driver were the repairs made to honeycomb panels. The processes and techniques developed to test and repair panels were unique and by far the most frequently employed during the XB-70 Program. The repairs to the airframe non-metallics and conventional structure were also unique due to the materials involved; however, the repairs, per se, were not considered technical drivers.

The repairs to honeycomb panels were made during all phases of the XB-70 program and essentially were required to correct the condition(s) of: (1) core to face fillet strength inadequate, (2) corrosion, and/or (3) impact damage. These faults resulted in panel "voids," skin "wrinkles" and "buckles," crushed cores, cracked skins, pin-holes, dimples, etc., from the time of fabrication through the flight test program (see "Design/Programmatics," Special Chart, page III-53).

Under airframe technical drivers "Contamination/corrosion" and "Fuel Tank Sealing," several passive techniques for panel inspection are discussed. In addition to these techniques, a method of non-destructive testing was developed to determine honeycomb panel integrity. These tests were performed to demonstrate that the core to face braze fillet strength was adequate. For this non-destructive test, a circular plug was bonded to the face sheet and a flatwise tensile load applied up to 80% design. To perform the tests, deflection limits as well as load limits were required for each density and core depth. The load level was large enough to give a high degree of integrity assurance without panel damage.

DISCUSSION

During the XB-70 Program, honeycomb panel faults were determined by the active or passive inspection methods discussed, by visual inspection or by "peening." Once a fault was established, one or more of the following repair techniques was used.

Use of Welded Pins: Installation of welded pins was one of the most valuable and practical processes used in salvaging faulted honeycomb panels. This type of repair was used in areas of defective core to face attachments, such as gross voids, cell wall voids, undersize fillets, etc., and in regions of reduced core shear strength caused by shear tie voids and no node flow. This method of repair was also used to interlace perpendicular truss systems to restore shear capability in both directions.

To restore tensile and face sheet stability to an affected area, welded pins were installed normal to the face sheets. This provided to the affected area support from the opposite face and the attached core. When necessary, doublers were added to distribute the pin load over a sufficiently broad area of the core. Welded pins were installed at an angle to the face sheets (45^o to 60^o) to provide a load path for core shear. This installation was used to replace or augment the existing shear strength. For some repairs, a series or combination of diagonal and straight welded pins were installed to form a truss for transmitting loads as a conventional type of structure.

Plasma Spray Repair: The prime characteristic of honeycomb panel was the ability to sustain in-plane stresses of a very high order due to the continuous load paths furnished by the core to the load carrying face sheets. Honeycomb panel faults, such as core to face attachment voids and face sheet dents/creases, lowered panel stability and hence the strength of the face sheets for carrying compression or shear loadings. One means used to restore a measure of face sheet stability was to deposit aluminum, as a spray by a plasma gun, onto the face sheets over the defective area. The aluminum deposit was strictly a stability adjunct for compression loading and was never used to repair defects which caused loss of tensile loading since the spray lacked intrinsic strength.

Nickel Plate Repair: As discussed under Plasma Spray Repair, the most direct method of restoring compression loading stability to a honeycomb panel was the deposit of additional material to the face sheets over the defected area. One of the best repair techniques used during the XB-70 program was face sheet nickel plating. The nickel deposit was built up to the required thickness by electro-chemical plating. Unlike plasma deposits, the nickel plate had inherent strength and was used structurally to restore tensile loading as well as compression loading capabilities. The nickel plating process had a further advantage in that no heat was required and therefore no heat affected zone nor reduction in face sheet strength.

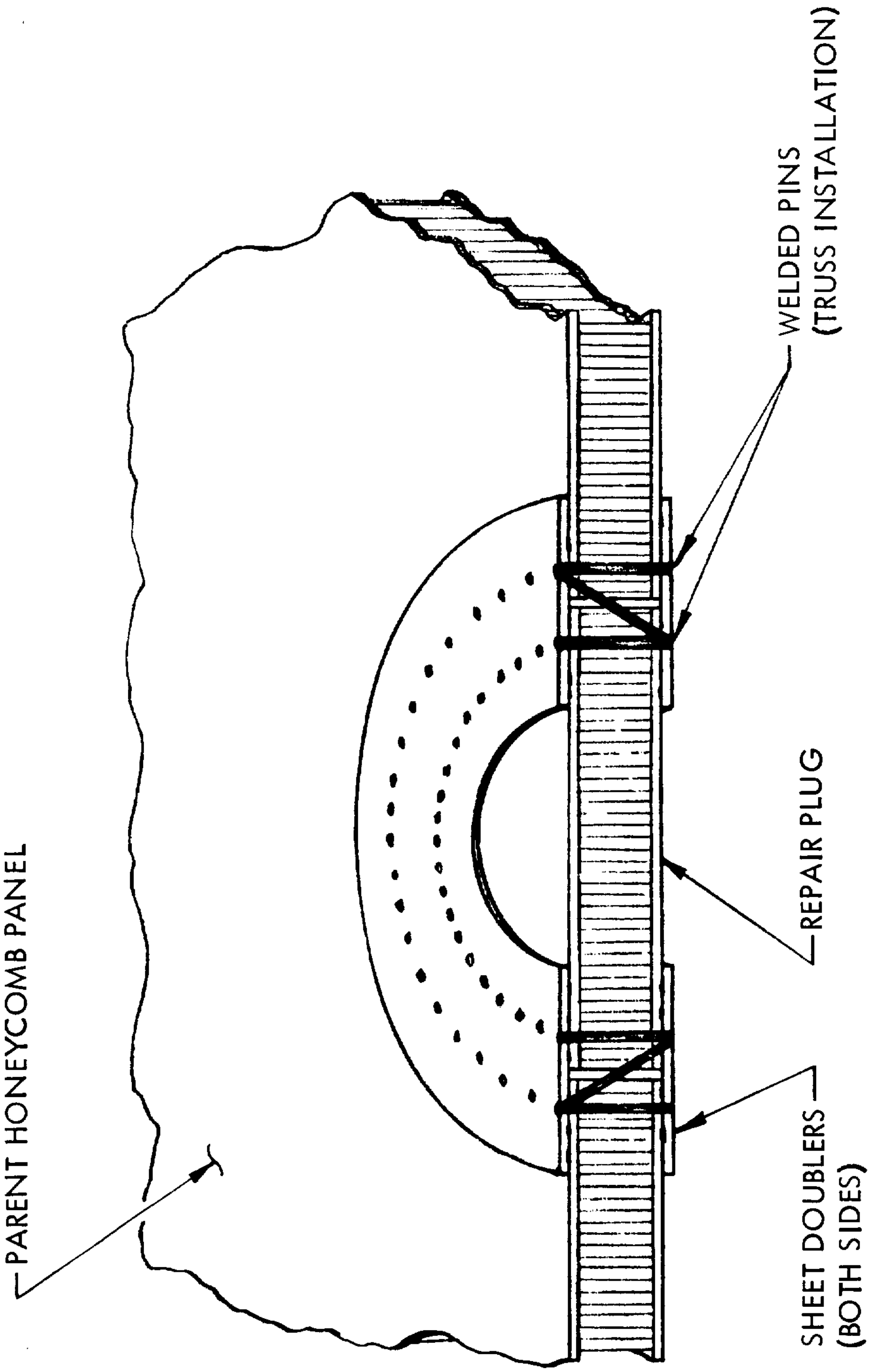
Spot Brazed Doublers: A spot brazed repair doubler was one of the most common instruments used for the repair of honeycomb panel defects. Although spot brazed doublers were used as sole load paths between two separate face sheets, its most common usage was to reinforce under strength conditions in honeycomb face sheets. The understrength conditions (which were usually caused by a crush core, core to face sheet gross void, or low heat treat) were restored with the addition of the doubler by reducing the effective stress level through increased effective thickness.

A spot brazed doubler was installed on the honeycomb panel by locally fusing a pattern of spot brazes through a continuous sheet of braze alloy laid between face sheet and doubler. Spot braze diameters were typically 3/16 to 1/4 inch with the space between spots and rows of spots typically 1/2 to 3/4 inches. Doubler material used was PH15-7Mo sheet steel in the RH 1075 heat treat condition.

WBS: 1.1

Panel Repair Plugs: A repair plug in a honeycomb panel was used when the faulted area was too extensive to be repaired by a local reinforcement. The defected area was cut out in its entirety and replaced by a "plug" or panel which had been fabricated to the specific dimensions, core and face sheet requirements of the original panel. The plug was assembled to the parent panel by means of peripheral face sheet doublers which transmitted axial and shear loads into the face sheets of the plug. Attachment of the doublers was either by spot brazing or arc spot welding depending on face sheet thickness and load requirements. Welded truss pins were installed around the periphery of the plug/panel splice joint to give in-plane stability and to transmit across the splice joint beam shear loads. See Exhibit 13, page III-41, for typical honeycomb panel repair plug installation.

HONEYCOMB PANEL REPAIR PLUG INSTALLATION



Space Division
North American Rockwell

DEVELOPMENT DATA SUMMARY

WBS TITLE: AIRFRAME STRUCTURES SUBSYSTEM WBS CODE: 1.1

STATE-OF-THE-ART RATING: 5 (SEE REMARKS)

PERCENT DEVELOPED MATRIX:

	PRIOR TO FLIGHT		FLIGHT TEST
	CONFIGURATION	GROUND TEST	
PROGRAM LEVEL	80%	80%	28%
EFFORT TO GO	44%	44%	89%

GROUND TESTS WIND TUNNEL DEVELOPMENT

TYPE OF TEST	NUMBER OF UNITS	TEST HOURS
CONFIGURATION RESEARCH	10	2153
DESIGN FEASIBILITY	12	1543
DESIGN VERIFICATION	21	5074
AIRWORTHINESS		
QUALIFICATION		
OTHER		
TOTAL	43	8770

*The hours shown are tunnel occupancy hours.

REMARKS:

In addition to the wind tunnel tests, the following table summarizes the testing conducted on structural specimens.

Type of Tests	Number of Items	Test Hours
Configuration Research	319	14,366
Design Feasibility	454	15,567
Design Verification	504	19,772
Air Worthiness	815	22,667
Qualification	456	27,946
Repair Development Tests	1,224	37,956
Misc: Tabs, Pins, Patches, Coupons, etc.	2,355	14,850
Total	6,127	153,124

STATE-OF-THE-ART

WBS CODE: 1.1

The airframe structures 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 state-of-the-art determination since it was the production configuration defined. This selection is considered valid since the development status (% comparison) 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 required

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 an off-the-shelf commercial item or standard military issue which required physical modification only 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 is 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 all two of the design criteria will be rated 5.

As previously stated under airframe structures subsystem description, the B-70 mission required a vehicle which would maintain structural integrity at high pressures, loads, and acoustic impact under sustained high temperature conditions. In addition, mission range criteria required the use of high tensile strength to weight ratio materials which resulted in unique fabrication processes and techniques. Although the air vehicle, per se, was an existing concept, the structural design was required to meet all three of the design criteria, thus the state-of-the-art rating of 5.

Percent Developed

The structural development status percent comparisons of the XB-70 to that scheduled for the RS-70 were made at two development stages; one for the "out-the-door" time period or prior-to-flight and the other for the flight test programs. For the "out-the-door" time period, the structures configuration was assessed as 80% representative of an RS-70 and would have required 44% more effort to attain a Number 1 air vehicle production level status. For the same time period, the ground testing level was determined as being 56% of that scheduled for the RS-70 and that 44% more ground testing would also have been required to attain the production level status. For the flight test program status, as presented by Exhibit 13, page II-23, (WBS 1.0), the direct comparison of equivalent test hours would indicate 84% more flight test effort required to achieve a production level status. However, this did not reflect the impact of the two different flight envelopes (XB-70 versus RS-70) which increased the effort to go from 84% to 89%. Based on the two testing levels achieved, it was established that an 80% program confidence level was attained with prior to flight ground testing and a 28% program confidence level achieved with the XB-70 flight test program. Exhibit 14, page III-47, presents a summary of the XB-70 structural development status. The curve, shown in the summary exhibit and used in establishing statuses, reflects complexity or learning impact and has been used for some time by NR for program planning. The validity of the curve and the methodology developed for status level comparisons are discussed in subsequent paragraphs.

The methodology developed for comparing the XB-70 configuration and testing levels to that scheduled for the RS-70 was verified for the Airframe Structures Subsystem and then applied without verification to the other subsystems. This approach was considered valid since the effort required for the structures subsystem was substantially more than 50% of the total effort expended which would limit any stray variations of the other 10 subsystems to a small allowable band. Based on this approach, the following basic steps were taken for each of the air vehicle subsystems:

(1) Each subsystem was assessed to the major assembly level by the Design Group to establish the subsystem configuration level. In addition, the testing conducted was analyzed to determine if the configuration tested impacted the validity of the data obtained as related to a production effort.

(2) The Progression/Exposure curve was then used to determine effort to go for the configuration.

(3) The XB-70 test hours were compared to that scheduled of the RS-70 and a percentage established. This status level was then adjusted as required based on the Design Group analyses.

(4) The Progression/Exposure curve was then used to determine program confidence level achieved.

The Airframe Structures Subsystem configuration was assessed as being 80% representative of an RS-70 No. 1 air vehicle at the time of "out-the-door". Entering the progression/exposure curve, Exhibit 14, page III-47, at 80% on the left-hand scale, the bottom scale indicates 44% more effort required by Engineering and Manufacturing to achieve a No. 1 air vehicle production level status. To determine the ground test status, the scheduled RS-70 structural tests hours of 290,000 was compared to the XB-70 test hours of 161,894. This comparison showed a status level of 56% achieved which indicated that 44% more test effort would be required to attain production level status in ground testing.

The above XB-70 structural status comparisons for "out-the-door" and flight test were verified by reviewing the structural program from the on set through flight testing as related to program objectives, ground test calendar time, and actual data obtained. At the time of redirection (RS-70 to XB-70), all engineering disciplines were required to analyze the revised requirements and establish the most timely and economical approach to achieve the XB-70 objectives: mainly, to demonstrate technical feasibility of sustained Mach 3 flight. In the structures area, it was determined that the air vehicle would be required to withstand inflight loads of plus 1.6 "g's" to plus 0.4 "g's" in a flight envelope up to 80% of the design limit as shown by Exhibit 14, page II-24, under Air Vehicle: WBS 1.0. Based on this analysis, all subsequent structural effort was directed toward verifying XB-70 structure integrity to 80% of the design loads (except for ground loads which were to 100% of design). This philosophy was followed for all re-design due to test data with the ground rule being: if it was satisfactory for 80% loads, no rework was necessary. This structures program directive supported the comparison analysis that the XB-70 structure subsystem was approximately 80% representative. The structural redesign that would have been required was reviewed and it was estimated that approximately 42% more design effort would have been required. In addition, as presented by Exhibit 15, page III-48, the major structural testing conducted on the XB-70 was compared to that scheduled for the RS-70. This comparison showed that testing level attained was approximately 60% of that scheduled for the RS-70. Entering the Progression/Exposure curve at the bottom scale at 60%, the left-hand scales indicates that the structures program or confidence level was 82%.

To substantiate the comparison percentages of the flight test program and to further validate the use of the Progression/Exposure curve, an analysis was conducted on actual structural loads data obtained during the XB-70 flight test program. Exhibit 16, page III-49, summarizes the results of the data analysis and shows the maximum load levels attained in percent of limit for each of the major structure assemblies. The average maximum load level was determined to be 57% of the RS-70 limit with all the data obtained within an 80% envelope and on an 80% representative configuration. The impact of the 80% configuration adjusted the 57% down to 45.6% and this data level was then used in the adjustment for the envelope impact. Exhibit 17 page III-50, presents a summary of the impact for the envelope flown. Past statistical flight data showed that the first 80% of an envelope required only 60% of the total effort while the last 20% of the flight envelope required 40% of the total effort. Based on this ratio, the data level of 45.6% was weighted as follows: 60%:80%::X:45.6%. This showed that, after adjustment for both configuration and envelope, a 34% program level was attained during the XB-70 flight test program. Entering the Progression/ Exposure on the left-hand scale at 34%, the bottom scale showed 14% test effort accomplished with 86% test effort to go to attain a RS-70 flight test status.

The flight test program comparison was also verified by entering the Progression/Exposure curve on the left-hand scale at 57% data level which by the bottom scale indicates 30% test effort achieved. This test effort was then adjusted to 24% due to configuration impact. Using the test level of 24%, the test effort remaining was then adjusted by the weight function 40% + 60%-(2X24 ÷ 3), where the 40% represents the effort required for the last 20% of the RS-70 flight envelope. This method of verification showed that 84% more test effort was required to attain a production level status. Entering the Progression/Exposure curve on the bottom scale at 16%, the left-hand scale shows a program confidence level of 37% was achieved during the XB-70 flight test programs.

In summary, the verification techniques showed a total percentage spread of 2% for configuration and 4% for effort to go at the "out-the-door" time period. The flight test program spread was 9% for program status and 5% for effort to go to attain a production level status. Analyzing these results, it shows that at the high confidence level items, the percent comparisons are very close while at the lower confidence level items the percent variations are slightly larger. This was considered valid and the methodology employed acceptable.

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.

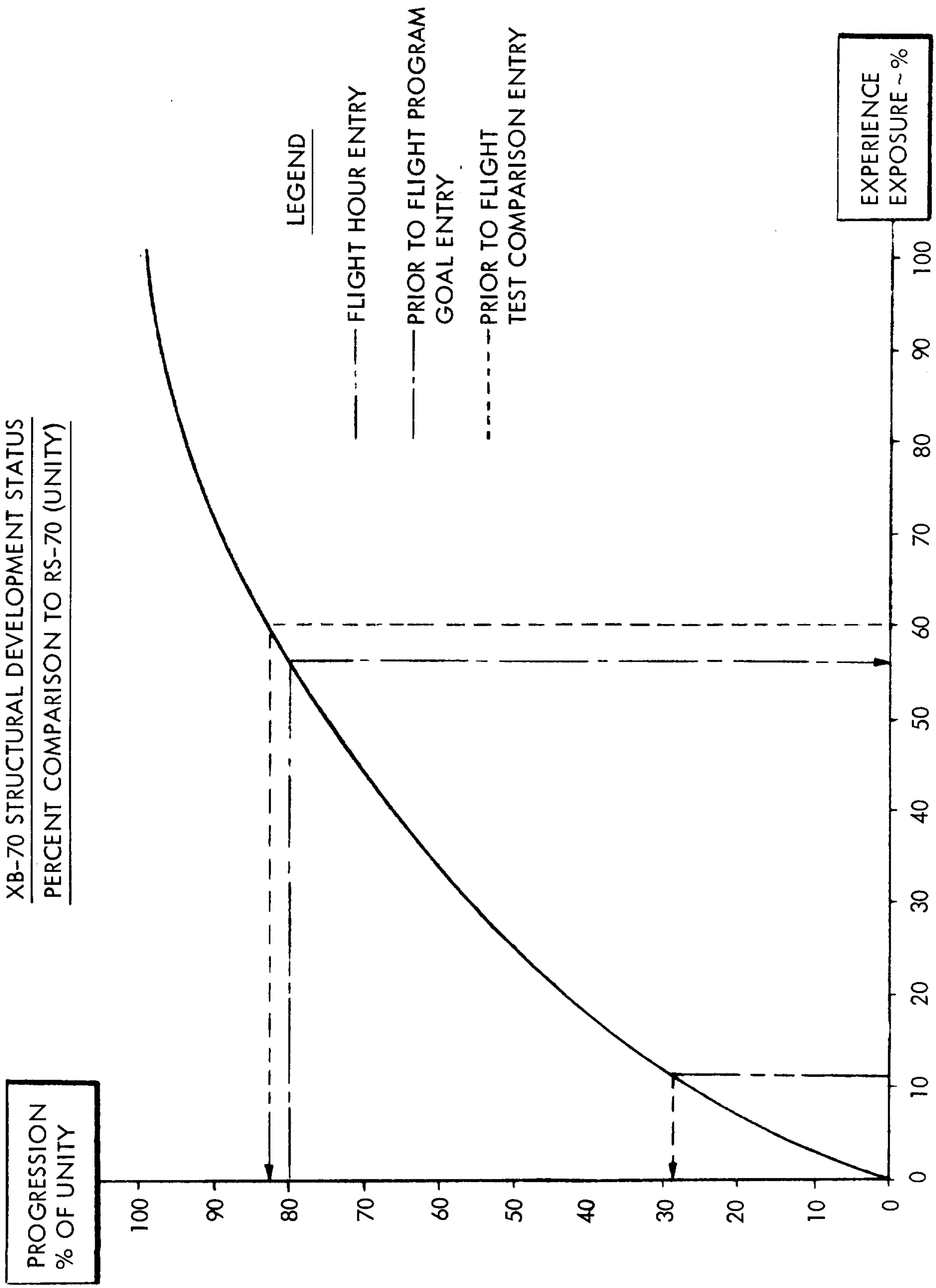
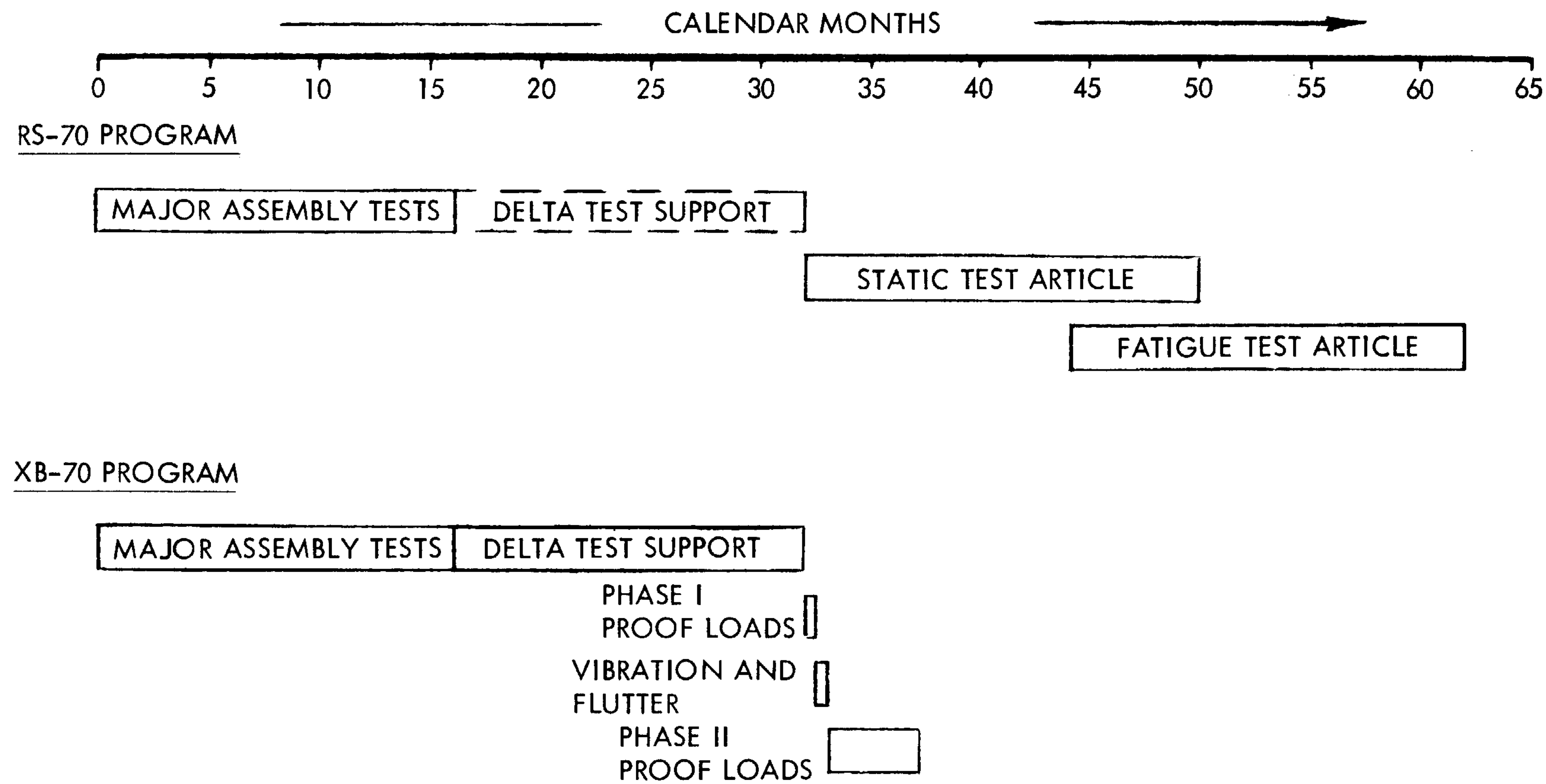

XB-70 STRUCTURAL DEVELOPMENT STATUS
PERCENT COMPARISON TO RS-70 (UNITY)
LEGEND
FLIGHT HOUR ENTRY
PRIOR TO FLIGHT PROGRAM GOAL ENTRY
PRIOR TO FLIGHT TEST COMPARISON ENTRY
PROGRESSION % OF UNITY
EXPERIENCE EXPOSURE ~ %
0
10
20
30
40
50
60
70
80
90
100

EXHIBIT 14

MAJOR STRUCTURAL TEST SUMMARY
PRIOR TO FLIGHT COMPARISON OF XB-70 AND RS-70



EXPERIENCES

RS-70 MAJOR STRUCTURAL TESTS = 62 MO'S
XB-70 MAJOR STRUCTURAL TESTS = 37 MO'S
XB-70 EXPERIENCE = 60% OF RS-70 LEVEL

EXHIBIT 15

FLIGHT TEST STRUCTURAL LOADS SUMMARY STRUCTURAL LOADS DATA OBTAINED DURING XB-70 PROGRAM

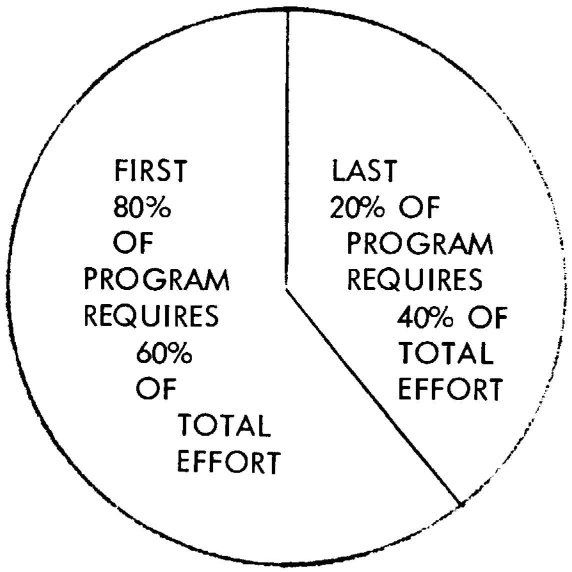
STRUCTURAL ITEM	MAX LOAD % OF XB-70 LIMIT*	EQUIVALENT % OF RS-70 LIMIT
WING TIP	40%	32%
WING ROOT	70%	56%
FORWARD AND INTERMEDIATE FUSELAGE		
SHELL	76%	61%
DUCT PRESSURE	85%	68%
AFT FUSELAGE		
SHELL	76%	61%
DUCT PRESSURE	85%	69%
HORIZONTAL STABILIZER	67%	54%
VERTICAL STABILIZERS	65%	52%
	AVERAGE	57%

*XB-70 LIMIT WAS ESTABLISHED AT 80% OF RS-70 LIMIT

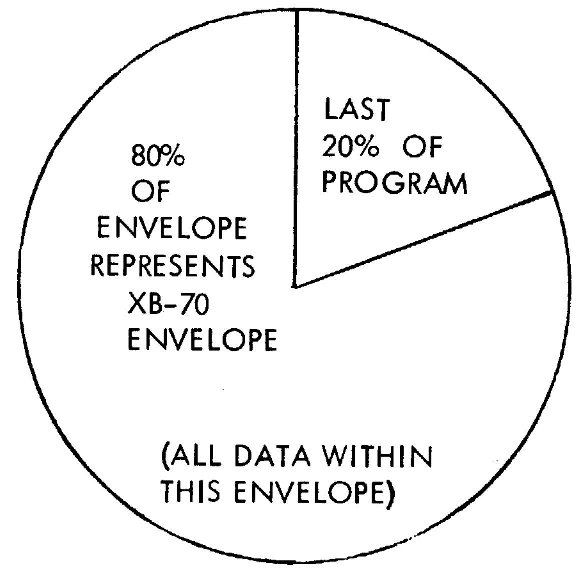
FLIGHT TEST STRUCTURAL LOADS SUMMARY

EQUIVALENT COMPLETION OF AN RS-70 PROGRAM

PROGRAM REQUIRED EFFORT RATIOS



RS-70 ENVELOPE



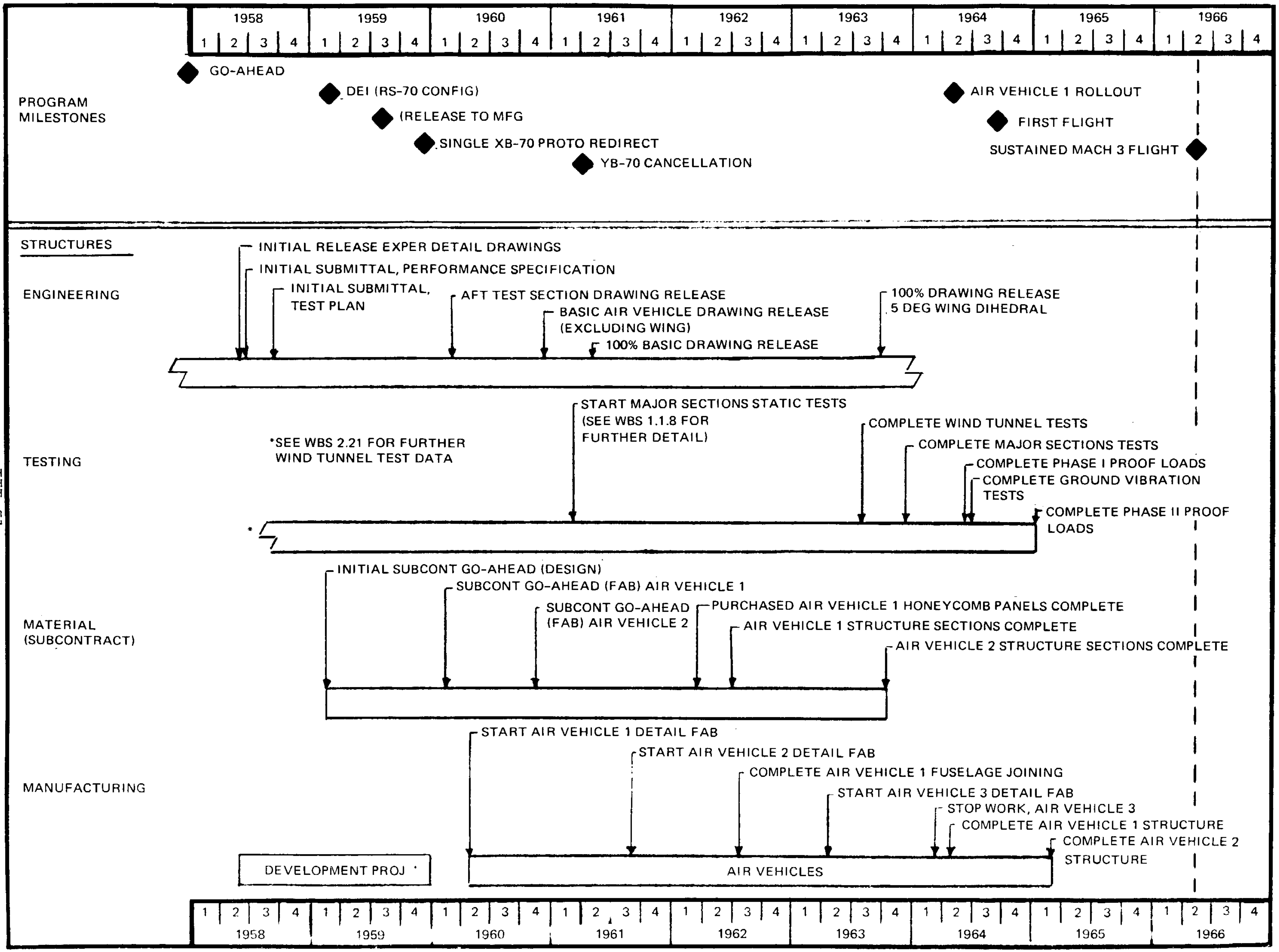
SUMMARY

1. BASED ON PROGRAM LEVEL OF 57 PERCENT: 57 PERCENT X 80 PERCENT (CONFIGURATION IMPACT) EQUALS 45.6 PERCENT ADJUSTED FOR ENVELOPE FLOWN (RATIO 2:3) EQUALS 34 PERCENT OF AN RS-70 PROGRAM.

2. BASED ON PROGRAM LEVEL REMAINING: 40 PERCENT EFFORT REMAINING FOR LAST 20 PERCENT OF ENVELOPE PLUS 60 PERCENT - (2 X 45.6 ÷ 3) FOR ENVELOPE EQUALS 70 PERCENT PROGRAM TO GO OR 30 PERCENT PROGRAM LEVEL ATTAINED.

AIRFRAME STRUCTURE
DEVELOPMENT SUMMARY

WBS 1.1

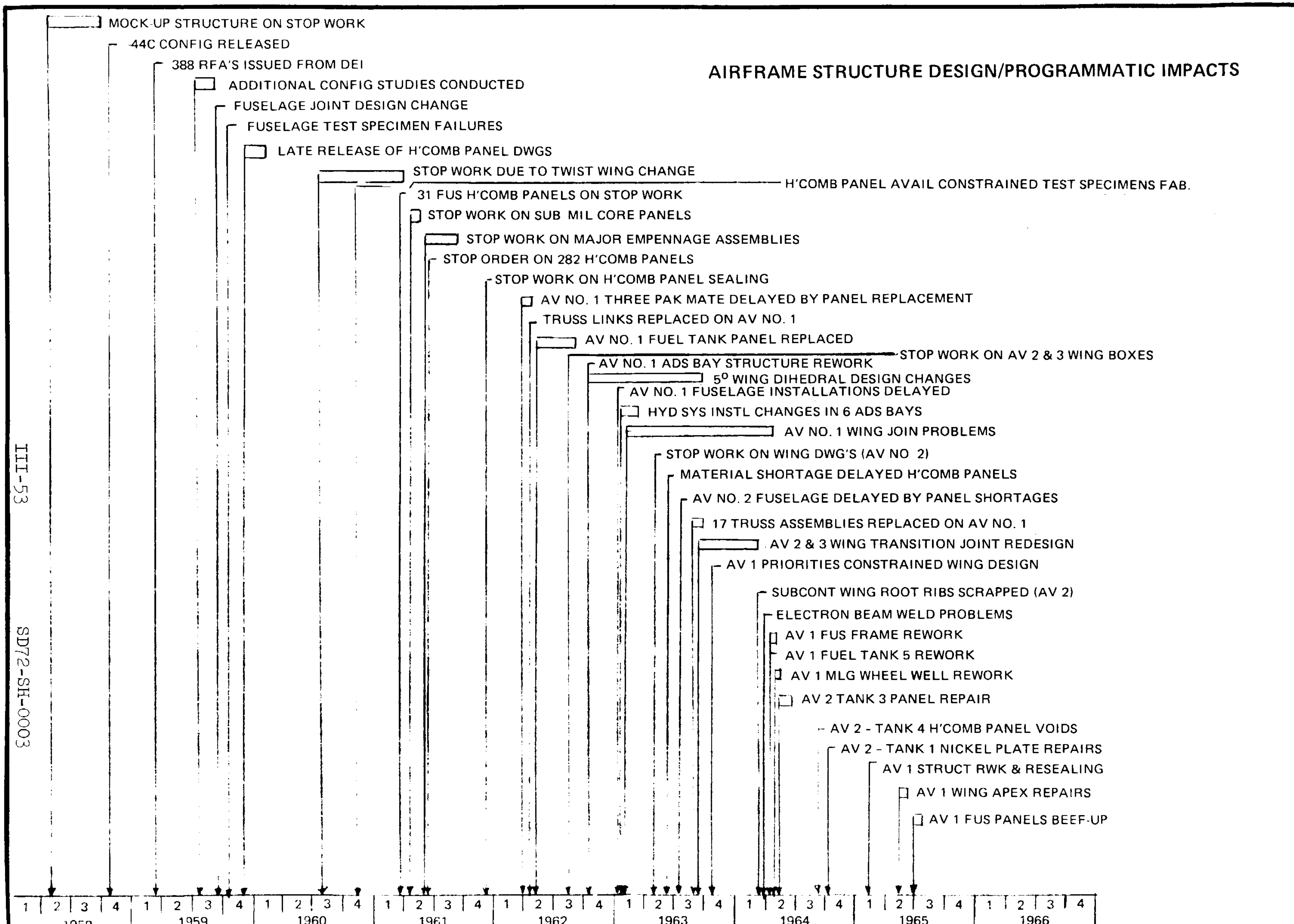


AIRFRAME STRUCTURE
DEVELOPMENT SUMMARY
TABULATION OF DATES

WBS 1.1

ENGINEERING	
INITIAL RELEASE - EXPER. DETAILS DWGS	5-28-58
INITIAL SUBMITTAL - PERFORMANCE SPEC	7-10-58
INITIAL SUBMITTAL - TEST PLAN	9-10-58
BASIC DRAWING REL - AFT TEST SECTION	3-4-60
BASIC AV DRAWING REL (EXCL WING)	12-2-60
100% BASIC AV DRAWING RELEASE	4-21-61
100% RELEASE - 5° WING DIHEDRAL CHANGE	9-27-63
TESTING	
START MAJOR SECTIONS STATIC TESTS	3-4-61
COMPLETE WIND TUNNEL TESTS	7-30-63
COMPLETE MAJOR SECTIONS STATIC TESTS	12-3-63
COMPLETE PHASE I PROOF LOADS	6-3-64
COMPLETE GROUND VIBRATION	6-28-64
COMPLETE PHASE II PROOF LOADS	1-15-65
MATERIAL (SUBCONTRACT)	
INITIAL SUBCONT G.A.-DES/TOOL ON FUS (LOCKHEED)	2-13-59
SUBCONT G.A.-MFG OF FUS SECTION (AV #1)	2-12-60
SUBCONT G.A.-MFG OF FUS SECTION (AV #2)	11-14-60
PURCHASED AV #1 H.COMB PANELS COMPLETE	3-10-62
AV #1 STRUCT SECTIONS COMPLETE	6-29-62
AV #2 STRUCT SECTIONS COMPLETE	10-15-63
MANUFACTURING	
START DEVELOPMENT PROJECTS	5-29-58
COMPLETE DEVELOPMENT PROJECTS	12-31-59
INITIAL TOOL ORDER RELEASE	7-2-59
START AV #1 DETAIL FAB	5-1-60
START AV #2 DETAIL FAB	8-25-61
COMPLETE AV #1 FUS JOINING	7-21-62
START AV #3 DETAIL FAB	4- -63
STOP WORK AV #3	3-6-64
COMPLETE AV #1 STRUCTURE	4-24-64
COMPLETE AV #2 STRUCTURE	2-21-65

AIRFRAME STRUCTURE DESIGN/PROGRAMMATIC IMPACTS



DESIGN/PROGRAMMATIC IMPACTS

SUBSYSTEM: AIRFRAME STRUCTURES WBS CODE: 1.1

5-2-58 to 10-10-58

All work was stopped on the full scale mockup due to major air vehicle design changes. Multiple configurations were being considered in conjunction with the Air Force, and it was resolved in mid-September that the -44 would be the air vehicle specification configuration. Alternate plans for static and fatigue testing based on revised funding levels were also developed during this period. These plans considered testing a complete air vehicle versus individual sections and testing at Palmdale versus Wright Air Development Center. On 10-3-58 it was resolved that a separate fatigue test vehicle would be required and tested by North American. On 10-10-58, fabrication of DEI mockup items was resumed where sufficient engineering information was available.

10-29-58

The "C" change to the -44 configuration was released to reflect a single bomb bay and a ramp type nose.

3-20-59

A total of 856 request for alternations resulted from the DEI. The DEI Board resolved that 388 RFA's were to be incorporated on the air vehicle and as many as possible on the mockups in support of the mockup inspection which started on March 30.

5-1-59 to 6-19-59

Subsequent to the March mockup inspection, further configuration studies were conducted. On 6-19-59, the WSPO verbally approved the -70 configuration which imposed the following major changes:

1. Forward fuselage shortened by approximately 30 inches.
2. Upper intermediate fuselage tank section refaired to hold approximately 16,000 additional pounds of fuel.
3. Engines moved forward.
4. Fuselage shortened by approximately 5 inches.

9-11-59

Tooling masters and template changes affecting the mating area between the tank section and forward lower fuselage were made due to a design change which increased the length of the tank section and decreased the length of the equipment section.

WBS CODE: 1.1

10-16-59

Failures were being experienced in developing satisfactory aft and aft intermediate fuselage test specimens due to incompatibility between design concept and existing manufacturing capabilities.

11-25-59 to 2-15-61

Normal timespread manufacturing plans were being decreased due to late Engineering release of honeycomb panel drawings.

8-4-60 to 3-31-61

Incorporation of the "twist wing" design concept was authorized. This change necessitated stop work of the leading edge test section fabrication at a subcontractor and affected a total of 973 drawings. The lower intermediate fuselage was also impacted.

11-15-60

Manufacturing of the aft intermediate and upper intermediate fuselage test specimens were constrained by the availability of approximately 109 brazed honeycomb panels.

3-24-61

Stop orders were issued on 31 panels in the forward upper intermediate fuselage for redesign. Revision consisted of adding a post braze welding operation for attachment of standing members. The panel rework involved brazing a pad onto the facing sheet for standing member attachment.

4-14-61 to 5-12-61

Manufacturing stopped work on all honeycomb panels requiring sub-mil core. This decision was due to the fact a 95% rejection rate was being experienced due to crushed core. Subsequently, Engineering changed the requirements on 122 on-site panels to $1\frac{1}{2}$ mil core.

5-26-61 to 9-7-61

Stress evaluations revealed load distribution problems in the flap, horizontal and vertical stabilizers requiring extensive redesign. Several honeycomb panels and all corrugated web members in these sections were affected. Stop orders were issued to subcontractors on major empennage assemblies.

6-9-61

Cost reduction stop orders were issued against the 282 honeycomb panels changed to conventional construction on AV #1.

12-7-61

Due to unsuccessful attempts in sealing honeycomb panels per existing processes a stop work was issued pending resolution of problems by a special investigation team.

3-30-62 to 4-29-62

A schedule delay in 3 pak mate and final joining of AV #1 intermediate sections was caused by scrappage of the RH 259-316903 panel (See Exhibit 18). This panel had experienced defects during fabrication and had been accepted with satisfactory, but marginal, strength. A misalignment and out-of-contour condition appeared upon joining with adjacent panels during next assembly. During rework to alleviate these conditions, evidence of water within the panel required baking to dry out the moisture areas. During this process the face sheet separated from the core in three small areas. The decision to scrap the panel was made after evaluation of the necessary repairs. A backup AV #2 panel was used to replace the scrapped panel. Subject Panel was redesigned to facilitate fabrication in support of subsequent units.

4-16-62

Due to a failure in the aft fuselage test section during duct pressure test at minimum load, a stop work was issued on 18 truss end fittings required for AV #1. This necessitated replacement of 4 links on AV #1.

5-11-62 to 8-24-62

A honeycomb panel replacement (AV #1) above the weapons bay in fuel tank # 3 was accomplished. This change was a resultant from a review of stress loads which revealed a negative margin.

9-17-62

A Stop Work wire was forwarded to the subcontractor supplying the forward wing boxes for AV's #2 and #3. This action was prompted by redesign of the wing root rib caps associated with the 5° wing dihedral change.

10-12-62

AV #1 electrical mockup and installations were being constrained by structure rework in the auxiliary drive system bay.

10-24-62 to 9-27-63

Approximately 750 design changes associated with incorporation of the 5° wing dihedral were released. Subject design entailed replacement of wing root rib caps in AV #2 and also affected 90 honeycomb panels in the wing transition area.

1-4-63

AV #1 lower aft intermediate fuselage installations were being constrained by the following structure conditions:

1. Panel 766, aft of Tank #4, was removed and replaced with a sheet metal frame.
2. 50% of panel 628 in the Tank #4 area was being replaced.
3. 17 contaminated honeycomb panels were pending production development laboratory disposition.

1-11-63 to 3-1-63

Mounting provisions for hydraulic installations in the 6 auxiliary drive system bays were changed on AV #1. 11 structure drawings were revised to accommodate hydraulic line changes. Subject changes were triggered by results from propulsion system tests.

1-14-63 to 4-24-64

Wing to Fuselage Joining (AV #1)

Originally, a series of tools were programmed that would have assured the close tolerances required to mate the wing to the wing stub. However, to conserve funds, most of the wing joining tools were eliminated earlier in the program, and only contour support tools were built. This necessitated matching the wing joint by optical methods, involving the fit of four contoured surfaces along an 80 foot distance to an accuracy of .008 inches or less. When this was initially attempted, it was found that the support surfaces along the length of the wing would move and that ambient temperature differentials would also move the two surfaces of the wing and wing stub apart. A special fitting was designed to attach to the wing stub to compensate for the inaccuracies in the joint alignment permitted by the simplified tooling. The first step of wing mate was to bring the wing up to the wing stub and complete final trim on the areas to be welded. Shear ties, 49 to each wing, were then located and welded to the wing and stub frames. Subsequent to this, a few cross ship installations were completed, after which actual joining weld commenced.

The wing joining completion was constrained by major section mismatch, multiple matching attempts, design and fabrication of special parts, fuel tank sealing, and reweld of discrepant areas.

5-3-63

AV #2 - Engineering Stop Work issued on 27 wing root rib drawings due to a critical under stress condition in the transition area associated with the 5^{o} dihedral change.

6-7-63

Honeycomb panels rework was delayed by a shortage of material, primarily face sheets. Further delay of placing AV #3 panels in work was attributable to a requirement of sizing out-of-tolerance face sheet material used as substitution material.

7-12-63

Key honeycomb panel shortages were delaying buildup of the AV #2 forward lower intermediate fuselage.

8-23-63 to 9-24-63

17 truss assemblies were replaced in the AV #1 aft intermediate fuselage. Structure and sealing rework in this area had caused misfit of truss covers and truss assemblies spanning the boundry layer control duct. Approximately 400 machined parts were required.

9-16-63 to 3-6-64

AV #2 and #3 upper wing honeycomb panels, shear webs, upper and lower shear web attach fittings were redesigned. This redesign affected 84 drawings and accommodated resequencing of manufacturing operations in the wing to wing stub joining.

10-21-63

5^o wing dihedral design effort was constrained by diversion of engineering personnel to priority assignments supporting AV #1.

2-28-64

Replacement wing root ribs being fabricated at a subcontractor for the 5^o dihedral change on AV #2 were scrapped due to inadequate resistance welds between the close-out face sheets and corrugated webs.

3-23-64

Continued experiencing blown holes during electron beam welding while joining AV #1 RH wing to wing stub.

4-3-64 to 4-17-64

Structural repairs to the AV #1 fuselage station 1720 frame were completed. Subject frame was damaged during the fold and rotate operations on the RH main landing gear.

4-10-64

Experienced mismatch in tank #5 on AV #2 between the station frames and outboard structure. Required complete tee replacement.

WBS CODE: 1.1

4-26-64 to 5-1-64

Beef-up straps were installed in AV #1 main landing wheel well area to satisfy a stress change.

5-7-64 to 6-26-64

During nickel plating operations in AV #2, a container of acid was spilled within sump tank #3. The spillage contaminated the core of the duct roof and duct wall panels necessitating replacement of approximately 16 sq. ft. of paneling.

9-11-64

During vacuum check operations in Tank #4 on AV #2, voids were discovered in honeycomb panels. This necessitated the installation of doublers, pins and nickel plating which in turn delayed the completion of tank pressure testing.

10-2-64

Nickel plate repairs on the 313020 bulkhead in tank 1 of AV #2 necessitated 13 setups with special plating boxes for accessibility. This effort delayed the start of pressure check operations.

2-16-65

Structural rework and sealing required due to fuel leakage during 4th flight on AV #1.

5-15-65 to 5-29-65

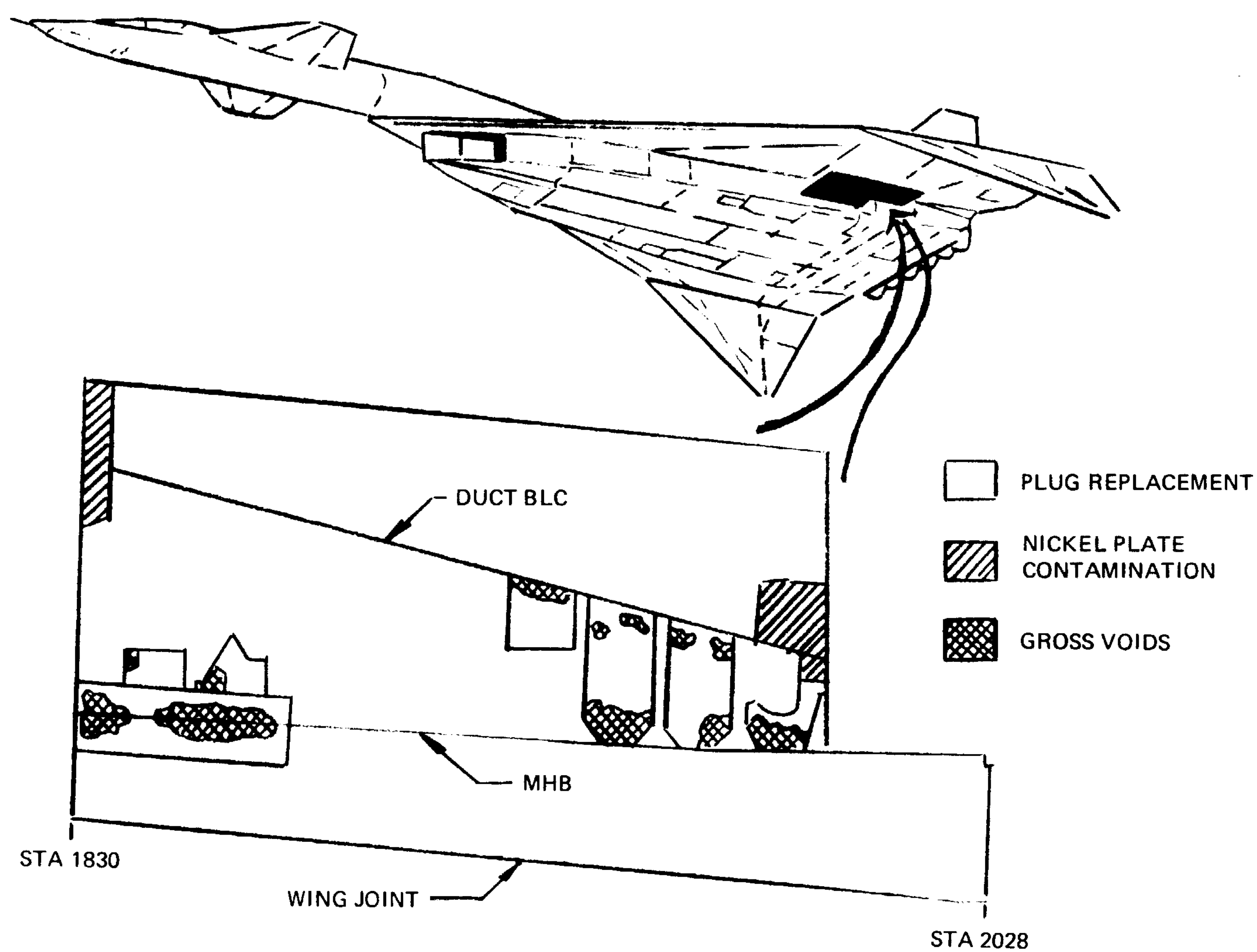
Experienced wing apex skin failure during the 12th flight on AV #1. Structural repairs made to apex and right hand inlet.

7-1-65 to 7-20-65

Experienced loss of some wing and fuselage outer facesheets during 14th flight on AV #1. Resulted in beef up of suspected weak panels and associated welding. See exhibits 19 and 20.

903 HONEYCOMB PANEL (LEFT-HAND)

WBS 1.1

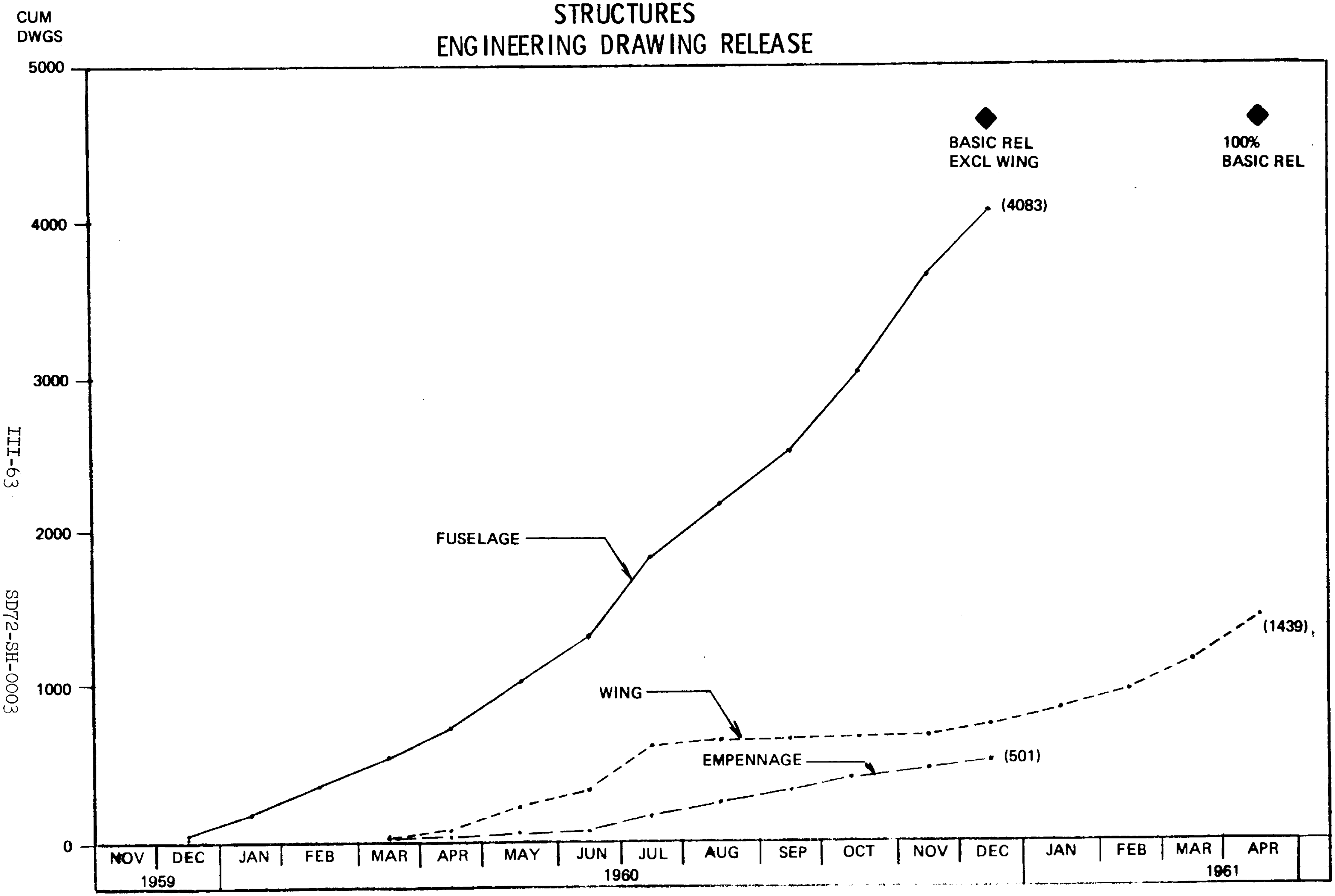


AIR VEHICLE NO 1 WING PANEL REPAIR

AIR VEHICLE NO 1 FUSELAGE PANEL REPAIR

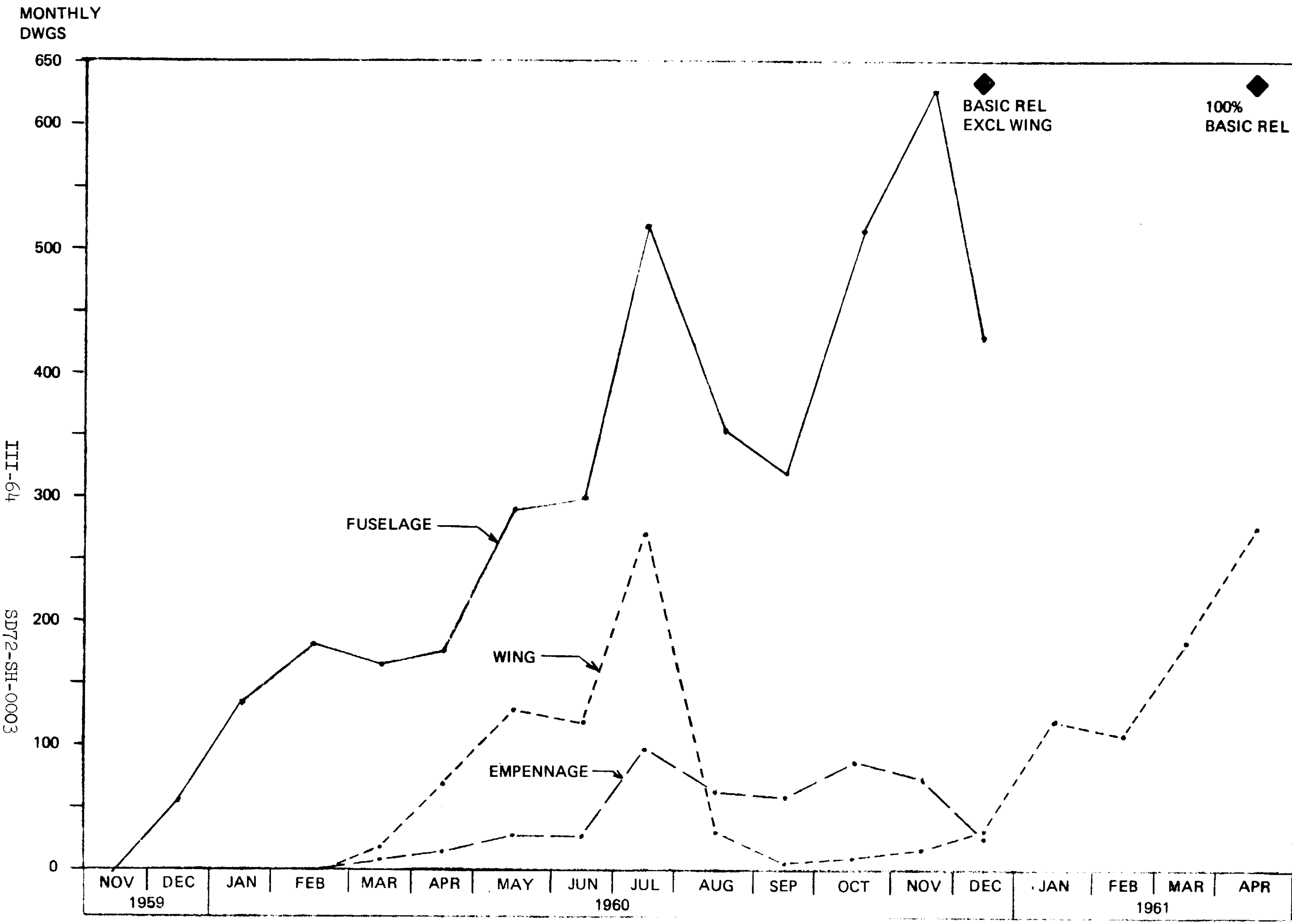
EXHIBIT 20

STRUCTURES
ENGINEERING DRAWING RELEASE



STRUCTURES
ENGINEERING DRAWING RELEASE

WBS 1.1



COST DEFINITION

SUBSYSTEM: AIRFRAME STRUCTURES WBS CODE: 1.1

The cost data displayed at this level of the Work Breakdown Structure is an accumulation of all level 6 (Major Assembly) items and the recorded costs not identifiable to the Major Assemblies. The schedule below provides a summation of the individual level 6 items and the costs displayed at the subsystem (Airframe Structures) level only.

1.1	Airframe Structure	$ 52,745,247	Page	III-120
1.1.1	Horizontal Stabilizer and Flaps	11,295,558	Page	III-147
1.1.2	Wing Structure	63,935,695	Page	III-173
1.1.3	Vertical Stabilizer	13,113,594	Page	III-199
1.1.4	Forward Fuselage	13,470,124	Page	III-214
1.1.5	Intermediate Fuselage	120,085,833	Page	III-242
1.1.6	Aft Fuselage	21,357,837	Page	III-266
1.1.7	Honeycomb Panels	51,702,179	Page	III-286
1.1.8	Ground Tests	58,330,017	Page	III-303
	Total	$406,036,084	Page	III-70

Data displayed at WBS level 6 (1.1.1 through 1.1.8) contains costs identifiable to the design, development, ground testing, fabrication and assembly of all components, assemblies and developmental test hardware within the Airframe Structures Subsystem as defined by the WBS. Excluded from the WBS level 6 data are:

a) development of subsystem specification requirements

b) subsystem installation and integration design

c) vendor-coordination

d) other subsystem level data not identified to the Major Assemblies

Items (a) through (d) above are displayed at WBS level 5 (Airframe Structure) because they cannot be assigned to a level 6 item. Additional data on the level 6 items is contained in this section of the report under the appropriate Major Assembly.

Excluded from the total cost of the Airframe Structure subsystem ($406,036,084) are the following items:

a) fabrication of subsystem provisions (brackets, wire harnesses, shelves, supports, etc., (WBS 1.1.2))

b) subsystem equipment as defined by the WBS under items 1.2 through 1.11

c) installation of subsystems and equipment (WBS 1.12)

WBS CODE: 1.1

d) vehicle checkout and preflight operations (WBS 1.12)

e) in-house tooling (WBS 8.0), GSE (WBS 5.0) and Special Test Equipment (WBS 7.0).

f) joining of the major airframe sections (WBS 3.0)

Production costs contained in this subsystem reflect manufacturing effort to produce two complete air vehicle structures and a portion of a third vehicle. The third XB-70 was cancelled in March 1964. At the time of cancellation in-house fabrication and subassembly effort was 38% complete. This "physical" percent complete breaks down in the following manner:

	Percent Complete	Weighting	Air Vehicle No. 3 Percent Complete
Sheet Metal	67.5	6.2	4.2
Experimental Fabrication	19.3	1.6	.3
Machine Parts	55.7	26.3	14.6
Extrustions	57.2	3.5	2.0
Weldments	32.3	6.4	2.1
Honeycomb Panels	69.3	18.8	13.0
Miscellaneous	50.0	2.1	1.1
Support by Equipment	9.0	Nominal	-
Palmdale Assembly	1.8	33.7	.6
Instrumentation	10.0	1.4	1.4
		100.0%	38.0%

These figures exclude the subcontracted portions of the structures. Subcontract summaries for each major assembly should be consulted for a discussion of their percent complete. Technical description of the three air vehicles and a percent complete analysis on Air Vehicle No. 3 are presented in Volume I, page I-305.

All cost data is displayed by Subdivision of Work (SDW) and Elements of Cost (EOC). Section III , Volume I, provides a detailed explanation of these items.

A summary of the subcontractor cost data is presented on page III-68. Detail of the items furnished, contractual arrangements, delivery dates and other pertinent subcontractor data can be found within the level 6 cost sections. Subcontractor cost includes engineering, manufacturing, tooling and testing effort performed at the supplier's facility. Refer to the Subcontractor EOC, Volume I, page I-26, for a detail explanation of the supplier cost.

As an aid in defining the Engineerings costs included in this subsystem, a matrix of the engineeing hours expended by group has been developed. This matrix is displayed as Exhibit 21, page III-69. It provides a summary of all engineering groups that supported the structures effort. The hours cannot be segregated between design, development and testing.

Also provided for purposes of evaluation, explanation and definition of the Ground Test item (WBS 1.1.8) is a listing of the major in-house test activities performed on the structural test assemblies. This summary is located on page III-300.

SUBCONTRACTOR MATRIX

WBS CODE			
1.1.1	Horizontal Stabilizer and Flaps		$ 10,140,880
	Chance Vought	$ 10,140,880	
1.1.2	Wing Assembly		41,204,612
	Boeing	19,722,370	
	Aeronca	10,373,089	
	Convair	2,586,242	
	Rohr	7,897,419	
	LTV	332,974	
	Automation	292,518	
1.1.3	Vertical Stabilizer		10,522,071
	Chance Vought	10,522,071	
1.1.5	Intermediate Fuselage		12,595,839
	Lockheed	9,491,111	
	Avco	3,104,728	
1.1.7	Honeycomb Panels		29,036,045
	LTV	14,681,555	
	Northrup	5,142,497	
	Rohr	4,048,427	
	Aeronca	2,180,972	
	Gen. Dynamics	1,129,595	
	Avco	631,172	
	Miscellaneous	1,221,827	
	Total Structures Subcontracting		$ 103,499,447

Engineering Group Matrix (Hours)

No.	Title	WBS 1.1 & 1.1.8	Horiz.Stab. 1.1.1	Wing 1.1.2	Vert.Stab. 1.1.3	Fwd.Fuse.. 1.1.4	Inter.Fuse. 1.1.5	Aft Fuse. 1.1.6	Total
3	Electronic & Avionics Installation	5,556							5,556
4	Fluid Power System	142,209							142,209
5	Empennage				137,424				137,424
10	Structural Analysis	1,019,126							1,019,126
11	Weight Control	32,796							32,796
12	Checking	146,505							146,505
13	Aerodynamics	124,770							124,770
14	Wind Tunnel Models	125,534							125,534
19	Propulsion System Development	2,963							2,963
30	Numerical Design	215,538							215,538
33	Advanced Structures	256,050							256,050
34	Structural Projects	242,904							242,904
35	Fuselage		56,251			318,743	937,482	562,491	1,874,967
36	Wing and Empennage			447,961	49,504				497,465
40	Wing and Empennage			427,717	47,500				475,217
47	Human Factors & Cockpit Display	36,687							36,687
50	Metallurgy	22,872							22,872
53	Design Producibility	241,403							241,403
54	Material & Processes	409,495							409,495
55	Flight Control Analysis	3,608							3,608
57	Engineering Specifications	23,228							23,228
64	Design Support	2,035							2,035
66	Metallic Materials Lab	336,180							336,180
67	Structural Test Lab	387,804							387,804
73	Structural Loads	306,050							306,050
74	Flight Test Instrumentation	7,461							7,461
75	Non-Metallics	131,066							131,066
94	Flight Similation	71,659							71,659
95	Electrical System Design	20,998							20,998
96	Wind Tunnel Projects	138,560							138,560
97	Laboratory Services	126,386							126,386
99	Auxiliary Control System	33,567							33,567
109	Hydraulics Lab	40,465							40,465
110	Electrical Power Lab	5,532							5,532
125	Electrical System Equipment	8,068							8,068
131	Aerodynamics Special Project	70,307							70,307
132	Thermodynamics	32,130							32,130
133	Aerodynamics	197,753							197,753
134	Wind Tunnel Projects	75,897							75,897
Miscellaneous		191,160	2,800	6,441			1,232		201,633
	Total Engineering Hours	5,234,322	59,051	882,119	234,428	318,743	938,714	562,491	8,229,868

EXHIBIT 21

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 01
AIRFRAME STRUCTURES SUBSYSTEM

	6-M ASSY 0 HOURS DOLLARS	6-M ASSY 01 HOURS DOLLARS	6-M ASSY 02 HOURS DOLLARS	6-M ASSY 03 HOURS DOLLARS
DESIGN/ENGINEERING	4207914	59051	338856	234428
LABOR AT $ 4.910	21253059	298310	4409211	1135615
ENGR BURDEN AT $ 4.426	18848487	266160	3775893	840136
PRODUCTION		2181	1083365	
LABOR AT $ 3.220		6980	3489030	
SHOP SUPPORT	40369			
LABOR AT $ 3.206	126077			
PLANNING			63343	
LABOR AT $ 3.409			214508	
TEST/QC	5248		133658	
LABOR AT $ 3.522	18122		434737	
MFG BURDEN AT $ 3.907	184230	9001	5180191	
ENGR MATERIAL	65569			
MFG MATERIAL			2528839	
SUBCONTRACT		10140880	41204612	10522071
MPC	7334	397552	1763994	408812
WIND TUNNEL				
OTHER COST	11519745			
SUB-TOTAL	52022623	11118883	63051015	12906634
GEN & ADMIN	722624	176675	884680	206960
IOWA				
TOTAL COST	52745247	11295558	63935695	13113594

SUBDIVISION OF WORK COST DETAIL - SEE PAGE	III-120	III-147	III-173	III-199

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
AIRFRAME STRUCTURES SUBSYSTEM

	6-M ASSY 04 HOURS DOLLARS	6-M ASSY 05 HOURS DOLLARS	6-M ASSY 06 HOURS DOLLARS	6-M ASSY 07 HOURS DOLLARS
DESIGN/ENGINEERING	323605	991846	570473	
LABOR AT $ 4.910	1648193	5018432	2907061	
ENGR BURDEN AT $ 4.426	1477580	4578958	2604034	
PRODUCTION	870571	8580889	1367703	
LABOR AT $ 3.220	2799055	27640517	4402149	
SHOP SUPPORT				
LABOR AT $ 3.006				
PLANNING	48900	496164	77676	
LABOR AT $ 3.409	164371	1681324	262326	
TEST/QC	102340	1071121	164636	
LABOR AT $ 3.523	368950	3887314	595862	
MFG BURDEN AT $ 3.907	4169653	41038988	6536347	
ENGR MATERIAL				
MFG MATERIAL	2361356	19028206	3309090	
SUBCONTRACT		12595839		29036045
MPC	239578	2515643	343242	1279298
WIND TUNNEL				
OTHER COST		13826		
SUB-TOTAL	13223736	117999247	20960611	30315343
GEN & ADMIN	241388	2086586	397226	912634
IOWA				20474202
TOTAL COST	13470124	120085833	21357837	51702179

SUBDIVISION OF WORK COST DETAIL - SEE PAGE	III-214	III-242	III-266	III-286

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
AIRFRAME STRUCTURES SUBSYSTEM

	6-M ASSY 05 HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	1026408	8302581
LABOR AT $ 4.910	4079436	40769287
ENGR BURDEN AT $ 4.426	4355479	36746727
PRODUCTION		11904709
LABOR AT $ 3.220		38337731
SHOP SUPPORT	4345663	4386037
LABOR AT $ 3.006	13057633	13133710
PLANNING	35449	716532
LABOR AT $ 3.409	120201	2442730
TEST/QC	473762	1950755
LABOR AT $ 3.522	1516782	6871767
MFG BURDEN AT $ 3.907	16954493	74073403
ENGR MATERIAL	11628100	11693669
MFG MATERIAL		27227491
SUBCONTRACT		103499447
MPC	1249394	8205547
WIND TUNNEL	2760920	2760920
OTHER COST	762412	12295983
	--------	--------
SUB-TOTAL	56505320	378108412
GEN & ADMIN	966324	6595097
IOWA	858373	21332575
	--------	--------
TOTAL COST	58330017	406036084

SUBDIVISION OF WORK
COST DETAIL - SEE PAGE III-303 III-73

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
AIRFRAME STRUCTURES SUBSYSTEM

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOOLING AND STE HOURS DOLLARS	TEST /QC HOURS DOLLARS
DESIGN/ENGINEERING	7203460	72713		1026408
LABOR AT $ 4.910	35360368	309513		4099406
ENGR BURDEN AT $ 4.426	31963434	427814		4355479
PRODUCTION		11904709		
LABOR AT $ 3.220		38337731		
SHOP SUPPORT	40369			4345668
LABOR AT $ 3.006	126077			13057633
PLANNING		686083		30449
LABOR AT $ 3.409		2322529		120201
TEST/QC	5248	1471755		473762
LABOR AT $ 3.525	18122	5336863		1516782
MFG BURDEN AT $ 3.907	184230	56934680		16954493
ENGR MATERIAL	65569			11628100
MFG MATERIAL		27227491		
SUBCONTRACT	24811212	54120504	24510375	57356
MPC	961320	5090011	902644	1251572
WIND TUNNEL				2760920
OTHER COST	10876309	657262		762412
SUB-TOTAL	105366641	190764398	25413019	56564354
GEN & ADMIN	1422748	3711696	447933	1012720
IOWA		13019255		3313320
TOTAL COST	106789389	212495349	25860952	60890394

TIME-PHASED COST DETAIL - SEE PAGE III-75 III-84 III-91 III-92

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
AIRFRAME STRUCTURES SUBSYSTEM

			TOTAL HOURS DOLLARS
DESIGN/ENGINEERING			8302581
LABOR AT $ 4.910			40769287
ENGR BURDEN	AT $	4.426	36746727
PRODUCTION			11904709
LABOR AT $ 3.220			38337731
SHOP SUPPORT			4386037
LABOR AT $ 3.006			13183710
PLANNING			716532
LABOR AT $ 3.409			2442730
TEST/QC			1950765
LABOR AT $ 3.523			6871767
MFG BURDEN	AT $	3.507	74073403
ENGR MATERIAL			11693659
MFG MATERIAL			27227491
SUBCONTRACT			103499447
MPC			8265547
WIND TUNNEL			2760920
OTHER COST			12295083

SUB-TOTAL			373108412
GEN & ADMIN			6595097
IOWA			21332575

TOTAL COST			406036084

TIME-PHASE COST
DETAIL - SEE PAGE III-105

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1 **AIRFRAME STRUCTURES SUBSYSTEM**
5-SUBSYSTEM 01
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	305.5	51256	4.670	239389	233208	472597
Q-2 58						
Q-3 58	1541.5	259018	4.628	1198738	1014387	2213125
Q-4 58						
Q-1 59	2083.5	355649	4.518	1606992	1222797	2829789
Q-2 59						
Q-3 59	3476.5	611862	4.346	2659009	2191949	4850958
Q-4 59						
Q-1 60	4372.0	757830	4.603	3487933	2898876	6386809
Q-2 60						
Q-3 60	4679.5	786126	4.655	3659541	2927851	6587392
Q-4 60						
Q-1 61	5915.0	1009491	4.827	4872753	3474171	8346924
Q-2 61						
Q-3 61	4027.0	730239	4.843	3536457	3324529	6860986
Q-4 61						
Q-1 62	3198.0	545860	5.329	2908741	2518180	5426921
Q-2 62						
Q-3 62	2831.5	475617	5.416	2575724	2446802	5022526
Q-4 62						
Q-1 63	2161.5	368961	6.725	2481132	2308720	4789852
Q-2 63						
Q-3 63	2662.0	447234	5.120	2289837	2270510	4560347
Q-4 63						
Q-1 64	2315.0	395098	5.922	2339752	2485783	4825535
Q-2 64						
Q-3 64	1753.5	308684	5.895	1819687	1982164	3801851
Q-4 64						
Q-1 65	404.5	70055	6.811	477136	462522	939658
Q-2 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1 **AIRFRAME STRUCTURES SUBSYSTEM**
5-SUBSYSTEM 01
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	168.0	28239	6.811	192330	186250	378580
Q-4 65						
Q-1 66	13.5	2241	6.790	15217	14735	29952
TOTAL	41908.0	7203460		36360368	31963434	68323802

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SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 01 **AIRFRAME STRUCTURES SUBSYSTEM**
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	27.0	4420	3.097	13687	11579	25266
Q-2 58						
Q-3 58	25.5	4251	3.112	13230	13192	26422
Q-4 58						
Q-1 59	-3.0	-456	2.022	-922	-195	-1117
Q-2 59						
Q-3 59	127.5	22555	2.947	66473	90502	156975
Q-4 59						
Q-1 60	-31.0	-14115	2.957	-41733	-30969	-72702
Q-2 60						
Q-3 60	19.5	3266	2.844	9289	14522	23811
Q-4 60						
Q-1 61	18.5	3197	2.985	9543	12112	21655
Q-2 61						
Q-3 61	6.0	1077	2.845	3064	5416	8480
Q-4 61						
Q-1 62	7.5	1237	2.711	3354	6026	9380
Q-2 62						
Q-3 62	3.0	579	3.280	1899	2018	3917
Q-4 62						
Q-1 63	7.5	1232	3.216	3962	5168	9130
Q-2 63						
Q-3 63	37.5	6262	3.355	21006	24998	46004
Q-4 63						
Q-1 64	31.5	5269	3.423	18036	22367	40403
Q-2 64						
Q-3 64	6.0	1084	3.221	3492	5104	8596
Q-4 64						
Q-1 65	3.0	511	3.321	1697	2415	4112
Q-2 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 01 **AIRFRAME STRUCTURES SUBSYSTEM**
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65					-25	-25
TOTAL	236.0	40369		126077	184230	310307

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B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1 **AIRFRAME STRUCTURES SUBSYSTEM**
5-SUBSYSTEM 01
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		85	3.035	258		258
Q-2 58						
Q-3 58		22	2.500	55		55
Q-4 58						
Q-1 59		-27	2.185	-59		-59
Q-2 59						
Q-3 59	9.0	1541	3.086	4756		4756
Q-4 59						
Q-1 60	9.0	1649	3.502	5775		5775
Q-2 60						
Q-3 60	6.0	1058	3.518	3722		3722
Q-4 60						
Q-1 61	1.5	314	3.484	1094		1094
Q-2 61						
Q-3 61		125	3.936	492		492
Q-4 61						
Q-1 62	1.5	199	4.372	870		870
Q-2 62						
Q-3 62		53	3.358	178		178
Q-4 62						
Q-1 63		40	3.400	136		136
Q-2 63						
Q-3 63		73	4.178	305		305
Q-4 63						
Q-1 64		102	4.451	454		454
Q-2 64						
Q-3 64		14	6.143	86		86
TOTAL	27.0	5248		18122		18122

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B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
SUBD OF WORK DESIGN/ENGINEERING

AIRFRAME STRUCTURES SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	332.5	55761	4.543	253334	244787	498121	1271
Q-2 58							
Q-3 58	1567.0	263291	4.603	1212023	1027579	2239602	6253
Q-4 58							
Q-1 59	2030.5	355166	4.522	1606011	1222602	2828613	7530
Q-2 59							
Q-3 59	3613.0	635958	4.293	2730238	2282451	5012689	8964
Q-4 59							
Q-1 60	4300.0	745364	4.631	3451975	2867907	6319882	3397
Q-2 60							
Q-3 60	4705.0	790450	4.646	3672552	2942373	6614925	366
Q-4 60							
Q-1 61	5935.0	1013002	4.821	4883390	3486283	8369673	1538
Q-2 61							
Q-3 61	4033.0	731441	4.840	3540013	3329945	6869958	23716
Q-4 61							
Q-1 62	3207.0	547296	5.322	2912965	2524206	5437171	-336
Q-2 62							
Q-3 62	2834.5	476249	5.413	2577801	2448820	5026621	2115
Q-4 62							
Q-1 63	2169.0	370233	6.713	2485230	2313888	4799118	629
Q-2 63							
Q-3 63	2699.5	453569	5.095	2311148	2295508	4606656	164
Q-4 63							
Q-1 64	2346.5	400469	5.889	2358242	2008150	4366392	581
Q-2 64							
Q-3 64	1759.5	309782	5.886	1823265	1987268	3810533	-324
Q-4 64							
Q-1 65	407.5	70566	6.786	478833	464937	943770	8735
Q-2 65							
Q-3 65	168.0	28239	6.811	192330	186225	378555	
Q-4 65							

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B-70 AIRCRAFT STUDY

4-SYSTEM 1 **AIRFRAME STRUCTURES SUBSYSTEM**
5-SUBSYSTEM 01
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
0-1 66	13.5	2241	6.790	15217	14735	29952	
TOTAL	42171.0	7249077		36504567	32147664	68652231	65569

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4-SYSTEM 1 **AIRFRAME STRUCTURES SUBSYSTEM**
5-SUBSYSTEM 01
SUBD OF WORK DESIGN/ENGINEERING

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58		1271	69		499461		499461
Q-2 58							
Q-3 58		6253	342		2246197		2246197
Q-4 58							
Q-1 59	2064711	2072241	55347	107255	5063456		5063456
Q-2 59							
Q-3 59	11876308	11885272	325522	445220	17668703		17668703
Q-4 59							
Q-1 60	5316651	5320548	315946	795288	12751664	170271	12921935
Q-2 60							
Q-3 60	2868241	2869107	170292	1267426	10921750	208092	11129842
Q-4 60							
Q-1 61	227495	229033	6648	1674202	10279556	191026	10470582
Q-2 61							
Q-3 61	1811171	1834887	53892	1066812	9825549	182587	10008136
Q-4 61							
Q-1 62	323119	322783	10242	1475956	7246152	121627	7367779
Q-2 62							
Q-3 62	111259	113374	3699	1363895	6507589	109229	6616818
Q-4 62							
Q-1 63	102569	103198	4416	967578	5874310	98219	5972529
Q-2 63							
Q-3 63	65335	65499	2114	-276913	4397356	73524	4470880
Q-4 63							
Q-1 64	22373	22954	3134	678026	5570506	118527	5689033
Q-2 64							
Q-3 64	12390	12066	3924	672337	4498860	95726	4594586
Q-4 64							
Q-1 65	9590	18295	5733	447459	1415257	37758	1453015
Q-2 65							
Q-3 65				178983	557538	14875	572413
Q-4 65							

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
SUBD OF WORK DESIGN/ENGINEERING

AIRFRAME STRUCTURES SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 66				12785	42737	1287	44024
TOTAL	24811212	24876781	961320	10876309	105366541	1422748	106789389

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 01 **AIRFRAME STRUCTURES SUBSYSTEM**
SUBD OF WORK PRODUCTION

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	81.0	13518	5.414	73189	9721	82910
Q-4 58						
Q-1 59	96.0	16494	5.466	90152	14078	104230
Q-2 59						
Q-3 59	160.5	28132	5.361	150820	25868	176688
Q-4 59						
Q-1 60	61.5	10783	5.589	60271	12761	73032
Q-2 60						
Q-3 60	1.5	234	4.060	950	-759	191
Q-4 60						
Q-1 61	3.0	608	4.942	3005	3088	6093
Q-2 61						
Q-3 61	3.0	523	2.927	1531	714	2245
Q-4 61						
Q-1 62	3.0	613	2.729	1673	5015	6688
Q-2 62						
Q-3 62	22.5	3744	3.557	13316	23001	36317
Q-4 62						
Q-1 63	10.5	1877	3.490	6550	11754	18304
Q-2 63						
Q-3 63	-413.0	-69421	5.371	-372829	-69482	-442311
Q-4 63						
Q-1 64	39.0	6730	4.575	30789	40169	70958
Q-2 64						
Q-3 64	145.5	25637	4.452	114146	161160	275306
Q-4 64						
Q-1 65	78.0	13598	4.432	60263	84556	144819
Q-2 65						
Q-3 65	117.0	19643	3.853	75687	106170	181857
TOTAL	409.0	72713		309513	427814	737327

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B-70 AIRCRAFT STUDY

PRODUCTION
4-SYSTEM 1
5-SUBSYSTEM 01 **AIRFRAME STRUCTURES SUBSYSTEM**
SUBD OF WORK PRODUCTION

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 60	42.0	7236	4.619	33421	15282	48703
Q-2 60						
Q-3 60	73.5	12243	2.525	30908	23864	54772
Q-4 60						
Q-1 61	3259.5	556179	3.143	1747953	2094249	3842202
Q-2 61						
Q-3 61	9259.5	1679113	3.152	5292403	6735198	12027601
Q-4 61						
Q-1 62	12004.5	2048847	3.067	6284460	8492635	14777095
Q-2 62						
Q-3 62	8566.5	1439052	3.225	4641400	6657120	11298520
Q-4 62						
Q-1 63	8835.0	1507941	3.299	4974373	6839887	11814260
Q-2 63						
Q-3 63	9736.5	1635704	2.796	4573150	7397924	11971054
Q-4 63						
Q-1 64	11595.0	1978760	3.568	7061038	11715896	18776934
Q-2 64						
Q-3 64	3529.5	621267	3.373	2095374	3581095	5676469
Q-4 64						
Q-1 65	2320.5	402139	3.581	1439919	2192663	3632582
Q-2 65						
Q-3 65	96.0	16228	10.066	163352	210387	373739
TOTAL	69318.0	11904709		38337731	55956200	94293931

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B-70 AIRCRAFT STUDY

PLANNING
4-SYSTEM 1
5-SUBSYSTEM 01 **AIRFRAME STRUCTURES SUBSYSTEM**
SUBD OF WORK PRODUCTION

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	12.0	1905	2.998	5711		5711
Q-4 58						
Q-1 59	55.5	9569	2.960	28324		28324
Q-2 59						
Q-3 59	133.5	23401	2.989	69940		69940
Q-4 59						
Q-1 60	270.0	46837	3.160	147990	483	148473
Q-2 60						
Q-3 60	384.0	64486	3.043	196221		196221
Q-4 60						
Q-1 61	678.0	115604	3.017	348772	57787	406559
Q-2 61						
Q-3 61	612.0	111092	2.908	323000	57015	380015
Q-4 61						
Q-1 62	571.5	97653	2.978	290851	56936	347787
Q-2 62						
Q-3 62	516.0	86781	2.975	258204	60964	319168
Q-4 62						
Q-1 63		45	3.800	171	207	378
Q-2 63						
Q-3 63	247.5	41508	8.966	372150	326600	698750
Q-4 63						
Q-1 64	364.5	62137	3.206	199185	299909	499094
Q-2 64						
Q-3 64	91.5	16231	3.340	54211	78957	133168
Q-4 64						
Q-1 65	39.0	6751	3.146	21236	30212	51448
Q-2 65						
Q-3 65	12.0	2083	3.151	6563	9410	15973
TOTAL	3987.0	686083		2322529	978480	3301009

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

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 01
SUBD OF WORK PRODUCTION

AIRFRAME STRUCTURES SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	6.0	931	4.908	4569		4569
Q-4 58						
Q-1 59	6.0	898	4.257	3823		3823
Q-2 59						
Q-3 59	25.5	4471	4.665	20855		20855
Q-4 59						
Q-1 60	51.0	8736	5.043	44060		44060
Q-2 60						
Q-3 60	9.0	1591	3.901	6207		6207
Q-4 60						
Q-1 61	232.5	39568	3.133	123963		123963
Q-2 61						
Q-3 61	616.5	111670	3.120	348436		348436
Q-4 61						
Q-1 62	1042.5	177835	3.302	587136		587136
Q-2 62						
Q-3 62	1048.5	176197	3.374	594575		594575
Q-4 62						
Q-1 63	1117.5	190758	3.629	692258		692258
Q-2 63						
Q-3 63	1407.0	236277	4.267	1008196		1008196
Q-4 63						
Q-1 64	1938.0	330756	3.586	1186153		1186153
Q-2 64						
Q-3 64	748.5	131680	3.586	472221		472221
Q-4 64						
Q-1 65	309.0	53453	3.906	208804		208804
Q-2 65						
Q-3 65	42.0	6934	5.135	35607		35607
TOTAL	8599.5	1471755		5336863		5336863

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

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01 **AIRFRAME STRUCTURES SUBSYSTEM**
SUBD OF WORK PRODUCTION

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	MFG MATL
Q-3 58	99.0	16354	5.104	83469	9721	93190	
Q-4 58							
Q-1 59	157.5	26961	4.536	122299	14078	136377	
Q-2 59							
Q-3 59	319.5	56024	4.314	241615	25868	267483	
Q-4 59							
Q-1 60	424.5	73592	3.883	285742	28526	314268	400
Q-2 60							
Q-3 60	468.0	78554	2.982	234286	23105	257391	15609
Q-4 60							
Q-1 61	4173.0	711959	3.123	2223692	2155124	4378817	1001899
Q-2 61							
Q-3 61	10491.0	1902398	3.136	5965370	6792927	12758297	4392657
Q-4 61							
Q-1 62	13621.5	2324948	3.081	7164120	8554586	15718706	3749452
Q-2 62							
Q-3 62	10153.5	1705774	3.229	5507495	6741085	12248580	3466176
Q-4 62							
Q-1 63	9963.0	1700621	3.336	5673352	6851848	12525200	4333058
Q-2 63							
Q-3 63	10978.0	1844068	3.026	5580647	7655042	13235689	4341206
Q-4 63							
Q-1 64	13936.5	2378383	3.564	8477165	12055974	20533139	4419370
Q-2 64							
Q-3 64	4515.0	794815	3.442	2735952	3821212	6557164	1236831
Q-4 64							
Q-1 65	2746.5	475941	3.635	1730222	2307431	4037653	98561
Q-2 65							
Q-3 65	267.0	44868	6.265	281209	325967	607176	171772
TOTAL	82313.5	14135260		46306636	57362494	103669130	27227491

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
SUBD OF WORK PRODUCTION

AIRFRAME STRUCTURES SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	IOWA
Q-1 58				5641	5641		
Q-2 58							
Q-3 58				112960	206150		
Q-4 58							
Q-1 59	376336	376336	9978	190600	713291		11147
Q-2 59							
Q-3 59	6000625	6000625	163966	269832	6701906		4243
Q-4 59							
Q-1 60	3427694	3428094	203415	5714	3951491	75610	6400
Q-2 60							
Q-3 60	1798819	1814428	108779	19836	2200484	55041	13353
Q-4 60							
Q-1 61	3818813	4820712	194020	26283	9419832	206159	1052330
Q-2 61							
Q-3 61	9623282	14015959	646620	12977	27433833	561582	2491270
Q-4 61							
Q-1 62	12176907	15926359	682328		32327393	589964	2924005
Q-2 62							
Q-3 62	7068565	10534741	497442		23280763	420438	2610066
Q-4 62							
Q-1 63	3427156	7760214	572433		20857847	393918	2496459
Q-2 63							
Q-3 63	3017047	7358253	524722	2424	21121088	390637	2489662
Q-4 63							
Q-1 64	3173153	7593023	906950	9882	29042994	658490	2536545
Q-2 64							
Q-3 64	170650	1407481	505694	1063	8471402	209569	1380391
Q-4 64							
Q-1 65	41457	140018	43017		4220638	125857	1197
Q-2 65							
Q-3 65		171772	30647		809595	24431	1687
TOTAL	54120504	81347995	5090011	657262	190764398	3711696	18019255

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01 **AIRFRAME STRUCTURES SUBSYSTEM**
SUBD OF WORK PRODUCTION

	TOTAL COST
Q-1 58	5641
Q-2 58	
Q-3 58	206150
Q-4 58	
Q-1 59	724438
Q-2 59	
Q-3 59	6706149
Q-4 59	
Q-1 60	4033501
Q-2 60	
Q-3 60	2268878
Q-4 60	
Q-1 61	10678321
Q-2 61	
Q-3 61	30486685
Q-4 61	
Q-1 62	35841362
Q-2 62	
Q-3 62	26311267
Q-4 62	
Q-1 63	23748224
Q-2 63	
Q-3 63	24001387
Q-4 63	
Q-1 64	32238029
Q-2 64	
Q-3 64	10061862
Q-4 64	
Q-1 65	4347742
Q-2 65	
Q-3 65	835713
TOTAL	212495349

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

4-SYSTEM 1
5-SUBSYSTEM 01
SUBC OF WORK TOOLING AND STE

AIRFRAME STRUCTURES SUBSYSTEM

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 59	41815	1108	42923		42923
Q-2 59					
Q-3 59	672011	18362	690373		690373
Q-4 59					
Q-1 60	1790930	106254	1897184	42997	1940181
Q-2 60					
Q-3 60	2059097	122171	2181268	82307	2263575
Q-4 60					
Q-1 61	4556468	130545	4687013	90165	4777178
Q-2 61					
Q-3 61	7690446	220336	7910782	124442	8035224
Q-4 61					
Q-1 62	2657879	84471	2742350	36317	2778667
Q-2 62					
Q-3 62	3427677	108837	3536514	41657	3578171
Q-4 62					
Q-1 63	781485	33182	814667	13413	828080
Q-2 63					
Q-3 63	503402	16175	519577	8203	527780
Q-4 63					
Q-1 64	244499	33578	278077	5917	283994
Q-2 64					
Q-3 64	67059	21881	88940	1892	90832
Q-4 64					
Q-1 65	17607	5744	23351	623	23974
TOTAL	24510375	902644	25413019	447933	25860952

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

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 01
SUBD OF WORK TEST/QC

AIRFRAME STRUCTURES SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	4.5	854	4.984	4256	3884	8140
Q-2 58						
Q-3 58	31.5	5213	4.184	21811	20353	42164
Q-4 58						
Q-1 59	90.0	15336	4.184	64168	52536	116704
Q-2 59						
Q-3 59	66.0	11616	4.131	47981	41904	89885
Q-4 59						
Q-1 60	154.0	26641	4.451	118587	84753	203340
Q-2 60						
Q-3 60	851.0	142993	3.900	557621	529904	1087525
Q-4 60						
Q-1 61	1143.0	195034	3.458	674353	609231	1283584
Q-2 61						
Q-3 61	811.5	147148	4.359	641474	711260	1352734
Q-4 61						
Q-1 62	878.0	149810	4.006	600213	668963	1269176
Q-2 62						
Q-3 62	838.0	140691	4.266	600223	701616	1301839
Q-4 62						
Q-1 63	256.5	43842	4.714	206674	274592	481266
Q-2 63						
Q-3 63	297.0	49924	4.663	232793	240051	472844
Q-4 63						
Q-1 64	197.5	33687	4.777	160920	209009	369929
Q-2 64						
Q-3 64	89.5	15740	4.179	65771	89307	155078
Q-4 64						
Q-1 65	194.5	33728	1.904	64233	69975	134208
Q-2 65						

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

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 01 **AIRFRAME STRUCTURES SUBSYSTEM**
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	94.5	15957	2.831	45179	54180	99359
Q-4 65						
Q-1 66	-9.0	-1484	3.857	-5724	-4912	-10636
Q-2 66						
Q-3 66	-1.5	-322	3.500	-1127	-1127	-2254
TOTAL	5986.5	1025468		4099406	4355479	8454885

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 01 **AIRFRAME STRUCTURES SUBSYSTEM**
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		21	2.476	52	73	125
Q-2 58						
Q-3 58	276.0	46303	3.053	141378	151361	292739
Q-4 58						
Q-1 59	455.5	77732	3.122	242709	262281	504990
Q-2 59						
Q-3 59	1675.5	294956	2.962	873573	1094547	1968120
Q-4 59						
Q-1 60	2199.0	381179	2.986	1138144	1362331	2500475
Q-2 60						
Q-3 60	5176.0	869539	3.044	2646891	3227482	5874373
Q-4 60						
Q-1 61	8506.5	1451845	3.103	4505362	5541096	10046458
Q-2 61						
Q-3 61	3764.5	682615	3.030	2068214	3155756	5223970
Q-4 61						
Q-1 62	1304.5	222653	2.195	488719	648315	1137034
Q-2 62						
Q-3 62	998.0	150810	3.101	467694	614033	1081727
Q-4 62						
Q-1 63	436.0	74396	2.965	220549	285107	505656
Q-2 63						
Q-3 63	317.5	53447	3.227	172473	424647	597120
Q-4 63						
Q-1 64	307.5	52489	2.387	125265	191345	316610
Q-2 64						
Q-3 64	41.5	7221	5.787	-41794	-29376	-71170
Q-4 64						
Q-1 65	-99.0	-17103	.347	-5927	-6256	-12183
Q-2 65						

NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12190

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 01 AIRFRAME STRUCTURES SUBSYSTEM
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	-10.5	-1707	8.878	15157	21696	36853
Q-4 65						
Q-1 66	-4.5	-720	1.101	-793	-382	-1175
Q-2 66						
Q-3 66		-3	4.125	-33	53	20
TOTAL	25244.0	4345568		13057633	16944109	30001742

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

PLANNING
4-SYSTEM 1
5-SUBSYSTEM 01
SUBD OF WORK TEST/QC

AIRFRAME STRUCTURES SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 63		-82	3.317	-272	-141	-413
Q-2 63						
Q-3 63	160.0	26848	3.970	106582	2586	109168
Q-4 63						
Q-1 64	9.0	1451	3.747	5437	3399	8836
Q-2 64						
Q-3 64	7.5	1449	3.738	5417	3410	8827
Q-4 64						
Q-1 65	3.0	549	3.880	2126	791	2917
Q-2 65						
Q-3 65	1.5	219	3.881	850	316	1166
Q-4 65						
Q-1 66		16	3.813	61	23	84
TOTAL	181.0	30449		120201	10384	130585

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 01
SUBD OF WORK TEST/QC

AIRFRAME STRUCTURES SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	6.0	977	3.475	3395		3395
Q-4 58						
Q-1 59	27.0	4648	2.939	13661		13661
Q-2 59						
Q-3 59	99.0	17338	3.118	54064		54064
Q-4 59						
Q-1 60	198.0	34324	2.948	101178		101178
Q-2 60						
Q-3 60	585.0	98353	3.196	314355		314355
Q-4 60						
Q-1 61	1159.5	197947	3.281	649519		649519
Q-2 61						
Q-3 61	527.0	95560	3.127	298771		298771
Q-4 61						
Q-1 62	73.5	12501	3.331	41645		41645
Q-2 62						
Q-3 62	42.0	7089	2.989	21191		21191
Q-4 62						
Q-1 63	13.5	2255	3.745	8446		8446
Q-2 63						
Q-3 63	19.0	3137	3.394	10646		10646
Q-4 63						
Q-1 64	10.0	1675	5.451	9130		9130
Q-2 64						
Q-3 64	-19.5	-3260	3.822	-12461		-12461
Q-4 64						
Q-1 65	11.5	1975	3.592	7095		7095
Q-2 65						
Q-3 65	-4.5	-809	4.999	-4044		-4044
Q-4 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 01 AIRFRAME STRUCTURES SUBSYSTEM
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 66		54	3.556	192		192
Q-2 66						
Q-3 66		-2	.500	-1		-1
TOTAL	2748.0	473752		1516782		1516762

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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
SUBD OF WORK TEST/CC

AIRFRAME STRUCTURES SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	4.5	875	4.923	4308	3957	8265	32
Q-2 58							
Q-3 58	313.5	52493	3.173	166584	171714	338298	73110
Q-4 58							
Q-1 59	572.5	97716	3.280	320538	314817	635355	34454
Q-2 59							
Q-3 59	1840.5	323910	3.012	975618	1136451	2112069	202359
Q-4 59							
Q-1 60	2551.0	442144	3.071	1357909	1447084	2804993	1269725
Q-2 60							
Q-3 60	6612.0	1110885	3.168	3513867	3757396	7276253	450415
Q-4 60							
Q-1 61	10809.0	1844826	3.160	5829234	6150327	11979561	2127244
Q-2 61							
Q-3 61	5103.0	925323	3.251	3008459	3867016	6875475	2241751
Q-4 61							
Q-1 62	2256.0	384964	2.937	1130577	1317278	2447855	357267
Q-2 62							
Q-3 62	1778.0	298590	3.648	1089108	1315649	2404757	580069
Q-4 62							
Q-1 63	706.0	120411	3.616	435397	559558	994955	979536
Q-2 63							
Q-3 63	793.5	133356	3.918	522494	667284	1189778	2409920
Q-4 63							
Q-1 64	524.0	89302	3.368	300752	403753	704505	112033
Q-2 64							
Q-3 64	120.0	21150	.801	16933	63341	80274	75190
Q-4 64							
Q-1 65	110.0	19148	3.527	67527	64510	132037	474475
Q-2 65							
Q-3 65	81.0	13660	4.183	57142	76192	133334	179805
Q-4 65							

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
SUBD OF WORK TEST/QC

AIRFRAME STRUCTURES SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66	-13.5	-2134	2.935	-6264	-5271	-11535	34473
Q-2 66							
Q-3 66	-1.5	-332	3.497	-1161	-1074	-2235	24242
Q-4 66							
Q-1 67							
Q-2 67							
Q-3 67							
TOTAL	34159.5	5870287		18794022	21309972	40103994	11628100

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01 AIRFRAME STRUCTURES SUBSYSTEM
SUBD OF WORK TEST/QC

	SUBC	TOTAL MATERIAL	MPC	WIND TUNNEL	OTHER COST	TOTAL O/C $	SUB TOTAL
Q-1 58		32	2	153331	1283	154614	162913
Q-2 58							
Q-3 58		73110	3998	472658	-9659	462999	878405
Q-4 58							
Q-1 59		34454	2917	433600	71696	505296	1178022
Q-2 59							
Q-3 59		202359	17134	494129	55224	549353	2880915
Q-4 59							
Q-1 60		1269725	167014	155533	77173	232706	4474438
Q-2 60							
Q-3 60		450415	59247	237823	59808	297631	8083546
Q-4 60							
Q-1 61	20539	2147763	130234	163088	9323	172411	14479989
Q-2 61							
Q-3 61	25069	2260820	190033	137586	26564	164150	9496478
Q-4 61							
Q-1 62	6527	363794	28345	143216	8474	151690	2991684
Q-2 62							
Q-3 62	5221	585290	40640	147669	238671	386340	3423027
Q-4 62							
Q-1 63		979536	96506	117121	134592	251713	2322710
Q-2 63							
Q-3 63		2409920	237432	89098	74779	163877	4001007
Q-4 63							
Q-1 64		112033	11942		32001	32001	860481
Q-2 64							
Q-3 64		75190	27357		-27000	-27000	155621
Q-4 64							
Q-1 65		474475	141928		6638	6638	755078
Q-2 65							
Q-3 65		179805	32081		2655	2655	347875
Q-4 65							

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
SUBD OF WORK TEST/CC

AIRFRAME STRUCTURES SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	WIND TUNNEL	OTHER COST	TOTAL C/C $	SUB TOTAL
Q-1 66		34473	7150	11740	1[illegible]0	11930	42010
Q-2 66							
Q-3 66		26242	1612	4328		4328	29947
Q-4 66							
Q-1 67							
Q-2 67							
Q-3 67							
TOTAL	57356	11685456	1251572	276[illegible]92[illegible]	762412	3523332	56[illegible]64354

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01 AIRFRAME STRUCTURES SUBSYSTEM
SUBD OF WORK TEST/QC

	G & A	IDWA	TOTAL COST
Q-1 58			162913
Q-2 58			
Q-3 58			873415
Q-4 58			
Q-1 59		12067	1199989
Q-2 59			
Q-3 59		4605	2885520
Q-4 59			
Q-1 60	85776	6035	4567149
Q-2 60			
Q-3 60	155024	27775	8266345
Q-4 60			
Q-1 61	297394	1538637	16316020
Q-2 61			
Q-3 61	208108	1723301	11427387
Q-4 61			
Q-1 62	50102		3041786
Q-2 62			
Q-3 62	57365		3480392
Q-4 62			
Q-1 63	38836		2361546
Q-2 63			
Q-3 63	66897		4067904
Q-4 63			
Q-1 64	18309		678790
Q-2 64			
Q-3 64	3316		159137
Q-4 64			
Q-1 65	20145		775223
Q-2 65			
Q-3 65	9281		357156
Q-4 65			

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B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
SUBD OF WORK TEST/QC

AIRFRAME STRUCTURES SUBSYSTEM

	G & A	IDWA	TOTAL COST
Q-1 66	1265		43283
Q-2 66			
Q-3 66	902		30849
Q-4 66			
Q-1 67			
Q-2 67			
Q-3 67			
TOTAL	1012720	3313320	60890394

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 01
AIRFRAME STRUCTURES SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	310.0	52110	4.676	243645	237092	480737
Q-2 58						
Q-3 58	1653.0	277749	4.658	1293738	1044461	2338199
Q-4 58						
Q-1 59	2270.5	387479	4.546	1761312	1289411	3050723
Q-2 59						
Q-3 59	3702.0	651610	4.386	2857810	2259721	5117531
Q-4 59						
Q-1 60	4588.0	795254	4.611	3666791	2996390	6663181
Q-2 60						
Q-3 60	5532.0	929353	4.539	4218112	3456996	7675108
Q-4 60						
Q-1 61	7061.5	1205133	4.605	5550111	4086490	9636601
Q-2 61						
Q-3 61	4841.5	877910	4.761	4179462	4036503	8215965
Q-4 61						
Q-1 62	4079.5	696283	5.042	3510627	3192158	6702785
Q-2 62						
Q-3 62	3691.0	620052	5.144	3189263	3171419	6360682
Q-4 62						
Q-1 63	2429.5	414680	6.497	2694356	2595066	5289422
Q-2 63						
Q-3 63	2546.0	427737	5.026	2149801	2441079	4590880
Q-4 63						
Q-1 64	2552.0	435515	5.813	2531461	2734961	5266422
Q-2 64						
Q-3 64	1988.5	350061	5.712	1999604	2232631	4232235
Q-4 64						
Q-1 65	677.5	117381	5.125	601632	617053	1218685
Q-2 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 01
AIRFRAME STRUCTURES SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	380.5	63839	4.906	313196	346600	659796
Q-4 65						
Q-1 66	4.5	757	12.540	9493	9823	19316
Q-2 66						
Q-3 66	-1.5	-322	3.500	-1127	-1127	-2254
TOTAL	48306.0	8302581		40769287	36746727	77516014

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

PRODUCTION
4-SYSTEM 1
5-SUBSYSTEM 01
AIRFRAME STRUCTURES SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 60	42.0	7236	4.619	33421	15282	48703
Q-2 60						
Q-3 60	73.5	12243	2.525	30908	23864	54772
Q-4 60						
Q-1 61	3259.5	556179	3.143	1747953	2094249	3842202
Q-2 61						
Q-3 61	9259.5	1679113	3.152	5292403	6735198	12027601
Q-4 61						
Q-1 62	12004.5	2048847	3.067	6284460	8492635	14777095
Q-2 62						
Q-3 62	8566.5	1439052	3.225	4641400	6657120	11298520
Q-4 62						
Q-1 63	8835.0	1507941	3.299	4974373	6839887	11814260
Q-2 63						
Q-3 63	9736.5	1635704	2.796	4573130	7397924	11971054
Q-4 63						
Q-1 64	11595.0	1978760	3.568	7061038	11715896	18776934
Q-2 64						
Q-3 64	3529.5	621267	3.373	2095374	3581095	5676469
Q-4 64						
Q-1 65	2320.5	402139	3.581	1439919	2192663	3632582
Q-2 65						
Q-3 65	96.0	16228	10.066	163352	210387	373739
TOTAL	69318.0	11904709		38337731	55956200	94293931

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 01
AIRFRAME STRUCTURES SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	27.0	4441	3.094	13739	11652	25391
Q-2 58						
Q-3 58	301.5	50554	3.058	154608	164553	319161
Q-4 58						
Q-1 59	453.0	77276	3.129	241787	262086	503873
Q-2 59						
Q-3 59	1804.5	317511	2.961	940046	1185049	2125095
Q-4 59						
Q-1 60	2117.5	367064	2.987	1096411	1331362	2427773
Q-2 60						
Q-3 60	5195.5	872805	3.043	2656180	3242004	5898184
Q-4 60						
Q-1 61	8525.5	1455042	3.103	4514905	5553208	10068113
Q-2 61						
Q-3 61	3770.5	683692	3.030	2071278	3161172	5232450
Q-4 61						
Q-1 62	1312.0	223890	2.198	492073	654341	1146414
Q-2 62						
Q-3 62	901.0	151339	3.102	469593	616051	1085644
Q-4 62						
Q-1 63	443.5	75628	2.969	224511	290275	514786
Q-2 63						
Q-3 63	355.0	59709	3.240	193479	449645	643124
Q-4 63						
Q-1 64	338.5	57758	2.481	143301	213712	357013
Q-2 64						
Q-3 64	47.5	8305	4.611	-38302	-24272	-62574
Q-4 64						
Q-1 65	-96.0	-16592	.255	-4230	-3841	-8071
Q-2 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 01
AIRFRAME STRUCTURES SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	-10.5	-1707	8.878	15157	21671	36828
Q-4 65						
Q-1 66	-4.5	-720	1.101	-793	-382	-1175
Q-2 66						
Q-3 66		-8	4.125	-33	53	20
TOTAL	25481.5	4386037		13183710	17128339	30312049

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

PLANNING
4-SYSTEM 1
5-SUBSYSTEM 01
AIRFRAME STRUCTURES SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	12.0	1905	2.998	5711		5711
Q-4 58						
Q-1 59	55.5	9569	2.960	28324		28324
Q-2 59						
Q-3 59	133.5	23401	2.989	69940		69940
Q-4 59						
Q-1 60	270.0	46837	3.160	147990	483	148473
Q-2 60						
Q-3 60	384.0	64486	3.043	196221		196221
Q-4 60						
Q-1 61	678.0	115604	3.017	348772	57787	406559
Q-2 61						
Q-3 61	612.0	111092	2.908	323000	57015	380015
Q-4 61						
Q-1 62	571.5	97653	2.978	290851	56936	347787
Q-2 62						
Q-3 62	516.0	86781	2.975	258204	60964	319168
Q-4 62						
Q-1 63		-37	2.730	-101	66	-35
Q-2 63						
Q-3 63	406.5	68356	7.004	478732	329186	807918
Q-4 63						
Q-1 64	372.0	63588	3.218	204622	303308	507930
Q-2 64						
Q-3 64	100.5	17680	3.373	59628	82367	141995
Q-4 64						
Q-1 65	42.0	7299	3.201	23362	31003	54365
Q-2 65						
Q-3 65	13.5	2302	3.220	7413	9726	17139
Q-4 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

PLANNING
4-SYSTEM 1
5-SUBSYSTEM 01
AIRFRAME STRUCTURES SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 66		16	3.813	61	23	84
TOTAL	4167.0	716532		2442730	988864	3431594

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 01
AIRFRAME STRUCTURES SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		85	3.035	258		258
Q-2 58						
Q-3 58	12.0	1930	4.155	8019		8019
Q-4 58						
Q-1 59	32.5	5519	3.157	17425		17425
Q-2 59						
Q-3 59	132.0	23350	3.412	79675		79675
Q-4 59						
Q-1 60	258.0	44709	3.378	151013		151013
Q-2 60						
Q-3 60	601.5	101002	3.211	324284		324284
Q-4 60						
Q-1 61	1393.5	237829	3.257	774576		774576
Q-2 61						
Q-3 61	1143.5	207355	3.124	647699		647699
Q-4 61						
Q-1 62	1116.0	190535	3.305	629651		629651
Q-2 62						
Q-3 62	1091.5	183339	3.360	615944		615944
Q-4 62						
Q-1 63	1131.0	193053	3.630	700840		700840
Q-2 63						
Q-3 63	1425.5	239487	4.256	1019147		1019147
Q-4 63						
Q-1 64	1948.5	332533	3.596	1195737		1195737
Q-2 64						
Q-3 64	730.0	128434	3.580	459846		459846
Q-4 64						
Q-1 65	319.5	55428	3.895	215899		215899
Q-2 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 01
AIRFRAME STRUCTURES SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	36.0	6125	5.153	31563		31563
Q-4 65						
Q-1 66		54	3.556	192		192
Q-2 66						
Q-3 66		-2	.500	-1		-1
TOTAL	11371.0	1950765		6871767		6871767

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
AIRFRAME STRUCTURES SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	337.0	56636	4.549	257642	248744	506386	1303
Q-2 58							
Q-3 58	1978.5	332138	4.402	1462076	1209014	2671090	79363
Q-4 58							
Q-1 59	2811.5	479843	4.270	2043848	1551497	3600345	41984
Q-2 59							
Q-3 59	5772.0	1015872	3.886	3947471	3444770	7392241	211323
Q-4 59							
Q-1 60	7275.5	1261100	4.041	5095626	4343517	9439143	1273622
Q-2 60							
Q-3 60	11786.5	1979889	3.751	7425705	6722864	14148569	451281
Q-4 60							
Q-1 61	20918.0	3569787	3.624	12936317	11791734	24728051	2128782
Q-2 61							
Q-3 61	19627.0	3559162	3.516	12513842	13989888	26503730	2265467
Q-4 61							
Q-1 62	19083.5	3257208	3.441	11207662	12396070	23603732	356931
Q-2 62							
Q-3 62	14766.0	2480613	3.698	9174404	10505554	19679958	582184
Q-4 62							
Q-1 63	12839.0	2191265	3.922	8593979	9725294	18319273	980165
Q-2 63							
Q-3 63	14469.5	2430933	3.461	8414289	10617834	19032123	2410084
Q-4 63							
Q-1 64	16606.0	2868154	3.883	11136159	14967877	26104036	112614
Q-2 64							
Q-3 64	6396.0	1125747	4.065	4576150	5871821	10447971	74866
Q-4 64							
Q-1 65	3263.5	565655	4.025	2276582	2836878	5113460	483180
Q-2 65							
Q-3 65	515.5	86787	6.115	530681	588384	1119065	179805
Q-4 65							

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B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
AIRFRAME STRUCTURES SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66		107	83.673	8953	9464	18417	34473
Q-2 66							
Q-3 66	-1.5	-332	3.497	-1161	-1074	-2235	26242
Q-4 66							
Q-1 67							
Q-2 67							
Q-3 67							
TOTAL	158643.5	27260624		101605225	110820130	212425355	11693669

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
AIRFRAME STRUCTURES SUBSYSTEM

	MFG MATL	SUBC	TOTAL MATERIAL	MPC	WIND TUNNEL	OTHER COST	TOTAL O/C $
Q-1 58			1303	71	153331	6924	160255
Q-2 58							
Q-3 58			79363	4340	472658	103301	575959
Q-4 58							
Q-1 59		2482862	2524846	69350	433600	369551	803151
Q-2 59							
Q-3 59		18548944	18760267	524984	494129	770276	1264405
Q-4 59							
Q-1 60	400	10535275	11809297	792629	155533	878175	1033708
Q-2 60							
Q-3 60	15609	6726157	7193047	460489	237823	1347120	1584943
Q-4 60							
Q-1 61	1001899	8623315	11753996	511447	163088	1709808	1872896
Q-2 61							
Q-3 61	4392657	19149968	25808092	1110881	137586	1106353	1243939
Q-4 61							
Q-1 62	3749452	15164432	19270815	805386	143216	1484430	1627646
Q-2 62							
Q-3 62	3466176	10612722	14661082	656618	147669	1602566	1750235
Q-4 62							
Q-1 63	4333058	4311210	9624433	706537	117121	1102170	1219291
Q-2 63							
Q-3 63	4341206	3585784	10337074	780443	89098	-199710	-110612
Q-4 63							
Q-1 64	4419870	3440025	7972509	955604		719909	719909
Q-2 64							
Q-3 64	1236831	250099	1561796	558856		646400	646400
Q-4 64							
Q-1 65	98561	68654	650395	196422		454097	454097
Q-2 65							
Q-3 65	171772		351577	62728		181638	181638
Q-4 65							

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
AIRFRAME STRUCTURES SUBSYSTEM

	MFG MATL	SUBC	TOTAL MATERIAL	MPC	WIND TUNNEL	OTHER COST	TOTAL O/C $
Q-1 66			34473	7150	11740	12975	24715
Q-2 66							
Q-3 66			26242	1612	4328		4328
Q-4 66							
Q-1 67							
Q-2 67							
Q-3 67							
TOTAL	27227491	103499447	142420607	8205547	2760920	12295983	15056903

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
AIRFRAME STRUCTURES SUBSYSTEM

	SUB TOTAL	G & A	IDWA	TOTAL COST
Q-1 58	668015			668015
Q-2 58				
Q-3 58	3330752			3330752
Q-4 58				
Q-1 59	6997692		23214	7020906
Q-2 59				
Q-3 59	27941897		8848	27950745
Q-4 59				
Q-1 60	23074777	374654	13335	23462766
Q-2 60				
Q-3 60	23387048	500464	41128	23928640
Q-4 60				
Q-1 61	38866390	784744	2590967	42242101
Q-2 61				
Q-3 61	54666642	1076719	4214571	59957932
Q-4 61				
Q-1 62	45307579	798010	2924005	49029594
Q-2 62				
Q-3 62	36747893	628689	2610066	39986648
Q-4 62				
Q-1 63	29869534	544386	2496459	32910379
Q-2 63				
Q-3 63	30039028	539261	2489662	33067951
Q-4 63				
Q-1 64	35752058	801243	2536545	39089846
Q-2 64				
Q-3 64	13215023	310503	1380891	14906417
Q-4 64				
Q-1 65	6414374	184383	1197	6599954
Q-2 65				
Q-3 65	1715008	48587	1687	1765232
Q-4 65				

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

4-SYSTEM 1
5-SUBSYSTEM 01
AIRFRAME STRUCTURES SUBSYSTEM

	SUB TOTAL	G & A	IOWA	TOTAL COST
Q-1 66	84755	2552		87307
Q-2 66				
Q-3 66	29947	902		30849
Q-4 66				
Q-1 67				
Q-2 67				
Q-3 67				
TOTAL	378108412	6595097	21332575	406036084

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 01
6-MAJ ASSY 0

AIRFRAME STRUCTURES SUBSYSTEM

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	4207914		4207914
LABOR AT $ 5.051	21253059		21253059
ENGR BURDEN AT $ 4.479	18848487		18848487
SHOP SUPPORT	40369		40369
LABOR AT $ 3.125	126077		126077
TEST/QC	5248		5248
LABOR AT $ 3.453	18122		18122
MFG BURDEN AT $ 4.039	184230		184230
ENGR MATERIAL	65569		65569
MPC	7334		7334
OTHER COST	10875852	643893	11519745
SUB-TOTAL	51378730	643893	52022623
GEN & ADMIN	721407	1217	722624
TOTAL COST	52100137	645110	52745247

TIME-PHASED COST
DETAIL - SEE PAGE III-121 III-130 III-132

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SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 01 AIRFRAME STRUCTURES 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	295.0	49570	4.670	231515	225537	457052
Q-2 58						
Q-3 58	1249.0	209777	4.628	970841	821558	1792399
Q-4 58						
Q-1 59	1504.0	256631	4.519	1159629	882373	2042002
Q-2 59						
Q-3 59	2902.0	510809	4.345	2219673	1829283	4048956
Q-4 59						
Q-1 60	2286.0	396247	4.755	1884300	1622048	3506348
Q-2 60						
Q-3 60	2163.0	363336	4.655	1691455	1353402	3044857
Q-4 60						
Q-1 61	2829.0	482857	4.827	2330690	1662024	3992714
Q-2 61						
Q-3 61	2032.0	368505	4.843	1784579	1677554	3462133
Q-4 61						
Q-1 62	1767.0	301593	5.324	1605580	1390911	2996491
Q-2 62						
Q-3 62	1634.5	274635	5.416	1487406	1412950	2900356
Q-4 62						
Q-1 63	1166.5	199021	6.724	1338285	1245405	2583690
Q-2 63						
Q-3 63	1608.0	270198	5.120	1383412	1371698	2755110
Q-4 63						
Q-1 64	1291.5	220439	5.922	1305422	1386829	2692251
Q-2 64						
Q-3 64	1316.5	231645	5.895	1365542	1487497	2853039
Q-4 64						
Q-1 65	258.0	44721	6.811	304586	295267	599853

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 01 AIRFRAME STRUCTURES 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	153.0	25684	6.811	174927	169416	344343
Q-4 65						
Q-1 66	13.5	2241	6.790	15217	14735	29952
TOTAL	24468.5	4207914		21253059	18848487	40101546

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 01 AIRFRAME STRUCTURES 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	27.0	4420	3.097	13687	11579	25266
Q-2 58						
Q-3 58	25.5	4251	3.112	13230	13192	26422
Q-4 58						
Q-1 59	-3.0	-456	2.022	-922	-195	-1117
Q-2 59						
Q-3 59	127.5	22555	2.947	66473	90502	156975
Q-4 59						
Q-1 60	-81.0	-14115	2.957	-41733	-30969	-72702
Q-2 60						
Q-3 60	19.5	3266	2.844	9289	14522	23811
Q-4 60						
Q-1 61	18.5	3197	2.985	9543	12112	21655
Q-2 61						
Q-3 61	6.0	1077	2.845	3064	5416	8480
Q-4 61						
Q-1 62	7.5	1237	2.711	3354	6026	9380
Q-2 62						
Q-3 62	3.0	579	3.280	1899	2018	3917
Q-4 62						
Q-1 63	7.5	1232	3.216	3962	5168	9130
Q-2 63						
Q-3 63	37.5	6262	3.355	21006	24998	46004
Q-4 63						
Q-1 64	31.5	5269	3.423	18036	22367	40403
Q-2 64						
Q-3 64	6.0	1084	3.221	3492	5104	8596
Q-4 64						
Q-1 65	3.0	511	3.321	1697	2415	4112

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 01 AIRFRAME STRUCTURES 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					-25	-25
TOTAL	236.0	40369		126077	184230	310307

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 01 AIRFRAME STRUCTURES 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		85	3.035	258		258
Q-2 58						
Q-3 58		22	2.500	55		55
Q-4 58						
Q-1 59		-27	2.185	-59		-59
Q-2 59						
Q-3 59	9.0	1541	3.086	4756		4756
Q-4 59						
Q-1 60	9.0	1649	3.502	5775		5775
Q-2 60						
Q-3 60	6.0	1058	3.518	3722		3722
Q-4 60						
Q-1 61	1.5	314	3.484	1094		1094
Q-2 61						
Q-3 61		125	3.936	492		492
Q-4 61						
Q-1 62	1.5	199	4.372	870		870
Q-2 62						
Q-3 62		53	3.358	178		178
Q-4 62						
Q-1 63		40	3.400	136		136
Q-2 63						
Q-3 63		73	4.178	305		305
Q-4 63						
Q-1 64		102	4.451	454		454
Q-2 64						
Q-3 64		14	6.143	86		86
TOTAL	27.0	5248		18122		18122

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01 AIRFRAME STRUCTURES 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	322.0	54075	4.539	245460	237116	482576	1271
Q-2 58							
Q-3 58	1274.5	214050	4.598	984126	834750	1818876	5293
Q-4 58							
Q-1 59	1501.0	256148	4.523	1158648	882178	2040826	7530
Q-2 59							
Q-3 59	3038.5	534905	4.283	2290902	1919785	4210687	8964
Q-4 59							
Q-1 60	2214.0	383781	4.816	1848342	1591079	3439421	3897
Q-2 60							
Q-3 60	2188.5	367660	4.636	1704466	1367924	3072390	866
Q-4 60							
Q-1 61	2849.0	486368	4.814	2341327	1674136	4015463	1538
Q-2 61							
Q-3 61	2038.0	369707	4.837	1788135	1682970	3471105	23716
Q-4 61							
Q-1 62	1776.0	303034	5.312	1609804	1396937	3006741	-336
Q-2 62							
Q-3 62	1637.5	275267	5.411	1489483	1414968	2904451	2115
Q-4 62							
Q-1 63	1174.0	200293	6.702	1342383	1250573	2592956	629
Q-2 63							
Q-3 63	1645.5	276533	5.080	1404723	1396696	2801419	164
Q-4 63							
Q-1 64	1323.0	225810	5.863	1323912	1409196	2733108	581
Q-2 64							
Q-3 64	1322.5	232743	5.883	1369120	1492601	2861721	-324
Q-4 64							
Q-1 65	261.0	45232	6.771	306283	297682	603965	8705
Q-2 65							
Q-3 65	153.0	25684	6.811	174927	169391	344318	

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01 AIRFRAME STRUCTURES SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
)-4 65							
)-1 66	13.5	2241	6.790	15217	14735	29952	
TOTAL	24731.5	4253531		21397258	19032717	40429975	65569

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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01 AIRFRAME STRUCTURES SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58	69		483916		483916
Q-2 58					
Q-3 58	342		1825471		1825471
Q-4 58					
Q-1 59	638	107255	2156249		2156249
Q-2 59					
Q-3 59	759	445220	4665630		4665630
Q-4 59					
Q-1 60	512	794831	4238661	8072	4246733
Q-2 60					
Q-3 60	113	1267426	4340795	82705	4423500
Q-4 60					
Q-1 61	130	1674202	5691333	105762	5797095
Q-2 61					
Q-3 61	2004	1066812	4563637	84806	4648443
Q-4 61					
Q-1 62	-26	1475956	4482335	75236	4557571
Q-2 62					
Q-3 62	167	1363895	4270628	71682	4342310
Q-4 62					
Q-1 63	62	967578	3561225	59544	3620769
Q-2 63					
Q-3 63	16	-276913	2524686	42213	2566899
Q-4 63					
Q-1 64	62	678026	3411777	72596	3484373
Q-2 64					
Q-3 64	-118	672337	3533616	75188	3608804
Q-4 64					
Q-1 65	2604	447459	1062733	28354	1091087
Q-2 65					
Q-3 65		178983	523301	13962	537263

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

4-SYSTEM 1
5-SUBSYSTEM 01 AIRFRAME STRUCTURES SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-4 65					
Q-1 66		12795	42737	1287	44024
TOTAL	7334	10875852	51378730	721407	52100137

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SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01 AIRFRAME STRUCTURES SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK PRODUCTION

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	OTHER COST
Q-1 58 Q-2 58							5641
Q-3 58 Q-4 58							112960
Q-1 59 Q-2 59							190600
Q-3 59 Q-4 59							269832
Q-1 60 Q-2 60							5714
Q-3 60 Q-4 60							19886
Q-1 61 Q-2 61							26283
Q-3 61							12977
TOTAL							643893

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

4-SYSTEM 1
5-SUBSYSTEM 01 AIRFRAME STRUCTURES SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK PRODUCTION

	SUB TOTAL	G & A	TOTAL COST
Q-1 58	5641		5641
Q-2 58			
Q-3 58	112960		112960
Q-4 58			
Q-1 59	190600		190600
Q-2 59			
Q-3 59	269832		269832
Q-4 59			
Q-1 60	5714	109	5823
Q-2 60			
Q-3 60	19886	379	20265
Q-4 60			
Q-1 61	26283	438	26771
Q-2 61			
Q-3 61	12977	241	13218
TOTAL	643893	1217	645110

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 01 AIRFRAME STRUCTURES SUBSYSTEM
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	295.0	49570	4.670	231515	225537	457052
Q-2 58						
Q-3 58	1249.0	209777	4.628	970841	821558	1792399
Q-4 58						
Q-1 59	1504.0	256631	4.519	1159629	882373	2042002
Q-2 59						
Q-3 59	2902.0	510809	4.345	2219673	1829283	4048956
Q-4 59						
Q-1 60	2286.0	396247	4.755	1884300	1622048	3506348
Q-2 60						
Q-3 60	2163.0	363336	4.655	1691455	1353402	3044857
Q-4 60						
Q-1 61	2829.0	482857	4.827	2330690	1662024	3992714
Q-2 61						
Q-3 61	2032.0	368505	4.843	1784579	1677554	3462133
Q-4 61						
Q-1 62	1767.0	301598	5.324	1605580	1390911	2996491
Q-2 62						
Q-3 62	1634.5	274635	5.416	1487406	1412950	2900356
Q-4 62						
Q-1 63	1166.5	199021	6.724	1338285	1245405	2583690
Q-2 63						
Q-3 63	1608.0	270198	5.120	1383412	1371698	2755110
Q-4 63						
Q-1 64	1291.5	220439	5.922	1305422	1386829	2692251
Q-2 64						
Q-3 64	1316.5	231645	5.895	1365542	1487497	2853039
Q-4 64						
Q-1 65	258.0	44721	6.811	304586	295267	599853
Q-2 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 01 AIRFRAME STRUCTURES SUBSYSTEM
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	153.0	25684	6.811	174927	169416	344343
Q-4 65						
Q-1 66	13.5	2241	6.790	15217	14735	29952
TOTAL	24468.5	4207914		21253059	18848487	40101546

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

SHOP SUPPORT

4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 0

AIRFRAME STRUCTURES SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	27.0	4420	3.097	13687	11579	25266
Q-2 58						
Q-3 58	25.5	4251	3.112	13230	13192	26422
Q-4 58						
Q-1 59	-3.0	-456	2.022	-922	-195	-1117
Q-2 59						
Q-3 59	127.5	22555	2.947	66473	90502	156975
Q-4 59						
Q-1 60	-81.0	-14115	2.957	-41733	-30969	-72702
Q-2 60						
Q-3 60	19.5	3266	2.844	9289	14522	23811
Q-4 60						
Q-1 61	18.5	3197	2.985	9543	12112	21655
Q-2 61						
Q-3 61	6.0	1077	2.845	3064	5416	8480
Q-4 61						
Q-1 62	7.5	1237	2.711	3354	6026	9380
Q-2 62						
Q-3 62	3.0	579	3.280	1899	2018	3917
Q-4 62						
Q-1 63	7.5	1232	3.216	3962	5168	9130
Q-2 63						
Q-3 63	37.5	6262	3.355	21006	24998	46004
Q-4 63						
Q-1 64	31.5	5269	3.423	18036	22367	40403
Q-2 64						
Q-3 64	6.0	1084	3.221	3492	5104	8596
Q-4 64						
Q-1 65	3.0	511	3.321	1697	2415	4112
Q-2 65						

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

SHOP SUPPORT

4-SYSTEM 1
5-SUBSYSTEM 01 AIRFRAME STRUCTURES SUBSYSTEM
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65					-25	-25
TOTAL	236.0	40369		126077	184230	310307

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 01 AIRFRAME STRUCTURES SUBSYSTEM
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		85	3.035	258		258
Q-2 58						
Q-3 58		22	2.500	55		55
Q-4 58						
Q-1 59		-27	2.185	-59		-59
Q-2 59						
Q-3 59	9.0	1541	3.086	4756		4756
Q-4 59						
Q-1 60	9.0	1649	3.502	5775		5775
Q-2 60						
Q-3 60	6.0	1058	3.518	3722		3722
Q-4 60						
Q-1 61	1.5	314	3.484	1094		1094
Q-2 61						
Q-3 61		125	3.936	492		492
Q-4 61						
Q-1 62	1.5	199	4.372	870		870
Q-2 62						
Q-3 62		53	3.358	178		178
Q-4 62						
Q-1 63		40	3.400	136		136
Q-2 63						
Q-3 63		73	4.178	305		305
Q-4 63						
Q-1 64		102	4.451	454		454
Q-2 64						
Q-3 64		14	6.143	86		86
TOTAL	27.0	5248		18122		18122

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 01 AIRFRAME STRUCTURES SUBSYSTEM
6-MAJ ASSY 0

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	322.0	54075	4.539	245460	237116	482576	1271
Q-2 58							
Q-3 58	1274.5	214050	4.598	984126	834750	1818876	6253
Q-4 58							
Q-1 59	1501.0	256148	4.523	1158648	882178	2040826	7530
Q-2 59							
Q-3 59	3038.5	534905	4.283	2290902	1919785	4210687	8964
Q-4 59							
Q-1 60	2214.0	383781	4.816	1848342	1591079	3439421	3897
Q-2 60							
Q-3 60	2188.5	367660	4.636	1704466	1367924	3072390	866
Q-4 60							
Q-1 61	2849.0	486368	4.814	2341327	1674136	4015463	1538
Q-2 61							
Q-3 61	2038.0	369707	4.837	1788135	1682970	3471105	23716
Q-4 61							
Q-1 62	1776.0	303034	5.312	1609804	1396937	3006741	-336
Q-2 62							
Q-3 62	1637.5	275267	5.411	1489483	1414968	2904451	2115
Q-4 62							
Q-1 63	1174.0	200293	6.702	1342383	1250573	2592956	629
Q-2 63							
Q-3 63	1645.5	276533	5.080	1404723	1396696	2801419	164
Q-4 63							
Q-1 64	1323.0	225810	5.863	1323912	1409196	2733108	581
Q-2 64							
Q-3 64	1322.5	232743	5.883	1369120	1492601	2861721	-324
Q-4 64							
Q-1 65	261.0	45232	6.771	306283	297682	603965	8705
Q-2 65							
Q-3 65	153.0	25684	6.811	174927	169391	344318	
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 01 AIRFRAME STRUCTURES SUBSYSTEM
6-MAJ ASSY 0

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 65	13.5	2241	6.790	15217	14735	29952	
TOTAL	24731.5	4253531		21397258	19032717	40429975	65569

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 01 AIRFRAME STRUCTURES SUBSYSTEM
6-MAJ ASSY 0

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58	69	5641	489557		489557
Q-2 58					
Q-3 58	342	112960	1938431		1938431
Q-4 58					
Q-1 59	638	297855	2346849		2346849
Q-2 59					
Q-3 59	759	715052	4935462		4935462
Q-4 59					
Q-1 60	512	800545	4244375	8181	4252556
Q-2 60					
Q-3 60	113	1287312	4360681	83084	4443765
Q-4 60					
Q-1 61	130	1700485	5717616	106250	5823866
Q-2 61					
Q-3 61	2004	1079789	4576614	85047	4661661
Q-4 61					
Q-1 62	-26	1475956	4482335	75236	4557571
Q-2 62					
Q-3 62	167	1363895	4270628	71682	4342310
Q-4 62					
Q-1 63	62	967578	3561225	59544	3620769
Q-2 63					
Q-3 63	16	-276913	2524686	42213	2566899
Q-4 63					
Q-1 64	62	678026	3411777	72596	3484373
Q-2 64					
Q-3 64	-118	672337	3533616	75188	3608804
Q-4 64					
Q-1 65	2604	447459	1062733	28354	1091087
Q-2 65					
Q-3 65		178983	523301	13962	537263
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 01
6-MAJ ASSY 0

AIRFRAME STRUCTURES SUBSYSTEM

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 66		12785	42737	1287	44024
TOTAL	7334	11519745	52022623	722624	52745247

TECHNICAL DESCRIPTION

SUBSYSTEM: AIRFRAME STRUCTURE — WBS CODE: 1.1

MAJOR ASSEMBLY: HORIZONTAL STABILIZER & FLAPS — WBS CODE: 1.1.1

The horizontal stabilizer was attached to the upper forward fuselage at FS-605 (Being forward of the wing, this control surface was sometimes identified as a canard.). The left hand and right hand control surfaces of the horizontal stabilizer were tied together through the fuselage by a large "sewer pipe" and were controlled by hydraulic actuators as part of the **air vehicle Flight Control Subsystem (WBS 1.6). The horizontal sta-**bilizer construction consisted of leading edges and box sections made up of multi-beams, corrugated webs, caps, and skins. Materials and fabrication techniques used in this construction were riveted 4Al-3MO-1V and welded 6Al-4V titanium alloys with the leading edges being a full depth brazed PH15-7MO steel honeycomb mechanically attached to the box sections. See Exhibit 22, page 142, for construction details.

The span of the horizontal stabilizer was 28.8 ft. with mean aerodynamic chords of 184.34 inches. The airfoil section designation was 34.2-65.8 hex mod, the sweep of the leading edge was 31.7 degrees in the chord plane, dihedral was zero, and the aspect ratio was 1.997. The root or theoretical chord at the center line of the air vehicle was 20.79 ft. while the chords at the construction tips were 8.06 ft. (Note: Chord lengths include the flaps.) The total travel of the horizontal stabilizer was +6 to -0 degrees as measured to the air vehicle horizontal reference plane.

The aft sections of the horizontal stabilizer control surfaces were flaps controlled by hydraulic actuators as part of the Secondary Flight Control System. The center line of the flap hinge was at the 85.5% chord line and was full span with a total travel of zero to 20 degrees trailing edge down. Materials and fabrication techniques used in the construction of the flaps was the same as for the horizontal, being riveted 4Al-3MO-1V and welded 6Al-4V titanium alloys with full depth brazed PH15-7MO steel honeycomb leading edges.

The prime function of the horizontal stabilizer or canard was to reduce trim drag and thereby increase the air vehicle L/D (lift over drag) or performance. This was accomplished by using the canard for trim and maneuvering control along with the trailing edge elevons. The canard provided a positive lift input for cruise trim which resulted in less elevon deflection and less drag. A secondary function for the canard, but of some importance, was to improve visibility during landing and takeoff. This was accomplished by using the flaps to further augment the forward lifting moment which resulted in a downward deflection of the elevons to balance the aircraft, thereby reducing the angle of attack and improving the visibility for these conditions.

HORIZONTAL STABILIZER

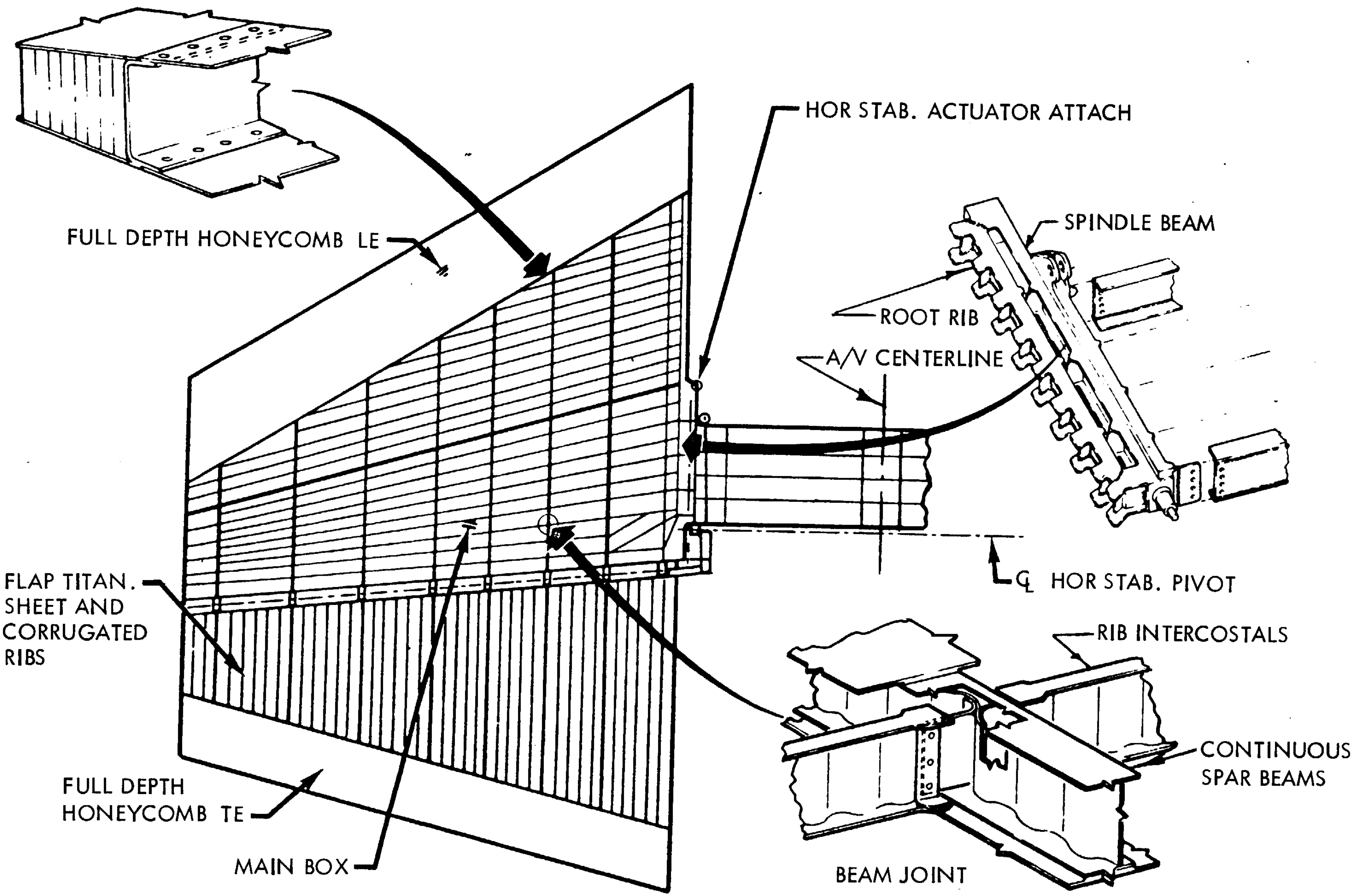

EXHIBIT 22

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: HORIZONTAL STABILIZER AND FLAPS WBS CODE: 1.1.1

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	Pounds	2240	TBD	TBD	3244	3285
HORIZONTAL STABILIZER	Type	- - Flying or load support stabilizer - -				
MATERIALS		- - 4Al-3Mo-1V & 6Al-4V Titanium, PH15-7Mo Steel - -				
SPAN (HORZ)	Feet	28.8	28.8	28.8	28.8	28.8
MAC (HORZ)	Inches	184.34	184.34	184.34	184.34	184.34
AREA (HORZ)	$Feet^2$	415.59	415.59	415.59	415.59	415.59
LOCATION	None	- - - Forward Fuselage (Conard) - - - - - - - - - -				
TRAVEL (HORZ)	Degrees	In work	0 to +6	0 to +6	0 to +6	0 to +6
TEMPERATURE	Degrees F	-65 to 630	-65 to 630	-65 to 630	-65 to 630	- 65 to 630
LOADS - DESIGN	$Pounds/Ft^2$	376	376	373	373	373
ASPECT RATIO (HORZ)	None	1.997	1.997	1.997	1.997	1.997
INCIDENCE	Degrees	In work	0 to +6	0 to +6	0 to +6	0 to +6
DIHEDRAL	Degrees	0	0	0	0	0
FLAP SPAN	Feet	10.41	10.41	10.41	10.41	10.41
FLAP CHORDS	Feet	3.35 & 7.17	3.35 & 7.17	3.35 & 7.17	3.35 & 7.17	3.35 & 7.17
TRAVEL (FLAPS)	Degrees	0 to 20	0 to 20	0 to 20	0 to 20	0 to 20
AREA (FLAPS)	$Feet^2$	109.42	109.42	109.42	109.42	109.42
MAIN ASSEMBLIES	Type/No.	- - - Honeycomb Leading Edges, Box Section Panels, and Flap Sections - - -				

COST DEFINITION

SUBSYSTEM: AIRFRAME STRUCTURE — WBS CODE: 1.1

MAJOR ASSEMBLY: HORIZONTAL STABILIZERS AND FLAPS — WBS CODE: 1.1.1

Recorded cost of $11,295,558 includes all identifiable in-house and subcontracted effort to design and fabricate the horizontal stabilizers and flaps. A detail discussion of the vendors involved with this major airframe assembly is included on page III-145.

In-house engineering effort includes the design and vendor support activities. It excludes the design support effort as these can not be identified at a level lower than WBS level 5 (Airframe Structure). The Engineering Group Matrix on page III-69 recaps the hours charged by the engineering design groups associated with this major assembly.

In-house production effort includes all identifiable costs to fabricate and assemble the structural components included in this WBS item. Specifically excluded from the production costs are:

a) Mating the horizontal stabilizer to the fuselage (WBS 3.0).
b) Fabrication and installation of subsystem provisions (brackets, supports, frames, etc.) or equipment (WBS 1.12).
c) In-house ground testing activities (WBS 1.1.8).
d) Vehicle checkout and preflight operations (WBS 1.12).

Subcontractor costs for the major assembly include all vendor engineering, production, tooling and testing costs. These are displayed in the subcontractor Element of Cost within the appropriate Subdivisions of Work. Additional vendor data is contained on page III-145.

SUBCONTRACTOR MATRIX

SUBSYSTEM: AIRFRAME STRUCTURE WBS CODE: 1.1

MAJOR ASSEMBLY: HORIZONTAL STABILIZER AND FLAPS WBS CODE: 1.1.1

SUBCONTRACTOR	ENG'R'G	PROD	TOOLING	TEST	TOTAL
Chance Vought	2,203,729	3,784,068	4,153,083	--	10,140,880

CHANCE VOUGHT was selected to produce the Horizontal and Vertical Stabilizers on the original B-70 program on a competitive bid basis. Five letter contracts were awarded to Chance Vought for the Horizontal and Vertical Stabilizers combined. However, for purposes of clarity, the cost schedules, and technical data for both stabilizers are shown separately in this study.

The five contracts with their award and completion dates are as follows:

L991-XH-600115	Feb. 13, 1959 - Dec. 8, 1959
L1J1-Y2-600332	Nov. 14, 1960 - June 29, 1962
L1J1-Y2-600333	Nov. 14, 1960 - Dec. 31, 1964
L2-A1-YJ-600401	Jan. 11, 1962 - Oct. 1, 1963
L2-A1-YJ-600526	Nov. 14, 1962 - Mar. 9, 1964

The Statement of Work for the five contracts directed the subcontractor to provide design, tooling, and production effort required to produce the Horizontal and Vertical Stabilizers for Air Vehicles 1, 2, and 3. In addition, management, planning services, and tool planning, directed toward the design and production effort were included in the contracts.

The basic design effort was completed on letter contract 600115 prior to its termination on December 8, 1959. When the YB-70 program was redirected to three XB-70 Air Vehicles, contract 600333 was issued for the fabrication of special tooling and pre-production effort.

WBS: 1.1.1

The Horizontal and Vertical Stabilizers and Flaps were procured for Air Vehicle 1 on Contract 600332, Air Vehicle 2 on 600401, and Air Vehicle 3 on 600526. Effort on Air Vehicle 3 was 73% completed when the contract was terminated on March 9, 1964.

Residual inventory and tooling was transferred or disposed of in accordance with instructions from the Air Force and the proceeds credited to the appropriate contract.

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

4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 01
HORIZONTAL STABILIZER AND FLAPS

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOOLING AND STE HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	59051			59051
LABOR AT $ 5.052	298310			298310
ENGR BURDEN AT $ 4.507	266160			266160
PRODUCTION		2181		2181
LABOR AT $ 3.200		6980		6980
MFG BURDEN AT $ 4.127		9001		9001
SUBCONTRACT	2203729	3784068	4153083	10140880
MPC	90440	182813	124299	397552
SUB-TOTAL	2858639	3982862	4277382	11118883
GEN & ADMIN	29359	70918	76398	176675
TOTAL COST	2887998	4053780	4353780	11295558
TIME-PHASED COST DETAIL - SEE PAGE	III-148	III-152	III-155	III-156

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 01 **HORIZONTAL STABILIZER AND FLAPS**
6-MAJ ASSY 01
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		34	4.676	159	155	314
Q-2 58						
Q-3 58	6.0	1009	4.628	4670	3951	8621
Q-4 58						
Q-1 59	12.0	2070	4.518	9352	7117	16469
Q-2 59						
Q-3 59	15.0	2623	4.334	11369	9405	20774
Q-4 59						
Q-1 60	54.0	9351	4.305	40255	35549	75804
Q-2 60						
Q-3 60	39.0	6553	4.655	30504	24403	54907
Q-4 60						
Q-1 61	49.5	8481	4.827	40938	29183	70121
Q-2 61						
Q-3 61	30.0	5354	4.843	25929	24377	50306
Q-4 61						
Q-1 62	22.5	3845	5.331	20498	17745	38243
Q-2 62						
Q-3 62	22.5	3733	5.415	20214	19203	39417
Q-4 62						
Q-1 63	21.0	3705	6.725	24916	23182	48098
Q-2 63						
Q-3 63	28.5	4907	5.120	25124	24913	50037
Q-4 63						
Q-1 64	27.0	4573	5.922	27081	28773	55854
Q-2 64						
Q-3 64	12.0	2029	5.895	11961	13028	24989
Q-4 64						
Q-1 65	4.5	716	6.811	4877	4727	9604

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

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 01 HORIZONTAL STABILIZER AND FLAPS
6-MAJ ASSY 01
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		68	6.809	463	449	912
TOTAL	343.5	59051		298310	266160	564470

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 01
SUBD OF WORK DESIGN/ENGINEERING

HORIZONTAL STABILIZER AND FLAPS

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-1 58		34	4.676	159	155	314	
Q-2 58							
Q-3 58	6.0	1009	4.628	4670	3951	8621	
Q-4 58							
Q-1 59	12.0	2070	4.518	9352	7117	16469	56041
Q-2 59							
Q-3 59	15.0	2623	4.334	11369	9405	20774	1170682
Q-4 59							
Q-1 60	54.0	9351	4.305	40255	35549	75804	66809
Q-2 60							
Q-3 60	39.0	6553	4.655	30504	24403	54907	879142
Q-4 60							
Q-1 61	49.5	8481	4.827	40938	29183	70121	9383
Q-2 61							
Q-3 61	30.0	5354	4.843	25929	24377	50306	21672
Q-4 61							
Q-1 62	22.5	3845	5.331	20498	17745	38243	
Q-2 62							
Q-3 62	22.5	3733	5.415	20214	19203	39417	
Q-4 62							
Q-1 63	21.0	3705	6.725	24916	23182	48098	
Q-2 63							
Q-3 63	28.5	4907	5.120	25124	24913	50037	
Q-4 63							
Q-1 64	27.0	4573	5.922	27081	28773	55854	
Q-2 64							
Q-3 64	12.0	2029	5.895	11961	13028	24989	
Q-4 64							
Q-1 65	4.5	716	6.811	4877	4727	9604	
Q-2 65							
Q-3 65		68	6.809	463	449	912	
TOTAL	343.5	59051		298310	266160	564470	2203729

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01 **HORIZONTAL STABILIZER AND FLAPS**
6-MAJ ASSY 01
SUBD OF WORK DESIGN/ENGINEERING

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 58		314		314
Q-2 58				
Q-3 58		8621		8621
Q-4 58				
Q-1 59	1439	73949		73949
Q-2 59				
Q-3 59	31988	1223444		1223444
Q-4 59				
Q-1 60	3963	146576	2793	149369
Q-2 60				
Q-3 60	52162	986211	18790	1005001
Q-4 60				
Q-1 61	268	79772	1482	81254
Q-2 61				
Q-3 61	620	72598	1349	73947
Q-4 61				
Q-1 62		38243	642	38885
Q-2 62				
Q-3 62		39417	662	40079
Q-4 62				
Q-1 63		48098	804	48902
Q-2 63				
Q-3 63		50037	837	50874
Q-4 63				
Q-1 64		55854	1188	57042
Q-2 64				
Q-3 64		24989	532	25521
Q-4 64				
Q-1 65		9604	256	9860
Q-2 65				
Q-3 65		912	24	936
TOTAL	90440	2858639	29359	2887998

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

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	PRODUCTION
4-SYSTEM	1
5-SUBSYSTEM	01
6-MAJ ASSY	01
SUBD OF WORK	PRODUCTION

HORIZONTAL STABILIZER AND FLAPS

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 63	3.0	513	3.172	1627	2184	3811
Q-2 63						
Q-3 63	6.0	1043	3.070	3202	3850	7052
Q-4 63						
Q-1 64	1.5	200	3.875	775	1131	1906
Q-2 64						
Q-3 64	3.0	425	3.238	1376	1836	3212
TOTAL	13.5	2181		6980	9001	15981

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 01
6-MAJ ASSY 01
SUBD OF WORK PRODUCTION

HORIZONTAL STABILIZER AND FLAPS

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-1 61							10458
Q-2 61							
Q-3 61							672758
Q-4 61							
Q-1 62							678347
Q-2 62							
Q-3 62							1059248
Q-4 62							
Q-1 63	3.0	513	3.172	1627	2184	3811	571486
Q-2 63							
Q-3 63	6.0	1043	3.070	3202	3850	7052	236774
Q-4 63							
Q-1 64	1.5	200	3.875	775	1131	1906	554497
Q-2 64							
Q-3 64	3.0	425	3.238	1376	1836	3212	
TOTAL	13.5	2181		6980	9001	15981	3784068

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 01
SUBD OF WORK PRODUCTION

HORIZONTAL STABILIZER AND FLAPS

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 60			200	200
Q-2 60				
Q-3 60			12860	12860
Q-4 60				
Q-1 61	299	10757	11757	22514
Q-2 61				
Q-3 61	19275	692033	18344	710377
Q-4 61				
Q-1 62	21575	700422	10025	710447
Q-2 62				
Q-3 62	33634	1092882	4204	1097086
Q-4 62				
Q-1 63	24267	599564	13460	613024
Q-2 63				
Q-3 63	7609	251435	68	251503
Q-4 63				
Q-1 64	76154	632557		632557
Q-2 64				
Q-3 64		3212		3212
TOTAL	182813	3582862	70918	4053780

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NASA CONTRACT NAS9-12100

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01 **HORIZONTAL STABILIZER AND FLAPS**
6-MAJ ASSY 01
SUBD OF WORK TOOLING AND STE

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 60				6852	6852
Q-2 60					
Q-3 60				40749	40749
Q-4 60					
Q-1 61	358475	10270	368745	9920	378665
Q-2 61					
Q-3 61	2131756	61076	2192832	18186	2211018
Q-4 61					
Q-1 62	572796	18204	591000	208	591208
Q-2 62					
Q-3 62	1050126	33344	1083470	483	1083953
Q-4 62					
Q-1 63	11933	506	12439		12439
Q-2 63					
Q-3 63	27997	899	28896		28896
TOTAL	4153083	124299	4277382	76398	4353780

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

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 01
HORIZONTAL STABILIZER AND FLAPS

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		34	4.676	159	155	314
Q-2 58						
Q-3 58	6.0	1009	4.628	4670	3951	8621
Q-4 58						
Q-1 59	12.0	2070	4.518	9352	7117	16469
Q-2 59						
Q-3 59	15.0	2623	4.334	11369	9405	20774
Q-4 59						
Q-1 60	54.0	9351	4.305	40255	35549	75804
Q-2 60						
Q-3 60	39.0	6553	4.655	30504	24403	54907
Q-4 60						
Q-1 61	49.5	8481	4.827	40938	29183	70121
Q-2 61						
Q-3 61	30.0	5354	4.843	25929	24377	50306
Q-4 61						
Q-1 62	22.5	3845	5.331	20498	17745	38243
Q-2 62						
Q-3 62	22.5	3733	5.415	20214	19203	39417
Q-4 62						
Q-1 63	21.0	3705	6.725	24916	23182	48098
Q-2 63						
Q-3 63	28.5	4907	5.120	25124	24913	50037
Q-4 63						
Q-1 64	27.0	4573	5.922	27081	28773	55854
Q-2 64						
Q-3 64	12.0	2029	5.895	11961	13028	24989
Q-4 64						
Q-1 65	4.5	716	6.811	4877	4727	9604

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 01
6-MAJ ASSY 01
HORIZONTAL STABILIZER AND FLAPS

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-2 65						
Q-3 65		68	6.809	463	449	912
TOTAL	343.5	59051		298310	266160	564470

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

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

PRODUCTION
4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 01
HORIZONTAL STABILIZER AND FLAPS

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 63	3.0	513	3.172	1627	2184	3811
Q-2 63						
Q-3 63	6.0	1043	3.070	3202	3850	7052
Q-4 63						
Q-1 64	1.5	200	3.875	775	1131	1906
Q-2 64						
Q-3 64	3.0	425	3.238	1376	1836	3212
TOTAL	13.5	2181		6980	9001	15981

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 01
6-MAJ ASSY 01
HORIZONTAL STABILIZER AND FLAPS

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-1 58		34	4.676	159	155	314	
Q-2 58							
Q-3 58	6.0	1009	4.628	4670	3951	8621	
Q-4 58							
Q-1 59	12.0	2070	4.518	9352	7117	16469	56041
Q-2 59							
Q-3 59	15.0	2623	4.334	11369	9405	20774	1170682
Q-4 59							
Q-1 60	54.0	9351	4.305	40255	35549	75804	66809
Q-2 60							
Q-3 60	39.0	6553	4.655	30504	24403	54907	879142
Q-4 60							
Q-1 61	49.5	8481	4.827	40938	29183	70121	378316
Q-2 61							
Q-3 61	30.0	5354	4.843	25929	24377	50306	2826186
Q-4 61							
Q-1 62	22.5	3845	5.331	20498	17745	38243	1251643
Q-2 62							
Q-3 62	22.5	3733	5.415	20214	19203	39417	2109374
Q-4 62							
Q-1 63	24.0	4218	6.293	26543	25366	51909	583419
Q-2 63							
Q-3 63	34.5	5950	4.761	28326	28763	57089	264771
Q-4 63							
Q-1 64	28.5	4773	5.836	27856	29904	57760	554497
Q-2 64							
Q-3 64	15.0	2454	5.435	13337	14864	28201	
Q-4 64							
Q-1 65	4.5	716	6.811	4877	4727	9604	
Q-2 65							
Q-3 65		68	6.809	463	449	912	
TOTAL	357.0	61232		305290	275161	580451	10140380

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 01
6-MAJ ASSY 01
HORIZONTAL STABILIZER AND FLAPS

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 58		314		314
Q-2 58				
Q-3 58		8621		8621
Q-4 58				
Q-1 59	1439	73949		73949
Q-2 59				
Q-3 59	31988	1223444		1223444
Q-4 59				
Q-1 60	3963	146576	9845	156421
Q-2 60				
Q-3 60	52162	986211	72399	1058610
Q-4 60				
Q-1 61	10837	459274	23159	482433
Q-2 61				
Q-3 61	80971	2957463	37879	2995342
Q-4 61				
Q-1 62	39779	1329665	10875	1340540
Q-2 62				
Q-3 62	66978	2215769	5349	2221118
Q-4 62				
Q-1 63	24773	660101	14264	674365
Q-2 63				
Q-3 63	8508	330368	905	331273
Q-4 63				
Q-1 64	76154	688411	1188	689599
Q-2 64				
Q-3 64		28201	532	28733
Q-4 64				
Q-1 65		9604	256	9860
Q-2 65				
Q-3 65		912	24	936
TOTAL	397552	11118883	176675	11295558

TECHNICAL DESCRIPTION

SUBYSYSTEM: AIRFRAME STRUCTURE WBS CODE: 1.1

MAJOR ASSEMBLY: WING STRUCTURE WBS CODE: 1.1.2

The wing was a modified delta type consisting of a root section integral with the upper portion of the lower intermediate fuselage, an intermediate section (main wing panel) permanently welded to the root section, and a folding outer wing panel. The net loads in the wing were carried spanwise as shears in the intermediate spars and chordwise in ribs, front spar, fold ribs, root rib, and trailing edge ribs. Sandwich honeycomb cover panels withstood the biaxial bending loads and shear flows resulting from transfer of net loads. Wing ribs, brazed honeycomb panels, and full depth honeycomb wedge sections were constructed of PH15-7MO steel. Individual fittings for attachments of the elevons and outer folding wing panels were constructed of AM-355 steel, H-11 steel, or titanium alloy.

The two main wing panels were basically comprised of multispar construction with brazed steel honeycomb covers. These main wing panel assemblies were joined to the root section by welding. Three integral fuel tanks were provided in each main wing panel with resealable doors used in the fuel area to permit equipment installation access. The wing trailing edge contained provisions for mounting actuators and associated equipment for the elevons with doors provided in the lower surface for access to these actuators. The main wing panel spars were made with corrugated steel webs assembled into the main wing panel by welding. The wing leading edge was full depth brazed steel honeycomb made of PH15-7MO steel and were attached to the main wing panel by mechanical fasteners. See Exhibit 23, page III-163, for construction details.

Each wing included a folding outer wing panel made up of multispar construction with PH15-7MO brazed steel honeycomb sandwich covers. Wing folding was accomplished by hydraulically driven power hinges as part of the Secondary Flight Control Subsystem (WBS 1.6.2). The outer wing panel spars were made with corrugated PH15-7MO steel webs with these spars assembled to the cover panels by welding. Each outer wing panel incorporated a transparent tip for housing the navigation lights which were part of the Secondary Power Subsystem (WBS 1.4).

Each wing had six elevon segments which performed the function of ailerons and elevators. The elevons were made of PH15-7MO steel honeycomb construction with a full depth brazed steel honeycomb trailing edge and were assembled by welding. The elevon leading edge structure was of riveted construction made of 4Al-3MO-1V titanium alloy and was mechanically attached to the elevon. Provisions were incorporated in the folding outer wing panel for hydraulically centering the two outer elevon sections in a trail position when the outer wing panels were folded downward.

The wings had a maximum span of 105 ft. with a root chord of 117.8 ft., a tip chord of 2.2 ft., and a mean aerodynamic chord of 942.38 inches. The airfoil section designation was 30-70 hex mod. with a root thickness of 2% chord and a tip thickness of 2.5% chord. The incidence of the wing was zero degrees at the exposed root, decreasing to -3 degrees at the tip fold line with a constant -3 degrees on out to the tip. The mean camber of the wing leading edge was 9 min. at BP-0, 4 deg. 24 min. at BP-107, 3 deg. 9 min. at BP-153, 2 deg. 20 min. at BP-257 and zero degrees from BP-367 to the tip. Sweepback of the wing at the aerodynamic 25% chord was 58.8 degrees and the aspect ratio was 1.751. The dihedral of the wing on air vehicle No. 2 was 5 degrees while air vehicle No. 1 had a dihedral of zero degrees. (This was a development change which occurred too late to incorporate on air vehicle No. 1) The elevons had a chord of 9.67 ft., a span on each wing of 20.45 ft., and a maximum travel (pitch and roll) of ±30 degrees. The outer wing panel folded at BP-385.2 (1.5 deg. toe-in fold line) and had three positions; zero degrees, 25 degrees, and 65 degrees.

In addition to the obvious requirements of supporting and providing control moments to the air vehicle, the wing on the B-70 was a unique design providing aerodynamic optimization. The 2.5% thick delta planform was basically optimized for supersonic cruise; however, the takeoff and landing capabilities and characteristics were equal to or better than the supersonic fighters of that time. This was accomplished by special application of wing camber and the use of folding wing tips.

The wing was cambered by twisting the leading edge downward in the portion in-board of the folding tip hinge line. Since the wing tip position varied for subsonic and supersonic flight, the camber improved the airflow for both speed ranges and resulted in an improvement in subsonic handling characteristics, acceleration drag, and supersonic cruise capability. The folding wing tips provided increase directional stability in the folded position by increasing effective vertical surface area. This increased vertical surface area allowed smaller vertical tails to be utilized resulting in an overall reduction in drag. The deflected wing tips (521 sq. ft. each) also reduced the effective wing area near the trailing edge which shifted the aerodynamic center forward and reduced the longitudinal static stability margin. This reduction in static stability margin at supersonic speeds resulted in less trim required thus reducing trim drag. The effect of folding the wing tips on both directional stability and the shift in the aerodynamic center is graphically presented by Exhibit 24, page III-164.

The deflected wing tips also enhanced the "Compression Lift" concept discussed under Intermediate Fuselage (WBS 1.1.5). The gain in compression lift due to folded tips was the result of the inlet wedge shock waves bouncing off the tips causing a delta pressure rise under the wings. This delta improvement to compression lift enabled the air vehicle to cruise at essentially the same angle of attack despite the reduction to the lift curve slope caused by reduced effective wing area and the change in aspect ratio, tapes ratio, etc. Exhibit 25, page III-165, presents the delta L/D increments realized due to the folding wing tips.

WING PLANFORM

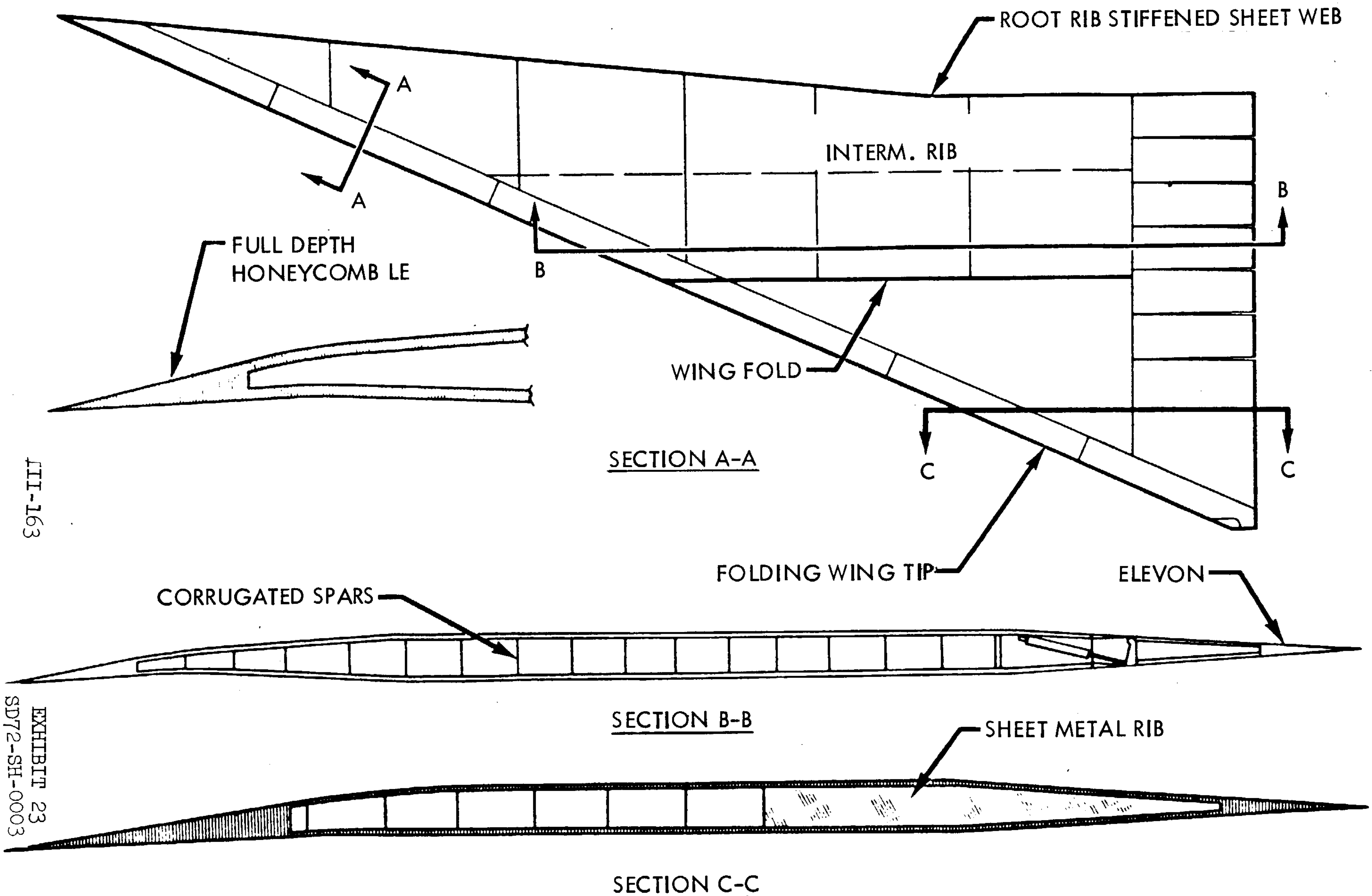
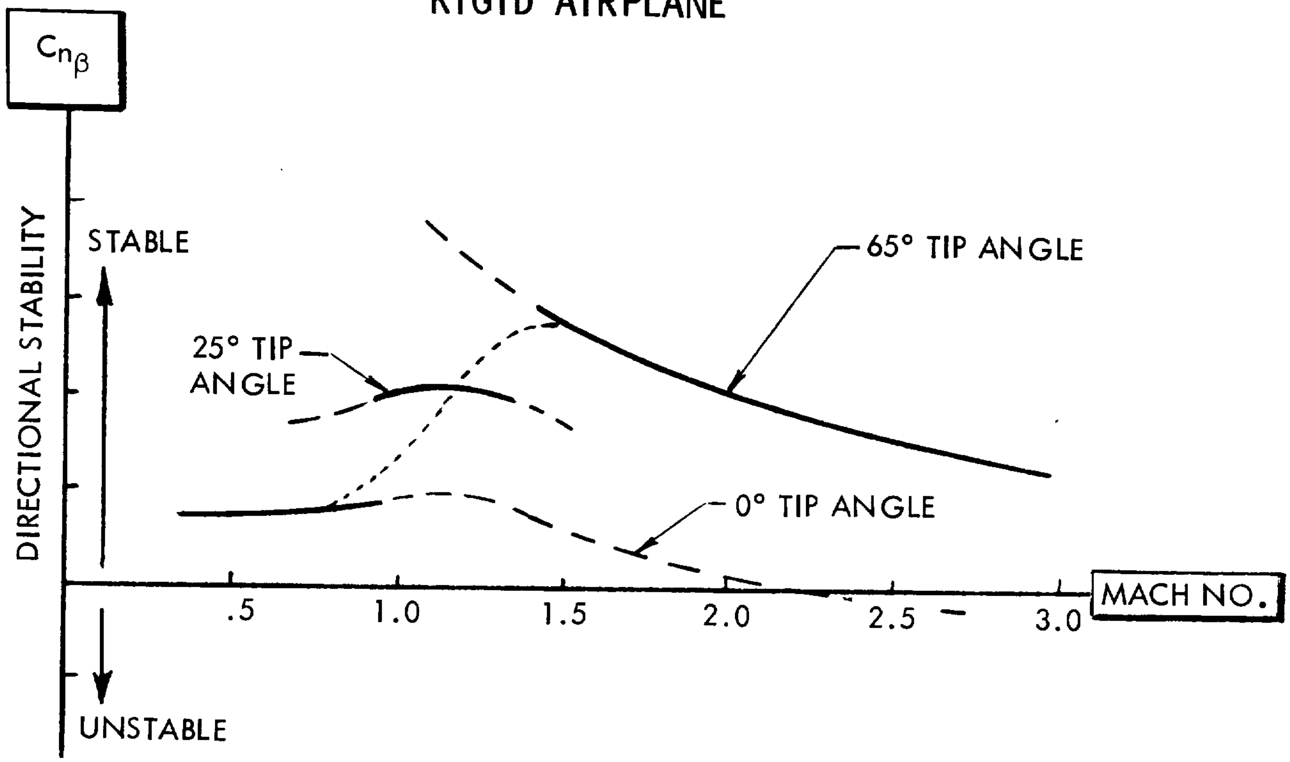


EXHIBIT 23
SD72-SH-0003

DIRECTIONAL STABILITY
RIGID AIRPLANE



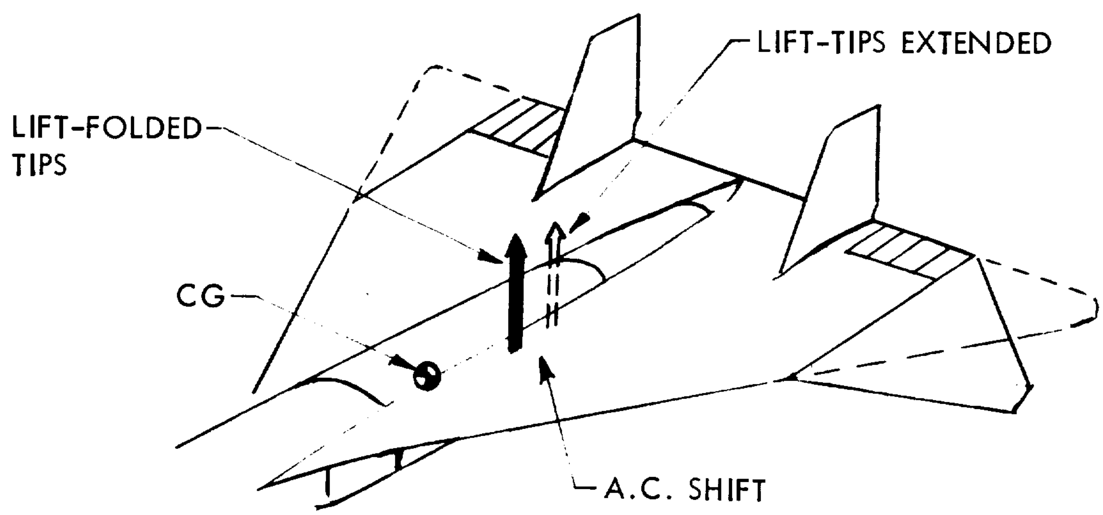
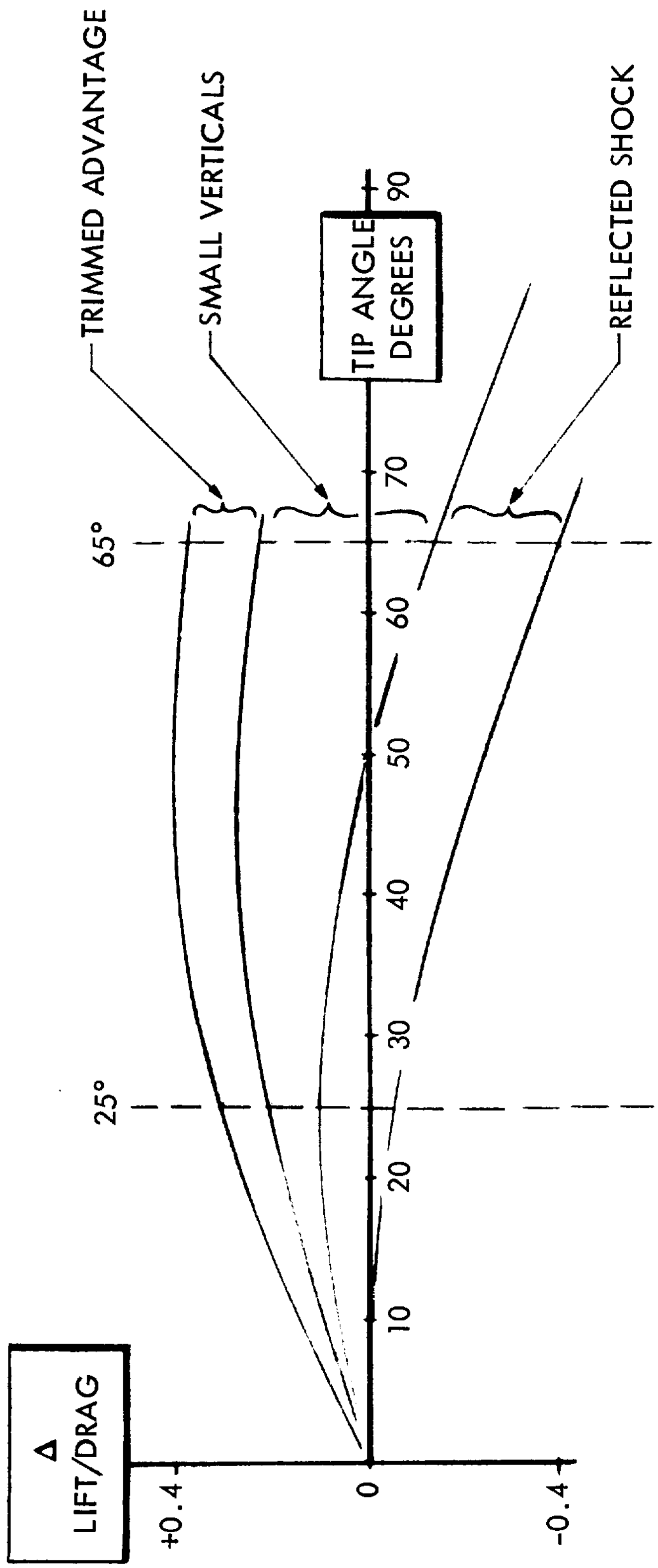


EXHIBIT 24

L/D RATIO VS WING TIP DEFLECTION ANGLE



TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: WING STRUCTURE WBS CODE: 1.1.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	Pounds	25,494	TBD	TBD	27,399	31,133
CONSTRUCTION	Type	- - -Multispar boxes with steel honeycomb covers, full depth honeycomb leading edges - - -				
MATERIALS	Type	- - PH15-7Mo Steel, 4Al-3Mo-1V Titanium, AM-355 steel, 6Al-4V Titanium, and H-11 tool steel - -				
SPAN	Feet	105	105	105	105	105
MAC	Inches	942.38	942.38	942.38	942.38	942.38
AREA (TOTAL)	$Feet^2$	6297.8	6297.8	6297.8	6297.8	6297.8
ASPECT RATIO	None	1.751	1.751	1.751	1.751	1.751
ANGLE OF DROOP AT HINGE	Degrees	5	5	3	3	3
DIHEDRAL	Degrees	0	0	0	0	5
ROOT CHORD	Feet	117.8	117.8	117.8	117.8	117.8
TIP CHORD	Feet	2.2	2.2	2.2	2.2	2.2
ELEVON AREA (WING TIPS UP)	$Feet^2$	197.7	197.7	197.7	197.7	197.7
(WING TIPS DOWN)	$Feet^2$	135.26	135.26	135.26	135.26	135.26
ELEVON TRAVEL (PITCH)	Degrees	-15 & +25	-15 & +25	-15 & +25	-15 & +25	± 20
(ROLL)	Degrees	± 15	± 15	± 15	± 15	± 15
(MAX COMBINED)	Degrees	± 30	± 30	± 30	± 30	± 30
ELEVONS (EACH SIDE)	Number	6	6	6	6	6
WING TIP TRAVEL (DOWN)	Degrees	0,25,50	0,25,65	0,25,65	0,25,65	0,25,65
WING TIP AREA (EACH)	$Feet^2$	520.9	520.9	520.9	520.9	520.9

Space Division
North American Rockwell

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: WING STRUCTURE WBS CODE: 1.1.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
AIRFOIL DESIGNATION WING THICKNESS (ROOT) (TIP)	Type % Chord % Chord	30-70 2.0 2.5	30-70 2.0 2.5	30-70 2.0 2.5	30-70 2.0 2.5	30-70 2.0 2.5
SWEEPBACK (AT 25% AERO CHORD) TAPER RATIO FUEL TANKS (TOTAL)	Degrees None No.	58.8 0.019 8	58.8 0.019 6	58.8 0.019 6	58.8 0.019 6	58.8 0.019 6
INTERNAL FUEL (TOTAL)	Gallons	25,563	18,968	18,968	19,224	17,617

COST DEFINITION

SUBSYSTEM: AIRFRAME STRUCTURE — WBS CODE: 1.1

MAJOR ASSEMBLY: WING — WBS CODE: 1.1.2

Recorded costs of $63,935,695 include all identifiable in-house and subcontracted effort to design and fabricate the wing structure as defined by the Work Breakdown Structure. A detail discussion of the vendors involved with this major structural assembly is contained on page III-169.

The in-house engineering effort includes the design and vendor support activities only. It excludes the design support effort as these can not be identified at a level lower than WBS level 5 (Airframe Structure). The Engineering Group Matrix on page III-69 recaps the hours charged by the engineering design groups associated with this major assembly.

In-house production effort includes all identifiable costs to fabricate and assemble the structural components included in this WBS item. Specifically excluded from the production costs are:

a) Mating of the wing to the fuselage (WBS 3.0). Fuel tank sealing problems in the wing and wing stub area are discussed as a Technical Driver on page III-35. Costs associated with fuel tank sealing are contained in WBS 3.0.
b) Fabrication and installation of subsystem provisions (brackets, supports, frames, etc.) or equipment (WBS 1.12).
c) In-house ground testing activities (WBS 1.1.8).
d) Vehicle checkout and preflight operations (WBS 1.12).

Subcontractor costs for this major assembly include all vendor engineering, production, tooling and testing costs. These are displayed in the subcontractor Element of Cost within the appropriate Subdivision of Work. Additional vendor data is contained on page III-169.

SUBCONTRACTOR MATRIX

SUBSYSTEM: AIRFRAME STRUCTURE — WBS CODE: 1.1

MAJOR ASSEMBLY: WING ASSEMBLY — WBS CODE: 1.1.2

SUBCONTRACTOR	ENG'R'G	PROD.	TOOLING	TEST	TOTAL
Boeing	10,758,428	7,490,747	1,473,195	--	19,722,370
Aeronca	497,015	5,399,887	4,476,187	--	10,373,089
Convair	5,392	2,488,777	92,073	--	2,586,242
Rohr	--	5,617,663	2,222,400	57,356	7,897,419
LTV	--	332,974	--	--	332,974
Automation	--	292,518	--	--	292,518
Total	11,260,835	21,622,566	8,263,855	57,356	41,204,612

BOEING was awarded letter contract L-966-XH-600103 on February 2, 1959, for the Fixed Wing Structure. The contract was terminated December 8, 1959 for the convenience of the Government.

The Statement of Work directed the subcontractor to provide engineering, management, planning services, tool planning, design and fabrication services directed toward the design and production of the B-70 Wing. In addition, effort was to continue with research and development and management development necessary for the performance of the foregoing.

The expenditure of effort and progress made was essentially Research and Developmental at the time of contract termination, with major fabrication of hardware scheduled later in time. Therefore, the fabrication effort accounted for a relatively small portion of the overall percentage of completion. The initial Research and Development phase involved concept studies, analysis, design, test, planning, and the initiation of tooling and production. The percentage of completion of the B-70 Wing Program was 31.677% as of December 8, 1959, the date of termination. Subsequent program and configuration changes obsoleted the wing design and tooling produced by this contract and therefore they were not used on the final B-70 air vehicle.

WBS CODE: 1.1.2

AERONCA was selected to produce the Folding Wing Tip Assembly and the Wing Box. The three letter contracts awarded to Aeronca for this effort, along with their award and completion dates, are as follows:

LOA1-XZ-600205	Sept. 2, 1960 - May 1, 1962
L1A1-YZ-600324	Nov. 14, 1960 - April 8, 1964
L3A1-YJ-600519	Nov. 27, 1962 - Mar. 6, 1964

The Statement of Work for the three contracts directed the subcontractor to provide design, tooling, and production of the B-70 Wing Tip Leading Edge, Wing Tip Aft Box Assembly, and the Wing Box Assembly for Air Vehicles 1, 2, and 3. The subcontractor was required to plan, design, and fabricate all master tooling, detail tooling, and assembly tooling as required to perform the work called for in the purchase order. However, some masters were furnished by NR and were included in the scope of work. In addition, the tooling fabricated by the subcontractor was coordinated with master tooling furnished by NR to satisfy interchangeability, replaceability, and mating requirements.

Purchase Order 600205 covered the fabrication of the left and right hand Wing Tip Leading Edges, left and right hand Wing Tip Aft Box Assemblies, and the left and right hand Wing Box Assemblies for Air Vehicle 1. A second set of left and right hand Wing Tip Leading Edges were scrapped in December 1962.

Purchase Order 600324 covered the same wing assemblies for Air Vehicle 2, together with the additional tooling required over that furnished for Air Vehicle 1. In addition, nine left hand and nine right hand Root Rib Assemblies were included in this purchase order.

Purchase Order 600519 covered fabrication of the Wing Tip Leading Edges, Wing Tip Aft Box Assemblies, Wing Box Assemblies, and the loose Root Rib Assemblies for the B-70 Air Vehicle 3. In addition, SST Instrumentation for prime contract AF33(657)-10232, amounting to $10,564.00 was included.

The above assemblies were furnished for Air Vehicle 3 on Purchase Order 600519. This effort was 84% completed on March 6, 1964, the date the contract was terminated.

CONVAIR was selected to produce three Inboard Wing Boxes joined, the Forward Portion of the Folding Wing Tip, Sine Waves, and Sine Wave Spars. Three letter contracts were awarded to Convair for this effort, L1A1-YZ-600328, L1A1-XZ-600331, L1A1-YZ-600415. Purchase Order 600331, which covered the tooling and fabrication of the Inboard Wing Boxes joined, was awarded December 7, 1960 and terminated March 31, 1961; 31.5% of the effort was completed at the time of termination.

The Sine Waves and Sine Wave Spars were completed on schedule.

WBS CODE: 1.1.2

ROHR was selected to produce the Elevons, Leading Edges and four Bulkheads for the B-70 program.

Two major purchase orders were issued for this effort:

L0A1-XZ-600207	February 12, 1960 - February 4, 1963
L1A1-YZ-600322	November 14, 1960 - January 22, 1964

The Statement of Work for the two contracts required the subcontractor to provide technical and manufacturing services and facilities; design and fabricate tooling, detailed and machine parts, and accomplish such other work as may be required to fabricate and deliver a set of Elevons, Leading Edges, and four Bulkheads for Air Vehicles 1 and 2.

The schedule shipping dates for Air Vehicle 1 began on August 24, 1961, with partial deliveries intermittently scheduled until final delivery was made on February 4, 1963.

The schedules shipping dates for Air Vehicle 2 began on November 16, 1962, with partial deliveries intermittently scheduled until final delivery was made on January 22, 1964.

All items of residual inventory were disposed of and all tooling accountable to this order that was determined to be obsolete was scrapped and the resulting credits applied to the appropriate contract.

LTV - The fabrication of the B-70 Leading Edges was originally awarded to Rohr Corporation but due to brazing and other problems it became necessary to move fabrication of some units to LTV. Material and tooling also was transferred from Rohr to LTV.

Two Purchase Orders were issued for this effort:

L2A1-YZ-600412	April 10, 1962 - October 1, 1962
L3A1-YJ-600501	October 18, 1962 - April 1, 1963

The Statement of Work for the two contracts required LTV to fabricate two Leading Edge Assemblies for Air Vehicle 1, and Air Vehicle 2. Each Leading Edge is approximately 25 square feet.

On December 20, 1962, the scope of work on Purchase Order 600501 was increased to include the fabrication of two additional Wing Leading Edges, which up to that time were held by N.A.A. Engineering for redesign to accommodate the Wing Dihedral change. The additional units totaled 16 square feet each and utilized the welded - skin method of fabrication rather than the chemmilled method employed on Air Vehicle 1.

WBS CODE: 1.1.2

Delivery of the Leading Edge Assemblies for Air Vehicle 1 were scheduled for delivery in May 1962. Scrappage of one assembly extended the period of performance to October 1962. Delivery of the four units for Air Vehicle 2 were scheduled for February and April 1963.

The residual inventory was disposed of as scrap and the remainder was transferred for use on other B-70 purchase orders at LTV.

AUTOMATION was selected to produce a minor Wing Rib Assembly, Wing Spars, and Edge Members.

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 01
6-MAJ ASSY 02
WING STRUCTURE

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOOLING AND STE HOURS DOLLARS	TEST /QC HOURS DOLLARS
DESIGN/ENGINEERING	882119	6737		
LABOR AT $ 4.961	4380539	28672		
ENGR BURDEN AT $ 4.248	3736250	39643		
PRODUCTION		1083335		
LABOR AT $ 3.221		3489030		
PLANNING		63342		
LABOR AT $ 3.386		214508		
TEST/QC		133658		
LABOR AT $ 3.627		484737		
MFG BURDEN AT $ 4.046		5180191		
MFG MATERIAL		2528839		
SUBCONTRACT	11260835	21622566	8263855	57356
MPC	384625	1077985	299706	1678
SUB-TOTAL	19762249	34666171	8563561	59034
GEN & ADMIN	226126	515037	142442	1075
TOTAL COST	19988375	35181208	8706003	60109
TIME-PHASED COST DETAIL - SEE PAGE	III-175	III-179	III-185	III-186

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 01
6-MAJ ASSY 02
WING STRUCTURE

			TOTAL HOURS DOLLARS
DESIGN/ENGINEERING			888856
LABOR AT $	4.961		4409211
ENGR BURDEN	AT $	4.248	3775893
PRODUCTION			1083365
LABOR AT $	3.221		3489039
PLANNING			63343
LABOR AT $	3.386		214508
TEST/QC			133658
LABOR AT $	3.627		484737
MFG BURDEN	AT $	4.046	5180191
MFG MATERIAL			2528839
SUBCONTRACT			41204612
MPC			1763994
SUB-TOTAL			63051015
GEN & ADMIN			884680
TOTAL COST			63935695

TIME-PHASED COST DETAIL - SEE PAGE III-187

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 01 **WING STRUCTURE**
6-MAJ ASSY 02
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	2.5	377	4.671	1761	1715	3476
Q-2 58						
Q-3 58	58.5	9945	4.628	46025	38945	84970
Q-4 58						
Q-1 59	108.0	18471	4.518	83452	63503	146955
Q-2 59						
Q-3 59	57.0	10042	4.365	43832	36036	79868
Q-4 59						
Q-1 60	601.5	104273	4.423	461205	398334	859539
Q-2 60						
Q-3 60	925.5	155370	4.655	723247	578598	1301845
Q-4 60						
Q-1 61	1116.0	190438	4.827	919244	655297	1574541
Q-2 61						
Q-3 61	823.5	149222	4.843	722682	679408	1402090
Q-4 61						
Q-1 62	564.0	96350	5.331	513642	444655	958297
Q-2 62						
Q-3 62	387.0	65021	5.415	352089	334468	686557
Q-4 62						
Q-1 63	238.5	40660	6.725	273439	254410	527849
Q-2 63						
Q-3 63	72.0	12045	5.120	61670	61152	122822
Q-4 63						
Q-1 64	117.0	19927	5.922	118008	125381	243389
Q-2 64						
Q-3 64	48.0	8425	5.895	49665	54097	103762
Q-4 64						
Q-1 65	7.5	1303	6.811	8875	8602	17477

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 01
6-MAJ ASSY 02
SUBD OF WORK DESIGN/ENGINEERING

WING STRUCTURE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-2 65						
Q-3 65	1.5	250	6.812	1703	1649	3352
TOTAL	5128.0	982119		4380539	3736250	8116789

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 01 **WING STRUCTURE**
6-MAJ ASSY 02
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-1 58	2.5	377	4.671	1761	1715	3476	
Q-2 58							
Q-3 58	58.5	9945	4.628	46025	38945	84970	
Q-4 58							
Q-1 59	108.0	18471	4.518	83452	63503	146955	1672006
Q-2 59							
Q-3 59	57.0	10042	4.365	43832	36036	79868	5312080
Q-4 59							
Q-1 60	601.5	104273	4.423	461205	398334	859539	1852258
Q-2 60							
Q-3 60	925.5	155370	4.655	723247	578598	1301845	235417
Q-4 60							
Q-1 61	1116.0	190438	4.527	919244	655297	1574541	31285
Q-2 61							
Q-3 61	823.5	149222	4.843	722682	679408	1402090	1571457
Q-4 61							
Q-1 62	564.0	96350	5.331	513642	444655	958297	312426
Q-2 62							
Q-3 62	387.0	65021	5.415	352089	334468	686557	104763
Q-4 62							
Q-1 63	238.5	40660	6.725	273439	254410	527849	91687
Q-2 63							
Q-3 63	72.0	12045	5.120	61670	61152	122822	46349
Q-4 63							
Q-1 64	117.0	19927	5.922	118006	125381	243369	18540
Q-2 64							
Q-3 64	48.0	8425	5.895	49665	54097	103762	9607
Q-4 64							
Q-1 65	7.5	1303	6.311	8575	8602	17477	2360
Q-2 65							
Q-3 65	1.5	250	6.812	1703	1649	3352	
TOTAL	5128.0	882119		4380539	3736250	8116789	11260835

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 01
6-MAJ ASSY 02
SUBD OF WORK DESIGN/ENGINEERING

WING STRUCTURE

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 58		3476		3476
Q-2 58				
Q-3 58		84970		84970
Q-4 58				
Q-1 59	44360	1863921		1863921
Q-2 59				
Q-3 59	145398	5537346		5537346
Q-4 59				
Q-1 60	109894	2821691	53762	2875453
Q-2 60				
Q-3 60	13967	1551229	29556	1580785
Q-4 60				
Q-1 61	896	1606722	29858	1636580
Q-2 61				
Q-3 61	45023	3018570	56094	3074664
Q-4 61				
Q-1 62	9929	1280652	21496	1302148
Q-2 62				
Q-3 62	3326	794646	13338	807984
Q-4 62				
Q-1 63	3893	623429	10424	633853
Q-2 63				
Q-3 63	1489	170660	2853	173513
Q-4 63				
Q-1 64	2546	264475	5627	270102
Q-2 64				
Q-3 64	3134	116503	2479	118982
Q-4 64				
Q-1 65	770	20607	550	21157
Q-2 65				
Q-3 65		3352	89	3441
TOTAL	384625	19762249	226126	19988375

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

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 02
SUBD OF WORK PRODUCTION

WING STRUCTURE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	7.5	1257	5.414	6806	904	7710
Q-4 58						
Q-1 59	9.0	1534	5.465	8384	1309	9693
Q-2 59						
Q-3 59	15.0	2616	5.361	14025	2406	16431
Q-4 59						
Q-1 60	6.0	1003	5.589	5606	1137	6793
Q-2 60						
Q-3 60		22	4.045	89	-71	18
Q-4 60						
Q-1 61		57	4.947	282	288	570
Q-2 61						
Q-3 61		49	2.959	145	66	211
Q-4 61						
Q-1 62		57	2.719	155	467	622
Q-2 62						
Q-3 62	1.5	348	3.555	1237	2139	3376
Q-4 62						
Q-1 63	1.5	174	3.328	579	1092	1671
Q-2 63						
Q-3 63	-39.0	-6469	5.364	-34699	-6526	-41225
Q-4 63						
Q-1 64	3.0	614	4.570	2806	3664	6470
Q-2 64						
Q-3 64	13.5	2384	4.452	10614	14981	25595
Q-4 64						
Q-1 65	7.5	1264	4.453	5629	7859	13488
Q-2 65						
Q-3 65	10.5	1827	3.839	7014	9878	16892
TOTAL	36.0	6737		28672	39643	68315

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

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	PRODUCTION
4-SYSTEM	1
5-SUBSYSTEM	01
6-MAJ ASSY	02
SUBD OF WORK	PRODUCTION

WING STRUCTURE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 60	3.0	592	4.738	2805	1431	4236
Q-2 60						
Q-3 60	7.5	1147	2.412	2766	2237	5003
Q-4 60						
Q-1 61	306.0	52114	3.143	163786	196234	360020
Q-2 61						
Q-3 61	865.5	157048	3.152	494981	629972	1124953
Q-4 61						
Q-1 62	1114.5	190266	3.067	585532	788835	1372367
Q-2 62						
Q-3 62	780.0	131098	3.228	423123	607809	1030932
Q-4 62						
Q-1 63	801.0	135515	3.302	451106	620562	1071668
Q-2 63						
Q-3 63	870.0	146103	2.785	406951	658686	1065637
Q-4 63						
Q-1 64	1018.5	173878	3.586	623583	1039341	1662924
Q-2 64						
Q-3 64	318.0	56017	3.380	189310	324443	513753
Q-4 64						
Q-1 65	213.0	36995	3.571	132124	201385	333509
Q-2 65						
Q-3 65	9.0	1492	10.029	14963	19527	34490
TOTAL	6306.0	1083365		3489030	5090462	8579492

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

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	PLANNING
4-SYSTEM	1
5-SUBSYSTEM	01
6-MAJ ASSY	02
SUBD OF WORK	PRODUCTION

WING STRUCTURE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	1.5	177	3.000	531		531
Q-4 58						
Q-1 59	4.5	889	2.958	2630		2630
Q-2 59						
Q-3 59	12.0	2176	2.998	6524		6524
Q-4 59						
Q-1 60	25.5	4355	3.160	13760	66	13826
Q-2 60						
Q-3 60	36.0	5997	3.043	18249		18249
Q-4 60						
Q-1 61	63.0	10751	3.017	32434	5353	37787
Q-2 61						
Q-3 61	57.0	10351	2.907	30034	5302	35336
Q-4 61						
Q-1 62	52.5	9081	2.978	27045	5296	32341
Q-2 62						
Q-3 62	48.0	8070	2.970	24019	5667	29686
Q-4 62						
Q-1 63						
Q-2 63						
Q-3 63	21.0	3627	9.300	33732	29535	63267
Q-4 63						
Q-1 64	32.0	5560	3.228	17945	27004	44949
Q-2 64						
Q-3 64	9.0	1509	3.340	5040	7374	12414
Q-4 64						
Q-1 65	3.0	627	3.148	1974	2767	4741
Q-2 65						
Q-3 65	1.5	193	3.166	611	1365	1976
TOTAL	367.5	63343		214508	89729	304237

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

	TEST/QC
4-SYSTEM	1
5-SUBSYSTEM	01
6-MAJ ASSY	02
SUBD OF WORK	PRODUCTION

WING STRUCTURE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		85	4.906	417		417
Q-4 58						
Q-1 59		81	4.259	345		345
Q-2 59						
Q-3 59	3.0	407	4.663	1898		1898
Q-4 59						
Q-1 60	4.5	772	5.004	3863		3863
Q-2 60						
Q-3 60	1.5	143	3.902	558		558
Q-4 60						
Q-1 61	21.0	3601	3.133	11283		11283
Q-2 61						
Q-3 61	55.5	10162	3.120	31706		31706
Q-4 61						
Q-1 62	94.5	16183	3.302	53431		53431
Q-2 62						
Q-3 62	96.0	16034	3.375	54107		54107
Q-4 62						
Q-1 63	102.0	17359	3.629	62995		62995
Q-2 63						
Q-3 63	127.5	21468	4.268	91636		91636
Q-4 63						
Q-1 64	175.5	29825	3.590	107062		107062
Q-2 64						
Q-3 64	67.5	11983	3.586	42974		42974
Q-4 64						
Q-1 65	28.5	4864	3.906	19001		19001
Q-2 65						
Q-3 65	4.5	691	5.009	3461		3461
TOTAL	781.5	133658		484737		484737

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

4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 02
SUBD OF WORK PRODUCTION

WING STRUCTURE

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	MFG MATL
Q-3 58	9.0	1519	5.105	7754	904	8658	
Q-4 58							
Q-1 59	13.5	2504	4.536	11359	1309	12668	
Q-2 59							
Q-3 59	30.0	5199	4.314	22427	2406	24833	
Q-4 59							
Q-1 60	39.0	6722	3.873	26034	2684	28718	41
Q-2 60							
Q-3 60	45.0	7309	2.964	21662	2166	23828	1424
Q-4 60							
Q-1 61	390.0	66523	3.124	207785	201875	409660	91575
Q-2 61							
Q-3 61	978.0	177590	3.136	556866	635340	1192206	401927
Q-4 61							
Q-1 62	1261.5	215587	3.081	664168	794593	1458761	343075
Q-2 62							
Q-3 62	925.5	155550	3.230	502486	615615	1118101	320086
Q-4 62							
Q-1 63	904.5	154148	3.339	514680	621654	1136334	379405
Q-2 63							
Q-3 63	979.5	164729	3.021	497620	681695	1179315	335453
Q-4 63							
Q-1 64	1230.0	209877	3.580	751396	1070009	1821405	388988
Q-2 64							
Q-3 64	408.0	71893	3.449	247943	346793	594736	112045
Q-4 64							
Q-1 65	252.0	43760	3.629	158728	212011	370739	12850
Q-2 65							
Q-3 65	25.5	4203	6.198	26049	30770	56819	91370
TOTAL	7491.0	1287103		4216947	5219834	9436781	2528839

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 02
SUBD OF WORK PRODUCTION

WING STRUCTURE

	SUBC	TOTAL MATERIAL	MPC	SUB TOTAL	G & A	TOTAL COST
Q-3 58				8658		8658
Q-4 58						
Q-1 59	376336	376336	9978	398982		398982
Q-2 59						
Q-3 59	5882864	5882864	160749	6068446		6068446
Q-4 59						
Q-1 60	1704130	1704171	101111	1834000	34943	1868943
Q-2 60						
Q-3 60	247477	248901	14870	287599	5480	293079
Q-4 60						
Q-1 61	2163290	2254965	69722	2734347	50812	2785159
Q-2 61						
Q-3 61	4026881	4428808	149264	5770278	107229	5877507
Q-4 61						
Q-1 62	2307222	2650297	100349	4209407	70655	4280062
Q-2 62						
Q-3 62	1992080	2312166	88464	3518731	59062	3577793
Q-4 62						
Q-1 63	1585897	1965302	104723	3206359	53610	3259969
Q-2 63						
Q-3 63	805844	1191297	63874	2434486	40705	2475191
Q-4 63						
Q-1 64	321266	710254	85588	2617247	55690	2672937
Q-2 64						
Q-3 64	167644	279689	95471	969896	20637	990533
Q-4 64						
Q-1 65	41635	54495	17430	442654	11810	454464
Q-2 65						
Q-3 65		91870	16392	165081	4404	169485
TOTAL	21622566	24151405	1077985	34666171	515037	35181208

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

4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 02
SUBD OF WORK TOOLING AND STE

WING STRUCTURE

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 59	41815	1108	42923		42923
Q-2 59					
Q-3 59	584176	15962	600138		600138
Q-4 59					
Q-1 60	256732	15231	271963	5181	277144
Q-2 60					
Q-3 60	95397	5660	101057	1925	102982
Q-4 60					
Q-1 61	1752218	50202	1802420	33494	1835914
Q-2 61					
Q-3 61	2303901	66009	2369910	44040	2413950
Q-4 61					
Q-1 62	1114483	35420	1149903	19301	1169204
Q-2 62					
Q-3 62	998274	31698	1029972	17288	1047260
Q-4 62					
Q-1 63	607571	25799	633370	10590	643960
Q-2 63					
Q-3 63	307136	9870	317006	5300	322306
Q-4 63					
Q-1 64	122854	16872	139726	2973	142699
Q-2 64					
Q-3 64	63661	20773	84434	1797	86231
Q-4 64					
Q-1 65	15637	5102	20739	553	21292
TOTAL	8263855	299706	8563561	142442	8706003

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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 01
6-MAJ ASSY 02
SUBD OF WORK TEST/QC

WING STRUCTURE

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 60				393	393
Q-2 60					
Q-3 60				479	479
Q-4 60					
Q-1 61	20539	588	21127	113	21240
Q-2 61					
Q-3 61	25069	718	25787	90	25877
Q-4 61					
Q-1 62	6527	207	6734		6734
Q-2 62					
Q-3 62	5221	165	5386		5386
TOTAL	57356	1678	59034	1075	60109

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

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 02
WING STRUCTURE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	2.5	377	4.671	1761	1715	3476
Q-2 58						
Q-3 58	66.0	11202	4.716	52831	39849	92680
Q-4 58						
Q-1 59	117.0	20005	4.591	91836	64812	156648
Q-2 59						
Q-3 59	72.0	12658	4.571	57857	38442	96299
Q-4 59						
Q-1 60	607.5	105276	4.434	466811	399521	866332
Q-2 60						
Q-3 60	925.5	155392	4.655	723336	578527	1301863
Q-4 60						
Q-1 61	1116.0	190495	4.827	919526	655585	1575111
Q-2 61						
Q-3 61	823.5	149271	4.842	722827	679474	1402301
Q-4 61						
Q-1 62	565.5	96407	5.329	513797	445122	958919
Q-2 62						
Q-3 62	338.5	65369	5.405	353326	336607	689933
Q-4 62						
Q-1 63	240.0	40834	6.711	274018	255502	529520
Q-2 63						
Q-3 63	33.0	5576	4.837	26971	54626	81597
Q-4 63						
Q-1 64	120.0	20541	5.882	120814	129045	249859
Q-2 64						
Q-3 64	61.5	10809	5.577	60279	69078	129357
Q-4 64						
Q-1 65	15.0	2567	5.650	14504	16461	30965

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 01
6-MAJ ASSY 02
WING STRUCTURE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-2 65						
Q-3 65	12.0	2077	4.197	8717	11527	20244
TOTAL	5165.5	889856		4409211	3775893	8185104

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

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

PRODUCTION
4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 02
WING STRUCTURE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 60	3.0	592	4.738	2805	1431	4236
Q-2 60						
Q-3 60	7.5	1147	2.412	2766	2237	5003
Q-4 60						
Q-1 61	306.0	52114	3.143	163786	196234	360020
Q-2 61						
Q-3 61	865.5	157048	3.152	494981	629972	1124953
Q-4 61						
Q-1 62	1114.5	190266	3.067	583532	788835	1372367
Q-2 62						
Q-3 62	780.0	131098	3.228	423123	607809	1030932
Q-4 62						
Q-1 63	801.0	136615	3.302	451106	620562	1071668
Q-2 63						
Q-3 63	870.0	146103	2.785	406951	658686	1065637
Q-4 63						
Q-1 64	1018.5	173878	3.586	623583	1039341	1662924
Q-2 64						
Q-3 64	318.0	56017	3.380	189310	324443	513753
Q-4 64						
Q-1 65	213.0	36995	3.571	132124	201385	333509
Q-2 65						
Q-3 65	9.0	1492	10.029	14963	19527	34490
TOTAL	6306.0	1083365		3489030	5090462	8579492

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

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

PLANNING
4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 02
WING STRUCTURE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	1.5	177	3.000	531		531
Q-4 58						
Q-1 59	4.5	889	2.958	2630		2630
Q-2 59						
Q-3 59	12.0	2176	2.989	6504		6504
Q-4 59						
Q-1 60	25.5	4355	3.160	13760	66	13826
Q-2 60						
Q-3 60	36.0	5997	3.043	18249		18249
Q-4 60						
Q-1 61	63.0	10751	3.017	32434	5353	37787
Q-2 61						
Q-3 61	57.0	10331	2.907	30034	5302	35336
Q-4 61						
Q-1 62	52.5	9081	2.978	27045	5296	32341
Q-2 62						
Q-3 62	48.0	8070	2.976	24019	5667	29686
Q-4 62						
Q-1 63						
Q-2 63						
Q-3 63	21.0	3627	9.300	33732	29535	63267
Q-4 63						
Q-1 64	33.0	5560	3.228	17945	27004	44949
Q-2 64						
Q-3 64	9.0	1509	3.340	5040	7374	12414
Q-4 64						
Q-1 65	3.0	627	3.148	1974	2767	4741
Q-2 65						
Q-3 65	1.5	193	3.166	611	1365	1976
TOTAL	367.5	63343		214508	89729	304237

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 01
6-MAJ ASSY 02
WING STRUCTURE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		85	4.906	417		417
Q-4 58						
Q-1 59		81	4.259	345		345
Q-2 59						
Q-3 59	3.0	407	4.663	1898		1898
Q-4 59						
Q-1 60	4.5	772	5.004	3863		3863
Q-2 60						
Q-3 60	1.5	143	3.902	558		558
Q-4 60						
Q-1 61	21.0	3601	3.133	11283		11283
Q-2 61						
Q-3 61	55.5	10162	3.120	31706		31706
Q-4 61						
Q-1 62	94.5	16183	3.302	53431		53431
Q-2 62						
Q-3 62	96.0	16034	3.375	54107		54107
Q-4 62						
Q-1 63	102.0	17359	3.629	62995		62995
Q-2 63						
Q-3 63	127.5	21468	4.268	91636		91636
Q-4 63						
Q-1 64	175.5	29825	3.590	107062		107062
Q-2 64						
Q-3 64	67.5	11983	3.586	42974		42974
Q-4 64						
Q-1 65	28.5	4864	3.906	19001		19001
Q-2 65						
Q-3 65	4.5	691	5.009	3461		3461
TOTAL	781.5	133658		484737		484737

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 01
6-MAJ ASSY 02
WING STRUCTURE

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	MFG MATL
Q-1 58	2.5	377	4.671	1761	1715	3476	
Q-2 58							
Q-3 58	67.5	11464	4.691	53779	39849	93628	
Q-4 58							
Q-1 59	121.5	20975	4.520	94811	64812	159623	
Q-2 59							
Q-3 59	87.0	15241	4.347	66259	38442	104701	
Q-4 59							
Q-1 60	640.5	110995	4.390	487239	401018	888257	41
Q-2 60							
Q-3 60	970.5	162679	4.579	744909	580764	1325673	1424
Q-4 60							
Q-1 61	1506.0	256961	4.386	1127029	857172	1984201	91675
Q-2 61							
Q-3 61	1801.5	326812	3.915	1279548	1314748	2594296	401927
Q-4 61							
Q-1 62	1827.0	311937	3.776	1177805	1239253	2417058	343075
Q-2 62							
Q-3 62	1312.5	220571	3.874	854575	950083	1804658	320086
Q-4 62							
Q-1 63	1143.0	194808	4.046	788119	876064	1664183	379405
Q-2 63							
Q-3 63	1051.5	176774	3.164	559290	742847	1302137	385453
Q-4 63							
Q-1 64	1347.0	229804	3.783	869404	1195390	2064794	388938
Q-2 64							
Q-3 64	456.0	80318	3.705	297603	400895	698498	112045
Q-4 64							
Q-1 65	259.5	45053	3.720	167603	220613	388216	12850
Q-2 65							
Q-3 65	27.0	4453	6.232	27752	32419	60171	91870
TOTAL	12620.5	2169222		8597486	8956084	17553570	2528839

C-3

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 01
6-MAJ ASSY 02
WING STRUCTURE

	SUBC	TOTAL MATERIAL	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 58				3476		3476
Q-2 58						
Q-3 58				93628		93628
Q-4 58						
Q-1 59	2090757	2090757	55446	2305826		2305826
Q-2 59						
Q-3 59	11779120	11779120	322109	12205930		12205930
Q-4 59						
Q-1 60	3813120	3813161	226236	4927654	94279	5021933
Q-2 60						
Q-3 60	578291	579715	34497	1939885	37440	1977325
Q-4 60						
Q-1 61	3967332	4059007	121408	6164616	114277	6278893
Q-2 61						
Q-3 61	7927308	8329235	261014	11184545	207453	11391998
Q-4 61						
Q-1 62	3740658	4083733	145905	6646696	111452	6758148
Q-2 62						
Q-3 62	3100338	3420424	123653	5348735	89688	5438423
Q-4 62						
Q-1 63	2285155	2664560	134415	4463158	74624	4537782
Q-2 63						
Q-3 63	1159329	1544782	75233	2922152	48858	2971010
Q-4 63						
Q-1 64	462660	851648	105006	3021448	64290	3085738
Q-2 64						
Q-3 64	240912	352957	119378	1170833	24913	1195746
Q-4 64						
Q-1 65	59632	72482	23302	484000	12913	496913
Q-2 65						
Q-3 65		91870	16392	168433	4493	172926
TOTAL	41204612	43733451	1763994	63051015	884680	63935695

TECHNICAL DESCRIPTION

SUBSYSTEM: AIRFRAME STRUCTURE — WBS CODE: 1.1

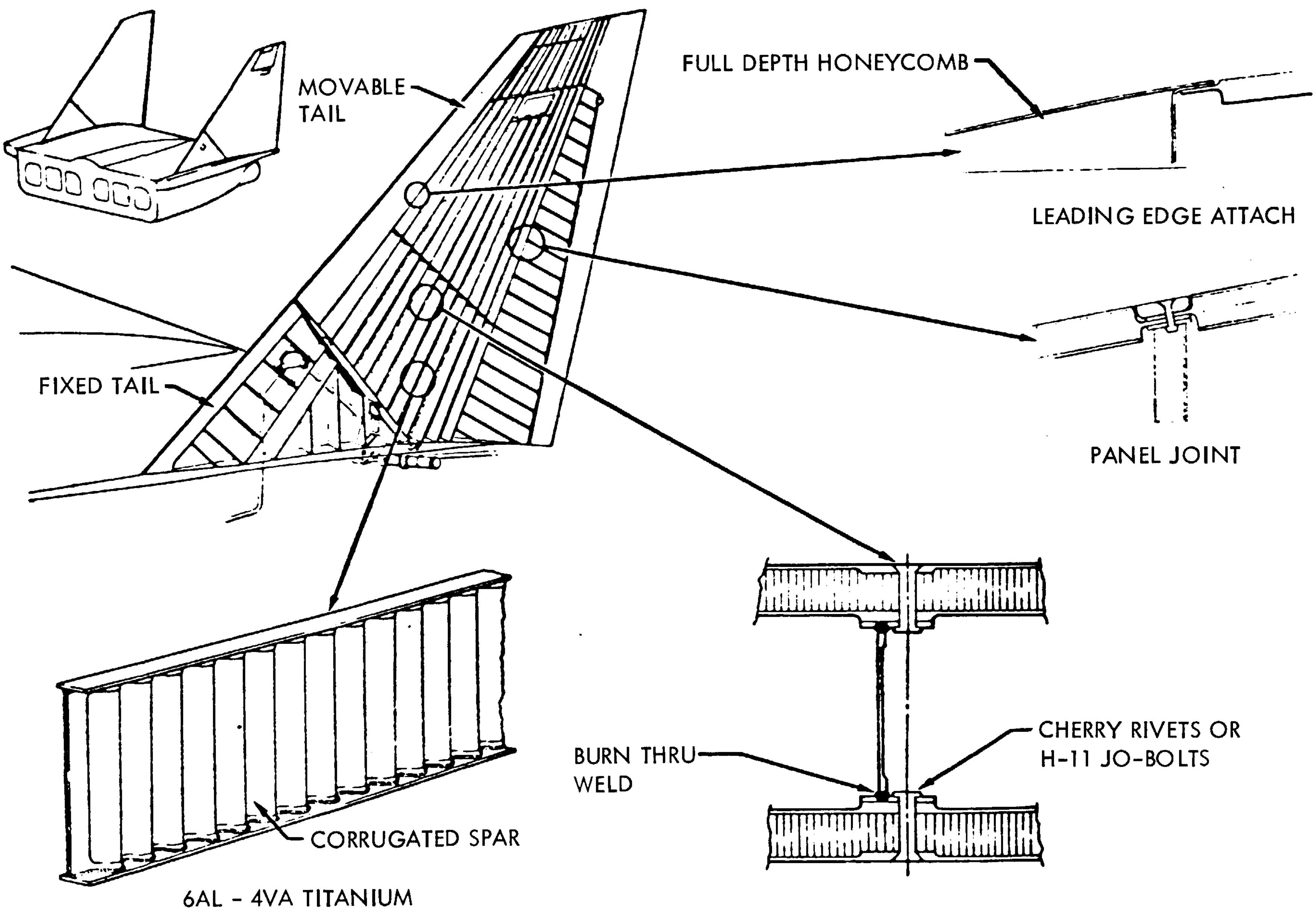
MAJOR ASSEMBLY: VERTICAL STABILIZER STRUCTURES — WBS CODE: 1.1.3

Two vertical stabilizers were supported on the aft fuselage 173 inches to the left and right of the fuselage reference plane (FRL). Each vertical stabilizer was comprised of a short fixed stub and a large movable control surface hydraulically actuated for directional control and trim as part of the Flight Control Subsystem (WBS 1.6). The construction of the stabilizers was brazed PH15-7MO steel honeycomb panels mechanically attached to corrugated 6Al-4V titanium alloy spars and ribs. The leading and trailing edges were full depth brazed PH15-7MO steel honeycomb which were mechanically attached to the forward and rear spars. See Exhibit 26, page III-195, for construction details.

The fixed stub of each vertical stabilizer had an area of 42.85 sq. ft. while the movable control surface (rudder) had an area of 191.11 sq. ft. The total vertical stabilizer area was 467.92 sq. ft. and the total rudder area was 382.22 sq. ft. Each vertical had an aspect ratio of 1.0, a taper ratio of 0.3, and a sweep back at the 25% element of 25 degrees. Each vertical had a root chord of 23.07 ft., a tip chord of 6.92 ft., and a mean aerodynamic chord of 197.4 inches. The airfoil designation was a 30-70 hex mod with a max root thickness of 3.75% chord and a max tip thickness of 2.5% chord. Maximum travel for the rudders with the landing gear down was ±12 degrees and with the landing gear up ±3 degrees.

The vertical stabilizers provided directional static stability while the rudders, operating in unison, provided directional control and trim. As stated under Wing Structure (WBS 1.1.2), the folding wing tips allowed a smaller rudder area to be utilized for the gear up flight conditions. Another B-70 design feature that allowed a smaller rudder area for the landing flight conditions was the rudder limitor changes which provided ± 12 degrees of travel when the landing gear was extended. This increase in rudder travel provided the necessary directional control for 10 degrees of yaw required by the stability and control spec to offset cross wind landings during flare. The rudder control system was so designed that full rudder pedal was required for both full rudder travels (gear up or down). This feature provided good rudder feel or sensitivity for high speed as well as for landing and takeoff.

VERTICAL STABILIZER



TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: VERTICAL STABILIZER STRUCTURE   WBS CODE: 1.1.3

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT VERTICALS MATERIALS/CONSTRUCTION	Pounds Type/No. Type	2250 - - - - Twin Verticals - - - - PH15-7Mo Honeycomb panels mechanically attached to corrugated 6Al-4V Titanium spars and ribs. Leading and tailing edges full depth honeycomb	TBD	TBD	3965	3965
AREA (TOTAL)	$Feet^2$	467.9	467.9	467.9	467.9	467.9
AREA (TOTAL MOVABLE) AIRFOIL DESIGNATION THICKNESS (ROOT) (TIP)	$Feet^2$ Type % Chord % Chord	382.22 30-70 3.75 2.50	382.22 30-70 3.75 2.50	382.22 30-70 3.75 2.50	382.22 30-70 3.75 2.50	382.22 30-70 3.75 2.50
SWEEP OF LEADING EDGE ASPECT RATIO	Degrees None	51.8 1.0	51.8 1.0	51.8 1.0	51.8 1.0	51.8 1.0
TRAVEL (GEAR UP) (GEAR DOWN) ROOT CHORD	Degrees Degrees Feet	± 3 ± 12 24.79	± 3 ± 12 24.79	± 3 ± 12 24.79	± 3 ± 12 24.79	± 3 ± 12 24.79
TIP CHORD MAC LOADS - DESIGN	Feet Inches $Pounds/Ft^2$	8.06 197.4 336	8.06 197.4 336	8.06 197.4 336	8.06 197.4 336	8.06 197.4 338

COST DEFINITION

SUBSYSTEM: AIRFRAME STRUCTURE — WBS CODE: 1.1

MAJOR ASSEMBLY: VERTICAL STABILIZER — WBS CODE: 1.1.3

Recorded costs of $13,113,594 include all identifiable in-house and subcontracted effort to design and fabricate the vertical stabilizer as defined by the Work Breakdown Structure. A detail discussion of the vendors involved with this major structural assembly is contained on page III-198.

The in-house engineering effort includes the design and vendor support activities only. It excludes the design support effort as these can not be identified at a level lower than WBS level 5 (Airframe Structure). The Engineering Group Matrix on page III-69 recaps the hours charged by the engineering design groups associated with this major assembly.

Vendor production effort includes all identifiable costs to fabricate and assemble the structural components included in this WBS item. Specifically excluded from the production costs are:

a) Mating of the vertical stabilizer to the fuselage (WBS 3.0).
b) Fabrication and installation of subsystem provisions (brackets, supports, frames, etc.) or equipment (WBS 1.12).
c) Vehicle checkout and preflight operations (WBS 1.12).

Subcontractor costs for this major assembly include all vendor engineering, production, tooling and testing costs. These are displayed in the Subcontractor Element of Cost within the appropriate Subdivision of Work. Additional vendor data is contained on page III-198.

SUBCONTRACTOR MATRIX

SUBSYSTEM: AIRFRAME STRUCTURE WBS CODE: 1.1

MAJOR ASSEMBLY: VERTICAL STABILIZER WBS CODE: 1.1.3

SUBCONTRACTOR	ENG'R'G	PROD.	TOOLING	TEST	TOTAL
Chance Vought	2,134,321	3,815,870	4,571,880	--	10,522,071

Five contracts were awarded to Chance Vought for the Horizontal and Vertical Stabilizers combined. See WBS 1.1.1, "Horizontal Stabilizer and Flaps", for a summary of this effort.

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 01
6-MAJ ASSY 03
VERTICAL STABILIZER

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOOLING AND STE HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	234428			234428
LABOR AT $ 4.844	1135615			1135615
ENGR BURDEN AT $ 3.584	840136			840136
SUBCONTRACT	2134321	3815870	4571880	10522071
MPC	87637	184340	136835	408812
SUB-TOTAL	4197709	4000210	4708715	12906634
GEN & ADMIN	51638	71220	84102	206960
TOTAL COST	4249347	4071430	4792817	13113594
TIME-PHASED COST DETAIL - SEE PAGE	III-200	III-204	III-205	III-206

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 01 **VERTICAL STABILIZER**
6-MAJ ASSY 03
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	1.5	184	4.668	859	837	1696
Q-2 58						
Q-3 58	34.5	5671	4.628	26245	22208	48453
Q-4 58						
Q-1 59	67.5	11556	4.518	52210	39730	91940
Q-2 59						
Q-3 59	45.0	7829	4.346	34025	28098	62123
Q-4 59						
Q-1 60	177.0	30686	4.445	136399	11740	148139
Q-2 60						
Q-3 60	291.0	48979	4.655	227997	182398	410395
Q-4 60						
Q-1 61	313.5	53511	4.827	258298	184131	442429
Q-2 61						
Q-3 61	187.5	34013	4.843	164725	154861	319586
Q-4 61						
Q-1 62	115.5	19773	5.331	105410	91252	196662
Q-2 62						
Q-3 62	69.0	11523	5.415	62397	59274	121671
Q-4 62						
Q-1 63	34.5	5795	6.725	38971	36259	75230
Q-2 63						
Q-3 63	9.0	1415	5.120	7245	7184	14429
Q-4 63						
Q-1 64	13.5	2327	5.922	13780	14641	28421
Q-2 64						
Q-3 64	6.0	969	5.895	5712	6222	11934
Q-4 64						
Q-1 65	1.5	169	6.811	1151	1116	2267

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 01
6-MAJ ASSY 03

VERTICAL STABILIZER

SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
0-2 65						
0-3 65		28	6.021	191	185	376
TOTAL	1356.5	234428		1135615	940145	1975751

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12106

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 03
SUBD OF WORK DESIGN/ENGINEERING

VERTICAL STABILIZER

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-1 58	1.5	184	4.668	859	837	1696	
Q-2 58							
Q-3 58	34.5	5671	4.628	26245	22208	48453	
Q-4 58							
Q-1 59	67.5	11556	4.518	52210	39730	91940	54276
Q-2 59							
Q-3 59	45.0	7829	4.346	34025	28098	62123	1133819
Q-4 59							
Q-1 60	177.0	30686	4.445	136399	11740	148139	64705
Q-2 60							
Q-3 60	291.0	48979	4.655	227997	182398	410395	851458
Q-4 60							
Q-1 61	313.5	53511	4.827	258298	184131	442429	8391
Q-2 61							
Q-3 61	187.5	34013	4.843	164725	154861	319586	21672
Q-4 61							
Q-1 62	115.5	19773	5.331	105410	91252	196662	
Q-2 62							
Q-3 62	69.0	11523	5.415	62397	59274	121671	
Q-4 62							
Q-1 63	34.5	5795	6.725	38971	36259	75230	
Q-2 63							
Q-3 63	9.0	1415	5.120	7245	7184	14429	
Q-4 63							
Q-1 64	13.5	2327	5.922	13780	14641	28421	
Q-2 64							
Q-3 64	6.0	969	5.895	5712	6222	11934	
Q-4 64							
Q-1 65	1.5	169	6.811	1151	1116	2267	
Q-2 65							
Q-3 65		28	6.821	191	185	376	
TOTAL	1368.5	234428		1135615	840136	1975751	2134321

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NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12109

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 02
SUBD OF WORK DESIGN/ENGINEERING

VERTICAL STABILIZER

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 58		1696		1696
Q-2 58				
Q-3 58		48453		48453
Q-4 58				
Q-1 59	1449	147655		147655
Q-2 59				
Q-3 59	30901	1226923		1226923
Q-4 59				
Q-1 60	3836	216682	4128	220810
Q-2 60				
Q-3 60	50519	1312372	25005	1337377
Q-4 60				
Q-1 61	240	451060	6382	457442
Q-2 61				
Q-3 61	620	341378	6353	347731
Q-4 61				
Q-1 62		196662	3301	199963
Q-2 62				
Q-3 62		121671	2042	123713
Q-4 62				
Q-1 63		75230	1257	76487
Q-2 63				
Q-3 63		14429	241	14670
Q-4 63				
Q-1 64		28421	605	29326
Q-2 64				
Q-3 64		11934	254	12189
Q-4 64				
Q-1 65		2267	60	2327
Q-2 65				
Q-3 65		376	10	386
TOTAL	87657	4197709	51638	4249347

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NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12109

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 03
SUBD OF WORK PRODUCTION

VERTICAL STABILIZER

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 61	10542	302	10844	201	11045
Q-2 61					
Q-3 61	678437	19437	697874	12969	710843
Q-4 61					
Q-1 62	684573	21757	706330	11856	718186
Q-2 62					
Q-3 62	1068183	33918	1102101	18499	1120600
Q-4 62					
Q-1 63	576308	24472	600780	10045	610825
Q-2 63					
Q-3 63	238763	7673	246436	4120	250556
Q-4 63					
Q-1 64	559064	76781	635845	13530	649375
TOTAL	3815870	184340	4000210	71220	4071430

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NORTH AMERICAN ROCKWELL CORP. APRIL 1972
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-121??

TIME PHASED EXPEND.
B-7? AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01 **VERTICAL STABILIZER**
6-MAJ ASSY 03
SUBD OF WORK TOOLING AND STE

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 61	394620	11306	405926	7543	413469
Q-2 61					
Q-3 61	2346705	67235	2413940	44858	2458798
Q-4 61					
Q-1 62	630552	20040	650592	10920	661512
Q-2 62					
Q-3 62	1155011	37706	1192717	20020	1212737
Q-4 62					
Q-1 63	12007	597	12604	229	12833
Q-2 63					
Q-3 63	31255	591	31846	532	32378
TOTAL	4571880	136835	4708715	84102	4792817

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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

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 03
VERTICAL STABILIZER

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	1.5	184	4.668	859	837	1696
Q-2 58						
Q-3 58	34.5	5671	4.628	26245	22208	48453
Q-4 58						
Q-1 59	67.5	11566	4.518	52210	39730	91940
Q-2 59						
Q-3 59	45.0	7829	4.346	34025	28098	62123
Q-4 59						
Q-1 60	177.0	30686	4.445	136399	11740	148139
Q-2 60						
Q-3 60	291.0	48979	4.655	227997	182398	410395
Q-4 60						
Q-1 61	313.5	52511	4.827	258298	184131	442429
Q-2 61						
Q-3 61	187.5	34013	4.843	164725	154861	319586
Q-4 61						
Q-1 62	115.5	19772	5.331	105410	91252	196662
Q-2 62						
Q-3 62	69.0	11523	5.415	62397	59274	121671
Q-4 62						
Q-1 63	34.5	5795	6.725	38971	36259	75230
Q-2 63						
Q-3 63	9.0	1415	5.120	7245	7184	14429
Q-4 63						
Q-1 64	13.5	2327	5.922	13780	14641	28421
Q-2 64						
Q-3 64	5.0	969	5.895	5712	6222	11934
Q-4 64						
Q-1 65	1.5	169	6.811	1151	1116	2267

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 01
6-MAJ ASSY 03
VERTICAL STABILIZER

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-2 65						
Q-3 65		28	6.821	191	185	376
TOTAL	1366.5	234428		1135615	840136	1975751

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 03
VERTICAL STABILIZER

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-1 58	1.5	184	4.668	859	837	1696	
Q-2 58							
Q-3 58	34.5	5671	4.628	26245	22208	48453	
Q-4 58							
Q-1 59	67.5	11556	4.518	52210	39730	91940	54276
Q-2 59							
Q-3 59	45.0	7829	4.346	34025	28098	62123	1133319
Q-4 59							
Q-1 60	177.0	30686	4.445	136399	11740	148139	64705
Q-2 60							
Q-3 60	291.0	48979	4.655	227997	182398	410395	851458
Q-4 60							
Q-1 61	313.5	53511	4.827	258298	184131	442429	413553
Q-2 61							
Q-3 61	187.5	34013	4.843	164725	154861	319586	3046814
Q-4 61							
Q-1 62	115.5	19773	5.331	105410	91252	196662	1315125
Q-2 62							
Q-3 62	69.0	11523	5.415	62397	59274	121671	2224194
Q-4 62							
Q-1 63	34.5	5795	6.725	38971	36259	75230	589445
Q-2 63							
Q-3 63	9.0	1415	5.120	7245	7184	14429	269618
Q-4 63							
Q-1 64	13.5	2327	5.922	13780	14641	28421	550064
Q-2 64							
Q-3 64	6.0	969	5.895	5712	6222	11934	
Q-4 64							
Q-1 65	1.5	169	6.811	1151	1116	2267	
Q-2 65							
Q-3 65		28	6.821	191	185	376	
TOTAL	1366.5	234428		1135615	940136	1975751	10522071

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 01
6-MAJ ASSY 03
VERTICAL STABILIZER

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 58		1696		1696
Q-2 58				
Q-3 58		48453		48453
Q-4 58				
Q-1 59	1439	147655		147655
Q-2 59				
Q-3 59	30981	1226923		1226923
Q-4 59				
Q-1 60	3838	216682	4128	220810
Q-2 60				
Q-3 60	50519	1312372	25005	1337377
Q-4 60				
Q-1 61	11848	867830	16126	883956
Q-2 61				
Q-3 61	87292	3453692	64180	3517872
Q-4 61				
Q-1 62	41797	1553584	26077	1579661
Q-2 62				
Q-3 62	70624	2416489	40561	2457050
Q-4 62				
Q-1 63	25029	689704	11531	701235
Q-2 63				
Q-3 63	8664	292711	4893	297604
Q-4 63				
Q-1 64	76781	664266	14135	678401
Q-2 64				
Q-3 64		11934	254	12188
Q-4 64				
Q-1 65		2267	60	2327
Q-2 65				
Q-3 65		376	10	386
TOTAL	408812	12906634	206960	13113594

TECHNICAL DESCRIPTION

SUBSYSTEM: AIRFRAME STRUCTURE WBS CODE: 1.1
MAJOR ASSEMBLY: FORWARD FUSELAGE WBS CODE: 1.1.4

The forward fuselage consisted of the nose section, crew compartment, and the equipment compartment covering fuselage stations zero to 857.5. The forward fuselage was of a semi-monocoque stressed skin structure with bulkheads, frames, and longerons. Riveted titanium construction was used predominantly with the skins made of titanium 6Al-4V and titanium 4Al-3MO-1V used for the other areas and substructure. See Exhibit 27, page III-211, for details.

In the nose section, structural provisions were incorporated for the installation of a pitot-static boom, ILS antenna, and the windshield. The nose bay antenna cavity cover consisted of high temperature resistant non-metallic structural material which provided the necessary strength and rigidity but allowed reception of signals by the enclosed antennas. The windshield was comprised of fixed inner transparent panels forming a part of the forward section of the crew compartment and an outer variable position windshield and forward ramp. Control was provided in the crew compartment, as part of the Secondary Flight Control Subsystem (WBS 1.6.2), for positioning the outer windshield and ramp to the up or down position while on the ground or during flight. This feature provided eleven-degree over-the-nose vision with the windshield down at low speeds and at high speeds, with the windshield ramp up, improved air flows over the forebody reducing the overall drag.

The structure of the crew compartment, which was a pressurized cabin, consisted of flooring, provisions for environmental control, transpiration walls, and provisions for installation of the escape capsules for pilot and copilot. The space between the two encapsulated seats was 18.5 inches wide and 63 inches high. Provisions were incorporated for installation of the main instrument panel and panel shroud, consoles, overhead switch panel, center aisle control pedestals, rudder pedals, and control columns. In the area immediately aft of the pilot and copilot stations, structural provisions were provided for two additional crew stations. This structure included wall and bulkhead provisions for instrument panels and capsule installation; however, for the XB-70, the electrical and electronic equipment was located in this area between canted station FS421 and FS605.

A door was located on the left side of the crew compartment to provide for crew ingress and egress. Four overhead crew escape hatches were constructed of titanium skin with steel support frames. A side window consisting of nonolithic outer panels and laminated inner panels was located on both the left and right sides of the crew compartment. In each window, the glass panels were separated by an air gap and were restrained by metal retainers. Provisions were made for attachment and carry-through structure of the horizontal stabilizer and actuation system.

In the unpressurized area between FS605 and 796 of the equipment compartment, portions of the environmental control subsystem, antenna items, hydraulic replenishing tank, and ballast were installed. The remainder of the environmental control equipment was contained in the unpressurized area between FS796 and FS857.5.

FORWARD FUSELAGE

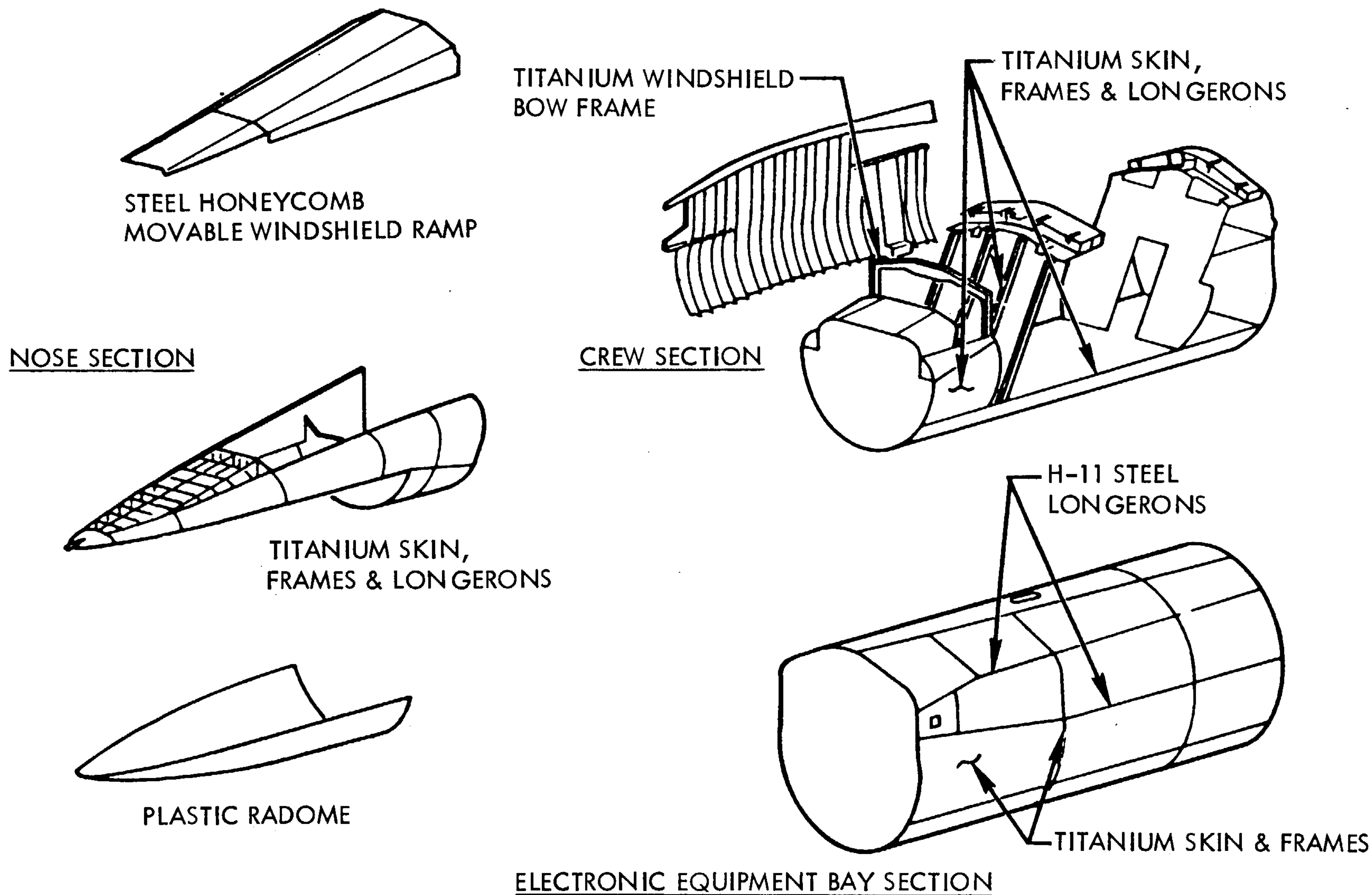

EXHIBIT 27

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: FORWARD FUSELAGE WBS CODE: 1.1.4

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT MATERIALS/CONSTRUCTION	Pounds Type	7490 Conventional (semi-monocoque stressed skin) mainly riveted and welded titanium with some H-11 used as longeron stiffeners. (6Al-4V & 4Al-3Mo-1V Titanium)	TBD	TBD	9143	9186
LENGTH (EXCLUDING NOSE BOOM) HEIGHT (MAX)	Inches Inches	729.5 100	729.5 100	729.5 100	729.5 100	729.5 100
WIDTH (MAX) TEMPERATURE (GENERAL) LOADS ~ DESIGN	Inches Degrees F Pounds/Ft^2	100 -65 to 630 258	100 -65 to 630 258	100 -65 to 630 258	100 -65 to 630 188	100 -65 to 630 188
MAJOR ASSEMBLIES JOINING MAJOR ASSEMBLIES CONTROL SURFACES (EACH SIDE)	Type/No. Type No.	- (1) Nose Section, (1) Crew Compartment, (1) Equip Compt - Welded 2	Welded 2	Welded 2	Welded 2	Welded 2
MAJOR COMPARTMENTS	No.	4	5	5	5	5

COST DEFINITION

SUBSYSTEM: AIRFRAME STRUCTURE WBS CODE: 1.1

MAJOR ASSEMBLY: FORWARD FUSELAGE WBS CODE: 1.1.4

Recorded costs of $13,470,124 include all identifiable in-house effort to design and fabricate the forward fuselage as defined by the Work Breakdown Structure. No part of this section of the structure was subcontracted. Excluded from the engineering costs are those activities designated as design support. The design support costs cannot be associated to a WBS level lower than level 5 (Airframe Structure). The Engineering Group Matrix on page III-69 recaps the hours charged by the engineering design groups associated with this section of the fuselage.

In-house production effort includes all costs associated with the fabrication and assembly of the structural components defined as the forward fuselage. Specifically excluded from these production costs are:

a) Mating of the forward fuselage to the other fuselage sections (WBS 3.0).
b) Fabrication and installation of subsystem provisions (brackets, wire harnesses, racks, shelves, etc.) and equipment into the forward fuselage (WBS 1.12).
c) In-house ground testing activities (WBS 1.1.8).
d) Vehicle checkout and preflight operations (WBS 1.12).

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 01
6-MAJ ASSY 04
FORWARD FUSELAGE

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	318743	4862	323605
LABOR AT $ 5.093	1627501	20692	1648193
ENGR BURDEN AT $ 4.566	1448971	28609	1477580
PRODUCTION		870571	870571
LABOR AT $ 3.215		2799055	2799055
PLANNING		48900	48900
LABOR AT $ 3.361		164371	164371
TEST/QC		102340	102340
LABOR AT $ 3.605		368950	368950
MFG BURDEN AT $ 4.081		4169653	4169653
MFG MATERIAL		2361356	2361356
MPC		239578	239578
SUB-TOTAL	3076472	10152264	13228736
GEN & ADMIN	52596	188792	241388
TOTAL COST	3129068	10341056	13470124
TIME-PHASED COST DETAIL - SEE PAGE	III-215	III-219	III-225

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

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 01 FORWARD FUSELAGE
6-MAJ ASSY 04
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	1.5	191	4.670	892	869	1761
Q-2 58						
Q-3 58	34.5	5716	4.628	26454	22384	48838
Q-4 58						
Q-1 59	69.0	11729	4.518	52992	40324	93316
Q-2 59						
Q-3 59	79.5	14118	4.346	61357	50670	112027
Q-4 59						
Q-1 60	219.0	37863	4.445	168301	144864	313165
Q-2 60						
Q-3 60	220.5	37135	4.655	172863	138291	311154
Q-4 60						
Q-1 61	282.0	48057	4.827	231971	165364	397335
Q-2 61						
Q-3 61	168.0	30345	4.843	146961	138161	285122
Q-4 61						
Q-1 62	127.5	21783	5.331	116125	100529	216654
Q-2 62						
Q-3 62	126.0	21154	5.415	114549	108816	223365
Q-4 62						
Q-1 63	123.0	20993	6.725	141178	131353	272531
Q-2 63						
Q-3 63	165.0	27808	5.120	142377	141181	283558
Q-4 63						
Q-1 64	151.5	25909	5.922	153433	163019	316452
Q-2 64						
Q-3 64	66.0	11499	5.895	67787	73835	141622
Q-4 64						
Q-1 65	24.0	4056	6.811	27625	26778	54403

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

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 01 **FORWARD FUSELAGE**
6-MAJ ASSY 04
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	3.0	387	6.811	2636	2533	5169
TOTAL	1860.0	318743		1627501	1448971	3076472

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 01 **FORWARD FUSELAGE**
6-MAJ ASSY 04
SUED OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	G & A
Q-1 58	1.5	191	4.670	892	869	1761	
Q-2 58							
Q-3 58	34.5	5716	4.628	26454	22384	48838	
Q-4 58							
Q-1 59	69.0	11729	4.518	52992	40324	93316	
Q-2 59							
Q-3 59	79.5	14113	4.346	61357	50670	112027	
Q-4 59							
Q-1 60	219.0	37863	4.445	168301	144864	313165	5367
Q-2 60							
Q-3 60	220.5	37135	4.655	172863	138291	311154	5928
Q-4 60							
Q-1 61	282.0	48057	4.827	231971	165364	397335	7354
Q-2 61							
Q-3 61	168.0	30345	4.843	146961	138161	285122	5298
Q-4 61							
Q-1 62	127.5	21783	5.331	116125	100529	216654	3637
Q-2 62							
Q-3 62	126.0	21154	5.415	114549	108816	223365	3749
Q-4 62							
Q-1 63	123.0	20993	6.725	141178	131353	272531	4557
Q-2 63							
Q-3 63	165.0	27808	5.120	142377	141181	283558	4741
Q-4 63							
Q-1 64	151.5	25909	5.922	153433	163019	316452	6733
Q-2 64							
Q-3 64	66.0	11499	5.895	67787	73835	141622	3313
Q-4 64							
Q-1 65	24.0	4056	6.811	27625	26778	54403	1451
Q-2 65							
Q-3 65	3.0	387	6.811	2636	2533	5169	138
TOTAL	1860.0	318743		1627501	1448971	3076472	52596

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OF POOR QUALITY

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01 **FORWARD FUSELAGE**
6-MAJ ASSY 04
SUBD OF WORK DESIGN/ENGINEERING

	TOTAL COST
Q-1 58	1761
Q-2 58	
Q-3 58	43838
Q-4 58	
Q-1 59	93316
Q-2 59	
Q-3 59	112027
Q-4 59	
Q-1 60	319132
Q-2 60	
Q-3 60	317062
Q-4 60	
Q-1 61	404719
Q-2 61	
Q-3 61	290420
Q-4 61	
Q-1 62	220291
Q-2 62	
Q-3 62	227114
Q-4 62	
Q-1 63	277066
Q-2 63	
Q-3 63	288299
Q-4 63	
Q-1 64	323185
Q-2 64	
Q-3 64	144635
Q-4 64	
Q-1 65	55854
Q-2 65	
Q-3 65	5307
TOTAL	3129068

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

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 01 **FORWARD FUSELAGE**
6-MAJ ASSY 04
SUBD OF WORK PRODUCTION

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	6.0	906	5.414	4905	651	5556
Q-4 58						
Q-1 59	6.0	1105	5.466	6040	944	6984
Q-2 59						
Q-3 59	10.5	1885	5.361	10106	1733	11839
Q-4 59						
Q-1 60	4.5	722	5.589	4035	854	4889
Q-2 60						
Q-3 60		16	4.063	65	-50	15
Q-4 60						
Q-1 61		41	4.951	203	207	410
Q-2 61						
Q-3 61		35	2.943	103	48	151
Q-4 61						
Q-1 62		41	2.707	111	336	447
Q-2 62						
Q-3 62	1.5	250	3.552	888	1540	2428
Q-4 62						
Q-1 63		125	3.320	415	786	1201
Q-2 63						
Q-3 63	-27.0	-4653	5.366	-24967	-4669	-29636
Q-4 63						
Q-1 64	3.0	443	4.576	2027	2647	4674
Q-2 64						
Q-3 64	10.5	1718	4.452	7649	10799	18448
Q-4 64						
Q-1 65	6.0	912	4.429	4039	5671	9710
Q-2 65						
Q-3 65	7.5	1316	3.855	5073	7112	12185
TOTAL	28.5	4862		20692	28609	49301

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

	PRODUCTION	
4-SYSTEM	1	
5-SUBSYSTEM	01	**FORWARD FUSELAGE**
6-MAJ ASSY	04	
SUBD OF WORK	PRODUCTION	

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 60	3.0	441	4.737	2069	1066	3155
Q-2 60						
Q-3 60	4.5	854	2.411	2059	1665	3724
Q-4 60						
Q-1 61	228.0	38793	3.143	121921	146075	267996
Q-2 61						
Q-3 61	642.0	116528	3.152	367271	467462	834733
Q-4 61						
Q-1 62	816.0	139360	3.066	427323	577995	1005318
Q-2 62						
Q-3 62	552.0	92614	3.231	299276	431248	730524
Q-4 62						
Q-1 63	559.5	95604	3.307	316174	435446	751620
Q-2 63						
Q-3 63	706.5	118597	2.817	334146	533953	868099
Q-4 63						
Q-1 64	1189.5	203093	3.426	695751	1119237	1814988
Q-2 64						
Q-3 64	235.5	41354	3.427	141728	231213	372941
Q-4 64						
Q-1 65	127.5	22006	3.625	79777	125202	204979
Q-2 65						
Q-3 65	7.5	1327	8.696	11540	15165	26705
TOTAL	5071.5	870571		2799055	4085727	6884782

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

PLANNING
4-SYSTEM 1
5-SUBSYSTEM 01 **FORWARD FUSELAGE**
6-MAJ ASSY 04
SUBD OF WORK PRODUCTION

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	.5	124	3.000	372		372
Q-4 58						
Q-1 59	3.0	622	2.958	1840		1840
Q-2 59						
Q-3 59	9.0	1456	2.989	4352		4352
Q-4 59						
Q-1 60	18.0	3044	3.158	9612	47	9659
Q-2 60						
Q-3 60	25.5	4192	3.041	12748		12748
Q-4 60						
Q-1 61	43.5	7514	3.019	22687	3726	26413
Q-2 61						
Q-3 61	40.5	7221	2.906	20987	3700	24687
Q-4 61						
Q-1 62	37.5	6347	2.978	18904	3697	22601
Q-2 62						
Q-3 62	33.0	5641	2.976	16789	3960	20749
Q-4 62						
Q-1 63						
Q-2 63						
Q-3 63	27.0	4544	6.529	29669	29416	59085
Q-4 63						
Q-1 64	39.0	6566	3.210	21078	31806	52884
Q-2 64						
Q-3 64	6.0	1055	3.340	3524	5124	8648
Q-4 64						
Q-1 65	3.0	440	3.141	1382	1965	3347
Q-2 65						
Q-3 65	1.5	134	3.187	427	485	912
TOTAL	287.0	48900		164371	83926	248297

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	TEST/QC	
4-SYSTEM	1	
5-SUBSYSTEM	01	**FORWARD FUSELAGE**
6-MAJ ASSY	04	
SUBD OF WORK	PRODUCTION	

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		61	4.918	300		300
Q-4 58						
Q-1 59		59	4.237	250		250
Q-2 59						
Q-3 59	1.5	296	4.666	1381		1381
Q-4 59						
Q-1 60	3.0	559	5.005	2798		2798
Q-2 60						
Q-3 60		105	3.914	411		411
Q-4 60						
Q-1 61	15.0	2611	3.133	8179		8179
Q-2 61						
Q-3 61	40.5	7370	3.120	22995		22995
Q-4 61						
Q-1 62	69.0	11737	3.302	38752		38752
Q-2 62						
Q-3 62	69.0	11629	3.374	39241		39241
Q-4 62						
Q-1 63	73.5	12590	3.629	45689		45689
Q-2 63						
Q-3 63	96.0	16140	4.234	68336		68336
Q-4 63						
Q-1 64	154.5	26395	3.520	92911		92911
Q-2 64						
Q-3 64	49.5	8691	3.586	31168		31168
Q-4 64						
Q-1 65	21.0	3528	3.906	13782		13782
Q-2 65						
Q-3 65	3.0	569	4.845	2757		2757
TOTAL	595.5	102340		368950		368950

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

4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 04
SUBD OF WORK PRODUCTION

FORWARD FUSELAGE

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	MFG MATL
Q-3 58	6.5	1091	5.112	5577	651	6228	
Q-4 58							
Q-1 59	9.0	1786	4.552	8130	944	9074	
Q-2 59							
Q-3 59	21.0	3637	4.355	15839	1733	17572	
Q-4 59							
Q-1 60	28.5	4766	3.889	18534	1967	20501	26
Q-2 60							
Q-3 60	30.0	5167	2.958	15283	1615	16898	1013
Q-4 60							
Q-1 61	286.5	48959	3.125	152990	150008	302998	65023
Q-2 61							
Q-3 61	723.0	131154	3.136	411356	471210	882566	285083
Q-4 61							
Q-1 62	922.5	157485	3.080	485090	582028	1067118	243340
Q-2 62							
Q-3 62	655.5	110134	3.234	356194	436748	792942	224955
Q-4 62							
Q-1 63	633.0	108319	3.345	362278	436232	798510	365147
Q-2 63							
Q-3 63	802.5	134628	3.025	407184	558700	965884	591704
Q-4 63							
Q-1 64	1386.0	236497	3.432	811767	1153690	1965457	521452
Q-2 64							
Q-3 64	301.5	52818	3.485	184069	247136	431205	97223
Q-4 64							
Q-1 65	157.5	26886	3.681	98980	132838	231818	-51703
Q-2 65							
Q-3 65	19.5	3346	5.917	19797	22762	42559	18093
TOTAL	5982.5	1026673		3353068	4198262	7551330	2361356

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 01
6-MAJ ASSY 04
SUBD OF WORK PRODUCTION

FORWARD FUSELAGE

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-3 58		6228		6228
Q-4 58				
Q-1 59		9074		9074
Q-2 59				
Q-3 59		17572		17572
Q-4 59				
Q-1 60	3	20530	391	20921
Q-2 60				
Q-3 60	133	18044	344	18388
Q-4 60				
Q-1 61	5491	373512	6941	380453
Q-2 61				
Q-3 61	24075	1191724	22146	1213870
Q-4 61				
Q-1 62	19165	1329623	22318	1351941
Q-2 62				
Q-3 62	17717	1035614	17383	1052997
Q-4 62				
Q-1 63	35975	1199632	20058	1219690
Q-2 63				
Q-3 63	58296	1615884	27018	1642902
Q-4 63				
Q-1 64	55586	2542495	54099	2596594
Q-2 64				
Q-3 64	35374	563802	11997	575799
Q-4 64				
Q-1 65	-15465	164650	4393	169043
Q-2 65				
Q-3 65	3228	63880	1704	65584
TOTAL	239578	10152264	188792	10341056

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 01
6-MAJ ASSY 04
FORWARD FUSELAGE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	1.5	191	4.670	892	869	1761
Q-2 58						
Q-3 58	39.0	6622	4.736	31359	23035	54394
Q-4 58						
Q-1 59	75.0	12834	4.600	59032	41268	100300
Q-2 59						
Q-3 59	91.5	16003	4.466	71463	52403	123866
Q-4 59						
Q-1 60	222.0	38585	4.466	172336	145718	318054
Q-2 60						
Q-3 60	220.5	37151	4.655	172928	138241	311169
Q-4 60						
Q-1 61	282.0	48098	4.827	232174	165571	397745
Q-2 61						
Q-3 61	168.0	30380	4.841	147064	138209	285273
Q-4 61						
Q-1 62	127.5	21824	5.326	116236	100865	217101
Q-2 62						
Q-3 62	127.5	21404	5.393	115437	110356	225793
Q-4 62						
Q-1 63	123.5	21118	6.705	141593	132139	273732
Q-2 63						
Q-3 63	138.0	23155	5.071	117410	136512	253922
Q-4 63						
Q-1 64	154.5	26352	5.899	155460	165666	321126
Q-2 64						
Q-3 64	75.0	13217	5.707	75436	84634	160070
Q-4 64						
Q-1 65	28.5	4968	6.374	31664	32449	64113

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 01
6-MAJ ASSY 04
FORWARD FUSELAGE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-2 65						
Q-3 65	10.5	1703	4.527	7709	9645	17354
TOTAL	1884.5	323605		1648193	1477580	3125773

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

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

PRODUCTION
4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 04
FORWARD FUSELAGE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 60	3.0	441	4.737	2089	1066	3155
Q-2 60						
Q-3 60	4.5	854	2.411	2059	1665	3724
Q-4 60						
Q-1 61	228.0	38793	3.143	121921	146075	267996
Q-2 61						
Q-3 61	642.0	116528	3.152	367271	467462	834733
Q-4 61						
Q-1 62	816.0	139360	3.066	427323	577995	1005318
Q-2 62						
Q-3 62	552.0	92614	3.231	299276	431248	730524
Q-4 62						
Q-1 63	559.5	95604	3.307	316174	435446	751620
Q-2 63						
Q-3 63	706.5	118597	2.817	334146	533953	868099
Q-4 63						
Q-1 64	1189.5	203093	3.426	695751	1119237	1814988
Q-2 64						
Q-3 64	235.5	41354	3.427	141728	231213	372941
Q-4 64						
Q-1 65	127.5	22006	3.625	79777	125202	204979
Q-2 65						
Q-3 65	7.5	1327	8.696	11540	15165	26705
TOTAL	5071.5	870571		2799055	4085727	6884782

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

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

PLANNING
4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 04
FORWARD FUSELAGE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	.5	124	3.000	372		372
Q-4 58						
Q-1 59	3.0	622	2.958	1840		1840
Q-2 59						
Q-3 59	9.0	1456	2.989	4352		4352
Q-4 59						
Q-1 60	18.0	3044	3.158	9612	47	9659
Q-2 60						
Q-3 60	25.5	4192	3.041	12748		12748
Q-4 60						
Q-1 61	43.5	7514	3.019	22687	3726	26413
Q-2 61						
Q-3 61	40.5	7221	2.906	20987	3700	24687
Q-4 61						
Q-1 62	37.5	6347	2.978	18904	3697	22601
Q-2 62						
Q-3 62	33.0	5641	2.976	16789	3960	20749
Q-4 62						
Q-1 63						
Q-2 63						
Q-3 63	27.0	4544	6.529	29669	29416	59085
Q-4 63						
Q-1 64	39.0	6566	3.210	21078	31806	52884
Q-2 64						
Q-3 64	6.0	1055	3.340	3524	5124	8648
Q-4 64						
Q-1 65	3.0	440	3.141	1382	1965	3347
Q-2 65						
Q-3 65	1.5	134	3.187	427	485	912
TOTAL	287.0	48900		164371	83926	248297

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 01
6-MAJ ASSY 04
FORWARD FUSELAGE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		61	4.918	300		300
Q-4 58						
Q-1 59		59	4.237	250		250
Q-2 59						
Q-3 59	1.5	296	4.666	1381		1381
Q-4 59						
Q-1 60	3.0	559	5.005	2798		2798
Q-2 60						
Q-3 60		105	3.914	411		411
Q-4 60						
Q-1 61	15.0	2611	3.133	8179		8179
Q-2 61						
Q-3 61	40.5	7370	3.120	22995		22995
Q-4 61						
Q-1 62	69.0	11737	3.302	38752		38752
Q-2 62						
Q-3 62	69.0	11629	3.374	39241		39241
Q-4 62						
Q-1 63	73.5	12590	3.629	45689		45689
Q-2 63						
Q-3 63	96.0	16140	4.234	68336		68336
Q-4 63						
Q-1 64	154.5	26395	3.520	92911		92911
Q-2 64						
Q-3 64	49.5	8691	3.586	31168		31168
Q-4 64						
Q-1 65	21.0	3528	3.906	13782		13782
Q-2 65						
Q-3 65	3.0	569	4.845	2757		2757
TOTAL	595.5	102340		368950		368950

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 01
6-MAJ ASSY 04
FORWARD FUSELAGE

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	MFG MATL
Q-1 58	1.5	191	4.670	892	869	1761	
Q-2 58							
Q-3 58	39.5	6807	4.706	32031	23035	55066	
Q-4 58							
Q-1 59	78.0	13515	4.523	61122	41268	102390	
Q-2 59							
Q-3 59	102.0	17755	4.348	77196	52403	129599	
Q-4 59							
Q-1 60	246.0	42629	4.383	186835	146831	333666	26
Q-2 60							
Q-3 60	250.5	42302	4.448	188146	139906	328052	1013
Q-4 60							
Q-1 61	568.5	97016	3.968	384961	315372	700333	65023
Q-2 61							
Q-3 61	891.0	161499	3.457	558317	609371	1167688	285083
Q-4 61							
Q-1 62	1050.0	179268	3.354	601215	682557	1283772	243340
Q-2 62							
Q-3 62	781.5	131288	3.586	470743	545564	1016307	224955
Q-4 62							
Q-1 63	756.5	129312	3.893	503456	567585	1071041	365147
Q-2 63							
Q-3 63	967.5	162436	3.383	549561	699881	1249442	591704
Q-4 63							
Q-1 64	1537.5	262406	3.678	965200	1316709	2281909	521452
Q-2 64							
Q-3 64	366.0	64317	3.916	251856	320971	572827	97223
Q-4 64							
Q-1 65	180.0	30942	4.092	126605	159616	286221	-51703
Q-2 65							
Q-3 65	22.5	3733	6.009	22433	25295	47728	18093
TOTAL	7838.5	1345416		4980569	5647233	10627802	2361356

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 01
6-MAJ ASSY 04
FORWARD FUSELAGE

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 58		1761		1761
Q-2 58				
Q-3 58		55066		55066
Q-4 58				
Q-1 59		102390		102390
Q-2 59				
Q-3 59		129599		129599
Q-4 59				
Q-1 60	3	333695	6358	340053
Q-2 60				
Q-3 60	133	329198	6272	335470
Q-4 60				
Q-1 61	5491	770847	14325	785172
Q-2 61				
Q-3 61	24075	1476846	27444	1504290
Q-4 61				
Q-1 62	19165	1546277	25955	1572232
Q-2 62				
Q-3 62	17717	1258979	21132	1280111
Q-4 62				
Q-1 63	35975	1472163	24615	1496778
Q-2 63				
Q-3 63	58296	1899442	31759	1931201
Q-4 63				
Q-1 64	55586	2858947	60832	2919779
Q-2 64				
Q-3 64	35374	705424	15010	720434
Q-4 64				
Q-1 65	-15465	219053	5844	224897
Q-2 65				
Q-3 65	3228	69049	1842	70891
TOTAL	239578	13228736	241388	13470124

TECHNICAL DESCRIPTION

SUBSYSTEM: AIRFRAME STRUCTURE WBS CODE: 1.1

MAJOR ASSEMBLY: INTERMEDIATE FUSELAGE WBS CODE: 1.1.5

The intermediate fuselage consisted of three separate large structural sections identified as the upper intermediate, lower forward intermediate and the lower aft intermediate. The intermediate fuselage included all fuselage structure from FS857.5 to FS2028.5 and contained integral fuel tanks, the landing gear, weapons bay, and the engine air inlets. Construction consisted of brazed steel honeycomb sandwich for skins, bulkheads, and pressure webs and single stiffened sheet for internal frame webs. PH15-7MO steel was used throughout with brazing and welding (resistance and fusion) being the principal methods for assembly joining of webs, panels, and sections. H-11 type steel was employed for mechanically attached fittings and trusses. Although longerons did exist in some areas, longitudinal loads from vertical and side bending were carried principally in the skin panels, whereas the transverse loads from wing bending were carried by frame caps in combination with the skin panels. Torsional loads were carried almost entirely by the skin and inlet duct panels. Fuel-tight piping was provided for environmental control air ducts, primary flight controls, electrical conduits, fuel lines, and hydraulic lines. See Exhibit 28, page III-235, for construction details.

The upper intermediate fuselage section included all fuselage structure above the fuselage reference plane from FS857.5 to FS1838. This section contained integral fuel tanks and provisions for portions of electrical, hydraulic and environmental subsystems. The lower forward intermediate fuselage section included all fuselage structure forward of FS1521 bounded by the wing fuselage joint. It included the forward apex portion of the wing, forward wing stub, the air induction system inlet, integral fuel tanks, and the forward section of the weapons bay. It contained provisions for the nose landing gear, its well, cooling walls, and door. Also in the lower forward section was the air induction inlet variable ramps and the provisions for their power linkage and controls. The lower aft intermediate fuselage section included all fuselage structure from FS1521 to FS2028.5 below the fuselage reference plane between the wing fuselage joints plus a portion of the upper fuselage from FS1838 to 2028.5. This structure contained the diffuser section of each engine air inlet duct, intermediate wing stub, integral fuel tanks, main landing gear, aft weapons bay section, various equipment items and line routings. The two main landing gear wells, including cooling walls and doors, were provided outboard of the engine air inlet ducts. The most aft bulkhead of this section served as an engine compartment firewall with the air vehicle power generating accessories located in compartments forward of the firewall and below the air inlet duct.

The integral fuel tanks within the intermediate fuselage were constructed of longerons, frames, steel honeycomb fuselage skin, steel honeycomb or stiffened sheet bulkheads and structure, as required, for structural integrity of the tanks and proper thermal environment for the fuel. Resealable fuel-tight access doors were provided for access to fuel system equipment and, for equipment compartments contained within the bounds of the fuel tanks, steel closeout structure was utilized. The fuel tanks contained within the intermediate fuselage were designated tanks no. 1, no. 2, no. 3 (sump), no. 4 and no. 5 with maximum usable capacities of 7422 lbs., 4900 lbs., 5485 lbs., 5906 lbs., and 4641 lbs. of fuel, respectively. (Note: on Air Vehicle No. 1, due to sealing problems, fuel tank no. 5 was dry.)

The air induction system consisted of two ducts with each supplying air for three engines. The ducts were made of steel honeycomb and extended through both the lower forward and aft sections of the intermediate fuselage connecting the variable geometry inlet with the engines. Dividers were located in each duct immediately forward of the engine inlets to direct the air from the duct diffuser section into each of the three engines. Each duct had a variable geometry inlet located under the wing aft of the wing leading edge. The variable portion of the inlets consisted of hinged panels of steel honeycomb located on the inboard side of each duct. In each duct, immediately aft of the diffuser, porous walls were provided around the periphery of the duct and along the engine dividers to remove the air supplied by the duct but not required by the engines. This excess air bled into a compartment surrounding the porous regions. To this bypass plenum variable area flap-type bypass doors were provided on the upper surface of the fuselage to permit overboard discharge of the excess air. In each duct provisions were made for installation of the necessary probes, actuators, and controls as part of the Air Induction Subsystem (WBS 1.5).

Boundary layer ducting was provided between each engine air inlet and the lower wing surface to remove the boundary layer formed under the wing forward of the inlet. This air was discharged overboard through an exit on the top surface of the wing. Porous surfaces were provided on the four walls of each inlet in the throat region and forward of the throat to remove the boundary layer formed along the inlet surfaces. The air from the region forward of the throat was bled into compartments (chambers) and ducted to exits located underneath the air vehicle close to the bleed locations. The air from the throat region was bled into compartments (chambers) between the two ducts and then ducted aft to the engine compartment to be used as base area relief or for engine compartment cooling.

The weapons bay in the intermediate fuselage was 84 inches high, 73.4 inches wide and 348 inches long. Structural provisions and hard spots were provided in the bay for the suspension of the AICS electronic equipment package and the flight test instrumentation equipment package.

One of the most distinctive features of the B-70 configuration was the underslung afterbody of the fuselage which housed six engines, the weapons bay, a large amount of fuel and the landing gear. This wedge shaped body which was arranged to house multi-shock two-dimensional variable inlets with each supplying air to three engines, permitted the application of the "Compression Lift" concept. This compression lift was achieved by positioning the wing in a manner to take advantage of the pressure field behind the shock wave generated by the fuselage body as illustrated by Exhibit 29, page III-236.

In addition to the compression lift application, this fuselage design provided maximum density at minimum volume which further optimized L/D.

Compression lift on the B-70 resulted when the supersonic inlets created disturbances in the form of shock waves to perform the function of compressing and slowing the air to subsonic speeds for delivery to the engines. The first shock of that compression was generated by the inlet external fixed wedge. At vehicle Mach 3.0, this shock was bent back approximately 65^{o} with a Mach number change across the shock of 0.3 which resulted in an average downstream pressure rise of 40 lbs/ft^2. With the rest of the fuselage afterbody shaped to the same angle as the wedge, the downstream compression field was maintained with a large portion of the wing exposed under surface influenced by the pressure rise. (This pressure field was further enhanced by the folded wing tips as discussed under Wing Structure.) Since the average wing loading at cruise was approximately 50 lbs/ft^2, a significant portion of the air vehicle weight was carried by the compression field, hence the term "Compression Lift." The improvement in lift and L/D at a given angle of attack due to compression lift is presented by Exhibit 30, page III-237.

FWD & AFT INTERMEDIATE FUSELAGE

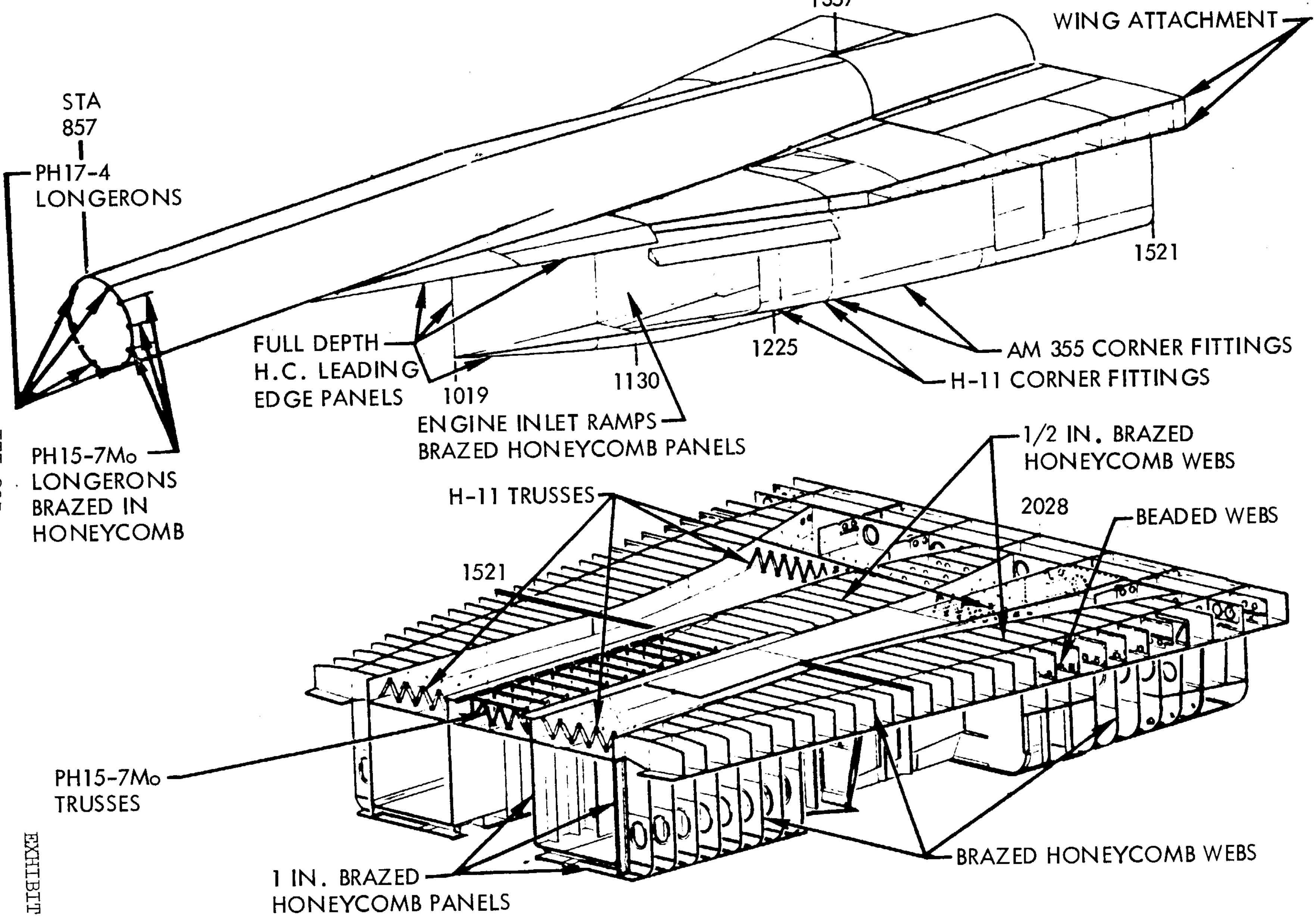

EXHIBIT 28

COMPRESSION LIFT
(WEDGE SHAPE AFTERBODY)

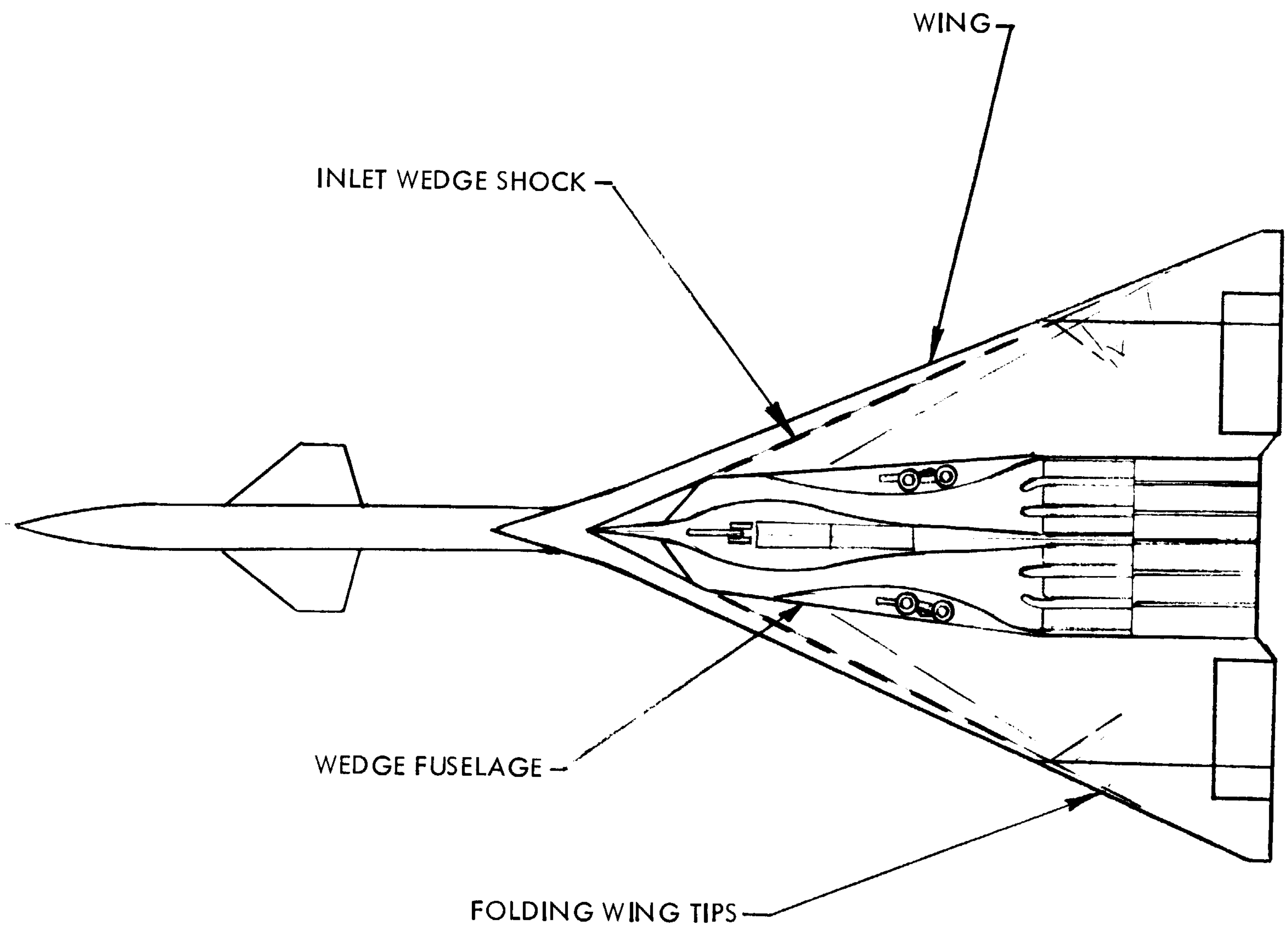

EXHIBIT 29

EFFECT OF COMPRESSION LIFT ON ANGLE OF ATTACK

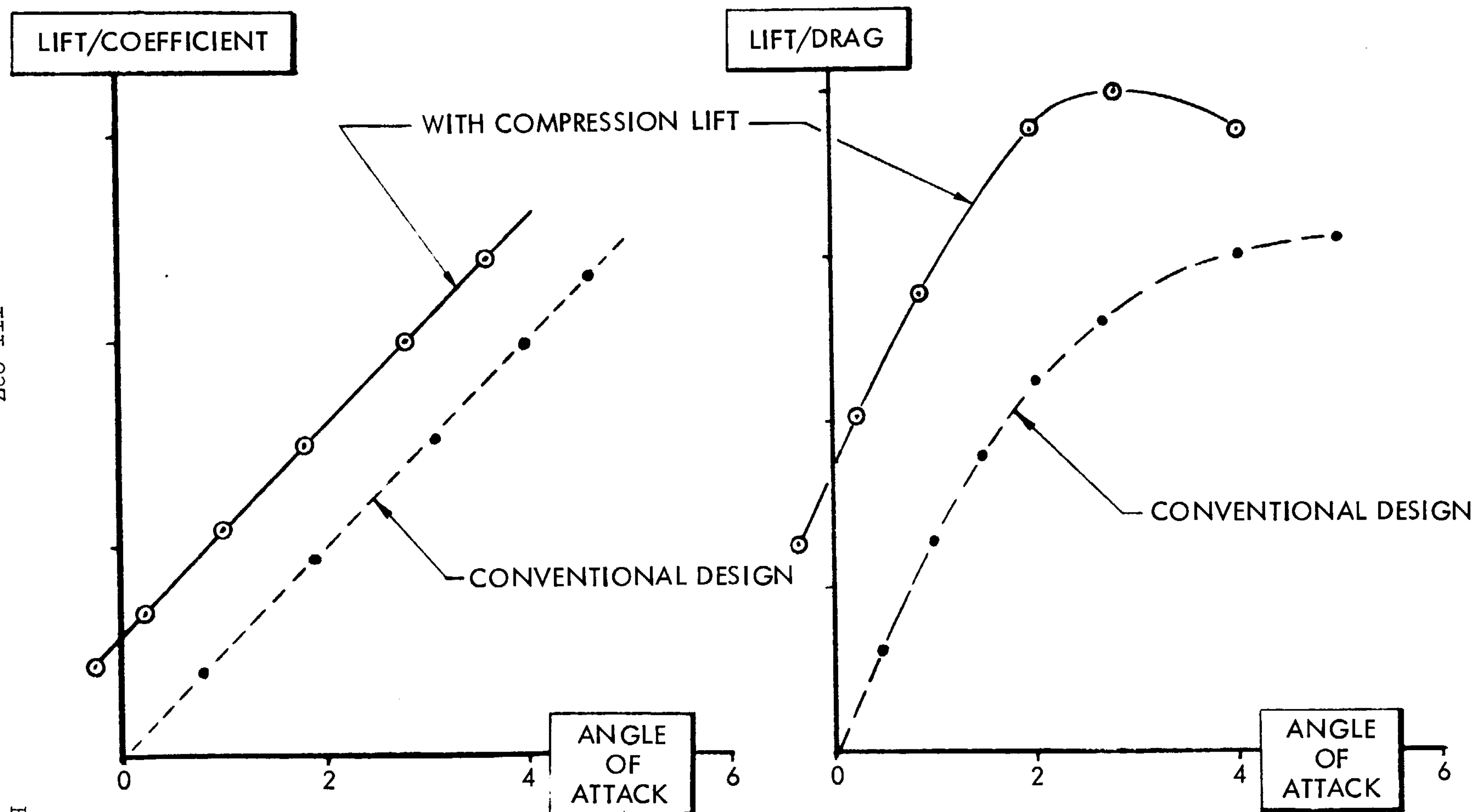

EXHIBIT 30

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: INTERMEDIATE FUSELAGE   WBS CODE: 1.1.5

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	Pounds	40,699	TBD	TBD	64,992	62,626
CONSTRUCTION	Type	- - Honeycomb skins, bulkheads, and pressure webs - -				
		- - Single stiffened sheet for internal webs - -				
		- - Streamlined tubes for trusses - -				
MATERIAL	Type	PH15-7Mo steel, AM355 steel, H-11 steel				
LENGTH	Inches	1171	1171	1171	1171	1171
HEIGHT	Inches	176.5	176.5	176.5	176.5	176.5
WIDTH	Inches	358	358	358	358	358
TEMPERATURE - GENERAL	Degrees F	-65 to 630	-65 to 630	-65 to 630	-65 to 630	-65 to 630
MAJOR ASSEMBLIES	Type/No.	- - (1) Upper, (1) Lower Fwd, & (1) Lower Aft - -				
MAJOR COMPARTMENTS	No.	25	25	25	25	25
FUEL TANKS	No.	5	5	5	5	5
FUEL QUANTITY (TOTAL)	Gallons	27,535	27,535	27,535	23,947	28,354
CONTROL SURFACES	No.	16	12	12	12	12
CONTROL SURFACES	Type	Inlet Ramps	Inlet Ramps	----------	----------	Inlet Ramps
		Bypass Doors		----------	----------	Bypass Doors
		Inlet Aux Doors				

COST DEFINITION

SUBSYSTEM: AIRFRAME STRUCTURE   WBS CODE: 1.1

MAJOR ASSEMBLY: INTERMEDIATE FUSELAGE   WBS CODE: 1.1.5

Recorded costs of $120,085,833 include all identifiable in-house and subcontracted effort to design and fabricate the Intermediate Fuselage as defined by the Work Breakdown Structure. A detail discussion of the vendors involved with this major structural assembly is contained on page III-240.

The in-house engineering effort includes the design and vendor support activities only. It excludes the design support effort as these can not be identified at a level lower than WBS level 5 (Airframe Structure). The Engineering Group Matrix on page III-69 recaps the hours charged by the engineering design groups associated with this major assembly.

In-house production effort includes all identifiable costs to fabricate and assemble the structural components included in this WBS item. This item also includes the fabrication of the structural items of the Air Induction System (WBS 1.5) such as the ramps, panels, duct splitters, etc. Specifically excluded from the production costs are:

a) Mating of the intermediate fuselage sections (WBS 3.0).
b) Fabrication and installation of subsystem provisions (Brackets, supports, frames, etc.) or equipment (WBS 1.12).
c) In-house ground testing activities (WBS 1.1.8).
d) Vehicle check-out and preflight operations (WBS 1.12).

Subcontractor costs for this major assembly include all vendor engineering, production, tooling and testing costs. These are displayed in the Subcontractor Element of Cost within the appropriate Subdivision of Work. Additional vendor data is contained on page III-240.

SUBCONTRACTOR MATRIX

SUBSYSTEM: AIRFRAME STRUCTURE WBS CODE: 1.1

MAJOR ASSEMBLY: INTERMEDIATE FUSELAGE WBS CODE: 1.1.5

SUBCONTRACTOR	ENG'R'G	PROD.	TOOLING	TEST	TOTAL
Lockheed	8,687,111	428,667	375,333	--	9,491,111
Avco	233,721	1,164,129	1,706,878	--	3,104,728
Total	8,920,832	1,592,796	2,082,211	--	12,595,839

LOCKHEED was awarded the Upper Intermediate Fuselage of the B-70 based upon their capabilities and reasonable operating rates. Two major contracts were issued for this effort:

L991-XH-600117 February 13, 1959 - December 8, 1959

L1A1-XZ-600334 December 21, 1960 - March 31, 1961

The Statement of Work for Purchase Order 600117 required the subcontractor to provide engineering, management planning services, tool planning, design, and fabrication directed towards the design and production of the B-70 Upper Intermediate Fuselage. In addition, the subcontractor was to perform research and development necessary to produce the above hardware.

Purchase Order 600334 provided for the production of the Upper Intermediate Fuselage for Air Vehicle 1.

Lockheed was awarded purchase order 600117 for the design effort on the original 60 vehicle B-70 program. When this program was redirected to a one air vehicle program in December 1959, this letter contract was cancelled. Late in 1960 the YB-70 program was initiated adding 11 flight test vehicles to the one XB-70 on order. At this point, Lockheed was awarded the Upper Forward Intermediate Fuselage portion of the structure. When the program was redirected to a three air vehicle program, NAR again had sufficient in-house capacity; and Letter Contract 600334 was cancelled.

The manufacturing processes and tooling needed to produce this type of hardware were an advancement to the state-of-art. The honeycomb stainless steel sandwich construction had never before been manufactured on a production

WBS CODE: 1.1.5

basis. It required new ideas, tooling and facilities in its development. The weapon system concept and type of contracting were also new on this scale.

AVCO was selected to produce the Aft Section - Upper Forward Intermediate Fuselage for the XB-70 Air Vehicle.

The three letter contracts awarded to AVCO for this effort, along with their award and completion dates are as follows:

LOA1-XZ-600206	February 12, 1960 - December 5, 1961
L1A1-YZ-600323	November 14, 1960 - May 6, 1963
L3A1-YJ-600518	March 17, 1963 - March 9, 1964

The Statement of Work for the three contracts directed the subcontractor to provide technical and manufacturing services and facilities, necessary to design, fabricate tooling, and accomplish other work as may be required to fabricate and deliver the Aft Section - Upper Forward Intermediate Fuselage for the B-70 Air Vehicles 1, 2, and 3.

Purchase Order 600206 was issued to cover the initial subcontractor design, tooling and production effort required for Air Vehicle 1. Purchase Orders 600323 and 600518 were for Air Vehicles 2, and 3.

The schedule final delivery date for Air Vehicle 1 was December 5, 1961, and Air Vehicle 2 was March 29, 1963. The Aft Section for Air Vehicle 3 was covered on Purchase Order 600518 which was terminated on March 9, 1964 with 65% of the effort completed.

All of the residual inventory and tooling accountable under this contract was scrapped or returned to NR for storage with appropriate credits issued to the purchase order.

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 01
6-MAJ ASSY 05
INTERMEDIATE FUSELAGE

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOOLING AND STE HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	938714	53132		991846
LABOR AT $ 5.060	4792253	226179		5018432
ENGR BURDEN AT $ 4.617	4266364	312594		4578958
PRODUCTION		8580889		8580889
LABOR AT $ 3.221		27640517		27640517
PLANNING		496164		496164
LABOR AT $ 3.389		1681324		1681324
TEST/QC		1071121		1071121
LABOR AT $ 3.629		3887314		3887314
MFG BURDEN AT $ 4.044		41038988		41038988
MFG MATERIAL		19028206		19028206
SUBCONTRACT	8920832	1592796	2082211	12595839
MPC	376604	2069352	69887	2515843
OTHER COST	457	13369		13826
SUB-TOTAL	18356510	97490639	2152098	117999247
GEN & ADMIN	243459	1803511	39616	2086586
TOTAL COST	18599969	99294150	2191714	120085833
TIME-PHASED COST DETAIL - SEE PAGE	III-243	III-247	III-253	III-254

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 01 **INTERMEDIATE FUSELAGE**
6-MAJ ASSY 05
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	562	4.671	2625	2557	5182
Q-2 58						
Q-3 58	100.5	16812	4.628	77806	65836	143642
Q-4 58						
Q-1 59	202.5	34495	4.518	155848	118594	274442
Q-2 59						
Q-3 59	235.5	41526	4.346	180472	149037	329509
Q-4 59						
Q-1 60	649.5	112593	4.445	500471	430699	931170
Q-2 60						
Q-3 60	649.5	109221	4.655	508424	406718	915142
Q-4 60						
Q-1 61	828.0	141342	4.827	682258	486358	1168616
Q-2 61						
Q-3 61	492.0	89250	4.843	432238	406355	838593
Q-4 61						
Q-1 62	375.0	64070	5.331	341557	295683	637240
Q-2 62						
Q-3 62	370.5	62219	5.415	336916	320055	656971
Q-4 62						
Q-1 63	361.5	61742	6.725	415215	386320	801535
Q-2 63						
Q-3 63	487.5	81738	5.120	418755	415238	833993
Q-4 63						
Q-1 64	447.0	76202	5.922	451268	479463	930731
Q-2 64						
Q-3 64	192.0	33823	5.895	199387	217177	416564
Q-4 64						
Q-1 65	69.0	11931	6.811	81262	78768	160030

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

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 01 **INTERMEDIATE FUSELAGE**
6-MAJ ASSY 05
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	7.5	1138	6.811	7751	7506	15257
TOTAL	5470.5	938714		4792253	4266364	9058617

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 01 **INTERMEDIATE FUSELAGE**
6-MAJ ASSY 05
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-1 58	3.0	562	4.671	2625	2557	5182	
Q-2 58							
Q-3 58	100.5	16812	4.628	77806	65836	143642	
Q-4 58							
Q-1 59	202.5	34495	4.518	155848	118594	274442	281788
Q-2 59							
Q-3 59	235.5	41526	4.346	180472	149037	329509	4236782
Q-4 59							
Q-1 60	649.5	112593	4.445	500471	430699	931170	3198604
Q-2 60							
Q-3 60	649.5	109221	4.655	508424	406713	915142	835087
Q-4 60							
Q-1 61	828.0	141342	4.827	682258	486358	1168616	144867
Q-2 61							
Q-3 61	492.0	89250	4.843	432238	406355	838593	179536
Q-4 61							
Q-1 62	375.0	64070	5.331	341557	295683	637240	2300
Q-2 62							
Q-3 62	370.5	62219	5.415	336916	320055	656971	2300
Q-4 62							
Q-1 63	361.5	61742	6.725	415215	386320	801535	8784
Q-2 63							
Q-3 63	487.5	81788	5.120	418755	415233	833993	17937
Q-4 63							
Q-1 64	447.0	76202	5.922	451268	479463	930731	2784
Q-2 64							
Q-3 64	192.0	33823	5.895	199387	217177	416564	2783
Q-4 64							
Q-1 65	69.0	11931	6.811	81262	78768	160030	7230
Q-2 65							
Q-3 65	7.5	1138	6.811	7751	7506	15257	
TOTAL	5470.5	938714		4792253	4266364	9058617	8920832

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 01
6-MAJ ASSY 05
SUBD OF WORK DESIGN/ENGINEERING

INTERMEDIATE FUSELAGE

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58			5182		5182
Q-2 58					
Q-3 58			143642		143642
Q-4 58					
Q-1 59	7471		563701		563701
Q-2 59					
Q-3 59	115770		4682061		4682061
Q-4 59					
Q-1 60	189773	457	4320004	82309	4402313
Q-2 60					
Q-3 60	49548		1799777	34291	1834068
Q-4 60					
Q-1 61	4153		1317636	24486	1342122
Q-2 61					
Q-3 61	5145		1023324	19016	1042340
Q-4 61					
Q-1 62	73		639613	10736	650349
Q-2 62					
Q-3 62	73		659344	11067	670411
Q-4 62					
Q-1 63	373		810692	13555	824247
Q-2 63					
Q-3 63	576		852506	14254	866760
Q-4 63					
Q-1 64	382		933897	19871	953768
Q-2 64					
Q-3 64	908		420255	8942	429197
Q-4 64					
Q-1 65	2359		169619	4525	174144
Q-2 65					
Q-3 65			15257	407	15664
TOTAL	376604	457	18356510	243459	18599969

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 01 **INTERMEDIATE FUSELAGE**
6-MAJ ASSY 05
SUBD OF WORK PRODUCTION

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	58.5	9868	5.414	53427	7097	60524
Q-4 58						
Q-1 59	70.5	12041	5.466	65813	10276	76089
Q-2 59						
Q-3 59	117.0	20537	5.361	110102	18884	128986
Q-4 59						
Q-1 60	45.0	7872	5.590	44001	9317	53318
Q-2 60						
Q-3 60	1.5	170	4.059	690	-554	136
Q-4 60						
Q-1 61	3.0	443	4.941	2189	2252	4441
Q-2 61						
Q-3 61	1.5	382	2.924	1117	522	1639
Q-4 61						
Q-1 62	3.0	448	2.737	1226	3661	4887
Q-2 62						
Q-3 62	16.5	2734	3.557	9725	16793	26518
Q-4 62						
Q-1 63	7.5	1372	3.331	4570	8584	13154
Q-2 63						
Q-3 63	-301.5	-50660	5.367	-271873	-50624	-322497
Q-4 63						
Q-1 64	28.5	4946	4.575	22630	29515	52145
Q-2 64						
Q-3 64	106.5	18715	4.453	83331	117654	200985
Q-4 64						
Q-1 65	57.0	9926	4.429	43965	61723	105688
Q-2 65						
Q-3 65	85.5	14338	3.855	55266	77494	132760
TOTAL	300.0	53132		226179	312594	538773

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

PRODUCTION
4-SYSTEM 1
5-SUBSYSTEM 01 **INTERMEDIATE FUSELAGE**
6-MAJ ASSY 05
SUBD OF WORK PRODUCTION

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 60	31.5	5533	4.582	25353	11165	36518
Q-2 60						
Q-3 60	54.0	9050	2.574	23292	17655	40947
Q-4 60						
Q-1 61	2380.5	406261	3.143	1276778	1529907	2806685
Q-2 61						
Q-3 61	6765.0	1226784	3.152	3866762	4920820	8787582
Q-4 61						
Q-1 62	8778.0	1498237	3.057	4595654	6210148	10805802
Q-2 62						
Q-3 62	6279.0	1054777	3.225	3401663	4878195	8279858
Q-4 62						
Q-1 63	6477.0	1105494	3.298	3646390	5013730	8660120
Q-2 63						
Q-3 63	6997.5	1175517	2.791	3280524	5325457	8605981
Q-4 63						
Q-1 64	7846.5	1339089	3.601	4822000	8058881	12880881
Q-2 64						
Q-3 64	2569.5	452258	3.371	1524704	2620904	4145608
Q-4 64						
Q-1 65	1710.0	296505	3.573	1059378	1615003	2674381
Q-2 65						
Q-3 65	67.5	11384	10.367	118019	150780	268799
TOTAL	49956.0	8580839		27640517	40352645	67993162

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

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

PLANNING
4-SYSTEM 1
5-SUBSYSTEM 01 **INTERMEDIATE FUSELAGE**
6-MAJ ASSY 05
SUBD OF WORK PRODUCTION

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	9.0	1394	2.997	4178		4178
Q-4 58						
Q-1 59	40.5	7006	2.960	20741		20741
Q-2 59						
Q-3 59	97.5	17195	2.989	51391		51391
Q-4 59						
Q-1 60	198.0	34286	3.160	108340	291	108631
Q-2 60						
Q-3 60	280.5	47204	3.043	143640		143640
Q-4 60						
Q-1 61	496.5	84623	3.017	255288	42378	297666
Q-2 61						
Q-3 61	448.5	81320	2.908	236454	41741	278195
Q-4 61						
Q-1 62	418.5	71484	2.978	212913	41661	254594
Q-2 62						
Q-3 62	378.0	63525	2.975	188987	44631	233618
Q-4 62						
Q-1 63		45	3.800	171	207	378
Q-2 63						
Q-3 63	166.5	27867	9.519	265258	227544	492802
Q-4 63						
Q-1 64	246.0	41864	3.199	133934	201560	335494
Q-2 64						
Q-3 64	67.5	11882	3.340	39685	57779	97464
Q-4 64						
Q-1 65	28.5	4942	3.145	15544	22152	37696
Q-2 65						
Q-3 65	9.0	1527	3.143	4800	6379	11179
TOTAL	2884.5	496164		1681324	686343	2367667

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 01
6-MAJ ASSY 05
SUBD OF WORK PRODUCTION

INTERMEDIATE FUSELAGE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	4.5	683	4.908	3352		3352
Q-4 58						
Q-1 59	4.5	658	4.257	2801		2801
Q-2 59						
Q-3 59	18.0	3277	4.665	15286		15286
Q-4 59						
Q-1 60	37.5	6472	5.057	32730		32730
Q-2 60						
Q-3 60	7.5	1170	3.899	4562		4562
Q-4 60						
Q-1 61	169.5	29004	3.133	90867		90867
Q-2 61						
Q-3 61	451.5	81854	3.120	255407		255407
Q-4 61						
Q-1 62	763.5	130353	3.302	430367		430367
Q-2 62						
Q-3 62	769.5	129152	3.374	435822		435822
Q-4 62						
Q-1 63	819.0	139826	3.629	507428		507428
Q-2 63						
Q-3 63	1026.0	172395	4.272	736390		736390
Q-4 63						
Q-1 64	1381.5	235850	3.597	848327		848327
Q-2 64						
Q-3 64	549.0	96521	3.586	346132		346132
Q-4 64						
Q-1 65	226.5	39181	3.906	153051		153051
Q-2 65						
Q-3 65	28.5	4725	5.247	24792		24792
TOTAL	6256.5	1071121		3887314		3887314

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 01 **INTERMEDIATE FUSELAGE**
6-MAJ ASSY 05
SUBD OF WORK PRODUCTION

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	MFG MATL
Q-3 58	72.0	11945	5.103	60957	7097	68054	
Q-4 58							
Q-1 59	115.5	19705	4.535	89355	10276	99631	
Q-2 59							
Q-3 59	232.5	41009	4.311	175779	18884	195663	
Q-4 59							
Q-1 60	312.0	54163	3.885	210424	20773	231197	293
Q-2 60							
Q-3 60	343.5	57594	2.990	172184	17101	189285	11440
Q-4 60							
Q-1 61	3049.5	520331	3.123	1625122	1574537	3199659	734291
Q-2 61							
Q-3 61	7666.5	1390340	3.136	4359740	4963083	9322823	3219379
Q-4 61							
Q-1 62	9963.0	1700522	3.082	5240160	6255490	11495650	2747973
Q-2 62							
Q-3 62	7443.0	1250138	3.228	4035197	4939619	8975816	2537429
Q-4 62							
Q-1 63	7303.5	1246737	3.336	4158559	5022521	9181080	3073736
Q-2 63							
Q-3 63	7888.5	1325119	3.026	4010299	5502377	9512676	2720849
Q-4 63							
Q-1 64	9502.5	1621749	3.593	5826891	8289956	14116847	2902382
Q-2 64							
Q-3 64	3292.5	579376	3.441	1993852	2796337	4790189	682135
Q-4 64							
Q-1 65	2022.0	350554	3.628	1271938	1698878	2970816	155671
Q-2 65							
Q-3 65	190.5	31974	6.345	202877	234653	437530	42628
TOTAL	59397.0	10201306		33435334	41351582	74786916	19028206

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 01
6-MAJ ASSY 05
SUBD OF WORK PRODUCTION

INTERMEDIATE FUSELAGE

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-3 58 / Q-4 58					68054		68054
Q-1 59 / Q-2 59					99631		99631
Q-3 59 / Q-4 59					195663		195663
Q-1 60 / Q-2 60	678	971	78		232246	4425	236671
Q-3 60 / Q-4 60	64147	75587	5310		270182	5148	275330
Q-1 61 / Q-2 61	532498	1266789	77266		4543714	84435	4628149
Q-3 61 / Q-4 61	495119	3714498	286061		13323382	247588	13570970
Q-1 62 / Q-2 62	101814	2849787	219665		14565102	244475	14809577
Q-3 62 / Q-4 62	84252	2621681	202523		11800020	198063	11998083
Q-1 63 / Q-2 63	102566	3176302	307189		12664571	211751	12876322
Q-3 63 / Q-4 63	103981	2824830	271407	2424	12611337	210862	12822199
Q-1 64 / Q-2 64	104913	3007295	323799	9682	17457823	371467	17829290
Q-3 64 / Q-4 64	3006	885141	321936	1063	5998329	127632	6125961
Q-1 65 / Q-2 65	-178	155493	46513		3172822	84651	3257473
Q-3 65		42628	7605		487763	13014	500777
TOTAL	1592796	20621002	2069352	13369	97490639	1803511	99294150

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 01 **INTERMEDIATE FUSELAGE**
6-MAJ ASSY 05
SUBD OF WORK TOOLING AND STE

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 60	1619	96	1715	32	1747
Q-2 60					
Q-3 60	153064	9081	162145	3089	165234
Q-4 60					
Q-1 61	1145902	32831	1178733	21904	1200637
Q-2 61					
Q-3 61	455433	13048	468481	8706	477187
Q-4 61					
Q-1 62	113723	3614	117337	1969	119306
Q-2 62					
Q-3 62	110103	3496	113599	1907	115506
Q-4 62					
Q-1 63	35681	1515	37196	622	37818
Q-2 63					
Q-3 63	37679	1210	38889	650	39539
Q-4 63					
Q-1 64	23639	3246	26885	572	27457
Q-2 64					
Q-3 64	3398	1108	4506	95	4601
Q-4 64					
Q-1 65	1970	642	2612	70	2682
TOTAL	2082211	69887	2152098	39616	2191714

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 01
6-MAJ ASSY 05
INTERMEDIATE FUSELAGE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	3.0	562	4.671	2625	2557	5182
Q-2 58						
Q-3 58	159.0	26680	4.919	131233	72933	204166
Q-4 58						
Q-1 59	273.0	46536	4.763	221661	128870	350531
Q-2 59						
Q-3 59	352.5	62063	4.682	290574	167921	458495
Q-4 59						
Q-1 60	694.5	120465	4.520	544472	440016	984488
Q-2 60						
Q-3 60	651.0	109391	4.654	509114	406164	915278
Q-4 60						
Q-1 61	831.0	141785	4.827	684447	488610	1173057
Q-2 61						
Q-3 61	495.0	89632	4.835	433355	406877	840232
Q-4 61						
Q-1 62	378.0	64518	5.313	342783	299344	642127
Q-2 62						
Q-3 62	387.0	64953	5.337	346641	336848	683489
Q-4 62						
Q-1 63	370.5	63114	6.651	419785	394904	814689
Q-2 63						
Q-3 63	186.0	31128	4.719	146882	364614	511496
Q-4 63						
Q-1 64	475.5	81148	5.840	473898	508978	982876
Q-2 64						
Q-3 64	298.5	52538	5.381	282718	334831	617549
Q-4 64						
Q-1 65	126.0	21857	5.729	125227	140491	265718

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 01
6-MAJ ASSY 05
INTERMEDIATE FUSELAGE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-2 65						
Q-3 65	91.5	15476	4.072	63017	85000	148017
TOTAL	5772.0	991846		5018432	4578958	9597390

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

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

PRODUCTION
4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 05
INTERMEDIATE FUSELAGE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 60	31.5	5533	4.582	25353	11165	36518
Q-2 60						
Q-3 60	54.0	9050	2.574	23292	17655	40947
Q-4 60						
Q-1 61	2380.5	406261	3.143	1276778	1529907	2806685
Q-2 61						
Q-3 61	6765.0	1226784	3.152	3866762	4920820	8787582
Q-4 61						
Q-1 62	8778.0	1498237	3.067	4595654	6210148	10805802
Q-2 62						
Q-3 62	6279.0	1054777	3.225	3401663	4878195	8279858
Q-4 62						
Q-1 63	6477.0	1105494	3.298	3646390	5013730	8660120
Q-2 63						
Q-3 63	6997.5	1175517	2.791	3280524	5325457	8605981
Q-4 63						
Q-1 64	7846.5	1339089	3.601	4822000	8058881	12880881
Q-2 64						
Q-3 64	2569.5	452258	3.371	1524704	2620904	4145608
Q-4 64						
Q-1 65	1710.0	296505	3.573	1059378	1615003	2674381
Q-2 65						
Q-3 65	67.5	11384	10.367	118019	150780	268799
TOTAL	49956.0	8580889		27640517	40352645	67993162

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

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

PLANNING
4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 05
INTERMEDIATE FUSELAGE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	9.0	1394	2.997	4178		4178
Q-4 58						
Q-1 59	40.5	7006	2.960	20741		20741
Q-2 59						
Q-3 59	97.5	17195	2.989	51391		51391
Q-4 59						
Q-1 60	198.0	34286	3.160	108340	291	108631
Q-2 60						
Q-3 60	280.5	47204	3.043	143640		143640
Q-4 60						
Q-1 61	496.5	84623	3.017	255288	42378	297666
Q-2 61						
Q-3 61	448.5	81320	2.908	236454	41741	278195
Q-4 61						
Q-1 62	418.5	71484	2.978	212913	41681	254594
Q-2 62						
Q-3 62	378.0	63525	2.975	188987	44631	233618
Q-4 62						
Q-1 63		45	3.800	171	207	378
Q-2 63						
Q-3 63	166.5	27867	9.519	265258	227544	492802
Q-4 63						
Q-1 64	246.0	41864	3.199	133934	201560	335494
Q-2 64						
Q-3 64	67.5	11882	3.340	39685	57779	97464
Q-4 64						
Q-1 65	28.5	4942	3.145	15544	22152	37696
Q-2 65						
Q-3 65	9.0	1527	3.143	4800	6379	11179
TOTAL	2384.5	496164		1681324	686343	2367667

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 01
6-MAJ ASSY 05
INTERMEDIATE FUSELAGE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	4.5	683	4.908	3352		3352
Q-4 58						
Q-1 59	4.5	658	4.257	2801		2801
Q-2 59						
Q-3 59	18.0	3277	4.665	15286		15286
Q-4 59						
Q-1 60	37.5	6472	5.057	32730		32730
Q-2 60						
Q-3 60	7.5	1170	3.899	4562		4562
Q-4 60						
Q-1 61	169.5	29004	3.133	90867		90867
Q-2 61						
Q-3 61	451.5	81854	3.120	255407		255407
Q-4 61						
Q-1 62	763.5	130353	3.302	430367		430367
Q-2 62						
Q-3 62	769.5	129152	3.374	435822		435822
Q-4 62						
Q-1 63	819.0	139826	3.629	507428		507428
Q-2 63						
Q-3 63	1026.0	172395	4.272	736390		736390
Q-4 63						
Q-1 64	1381.5	235850	3.597	848327		848327
Q-2 64						
Q-3 64	549.0	96521	3.586	346132		346132
Q-4 64						
Q-1 65	226.5	39191	3.906	153051		153051
Q-2 65						
Q-3 65	28.5	4725	5.247	24792		24792
TOTAL	6256.5	1071121		3887314		3867314

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 01
6-MAJ ASSY 05
INTERMEDIATE FUSELAGE

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	MFG MATL
Q-1 58	3.0	562	4.671	2625	2557	5182	
Q-2 58							
Q-3 58	172.5	28757	4.825	138763	72933	211696	
Q-4 58							
Q-1 59	318.0	54200	4.524	245203	128870	374073	
Q-2 59							
Q-3 59	469.0	82535	4.328	357251	167921	525172	
Q-4 59							
Q-1 60	961.5	166756	4.263	710895	451472	1162367	293
Q-2 60							
Q-3 60	993.0	166815	4.080	680608	423819	1104427	11440
Q-4 60							
Q-1 61	3877.5	661673	3.487	2307380	2060895	4368275	734291
Q-2 61							
Q-3 61	8160.0	1479590	3.239	4791978	5369438	10161416	3219379
Q-4 61							
Q-1 62	10338.0	1764592	3.163	5581717	6551173	12132890	2747973
Q-2 62							
Q-3 62	7813.5	1312407	3.332	4373113	5259674	9632787	2537429
Q-4 62							
Q-1 63	7666.5	1308479	3.495	4573774	5408841	9982615	3073736
Q-2 63							
Q-3 63	8376.0	1406907	3.148	4429054	5917615	10346669	2720849
Q-4 63							
Q-1 64	9949.5	1697951	3.697	6278159	8769419	15047578	2902382
Q-2 64							
Q-3 64	3484.5	613199	3.577	2193239	3013514	5206753	882135
Q-4 64							
Q-1 65	2091.0	362485	3.733	1353200	1777646	3130846	155671
Q-2 65							
Q-3 65	196.5	33112	6.361	210628	242159	452787	42628
TOTAL	64869.0	11140020		38227587	45617946	83845533	19028206

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 01
6-MAJ ASSY 05
INTERMEDIATE FUSELAGE

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58					5182		5182
Q-2 58							
Q-3 58					211696		211696
Q-4 58							
Q-1 59	281788	281788	7471		663332		663332
Q-2 59							
Q-3 59	4236782	4236782	115770		4877724		4877724
Q-4 59							
Q-1 60	3200901	3201194	189947	457	4553965	86766	4640731
Q-2 60							
Q-3 60	1052298	1063738	63939		2232104	42528	2274632
Q-4 60							
Q-1 61	1823267	2557558	114250		7040083	130825	7170908
Q-2 61							
Q-3 61	1130138	4349517	304254		14815187	275310	15090497
Q-4 61							
Q-1 62	217837	2965810	223352		15322052	257180	15579232
Q-2 62							
Q-3 62	196655	2734084	206092		12572963	211037	12784000
Q-4 62							
Q-1 63	147031	3220767	309077		13512459	225928	13738387
Q-2 63							
Q-3 63	159597	2880446	273193	2424	13502732	225766	13728498
Q-4 63							
Q-1 64	131336	3033718	327427	9882	18418605	391910	18810515
Q-2 64							
Q-3 64	9187	891322	323952	1063	6423090	136669	6559759
Q-4 64							
Q-1 65	9022	164693	49514		3345053	89246	3434299
Q-2 65							
Q-3 65		42628	7605		503020	13421	516441
TOTAL	12595839	31624045	2515843	13826	117999247	2086586	120085833

TECHNICAL DESCRIPTION

SUBSYSTEM: AIRFRAME STRUCTURE WBS CODE: 1.1
MAJOR ASSEMBLY: AFT FUSELAGE WBS CODE: 1.1.6

DESCRIPTION/FUNCTION

The aft fuselage consisted of portions of the wing stub, fuel tanks (No. 8), and the engine compartments for the six engines and engine-mounted accessories. This section included all fuselage structure aft of FS2028.5 (to 2276.8) between the fuselage-wing joints. The six engine compartments were partitioned by structural longitudinal panels and had access doors (fore and aft) for engine maintenance and removal. The aft fuselage had provisions for engine mounts and for attachment of the wings and vertical stabilizers. The fairing on the upper structure incorporated a drag chute compartment.

The aft fuselage was constructed primarily of riveted 4Al-3MO-1V and 6Al-4V titanium alloy skins welded to frames made of H-11 steel alloy caps riveted to 4Al-3MO-1V titanium alloy webs. The engine longitudinal panels were constructed of Rene 41 and Inconel 718 nickel alloys. The PH15-7MO steel honeycomb wing cover skins (for the stubs) extended inboard of the fuselage maximum half-breath to the side frame inner caps to unload directly into the fuselage frames. The drag chute compartment doors were constructed of brazed PH15-7MO steel honeycomb. See Exhibit 31, page III-262, for construction details.

Access to each engine was provided by two individual tandem doors located in the bottom of the fuselage. The forward door provided access to the entire engine accessory compartment, while the aft door, which was separated from the forward door by a section of fixed structure, was utilized for engine installation and removal. The access doors for each engine were hinge-mounted on the under structure with the forward door side hinged and the aft door hinged at its forward edge. Engine compartment cooling is discussed under Propulsion Subsystem (WBS 1.3) and the drag compartment and operation is discussed under Alighting and Arresting Subsystem (WBS 1.8).

Exhibit 32, page III-263, presents a view of the aft fuselage looking forward showing the 6 engine compartments.

AFT FUSELAGE

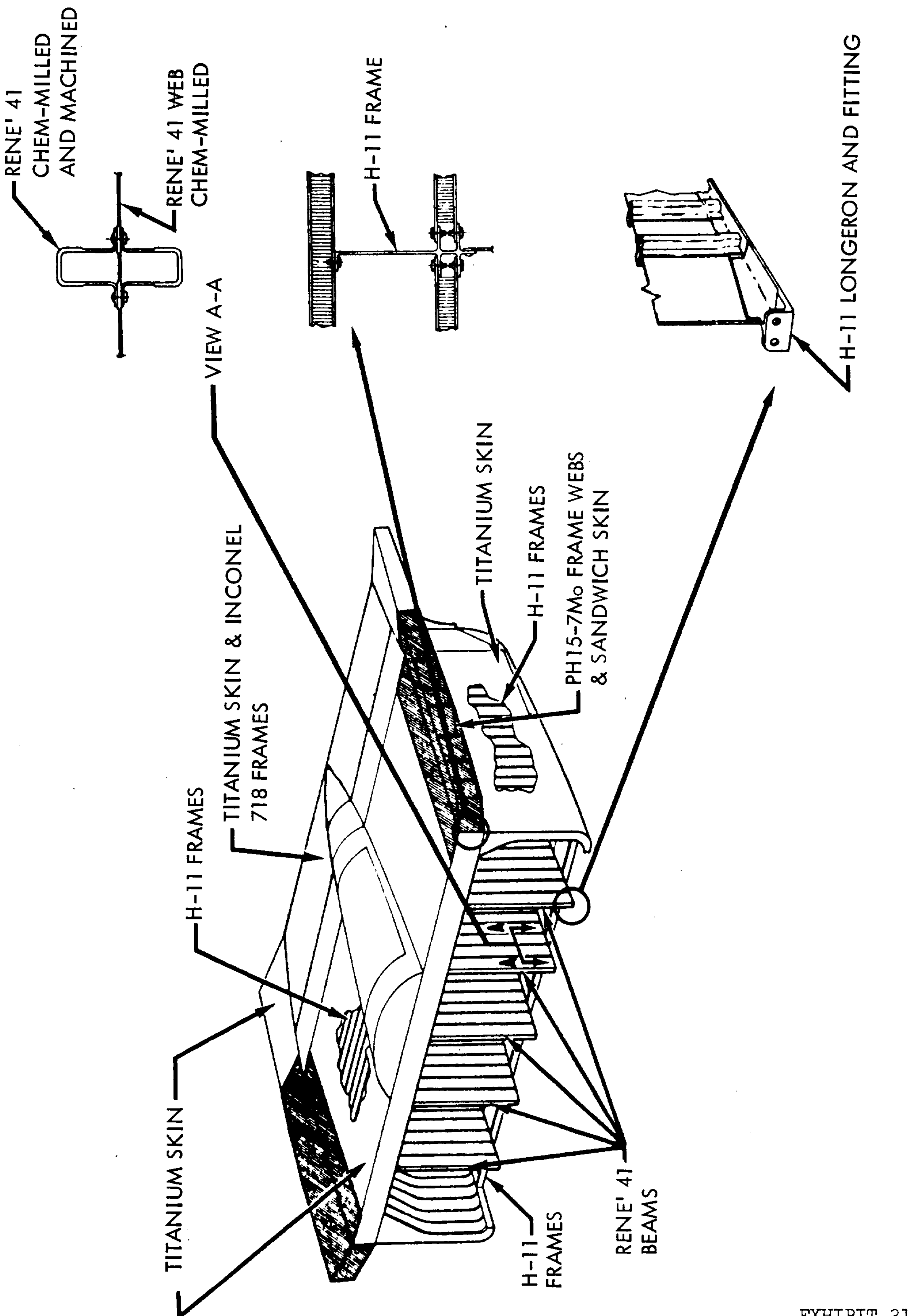
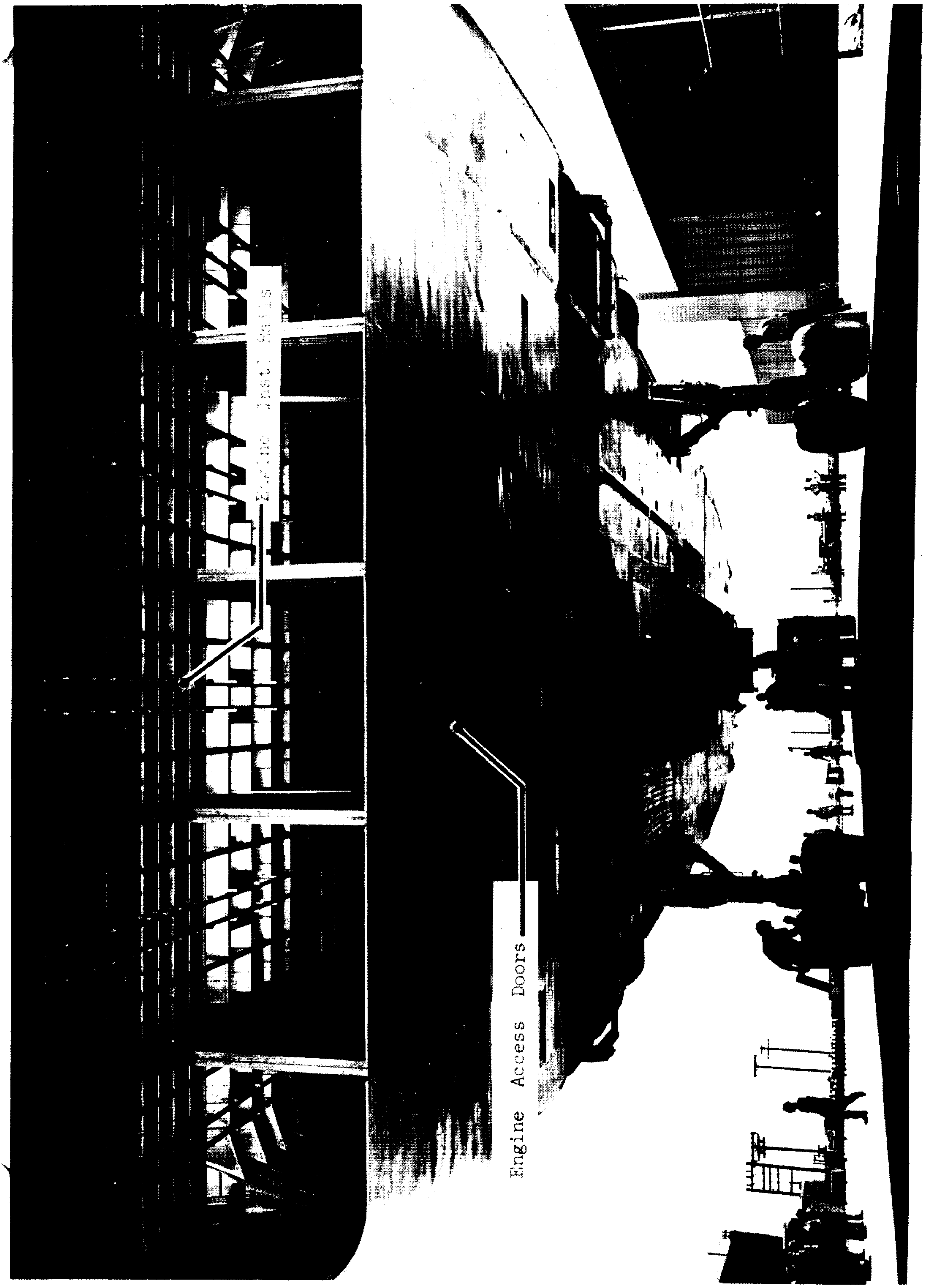


EXHIBIT 31

AFT FUSELAGE STRUCTURE



TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: AFT FUSELAGE WBS CODE: 1.1.6

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT (BASIC STRUCTURE)	Pounds	7412	TBD	TBD	11,166	10,768
WEIGHT (ENG MOUNTS & FIRE SHROUD)	Pounds	1328	TBD	TBD	2367	2372
CONSTRUCTION/MATERIALS	Type	- Riveted 4Al-3Mo-1V & 6Al-4V Titanium Skins welded to frames of H-11 steel caps which were riveted to 4Al-3Mo-1V Titanium webs. Longitudinal engine panels were of Rene 41 and Inconel 718				
LENGTH	Inches	248.3	248.3	248.3	248.3	248.3
HEIGHT (LESS VERTICALS)	Inches	99	99	99	99	99
WIDTH	Inches	355	355	355	355	355
TEMPERATURE (GENERAL)	Degrees F	-65 to 630	-65 to 630	-65 to 630	-65 to 630	-65 to 630
(ENGINE BAYS)	Degrees F	-65 to 1000	-65 to 1000	-65 to 1000	-65 to 1000	-65 to 1000
MAJOR COMPARTMENTS	No.	7	7	7	7	7

COST DEFINITION

SUBSYSTEM: AIRFRAME STRUCTURE WBS CODE: 1.1

MAJOR ASSEMBLY: AFT FUSELAGE WBS CODE: 1.1.6

Recorded costs of $21,357,837 include all identifiable in-house and subcontracted effort to design and fabricate the aft fuselage as defined bv the Work Breakdown Structure.

The in-house engineering effort includes the design and vendor support activities only. It excludes the design support effort as these can not be identified at a level lower than WBS level 5 (Airframe Structure). The Engineering Group Matrix on page III-69 recaps the hours charged by the engineering design groups associated with this major assembly.

In-house production effort includes all identifiable costs to fabricate and assemble the structural components included in this WBS item. Specifically excluded from the production costs are:

a) Mating of the aft fuselage to the other fuselage sections (WBS 3.0).
b) Fabrication and installation of subsystem provisions (brackets, supports, frames, etc.) or equipment (WBS 1.12).
c) In-house ground testing activities (WBS 1.1.8).
d) Vehicle check-out and preflight operations (WBS 1.12).

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

4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 06
AFT FUSELAGE

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	562491	7982	570473
LABOR AT $ 5.096	2873091	33970	2907061
ENGR BURDEN AT $ 4.565	2557066	46968	2604034
PRODUCTION		1367703	1367703
LABOR AT $ 3.219		4402149	4402149
PLANNING		77676	77676
LABOR AT $ 3.377		262326	262326
TEST/QC		164636	164636
LABOR AT $ 3.619		595862	595862
MFG BURDEN AT $ 4.060		6536847	6536847
MFG MATERIAL		3309090	3309090
MPC		343242	343242
SUB-TOTAL	5430157	15530454	20960611
GEN & ADMIN	92837	304389	397226
TOTAL COST	5522994	15834843	21357837
TIME-PHASED COST DETAIL - SEE PAGE	III-267	III-271	III-277

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 01 **AFT FUSELAGE**
6-MAJ ASSY 06
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	1.5	338	4.669	1578	1538	3116
Q-2 58						
Q-3 58	60.0	10088	4.629	46697	39505	86202
Q-4 58						
Q-1 59	121.5	20697	4.518	93509	71156	164665
Q-2 59						
Q-3 59	141.0	24915	4.346	108281	89420	197701
Q-4 59						
Q-1 60	385.5	66817	4.445	297002	255642	552644
Q-2 60						
Q-3 60	390.0	65532	4.655	305051	244041	549092
Q-4 60						
Q-1 61	496.5	84805	4.827	409354	291814	701168
Q-2 61						
Q-3 61	295.5	52550	4.943	259343	243813	503156
Q-4 61						
Q-1 62	225.0	38441	5.357	205929	177405	383334
Q-2 62						
Q-3 62	222.0	37332	5.415	202153	192036	394189
Q-4 62						
Q-1 63	217.5	37045	6.725	249128	231791	480919
Q-2 63						
Q-3 63	292.5	49073	5.120	251254	249144	500398
Q-4 63						
Q-1 64	268.5	45721	5.922	270760	287677	558437
Q-2 64						
Q-3 64	115.5	20294	5.895	119633	130308	249941
Q-4 64						
Q-1 65	42.0	7159	6.811	48760	47264	96024

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 06
SUBD OF WORK DESIGN/ENGINEERING

AFT FUSELAGE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-2 65						
Q-3 65	4.5	684	6.811	4659	4512	9171
TOTAL	3279.0	562491		2873091	2557066	5430157

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

4-SYSTEM 1
5-SUBSYSTEM 01 **AFT FUSELAGE**
6-MAJ ASSY 06
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	G & A
Q-1 58	1.5	338	4.669	1578	1538	3116	
Q-2 58							
Q-3 58	60.0	10088	4.629	46697	39505	86202	
Q-4 58							
Q-1 59	121.5	20697	4.518	93509	71156	164665	
Q-2 59							
Q-3 59	141.0	24915	4.346	108281	89420	197701	
Q-4 59							
Q-1 60	385.5	66817	4.445	297002	255642	552644	10530
Q-2 60							
Q-3 60	390.0	65532	4.655	305051	244041	549092	10462
Q-4 60							
Q-1 61	496.5	84805	4.827	409354	291814	701168	13030
Q-2 61							
Q-3 61	295.5	53550	4.843	259343	243813	503156	9350
Q-4 61							
Q-1 62	225.0	38441	5.357	205929	177405	383334	6434
Q-2 62							
Q-3 62	222.0	37332	5.415	202153	192036	394189	6616
Q-4 62							
Q-1 63	217.5	37045	6.725	249128	231791	480919	8041
Q-2 63							
Q-3 63	292.5	49073	5.120	251254	249144	500398	8367
Q-4 63							
Q-1 64	268.5	45721	5.922	270760	287677	558437	11832
Q-2 64							
Q-3 64	115.5	20294	5.895	119633	130308	249941	5318
Q-4 64							
Q-1 65	42.0	7159	6.811	48760	47264	96024	2562
Q-2 65							
Q-3 65	4.5	684	6.811	4659	4512	9171	245
TOTAL	3279.0	562491		2873091	2557066	5430157	92837

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 01 **AFT FUSELAGE**
6-MAJ ASSY 06
SUBD OF WORK DESIGN/ENGINEERING

	TOTAL COST
Q-1 58	3116
Q-2 58	
Q-3 58	86202
Q-4 58	
Q-1 59	164665
Q-2 59	
Q-3 59	197701
Q-4 59	
Q-1 60	563174
Q-2 60	
Q-3 60	559554
Q-4 60	
Q-1 61	714198
Q-2 61	
Q-3 61	512506
Q-4 61	
Q-1 62	389768
Q-2 62	
Q-3 62	400805
Q-4 62	
Q-1 63	488960
Q-2 63	
Q-3 63	508765
Q-4 63	
Q-1 64	570319
Q-2 64	
Q-3 64	255259
Q-4 64	
Q-1 65	98586
Q-2 65	
Q-3 65	9416
TOTAL	5522994

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 01
6-MAJ ASSY 06
SUBD OF WORK PRODUCTION

AFT FUSELAGE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	9.0	1487	5.414	8051	1069	9120
Q-4 58						
Q-1 59	10.5	1814	5.466	9915	1549	11464
Q-2 59						
Q-3 59	18.0	3094	5.361	16587	2845	19432
Q-4 59						
Q-1 60	7.5	1186	5.589	6629	1403	8032
Q-2 60						
Q-3 60		26	4.077	106	-84	22
Q-4 60						
Q-1 61		67	4.940	331	341	672
Q-2 61						
Q-3 61		57	2.912	166	78	244
Q-4 61						
Q-1 62		67	2.701	181	551	732
Q-2 62						
Q-3 62	3.0	412	3.558	1466	2529	3995
Q-4 62						
Q-1 63	1.5	206	4.786	986	1292	2278
Q-2 63						
Q-3 63	-45.0	-7639	5.405	-41290	-7663	-48953
Q-4 63						
Q-1 64	4.5	727	4.575	3326	4343	7669
Q-2 64						
Q-3 64	16.5	2820	4.451	12552	17726	30278
Q-4 64						
Q-1 65	9.0	1496	4.432	6630	9303	15933
Q-2 65						
Q-3 65	13.5	2162	3.855	8334	11686	20020
TOTAL	48.0	7982		33970	46968	80938

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

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	PRODUCTION
4-SYSTEM	1
5-SUBSYSTEM	01
6-MAJ ASSY	06
SUBD OF WORK	PRODUCTION

AFT FUSELAGE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 60	4.5	670	4.737	3174	1620	4794
Q-2 60						
Q-3 60	7.5	1192	2.341	2791	2307	5098
Q-4 60						
Q-1 61	346.5	59011	3.143	185468	222033	407501
Q-2 61						
Q-3 61	985.5	178753	3.152	563389	716944	1280333
Q-4 61						
Q-1 62	1294.5	220984	3.068	677951	915657	1593608
Q-2 62						
Q-3 62	955.5	160563	3.222	517238	739868	1257206
Q-4 62						
Q-1 63	994.5	169715	3.294	559076	767965	1327041
Q-2 63						
Q-3 63	1158.0	194444	2.820	548307	875978	1424285
Q-4 63						
Q-1 64	1537.5	262500	3.501	918929	1497306	2416235
Q-2 64						
Q-3 64	405.0	71213	3.346	238256	402699	640955
Q-4 64						
Q-1 65	268.5	46633	3.616	168640	251073	419713
Q-2 65						
Q-3 65	12.0	2025	9.299	18830	24915	43745
TOTAL	7969.5	1367703		4402149	6418365	10820514

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

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

PLANNING
4-SYSTEM 1
5-SUBSYSTEM 01 **AFT FUSELAGE**
6-MAJ ASSY 06
SUBD OF WORK PRODUCTION

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	1.5	210	3.000	630		630
Q-4 58						
Q-1 59	6.0	1052	2.959	3113		3113
Q-2 59						
Q-3 59	15.0	2574	2.989	7693		7693
Q-4 59						
Q-1 60	30.0	5152	3.160	16278	79	16357
Q-2 60						
Q-3 60	42.0	7093	3.043	21584		21584
Q-4 60						
Q-1 61	75.0	12716	3.017	38363	6330	44693
Q-2 61						
Q-3 61	67.5	12220	2.907	35525	6272	41797
Q-4 61						
Q-1 62	63.0	10741	2.978	31989	6262	38251
Q-2 62						
Q-3 62	57.0	9545	2.976	28409	6706	35115
Q-4 62						
Q-1 63						
Q-2 63						
Q-3 63	33.0	5470	7.951	43491	40105	83596
Q-4 63						
Q-1 64	48.0	8147	3.219	26228	39539	65767
Q-2 64						
Q-3 64	10.5	1765	3.340	5962	8680	14642
Q-4 64						
Q-1 65	4.5	742	3.148	2336	3328	5664
Q-2 65						
Q-3 65	1.5	229	3.166	725	1181	1906
TOTAL	454.5	77676		262326	118432	380808

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	01
6-MAJ ASSY	06
SUBD OF WORK	PRODUCTION

AFT FUSELAGE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		102	4.902	500		500
Q-4 58						
Q-1 59		100	4.270	427		427
Q-2 59						
Q-3 59	3.0	491	4.664	2290		2290
Q-4 59						
Q-1 60	5.0	933	5.004	4669		4669
Q-2 60						
Q-3 60	1.5	173	3.908	676		676
Q-4 60						
Q-1 61	25.5	4352	3.133	13634		13634
Q-2 61						
Q-3 61	67.5	12284	3.120	38328		38328
Q-4 61						
Q-1 62	114.0	19562	3.302	64586		64586
Q-2 62						
Q-3 62	115.5	19382	3.375	65405		65405
Q-4 62						
Q-1 63	123.0	20983	3.629	76146		76146
Q-2 63						
Q-3 63	156.0	26274	4.256	111834		111834
Q-4 63						
Q-1 64	226.5	38686	3.563	137853		137853
Q-2 64						
Q-3 64	82.5	14485	3.586	51947		51947
Q-4 64						
Q-1 65	34.5	5880	3.906	22970		22970
Q-2 65						
Q-3 65	6.0	949	4.844	4597		4597
TOTAL	961.5	164636		595862		595862

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 01 **AFT FUSELAGE**
6-MAJ ASSY 06
SUBD OF WORK PRODUCTION

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	MFG MATL
Q-3 58	10.5	1799	5.103	9181	1069	10250	
Q-4 58							
Q-1 59	16.5	2966	4.536	13455	1549	15004	
Q-2 59							
Q-3 59	36.0	6159	4.314	26570	2845	29415	
Q-4 59							
Q-1 60	48.0	7941	3.872	30750	3102	33852	40
Q-2 60							
Q-3 60	51.0	8484	2.965	25157	2223	27380	1732
Q-4 60							
Q-1 61	447.0	76146	3.123	237796	228704	466500	110910
Q-2 61							
Q-3 61	1120.5	203314	3.135	637408	723294	1360702	436268
Q-4 61							
Q-1 62	1471.5	251354	3.082	774737	922470	1697177	415064
Q-2 62							
Q-3 62	1131.0	189902	3.226	612618	749103	1361721	383706
Q-4 62							
Q-1 63	1119.0	190904	3.333	636208	769257	1405465	514770
Q-2 63							
Q-3 63	1302.0	218549	3.031	662342	908420	1570762	643200
Q-4 63							
Q-1 64	1816.5	310060	3.504	1086336	1541188	2627524	607048
Q-2 64							
Q-3 64	514.5	90303	3.419	308717	429105	737822	145428
Q-4 64							
Q-1 65	316.5	54751	3.663	200576	263704	464280	-18257
Q-2 65							
Q-3 65	33.0	5365	6.055	32486	37782	70268	19181
TOTAL	9433.5	1617957		5294307	6583815	11878122	3309090

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 01
6-MAJ ASSY 06
SUBD OF WORK PRODUCTION

AFT FUSELAGE

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-3 58		10250		10250
Q-4 58				
Q-1 59		15004		15004
Q-2 59				
Q-3 59		29415		29415
Q-4 59				
Q-1 60	5	33897	646	34543
Q-2 60				
Q-3 60	227	29339	559	29898
Q-4 60				
Q-1 61	9366	586776	10904	597680
Q-2 61				
Q-3 61	41065	1888035	35085	1923120
Q-4 61				
Q-1 62	32690	2144931	36003	2180934
Q-2 62				
Q-3 62	30220	1775647	29804	1805451
Q-4 62				
Q-1 63	50716	1970951	32954	2003905
Q-2 63				
Q-3 63	63369	2277331	38077	2315408
Q-4 63				
Q-1 64	64710	3299282	70202	3369484
Q-2 64				
Q-3 64	52913	936163	19920	956083
Q-4 64				
Q-1 65	-5461	440562	24971	465533
Q-2 65				
Q-3 65	3422	92871	5264	98135
TOTAL	343242	15530454	304389	15834843

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 01
6-MAJ ASSY 06
AFT FUSELAGE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	1.5	338	4.669	1578	1538	3116
Q-2 58						
Q-3 58	69.0	11575	4.730	54748	40574	95322
Q-4 58						
Q-1 59	132.0	22511	4.594	103424	72705	176129
Q-2 59						
Q-3 59	159.0	28009	4.458	124868	92265	217133
Q-4 59						
Q-1 60	393.0	68003	4.465	303631	257045	560676
Q-2 60						
Q-3 60	390.0	65558	4.655	305157	243957	549114
Q-4 60						
Q-1 61	498.0	84872	4.827	409685	292155	701840
Q-2 61						
Q-3 61	295.5	53607	4.841	259509	243891	503400
Q-4 61						
Q-1 62	225.0	38508	5.352	206110	177956	384066
Q-2 62						
Q-3 62	225.0	37744	5.395	203619	194565	398184
Q-4 62						
Q-1 63	219.0	37251	6.714	250114	233083	483197
Q-2 63						
Q-3 63	246.0	41434	5.067	209964	241481	451445
Q-4 63						
Q-1 64	271.5	46448	5.901	274086	292020	566106
Q-2 64						
Q-3 64	132.0	23114	5.719	132185	148034	280219
Q-4 64						
Q-1 65	49.5	8655	6.400	55390	56567	111957

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 01
6-MAJ ASSY 06
AFT FUSELAGE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-2 65						
Q-3 65	16.5	2846	4.565	12993	16198	29191
TOTAL	3322.5	570473		2907061	2604034	5511095

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

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

PRODUCTION
4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 06
AFT FUSELAGE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 60	4.5	670	4.737	3174	1620	4794
Q-2 60						
Q-3 60	7.5	1192	2.341	2791	2307	5098
Q-4 60						
Q-1 61	346.5	59011	3.143	185468	222033	407501
Q-2 61						
Q-3 61	985.5	178753	3.152	563389	716944	1280333
Q-4 61						
Q-1 62	1294.5	220984	3.068	677951	915657	1593608
Q-2 62						
Q-3 62	955.5	160563	3.222	517338	739868	1257206
Q-4 62						
Q-1 63	994.5	169715	3.294	559076	767965	1327041
Q-2 63						
Q-3 63	1158.0	194444	2.820	548307	875978	1424285
Q-4 63						
Q-1 64	1537.5	262500	3.501	918929	1497306	2416235
Q-2 64						
Q-3 64	405.0	71213	3.346	233256	402699	640955
Q-4 64						
Q-1 65	268.5	46633	3.616	168640	251073	419713
Q-2 65						
Q-3 65	12.0	2025	9.299	18830	24915	43745
TOTAL	7969.5	1367703		4402149	6418365	10820514

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

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	PLANNING
4-SYSTEM	1
5-SUBSYSTEM	01
6-MAJ ASSY	06
AFT FUSELAGE	

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	1.5	210	3.000	630		630
Q-4 58						
Q-1 59	6.0	1052	2.959	3113		3113
Q-2 59						
Q-3 59	15.0	2574	2.989	7693		7693
Q-4 59						
Q-1 60	30.0	5152	3.160	16278	79	16357
Q-2 60						
Q-3 60	42.0	7093	3.043	21584		21584
Q-4 60						
Q-1 61	75.0	12716	3.017	38363	6330	44693
Q-2 61						
Q-3 61	67.5	12220	2.907	35525	6272	41797
Q-4 61						
Q-1 62	63.0	10741	2.978	31989	6262	38251
Q-2 62						
Q-3 62	57.0	9545	2.976	28409	6706	35115
Q-4 62						
Q-1 63						
Q-2 63						
Q-3 63	33.0	5470	7.951	43491	40105	83596
Q-4 63						
Q-1 64	48.0	8147	3.219	26228	39539	65767
Q-2 64						
Q-3 64	10.5	1785	3.340	5962	8680	14642
Q-4 64						
Q-1 65	4.5	742	3.148	2336	3328	5664
Q-2 65						
Q-3 65	1.5	229	3.166	725	1181	1906
TOTAL	454.5	77676		262326	118482	380808

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

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 06
AFT FUSELAGE

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		102	4.902	500		500
Q-4 58						
Q-1 59		100	4.270	427		427
Q-2 59						
Q-3 59	3.0	491	4.664	2290		2290
Q-4 59						
Q-1 60	6.0	933	5.004	4669		4669
Q-2 60						
Q-3 60	1.5	173	3.908	676		676
Q-4 60						
Q-1 61	25.5	4352	3.133	13634		13634
Q-2 61						
Q-3 61	67.5	12284	3.120	38328		38328
Q-4 61						
Q-1 62	114.0	19562	3.302	64586		64586
Q-2 62						
Q-3 62	115.5	19382	3.375	65405		65405
Q-4 62						
Q-1 63	123.0	20983	3.629	76146		76146
Q-2 63						
Q-3 63	156.0	26274	4.256	111834		111834
Q-4 63						
Q-1 64	226.5	38686	3.563	137853		137853
Q-2 64						
Q-3 64	82.5	14485	3.586	51947		51947
Q-4 64						
Q-1 65	34.5	5880	3.906	22970		22970
Q-2 65						
Q-3 65	6.0	949	4.844	4597		4597
TOTAL	961.5	164636		595862		595862

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 01
6-MAJ ASSY 06
AFT FUSELAGE

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	MFG MATL
Q-1 58	1.5	338	4.669	1578	1538	3116	
Q-2 58							
Q-3 58	70.5	11887	4.701	55878	40574	96452	
Q-4 58							
Q-1 59	138.0	23663	4.520	106964	72705	179669	
Q-2 59							
Q-3 59	177.0	31074	4.340	134851	92265	227116	
Q-4 59							
Q-1 60	433.5	74758	4.384	327752	258744	586496	40
Q-2 60							
Q-3 60	441.0	74016	4.461	330208	246264	576472	1732
Q-4 60							
Q-1 61	945.0	160951	4.021	647150	520518	1167668	110910
Q-2 61							
Q-3 61	1416.0	256864	3.491	896751	967107	1863858	486268
Q-4 61							
Q-1 62	1696.5	289795	3.384	980636	1099875	2080511	415064
Q-2 62							
Q-3 62	1353.0	227234	3.586	814771	941139	1755910	383706
Q-4 62							
Q-1 63	1336.5	227949	3.884	885336	1001048	1886384	514770
Q-2 63							
Q-3 63	1593.0	267622	3.414	913596	1157564	2071160	643200
Q-4 63							
Q-1 64	2083.5	355781	3.814	1357096	1828865	3185961	607048
Q-2 64							
Q-3 64	630.0	110597	3.873	428350	559413	987763	145428
Q-4 64							
Q-1 65	357.0	61910	4.027	249336	310968	560304	-18257
Q-2 65							
Q-3 65	36.0	6049	6.141	37145	42294	79439	19181
TOTAL	12708.0	2180488		8167398	9140881	17308279	3309090

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 01
6-MAJ ASSY 06
AFT FUSELAGE

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 58		3116		3116
Q-2 58				
Q-3 58		96452		96452
Q-4 58				
Q-1 59		179669		179669
Q-2 59				
Q-3 59		227116		227116
Q-4 59				
Q-1 60	5	586541	11176	597717
Q-2 60				
Q-3 60	227	578431	11021	589452
Q-4 60				
Q-1 61	9366	1287944	23934	1311878
Q-2 61				
Q-3 61	41065	2391191	44435	2435626
Q-4 61				
Q-1 62	32690	2528265	42437	2570702
Q-2 62				
Q-3 62	30220	2169836	36420	2206256
Q-4 62				
Q-1 63	50716	2451870	40995	2492865
Q-2 63				
Q-3 63	63369	2777729	46444	2824173
Q-4 63				
Q-1 64	64710	3857719	82084	3939803
Q-2 64				
Q-3 64	52913	1186104	25238	1211342
Q-4 64				
Q-1 65	-5461	536586	27533	564119
Q-2 65				
Q-3 65	3422	102042	5509	107551
TOTAL	343242	20960611	397226	21357837

COST DEFINITION

SUBSYSTEM: AIRFRAME STRUCTURE — WBS CODE: 1.1

MAJOR ASSEMBLY: HONEYCOMB PANELS — WBS CODE: 1.1.7

This WBS item is established to accumulate all subcontractor and IDWA costs for producing honeycomb panels in support of Ships No. 1, 2 and 3. The Subcontractor Data Sheet on page III-285 provides a detail discussion of the honeycomb panel suppliers. No in-house costs are included in this item as the costs can not be segregated from other in-house structural fabrication effort. Exhibit 11, page III-27 of this section recaps the number of panels and the gross square footage produced on-site and off-site for each of the three vehicles. Honeycomb panel costs in this WBS item can not be associated back to a particular major assembly of the structure. Procurement and control of these panels was not segregated by major assembly.

Cost data excluded from this WBS item are:

a) In-house design and fabrication of honeycomb panels.
b) Installation of the panels into the structural major assemblies (WBS 1.12).
c) In-house ground testing (WBS 1.1.8).

SUBCONTRACTOR MATRIX

SUBSYSTEM: AIRFRAME STRUCTURE WBS CODE: 1.1

MAJOR ASSEMBLY: HONEYCOMB PANELS WBS CODE: 1.1.7

SUBCONTRACTOR	ENGR'G	PROD	TOOLING	TEST	TOTAL
LTV	235,888	12,688,297	1,757,370	-	14,681,555
NORTHRUP	-	3,860,978	1,281,519	-	5,142,497
ROHR	5,724	2,835,161	1,207,542	-	4,048,427
AERONCA	21,821	1,771,367	387,784	-	2,180,972
GEN DYNAMICS	11,188	818,354	300,053	-	1,129,595
AVCO	6,256	457,154	167,762	-	631,172
MISC	10,618	873,893	337,316	-	1,221,827
TOTAL	291,495	23,305,204	5,439,346	-	29,036,045

A total of 38 major contracts were awarded to the above subcontractors for B-70 honeycomb panels. The individual contracts covered a wide assortment of panels, both in size, shape, thickness and quantity.

Air Vehicle No. 1 contained 1742 panels with a net area of 21,350 square feet and an average density of 2.47 pounds per square foot. Air Vehicle No. 2 contained 1392 panels with a net area of 20,502 square feet and a density of 2.65 pounds per square foot. Air Vehicle No. 3 contained 1465 panels with a net area of 20,591 square feet and a density of 3.00 pounds per square foot.

LTV was awarded 11 major honeycomb panel contracts for the fabrication of 414 panels having a total net area of 10,152 square feet.

NORTHRUP was awarded 7 major contracts covering 211 panels having a total net area of 1640 square feet.

ROHR was awarded 7 major honeycomb panel contracts covering 118 panels having a total net area of 1,024 square feet.

AERONCA was awarded 5 major contracts covering 93 panels having a total net area of 957 square feet.

GENERAL DYNAMICS was awarded 3 major honeycomb panel contracts covering 53 panels having a total net area of 222 square feet.

AVCO was awarded 4 major contracts covering 108 panels having a total net area of 470 square feet.

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 01
6-MAJ ASSY 07
SUBCONTRACTOR HONEYCOMB PANELS

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOOLING AND STE HOURS DOLLARS	TEST /QC HOURS DOLLARS
SUBCONTRACT	291495	23305204	5439346	
MPC	14680	992701	271917	
SUB-TOTAL	306175	24297905	5711263	
GEN & ADMIN	5326	756612	105375	45321
IDWA		18019255		2454947
TOTAL COST	311501	43073772	5816638	2500268
TIME-PHASED COST DETAIL - SEE PAGE	III-288	III-289	III-290	III-291

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 01
6-MAJ ASSY 07
SUBCONTRACTOR HONEYCOMB PANELS

	TOTAL HOURS DOLLARS
SUBCONTRACT	29036045
MPC	1279298
SUB-TOTAL	30315343
GEN & ADMIN	912634
IOWA	20474202
TOTAL COST	51702179

TIME-PHASED COST DETAIL - SEE PAGE III-292

NORTH AMERICAN ROCKWELL CORP.
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DATA PREPARED UNDER
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 07
SUBD OF WORK DESIGN/ENGINEERING

SUBCONTRACTOR HONEYCOMB PANELS

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-3 59	22945	626	23571		23571
Q-4 59					
Q-1 60	134275	7966	142241	2710	144951
Q-2 60					
Q-3 60	67137	3983	71120	1355	72475
Q-4 60					
Q-1 61	33569	961	34530	642	35172
Q-2 61					
Q-3 61	16784	480	17264	321	17585
Q-4 61					
Q-1 62	8393	266	8659	145	8804
Q-2 62					
Q-3 62	4196	133	4329	73	4402
Q-4 62					
Q-1 63	2098	88	2186	37	2223
Q-2 63					
Q-3 63	1049	33	1082	18	1100
Q-4 63					
Q-1 64	1049	144	1193	25	1218
TOTAL	291495	14680	306175	5326	311501

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 01
6-MAJ ASSY 07
SUBD OF WORK PRODUCTION

SUBCONTRACTOR HONEYCOMB PANELS

	SUBC	MPC	SUB TOTAL	G & A	IDWA	TOTAL COST
Q-1 59					11147	11147
Q-2 59						
Q-3 59	117761	3217	120978		4243	125221
Q-4 59						
Q-1 60	1722886	102218	1325104	34896	6400	1866400
Q-2 60						
Q-3 60	1487195	88239	1575434	30271	13353	1619058
Q-4 60						
Q-1 61	1102025	31574	1133599	40621	1052330	2226550
Q-2 61						
Q-3 61	3750037	107443	3857530	117980	2491270	6466780
Q-4 61						
Q-1 62	8404451	267127	8671578	194632	2924005	11790215
Q-2 62						
Q-3 62	2864802	90966	2955768	93423	2610066	5659257
Q-4 62						
Q-1 63	590899	25091	615990	52040	2496459	3164489
Q-2 63						
Q-3 63	1631685	52494	1684179	69787	2489662	4243628
Q-4 63						
Q-1 64	1633413	224332	1857745	93502	2536545	4487792
Q-2 64						
Q-3 64				29383	1380891	1410274
Q-4 64						
Q-1 65				32	1197	1229
Q-2 65						
Q-3 65				45	1687	1732
TOTAL	23305204	992701	24297905	756612	18019255	43073772

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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 01 **SUBCONTRACTOR HONEYCOMB PANELS**
6-MAJ ASSY 07
SUBD OF WORK TOOLING AND STE

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-3 59 Q-4 59	87835	2400	90235		90235
Q-1 60 Q-2 60	1532579	90927	1623506	30932	1654438
Q-3 60 Q-4 60	1810636	107430	1918066	36544	1954610
Q-1 61 Q-2 61	905253	25936	931189	17304	948493
Q-3 61 Q-4 61	452651	12968	465619	8652	474271
Q-1 62 Q-2 62	226325	7193	233518	3919	237437
Q-3 62 Q-4 62	113163	3593	116756	1959	118715
Q-1 63 Q-2 63	113163	4805	117968	1972	119940
Q-3 63 Q-4 63	99735	3205	102940	1721	104661
Q-1 64	98006	13400	111406	2372	113838
TOTAL	5439346	271917	5711263	105375	5816638

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 01 SUBCONTRACTOR HONEYCOMB PANELS
6-MAJ ASSY 07
SUBD OF WORK TEST/QC

	G & A	IDWA	TOTAL COST
Q-1 59		12067	12067
Q-2 59			
Q-3 59		4605	4605
Q-4 59			
Q-1 60	132	6935	7067
Q-2 60			
Q-3 60	276	14464	14740
Q-4 60			
Q-1 61	21185	1140026	1161211
Q-2 61			
Q-3 61	23728	1276850	1300578
TOTAL	45321	2454947	2500268

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 01
6-MAJ ASSY 07
SUBCONTRACTOR HONEYCOMB PANELS

	SUBC	MPC	SUB TOTAL	G & A	IDWA	TOTAL COST
Q-1 59					23214	23214
Q-2 59						
Q-3 59	228541	6243	234784		8848	243632
Q-4 59						
Q-1 60	3389740	201111	3590851	68670	13335	3672856
Q-2 60						
Q-3 60	3364968	199652	3564620	68446	27817	3660883
Q-4 60						
Q-1 61	2040847	58471	2099318	79752	2192356	4371426
Q-2 61						
Q-3 61	4219522	120891	4340413	150681	3768120	8259214
Q-4 61						
Q-1 62	8639169	274586	8913755	198696	2924005	12036456
Q-2 62						
Q-3 62	2982161	94692	3076853	95455	2610066	5782374
Q-4 62						
Q-1 63	706160	29984	736144	54049	2496459	3286652
Q-2 63						
Q-3 63	1732469	55732	1788201	71526	2489662	4349389
Q-4 63						
Q-1 64	1732468	237936	1970404	95345	2536545	4602848
Q-2 64						
Q-3 64				29383	1380891	1410274
Q-4 64						
Q-1 65				32	1197	1229
Q-2 65						
Q-3 65				45	1687	1732
TOTAL	29036045	1279298	30315343	912634	20474202	51702179

TECHNICAL DRIVER

WBS TITLE: GROUND TESTS WBS CODE: 1.1.8

DRIVER: **MAJOR STRUCTURE ASSEMBLIES**

GENERAL

At the onset of the XB-70 Program, several redirections occurred as program cost reduction measures. Two of the redirections deleted the requirements for the airframe static test article and the airframe fatigue article. The cancellation of the two full scale test articles resulted in the No. 1 flight article being subjected to airframe static and dynamic ground test programs. The critical nature of conducting structural static and dynamic loads tests on the first flight article stressed the need to achieve a very high confidence level in structural analyses predictions. This was attained by direct comparison of analytical data with actual test data obtained during tests conducted on the major structural assemblies. All of the major assembly tests conducted, as defined by Exhibit 33, page III-298, are discussed in subsequent paragraphs; however, only those tests where anomalies occurred were considered technical drivers.

The impact or risk factor of the above approach for verifying structural integrity was lessened somewhat by the advancement made in analytical methodology for determining influence coefficients of complex structures. The methods of calculating these critical coefficients were advanced far beyond the existing state-of-the-art with the maximum potential of high speed computation equipment being exploited as well as utilizing the most advanced techniques of deflection and rigidity analysis. The programs developed had the capacity to compute influence coefficients for highly redundant three dimensional structures containing 25,000 structural elements and 4000 internal redundancies. The high density programs were of extreme importance in the predictions involved with flutter, vibration, and aeroelastic effects as well as for load/stress analysis.

DISCUSSION

As previously stated, all of the major assemblies tested did not become technical drivers; however, the tests are discussed in varying degrees to present the complete picture. Each test assembly discussed may be identified by reviewing Exhibit 33, page III-298, which locates each assembly as related to the basic airframe. Testing milestones appear on Exhibit 34, page III-299.

Cockpit and Windshield Specimen: The cockpit and windshield assembly test specimen consisted of the XB-70 crew compartment with one escape system. The test program was conducted utilizing structure laboratory test rigs and in a hydrostatic pressure tank. The tests performed were:

(1) Flight Loads (static and repeated)

(2) Pressurization (operational: 10.9 psi, limit: 14.5 psi, and ultimate: 21.8 psi)

WBS: 1.1.8

(3) Escape System Qualification (with and without pressurization)

(4) Thermal shock to windshield

During the initial design of the B-70 cockpit, particular attention was placed on the design of the glass enclosure since failures were experienced on SAC vehicles and in commercial jet airlines. Specific attention was paid to the design of the edge attach members of the glass, the quality of glass used, and the determination of Mach 3 temperatures effects on the glass and its attachments. The enclosure developed utilized two glass panels separated by an air gap for each windshield. The air gap kept the inner windshield at a cooler temperature which allowed this inner glass to be used at the prime structure to resist internal cabin pressurization. The outer glass, which saw a very small load, was the first layer of insulation to the high Mach 3 temperatures.

During the hydrostatic pressure tank tests, glass failures occurred due to two causes: (1) Latent flaws in the glass which could not be detected by existing inspection techniques; and (2) structural deflections under pressure which caused metallic structure to apply localized loading to the glass. The first problem was eliminated by initiating a new quality assurance program at the glass supplier which consisted of "thermal shocking" the glass panels. In this procedure, the heated panels were quenched with a water spray to rapidly cool the glass. If defects were present, the internal stresses developed caused cracking and the panel was rejected. To solve the structural deflection problem, detail deflection measurements were made of the surrounding structure which resulted in clearances being increased or local structure stiffened.

The escape system test specimen was a complete structural assembly of an XB-70 capsule. The test program conducted consisted of test conditions which simulated: (1) air vehicle crash conditions; (2) catapult loading; (3) internal pressurization; and (3) ejection conditions. During the tests, failures occurred at 100% ultimate for all conditions except for the shell during ejection which failed at 98% ultimate. The results were considered satisfactory with no design changes required.

Horizontal Stabilizer Main Box and Interconnect: The test specimen consisted of multiple cell riveted titanium boxes with tests conducted to determine stiffness measurements and ultimate bending strength. The interconnect structure failed at 90% design ultimate and the outer box lower skin cracked at 95% design ultimate load. Based on analyses of loading conditions and types of failures, it was concluded that the design was satisfactory and no changes were required.

WBS CODE: 1.1.8

Forward Fuselage Specimen: The forward fuselage test specimen was a 100 inch diameter cylindrical skin-longeron constructed assembly. The test program was conducted to determine general structure stability and the stability of the ring frames and straps. The test results were as follows.

1. Vertical bending was stopped at 100% design ultimate.

2. Side bending was stopped at 90% design ultimate due to excessive longeron deflection.

3. Combine vertical and side bending went to 90% design ultimate where an H-11 longeron failed in tension.

4. Maximum vertical shear (with and without straps) went to 110% design ultimate loads where frames without straps failed.

Based on the analyses of loading conditions and types of failures, it was concluded that the design was satisfactory. However, it was apparent that the drilling and machining specifications for H-11 steel had to be expanded to assure proper processing techniques.

Fuselage Joint at Station 857: The test specimen was constructed to represent the upper longeron and upper shoulder longeron splices at fuselage station 857. The test program was conducted to determine the ultimate strength of the joint in compression and the stress distribution in the transition area. During the tests the upper longeron failed at 114% design ultimate and the upper shoulder longeron failed at 104% design ultimate load. This design was considered satisfactory with no design changes required.

Upper Forward Intermediate Fuselage Specimen: The test specimen was a (one-half) 100 inch diameter upper forward fuselage fuel tank assembly and was subjected to the following test program.

1. Elevated temperature tests to determine fuel tank insulation.

2. Load redistribution tests for sheet metal to honeycomb loading and for load distribution around doors.

3. General structure stability of the shell. All tests were satisfactorily completed and analysis of test data showed redesign not required.

Aft Intermediate Fuselage Specimen: The test specimen was fabricated to represent the fuselage structure between FS 1914 and FS 1990. The structure test program was conducted to: (1) determine load distributions due to wing bending and inlet duct pressures, and (2) apply repeated loads for fuel tank qualification. Several H-11 steel truss links failed at 99% of limit duct pressure during the initial test phase.

The passage ways for inlet boundary layer air going aft to the engine compartments were located directly above the engine air inlets. The wing bending loads were carried across ship through the boundary layer control ducts by numerous truss members made of H-11 steel. The structural tests showed that the allowable strengths of the truss members were less than predicted. Since fabrication of this area for air vehicle no. 1 had been completed, a concentrated testing program was initiated to: (1) establish allowable strengths for H-11 truss members, and (2) devise satisfactory rework techniques for air vehicle no. 1. The concentrated test program was completed, the test specimen reworked using established production techniques, and subsequent tests demonstrated satisfactory structural integrity. This same rework was then performed on air vehicle no. 1.

Aft Fuselage Specimen: The test specimen was fabricated to structurally represent the aft fuselage/engine compartments from FS 2069 to FS 2210. The structural test program was conducted in the following sequence: (1) limit maneuver and taxi conditions, (2) fatigue and (3) ultimate maneuver and taxi conditions. All tests were completed satisfactorily except the left and right hand wing boxes failed at 60% of maximum gust loading condition. Analysis of the failed components established the cause of failure to be a manufacturing process defect and that redesign was not required. Rework of the test specimen was performed, and subsequent tests demonstrated structural integrity.

Vertical Stabilizer Main Box Specimen: This test assembly was a structural specimen of corrugated spars and honeycomb panels representing the construction of the vertical stabilizer. The test program conducted was to determine ultimate biaxial bending strength. During initial load application, a major failure of the test equipment occurred at 67% of design ultimate load. A smaller box section was assembled from the unfailed portion of the large box and during subsequent tests, the smaller box failed at 97% of design ultimate load. It was concluded by analysis that the structure was satisfactory and redesign was not required.

Forward Wing Box Specimen: The test assembly was constructed of corrugated spars and honeycomb panels with the test program conducted to determine ultimate strength of the box under combined bending, shear, and pressure loads. The test assembly failed at 110% design ultimate load and based on the analysis of the failure, redesign was not required.

Wing Tip Box Specimen: The test assembly was constructed of corrugated spars and honeycomb panels with the test program conducted to determine ultimate strength in biaxial bending. The first specimen failed at 47% of design ultimate load and by laboratory analysis, the cause was determined to be a bad edge condition when the panel was mated to the spar. Redesign to correct the edge condition was issued and second test specimen built. Up to 100% ultimate biaxial bending loads were applied to the second specimen with no failures experienced.

Fold Tip to Wing Boxes Specimen: The test assembly consisted of two boxes constructed of honeycomb panels and corrugated spars, wing fold fittings, and a simulated wing fold power drive. The test program was conducted to determine stiffness measurements and ultimate bending strength of the hinge system. The tests were satisfactorily completed and by analysis, determined that redesign was not required. However, the stiffness tests were subsequently repeated with a power hinge installed due to a problem encountered at the power hinge supplier.

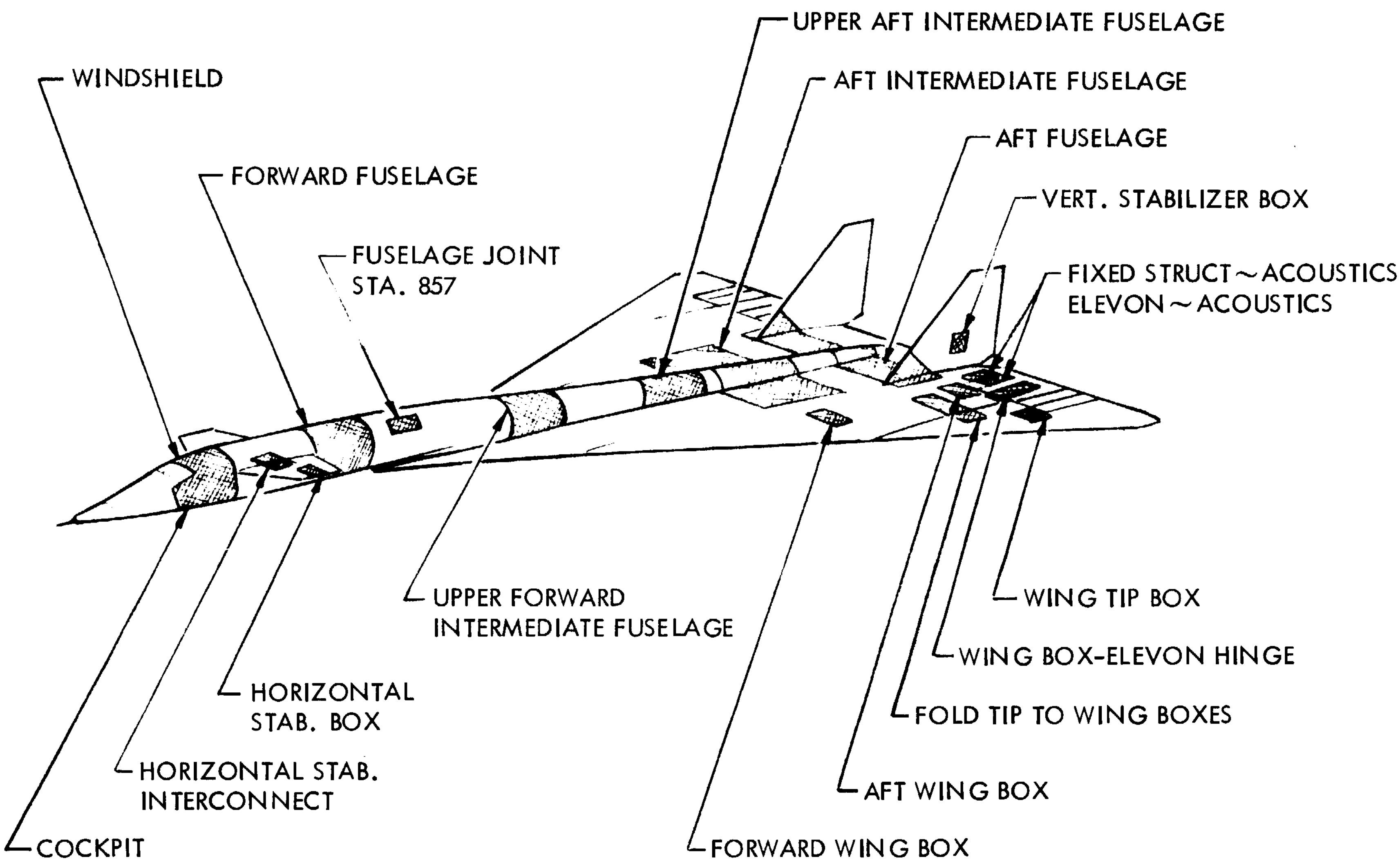
The wing fold system consisted of six mechanical rotary power hinges in-line per wing connected by shafting which was driven by dual hydraulic motors. The power hinges served both as hinges and as structural support to the folding wing tips. All hinges were identical and were two-stage differential cyclic gear reduction devices (made of H-11 steel) which utilized multiple spindle gears in the output stage. During early development testing of the power hinge, structural failures were encountered. Analyses attributed the cause of failure to be material deficiencies, poorly controlled processes, and inadequate surface finishes. This was corrected by changing from Air Melt H-11 steel to Vacuum Melt H-11 steel, incorporation of developed material and process technology into the subcontractor's effort, and an increased requirement on the subcontractor for detail machining to produce extremely fine finishes.

Stiffness tests conducted at the supplier showed the final configuration did not meet specification stiffness requirements. Analysis showed this to be caused by the subcontractor's weight (hence stiffness) commitments being overly optimistic. Since the new power hinge exhibited excellent structure integrity characteristics, it was installed as an integrated element of the wing structure (test assembly) and total stiffness measurements obtained. The test showed a sufficient margin for total system stiffness which allowed a reduction in the subcontractor's requirements to an acceptable level.

Elevon Specimen: The test assembly was a complete elevon, on which the structures test program was conducted to determine ultimate static bending strength. During the test the upper skin panel failed at 93% design ultimate load. Based on analysis of the failure and design, it was concluded that redesign was not required.

Acoustic Specimens: Two test assemblies were fabricated for acoustic testing to determine the effect of local impingement. One test specimen was the in-board elevon and the other represented the fixed structure between the in-board elevon and the boat tail aft fuselage. The tests conducted showed the structure to have satisfactory resistance to fatigue.

STRUCTURAL ASSEMBLIES TESTS
MAJOR SPECIMENS



SD72-SH-0003

EXHIBIT 33

WBS 1.1.8

GROUND TESTS STRUCTURAL ASSEMBLIES

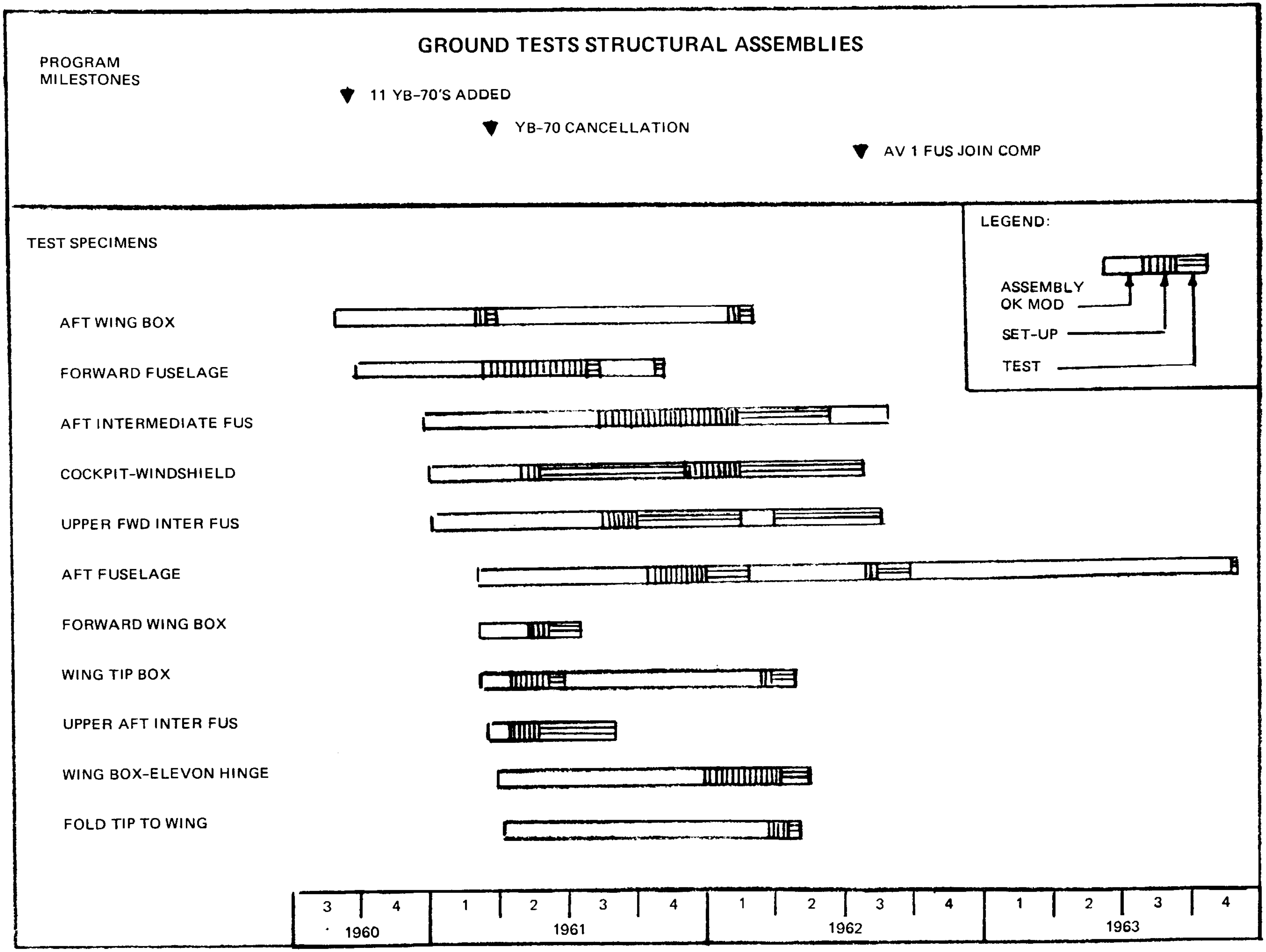


EXHIBIT 34

COST DEFINITION

SUBSYSTEM: AIRFRAME STRUCTURE — WBS CODE: 1.1

MAJOR ASSEMBLY: GROUND TEST — WBS CODE: 1.1.8

Cost data contained in this level 6 item reflect the total in-house cost associated with ground testing of the structural assemblies and the subcontracted wind tunnel testing of structural assemblies and models. Accumulated on-site cost contain:

a) fabrication costs of models and mock-ups (labor and material)
b) engineering support to the test effort (all subsystem engineering supporting structures included)
c) data reduction and evaluation
d) direct labor to conduct tests
e) wind tunnel test technicians (North American Rockwell Corporation)
f) test planning
g) subcontracted wind tunnel testing
h) developmental testing performed by the labs

Excluded from this item are:

a) in-house wind tunnel (test of the Air Induction System (WBS 1.5.6))
b) testing costs associated with the government owned or government contracted wind tunnel programs.
c) subcontractor development testing on structural assemblies (where identifiable, contained in the Test SOW, Subcontractor EOC for each major assembly)
d) final checkout and preflight testing of the Air Vehicle (WBS 1.12)

Examples of the types of tests included in this item are listed below. They represent only the major test activites. All costs shown include labor, material and their associated burdens. Included also is the structural test support to other subsystems.

Description	Recorded Cost
Fuselage Specimen	$ 9,320,562
Aft Fuselage	7,146,016
Structural Component Tests	2,466,582
Lab Tests	1,811,156
Cockpit & Wind Shield Specimen	1,719,750
Airplane Complete - Preflight proof and qual tests	1,104,474
Joint Structural - folding tip to wing	670,738
Primary Structure Box Beam - elevon hinges	652,473
Airframe & Structure Design Tests	505,739
Support to B-70 Structure Engineering	498,156
Joint Wing to Fuselage	473,453
Joints - fusion welded	406,534
Hydro Mechanical Lab Tests	385,554

WBS CODE: 1.1.8

Description	Recorded Cost
Wing Structure Box Beam - aft wing	$ 382,940
Joint - intake duct corner	365,975
Wing Structure Box Beam - wing tip	359,172
Honeycomb Access Door Test	353,679
Major Production - break transition - joint	352,318
Panel test	322,011
General Shop Support	284,867
Forward Fuselage test specimen	278,908
Acoustic Testing of trailing edge and main box	258,752
Environmental Simulator	231,296
Simulator - Upper Forward Intermediate Fuselage	230,247
Frame Fuselage Wing Stub Intermediate Fuselage	221,714
Brazed Honeycomb Panels	218,871
R & D Test	205,412
Simulated Aft Intermediate Fuselage	197,257
Vertical Stabilizer	192,007
Panel test	185,212
Brazed Honeycomb Panel tapered face sheets	182,715
Forward Wing	179,401
Sandwich Panels	168,613
Inlet Control Model	152,587
Hydro-mechanical Lab Test	147,602
Air Worthiness	144,066
Engineering Order 762119	135,701
Major Axial load transmission into Honeycomb Panel	130,108
Testing Equipment	127,760
Repair of Aft Fuselage - test section wing stub	115,247
Simulated Trunnion Support Fitting in Honeycomb Panel	106,833
Honeycomb Panel-Crack Propagation - Cyclic loading	102,881
GSE for Air Vehicle Mockup	100,243
Joint Brazed Honeycomb Panel	92,027
Elevon Aft Section Acoustic Test	88,826
Horizontal Stabilizer	87,235
Crack Propagation Honeycomb Panel at Panel Splice Load	86,514
Deficiency Items	85,513
Aging Steel	75,943
Joint Longeron	75,834
Mockup of YB-70 Nose Gear Wheel Well Cavity	75,449
Materials and Processes Lab Tests	73,064
Honeycomb Panel Crack Propagation - Biaxial Loading	68,440
Horizontal Stabilizer	66,973
Floor Mounted Forward Fuselage Mockup	65,966
Fuel Tank Sealing	65,580
Simulated Trunnion Attached to Honeycomb Panel	62,689
Simulated Elevon Welded F-Joint	61,181
Fuel Tank Mockup	59,437
Honeycomb Panel Reinforced Holes	55,723
Pressure Model	54,408

WBS CODE: 1.1.8

Description	Recorded Cost
Edge Closeouts Miscellaneous Honeycomb Static and Fatigue	$ 52,826
Special Welded Joints	52,467
Fuel Tank Makeup	52,195
Organic Sealing of Repairs of Honeycomb	52,027
Repair Program Brazed Honeycomb Panel	51,022
Sub total	$35,156,921
Honeycomb Panel Tests (various)	1,373,993
Miscellaneous Fuselage Tests (tanks, stabilizer, etc)	2,117,133
Miscellaneous Wing Tests	342,079
Various Plumbing, Tubing, Fittings, Joints, Lines, Valves, etc. tests	1,038,468
Various	13,324,285
Costs (less Wind Tunnel, MPC and G&A)	$53,352,879
Subcontract Wind Tunnel	2,760,920
Material Procurement Cost	1,249,894
General and Administrative	966,324
Total Cost WBS 1.1.8	$58,330,017

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 01
6-MAJ ASSY 08
STRUCTURAL GROUND TESTS

			TEST /QC HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING			1026408	1026408
LABOR	AT $ 3.994		4099406	4099406
ENGR BURDEN		AT $ 4.243	4355479	4355479
SHOP SUPPORT			4345663	4345663
LABOR	AT $ 3.005		13057633	13057633
PLANNING			30449	30449
LABOR	AT $ 3.948		120201	120201
TEST/QC			473762	473762
LABOR	AT $ 3.202		1516782	1516782
MFG BURDEN		AT $ 3.496	16954493	16954493
ENGR MATERIAL			11628100	11628100
MPC			1249894	1249894
WIND TUNNEL			2760920	2760920
OTHER COST			762412	762412
			--------	--------
SUB-TOTAL			56505320	56505320
GEN & ADMIN			966324	966324
IOWA			858373	858373
			--------	--------
TOTAL COST			58330017	58330017
TIME-PHASED COST DETAIL - SEE PAGE			III-304	III-311

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 01
6-MAJ ASSY 08 **STRUCTURAL GROUND TESTS**
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	4.5	854	4.984	4256	3884	8140
Q-2 58						
Q-3 58	31.5	5213	4.184	21811	20353	42164
Q-4 58						
Q-1 59	90.0	15336	4.184	64168	52536	116704
Q-2 59						
Q-3 59	66.0	11616	4.131	47981	41904	89885
Q-4 59						
Q-1 60	154.0	26641	4.451	118587	84753	203340
Q-2 60						
Q-3 60	851.0	142993	3.900	557621	529904	1087525
Q-4 60						
Q-1 61	1143.0	195034	3.458	674353	609231	1283584
Q-2 61						
Q-3 61	811.5	147148	4.359	641474	711260	1352734
Q-4 61						
Q-1 62	878.0	149810	4.006	600213	668963	1269176
Q-2 62						
Q-3 62	838.0	140691	4.266	600223	701616	1301839
Q-4 62						
Q-1 63	256.5	43842	4.714	206674	274592	481266
Q-2 63						
Q-3 63	297.0	49924	4.663	232793	240051	472844
Q-4 63						
Q-1 64	197.5	33687	4.777	160920	209009	369929
Q-2 64						
Q-3 64	89.5	15740	4.179	65771	89307	155078
Q-4 64						
Q-1 65	194.5	33728	1.904	64233	69975	134208

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 01 **STRUCTURAL GROUND TESTS**
6-MAJ ASSY 08
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	94.5	15957	2.831	45179	54180	99359
Q-4 65						
Q-1 66	-9.0	-1484	3.857	-5724	-4912	-10636
Q-2 66						
Q-3 66	-1.5	-322	3.500	-1127	-1127	-2254
TOTAL	5986.5	1026408		4099406	4355479	8454885

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	01	**STRUCTURAL GROUND TESTS**
6-MAJ ASSY	08	
SUBD OF WORK	TEST/QC	

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		21	2.476	52	73	125
Q-2 58						
Q-3 58	276.0	46063	3.053	141378	151361	292739
Q-4 58						
Q-1 59	455.5	77732	3.122	242709	262281	504990
Q-2 59						
Q-3 59	1675.5	294956	2.962	873573	1094547	1968120
Q-4 59						
Q-1 60	2199.0	381179	2.986	1138144	1362331	2500475
Q-2 60						
Q-3 60	5176.0	869539	3.044	2646891	3227482	5874373
Q-4 60						
Q-1 61	8506.5	1451845	3.103	4505362	5541096	10046453
Q-2 61						
Q-3 61	3764.5	682615	3.030	2068214	3155756	5223970
Q-4 61						
Q-1 62	1304.5	222653	2.195	483719	648315	1137034
Q-2 62						
Q-3 62	898.0	150810	3.101	467694	614033	1081727
Q-4 62						
Q-1 63	436.0	74396	2.965	220549	285107	505656
Q-2 63						
Q-3 63	317.5	53447	3.227	172473	424647	597120
Q-4 63						
Q-1 64	307.5	52489	2.387	125265	191345	316610
Q-2 64						
Q-3 64	41.5	7221	5.787	-41794	-29376	-71170
Q-4 64						
Q-1 65	-95.0	-17103	.347	-5927	-6256	-12183

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 01 **STRUCTURAL GROUND TESTS**
6-MAJ ASSY 08
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	-10.5	-1707	8.878	15157	21696	36853
Q-4 65						
Q-1 66	-4.5	-720	1.101	-793	-382	-1175
Q-2 66						
Q-3 66		-8	4.125	-33	53	20
TOTAL	25244.0	4345658		13057633	16944109	30001742

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

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

PLANNING
4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 08
SUBD OF WORK TEST/QC

STRUCTURAL GROUND TESTS

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 63		-82	3.317	-272	-141	-413
Q-2 63						
Q-3 63	160.0	26848	3.970	106582	2586	109168
Q-4 63						
Q-1 64	9.0	1451	3.747	5437	3399	8836
Q-2 64						
Q-3 64	7.5	1449	3.738	5417	3410	8827
Q-4 64						
Q-1 65	3.0	548	3.880	2126	791	2917
Q-2 65						
Q-3 65	1.5	219	3.881	850	316	1166
Q-4 65						
Q-1 66		16	3.813	61	23	84
TOTAL	181.0	30449		120201	10384	130585

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

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 01 **STRUCTURAL GROUND TESTS**
6-MAJ ASSY 08
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	6.0	977	3.475	3395		3395
Q-4 58						
Q-1 59	27.0	4648	2.939	13661		13661
Q-2 59						
Q-3 59	99.0	17338	3.118	54064		54064
Q-4 59						
Q-1 60	198.0	34324	2.948	101178		101178
Q-2 60						
Q-3 60	585.0	98353	3.196	314355		314355
Q-4 60						
Q-1 61	1159.5	197947	3.281	649519		649519
Q-2 61						
Q-3 61	527.0	95560	3.127	298771		298771
Q-4 61						
Q-1 62	73.5	12501	3.331	41645		41645
Q-2 62						
Q-3 62	42.0	7089	2.989	21191		21191
Q-4 62						
Q-1 63	13.5	2255	3.745	8446		8446
Q-2 63						
Q-3 63	19.0	3137	3.394	10646		10646
Q-4 63						
Q-1 64	10.0	1675	5.451	9130		9130
Q-2 64						
Q-3 64	-18.5	-3260	3.822	-12461		-12461
Q-4 64						
Q-1 65	11.5	1975	3.592	7095		7095
Q-2 65						
Q-3 65	-4.5	-809	4.999	-4044		-4044

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 01
6-MAJ ASSY 08
SUBD OF WORK TEST/QC

STRUCTURAL GROUND TESTS

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-4 65						
Q-1 66		54	3.556	192		192
Q-2 66						
Q-3 66		-2	.500	-1		-1
TOTAL	2748.0	473762		1516782		1516782

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 01
6-MAJ ASSY 08
STRUCTURAL GROUND TESTS

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	4.5	954	4.984	4256	3884	8140
Q-2 58						
Q-3 58	31.5	5213	4.184	21811	20353	42164
Q-4 58						
Q-1 59	90.0	15336	4.184	64168	52536	116704
Q-2 59						
Q-3 59	66.0	11616	4.131	47981	41904	89885
Q-4 59						
Q-1 60	154.0	26641	4.451	118587	84753	203340
Q-2 60						
Q-3 60	851.0	142993	3.900	557621	529904	1087525
Q-4 60						
Q-1 61	1143.0	195034	3.458	674353	609231	1283584
Q-2 61						
Q-3 61	811.5	147148	4.359	641474	711260	1352734
Q-4 61						
Q-1 62	878.0	149810	4.006	600213	668963	1269176
Q-2 62						
Q-3 62	838.0	140691	4.266	600223	701616	1301839
Q-4 62						
Q-1 63	256.5	43842	4.714	206674	274592	481266
Q-2 63						
Q-3 63	297.0	49924	4.663	232793	240051	472844
Q-4 63						
Q-1 64	197.5	33687	4.777	160920	209009	369929
Q-2 64						
Q-3 64	89.5	15740	4.179	65771	89307	155078
Q-4 64						
Q-1 65	194.5	33728	1.904	64233	69975	134208

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 01
6-MAJ ASSY 08
STRUCTURAL GROUND TESTS

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-2 65						
Q-3 65	94.5	15957	2.831	45179	54180	99359
Q-4 65						
Q-1 66	-9.0	-1484	3.857	-5724	-4912	-10636
Q-2 66						
Q-3 66	-1.5	-322	3.500	-1127	-1127	-2254
TOTAL	5986.5	1026408		4099406	4355479	8454885

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 01
6-MAJ ASSY 08
STRUCTURAL GROUND TESTS

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		21	2.476	52	73	125
Q-2 58						
Q-3 58	276.0	46303	3.053	141378	151361	292739
Q-4 58						
Q-1 59	455.5	77732	3.122	242709	262281	504990
Q-2 59						
Q-3 59	1675.5	294956	2.962	873573	1094547	1968120
Q-4 59						
Q-1 60	2199.0	381179	2.986	1138144	1362331	2500475
Q-2 60						
Q-3 60	5176.0	869539	3.044	2646891	3227482	5874373
Q-4 60						
Q-1 61	8506.5	1451845	3.103	4505362	5541096	10046458
Q-2 61						
Q-3 61	3764.5	682615	3.030	2068214	3155756	5223970
Q-4 61						
Q-1 62	1304.5	222653	2.195	488719	648315	1137034
Q-2 62						
Q-3 62	898.0	150810	3.101	467694	614033	1081727
Q-4 62						
Q-1 63	436.0	74396	2.965	220549	285107	505656
Q-2 63						
Q-3 63	317.5	53447	3.227	172473	424647	597120
Q-4 63						
Q-1 64	307.5	52489	2.387	125265	191345	316610
Q-2 64						
Q-3 64	41.5	7221	5.787	-41794	-29376	-71170
Q-4 64						
Q-1 65	-99.0	-17103	.347	-5927	-6256	-12183

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 01
6-MAJ ASSY 08
STRUCTURAL GROUND TESTS

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-2 65						
Q-3 65	-10.5	-1707	8.878	15157	21696	36853
Q-4 65						
Q-1 66	-4.5	-720	1.101	-793	-382	-1175
Q-2 66						
Q-3 66		-8	4.125	-33	53	20
TOTAL	25244.0	4345668		13057633	16944109	30001742

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

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

PLANNING
4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 08
STRUCTURAL GROUND TESTS

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 63		-82	3.317	-272	-141	-413
Q-2 63						
Q-3 63	160.0	26848	3.970	106582	2586	109168
Q-4 63						
Q-1 64	9.0	1451	3.747	5437	3399	8836
Q-2 64						
Q-3 64	7.5	1449	3.738	5417	3410	8827
Q-4 64						
Q-1 65	3.0	548	3.880	2126	791	2917
Q-2 65						
Q-3 65	1.5	219	3.881	850	316	1166
Q-4 65						
Q-1 66		16	3.813	61	23	84
TOTAL	181.0	30449		120201	10384	130585

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 01
6-MAJ ASSY 08
STRUCTURAL GROUND TESTS

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58 Q-4 58	6.0	977	3.475	3395		3395
Q-1 59 Q-2 59	27.0	4648	2.939	13661		13661
Q-3 59 Q-4 59	99.0	17338	3.118	54064		54064
Q-1 60 Q-2 60	198.0	34324	2.948	101178		101178
Q-3 60 Q-4 60	585.0	98353	3.196	314355		314355
Q-1 61 Q-2 61	1159.5	197947	3.281	649519		649519
Q-3 61 Q-4 61	527.0	95560	3.127	298771		298771
Q-1 62 Q-2 62	73.5	12501	3.331	41645		41645
Q-3 62 Q-4 62	42.0	7089	2.989	21191		21191
Q-1 63 Q-2 63	13.5	2255	3.745	8446		8446
Q-3 63 Q-4 63	19.0	3137	3.394	10646		10646
Q-1 64 Q-2 64	10.0	1675	5.451	9130		9130
Q-3 64 Q-4 64	-18.5	-3260	3.822	-12461		-12461
Q-1 65 Q-2 65	11.5	1975	3.592	7095		7095
Q-3 65	-4.5	-809	4.999	-4044		-4044

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 01
6-MAJ ASSY 09
STRUCTURAL GROUND TESTS

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-4 65						
Q-1 66		54	3.556	192		192
Q-2 66						
Q-3 66		-2	.500	-1		-1
TOTAL	2748.0	473762		1516782		1516782

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 01
6-MAJ ASSY 08
STRUCTURAL GROUND TESTS

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58 Q-2 58	4.5	875	4.923	4308	3957	8265	32
Q-3 58 Q-4 58	312.5	52493	3.173	166584	171714	338298	73110
Q-1 59 Q-2 59	572.5	97716	3.280	320538	314817	635355	34454
Q-3 59 Q-4 59	1840.5	323910	3.012	975618	1136451	2112069	202359
Q-1 60 Q-2 60	2551.0	442144	3.071	1357909	1447084	2804993	1269725
Q-3 60 Q-4 60	6612.0	1110885	3.168	3518867	3757386	7276253	450415
Q-1 61 Q-2 61	10809.0	1844826	3.160	5829234	6150327	11979561	2127244
Q-3 61 Q-4 61	5103.0	925323	3.251	3008459	3867016	6875475	2241751
Q-1 62 Q-2 62	2256.0	384964	2.937	1130577	1317278	2447855	357267
Q-3 62 Q-4 62	1778.0	298590	3.648	1089108	1315649	2404757	580669
Q-1 63 Q-2 63	706.0	120411	3.616	435397	559558	994955	979536
Q-3 63 Q-4 63	793.5	133356	3.918	522494	667284	1189778	2409920
Q-1 64 Q-2 64	524.0	89302	3.368	300752	403753	704505	112333
Q-3 64 Q-4 64	120.0	21130	.801	16933	63341	80274	75190
Q-1 65 Q-2 65	112.0	19148	3.527	67527	64510	132037	474475
Q-3 65	81.0	12660	4.183	57142	76192	133334	179805

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 01
6-MAJ ASSY 08
STRUCTURAL GROUND TESTS

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-4 65							
Q-1 66	-13.5	-2134	2.935	-6264	-5271	-11535	34473
Q-2 66							
Q-3 66	-1.5	-332	3.497	-1161	-1074	-2235	26242
Q-4 66							
Q-1 67							
Q-2 67							
Q-3 67							
TOTAL	34159.5	5876287		18794022	21309972	40103994	11628100

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
DATA PREPARED UNDER
NASA CONTRACT NAS9-12190

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY 08
STRUCTURAL GROUND TESTS

	MPC	WIND TUNNEL	OTHER COST	TOTAL O/C $	SUB TOTAL	G & A	IDMA
Q-1 58	2	153331	1283	154614	162913		
Q-2 58							
Q-3 58	3998	472658	-9659	462999	378405		
Q-4 58							
Q-1 59	2917	433600	71696	505296	1178022		
Q-2 59							
Q-3 59	17134	494129	55224	549353	2885915		
Q-4 59							
Q-1 60	167014	155533	77173	232706	4474439	85251	
Q-2 60							
Q-3 60	59247	237823	59808	297631	6083546	154269	13311
Q-4 60							
Q-1 61	179646	163088	9323	172411	14458342	276096	398611
Q-2 61							
Q-3 61	189315	137586	26564	164150	9470691	184290	446451
Q-4 61							
Q-1 62	28138	143216	8474	151690	2984950	50102	
Q-2 62							
Q-3 62	46475	147669	238671	386340	3417641	57365	
Q-4 62							
Q-1 63	56506	117121	134592	251713	2322710	38836	
Q-2 63							
Q-3 63	237432	89098	74779	163877	4001007	66897	
Q-4 63							
Q-1 64	11942		32001	32001	350481	18309	
Q-2 64							
Q-3 64	27357		-27000	-27000	155821	3316	
Q-4 64							
Q-1 65	141928		6638	6638	755078	20145	
Q-2 65							
Q-3 65	32081		2655	2655	347875	9281	

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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 01
6-MAJ ASSY 08
STRUCTURAL GROUND TESTS

	MPC	WIND TUNNEL	OTHER COST	TOTAL O/C $	SUB TOTAL	G & A	IOWA
Q-4 65							
Q-1 66	7150	11740	190	11930	42018	1265	
Q-2 66							
Q-3 66	1612	4328		4328	29947	902	
Q-4 66							
Q-1 67							
Q-2 67							
Q-3 67							
TOTAL	1249894	2760920	762412	3523332	56505320	966324	858373

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 01
6-MAJ ASSY 08
STRUCTURAL GROUND TESTS

	TOTAL COST
Q-1 58	162913
Q-2 58	
Q-3 58	878405
Q-4 58	
Q-1 59	1178022
Q-2 59	
Q-3 59	2880915
Q-4 59	
Q-1 60	4559689
Q-2 60	
Q-3 60	8251126
Q-4 60	
Q-1 61	15133569
Q-2 61	
Q-3 61	10101432
Q-4 61	
Q-1 62	3035052
Q-2 62	
Q-3 62	3475006
Q-4 62	
Q-1 63	2361546
Q-2 63	
Q-3 63	4067904
Q-4 63	
Q-1 64	878790
Q-2 64	
Q-3 64	159137
Q-4 64	
Q-1 65	775223
Q-2 65	
Q-3 65	357156

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

APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 01
6-MAJ ASSY C8
STRUCTURAL GRCUND TESTS

	TOTAL COST
Q-4 65	
Q-1 66	43283
Q-2 66	
Q-3 66	30849
Q-4 66	
Q-1 67	
Q-2 67	
Q-3 67	
TOTAL	5833C017

TABLE OF CONTENTS

SUBSYSTEM: ENVIRONMENTAL CONTROL WBS CODE: 1.2

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: ENVIRONMENTAL CONTROL WBS CODE: 1.2

WBS LEVELS
4 5 6 7 8

1.2 ENVIRONMENTAL CONTROL SUBSYSTEM

1.2.1 Cabin Air Recirculation

1.2.1.1 Vapor Cycle

Freon Evaporators
Air Turbines
Freon Compressors
Freon/Water Condenser
Freon Subcooler
Expansion Valves
Plumbing/Reservoirs

1.2.1.2 Auxiliary Cabin Cooling

Ram Air Scoop
Scoop Hydraulic Actuator
Air/Water Heat Exchanger
Control Units
Water Ejector Valves
Ammonia Heat Exchanger
Ammonia Vent

1.2.1.3 Cabin Vent and Pressure

Pressure Regulators
Safety Valves
Controller
Control Sensors
Make-up Air Valves
Plumbing

1.2.1.4 Cabin Heating

Air Heat Exchanger
Temperature Controls
Manual Override

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: ENVIRONMENTAL CONTROL WBS CODE: 1.2

WBS LEVELS
4 5 6 7 8

1.2.1.5 Air Recirculation

Outlet Jets
Diverter Valve
Shut-off Valve
Equipment Cooling Racks
Transpiration Walls
Electrical Fans
Water Boiler
Cabin Air Ducting

1.2.2 Water Supply

1.2.2.1 Water Tanks

Pressure Relief Valves
Water Level Sensors
Air Pressure Regulator
Air Pressure Regulator Valve

1.2.2.2 Emergency Pump System

Electrical Motor/Pump
Pressure Sensor
Shut-off Valve
Pump Bypass Valve

1.2.3 Ammonia Supply

1.2.3.1 Ammonia Tanks

Relief Valves
Quantity Sensors
Backpressure Control

1.2.3.2 Overboard Vent and Ducting

1.2.3.3 System Metering

1.2.4 Secondary Pressurization

1.2.4.1 Hatch Seals

1.2.4.2 Door Seals

1.2.4.3 Pressure Regulators

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: ENVIRONMENTAL CONTROL

WBS CODE: 1.2

WBS LEVELS
4 5 6 7 8

1.2.4.4 Warning Sensors

1.2.4.5 Pressure Dump Control

1.2.5 Engine Inlet Fuel Cooling

1.2.5.1 Fuel/Water Boiler

1.2.5.2 Water Shut-Off Valve

1.2.5.3 Throttle Position Sensor

1.2.5.4 Fuel Temperature Sensors

1.2.5.5 Steam Ejectors

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1.2.6.1 Filters

1.2.6.2 Check Valves

1.2.6.3 Desiccants

1.2.6.4 Circulating Fan

1.2.6.5 Altitude Arm Control

1.2.7 Engine Extraction Air System

1.2.7.1 Supply Air Ducting

Isolation/Insulation
Leak-Pressure Sensors
Leak-Pressure Switches
Caution & Warning Circuit
Manual Switch
Shut-Off Valve

1.2.7.2 Air to Water Boiler

Water Level Control
Steam Ejector
Air Bypass System

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: ENVIRONMENTAL CONTROL WBS CODE: 1.2

WBS LEVELS
4 5 6 7 8

1.2.7.3 Freon Turbine Supply

Overspeed Control Valve
Auto Control Valve
Manual Control Valve
Overboard Dump

1.2.7.4 Ventalization/Pressure Supply

1.2.7.5 Cabin Heating Supply

Auto Control Valve
Manual Control Valve

1.2.7.6 Secondary Pressurization

1.2.7.7 Water Tank Air Supply

1.2.7.8 Flash Tank Ejector System

Manual Control Valve
Delta "P" Control Valve
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1.2.7.10 Hydraulic Replenishing Pressure

1.2.8 Recirculating Liquid Cooling

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1.2.8.2 Landing Gear Compartment

Cold Walls
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Flow Priority Valve

1.2.8.3 AICS Trim Actuator Cooling

1.2.8.4 W/G to Fuel Heat Exchanger

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: ENVIRONMENTAL CONTROL WBS CODE: 1.2

WBS LEVELS
4 5 6 7 8

1.2.8.5 W/G Reservoir

1.2.8.6 W/G Pumps

1.2.8.7 W/G Quantity Sensor

1.2.8.8 Pressure Regulator

1.2.8.9 Relief Valve

1.2.9 Remote Equipment Cooling

1.2.9.1 AICS Package

Liquid Nitrogen Storage
Door Seals
Emergency Nitrogen Bottle
Electric Fans
Control Unit
Cooling Effect Sensor
Pressure Sensors
Low Temperature Sensors
Tank Heaters

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Shut-Off Valves
Temperature Control Valves
Pressure Limiting Valves

1.2.10.2 Windshield Defogger

Transparent Electrical Film
Manual Switch
Temperature Sensors
Override Circuitry

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: ENVIRONMENTAL CONTROL

WBS CODE: 1.2

WBS LEVELS

4 5 6 7 8

1.2.11 Ground Tests

1.2.11.1 Models

1.2.11.2 Mockups

1.2.11.3 Test Stand (Engine)

1.2.11.4 Environmental Simulator

1.2.11.5 Wind Tunnel

TECHNICAL DESCRIPTION

SUBSYSTEM: ENVIRONMENTAL CONTROL SUBSYSTEM WBS CODE: 1.2

The Environmental Control Subsystem (ECS) provided controlled environment for the crew members, for various areas, and for components located throughout the air vehicle. A controlled environment was necessary for crew comfort and safety, and for optimum operation of electronic equipment. Backup provisions were provided for crew safety and electronic equipment operation during emergency conditions. Exhibit 1, page III-334, presents the principal areas affected by the ECS.

The XB-70 ECS primarily consisted of a cabin air circulation system, stored water system, stored ammonia emergency refrigerant system, Freon 11 vapor cycle refrigerant system, engine extraction air supply system, secondary pressurization system, recirculation liquid cooling system, and provisions for cooling remote located equipment. The narrative descriptions in the subsequent paragraphs describes the equipment, sensors, valves, and controls necessary for ECS operation in the following areas:

(1) Cabin normal and emergency cooling, heating, ventilation and pressurization.

(2) Electronic equipment compartment normal and emergency cooling, ventilation, and pressurization.

(3) Cooling of the deceleration chute, flight control equipment, and landing gear.

(4) Cooling of flight augmentation and engine air inlet control equipment.

(5) Engine extraction air supply and control.

(6) Heat sinks

(7) Pressurization of air vehicle door and hatch seals, electronic equipment and fluid reservoir.

(8) Windshield antifogging.

(9) Windshield anti-icing and rain removal.

(10) System provisions for ground support functions.

(11) Systems operations and controls.

ENVIRONMENTAL CONTROL SYSTEM (ECS)

PRINCIPAL AREAS AFFECTED

- WINDSHIELD
- CREW & ELECTRONIC EQUIPMENT BAY
- LANDING GEAR
- DRAG CHUTE

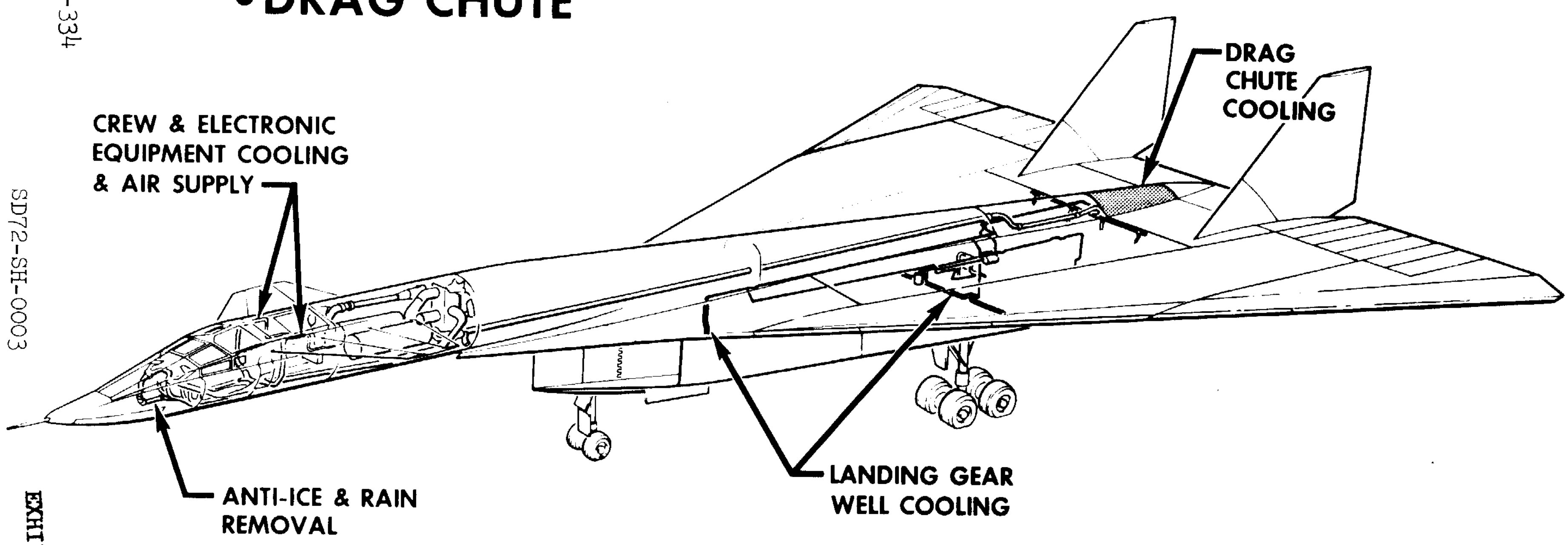


EXHIBIT 1

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: ENVIRONMENTAL CONTROL/SUBSYSTEM WBS CODE: 1.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
MAJOR ASSEMBLIES	NUMBER	9	9	10	10	10
FLUIDS	TYPE	LN_2	→	→	→	→
		FUEL	→	→	→	→
		WATER/GLYCOL	→	→	→	→
		FRION 11	→	→	→	→
		WATER	→	→	→	→
		-	ICE	→	→	→
		-	-	AMMONIA	→	→
GASES	TYPE	AIR	→	→	→	→
		GN_2	→	→	→	→
TEMPERATURE: DESIGN RANGE	DEGREES F	-65 TO 630	→	→	→	→
HEAT SINKS	TYPE	LN_2	→	→	→	→
		FUEL	→	→	→	→
		WATER	→	→	→	→
		-	ICE	→	→	→
		-	-	AMMONIA	→	→
NO. OF CREW MEMBERS	NO.	4	2	→	→	→

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: ENVIRONMENTAL CONTROL/SUBSYSTEM WBS CODE: 1.2

CHARACTERISTIC		UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
FLUIDS WORKING PRESS. RANGE	MEDIA	PSI					
	AIR	PSIA	10.9 - 180 →				→
	GN_2	PSIG	20 - 2500 →				→
	LN_2	PSIG	55 - 65 →				→
	W/G	PSIG	50 - 300	100 - 108 →			→
	FREON 11	PSIA	12 - 180	5.6 - 134 →			→
	WATER	PSIG	AMB TO 20 →				→
	FUEL	PSIG	20 TO 30 →				→
	ICE	PSIA	NA	AMB →			→
	AMMONIA	PSIG	NA	NA	400 →		→
FLOW RATES - MAX		LB/HR					
	AIR		27,000	34,000 →			→
	GN_2		NEG →				→
	LN_2		20	220	350 →		→
	W/G		42,000	6,600 →			→
	FREON 11		8,640	5,340 →			→
	FUEL		57,000	49,000 →			→
	AMMONIA		NA	NA	330 →		→
	WATER		900	2,400	2,400 →		→
HEAT EXCHANGERS	TYPE	NO.					
	AIR TO AIR		0	1 →			→
	AIR TO W-G		9	5 →			→
	AIR TO FREON		1 →				→
	AIR TO WATER		2	4 →			→
	AIR TO AMMONIA		0	0	1 →		→
	W-G TO FREON		1	0 →			→
	W-G TO FUEL		2	1 →			→
	FREON TO FUEL		1	0 →			→
	FREON TO WATER		1 →				→

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: ENVIRONMENTAL CONTROL SUBSYSTEM WBS CODE: 1.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
TYPE	NO.					
ELEC. TO AIR		1	0 →	→	→	→
ELEC. TO W-G		1	0 →	→	→	→
FREON TO FREON		2	1 →	→	→	→
FUEL TO WATER		1 →	→	→	→	→
HYD TO FUEL		2 →	→	→	→	→
GN_2 TO LN_2		0	1	2 →	→	→
RELIABILITY FACTOR	NONE	-	0.99780	0.99780	0.99780	0.99780
MTBF	HOURS	-	795	795	795	795

TECHNICAL DESCRIPTION

SUBSYSTEM: ENVIRONMENTAL CONTROL SUBSYSTEM — WBS CODE: 1.2

MAJOR ASSEMBLY: CABIN AIR RECIRCULATION — WBS CODE: 1.2.1

The cabin, located between fuselage stations (FS) 369.5 and 605, consisted of a crew compartment and an electronic equipment compartment which were separated by a metal closeout wall just aft of the pilot's and copilot's seats. The crew compartment housed two crew members and necessary controls, lights, and gages. The electronic equipment compartment contained the electronic equipment necessary to operate the air vehicle and which required a controlled environment. Exhibit 2, page III-343, presents a schematic of the cabin air recirculation system showing the major components and air flows.

The crew and electronic equipment compartments employed a common air recirculation loop that provided cooling, ventilation, and pressurization. Heating was provided for air supplied to the crew compartment only. The cooling of the recirculation air was accomplished primarily by a Freon 11 vapor cycle refrigeration system and was supplemented by a ram air water boiler and an air to ammonia heat exchanger. Ventilation and pressurization was accomplished through the use of engine extracted air. Exhibit 3, page III-344, presents a schematic of the Freon 11 vapor cycle system showing the major components along with the operational parameters. The air to be recirculated exhausted from the crew and electronic compartments and was routed through the common return air ducting, cooled in the ram air water boiler and Freon evaporator, then delivered back into both compartments through individual supply air ducting. This individual supply air ducting permitted independent supply air temperature control to the crew members and the electrical/electronic equipment. The air supplied to the crew compartment could be heated for crew comfort by an air-to-air heat exchanger using engine extraction air as the heat source. Additional cooling to the electronic equipment compartment was available through the use of an air-to-ammonia heat exchanger installed in the electronic equipment compartment supply air duct. Emergency cooling, ventilation, and pressurization was accomplished by an emergency ram air system.

The crew compartment was the forward section of the cabin from FS 369.5 to FS 493 with cooling air supplied through the following air outlets located at various positions around the crew who were seated within their capsules.

(1) An adjustable "eyeball" type air outlet.

(2) A control column outlet.

(3) A side air outlet.

(4) Foot air outlet.

(5) A diverter outlet.

Cooling air was also supplied through windshield and side window manifolds to the edges of the inboard glass plates, and was directed across the internal surface to cool the surface and reduce heat radiation to the crew from the windshield and window panels.

Due to numerous variations of flight conditions, aerodynamic and solar heat loads to the crew compartment varied both in intensity and location relative to the crew members. Since the crew compartment supply air ducting was designed for the maximum heat load conditions, a manually operated diverter valve was installed in the main supply air duct to allow the crew to vary the airflow rate through the air outlets. This valve diverted approximately 30% of the total airflow from the crew air outlets and routed it into the aisle just aft of the pilot's capsule. The cooling of various crew controls and instruments mounted on the side and center consoles was accomplished by crew compartment air passing over the units as it exhausted through the transpiration wall. Exhibit 16, page III-387, under Technical Innovations, presents a cross sectional view of the transpiration wall showing it's relationship to the cabin walls. Cooling of various gages, controls, and instruments on the crew instrument panels was accomplished by routing cooling air from the center aisle of the electronic equipment compartment through a duct to the rear of the instrument panels. The temperature of cooling air to the instrument panels was controlled by means of the electronic equipment compartment supply air cooling controls. The escape system initiators were cooled by free convection of the crew compartment air.

The electronic equipment compartment was the aft section of the cabin from FS 493 to the aft cabin bulkhead at FS 605. The electrical/electronic equipment was mounted on shelves located on either side of the center aisle between FS 493 and FS605 on the left, and between FS 522.75 and FS 605 on the right. Cooling air entered the center aisle from a supply duct terminating at the cabin aft bulkhead. The center aisle was closed off by the cabin aft bulkhead, the floor, a false ceiling, a door at the forward end of the aisle, and closeout panels of the shelves, thus forming a plenum at the inlet side of the cooled equipment. The cooling air was routed toward the transpiration wall from the aisle through and around the equipment mounted on the shelves. The shelves were used to mount the equipment and were also used as secondary plenums or air distribution chambers for each unit. Certain units were enclosed with shrouds which distributed the cooling air to critical areas and served as a shield from adjacent hot structure. Airflow through the shrouded units was controlled by a properly sized air gap between the unit and the shroud or by orifices in the air passages. Several units had an internal blower to aid the cooling airflow. Cooling air from the aisle was also routed through a duct to the rear of the crew instrument panels, as previously described, and through a duct to the aft right-hand hatch remover to maintain the charged ejector cartridge at a safe temperature.

Air that had been circulated through both compartments of the cabin was exhausted onto the return duct of the air recirculation loop through the transpiration wall. The transpiration wall was a concept used to minimize aerodynamic heat transfer into the cabin through the air vehicle skin. (See Exhibit 16, page III-387.) Thin perforated metal sheets were used to form the inner surface of the cabin walls. These sheets were separated from the air vehicle skin by two layers of aluminum foil-covered insulation blankets and two air spaces. One air space (outboard) was in between two layers of the insulation blankets, and the other air space (inboard) was between the inboard layer of the insulation blankets and the thin perforated metal sheets. The crew area perforated sheets had 50 holes per square inch while the other areas had 20 holes per square inch. The low velocity air exhausted from the cabin flowed in the inboard air space, absorbed aerodynamic heat, and was a shield to prevent the transfer of aerodynamic heat into the cabin. Return air manifolds collected the exhausted air and routed it to the main return air recirculation duct.

An electrically driven fan unit, comprised of an assembly of two fans in series, was located in the main return air recirculation duct to supply the motive power for the recirculation air loop. When the "Coolant Circ" switch was placed to "ON", the fans were energized and the air discharged from the fans flowed through the following components located in the equipment and ECS compartments.

(1) Check valve that prevented reverse flow of the recirculation air.

(2) Two-stage ram air water boiler that supplied supplemental cooling automatically when the water boiler air inlet temperature exceeded 150°F. This boiler provided primary cooling during emergency ram air operation.

(3) Freon evaporator that provided normal cooling of the recirculation air.

(4) Air-to-Air heat exchanger that provided heating to the crew compartment support air.

(5) Air-to-Ammonia heat exchanger that provided cooling to the electronic equipment compartment when supplemental cooling was required.

(6) Air shut off valve that was operated manually by the copilot and prevented recirculation air from entering the crew compartment during certain ground operations.

(7) Air diverter valve that was operated manually by the copilot and diverted part of the recirculation air to the outlet in back of the pilots capsule.

As previously stated, the basic cooling requirements of the cabin was achieved by a closed Freon vapor cycle loop. The main components of the Freon loop (see Exhibit 3, page III-344) included; Freon evaporator, air turbine-driven Freon compressor providing two stages of compression, Freon to water condenser, subcooler, expansion valves and various control devices required for optimum and stable operation. The Freon gas, after vaporizing and absorbing heat from the cabin recirculation air in the Freon evaporator, was compressed in the low stage section of the two stage compressor where it mixed with a by pass flow in the event of a compressor surge condition. The compressed hot gas was then mixed with Freon gas from the subcooler, further compressed in the high stage section of the compressor, and then flowed to the water cooled condenser where it was condensed to liquid as a resulting effect of rejecting heat to the water. The liquid Freon was then further cooled in the subcooler to insure that only liquid Freon was delivered to the expansion valves. A Freon drier and strainer was incorporated in the loop upstream of the expansion valves to remove any moisture or foreign particles that were present in the loop.

The components of the Freon vapor cycle loop were housed in a package referred to as the refrigeration package which was located in the ECS equipment compartment (FS 605 to FS 796). The package consisted of an insulated metal framework containing the Freon loop components such that the loop could be installed, removed and serviced as an integral unit without disrupting the closed vapor cycle loop. Exhibit 4, page III-345, presents a picture of the refrigeration package removed from the air vehicle.

The cabin pressure and ventilation was controlled by a pressure regulator installed in the return air duct and was normally controlled at an 8000 foot altitude pressure level when the air vehicle was above 8000 feet. The cabin was essentially vented to ambient below this altitude since the cabin pressure regulator and safety valves were in full open position at air vehicle altitudes of 8000 feet and 6500 feet, respectively. Pre-cooled engine extraction air was introduced into the cabin air recirculation duct downstream of the fans to make up air leakage and provide ventilation requirements. Overpressurization, either positive or negative, was prevented by two safety valves which were installed in the return air duct.

As previously stated, emergency cooling and pressurization was accomplished for both the crew and electronic equipment by means of an emergency ram air scoop and the emergency ram air water boiler. The electronic equipment supply air duct also incorporated an air-to-ammonia heat exchanger. Exhibit 2, page III-343, shows the ram air scoop in its retracted position while Exhibit 17, page III-388, (under Technical Innovations) shows the scoop extended and the shock pattern formed during supersonic flight. When the ECS system was unable to meet the cooling requirements of the electronic equipment compartment from either a weight flow or temperature standpoint, an overheat caution light was illuminated in the crew compartment. An auxiliary cooling system was then employed to initiate operation of the emergency water boiler and the air-to-ammonia heat exchanger for supplementary cooling. The pilot could also select emergency ram air and additional water supply to the water boiler by means of a cabin air purge switch if the auxiliary cooling was inadequate. A reduction of cabin pressure below 35,000 feet altitude pressure automatically opened the ram air scoop, initiated auxiliary cooling, and rescheduled the safety valve to maintain the cabin pressure at a 40,000 foot altitude pressure. The ram air system was sized to maintain a 40,000 foot altitude pressure in the cabin with a 25 square inch hole in the fuselage.

During emergency ram air operation, the air entered the scoop (located on the upper left-hand side at FS 830) and passed through a modulating flow control valve, the emergency ram air water boiler and the Freon evaporator for cooling prior to its entry into the cabin. (The air-to-ammonia heat exchanger provided supplementary cooling for the electronic equipment compartment only.) The ram air exhausted overboard through the pressure regulator, safety, and hi-flow valves. The hi-flow valve was incorporated to augment the flow area of the pressure regulator and safety valves during ram air (or purge) conditions at altitudes below 40,000 feet. The cabin air recirculating fans and the make-up air supply were shut-off during this emergency operation.

The pilot could also manually select and control the emergency ram air to purge the cabin air of contaminants. As with emergency cooling, the cabin pressure was rescheduled to a 40,000 foot altitude pressure during this operation. Repressurization to the 8,000 foot altitude pressure was accomplished, at the pilot's option, by the re-pressurization valve and controls. The controls calling for re-pressurization automatically overrode the manual selection of emergency ram air.

Display panels located in the crew compartment contained the switches, knobs, gages, and lights necessary for the crew members to monitor and control the environmental control subsystem. Switches and knobs were provided to operate and control the cabin and electronic equipment compartment temperatures and pressure for both normal and emergency conditions, cabin air purge, and the windshield/anti-fog equipment. Caution lights were provided to indicate to the crew members cabin pressure decay to a 10,000 foot altitude pressure, electronic equipment compartment overheat, drag chute compartment overheat, emergency ram air scoop in open position, and water and ammonia quantities low. Warning lights indicated a cabin pressure decay to 45,000 foot altitude pressure. Gages were provided to indicate the cabin pressure, electronic equipment supply air temperature, and water quantity.

ECS Recirculation System
Cabin and EE Bay
Normal Operation

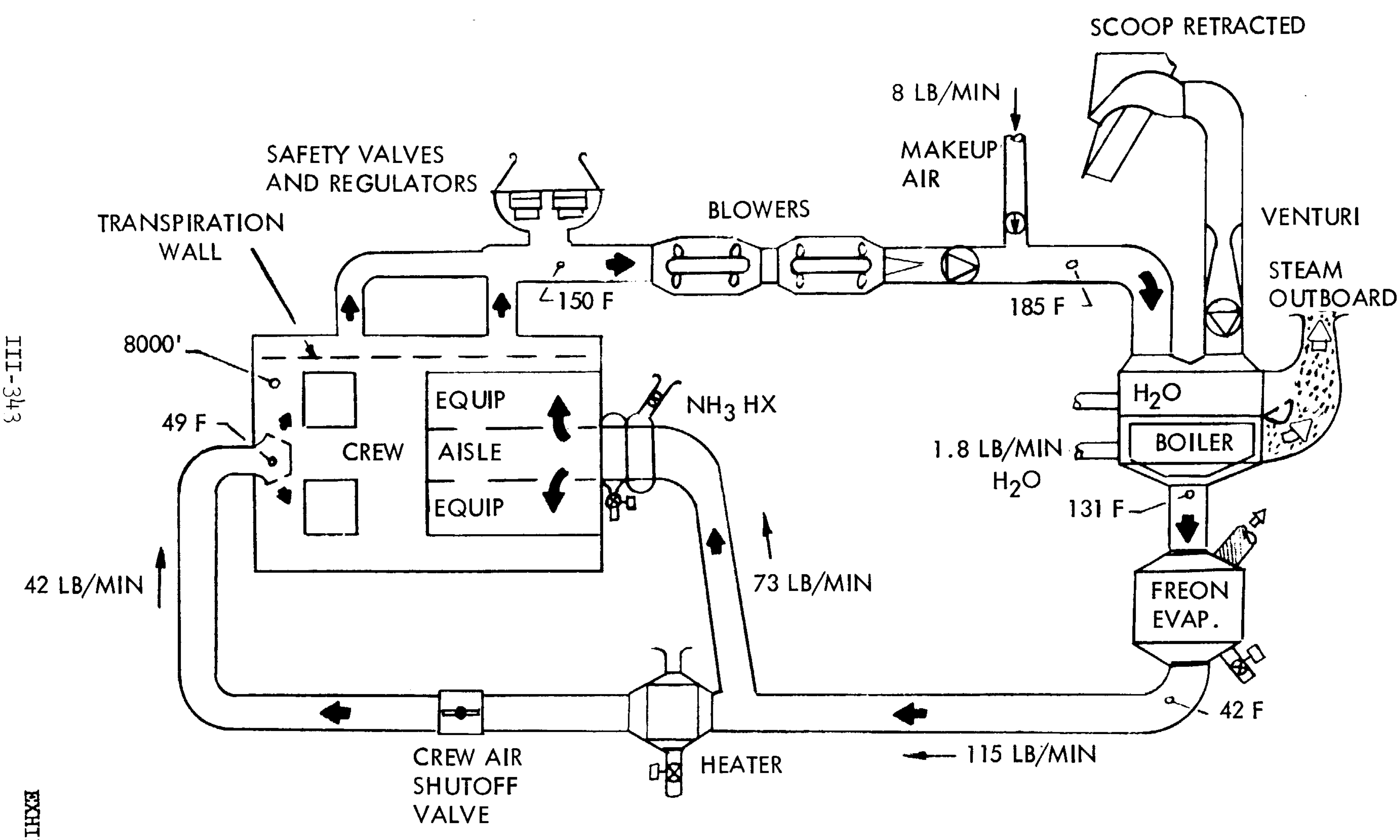


EXHIBIT 2

Freon Vapor Cycle System

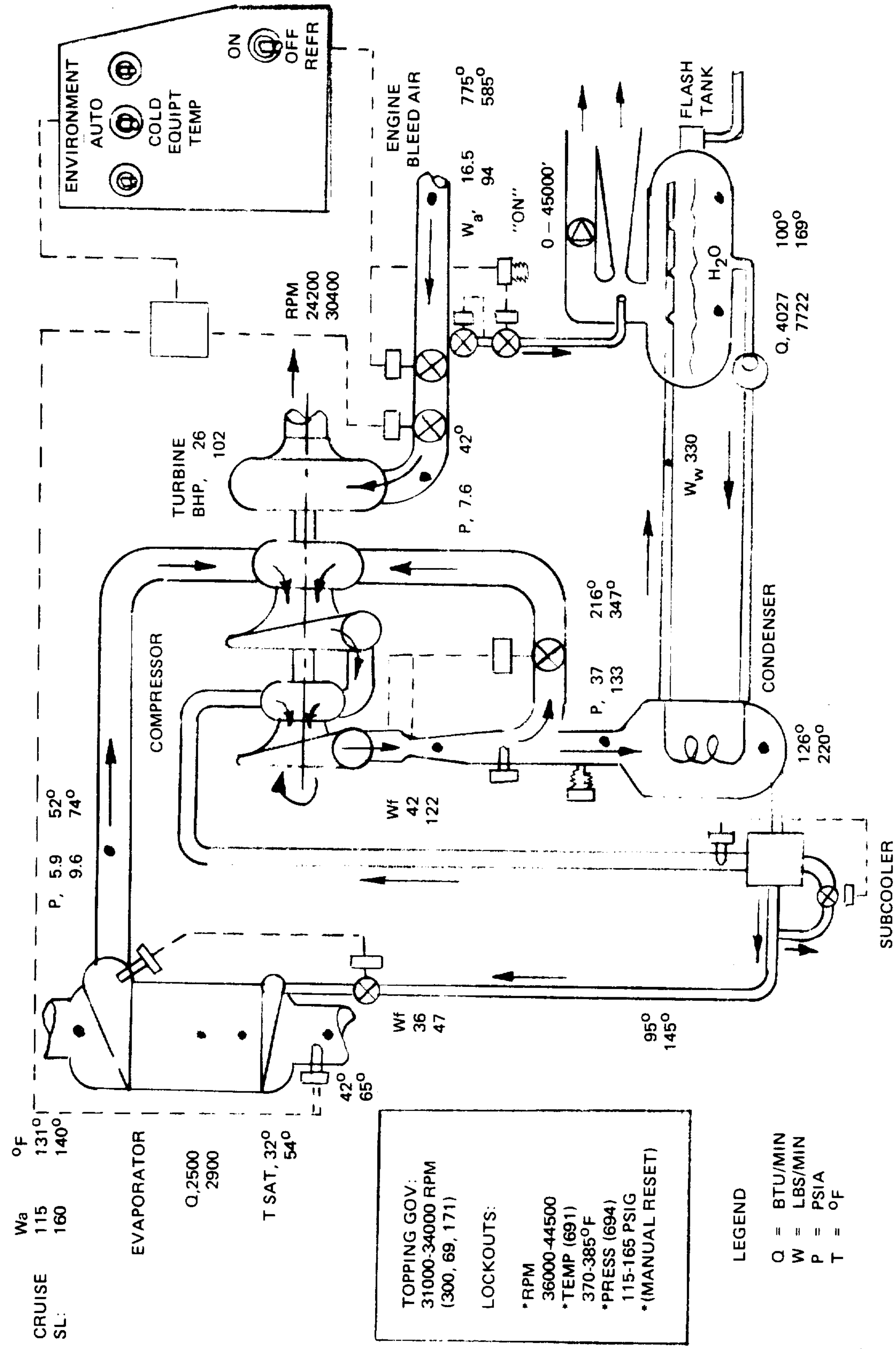
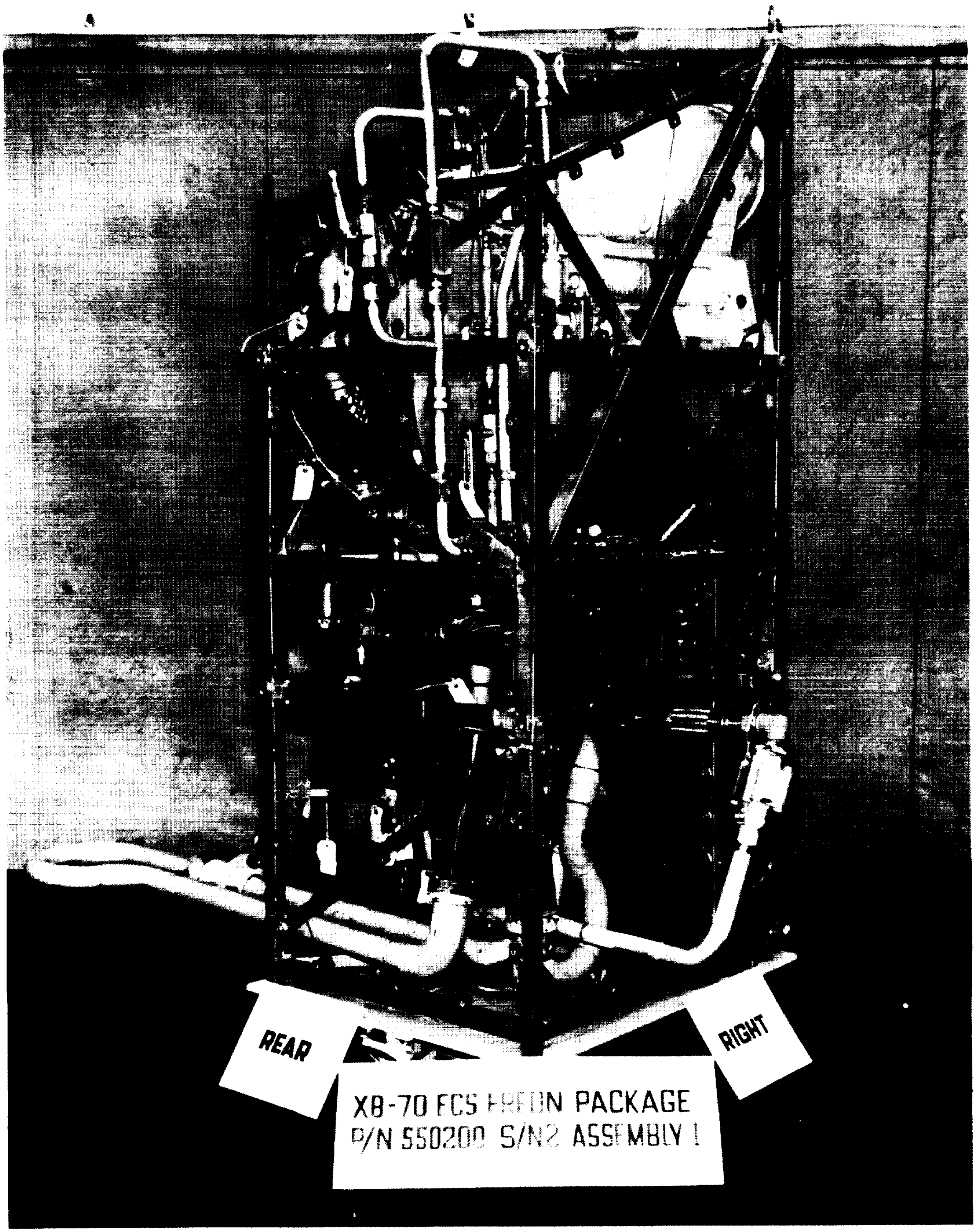


EXHIBIT 3


REAR
RIGHT
XB-70 ECS FREON PACKAGE
P/N 550200 S/N2 ASSEMBLY 1

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: CABIN AIR RECIRCULATION (AIR LOOP) WBS CODE: 1.2.1

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
TEMPERATURE - DES. RANGE	DEGREES F	-65 TO 160	-10 TO 160	→	→	→
HEAT SINKS	TYPE	COOLANT	-	-	-	-
		WATER	WATER	WATER	→	→
		FREON 11	FREON 11	FREON 11	→	→
		-	-	AMMONIA	→	→
HEAT EXCHANGERS	TYPE/NO.	AIR TO H_2O/2	AIR TO H_2O/2	→	→	→
		AIR TO FREON /1	AIR TO FREON /1	→	→	→
		AIR TO W-G/1	AIR TO AIR/1	→	→	→
		ELEC. TO AIR /1	-	-	-	-
		-	-	AIR TO NH_3/1	→	→
GASES WORKING PRESS.	PSID	1.0	1.5	→	→	→
FLOW RATES - AIR	LB/HR	12,480	6,900	8,220	→	→
HEAT LOAD REJECTION	BTU/HR	341,400	236,800	198,300	→	→
COMPARTMENTS	TYPE/NO.	CREW/1 ELEC/1	CREW/1	→	→	→
COMPARTMENTS VOLUME	$FEET^3$	1,520	869	→	→	→
FUNCTIONAL MODES	TYPE	NORMAL EMERG	→	→	→	→
NUMBER OF CREW MEMBERS	NO.	4	2	→	→	→

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: CABIN AIR RECIRCULATION (AIR LOOP) WBS CODE: 1.2.1

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	.9960	.9929	.9929	.9900	.9900
MTBF	NO. OF HR.	250	141	141	100	100
FLUID MEDIUM	TYPE	FREON 11	→	→	→	→
TEMPERATURE - DESIGN RANGE	OF	- 65 TO 348	-10 TO 348	→	→	→
HEAT SINKS	TYPE	FUEL	-	-	-	-
		WATER	WATER	→	→	→
HEAT EXCHANGERS	TYPE/NO.	FREON TO FREON/2	FREON TO FREON/1	→	→	→
		FREON TO WATER/1	FREON TO WATER/1	→	→	→
		FREON TO FUEL/1	AIR TO FREON/1	→	→	→
		AIR TO FREON /1	-	-	-	-
		W/G TO FREON /1	-	-	-	-
FLUID WORKING PRESS (FREON)	PSIA	12 TO 180	5.6 TO 134	→	→	→
FLOW RATES (FREON)	LB/HR	8,640	5,340	→	→	→
HEAT LOAD REJECTIONS	BTU/HR	720,000	468,000	456,000	→	→

TECHNICAL DESCRIPTION

SUBSYSTEM: ENVIRONMENTAL CONTROL SUBSYSTEM WBS CODE: 1.2

MAJOR ASSEMBLY: WATER SUPPLY SYSTEM WBS CODE: 1.2.2

The primary heat sink for the environmental control subsystem (ECS) was water with water also used to absorb heat from the engine extraction air and ram air prior to its use in the ECS equipment. Two water storage tanks with necessary ducting and controls supplied water to the following components:

(1) Engine extraction air water boiler
(2) Flash water tank
(3) Freon condenser
(4) Emergency ram air water boiler
(5) Fuel to water boiler

Water supplied to the water boilers absorbed heat from the air or fuel by ambient boiling of water with the resultant steam vented overboard. Water that was circulated through the Freon condenser absorbed heat from the gaseous Freon and rejected it to the atmosphere through a boiling process in the flash water tank. The steam ejectors, when operated below 55,000 ft. altitude, reduced the water boiling pressure and thereby provided a lower boiling temperature. Exhibit 5, page III-351, presents a picture of a two-stage water boiler.

Two water storage tanks were located in the equipment compartment, one on each side of a center aisle. Total capacity of both tanks was 4400 pounds (528 gallons) of water with an approximate allowance of three percent for expansion. The tanks were filled with demineralized water and had a water quantity gage and a water low caution light provided on the pilots instrument panel and center aisle console panel, respectively. The tanks were pressurized with air from the low temperature branch of the engine extraction air duct system. This pressurization provided a normal water pressure head necessary to supply water to all the utilization points. The pressure was regulated to 20 ± 1 psig by a pressure regulator valve. An interflow line connected each tank to assure equal water level and pressure in each tank with the pressure controlled by pressure relief valves set at 23 ± 1 psig. Water discharged from the under side and near the aft end of each tank into a common duct which emptied into a well that contained an emergency water pump and drive motor.

Under normal operation with water supplied at 20 psig, the water bypassed the pump and was routed from the pump well to the water utilizing equipment. If a malfunction occurred in the water pressurization system, the pump was activated to boost the pressure. A bypass was incorporated in the pump to limit its discharge to 24 psig which worked in conjunction with a variable opening bypass valve in the main supply line to control total system pressure within limits. The water pump activation was sensed by a supply pressure switch set at 15 psig; the pump was shut off at 19 psig.

WBS CODE: 1.2.2

The pump and drive motor was capable of supplying 80 pounds per minute of water at a pump delta pressure of 20 psi and water temperatures between 35°F and 150°F. The pump was a centrifugal type while the drive motor was a three-phase induction type motor powered by the right-hand primary AC electrical power bus.

Freezing of the water distribution lines was prevented by the use of electrically heated insulation covers and by automatic water draining provisions at the utilizing equipment and main supply lines. The covers were installed on the interconnecting lines between the flash boiler and the Freon condenser with the heater elements energized at compartment temperatures 47°F or below. No insulation or heating was provided for the tanks or the supply lines below their main shutoff valves which were located as close as practical to the pump well.

The engine extraction air water boiler was located immediately forward of FS 796 above the aft end of the right-hand water storage tank. Water was supplied from the main supply line to the boiler through a water level control valve located on the inboard side of the boiler. The steam formed as a result of evaporation was ducted overboard through an outlet in the fuselage skin. A pressure actuated drain valve was installed in a line routed from the bottom of the boiler to the main supply line. When the water supply pressure decayed below 3 psig, the drain valve allowed water to drain from the boiler to the main supply line back to the pump well. The flash water tank (spray-type boiler) was also located immediately forward of FS 796 but above the aft end of the left-hand water storage tank. Water was supplied to the flash water tank the same as described for the above water boiler. As shown by Exhibit 3, page III-344, a water pump was incorporated below the flash tank on the water line from the flash tank to the condenser of the Freon vapor cycle system. The water was pumped through the Freon condenser where it was heated by heat removed from the Freon. This heated water was then returned to the flash tank where it passed through spray nozzles and was cooled by evaporation.

The emergency ram air water boiler was located at the right-hand side of the refrigeration package in the ECS compartment. It incorporated two water boiling states; an ambient stage and an ejector stage. See Exhibit 5, page III-351, for picture of two stage boiler. The ambient stage of the boiler was supplied approximately three pounds of water by one variable valve and 25.4 pounds by two larger variable valves which were paralleled and sized so that either could supply the required flow. The total water flow rate for the ambient stage was determined by an orifice downstream of the water shutoff valves with the water head supplied from the water storage tanks. The ejector stage of the boiler was supplied water through a water shutoff valve at a rate of approximately 1.8 pounds per minute as determined by a downstream orifice.

WBS: 1.2.2

A fuel to water boiler was installed on the right-hand side of fuel tank No. 4 and FS 1812.5. The function of this boiler was to cool the engine inlet fuel after the fuel was routed through the heat exchangers of the fuel cooling loop (see WBS 1.2.5). Water was supplied to this boiler from the main supply line through two electrically operated water shutoff valves and a water flow control valve which consisted of two "vernatherm" actuating valves. Water flow rate to the boiler was controlled by the control valve which utilized a thermally expandable material called Vernalite. The force created by the material when it was heated and expanded was transmitted to a valve stem which opened the valve. A counteracting spring closed the valve as the Vernalite contracted.

EXHIBIT 5

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: WATER SUPPLY WBS CODE: 1.2.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WATER VOLUME	LBS	2,584	4,400	→	→	→
STATIC HEAD PRESS.	PSI	20	20	→	→	→
MEDIUM WORKING PRESS	PSI	20	20	→	→	→
TEMPERATURE - DESIGN RANGE	OF	35 TO 212	→	→	→	→
HEAT EXCHANGERS	TYPE/NO.	AIR TO WATER /2 FUEL TO WATER/1 FREON TO WATER/1	AIR TO WATER /3 FUEL TO WATER/1 FREON TO WATER/1	→	→	→
HEAT LOAD REJECTION MAX	BTU/HR	900,000	1,890,000	1,880,000	→	→
FLOW RATE - MAX	LB/HR	900	2,400	2,400	→	→
RELIABILITY FACTOR	NONE	.99911	.99911	.99911	.9987	.9987
MTBF	NO. OF HR	1550	1550	1550	770	770

TECHNICAL DESCRIPTION

SUBSYSTEM: ENVIRONMENTAL CONTROL SUBSYSTEM WBS CODE: 1.2

MAJOR ASSEMBLY: AMMONIA SUPPLY WBS CODE: 1.2.3

The ammonia supply, which was required for auxiliary cooling of the equipment compartment, was stored in a tank located just aft of the electronic equipment compartment. When activated, the ammonia flowed from the tank through a fixed metering system, through a double seamed heat exchanger, and then was vented overboard (see heat exchanger description under Technical Innovations). Due to the critical breathing reactions to ammonia fumes, special design precautions were enforced. These were:

1. Vent located aft of ram air scoop.
2. As remote as possible from engine inlets.
3. Located tank and heat exchanger in unpressurized compartment.
4. Heat exchanger in equipment cooling loop only.
5. Heat exchange had double end channels, extra heavy divider plates and subjected to severe leakage test.
6. Controlled usage of ammonia with back pressure to prevent freezing and metered for minimum flow.
7. Ground GSE for fume collection.

Exhibit 6, Page III-354, displays the ammonia heat exchanger.

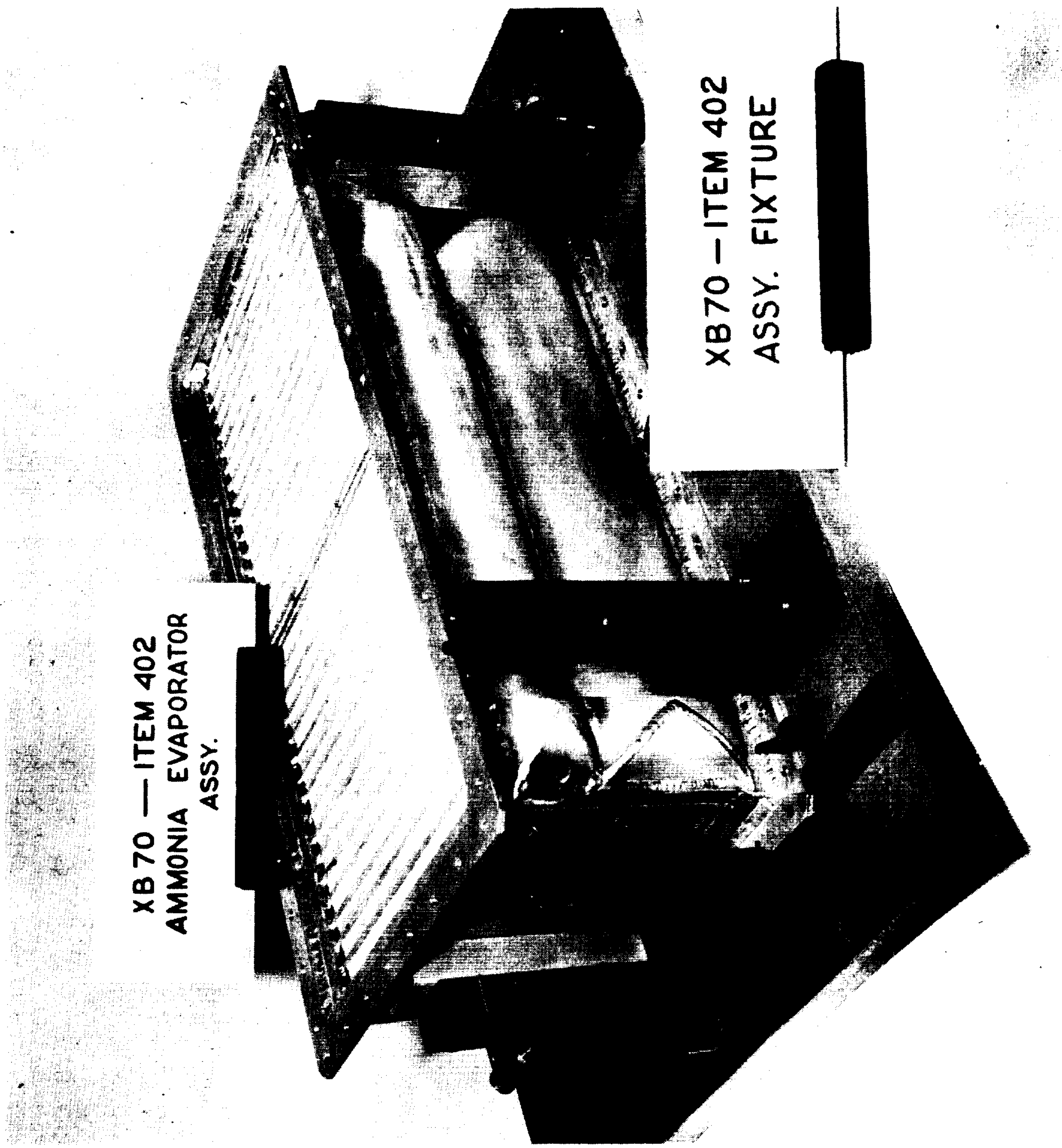

XB70 — ITEM 402
ASSY. FIXTURE
XB70 — ITEM 402
AMMONIA EVAPORATOR
ASSY.

EXHIBIT 6

C.7

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: AMMONIA SUPPLY WBS CODE: 1.2.3

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
AMMONIA VOLUME	LBS.	NONE	NONE	550	→	→
STATIC BACK PRESS.	PSI	NA	NA	400	→	→
MEDIUM WORKING PRESS	PSI	NA	NA	70	→	→
TEMPERATURE - DESIGN RANGE	^{o}F	NA	NA	-10 TO 140	→	→
HEAT EXCHANGERS	TYPE/NO.	NONE	NONE	AIR TO AMMONIA/1	→	→
HEAT LOAD REJECTION - MAX	BTU/HR	NA	NA	150,600	→	→
FLOW RATE - MAX	LB/HR	NA	NA	330	→	→
RELIABILITY FACTOR	NONE	-	-	.999363	.99926	.99926
MTBF	NO. OF HR.	-	-	1570	1350	1350

TECHNICAL DESCRIPTION

SUBSYSTEM: ENVIRONMENTAL CONTROL SUBSYSTEM WBS CODE: 1.2

MAJOR ASSEMBLY: SECONDARY PRESSURIZATION WBS CODE: 1.2.4

Secondary pressurization subsystem provided the necessary air pressure for the following items:

1. Four escape hatch seals.
2. Cabin external door seal.
3. Cabin to equipment compartment door seal.

Each seal was two separate inflation tubes with two separate sets of supply air regulation equipment. The outer cell of the seal was regulated to a pressure of 29 psig with the inner cell regulated to 27 psig. The system relief setting was 34 psig. The source of air pressure for the seals was the low temperature branch of the engine extraction air duct system (EEADS). This air was cooled to a maximum temperature of 250°F. See Exhibit 7, Page III-357 for the schematic of the secondary pressurization system and Exhibit 8, Page III-358 for the cross section of a seal.

Secondary Pressurization System

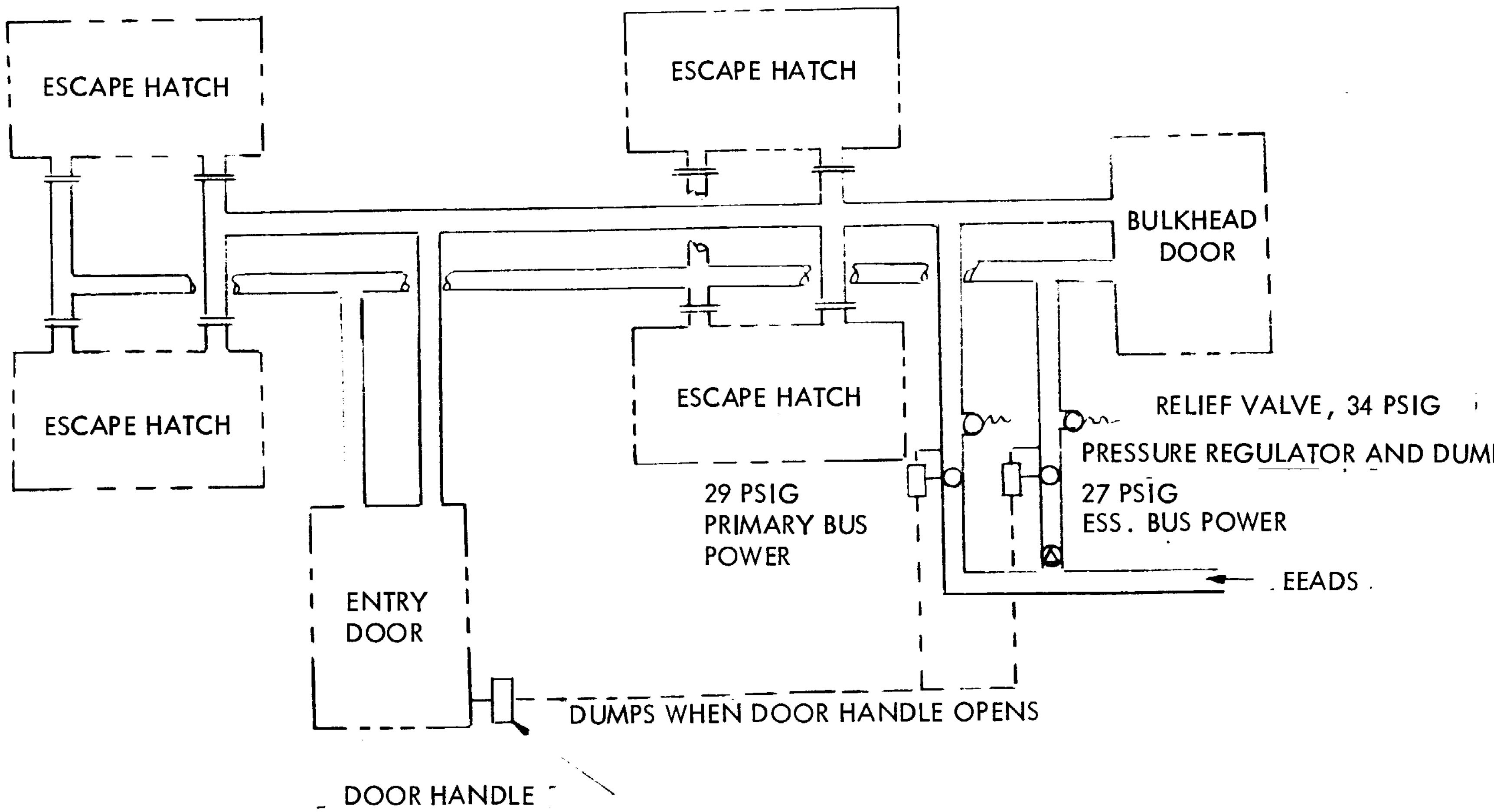


EXHIBIT 7

Door and Hatch Seal

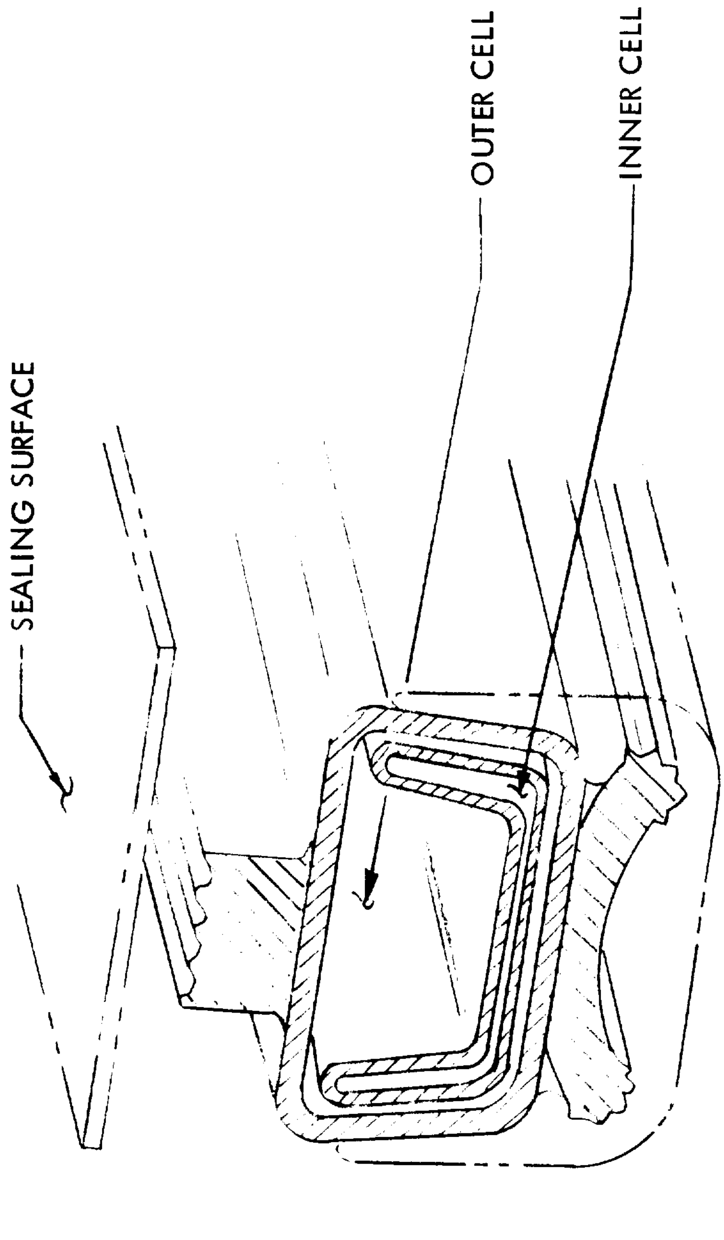


EXHIBIT 8

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: SECONDARY PRESSURIZATION   WBS CODE: 1.2.4

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
PRESSURIZED COMPONENTS	TYPE/NO.	DOOR SEALS/2 COOLANT TANK /2 AVIONICS/4 HATCH SEALS /4	DOOR SEALS/2 - AVIONICS/1 HATCH SEALS /4	→ - → →	→ - → →	→ - → →
OUTPUT PRESSURES	PSIA	29 27 18	→	→	→	→
SOURCE PRESSURE	PSIG	2500	40	→	→	→
TEMPERATURE - DESIGN RANGE	DEGREES F	-65 TO 120	-65 TO +750	→	→	→
PRESSURE SOURCE/VOL	TYPE/FT^3	GN_2 BOTTLE /6	ENGINE BLEED AIR/NA	→	→	→
RELIABILITY FACTOR	NONE	.9999999	→	→	→	→
MTBF	NO. OF HR.	10^6	→	→	→	→

TECHNICAL DESCRIPTION

SUBSYSTEM: ENVIRONMENTAL CONTROL SUBSYSTEM WBS CODE: 1.2

MAJOR ASSEMBLY: ENGINE INLET FUEL COOLING (FUEL COOLING LOOP) WBS CODE: 1.2.5

A fuel-cooling water boiler was installed on the fuel coolant loop downstream of the hydraulic heat exchangers. The water boiler supplied supplemental cooling to the fuel loop during descent in order that the engine inlet fuel temperature limit was not exceeded. Water flow to the boiler was controlled by dual shut-off valves which were actuated by throttle position and fuel temperature at the boiler outlet. When the throttles of three engines on the same side of the air vehicle were shifted out of afterburner power, the throttle switch closed. At this time, if the fuel temperature on the downstream side of the boiler was at a nominal 216°F, the circuit was completed and the water shut-off valves to the boiler opened. Water flow through the boiler was controlled by a thermal valve which modulated water flow to a maximum of 25 lbs/min for fuel temperatures of 240°F or higher. The fuel temperature leaving the fuel-to-water boiler was maintained at 260°F or less.

Exhibit 9, Page III-361 presents a schematic of the fuel cooling loop showing the heat exchangers and their fluid temperatures, No. 3 fuel sump tank, pumps, water boiler, and the fuel routing with fuel flows. The heat sink capacity for the fuel cooling loop was defined as a rate rather than an absolute capacity. Exhibit 10, Page III-362 presents the average heat rejection rates of the fuel cooling loop. The maximum rate at any one time was based on the cooling loop fuel flow rate and the difference between the engine inlet temperature limit and the sump tank fuel temperature. The maximum cooling rate available in the fuel loop was exceeded after $1\frac{1}{2}$ hours of cruise which was the prime reason for the water boiler at the inlet fuel to the engines.

Fuel Cooling Loop

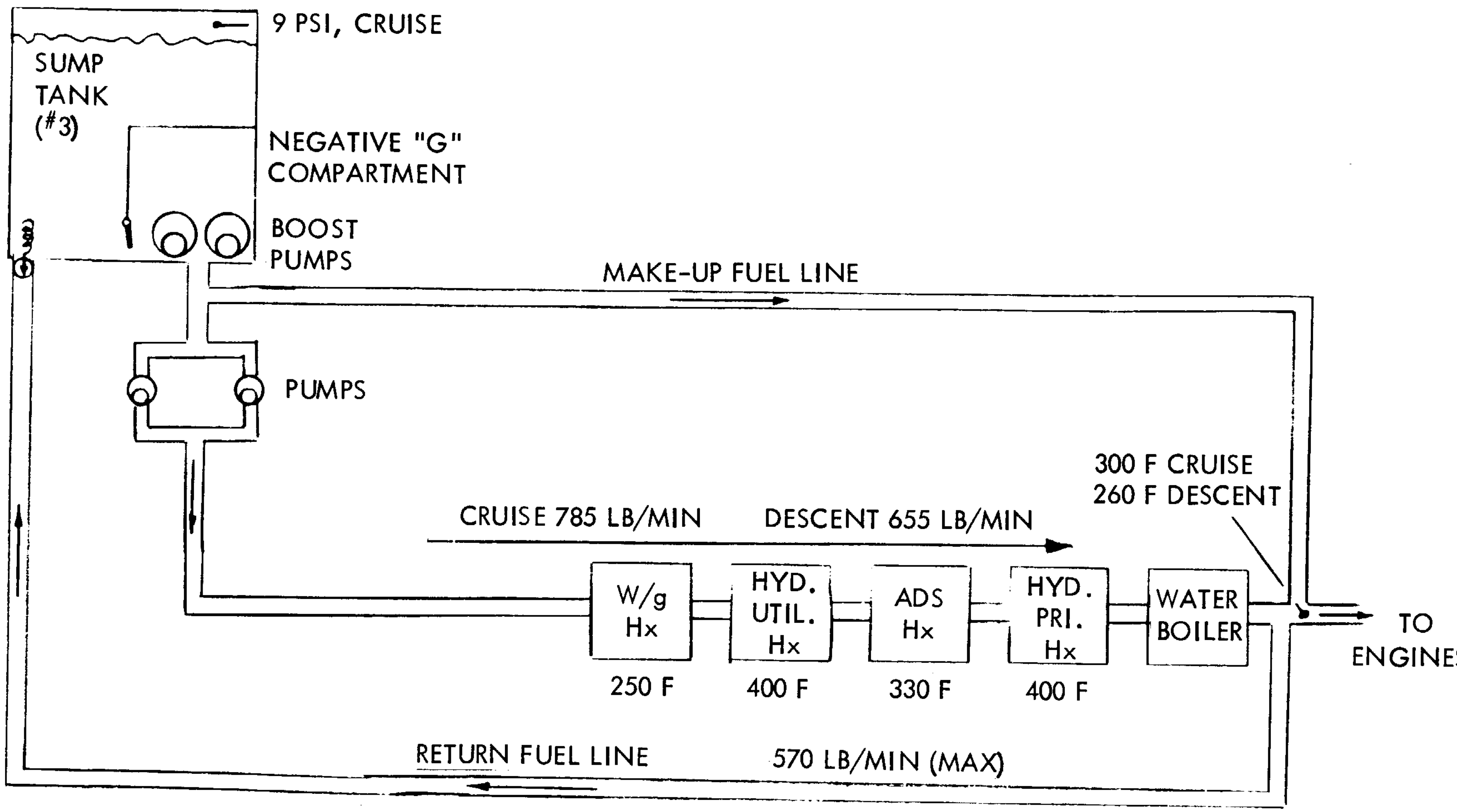


EXHIBIT 9

Average Heat Rejection Rates
Fuel Cooling Loop - BTU/min

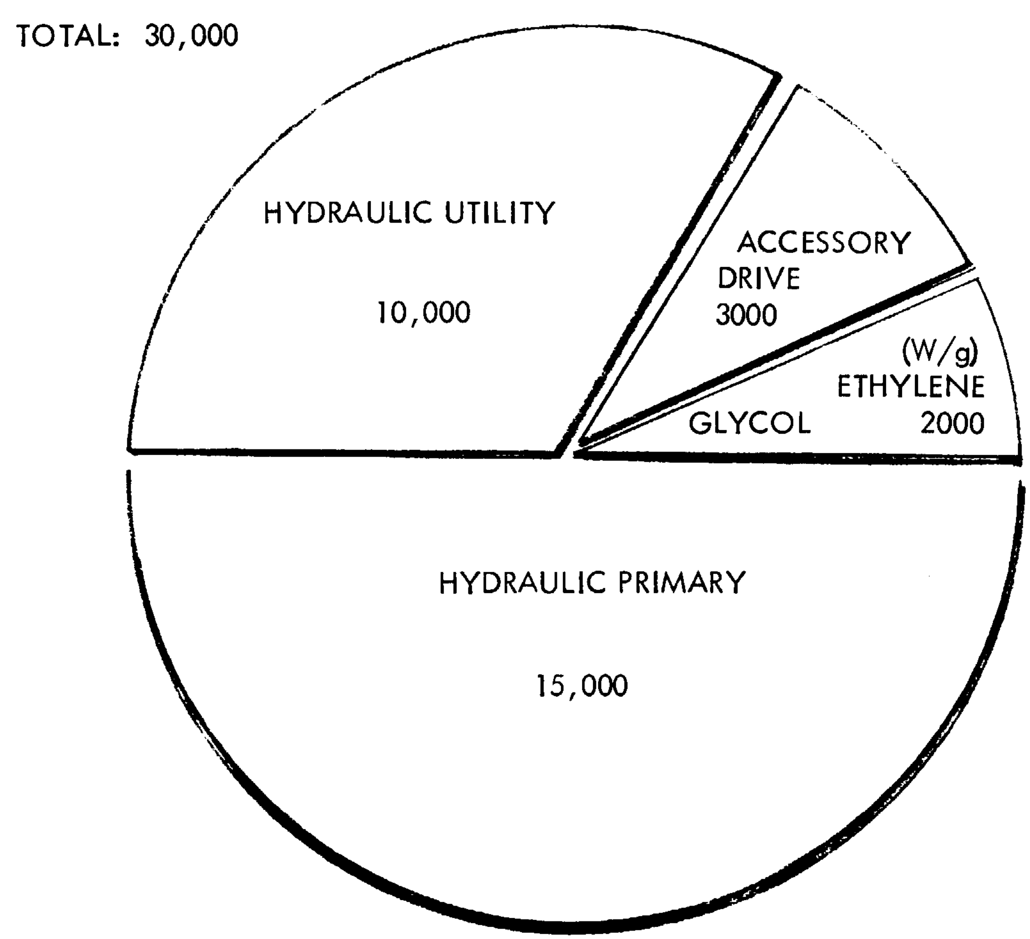


EXHIBIT 10

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: ENGINE INLET FUEL COOLING (FUEL HEAT SINK) WBS CODE: 1.2.5

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
HEAT SINK	TYPE	JP-6 FUEL WATER	JP-6 FUEL WATER →	→	→	→
HEAT EXCHANGER	TYPE/NO.	FREON TO FUEL /1	-	-	-	-
		W-G TO FUEL /2	W-G TO FUEL /1 →	→	→	→
		AIR TO W-G/1	-	-	-	-
		FUEL TO WATER/1	FUEL TO WATER/1 →	→	→	→
		HYD TO FUEL /2	HYD TO FUEL /2 →	→	→	→
MEDIUM DESIGN PRESSURE	PSI	30 →	→	→	→	→
MEDIUM FLOW RATE (FUEL)	LB/HR	57,000	49,000 →	→	→	→
HEAT LOAD REJECTION - MAX	BTU/HR	3×10^6	2×10^6 →	→	→	→
RELIABILITY FACTOR	NONE	.99998	.99998	.99998	.99997	.99997
MTBF	NO. OF HR.	50,000	50,000	50,000	33,333	33,333

TECHNICAL DESCRIPTION

SUBSYSTEM: ENVIRONMENTAL CONTROL SUBSYSTEM — WBS CODE: 1.2

MAJOR ASSEMBLY: WINDSHIELD AIR GAP FILTERING AND DRYING SUBSYSTEM — WBS CODE: 1.2.6

A circulating air system was provided to ventilate the air gap compartment between the movable and fixed windshields. The air was filtered and dried using special filters and drying agents to prevent foreign particles or moisture from being introduced and settling on the glass surface. Exhibit 11, III-365 presents a schematic of the system showing its major components and cockpit panel control for the condition of windshield full extended (or "up").

As stated under Structures Subsystem (WBS 1.1), the crew compartment windows were made up of an outer-pane and an inter-pane. The air gap filtration and drying system dehumidified and filtered the air for the space between the crew compartment side window panes and between the extendable windshield and the crew compartment front panes. When the nose ramp was extended or during air vehicle descent, air entered the system from the forward nose compartment through a filter, a desiccant, and into the nose ramp compartment. A backup path was provided bypassing the desiccant in the event the desiccant restricted flow. Air was expelled into the nose compartment through a check valve when the nose ramp was retracted or during air vehicle ascent. From zero to 25,000 ft., the air in the nose ramp compartment could be circulated by a fan through a second desiccant by the option of the crew: above 25,000 ft. an arming circuit disconnected power to the fan. The second desiccant also dehumidified and filtered the air to the crew compartment side windows. The system was designed to have a dew point of -30°F with a capacity of 25 ramp oscillations.

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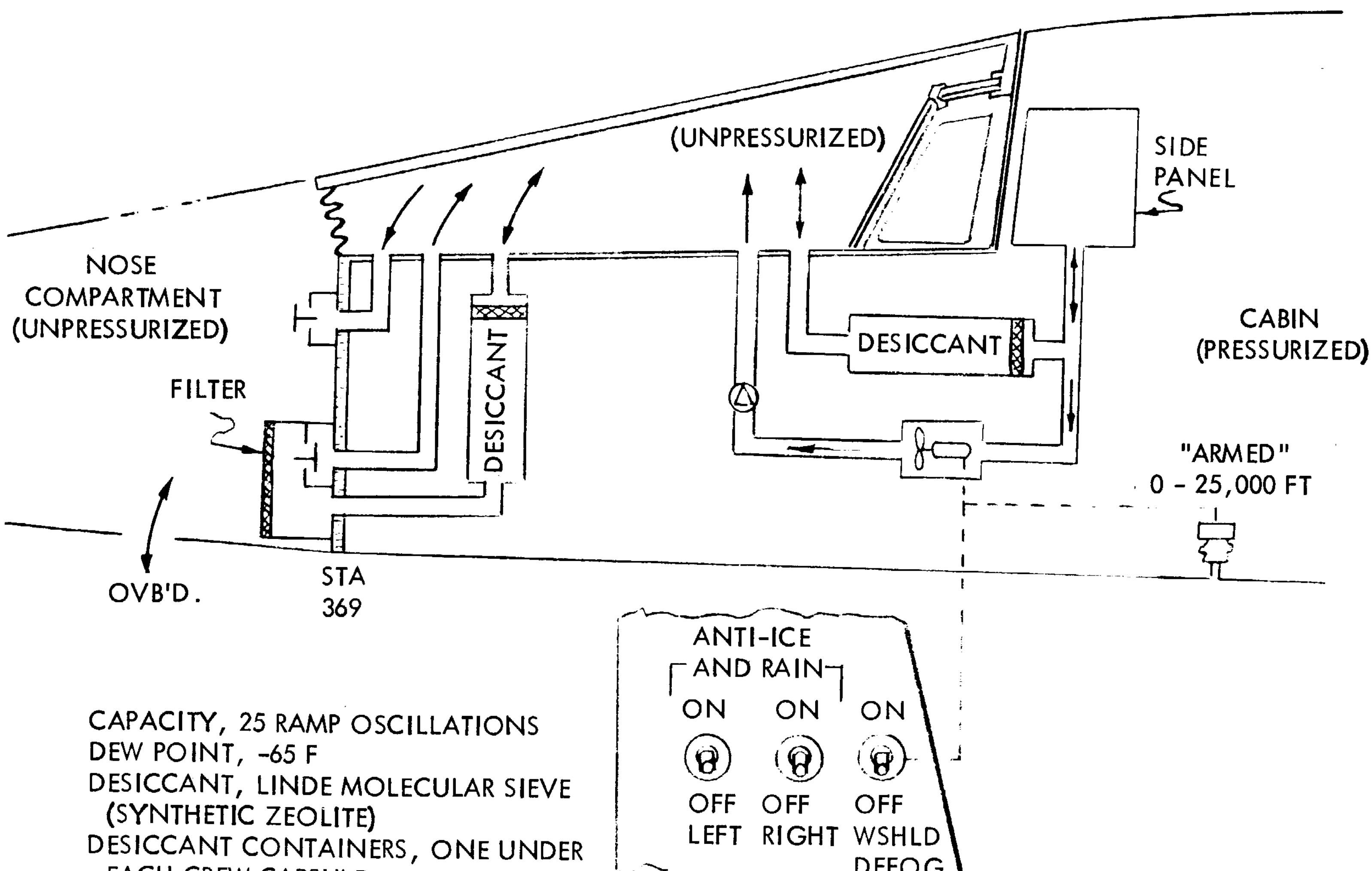
Windshield Air Gap Drying and Filtration



CAPACITY, 25 RAMP OSCILLATIONS
DEW POINT, -65 F
DESICCANT, LINDE MOLECULAR SIEVE (SYNTHETIC ZEOLITE)
DESICCANT CONTAINERS, ONE UNDER EACH CREW CAPSULE

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: W/S AIR GAP FILTER/DRYING WBS CODE: 1.2.6

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
FILTERS	TYPE/NO.	WIRE MESH/1 FELT PAD/2	→	→	→	→
DESICCANTS	TYPE/NO.	ZEOLITE/2	→	→	→	→
TEMPERATURE - DESIGN RANGE	DEGREES F	-65 TO 460	→	→	→	→
HUMIDITY CONTROL	% BY WT. DEW POINT °F	12.0 -65	→ -65	→ -30	→ -30	→ -30
RELIABILITY FACTOR	NONE	-	-	.99928	.99928	.99975
MTBF	NO. OF HR	-	-	1390	1390	4000

TECHNICAL DESCRIPTION

SUBSYSTEM: ENVIRONMENTAL CONTROL SUBSYSTEM WBS CODE: 1.2

MAJOR ASSEMBLY: ENGINE EXTRACTION AIR DUCT SYSTEM (EEADS) WBS CODE: 1.2.7

The EEADS routed high temperature-pressurized engine air from the final stage of compression of the four inboard engines forward through the air vehicle to support the following functions:

1. Freon compressor drive.
2. Cabin pressurization and ventilation.
3. Crew compartment heating.
4. Secondary pressurization.
5. Water storage tank pressurization.
6. Water flash tank ejector.
7. ECS equipment cooling.
8. Windshield rain removal and anti-icing.
9. Power pneumatic actuated valves.
10. Hydraulic replenishing system pressurization.

The final stage pressurized air from the four inboard engines was routed forward through the upper deck area; fuel tanks 4, 3, 2 and 1; the ECS equipment compartment; the electronic equipment compartment; and under the cabin floor to the nose area. Exhibit 12, Page III-369 presents a schematic of the EEADS showing the major subsystem support requirements. The engine compartment contained the ducting between the engine extraction ports and the horizontal firewall. This ducting connected to the lower right-hand port of engines #2, #3, #4 and #5, extracting the air from the final stage of engine compression. A check valve was incorporated downstream of each engine discharge to prevent reverse flow to a malfunctioned engine. Flow limiting nozzles in each extraction air port elbow prevented excess flow in the event of a duct malfunction. The engine extraction air from each of the four engines was routed forward along the engines and upward to join a cross-ship manifold to a main supply duct. The upper deck area included the portion of the main supply duct between the elbow assembly at fuselage station 2036 and the bulkhead at fuselage station 1838. The main shut-off valve was incorporated in this section of ducting at fuselage station 2024. See Exhibit 19, Page III-390 under Technical Innovations for details of main supply duct.

The main EEADS supply duct was routed through fuel tanks #4, #3, #2 and #1 which were located between fuselage stations 1838 and 8575. The duct in this area was insulated to minimize the heat transfer to the fuel in the tanks. The insulated ducting was enclosed in a conduit using double-walled construction. The main supply duct, immediately forward of fuselage station 796, divided into three main branches as follows:

1. A high temperature branch which provided unconditioned high temperature engine extracted air for crew compartment heating, windshield rain removal, and anti-icing.

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2. A portion of the high temperature air was routed through the bleed air-to-water heat exchanger. This branch was used for cabin pressurization, ECS pneumatically powered valves, and the hydraulic replenishing system pressurization.

3. A portion of the cooled air discharged from the bleed air-to-water heat exchanger was mixed with the hot air that bypassed the heat exchanger to provide a moderate temperature air. This branch provided air for use in the Freon turbine-driven compressor and the steam ejector for the water flash tank. This branch of air was limited to a temperature range of 750° to 850°F by controlling the quantity of hot extraction airflow through the heat exchanger bypass line. The temperature control valve modulated the bypass airflow in response to the temperature downstream of the mixing point.

A protection system was provided to detect leakage of extraction air from the main supply duct into the upper deck area, fuel tank area, ECS compartment, and equipment compartment. The system consisted of pressure switches, a caution light, a manual switch on the pilot's panel, and the main EEADS shut-off valve. (See Exhibit 19, Page III-390 under Technical Innovations for duct sensor details). If the pressure increased one psi above ambient pressure in the upper deck area or the fuel tank area conduit, the shut-off valve closed and shut off the flow of engine extraction air. If the pressure increased one psi above the canard compartment pressure, the ECS compartment, or the equipment compartment, a caution light illuminated in the pilot's panel. A manual switch was provided for closing the main shut-off valve or for reopening the valve if anomaly was in the ECS or equipment compartments.

Engine Extraction Air Duct System (EEADS)

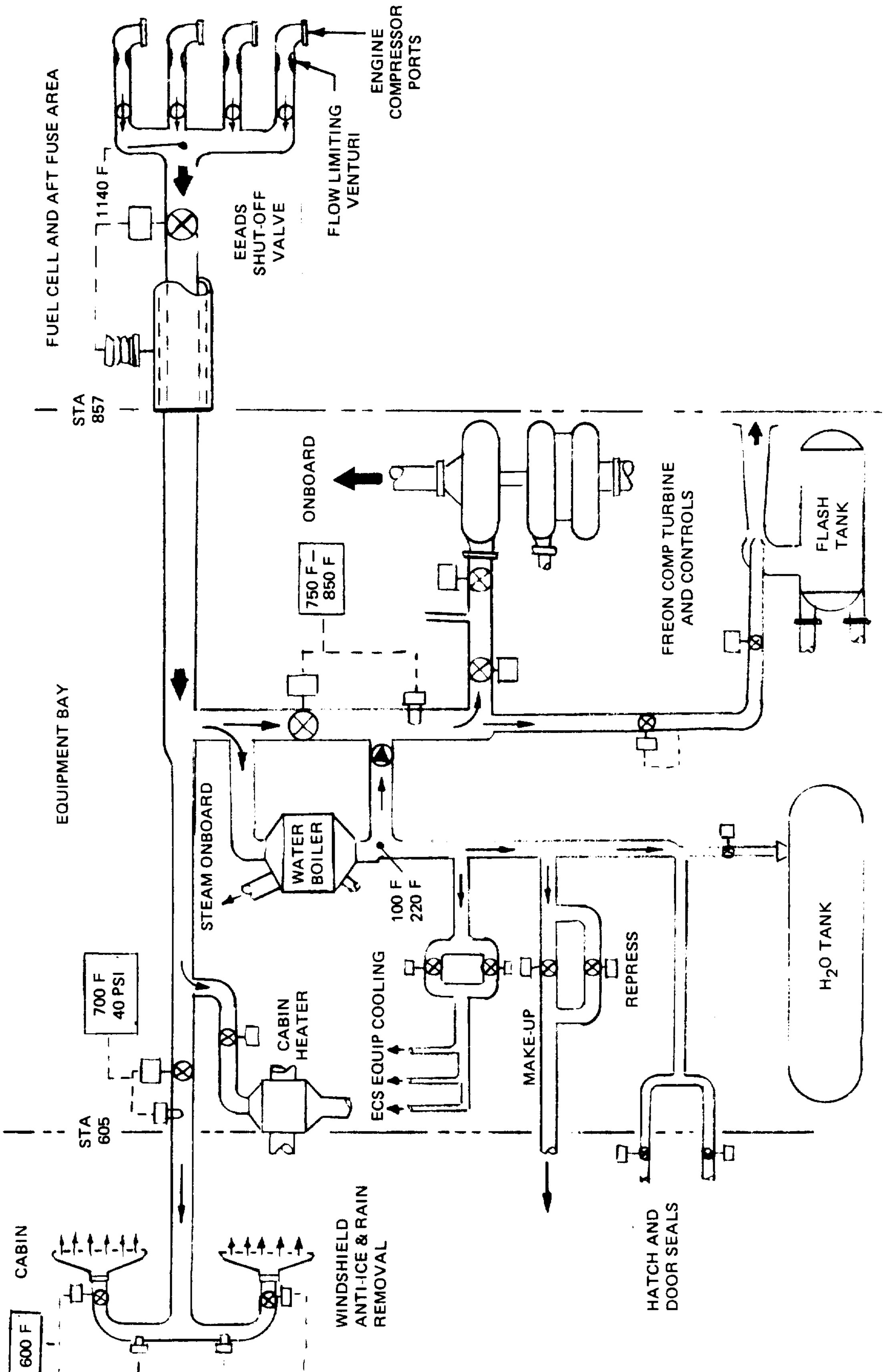

EXHIBIT 12

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: ENGINE EXTRACTION AIR WBS CODE: 1.2.7

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
AIR EXTRACTION PRESS. - MAX	PSIA	180 →	→	→	→	→
AIR FLOW - DESIGN MAX	LB/HR	27,000	34,000 →	→	→	→
TEMPERATURE - DESIGN RANGE	°F	100 TO 1140 →	→	→	→	→
HEAT SINK	TYPE	W/G	WATER →	→	→	→
HEAT EXCHANGERS	TYPE/NO.	AIR TO W-G/1	AIR TO WATER/1 AIR TO AIR/1 →	→	→	→
HEAT REJECTION	BTU/HR	60,000	165,000 →	→	→	→
RELIABILITY FACTOR	NONE	-	-	.99906	.99867	.99867
MTBF	NO. OF HR.	-	-	1065	750	750

TECHNICAL DESCRIPTION

SUBSYSTEM: ENVIRONMENTAL CONTROL SUBSYSTEM WBS CODE: 1.2

MAJOR ASSEMBLY: RECIRCULATION LIQUID COOLING LOOP WBS CODE: 1.2.8

A liquid recirculation loop was employed to maintain the temperature of the drag chute, main and nose landing gear tires, the electromechanical AIC trim actuators and for the primary flight control cooling shield, such that, the temperature limits of the protected components were not exceeded. Exhibit 13, Page III-372 presents a schematic of the liquid cooling loop showing the routing of the coolant lines and the areas of the air vehicle covered. Exhibit 18, Page III-389, under Technical Innovations, shows the construction details of the cooling wall panels.

Heat removed from the cooled areas was transported to a JP-6 fuel heat sink exchanger by the liquid coolant (See Exhibit 9, Page III-361 for heat exchanger location in fuel cooling loop). The liquid coolant was a solution of ethylene glycol and inhibitors, in accordance with Union Carbide Co. PM2251, mixed with demineralized water. The liquid coolant was recirculated by a coolant recirculation pump and electric motor assembly from a coolant reservoir to the cooled areas and through the coolant-to-fuel heat exchanger before returning to the coolant reservoir.

Exhibit 14, Page III-373 presents a graph showing the relationship of tire sidewall, cooling panel, and sump fuel temperatures versus mission events. During the "taxi-out" and take-off under heavy loading conditions, the flexing of the tires resulted in a sharp rise (and peak) in tire sidewall temperatures. After take-off, due to the influence of the cooling panel, the tire temperature dropped rapidly intersecting the cooling panel temperature shortly after start of cruise. As shown by the graph, the three temperatures essentially followed the same trend until preparations for landing occurred.

Ethylene Glycol Cooling System

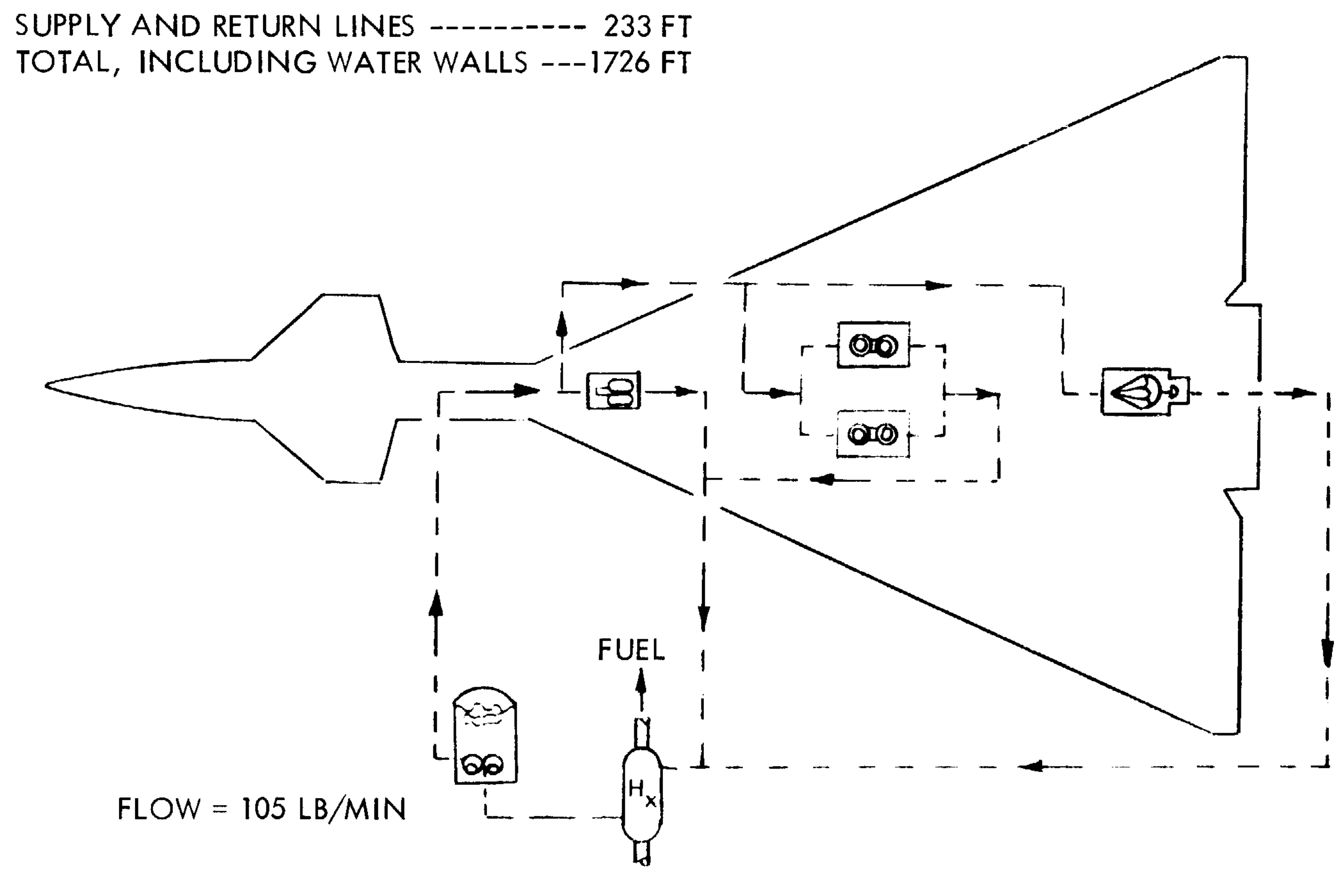

EXHIBIT 13

Tire Cooling System
Temperatures

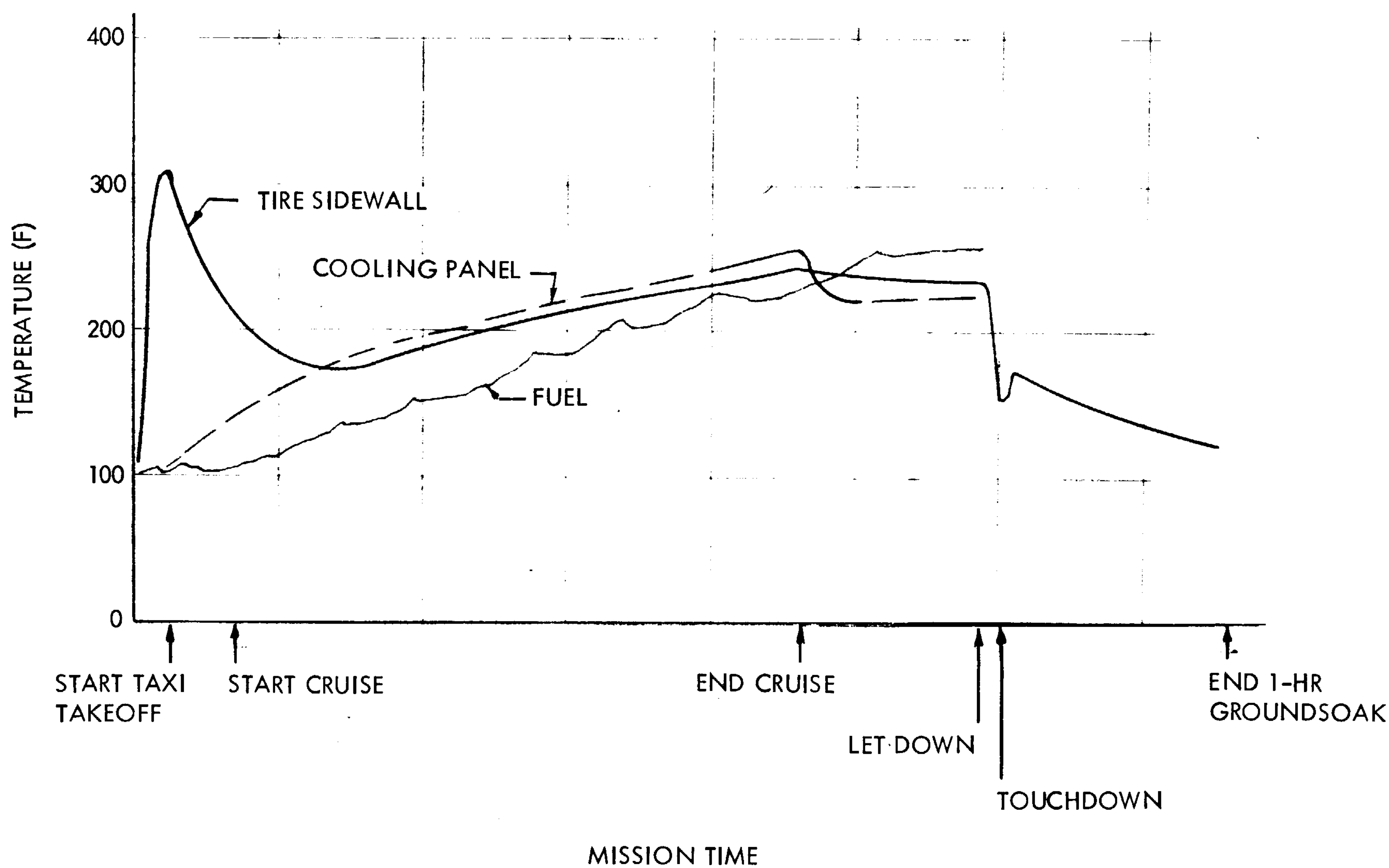

EXHIBIT 14

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: RECIRCULATION LIQUID COOLING WBS CODE: 1.2.8

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WATER/GLYCOL (W/G) VOLUME	LBS	290	64	→	→	→
TEMPERATURE - DESIGN RANGE	^{o}F	-35 TO 265	-35 TO 265	→	→	→
STATIC PRESSURE HEAD	PSIG	60	55	→	→	→
MEDIUM WORKING PRESS.	PSIG	300	108	→	→	→
HEAT EXCHANGERS	TYPE	W-G TO FREON /1	-	-	-	-
		W-G TO FUEL /2	W-G TO FUEL /1	→	→	→
		AIR TO W-G/7	-	-	-	-
		ELEC. TO W-G /1	AIR TO W-G /5	→	→	→
HEAT REJECTION - MAX.	BTU/HR	280,000	126,000	→	→	→
HEAT SINK	TYPE	JP-6 FUEL	JP-6 FUEL	→	→	→
		FREON	-	-	-	-
FLOW RATE	LB/HR	42,000	6,600	→	→	→
RELIABILITY FACTOR	NONE	-	-	.999512	.99931	.99931
MTBF	NO. OF HR	-	-	2,000	1,450	1,450

TECHNICAL DESCRIPTION

SUBSYSTEM: ENVIRONMENTAL CONTROL SUBSYSTEM WBS CODE: 1.2

MAJOR ASSEMBLY: REMOTE EQUIPMENT COOLING WBS CODE: 1.2.9

The remote equipment cooling described in this section covers the flight augmentation control (FACS) sensor and the air induction control (AICS) package. The flight test instrumentation package cooling will be discussed under WBS 1.11.

The FACS sensor unit was a small sealed box containing rate gyros and accelerometers. This unit was mounted on the aft side of fuselage station 1225 bulkhead within the confines of the nose landing gear cooling wall area. Cooling of the FACS unit was provided by ice and water stored in a cooler which surrounded the sensor unit. The cooler contained 15 pounds of ice premolded to fit the dimensions of the cooler and the sensor unit. After installation, 3 pounds of water at 70°F or lower was added to effect good thermal contact between the ice and sensor. The heat sink was designed to maintain component temperatures at 180°F or lower when the components were dissipating 30 watts. The sensor package-cooling was designed for continuous operation up to $8\frac{1}{2}$ hours under any combination of ground and flight conditions for atmospheric extremes of the XB-70.

The AICS package was installed in the aft weapons bay and contained AICS electronics, associated electrical distribution equipment, and a self-contained ECS. The ECS **utilized liquid nitrogen as the heat sink,** the package pressurization gas, and the pressurization gas for one set of door seals. The ECS also utilized a gaseous nitrogen bottle as the pressurization source for a second set of door seals and as a back-up system for package and LN_2 tank pressurization. The electrical and electronic equipment was cooled by blower recirculated nitrogen. A second recirculating system was installed which would provide all ECS cooling functions in the event of a malfunction of the No. 1 system. Sensors were included which monitored equipment cooling effect, package pressure, low equipment supply temperature, and LN_2 tank pressure. These sensors actuated the system controls and, in the event of a malfunction, took corrective action and the crew was informed by way of a light in the center console.

The AICS ECS maintained a temperature environment such that the temperature limits of the cooled components were not exceeded. It also maintained the package internal pressure equal to 8000 ft. altitude at all air vehicle altitudes above 8000 ft. In order to assure that enough LN_2 was boiled off to maintain package pressurization, heaters were installed which produced a nominal 1984 watts of heat.

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OF POOR QUALITY

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: REMOTE EQUIPMENT COOLING WBS CODE: 1.2.9

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
COOLING MEDIUM	TYPE	LN_2	ICE WATER GN_2 LN_2	ICE WATER GN_2 LN_2 } →	→	→
COOLING MEDIUM VOLUME	TYPE?LB	LN_2/100	ICE/15 WATER/3 LN_2/600	ICE/20 WATER/10 LN_2/2000 } →	→	→
STATIC PRESSURE HEAD	PSI	60	2,500 →	→	→	→
MEDIUM WORKING PRESS	PSI	60 →	→	→	→	→
HEAT EXCHANGER	TYPE	NA	AIR TO WATER /1 GN_2 TO LN_2 /1	AIR TO WATER /1 GN_2 TO LN_2 /2 } →	→	→
HEAT REJECTION	BTU/HR	6,000	31,000	79,400 →	→	→
HEAT SINK TYPE	TYPE	LN_2	ICE WATER LN_2	ICE-WATER WATER BOILER LN_2 } →	→	→
FLOW RATE (LN_2)	LB/HR	20	220	350 →	→	→
TEMPERATURE - DESIGN RANGE	DEGREES F	-	30 TO 100 →	→	→	→
COMPARTMENTS	TYPE	NA	ELEC. EQUIP →	→	→	→

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: REMOTE EQUIPMENT COOLING WBS CODE: 1.2.9

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
COMPARTMENT VOLUME	FT^3	NA	175	350 →	→	→

TECHNICAL DESCRIPTION

SUBSYSTEM: ENVIRONMENTAL CONTROL SUBSYSTEM WBS CODE: 1.2

MAJOR ASSEMBLY: RAIN REMOVAL AND DEFOGGING WBS CODE: 1.2.10

Rain removal and anti-icing of the left and right-hand external windshield were accomplished by a jet blast created by directing high temperature engine extraction air through nozzles across the outer surfaces of the windshield from the forward edge. (See Exhibit 12, Page III-369 for the EEADS schematic showing the rain/anti-icing nozzles.) Rain removal provisions were capable of maintaining clearance of either forward windshield panel during take-off, GCA approach, landing, and taxiing in heavy rain as defined in table C.6-3 of AFSCM 80-1. Anti-icing of the windshields **was** provided in accordance with MIL-T-5842.

The engine extraction air was supplied from the high temperature branch of the engine extraction air duct system. It was routed under the equipment compartment and cabin floors to the nose section where it branched into two ducts; one each routed to the left and right-hand windshield nozzles. The ducting in the nose compartment from the cabin forward bulkhead (STA 369.5) had three restrained flexible sections in a loop configuration to provide for raising and lowering of the windshield. Rain removal shut-off valves were incorporated in each branch of the nose compartment ducting just upstream of the nozzles. Temperature switches in the duct actuated the shut-off valves to limit the air temperature to 600°F maximum.

A windshield antifogging system was provided on the pilot's and copilot's fixed side windshield and fixed front windshield. This system supplied heat to the windshields to prevent the formation of moisture in accordance with MIL-T-5842. A Transparent electrical heating film was inlaid within the laminated glass panels. Electrical power was turned on by a manual switch and temperature sensing switches controlled the power supply to maintain the surface temperature within limits.

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: RAIN REMOVAL/DEFOGGING WBS CODE: 1.2.10

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
OPERATIONAL MEDIUM	TYPE	AIR →	→	→	→	→
OPERATIONAL PRESS	PSI	28 →	→	→	→	→
FLOW RATE	LB/HR	20,000 →	→	→	→	→
POWER	WATTS	916	380 →	→	→	→
TEMPERATURE - DESIGN RANGE	DEGREES	40 TO 750 →	→	→	→	→
RELIABILITY FACTOR	NONE	-	-	.999675	.99954	.99954
MTBF	NO. OF HR.	-	-	3080	2180	2180

TECHNICAL DESCRIPTION

SUBSYSTEM: ENVIRONMENTAL CONTROL SUBSYSTEM WBS CODE: 1.2

MAJOR ASSEMBLY: GROUND TESTS WBS CODE: 1.2.11

General

The crew compartment had to provide a "shirt sleeve" environment so that the crew members could readily perform their tasks. Because of the 470°F outside surface temperature and the problem of insulation thickness on the inside of the wall, early studies showed conventional air distribution methods would result in velocities over the crew that would be intolerable for the mission time period. Therefore, a means of intercepting the aerodynamic heat had to be developed.

The large quantity of fuel on board the B-70 represented a very attractive potential heat sink which, if used, would result in a substantial weight reduction when compared to an all water heat sink. If the maximum temperature of the fuel was 103°F (the equivalent of standing 10 days in a desert environment) and the maximum engine fuel inlet temperature was 300°F, a potential of 200°F differential could be used for cooling purposes amounting to approximately 35,000,000 BTU's. This development program and the crew compartment environment development program are discussed in subsequent paragraphs.

Discussion

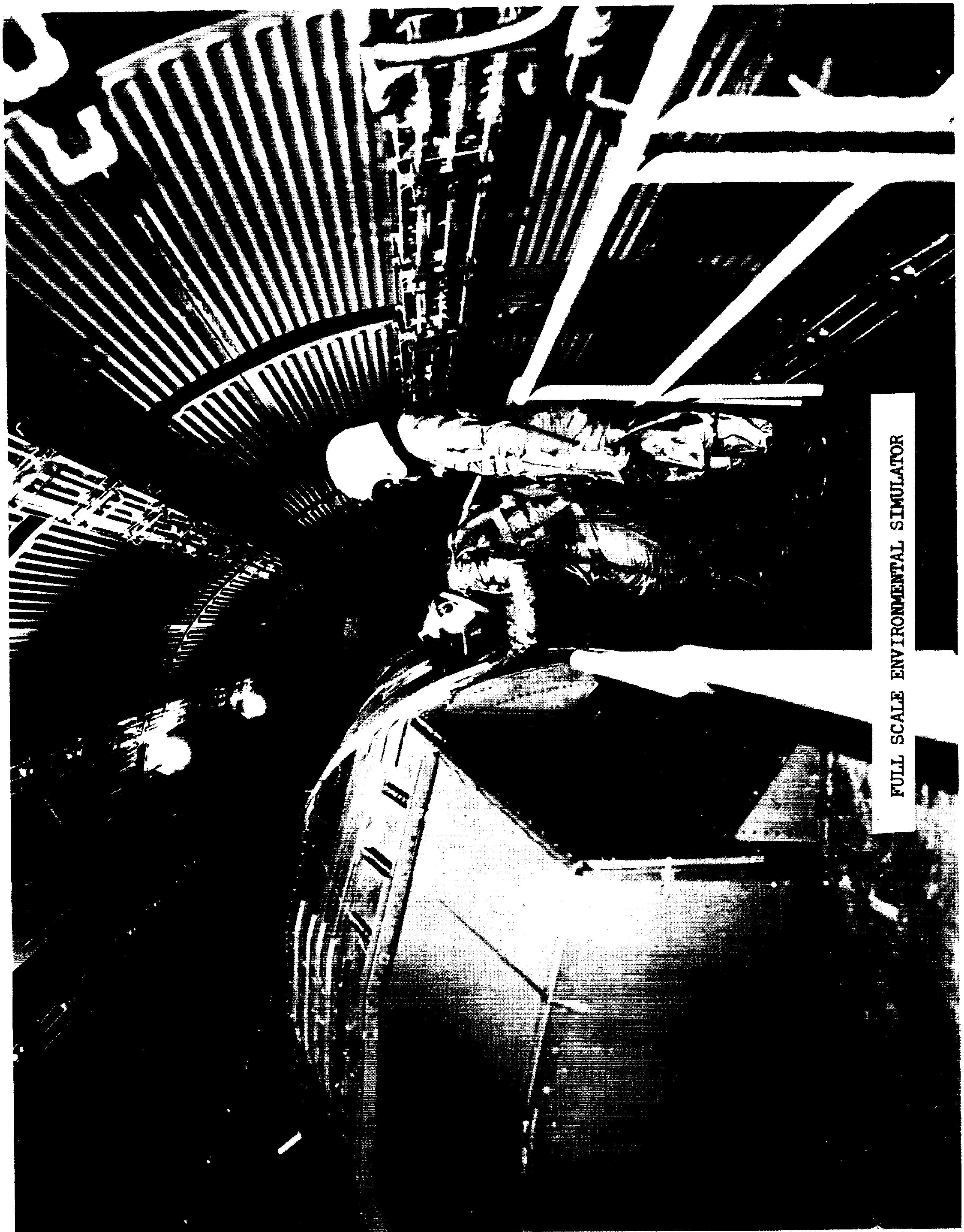
Crew Compartment: Extensive analytical studies showed that the aerodynamic heat that would come through the walls could be intercepted by applying the transpiration cooling principles to the compartment walls. This design would intercept the aerodynamic heat and deliver it to the cooling system before it reached the crew. Extensive laboratory tests were performed to develop a practical means of applying the transpiration cooling principle. Feasibility heat transfer tests were first performed with "T-wall" panels representing several possible construction methods. The final configuration consisted of an aluminum sheet 0.010 inches thick perforated with fifty 0.010 holes per square inch (See Exhibit 16, Page III-387 under Technical Innovations).

After demonstrating a transpiration wall to be practical, a section of fuselage, the diameter of the crew compartment and 8 ft. long, was constructed and tested with human occupants to verify the basic design criteria. Subsequently, a full size environmental simulator was designed and constructed to determine full scale heat loads and to evaluate crew comfort. See Exhibit 15, Page III-382.

Fuel Heat Sink: Preserving and utilizing the fuel as a heat sink required minimizing the aerodynamic heat flux into the fuel tank areas. Early in the B-70 program it was determined that brazed honeycomb sandwich construction was optimum with respect to weight, strength and insulating characteristics. The extensive effort expended in the honeycomb panel development is described under Airframe Structures Subsystem: WBS 1.1.

The fuel heat sink was further conserved by optimizing the fuel sequencing so that, within the air vehicle CG requirements, the fuel was used first from tanks with the higher aero heating rates. To establish the optimum sequencing, a substantial number of test hours were expended on the fuel simulator to determine valving, transfer rates, available and unavailable fuel, fuel temperatures, ullage inerting gas effects, and the criteria for shielding and insulation of hydraulic lines and equipment located in the fuel tanks.

Several means of applying the fuel heat sink were evaluated by analysis and tests. The most effective arrangement developed was to pass the fuel through a series of liquid to liquid heat exchangers which rejected the heat from the various heat generating subsystems. Sizing and arrangement of the heat exchangers and determination of supplemental engine inlet fuel cooling required the accumulation of a vast amount of analytical and test data, i.e., mission profiles, geometries of tanks, material properties, line routing, fuel sequencing, fluid system flows, efficiencies and duty cycles. Computing programs were developed for maximum utilization of the data in optimizing the heat disposal systems.


FULL SCALE ENVIRONMENTAL SIMULATOR

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: GROUND TESTS WBS CODE: 1.2.11

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
TOTAL SPECIMENS	NO.	12	50	50	15	-
MAJOR ASSEMBLIES	TYPE/NO.	-	-	DUCT SYS/1 BLOWER/1 HEAT EXCH/2	DUCT SYS/1 VALVES/2 HEAT EXCH/1 EQUIP PKG/3 RAM SCOOP/1 PRESS SYS/2	-
MODELS	TYPE/NO.	0	SIM FLT STA /1 EQUIP. COMPT /1 CABIN WALL/1	SIM FLT STA /1 EQUIP COMPT /1 CABIN WALL/1	FWD FUS/1 WINDSHIELD/1 RAM SCOOP INSTL./1	-
FACILITIES	TYPE/NO.	THERMO LAB/1	THERMO LAB/1 MECH LAB/1 PLASTIC SHOP /1 VIBRATION/1 MAT'LS LAB/1	THERMO LAB/1 HYD LAB/1 PLASTIC SHOP /1 ACOUSTIC LAB /1 MATLS LAB/1	THERMO LAB/1 HYD LAB/1 ALT CHAMBER /1 WIND TUNNEL /1 FLT LINE/1 MECH LAB/1	-
HEAT TRANSPORTS	TYPE	AIR FREON W-G FUEL WATER	AIR FREON W-G FUEL WATER GN_2	AIR FREON W-G FUEL WATER GN_2 AMMONIA	→ (same as February 1961)	-

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: GROUND TESTS WBS CODE: 1.2.11

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
TIME	HR	200	4,000	5,700	800	-
TESTS — TYPE	NO.					
THERMODYNAMIC		12	12	20	6	-
ENVIRONMENT SIMULATOR			15	5	20	
FLUID DYNAMIC			15	15	6	
AERODYNAMIC					2	
STRUCTURAL		2	12	13		
AUDIBLE NOISE				1	1	
MAT'L. DEVELOPMENT		5	15	15		
OTHER			6	10	2	
MEASUREMENTS (DATA)	TYPE	TEMP PRESS FLOW	TEMP PRESS FLOW ALTITUDE TIME	→	→	-
ACCURACY (DATA)	% OF FS	± 2	→	→	→	-
INTERNAL PRESS. LEVELS	PSIG	0 - 2500	0 - 300	0 - 2500	→	-
EXTERNAL PRESS. LEVELS	PSIA	1.0 - 14.7	→	→	→	-
TEMPERATURE RANGES	DEGREES F	-65 TO 1140	→	→	→	-

TECHNICAL INNOVATIONS

TITLE: ENVIRONMENTAL CONTROL SUBSYSTEM WBS CODE: 1.2

During the B-70 development program, the state-of-the-art was advanced considerably in the control of environments with the design based on exact natural operational criteria instead of the general extremes as had been the case on previous air vehicles. The "major breakthroughs" 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. Transpiration wall and air distribution concept: The problem of a high aerodynamic heat load on the B-70 environmental control system was significantly mutated by the development of the transpiration wall. With a 470°F outside surface temperature and the practical thickness of insulation that could be placed on the inside surface of the crew compartment walls, existing conventional air distribution methods would have resulted in excessive air velocities over the crew and inter-compartment movement would have been limited. With the development of the transpiration wall, the compartment wall temperatures were lowered, internal air velocities were reduced and thermodynamic cycle efficiency was improved since this technique intercepted most of the aerodynamic heat before it reached the crew compartment. Exhibit 16, Page III-387 presents a cross section of the crew compartment and the principle of transpiration wall cooling. This concept provided crew compartment "shirt sleeve" environment and allowed the crew members to perform their tasks throughout the mission envelope without the use of cumbersome clothing and equipment.

2. Flood flow principles and techniques: The use of a flood flow ram scoop to utilize the ram pressure at high air vehicle velocities for emergency pressurization of the crew and electronic equipment compartment was pioneered on the B-70. In the event of prime system failures, this emergency back-up system provided compartment pressurization and air flow until the air vehicle was decelerated (cooled) and descended in altitude. Principle design problems resolved were the techniques for controlling the shock wave at the scoop inlet and the requirement of rapid extension and retraction of the supersonic scoop. Exhibit 17, Page III-388 presents a schematic of the flood flow ram air scoop showing the shock pattern and air flow at supersonic speeds.

WBS CODE: 1.2

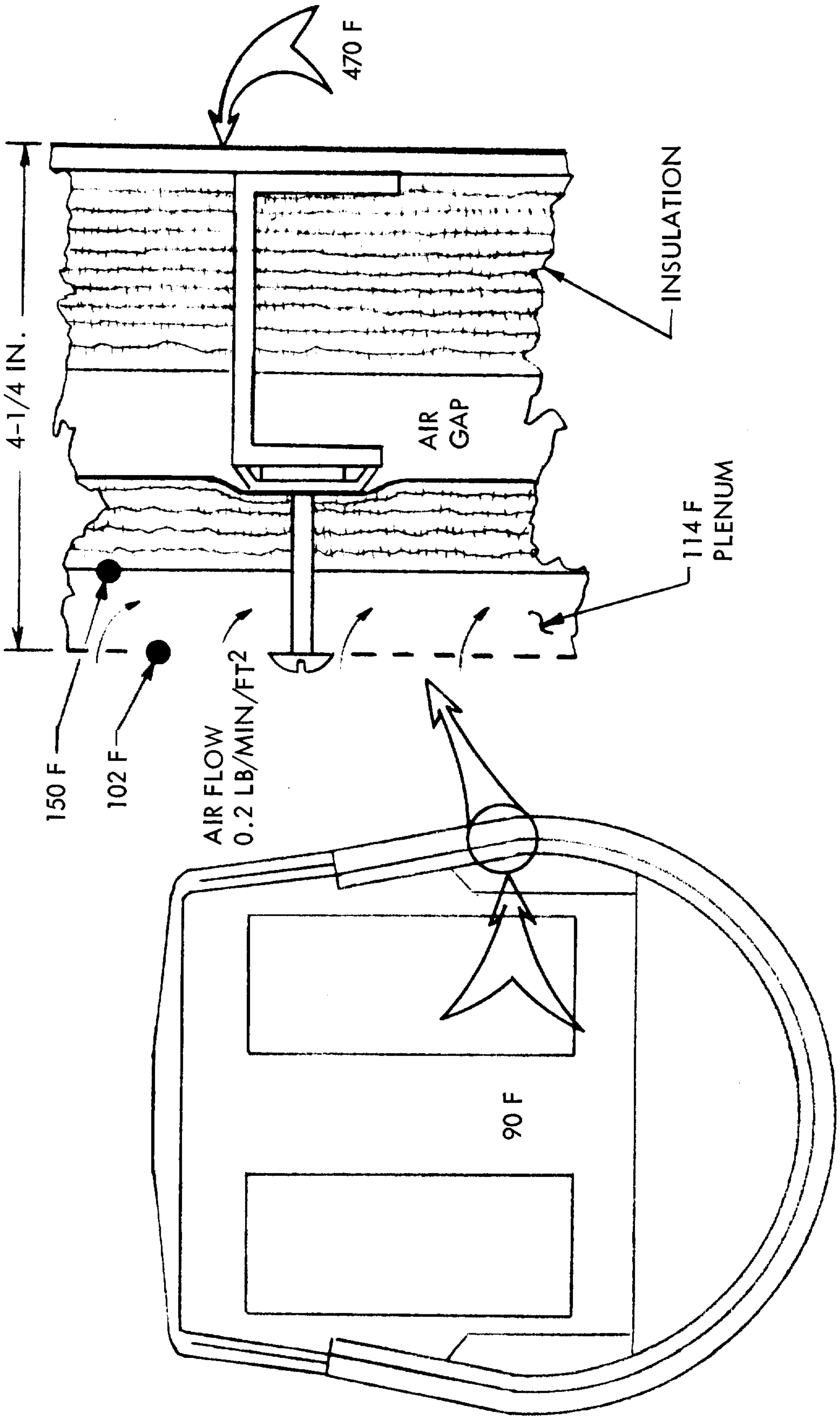
3. Liquid cooling of compartment walls: An intermediate temperature range system was developed which used a liquid transport fluid that was directly cooled by the air vehicle fuel. This system, which cooled the walls of the landing gear, drag chute, and the area of the inlet throat trim actuators, required new concepts in terms of integrally cooled walls and system components. Exhibit 18, Page III-389 presents a schematic of the drag chute compartment showing the "rollbond" cooling panel installation.

4. High temperature/pressure duct: A minimum weight duct was developed for extracting high pressure - high temperature air from the engine bleed ports and distributing it to the using equipment in the air vehicle. This duct extended nearly the full length of the air vehicle and was double walled with sensors between the walls to detect leaks. The duct design incorporated new concepts for thermal expansion compensation and insulation. Exhibit 19, Page III-390 presents a schematic of the engine air extraction duct installation showing method of insulation, sensors, and overboard venting. Temperatures shown are typical of those experienced when the engines were at 100% RPM.

5. Safety heat exchanger design for ammonia: On the XB-70, ammonia was used for auxiliary cooling of the crew and equipment compartment air by means of a heat exchanger. Since ammonia fumes had to be prevented from leaking into the compartments, a heat exchanger design was developed with double seams. The space between the seams was vented to ambient and thereby positively prevented any ammonia from entering the compartments' supply of air. See Exhibit 6, Page III-354.

6. Fuel as heat sink: The entire aerodynamic heat load due to flying at Mach 3, the 240 KVA heat rejection of the electrical and electronic equipment, and up to 2000 HP of hydraulic power heat rejection was absorbed almost entirely by the engine fuel as a heat sink. If existing state-of-the-art heat sink methods had been employed, many tons of water would have been required on the B-70 to provide a heat sink. Exhibit 20, Page III-391 presents the heat sink capacities of the XB-70 air vehicle.

Cabin Environmental Control
Transpiration Wall Principle



Flood Flow RAM Air Scoop

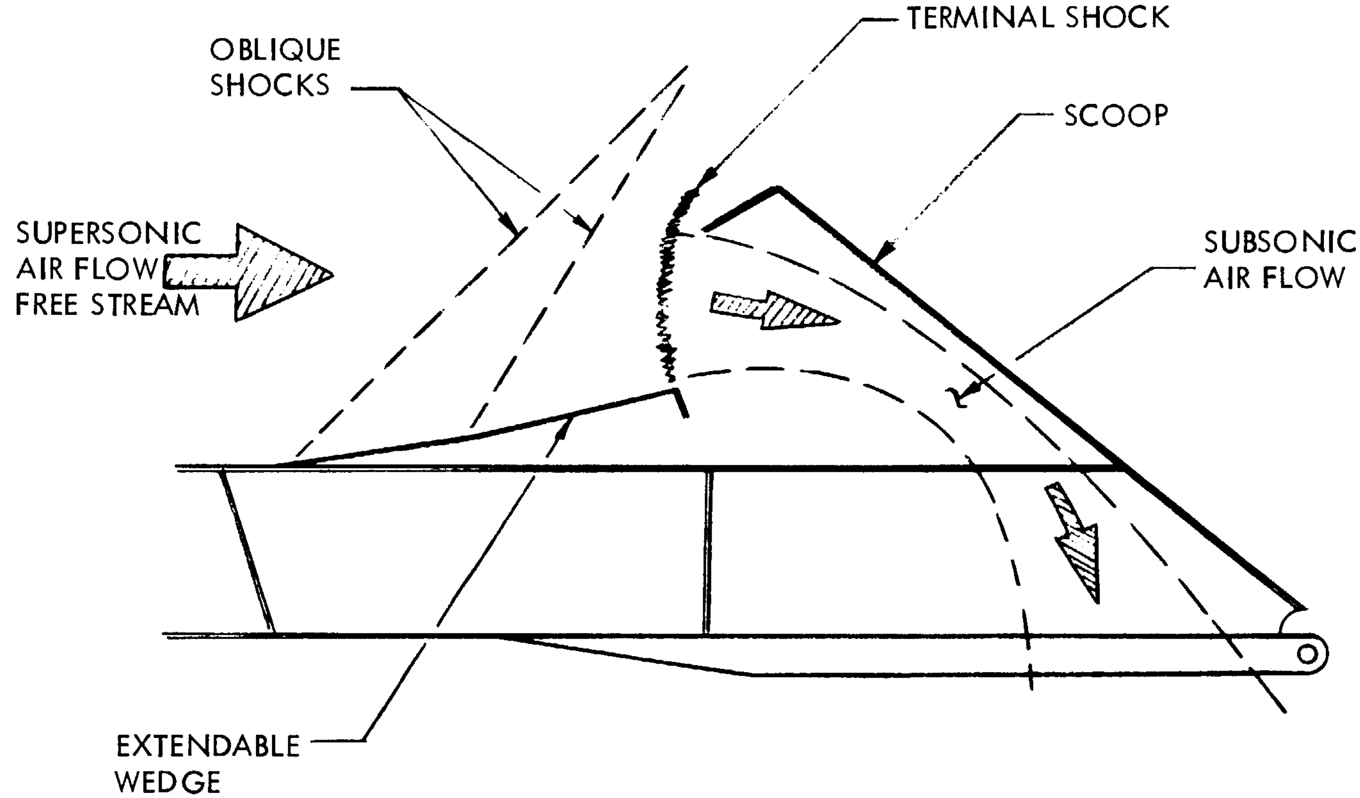


EXHIBIT 17

Drag Chute Cooling
Liquid-Cooled Compartment Walls

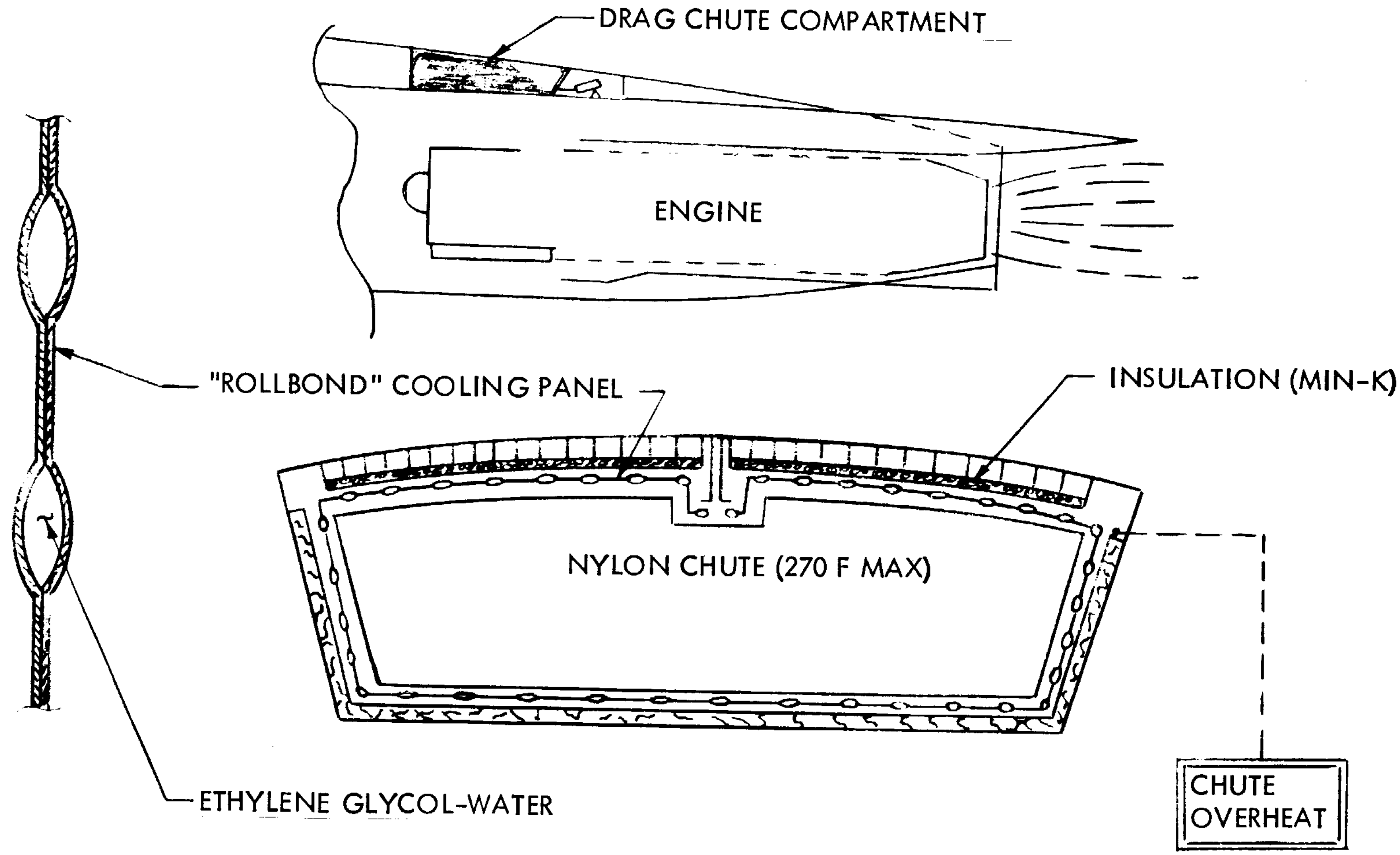
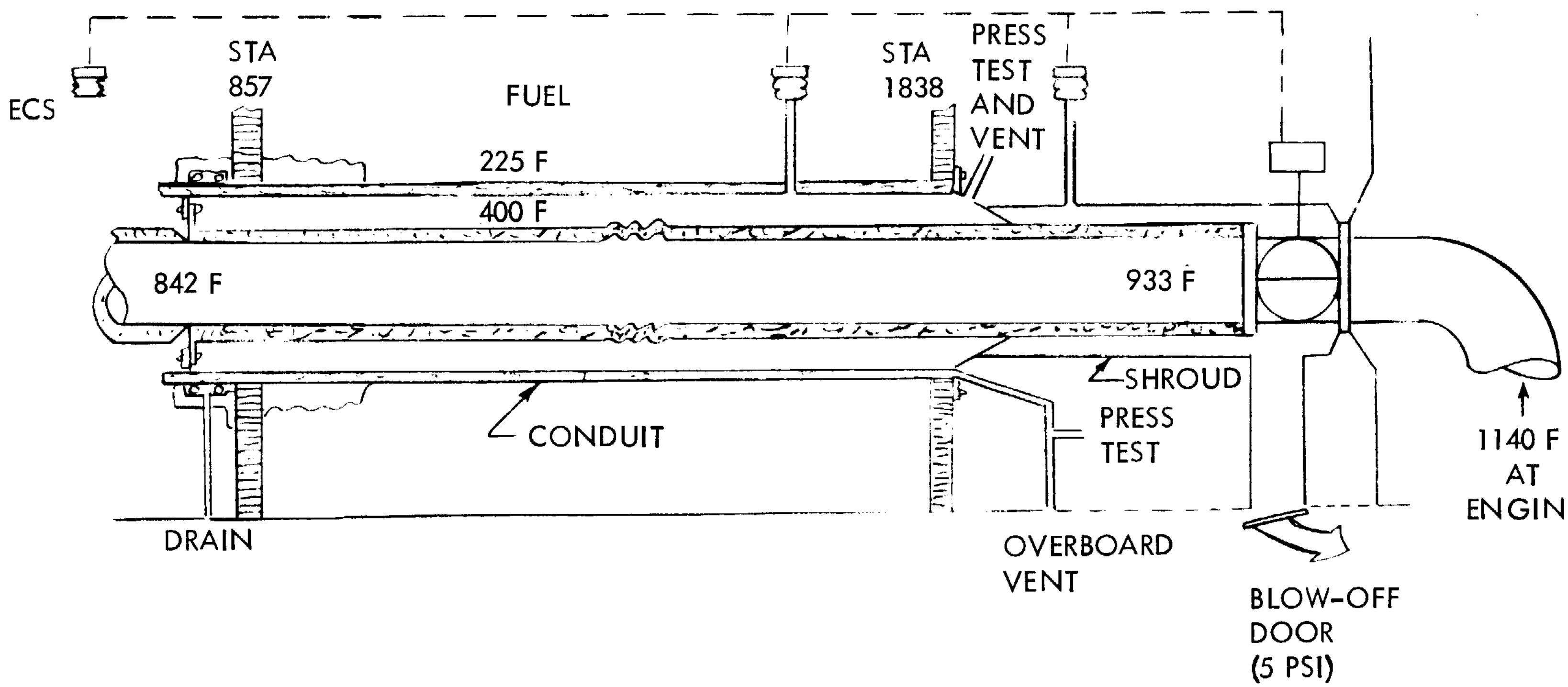
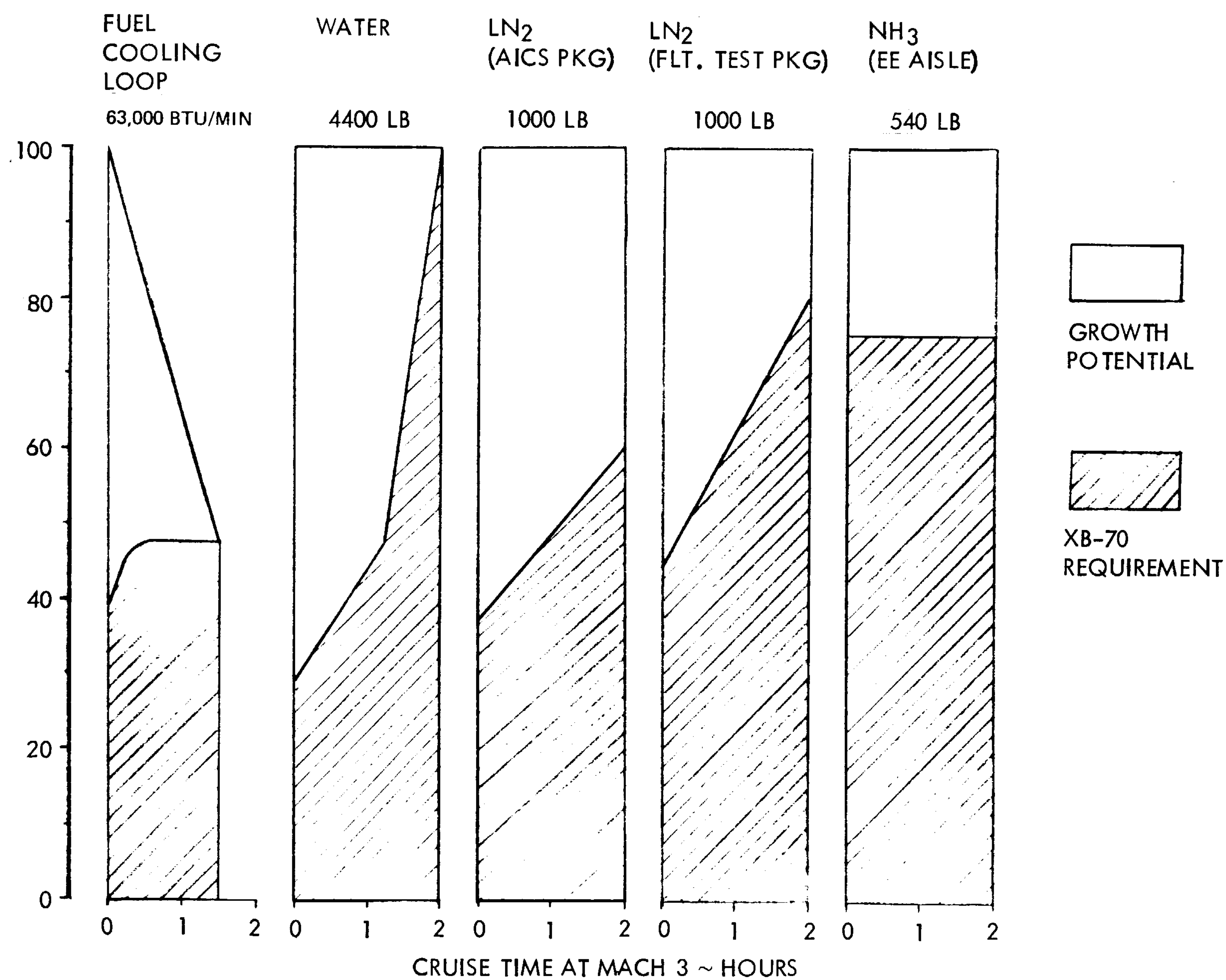


EXHIBIT 18

High Temperature/Pressure Duct
"Lightweight"



Heat Sink Capacities



DEVELOPMENT DATA SUMMARY

WBS TITLE: ENVIRONMENTAL CONTROL SUBSYSTEM

WBS CODE: 1.2

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

PERCENT DEVELOPED MATRIX:

	PRIOR TO FLIGHT		FLIGHT TEST
	CONFIGURATION	GROUND TEST	
PROGRAM LEVEL	40%	72%	15%
EFFORT TO GO	82%	53%	90%

GROUND TESTS

TYPE OF TEST	NUMBER OF UNITS	TEST HOURS
CONFIGURATION RESEARCH	12	200
DESIGN FEASIBILITY	35	1,700
DESIGN VERIFICATION*	65	4,000
AIRWORTHINESS	15	4,600
QUALIFICATION	-	-
OTHER **	10	200
TOTAL	137	10,700

REMARKS:

*These tests include a Phase I and a Phase II full scale cabin environmental simulator where runs were made with human occupants at simulated Mach 3 flight conditions.

** Vibration tests on specific equipment items.

State of the Art:

WBS CODE: 1.2

The Environmental Control 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.

The XB-70 ECS described under Technical Description (WBS 1.2) represents a subsystem substantially less complex than that planned for the RS-70. The RS-70 would have had four dual turbine/compressor closed loop heat transport systems compared to the one single Freon system of the XB-70. The massive avionics and the remote radar systems, HF standing wave guides, weapon cooling, etc., of the RS-70 military subsystems would have also impacted the complexity of effective cooling, including that for four crewmen instead of for two as with the

XB-70. However, there were many design features of the RS-70 utilized for the XB-70, such as transpiration wall cooling, fuel heat sink, remote "cold-panel" cooling, and a design based on exact requirements, not to a maximum extreme as on previous aircraft. Test data obtained during ground and flight tests substantiated the design analyses of the ECS, thus providing a high confidence level that the RS-70 goals would have been achieved. If the technical innovations were considered separately, a state-of-the-art rating of 5 would be assigned, however, for the overall ECS the rating is downgraded to 4 in compliance with the ground rules established.

Percent Developed:

The ECS development status percent comparison of the XB-70 to that scheduled for the RS-70 is more complex than that of the Airframe Structures Subsystem (WBS 1.1). However, the methodology developed and verified for the structures subsystem is applicable for the ECS. The XB-70 to RS-70 comparisons are made at two development stages: one at prior to flight or so called "out-the-door" for the No. 1 aircraft and the other for the flight test programs. The ECS comparisons are more complex in that, as previously stated, the XB-70 ECS configuration requirements were substantially less than those of the RS-70. If a straight across the board component to component comparison were made, the XB-70 would be assessed as representing 30% of that planned for the RS-70. However, as previously discussed, the RS-70 design analyses were applied in the design of the XB-70 ECS and were subsequently verified. Since the design analysis of any subsystem represents a major phase of that subsystem, the XB-70 configuration was upgraded from 30% and assessed as representing 40% of that planned for the RS-70 at the time of first aircraft "out-the-door."

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 ECS; Exhibit 21, page III-396. Entering this 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 ECS configuration, excluding ground test effort. In regards to the ground test effort, the ECS Design Group had scheduled approximately 15,000 test hours for the RS-70 ECS at the time of "out-the-door." When comparing this to the XB-70 level of 10,700 hours, it indicates that the testing level or verification level of the XB-70 at this time period to be approximately 71% of that planned for the RS-70. However, a substantial amount of the test hours expended were on major assemblies and components not representative of the RS-70 configuration with substantially less complexity.

The curve of Exhibit 21, page III-396, is used to evaluate or weight the ground testing effort since it also reflects the impact of complexity (moving up the left hand side of the curve). If the XB-70 ECS represented 40% of the RS-70 configuration, then 60% of the XB-70 ECS was not representative, being less complex and unique to the XB-70. Entering the curve on the left hand side at 60%, the bottom scale shows that 34% of the testing effort was expended on the less complex items. Multiplying the 71% by the 34% the result shows that 24% of the 71% cannot be applied to the RS-70 system or that 47% of the XB-70 ground test effort is applicable. This analysis shows that 53% more testing effort would be required to attain a production level status at time of "out-the-door." In summary of "out-the-door" status, the configuration is assessed as 40% representative requiring 82% more expenditure to attain production level status. The ground test level of effort applicable to the RS-70 is 47% (or a 72% confidence level) showing a testing effort of 53% required to attain the production level status for No. 1 "out-the-door." This is based on the tooling, test articles, GSE, etc., being at the RS-70 level in number and fidelity.

The XB-70 ECS flight test program was established at 7% of a production level status as presented by Exhibit 13, page II-23, under Air Vehicle: WBS 1.0. This would indicate that 93% more flight testing effort than expended would be required for a production level effort. However, as was the case for "out-the-door," the XB-70 ECS flight test hours must be readjusted due to the configuration flown. The same correction factor of 34% not applicable is used for downgrading the XB-70 flight test hours. Applying this correction (34% x 7%) results in approximately 2.5% of the test hours not applicable or that 4.5% of the XB-70 flight test hours were representative of an RS-70 test program. This shows that to attain a production level status approximately 90% more flight test effort would be required for the ECS. Using Exhibit 21, page III-396, the XB-70 ECS flight test program attained a confidence level of only 15% toward a full production system. The flight envelope flown by the XB-70 does not impact the ECS testing since maximum temperatures were experienced during the test program.

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.

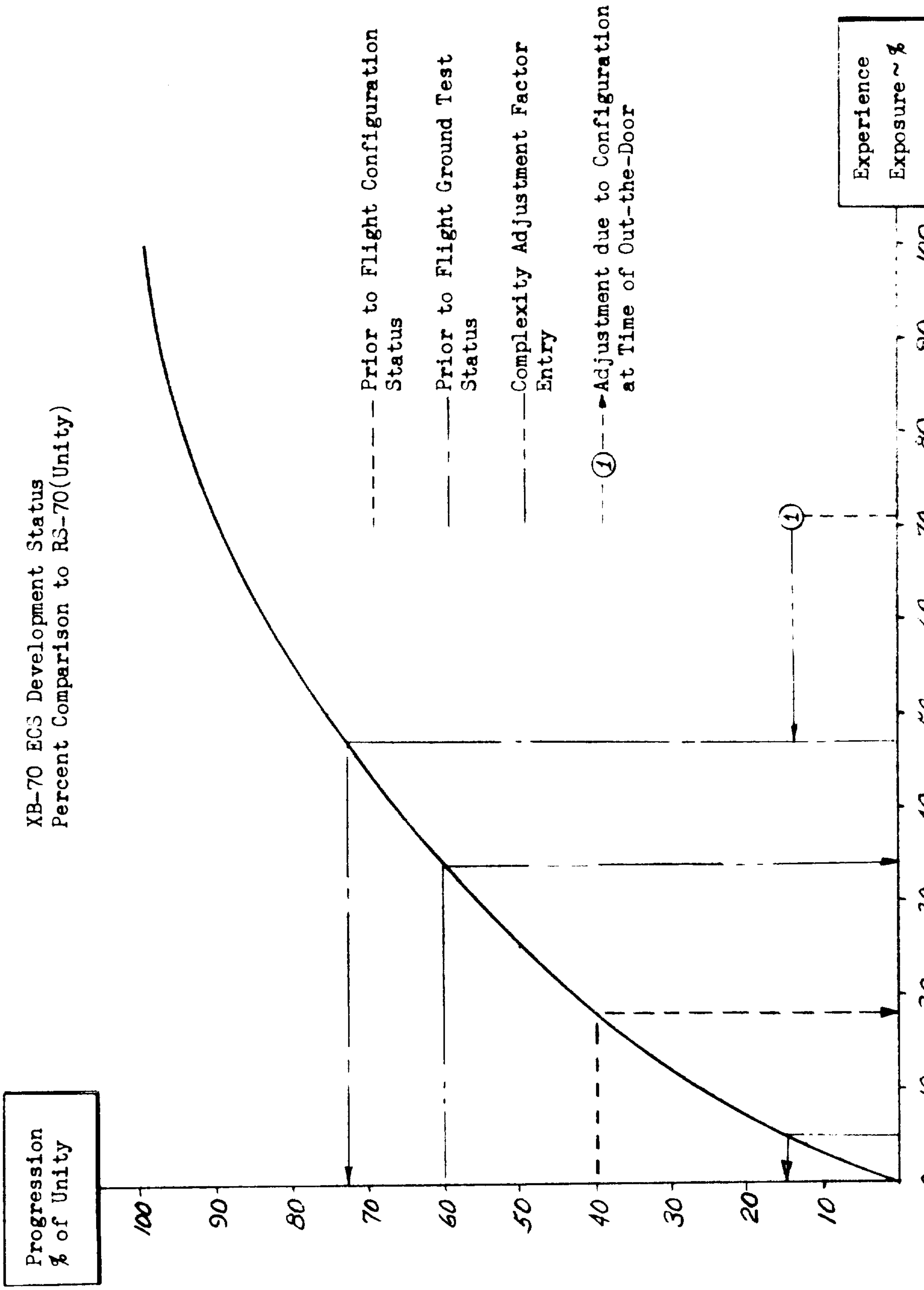
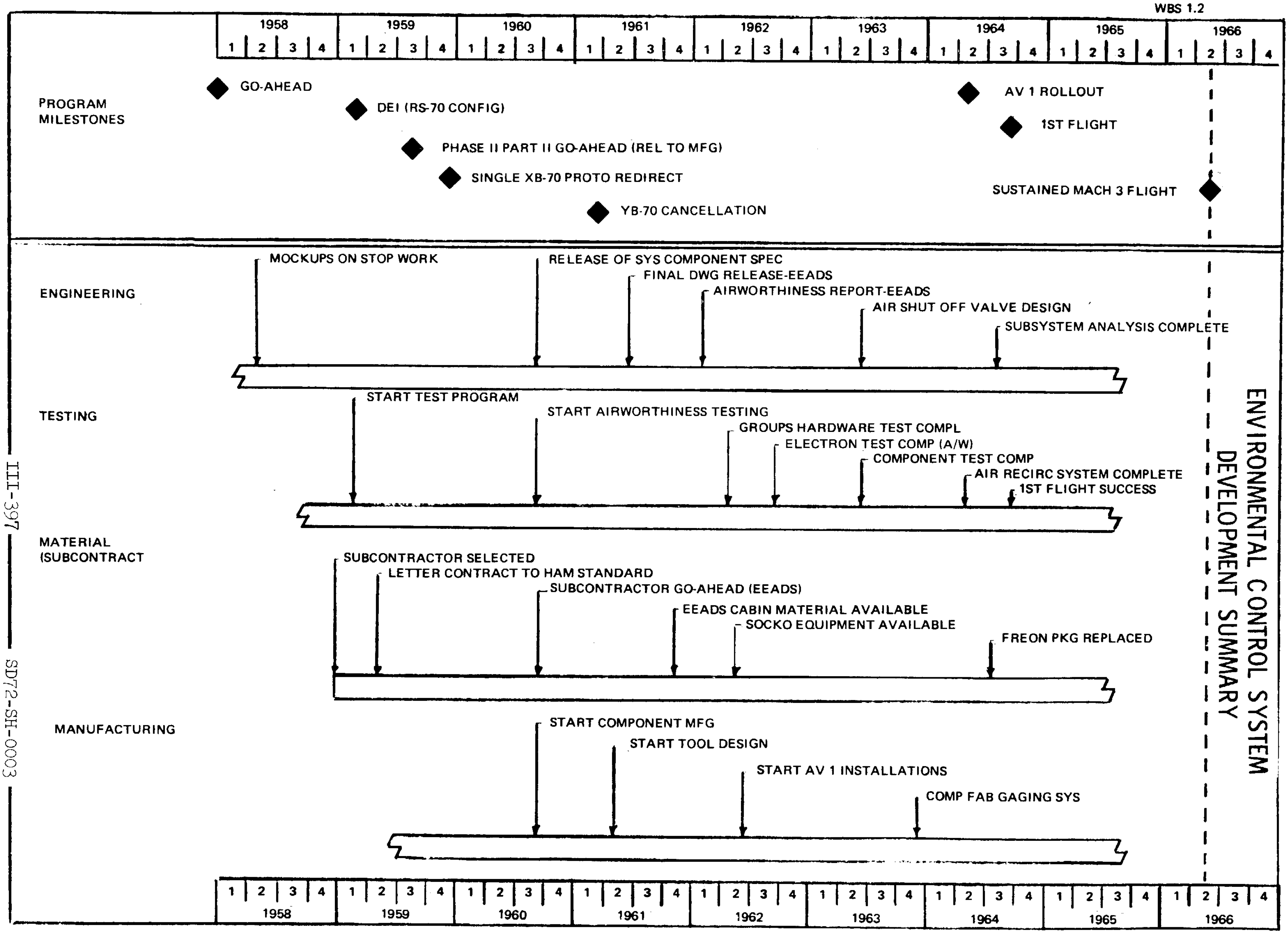

XB-70 ECS Development Status
Percent Comparison to RS-70(Unity)
Progression % of Unity
Experience Exposure ~ %
Prior to Flight Configuration Status
Prior to Flight Ground Test Status
Complexity Adjustment Factor Entry
Adjustment due to Configuration at Time of Out-the-Door
1
0
10
20
30
40
50
60
70
80
90
100

EXHIBIT 21

ENVIRONMENTAL CONTROL SYSTEM DEVELOPMENT SUMMARY

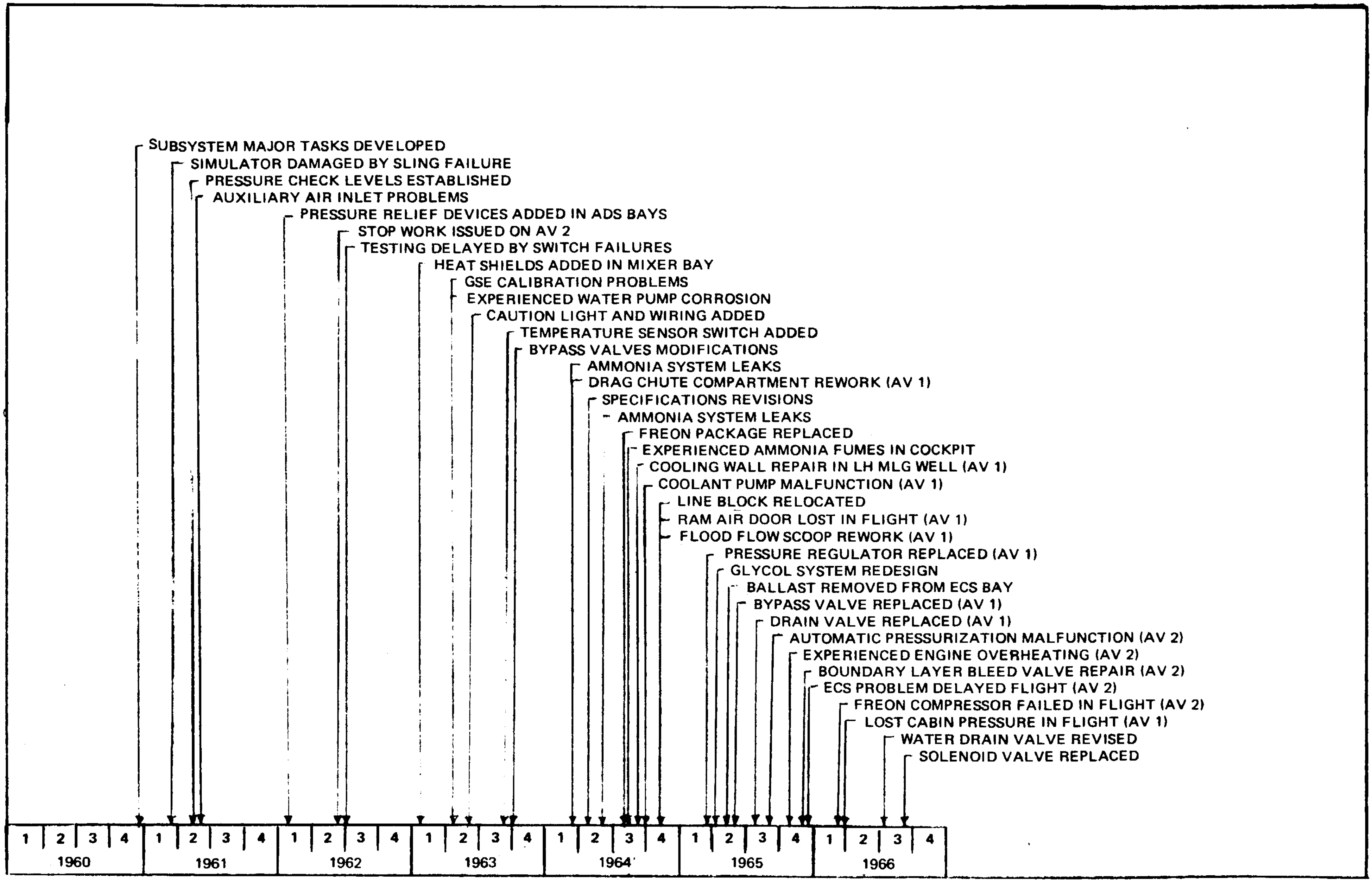


DEVELOPMENT SUMMARY
TABULATION OF DATES

Subsystem: Environmental Control System	WBS 1.2
Engineering	
All Work Stopped on Mockups - Configuration Change	5-2-58
Complete - Component Specification Release	9-21-60
Final Drawing Release - EEADS	6-16-61
Complete - Airworthiness Report - EEADS	2-9-62
Complete - Air Shutoff Valve Design	4-29-63
Complete - Analysis of Subsystems	7-31-64
Testing	
Start Test Program	2-19-59
Start Airworthiness Testing	9-20-60
Complete - Groups' Hardware Tests	4-13-62
Complete - Electronic Test	9-15-62
Complete - Component Tests	6-15-63
Complete - Air Recirculating System Verification by Air Force	4-24-64
Complete - System Verification in First Flight	9-21-64
Material	
Hamilton Standard Selected as Subcontractor	11-25-58
Letter Contract Issued to Hamilton Standard	2-19-59
Subcontractor Go Ahead on EEADS	9-20-60
EEADS Cabin Material Available	11-10-61
SOCKO Equipment Available	5-15-62
Freon Package Replacement Available	7-20-64
Manufacturing	
Start - Component Manufacturing	9-21-60
Start - Tool Design	5-1-61
Start - Installation in Air Vehicle No. 1	6-1-62
Complete - Fabrication of Quantity Gaging System	11-29-63

ENVIRONMENTAL CONTROL SYSTEM
DESIGN/PROGRAMMATIC IMPACTS

WBS 1.2



DESIGN/PROGRAMMATIC IMPACTS

SUBSYSTEM: ENVIRONMENTAL CONTROL SYSTEM WBS CODE: 1.2

12-16-60
The major tasks in the subsystem were being developed by teams consisting of Engineering, Manufacturing, and Material Division representatives.

3-24-61
Phase I of the Environmental Simulator was completed and delivered to the Thermal Lab on March 20, sixteen days behind schedule. Rotation while in the handling sling and subsequent failure of the sling resulted in a two-day delay in attaching the simulator to the environmental chamber.

5-12-61
Cockpit and Windshield Test Specimen. Rework of the hatches is complete, final pressure check was established at 7-1/2 pounds, with a leakage of 45 CPM (cubic foot minute). While the leakage rate should be 40 CPM, Engineering accepted the specimen.

5-22-61
Auxiliary Air Inlet System - Engineering cancelled approximately 30 drawings which eliminated the Auxiliary Air Inlet System. The function of this system was to furnish an additional supply of air to the engines in order to increase the Air Vehicle performance in all types of weather conditions, to allow heavier payloads, and allow takeoff from shorter runways. Cost reduction was $231,000.

2-3-62
Compartment Venting. Engineering studies revealed that a failure in The Accessory Drive System (ADS) shaft bellows seal would allow engine compartment pressure to leak into the ADS bay and over pressure this area beyond its structural capabilities. An Engineering Work Authorization (EWA) was written to add a pressure relief device in the three ADS compartment doors.

6-15-62
Air Vehicle No. 2 effort was stopped and drawings delayed, due to the high priority on Air Vehicle No. 1. Release of new Air Vehicle No. 2 drawings and drawings from Engineering Stop fell further behind schedule each week. Insufficient number of personnel were available to give proper emphasis to both air vehicles.

7-1-62
Dielectric failures and erratic operation on the emergency Ram air temperature switch on the ECS delayed completion of air worthiness testing.

WBS CODE: 1.2

1-11-63
Heat Shields Aft Mechanical Department. According to the Thermal Group, during sustained March 3 flight, heat radiated from the Engine Extraction Air Duct System would exceed temperatures allowable for actuator linkage rod-end bearings in the mixer bay. A shield, about 117 inches long, of aluminum sheet with fibreglass insulation on the duct side and glycol lines on the other side would be installed between the duct and critical bearings. Another shield would be installed around the EEADS shutoff valve to prevent fire that could result if a hydraulic line ruptured. Installation of the shields was not acceptable to Manufacturing, prior to first flight.

4-12-63
The cool effect detectors of the ground support equipment failed calibration (temperature and flow test) by Palmdale Quality Control. Both units were returned to the supplier for corrective action. The Maintenance Department calibrated the Keco Air Conditioning Supply units.

5-28-63
Fuel Coolant Failure Warning Lights. Engineering initiated an EWA to provide an additional "cooling fuel pump" caution light so that each cooling fuel pump would have a separate light. This change called for a new cap caution light and air vehicle wiring revisions. Engineering Flight Test made the change.

9-13-63
AICS Pod - Subzero Indication System - XB-70A No. 1. The twelve engine compartment cooling system bypass valves were removed from Air Vehicle No. 1 and returned to Whittaker Controls (Division of Telecomputing Corporation) for modification. Twelve other valves, already modified, were in Palmdale and were installed in the Air Vehicle.

3-13-64
Crew compartment ethylene glycol cooling loop system checkout was complete as possible until all three drag chute cooling panels were repaired. The defective windshield defogging system motor and fan assembly were removed and sent to Engineering for disposition. RH windshield rain removal shutoff shorted internally, a replacement was ordered. New seals and flex lines were ordered to repair ammonia system leaks. The water cooling system water pump was sent to Los Angeles due to shaft corrosion.

3-20-64
Rework of drag chute compartment cooling panels prevented completion of ethylene glycol cooling loop system checkout. Leak check and repair of (700 degrees) air system and of tempered engine bleed air system were also in work.

4-17-64
ECS Windshield Defogging. Revision to new specifications was sold off. Windshield defogging airgap system specification was still in Engineering. Redesigned ammonia leakage in emergency refrigerant tank system required specification revision.

5-22-64
Leaks in the XB-70 A No. 1 ammonia system were found.

7-20-64
Freon Package XB-70A No. 1. The turbine overspeed governor was erratic and a drain line in the system failed necessitating the replacement of the Freon package. The replacement was completed 7-19-64.

8-14-64
Ammonia Fume XB-70A No. 1. The gas, exhausted overboard from the emergency refrigeration unit, was drawn into the engine intake and mixed with engine extraction air and circulated into the cockpit. The condition could only have happened during taxi and ground operations when insufficient wind did not clear the fumes. A ground lockout relay contact was added which closed the makeup air valve, correcting the situation.

9-8-64
On 9-7-64 during gear operations, the LH strut unlocked prematurely, causing damage to inner door skins and cooling wall. The problem was attributed to a malfunction of the LH door sequencing switch. The switch was resequenced to correct the situation.

9-20-64
Just prior to first flight, Engine No. 4 was shut down due to No. 2 coolant loop pump malfunction. Switches and circuit breaker on system were recycled. Operation of pump began; all engines were started and no further problem was experienced.

10-23-64
Preparations for fourth flight. The hydraulic leak in Tank No. 3 was found to be the return line of the LH cooling loop pump which had worn through at the line block. It was determined that the line wearing was due to preload on the line. The block was rebuilt and relocated to eliminate the preload on the line.

10-26-64
During flight there was a malfunction of the Ram Air System preventing the repressurization of the cabin. After landing it was discovered that the Ram air door was lost during flight.

10-30-64
Structure Repair. The Freon package had been removed to provide access for the flood flow scoop removal. The flood flow scoop was reworked and linkage improved to prevent a reoccurrence of the failure encountered on the fourth flight.

3-12-65
XB-70A No. 1. Removed and replaced cabin pressure regulator as a result of overpressure during flight.

WBS CODE: 1.2

4-9-65
XB-70A No. 1. The glycol system swivel in the nose well was revised as a result of system leakage after door cycle.

5-14-65
XB-70A No. 1. The capacity of the fuel tanks was increased for the thirteenth flight after 2010 pounds of ballast were removed from the environmental bay.

5-24-65
XB-70A No. 1. Prior to Flight No. 13 an inoperative engine compartment cooling bypass valve was replaced in Bay No. 2.

7-30-65
XB-70A No. 1. The inoperative water system drain valve was replaced.

8-13-65
XB-70A No. 2 - Flight No. 2. All systems functioned satisfactorily except the ECS auto pressurization and hydraulic fluid level indicating systems.

12-6-65
XB-70A No. 2 Post Flight. Damage repair to the No. 4, No. 5, No. 6 boundary layer bleed valves was completed over the weekend.

12-22-65
XB-70A No. 2, Flight No. 16. The sixteenth flight was accomplished the afternoon of December 21. Problems with the ECS system resulted in postponement of the scheduled morning takeoff.

3-14-66
XB-70A No. 2, Freon Packages. The compressor failed in No. 003 in flight and the package was replaced by No. 005. During testing the condenser in No. 005 failed and, as a result, No. 004 was removed from Air Vehicle No. 1 and installed in Air Vehicle No. 2. A spare compressor was available and a condenser was promised by Hamilton Standard for March 18. A serviceable package was built with those parts.

3-28-66
XB-70A No. 1, Flight No. 38. A loss of cabin pressurization, limited the mission to subsonic speed and low altitude.

7-5-66
Work continued on the accomplishment of EWA 281-154: Water Drain Valve Revision.

9-6-66
After the airplane was moved to the hangar on 9-1-61, the inoperative cooling pump solenoid valve was replaced.

COST DEFINITION

SUBSYSTEM: ENVIRONMENTAL CONTROL WBS CODE: 1.2

Total costs displayed 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 Environmental Control Subsystem as defined by the Work Breakdown Structure. Total costs of $24,906,411 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, fabricating, 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 air 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 (Environmental Control Subsystem WBS 1.2) with the exception of in-house ground testing (WBS 1.2.11). Cost data can be located on the following pages:

	Cost Breakdown		Time-Phased Detail
WBS 1.2	$23,843,799	page III-409	page III-410
WBS 1.2.11 Ground Tests	1,062,612	page III-409	page III-430
Total WBS 1.2	$24,906,411	page III-409	page III-438

A summary of the subcontractor recorded cost data is presented on page III-407. Contractual arrangements, delivery dates, costs by supplier, quantity of hardware delivered and other pertinent data is provided. Cost data includes the subcontractor expenditures for engineering, production, tooling and testing (where applicable) 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 Environmental Control System.

Group No.	Title	Hours Expended
4	Fluid Power System	6,709
12	Checking	11,297
34	Structural Projects	6,515
35	Fuselage	21,047
36	Wing & Empennage	6,179
41	Environmental System & Equipment Design	447,390
47	Human Factors & Cockpit Display	18,359
50	Metallurgy	86,029
57	Engineering Specification	18,350
92	Thermodynamics	30,465
95	Electrical System Design	21,618
97	Laboratory Services	8,977
110	Electrical Power Lab	7,980
132	Thermodynamics	221,086
146	Thermodynamics Lab	18,587
	Miscellaneous	55,214
	Total Engineering Hours	985,802

WBS 1.2	971,618 hours	(page III-409)
WBS 1.2.11	14,184 hours	(page III-409)
	985,802 hours	

Ground testing activities associated with the development of the Environmental Control System have been identified and the costs assigned to WBS 1.2.11 (page III-430). These costs reflect the in-house expenditures only. Testing activities performed by the subcontractor where identified are included under WBS 1.2, Test/QC Subdivision of Work and Subcontracting Element of Cost. The following is a summary of the major in-house test activities identified to this subsystem.

Description	Recorded Costs
Environmental Control System Simulator	$701,525

WBS CODE: 1.2

Description		Recorded Costs
XB-70 Determination of the Air Flow Split and Pressure Drop of Cabin		$34,923
Airworthiness Test for Engine Extraction Air Shutoff Valve		31,266
Investigation of Air Distribution and Pressure Suit Requirements		8,743
Various		246,341
	Costs (less MPC & G&A)	$1,022,798
	Material and Procurement Cost	22,150
	General and Admin.	17,664
	Total Cost WBS 1.2.11	$1,062,612

SUBCONTRACTOR MATRIX

SUBSYSTEM: ENVIRONMENTAL CONTROL WBS CODE: 1.2

SUBCONTRACTOR	ENGR'G	PROD	TOOLING	TEST	TOTAL
HAMILTON STNDRD	9,229,678	1,706,577	132,558	-	11,068,813
SOLAR AIRCRAFT	1,565,991	800,648	117,275	-	2,483,914
TOTAL	10,795,669	2,507,225	249,833	-	13,552,727

HAMILTON STANDARD was selected to produce the B-70 Environmental Conditioning System. The three letter contracts issued for this effort, along with their start and completion dates are:

L-961-G-600105	February 19, 1959	January 5, 1960
L-961-X-600214	December 31, 1959	September 4, 1963
L1E1-Y2-600308	November 1, 1960	March 6, 1964

The Statement of Work for the three contracts directed the subcontractor to provide design, development testing, tooling, fabrication and delivery of the Environmental Conditioning System for Air Vehicles 1, 2 and 3. The purpose of the system was to provide a suitable temperature and pressure environment for the crew. In addition, conditioned and pressurized air was supplied to the electronic equipment bay and to the equipment in the nose compartment. There were four bidders for this system:

1. Airesearch Manufacturing
2. Chrysler Corporation
3. Fairchild Engine and Airplane Corporation
4. Hamilton Standard

Hamilton Standard was rated first in the total cost proposal and technical capability and was therefore awarded the contract.

Contract 600105 was for the basic design and development effort, and contracts 600214 and 600308 were for the production of units for Air Vehicles 1, 2 and 3.

The ECS unit for Air Vehicle 3 was 80% completed on March 6, 1964, the date the contract was terminated.

During the life of the contracts, NR received monthly cost reports, and proper adjustments were made as the program progressed to completion. There were no unresolved problems. At the conclusion of the program, all residual inventory and tooling were transferred to storage or disposed of as scrap and the resulting credits offered to the appropriate contract.

WBS CODE: 1.2

SOLAR AIRCRAFT was awarded letter contract L0EI-XZ-600216 for the Engine Extraction Air Ducting Subsystem for the B-70 vehicle. The purpose of the unit was to deliver bleed air from the engines forward to the cabin and Environmental System. Work was started on January 7, 1960, and completed on September 1, 1963.

There were five suppliers who elected to bid on the Engine Extraction Air Ducting Subsystem, which was an advance in the state-of-the-art. Solar was selected on the basis of their technical proposal and their approach to achieving the required reliability.

The Statement of Work required the subcontractor to provide design, development, testing, packaging and delivery of the Engine Extraction Air Ducting Subsystem. The design and development was completed without problem, and delivery of system hardware was started on November 10, 1961, and completed on March 14, 1963.

The residual inventory was disposed of and the resulting credits applied to the base contract. All tooling accountable to the purchase order was transferred to storage for the purpose of producing spare parts for overhaul and repair.

NORTH AMERICAN ROCKWELL CORP.
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NASA CONTRACT NAS9-12100

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 02
ENVIRONMENTAL CONTROL SUBSYSTEM

	6-M ASSY 0 HOURS DOLLARS	6-M ASSY 11 HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	971618	14184	985802
LABOR AT $ 4.983	4852642	59820	4912462
ENGR BURDEN AT $ 4.398	4272723	63028	4335751
SHOP SUPPORT	2218	109018	111236
LABOR AT $ 2.883	7022	313708	320730
TEST/QC	264	8667	8931
LABOR AT $ 3.038	872	26260	27132
MFG BURDEN AT $ 3.480	9707	408502	418209
ENGR MATERIAL	19300	148396	167696
SUBCONTRACT	13552727		13552727
MPC	560689	22150	582839
OTHER COST	194721	3084	197805
SUB-TOTAL	23470403	1044948	24515351
GEN & ADMIN	373396	17664	391060
TOTAL COST	23843799	1062612	24906411

SUBDIVISION OF WORK
COST DETAIL - SEE PAGE III-410 III-430 III-438

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 02
6-MAJ ASSY 0

ENVIRONMENTAL CONTROL SUBSYSTEM

	DESIGN /ENGR HOURS DOLLARS	PRCD HOURS DOLLARS	TOOLING AND STE HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	971618			971618
LABOR AT $ 4.994	4852642			4852642
ENGR BURDEN AT $ 4.398	4272723			4272723
SHOP SUPPORT	2218			2218
LABOR AT $ 3.166	7022			7022
TEST/QC	264			264
LABOR AT $ 3.303	872			872
MFG BURDEN AT $ 3.911	9707			9707
ENGR MATERIAL	19300			19300
SUBCONTRACT	10795669	2507225	249833	13552727
MPC	429370	122930	8389	560689
OTHER COST	194721			194721
SUB-TOTAL	20582026	2630155	258222	23470403
GEN & ADMIN	320262	48468	4666	373396
TOTAL COST	20902288	2678623	262888	23843799

TIME-PHASED COST DETAIL - SEE PAGE III-411 III-419 III-421 III-422

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL 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	39.0	6668	4.609	30730	30336	61066
Q-2 58						
Q-3 58	261.0	43929	4.430	194598	172838	367436
Q-4 58						
Q-1 59	373.0	63643	4.437	282390	218484	500874
Q-2 59						
Q-3 59	694.5	122240	4.250	519503	434878	954381
Q-4 59						
Q-1 60	499.5	86544	4.699	406628	325712	732340
Q-2 60						
Q-3 60	511.5	85860	4.686	402380	319089	721469
Q-4 60						
Q-1 61	742.5	126748	4.656	590153	428694	1018847
Q-2 61						
Q-3 61	399.0	72257	5.401	390282	345567	735849
Q-4 61						
Q-1 62	373.5	63677	5.721	364276	290910	655186
Q-2 62						
Q-3 62	420.0	70497	5.440	383493	357497	740990
Q-4 62						
Q-1 63	382.5	65189	5.627	366789	353701	720490
Q-2 63						
Q-3 63	411.5	69151	5.219	360915	402747	763662
Q-4 63						
Q-1 64	363.0	61944	5.623	348294	381455	729749
Q-2 64						
Q-3 64	142.5	24969	6.059	151280	156019	307299
Q-4 64						
Q-1 65	36.0	6136	7.348	45085	40518	85603

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL 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	12.C	1994	7.311	14579	13144	27723
Q-4 65						
Q-1 66	1.5	172	7.366	1267	1134	2401
TOTAL	5662.5	971618		4852642	4272723	9125365

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL 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		6	2.500	15	14	29
Q-2 58						
Q-3 58					28	28
Q-4 58						
Q-1 59		8	2.250	18	30	48
Q-2 59						
Q-3 59	9.0	1555	2.874	4469	6338	10807
Q-4 59						
Q-1 60	3.0	552	4.043	2232	2955	5187
Q-2 60						
Q-3 60		10	2.500	25	-170	-145
Q-4 60						
Q-1 61						
Q-2 61						
Q-3 61						
Q-4 61						
Q-1 62	1.5	298	4.232	1261	1377	2638
Q-2 62						
Q-3 62	-1.5	-212	4.698	-996	-1045	-2041
Q-4 62						
Q-1 63		5	2.800	14	20	34
Q-2 63						
Q-3 63		-6	3.667	-22	2	-20
Q-4 63						
Q-1 64				-1	149	148
Q-2 64						
Q-3 64		2	3.500	7	9	16
TOTAL	12.0	2218		7022	9707	16729

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL 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		8	2.125	17		17
Q-4 58						
Q-1 59						
Q-2 59						
Q-3 59		113	2.938	332		332
Q-4 59						
Q-1 60		109	3.514	383		383
Q-2 60						
Q-3 60						
Q-4 60						
Q-1 61						
Q-2 61						
Q-3 61						
Q-4 61						
Q-1 62						
Q-2 62						
Q-3 62		4	3.000	12		12
Q-4 62						
Q-1 63						
Q-2 63						
Q-3 63						
Q-4 63						
Q-1 64		30	4.267	128		128
TOTAL		264		872		872

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL 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	39.0	6674	4.607	30745	30350	61095	
Q-2 58							
Q-3 58	261.0	43937	4.429	194615	172866	367481	93
Q-4 58							
Q-1 59	373.0	63651	4.437	282408	218514	500922	
Q-2 59							
Q-3 59	703.5	123908	4.231	524304	441216	965520	1275
Q-4 59							
Q-1 60	502.5	87205	4.693	409243	328667	737910	-493
Q-2 60							
Q-3 60	511.5	85870	4.686	402405	318919	721324	18
Q-4 60							
Q-1 61	742.5	126748	4.656	590153	428694	1018847	-11
Q-2 61							
Q-3 61	399.0	72257	5.401	390282	345567	735849	
Q-4 61							
Q-1 62	375.0	63975	5.714	365537	292287	657824	
Q-2 62							
Q-3 62	418.5	70289	5.442	382509	356452	738961	
Q-4 62							
Q-1 63	382.5	65194	5.626	366803	353721	720524	-268
Q-2 63							
Q-3 63	411.5	69145	5.219	360893	402749	763642	2691
Q-4 63							
Q-1 64	363.0	61974	5.622	348421	381604	730025	9377
Q-2 64							
Q-3 64	142.5	24971	6.059	151287	156028	307315	6119
Q-4 64							
Q-1 65	36.0	6136	7.348	45085	40518	85603	499
Q-2 65							
Q-3 65	12.0	1994	7.311	14579	13144	27723	

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL 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	1.5	172	7.366	1267	1134	2401	
TOTAL	5674.5	974100		4860536	4282430	9142966	19300

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 02 **ENVIRONMENTAL 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					61095		61095
Q-2 58							
Q-3 58		93	5	1729	369308		369308
Q-4 58							
Q-1 59	24221	24221	642	4132	529917		529917
Q-2 59							
Q-3 59	1175206	1176481	32219	24125	2198345		2198345
Q-4 59							
Q-1 60	1673242	1672749	99209	15084	2524952	48108	2573060
Q-2 60							
Q-3 60	988355	988373	58644	13184	1781525	33943	1815468
Q-4 60							
Q-1 61	2465465	2465454	70637	16360	3571298	66365	3637663
Q-2 61							
Q-3 61	1737496	1737496	49780	14110	2537235	47149	2584384
Q-4 61							
Q-1 62	1058003	1058003	33625	16663	1766115	29644	1795759
Q-2 62							
Q-3 62	1053772	1053772	33460	16075	1842268	30922	1873190
Q-4 62							
Q-1 63	358906	358638	15214	26709	1121085	18745	1139830
Q-2 63							
Q-3 63	33741	36432	1349	21961	823384	13767	837151
Q-4 63							
Q-1 64	227262	236639	32211	14238	1013113	21557	1034670
Q-2 64							
Q-3 64		6119	2226	8324	323984	6894	330878
Q-4 64							
Q-1 65		499	149	1419	87670	2339	90009
Q-2 65							
Q-3 65				568	28291	755	29046

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

4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL 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				40	2441	74	2515
TOTAL	10795669	10814969	429370	194721	20582026	320262	20902288

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL CONTROL SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK PRODUCTION

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-1 60							15554
Q-2 60							
Q-3 60							340378
Q-4 60							
Q-1 61							475424
Q-2 61							
Q-3 61							501390
Q-4 61							
Q-1 62							221468
Q-2 62							
Q-3 62							221873
Q-4 62							
Q-1 63							144464
Q-2 63							
Q-3 63							256370
Q-4 63							
Q-1 64							330304
TOTAL							2507225

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL CONTROL SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK PRODUCTION

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 60	922	16476	314	16790
Q-2 60				
Q-3 60	20195	360573	6870	367443
Q-4 60				
Q-1 61	13621	489045	9088	498133
Q-2 61				
Q-3 61	14365	515755	9584	525339
Q-4 61				
Q-1 62	7038	228506	3835	232341
Q-2 62				
Q-3 62	7045	228918	3842	232760
Q-4 62				
Q-1 63	6142	150606	2518	153124
Q-2 63				
Q-3 63	8239	264609	4424	269033
Q-4 63				
Q-1 64	45363	375667	7993	383660
TOTAL	122930	2630155	48468	2678623

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

4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL CONTROL SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK TOOLING AND STE

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 60	5034	298	5332	102	5434
Q-2 60					
Q-3 60	22220	1318	23538	448	23986
Q-4 60					
Q-1 61	66751	1912	68663	1276	69939
Q-2 61					
Q-3 61	74450	2133	76583	1423	78006
Q-4 61					
Q-1 62	36234	1151	37385	628	38013
Q-2 62					
Q-3 62	40061	1272	41333	694	42027
Q-4 62					
Q-1 63	4127	175	4302	72	4374
Q-2 63					
Q-3 63	6		6		6
Q-4 63					
Q-1 64	950	130	1080	23	1103
TOTAL	249833	8389	258222	4666	262888

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 02
6-MAJ ASSY 0

ENVIRONMENTAL CONTROL SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	39.0	6668	4.609	30730	30336	61066
Q-2 58						
Q-3 58	261.0	43929	4.430	194598	172838	367436
Q-4 58						
Q-1 59	373.0	63643	4.437	282390	218484	500874
Q-2 59						
Q-3 59	694.5	122240	4.250	519503	434878	954381
Q-4 59						
Q-1 60	499.5	86544	4.699	406628	325712	732340
Q-2 60						
Q-3 60	511.5	85860	4.686	402380	319089	721469
Q-4 60						
Q-1 61	742.5	126748	4.656	590153	428694	1018847
Q-2 61						
Q-3 61	399.0	72257	5.401	390282	345567	735849
Q-4 61						
Q-1 62	373.5	63677	5.721	364276	290910	655186
Q-2 62						
Q-3 62	420.0	70497	5.440	383493	357497	740990
Q-4 62						
Q-1 63	382.5	65189	5.627	366789	353701	720490
Q-2 63						
Q-3 63	411.5	69151	5.219	360915	402747	763662
Q-4 63						
Q-1 64	363.0	61944	5.623	348294	381455	729749
Q-2 64						
Q-3 64	142.5	24969	6.059	151280	156019	307299
Q-4 64						
Q-1 65	36.0	6136	7.348	45085	40518	85603
Q-2 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL CONTROL 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	1994	7.311	14579	13144	27723
Q-4 65						
Q-1 66	1.5	172	7.366	1267	1134	2401
TOTAL	5662.5	971618		4852642	4272723	9125365

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

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL CONTROL SUBSYSTEM**
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		6	2.500	15	14	29
Q-2 58						
Q-3 58					28	28
Q-4 58						
Q-1 59		8	2.250	18	30	48
Q-2 59						
Q-3 59	9.0	1555	2.874	4469	6338	10807
Q-4 59						
Q-1 60	3.0	552	4.043	2232	2955	5187
Q-2 60						
Q-3 60		10	2.500	25	-170	-145
Q-4 60						
Q-1 61						
Q-2 61						
Q-3 61						
Q-4 61						
Q-1 62	1.5	298	4.232	1261	1377	2638
Q-2 62						
Q-3 62	-1.5	-212	4.698	-996	-1045	-2041
Q-4 62						
Q-1 63		5	2.800	14	20	34
Q-2 63						
Q-3 63		-6	3.667	-22	2	-20
Q-4 63						
Q-1 64				-1	149	148
Q-2 64						
Q-3 64		2	3.500	7	9	16
TOTAL	12.0	2218		7022	9707	16729

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL CONTROL SUBSYSTEM**
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		8	2.125	17		17
Q-4 58						
Q-1 59						
Q-2 59						
Q-3 59		113	2.938	332		332
Q-4 59						
Q-1 60		109	3.514	383		383
Q-2 60						
Q-3 60						
Q-4 60						
Q-1 61						
Q-2 61						
Q-3 61						
Q-4 61						
Q-1 62						
Q-2 62						
Q-3 62		4	3.000	12		12
Q-4 62						
Q-1 63						
Q-2 63						
Q-3 63						
Q-4 63						
Q-1 64		30	4.267	128		128
TOTAL		264		872		872

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL CONTROL SUBSYSTEM**
6-MAJ ASSY C

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58 / Q-2 58	39.0	6674	4.607	30745	30350	61095	
Q-3 58 / Q-4 58	261.0	43937	4.429	194615	172866	367481	93
Q-1 59 / Q-2 59	373.0	63651	4.437	282408	218514	500922	
Q-3 59 / Q-4 59	703.5	123908	4.231	524304	441216	965520	1275
Q-1 60 / Q-2 60	502.5	87205	4.693	409243	328667	737910	-493
Q-3 60 / Q-4 60	511.5	85870	4.686	402405	318919	721324	18
Q-1 61 / Q-2 61	742.5	126748	4.656	590153	428694	1018847	-11
Q-3 61 / Q-4 61	399.0	72257	5.401	390282	345567	735849	
Q-1 62 / Q-2 62	375.0	63975	5.714	365537	292287	657824	
Q-3 62 / Q-4 62	418.5	70289	5.442	382509	356452	738961	
Q-1 63 / Q-2 63	382.5	65194	5.626	366803	353721	720524	-268
Q-3 63 / Q-4 63	411.5	69145	5.219	360893	402749	763642	2691
Q-1 64 / Q-2 64	363.0	61974	5.622	348421	381604	730025	9377
Q-3 64 / Q-4 64	142.5	24971	6.059	151287	156028	307315	6119
Q-1 65 / Q-2 65	36.0	6136	7.348	45085	40518	85603	499
Q-3 65 / Q-4 65	12.0	1994	7.311	14579	13144	27723	

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 02
6-MAJ ASSY 0

ENVIRONMENTAL CONTROL SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66	1.5	172	7.366	1267	1134	2401	
TOTAL	5674.5	974100		4860536	4282430	9142966	19300

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL CONTROL SUBSYSTEM**
6-MAJ ASSY 0

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58					61095		61095
Q-2 58							
Q-3 58		93	5	1729	369308		369308
Q-4 58							
Q-1 59	24221	24221	642	4132	529917		529917
Q-2 59							
Q-3 59	1175206	1176481	32219	24125	2198345		2198345
Q-4 59							
Q-1 60	1693830	1693337	100429	15084	2546760	48524	2595284
Q-2 60							
Q-3 60	1350953	1350971	80157	13184	2165636	41261	2206897
Q-4 60							
Q-1 61	3007640	3007629	86170	16360	4129006	76729	4205735
Q-2 61							
Q-3 61	2313336	2313336	66278	14110	3129573	58156	3187729
Q-4 61							
Q-1 62	1315705	1315705	41814	16663	2032006	34107	2066113
Q-2 62							
Q-3 62	1315706	1315706	41777	16075	2112519	35458	2147977
Q-4 62							
Q-1 63	507497	507229	21531	26709	1275993	21335	1297328
Q-2 63							
Q-3 63	290117	292808	9588	21961	1087999	18191	1106190
Q-4 63							
Q-1 64	558516	567893	77704	14238	1389860	29573	1419433
Q-2 64							
Q-3 64		6119	2226	8324	323984	6894	330878
Q-4 64							
Q-1 65		499	149	1419	87670	2339	90009
Q-2 65							
Q-3 65				568	28291	755	29046
Q-4 65							

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL CONTROL SUBSYSTEM**
6-MAJ ASSY 0

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 66				40	2441	74	2515
TOTAL	13552727	13572027	560689	194721	23470403	373396	23843799

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 02
6-MAJ ASSY 11
ENVIRONMENTAL CONTROL GROUND TESTS

	TEST /QC HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	14184	14184
LABOR AT $ 4.217	59820	59820
ENGR BURDEN AT $ 4.444	63028	63028
SHOP SUPPORT	109018	109018
LABOR AT $ 2.878	313708	313708
TEST/QC	8667	8667
LABOR AT $ 3.030	26260	26260
MFG BURDEN AT $ 3.471	408502	408502
ENGR MATERIAL	148396	148396
MPC	22150	22150
OTHER COST	3084	3084
SUB-TOTAL	1044948	1044948
GEN & ADMIN	17664	17664
TOTAL COST	1062612	1062612

TIME-PHASED COST
DETAIL - SEE PAGE III-431

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL CONTROL GROUND TESTS**
6-MAJ ASSY 11
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 60	9.0	1607	4.050	6508	6012	12520
Q-4 60						
Q-1 61	15.0	2563	4.787	12270	8716	20986
Q-2 61						
Q-3 61	12.0	2230	4.049	9029	10040	19069
Q-4 61						
Q-1 62	18.0	3038	4.090	12424	13606	26030
Q-2 62						
Q-3 62	16.5	2738	4.075	11158	14032	25190
Q-4 62						
Q-1 63		47	8.511	400	628	1028
Q-2 63						
Q-3 63	10.5	1751	4.026	7049	8794	15843
Q-4 63						
Q-1 64		119	4.714	561	726	1287
Q-2 64						
Q-3 64		37	5.946	220	262	482
Q-4 64						
Q-1 65		38	3.711	141	148	289
Q-2 65						
Q-3 65		15	3.733	56	59	115
Q-4 65						
Q-1 66		1	4.000	4	5	9
TOTAL	81.0	14184		59820	63028	122848

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL CONTROL GROUND TESTS**
6-MAJ ASSY 11
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	234	2.560	599	856	1455
Q-4 58						
Q-1 59	40.5	7013	2.708	18993	26755	45748
Q-2 59						
Q-3 59	25.5	4610	2.791	12868	19964	32832
Q-4 59						
Q-1 60		-76	3.802	289	-484	-195
Q-2 60						
Q-3 60	1.5	162	2.864	464	492	956
Q-4 60						
Q-1 61	546.0	93273	2.804	261552	311813	573365
Q-2 61						
Q-3 61	10.5	1894	6.977	13215	40870	54085
Q-4 61						
Q-1 62	4.5	876	3.023	2648	3575	6223
Q-2 62						
Q-3 62	1.5	365	2.896	1057	1404	2461
Q-4 62						
Q-1 63	1.5	239	2.690	643	1050	1693
Q-2 63						
Q-3 63	3.0	417	3.271	1364	2013	3377
Q-4 63						
Q-1 64		7	2.000	14	25	39
Q-2 64						
Q-3 64		4	1.250	5	12	17
Q-4 64						
Q-1 65				-2	106	104
Q-2 65						
Q-3 65				-1	42	41

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 02 ENVIRONMENTAL CONTROL GROUND TESTS
6-MAJ ASSY 11
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	3
TOTAL	636.0	109018		313708	408496	722204

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	TEST/QC	
4-SYSTEM	1	
5-SUBSYSTEM	02	**ENVIRONMENTAL CONTROL GROUND TESTS**
6-MAJ ASSY	11	
SUBD OF WORK	TEST/QC	

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		2	2.000	4		4
Q-4 58						
Q-1 59	1.5	219	2.845	623		623
Q-2 59						
Q-3 59	1.5	235	2.923	687		687
Q-4 59						
Q-1 60		-28	3.500	-98		-98
Q-2 60						
Q-3 60		14	4.000	56		56
Q-4 60						
Q-1 61	45.0	7672	2.994	22971		22971
Q-2 61						
Q-3 61	1.5	371	3.968	1472		1472
Q-4 61						
Q-1 62		101	3.010	304		304
Q-2 62						
Q-3 62		20	3.000	60		60
Q-4 62						
Q-1 63		22	2.864	63		63
Q-2 63						
Q-3 63		-2	5.000	-10		-10
Q-4 63						
Q-1 64		1	5.000	5		5
Q-2 64						
Q-3 64		1	4.000	4		4
Q-4 64						
Q-1 65		27	3.074	83		83
Q-2 65						
Q-3 65		11	3.000	33		33

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 02 ENVIRONMENTAL CONTROL GROUND TESTS
6-MAJ ASSY 11
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		1	3.000	3	6	9
TOTAL	49.5	8667		26260	6	26266

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 02
6-MAJ ASSY 11
ENVIRONMENTAL CONTROL GROUND TESTS

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-3 58	1.5	236	2.555	603	856	1459	96
Q-4 58							
Q-1 59	42.0	7232	2.712	19616	26755	46371	9315
Q-2 59							
Q-3 59	27.0	4845	2.798	13555	19964	33519	1189
Q-4 59							
Q-1 60		-104	1.836	191	-484	-293	447
Q-2 60							
Q-3 60	10.5	1783	3.942	7028	6504	13532	1199
Q-4 60							
Q-1 61	606.0	103508	2.867	296793	320529	617322	78543
Q-2 61							
Q-3 61	24.0	4495	5.276	23716	50910	74626	11483
Q-4 61							
Q-1 62	22.5	4015	3.830	15376	17181	32557	4877
Q-2 62							
Q-3 62	18.0	3123	3.931	12275	15436	27711	6394
Q-4 62							
Q-1 63	1.5	308	3.591	1106	1678	2784	632
Q-2 63							
Q-3 63	13.5	2166	3.880	8403	10807	19210	-122
Q-4 63							
Q-1 64		127	4.567	580	751	1331	3
Q-2 64							
Q-3 64		42	5.452	229	274	503	34341
Q-4 64							
Q-1 65		65	3.415	222	254	476	-1
Q-2 65							
Q-3 65		26	3.385	88	101	189	
Q-4 65							
Q-1 66		2	3.500	7	14	21	
TOTAL	766.5	131869		399788	471530	871318	148396

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 02
6-MAJ ASSY 11
ENVIRONMENTAL CONTROL GROUND TESTS

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-3 58	5		1560		1560
Q-4 58					
Q-1 59	789		56475		56475
Q-2 59					
Q-3 59	101		34809		34809
Q-4 59					
Q-1 60	59		213	4	217
Q-2 60					
Q-3 60	158		14889	284	15173
Q-4 60					
Q-1 61	6637		702502	13055	715557
Q-2 61					
Q-3 61	970	3069	90148	1675	91823
Q-4 61					
Q-1 62	384	1089	38907	653	39560
Q-2 62					
Q-3 62	504	2158	36767	617	37384
Q-4 62					
Q-1 63	62		3478	58	3536
Q-2 63					
Q-3 63	-12	-3235	15841	265	16106
Q-4 63					
Q-1 64		1	1335	28	1363
Q-2 64					
Q-3 64	12493	1	47338	1007	48345
Q-4 64					
Q-1 65		1	476	13	489
Q-2 65					
Q-3 65			189	5	194
Q-4 65					
Q-1 66			21		21
TOTAL	22150	3084	1044948	17664	1062612

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

4-SYSTEM 1
5-SUBSYSTEM 02
ENVIRONMENTAL CONTROL SUBSYSTEM

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOOLING AND STE HOURS DOLLARS	TEST /QC HOURS DOLLARS
DESIGN/ENGINEERING	971618			14184
LABOR AT $ 4.983	4852642			59820
ENGR BURDEN AT $ 4.398	4272723			63028
SHOP SUPPORT	2218			109018
LABOR AT $ 2.883	7022			313708
TEST/QC	264			8667
LABOR AT $ 3.038	872			26260
MFG BURDEN AT $ 3.480	9707			408592
ENGR MATERIAL	19300			148396
SUBCONTRACT	10795669	2507225	249833	
MPC	429370	122930	8389	22150
OTHER COST	194721			3084
SUB-TOTAL	20582026	2630155	258222	1044948
GEN & ADMIN	320262	48468	4666	17664
TOTAL COST	20902288	2678623	262888	1062612
TIME-PHASED COST DETAIL - SEE PAGE	III-440	III-448	III-450	III-451

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

4-SYSTEM 1
5-SUBSYSTEM 02
ENVIRONMENTAL CONTROL SUBSYSTEM

		TOTAL HOURS DOLLARS
DESIGN/ENGINEERING		985802
LABOR AT $ 4.983		4912462
ENGR BURDEN	AT $ 4.398	4335751
SHOP SUPPORT		111236
LABOR AT $ 2.883		320730
TEST/QC		8931
LABOR AT $ 3.038		27132
MFG BURDEN	AT $ 3.480	418209
ENGR MATERIAL		167696
SUBCONTRACT		13552727
MPC		582839
OTHER COST		197805
SUB-TOTAL		24515351
GEN & ADMIN		391060
TOTAL COST		24906411

TIME-PHASED COST
DETAIL - SEE PAGE III-458

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL 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	39.0	6668	4.609	30730	30336	61066
Q-2 58						
Q-3 58	261.0	43929	4.430	194598	172838	367436
Q-4 58						
Q-1 59	373.0	63643	4.437	282390	218484	500874
Q-2 59						
Q-3 59	694.5	122240	4.250	519503	434878	954381
Q-4 59						
Q-1 60	499.5	86544	4.699	406628	325712	732340
Q-2 60						
Q-3 60	511.5	85860	4.686	402380	319089	721469
Q-4 60						
Q-1 61	742.5	126748	4.656	590153	428694	1018847
Q-2 61						
Q-3 61	399.0	72257	5.401	390282	345567	735849
Q-4 61						
Q-1 62	373.5	63677	5.721	364276	290910	655186
Q-2 62						
Q-3 62	420.0	70497	5.440	383493	357497	740990
Q-4 62						
Q-1 63	382.5	65189	5.627	366789	353701	720490
Q-2 63						
Q-3 63	411.5	69151	5.219	360915	402747	763662
Q-4 63						
Q-1 64	363.0	61944	5.623	348294	381455	729749
Q-2 64						
Q-3 64	142.5	24969	6.059	151280	156019	307299
Q-4 64						
Q-1 65	36.0	6136	7.348	45085	40518	85603
Q-2 65						

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SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL 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	12.0	1994	7.311	14579	13144	27723
Q-4 65						
Q-1 66	1.5	172	7.366	1267	1134	2401
TOTAL	5662.5	971618		4852642	4272723	9125365

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	SHOP SUPPORT	
4-SYSTEM	1	
5-SUBSYSTEM	02	**ENVIRONMENTAL 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		6	2.500	15	14	29
Q-2 58						
Q-3 58						
Q-4 58					28	28
Q-1 59		8	2.250	18	30	48
Q-2 59						
Q-3 59	9.0	1555	2.874	4469	6338	10807
Q-4 59						
Q-1 60	3.0	552	4.043	2232	2955	5187
Q-2 60						
Q-3 60		10	2.500	25	-170	-145
Q-4 60						
Q-1 61						
Q-2 61						
Q-3 61						
Q-4 61						
Q-1 62	1.5	298	4.232	1261	1377	2638
Q-2 62						
Q-3 62	-1.5	-212	4.698	-996	-1045	-2041
Q-4 62						
Q-1 63		5	2.800	14	20	34
Q-2 63						
Q-3 63		-6	3.667	-22	2	-20
Q-4 63						
Q-1 64				-1	149	148
Q-2 64						
Q-3 64		2	3.500	7	9	16
TOTAL	12.0	2218		7022	9707	16729

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1 **ENVIRONMENTAL CONTROL SUBSYSTEM**
5-SUBSYSTEM 02
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		8	2.125	17		17
Q-4 58						
Q-1 59						
Q-2 59						
Q-3 59		113	2.938	332		332
Q-4 59						
Q-1 60		109	3.514	383		383
Q-2 60						
Q-3 60						
Q-4 60						
Q-1 61						
Q-2 61						
Q-3 61						
Q-4 61						
Q-1 62						
Q-2 62						
Q-3 62		4	3.000	12		12
Q-4 62						
Q-1 63						
Q-2 63						
Q-3 63						
Q-4 63						
Q-1 64		30	4.267	128		128
TOTAL		264		872		872

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

4-SYSTEM 1
5-SUBSYSTEM 02
ENVIRONMENTAL CONTROL SUBSYSTEM
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	39.0	6674	4.607	30745	30350	61095	
Q-2 58							
Q-3 58	261.0	43937	4.429	194615	172866	367481	93
Q-4 58							
Q-1 59	373.0	63651	4.437	282408	218514	500922	
Q-2 59							
Q-3 59	703.5	123908	4.231	524304	441216	965520	1275
Q-4 59							
Q-1 60	502.5	87205	4.693	409243	328667	737910	-493
Q-2 60							
Q-3 60	511.5	85870	4.686	402405	318919	721324	18
Q-4 60							
Q-1 61	742.5	126748	4.656	590153	428694	1018847	-11
Q-2 61							
Q-3 61	399.0	72257	5.401	390282	345567	735849	
Q-4 61							
Q-1 62	375.0	63975	5.714	365537	292287	657824	
Q-2 62							
Q-3 62	418.5	70289	5.442	382509	356452	738961	
Q-4 62							
Q-1 63	382.5	65194	5.626	366803	353721	720524	-268
Q-2 63							
Q-3 63	411.5	69145	5.219	360893	402749	763642	2691
Q-4 63							
Q-1 64	363.0	61974	5.622	348421	381604	730025	9377
Q-2 64							
Q-3 64	142.5	24971	6.059	151287	156028	307315	6119
Q-4 64							
Q-1 65	36.0	6136	7.348	45085	40518	85603	499
Q-2 65							
Q-3 65	12.0	1994	7.311	14579	13144	27723	
Q-4 65							

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B-70 AIRCRAFT STUDY

4-SYSTEM 1 **ENVIRONMENTAL CONTROL SUBSYSTEM**
5-SUBSYSTEM 02
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66	1.5	172	7.366	1267	1134	2401	
TOTAL	5674.5	974100		4860536	4282430	9142966	19300

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1 ENVIRONMENTAL CONTROL SUBSYSTEM
5-SUBSYSTEM 02
SUBD OF WORK DESIGN/ENGINEERING

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58					61095		61095
Q-2 58							
Q-3 58		93	5	1729	369308		369308
Q-4 58							
Q-1 59	24221	24221	642	4132	529917		529917
Q-2 59							
Q-3 59	1175206	1176481	32219	24125	2198345		2198345
Q-4 59							
Q-1 60	1673242	1672749	99209	15084	2524952	48108	2573060
Q-2 60							
Q-3 60	988355	988373	58644	13184	1781525	33943	1815468
Q-4 60							
Q-1 61	2465465	2465454	70637	16360	3571298	66365	3637663
Q-2 61							
Q-3 61	1737496	1737496	49780	14110	2537235	47149	2584384
Q-4 61							
Q-1 62	1058003	1058003	33625	16663	1766115	29644	1795759
Q-2 62							
Q-3 62	1053772	1053772	33460	16075	1842268	30922	1873190
Q-4 62							
Q-1 63	358906	358638	15214	26709	1121085	18745	1139830
Q-2 63							
Q-3 63	33741	36432	1349	21961	823384	13767	837151
Q-4 63							
Q-1 64	227262	236639	32211	14238	1013113	21557	1034670
Q-2 64							
Q-3 64		6119	2226	8324	323984	6894	330878
Q-4 64							
Q-1 65		499	149	1419	87670	2339	90009
Q-2 65							
Q-3 65				568	28291	755	29046
Q-4 65							

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1 **ENVIRONMENTAL CONTROL SUBSYSTEM**
5-SUBSYSTEM 02
SUBD OF WORK DESIGN/ENGINEERING

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 66				40	2441	74	2515
TOTAL	10795669	10814969	429370	194721	20582026	320262	20902288

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1 **ENVIRONMENTAL CONTROL SUBSYSTEM**
5-SUBSYSTEM 02
SUBD OF WORK PRODUCTION

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUPC
Q-1 60							
Q-2 60							15554
Q-3 60							
Q-4 60							340378
Q-1 61							
Q-2 61							475424
Q-3 61							
Q-4 61							501390
Q-1 62							
Q-2 62							221468
Q-3 62							
Q-4 62							221973
Q-1 63							
Q-2 63							144464
Q-3 63							
Q-4 63							256370
Q-1 64							330304
TOTAL							2507225

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B-70 AIRCRAFT STUDY

4-SYSTEM 1 **ENVIRONMENTAL CONTROL SUBSYSTEM**
5-SUBSYSTEM 02
SUBD OF WORK PRODUCTION

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 60	922	16476	314	16790
Q-2 60				
Q-3 60	20195	360573	6870	367443
Q-4 60				
Q-1 61	13621	489045	9088	498133
Q-2 61				
Q-3 61	14365	515755	9584	525339
Q-4 61				
Q-1 62	7038	228506	3835	232341
Q-2 62				
Q-3 62	7045	228918	3842	232760
Q-4 62				
Q-1 63	6142	150606	2518	153124
Q-2 63				
Q-3 63	8239	264609	4424	269033
Q-4 63				
Q-1 64	45363	375667	7993	383660
TOTAL	122930	2630155	48468	2678623

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1 **ENVIRONMENTAL CONTROL SUBSYSTEM**
5-SUBSYSTEM 02
SUBD OF WORK TOOLING AND STE

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 60	5034	298	5332	102	5434
Q-2 60					
Q-3 60	22220	1318	23538	448	23986
Q-4 60					
Q-1 61	66751	1912	68663	1276	69939
Q-2 61					
Q-3 61	74450	2133	76583	1423	78006
Q-4 61					
Q-1 62	36234	1151	37385	628	38013
Q-2 62					
Q-3 62	40061	1272	41333	694	42027
Q-4 62					
Q-1 63	4127	175	4302	72	4374
Q-2 63					
Q-3 63	6		6		6
Q-4 63					
Q-1 64	950	130	1080	23	1103
TOTAL	249833	8389	258222	4666	262888

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 02 ENVIRONMENTAL 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	9.0	1607	4.050	6508	6012	12520
Q-4 60						
Q-1 61	15.0	2563	4.787	12270	8716	20986
Q-2 61						
Q-3 61	12.0	2230	4.049	9029	10040	19069
Q-4 61						
Q-1 62	18.0	3038	4.090	12424	13606	26030
Q-2 62						
Q-3 62	16.5	2738	4.075	11158	14032	25190
Q-4 62						
Q-1 63		47	8.511	400	628	1028
Q-2 63						
Q-3 63	10.5	1751	4.026	7049	8794	15843
Q-4 63						
Q-1 64		119	4.714	561	726	1287
Q-2 64						
Q-3 64		37	5.946	220	262	482
Q-4 64						
Q-1 65		38	3.711	141	148	289
Q-2 65						
Q-3 65		15	3.733	56	59	115
Q-4 65						
Q-1 66		1	4.000	4	5	9
TOTAL	81.0	14184		59820	63028	122848

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 02 **ENVIRONMENTAL 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	234	2.560	599	856	1455
Q-4 58						
Q-1 59	40.5	7013	2.708	18993	26755	45748
Q-2 59						
Q-3 59	25.5	4610	2.791	12868	19964	32832
Q-4 59						
Q-1 60		-76	3.802	289	-484	-195
Q-2 60						
Q-3 60	1.5	162	2.864	464	492	956
Q-4 60						
Q-1 61	546.0	93273	2.804	261552	311813	573365
Q-2 61						
Q-3 61	10.5	1894	6.977	13215	40870	54085
Q-4 61						
Q-1 62	4.5	876	3.023	2648	3575	6223
Q-2 62						
Q-3 62	1.5	365	2.896	1057	1404	2461
Q-4 62						
Q-1 63	1.5	239	2.690	643	1050	1693
Q-2 63						
Q-3 63	3.0	417	3.271	1364	2013	3377
Q-4 63						
Q-1 64		7	2.000	14	25	39
Q-2 64						
Q-3 64		4	1.250	5	12	17
Q-4 64						
Q-1 65				-2	106	104
Q-2 65						
Q-3 65				-1	42	41
Q-4 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 02 ENVIRONMENTAL 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					3	3
TOTAL	636.0	109018		313708	408496	722204

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	TEST/QC	
4-SYSTEM	1	
5-SUBSYSTEM	02	ENVIRONMENTAL 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		2	2.000	4		4
Q-4 58						
Q-1 59	1.5	219	2.845	623		623
Q-2 59						
Q-3 59	1.5	235	2.923	687		687
Q-4 59						
Q-1 60		-28	3.500	-98		-98
Q-2 60						
Q-3 60		14	4.000	56		56
Q-4 60						
Q-1 61	45.0	7672	2.994	22971		22971
Q-2 61						
Q-3 61	1.5	371	3.968	1472		1472
Q-4 61						
Q-1 62		101	3.010	304		304
Q-2 62						
Q-3 62		20	3.000	60		60
Q-4 62						
Q-1 63		22	2.864	63		63
Q-2 63						
Q-3 63		-2	5.000	-10		-10
Q-4 63						
Q-1 64		1	5.000	5		5
Q-2 64						
Q-3 64		1	4.000	4		4
Q-4 64						
Q-1 65		27	3.074	83		83
Q-2 65						
Q-3 65		11	3.000	33		33
Q-4 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1 ENVIRONMENTAL CONTROL SUBSYSTEM
5-SUBSYSTEM 02
SUBD CF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 66		1	3.000	3	6	9
TOTAL	49.5	8667		26260	6	26266

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 02
SUBD OF WORK TEST/QC

ENVIRONMENTAL CONTROL SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-3 58 Q-4 58	1.5	236	2.555	603	856	1459	96
Q-1 59 Q-2 59	42.0	7232	2.712	19616	26755	46371	9315
Q-3 59 Q-4 59	27.0	4845	2.798	13555	19964	33519	1189
Q-1 60 Q-2 60		-104	1.836	191	-484	-293	447
Q-3 60 Q-4 60	10.5	1783	3.942	7028	6504	13532	1199
Q-1 61 Q-2 61	606.0	103508	2.867	296793	320529	617322	78543
Q-3 61 Q-4 61	24.0	4495	5.276	23716	50910	74626	11483
Q-1 62 Q-2 62	22.5	4015	3.830	15376	17181	32557	4877
Q-3 62 Q-4 62	18.0	3123	3.931	12275	15436	27711	6394
Q-1 63 Q-2 63	1.5	308	3.591	1106	1678	2784	632
Q-3 63 Q-4 63	13.5	2166	3.880	8403	10807	19210	-122
Q-1 64 Q-2 64		127	4.567	580	751	1331	3
Q-3 64 Q-4 64		42	5.452	229	274	503	34341
Q-1 65 Q-2 65		65	3.415	222	254	476	-1
Q-3 65 Q-4 65		26	3.385	88	101	189	
Q-1 66		2	3.500	7	14	21	
TOTAL	766.5	131869		399788	471530	871318	148396

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B-70 AIRCRAFT STUDY

4-SYSTEM 1 ENVIROMMENTAL CONTROL SUBSYSTEM
5-SUBSYSTEM 02
SUBD OF WORK TEST/QC

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-3 58	5		1560		1560
Q-4 58					
Q-1 59	789		56475		56475
Q-2 59					
Q-3 59	101		34809		34809
Q-4 59					
Q-1 60	59		213	4	217
Q-2 60					
Q-3 60	158		14889	284	15173
Q-4 60					
Q-1 61	6637		702502	13055	715557
Q-2 61					
Q-3 61	970	3069	90148	1675	91823
Q-4 61					
Q-1 62	384	1089	38907	653	39560
Q-2 62					
Q-3 62	504	2158	36767	617	37384
Q-4 62					
Q-1 63	62		3478	58	3536
Q-2 63					
Q-3 63	-12	-3235	15841	265	16106
Q-4 63					
Q-1 64		1	1335	28	1363
Q-2 64					
Q-3 64	12493	1	47338	1007	48345
Q-4 64					
Q-1 65		1	476	13	489
Q-2 65					
Q-3 65			189	5	194
Q-4 65					
Q-1 66			21		21
TOTAL	22150	3084	1044948	17664	1062612

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B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 02
ENVIRONMENTAL CONTROL SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58 Q-2 58	39.0	6668	4.609	30730	30336	61066
Q-3 58 Q-4 58	261.0	43929	4.430	194598	172838	367436
Q-1 59 Q-2 59	373.0	63643	4.437	282390	218484	500874
Q-3 59 Q-4 59	694.5	122240	4.250	519503	434878	954381
Q-1 60 Q-2 60	499.5	86544	4.699	406628	325712	732340
Q-3 60 Q-4 60	520.5	87467	4.675	408888	325101	733989
Q-1 61 Q-2 61	757.5	129311	4.659	602423	437410	1039833
Q-3 61 Q-4 61	411.0	74487	5.361	399311	355607	754918
Q-1 62 Q-2 62	391.5	66715	5.646	376700	304516	681216
Q-3 62 Q-4 62	436.5	73235	5.389	394651	371529	766180
Q-1 63 Q-2 63	382.5	65236	5.629	367189	354329	721518
Q-3 63 Q-4 63	421.5	70902	5.190	367964	411541	779505
Q-1 64 Q-2 64	363.0	62063	5.621	348855	382181	731036
Q-3 64 Q-4 64	142.5	25006	6.059	151500	156281	307781
Q-1 65 Q-2 65	36.0	6174	7.325	45226	40666	85892

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 02
ENVIRONMENTAL CONTROL SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	12.0	2009	7.285	14635	13203	27838
Q-4 65						
Q-1 66	1.5	173	7.347	1271	1139	2410
TOTAL	5743.0	985802		4912462	4335751	9248213

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 02
ENVIRONMENTAL CONTROL SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		6	2.500	15	14	29
Q-2 58						
Q-3 58	1.5	234	2.560	599	884	1483
Q-4 58						
Q-1 59	40.5	7021	2.708	19011	26785	45796
Q-2 59						
Q-3 59	34.5	6165	2.812	17337	26302	43639
Q-4 59						
Q-1 60	3.0	476	5.296	2521	2471	4992
Q-2 60						
Q-3 60	1.5	172	2.843	489	322	811
Q-4 60						
Q-1 61	546.0	93273	2.804	261552	311813	573365
Q-2 61						
Q-3 61	10.5	1894	6.977	13215	40870	54085
Q-4 61						
Q-1 62	7.5	1174	3.330	3909	4952	8861
Q-2 62						
Q-3 62	1.5	153	.399	61	359	420
Q-4 62						
Q-1 63	1.5	244	2.693	657	1070	1727
Q-2 63						
Q-3 63	3.0	411	3.265	1342	2015	3357
Q-4 63						
Q-1 64		7	1.857	13	174	187
Q-2 64						
Q-3 64		6	2.000	12	21	33
Q-4 64						
Q-1 65				-2	106	104
Q-2 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 02
ENVIRONMENTAL CONTROL SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65				-1	42	41
Q-4 65						
Q-1 66					3	3
TOTAL	651.0	111236		320730	418203	738933

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 02
ENVIRONMENTAL CONTROL SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		10	2.100	21		21
Q-4 58						
Q-1 59	1.5	219	2.845	623		623
Q-2 59						
Q-3 59	1.5	348	2.928	1019		1019
Q-4 59						
Q-1 60		81	3.519	285		285
Q-2 60						
Q-3 60		14	4.000	56		56
Q-4 60						
Q-1 61	45.0	7672	2.994	22971		22971
Q-2 61						
Q-3 61	1.5	371	3.968	1472		1472
Q-4 61						
Q-1 62		101	3.010	304		304
Q-2 62						
Q-3 62		24	3.000	72		72
Q-4 62						
Q-1 63		22	2.864	63		63
Q-2 63						
Q-3 63		-2	5.000	-10		-10
Q-4 63						
Q-1 64		31	4.290	133		133
Q-2 64						
Q-3 64		1	4.000	4		4
Q-4 64						
Q-1 65		27	3.074	83		83
Q-2 65						
Q-3 65		11	3.000	33		33
Q-4 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 02
ENVIRONMENTAL CONTROL SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 66		1	3.000	3	6	9
TOTAL	49.5	8931		27132	6	27138

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 02
ENVIRONMENTAL CONTROL SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	39.0	6674	4.607	30745	30350	61095	
Q-2 58							
Q-3 58	262.5	44173	4.419	195218	173722	368940	189
Q-4 58							
Q-1 59	415.0	70883	4.261	302024	245269	547293	9315
Q-2 59							
Q-3 59	730.5	128753	4.177	537859	461180	999039	2464
Q-4 59							
Q-1 60	502.5	87101	4.701	409434	328183	737617	-46
Q-2 60							
Q-3 60	522.0	87653	4.671	409433	325423	734856	1217
Q-4 60							
Q-1 61	1348.5	230256	3.852	886946	749223	1636169	78532
Q-2 61							
Q-3 61	423.0	76752	5.394	413998	396477	810475	11483
Q-4 61							
Q-1 62	399.0	67990	5.602	380913	309468	690381	4877
Q-2 62							
Q-3 62	438.0	73412	5.378	394784	371888	766672	6394
Q-4 62							
Q-1 63	384.0	65502	5.617	367909	355399	723308	364
Q-2 63							
Q-3 63	424.5	71311	5.179	369296	413556	782852	2569
Q-4 63							
Q-1 64	363.0	62101	5.620	349001	382355	731356	9380
Q-2 64							
Q-3 64	142.5	25013	6.057	151516	156302	307818	40460
Q-4 64							
Q-1 65	36.0	6201	7.306	45307	40772	86079	498
Q-2 65							
Q-3 65	12.0	2020	7.261	14667	13245	27912	
Q-4 65							

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TIME PHASED EXPEND.
B-7C AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 02
ENVIRONMENTAL CONTROL SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66	1.5	174	7.322	1274	1148	2422	
TOTAL	6443.5	1105969		5260324	4753960	10014284	167696

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SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 02
ENVIRONMENTAL CONTROL SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58					61095		61095
Q-2 58							
Q-3 58		189	10	1729	370868		370868
Q-4 58							
Q-1 59	24221	33536	1431	4132	586392		586392
Q-2 59							
Q-3 59	1175206	1177670	32320	24125	2233154		2233154
Q-4 59							
Q-1 60	1693830	1693784	100488	15084	2546973	48528	2595501
Q-2 60							
Q-3 60	1350953	1352170	80315	13184	2180525	41545	2222070
Q-4 60							
Q-1 61	3007640	3086172	92807	16360	4831508	89784	4921292
Q-2 61							
Q-3 61	2313336	2324819	67248	17179	3219721	59831	3279552
Q-4 61							
Q-1 62	1315705	1320582	42198	17752	2070913	34760	2105673
Q-2 62							
Q-3 62	1315706	1322100	42281	18233	2149286	36075	2185361
Q-4 62							
Q-1 63	507497	507861	21593	26709	1279471	21393	1300864
Q-2 63							
Q-3 63	290117	292686	9576	18726	1103840	18456	1122296
Q-4 63							
Q-1 64	558516	567896	77704	14239	1391195	29601	1420796
Q-2 64							
Q-3 64		40460	14719	8325	371322	7901	379223
Q-4 64							
Q-1 65		498	149	1420	88146	2352	90498
Q-2 65							
Q-3 65				568	28480	760	29240
Q-4 65							

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 02
ENVIRONMENTAL CONTROL SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 66				40	2462	74	2536
TOTAL	13552727	13720423	582839	197805	24515351	391060	24906411

TABLE OF CONTENTS

SUBSYSTEM: PROPULSION — WBS CODE: 1.3

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: PROPULSION

WBS CODE: 1.3

WBS LEVEL
4 5 6 7 8

1.3 PROPULSION SUBSYSTEM

1.3.1 Engine (YJ-93 GE) (GFE)

1.3.1.1 Front Frame

1.3.1.2 Compressor Section

Starters
Rotor
Rear Frame

1.3.1.3 Combustion Liner

1.3.1.4 Turbine Section

Nozzle
Rotor
Stator Assembly
Frame

1.3.1.5 Exhaust Section

Inner Cone
Duct Assembly
Nozzle Assembly

1.3.1.6 Fuel Distribution

1.3.1.7 Accessory Pod

Housing/Inerting
Main Fuel Control
Nozzle Area Control
A/B Control
Power Train/Take-Off
Fluid Drains

1.3.1.8 Lubrication System

Pumps
Filters
Reservoir
Oil Heat Exchanger
Sensors
Ejectors/Seals

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: PROPULSION

WBS CODE: 1.3

WBS LEVEL
4 5 6 7 8

1.3.1.9 Hydraulic System

Pumps
Filters
Reservoir
Actuators
Oil Heat Exchanger
Sensors
Seals

1.3.2 Engine Installation

1.3.2.1 Engine Shroud and Seals

1.3.2.2 Air Guide and Seals

1.3.2.3 Nose Fairing

1.3.2.4 Fire Detection Rings

1.3.2.5 Mount Assemblies

1.3.2.6 PTO Coupling

1.3.2.7 Drain and Vent Lines

1.3.2.8 Nitrogen Supply Lines

1.3.2.9 Compressor Bleed Air

1.3.2.10 Servicing Provisions

1.3.3 Engine Compartment Cooling

1.3.3.1 Bypass Plenum Valves

1.3.3.2 BLB Diverter Valves

Actuation Mechanism
Bellows Pressure Switch

1.3.3.3 BLB Check Valves

1.3.3.4 A/B Override Valves

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: PROPULSION

WBS CODE: 1.3

WBS LEVEL

4 5 6 7 8

1.3.3.5 Fire Override Control

1.3.3.6 Servo Valves

1.3.3.7 Filters

1.3.3.8 Ground Cooling Doors

1.3.3.9 Control Switches

1.3.3.10 Fire Wall/Heat Shield

1.3.4 Gaseous Nitrogen System

1.3.4.1 Nitrogen Tanks

Pressure Regulator
Sensors

1.3.4.2 Relief Valves

1.3.4.3 Engine Supply Regulator

1.3.4.4 ADS Supply Regulator

1.3.4.5 Flow Limit/Shut-Off

1.3.4.6 Fill Valve

1.3.4.7 Check Valves

1.3.5 Fuel System

1.3.5.1 Pressure Refueling/Defueling

Drain/Sample Valves
Spray Nozzles
Shut-off Valves
Refueling Panel
LCV Control Switches
Electrical Receptacle
Static Ground
Test Switch
LCV Test Circuit

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: PROPULSION

WBS CODE: 1.3

WBS LEVEL
4 5 6 7 8

1.3.5.2 Management/Quantity Indication

- Digital Gages
- Rotary Selector Switch
- Display Panel
- Pump Control Panel
- Pump Control Switches
- Test Switches
- Panel Tapes
- Caution and Warning
- Fuel Probes
- Fuel Control Unit
- Antilog Driver Assembly
- Sequence Switches
- Panel Motor
- Manual Override Circuit

1.3.5.3 Fuel Transfer

- Dual Level Control Valves
- Fuel Pumps
- Check Valves

1.3.5.4 Filtration

- Filter Elements
- Housing/Seals

1.3.5.5 Engine Fuel Supply

- Booster Pumps
- Check Valves
- Engine Shut-off Valve
- Thermal Bypass

1.3.5.6 Cooling Loop

- Hydraulic Heat Exchangers
- ADS Heat Exchangers
- Fuel/Water Boiler
- W/G Heat Exchanger
- Inert Heat Exchanger
- System Bypass
- Check Valves
- Cooling Loop Pumps
- Sensors and Controls

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WORK BREAKDOWN STRUCTURE

SUBSYSTEM: PROPULSION

WBS CODE: 1.3

WBS LEVEL
4 5 6 7 8

1.3.5.7 Pressurization/Inerting

Liquid Nitrogen Tanks
Quantity Probes
Shut-off Valves
Overboard Dump
Emergency Vent Valves
Nitrogen Heat Exchanger
Check Valves
Collector Pumps

1.3.6 Engine Thrust Control System

1.3.6.1 Throttle Quadrant Assembly

1.3.6.2 Capsule Control Assembly

1.3.6.3 Thrust Control Box

1.3.6.4 Engine Actuators

1.3.6.5 Control Communications

1.3.7 Engine Indicating System

1.3.7.1 RPM Gages (GFE)

1.3.7.2 EGT Gages (GFE)

1.3.7.3 Nozzle Position Indicators

1.3.7.4 Vibration Indicators

1.3.8 Fire Protection System

1.3.8.1 Fire Detection System

Sensing Cables
Sensing Rings
Control Units
Display Panel
Test Circuitry

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: PROPULSION WBS CODE: 1.3

WBS LEVEL
4 5 6 7 8

1.3.8.2 Fire Extinguishing System

Agent Container Assy
Double Check "Tee" Valve
Swing Check Valve
Distribution Lines
Spray Jets

1.3.8.3 Engine Compartment Cooling Interlock

1.3.8.4 Fuel Main Shutoff Interlock

1.3.9 Ground Tests

1.3.9.1 Engine Test Stand

1.3.9.2 Fire Tolerance Tests

1.3.9.3 Fuel Simulators

1.3.9.4 Wind Tunnel

TECHNICAL DESCRIPTION

SUBSYSTEM: PROPULSION SUBSYSTEM WBS CODE: 1.3

The propulsion subsystem consisted of the fuel system, fire protection system and engine system in addition to the various supporting systems including engine installation, engine compartment cooling, thrust control, and engine performance indication system.

The air vehicle was equipped with six axial flow turbojet General Electric YJ93-GE-3 engines installed side by side in the aft fuselage section to provide air vehicle thrust and to provide mechanical power and compressed air for operating equipment items. These engines burned JP-6 fuel and each developed 28,000 pounds of thrust at sea level.

The fuel supply consisted of a maximum usable quantity of 45,971 gallons contained in 5 tanks within the fuselage and 3 tanks within each of the wings. The location of fuel tankage is depicted in Exhibit 6, page II-16, under WBS 1.0.

The basic requirement of the propulsion subsystem was to propel the air vehicle at a velocity of Mach 3.0 at an altitude of 70,000 ft.

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: PROPULSION WBS CODE: 1.3

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
PROPULSION	TYPE/NO.	6 TURBO-JETS - (3 PER SIDE PER INLET) →				
WEIGHT	POUNDS	37,336	NOT AVAILABLE		38,964	38,984
FUEL	TYPE	JP-6	JP-6	JP-6	JP-6	JP-6
		HEF	-	-	-	-
THRUST: STATIC -IDLE	POUNDS	8400	8100	7500	7500	7500
THRUST: STATIC - MAXIMUM	POUNDS	165,000	151,500	147,000	140,100	140,100
THRUST: STATIC - MILITARY	POUNDS	120,000	107,520	105,000	97,500	97,500
AIRFLOW: STATIC - 100%	POUNDS/SEC.	1566	1566	1566	1566	1566
AIRFLOW: TAKE-OFF - 104%	POUNDS/SEC.	1620	1620	1620	1620	1620
AIRFLOW: CRUISE	POUNDS/SEC	(SEE CONFIDENTIAL REPORT SD72-SH-0035)				
FUEL CONSUMPTION: STATIC/MIL.	LBS/HR/LB	(SEE CONFIDENTIAL REPORT SD72-SH-0035)				
FUEL CONSUMPTION: STATIC/MAX.	LBS/HR/LB	(SEE CONFIDENTIAL REPORT SD72-SH-0035)				
FUEL SPECIFIC WEIGHT	LBS/GAL	6.7	6.7	6.7	6.55	6.55
ENGINE SPEED: 100%	RPM	6825	6825	6825	6825	6825
ENGINE INTERNAL PRESSURE	PSI	(SEE CONFIDENTIAL REPORT SD72-SH-0035)				

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: PROPULSION WBS CODE: 1.3

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	-	-	0.96034	0.96034	0.96034
MTBF	HOURS	-	-	44	44	44

TECHNICAL DESCRIPTION

SUBSYSTEM: PROPULSION SUBSYSTEM — WBS CODE: 1.3

MAJOR ASSEMBLY: ENGINE — WBS CODE: 1.3.1

The requirements for the YJ93 engine and the resultant features are listed in Exhibit 1, page III-481. The items most pertinent in describing the engine are as follows:

- High mach number air-breathing turbojet (design point - mach 3 @ 70,000 ft.).
- Medium pressure ratio (8.7:1) axial flow compressor.
- Single rotor (6825 rpm).
- Eleven-stage variable stator compressor.
- Two-stage turbine.
- Variable area C-D exhaust nozzle.
- Weight - 5,030 lbs.
- Length - 236.3 inches
- Nozzle diameter - 52.7 inches maximum full open.
-

The performance of the engine was as follows:

- Fuel - JP-6
- Sea level (static):
  - Thrust (maximum) - 28,000 lbs.
  - Thrust (military) - 19,900 lbs.
  - Airflow (100% rpm)- 261 lbs/sec.
- Turbine temperature - 2000°F - cruise
  - 2100°F - take off
- 104% rpm overspeed for hot day take-off (approximately 3% thrust increase).

In addition to the subsystems that were provided to support the engines, the engines were also designed and delivered with integral subsystems and accessories. These items included an engine power control system, engine windmill brake, lubrication system and a hydraulic system.

The power control system was supplied with each engine. It was designed to respond to throttle lever position, idle speed reset electrical signal and ambient pressure synchrosignal inputs from the air vehicle.

An engine braking system was provided with each engine as a safety device. The braking system was used under any circumstances when reducing engine windmilling was required to minimize damage to the engine or to the air vehicle such as fire, excessive engine vibration, loss of engine oil pressure or engine hydraulic pressure. Actuation of the braking system resulted in closure of the eleventh stage stators which reduced airflow through the engine to a degree that engine rotation became nil.

WBS CODE: 1.3.1

Each engine was delivered with an engine oil system. The system was designed to permit ten hours of engine operation at maximum oil consumption rate. The tank fluid level could be checked between flights from outside the air vehicle using an electrical portable tester. A float operated switch inside the oil tank controlled the test circuitry.

For operation of the engine actuator and controls an integral hydraulic system was supplied with each engine. The hydraulic system was designed to assure a 16-hour supply of fluid based on maximum consumption rate. The hydraulic reservoir was pressurized with nitrogen from an air vehicle supply to 65 psig. The pressurized nitrogen was to prevent cavitation of the hydraulic pump and oxidation of the hydraulic oil.

J93 ENGINE

REQUIREMENTS

- HIGH TAKEOFF & ACCELERATION THRUST
- LOW CRUISE SFC
- HIGH THRUST TO WEIGHT RATIO
- EFFICIENT OPERATION WITH 700°F INLET AIRFLOW RANGE

RESULTANT YJ93 FEATURES

- VARIABLE STATOR COMPRESSOR
- AIR COOLED TURBINE BLADES
- CONTINUOUS 100% RPM IN FLIGHT
- VARIABLE A/B-CONTINUOUS OPERATION
- WINDMILL BRAKE

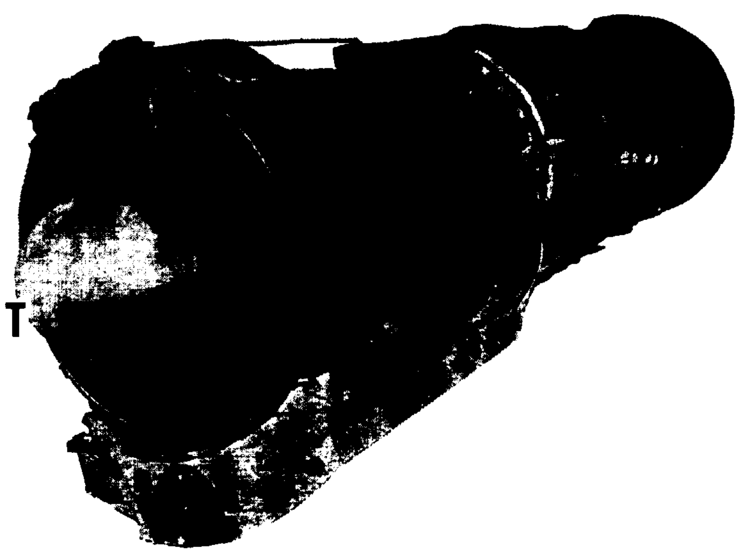


EXHIBIT 1

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: ENGINES WBS CODE: 1.3.1

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
ENGINE	TYPE	AFTER BURNING TURBO-JET WITH C/D NOZZLE →				
WEIGHT PER ENGINE	POUNDS	5003	5003	NOT AVAILABLE	5173	5183
THRUST: MAX. RATED	POUNDS	(SEE CONFIDENTIAL REPORT SD72-SH-0035)				
THRUST: INSTALLED, MAX. STATIC	POUNDS	(SEE CONFIDENTIAL REPORT SD72-SH-0035)				
COMPRESSION RATIO	NONE	8.75	8.75	8.75	8.75	8.75
LENGTH	INCHES	235 →				
DIAMETER	INCHES	56 →				
SPEED: 100%	RPM	6825 →				
HORSEPOWER EXTRACTED: CONTINUOUS	HP	300	280	280	280	280
: MAXIMUM	HP	425	405	405	405	405
AIRFLOW: TAKEOFF 100%	POUNDS/SEC	263 →				
104%	POUNDS/SEC	270 →				
AIRFLOW: CRUISE	POUNDS/SEC	(SEE CONFIDENTIAL REPORT SD72-SH-0035)				
SFC: MILITARY POWER, STATIC	LBS/HR/LB	(SEE CONFIDENTIAL REPORT SD72-SH-0035)				
AFTERBURNER POWER, STATIC	LBS/HR/LB	(SEE CONFIDENTIAL REPORT SD72-SH-0035)				

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: ENGINES WBS CODE: 1.3.1

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
NOZZLE COEFFICIENT	NONE	0.98	0.98	NOT AVAIL.	0.95	0.95
GAS TEMPERATURE: MILITARY	DEGREES F	(SEE CONFIDENTIAL REPORT SD72-SH-0035)				
AFTERBURNER	DEGREES F	(SEE CONFIDENTIAL REPORT SD72-SH-0035)				
ENGINE FWD. STRUCTURE TEMP.	DEGREES F	700 →				
ENGINE AFT STRUCTURE TEMP.	DEGREES F	1100 →				
HYDRAULIC FLUID	TYPE	GE 81406 (VERSILUBE F-50) →				
LUBRICANT	TYPE	MIL-L-9236 →				
AIRSPEED: MAX. DESIGN, CONTINUOUS	MACH NO.	(SEE CONFIDENTIAL REPORT SD72-SH-0035)				
FUEL COMPATIBILITY	TYPE	JP-6 → JP-4 → HEF →				
WINDMILL BRAKE	NONE	NO	NO	YES	YES	YES
ROTORS	NUMBER	1	1	1	1	1
COMPRESSOR STATORS	NUMBER	11	11	11	11	11
FIXED STATORS	NUMBER	6	6	6	6	6
TURBINE STAGES	NUMBER	2	2	2	2	2

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: ENGINES WBS CODE: 1.3.1

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
TURBINE TEMP.: CRUISE	DEGREES F	2000	→	→	→	→
: TAKEOFF	DEGREES F	2100	→	→	→	→
EXHAUST SECTION	TYPE	C-D	C-D	C-D	C-D	C-D
RELIABILITY FACTOR	NONE	-	-	0.96593	0.96593	0.96593
MTBF	HOURS	-	-	51	51	51

TECHNICAL DESCRIPTION

SUBSYSTEM: PROPULSION SUBSYSTEM WBS CODE: 1.3

MAJOR ASSEMBLY: ENGINE INSTALLATION WBS CODE: 1.3.2

The engines were installed in six individual compartments arranged side by side across the rear of the fuselage. Each compartment was sealed from the adjacent compartment and separated from the forward portion of the air vehicle by a transverse firewall immediately forward of the engine. A portion of the forward side of the firewall can be seen on the right hand side of Exhibit 2, page III-486. The air vehicle hydraulic and electric power generating equipment was separated from the engines and installed on gearboxes located below the air inlet ducts and forward of the engine compartment firewalls. The gearboxes were driven by drive shafts from each engine (see cone shaped component in Exhibit 2, page III-486).

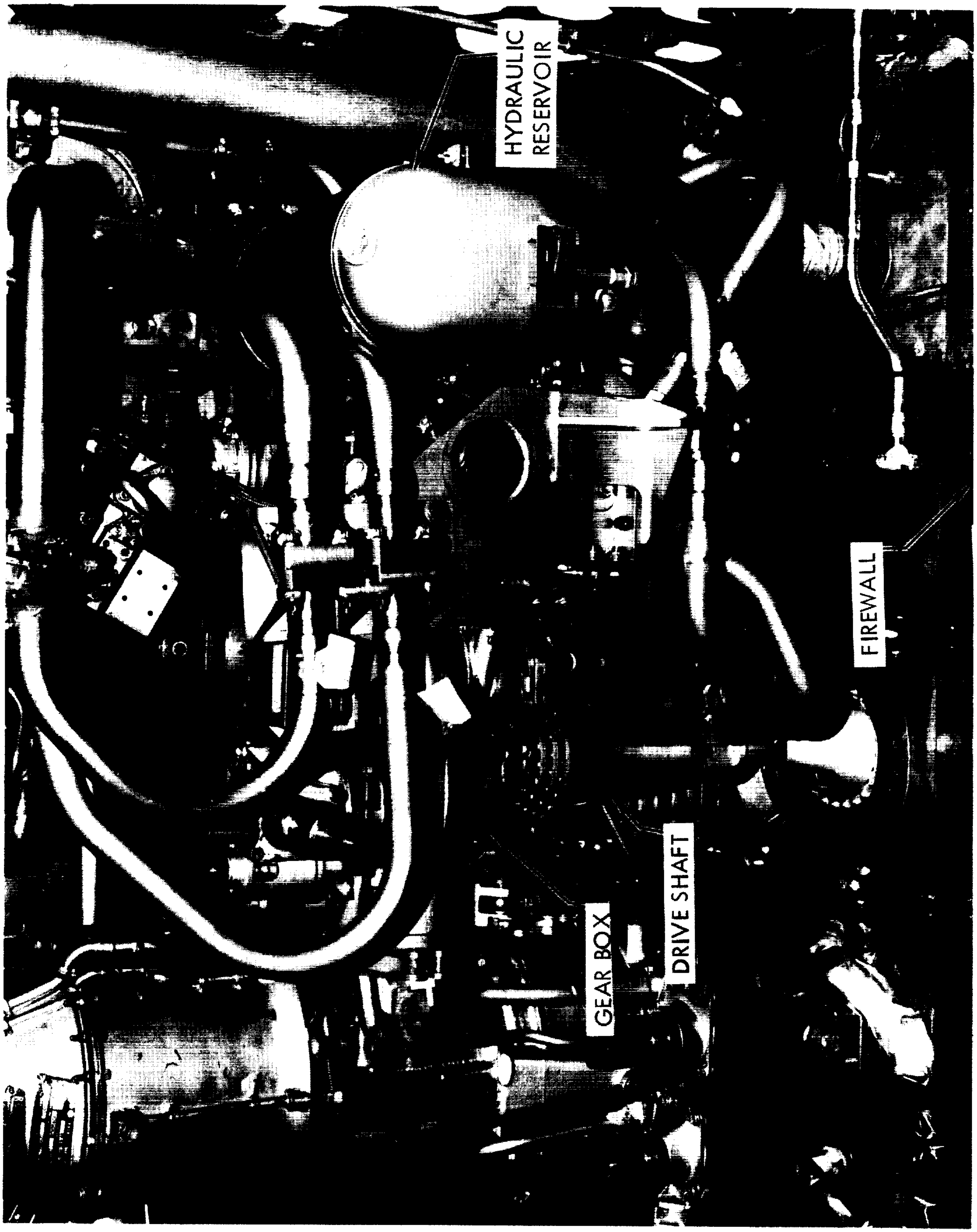
Each engine was mounted to the air vehicle structure by adjustable support links attached to the engine compressor front frame and the turbine rear frame. Mounting supports for each engine consisted of six links, each having provisions for adjustment to facilitate engine alignment in the air vehicle. To facilitate inspection, maintenance and engine removal, access doors and engine hoist points and tracks were provided in the bottom of the fuselage.

Additional items required to complete the engine installations were:

- Engine mounted shroud.
- Engine mounted air guide.
- Engine nose fairing.
- Fuel line.
- Engine drain lines.
- Engine oil tank vent line.
- Compressor bleed air line.

The purpose of the shroud, which was designed as a cylinder 10 feet long and $4\frac{1}{2}$ feet in diameter, was to provide a thermal barrier between the engine and the air vehicle structure, to duct high velocity cooling air around the engine and to provide fire protection from the engine combustion chamber aft.

ORIGINAL PAGE
BLACK AND WHITE PHOTOGRAPH



Air Vehicle 1, ADS Bay 2

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: ENGINE INSTALLATION WBS CODE: 1.3.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
ENGINE COMPARTMENTS	TYPE/NO.	6 FORWARD: SIDE BY SIDE →	→	→	→	→
		6 AFT : SIDE BY SIDE →	→	→	→	→
STRUCTURE/MATERIAL						
HAT SECTIONS	TYPE	RENE' 41 →	→	→	→	→
SKINS	TYPE	RENE' 41 →	→	→	→	→
FRAMES	TYPE	[H-11 (FWD), RENE' 41 (AFT)] →	→	→	→	→
SHROUD (ENGINE)	TYPE	RENE' 41 →	→	→	→	→
SHROUD (BULKHEAD)	TYPE	718 INCONEL →	→	→	→	→
ACCESS POINTS (TOTAL)						
FORWARD COMPARTMENT	NUMBER	6	6	6	6	6
AFT COMPARTMENT	NUMBER	6	6	6	6	6
OIL SERVICE	NUMBER	6	6	6	6	6
FWD MOUNTS	NUMBER	6	6	6	6	6
GROUND HANDLING HOIST	NUMBER	6	6	6	6	6
SHROUD ACCESS	NUMBER	6	6	6	6	6

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: **ENGINE INSTALLATION** WBS CODE: 1.3.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
TEMPERATURE: DESIGN						
FORWARD COMPARTMENT	DEGREES F	-65 to 800	(2000 for 10 Min)	→	→	→
AFT COMPARTMENT	DEGREES F	-65 to 800	(2000 for 10 Min)	→	→	→
SHROUD COMPARTMENT	DEGREES F	-65 to 1250	(2000 for 10 Min)	→	→	→
MOUNTING INSTALLATION	TYPE	3 POINT	→	→	→	→
FORWARD	TYPE/NO.	SINGLE VERTICAL	→	→	→	→
TURBINE FRAME	TYPE/NO.	TWO EACH SIDE ONE BOTTOM	→	→	→	→
FLUID DRAINS						
POD AMBIENT VENT	NUMBER	6	6	6	6	6
P&D VALVE DRAIN	NUMBER	6	6	6	6	6
BEARING SUMP DRAIN	NUMBER	12	12	12	12	12
POD MANIFOLD	NUMBER	6	6	6	6	6
COMPARTMENT DOORS	NUMBER	6	6	6	6	6
WEIGHT (TOTAL)	POUNDS	270	270	NOT AVAIL.	388	399

TECHNICAL DESCRIPTION

SUBSYSTEM: PROPULSION SUBSYSTEM WBS CODE: 1.3

MAJOR ASSEMBLY: ENGINE COMPARTMENT COOLING SYSTEM WBS CODE: 1.3.3

The general requirements for the system were:

- To provide sufficient cooling air for:

  Engine compartment
  Compartment structure
  Jet nozzle

- Impose minimum penalty on air vehicle performance

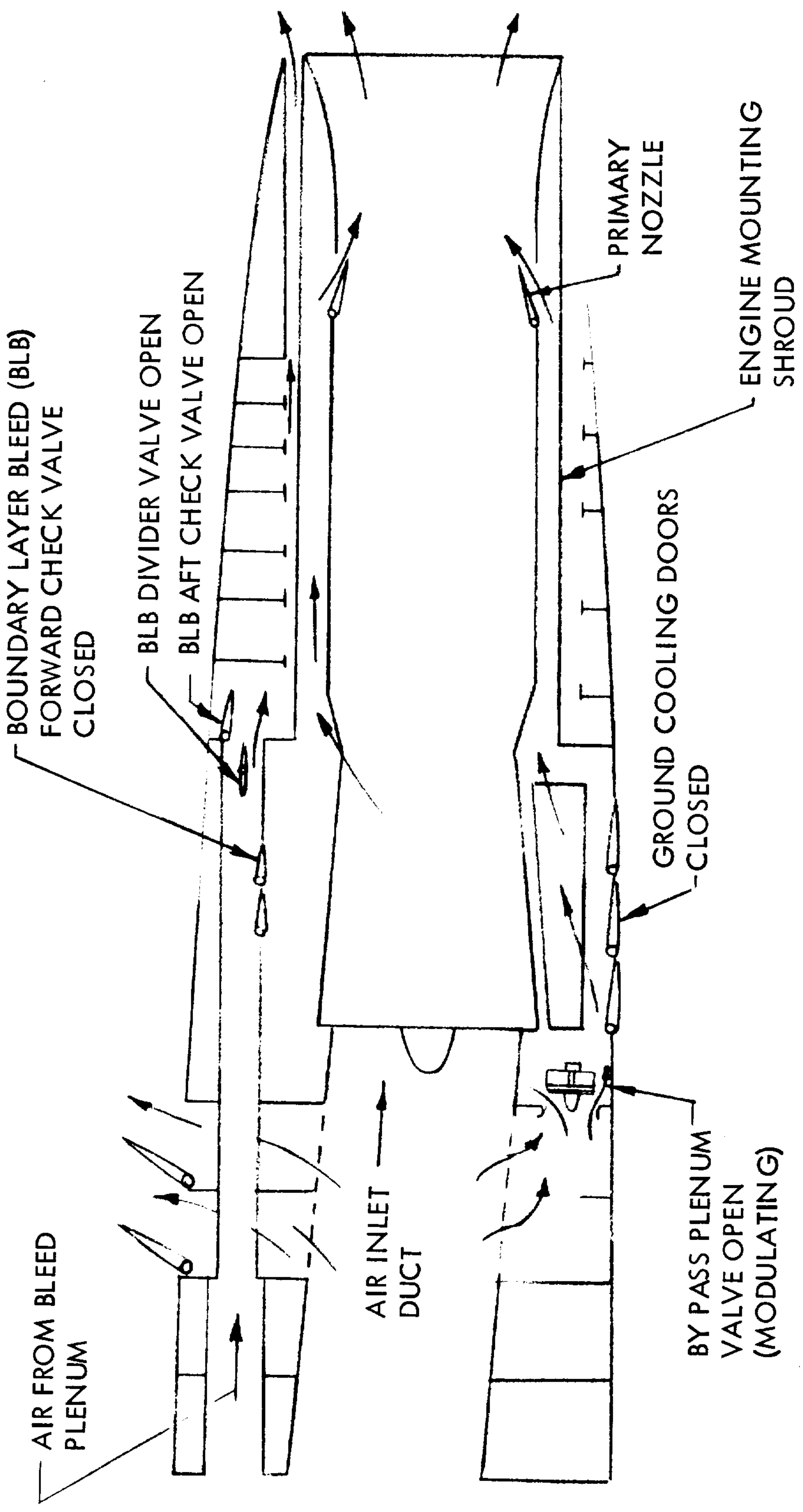
The characteristics of the resultant system were:

- Unidirectional airflow (front to aft - to keep combustion products and combustible mixtures out of inlet duct and engine).
- Transient flow condition (airflow - slow rate of change to keep boundary layer bleed above a specified value).
- Time at reduced flow is limited.
- Fire condition override - airflow reduced in event of fire.
- Control failure provision - system designed to provide adequate cooling air even under failure condition.
- Compartment over-pressure provision - system designed to limit pressure to compartment structural capability.

Air was supplied from three independent sources, namely ambient air, inlet bypass air and inlet boundary-layer-bleed air. These sources or modes of cooling air were defined as Regime I, II and III respectively. The incoming air exhausted as secondary airflow through the engine mounted shroud and the engine secondary nozzle. The cooling air directed to the engine compartments was controlled by a separate control for each compartment. Exhibit 3, page III-490, depicts schematically, a typical engine cooling system that is operating in Regime II. For the Regime I mode, cooling air enters through the ground cooling doors which were spring loaded open. As air vehicle speed increased the inlet air flow effected closure of these doors. For the Regime II mode cooling air flow was regulated by the modulating bypass plenum valve controlled by the cooling system control unit. For the Regime III mode (cruise speed) the most efficient source of cooling air was from the inlet bleed plenum by opening the forward boundary layer bleed check valves and closing the aft check valves.

In the event of an engine compartment fire, the fire extinguishing system was designed to provide a signal to the control unit resulting in override of the normal function and minimization of air flow into the engine compartment.

Relief valves were installed in the engine compartment to assure that compartment pressure would not exceed 12 psig.


BOUNDARY LAYER BLEED (BLB)
FORWARD CHECK VALVE
CLOSED
BLB DIVIDER VALVE OPEN
BLB AFT CHECK VALVE OPEN
PRIMARY
NOZZLE
ENGINE MOUNTING
SHROUD
GROUND COOLING DOORS
CLOSED
AIR FROM BLEED
PLENUM
AIR INLET
DUCT
BY PASS PLENUM
VALVE OPEN
(MODULATING)

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: ENGINE COMPARTMENT COOLING WBS CODE: 1.3.3

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
COMPARTMENTS	TYPE/NO.	ENGINE/6	→	→	→	→
CONTROL MEDIUM	TYPE	AIR	→	→	→	→
TEMPERATURE: DESIGN MAX.	DEGREES F	630	→	→	→	→
AIR FLOW: CRUISE	POUNDS/SEC	15	→	→	→	→
INTERNAL PRESS.: NORMAL	PSI	5	→	→	→	→
: MAXIMUM	PSI	10	→	→	→	→
AIRSPEED: MAX. DESIGN	MACH NO.	3.0+	→	→	→	→
ALTITUDE: MAX. DESIGN	FEET	100,000	90,000	→	→	→
BOUNDRY LAYER BLEED AIRFLOW	% OF ENGINE	5	→	→	→	→
AIS BYPASS AIRFLOW	% OF ENGINE	7	7	7	13	7
WEIGHT	POUNDS	179	→	→	→	→

TECHNICAL DESCRIPTION

SUBSYSTEM: PROPULSION SUBSYSTEM — WBS CODE: 1.3

MAJOR ASSEMBLY: GASEOUS NITROGEN SYSTEM — WBS CODE: 1.3.4

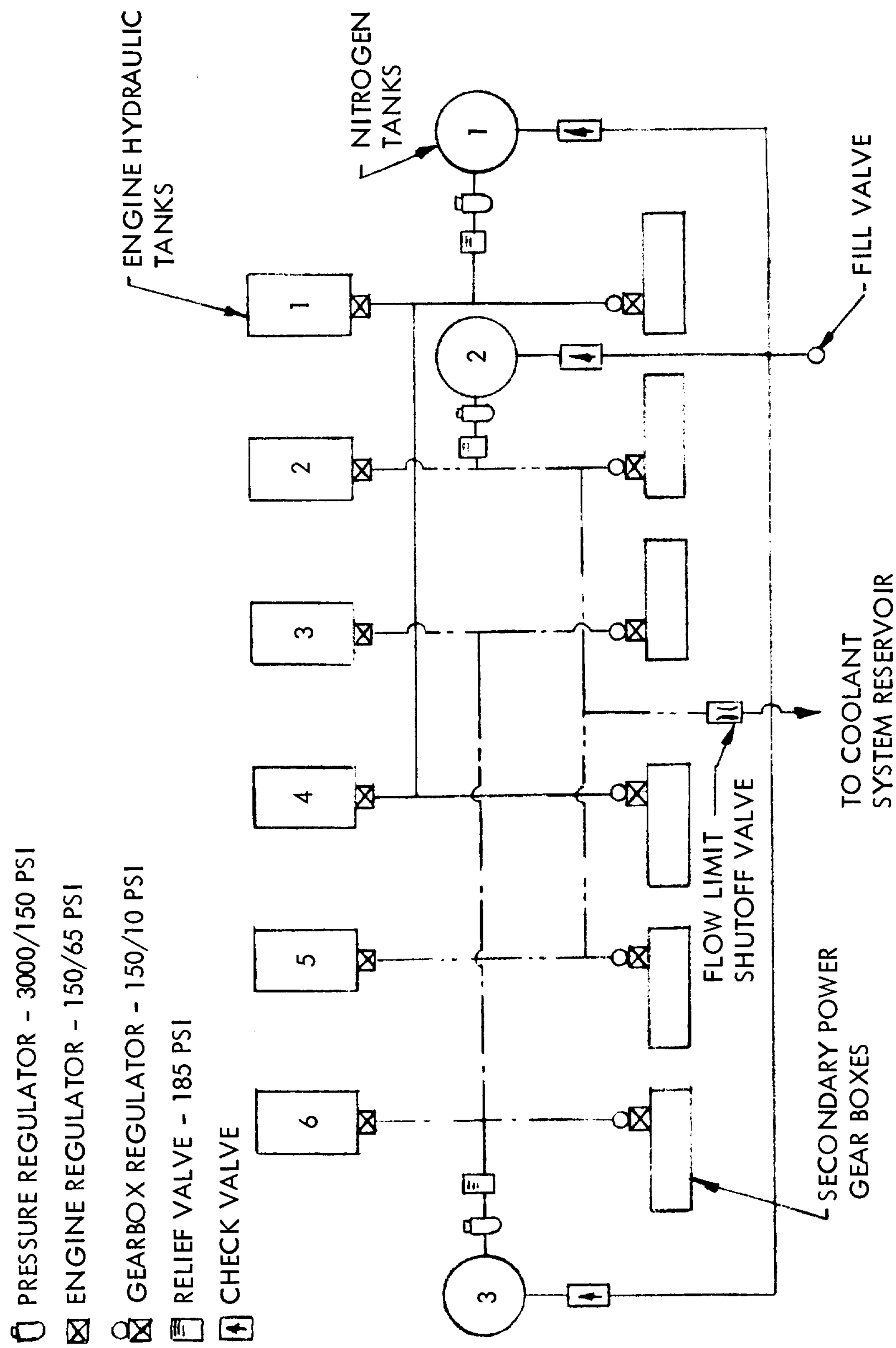
A gaseous nitrogen system was provided to pressurize the engine hydraulic reservoir, the accessory drive gearbox reservoirs, and the liquid reservoir in the cooling loop for the landing gear and the drag chute cooling systems.

The purpose of the engine nitrogen system, shown schematically in Exhibit 4, page III-493 was to:

- Pressurize and inert the engine hydraulic system reservoir to prevent pump cavitation and oil oxidation. (Reservoir is shown at top of Exhibit 2, page III-486)
- Pressurize and inert the secondary power gearbox also to prevent pump cavitation and oil oxidation. (Gearbox is connected to the conical shaped drive shaft shown in Exhibit 2, page III-486).
- Pressurize the coolant reservoir for the drag chute, wheel well cooling system to prevent premature boiling of the coolant.

Some of the significant features of the system were as follows:

- Three systems were used to increase reliability of the electrical and hydraulic systems.
- System was designed for 8 hour standby plus 4.1 hour operation.
- System pressure regulation - 150 psi.
- System relief pressure - 185 psi.
- Systems employed a common fill valve.



ENGINE NITROGEN SYSTEM

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: GASEOUS NITROGEN SYSTEM WBS CODE: 1.3.4

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
STORAGE	TYPE/NO	BOTTLES/4	BOTTLES/3	→	→	→
SYSTEM PRESS. REGULATOR	PSI	3000 to 150	→	→	→	→
RELIEF VALVE SETTING	PSI	185	→	→	→	→
ENGINE SUPPLY REGULATOR	PSI	150 to 65	→	→	→	→
GEARBOX SUPPLY REGULATOR	PSI	150 to 10	→	→	→	→
OPERATION: DESIGN TIME	HOURS	12.1	→	→	→	→

TECHNICAL DESCRIPTION

SUBSYSTEM: PROPULSION SUBSYSTEM WBS CODE: 1.3

MAJOR ASSEMBLY: FUEL SYSTEM WBS CODE: 1.3.5

The fuel system consisted of five integral tanks in the fuselage and three integral tanks in each wing. The distribution of the fuel is shown in the following table:

	Tank	A/V 1 Gallons	A/V 2 Gallons
FUS	1	7526	7422
	2	4889	4900
	3 sump	5413	5485
	4	6119	5906
	5	Dry	4641
Wing	6L&R	11857	10787
	7L&R	3290	3146
	8L&R	4077	3684
Total Gallons		43,171	45,971

All tanks were constructed as integral parts of the wing and fuselage. The tank structure was basically sealed by welding and brazing. Where required, nonmetallic materials were employed for sealing joints.

Many design advancements and innovations were achieved during the system development. For example chem-milled, corrosion resistant, steel tubing was utilized to reduce weight. The tubing was formed while at stock wall thicknesses and then chem-milled to reduce wall thickness. Where heavier gage was required at a clamp or braze joint location milling was controlled by local masking of the surface. For joining of the fluid lines,two types of light-weight couplings were developed for in-place induction brazing. One type consisted of an adjustable, wrap-around strap and the other type being a light-weight machined sleeve. For sealing of mechanical joints a high temperature seal was developed called a V-seal. It consisted of a circular ring of spring steel formed with a V shaped cross-section and coated with teflon. They were sized to fit in the conventional "O" ring grooves. To utilize metallic seals against aluminum surfaces at high temperatures it was necessary to prevent the metal seals from gouging the sealing surface. This was accomplished by bonding a corrosion resistant steel ring both to the seal groove and also to the seal surface of the mating part. Bonding was accomplished by utilizing an epoxy resin. The fuel filter element used in the engine feed line was the largest single element ever constructed for aircraft use. The element was of pleated, corrugated wire mesh. The corrugated configuration provided a greater contaminant holding capacity.

WBS CODE: 1.3.5

The overall fuel system was comprised of various subsystems consisting of valves, pumps, plumbing, filters, hydraulic motors, level control valves, etc. These systems were as follows:

- Refueling
- Venting
- Fuel transfer
- Engine feed
- Pressurization inerting
- Fuel management
- Cooling fuel

For refueling, a single-point, 600 gallon per minute, servicing coupling was employed in the refueling system. The refueling system was designed with a 1200 gallon per minute refueling capacity. The refueling system is shown schematically in Exhibit 5, page III-499. To conserve weight and maintain maximum system simplicity the refueling system and fuel transfer (inter-tank transfer) system employed a high degree of common plumbing. The level control valves (22) controlled the ultimate fill level in each tank preventing overfill.

A new fail closed type of level control valve was developed for the air vehicle. Metal diaphragms and high temperature fabric diaphragms were developed and used. The pressure drop characteristics of the design in relation to flow rate and size of the valve was considered a state-of-the-art advancement. Provisions for pre-checking the operation of the fuel level control valves prior to air vehicle refueling were incorporated in the design.

The fuel transfer system utilized 26 fuel transfer pumps controlled by automatic fuel sequencing (with manual override) to transfer fuel to a common sump tank (tank 3). The transfer system is shown schematically in Exhibit 6, page III-500. From the sump tank, fuel was fed to the six engines by three booster pumps. All pumps were powered by hydraulic motors. The hydraulic, motor driven, fuel pumps developed for the B-70 were of larger capacity for pump weight than any pump previously developed. They were designed to pump boiling fuel and this capability was demonstrated in the full scale fuel system simulator. Dual pumps for fuel transfer were provided at each location with separate hydraulic systems to each for reliability. This was the first air vehicle to utilize all hydraulic motor driven fuel pumps and the first to impose such elevated temperature conditions. Two different hydraulic motors were developed, a 16 horse power motor for the booster pumps and a 5 horse power motor for the fuel transfer pumps. The transfer pump impeller was designed to pump hot fuel down to a low level within the tanks to assure minimum residuals. The booster pump impeller was designed for extremely high performance since each pump had to deliver up to 600 gallons of fuel per minute. For control of these hydraulic motors, solenoid valves were developed which controlled the pilot operated hydraulic valve.

WBS CODE: 1.3.5

The vent system was designed to assure proper elimination of nitrogen and fuel vapors from each air vehicle tank as refueling was in progress. The vent system was closed following refueling and during flight except as necessary to maintain tank pressure at allowable limits.

The feed system transferred the fuel from the sump tank (number 3) to the six engines. Three booster pumps were incorporated in the system although only two were required. During take-off, fuel flow rates increased to 1200 gallons per minute. Each booster pump was driven by a different hydraulic system to increase reliability. The feed system also included fuel shut-off valves (6) and a filter.

The pressurization and inerting system for the B-70 fuel system was a significant first time application. Aerodynamic heating of the integral fuel tanks raised temperatures into the danger zone of auto-ignition of the JP-6 vapors. Through an extensive test program it was ultimately decided to control auto-ignition through lowering the oxygen content of the JP-6 and by maintaining an inert atmosphere of nitrogen in the tanks as fuel was consumed. Reduction of oxygen content in the fuel was accomplished by injecting nitrogen gas into the fuel flow during refueling. As the fuel level rose in the tanks bubbles of air and nitrogen were expelled through the vent system. This method maintained the oxygen content in the vent space at safe levels. During flight, nitrogen gas was introduced into the tanks at a pressure sufficient to prevent boiling of the fuel. This also provided an inert atmosphere in the fuel tanks. The nitrogen was provided from liquid nitrogen tanks with a capacity of 700 pounds.

The fuel management system consisted of a fuel distribution display panel, a fuel quantity indicating system, and a fuel sequencing control system. The fuel sequencing system automatically controlled the flow of fuel during normal operation to maintain the air vehicle center of gravity within prescribed limits. A manual override of the automatic function was provided for use at the crew's discretion.

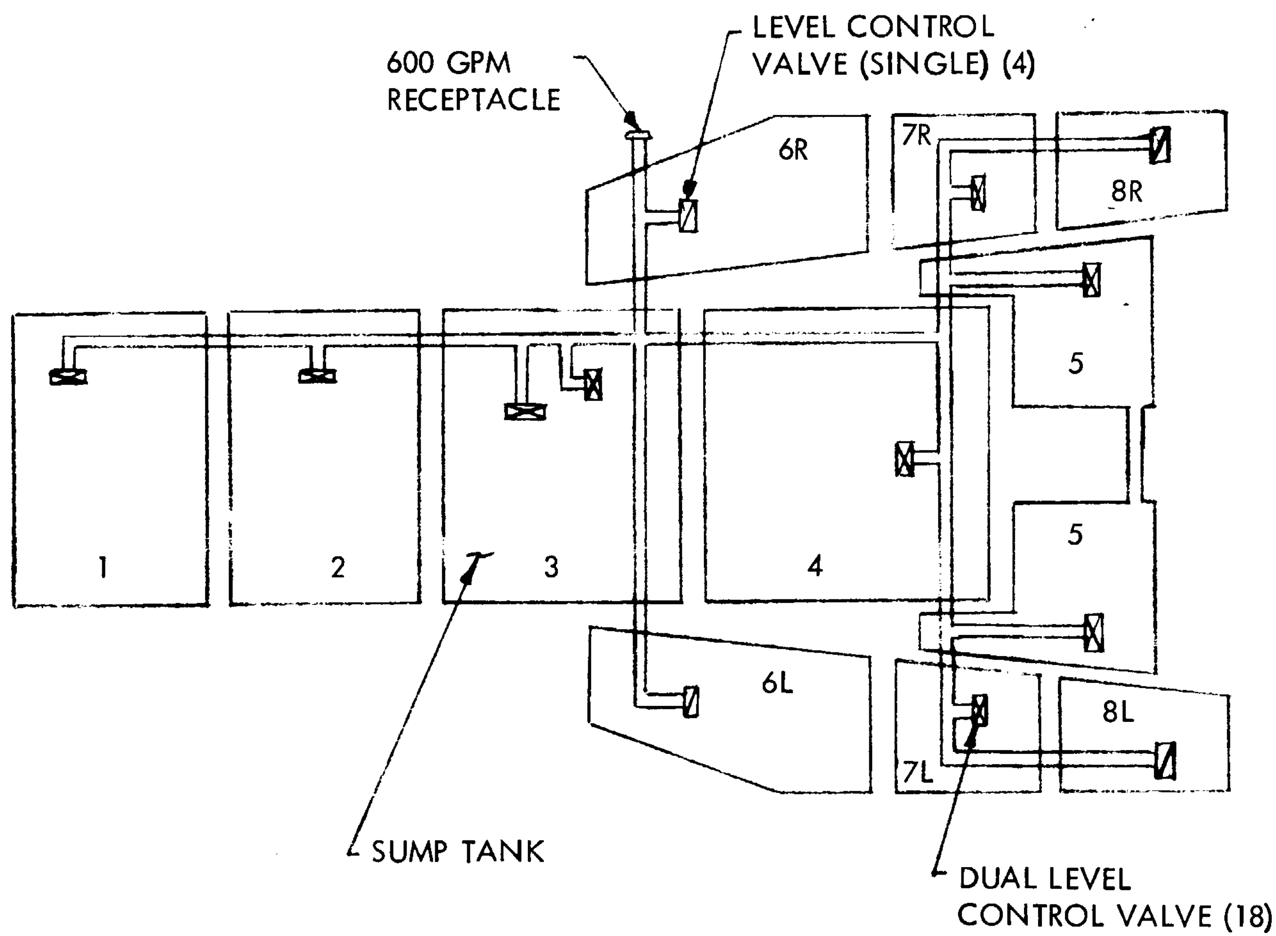
The fuel management system employed extensively, state-of-the-art capacitance type, fuel quantity indicating systems. Throughout the fuel system 66 capacitance probes were used. These tank units operated at elevated temperature and thus required temperature resistant insulators. The coaxial cables which carried the signals to the control unit also were developed for high temperature use. System reliability was attained through use of dual tank units (each location), dual selector switches and carrying spare plug in type control unit modules.

The fuel tank sequence indicator, shown in Exhibit 7, page III-501, consisted of a series of vertical tapes driven by actuator motors within the display unit and arranged in the sequence of fuel usage. In addition to this indicator a total fuel quantity indicator and a "selected tank" quantity indicator both with digital counter type registers are also provided in the cockpit.

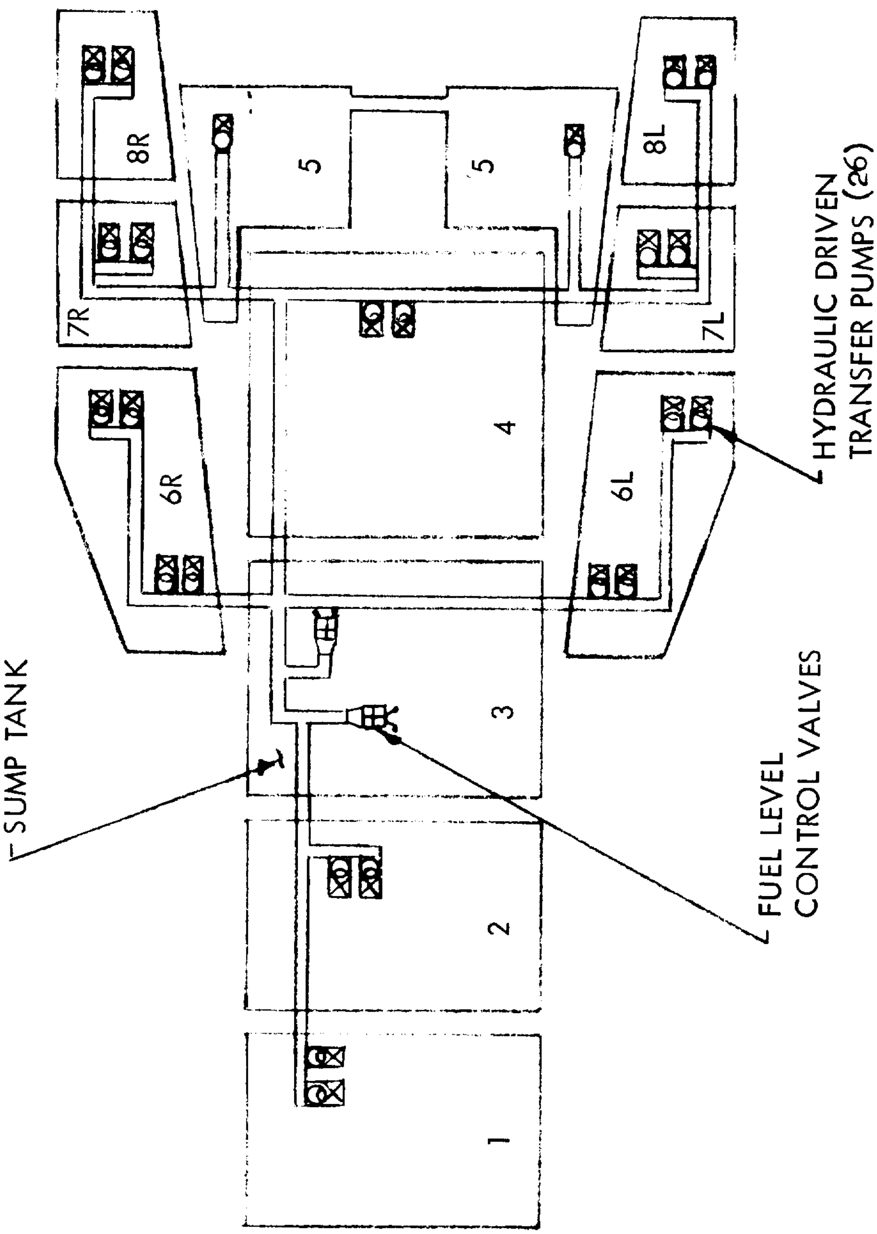
WBS CODE: 1.3.5

At the outset of the B-70 program, it was apparent that the temperature of air at Mach 3 speeds would preclude its use as cooling media for the aircraft working and lubricating fluids. Consequently, the heat-sink potential of the large volume of fuel on board was investigated; heat-sink capability being dependent on the temperature differential between the bulk fuel temperature and the allowable temperature of the engine heat exchanger fuel discharge. A fuel temperature limit of 300°F at the engine inlet was established early in the B-70 development program, based on the fuel thermal stability. Utilization of the fuel as a heat sink was accomplished by a fuel cooling loop incorporated into the engine fuel supply system. The loop contained the heat exchangers for cooling the landing gear drag chute and various air induction control and primary control components, the utility hydraulic system, the accessory drive systems and the primary hydraulic systems as well as the heat exchanger which supplied the gaseous nitrogen to the fuel tank inerting and venting system. The coolant fuel was supplied by the engine feed boost pumps to two line-mounted pumps (hydraulically driven) which circulate the fuel through the heat exchangers and back to the engine feed lines. To assure that the fuel did not accumulate too much heat, a water boiler system was incorporated in the coolant loop to maintain a maximum fuel temperature of 260°F during air vehicle descent.

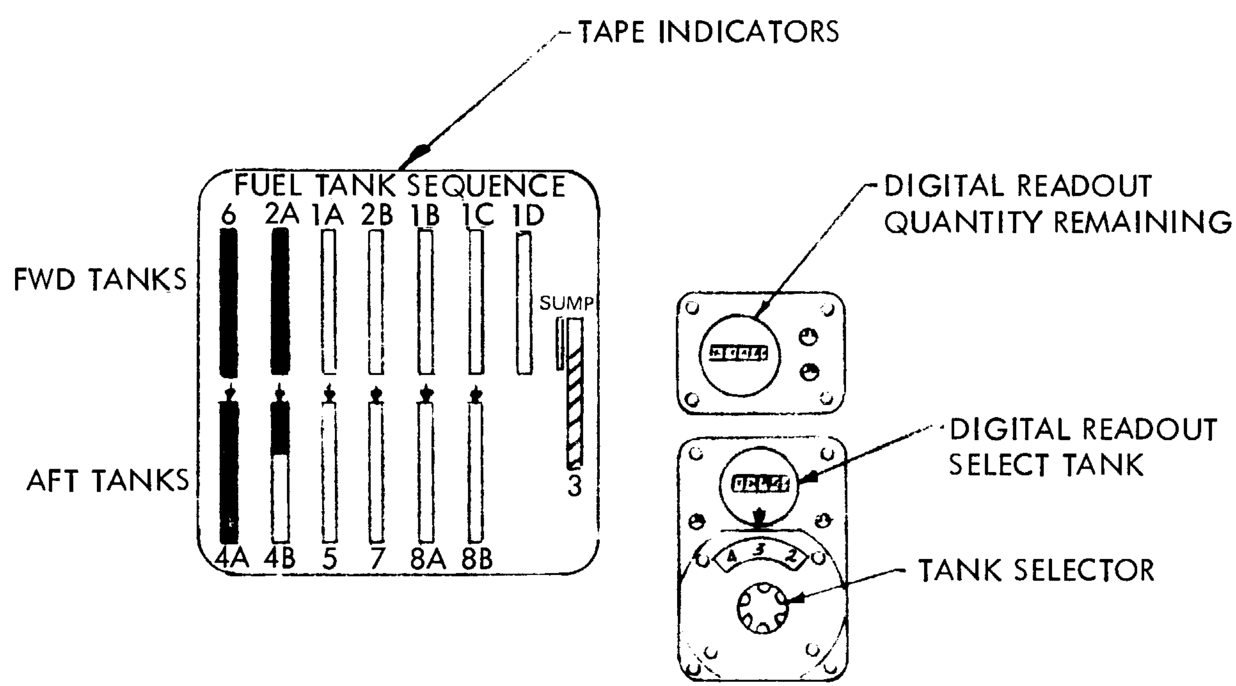
In view of the extensive plumbing and components located within the B-70 fuel tanks the need for safe maintenance procedures was evident. The inerting system was designed to provide an inert nitrogen atmosphere within the tanks as fuel was depleted. The oxygen content within the tanks had to be carefully controlled, particularly where a heat source (welding) was required for the maintenance activity. This then established the need for reliable equipment to maintain a safe atmosphere within the tanks. Special personnel protective equipment was also developed with safeguards against leakage or loss of breathing gas. Means were devised to cool the personnel by directing some of the tank-inerting nitrogen through a ventilation garment worn by each man. To further improve safety and work efficiency a communication system was also devised. With this equipment, maintenance was conducted safely and efficiently in the cramped confines of the fuel tanks.



REFUELING SYSTEM



TRANSFER SYSTEM



FUEL MANAGEMENT DISPLAY

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: FUEL SYSTEM WBS CODE: 1.3.5

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
FUEL	TYPE	JP-6 HEF	JP-6 -	JP-6 -	JP-6 -	JP-6 -
VOLUME (JP-6)	GALLONS	53,168	43,646	43,646	43,171	45,971
TANKS	NUMBER	14	11	11	10	11
SPECIFIC ENERGY (JP-6)	BTU/LB	18,400	→	→	→	→
FLASH POINT (JP-6)	DEGREES F	150	→	→	→	→
SPECIFIC WEIGHT (JP-6)	POUNDS/GAL	6.7	6.7	-	6.55	6.55
INERTING MEDIUM	TYPE	NITROGEN	→	→	→	→
FLOW RATE (MAXIMUM)	POUNDS/HOUR	450,000	→	→	→	→
ENGINE SUPPLY PRESSURE	PSI	50	→	→	→	→
FILTRATION (ENGINE SUPPLY)	TYPE	200 MESH	→	→	→	→
REFUELING RATE	GAL/MIN	1200	→	→	→	→
PUMPS: TRANSFER	NUMBER	32	26	26	24	26
BOOSTER	NUMBER	3	→	→	→	→
COOLING LOOP	NUMBER	2	→	→	→	→

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: FUEL SYSTEM WBS CODE: 1.3.5

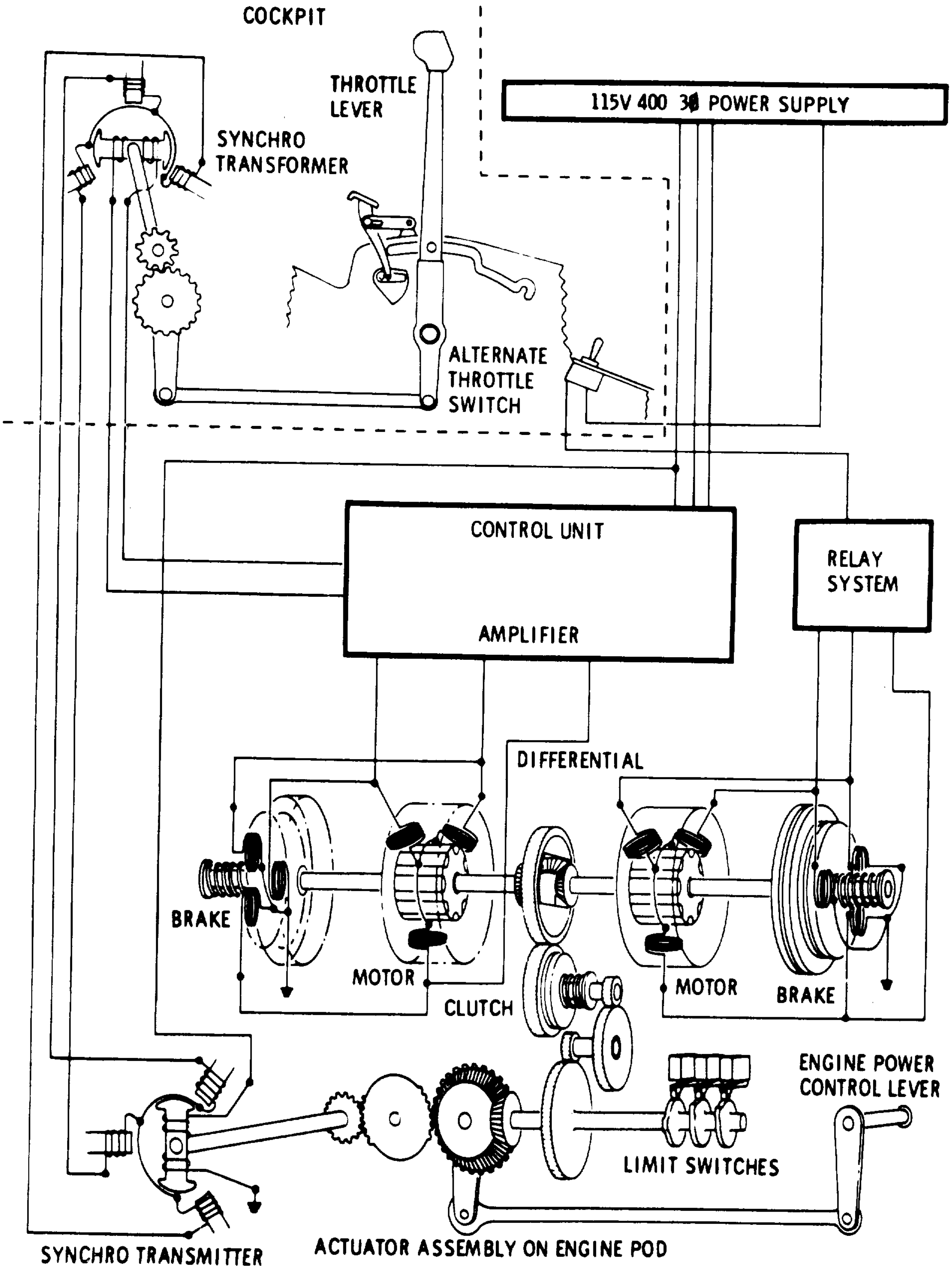
CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
FUEL GAGING	TYPE/NO	73	66	66	60	66
COOLING LOOP HEAT EXCHANGERS	NUMBER	10	8	8	8	8
N_2 STORAGE WEIGHT: DRY	POUNDS	489	489	-	716	716
N_2 STORAGE WEIGHT: WET	POUNDS	1219	1219	-	1416	1416
N_2 STORAGE SYSTEM	TYPE/NO.	DEWAR/2	→	→	→	→
N_2 SYSTEM PRESSURE	PSI	93	→	→	→	→
N_2 SYSTEM MAX FLOW RATE	POUNDS/HOUR	7200	→	→	→	→
N_2 SYSTEM TEMP: DESIGN	DEGREES F	-320 to 450	→	→	→	→
FUEL VENT PRESS.: NORMAL	PSIG	± 2	→	→	→	→
FUEL VENT PRESS.: MAXIMUM	PSIG	-4.2 to 12.2	→	→	→	→
FUEL STORAGE TEMP.: DESIGN	DEGREES F	-65 to 250	→	→	→	→
FUEL AMBIENT TEMP.: DESIGN	DEGREES F	-65 to 450	→	→	→	→
COOLING LOOP HEAT ABSORBED	DEGREES F	50 (785 LBS/MIN FUEL FLOW)	→	→	→	→

TECHNICAL DESCRIPTION

SUBSYSTEM: PROPULSION SUBSYSTEM WBS CODE: 1.3

MAJOR ASSEMBLY: ENGINE THRUST CONTROL SYSTEM WBS CODE: 1.3.6

The extensive distance between the cockpit and the engines and thermal gradients made the conventional mechanical control system unfeasible in terms of weight, operating force requirements and accuracy. An electrical system approach was finally selected because of superiority in accuracy, operating loads, installation volume, structural compatibility, weight and accessibility. The development of the electrically powered throttle system, (shown schematically in Exhibit 8, page III-505) required the development of electric motors capable of operating in a 500°F environment in addition to developing confidence in the reliability of the system. The major components of the system were throttle quadrant, cockpit to engine electric servo mechanism, control amplifiers and electric motor actuator. The thrust control system consisted of a thrust control quadrant (throttle) and dual electrical circuitry for each engine. The quadrant had six individual engine throttle levers. Each lever controlled its respective engine through the entire power range. A positive means was provided which prevented inadvertent throttle setting at overspeed or shutdown. The throttle levers (6) were grouped so that all engines could be operated simultaneously with one hand. Thrust control communication between the throttle quadrant and the engines was by means of an independent electric servomechanism for each engine. The principal mode of operation was by a closed loop servo system consisting of an input synchrotransformer connected to the throttle lever, a control amplifier, an electric motor actuator for positioning the engine power control lever and a feed back sensor called a synchrotransmitter. An alternate throttle switch called a "jog" switch was provided as a backup measure to directly control a second electric motor actuator by bypassing the control amplifier. This switch is located immediately aft of the throttle lever. Actuation of the "jog" switch locked out the servosystem for that engine until the reset switch was operated, at which time the control of the engine reverted back to the servosystem.



Electrical Throttle System

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: ENGINE THRUST CONTROL WBS CODE: 1.3.6

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
THRUST CONTROL	TYPE	ELECTRO-MECHANICAL →	→	→	→	→
WEIGHT	POUNDS	288	288	288	581	581
MAJOR SYSTEMS	TYPE	THROTTLE QUADRANT ELECTRO-SERVO MECHANISM CONTROL AMPLIFIERS ELECT. MOTOR ACTUATOR		→	→	→
POSITIVE STOPS	TYPE	OFF IDLE MAX. A/B	→	→	→	→
DETENTS	TYPE	MIL. PWR. NIN. A/B	→	→	→	→
CONTROL RANGE	TYPE	OFF TO 104%	→	→	→	→
EMERGENCY CONTROL	TYPE	JOG SWITCHES	→	→	→	→
ELECT. MOTOR ACTUATOR (DUAL)	TYPE	3 PHASE/BRAKED	→	→	→	→
ELECT. MOTOR ACT. CONTROL	TYPE	SYNCHRO	→	→	→	→
ELECT. MOTOR OPERATING TEMP.	DEGREES F	550	→	→	→	→
ELECT. MOTOR POWER OUTPUT	HORSEPOWER	1/50	→	→	→	→
ELECT. MOTOR TORQUE OUTPUT	INCH-OZ	7	→	→	→	→

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: ENGINE THRUST CONTROL WBS CODE: 1.3.6

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
CONTROL AMPLIFIERS	TYPE	(SOLID (2 TRANSITORS AND 2 MAGNETIC)) →	→	→	→	→
CONTROL AMPLIFIERS: MAX TEMP	DEGREES F	250	→	→	→	→
CONTROL AMPLIFIERS: RECTIFIER	TYPE	SOLID STATE (GE SILICON) →	→	→	→	→
SYNCHROS TRANSMITTER POWER REQ.	SPECIFY	115 VAC, 400 HERTZ →	→	→	→	→
SYNCHROS TRANSMITTER: DES. TEMP	DEGREES F	550	→	→	→	→
SYNCHROS TRANSFORMER: DES TEMP	DEGREES F	160	→	→	→	→
ACCURACY: MIL POWER	DEGREES	-	± 2	→	→	→
ACCURACY: A/B POWER	DEGREES	-	± 3	→	→	→
RESPONSE: NORMAL	DEGREES/SEC.	-	67	→	→	→
RESPONSE: MINIMUM	DEGREES/SEC.	-	57	→	→	→
SYSTEM TORQUE: NORMAL	INCH/LBS	-	45	→	→	→
SYSTEM TORQUE: STALL-FAULT	INCH/LBS	-	100	→	→	→
SYSTEM TORQUE: MAXIMUM	INCH/LBS	-	300	→	→	→
RELIABILITY FACTOR	NONE	-	-	0.99990	0.99990	0.99990
MTBF	HOURS	-	-	17,543	17,543	17,543

TECHNICAL DESCRIPTION

SUBSYSTEM: PROPULSION SUBSYSTEM WBS CODE: 1.3

MAJOR ASSEMBLY: ENGINE INDICATING SYSTEM WBS CODE: 1.3.7

To provide the air vehicle crew with pertinent information concerning the performance status of the engines, various indicators were installed on the main instrument panels. For monitoring engine speed an electrical tachometer indicator was installed on the center section of the instrument display panel. The indicator for each engine was driven by a tachometer generator furnished as part of each engine. To preclude the possibility of an engine overtemperature condition an engine exhaust gas temperature indicator was provided for each engine. A chromel-alumel thermocouple, furnished as part of the engine, provided the input signals to the indicator. To assist in crew monitoring, a flashing light warning circuit was incorporated in each indicator. Engine primary nozzle area in percent of nozzle opening for each engine was also displayed. The synchro torque transmitter which supplied the signal to the indicator was furnished as part of the engine. An engine vibration system was also provided for each engine. The two vibration sensors (accelerometers) were mounted, one on the engine compressor rear frame and one on the turbine frame. The displays and control units were calibrated to show the percentage of vibration amplitude. Included in the display was a yellow "vibration high" caution light and an engine selector switch.

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: ENGINE INDICATING SYSTEM WBS CODE: 1.3.7

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	LBS	1111	NOT AVAILABLE		795	863
RPM INDICATOR						
ACCURACY	% FS	-	-	0.8	→	→
FREQ. RESPONSE	HERTZ	-	-	0.037	→	→
HYSTERESES	% FS	-	-	0.5	→	→
EXHAUST GAS TEMP						
ACCURACY	% FS	-	-	1.25	→	→
NOZZLE POSITION						
ACCURACY	% FS	-	-	2.1	→	→
FREQ. RESPONSE	HERTZ	-	-	0.25	→	→
RESOLUTION	% FS	-	-	INFINITE	→	→
HYSTERESES	% FS	-	-	0.83	→	→
TEMPERATURE (OPERATING)	DEGREES F	-65 to 160	→	→	→	→

TECHNICAL DESCRIPTION

SUBSYSTEM: PROPULSION WBS CODE: 1.3

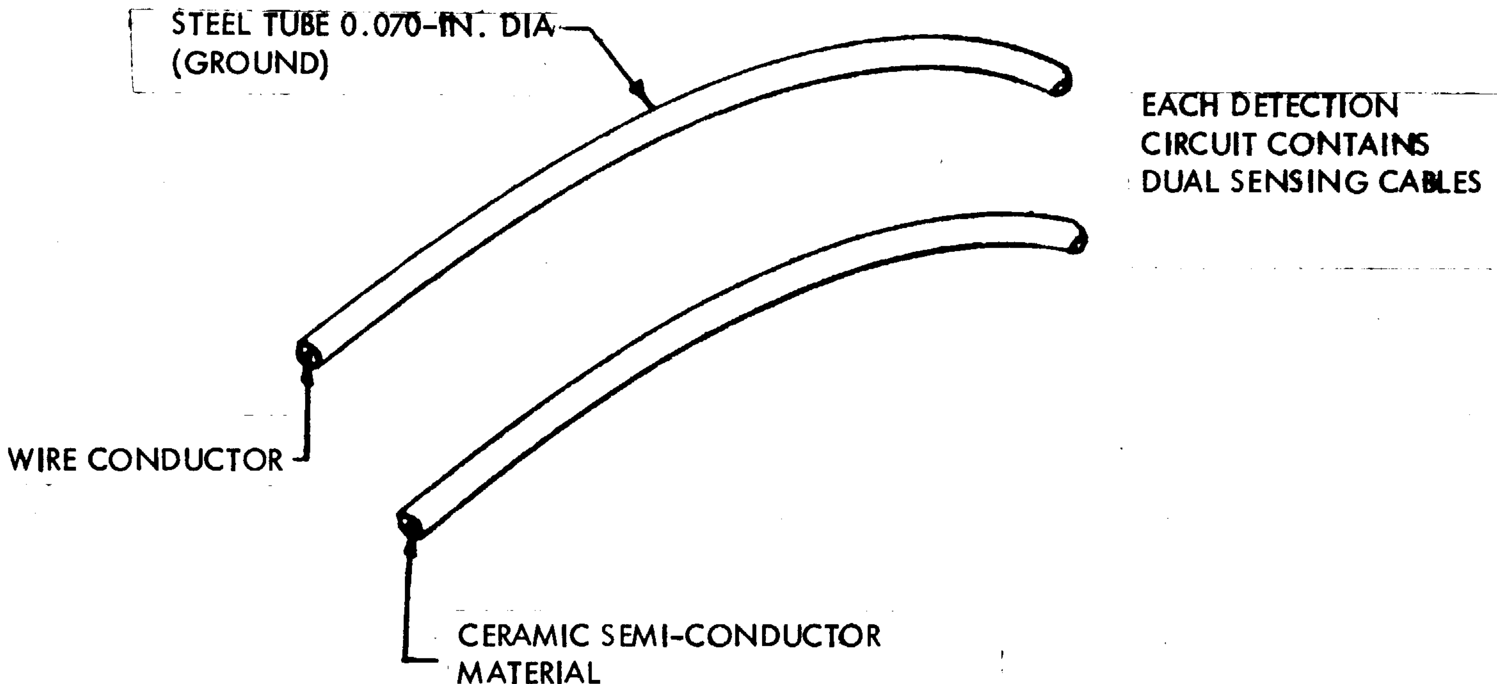
MAJOR ASSEMBLY: FIRE PROTECTION WBS CODE: 1.3.8

The B-70 was provided with a fire protection subsystem consisting of twelve separate continuous type systems - one for each of the six engine compartments and one for each of the six accessory drive subsystem compartments. The continuous type sensing cables and the magnetic amplifier type control unit in each system provided a reliable fire or overtemperature detection system. The problem of false fire warning signals experienced in most earlier systems was essentially eliminated by (1) utilization of dual instead of single sensing cable circuits which eliminated false signals due to a single cable failure in these vulnerable circuits, (2) twisting of the electrical wires and providing shielding which eliminated false signals due to electro-interference. Each of the twelve systems consisted of a control unit, fixed adjustment resistors, warning lamps, sensing cables, electrical connectors,test switches, test relays and associated electrical wiring. The control unit containedtwo sensing cable circuits independent except for power supply. The circuits constituted a Wheatstone bridge type circuit with fixed resistors in the control unit forming two legs of the circuit and the associated sensing cables constituting the other two legs. In the event the resistance of the sensing cable was altered, the bridge became electrically unbalanced, relays actuated and the display signal was energized. The sensing cable consisted of two concentric metal tubes with an outside diameter of .07 inch. The inner tube contained a semi-conductor core material except for the conductive wire through its center. A sketch of the sensing cable is shown in Exhibit 9, page III-512.

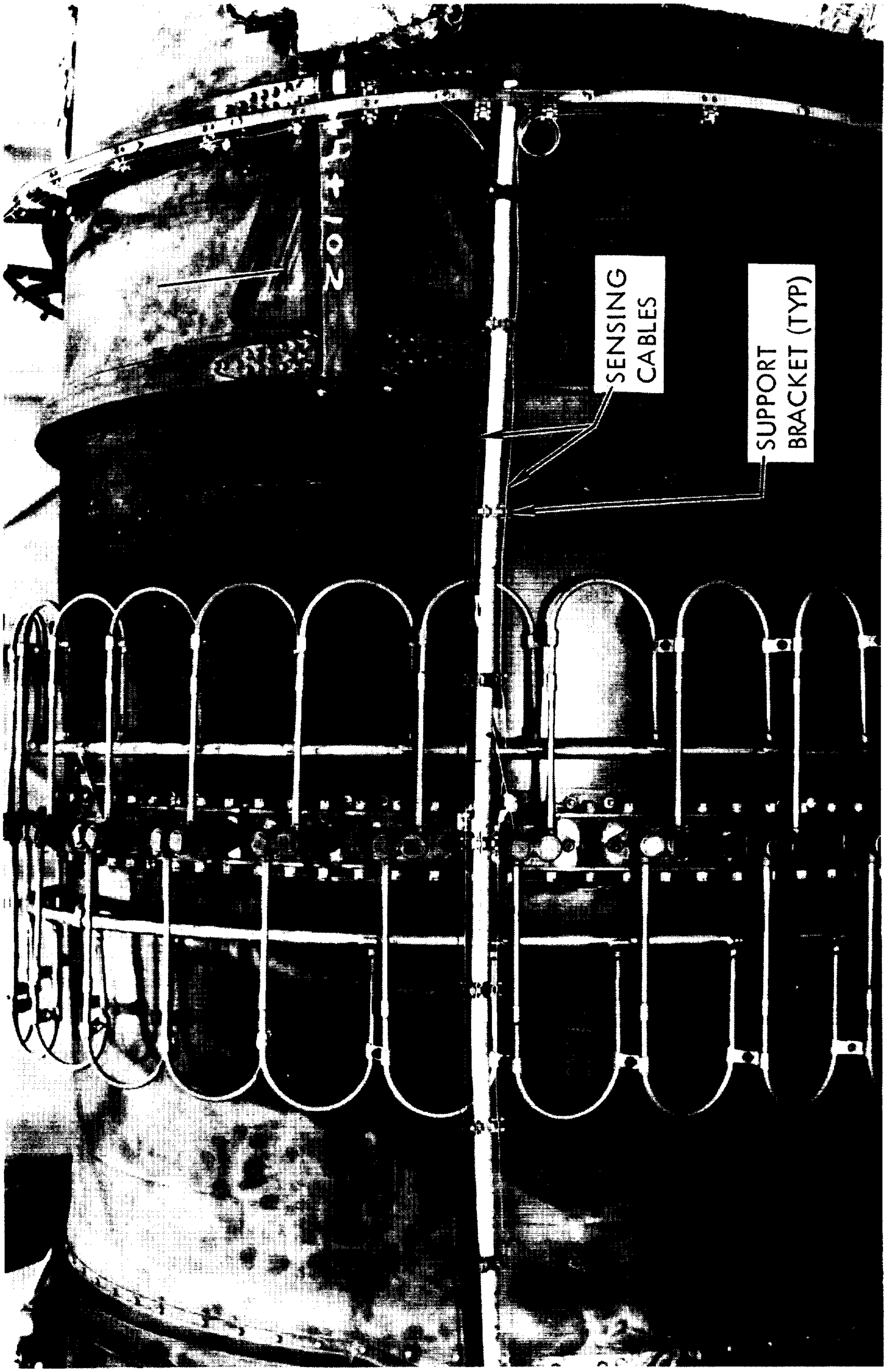
Each engine compartment and each accessory drive subsystem compartment had a separate fire detection system. When a fire or overtemperature condition existed, the cable conductor-to-case resistance decreased to or below the corresponding fixed resistor value, energizing the control unit relays and illuminating the corresponding warning lamps. Both sensing cable circuits within an installation had to detect or be influenced by the hazardous condition before the warning lamps could be illuminated. Exhibits 10 through 12 show typical sensing cable installations on a B-70 engine.

The fire extinguishing system consisted of two, essentially identical systems. The left-hand system provided protection for the engines and accessory drive subsystems compartments on the left of centerline and the right-hand system protected the right-hand engines and accessory drive subsystem compartments. Each system had a main and a reserve charge of extinguishing fluid (dibromodifluor-omethane). Both of the charges could be directed selectively to any of the three engine and accessory drive subsystem compartments. The control panel switches were push button type - three for each side of the extinguishing system. Actuating a switch resulted in fuel shutoff to the affected engine, reduction of compartment cooling airflow and arming of the agent discharge switch. The switches were interlocked such that only one switch could be actuated at one time. Actuation of the discharge switch to "Main" would fire the squib, thereby releasing the extinguishing agent into the problem engine and accessory drive compartment. The extinguishing agent tanks consisted of two identical spherical tanks (1550 cubic inches) each filled to half capacity (64 pounds) with the extinguishing agent and pressurized to 600 psig with nitrogen. The discharge valves were of the explosive actuation type and contained dual charges for increased reliability. The system is shown schematically in Exhibit 13, page III-516.

Sensor Cables.

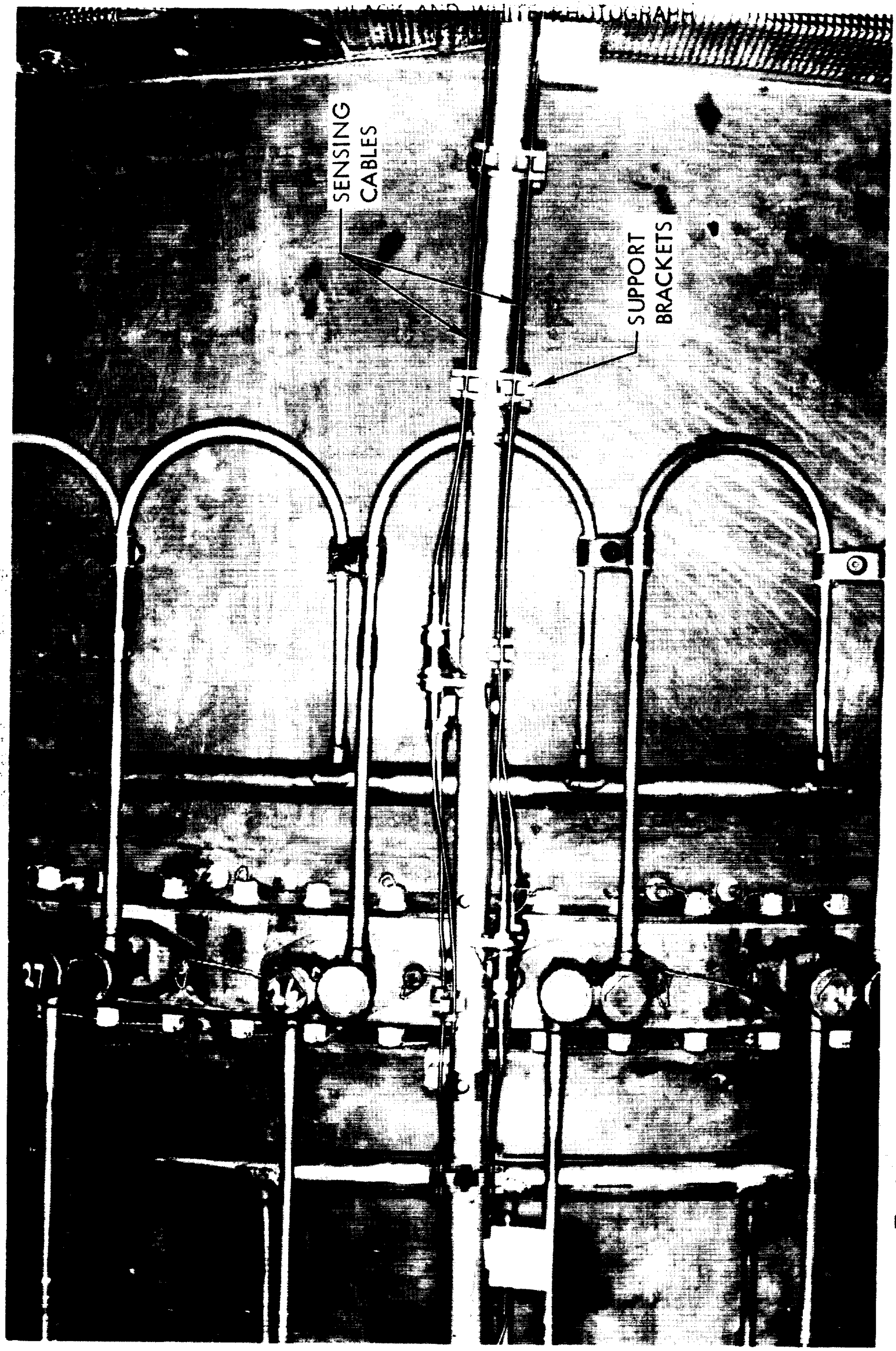


- BOTH CABLES MUST SENSE FIRE TO INITIATE WARNING
- BOTH CABLES MUST BE SHORT CIRCUITED BEFORE A FALSE WARNING CAN OCCUR
- SEMI-CONDUCTOR MATERIAL BECOMES CONDUCTIVE WHEN HEATED - THE ALARM CIRCUIT IS THEN COMPLETED



278-54-17 "O"

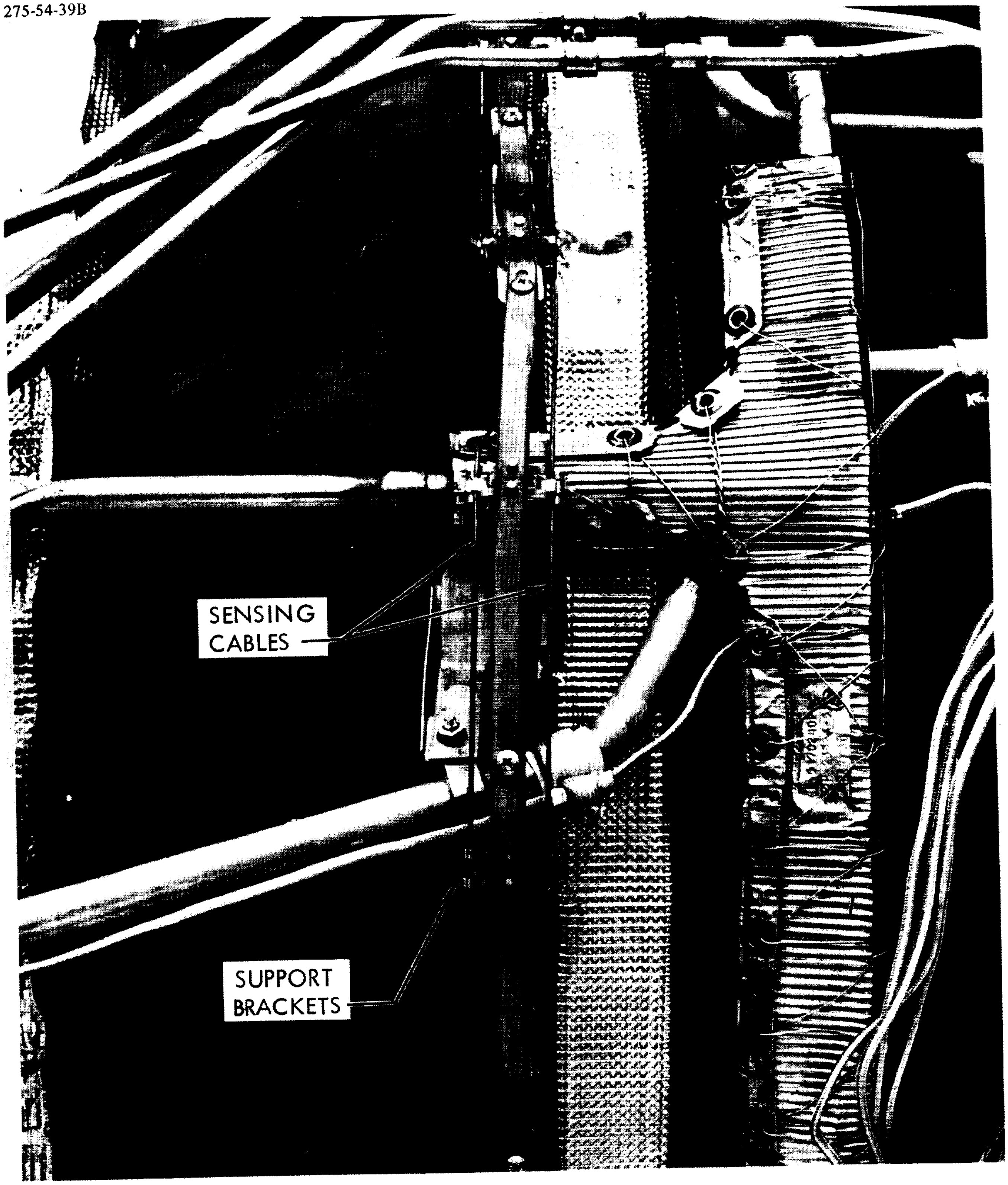
Engine M0554 Fire Detection System



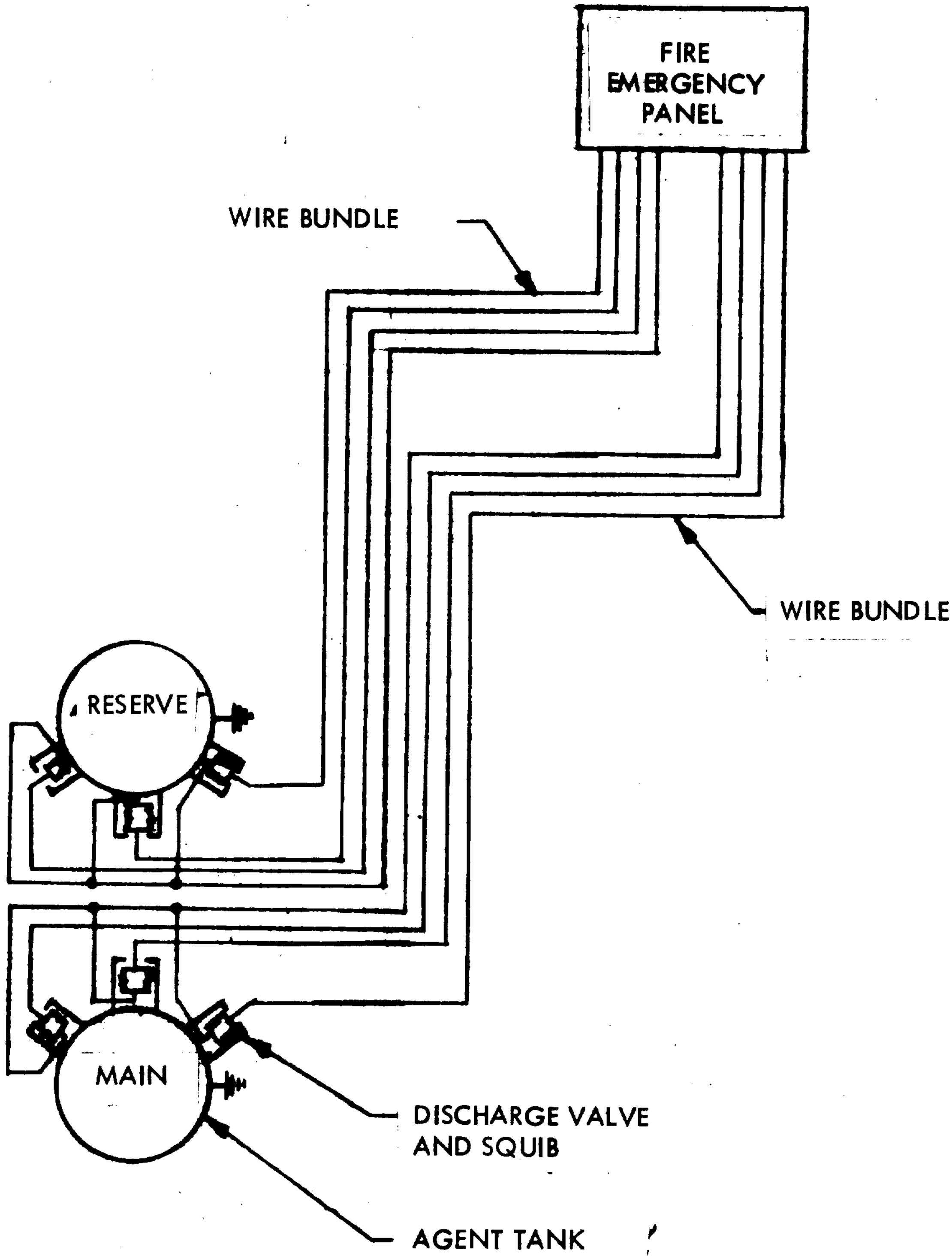
278-54-45M

Engine 170-557 Fire Detection System (Typical of Air Vehicle 1 Except Instrument and Brake)

275-54-39B



Engine Fire Detection Aft Ring (Bottom)



Left-Hand **Extinguishing** System

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: FIRE PROTECTION SYSTEM WBS CODE: 1.3.8

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
MAJOR FUNCTIONS	TYPE	DETECTION - AIRFLOW CONTROL FUEL SHUTOFF	→ EXTINGUISHING → →	→	→	→
POWER SOURCE	TYPE	115 VAC: 400 HERTZ	→	→	→	→
TEMPERATURE RANGE: ENGINE	DEGREES F	-65 to 1000	→	→	→	→
TEMPERATURE RANGE: ADS	DEGREES F	-65 to 580	→	→	→	→
COMPARTMENTS: DETECTION	NUMBER	12	→	→	→	→
COMPARTMENTS: EXTINGUISHING	NUMBER	-	12	→	→	→
DETECTION CABLE: TOTAL LENGTH	FEET	462	→	→	→	→
DETECTION CABLE: ENGINES	FEET	384	→	→	→	→
DETECTION CABLE: ADS	FEET	78	→	→	→	→
DETECTION CABLE: DIAMETER	INCHES	0.07	→	→	→	→
DETECTION POWER REQUIRED	WATTS	60	→	→	→	→
SENSING	TYPE	CONTINUOUS/AVERAGING	→	→	→	→
DISPLAY LIGHTS (TOTAL)	NUMBER	6	→	→	→	→

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: FIRE PROTECTION SYSTEM WBS CODE: 1.3.8

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
EXTINGUISHING AGENT	TYPE	-	CBR_2F_2	→	→	→
EXTINGUISHING AGENT VOLUME	POUNDS	-	256	→	→	→
EXTINGUISHING DISCHARGES	NUMBER	-	2 MAIN	→	→	→
	NUMBER	-	2 RESERVE	→	→	→
EXTING. DISCHARGE TIME	SECONDS	-	2	→	→	→
EXTING. AGENT STORAGE	TYPE/NO.	-	SPHEREs/4	→	→	→
EXTING. SYSTEM PRESSURE	PSI	-	600	→	→	→
EXTING. VOLUME COMPACITY	$FEET^3$	-	584	→	→	→
RELIABILITY FACTOR	NONE	-	-	0.999995	0.999995	0.999995
MTBF	HOURS	-	-	357,142	357,142	357,142

TECHNICAL DESCRIPTION

SUBSYSTEM: PROPULSION WBS CODE: 1.3

MAJOR ASSEMBLY: GROUND TESTS WBS CODE: 1.3.9

The development of the propulsion system for the B-70 was accomplished through use of a fuel system simulator, a propulsion system test stand, extensive engine tests plus all the test performed in development of the components. The fuel system simulator represented a full scale simulation of the actual air vehicle fuel system. It also had the capability of simulating aerodynamic heating. It could be oriented in any position in the pitch direction and in three definite positions in the roll direction. Through the use of the simulator, various system characteristics and operating methods were determined. The method of oxygen removal from the JP-6 fuel was verified, adequacy of the structural cutouts to permit fuel transfer without hindrance was confirmed, and surge pressure magnitude was measured at various control valve locations. It was possible to determine the amount of trapped (unavailable) fuel within the tanks. Some deficiencies were identified and corrective action accomplished. For example it was found necessary to increase the plumbing wall thickness at the beaded ends to preclude collapse of the bead and separation at the mechanical Wiggins couplings. The compatibility and operational characteristics of the pressurization, inerting and venting systems were also established. Also system performance was determined under both normal and emergency conditions.

The propulsion system test stand located at Santa Susana was a primary tool in developing many of the propulsion system subsystems. One of its most important uses was in the compatibility testing of the engine and the secondary power generating subsystem - the aircraft accessories package driven from the engine. This was the first opportunity to operate the two major assemblies together and determine their operational compatibility. The engine starting system which was integrated into the secondary power generating subsystem was also subjected to testing. During this testing, a 244 hours of operation were accumulated and 426 engine starts or motorings were made. The engine development required extensive effort by the subcontractor General Electric. This program and the numerous problems encountered required substantial technical effort and coordination by NR. Some of the problems encountered were windmilling, nozzle buzz, high frequency vibration, turbine casing cracking, and foreign object damage (to turbine blades).

TECHNICAL DRIVER

WBS TITLE: PROPULSION
DRIVER: CONTAMINATION

WBS CODE: 1.3

Operational problems were experienced within the engine fuel system due to high levels of fibrous material contamination. In-flight test data from A/V number 1 flights 6 - 11 showed that an abnormal engine RPM decrease occurred when going from the 100 percent speed power setting to the augmented power levels. In one instance the particular engine could not maintain 100 percent speed while in the augmented power setting. Subsequent investigation revealed that the 60 micron filter in the main Engine Control unit was plugged whereas the 40 micron upstream filter in the feed line was not excessively loaded with contaminants. Typical composition of the contaminants by volume was 75 percent fiberglass, 10 percent other fiber and 15 percent sand and metals. This confirmed fiberglass rods to be the main cause of plugging. The source of the fiberglass was identified as the fiber-glass lined air conditioning ducts used to supply air inside the tanks during their construction and also from the batting of heating blankets. Satisfactory resolution of the problem was effected by:

- eliminated of fiberglass ducting and heating blankets in production cycle
- Wiped down tank interiors with lint free chemically treated cloths
- Vacuum swept tanks
- Flushed tanks with fuel to obtain the 15 milligram/gal allowable of contaminants

TECHNICAL DRIVER

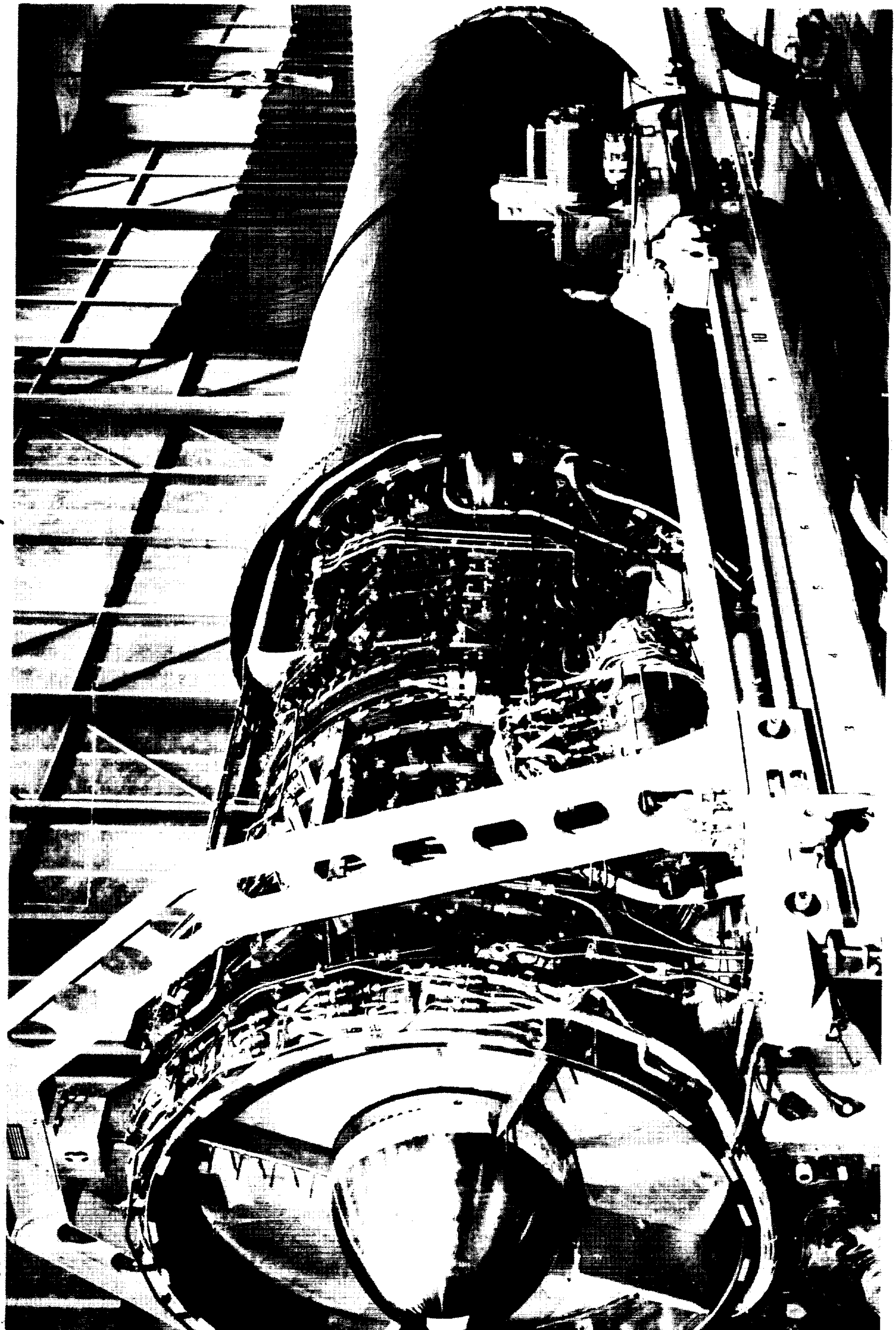
SUBSYSTEM: PROPULSION SUBSYSTEM — WBS CODE: 1.3

MAJOR ASSEMBLY: ENGINE INSTALLATION
ENGINE SHROUDS — WBS CODE: 1.3.2

The engine shroud, which was part of the engine buildup for installation, was of Rene 41 sandwich construction with 0.004 face sheets and 0.003 corrugations. The shroud was designed for 9.7 psi pressure and 1200° F operating temperature. It was 10 ft. long, 4 ½ ft in diameter and was cylindrically mounted to the engine fore and aft. Exhibits 14, 15, 16, and 17, on pages III 522, III-523, III-524, and III-525, presents a series of various veiws of the shroud installed on the engine. (It should be noted that the aft mounting ring and exhaust nozzles shown in the exhibits were not part of the shroud.) As indicated by the shroud installation, it performed two functions; as a cooling airflow shield for the engine and as a heat shield for surrounding air vehicle structure.

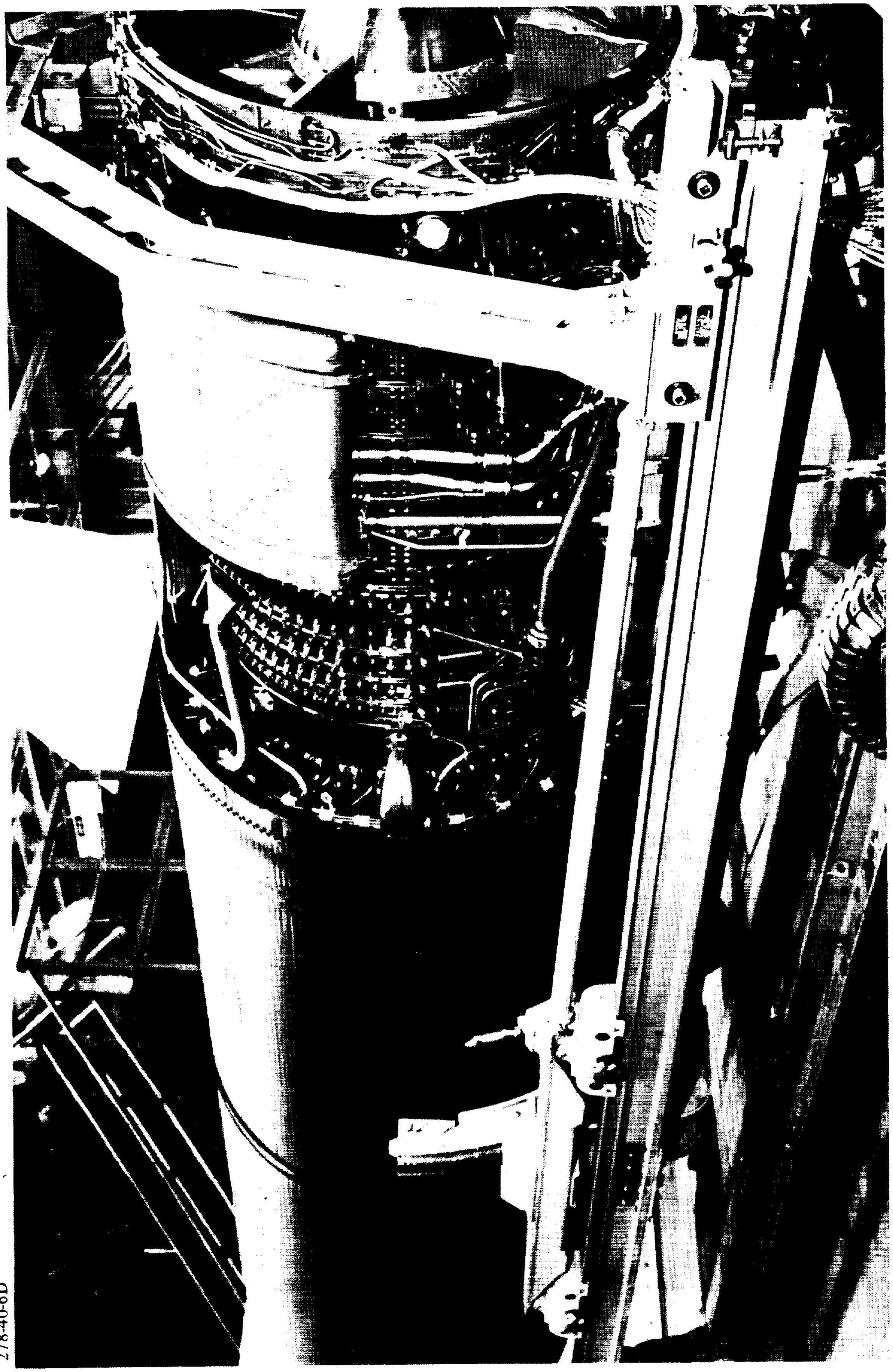
The first indication of a problem was at AEDC during the 0.577 scale model inlet and engine wind tunnel tests during late 1962 and early 1963. During the wind tunnel tests after 34 running hours, cracks occurred in the shroud upper aft segment in the inner skin (40" long) and the outer skin (42" long). A repair was made with Rene 41 doublers over the cracks and testing continued. After 28 ½ additional running hours, a complete rupture of the shroud sandwich occurred in the forward upper half segment.

The AEDC failures were repeated at NR's engine test stand where instrumentation showed the shroud to have natural frequencies of 114 CPS, 360 CPS and 500 CPS. Since the first order engine RPM generated 114 CPS and the whirling/combustion instability modes of the engine generated 360 CPS and 520 CPS, the shroud was failing due to high stresses at resonance. The modification to the shroud was to install nine external and nine internal hat sections around the shroud equally spaced fore and aft. The hat sections were of 0.012 inconel and were spot welded to the face sheets followed by 30 minutes at 1950°F for stress relieving and then 16 hours at 1400°F for aging. The first hat section installation buckled the corrugation of the shroud's sandwich section. The cause of the buckling was due to differential stresses induced at the stress relief temperature of 1950°F. The next hat section installation attempts were made on test panels with no stress relieving heat treat, just 16 hours at 1400°F for aging. Since this appeared satisfactory, this same technique was used on two shrouds; however, the shrouds cracked in the areas adjacent to the spot welding showing stress buildup. The final modification technique for the spot welded hat sections was to heat treat for 30 minutes at 1800°F for stress relieving followed by 16 hours at 1400°F for aging. It was also established that repair doublers were not to be heat treated for stress relieving.



ENGINE SHROUD INSTALLATION
(PRIOR TO MODIFICATION)

278-40-6C



ENGINE SHROUD INSTALLATION
(PRIOR TO MODIFICATION)

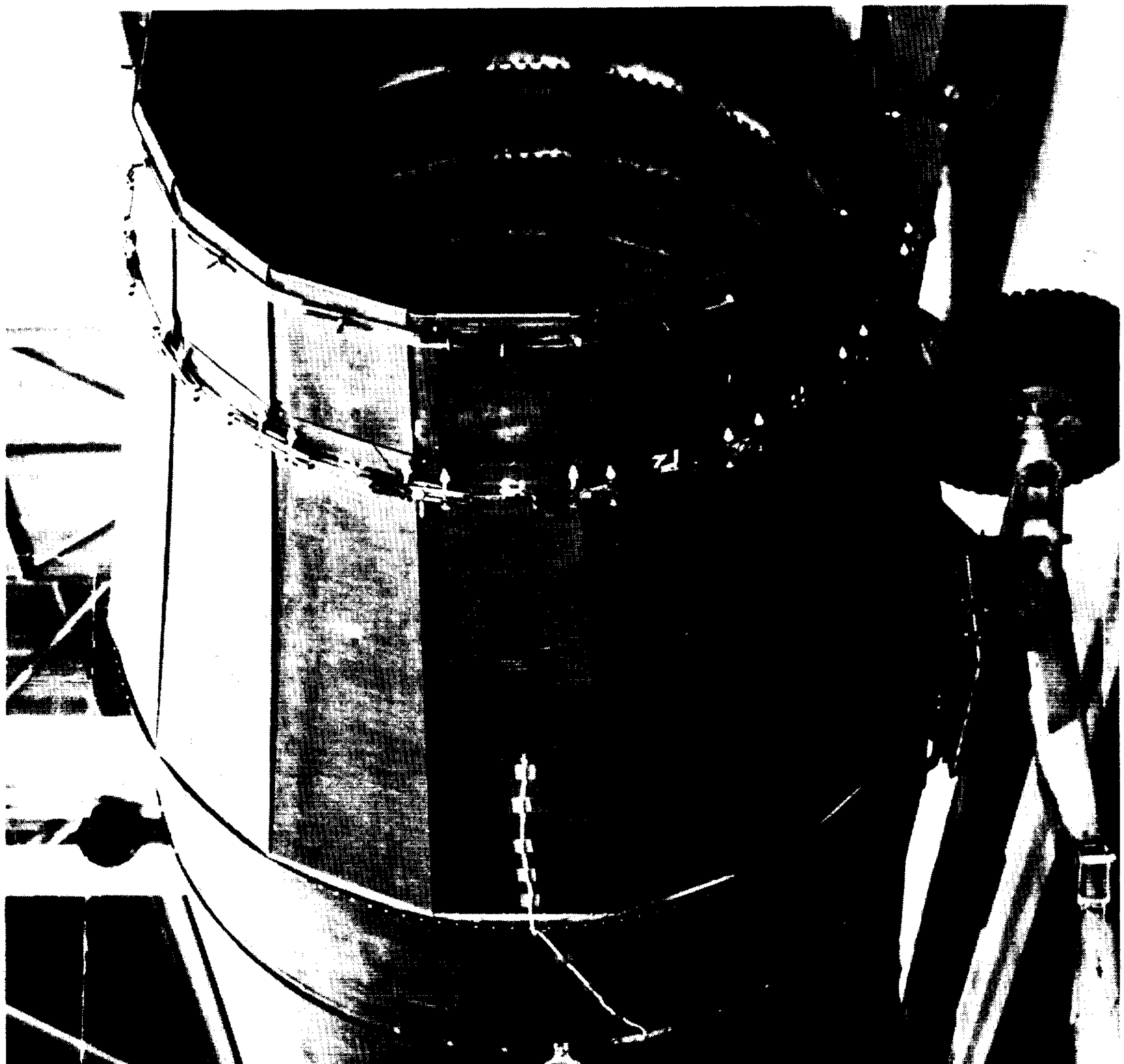
278-40-6D

EXHIBIT 15

ENGINE SHROUD INSTALLATION
(PRIOR TO MODIFICATION)

278-40-6B

ENGINE SHROUD INSTALLATION
(PRIOR TO MODIFICATION)



278-40-6A

TECHNICAL DRIVER

SUBSYSTEM: PROPULSION SUBSYSTEM WBS CODE: 1.3

MAJOR ASSEMBLY: ENGINE INSTALLATION WBS CODE: 1.3.2
ENGINE FOREIGN OBJECT DAMAGE

One of the major concerns of aircraft with air breathing engines is foreign object damage (FOD). From the onset of the B-70 program, a program of eliminating FOD was of the first order influencing the inlet structure design, inlet location, upstream subsystem ejections, manufacturing techniques and maintenance procedures. In mid 1961, a committee of "foreign object damage deterrent representatives (FODDER Committee) was established to coordinate and carry out a FOD prevention program. It reviewed the design features and formulated an educational program for manufacturing and flight test superintendents, general foremen, foremen and leadmen. In addition, a process specification was released to guide the efforts of personnel in FOD prevention. However, during the first engine runs, FOD occurred. When the first cases of FOD occurred, additional steps were taken to supplement those already in use, they were:

(1) The boundary layer bleed plenums in back of the inlet duct ramps were cleaned.

(2) Examination of the bypass plenums from above as well as from below was added to the post engine run inspection.

(3) Plasma patches in the duct were inventoried and inspected during the post run inspection.

(4) Inspection of the boundary layer bleed (BLB) exhaust openings was added to the post engine run check test.

(5) Inspection of the nose gear, nose gear well, and the ramp below them was included in the pre-engine run inspection.

Although the above described program was enforced, 14 incidents of FOD occurred during engine runs from Sept. to Dec., 1964. In only two of the incidents was the foreign object identified: a screw driver bit and ice ingestion. The other 12 incidents involved unknown objects, some apparently as small as lockwire tangs.

Since the FOD incidents were still occuring periodically, the following additional steps were incorporated:

WBS CODE: 1.3.2

(1) The bullet nose vent holes on all engines were screened with 10 mesh screen to prevent loose objects inside the engine nose cavity from falling into the duct.

(2) The engine air guide bellows were washed to clean out small particles.

(3) The No. 2 BLB plenum was inspected following each flight with plenums #1 and #3 inspected periodically.

(4) Large drain holes that connected the duct divider nose section forward of Sta 1990 to the bypass plenum were sealed.

(5) Drain holes in the bypass doors were plugged to trap any loose debris that might be in the doors.

(6) Overload springs were installed to increase the engine air guide bellows sealing force.

(7) FOD screens installed for "sweeper" runs on the ground were changed from a 4 mesh to an 8 mesh screen (.203 square tc .097 square).

(8) The crew compartment access ladder was modified so that it ran forward from the door instead of aft.

(9) All flight test instrumentation forward of engines, such as, bypass plenums, throats, probes, etc., were thoroughly inspected and installations changed to reflect "safetied" fastners and components.

(10) The inboard ends of the canard flaps were closed out.

(11) Water boiler drain system was revised to prevent build up of ice.

(12) Hand size access doors added to the porous skin of the bypass plenum to facilitate cleaning the plenum.

(13) No. 10 mesh screens installed over No. 1, No. 2 and No. 3 BLB plenum ports in back of inlet ramps.

(14) All unauthorized entries into inlet prohibited with a designated leadman as Inlet Duct Controller. In addition, an inspector was assigned as FOD prevention inspector with the responsibility of verifying spec compliance.

(15) All GSE inspection controlled for cleanness prior to being positioned near the XB-70.

(16) All personnel entering the inlet were required to wear "bunny" suits and all under clothes inspected for loose objects.

(17) The hangar floor and loft areas cleaned and the outside ramp areas cleaned prior to B-70 movement.

(18) The runway swept and inspected immediately prior to each take-off. This also included the taxi ways.

Subsequent to the above initiated steps, which were included on air vehicle No. 2 also, FOD incidents were substantially reduced. However, since FOD still occurred, it did impact the flight test program as all major damage required engine removal while minor damage required time consuming filing and smoothing of the engine compressor blades.

TECHNICAL DRIVER

SUBSYSTEM: PROPULSION SUBSYSTEM WBS CODE: 1.3

MAJOR ASSEMBLY: ENGINE COMPARTMENT COOLING: FIRE OVERRIDE VALVE & TEMPERATURE SERVO WBS CODE: 1.3.3

The bypass air valves, which directed air from the bypass plenum into the engine compartment during Regime II cooling, incorporated a temperature servo for the modulation of the cooling air flow. In addition, the bypass valves incorporated a fire override valve which closed the valves to cut-off airflow as an aid to fire extinguishing. See Exhibit 3, page III-490, for presentation of the cooling airflows and bypass air valves.

During the flight test program, the spool of the fire override valve had a tendency to become sticky. This was attributed to the close tolerance fit between the spool and the valve body which accentuated the presence of small particles. The most serious instances of the stickiness were the failures of the valve to reset to the normal position following checks of the fire protection and windmill brake systems. If the failures had not been detected, the bypass valves would have been locked in the closed position shuting off all air to that engine from the bypass plenum. This would have resulted in overheating of the engine secondary nozzle. In some instances, repeated operation of the spool cleared the jam; in others, it was necessary to remove the complete control package from the bypass valve in order to clean the spool.

In several instances, a jammed sleeve in the temperature servo caused the bypass valves to remain partially closed when switched from Regime I to Regime II cooling. This condition resulted in reduced airflow into the engine compartment and, if undetected, would result in overheating the secondary nozzles. As with the fire override valve, this was attributed to the close tolerance fit of the sleeve to its mating surfaces which rendered the assembly susceptible to jamming by very small particles. During the flight test program, the condition of low or no air flow to an engine, was detected in time to prevent structural damage. Detection after take-off was accomplished by chase plane observance of the ground cooling doors; if the doors did not close at the proper time, that engine compartment had low or no airflow from the bypass plenum. When the condition occurred, that engine was operated at reduced thrust above Mach 0.9 and high supersonic flight prohibited.

During the first 50 flights (total: air vehicles #1 & #2), inspections, tests, analysis, etc., were conducted to determine the source of the contamination. This resulted in establishing that the dry film lubricant finish reacted with fuel and hydraulic fluids above a certain temperature which resulted in hardening and flaking of the lubricant. The dry film lubricant finish was replaced with a finish more resistant to fluid contamination.

TECHNICAL DRIVER

SUBSYSTEM: PROPULSION SUBSYSTEM WBS CODE: 1.3

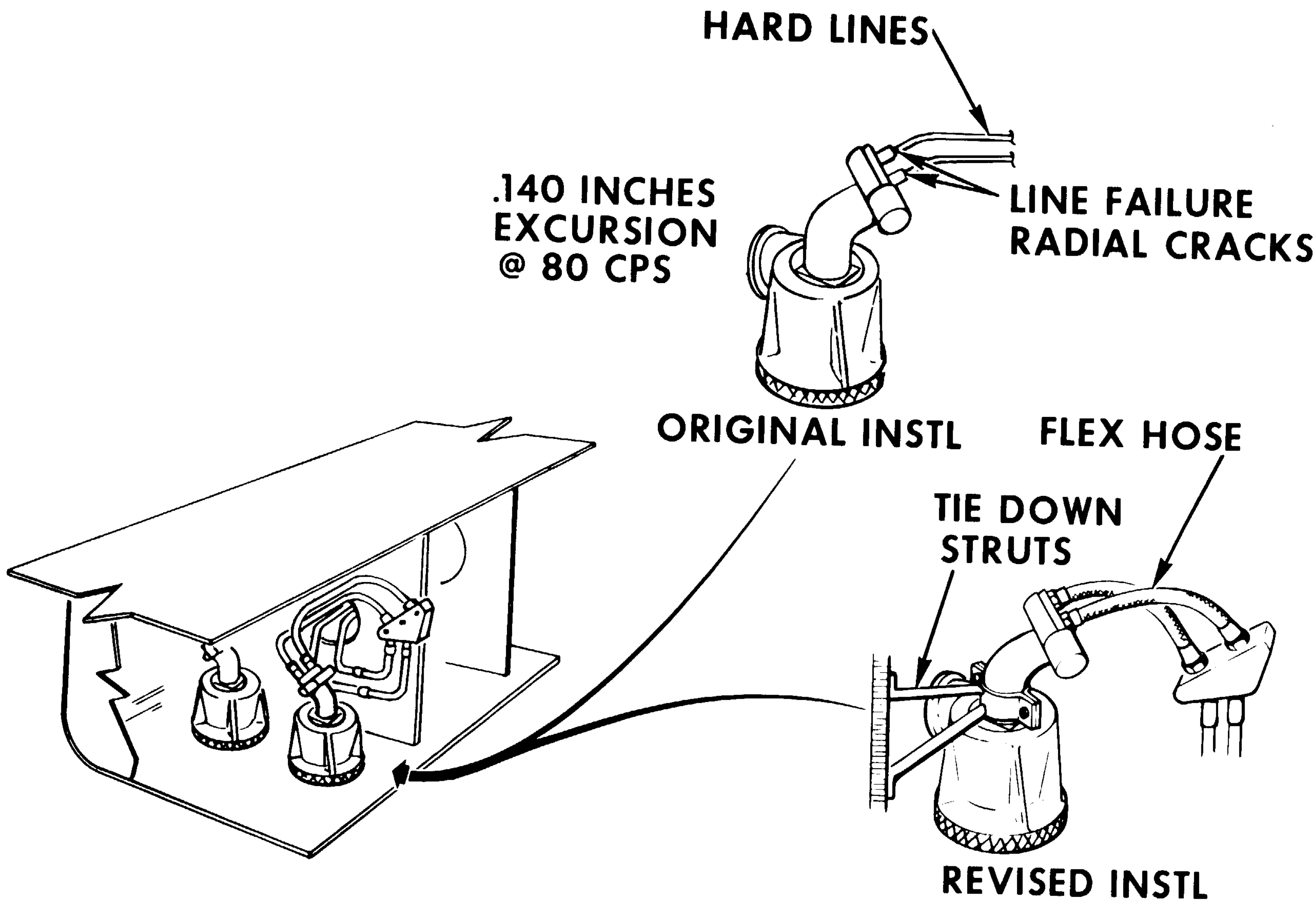
MAJOR ASSEMBLY: FUEL SYSTEM: WBS CODE: 1.3.5
BOOSTER, COOLING LOOP & TRANSFER PUMPS

Air vehicle data revealed engine fuel supply system pressure pulsations which were not evident during the fuel simulator test program. The pulsations were found to be induced by hydraulic system pressure variations which occurred due to flight control system load demands. The hydraulic system pressure variations reached a maximum double amplitude of 2,100 psi which caused fuel pump/motor speed variations and resulted in an approximate 2 psi fuel pulse for each 100 psi hydraulic surge. The frequency range of pressure variations was 2 $\frac{1}{2}$ to 4 $\frac{1}{2}$ cycles per second. The condition was corrected by resetting the pump hydraulic motor overspeed control so that the pumps operated in a constant speed mode. (Prior to resetting, the pumps operated in a constant torque mode and entered speed control only when unloaded.) During the initial engine runs, structural material type failures occurred to the fuel pumps. One type of failure was pump volute discharge flange fractures attributed to a design deficiency which allowed a minimum cross-section that was over-stressed under normal pressure loadings. Prior to first flight, pumps with redesigned discharge flanges were installed and special V-band attachment clamps were utilized. Exhibit 18, page III-532, presents the modification made to a transfer pump which was essentially typical for all pumps.

Impeller blade fractures of the fuel pumps were experienced during the initial phase of the flight test program. Based on material analysis, the failures were attributed to fatigue caused by blade flexures of the single shroud type impeller. Based on this determination, all impellers were changed to a double shroud design with subsequent satisfactory operation. In addition to the impeller failures, pump bearing failures occurred, however, they were random failures with respect to pump running time. After 8 failures, evidence assembled indicated that bearings were failing due to pumps being subjected to dry running (no fuel) operation. To minimize this condition, inflight check items were added for pumps plus reminders by ground control. In addition, ground maintenance inspection items were added for circuit breaker control of pumps.

After flight 1-15, when the engine fuel supply line was disconnected at the lower boost pumps in tank #3 as part of defueling for air wash, it was found that the check valve mounting plates of the boost pumps were deformed. Structural analysis determined that stress levels exceeded the material yield value at pressure loadings below the design 120 psig proof pressure. All boost pumps were modified to include new check valve mounting plates strengthened with additional backup plates.

FUEL TRANSFER PUMP INSTALLATION



C.10

Space Division
North American Rockwell

DEVELOPMENT DATA SUMMARY

WBS TITLE: PROPULSION SUBSYSTEM WBS CODE: 1.3

STATE-OF-THE-ART RATING: 5 (See remarks)

PERCENT DEVELOPED: MATRIX:

	PRIOR TO FLIGHT		FLIGHT TEST
	CONFIGURATION	GROUND TEST	
PROGRAM LEVEL	70%	80%	20%
EFFORT TO GO	56%	44%	93%

GROUND TESTS

TYPE OF TEST	NUMBER OF UNITS	TEST HOURS
CONFIGURATION RESEARCH (1)	1	400
DESIGN FEASIBILITY (1)	2	1,625
DESIGN VERIFICATION (1) (2)	69	13,670
AIRWORTHINESS (2)	132	16,300
QUALIFICATION	-	-
OTHER	-	-
TOTAL	204	31,995

REMARKS:

(1) These hours include 2400 test hours on full scale fuel simulator.

(2) These hours do not include AEDC wind tunnel tests on .577 scale inlet.

(3) Ground tests conducted by GE and subcontractors not included.

WBS 1.3 PROPULSION SUBSYSTEM

State of the Art:

The Propulsion Subsystem was assigned an overall state-of-the-art rating of 5 based on definition 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 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.

A major advancement in the state of the art for manned aircraft was achieved with the design, development, and subsequent verification of the Propulsion Subsystem. As discussed under the propulsion Technical Descriptions (WBS 1.3), these breakthroughs were attained in the design of the engine, engine compartmentation and cooling, engine controls, and the fuel system tankage, plumbing, pumping and heat sink. The engine was designed for continuous operation with inlet air temperatures at 700°F which required the application of new materials and fabrication techniques. The J-93 engine had a supersonic nozzle (C-D nozzle) which increased the nozzle coefficient resulting in increased thrust for a given energy level exhaust flow. A single state rotor was developed which greatly reduced the weight factor and facilitated the manufacturing process. In addition to the composite accessory pod concept and its own hydraulic system, the engine controls were designed for high temperature and finite resolution operation. The engine compartmentation and cooling were unique in that maximum utilization of available air was employed and the energy transmitted subsequently used to increase base pressures and reduce boattail drag.

The fuel system tanks were integral and enclosed by honeycomb panels deleting the requirement for insulation and the associated weight penalties. The fuel lines or plumbing were chem-milled thin-walled steel tubes that were permanently joined which reduced weight and increased reliability. The fuel pumps were all hydraulically driven and sized to pump boiling fuel. The fuel system was used as a major heat sink for the heat loads generated by the air vehicle subsystems and the mission ambient temperatures.

The Propulsion Subsystem designs produced major weight savings and required new manufacturing techniques and processes in the use of new high strength-to-weight ratio materials. Based on this assessment which shows that all three B-70 design criteria were applied, the Propulsion Subsystem was assigned a state-of-the-art rating of 5.

Percent Development:

The Propulsion Subsystem development status percent comparisons of the XB-70 configuration to that scheduled for the RS-70, are made at two development stages; one at prior to flight or at the time period of "out-the-door" of Vehicle No. 1 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 the Propulsion Subsystem status. The analysis was conducted to arrive at a status level for the overall subsystem, however, to achieve that goal, each major assembly was assessed. As noted in the "Remarks," the ground test summary does not include the GE test hours which were 5000 hours for the XB-70 compared to 8500 test hours planned for the RS-70 at time of "out-the-door." Although the addition of these test hours did not impact overall subsystem percentages, they were included in the analysis to indicate test effort involved.

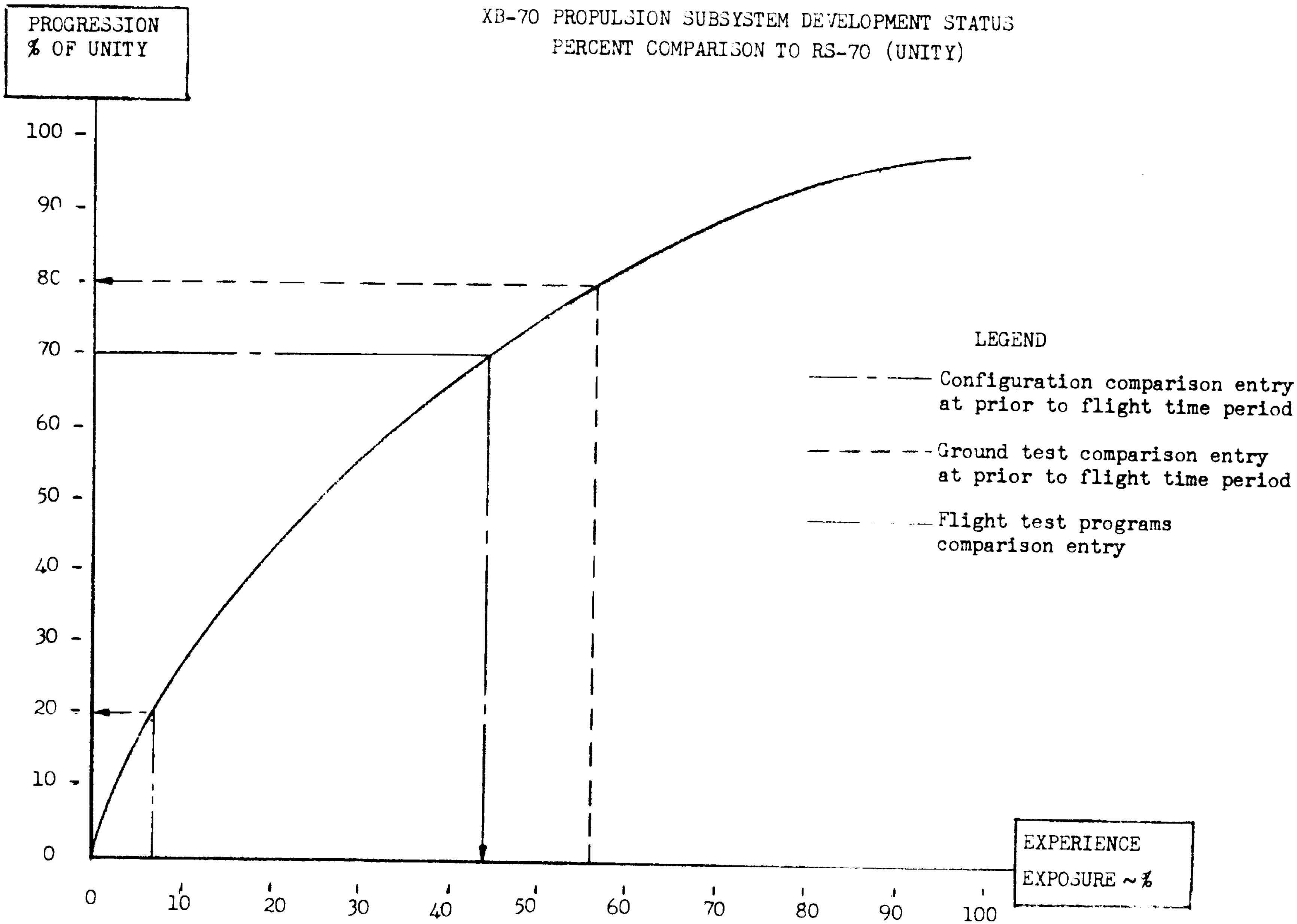
The overall XB-70 Propulsion Subsystem configuration was assessed as being 70% representative of that planned for the RS-70 at the time of prior to flight of the No. 1 air vehicle. The downgrading of the XB-70 configuration was mainly due to the fuel system which did not have folding wing tip fuel tanks, weapons bay fuel tanks, inflight refueling probe, and a fully automatic center-of-gravity control. Each of these items was compared to the overall subsystem and assigned the following percentages: refueling probe, 10%; wing tip fuel, 3%; weapons bay tanks, 2%, and the CG control, 15%. All other major assemblies of the Propulsion Subsystem were essentially as proposed for the RS-70.

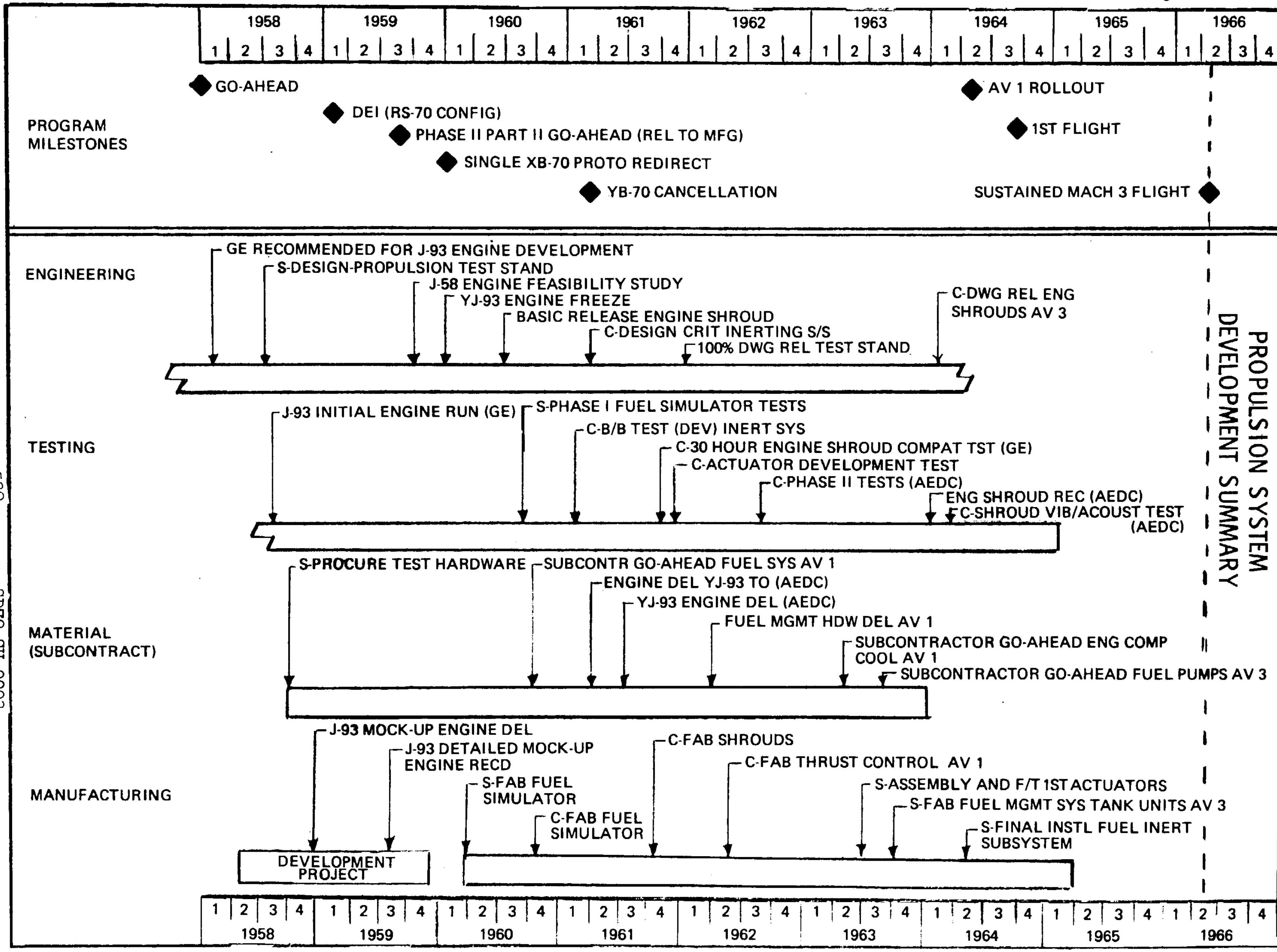
To establish what expenditures would have been required to attain a No. 1 air vehicle production level status, the same curve used for the structures analyses was utilized for the Propulsion Subsystem; Exhibit 19, page III-538. Entering this exhibit on the left hand side at 70%, across to the curve, and then down to the bottom scale, it shows that 56% more effort would have been required for a No. 1 RS-70 propulsion configuration. To determine if this percentage was also true for ground testing required, a comparison was made of the ground test hours expended on the XB-70 to that scheduled for the RS-70 at the time period of "out-the-door." The RS-70 program had 65,500 ground test hours scheduled at this time period compared to the XB-70 ground test hours of 36,995 (both numbers include the GE effort). This comparison shows that the XB-70 ground test hours were at a status level of 56% of that planned for the RS-70. Entering the curve of Exhibit 19, page III-538, shows that with this level of testing, the confidence level of the XB-70 Propulsion Subsystem for first flight was 80%. In summary for the "out-the-door" time period, the RS-70 propulsion configuration would have required 56% more expenditures than that of the XB-70, however, only 44% more testing effort would have been required. As noted, no downgrading of the XB-70 test hours were made due to the fuel system configuration, since it was the opinion of the Design Group that all testing effort was 100% applicable to a full production subsystem.

The XB-70 flight test program was established at 11% of a production level status as presented by Exhibit 13, page II-23, under Air Vehicle WBS 1.0. This would indicate that 79% more flight testing effort than expended would be required for a production level status. However, consideration must be given to the testing conditions of the XB-70 flight test program; that is, that the flight envelope explored was essentially 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 11% flight effort established was based on a direct comparison of equivalent test hours, an adjustment must be made to reflect the different flight envelopes. It should be noted that, based on an analysis of the type of data obtained during the XB-70 program, no adjustment was required to reflect configuration differences. 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% which requires 40% of the total effort. For the Propulsion 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. This ratio was used as a weight factor so that the flight test programs comparisons would be based on the same flight envelope as the RS-70 flight envelope. The equation for weighting the XB-70 flight effort would be 2:3:: x :11 and based on this equation, the total flight test effort remaining to attain a production level status would be 40% + 60% - (2 x 11 ÷ 3) or 93% (where 40% is that effort required for the last 20% of the envelope). In summary, the flight test program comparisons show that the XB-70 Propulsion Subsystem flight test effort was 7% of that planned for the RS-70 program and that 93% more effort would be required to attain the production level status. It should be noted that all of the comparison for the Propulsion Subsystem is based on tooling, test articles, GSE, etc., being at the RS-70 or production level in both numbers and fidelity. Exhibit 19, page III-538, presents a graph showing the Propulsion Subsystem percent comparisons. It may be noted that the XB-70 propulsion flight test program attained only a 20% confidence level toward a full production level status.

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 PROPULSION SUBSYSTEM DEVELOPMENT STATUS
PERCENT COMPARISON TO RS-70 (UNITY)




PROPULSION SYSTEM
DEVELOPMENT SUMMARY
1958 1959 1960 1961 1962 1963 1964 1965 1966
1 2 3 4
PROGRAM MILESTONES
GO-AHEAD
DEI (RS-70 CONFIG)
PHASE II PART II GO-AHEAD (REL TO MFG)
SINGLE XB-70 PROTO REDIRECT
YB-70 CANCELLATION
AV 1 ROLLOUT
1ST FLIGHT
SUSTAINED MACH 3 FLIGHT
ENGINEERING
GE RECOMMENDED FOR J-93 ENGINE DEVELOPMENT
S-DESIGN-PROPULSION TEST STAND
J-58 ENGINE FEASIBILITY STUDY
YJ-93 ENGINE FREEZE
BASIC RELEASE ENGINE SHROUD
C-DESIGN CRIT INERTING S/S
100% DWG REL TEST STAND
C-DWG REL ENG SHROUDS AV 3
TESTING
J-93 INITIAL ENGINE RUN (GE)
S-PHASE I FUEL SIMULATOR TESTS
C-B/B TEST (DEV) INERT SYS
C-30 HOUR ENGINE SHROUD COMPAT TST (GE)
C-ACTUATOR DEVELOPMENT TEST
C-PHASE II TESTS (AEDC)
ENG SHROUD REC (AEDC)
C-SHROUD VIB/ACOUST TEST (AEDC)
MATERIAL (SUBCONTRACT)
S-PROCURE TEST HARDWARE
SUBCONTR GO-AHEAD FUEL SYS AV 1
ENGINE DEL YJ-93 TO (AEDC)
YJ-93 ENGINE DEL (AEDC)
FUEL MGMT HDW DEL AV 1
SUBCONTRACTOR GO-AHEAD ENG COMP COOL AV 1
SUBCONTRACTOR GO-AHEAD FUEL PUMPS AV 3
MANUFACTURING
J-93 MOCK-UP ENGINE DEL
J-93 DETAILED MOCK-UP ENGINE RECD
DEVELOPMENT PROJECT
S-FAB FUEL SIMULATOR
C-FAB FUEL SIMULATOR
C-FAB SHROUDS
C-FAB THRUST CONTROL AV 1
S-ASSEMBLY AND F/T 1ST ACTUATORS
S-FAB FUEL MGMT SYS TANK UNITS AV 3
S-FINAL INSTL FUEL INERT SUBSYSTEM

DEVELOPMENT SUMMARY
TABULATION OF DATES

SUBSYSTEM: PROPULSION — WBS CODE: 1.3

ENGINEERING

NR Recommended GE for J-93 Engine Development	2-24-58
Start Design Propulsion Test Stand	7-01-58
J-58 Engine Feasibility Study	12-01-59
EOPR Engine Test Shroud	3-30-60
Basic Release Engine Shroud	6-28-60
Complete Inerting Subsystem Design Criteria	4-11-61
100% Drawing Release Propulsion Test Stand	2-16-62
Complete Drawing Release Shrouds AV #3	1-17-64

TESTING

Initial Test Run at GE on J-93 Engine	9-20-58
Start Phase I Fuel Simulator Test	9-01-60
Complete Bread Board Development Test - Inerting Sys.	2-04-61
Complete 30-Hour Engine Shroud Compatibility Test at GE	10-06-61
Complete Actuator Development Test	12-29-61
Complete Phase II Tests - AEDC	8-15-62
Receive Engine Shrouds at AEDC	1-17-64
Complete Vibration/Acoustical Env. Test AEDC Shrouds	2-04-64

MATERIAL (SUBCONTRACT)

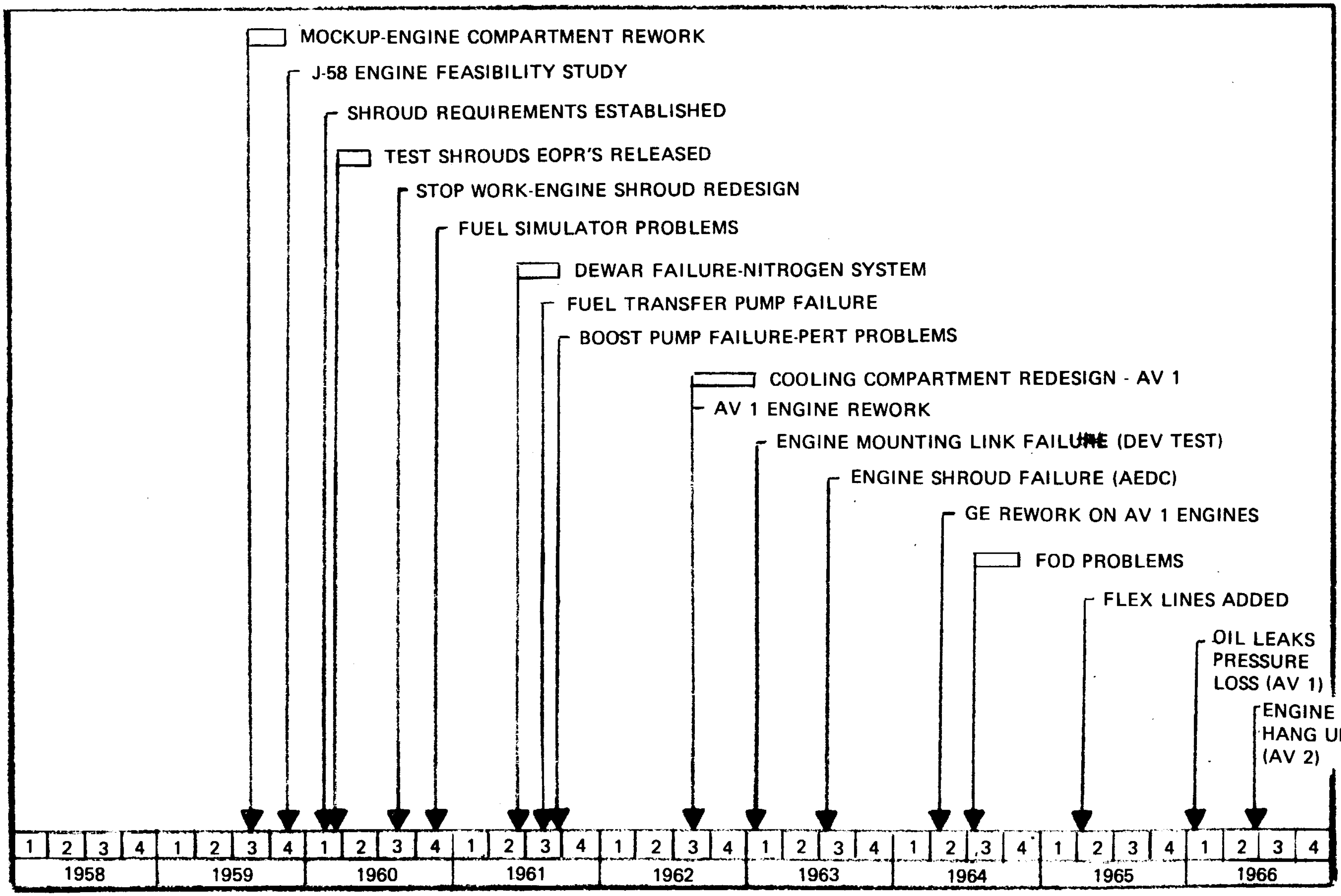
Initial Procurement Test Hardware	7-01-58
Subcontractor Go-ahead Fuel Sys. Equip. AV #1	12-01-60
Delivery YJ-93 Engines to AEDC for Dev. Test (2)	4-11-61 & 9-06-61
Receive all Fuel Management Hardware AV #1	5-21-62
Subcontractor Go-ahead Engine Compartment Cooling AV #2	5-24-63
Subcontractor Go-ahead Fuel XFR & Boost Pumps AV #3	11-15-63

MANUFACTURING

J-93 Mock-up Engine Received from GE	12-20-58
J-93 Detailed Mock-up Engine Received from GE	8-18-59
Start Fab Fuel Simulator	1-02-60
Complete Fab Fuel Simulator	11-01-60
Complete Fab Engine Shrouds AV No. 1	12-22-61
Complete Fab Engine Thrust Control AV No. 1	6-28-62
Start Assembly & F/T First Actuators	7-15-63
Start Fab Fuel Mgmnt System Tank Units AV No. 3	12-19-63
Start Final Installation Fuel Inerting System	4-07-64

PROPULSION SYSTEM
DESIGN / PROGRAMMATIC IMPACTS

WBS 1.3



DESIGN/DEVELOPMENT PROGRAMMATIC NARRATIVE

SUBSYSTEM: PROPULSION

WBS CODE: 1.3

8-59 to 10-59

Authorization was received to rework the mock-up engine compartment, reflecting the 70 configuration Rework completed October 30, 1959.

12-59

A feasibility study was directed to be conducted to evaluate the possible use of Pratt and Whitney J-58 engines in an XB-70 air vehicle as a possible means of reducing total program costs.

2-60

Requirements were established for engine shrouds for General Electric XB-70 prototype engines. Shroud testing to be accomplished in the RAM test facility under Mach 3 conditions.

3-60 to 5-60

Engineering Purchase Order Requests (EOPRs) were released for procurement of material and fabrication was started for test shrouds.

8-60 to 9-60

An engineering "STOP" was placed on all major shroud drawings for redesign.

11-60

Problems with the fuel simulator delayed Phase I testing to February 28, 1961. Problems encountered were malfunctions of fuel pumps and level control valves, when comtamination in the form of weld pellets was flushed through the system. The plumbing failures necessitated shutdown and serious delays for internal repairs and replacement of components. Design problems, i.e., thin-wall tubing required beefup at the beaded ends to prevent them from pulling out of the couplings.

6-60 to 9-61

The fuel pressurization and inerting system encountered failure of the Dewar - Nitrogen system during airworthiness testing while undergoing the vibration phase of the test program. Air Vehicle type hardware was modified and the test program resumed. Air Vehicle No. 1 hardware was delivered to Palmdale January and February 1962.

WBS CODE: 1.3

8-61

Failure of fuel transfer pumps was encountered during airworthiness tests being conducted at Vickers, supplier of the pumps. The failures resulted in redesign and development delays and subsequent hardware delivery delays. Mock-up pumps were used temporarily for air vehicle installation in lieu of flight hardware as part of the work around to offset pump delivery delays.

9-61

Failure of the boost fuel pump was encountered at T.R.W. Corporation when the aluminum impeller failed during airworthiness testing in September. The redesign, retesting and hardware delivery covered the period of September 8, 1961 through February 2, 1962.

9-61

The Preliminary Flight Rating Testing (PFRT) was basically complete on the YJ-93-3 engine; however, several difficulties were encountered and fixes were made. Some penalty reruns were required. This was the endurance portion of PFRT, and altitude demonstration tests were completed in October at AEDC.

8-62 to 1-18-63

Problems with development, redesign and fabrication have caused the engine compartment and cooling system to be a critical area due to flight limitations imposed to the system hardware and in completing system performance tests prior to production acceptance tests.

8-62

During transit from Ohio to California by truck, engine damage was encountered when the engine SER #558 hit an underpass. The afterburner was removed and the engine was flown back to Evendale, Ohio for repair. In addition, parts shortages caused buildup and installation of YJ-93 engines to fall behind schedule General Electric advised NR that six AV No. 1 engines and the first spare will require mandatory rework to prevent failure by vibration. Rework consisted of replacing eight hydraulic lines per engine, and the addition of new clamps to increase line support.

1-63

Failure of engine mounting links occurred during development lab tests. One failed during pull tests and four failed X-ray inspection. The links were subsequently tested successfuly at Mach 3 conditions in the AFT fuselage structural test section, and were run at sea level static conditions on the NAA propulsion test stand.

7-63

Engine shroud failure at AEDC, Arnold Engineering Development Center, during testing was experienced. The failure was caused by vibration fatigue. Subsequent testing at NAA Santa Susana test facility confirmed the requirement to modify air vehicle shrouds to prevent failure which occurred at AEDC. Air vehicle #1 shrouds were removed and reworked by adding circumferential stiffeners to the inside and outside during September through November 1963.

4-64

General Electric has requested retro-fit of the afterburner pumps and throttle linkage prior to ground testing of AV #1 engines. A more intensive evaluation at General Electric indicated that existing differential pressure could cause thrust bearing in the pumps to fail, and that linkage as designed is subject to disengagement or hang up.

7-64 to 10-64

Foreign object damage (FOD) was incurred to AV #1 engines during pre-flight, flight, and taxi runs and were removed from the aircraft for repair or replacement. During this period of time, 14 engines have sustained foreign object damage, and seven were damaged to the extent that required removal from the aircraft for unscheduled repairs. The following FOD occurred:

Engine SER #:	Date:
# 554	7-09-64
# 563	7-11-64
# 565	7-13-64
# 568	7-20-64
# 552	8-08-64
# 572	8-24-64

WBS CODE: 1.3

Engine SER #:	Date:
# 565	9-14-64
# 563	9-14-64
# 567	9-21-64
# 571	10-3-64
# 571	10-18-64
# 569	10-25-64
# 577	10-25-64

The General Electric Company recommended the addition of FOD prevention screens over the inner surface of the bulletnose area behind the inlet screen to preclude the possibility of FOD from the bulletnose vented area. Stringent measures were applied on a continuing basis during manufacture to preclude FOD.

4-65

Problems encountered with damage of the fuel boost and fuel transfer pump hydraulic supply "hard lines," caused by excessive vibration, necessitated Engineering Work Authorizations. The EWA's consisted of replacing the hard lines with flexible lines.

1-07-66

Post flight #17, engine #1, was shut down due to oil pressure loss - engine had to be replaced.

1-10-66

Flight # 18 - Oil leak developed in engine #3. Flight was cancelled. Engine was replaced.

1-66

Fuel pump hard lines were replaced with flex-lines per EWA-20; damage due to vibration - modification was completed.

6-66

Flight #43, air vehicle #2, experienced engine hang up at 70% RPM on acceleration and the nozzle stuck at 20%.

COST DEFINITION

SUBSYSTEM: Propulsion WBS CODE: 1.3

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 Propulsion Subsystem as defined by the WBS except for those items supplied to North American as Government Furnished Equipment (GFE). The GFE items are: YJ-93-GE Engine (WBS 1.3.1) and the RMP and EGT Gages (WBS 1.3.7). Total costs of $35,843,291 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.
j) GFE items.

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 (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 (Propulsion Subsystem WBS 1.3) with the exception of in-house ground testing (WBS 1.3.9). Cost data can be located on the following pages:

		Cost Breakdown	Time-Phased Detail
WBS 1.3	$30,890,863	page III-553	page III-554
WBS 1.3.9 Ground Tests	4,952,428	page III-553	page III-580
Total WBS 1.3	$35,843,291	page III-553	page III-590

WBS CODE: 1.3

A summary of the subcontractor recorded cost data is provided on page III-550. 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 Propulsion Subsystem.

Group No.	Title	Hours Expended
2	Propulsion Design & Development	220,179
3	Electrical and Avionics Installation	5,412
10	Structural Analysis	5,662
11	Weight Control	7,559
12	Checking	12,431
18	Propulsion System Test	201,546
19	Propulsion System Development	282,304
30	Numerical Design	5,816
43	Fuel Systems	284,118
48	Communication and Indicating System	4,851
50	Metallurgy	86,717
53	Design Producibility	8,582
54	Material and Processes	19,053
57	Engineering Specifications	32,202
63	Flight Test Maintenance	8,148
66	Metallic Materials Lab	17,776
92	Thermodynamics	22,691
94	Flight Simulation	32,172
95	Electrical System Design	49,167
97	Laboratory Services	34,023
99	Auxiliary Control System	94,890
109	Hydraulics Lab	78,321
114	Flight Test Instrumentation	4,819
125	Electrical System Equipment	7,947
130	Flight Sciences	13,344
131	Aerodynamics Special Projects	6,658

WBS CODE: 1.3

Group No.	Title	Hours Expended
133	Aerodynamics	128,814
146	Thermodynamics Lab	19,595
155	Propulsion Sciences	3,510
	Miscellaneous	62,717
	Total Engineering Hours	1,761,024

WBS 1.3	1,585,058 hours	(page III-553)
WBS 1.3.9	175,966 hours	(page III-553)
	1,761,024 hours	

Ground testing activities associated with the development of the Propulsion Subsystem have been identified and the costs assigned to WBS 1.3.9 (page III-580). These costs reflect the in-house expenditures only. Testing activities performed by the subcontractors where identified are included under WBS 1.3, 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
Propulsion Test Stand	$1,258,842
Fabrication of Parts for Airworthiness Testing	1,010,850
Shop Support to A/V No. 1 Instrumentation	723,644
Engine: Engine Installation Development Support	190,886
Fuel System Simulator	129,857
Model Shop - General Effort	87,232
Fire Tolerance Test Stand	39,040
Wing Fuel Pump Cavity Mockup: Associated Equipment	36,985
Mechanical Systems Tests	27,110
Thrust Control System - Development Testing Program	21,005
Thrust Control System Airworthiness Test	20,438
Evaluation of Sterer Solenoid Valve	18,629
Fuel System - Flexible Line Assembly Test	16,565
Engine Compartment Fire Test Section	13,829
Actuator Motor - Performance & Endurance Test	12,799
Engine Compartment Mockup	12,772
Icing Tests - Fuel Level Control Valves	12,302
Aft Ramp Compartment Pressure Regulating Valve	11,787
Fire Extinguishing System Tests	11,240
Brazed Joint - Thin Wall Tubing Test	10,585

WBS CODE: 1.3

Description	Recorded Costs
Minimum Airworthiness Tests - Thrust Control Actuators	10,233
Vibration Testing - Fuel Booster and Transfer Pump	10,160
Various	1,123,811
Costs (less MPC & G&A)	$4,810,601
Material Procurement Cost	59,054
General and Administrative	82,773
Total Cost WBS 1.3.9	$4,952,428

SUBCONTRACTOR MATRIX

SUBSYSTEM: PROPULSION WBS CODE: 1.3

SUBCONTRACTOR	ENGR'G	PROD	TOOLING	TEST	TOTAL
PARKER	1,897,874	468,034	14,685	-	2,380,593
TRW	2,120,666	2,383,160	1,686	-	4,505,512
LIQUIDOMETER	619,246	788,718	9,355	-	1,417,319
KOEHLER	417,464	665,022	92,118	-	1,174,604
WHITTAKER	921,804	916,397	54,000	-	1,892,201
OTHER	23,446	197,342	7,425	-	228,213
TOTAL	6,000,500	5,418,673	179,269	-	11,598,442

PARKER was selected to provide the Fuel Tanks Inerting and Pressurization Subsystem. Three letter contracts were awarded to Parker for this effort:

L961-X-600119	September 1, 1959	thru	November 30, 1963
L1A1-YZ-600311	November 1, 1959	thru	March 13, 1961
LZE1-YZ-600403	February 3, 1960	thru	April 4, 1963

The Statement of Work outlined in the purchase order required the subcontractor to provide engineering, management, manufacturing and other necessary services to design, develop, fabricate, test, package, and deliver the above subsystem in accordance with specification NA5-6478-1C.

The Fuel Tanks Inerting and Pressurization Subsystem used gaseous nitrogen to inert and pressurize the fuel tanks. The gaseous nitrogen was generated by heating liquid nitrogen, which was stored in dewars, to the boiling temperature. A system of coils, heat exchangers, regulators, a mode selector switch, fill and drain valves, and filters were used to control the quality, pressure and flow of the purge gas to the required location.

Nine sources were solicited for bids on the system for Air Vehicle No. 1. Five of the eight proposals received were technically acceptable. Three of the five acceptable sources were priced too high. The remaining two teams were:

1. Parker Aircraft Co./A. D. Little, Inc.
2. Stratos Division/Olin Mathieson, Inc.

Both basic companies were acceptable as to financial position, facilities, personnel, quality, and ability to produce. Parker was selected because their system was considerably lighter in weight and their method of suspension of dewars in the air vehicle was more acceptable.

WBS CODE: 1.3

The material and parts excess to Purchase Order 600119 were transferred to Purchase Order 600403, covering Air Vehicle No. 2. Final tooling and other surplus inventory was transferred to storage or salvaged and the proceeds credited to the appropriate contract.

TRW was awarded the Fuel System Simulator which was a full-size replica of the main fuel and wing tanks of the XB-70. This system was developed to integrate various subsystems pertaining to fuel management in the Air Vehicle. Purchase Order L961-X-600111 was issued June 1, 1959, for this effort and was completed on July 1, 1962, with the delivery of the system as established in the program.

The Statement of Work required TRW to design, develop and fabricate the Simulator in accordance with the released NR specification.

TRW was also awarded the Fuel Booster and Transfer Pump for the XB-70. This effort was covered on Purchase Orders L961-GX-600140 and L2E1-XJ-600413. The work started in September 1959 for Air Vehicle 1 and was completed on August 13, 1963, for Air Vehicle No. 2.

LIQUIDOMETER Corporation was awarded the Fuel Management System of the XB-70 to meet the requirements of Specification NA5-6488. Letter contract L961-X-600145 was issued on December 23, 1959, and was fully executed by Liquidometer. The Statement of Work required the subcontractor to provide engineering, management, manufacturing, and other necessary services to design, develop, fabricate, test, package, and deliver a Fuel Management System in time to meet the performance and delivery schedules outlined in the Purchase Order.

At the conclusion of the program, the residual inventory and tooling were transferred to storage or disposed of as scrap and the proceeds credited to the base contract.

KOEHLER was awarded the Fuel Level Control Valves for the Propulsion System. P.O. LOE1-WZ-600202 was issued November 25, 1959, for this effort. All deliveries were completed, and the order was closed out on September 16, 1962.

The Statement of Work covered the design, development, tooling and fabrication of the Fuel Level Control Valves for the XB-70. Each tank had two valves, one as an inlet for the fuel and the other to initiate the shut-off when the tank was filled to the desired level. The major portion of the tooling cost was expended to build a test stand which simulated the B-70 tanks and pumping equipment. This stand required two underground tanks to hold the fuel used in the tests. The tanks had 12,000 and 3,000 gallon capacities. The larger tank was approximately 8 feet in diameter by 32 feet in length. Most of the piping and flowmeters were welded together into an integrated system with recording instruments and a CO_2 fire protection system. The entire test stand was enclosed by a metal lean-to type structure anchored in the cement slab which supported the stand, all of which were included in the total tooling cost. The cost of removing the test stands and all equipment was also included in the final purchase order cost.

All proceeds from the sale of this equipment as well as the residual inventory was credited to the purchase order.

WHITTAKER was awarded the Engine Compartment Cocling System for the XB-70 Program.

Ten potential suppliers were invited to bid on the system, of which four submitted proposals. Of these, two were unacceptable from an engineering standpoint. The remaining two were considered equal in technical approach and experience. Whittaker was nearly 40% lower in cost, so the contract was awarded to them. The contract was on a cost reimbursable basis because of the many unknowns and the required advance in the state-of-the-art.

Two Purchase Orders were awarded to Whittaker for this effort, L1E1-YZ-600300 and L2F1-YJ-600422, extending from August 7, 1960, to June 15, 1964.

The Statement of Work called for the subcontractor to provide Engineering and Management required to design, develop, fabricate, test, and deliver the XB-70 Engine Compartment Cooling System Control System for Air Vehicle No. 1 and 2.

The engine compartment cooling system, control system was a completely pneumatic control and actuation system consisting of bypass valves and valve actuators, sensing and switching control elements within the control package.

The function of this system was to supply cooling air for each of the six XB-70 engines. Within the system each engine contained its separate control system independent from the other five. Under normal conditions, the system functioned automatically, but there were provisions for overriding the system for a fire condition.

The delivery schedule called for five ECCSCS on 1 April 1962 and one ECCSCS on 18 April 1962. Delivery of six units for use with the manually-operated AICS was completed in July 1962. Further development, testing, and rework or fabrication of units suitable for use with the automatic AICS was required and completed in late 1963. This control system was an advancement in the state-of-the-art. High temperatures together with the necessity to control weight added to the complexity of the task.

Whittaker fabricated and/or procured 193 items of tooling and test equipment having a value, including design, of $54,000. The tooling and residual material were shipped to NR for storage and disposal on October 1, 1964. The proceeds obtained were credited to the subject contracts.

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 03
PROPULSION SUBSYSTEM

	6-M ASSY 0 HOURS DOLLARS	6-M ASSY CO HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	1585058	175966	1761024
LABOR AT $ 4.821	7723071	766573	8489644
ENGR BURDEN AT $ 4.080	6664755	520675	7185430
SHOP SUPPORT	44910	397964	442874
LABOR AT $ 3.147	129553	1264093	1393646
TEST/QC	2925	24913	27838
LABOR AT $ 3.158	9041	78870	87911
MFG BURDEN AT $ 3.649	173349	1544471	1717820
ENGR MATERIAL	194088	621358	815446
SUBCONTRACT	11598442		11598442
MPC	549299	59054	608353
OTHER COST	3368866	14561	3383427
SUB-TOTAL	30410464	4869655	35280119
GEN & ADMIN	480399	82773	563172
TOTAL COST	30890863	4952428	35843291

SUBDIVISION OF WORK
COST DETAIL - SEE PAGE III-554 III-580 III-590

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

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 03
6-MAJ ASSY 0

PROPULSION SUBSYSTEM

		DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOOLING AND STE HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING		1585058			1585058
LABOR AT $ 4.872		7723071			7723071
ENGR BURDEN	AT $ 4.205	6664755			6664755
SHOP SUPPORT		44910			44910
LABOR AT $ 2.885		129553			129553
TEST/QC		2925			2925
LABOR AT $ 3.091		9041			9041
MFG BURDEN	AT $ 3.624	173349			173349
ENGR MATERIAL		194088			194088
SUBCONTRACT		6000500	5418673	179269	11598442
MPC		316180	222845	10274	549299
OTHER COST		3368865			3368865
SUB-TOTAL		24579403	5641518	189543	30410464
GEN & ADMIN		377548	99571	3280	480399
TOTAL COST		24956951	5741089	192823	30890863

TIME-PHASED COST DETAIL - SEE PAGE III-555 III-565 III-566 III-568

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 03 **PROPULSION 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	109.5	18422	4.350	80132	83809	163941
Q-2 58						
Q-3 58	494.5	83073	4.105	340995	321634	662629
Q-4 58						
Q-1 59	620.5	105903	4.166	441222	363523	804745
Q-2 59						
Q-3 59	940.0	165371	4.094	677008	593806	1270814
Q-4 59						
Q-1 60	854.5	148169	4.428	656150	530477	1186627
Q-2 60						
Q-3 60	865.0	145277	4.669	678252	515608	1193860
Q-4 60						
Q-1 61	1111.5	189678	4.804	911241	628124	1539365
Q-2 61						
Q-3 61	610.5	110744	5.194	575184	504875	1080059
Q-4 61						
Q-1 62	493.5	84272	5.033	424169	381365	805534
Q-2 62						
Q-3 62	529.0	88829	5.119	454758	477303	932061
Q-4 62						
Q-1 63	788.5	134529	5.229	703459	673852	1377311
Q-2 63						
Q-3 63	935.5	157119	5.525	868026	530352	1398378
Q-4 63						
Q-1 64	431.5	73677	5.786	426320	462502	888822
Q-2 64						
Q-3 64	346.0	60878	5.823	354517	481954	836471
Q-4 64						
Q-1 65	80.5	13993	6.927	96936	88238	185174

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 03
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

PROPULSION SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-2 65						
Q-3 65	28.0	4666	6.918	32279	25393	57672
Q-4 65						
Q-1 66	3.0	458	5.290	2423	1940	4363
TOTAL	9241.5	1585058		7723071	6664755	14387826

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 03 PROPULSION 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	19.5	3382	3.024	10228	9216	19444
Q-2 58						
Q-3 58		-70	2.514	-176	-837	-1013
Q-4 58						
Q-1 59		29	2.517	73	103	176
Q-2 59						
Q-3 59	10.5	1737	3.176	5517	6520	12037
Q-4 59						
Q-1 60	-9.0	-1442	3.096	-4464	-4123	-8587
Q-2 60						
Q-3 60	93.0	15686	2.893	45387	57524	102911
Q-4 60						
Q-1 61	108.0	18529	2.872	53219	65051	118270
Q-2 61						
Q-3 61	22.5	4052	2.839	11505	20293	31798
Q-4 61						
Q-1 62	3.0	492	4.028	1982	2505	4487
Q-2 62						
Q-3 62	-3.0	-501	3.910	-1959	-2333	-4292
Q-4 62						
Q-1 63	1.5	201	3.080	619	888	1507
Q-2 63						
Q-3 63	15.0	2569	2.627	6749	16007	22756
Q-4 63						
Q-1 64		-1	1.000	-1	2	1
Q-2 64						
Q-3 64		59	3.814	225	1455	1680
Q-4 64						
Q-1 65	1.5	145	3.483	505	810	1315

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 03 **PROPULSION 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		43	3.349	144	268	412
TOTAL	262.5	44910		129553	173349	302902

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

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 03 **PROPULSION 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	1.5	180	3.017	543		543
Q-2 58						
Q-3 58		9	2.333	21		21
Q-4 58						
Q-1 59						
Q-2 59						
Q-3 59	1.5	206	3.495	720		720
Q-4 59						
Q-1 60		79	3.304	261		261
Q-2 60						
Q-3 60	4.5	696	2.909	2025		2025
Q-4 60						
Q-1 61	6.0	1137	2.872	3266		3266
Q-2 61						
Q-3 61	1.5	295	3.112	918		918
Q-4 61						
Q-1 62		16	3.438	55		55
Q-2 62						
Q-3 62						
Q-4 62						
Q-1 63		18	3.000	54		54
Q-2 63						
Q-3 63		4	2.500	10		10
Q-4 63						
Q-1 64						
Q-2 64						
Q-3 64	1.5	241	4.253	1025		1025
Q-4 64						
Q-1 65		27	3.370	91		91

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

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 03 **PROPULSION 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		17	3.059	52		52
TOTAL	16.5	2925		9041		9041

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 03 PROPULSION 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	130.5	21984	4.135	90903	93025	183928	263
Q-2 58							
Q-3 58	494.5	83012	4.106	340840	320797	661637	363
Q-4 58							
Q-1 59	620.5	105932	4.166	441295	363626	804921	
Q-2 59							
Q-3 59	952.0	167314	4.084	683245	600326	1283571	1687
Q-4 59							
Q-1 60	845.5	146806	4.441	651947	526354	1178301	1587
Q-2 60							
Q-3 60	962.5	161659	4.489	725664	573132	1298796	17109
Q-4 60							
Q-1 61	1225.5	209344	4.623	967726	693175	1660901	8328
Q-2 61							
Q-3 61	634.5	115091	5.106	587607	525168	1112775	1308
Q-4 61							
Q-1 62	496.5	84780	5.027	426206	383870	810076	-174
Q-2 62							
Q-3 62	526.0	88328	5.126	452799	474970	927769	189
Q-4 62							
Q-1 63	790.0	134748	5.226	704132	674740	1378872	1054
Q-2 63							
Q-3 63	950.5	159692	5.478	874785	546359	1421144	12602
Q-4 63							
Q-1 64	431.5	73676	5.786	426319	462504	888823	34906
Q-2 64							
Q-3 64	347.5	61178	5.815	355767	483409	839176	102105
Q-4 64							
Q-1 65	82.0	14165	6.885	97532	89048	186580	12632
Q-2 65							
Q-3 65	28.0	4726	6.872	32475	25661	58136	129

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

4-SYSTEM 1
5-SUBSYSTEM 03 **PROPULSION 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	3.0	458	5.290	2423	1940	4363	
TOTAL	9520.5	1632393		7861665	5338104	14699769	194088

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

4-SYSTEM 1
5-SUBSYSTEM 03 **PROPULSION 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		263	14		184205		184205
Q-2 58							
Q-3 58		363	20	97435	759455		759455
Q-4 58							
Q-1 59	226079	226079	5994	324815	1361809		1361809
Q-2 59							
Q-3 59	200279	201966	5615	362862	1854014		1854014
Q-4 59							
Q-1 60	643973	645560	38414	1106062	2968337	56556	3024893
Q-2 60							
Q-3 60	2027751	2044860	122562	23726	3489944	66494	3556438
Q-4 60							
Q-1 61	511870	520198	15368	258897	2465364	45814	2511178
Q-2 61							
Q-3 61	621523	622831	17917	487801	2241324	41651	2282975
Q-4 61							
Q-1 62	766549	766375	24375	341177	1942003	32597	1974600
Q-2 62							
Q-3 62	699523	699712	22225	170652	1820358	30554	1850912
Q-4 62							
Q-1 63	212496	213550	9126	310101	1911649	31962	1943611
Q-2 63							
Q-3 63	35933	48535	2395	-205917	1266157	21170	1287327
Q-4 63							
Q-1 64	54524	89430	11208	38334	1027795	21869	1049664
Q-2 64							
Q-3 64		102105	37146	34449	1012876	21552	1034428
Q-4 64							
Q-1 65		12632	3778	5930	208920	5574	214494
Q-2 65							
Q-3 65		129	23	2372	60660	1618	62278

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

4-SYSTEM 1
5-SUBSYSTEM 03 PROPULSION 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				170	4533	137	4670
TOTAL	6000500	6194588	316180	3358866	24579403	377548	24956951

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 03 **PROPULSION SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK PRODUCTION

	SUBC	TOTAL MATERIAL	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 59	49952	49952	1324	51276		51276
Q-2 59						
Q-3 59	59613	59613	1628	61241		61241
Q-4 59						
Q-1 60	238693	238693	14161	252854	4818	257672
Q-2 60						
Q-3 60	1207576	1207576	71649	1279225	24373	1303598
Q-4 60						
Q-1 61	855993	855993	24525	880518	16363	896881
Q-2 61						
Q-3 61	739266	739266	21180	760446	14131	774577
Q-4 61						
Q-1 62	722650	722650	22967	745617	12515	758132
Q-2 62						
Q-3 62	665354	665354	21126	686480	11523	698003
Q-4 62						
Q-1 63	763230	763230	32409	795639	13303	808942
Q-2 63						
Q-3 63	38985	38985	1252	40237	673	40910
Q-4 63						
Q-1 64	77361	77361	10624	87985	1872	89857
TOTAL	5418673	5418673	222845	5641518	99571	5741089

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 03
6-MAJ ASSY 0
SUBD OF WORK TOOLING AND STE

PROPULSION SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-3 59							
Q-4 59							16140
Q-1 60							
Q-2 60							59068
Q-3 60							
Q-4 60							54905
Q-1 61							
Q-2 61							541
Q-3 61							
Q-4 61							15979
Q-1 62							
Q-2 62							8350
Q-3 62							
Q-4 62							6119
Q-1 63							
Q-2 63							3576
Q-3 63							
Q-4 63							119
Q-1 64							14472
TOTAL							179269

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 03
6-MAJ ASSY 0
SUBD OF WORK TOOLING AND STE

PROPULSION SUBSYSTEM

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-3 59	441	16581		16581
Q-4 59				
Q-1 60	3504	62572	1192	63764
Q-2 60				
Q-3 60	3257	58162	1108	59270
Q-4 60				
Q-1 61	15	556	10	566
Q-2 61				
Q-3 61	457	16436	305	16741
Q-4 61				
Q-1 62	265	8615	145	8760
Q-2 62				
Q-3 62	194	6313	106	6419
Q-4 62				
Q-1 63	151	3727	62	3789
Q-2 63				
Q-3 63	3	122	2	124
Q-4 63				
Q-1 64	1987	16459	350	16809
TOTAL	10274	189543	3280	192823

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	DESIGN/ENGINEERING
4-SYSTEM	1
5-SUBSYSTEM	03
6-MAJ ASSY	0

PROPULSION SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	109.5	18422	4.350	80132	83809	163941
Q-2 58						
Q-3 58	494.5	83073	4.105	340995	321634	662629
Q-4 58						
Q-1 59	620.5	105903	4.166	441222	363523	804745
Q-2 59						
Q-3 59	940.0	165371	4.094	677008	593806	1270814
Q-4 59						
Q-1 60	854.5	148169	4.428	656150	530477	1186627
Q-2 60						
Q-3 60	865.0	145277	4.669	678252	515608	1193860
Q-4 60						
Q-1 61	1111.5	189678	4.804	911241	628124	1539365
Q-2 61						
Q-3 61	610.5	110744	5.194	575184	504875	1080059
Q-4 61						
Q-1 62	493.5	84272	5.033	424169	381365	805534
Q-2 62						
Q-3 62	529.0	88829	5.119	454758	477303	932061
Q-4 62						
Q-1 63	788.5	134529	5.229	703459	673852	1377311
Q-2 63						
Q-3 63	935.5	157119	5.525	868026	530352	1398378
Q-4 63						
Q-1 64	431.5	73677	5.786	426320	462502	888822
Q-2 64						
Q-3 64	346.0	60878	5.823	354517	481954	836471
Q-4 64						
Q-1 65	80.5	13993	6.927	96936	88238	185174
Q-2 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	DESIGN/ENGINEERING	
4-SYSTEM	1	
5-SUBSYSTEM	03	**PROPULSION SUBSYSTEM**
6-MAJ ASSY	0	

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	28.0	4666	6.918	32279	25393	57672
Q-4 65						
Q-1 66	3.0	458	5.290	2423	1940	4363
TOTAL	9241.5	1585058		7723071	6664755	14387826

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 03 PROPULSION SUBSYSTEM
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	19.5	3382	3.024	10228	9216	19444
Q-2 58						
Q-3 58		-70	2.514	-176	-837	-1013
Q-4 58						
Q-1 59		29	2.517	73	103	176
Q-2 59						
Q-3 59	10.5	1737	3.176	5517	6520	12037
Q-4 59						
Q-1 60	-9.0	-1442	3.096	-4464	-4123	-8587
Q-2 60						
Q-3 60	93.0	15686	2.893	45387	57524	102911
Q-4 60						
Q-1 61	108.0	18529	2.872	53219	65051	118270
Q-2 61						
Q-3 61	22.5	4052	2.839	11505	20293	31798
Q-4 61						
Q-1 62	3.0	492	4.028	1982	2505	4487
Q-2 62						
Q-3 62	-3.0	-501	3.910	-1959	-2333	-4292
Q-4 62						
Q-1 63	1.5	201	3.080	619	888	1507
Q-2 63						
Q-3 63	15.0	2569	2.627	6749	16007	22756
Q-4 63						
Q-1 64		-1	1.000	-1	2	1
Q-2 64						
Q-3 64		59	3.814	225	1455	1680
Q-4 64						
Q-1 65	1.5	145	3.483	505	810	1315
Q-2 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 03
6-MAJ ASSY 0

PROPULSION SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65		43	3.349	144	268	412
TOTAL	262.5	44910		129553	173349	302902

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

	TEST/QC
4-SYSTEM	1
5-SUBSYSTEM	03
6-MAJ ASSY	0

PROPULSION SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	1.5	180	3.017	543		543
Q-2 58						
Q-3 58		9	2.333	21		21
Q-4 58						
Q-1 59						
Q-2 59						
Q-3 59	1.5	206	3.495	720		720
Q-4 59						
Q-1 60		79	3.304	261		261
Q-2 60						
Q-3 60	4.5	696	2.909	2025		2025
Q-4 60						
Q-1 61	6.0	1137	2.872	3266		3266
Q-2 61						
Q-3 61	1.5	295	3.112	918		918
Q-4 61						
Q-1 62		16	3.438	55		55
Q-2 62						
Q-3 62						
Q-4 62						
Q-1 63		18	3.000	54		54
Q-2 63						
Q-3 63		4	2.500	10		10
Q-4 63						
Q-1 64						
Q-2 64						
Q-3 64	1.5	241	4.253	1025		1025
Q-4 64						
Q-1 65		27	3.370	91		91
Q-2 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 03 **PROPULSION SUBSYSTEM**
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65		17	3.C59	52		52
TOTAL	16.5	2925		9041		9041

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

4-SYSTEM 1
5-SUBSYSTEM 03
6-MAJ ASSY 0

PROPULSION SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	130.5	21984	4.135	90903	93025	183928	263
Q-2 58							
Q-3 58	494.5	83012	4.106	340840	320797	661637	363
Q-4 58							
Q-1 59	620.5	105932	4.166	441295	363626	804921	
Q-2 59							
Q-3 59	952.0	167314	4.084	683245	600326	1283571	1687
Q-4 59							
Q-1 60	845.5	146806	4.441	651947	526354	1178301	1587
Q-2 60							
Q-3 60	962.5	161659	4.489	725664	573132	1298796	17109
Q-4 60							
Q-1 61	1225.5	209344	4.623	967726	693175	1660901	8328
Q-2 61							
Q-3 61	634.5	115091	5.106	587607	525168	1112775	1308
Q-4 61							
Q-1 62	496.5	84780	5.027	426206	383870	810076	-174
Q-2 62							
Q-3 62	526.0	88328	5.126	452799	474970	927769	189
Q-4 62							
Q-1 63	790.0	134748	5.226	704132	674740	1378872	1054
Q-2 63							
Q-3 63	950.5	159692	5.478	874785	546359	1421144	12602
Q-4 63							
Q-1 64	431.5	73676	5.786	426319	462504	888823	34906
Q-2 64							
Q-3 64	347.5	61178	5.815	355767	483409	839176	102105
Q-4 64							
Q-1 65	82.0	14165	6.885	97532	89048	186580	12632
Q-2 65							
Q-3 65	28.0	4726	6.872	32475	25661	58136	129
Q-4 65							

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 03
6-MAJ ASSY 0

PROPULSION SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
-1 66	3.0	458	5.290	2423	1940	4363	.
TOTAL	9520.5	1632893		7861665	6838104	14699769	194088

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 03
6-MAJ ASSY 0

PROPULSION SUBSYSTEM

	MFG MATL	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A
Q-1 58			263	14		184205	
Q-2 58							
Q-3 58			363	20	97435	759455	
Q-4 58							
Q-1 59		276031	276031	7318	324815	1413085	
Q-2 59							
Q-3 59		276032	277719	7684	362862	1931836	
Q-4 59							
Q-1 60		941734	943321	56079	1106062	3283763	62566
Q-2 60							
Q-3 60		3290232	3307341	197468	23726	4827331	91975
Q-4 60							
Q-1 61		1368404	1376732	39908	268897	3346438	62187
Q-2 61							
Q-3 61		1376768	1378076	39554	487801	3018206	56087
Q-4 61							
Q-1 62		1497549	1497375	47607	341177	2696235	45257
Q-2 62							
Q-3 62		1370996	1371185	43545	170652	2513151	42183
Q-4 62							
Q-1 63		979302	980356	41686	310101	2711015	45327
Q-2 63							
Q-3 63		75037	87639	3650	-205917	1306516	21845
Q-4 63							
Q-1 64		146357	181263	23819	38334	1132239	24091
Q-2 64							
Q-3 64			102105	37146	34449	1012876	21552
Q-4 64							
Q-1 65			12632	3778	5930	208920	5574
Q-2 65							
Q-3 65			129	23	2372	60660	1618
Q-4 65							

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 03
6-MAJ ASSY 0

PROPULSION SUBSYSTEM

	MFG MATL	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A
Q-1 66					170	4533	137
TOTAL		11598442	11792530	549295	3368866	30410464	480399

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 03
6-MAJ ASSY 0

PROPULSION SUBSYSTEM

		TOTAL COST
Q-1	58	184205
Q-2	58	
Q-3	58	759455
Q-4	58	
Q-1	59	1413085
Q-2	59	
Q-3	59	1931836
Q-4	59	
Q-1	60	3346329
Q-2	60	
Q-3	60	4919306
Q-4	60	
Q-1	61	3408625
Q-2	61	
Q-3	61	3074293
Q-4	61	
Q-1	62	2741492
Q-2	62	
Q-3	62	2555334
Q-4	62	
Q-1	63	2756342
Q-2	63	
Q-3	63	1328361
Q-4	63	
Q-1	64	1156330
Q-2	64	
Q-3	64	1034428
Q-4	64	
Q-1	65	214494
Q-2	65	
Q-3	65	62278
Q-4	65	

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 03
6-MAJ ASSY 0

PROPULSION SUBSYSTEM

	TOTAL COST
Q-1 66	4670
TOTAL	30890863

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 03
6-MAJ ASSY 09
PROPULSION GROUND TESTS

	TEST /QC HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	175966	175966
LABOR AT $ 4.356	766573	766573
ENGR BURDEN AT $ 2.959	520675	520675
SHOP SUPPORT	397964	397964
LABOR AT $ 3.176	1264093	1264093
TEST/QC	24913	24913
LABOR AT $ 3.166	78870	78870
MFG BURDEN AT $ 3.652	1544471	1544471
ENGR MATERIAL	621358	621358
MPC	59054	59054
OTHER COST	14561	14561
SUB-TOTAL	4869655	4869655
GEN & ADMIN	82773	82773
TOTAL COST	4952428	4952428

TIME-PHASED COST
DETAIL - SEE PAGE III-581

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 03 **PROPULSION GROUND TESTS**
6-MAJ ASSY 09
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 60		50	3.220	161	186	347
Q-2 60						
Q-3 60	49.5	8223	3.910	32149	30454	62603
Q-4 60						
Q-1 61	105.0	17936	3.932	70517	62000	132517
Q-2 61						
Q-3 61	123.0	22354	4.191	93688	83287	176975
Q-4 61						
Q-1 62	282.0	48059	4.412	212020	141347	353367
Q-2 62						
Q-3 62	337.5	56668	4.502	255131	118823	373954
Q-4 62						
Q-1 63	87.0	14733	4.652	68542	50329	118871
Q-2 63						
Q-3 63	24.0	4003	4.648	18605	16946	35551
Q-4 63						
Q-1 64	7.5	1310	5.044	6608	7971	14579
Q-2 64						
Q-3 64	7.5	1252	5.090	6373	7635	14008
Q-4 64						
Q-1 65	6.0	964	2.018	1945	1188	3133
Q-2 65						
Q-3 65	3.0	386	2.016	778	475	1253
Q-4 65						
Q-1 66		28	2.000	56	34	90
TOTAL	1032.0	175966		766573	520675	1287248

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B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 03 **PROPULSION GROUND TESTS**
6-MAJ ASSY 09
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	18.0	3070	2.774	8516	11140	19656
Q-4 58						
Q-1 59	57.0	9647	2.947	28428	35622	64050
Q-2 59						
Q-3 59	16.5	3028	2.851	8633	13224	21857
Q-4 59						
Q-1 60	39.0	6663	3.076	20496	22547	43043
Q-2 60						
Q-3 60	174.0	29167	2.994	87318	98777	186095
Q-4 60						
Q-1 61	378.0	64489	2.953	190468	227655	418123
Q-2 61						
Q-3 61	395.0	72361	2.983	215844	262012	477856
Q-4 61						
Q-1 62	732.0	125030	3.054	381826	463697	845523
Q-2 62						
Q-3 62	265.5	44657	3.098	138342	200652	338994
Q-4 62						
Q-1 63	174.0	29664	3.233	95900	126547	222447
Q-2 63						
Q-3 63	49.5	8241	6.330	52162	72503	124665
Q-4 63						
Q-1 64	6.0	924	19.360	17889	4710	22599
Q-2 64						
Q-3 64	6.0	924	19.360	17889	4685	22574
Q-4 64						
Q-1 65		69	3.870	267	458	725
Q-2 65						
Q-3 65		28	3.821	107	183	290

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SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 03 **PROPULSION GROUND TESTS**
6-MAJ ASSY 09
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		2	4.000	8	59	67
TOTAL	2314.5	397964		1264093	1544471	2808564

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SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	TEST/QC	
4-SYSTEM	1	
5-SUBSYSTEM	03	**PROPULSION GROUND TESTS**
6-MAJ ASSY	09	
SUBD OF WORK	TEST/QC	

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		16	2.688	43		43
Q-4 58						
Q-1 59	1.5	154	3.682	567		567
Q-2 59						
Q-3 59		117	2.684	314		314
Q-4 59						
Q-1 60	1.5	264	3.144	830		830
Q-2 60						
Q-3 60	13.5	2164	3.073	6649		6649
Q-4 60						
Q-1 61	24.0	4188	3.073	12871		12871
Q-2 61						
Q-3 61	24.0	4296	3.127	13434		13434
Q-4 61						
Q-1 62	37.5	6449	3.145	20279		20279
Q-2 62						
Q-3 62	25.5	4273	3.151	13465		13465
Q-4 62						
Q-1 63	10.5	1767	3.337	5897		5897
Q-2 63						
Q-3 63	6.0	1043	3.604	3759		3759
Q-4 63						
Q-1 64		101	3.614	365		365
Q-2 64						
Q-3 64		95	3.568	339		339
Q-4 64						
Q-1 65		-19	.420	8		8
Q-2 65						
Q-3 65		-8	.374	3		3

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TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 03 PROPULSION GROUND TESTS
6-MAJ ASSY 09
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					-46	-46
Q-2 66						
Q-3 66		13	3.615	47	46	93
TOTAL	144.0	24913		78870		78870

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 03
6-MAJ ASSY 09
PROPULSION GROUND TESTS

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-3 58	18.0	3086	2.773	8559	11140	19699	4088
Q-4 58							
Q-1 59	58.5	9801	2.958	28995	35622	64617	56868
Q-2 59							
Q-3 59	16.5	3145	2.845	8947	13224	22171	1798
Q-4 59							
Q-1 60	40.5	6977	3.080	21487	22733	44220	6001
Q-2 60							
Q-3 60	237.0	39554	3.188	126116	129231	255347	38958
Q-4 60							
Q-1 61	507.0	86613	3.162	273856	289655	563511	94826
Q-2 61							
Q-3 61	546.0	99011	3.262	322966	345299	668265	103990
Q-4 61							
Q-1 62	1051.5	179538	3.421	614125	605044	1219169	91051
Q-2 62							
Q-3 62	628.5	105598	3.854	406938	319475	726413	112591
Q-4 62							
Q-1 63	271.5	46164	3.690	170339	176876	347215	65755
Q-2 63							
Q-3 63	79.5	13287	5.609	74526	89449	163975	15813
Q-4 63							
Q-1 64	13.5	2335	10.648	24862	12681	37543	12219
Q-2 64							
Q-3 64	13.5	2271	10.833	24601	12320	36921	12004
Q-4 64							
Q-1 65	6.0	1014	2.189	2220	1646	3866	3770
Q-2 65							
Q-3 65	3.0	406	2.187	888	658	1546	1508
Q-4 65							
Q-1 66		30	2.133	64	47	111	108

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 03
6-MAJ ASSY 09
PROPULSION GROUND TESTS

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-2 66							
Q-3 66		13	3.615	47	46	93	
TOTAL	3490.5	598843		2109536	2065146	4174682	621358

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

4-SYSTEM 1
5-SUBSYSTEM 03
6-MAJ ASSY 09
PROPULSION GROUND TESTS

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-3 58	224		24011		24011
Q-4 58					
Q-1 59	4815		126300		126300
Q-2 59					
Q-3 59	152		24121		24121
Q-4 59					
Q-1 60	789		51010	972	51982
Q-2 60					
Q-3 60	5124		299429	5705	305134
Q-4 60					
Q-1 61	8008		666345	12383	678728
Q-2 61					
Q-3 61	8781	6461	787497	14634	802131
Q-4 61					
Q-1 62	7171	7546	1324937	22239	1347176
Q-2 62					
Q-3 62	8867	2883	850754	14280	865034
Q-4 62					
Q-1 63	6479	7523	426982	7139	434121
Q-2 63					
Q-3 63	1557	-9959	171386	2866	174252
Q-4 63					
Q-1 64	1302	18	51082	1087	52169
Q-2 64					
Q-3 64	4367	19	53311	1134	54445
Q-4 64					
Q-1 65	1127	49	8812	235	9047
Q-2 65					
Q-3 65	269	20	3343	89	3432
Q-4 65					
Q-1 66	22	1	242	7	249

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 03
6-MAJ ASSY 09
PROPULSION GROUND TESTS

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-2 66					
Q-3 66			93	3	96
TOTAL	59054	14561	4869655	82773	4952428

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

4-SYSTEM 1
5-SUBSYSTEM 03
PROPULSION SUBSYSTEM

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOOLING AND STE HOURS DOLLARS	TEST /QC HOURS DOLLARS
DESIGN/ENGINEERING	1585058			175966
LABOR AT $ 4.821	7723071			766573
ENGR BURDEN AT $ 4.080	6664755			520675
SHOP SUPPORT	44910			397964
LABOR AT $ 3.147	129553			1264093
TEST/QC	2925			24913
LABOR AT $ 3.158	9041			78870
MFG BURDEN AT $ 3.649	173349			1544471
ENGR MATERIAL	194088			621358
SUBCONTRACT	6000500	5418673	179269	
MPC	316180	222845	10274	59054
OTHER COST	3368866			14561
	--------	--------	--------	--------
SUB-TOTAL	24579403	5641518	189543	4869655
GEN & ADMIN	377548	99571	3280	82773
	--------	--------	--------	--------
TOTAL COST	24956951	5741089	192823	4952428
TIME-PHASED COST DETAIL - SEE PAGE	III-592	III-602	III-603	III-605

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 03
PROPULSION SUBSYSTEM

			TOTAL HOURS DOLLARS
DESIGN/ENGINEERING			1761024
LABOR AT $ 4.821			8489644
ENGR BURDEN	AT $	4.080	7185430
SHOP SUPPORT			442874
LABOR AT $ 3.147			1393646
TEST/QC			27838
LABOR AT $ 3.158			87911
MFG BURDEN	AT $	3.649	1717820
ENGR MATERIAL			815446
SUBCONTRACT			11598442
MPC			608353
OTHER COST			3383427
SUB-TOTAL			35280119
GEN & ADMIN			563172
TOTAL COST			35843291

TIME-PHASED COST
DETAIL - SEE PAGE III-614

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

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 03 **PROPULSION SUBSYSTEM**
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	109.5	18422	4.350	80132	83809	163941
Q-2 58						
Q-3 58	494.5	83073	4.105	340995	321634	662629
Q-4 58						
Q-1 59	620.5	105903	4.166	441222	363523	804745
Q-2 59						
Q-3 59	940.0	165371	4.094	677008	593806	1270814
Q-4 59						
Q-1 60	854.5	148169	4.428	656150	530477	1186627
Q-2 60						
Q-3 60	865.0	145277	4.669	678252	515608	1193860
Q-4 60						
Q-1 61	1111.5	189678	4.804	911241	628124	1539365
Q-2 61						
Q-3 61	610.5	110744	5.194	575184	504875	1080059
Q-4 61						
Q-1 62	493.5	84272	5.033	424169	381365	805534
Q-2 62						
Q-3 62	529.0	88829	5.119	454758	477303	932061
Q-4 62						
Q-1 63	788.5	134529	5.229	703459	673852	1377311
Q-2 63						
Q-3 63	935.5	157119	5.525	868026	530352	1398378
Q-4 63						
Q-1 64	431.5	73677	5.786	426320	462502	888822
Q-2 64						
Q-3 64	346.0	60878	5.823	354517	481954	836471
Q-4 64						
Q-1 65	80.5	13993	6.927	96936	88238	185174
Q-2 65						

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SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 03 PROPULSION SUBSYSTEM
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	28.0	4666	6.918	32279	25393	57672
Q-4 65						
Q-1 66	3.0	458	5.290	2423	1940	4363
TOTAL	9241.5	1585058		7723071	6664755	14387826

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SPACE DIVISION
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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 03 PROPULSION SUBSYSTEM
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	19.5	3382	3.024	10228	9216	19444
Q-2 58						
Q-3 58		-70	2.514	-176	-837	-1013
Q-4 58						
Q-1 59		29	2.517	73	103	176
Q-2 59						
Q-3 59	10.5	1737	3.176	5517	6520	12037
Q-4 59						
Q-1 60	-9.0	-1442	3.096	-4464	-4123	-8587
Q-2 60						
Q-3 60	93.0	15686	2.893	45387	57524	102911
Q-4 60						
Q-1 61	108.0	18529	2.872	53219	65051	118270
Q-2 61						
Q-3 61	22.5	4052	2.839	11505	20293	31798
Q-4 61						
Q-1 62	3.0	492	4.028	1982	2505	4487
Q-2 62						
Q-3 62	-3.0	-501	3.910	-1959	-2333	-4292
Q-4 62						
Q-1 63	1.5	201	3.080	619	888	1507
Q-2 63						
Q-3 63	15.0	2569	2.627	6749	16007	22756
Q-4 63						
Q-1 64		-1	1.000	-1	2	1
Q-2 64						
Q-3 64		59	3.814	225	1455	1680
Q-4 64						
Q-1 65	1.5	145	3.483	505	810	1315
Q-2 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1 PROPULSION SUBSYSTEM
5-SUBSYSTEM 03
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65		43	3.349	144	268	412
TOTAL	262.5	44910		129553	173349	302902

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 03 PROPULSION SUBSYSTEM
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	1.5	180	3.017	543		543
Q-2 58						
Q-3 58		9	2.333	21		21
Q-4 58						
Q-1 59						
Q-2 59						
Q-3 59	1.5	206	3.495	720		720
Q-4 59						
Q-1 60		79	3.304	261		261
Q-2 60						
Q-3 60	4.5	696	2.909	2025		2025
Q-4 60						
Q-1 61	6.0	1137	2.872	3266		3266
Q-2 61						
Q-3 61	1.5	295	3.112	918		918
Q-4 61						
Q-1 62		16	3.438	55		55
Q-2 62						
Q-3 62						
Q-4 62						
Q-1 63		18	3.000	54		54
Q-2 63						
Q-3 63		4	2.500	10		10
Q-4 63						
Q-1 64						
Q-2 64						
Q-3 64	1.5	241	4.253	1025		1025
Q-4 64						
Q-1 65		27	3.370	91		91
Q-2 65						

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

TEST/QC
4-SYSTEM 1 **PROPULSION SUBSYSTEM**
5-SUBSYSTEM 03
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65		17	3.059	52		52
TOTAL	16.5	2925		9041		9041

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 03
SUBD OF WORK DESIGN/ENGINEERING

PROPULSION SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58 Q-2 58	130.5	21984	4.135	90903	93025	183928	263
Q-3 58 Q-4 58	494.5	83012	4.106	340840	320797	661637	363
Q-1 59 Q-2 59	620.5	105932	4.166	441295	363626	804921	
Q-3 59 Q-4 59	952.0	167314	4.084	683245	600326	1283571	1687
Q-1 60 Q-2 60	845.5	146806	4.441	651947	526354	1178301	1507
Q-3 60 Q-4 60	962.5	161659	4.489	725664	573132	1298796	17109
Q-1 61 Q-2 61	1225.5	209344	4.623	967726	693175	1660901	8328
Q-3 61 Q-4 61	634.5	115091	5.106	587607	525168	1112775	1308
Q-1 62 Q-2 62	496.5	84780	5.027	426206	383870	810076	-174
Q-3 62 Q-4 62	526.0	88328	5.126	452799	474970	927769	189
Q-1 63 Q-2 63	790.0	134748	5.226	704132	674740	1378872	1054
Q-3 63 Q-4 63	950.5	159692	5.478	874785	546359	1421144	12602
Q-1 64 Q-2 64	431.5	73676	5.786	426319	462504	888823	34906
Q-3 64 Q-4 64	347.5	61178	5.815	355767	483409	839176	102105
Q-1 65 Q-2 65	82.0	14165	6.885	97532	89048	186580	12632
Q-3 65 Q-4 65	28.0	4726	6.872	32475	25661	58136	129

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1 PROPULSION SUBSYSTEM
5-SUBSYSTEM 03
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66	3.0	458	5.290	2423	1940	4363	
TOTAL	9520.5	1632893		7861665	6838104	14699769	194088

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B-70 AIRCRAFT STUDY

4-SYSTEM 1 PROPULSION SUBSYSTEM
5-SUBSYSTEM 03
SUBD OF WORK DESIGN/ENGINEERING

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58		263	14		184205		184205
Q-2 58							
Q-3 58		363	20	97435	759455		759455
Q-4 58							
Q-1 59	226079	226079	5994	324815	1361809		1361809
Q-2 59							
Q-3 59	200279	201966	5615	362862	1854014		1854014
Q-4 59							
Q-1 60	643973	645560	38414	1106062	2968337	56556	3024893
Q-2 60							
Q-3 60	2027751	2044860	122562	23726	3489944	66494	3556438
Q-4 60							
Q-1 61	511870	520198	15368	268897	2465364	45814	2511178
Q-2 61							
Q-3 61	621523	622831	17917	487801	2241324	41651	2282975
Q-4 61							
Q-1 62	766549	766375	24375	341177	1942003	32597	1974600
Q-2 62							
Q-3 62	699523	699712	22225	170652	1820358	30554	1850912
Q-4 62							
Q-1 63	212496	213550	9126	310101	1911649	31962	1943611
Q-2 63							
Q-3 63	35933	48535	2395	-205917	1266157	21170	1287327
Q-4 63							
Q-1 64	54524	89430	11208	38334	1027795	21869	1049664
Q-2 64							
Q-3 64		102105	37146	34449	1012876	21552	1034428
Q-4 64							
Q-1 65		12632	3778	5930	208920	5574	214494
Q-2 65							
Q-3 65		129	23	2372	60660	1618	62278
Q-4 65							

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B-70 AIRCRAFT STUDY

4-SYSTEM 1 PROPULSION SUBSYSTEM
5-SUBSYSTEM 03
SUBD OF WORK DESIGN/ENGINEERING

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
0-1 66				170	4533	137	4670
TOTAL	6000500	6194588	316180	3363866	24579403	377548	24956951

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 03
SUBD OF WORK PRODUCTION

PROPULSION SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	SUB TOTAL	G & A	TOTAL COST
Q-1 59	49952	49952	1324	51276		51276
Q-2 59						
Q-3 59	59613	59613	1628	61241		61241
Q-4 59						
Q-1 60	238693	238693	14161	252854	4818	257672
Q-2 60						
Q-3 60	1207576	1207576	71649	1279225	24373	1303598
Q-4 60						
Q-1 61	855993	855993	24525	880518	16363	896881
Q-2 61						
Q-3 61	739266	739266	21180	760446	14131	774577
Q-4 61						
Q-1 62	722650	722650	22967	745617	12515	758132
Q-2 62						
Q-3 62	665354	665354	21126	686480	11523	698003
Q-4 62						
Q-1 63	763230	763230	32409	795639	13303	808942
Q-2 63						
Q-3 63	38985	38985	1252	40237	673	40910
Q-4 63						
Q-1 64	77361	77361	10624	87985	1872	89857
TOTAL	5418673	5418673	222845	5641518	99571	5741089

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B-70 AIRCRAFT STUDY

4-SYSTEM 1 **PROPULSION SUBSYSTEM**
5-SUBSYSTEM 03
SUBD OF WORK TOOLING AND STE

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-3 59							16140
Q-4 59							
Q-1 60							59068
Q-2 60							
Q-3 60							54905
Q-4 60							
Q-1 61							541
Q-2 61							
Q-3 61							15979
Q-4 61							
Q-1 62							8350
Q-2 62							
Q-3 62							6119
Q-4 62							
Q-1 63							3576
Q-2 63							
Q-3 63							119
Q-4 63							
Q-1 64							14472
TOTAL							179269

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B-70 AIRCRAFT STUDY

4-SYSTEM 1 — PROPULSION SUBSYSTEM
5-SUBSYSTEM 03
SUBD OF WORK TOOLING AND STE

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-3 59	441	16581		16581
Q-4 59				
Q-1 60	3504	62572	1192	63764
Q-2 60				
Q-3 60	3257	58162	1108	59270
Q-4 60				
Q-1 61	15	556	10	566
Q-2 61				
Q-3 61	457	16436	305	16741
Q-4 61				
Q-1 62	265	8615	145	8760
Q-2 62				
Q-3 62	194	6313	106	6419
Q-4 62				
Q-1 63	151	3727	62	3789
Q-2 63				
Q-3 63	3	122	2	124
Q-4 63				
Q-1 64	1987	16459	350	16809
TOTAL	10274	189543	3280	192823

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B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 03 PROPULSION SUBSYSTEM
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 60		50	3.220	161	186	347
Q-2 60						
Q-3 60	49.5	8223	3.910	32149	30454	62603
Q-4 60						
Q-1 61	105.0	17936	3.932	70517	62000	132517
Q-2 61						
Q-3 61	123.0	22354	4.191	93688	83287	176975
Q-4 61						
Q-1 62	282.0	48059	4.412	212020	141347	353367
Q-2 62						
Q-3 62	337.5	56668	4.502	255131	118823	373954
Q-4 62						
Q-1 63	87.0	14733	4.652	68542	50329	118871
Q-2 63						
Q-3 63	24.0	4003	4.648	18605	16946	35551
Q-4 63						
Q-1 64	7.5	1310	5.044	6608	7971	14579
Q-2 64						
Q-3 64	7.5	1252	5.090	6373	7635	14008
Q-4 64						
Q-1 65	6.0	964	2.018	1945	1188	3133
Q-2 65						
Q-3 65	3.0	386	2.016	778	475	1253
Q-4 65						
Q-1 66		28	2.000	56	34	90
TOTAL	1032.0	175966		766573	520675	1287248

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B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 03 PROPULSION SUBSYSTEM
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58	18.0	3070	2.774	8516	11140	19656
Q-4 58						
Q-1 59	57.0	9647	2.947	28428	35622	64050
Q-2 59						
Q-3 59	16.5	3028	2.851	8633	13224	21857
Q-4 59						
Q-1 60	35.0	6663	3.076	20496	22547	43043
Q-2 60						
Q-3 60	174.0	29167	2.994	87318	98777	186095
Q-4 60						
Q-1 61	378.0	64489	2.953	190468	227655	418123
Q-2 61						
Q-3 61	399.0	72361	2.983	215844	262012	477856
Q-4 61						
Q-1 62	732.0	125030	3.054	381826	463697	845523
Q-2 62						
Q-3 62	265.5	44657	3.098	138342	200652	338994
Q-4 62						
Q-1 63	174.0	29664	3.233	95900	126547	222447
Q-2 63						
Q-3 63	49.5	8241	6.330	52162	72503	124665
Q-4 63						
Q-1 64	6.0	924	19.360	17889	4710	22599
Q-2 64						
Q-3 64	6.0	924	19.360	17889	4685	22574
Q-4 64						
Q-1 65		69	3.870	267	458	725
Q-2 65						
Q-3 65		28	3.821	107	183	290
Q-4 65						

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SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 03 PROPULSION SUBSYSTEM
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 66		2	4.000	8	59	67
TOTAL	2314.5	397964		1264093	1544471	2808564

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TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 03 PROPULSION SUBSYSTEM
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58		16	2.688	43		43
Q-4 58						
Q-1 59	1.5	154	3.682	567		567
Q-2 59						
Q-3 59		117	2.684	314		314
Q-4 59						
Q-1 60	1.5	264	3.144	830		830
Q-2 60						
Q-3 60	13.5	2164	3.073	6649		6649
Q-4 60						
Q-1 61	24.0	4188	3.073	12871		12871
Q-2 61						
Q-3 61	24.0	4296	3.127	13434		13434
Q-4 61						
Q-1 62	37.5	6449	3.145	20279		20279
Q-2 62						
Q-3 62	25.5	4273	3.151	13465		13465
Q-4 62						
Q-1 63	10.5	1767	3.337	5897		5897
Q-2 63						
Q-3 63	6.0	1043	3.604	3759		3759
Q-4 63						
Q-1 64		101	3.614	365		365
Q-2 64						
Q-3 64		95	3.568	339		339
Q-4 64						
Q-1 65		-19	.420	8		8
Q-2 65						
Q-3 65		-8	.374	3		3
Q-4 65						

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5-SUBSYSTEM 03
SUBD OF WORK TEST/QC

PROPULSION SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 66					-46	-46
Q-2 66						
Q-3 66		13	3.615	47	46	93
TOTAL	144.0	24913		78870		78870

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4-SYSTEM 1
5-SUBSYSTEM 03 PROPULSION SUBSYSTEM
SUBD OF WORK TEST/QC

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-3 58 Q-4 58	18.0	3086	2.773	8559	11140	19699	4088
Q-1 59 Q-2 59	58.5	9801	2.958	28995	35622	64617	56858
Q-3 59 Q-4 59	16.5	3145	2.845	8947	13224	22171	1798
Q-1 60 Q-2 60	40.5	6977	3.080	21487	22733	44220	6001
Q-3 60 Q-4 60	237.0	39554	3.188	126116	129231	255347	38958
Q-1 61 Q-2 61	507.0	86613	3.162	273856	289655	563511	94826
Q-3 61 Q-4 61	546.0	99011	3.262	322966	345299	668265	103990
Q-1 62 Q-2 62	1051.5	179538	3.421	614125	605044	1219169	91051
Q-3 62 Q-4 62	628.5	105598	3.854	406938	319475	726413	112591
Q-1 63 Q-2 63	271.5	46164	3.690	170339	176876	347215	65765
Q-3 63 Q-4 63	79.5	13287	5.609	74526	89449	163975	15813
Q-1 64 Q-2 64	13.5	2335	10.648	24862	12681	37543	12219
Q-3 64 Q-4 64	13.5	2271	10.833	24601	12320	36921	12004
Q-1 65 Q-2 65	6.0	1014	2.189	2220	1646	3866	3770
Q-3 65 Q-4 65	3.0	406	2.187	888	658	1546	1508
Q-1 66 Q-2 66		30	2.133	64	47	111	108

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4-SYSTEM 1
5-SUBSYSTEM 03
SUBD OF WORK TEST/QC

PROPULSION SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-3 66		13	3.615	47	46	93	
TOTAL	3490.5	598843		2109536	2065146	4174682	621358

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4-SYSTEM 1
5-SUBSYSTEM 03 PROPULSION SUBSYSTEM
SUBD OF WORK TEST/QC

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-3 58	224		24011		24011
Q-4 58					
Q-1 59	4815		126300		126300
Q-2 59					
Q-3 59	152		24121		24121
Q-4 59					
Q-1 60	789		51010	972	51982
Q-2 60					
Q-3 60	5124		299429	5705	305134
Q-4 60					
Q-1 61	8008		666345	12383	678728
Q-2 61					
Q-3 61	8781	6451	787497	14634	802131
Q-4 61					
Q-1 62	7171	7546	1324937	22239	1347176
Q-2 62					
Q-3 62	8867	2883	850754	14280	865034
Q-4 62					
Q-1 63	6479	7523	426982	7139	434121
Q-2 63					
Q-3 63	1557	-9959	171386	2866	174252
Q-4 63					
Q-1 64	1302	18	51082	1087	52169
Q-2 64					
Q-3 64	4367	19	53311	1134	54445
Q-4 64					
Q-1 65	1127	49	8812	235	9047
Q-2 65					
Q-3 65	269	20	3343	89	3432
Q-4 65					
Q-1 66	22	1	242	7	249
Q-2 66					

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5-SUBSYSTEM 03 PROPULSION SUBSYSTEM
SUBD OF WORK TEST/QC

	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-3 66			93	3	96
TOTAL	59054	14561	4869655	82773	4952428

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DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 03
PROPULSION SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58 Q-2 58	109.5	18422	4.350	80132	83809	163941
Q-3 58 Q-4 58	494.5	83073	4.105	340995	321634	662629
Q-1 59 Q-2 59	620.5	105903	4.166	441222	363523	804745
Q-3 59 Q-4 59	940.0	165371	4.094	677008	593806	1270814
Q-1 60 Q-2 60	855.0	148219	4.428	656311	530663	1186974
Q-3 60 Q-4 60	913.5	153500	4.628	710401	546062	1256463
Q-1 61 Q-2 61	1216.5	207614	4.729	981758	690124	1671882
Q-3 61 Q-4 61	734.5	133098	5.025	668872	588162	1257034
Q-1 62 Q-2 62	775.0	132331	4.808	636189	522712	1158901
Q-3 62 Q-4 62	866.5	145497	4.879	709889	596126	1306015
Q-1 63 Q-2 63	874.5	149262	5.172	772001	724181	1496182
Q-3 63 Q-4 63	959.5	161122	5.503	886631	547298	1433929
Q-1 64 Q-2 64	439.0	74987	5.773	432928	470473	903401
Q-3 64 Q-4 64	353.5	62130	5.809	360890	489589	850479
Q-1 65 Q-2 65	86.5	14957	6.611	98881	89426	188307

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DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 03
PROPULSION SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	30.0	5052	6.543	33057	25868	58925
Q-4 65						
Q-1 66	3.0	486	5.101	2479	1974	4453
TOTAL	10271.5	1761024		8489644	7185430	15675074

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SHOP SUPPORT
4-SYSTEM 1
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PROPULSION SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	19.5	3382	3.024	10228	9216	19444
Q-2 58						
Q-3 58	18.0	3000	2.780	8340	10303	18643
Q-4 58						
Q-1 59	57.0	9676	2.946	28501	35725	64226
Q-2 59						
Q-3 59	27.0	4765	2.970	14150	19744	33894
Q-4 59						
Q-1 60	30.0	5221	3.071	16032	18424	34456
Q-2 60						
Q-3 60	267.0	44853	2.959	132705	156301	289006
Q-4 60						
Q-1 61	486.0	83018	2.935	243687	292706	536393
Q-2 61						
Q-3 61	421.5	76413	2.975	227349	282305	509654
Q-4 61						
Q-1 62	735.0	125522	3.058	383808	466202	850010
Q-2 62						
Q-3 62	262.5	44156	3.089	136383	198319	334702
Q-4 62						
Q-1 63	175.5	29865	3.232	96519	127435	223954
Q-2 63						
Q-3 63	64.5	10810	5.450	58911	88510	147421
Q-4 63						
Q-1 64	6.0	923	19.380	17888	4712	22600
Q-2 64						
Q-3 64	6.0	983	18.427	18114	6140	24254
Q-4 64						
Q-1 65	1.5	214	3.607	772	1268	2040
Q-2 65						

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SHOP SUPPORT
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PROPULSION SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65		71	3.535	251	451	702
Q-4 65						
Q-1 66		2	4.000	8	59	67
TOTAL	2577.0	442874		1393646	1717820	3111466

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PROPULSION SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	1.5	180	3.017	543		543
Q-2 58						
Q-3 58		25	2.560	64		64
Q-4 58						
Q-1 59	1.5	154	3.682	567		567
Q-2 59						
Q-3 59	1.5	323	3.201	1034		1034
Q-4 59						
Q-1 60	1.5	343	3.181	1091		1091
Q-2 60						
Q-3 60	16.5	2860	3.033	8674		8674
Q-4 60						
Q-1 61	31.5	5325	3.030	16137		16137
Q-2 61						
Q-3 61	25.5	4591	3.126	14352		14352
Q-4 61						
Q-1 62	37.5	6465	3.145	20334		20334
Q-2 62						
Q-3 62	25.5	4273	3.151	13465		13465
Q-4 62						
Q-1 63	10.5	1785	3.334	5951		5951
Q-2 63						
Q-3 63	6.0	1047	3.600	3769		3769
Q-4 63						
Q-1 64		101	3.614	365		365
Q-2 64						
Q-3 64	1.5	336	4.060	1364		1364
Q-4 64						
Q-1 65		8	12.375	99		99
Q-2 65						

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TEST/QC
4-SYSTEM 1
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PROPULSION SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65		9	6.111	55		55
Q-4 65						
Q-1 66					-46	-46
Q-2 66						
Q-3 66		13	3.615	47	46	93
TOTAL	160.5	27838		87911		87911

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4-SYSTEM 1
5-SUBSYSTEM 03
PROPULSION SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	130.5	21984	4.135	90903	93025	183928	263
Q-2 58							
Q-3 58	512.5	86098	4.058	349399	331937	681336	4451
Q-4 58							
Q-1 59	679.0	115733	4.064	470290	399248	869538	56868
Q-2 59							
Q-3 59	968.5	170459	4.061	692192	613550	1305742	3485
Q-4 59							
Q-1 60	886.5	153783	4.379	673434	549087	1222521	7588
Q-2 60							
Q-3 60	1197.0	201213	4.233	851780	702363	1554143	56067
Q-4 60							
Q-1 61	1734.0	295957	4.195	1241582	982830	2224412	103154
Q-2 61							
Q-3 61	1181.5	214102	4.253	910573	870467	1781040	105298
Q-4 61							
Q-1 62	1547.5	264318	3.936	1040331	988914	2029245	90877
Q-2 62							
Q-3 62	1154.5	193926	4.433	859737	794445	1654182	112780
Q-4 62							
Q-1 63	1060.5	180912	4.834	874471	851616	1726087	66819
Q-2 63							
Q-3 63	1030.0	172979	5.488	949311	635808	1585119	28415
Q-4 63							
Q-1 64	445.0	76011	5.936	451181	475185	926366	47125
Q-2 64							
Q-3 64	361.0	63449	5.995	380368	495729	876097	114109
Q-4 64							
Q-1 65	88.0	15179	6.572	99752	90694	190446	16402
Q-2 65							
Q-3 65	30.0	5132	6.501	33363	26319	59682	1637
Q-4 65							

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4-SYSTEM 1
5-SUBSYSTEM 03
PROPULSION SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66	3.0	488	5.096	2487	1987	4474	108
Q-2 66							
Q-3 66		13	3.615	47	46	93	
TOTAL	13009.0	2231736		9971201	8903250	18874451	815446

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4-SYSTEM 1
5-SUBSYSTEM 03
PROPULSION SUBSYSTEM

	MFG MATL	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A
Q-1 58			263	14		184205	
Q-2 58							
Q-3 58			4451	244	97435	783466	
Q-4 58							
Q-1 59		276031	332899	12133	324815	1539385	
Q-2 59							
Q-3 59		276032	279517	7836	362862	1955957	
Q-4 59							
Q-1 60		941734	949322	56868	1106062	3334773	63538
Q-2 60							
Q-3 60		3290232	3346295	202592	23726	5126760	97680
Q-4 60							
Q-1 61		1368404	1471558	47916	263897	4012783	74570
Q-2 61							
Q-3 61		1376768	1482066	48335	494262	3805703	70721
Q-4 61							
Q-1 62		1497549	1588426	54778	348723	4021172	67496
Q-2 62							
Q-3 62		1370996	1483776	52412	173535	3363905	56463
Q-4 62							
Q-1 63		979302	1046121	48165	317624	3137997	52466
Q-2 63							
Q-3 63		75037	103452	5207	-215876	1477902	24711
Q-4 63							
Q-1 64		146357	193482	25121	38352	1183321	25178
Q-2 64							
Q-3 64			114109	41513	34468	1066187	22686
Q-4 64							
Q-1 65			16402	4905	5979	217732	5809
Q-2 65							
Q-3 65			1637	292	2392	64003	1707
Q-4 65							

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4-SYSTEM 1
5-SUBSYSTEM 03
PROPULSION SUBSYSTEM

	MFG MATL	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A
Q-1 66			108	22	171	4775	144
Q-2 66							
Q-3 66						93	3
TOTAL		11598442	12413888	608353	3383427	35280119	563172

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4-SYSTEM 1
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PROPULSION SUBSYSTEM

	TOTAL COST
Q-1 58	184205
Q-2 58	
Q-3 58	783466
Q-4 58	
Q-1 59	1539385
Q-2 59	
Q-3 59	1955957
Q-4 59	
Q-1 60	3398311
Q-2 60	
Q-3 60	5224440
Q-4 60	
Q-1 61	4087353
Q-2 61	
Q-3 61	3876424
Q-4 61	
Q-1 62	4088668
Q-2 62	
Q-3 62	3420368
Q-4 62	
Q-1 63	3190463
Q-2 63	
Q-3 63	1502613
Q-4 63	
Q-1 64	1208499
Q-2 64	
Q-3 64	1088873
Q-4 64	
Q-1 65	223541
Q-2 65	
Q-3 65	65710
Q-4 65	

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PROPULSION SUBSYSTEM

	TOTAL COST
Q-1 66	4919
Q-2 66	
Q-3 66	96
TOTAL	35843291

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SUBSYSTEM: SECONDARY POWER — WBS CODE: 1.4

WORK BREAKDOWN STRUCTURE

SUBSYSTEM: SECONDARY POWER

WBS CODE 1.4

WBS LEVELS

4 5 6 7 8

1.4 SECONDARY POWER SUBSYSTEM

1.4.1 Hydraulic Power Supply System

1.4.1.1 Power Generation

Pumps
Filters
Wave Guides
Ripple Dampers
Check Valves
Bypass Valves
Relief Valves

1.4.1.2 Reservoir System

Reservoirs
Oil Heat Exchangers
Quantity Probes
Relief/Bypass Valve
Nitrogen Pressure System
Hydraulic Replenishing System
Ground Checkout/Service

1.4.1.3 Hydraulic Distribution System

Manifolds - Lines
Filters
Wing Fold Supply
Main Gear Supply
Nose Gear Supply
Primary Flight Control
Secondary Flight Control
Flight Augmentation Control System
Fuel System Supply
Windshield Ramp
Emergency Generation Supply
ECS Supply
Drag Chute System

SUBSYSTEM: SECONDARY POWER

WBS CODE 1.4

WBS LEVELS
4 5 6 7 8

1.4.1.4 Controls and Displays

Annunciator Panel
Pressure Gages (GFE)
Pressure Sensors (GFE)
Signal Transmitters
Systems Manual Selector

1.4.2 Accessory Drive System

1.4.2.1 Accessory Gear Box

Supports
Gear Train
Torque/Shear Relief

1.4.2.2 Power Transmission Shaft

Flex/Diaphragm Coupling
Telescoping Shafts
Torque/Shear Relief
Input Pad
PTO Pad
Ball/Joint Coupling
Cover and Seals

1.4.2.3 Lubrication and Cooling

Lube Pumps
Fuel Heat Exchanger
Reservoir/Servicing
Deaeration Assembly
Nitrogen Pressure/Inert

1.4.2.4 Speed Switch

Flyball Governor
System Mode Switch
Engine Ignition Control

SUBSYSTEM: SECONDARY POWER

WBS CODE 1.4

WBS LEVELS
4 5 6 7 8

1.4.3 Ground Starting System

1.4.3.1 External Power Interconnect

1.4.3.2 Motor Mode (Hydraulic Pump)

1.4.3.3 Starting Control Panel

1.4.4 Constant Speed Drive (CSD)

1.4.5 Electrical Power Supply System

1.4.5.1 Power Generation

Primary Generators
Emergency Generator (GFE)
Voltage Regulators (GFE)
Line Transformers
Line Contactors
Battery (GFE)
Generator Controls

Overvoltage
Undervoltage
Overexcitation
Underexcitation
Open Phase
Unbalance
Feeder Fault

1.4.5.2 External Power Supply

Interlock Control
Receptacle
Interconnect Control

1.4.5.3 Power Transmission and Distribution

Feeder Lines
Primary Busses
Essential Bus
DC Bus
Transformer/Rectifier
Relays
Bus Tie Connectors
Connectors/Wires

SUBSYSTEM: SECONDARY POWER

WBS CODE 1.4

WBS LEVELS
4 5 6 7 8

Yaw Trim Motor
AIS Trim Motors
Thrust Control Supply
Stabilizer Trim Motor
Pitch Trim Motor
Roll Trim Motor
Landing Light Actuators
Instrument Panel Vibrator
Bomb Bay Door Locks
Circuit Breakers/Panel
Crew Compartment Supply
Cockpit Flood Lights
Cockpit Utility Lights
Anti-Collision Lights
Navigation Lights
Landing Lights
Emergency Gear Lowering
Auxiliary Lights
Switches
Transformers
Wing Tip Fold Control
Landing Gear Control
Drag Chute Control

1.4.5.4 Controls and Displays

Bus Indicator Panel
Voltage Indicator
Bus Selector Switch
Auto-Recycle Control
Phase Selector Switch
Manual On-Off/Recycle Switch

1.4.6 Ground Tests

1.4.6.1 Engine Test Stand

1.4.6.2 Flight Control Simulator

1.4.6.3 Hydraulics Labs

1.4.6.4 Electrical Labs

1.4.6.5 Models

1.4.6.6 Mockups

1.4.6.7 Wind Tunnel

TECHNICAL DESCRIPTION

SUBSYSTEM: SECONDARY POWER WBS CODE: 1.4

The XB-70 Secondary Power Subsystem furnished all of the "on-board" power requirements for the air vehicle. The total combined power capability of the system was approximately 1500 HP of which 1000 HP was used on a normal continuous duty cycle basis during an XB-70 mission. This power was supplied by hydraulic and electrical accessories which operated in an environment essentially twice as stringent as the existing aircraft of its time.

To meet the low weight and volume, high performance, and high temperature requirements, several unique features and new developments were achieved. One of these unique features was the mounting of the secondary power generating components on a special gearbox remotely located from the engine and driven from an engine power take-off pad by a connecting drive shaft. Exhibit 1, Page III-633, presents the arrangement of the six secondary power generating system (SPGS) compartments showing the relationship of these compartments to the six engines. As indicated, each SPGS had a utility and a primary hydraulic pump, while only stations no. 2, no. 3 and no. 4 had electrical generators with constant speed drives (CSD). Exhibit 2, page III-634, depicts an SPGS package configured for stations no. 2, no. 3 or no. 4 showing the major components that made up the SPGS. For those stations without the CSD and generator, the gearbox had a "close-out" plate in place of the electrical generating assembly.

This unique SPGS packaging concept, in addition to providing separate compartmentation, yielded the following advantages:

(1) Optimum packaging of components for minimum envelope.

(2) Improved accessibility and ease of maintenance.

(3) Separate removal of engine or SPGS.

(4) Self-containment allowing a minimum of design and operational compromises with the engine in lubrication, cooling, etc.

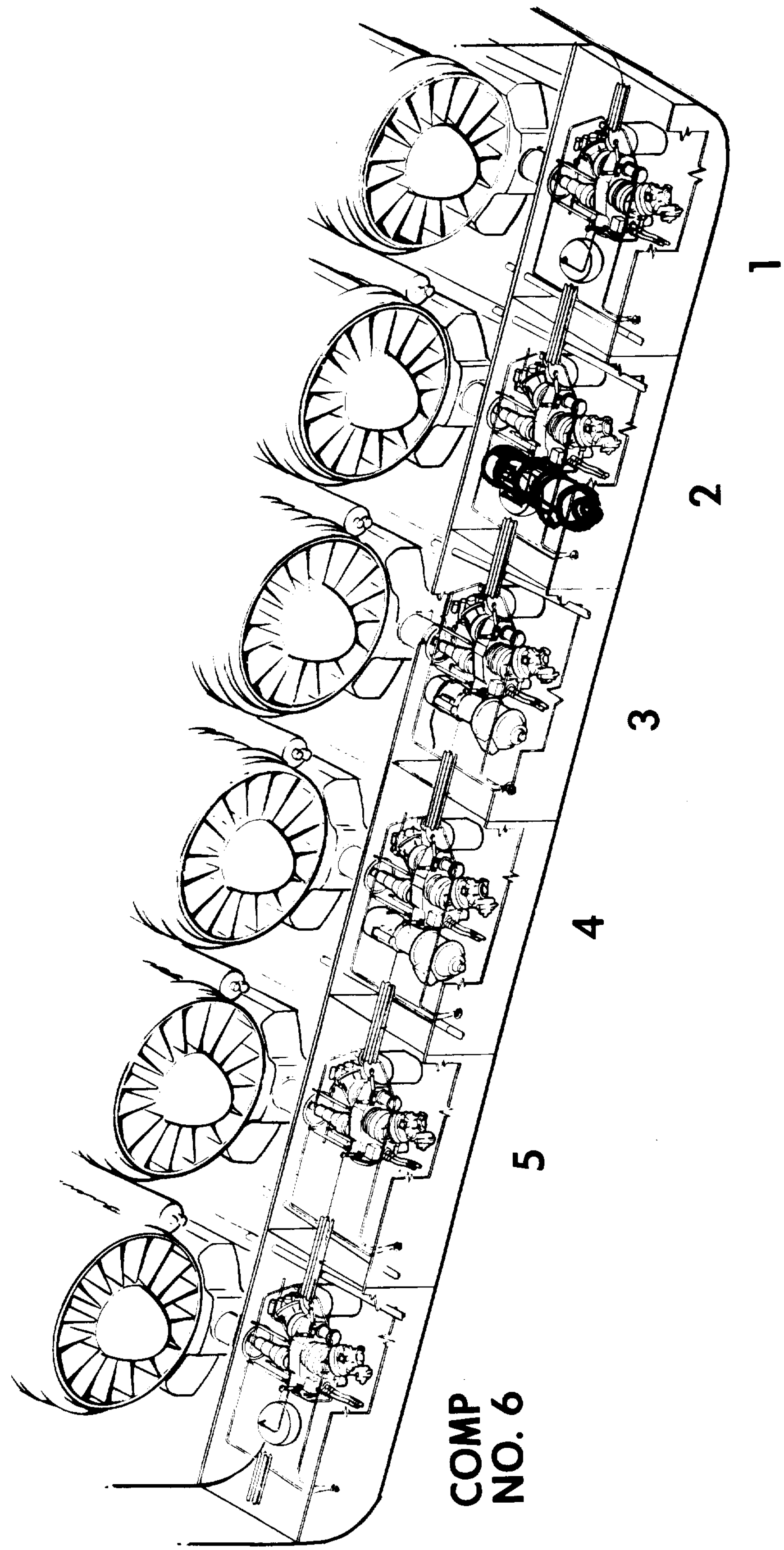
(5) Higher reliability and reduced fire hazard.

(6) Simplified engine power take-off provisions.

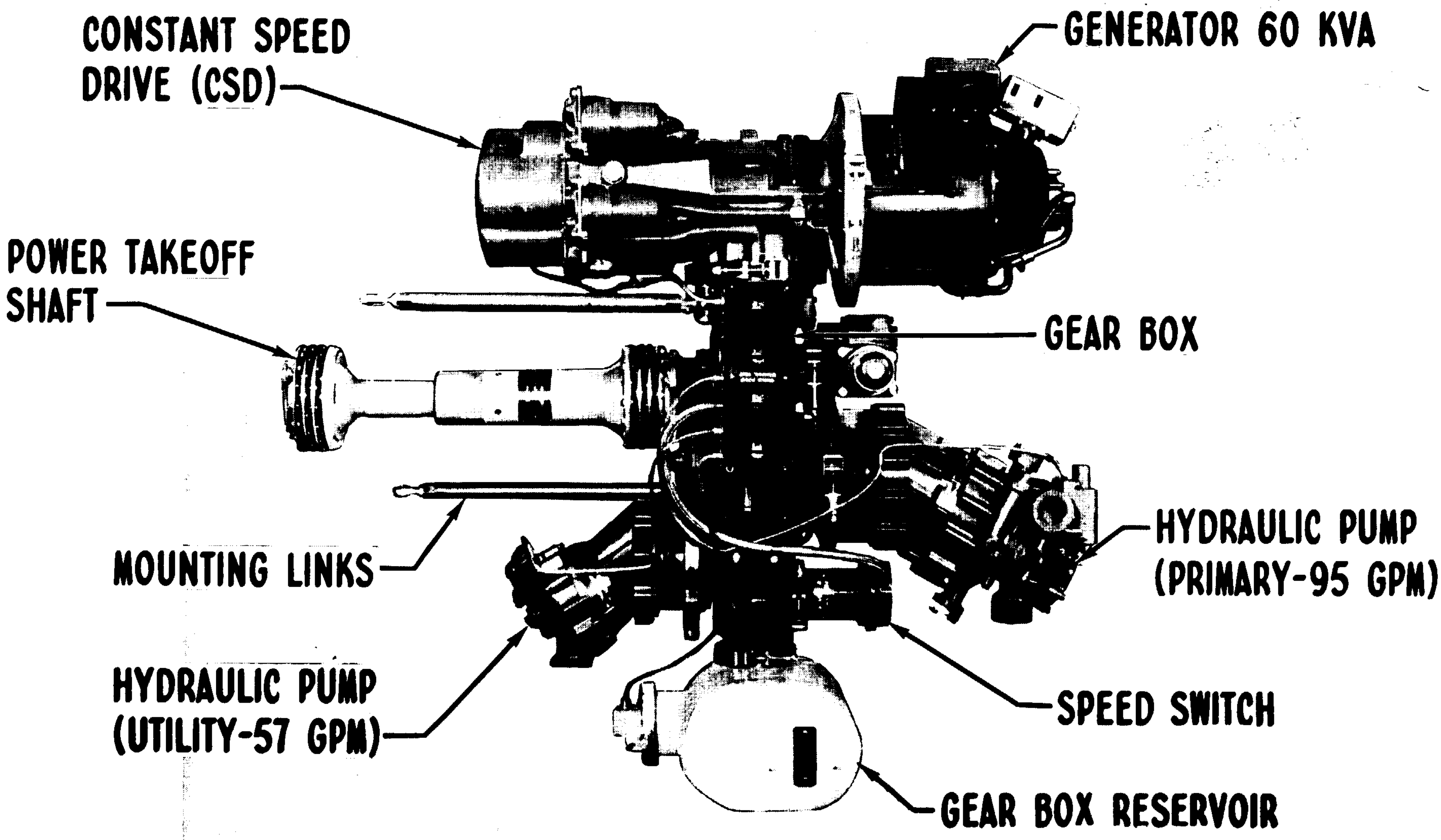
Other state-of-the-art advancements achieved during the B-70 secondary power subsystem development program are discussed in detail in subsequent paragraphs.

The secondary power subsystem group provided for the generation and distribution of electrical and hydraulic power for the air vehicle under all operating conditions. It was essentially comprised of the accessories drive system (ADS), the constant speed drive (CSD), the electrical power generation system (EPGS), the integrated hydraulic pumping (IHPS) and starting system, and the electrical and hydraulic distribution systems. These secondary power systems are described in detail in subsequent paragraphs including their functional interfaces.

SECONDARY POWER



SECONDARY POWER GENERATING SUBSYSTEM PACKAGE



TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: SECONDARY POWER SUBSYSTEM WBS CODE: 1.4

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
MAJOR FUNCTIONS	TYPE	HYDRAULIC POWER SUPPLY ELECTRICAL " " ENGINE STARTING (GROUND)		→	→	→
WEIGHT	POUNDS	12,132	12,132	11,273	11,273	12,594
ELECTRICAL POWER: MAXIMUM	WATTS	270,000	135,000	135,000	135,000	197,500
: CONTINUOUS	"	180,000	90,000	90,000	90,000	135,000
HYDRAULIC PRESSURE	PSI	4,000	→	→	→	→
HYDRAULIC FLOW RATE: TOTAL	GAL/MIN	456	→	→	→	→
TEMPERATURE: DESIGN RANGE	DEGREES F	-65 to 630	→	→	→	→
ENGINE GROUND STARTING	TYPE	CARTRIDGE	-	-	-	-
		HYD/MOTOR	→	→	→	→
RELIABILITY FACTOR	NONE	-	-	0.98057	0.98057	0.98057
MTBF	HOURS	-	-	90	90	90

TECHNICAL DESCRIPTION

SUBSYSTEM:	SECONDARY POWER	WBS CODE:	1.4
MAJOR ASSEMBLY:	HYDRAULIC POWER SUPPLY	WBS CODE:	1.4.1

The B-70 employed four completely independent, simultaneously operating 4000 psi, constant pressure hydraulic systems capable of satisfactory operation at -65° F to 450° F bulk fluid temperature. Dual reliability in system arrangement provided adequate emergency operation of all functions that was deemed necessary for flight safety and mission reliability in the event of single system failure. Eighty-five linear actuators and 44 rotary actuators or hydraulic motors were employed along with 120-400 cycle, 110 volt nonrectified solenoid operated valves and 50 mechanically operated valves. The 4 hydraulic systems contained approximately 220 gallons of fluid at room temperature which increased to 260 gallons at 450° F. Over one mile of hydraulic tubing was utilized which required approximately 3300 brazed connections and 600 mechanical joints. Each of the 4 power systems employed 3 positive displacement variable output remotely located hydraulic pumps driven by the ADS gearbox.

The bulk oil temperature was maintained at approximately 450° F with pump suction oil inlet temperature at 400° F maximum. The pump inlet oil temperature was controlled by oil to fuel heat exchangers located within the all attitude hydraulic reservoirs. Hot spots in the system reached 630° F with a large portion of the noncontinuous flowing systems in the 530° F region (elastomer seals were not used due to the temperature extremes). In addition to the high temperature operations, the hydraulic system was capable of starting and operating at -65° F temperature.

The pumping systems provided hydraulic power for each of two independent primary systems and two independent utility systems. Each independent system was powered by three pumps which received power from three separate ADS gearboxes. (The primary systems pumping units also functioned as hydraulic motoring units for engine starting.) Exhibit 3, Page III-640, presents a simplified hydraulic system schematic which shows the primary and utility pumps on each of the ADS gearboxes. (The subscript "m" stands for the master pump in each system, while the subscript "s" indicates a slave pump.) See Exhibit 2, Page III-634, for SPGS configuration showing primary and utility pumps mounted on the ADS gearbox.

The pumps were axial piston fixed angle variable output type. The primary pumps displaced five cubic inches per revolution rotating at 5000 RPM, while the utility pumps displaced 2.69 cubic inches per revolution rotating at 6000 RPM. Each primary and utility generating system was capable of generating 276 gpm and 180 gpm, respectively, from 3800 to 4000 psi at minimum allowable volumetric efficiency including compressibility. The hydraulic power systems were designed to provide hydraulic services for eight basic air vehicle subsystems. See Exhibit 3, Page III-640, for subsystem assignments.

WBS CODE: 1.4.1

Since safe and adequate flight had to be maintained with any three engines operating concurrently with varied duty cycle demands, an excess of potential hydraulic horsepower existed for all normal operating modes. With the size of the B-70 power systems, coupled with environmental conditions and duty cycle requirements, self-generated hydraulic heating was the primary source of heat that had to be dissipated to maintain design bulk fluid and pump inlet temperatures. To minimize this heat load, a master-slave concept was utilized which reduced the heat load by 5000 BTU per minute and saved 1000 lbs in additional cooling provisions. The master pump in each of the three pump systems supplied the continuous demands and the other two pumps, called slaves, remained positioned for minimum power output, depressurized to approximately 250 psi and pumped only that oil required for self-lubrication and cooling. The slaves pumps were set approximately 200 psi less than the master and came "on-line" only when cycle demands lowered the system pressure.

The pumping systems were designed so that individual pump efficiency could be determined while the pump was installed in the air vehicle. This was accomplished by operating one engine at a time and directing that system fluid through a ground unit at system pressure which provided an accurate measurement of actual output delivery. All fluid in the pressure system was filtered through a 10 micron (nominal) non-bypassing filter in each pump outlet line and was refiltered through 10 micron (nominal) bypassing type filter on the return system.

The fluid, which was Oronite 8200, was supplied to each of the various pumping systems by independent air oil type reservoirs (with an internal swirl pattern for deaeration). The reservoir pressurization and inerting was accomplished by use of dry nitrogen. Each reservoir had an integral oil to fuel heat exchanger with a temperature controlled thermal bypass valve, capacitance type liquid level probe (temperature compensated which allowed accurate readings regardless of oil temperature), necessary relief valves, and trapped oil design features for operation at negative "G" conditions. The reservoirs were located in integral air vehicle fuel tank no. 4 on the engine inlet fuel cooling loop which was the heat sink for the hydraulic systems.

Fluid power utilization equipment on the B-70 was extensive; however, the mechanical output fell into two categories: rotary and linear. Temperature extremes dictated the use of all metal seals (See Technical Driver: Seals), new materials of construction, and many new design and manufacturing techniques for valves, actuators, and motors.

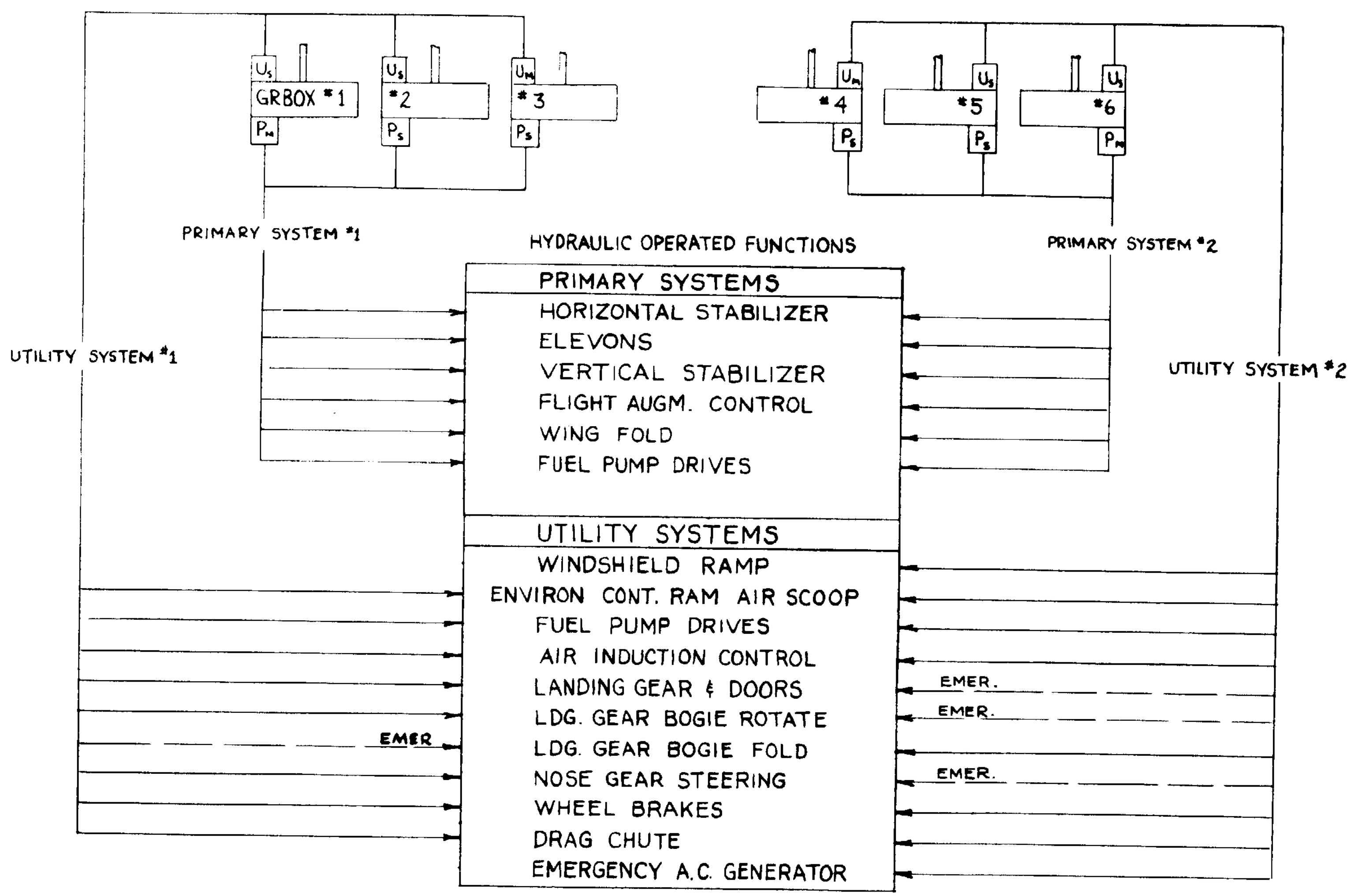
The 85 actuators employed on the XB-70 covered a range of sizes and requirements varying from $\frac{1}{2}$ inch to $3\frac{1}{4}$ inch diameter rods utilized in piston bores of from 1 inch to $7\frac{1}{4}$ inch in diameter. Strokes varied from a few inches to a maximum of 30 inches with extended lengths of over six feet. The output of several large tandem actuators exceeded 316,000 lbs. with an actuator weight of over 290 lbs. Vacuum melt H-11 tool steel heat treated to 260,000/280,000 psi was used almost exclusively in all actuators for cylinder barrels, pistons, piston rods, end caps, and rod ends. Inside surfaces in contact with oil were left bare with external surfaces coated with Coroloy (zinc nickel coating). The piston rods were Linde LW-1 tungsten carbide flame plated and lapped. Exhibit 4, Page III-641, presents a view of the air induction system no. 2 ramp actuator installation which had a stroke of 30 inches.

Two types of self-aligning bearings were used with the B-70 actuators. Actuators in areas of below 530° F temperature utilized fabroid liner coated bearings while actuators in areas that exceeded 530° F used a dry film lubricant. The bearing pressures were designed to a nominal 30,000 psi. The most significant hydraulic distribution problem was the design and development of all types of seals to replace the elastomer "O" rings (see Technical Driver: Seals). Seven basic seals utilized for equipment items: static face, two types of static diametral seals, dynamic piston rings, oscillatory, and first and second stage dynamic rod seals. All actuators were classified into two categories: those which are continually pressurized during flight (constant duty cycle) and those that operation required pressurization intermittently during the air vehicle mission. The actuators that were constant duty employed a two-stage dynamic rod seal with the first stage operated at approximately 3500 delta "P" with the second stage at approximately 500 delta "P" or the average return back pressure of the system. Intermittent duty type actuators, such as for the landing gear, employed a single stage dynamic rod seal which operated at 4000 delta "P". Actuator cylinder barrels were designed to burst requirements only since deflection under pressure or maintaining clearance between piston and cylinder bore to take care of extrusion problems did not exist with the structural loading metal piston rings.

There were no direct hydraulic rotary actuators used on the B-70; however, hydraulic motors (44) were used extensively to drive fuel pumps, generators, and gearboxes which in turn provided rotary mechanical output. All motors were fixed angle axial piston with both constant torque and variable torque types utilized. The motors ranged in size from 0.097 cu. in. per revolution to 0.62 cu. in. per revolution. All of the motors were designed to operate without a separate case return system. This required the motor manufacturers to develop shaft seals and operational capabilities with case pressures in the 3000 psi range. However, the elimination of the third line or case return line afforded a weight saving for the XB-70 of over 400 lbs.

All electrically operated hydraulic valves were AC, 400 cycle, 110 volt non-rectified solenoid type. The majority of the solenoid operated valves were pilot operated, pressure centered with both ball and slide pilots employed. The valve sizes ranged from flow requirements of 0.25 gpm to 70 gpm. During the B-70 Program, one of the most significant advancements in the state-of-the-art for valves was the development of the pure AC solenoid within the weight and space limitations established. At the onset of the B-70 Program, there were no true AC solenoids which met the 630° F ambient and the small space and weight required for the B-70 air vehicle application. The AC solenoids developed performed reliably under the XB-70 environment and were lighter than the prior 275° F counterparts with less airframe volume required. (See Exhibit 13, Page III-682)

HYDRAULIC SYS SCHEMATIC



278-58-9D 9-11-62

Number 2 Ramp Actuator

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: HYDRAULIC POWER SUPPLY WBS CODE: 1.4.1

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	LBS.	8618	NOT AVAILABLE		6455	7145
HYDRAULIC FLUID	TYPE	ORONITE 8200	→	→	→	→
FLUID CAPACITY	GALLONS	220 @ 70 F	→	→	→	→
TEMPERATURE (OPERATING)	DEGREES F	-65 to 450	→	→	→	→
PRESSURE (OPERATING)	PSI	3800 to 4000	→	→	→	→
INERTING MEDIA	FLUID	N_2	→	→	→	→
INERTING MEDIA PRESSURE	PSI	10	→	→	→	→
RELIABILITY						
PRIMARY	NONE	-	-	0.99989	0.99989	0.99989
UTILITY	NONE	-	-	0.99290	0.99290	0.99290
MTBF						
PRIMARY	HOURS	-	-	16,129	16,129	16,129
UTILITY	HOURS	-	-	246	246	246
FILTERS	MICRON RATING	10	→	→	→	→
FLOW RATE (PRIMARY)	GPM	276	→	→	→	→

Space Division
North American Rockwell

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: HYDRAULIC POWER SUPPLY WBS CODE: 1.4.1

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
FLOW RATE (UTILITY)	GPM	180 →	→	→	→	→
PUMPS: PRIMARY	NUMBER	6	6	6	6	6
UTILITY	"	6	6	6	6	6

TECHNICAL DESCRIPTION

SUBSYSTEM: SECONDARY POWER WBS CODE: 1.4

MAJOR ASSEMBLY: ACCESSORY DRIVE SYSTEM WBS CODE: 1.4.2

The XB-70 incorporated six accessory drive systems (ADS) with each air vehicle engine driving an independent gearbox. Each ADS gearbox consisted of the necessary housing, gear trains, shaft, seals, and accessory drive mounting pads to operate air vehicle accessories with the speed and power required for the secondary power subsystem. During the normal operation mode, power from the engine was transmitted by the power transmission shaft to the gearbox to drive the gearbox-mounted secondary power generating units. During the starting mode, power was transmitted from the hydraulic pump/motors through the gearbox and power transmission shaft to the engine. A gear ratio changing device was provided in the gearbox to accomplish automatic gear train selection during hydraulic starting mode operation. Gear ratio change to convert from starting to the normal mode of operation was accomplished automatically by overrunning clutches.

The power transmission shaft was the link between the engine power take-off and the gearbox. A shear section, integral with the engine power take-off, provided for engine protection in the event of an SPGS failure that loaded the power train. The shaft incorporated means to accommodate relative motion between the engine and the gearbox. This was accomplished with two flexible diaphragms that allowed normal flight movement between the engine and gearbox and a telescoping spline which allowed for normal growth due to temperature. The normal rated speed for the power transmission shaft was 6825 RPM with a maximum overspeed to 7508 RPM allowed for a maximum duration of one second. The shaft had a bolted disconnect flange at each end to permit engine removal or gearbox removal without removing the shaft. This same design feature allowed the shaft to be removed without moving the engine or gearbox which allowed critical alignments to be maintained during shaft maintenance. See Exhibit 2, page III-634, for details of shaft and configuration arrangement showing relationship of shaft to the ADS gearbox.

The B-70 ADS lubrication system consisted of six independent lubrication and cooling systems, one for each of the accessories gearbox assemblies. The lubrication/cooling fluid was routed through a common heat exchanger (six independent oil passages) on the fuel cooling loop which was utilized as the heat sink. The reservoir for each system supplied the common fluid to lubricate and cool each gearbox and, additionally, for the CSD/generator installations, lubricated and cooled the generators and CSD's. The fluid was also utilized as the working medium of the CSD for constant speed control. The ADS lubrication/cooling systems were independent of the engine lubrication systems and utilized gaseous nitrogen for system pressurization and to inert the reservoir atmosphere.

WBS CODE: 1.4.2

A speed switch was installed on each gearbox assembly (see Exhibit 2, page III-634) to provide automatic control of the subsystem. The speed switch provided signals for the following functions at the proper engine speed by making or breaking electrical contacts.

(1) Engine ignition

(2) Primary hydraulic pump outlet depressurization during engine start

(3) Selection of the pumping mode of operation of the primary hydraulic pump/motors at the end of the engine starting cycle

(4) Engine overspeed generator lockout relay

The high temperature, high torque, and low weight demands of the B-70, at the onset of the program, were beyond the capabilities of standard lubricants, gear materials, flexible diaphragms and speed switches. Several thousand hours of development running were required to establish the special gear geometry, gear material, and case hardening requirements. In conjunction with the gear development, special lubricants were tested operating at temperature levels of 300° F under the heavy loading. The electrical speed switch and the flexible diaphragm of the power shaft required the development of unique design features, fabrication techniques, and materials.

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: ACCESSORY DRIVE SYSTEM (SIX ASSEMBLIES) WBS CODE: 1.4.2

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	LBS.	1367	NOT AVAILABLE		1504 (INCLUDING LUBE & N_2 SYSTEMS	1510 (INCLUDING LUBE & N_2 SYSTEMS
GEARBOXES	QUANTITY	6	6	6	6	6
POWER INPUT (MAX)	HORSEPOWER	450	450	450	450	450
COOLING/LUBRICANT FLUID	TYPE	MIL-L-9236	MIL-L-7808	MIL-L-7808	MIL-L-7808	MIL-L-7808
HEAT SINK	TYPE	JP-6 FUEL	JP-6 FUEL	JP-6 FUEL	JP-6 FUEL	JP-6 FUEL
TEMPERATURE (OPERATING)	DEGREES F (+)	320 TO 415	320 TO 415	320 TO 415	320 TO 415	320 TO 415
SPEED (INPUT)	RPM	4200 TO 6825	4200 TO 6825	4200 TO 6825	4200 TO 6825	4200 TO 6825
PRESSURANT/INERTING FLUID	TYPE	N_2	N_2	N_2	N_2	N_2
PRESSURE - INERTING MEDIUM/GEARBOX	PSI	10 - 25	10 - 25	10 - 25	10 - 25	10 - 25

TECHNICAL DESCRIPTION

SUBSYSTEM: SECONDARY POWER WBS CODE: 1.4

MAJOR ASSEMBLY: GROUND STARTING SYSTEM WBS CODE: 1.4.3

The primary hydraulic systems pumps were used in the dual purpose of pumping fluid to the hydraulic system and starting the engines. The pumps were operated as motors to start the engines and then reverted to hydraulic pumps after the engine was running. As previously stated, a clutching arrangement in the ADS gearbox provided automatic selection of the proper gear ratio for the starting and pumping modes.

During ground engine starting, each primary system pump operated as a constant horsepower motor for engine rotation with the torque transmitted through the gearbox and the power shaft to the engine. Internal valving within the pump allowed its operation as a motor by pressurization of the pump outlet port which rotated the unit in the pumping direction. Pump to motor was automatically controlled electrically during the engine start mode and was hydraulically controlled during the pumping mode. During the engine start mode the utility system pumps were in a depressurized mode to reduce starting drag torque. The XB-70 was designed so that engine start could be accomplished from a ground power unit or could be accomplished through self-sufficiency by starting a single engine on one side and then employing this engine hydraulic pumping capacity to boot strap the other two engines. The integration and utilization of the hydraulic pumps as engine start motors provided a 380 lbs. weight saving and considerable air vehicle space.

Power for ground starting was furnished by an electrical ground power unit (GPU) and a hydraulic GPU. The electrical GPU furnished 120/208V to an air vehicle receptacle which was tied into a step-up transformer to transform the ground power to 240/416 volts. The step-up transformer fed an external power contactor which had the function of connecting the air vehicle buses to the external power and disconnecting the main generators from the feeder system (See Electrical Power Supply Exhibit 5, Page III-656).

The hydraulic GPU was designed to meet the requirements for air vehicle engine starting and for hydraulic system maintenance. It contained two hydraulic systems for air vehicle maintenance and provisions which allowed the two systems to be joined together for engine starting. Each hydraulic system of the GPU had heat exchangers and filters to maintain the hydraulic fluid within air vehicle specifications. It should be noted that the hydraulic GPU also supplied the following functions to the air vehicle:

1. Hydraulic system ground operations.
2. Hydraulic reservoir filling.
3. Hydraulic pump checkout.
4. Hydraulic system flushing and filtering.
5. Hydraulic system heating and cooling.

As with the hydraulic GPU, the electrical GPU was also used as the electrical power source during air vehicle ground maintenance of the subsystems.

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: GROUND STARTING SYSTEM WBS CODE: 1.4.3

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	LBS.	397	NOT AVAILABLE	NOT AVAILABLE	309	324
POWER SOURCE	TYPE	HYDRAULIC CARTRIDGE	→ NO	→ NO	→ NO	→ NO
POWER INPUT	HORSEPOWER	100	→	→	→	→
TORQUE TRANSMITTED	FT-LBS.	432	→	→	→	→

TECHNICAL DESCRIPTION

SUBSYSTEM: SECONDARY POWER WBS CODE: 1.4

MAJOR ASSEMBLY: CONSTANT SPEED DRIVE WBS CODE: 1.4.4

The XB-70 had three constant speed drives (CSD) systems, one on each inboard gearbox and one on the No. 2 gearbox. NOTE: The XB-70 came out the door with two primary electrical generating systems; the No. 2 installation or stand-by generator was installed during the flight test program on the No. 1 air vehicle and prior to flight on the No. 2 air vehicle. Each CSD included a variable speed transmission with necessary governing and load sharing equipment to transmit variable input speed power to the AC generators at a constant shaft speed.

The CSD was capable of providing the full output required by a 60 KVA generator throughout an input speed range equivalent to minimum engine idle through 105% engine rated speed. At the maximum engine overspeed (110%), the CSD was not required to perform within spec limits; however, subsequent performance was not impaired. The CSD would structurally withstand and provide output speed regulation compatible with demands when subjected to the maximum acceleration rates of the engine. The working medium of the CSD was the lubrication and cooling fluid of the accessory drive system.

An overspeed device was incorporated to automatically prevent the CSD output speed from exceeding the limits of the AC generator in the event of failure of the CSD governing circuit. The overspeed device would return and hold the CSD at the minimum output speed after overspeed. The device would automatically reset for normal operation after the CSD had been stopped. An overrunning clutch was provided to automatically prevent the CSD from being driven by its output shaft. When the CSD fell below or exceeded safe levels of speed, a signal was provided to the generation system which through line contactors, unloaded the generator. A means was also incorporated to prevent destruction of the gearbox in the event of a failed CSD (shear pin).

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TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: CONSTANT SPEED DRIVE WBS CODE: 1.4.4

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
WEIGHT	LBS.	NOT AVAILABLE →	→	→	242	372
INSTALLATIONS	QUANTITY	2	2	2	2	3
FLUID MEDIUM	TYPE	MIL-L-9236	MIL-L-7808 →	→	→	→
TEMPERATURE (OPERATING)	DEGREES F (+)	320 TO 390 →	→	→	→	→
SPEED - INPUT	RPM	4536-7370 →	→	→	→	→
SPEED - OUTPUT	RPM	8000 →	→	→	→	→
POWER OUTPUT (NORMAL)	HORSEPOWER	60 →	→	→	→	→
POWER OUTPUT (MAX)	HORSEPOWER	90 →	→	→	→	→
HEATSINK	TYPE	FUEL →	→	→	→	→

TECHNICAL DESCRIPTION

SUBSYSTEM: SECONDARY POWER — WBS CODE: 1.4

MAJOR ASSEMBLY: ELECTRICAL POWER SUPPLY — WBS CODE: 1.4.5

The primary AC generation and supply system consisted of two primary generators, two stepdown transformers, main feeder lines, electrical distribution, and various control, protective and regulation devices for single unit or parallel operation. Exhibit 5, Page III-656 presents a schematic of the electrical power system up to the three major buses. The electrical power was generated at 240/416 volts and transmitted at this voltage to stepdown transformers. The system provided 115/200 volt, 400 cps, three-phase, four wire power to the bus with an insulated neutral return connected to the airframe at one point only. Normal operation was with the two generators in parallel supplying low voltage power to the bus system; however, each main generator and its controls were capable of operating as a single generating system. The control and protective devices of the EPGS provided protection against:

1. Over and under frequency.
2. Over and under voltage.
3. Unbalanced current between paralleled generators.
4. Open phase of a paralleled generator.
5. Differential current faults.
6. Over and under excitation.

The system included three annunciator lights: "#3 Gen Out", "#4 Gen Out", "Bus Tie Open". During normal operation, all three lights were extinguished.

The standby primary AC generation consisted of one generator in ADS bay No. 2, and various control protective and regulation devices for single unit operation only (#3 off and #4 isolated). The electrical power was generated at 240/416 volts and transmitted at this voltage to the left-hand stepdown transformer. The system provided 200/115 volt, 400 cps, three-phase, four wire power to the left-hand primary bus and the essential bus. A control switch was provided in the cockpit to supply power to the right-hand primary bus. This generator did not supply power until the left-hand primary bus lost power from the normal primary generator. The control and protective devices provided protection against:

1. Over and under excitation.
2. Over and underfrequency.
3. Over and undervoltage.
4. Differential current protection.

The system included an advisory light, "Standby Pri Gen On", which was illuminated only when the generator was connected to the bus.

Each primary generator had a rating of 60 KVA, 0.75 PF, 240/416v AC, 400 cps at 8000 RPM. The net power available at the air vehicle buses was 110

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KVA due to the 10 KVA that was lost during paralleling, distribution, and transmission. (Each generator operating independently produced 56.5 KVA at its respective bus.) Each generator was capable of operation at 150% of rated load for 2 minutes and 200% of rated load for 5 seconds. The generator was wye-connected to a three-wire output terminal block with the internal phases connected through three CT's (current transformers) to a generator-mounted ungrounded neutral. The generator was salient pole, rotating field, stationary armature type. Field excitation was supplied by a rotating exciter, the output (AC) of which was rectified by an oil cooled rectifier mounted on the rotating shaft. A small 1600 cps permanent magnet generator (PMG), also on the shaft, supplied power for the regulator and operation of the control relays. The generator was cooled by oil, from the CSD, which entered and left by ports in the mounting flanges. Exhibit 6, Page III-657 presents a primary (or standby) AC generator with a summary of its ratings.

Each generator was driven by a CSD which was hydro-mechanical, oil cooled and mounted on the ADS gearbox assembly. The gearbox speed switch opened at 94% of idle engine speed. The CSD switch opened at approximately 380 cps (on increasing speed) to make the circuit for the generator to excite. A mechanical governor held the generator speed constant within the required tolerance of 400 ± 4 cps. In addition, there was a trim adjustment, controlled by a Real Load Control Panel, which was used while the generators were in parallel to adjust the real load balance.

The voltage regulator was of the controlled rectifier type with control power supplied by the PMG. Voltage sensing was essentially three-phase average with high phase takeover and with Zener diodes used for voltage reference. The error signal was modified by a reactive bias signal, amplified, and used to control the firing of the main rectifier which controlled the field of the exciter. The sensing point was in the equipment bay area on the generator side of the generator line contactor. In addition, the regulator provided reactive load division control between generators operating in parallel.

A differential relay circuit protected the system against internal generator faults and generator feeder faults within the differential current protection (DPR) loop. The output of CT's (current transformers) on each phase of the generator to its neutral was balanced against similar CT's in the equipment area. DPR CT's were also incorporated in the external power circuit (near the external power contactor) to protect against feeder faults with external power. A differential current unbalance of 37.5 amp three phase fault or 72 amp for a single phase fault would trip the generator line contactor and de-excite the generator. An interlock circuit prevented return of a DPR tripped generator to the system until special ground maintenance checkout was performed.

When an overvoltage or an undervoltage condition existed, the generator line contactor de-excited the generator. The overvoltage circuit had an inverse time delay and the undervoltage circuit had a fixed time delay with the combined circuits incorporating an automatic cycling circuit which cycled the faulted system three times to clear the fault before locking the faulted system off the bus and de-exciting the generator. The magnitude of reactive load unbalance (over or underexcitation) between paralleled generators was detected by a control transformer loop in the feeders of the two primary generators. When excessive unbalance occurred, the reactive bias circuit placed a bias on the over/undervoltage protective circuit and removed the deflective generator. If an unbalanced load current occurred between the two main generators, the protective circuitry split the paralleled systems (opened the bus tie contactors). This left one generator on each main bus, each operating as an isolated single unit.

When operating in parallel, an open phase unbalanced the generator phase currents. The CT loop signal derived from unbalance current between the generators caused the faulted system to be removed from the bus and de-excited the generator. The over and underfrequency limits were controlled by the CSD limit governor and pressure switch. The underspeed switch (USS) had to be open for the generator to build up electrically. The USS would normally open at 395 to 375 cps; it reclosed at 375 ± 5 cps for underfrequency protection. For overfrequency protection, the limit governor at 460 ± 10 cps tripped the CSD into underdrive and subsequently the USS tripped the generator off at its set point of 375 ± 5 cps.

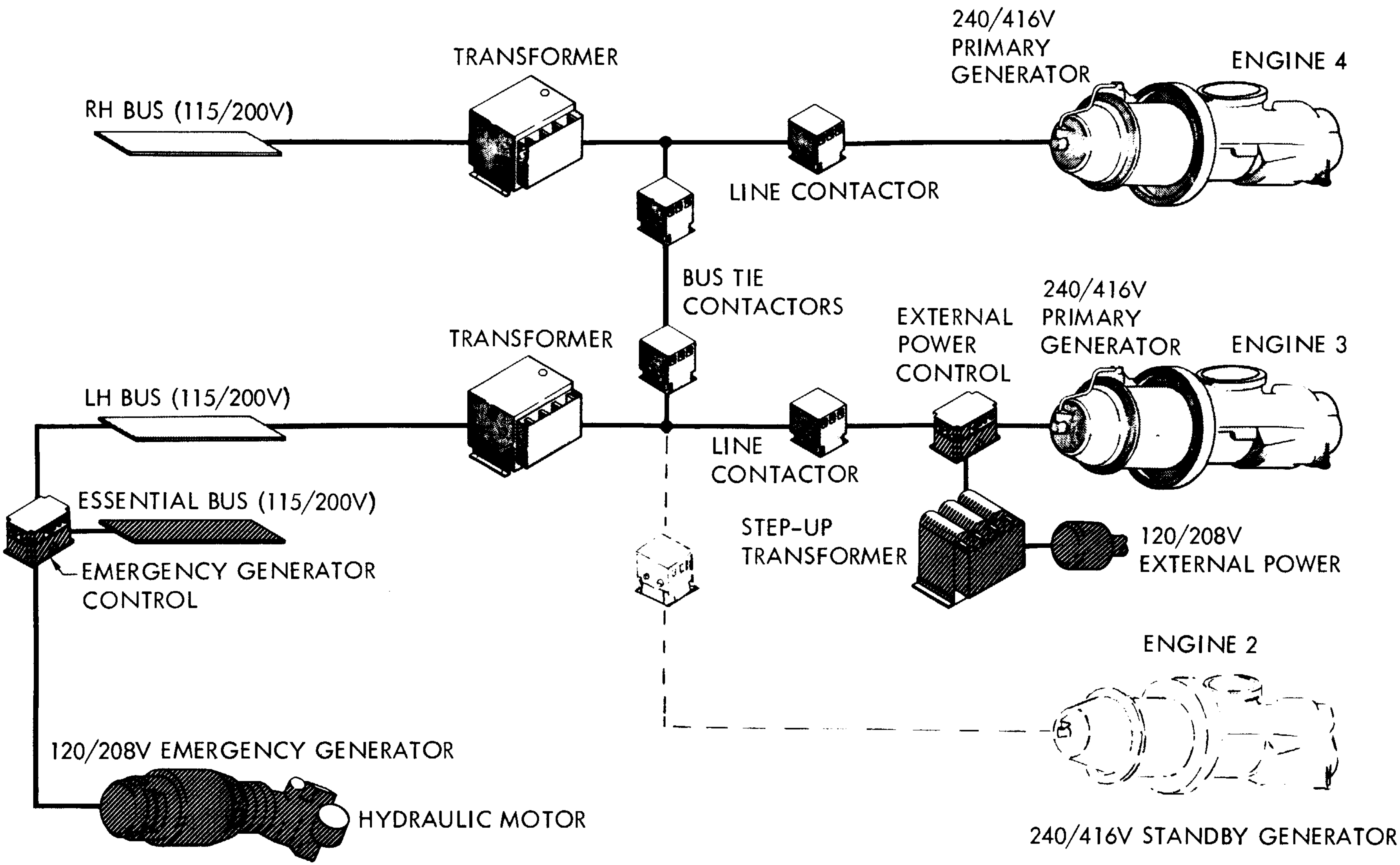
The emergency AC generator system consisted of one generator/hydraulic drive, one voltage regulator, and one current transformer. The system supplied power to equipment necessary to maintain controlled flight when the primary and standby generating system failed. The emergency generating system was isolated and independent of the main AC generating systems. The generator and control components were installed in the left-hand electrical equipment bay just forward of FS 605. An indicator light was located on the crew's center aisle console to indicate when generator power was on.

The emergency generator was rated at 10 KVA, 0.7 PF, 120/208 V AC, and 400 cycles at 8000 rpm. The net system capacity was 9.3 KVA due to transmission and distribution losses of 0.7 KVA. The generator was capable of operating at 150% of rated load for 2 minutes and 200% for 5 seconds. The generator was brushless, air cooled, self-excited, rotating rectifier-type machine which was driven by a constant speed (8000 ± 400 rpm) hydraulic motor. The hydraulic power was supplied by utility No. 2 system: utility pumps on engines #4, #5, and #6 (RH engines).

The voltage regulator of the emergency system was a controlled rectifier type with control power supplied from the boost transformer and full wave rectifier inherent in the regulator. Voltage sensing was essentially three-phase average with high phase take-over and with Zener diodes used for voltage reference. The power regulation was maintained within ± 3 percent. The current transformer used was an assembly composed of a boost transformer (voltage) and a current transformer (sensing). The unit provided current sensing and power inputs to the system voltage regulator. See Exhibit 5, Page III-656 for electrical schematic showing emergency generator tie-in to the essential bus.

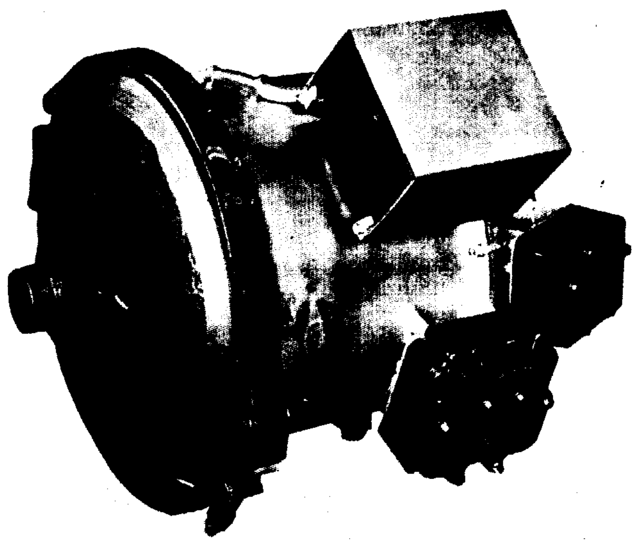
The AC and DC power transmission system consisted of the conductor network required to transmit electrical power from the generating source to the utilizing equipment circuit protective device. The AC and DC load distribution system consisted of the conductor network and associated components required to distribute and control electrical power from the bus network to the utilizing equipment. The primary (and standby generator) feeders were the conductor networks connecting the main generators to their appropriate line contactors in the equipment bay. The feeders for each generator were routed separately through the fuel tanks in individual metallic conduits and each consisted of six #8 gage wire (two per phase). The bus system consisted of a left and right hand primary AC bus, a flight safety essential AC bus, an essential DC bus, a primary DC bus, and a 26 volt AC instrument bus. The primary and essential AC buses, which distribute 115/200 volt power, normally received their power from the main generators through the feeders and stepdown transformers. Power was supplied to the left and right DC buses through the AC buses and transformer-rectifier units.

The load distribution system provided power to all the equipment and components which required electrical power to either function and/or for controls and displays. It also provided the electrical power for all interior and exterior lighting. In addition, the load distribution system included an emergency battery/inverter power system as back-up for a total generator failure condition. This system consisted of a five ampere-hour squib initiated battery and an inverter to produce 115/200 volt, 400 cps, AC power for the electrical control operation necessary to land the air vehicle. Exhibit 7, Page III-658 presents a picture of the left-hand aft electrical equipment rack showing a sample of the wire bundling and routing.



ELECRIC POWER SYSTEM

AC GENERATOR



	XB-70
• RATING	60KVA
• VOLTAGE	416 V
• WT TO PWR	1.6 LB/KVA
• AMB TEMP	550° F
• COOL OIL TEMP	330° F

278-54-42C 8-6-62

Left-Hand Aft Electrical Rack Area Prior to Closeout

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: ELECTRICAL POWER SUPPLY WBS CODE: 1.4.5

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
POWER: MAXIMUM	WATTS	270,000	135,000	135,000	135,000	197,500
: CONTINUOUS	"	180,000	90,000	90,000	90,000	90,000
: NORMAL LEVEL	"	NOT. AVAIL	51,000	51,000	51,000	51,000
CURRENT: RATED DESIGN	AMPERES	167	→	→	→	→
: MAXIMUM DESIGN	"	125	→	→	→	→
FORCE LEVEL: MAX. MAIN	VOLTS	416/240	→	→	→	→
: MAX. EMERGENCY	"	208/120	→	→	→	→
POWER PHASES	NUMBER	3	→	→	→	→
POWER FREQUENCY	HERTZ	400±4	→	→	→	→
GENERATORS: MAIN	TYPE/NO.	60KVA/4	60KVA/2	60KVA/2	60KVA/2	60KVA/3
: EMERGENCY	TYPE/NO.	10KVA/1	→	→	→	→
GENERATOR (MAIN): SPEED	RPM	8000	→	→	→	→
: POWER FACTOR	NONE	0.75	→	→	→	→
: PHASES	NUMBER	3	→	→	→	→
: FREQUENCY	HERTZ	400	→	→	→	→
: PMG	HERTZ	1600	→	→	→	→
: FORCE LEVEL	VOLTS	416/240	→	→	→	→
GENERATOR (EMERG.): FORCE LEVEL	VOLTS	208/120	→	→	→	→
: FREQUENCY	HERTZ	400	→	→	→	→
: PHASES	NUMBER	3	→	→	→	→
TRANSFORMER/RECTIFIER	TYPE/NO.	30AMP/4	50AMP/2	→	→	→
FEEDER LINES: MAIN	" "	18-#2 GAGE	6-#2 GAGE	→	→	→
		6-#8 GAGE	-	-	-	-
: EMERGENCY	" "	8-#10 GAGE	→	→	→	→

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: ELECTRICAL POWER SUPPLY WBS CODE: 1.4.5

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
BUSSES	NO./TYPE	NOT. AVAIL.	3-AC (MAINS)	→	→	→
			2-DC (MAINS)	→	→	→
			1-DC (TOWING)	→	→	→
			1-AC (TOWING)	→	→	→
			2-AC (FUEL)	→	→	→
			1-26VAC (INSTRUM)	→	→	→
FAULT PROTECTION	TYPE	FEEDERS	→	→	→	→
		UNDER FREQUENCY	→	→	→	→
		UNDER EXCITATION	→	→	→	→
		UNBALANCE CURRENT	→	→	→	→
		OPEN PHASE	→	→	→	→
		REAL LOAD DIVISION	→	→	→	→
		REACTIVE LOAD DIVISION	→	→	→	→
		UNDER VOLTAGE	→	→	→	→
POWER TRANSFORMERS	NO./TYPE	NOT. AVAIL.	2-STEPDOWN	→	→	→
		"	1-STEPUP	→	→	→
AUXILIARY	SPECIFY	EMERG. GEN.	→	→	→	→
		-	BATTERY	→	→	→
WIRING PROVISIONS	TYPE	CONDUITS	→	→	→	→
		BUNDLES	→	→	→	→
		ISOLATION TRAYS	→	→	→	→
		WIRE WAYS	→	→	→	→
TEMPERATURE (DESIGN RANGE)						
COOLED AREAS	DEGREES F	-65 TO 250	→	→	→	→
UNCOOLED AREAS	"	-65 TO 630	→	→	→	→
GROUND POWER SOURCE	SPECIFY	200/115 VAC	400 Hz	→	→	→

Space Division
North American Rockwell

TECHNICAL CHARACTERISTICS PROGRESS SUMMARY

WBS IDENTIFICATION: ELECTRICAL POWER SUPPLY WBS CODE: 1.4.5

CHARACTERISTIC	UNIT OF MEASURE	MARCH 1959	DECEMBER 1959	FEBRUARY 1961	A/V NO. 1 MAR 1964	A/V NO. 2 MAY 1966
ELECTRICAL COMPONENTS						
SWITCHES	NUMBER	600	280 →	→	→	→
CIRCUIT BREAKERS	"	900	625 →	→	→	→
RELAYS	"	850	560 →	→	→	→
WIRE	FEET	407,000	255,000 →	→	→	→
RELIABILITY FACTOR	NONE	-	-	0.98769	0.98769	0.98810
MTBF	HOURS	-	-	142	142	147

TECHNICAL DRIVER

SUBSYSTEM: SECONDARY POWER WBS CODE: 1.4

DRIVER: HYDRAULIC FLUID

GENERAL

The B-70 employed four completely independent, simultaneously operating 4000 psi, constant pressure hydraulic systems with bulk fluid temperatures of -65°F to 450°F. In addition, hot spots would reach 630°F with a large portion of the non-continuous flowing systems in the 530°F region. The extensive hydraulic system requirements, together with the operational temperature environment, required a state-of-the-art advancement for hydraulic fluid.

Selection of a fluid so that system sizing and hardware development can proceed was the first step in the overall integration of the hydraulic system. A non-flammable fluid was highly desirable for the B-70; however, no current fluid with that characteristic was capable of operating over the required temperature range. Thus a development program was initiated to evaluate fluids with properties best suited for the B-70 air vehicle.

DISCUSSION

In the selection of the most desirable fluid, five fluid properties were considered of major importance. These properties were:

1. Viscosity: a measure of low and high temperature pumpability.

2. Bulk Modules: a measure of the fluid's ability to transmit power with minimum compressibility loss.

3. Thermal Stability: a measure of the ability of the fluid to retain its properties unchanged after exposure to temperature extremes.

4. Lubricity: a measure of the fluids ability to satisfactorily lubricate the pumps, motors, valves, and actuators making up the hydraulic system.

5. Weight: a prime consideration due to the large quantities of fluid in the system.

A number of other properties, such as oxidation stability, foaming tendency, and hydrolytic stability were also evaluated. However, these were considered of lesser importance in a closed, purged, pressure-filled and relatively oxygen-free system of the B-70. In no case was the deviation from norm of any of these lesser properties of sufficient magnitude as to affect the final selection.

The most promising fluids available fell into four "families" as far as chemical composition was concerned. These were:

1. Mineral oils
2. Diesters
3. Silicate Esters
4. Chlorinated Silicones

(only fluids which met the -65°F requirement were considered)

The best representative fluids from each "family" were considered under the program of comparative evaluation. When evaluated on the basis of each of the major fluid properties, the fluid or fluid "family" which had the best characteristics in relation to each major property was given a rating of 100% in that property with the other fluids rated on a basis of comparison. No single fluid proved 'best' in all, or even in a majority of the major properties.

After all testing was completed, a summary rating, which averaged the five major property ratings, showed the Silicate Ester family of fluids had the best balance of the required characteristics. For this reason Oronite 8200 fluid was selected for use in the B-70 hydraulic systems.

TECHNICAL DRIVERS

SUBSYSTEM: SECONDARY POWER WBS CODE: 1.4

DRIVER: HYDRAULIC SEALS

The B-70 hydraulic system was a 4000 psig system that operated in an ambient and fluid temperature environment of from -65°F to +630°F. In this hydraulic environment, only seals of metallic construction or other material processing performance characteristics equivalent to metallic construction could be considered. The seal material also had to be compatible with H-11, AM355, 17-4PH, 410, and 440C steel alloys and the hydraulic fluid that would operate satisfactorily over the required temperature range (see Technical Driver: Hydraulic Fluid). In addition, the seals had to perform satisfactorily with cavity dimensional variations or breathing induced by pressure and temperature changes.

Six basic types of seals were required for the hydraulic equipment design: (1) Static Face, (2) Static Diametral, (3) Static Barrier, (4) Oscillatory, (5) Dynamic Piston, and (6) Dynamic Rod. Exhibit 8, page III-669, presents cross sectionals of components showing typical applications of the six different types of seals. The basic design problem with the seals was to determine the correct sizes and shapes so that minimum effects of pressure, environment, material, and seal complexity could be achieved. Also, catastrophic-type failures could not be tolerated.

For the seal development program, the actual pressure test requirements for endurance, although based on a nominal 4000 psi operating pressure, were modified to conform to a specific application involving 12,000 psi proof pressure and pressure cycles to 8500 psi (not the normal 6000 psi proof and 10,000 psi burst). Two types of endurance test profiles were established. The first profile consisted of a screening test consisting of 47,000 cycles of pressure application. The seals that passed the screening tests were then subjected to 201,250 additional cycles for a total of 248,250 cycles. The test profile for the barrier seal was essentially the same as for the static face and diametral seal, except a goal of zero leakage was established for the latter two as opposed to one CC per minute (at 4000 psi delta) for the barrier seal. All testing was conducted with Oronite 8200 fluid. The thermal cycles during the endurance testing were based on $7\frac{1}{2}$-hour-test day, allowing no more than $1\frac{1}{2}$ hours to come up to maximum stabilized temperature and no less than 5 hours at the maximum temperature.

In one case, they would not seal in all sizes; in another, they would not fit the standarized cavity or the configuration scored the cavity. Various seal material combinations were tested in an effort to establish an optimum seal material and an optimum plating combination. Typical of the seal materials were Inconel X, H-11, 17-4PH, and 321 with the seal plating in most cases limited to various alloys of gold and silver.

The finalized face seal configuration, although unable to completely meet the testing goals in the large diameters (zero leakage), did perform satisfactorily without catastrophic failures. The test results indicated that, in general, pure face sealing with elastic cavities coupled with very high pressures did not produce completely satisfactory performance. Elimination of axial breathing reduced the fretting or galling between the seal and sealing face which in almost all cases was the cause of leakage. However, the severity of the test coupled with the actual results in air vehicle hardware usage has shown these seals completely satisfactory.

As indicated by Exhibit 8, page III-669, and the enlarged installation presented by Exhibit 9, page III-670, the basic function of the diametral type of seal was to provide static sealing between two concentric diameters. At the onset of the seal development program, serious consideration was given to making this type of seal the "basic" static seal. Had this occurred, the Static Face Seal would have been relegated to a supporting role and used only for special applications. Other things being equal, the diametral type seal has an inherent advantage in that the breathing between sealing surfaces is considerably less than that of a face seal. This factor was given considerable weight in comparative evaluations; however, the face seal was selected as the "basic" seal for the following reasons:

(1) The Diametral Seal must be pressed into place at assembly. The Face Seal can be dropped into place.

(2) The sealing surfaces for the Diametral Seal are very hard to hold concentrically. If serious variations in cross sectional "squeeze" were to be avoided, either extremely accurate concentricity tolerances must be held or the seal must act as the centering device and take all centering loads. On the other hand, the geometric relationship of the Face Seal's parallel sealing surfaces could be relatively easily held by means ofspacers or similar devices, which at the same time transmit structural loads without loading the seal.

Based on the above factors, the use of the Diametral Seal was confined to smaller diameter applications for insert-type cartridges and component bodies where concentricity and/or seal loading problems were at a minimum.

During the course of the development program, 70 diametral-type seals in various sizes and materials were tested. The seals were tested in fixtures similar to the face seal rigs and essentially to the same pressures and temperatures. As a result of the tests, the "cup"-type cross section was selected even though this configuration never demonstrated that it was a true "zero leaker."

WBS CODE: 1.4

The primary function of the Barrier Seal was to act as a seal between the inside of a housing and the outside diameter of the sleeve on a sleeve and spool assembly. Exhibit 10, page III-671 presents an enlarged view of Barrier Seal installation. This seal had to be capable of installation in a piston-ring type groove, and it also had to be capable of limiting bi-directional leakage to a maximum of one cubic centimeter per minute under all operational conditions. These requirements generated several subsidiary requirements unique to the Barrier Seal, such as:

(1) The seal's free diameter had to be small enough to permit entrance into the lead-in taper in the housing in which it was to be used.

(2) When male parts, with Barrier Seals installed, are pressed into bores having a series of relief grooves and/or parts, the seal must not expand or offset in such a manner as to "key-lock" the male and female parts at some intermediate position.

(3) If installation requires that the seal slide along the male part (sleeve), the inside diameter of the seal must be readily expandable so that the seal may be installed over other seal cavities and irregular surfaces without causing yield of the material sufficient to impair the sealing properties.

Initial tests were conducted on piston-ring type barrier seals but complexity of design, difficulties with installation and fabrication of the small sizes prevented consistent sealing. As a result, the configuration as depicted by Exhibit 10, page III-671 was developed. In cross section, the barrier-type seal was similar to the Face Seal except that it consisted of two half-circle segments.

The piston-type groove, which received the Barrier Seal segment, was slightly narrower than the width between the two legs. A slight force was required to install the seal in the groove, compress the legs and initiate a seal between the legs and the groove wall. Installation of the second segment butted the ends together. As the seal was then forced into the housing, it was compressed due to the smaller diameter of the housing. This assured intimate contact between the housing bore and the outside diameter of the seal. Also, the segment ends were concurrently pressed together to effectuate a continuous ring. The application of hydraulic pressure tended to unseat the leg on the pressure side which allowed pressure to build up inside the seal cavity. This buildup of pressure energized the other leg against the cavity wall, the outside diameter of the seal against the housing bore, and slightly relaxed the butt joint between the two segments (this leakage path was only 2% of the total leakage path on a one-inch diameter seal.

WBS CODE: 1.4

At the onset, optimum mechanical sealing efficiency was to be accomplished by having the pressure (bearing stress) between the seal surfaces slightly greater than the pressure of the fluid being sealing. This, it was felt, would reduce galling tendencies and extend seal life indefinitely. However, when the realities of cavity breathing and machine tolerances were faced, the bearing stress in the static face seals ran considerably higher than optimum. In the case of a large actuator or pressure vessel, to provide efficiency in terms of weight saving, it was necessary to take maximum advantage of the strength properties of the seals. In this regard, maximum weight saving by use of high strength steel was realized only if proportionally greater elastic material deformations were permitted. However, the resulting or accompanying seal cavity breathing created a fatigue and fretting problem. Since fatigue and fretting was a major problem, and, in order to establish the true fretting resistance capabilities of seals screened, cavity breathing limits expected for components were established; and, to provide a margin of safety, seal design goals were established at twice this limit.

As indicated in Exhibit 8, page III-669, the basic function of the static face type of seal was to provide static sealing between two parallel faces. In development of this type seal, seven basic seal diameters (inside) were selected as representative of the seal diametral range for listing. The sizes were 5/8, 1-15/16, 2, 3-15/16, 4, 4-7/8, and 7-3/8 inches diameters.

Approximately 500 seals were screened consisting of approximately 100 configurations. In the test program, early success was obtained with seals installed in relatively rigid test fixtures; however, when many of the same type of seals were installed in fixtures allowing maximum deformation, three basic failure modes were encountered:

(1) Seal permanent deformation or fracture at proof pressure.

(2) Fatigue failure.

(3) Scoring or coating removal at sealing surfaces.

The scoring or coating removal from the seal, which resulted in leakage, was cuased by relative motion between the sealing surface of the seal and the fixture when the interface was subjected to high bearing loads.

As stated, many types and configurations of seals were tested with varying results. Some of the seals tested yielded excellent performance, but in all cases these seals had one or more outstanding drawbacks.

WBS CODE: 1.4

During the Barrier Seal development, tests were conducted on more than thirty seal configurations for diameter sizes of 9/16, 13/16, and 1-3/8 inches. The resultant configuration was fabricated from 17-4PH steel with a heat treat of 135,000 to 165,000 psi while the housing was heat-treated to 190,000 psi to minimize scoring.

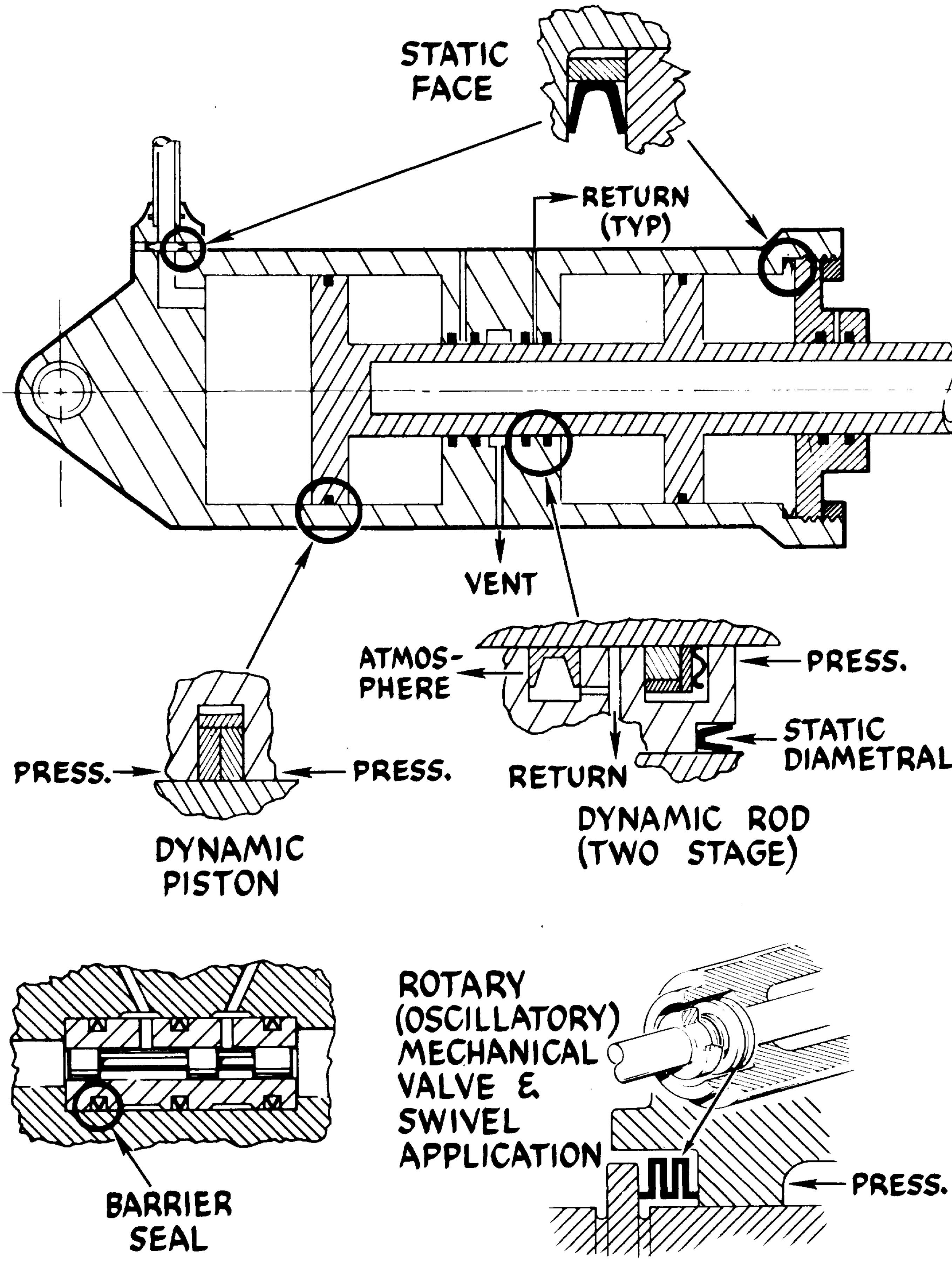
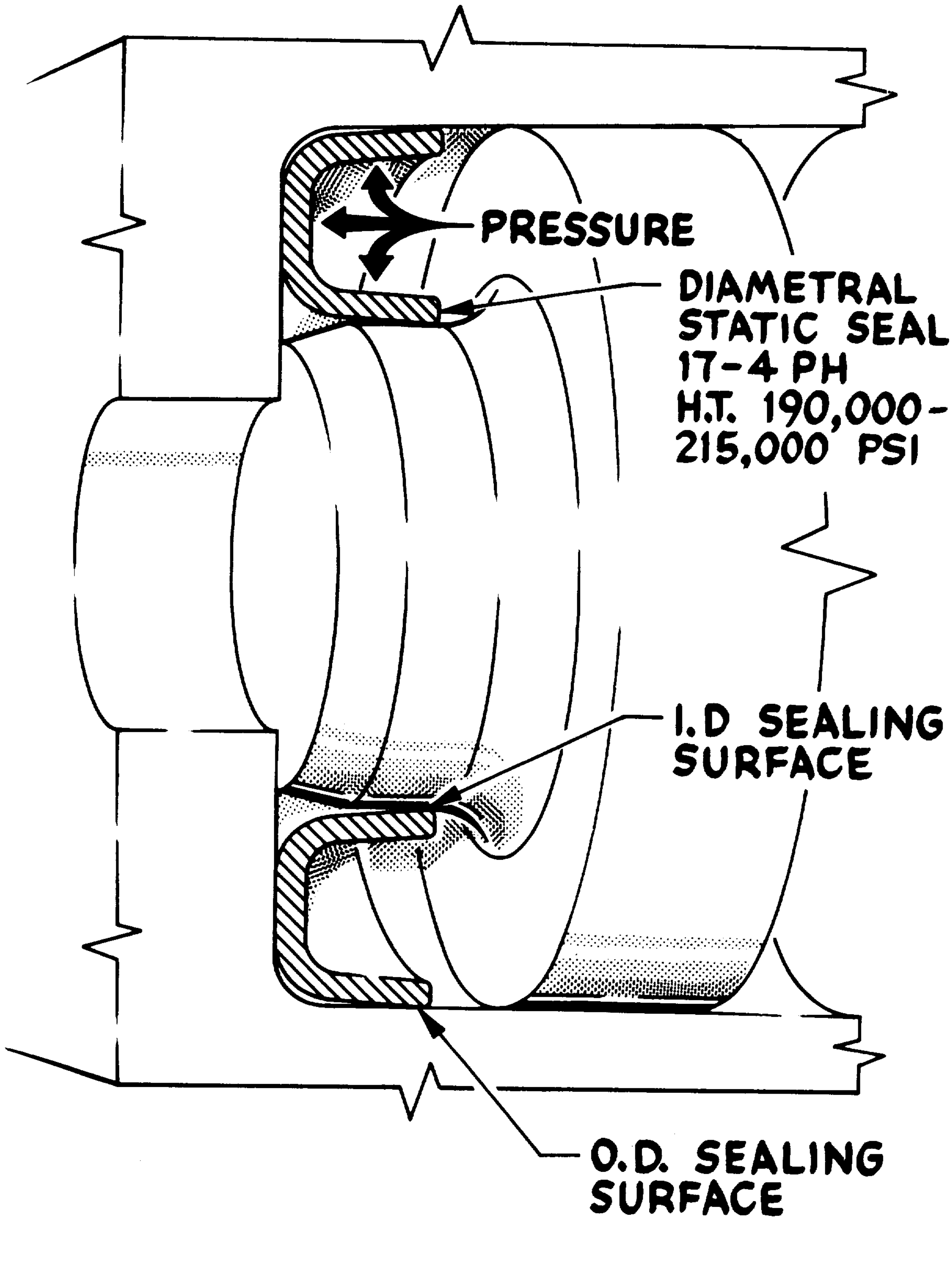
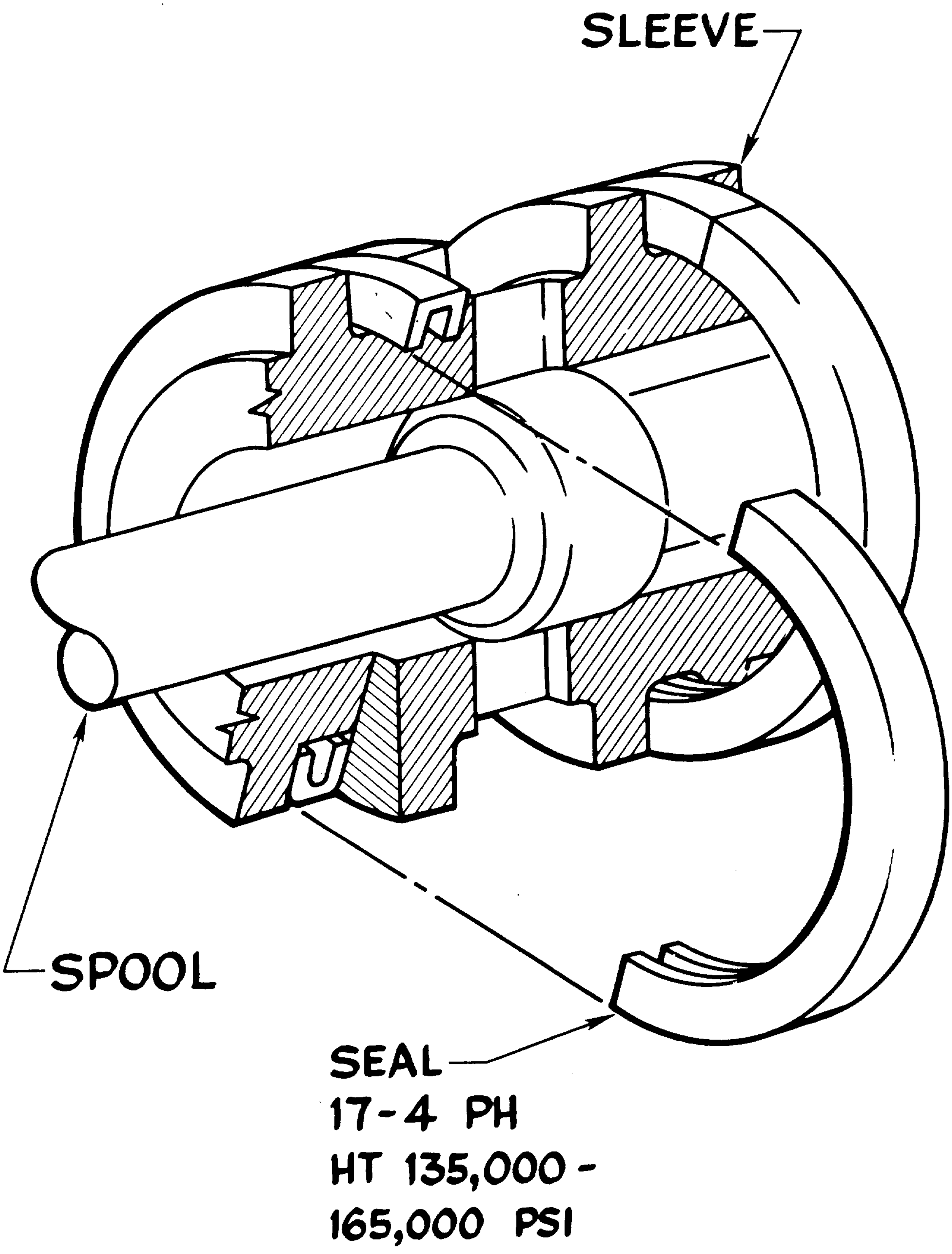


EXHIBIT 8

TYPICAL SEAL APPLICATION



DIAMETRAL SEAL INSTALLATION



BARRIER SEAL INSTALLATION

EXHIBIT 10

TECHNICAL DRIVER

SUBSYSTEM: SECONDARY POWER WBS CODE: 1.4

DRIVER: HYDRAULIC PUMPS

GENERAL

The initial B-70 studies showed that the hydraulic system would have to provide a potential maximum of 2000 horsepower and operate in a temperature environment extending from -65° F to 630° F. Since it was readily apparent that existing state-of-the-art hardware was totally inadequate, extensive trade-off studies were conducted with the objective of providing a system with maximum reliability at minimum weight and capable of operating throughout the wide temperature range noted above.

These studies evolved a four power system supplied by 12 positive displacement, variable output, engine-driven pumps (three for each system). These 12 remotely located hydraulic pumps were to provide system pressures of 4000 psi with the 6 utility pumps providing 58 gpm each and the six primary pumps providing 97 gpm each. These units required a considerable advance in technology, not only because of the high operating pressure and temperature, but because of their size, the largest pumps ever used in an aircraft. The 58 gpm pumps rotated at 6000 RPM while the 97 gpm pumps rotated at 5000 RPM. These speeds produced piston velocities well beyond those of the normally used 3750 RPM pumps and dictated the adoption of higher strength materials as well as for more refined detail design. In addition, it was required that the primary pump operate as a constant horsepower motor for engine starting. Exhibit 11, page III-674, presents the primary and utility pumps used on the B-70.

DISCUSSION

In the hydraulic pump development program, the initial testing produced failures which were traced to inadequate lubrication of the pump thrust bearing. This was rectified by replacing the thrust bearing with a roller bearing configuration similar to that used in existing pumps. The continued testing of this original configuration also revealed that the material compatibility of the pump pistons and bore was such that pump life was limited. As an interim fix, sulphurized M-2 steel pistons working in a sulphurized M-2 steel block, coupled with improved piston rod lubrication techniques produced a piston-bore configuration which was satisfactory; however, it had a maximum operating temperature of 300° F. The continued development work on the pump produced H-11 steel-silver plated pistons fitted to an M-2 block which was sulphurized. This configuration proved satisfactory on a component basis and met the full 400° F inlet fluid temperature requirement.

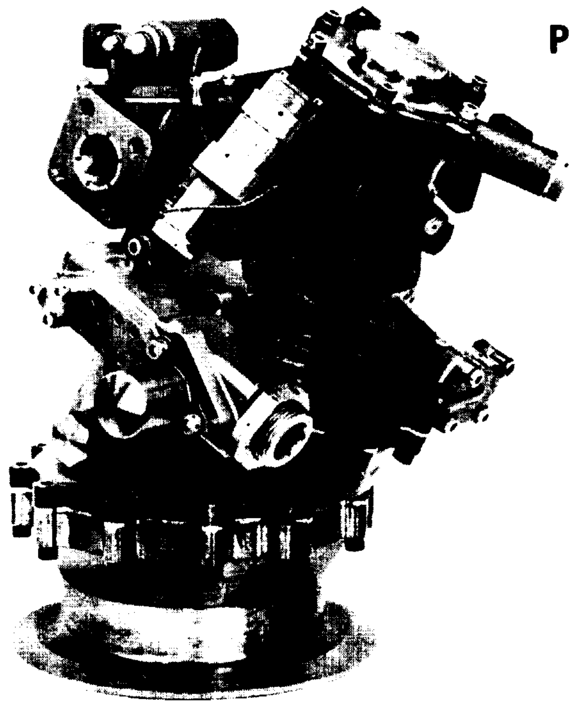
In the course of the testing outlined above and during the engine test stand operation, numerous hydraulic line failures were experienced. The lines that continued to fail were those in the accessory drive compartment which attached to the secondary power package (pumps). It was believed that the lines failed due to vibration and inadequate supporting mounts for the hydraulic lines. However, even though existing mounts were reinforced and additional mounts were added, continued line failures were still experienced.

An examination and materials analysis of subsequent line failures revealed that the lines failed due to work hardening caused by internal stresses. Sensitive instrumentation was installed and subsequent system operation showed the pumps to have a natural pulse frequency of approximately 11,000 cps at an amplitude of $\pm$ 25 psi at the nominal system pressure of 4000 psi. Laboratory tests showed that this small amplitude pulse at 11,000 cps would work harden the steel lines in a relatively short time. Due to the status of the XB-70 funding, it was decided to boot strap the installation instead of initiating a new pump development program. All pressure lines in the accessory drive compartment were replaced by lines with three times the design wall thickness and the line supports were redesigned so as to provide some damping.

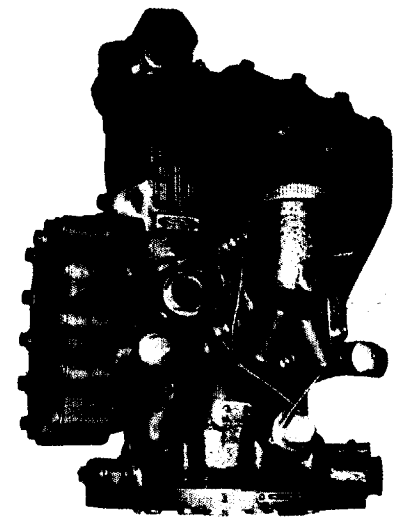
On the engine test stand these fixes appeared satisfactory; however, on the air vehicle line failures were experienced on the initial taxi tests of air vehicle #1. Analysis showed that the heavy walled lines were extremely hard to align during installation and were being prestressed. Better mockup of lines along with the incorporation of a ripple-damper and a wave trap on each pressure line eliminated the line failures.

HYDRAULIC PUMP/MOTOR

PRIMARY



UTILITY



	B-70	CONVENTIONAL	RESULT
PRESSURE	4000 PSI	3000 PSI	SMALLER ACTUATORS & HYD LINES
FLOW	95 GPM	15 TO 30 GPM	MIN NO. OF PUMPS FOR MAX POWER
TEMPERATURE	–65°F TO 450°F (650°F TRANSIENTS)	–65° TO 250°F	REDUCED COOLING CAP
FUNCTION	DUAL-PUMPING AND MOTORING	PUMPING ONLY	REDUCTION IN WT & SPACE

TECHNICAL DRIVER

SUBSYSTEM: SECONDARY POWER WBS CODE: 1.4

MAJOR ASSEMBLY: ELECTRICAL POWER TRANSMISSION/DISTRIBUTION; HIGH TEMPERATURE SWITCHES WBS CODE: 1.4.3.3

The high temperature switches for the B-70, which were used throughout the air vehicle, were to be developed and supplied by the Hayden Switch Company. The original problems encountered by the subcontractor were those typical of a switch development program, including high temperature material solution, isolating vibration effects, sealing, etc. However, by mid 1962, it became evident that the Hayden switch delivery would fall way short of supporting the B-70 Program. At the time, the problem was in obtaining satisfactory production yield in electron beam welding of the switch housing to its base. In addition, a large percentage of the Hayden switches that had been received failed prior to installation which was attributed to poor quality control. In an effort to resolve the switch problems, NR established a team (representing Engineering, Quality Control and Purchasing) at Hayden with a two-fold objective: to expedite the manufacturing of switches and to improve the quality control.

In the third quarter of 1962, due to the unsatisfactory performance of the Hayden Company, a proposal was solicited from Micro Switch for the development of an alternate switch source. The alternate source was approved, and NR worked as a team with Micro Switch to expedite development of the new switch design with the objective being to replace the Hayden switches as soon as possible. The replacement of the Hayden switches with the Micro switches could not be made without engineering, since dimensions were not exactly the same. The plan established was to install the Micro switch units in Air Vehicle No. 2 prior to flight, Air Vehicle No. 3 during fabrication, and Air Vehicle No. 1 during the course of normal maintenance.

In the fourth quarter of 1962, engineering was released to implement the installations of the new Micro switches which were expected to be available the first part of 1963. However, during the airworthiness tests, the switches were proved to be "sticky." This condition was solved by changing the common contact from fine silver to silver cadmium oxide. Additional tests showed that this material change did not affect the inductive or motor load ratings and that only a minimum retest was required for airworthiness. Based on this, full scale delivery of the Micro type switches was scheduled to start the first of April.

The Micro Switch airworthiness tests were completed the first part of June, 1963. These tests consisted of ten units operated for 12,500 cycles at 550° F with 2.5 amperes inductive at 115 volts/400 cycles. The switches for Air Vehicles No. 2 and No. 3 were delivered on schedule with the switches for Air Vehicle No. 1 delivered in July, 1963.

WBS CODE: 1.4.3.3

The Hayden switch malfunctions continued to plague the systems checkout of Air Vehicle No. 1 during this time period, with final replacement accomplished during the flight test program.

TECHNICAL DRIVER

SUBSYSTEM: SECONDARY POWER WBS CODE: 1.4

DRIVER: HYDRAULIC TUBING AND FITTINGS

GENERAL

At the onset of the B-70 development program, an analysis was conducted of 846,964 flying hours logged on 2,215 F-100 series aircraft where fluid loss resulted in complete system failure. Of all total system losses, 61.6% were attributed to hoses, fittings, and tubing failures of which 18.6% were hose and tubing while 43% were failures of the fitting and tubing combinations. The F-100 series employed AN fittings utilizing 5052-O and 6061-T6 al-alloy tubing from $\frac{1}{4}$ in. to 5/8 in. diameter for pressure lines with suction and return lines a maximum of one inch diameter.

The B-70 required pressure lines from $\frac{1}{4}$ in. to 1 5/8 in. diameter with suction and return lines up to a maximum of 1 7/8 in. diameter. It was obvious that existing state-of-the-art in tubing fittings and connectors would not only impose an extreme weight penalty but would not, by statistical evidence, perform to the reliability required for the B-70. The development program initiated resulted in one of the B-70's most fruitful areas of design improvement with a high reliability factor and a large weight savings in the hydraulic tubing and fittings.

DISCUSSION

Several goals were established for the B-70 hydraulic distribution design as follows:

1. Permanent tube joints to be employed where possible since a major portion of the distribution system was within integral fuel cells and maintenance could not be readily performed.

2. Tubing having a high strength to weight ratio at elevated temperatures had to be employed.

3. Where removable threaded type fittings had to be employed, their integrity was not to depend on specific torque values, and because of the large tube sizes employed, the installation torques had to be low.

4. Murphy's Law had to be eliminated or reduced to a minimum to provide maximum confidence level.

5. Specific design parameters for determination of acceptability of the tubing and joints had to be established.

6. Flexible joints, swivels, all metallic hoses, coiled tubing, or other devices had to be designed to take more than the required relative motion between components and structure.

WBS CODE: 1.4

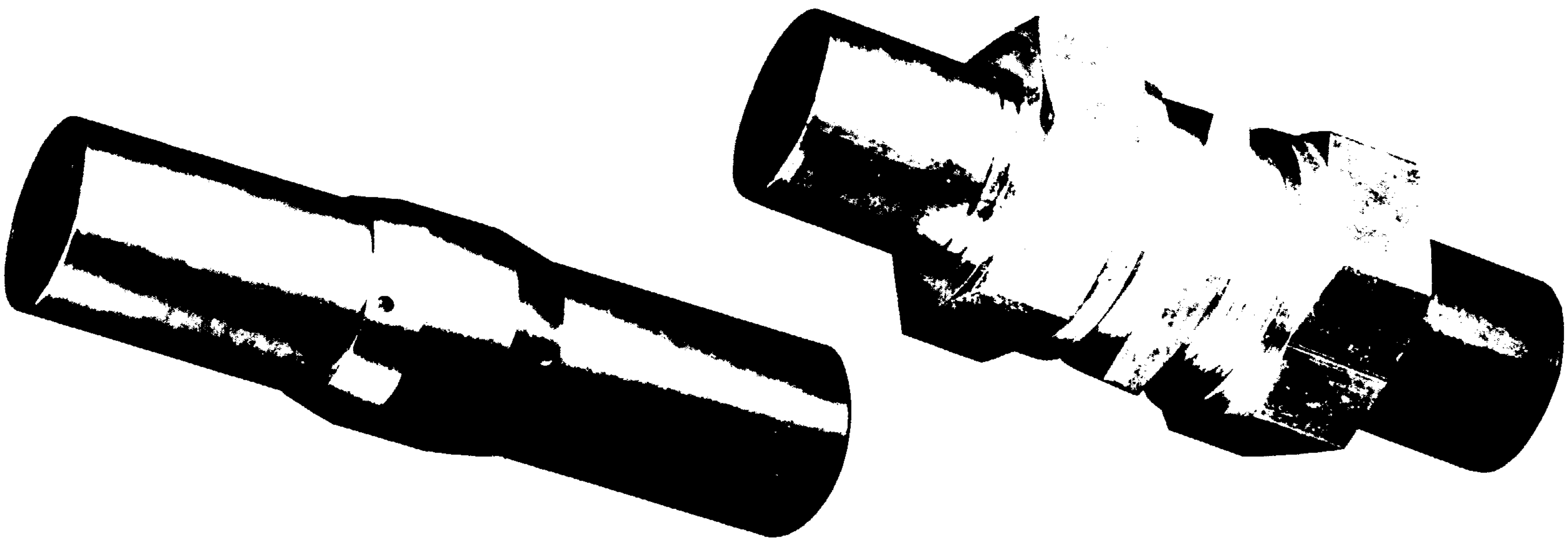
Two different types of 350 CRES tubing were developed for use as hydraulic lines. CRT (cold reduced and tempered) was used for general line plumbing while annealed 350 CRES tubing was used for fittings, such as elbows, tees, and crosses. The CRT tubing was work hardened by redraws through sizing tools to a minimum tensile strength of 185,000 psi while the annealed 350 CRES, after heat treatment, was classed as SCT (sub-zero cooled and tempered) tubing. The unions which joined the tubing and fittings were made of 355 CRES stainless steel.

Machine fittings were kept to a minimum with crosses, tees and reducing fittings all fabricated from a heavier wall annealed 350 CRES tubing. (Heavier walls than the normal tubing were necessary due to the unsupported areas which existed at intersecting cylindrical surfaces.) Tees and crosses were all machine welded and, where required, elbows were formed to a one tube diameter bend radius then heat treated to the SCT condition after fabrication.

Lines and fittings within the airframe were joined with an NR developed standard brazed union which utilized a silver-lithium copper braze material. Induction braze tools were developed which included a line jigging fixture and a gas purge chamber that could be operated in congested areas. Furnace brazing was also utilized, specifically in joining tubing to manifolds which were used extensively to install equipment items. These manifolds were constructed with tubing pigtails furnace brazed in place and then induction brazed to equipment within the airframe. The manifolds were used to reduce the leak paths to a minimum by eliminating one leak path in the conventional fitting system. Threaded joints were kept to a minimum within the air vehicle; however, where used, the joint employed embodied features which improved the undesirable traits of the existing AN and MS joints. Installation torque was low with no specific torque required to bottom the fitting positively. A single leak path was utilized which was pressure energized to the sealing position.

The effort expended in design and testing of the fluid distribution system, without assessing the increased reliability, provided a weight savings for the B-70 of over 10,000 lbs. This comparison is based on the system described to that using 321 CRES tubing and MS fittings. Exhibit 12, Page III-679 shows the difference between the two types of installation.

BRAZED HYDRAULIC FITTINGS



- REDUCED WEIGHT
- INCREASED RELIABILITY

TECHNICAL DRIVER

SUBSYSTEM: SECONDARY POWER WBS CODE: 1.4

DRIVER: ELECTRICAL POWER SYSTEM, CONCEPTS AND EQUIPMENT

GENERAL

The large electrical power demands of the B-70 air vehicle and its equipment necessitated extensive investigation into the electrical distribution system as well as the generating system itself. The primary power was established as AC rather than DC, which represented the first time that an all AC system of this magnitude was used in an air vehicle. Heretofore, low voltage DC systems were used almost exclusively as the basic power system with AC generators added for large and/or specialized AC loads. In the XB-70, over 100 feet of feeder cable transmitted the power from the generators in the aft power plant section to the load centers in the equipment areas of the forward fuselage.

In the transmission of large amounts of power, system studies showed that a low voltage DC system was very costly in terms of efficiency versus weight. In addition, DC power consuming devices are very bulky and heavy when compared to their AC counterparts. Further studies proved that, even for an AC system, a significant weight savings could be realized if the power were generated and transmitted at 416 volts, rather than the more conventional 110 volts. Although transformers were required at the equipment areas to step-down the voltage, the net result was decreased total system weight.

DISCUSSION

In the development of the B-70 60KVA generators, special attention had to be given to the high temperature, high altitude environment to be encountered in the air vehicle. The generator was designed for operation at altitudes of more than 100,000 ft. over a temperature range of -65° F to 330° F. It was a 3 phase, 240/416 volt, 440 cps machine designed to be oil cooled. Further, it was of the rotating rectifier type which eliminated the need for brushes, an arcing problem source at altitude. The generator cavity was pressurized with dry nitrogen which prevented ingestion of atmosphere contaminants and provided improved arc and corona resistance of the insulation system. The advanced design of the generator was exemplified by its extremely light weight; while conventional oil-cooled generators had a weight to power ratio in the order of 2.3 lbs. per KVA, the B-70 generator, the largest oil-cooled unit produced at that time, was only 1.6 lbs. per KVA.

For the first time, the design of true AC-coil relays for high altitude, high performance military weapon systems application was achieved. The B-70 relays had the unique capability of continuous operation when the coil circuit was energized from a 115 volt, AC, 400 cps power supply without utilization of internal or external rectifiers or other similar auxiliary components. In addition, comparable relay performance was also provided when the same AC relay coil circuit was energized directly from a 28 volt DC power supply. The relays developed were a miniature "tone" 400 cycle AC coil relay of the 1, 3, and 10 ampere class, capable of operating in ambient temperatures of 250° F. The miniaturization achieved provided a configuration which was specifically designed for adaption to rack and panel connector installation to affect ease of maintenance and installation. Exhibit 13, page III-682, presents a display of pure AC relays used on the XB-70.

The development of AC solenoids was another achievement in the effort to operate electrical components from the primary alternating current power source. The AC solenoids were developed due to the inefficiency of transmitting low voltage DC power to remote locations of the air vehicle and the fact that rectifiers for conversion of AC power at the using component could not withstand the high ambient temperatures of 600° F. See Exhibit 13, page III-682, for a typical pure AC solenoid used on the XB-70.

In the initial design of the B-70 a conventional mechanical linkage between the cockpit and the engines was contemplated. However, as design proceeded, it was soon apparent that 162 feet of cables and levers presented severe problems in terms of poor accuracy and high lever loads, unless a boost system, with the associated weight and complication, was incorporated. After extensive trade-off studies, it was concluded that an all-electrical throttle system was the best way to meet the design objectives. (For a functional description see Thrust Control under Propulsion: WBS 1.3.)

Although the use of an electrical throttle per se was not new, the application where the engine throttle lever actuator must operate in a 550° F temperature environment at altitudes above 70,000 ft. definitely was a substantial advance in the state-of-the-art. This actuator unit, which was mounted directly on the engine, was comprised of dual high temperature (550° F) motors, coupled to the engine thrust lever through a precision gear box, and controlled by a position sensing synchro. The successful development of this unit provided the following advantages over a mechanical system.

(1) Greater accuracy (± 1.5°) of engine lever positioning

(2) Smaller volume

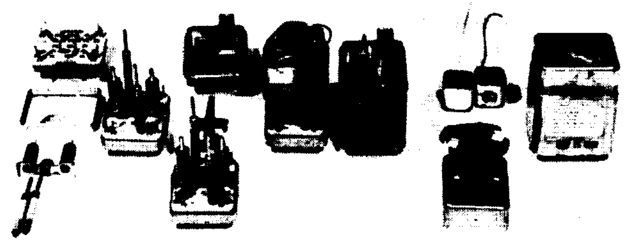
(3) Approximately 200 pounds less weight

(4) Components (input sensor, control amplifier, actuator) located for easy access

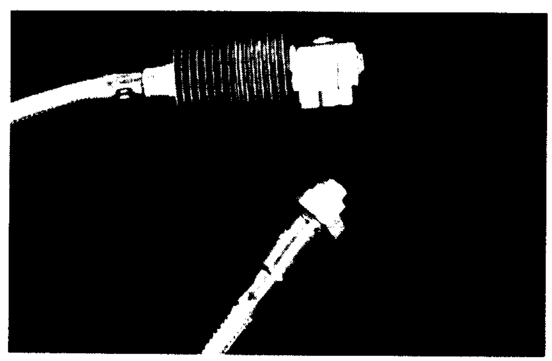
(5) High reliability (.9999)

The engine thrust control was subjected to some 1800 hours of laboratory and engine test operation, including 700 hours of heated testing, prior to air vehicle operation.

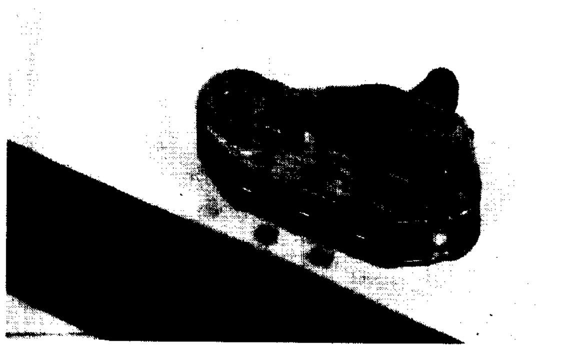
HI-TEMP RELAYS/SOLENOIDS/SWITCHES



• PURE AC RELAY



• PURE AC SOLENOID



• QUALIFIED MICRO-SWITCH

DEVELOPMENT DATA SUMMARY

WBS TITLE: SECONDARY POWER SUBSYSTEM WBS CODE: 1.4

STATE-OF-THE-ART RATING: 5 (See Remarks)

PERCENT DEVELOPED MATRIX:

	PRIOR TO FLIGHT		FLIGHT TEST
	CONFIGURATION	GROUND TEST	
PROGRAM LEVEL	68%	83%	28%
EFFORT TO GO	58%	39%	90%

GROUND TESTS

TYPE OF TEST		NUMBER OF UNITS	TEST HOURS
CONFIGURATION RESEARCH	(1)	105	115,000
DESIGN FEASIBILITY	(1)	70	118,500
DESIGN VERIFICATION	(1)	216	146,400
AIRWORTHINESS	(1)	73	166,620
QUALIFICATION		-	-
OTHER		-	-
TOTAL		464	546,520

REMARKS: (1) The two major systems of the Secondary Power testing were as follows:

HYDRAULIC SYSTEM TESTING:

Type of Test	No. of Units	Test Hours
Research	105	115,000
Design Feasibility	35	110,000
Design Verification	106	100,500
Airworthiness	22	116,000
TOTAL	268	441,500

ELECTRICAL SYSTEM TESTING:

Type of Test	No. of Units	Test Hours
Design Feasibility	35	8,500
Design Verification	110	45,900
Airworthiness	38	50,250
TOTAL	183	104,650

WBS CODE: 1.4

State-of-the-Art

The Secondary Power 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: 1.4

The three major systems of the Secondary Power Subsystem were unique in their individual design and in their operational integration for the support of the other air vehicle subsystems. As discussed under the Technical Descriptions and Technical Drivers, the design and development of the Hydraulic Power Supply, Electrical Power Supply, and the Accessory Drive System of the Secondary Power Subsystem were major achievements in the advancement of the state-of-the-art for operations in extreme environments, such as vibration, acoustic, loading, and temperatures. The use of new materials, manufacturing processes, and fabrication techniques were required in each of the systems to meet the demanding RS-70 requirements. In addition, the Secondary Power Subsystem design facilitated maintenance and increased mission success by critical area isolation. Based on the established ground rules and the major advancements made, the Secondary Power Subsystem was assigned a state-of-the-art rating of 5.

Percent Development

The Secondary Power 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 the Secondary Power Subsystem status. The analysis was conducted to arrive at a status level for the overall subsystem; however, to achieve that goal, each major assembly was assessed as presented in the following paragraphs.

The Secondary Power Subsystem configuration was assessed as being 68 percent representative of that planned for the RS-70 at the time of prior to flight of the No. 1 air vehicle excluding ground testing. The composite percentage for the overall subsystem was arrived at by analyzing each major assembly configuration, assigning each configuration a representative percentage as compared to its RS-70 counterpart, and the weighing the impact each major assembly had on the overall subsystem due to the differences. This exercise is summarized in the following table:

Major Assembly	% Complete	% Difference	Weight Factor
Hydraulic Supply	70	30	3
Electrical Supply	65	35	3
Accessory Drive System	70	30	1

The hydraulic system was downgraded 30 percent due mainly to the "ripple dampers" and "wave traps" incorporated into the XB-70 to compensate for the internal pressure dynamics. It was the opinion of the Hydraulic Design Group that these fixes were not production "type" fixes and that the pumps would have been modified for the RS-70 program. The electrical system was downgraded 35 percent due mainly to the difference in electrical power required which resulted in a less complex distribution system and two parallel generators instead of two sets of two parallel generators. The electrical system was not downgraded more since it was the opinion of the Electrical Design Group that the planned RS-70 protective controls were proven with the XB-70 configuration. The accessory drive was downgraded 30 percent due mainly to the two less generators and the associated heat loads. The weight factors were established based on each major assembly's complexity as related to the overall subsystem.

To establish what effort would have been required to attain a No. 1 air vehicle production level status, the same curve used for the structure analyses was utilized for the Secondary Power Subsystem; Exhibit 14, page III-688. Entering this exhibit on the left-hand side at 68 percent, across to the curve and then down to the bottom scale, it shows that 58 percent more effort would have been required for a No. 1 RS-70 production configuration. Entering the same curve for the Hydraulic Supply System and the Electrical Supply System, it shows that an increase in effort of 56 percent and 61 percent, respectively, would have been required for the RS-70. To determine the ground testing required, 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". The RS-70 program had 893,500 test hours scheduled at this phase compared to the XB-70 ground test hours of 546,620. This comparison shows that the XB-70 Secondary Power Subsystem ground test hours was at a status level of 61 percent of that planned for the RS-70 or that 39 percent more testing effort would have been required for the RS-70 at this phase to attain a production level status. Entering the same exhibit at 61 percent on the bottom scale, it shows by the left-hand scale that the XB-70 Secondary Power Subsystem was at a confidence level of approximately 83 percent at time of first flight. For the RS- 70 at prior to first flight time period, there were 736,000 test hours scheduled for the hydraulic system and 150,000 test hours scheduled for the electrical system. Comparing these scheduled hours to that expended, it shows that 40 percent and 30 percent more testing effort required for the hydraulic and electrical systems, respectively, to attain a production level status.

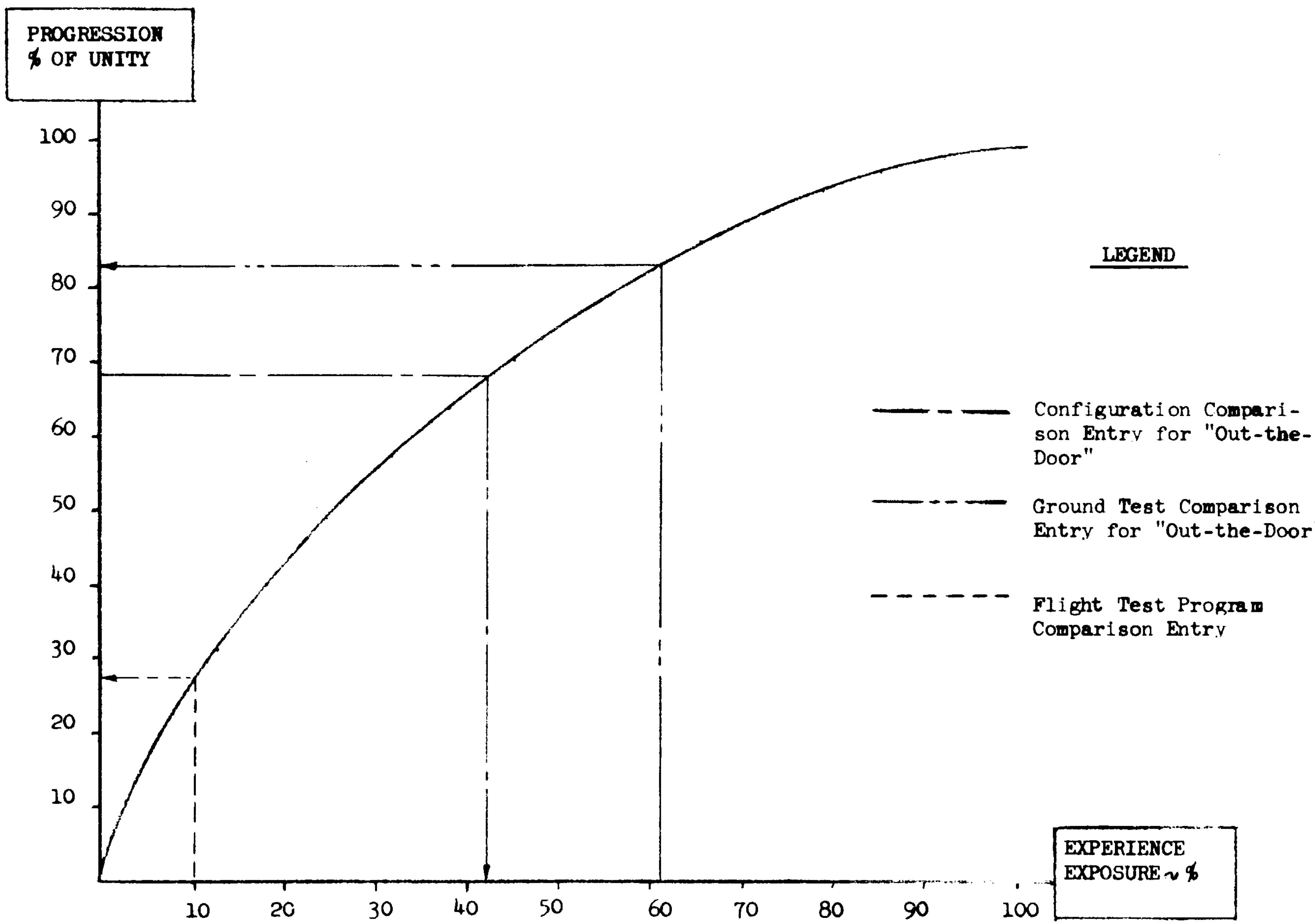
The flight test program comparison, presented by Exhibit 13, page II-23, under Air Vehicle (WBS: 1.0), shows that during the XB-70 flight test program, the Secondary Power Subsystem had an equivalent flight test hour total equal to 15 percent of that scheduled for the RS-70. However, this percentage did not take into account the difference in the RS-70 and XB-70 flight envelopes as shown by Exhibit 14, page II-24, under Air Vehicle (WBS: 1.0). To be able to directly compare the flight test programs, the 15 percent number had to be adjusted to reflect the less demanding envelope flown by the XB-70's. (Based on Design Group analyses, no adjustment required due to configuration flown). Using the same weight factor established for the Structures Subsystem (WBS: 1.1), that is, that the first

80 percent of the envelope requires only 60 percent of the total effort while the last 20 percent of the envelope requires 40 percent, the equation 2 : 3 = X : 15 was generated for flight envelope adjustment. Using this equation, the flight test effort remaining to attain a production level status would be stated as 40% + 60% - (2 X 15 ÷ 3) or that 90 percent more flight testing effort would be required.

In summary, the Secondary Power Subsystem configuration prior to flight was assessed as being 68 percent representative and would have required 48 percent more effort to attain an RS-70 No. 1 vehicle status. At this same time period, 39 percent more ground testing would have been required to attain the ground testing status level planned for the RS-70. It was also assessed that 90 percent more flight testing effort would be required to attain a production level status. All of the comparisons are based on test articles, tooling, GSE, etc., being at the RS-70 level in both numbers and fidelity.

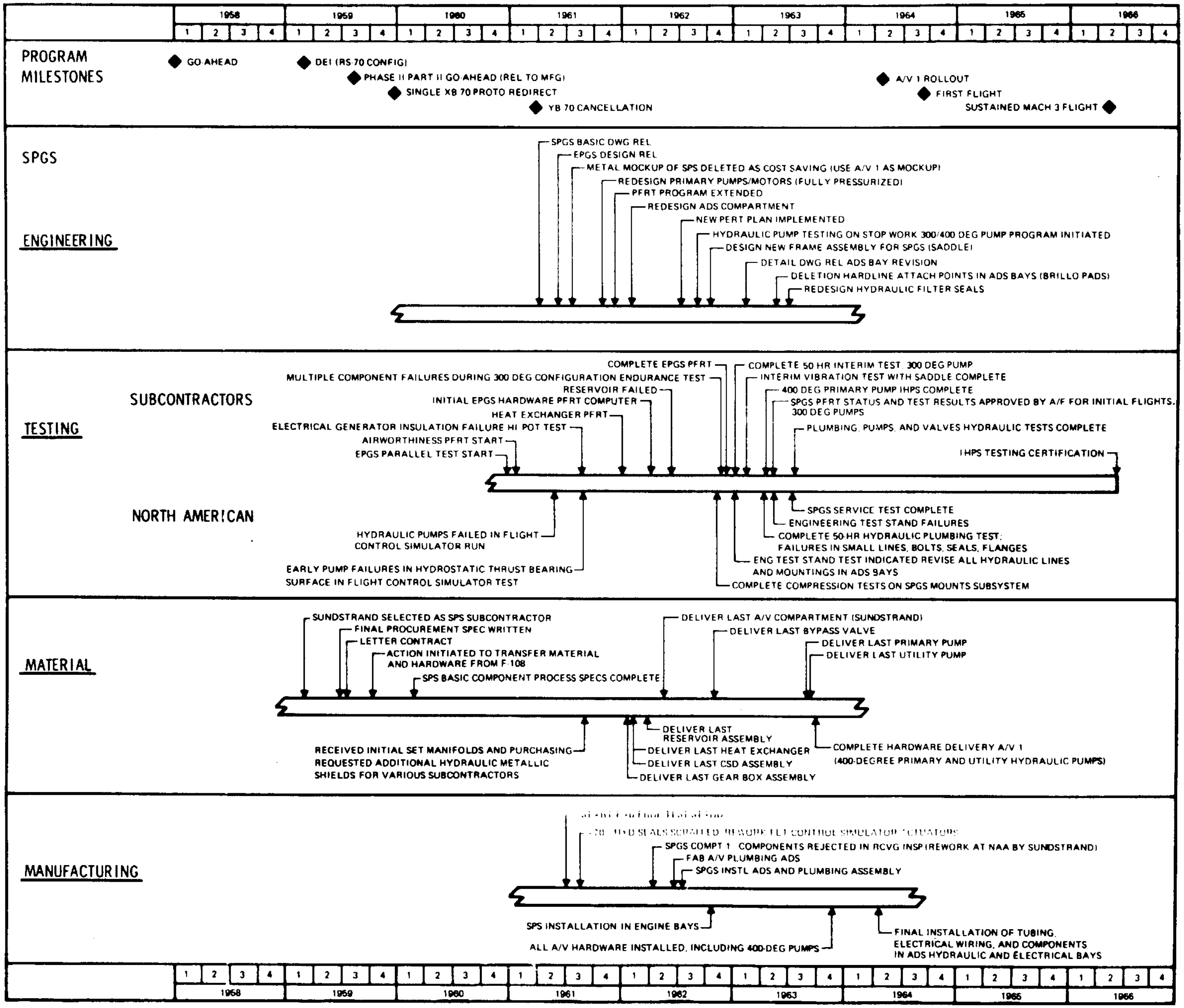
NOTE: THE USE OF THE "EFFORT TO GO" PERCENTAGES FOR COST DETERMINATION SHOULD NOT BE APPLIED WITHOUT CONSULTING SECTION IV-8, VOLUME I, PAGE I-310 FOR APPLICATION CONSIDERATIONS.

SECONDARY POWER SUBSYSTEM DEVELOPMENT STATUS
PERCENT COMPARISONS BASED ON RS-70 (UNITY)



SECONDARY POWER SUBSYSTEM DEVELOPMENT SUMMARY

(WBS 1.4)



DEVELOPMENT SUMMARY
TABULATION OF DATES

SUBSYSTEM: SECONDARY POWER | WBS CODE: 1.4

ENGINEERING

SPGS Basic Drawing Release	4-12-61
EPGS Design Release	6-15-61
SPS Metal Mockup Deleted	7-15-61
Redesign Primary Pumps/Motors	10-15-61
PFRT Program Extended	12-22-61
Redesign ADS Compartment	1-26-62
PFRT Plan Revised	7-15-62
Stop Work - All Hyd Pump Testing	7-15-62
Added Frame Assembly - SPGS Mounting	10-15-62
Detail Dwg. Release - ADS Bay Revision	2-15-63
Hardline Attach Points Deleted	5-24-63
Redesign Hyd Filter Seals	8-09-63

TESTING (SUBCONTRACTORS)

Start - EPGS Parallel Test	1-07-61
Start - PFRT Airworthiness	2-15-61
Elec. Generator Insulation Failure	8-15-61
Complete - Heat Exchange PFRT	1-05-62
Complete Speed Switch PFRT (Initial EPGS)	4-15-62
CSD & Reservoir Test Failure	6-08-62
Added Test Stands Due to Load	9-15-62
Gear Box, Lub Lines, Housing Failures	11-15-62
Comp. - PFRT, Ext. Power Contactor (Final EPGS)	12-14-62
Comp. - 300° Pump 50 Hr. Interim Test	1-11-63
Comp. - Interim Vibration Test	2-14-63
Comp. - 400° Primary Pump IPHS Test	4-24-63
AF Approval - SPS PFRT Test Results	5-15-63
Comp. - Plumbing, Pumps, Valves Tests	7-26-63
Final Cert. - SPGS IHPS Testing	6-09-66

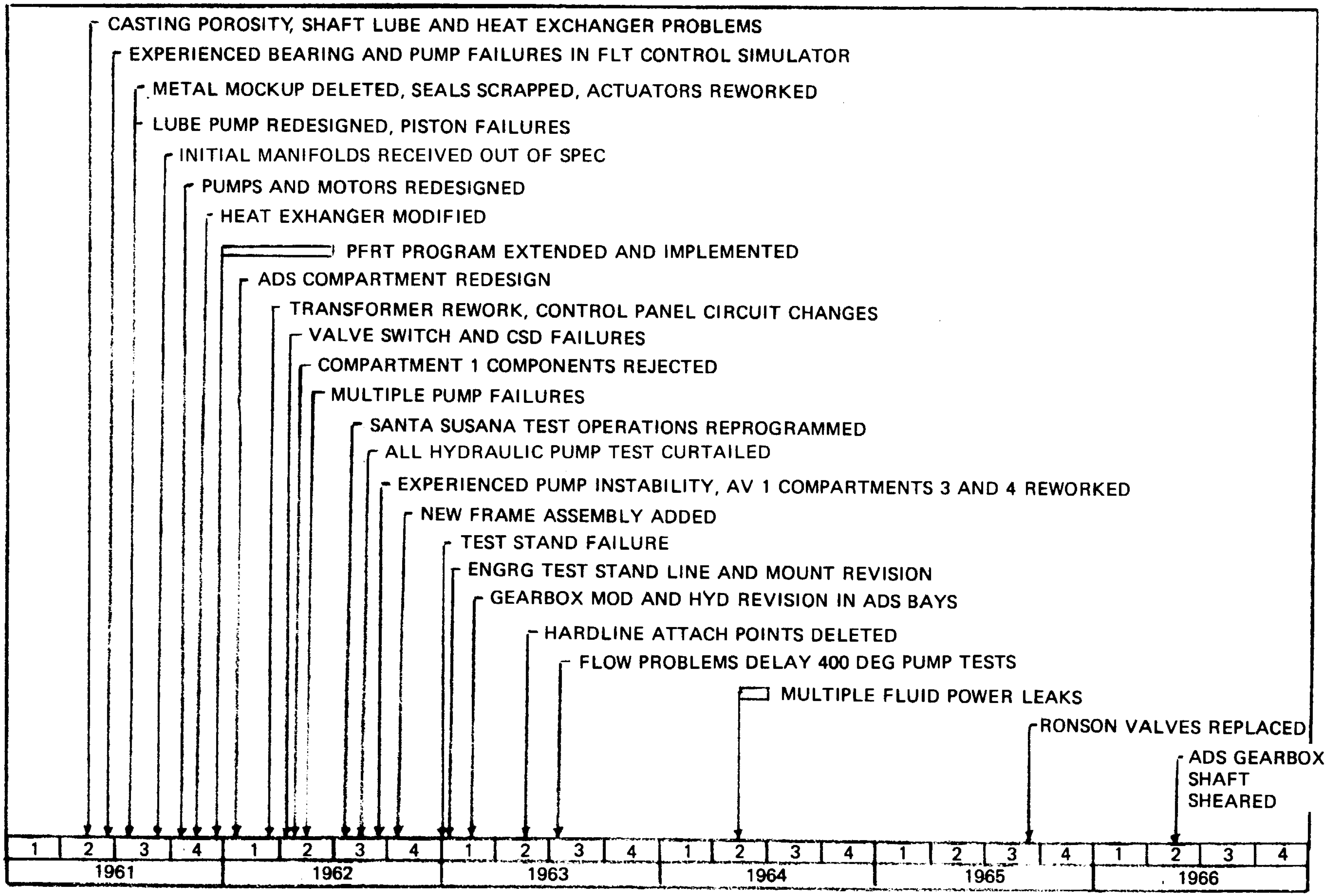
(North American)

Hyd Pump Failures in Flt. Control Sim.	6-23-61
Thrust Bearing Pump Failures in Sim.	9-08-61
Comp. - Compression Tests on SPGS Mounts	11-20-62
Revised Lines, Size, Mounts - Eng'g Test Stand	1-11-63

TESTING (North American)	WBS CODE: 1.4
Comp. - 50 Hour Hyd. Plumbing Test	5-10-63
Hyd. Lines/Mount Failures - Eng'g Test Stand	5-17-63
Comp. - SPGS Service Test	7-16-63
MATERIAL	
Award of Contract - Sunstrand	3-09-59
Comp. - Procurement Spec.	6-04-59
Letter Contract Issued	6-16-59
F-108 Hardware Transfer Initiated	10-16-59
Basic Component Process Spec's. Rel.	3-12-60
Initial Manifolds Received	9-04-61
Additional Shield Requirements Identified	9-26-61
Comp. Delivery - Reservoir Assemblies	3-07-62
Comp. Delivery - Heat Exchangers	3-24-62
Comp. Delivery - CSD Assemblies	3-29-62
Comp. Delivery - Gear Box Assemblies	4-01-62
Comp. Delivery - Last AV Compartment	5-25-62
Comp. Delivery - Bypass Valves	11-06-62
Comp. Delivery - Primary Pumps	8-30-63
Comp. Delivery - Utility Pumps	9-03-63
Comp. Delivery - AV #1 Hardware	9-15-63
MANUFACTURING	
Start - Fabrication of Propulsion Test Stand	7-06-61
Simulator Actuators Reworked	7-28-61
AV ADS Plumbing Fabricated (AV #1)	6-15-62
ADS & Plumbing Installed (AV #1)	7-09-62
SPS Installed in Engine Bays (AV #1)	10-12-62
ADS Compartment Reworked (AV #1)	6-07-63
Comp. AV #1 Hardware Installation (SPGS)	11-07-63
Comp. AV #1 Tubing, Plumbing Installation	4-24-64

SECONDARY POWER SUBSYSTEM
DESIGN / PROGRAMMATIC IMPACTS

WBS 1.4



DESIGN/PROGRAMMATIC NARRATIVE

SUBSYSTEM: SECONDARY POWER WBS CODE: 1.4

1 JANUARY 1961 - 31 DECEMBER 1961

Just over two years from subcontract award to Sunstrand, in mid May 1961, the first SPGS problems with programmatic impact became apparent. Porosity problems in pump castings had developed, lubrication difficulties appeared in power transmission shafts, and heat exchanger problems were reported. Shortly thereafter, those initial failures were followed by evidence of poor castings of valve block and body pump bearing failures and hydraulic pump failures in the flight control simulator. Pump failures were experienced due to thrust bearing failures. Late in July engineering changes were released changing hydraulic barrier seals, resulting in scrapping 70% of the completed seals and necessitating rework of 18 actuators for the flight control simulator. In July also, the metal mockup planned for the SPGS was deleted as a cost saving. It was decided to use AV #1 as a mockup. Piston failures occurred and the first design revision arose in the lub pump. The initial manifolds received were out of specification limits but were accepted in order to proceed with NAA tests. Early in the last quarter of 1961 it was necessary to redesign hydraulic pumps/motors because of failures. Pressure regulator instability was experienced, excessive oil appeared in generator cavities and high temperature solenoid problems added to increasing test failures. In November 1961 the heat exchanger was modified. By the end of 1961 the test failures encountered resulted in a six-month extension of the Preliminary Flight Rating Test (PFRT) program completion from June 1962 to December 1962. This also involved a change to a fully pressurized pumping system involving the hydraulic pumps. Priorities were established with regard to assignment of hardware to support various tests. The Integrated Hydraulic Pumping System (IHPS) test had first priority, followed by vibration test and then endurance testing.

1 JANUARY 1962 - 31 DECEMBER 1962

Between early and mid 1962 the Accessories Drive System (ADS) compartment was redesigned, units of the Electrical Power Generating System (EPGS) required rework and/or changes, by-pass valve switches failed and reservoir failures continued in the Constant Speed Drive (CSD). The SPGS situation worsened in the second quarter of 1962 when it was necessary to reject SPGS compartment #1 components. At about the same time it was reported that numerous pump problems previously experienced had been resolved. In July 1962 Santa Susana operations with the Engine Test Stand (ETS) were reprogrammed to fit the existing SPGS situation. An air starter was used in starting engines during phases of engine-SPGS testing when hydraulic pumps were not available. A fixed motor, with no pumping capability, was provided as a backup. In the middle of the third quarter of 1962, because of extensive failures, 1 JAN 1962 - 31 DEC 1962 (Continued)

all testing requiring use of hydraulic testing was curtailed. It was not feasible to run pumps of the same configuration, with high record of failure, further destroying good hardware until some progress toward solution could be realized. Priorities for deliverable hardware were for engine test stand PFRT and then AV units. Deliveries were to be split between test and AV. The earliest set would go to ETS and the next three to Sunstrand for IHPS tests. Others would be installed in the air vehicle followed by PFRT endurance, vibration and finally flight control simulator. PFRT would use the 300° pumps. It was planned to provide airworthy pumps limited to 300° for early flight support and to continue development of fully qualified 400° pumps for initial maximum performance flights.

In the third quarter of 1962 rework of SPGS compartments became necessary because of hydraulic line and mounting failures. A frame assembly (saddle) was designed to hold the hydraulic/mechanical SPGS units in place to reduce the vibration and subsequent failures in lines and attach points being experienced during test. Sunstrand also required additional test stands during this period to handle their test load.

1 JANUARY 1963 - 31 DECEMBER 1963

Early in 1963 a failure occurred in the test stand prime mover (dynamo) at Sunstrand. NAA also found it necessary to revise the ETS hydraulic lines and mounts because of vibration problems and leaks. A gear box modification was also made and a major hydraulics revision in the ADS bays was indicated. In the middle of the second quarter a decision was made to delete all hardline attach points of the SPGS. In mid June design was released for all six ADS bays replacing hardline block attach points with cushion type supports (Brillo pads). These changes resulted from propulsion test stand results. During this period Sunstrand also reworked all ADS compartment hardware. In the third quarter of 1963 flow problems in utility pumps delayed the 400° pump test. At this point NAA manufacturing recorded that 95% of the required ADS rework had been completed with an accumulated expenditure of 96,800 man-hours. The last SPGS change, hydraulic filter, occurred late in the third quarter. All SPGS hardware deliveries were complete in September, and AV installation was completed in mid November.

1 JANUARY 1964 - 31 DECEMBER 1964

In 1964, between AV #1 rollout and first flight, multiple fluid power leaks were experienced and a period of approximately six weeks was required to conduct leak checks. This was not recorded as specifically SPGS activity but is recorded as structures activity in this time period.

WBS CODE: 1.4

1 JANUARY 1965 - 31 DECEMBER 1965

In the AV #1 flight test program a hydraulic line failed in the utility system in late February. Line support was modified, pump mod-pressure dampers and flex lines were installed, and fuel pump mounting was re-worked. In April the hydraulic indicating system (pump status) indicators were found to need improvement in increasing their range and accuracy. Snubbers were provided for pressure indicators, fluid level and head pressure indicators were added, residual level continuous indication was provided, and the existing system was replaced with synchro type hydraulic pressure indicators. In May the #2 main generator was installed to provide the capability of driving the emergency generator with either utility system #1 or #2. A manual switch was also installed to achieve a buss-tie contactor reset capability. In September an apparent loss of fluid from the utility system caused the Ronson valves to be replaced.

During the flight test program the integrated pumping system experienced hydraulic line failures which were corrected by heavier walled tubing, improved clamping and line routing and reduction of pump pressure regulation by pulse dampers and modification of pump compensators. Throughout the program there were problems with utility pump pressure drop off (resetting down) requiring compensator redesign. Problems with engine starting system components were primarily speed switch, electrical depressurization valve and motor by pass valve malfunctions. At the start of the program reservoir fluid quantity indication system monitoring inadequacy was corrected by adding a modification to allow monitoring a sufficient range of fluid level. Fuel pump drive hydraulic line failures experienced due to pump vibration required the installation of a short section of flex line as a fix. Pump motor solenoid control valves sticking in the energized position was a frequent problem. ADS gearbox operations were generally satisfactory, but several failures were experienced in the clutch unit in the primary hydraulic pump drive gear train used during engine starting. Numerous failures occurred in the speed sensing switch used in the engine start circuit.

Electrical Power Generating Subsystem (EPGS) operations were very satisfactory. There were no major problems with the primary or emergency generator systems. The external power contractor case isolation fuse was replaced with a bleeder resister to eliminate internal component failures caused by voltage transients when ground electrical power was applied.

In the electrical power distribution system large quantities of relays were rejected during the flight test program placing an excessive demand on limited stock of spares.

WBS CODE: 1.4

1 JANUARY 1966 - 31 DECEMBER 1966

On June 9, 1966, the final SPGS testing certification was completed on the IHPS. This last recorded SPGS event followed closely after sustained Mach 3 flight and approximately 1½ years after first flight. This is pointed out as related to the earlier decision, in July 1961, to use AV #1 as a mockup instead of the metal SPGS originally planned.

Manufacturing recorded, on 8 June 1966, that the #2 ADS gear box shaft sheared during preflight vehicle attempting to start #2 engine. This is the last SPGS failure known prior to final SPGS testing certification.

COST DEFINITION

SUBSYSTEM: SECONDARY POWER WBS CODE: 1.4

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 Secondary Power Subsystem as defined by the WBS, except for those items supplied to North American as Government Furnished Equipment (GFE). GFE items in this subsystem are:

1) Pressure gages and sensors (WBS 1.4.1.4).
2) Emergency generator (WBS 1.4.5.1).
3) Voltage Regulators (WBS 1.4.5.1).
4) Battery (WBS 1.4.5.1)

Total costs of $54,383,954 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.
j) GFE items.

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 (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 (Secondary Power Subsystem, WBS 1.4) with the exception of in-house ground testing (WBS 1.4.6). Cost data can be located on the following pages:

WBS CODE: 1.4

	Cost Breakdown		Time-Phased Detail
WBS 1.4	$48,487,712	page III-703	page III-704
WBS 1.4.6 Ground Tests	5,896,242	page III-703	page III-724
Total WBS 1.4	$54,383,954	page III-703	page III-735

A summary of the subcontractor recorded cost data is provided on page III-701. 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 Secondary Power Subsystem:

Group No.	Title	Hours Expended
2	Propulsion Design & Development	46,231
3	Electrical & Avionics Installation	403,054
4	Fluid Power System	455,785
12	Checking	12,895
19	Propulsion System Design	42,122
48	Communication & Indicating System	7,012
53	Design Producibility	33,252
54	Material & Processes	39,063
57	Engineering Specifications	58,434
66	Metallics Material Lab	17,704
67	Structural Test Lab	4,854
75	Non-Metallics	24,500
94	Flight Simulation	4,803
95	Electrical System Design	290,530
97	Laboratory Services	57,963
109	Hydraulic Lab	167,950
110	Electrical Power Lab	36,026
125	Electrical System Equipment	218,095
	Miscellaneous	30,003
	Total Engineering Hours	1,950,276

WBS 1.4	1,719,776 hours	(page III-703)
WBS 1.4.6	230,500 hours	(page III-703)
	1,950,276 hours	

WBS CODE: 1.4

Ground testing activities associated with the development of the Secondary Power Subsystem have been identified and the costs assigned to WBS 1.4.6 (page III-724). These costs reflect the in-house expenditures only. Testing activities performed by the subcontractor where identified are included under WBS 1.4, 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
Hydro Mechanical Lab Tests	$1,101,178
Fabrication of Parts for Airworthiness Testing	642,945
Electronic System Checkout Lab	631,314
Support of B-70 Electronic Systems	262,360
Shop Support of Electrical Wiring Conduits	155,029
Leak Test of Dual Seal Piston	113,193
Evaluation: Qualification of Rod Seals to Eliminate Scoring and Brakage	102,660
Run-in of Vickers Pumps	98,748
Evaluation: Qualification Static Hydraulic Seals	92,491
Mechanical Systems Test	84,991
Burst: Fatigue Data for Standard Hydraulic Fittings	83,857
Electronic Systems Test - General	79,815
Test Fusion Welding on Hydraulic Lines	74,838
Sunstrand - Secondary Power System Tests	44,905
Evaluation of Prototype Actuators and Seals	41,344
Tubing to Manifold Braze, Assembly and Test	35,367
Burst Tests: Fatigue Data for Hydraulic Line Tubing	34,300
External Repair - Hydraulic Lines	27,759
350 Tubing Evaluation to Finalize Hydraulic Design Criteria	27,062
Varied Tests - Electrical System Equipment	25,267
Evaluation: Qualification of Third Stage Hydraulic Piston Rod Seals	23,833
Evaluation of the "hang up" probability of Temperature Hydraulic Valves	23,801
Evaluation: Qualification of Face Type Static Seals in Nitrogen	21,118
Establishment of S-N Valves for 350 CRT Hydraulic Tubing and 2D Loading Joints	21,049
Evaluation of Hydraulic Line Shrouds in a Fuel Tank	20,620
Evaluation: Qualification of Static Barrier Hydraulic Seals	20,507

WBS CODE: 1.4

Description	Recorded Costs
Fluid Monitoring Tests on Samples from Subcontractor & In-House	$20,271
R&D Testing - General	18,053
Flex Hose in Bays - Mockup	17,836
Various	1,761,456
Costs (less MPC & G&A)	$5,707,967
Material Procurement Cost	87,320
General and Administrative	100,955
Total Costs WBS 1.4.6	$5,896,242

SUBCONTRACTOR MATRIX

SUBSYSTEM: SECONDARY POWER WBS CODE: 1.4

SUBCONTRACTOR	ENGR'G	PROD	TOOLING	TEST	TOTAL
SUNSTRAND	5,216,018	21,605,701	196,560	-	27,018,279
VICKERS	282,989	49,309	-	-	332,298
OTHERS	330,786	1,314,161	9,848	-	2,319,391
TOTAL	5,829,793	22,969,171	206,408	-	29,005,372

SUNSTRAND was selected to produce the Secondary Power Generating System for the XB-70. The four letter contracts awarded to Sunstrand for this effort, along with their award and completion dates, are as follows:

L9C1-YZ-600110	June 29, 1959	thru	June 30, 1961
L1J1-YZ-600302	October 25, 1960	thru	April 5, 1961
L1E1-YZ-600366E	June 30, 1961	thru	September 10, 1964
LZE1-YJ-600408	April 1, 1962	thru	September 10, 1964

The Statement of Work for contracts 600110, 600302 and 600366 directed the subcontractor to provide analysis, design, development, testing, test equipment, tooling and fabrication required to produce the Secondary Power Generating System for the XB-70 Program.

An advance in the state-of-the-art was required to develop a system that was compatible with a 4,000 psi hydraulic system. The original design effort was started under Purchase Order 600110 for the B-70 program. When this program was later redirected (1959) to a single XB-70 air vehicle, the work program was modified to make it an austere development. The addition in 1960 of 11 flight test models (YB-70) required some upgrading. To accomplish this, the letter contract 600302 was awarded Sunstrand. Only a minor amount of effort was incurred by the time the (YB) program was redirected to a three air vehicle XB-70 Program.

To support the change in program as of June 30, 1961, purchase order 600110 was considered complete, and all efforts expended were applicable to the effort called for under Purchase Order 600366E. It was under this purchase order 600366E that all tooling and systems for the air vehicles 1 and 2 were completed. Although there were a few documents created purporting to move the accountability of the tooling to a repair and overhaul agreement, the transactions were never accomplished and those documents were considered void.

WBS CODE: 1.4

Sundstrand selected four major second tier subcontractors to support and assist in the development effort. They are listed below:

(a) General Electric Co., Waynesboro, Virginia, developed and produced the controls for the Secondary Power Generating Subsystem.

(b) General Electric Co., Erie, Pennsylvania, produced the necessary aircraft generators in support of G.E. Waynesboro.

(c) Vickers Corp., Troy, Michigan, developed and produced the hydraulic pumps and motors.

(d) Bendix Corp., Utica, New York, developed and produced the power transmission shaft in support of the Secondary Power System.

Purchase Order 600408 was a CPFF contract for spare items for the XB-70 air vehicle. This subcontract, dated September 10, 1962, provided for the procurement, fabrication, testing and other services necessary for the delivery of spare parts for the Secondary Power Generating Subsystem in support of the Flight Test Program and the Repair and Overhaul Program. All of the necessary tooling and test equipment required was available from the preceding purchase orders. Work commenced during April 1962 and was completed during September 1964 at a cost of $1,343,758.

All residual inventories were disposed of and all tooling and test equipment used in the performance of these purchase orders were sold on a salvage basis and credits applied against Purchase Order 600366.

VICKERS was selected to provide the Hydraulic Motor to drive the Emergency Electrical Generator for the XB-70 air vehicle. Purchase Order L1E1-YZ-600325 was awarded to Vickers for this effort in December 1960 and was completed in October 1964.

The Statement of Work was issued for design, development, fabrication, testing, and delivery of Hydraulic Motors for Emergency Generator Drive on the XB-70 air vehicle in accordance with the NR specification NA5-82041-1 "G". The effort was moved from Vickers Torrance facility to their Detroit plant during the performance of the contract.

Residual inventory and tooling were shipped to NR for storage and, where applicable, maintained by Vickers for production of spare parts. Resulting credits were applied to the purchase order.

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

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04
SECONDARY POWER SUBSYSTEM

	6-M ASSY 0 HOURS DOLLARS	6-M ASSY 06 HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	1719776	230500	1950276
LABOR AT $ 5.042	8844437	988443	9832880
ENGR BURDEN AT $ 4.733	8137967	1093110	9231077
SHOP SUPPORT	4882	334857	339739
LABOR AT $ 3.065	15713	1025709	1041422
TEST/QC	654	18941	19595
LABOR AT $ 3.218	2134	60917	63051
MFG BURDEN AT $ 3.769	25956	1328282	1354238
ENGR MATERIAL	28152	777127	805279
SUBCONTRACT	29005372		29005372
MPC	1282476	87320	1369796
OTHER COST	325016	5193	330209
SUB-TOTAL	47667223	5366101	53033324
GEN & ADMIN	820489	100955	921444
IOWA		429186	429186
TOTAL COST	48487712	5896242	54383954

SUBDIVISION OF WORK
COST DETAIL - SEE PAGE III-704 III-724 III-734

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

4-SYSTEM 1
5-SUBSYSTEM 04
6-MAJ ASSY 0

SECONDARY POWER SUBSYSTEM

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOOLING AND STE HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING	1719776			1719776
LABOR AT $ 5.143	8844437			8844437
ENGR BURDEN AT $ 4.732	8137967			8137967
SHOP SUPPORT	4882			4882
LABOR AT $ 3.219	15713			15713
TEST/QC	654			654
LABOR AT $ 3.263	2134			2134
MFG BURDEN AT $ 4.689	25956			25956
ENGR MATERIAL	28152			28152
SUBCONTRACT	5829793	22969171	206408	29005372
MPC	273149	1000371	8956	1282476
OTHER COST	325016			325016
SUB-TOTAL	23482317	23969542	215364	47667223
GEN & ADMIN	391096	425355	4038	820489
TOTAL COST	23873413	24394897	219402	48487712
TIME-PHASED COST DETAIL - SEE PAGE	III-705	III-713	III-715	III-716

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

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 04 SECONDARY POWER 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	30.0	5076	5.169	26240	23099	49339
Q-2 58						
Q-3 58	232.5	38960	4.469	174112	152258	326370
Q-4 58						
Q-1 59	400.0	68219	4.229	288483	234271	522754
Q-2 59						
Q-3 59	678.0	119416	4.120	491966	427053	919019
Q-4 59						
Q-1 60	711.0	123196	4.475	551263	461834	1013097
Q-2 60						
Q-3 60	624.0	104849	4.883	511968	388921	900889
Q-4 60						
Q-1 61	1024.5	174855	4.851	848285	589975	1438260
Q-2 61						
Q-3 61	751.5	136193	5.046	687254	634205	1321459
Q-4 61						
Q-1 62	991.5	169170	5.242	886835	775163	1661998
Q-2 62						
Q-3 62	1036.5	174085	5.171	900277	878037	1778314
Q-4 62						
Q-1 63	1023.0	174621	5.669	989898	946254	1936152
Q-2 63						
Q-3 63	1040.5	174768	5.588	976540	986728	1963268
Q-4 63						
Q-1 64	870.0	148547	5.658	840452	923480	1763932
Q-2 64						
Q-3 64	426.0	74968	6.099	457262	499594	956856
Q-4 64						
Q-1 65	136.0	23533	6.491	152745	155760	308505

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	DESIGN/ENGINEERING
4-SYSTEM	1
5-SUBSYSTEM	04 SECONDARY POWER 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	51.0	8673	6.529	56627	57071	113698
Q-4 65						
Q-1 66	3.0	647	6.538	4230	4264	8494
TOTAL	10029.0	1719776		8844437	8137967	16982404

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 04 SECONDARY POWER 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	2.000	6	9	15
Q-2 58						
Q-3 58		64	2.016	129	232	361
Q-4 58						
Q-1 59		48	2.771	133	178	311
Q-2 59						
Q-3 59	39.0	6805	2.920	19868	27066	46934
Q-4 59						
Q-1 60	-35.0	-6110	2.905	-17752	-19797	-37549
Q-2 60						
Q-3 60	1.5	162	3.840	622	923	1545
Q-4 60						
Q-1 61	1.5	356	2.885	1027	1544	2571
Q-2 61						
Q-3 61	1.5	337	2.941	991	1560	2551
Q-4 61						
Q-1 62	4.5	756	3.230	2442	2886	5328
Q-2 62						
Q-3 62	6.0	964	3.391	3269	4044	7313
Q-4 62						
Q-1 63	6.0	1078	3.438	3706	4450	8156
Q-2 63						
Q-3 63	1.5	229	2.869	657	1553	2210
Q-4 63						
Q-1 64	1.5	171	3.135	536	1207	1743
Q-2 64						
Q-3 64		15	3.600	54	82	136
Q-4 64						
Q-1 65		4	6.250	25	19	44
TOTAL	28.0	4882		15713	25956	41669

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	TEST/QC
4-SYSTEM	1
5-SUBSYSTEM	04 SECONDARY POWER 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 59	1.5	182	2.835	516		516
Q-4 59						
Q-1 60		72	3.444	248		248
Q-2 60						
Q-3 60		93	4.183	389		389
Q-4 60						
Q-1 61		81	2.741	222		222
Q-2 61						
Q-3 61		43	2.744	118		118
Q-4 61						
Q-1 62		16	7.750	124		124
Q-2 62						
Q-3 62		31	1.839	57		57
Q-4 62						
Q-1 63		18	4.833	87		87
Q-2 63						
Q-3 63		46	2.913	134		134
Q-4 63						
Q-1 64		70	3.286	230		230
Q-2 64						
Q-3 64		2	4.500	9		9
TOTAL	1.5	654		2134		2134

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 04 SECONDARY POWER 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	30.0	5079	5.168	26246	23108	49354	179
Q-2 58							
Q-3 58	232.5	39024	4.465	174241	152490	326731	-515
Q-4 58							
Q-1 59	400.0	68267	4.228	288616	234449	523065	
Q-2 59							
Q-3 59	718.5	126403	4.053	512350	454119	966469	7957
Q-4 59							
Q-1 60	676.0	117158	4.556	533759	442037	975796	-6585
Q-2 60							
Q-3 60	625.5	105104	4.881	512979	389844	902823	108
Q-4 60							
Q-1 61	1026.0	175292	4.846	849534	591519	1441053	145
Q-2 61							
Q-3 61	753.0	136573	5.040	688363	635765	1324128	35
Q-4 61							
Q-1 62	996.0	169942	5.234	889401	778049	1667450	253
Q-2 62							
Q-3 62	1042.5	175080	5.161	903603	882081	1785684	481
Q-4 62							
Q-1 63	1029.0	175717	5.655	993691	950704	1944395	3283
Q-2 63							
Q-3 63	1042.0	175043	5.583	977331	988281	1965612	14529
Q-4 63							
Q-1 64	871.5	148788	5.654	841218	924687	1765905	1345
Q-2 64							
Q-3 64	426.0	74985	6.099	457325	499676	957001	6271
Q-4 64							
Q-1 65	136.0	23537	6.491	152770	155779	308549	584
Q-2 65							
Q-3 65	51.0	8673	6.529	56627	57071	113698	82

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04 SECONDARY POWER 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	3.0	647	6.538	4230	4264	8494	
TOTAL	10058.5	1725312		8862284	8163923	17026207	28152

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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 04
6-MAJ ASSY 0
SUBD OF WORK DESIGN/ENGINEERING

SECONDARY POWER SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58		179	10		49543		49543
Q-2 58							
Q-3 58	89125	88610	762	933	417036		417036
Q-4 58							
Q-1 59	69125	69125	1832	94	594116		594116
Q-2 59							
Q-3 59	158249	166206	4997	35	1137707		1137707
Q-4 59							
Q-1 60	1749327	1742742	102921	8570	2830029	53921	2883950
Q-2 60							
Q-3 60	227790	227898	13529	8872	1153122	21970	1175092
Q-4 60							
Q-1 61	745572	745717	21373	11992	2220135	41257	2261392
Q-2 61							
Q-3 61	262311	262346	7518	7051	1601043	29752	1630795
Q-4 61							
Q-1 62	615772	616025	19590	17533	2320598	38951	2359549
Q-2 62							
Q-3 62	620561	621042	19742	63924	2490392	41801	2532193
Q-4 62							
Q-1 63	801344	804627	34351	54231	2837604	47445	2885049
Q-2 63							
Q-3 63	236696	251225	9037	69636	2295510	38380	2333890
Q-4 63							
Q-1 64	253921	255266	35016	66527	2122714	45167	2167881
Q-2 64							
Q-3 64		6271	2281	10069	975622	20759	996381
Q-4 64							
Q-1 65		584	175	3884	313192	8356	321548
Q-2 65							
Q-3 65		82	15	1554	115349	3078	118427

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

4-SYSTEM 1
5-SUBSYSTEM 04 SECONDARY POWER 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				111	8605	259	8864
TOTAL	5829793	5857945	273149	325016	23482317	391096	23873413

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

4-SYSTEM 1
5-SUBSYSTEM 04 SECONDARY POWER SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK PRODUCTION

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-3 58							29946
Q-4 58							
Q-1 59							49946
Q-2 59							
Q-3 59							79893
Q-4 59							
Q-1 60							2131814
Q-2 60							
Q-3 60							2219333
Q-4 60							
Q-1 61							3586486
Q-2 61							
Q-3 61							1793263
Q-4 61							
Q-1 62							2782093
Q-2 62							
Q-3 62							2800407
Q-4 62							
Q-1 63							4502000
Q-2 63							
Q-3 63							1857383
Q-4 63							
Q-1 64							1136607
TOTAL							22969171

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

4-SYSTEM 1
5-SUBSYSTEM 04 **SECONDARY POWER SUBSYSTEM**
6-MAJ ASSY 0
SUBD OF WORK PRODUCTION

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-3 58	265	30211		30211
Q-4 58				
Q-1 59	1324	51270		51270
Q-2 59				
Q-3 59	2183	82076		82076
Q-4 59				
Q-1 60	126480	2258294	43027	2301321
Q-2 60				
Q-3 60	131679	2351012	44784	2395796
Q-4 60				
Q-1 61	102756	3689242	68557	3757799
Q-2 61				
Q-3 61	51378	1844641	34279	1878920
Q-4 61				
Q-1 62	88420	2870513	48182	2918695
Q-2 62				
Q-3 62	88921	2889328	48497	2937825
Q-4 62				
Q-1 63	191172	4693172	78470	4771642
Q-2 63				
Q-3 63	59692	1917075	32053	1949128
Q-4 63				
Q-1 64	156101	1292708	27506	1320214
TOTAL	1000371	23969542	425355	24394897

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 04 SECONDARY POWER SUBSYSTEM
6-MAJ ASSY 0
SUBD OF WORK TOOLING AND STE

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-3 60	98441	5840	104281	1987	106268
Q-4 60					
Q-1 61	98685	2827	101512	1886	103398
Q-2 61					
Q-3 61	2561	73	2634	49	2683
Q-4 61					
Q-1 62	2843	90	2933	49	2982
Q-2 62					
Q-3 62	3569	113	3682	62	3744
Q-4 62					
Q-1 63	309	13	322	5	327
TOTAL	206408	8956	215364	4038	219402

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 04 **SECONDARY POWER SUBSYSTEM**
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	30.0	5076	5.169	26240	23099	49339
Q-2 58						
Q-3 58	232.5	38960	4.469	174112	152258	326370
Q-4 58						
Q-1 59	400.0	68219	4.229	288483	234271	522754
Q-2 59						
Q-3 59	678.0	119416	4.120	491966	427053	919019
Q-4 59						
Q-1 60	711.0	123196	4.475	551263	461834	1013097
Q-2 60						
Q-3 60	624.0	104849	4.883	511968	388921	900889
Q-4 60						
Q-1 61	1024.5	174855	4.851	848285	589975	1438260
Q-2 61						
Q-3 61	751.5	136193	5.046	687254	634205	1321459
Q-4 61						
Q-1 62	991.5	169170	5.242	886835	775163	1661998
Q-2 62						
Q-3 62	1036.5	174085	5.171	900277	878037	1778314
Q-4 62						
Q-1 63	1023.0	174621	5.669	989898	946254	1936152
Q-2 63						
Q-3 63	1040.5	174768	5.588	976540	986728	1963268
Q-4 63						
Q-1 64	870.0	148547	5.658	840452	923480	1763932
Q-2 64						
Q-3 64	426.0	74968	6.099	457262	499594	956856
Q-4 64						
Q-1 65	136.0	23533	6.491	152745	155760	308505
Q-2 65						

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

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 04 SECONDARY POWER SUBSYSTEM
6-MAJ ASSY 0

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	51.0	8673	6.529	56627	57071	113698
Q-4 65						
Q-1 66	3.0	647	6.538	4230	4264	8494
TOTAL	10029.0	1719776		8844437	8137967	16982404

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 04
6-MAJ ASSY 0

SECONDARY POWER SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		3	2.000	6	9	15
Q-2 58						
Q-3 58		64	2.016	129	232	361
Q-4 58						
Q-1 59		48	2.771	133	178	311
Q-2 59						
Q-3 59	39.0	6805	2.920	19868	27066	46934
Q-4 59						
Q-1 60	-35.0	-6110	2.905	-17752	-19797	-37549
Q-2 60						
Q-3 60	1.5	162	3.840	622	923	1545
Q-4 60						
Q-1 61	1.5	356	2.885	1027	1544	2571
Q-2 61						
Q-3 61	1.5	337	2.941	991	1560	2551
Q-4 61						
Q-1 62	4.5	756	3.230	2442	2886	5328
Q-2 62						
Q-3 62	6.0	964	3.391	3269	4044	7313
Q-4 62						
Q-1 63	6.0	1078	3.438	3706	4450	8156
Q-2 63						
Q-3 63	1.5	229	2.869	657	1553	2210
Q-4 63						
Q-1 64	1.5	171	3.135	536	1207	1743
Q-2 64						
Q-3 64		15	3.600	54	82	136
Q-4 64						
Q-1 65		4	6.250	25	19	44
TOTAL	28.0	4882		15713	25956	41669

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	TEST/QC
4-SYSTEM	1
5-SUBSYSTEM	04
6-MAJ ASSY	0

SECONDARY POWER SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 59	1.5	182	2.835	516		516
Q-4 59						
Q-1 60		72	3.444	248		248
Q-2 60						
Q-3 60		93	4.183	389		389
Q-4 60						
Q-1 61		81	2.741	222		222
Q-2 61						
Q-3 61		43	2.744	118		118
Q-4 61						
Q-1 62		16	7.750	124		124
Q-2 62						
Q-3 62		31	1.839	57		57
Q-4 62						
Q-1 63		18	4.833	87		87
Q-2 63						
Q-3 63		46	2.913	134		134
Q-4 63						
Q-1 64		70	3.286	230		230
Q-2 64						
Q-3 64		2	4.500	9		9
TOTAL	1.5	654		2134		2134

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04
6-MAJ ASSY 0

SECONDARY POWER SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58 Q-2 58	30.0	5079	5.168	26246	23108	49354	179
Q-3 58 Q-4 58	232.5	39024	4.465	174241	152490	326731	-515
Q-1 59 Q-2 59	400.0	68267	4.228	288616	234449	523065	
Q-3 59 Q-4 59	718.5	126403	4.053	512350	454119	966469	7957
Q-1 60 Q-2 60	676.0	117158	4.556	533759	442037	975796	-6585
Q-3 60 Q-4 60	625.5	105104	4.881	512979	389844	902823	108
Q-1 61 Q-2 61	1026.0	175292	4.846	849534	591519	1441053	145
Q-3 61 Q-4 61	753.0	136573	5.040	688363	635765	1324128	35
Q-1 62 Q-2 62	996.0	169942	5.234	889401	778049	1667450	253
Q-3 62 Q-4 62	1042.5	175080	5.161	903603	882081	1785684	481
Q-1 63 Q-2 63	1029.0	175717	5.655	993691	950704	1944395	3283
Q-3 63 Q-4 63	1042.0	175043	5.583	977331	988281	1965612	14529
Q-1 64 Q-2 64	871.5	148788	5.654	841218	924687	1765905	1345
Q-3 64 Q-4 64	426.0	74985	6.099	457325	499676	957001	6271
Q-1 65 Q-2 65	136.0	23537	6.491	152770	155779	308549	584
Q-3 65 Q-4 65	51.0	8673	6.529	56627	57071	113698	82

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

4-SYSTEM 1
5-SUBSYSTEM 04
6-MAJ ASSY 0

SECONDARY POWER SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66	3.0	647	6.538	4230	4264	8494	
TOTAL	10058.5	1725312		8862284	8163923	17026207	28152

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

4-SYSTEM 1
5-SUBSYSTEM 04
6-MAJ ASSY 0

SECONDARY POWER SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58 Q-2 58		179	10		49543		49543
Q-3 58 Q-4 58	119071	118556	1027	933	447247		447247
Q-1 59 Q-2 59	119071	119071	3156	94	645386		645386
Q-3 59 Q-4 59	238142	246099	7180	35	1219783		1219783
Q-1 60 Q-2 60	3881141	3874556	229401	8570	5088323	96948	5185271
Q-3 60 Q-4 60	2545564	2545672	151048	8872	3608415	68741	3677156
Q-1 61 Q-2 61	4430743	4430888	126956	11992	6010889	111700	6122589
Q-3 61 Q-4 61	2058135	2058170	58969	7051	3448318	64080	3512398
Q-1 62 Q-2 62	3400708	3400961	108100	17533	5194044	87182	5281226
Q-3 62 Q-4 62	3424537	3425018	108776	63924	5383402	90360	5473762
Q-1 63 Q-2 63	5303653	5306936	225536	54231	7531098	125920	7657018
Q-3 63 Q-4 63	2094079	2108608	68729	69636	4212585	70433	4283018
Q-1 64 Q-2 64	1390528	1391873	191117	66527	3415422	72673	3488095
Q-3 64 Q-4 64		6271	2281	10069	975622	20759	996381
Q-1 65 Q-2 65		584	175	3884	313192	8356	321548
Q-3 65 Q-4 65		82	15	1554	115349	3078	118427

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

4-SYSTEM 1
5-SUBSYSTEM 04
6-MAJ ASSY 0

SECONDARY POWER SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 66				111	8605	259	8864
TOTAL	29005372	29033524	1282476	325016	47667223	820489	48487712

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04
6-MAJ ASSY 06
SECONDARY POWER GROUND TESTS

			TEST /QC HOURS DOLLARS	TOTAL HOURS DOLLARS
DESIGN/ENGINEERING			230500	230500
LABOR AT $	4.288		988443	988443
ENGR BURDEN	AT $	4.742	1093110	1093110
SHOP SUPPORT			334857	334857
LABOR AT $	3.063		1025709	1025709
TEST/QC			18941	18941
LABOR AT $	3.216		60917	60917
MFG BURDEN	AT $	3.754	1328282	1328282
ENGR MATERIAL			777127	777127
MPC			87320	87320
OTHER COST			5193	5193
			--------	--------
SUB-TOTAL			5366101	5366101
GEN & ADMIN			100955	100955
IOWA			429186	429186
			--------	--------
TOTAL COST			5896242	5896242

TIME-PHASED COST
DETAIL - SEE PAGE III-725

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 04 SECONDARY POWER 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		13	3.846	50	49	99
Q-2 60						
Q-3 60	150.0	25261	3.869	97733	94498	192231
Q-4 60						
Q-1 61	172.5	29384	3.790	111354	99956	211310
Q-2 61						
Q-3 61	156.0	28243	4.235	119619	123522	243141
Q-4 61						
Q-1 62	342.0	58312	4.289	250102	269133	519235
Q-2 62						
Q-3 62	222.0	37308	4.374	163202	194553	357755
Q-4 62						
Q-1 63	64.5	11099	4.883	54191	58961	113152
Q-2 63						
Q-3 63	67.5	11327	4.721	53475	66051	119526
Q-4 63						
Q-1 64	78.0	13275	4.883	64820	80902	145722
Q-2 64						
Q-3 64	60.0	10579	4.724	49978	70081	120059
Q-4 64						
Q-1 65	22.5	3989	4.198	16744	24504	41248
Q-2 65						
Q-3 65	9.0	1596	4.196	6697	9800	16497
Q-4 65						
Q-1 66		114	4.193	478	1100	1578
TOTAL	1344.0	230500		988443	1093110	2081553

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

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 04 **SECONDARY POWER 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	15.0	2496	2.804	6998	10141	17139
Q-4 58						
Q-1 59	67.5	11480	2.926	33589	44171	77760
Q-2 59						
Q-3 59	106.5	18789	2.894	54370	77051	131421
Q-4 59						
Q-1 60	318.0	55150	2.962	164471	212380	376851
Q-2 60						
Q-3 60	400.5	67192	3.119	209605	244016	453621
Q-4 60						
Q-1 61	277.5	47292	3.032	143384	173740	317124
Q-2 61						
Q-3 61	217.5	39421	3.065	120845	161723	282568
Q-4 61						
Q-1 62	253.5	43367	3.069	133092	168913	302005
Q-2 62						
Q-3 62	136.5	22908	3.104	71097	99326	170423
Q-4 62						
Q-1 63	54.0	9151	3.304	30231	36328	66559
Q-2 63						
Q-3 63	55.5	9388	3.152	29595	56922	86517
Q-4 63						
Q-1 64	21.0	3504	3.376	11830	17568	29398
Q-2 64						
Q-3 64	18.0	3267	3.389	11071	16398	27469
Q-4 64						
Q-1 65	6.0	1016	3.811	3872	6725	10597
Q-2 65						
Q-3 65	3.0	407	3.806	1549	2691	4240

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

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

SECONDARY POWER GROUND TESTS

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-4 65						
Q-1 66		29	3.793	110	189	299
TOTAL	1950.0	334857		1025709	1328282	2353991

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

	TEST/QC
4-SYSTEM	1
5-SUBSYSTEM	04 SECONDARY POWER 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						
Q-2 58						
Q-3 58	1.5	314	3.287	1032		1032
Q-4 58						
Q-1 59	3.0	616	2.969	1829		1829
Q-2 59						
Q-3 59	4.5	726	2.915	2116		2116
Q-4 59						
Q-1 60	10.5	1754	3.067	5379		5379
Q-2 60						
Q-3 60	21.0	3542	3.504	12411		12411
Q-4 60						
Q-1 61	16.5	2777	3.127	8684		8684
Q-2 61						
Q-3 61	18.0	3366	3.054	10281		10281
Q-4 61						
Q-1 62	16.5	2727	3.190	8698		8698
Q-2 62						
Q-3 62	10.5	1669	3.070	5124		5124
Q-4 62						
Q-1 63		121	2.909	352		352
Q-2 63						
Q-3 63	4.0	628	3.299	2072		2072
Q-4 63						
Q-1 64	1.5	196	4.776	936		936
Q-2 64						
Q-3 64	1.5	192	4.813	924		924
Q-4 64						
Q-1 65	1.5	219	3.447	755		755

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

	TEST/QC	
4-SYSTEM	1	
5-SUBSYSTEM	04	**SECONDARY POWER 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		88	3.432	302		302
Q-4 65						
Q-1 66		6	3.667	22		22
TOTAL	110.5	18941		60917		60917

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04
6-MAJ ASSY 06
SECONDARY POWER 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	16.5	2810	2.858	8030	10141	18171	28063
Q-4 58							
Q-1 59	70.5	12096	2.928	35418	44171	79589	21316
Q-2 59							
Q-3 59	111.0	19515	2.894	56486	77051	133537	9763
Q-4 59							
Q-1 60	328.5	56917	2.985	169900	212429	382329	23440
Q-2 60							
Q-3 60	571.5	95995	3.331	319749	338514	658263	72346
Q-4 60							
Q-1 61	466.5	79453	3.315	263422	273696	537118	91944
Q-2 61							
Q-3 61	391.5	71030	3.530	250745	285245	535990	104432
Q-4 61							
Q-1 62	612.0	104405	3.754	391892	438046	829938	122455
Q-2 62							
Q-3 62	369.0	61885	3.869	239423	293879	533302	110945
Q-4 62							
Q-1 63	118.5	20371	4.162	84774	95289	180063	21436
Q-2 63							
Q-3 63	127.0	21343	3.989	85142	122973	208115	56176
Q-4 63							
Q-1 64	100.5	16975	4.571	77586	98470	176056	39973
Q-2 64							
Q-3 64	79.5	14038	4.415	61973	86479	148452	39452
Q-4 64							
Q-1 65	30.0	5224	4.091	21371	31229	52600	24770
Q-2 65							
Q-3 65	12.0	2091	4.088	8548	12491	21039	9908

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

4-SYSTEM 1
5-SUBSYSTEM 04
6-MAJ ASSY 06
SECONDARY POWER GROUND TESTS

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-4 65							
Q-1 66		149	4.094	610	1289	1899	708
TOTAL	3404.5	584298		2075069	2421392	4496461	777127

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

4-SYSTEM 1
5-SUBSYSTEM 04
6-MAJ ASSY 06
SECONDARY POWER GROUND TESTS

	MPC	OTHER COST	SUB TOTAL	G & A	IDWA	TOTAL COST
Q-1 58						
Q-2 58						
Q-3 58	1535		47769			47769
Q-4 58						
Q-1 59	1805		102710			102710
Q-2 59						
Q-3 59	827		144127			144127
Q-4 59						
Q-1 60	3082		408851	7790		416641
Q-2 60						
Q-3 60	9513		740122	14228	6655	761005
Q-4 60						
Q-1 61	7761		636823	15538	199305	851666
Q-2 61						
Q-3 61	8825	866	650113	16229	223226	889568
Q-4 61						
Q-1 62	9650	9319	971362	16304		987666
Q-2 62						
Q-3 62	8742	7558	660547	11087		671634
Q-4 62						
Q-1 63	2111	51	203661	3405		207066
Q-2 63						
Q-3 63	5533	171	269995	4514		274509
Q-4 63						
Q-1 64	4261	553	220843	4699		225542
Q-2 64						
Q-3 64	14352	553	202809	4315		207124
Q-4 64						
Q-1 65	7409	-9715	75064	2002		77066
Q-2 65						
Q-3 65	1768	-3885	28830	769		29599

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04
6-MAJ ASSY 06
SECONDARY POWER GROUND TESTS

	MPC	OTHER COST	SUB TOTAL	G & A	IDWA	TOTAL COST
Q-4 65						
Q-1 66	146	-278	2475	75		2550
TOTAL	87320	5193	5366101	100955	429186	5896242

NORTH AMERICAN ROCKWELL CORP.
SPACE DIVISION
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APRIL 1972

COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04
SECONDARY POWER SUBSYSTEM

	DESIGN /ENGR HOURS DOLLARS	PROD HOURS DOLLARS	TOOLING AND STE HOURS DOLLARS	TEST /QC HOURS DOLLARS
DESIGN/ENGINEERING	1719776			230500
LABOR AT $ 5.042	8844437			988443
ENGR BURDEN AT $ 4.733	8137967			1093110
SHOP SUPPORT	4882			334857
LABOR AT $ 3.065	15713			1025709
TEST/QC	654			16941
LABOR AT $ 3.218	2134			60917
MFG BURDEN AT $ 3.769	25956			1328282
ENGR MATERIAL	28152			777127
SUBCONTRACT	5829795	22969171	206408	
MPC	273149	1000371	8956	87320
OTHER COST	325016			5193
SUB-TOTAL	23482317	23969542	215364	5366101
GEN & ADMIN	391096	425355	4038	100955
IOWA				429186
TOTAL COST	23873413	24394897	219402	5896242

TIME-PHASED COST DETAIL - SEE PAGE III-736 III-744 III-746 III-747

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COST BREAKDOWNS
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04
SECONDARY POWER SUBSYSTEM

			TOTAL HOURS DOLLARS
DESIGN/ENGINEERING			1950276
LABOR AT $ 5.042			9832880
ENGR BURDEN	AT $	4.733	9231077
SHOP SUPPORT			339739
LABOR AT $ 3.065			1041422
TEST/QC			19595
LABOR AT $ 3.218			63051
MFG BURDEN	AT $	3.769	1354238
ENGR MATERIAL			805279
SUBCONTRACT			29005372
MPC			1369796
OTHER COST			330209
SUB-TOTAL			53033324
GEN & ADMIN			921444
IDWA			429186
TOTAL COST			54383954

TIME-PHASED COST DETAIL - SEE PAGE III-756

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 04 **SECONDARY POWER SUBSYSTEM**
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	30.0	5076	5.169	26240	23099	49339
Q-2 58						
Q-3 58	232.5	38960	4.469	174112	152258	326370
Q-4 58						
Q-1 59	400.0	68219	4.229	288483	234271	522754
Q-2 59						
Q-3 59	678.0	119416	4.120	491966	427053	919019
Q-4 59						
Q-1 60	711.0	123196	4.475	551263	461834	1013097
Q-2 60						
Q-3 60	624.0	104849	4.883	511968	388921	900889
Q-4 60						
Q-1 61	1024.5	174855	4.851	848285	589975	1438260
Q-2 61						
Q-3 61	751.5	136193	5.046	687254	634205	1321459
Q-4 61						
Q-1 62	991.5	169170	5.242	886835	775163	1661998
Q-2 62						
Q-3 62	1036.5	174085	5.171	900277	878037	1778314
Q-4 62						
Q-1 63	1023.0	174621	5.669	989898	946254	1936152
Q-2 63						
Q-3 63	1040.5	174768	5.588	976540	986728	1963268
Q-4 63						
Q-1 64	870.0	148547	5.658	840452	923480	1763932
Q-2 64						
Q-3 64	426.0	74968	6.099	457262	499594	956856
Q-4 64						
Q-1 65	136.0	23533	6.491	152745	155760	308505
Q-2 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 04 SECONDARY POWER SUBSYSTEM
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	51.0	8673	6.529	56627	57071	113698
Q-4 65						
Q-1 66	3.0	647	6.538	4230	4264	8494
TOTAL	10029.0	1719776		8844437	8137967	16982404

NORTH AMERICAN ROCKWELL CORP.
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APRIL 1972

TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 04 **SECONDARY POWER SUBSYSTEM**
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		3	2.000	6	9	15
Q-2 58						
Q-3 58		64	2.016	129	232	361
Q-4 58						
Q-1 59		48	2.771	133	178	311
Q-2 59						
Q-3 59	39.0	6805	2.920	19968	27066	46934
Q-4 59						
Q-1 60	-35.0	-6110	2.905	-17752	-19797	-37549
Q-2 60						
Q-3 60	1.5	162	3.840	622	923	1545
Q-4 60						
Q-1 61	1.5	356	2.885	1027	1544	2571
Q-2 61						
Q-3 61	1.5	337	2.941	991	1560	2551
Q-4 61						
Q-1 62	4.5	756	3.230	2442	2886	5328
Q-2 62						
Q-3 62	6.0	964	3.391	3269	4044	7313
Q-4 62						
Q-1 63	6.0	1078	3.438	3706	4450	8156
Q-2 63						
Q-3 63	1.5	229	2.869	657	1553	2210
Q-4 63						
Q-1 64	1.5	171	3.135	536	1207	1743
Q-2 64						
Q-3 64		15	3.600	54	82	136
Q-4 64						
Q-1 65		4	6.250	25	19	44
TOTAL	23.0	4832		15713	25956	41669

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1 **SECONDARY POWER SUBSYSTEM**
5-SUBSYSTEM 04
SUBD OF WORK DESIGN/ENGINEERING

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 59	1.5	182	2.835	516		516
Q-4 59						
Q-1 60		72	3.444	248		248
Q-2 60						
Q-3 60		93	4.183	389		389
Q-4 60						
Q-1 61		81	2.741	222		222
Q-2 61						
Q-3 61		43	2.744	118		118
Q-4 61						
Q-1 62		16	7.750	124		124
Q-2 62						
Q-3 62		31	1.839	57		57
Q-4 62						
Q-1 63		18	4.833	87		87
Q-2 63						
Q-3 63		46	2.913	134		134
Q-4 63						
Q-1 64		70	3.286	230		230
Q-2 64						
Q-3 64		2	4.500	9		9
TOTAL	1.5	654		2134		2134

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1 **SECONDARY POWER SUBSYSTEM**
5-SUBSYSTEM 04
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58 Q-2 58	30.0	5079	5.168	26246	23108	49354	179
Q-3 58 Q-4 58	232.5	39024	4.465	174241	152490	326731	-515
Q-1 59 Q-2 59	400.0	68267	4.228	288616	234449	523065	
Q-3 59 Q-4 59	718.5	126403	4.093	512350	454119	966469	7957
Q-1 60 Q-2 60	676.0	117153	4.556	533759	442037	975796	-6585
Q-3 60 Q-4 60	625.5	105104	4.881	512979	389844	902823	108
Q-1 61 Q-2 61	1026.0	175292	4.846	849534	591519	1441053	145
Q-3 61 Q-4 61	753.0	136573	5.040	688363	635765	1324128	35
Q-1 62 Q-2 62	996.0	169942	5.234	889401	778049	1667450	253
Q-3 62 Q-4 62	1042.5	175080	5.161	903603	882081	1785684	481
Q-1 63 Q-2 63	1029.0	175717	5.655	993691	950704	1944395	3283
Q-3 63 Q-4 63	1042.0	175043	5.583	977331	988281	1965612	14529
Q-1 64 Q-2 64	871.5	148788	5.654	841218	924687	1765905	1345
Q-3 64 Q-4 64	426.0	74985	6.099	457325	499676	957001	6271
Q-1 65 Q-2 65	136.0	23537	6.491	152770	155779	308549	584
Q-3 65 Q-4 65	51.0	8673	6.529	56627	57071	113698	82

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1 SECONDARY POWER SUBSYSTEM
5-SUBSYSTEM 04
SUBD OF WORK DESIGN/ENGINEERING

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66	3.0	647	6.538	4230	4264	8494	
TOTAL	10058.5	1725312		8862284	8163923	17026207	28152

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

4-SYSTEM 1
5-SUBSYSTEM 04 **SECONDARY POWER SUBSYSTEM**
SUBD OF WORK DESIGN/ENGINEERING

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 58 / Q-2 58		179	10		49543		49543
Q-3 58 / Q-4 58	89125	88610	762	933	417036		417036
Q-1 59 / Q-2 59	69125	69125	1832	94	594116		594116
Q-3 59 / Q-4 59	158249	166206	4997	35	11377[illegible]7		11377[illegible]7
Q-1 60 / Q-2 60	1749327	1742742	102921	8570	2830029	53921	2883950
Q-3 60 / Q-4 60	227790	227898	13529	8872	1153122	21970	1175092
Q-1 61 / Q-2 61	745572	745717	21373	11992	2220135	41257	2261392
Q-3 61 / Q-4 61	262311	262346	7518	7051	1601043	29752	1630795
Q-1 62 / Q-2 62	615772	616025	19590	17533	2320598	38951	2359549
Q-3 62 / Q-4 62	620561	621042	19742	63924	2490392	41801	2532193
Q-1 63 / Q-2 63	601344	804627	34351	54231	2837604	47445	2885049
Q-3 63 / Q-4 63	236696	251225	9037	69636	2295510	38380	2333890
Q-1 64 / Q-2 64	253921	255266	35016	66527	2122714	45167	2167881
Q-3 64 / Q-4 64		6271	2281	10069	975622	20759	996381
Q-1 65 / Q-2 65		584	175	3884	313192	8356	321548
Q-3 65 / Q-4 65		82	15	1554	115349	3078	118427

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1 SECONDARY POWER SUBSYSTEM
5-SUBSYSTEM 04
SUBD OF WORK DESIGN/ENGINEERING

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	TOTAL COST
Q-1 66				111	8605	259	8864
TOTAL	5829793	5857945	273149	325016	23482317	391096	23873413

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04 **SECONDARY POWER SUBSYSTEM**
SUBD OF WORK PRODUCTION

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	SUBC
Q-3 58							29946
Q-4 58							
Q-1 59							49946
Q-2 59							
Q-3 59							79893
Q-4 59							
Q-1 60							2131814
Q-2 60							
Q-3 60							2219333
Q-4 60							
Q-1 61							3586436
Q-2 61							
Q-3 61							1793263
Q-4 61							
Q-1 62							2782093
Q-2 62							
Q-3 62							2800407
Q-4 62							
Q-1 63							4502000
Q-2 63							
Q-3 63							1857383
Q-4 63							
Q-1 64							1136607
TOTAL							22969171

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04 **SECONDARY POWER SUBSYSTEM**
SUBD OF WORK PRODUCTION

	MPC	SUB TOTAL	G & A	TOTAL COST
Q-3 58	265	30211		30211
Q-4 58				
Q-1 59	1324	51270		51270
Q-2 59				
Q-3 59	2183	82076		82076
Q-4 59				
Q-1 60	126480	2258294	43027	2301321
Q-2 60				
Q-3 60	131679	2351012	44784	2395796
Q-4 60				
Q-1 61	102756	3689242	68557	3757799
Q-2 61				
Q-3 61	51378	1844641	34279	1878920
Q-4 61				
Q-1 62	88420	2870513	48182	2918695
Q-2 62				
Q-3 62	88921	2889328	48497	2937825
Q-4 62				
Q-1 63	191172	4693172	78470	4771642
Q-2 63				
Q-3 63	59692	1917075	32053	1949128
Q-4 63				
Q-1 64	156101	1292708	27506	1320214
TOTAL	1000371	23969542	425355	24394897

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04
SUBD OF WORK TOOLING AND STE

SECONDARY POWER SUBSYSTEM

	SUBC	MPC	SUB TOTAL	G & A	TOTAL COST
Q-3 60	98441	5840	104281	1987	106268
Q-4 60					
Q-1 61	98685	2827	101512	1886	103398
Q-2 61					
Q-3 61	2561	73	2634	49	2683
Q-4 61					
Q-1 62	2843	90	2933	49	2982
Q-2 62					
Q-3 62	3569	113	3682	62	3744
Q-4 62					
Q-1 63	309	13	322	5	327
TOTAL	206408	8956	215364	4038	219402

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 04 **SECONDARY POWER SUBSYSTEM**
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 60		13	3.846	50	49	99
Q-2 60						
Q-3 60	150.0	25261	3.869	97733	94498	192231
Q-4 60						
Q-1 61	172.5	29384	3.790	111354	99956	211310
Q-2 61						
Q-3 61	156.0	28243	4.235	119619	123522	243141
Q-4 61						
Q-1 62	342.0	58312	4.289	250102	269133	519235
Q-2 62						
Q-3 62	222.0	37308	4.374	163202	194553	357755
Q-4 62						
Q-1 63	64.5	11099	4.883	54191	58961	113152
Q-2 63						
Q-3 63	67.5	11327	4.721	53475	66051	119526
Q-4 63						
Q-1 64	78.0	13275	4.883	64820	80902	145722
Q-2 64						
Q-3 64	60.0	10579	4.724	49978	70081	120059
Q-4 64						
Q-1 65	22.5	3989	4.198	16744	24504	41248
Q-2 65						
Q-3 65	9.0	1596	4.196	6697	9800	16497
Q-4 65						
Q-1 66		114	4.193	478	1100	1578
TOTAL	1344.0	230500		988443	1093110	2081553

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 04 **SECONDARY POWER SUBSYSTEM**
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 58 Q-4 58	15.0	2496	2.804	6998	10141	17139
Q-1 59 Q-2 59	67.5	11480	2.926	33589	44171	77760
Q-3 59 Q-4 59	106.5	18789	2.894	54370	77051	131421
Q-1 60 Q-2 60	318.0	55150	2.982	164471	212380	376851
Q-3 60 Q-4 60	400.5	67192	3.119	209605	244016	453621
Q-1 61 Q-2 61	277.5	47292	3.032	143384	173740	317124
Q-3 61 Q-4 61	217.5	39421	3.065	120845	161723	282568
Q-1 62 Q-2 62	253.5	43367	3.069	133092	168913	302005
Q-3 62 Q-4 62	136.5	22908	3.104	71097	99326	170423
Q-1 63 Q-2 63	54.0	9151	3.304	30231	36328	66559
Q-3 63 Q-4 63	55.5	9388	3.152	29595	56922	86517
Q-1 64 Q-2 64	21.0	3504	3.376	11830	17568	29398
Q-3 64 Q-4 64	18.0	3267	3.389	11071	16398	27469
Q-1 65 Q-2 65	6.0	1016	3.811	3872	6725	10597
Q-3 65 Q-4 65	3.0	407	3.806	1549	2691	4240

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 04 SECONDARY POWER SUBSYSTEM
SUBD OF WORK TEST/QC

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 66		29	3.793	110	189	299
TOTAL	1950.0	334857		1025709	1328282	2353991

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 04 **SECONDARY POWER 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	1.5	314	3.287	1032		1032
Q-4 58						
Q-1 59	3.0	616	2.969	1829		1829
Q-2 59						
Q-3 59	4.5	726	2.915	2116		2116
Q-4 59						
Q-1 60	10.5	1754	3.067	5379		5379
Q-2 60						
Q-3 60	21.0	3542	3.504	12411		12411
Q-4 60						
Q-1 61	16.5	2777	3.127	8684		8684
Q-2 61						
Q-3 61	18.0	3366	3.054	10281		10281
Q-4 61						
Q-1 62	16.5	2727	3.190	8698		8698
Q-2 62						
Q-3 62	10.5	1669	3.070	5124		5124
Q-4 62						
Q-1 63		121	2.909	352		352
Q-2 63						
Q-3 63	4.0	628	3.299	2072		2072
Q-4 63						
Q-1 64	1.5	196	4.776	936		936
Q-2 64						
Q-3 64	1.5	192	4.813	924		924
Q-4 64						
Q-1 65	1.5	219	3.447	755		755
Q-2 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 04
SUBD OF WORK TEST/QC

SECONDARY POWER SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65		88	3.432	302		302
Q-4 65						
Q-1 66		6	3.667	22		22
TOTAL	110.5	18941		60917		60917

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04
SUBD OF WORK TEST/QC

SECONDARY POWER SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58							
Q-2 58							
Q-3 58	16.5	2610	2.858	8030	10141	18171	28063
Q-4 58							
Q-1 59	70.5	12096	2.928	35418	44171	79589	21316
Q-2 59							
Q-3 59	111.0	19515	2.894	56486	77051	133537	9763
Q-4 59							
Q-1 60	328.5	56917	2.985	169900	212429	382329	23440
Q-2 60							
Q-3 60	571.5	95955	3.331	319749	338514	658263	72346
Q-4 60							
Q-1 61	466.5	79453	3.315	263422	273696	537118	91944
Q-2 61							
Q-3 61	391.5	71030	3.530	250745	285245	535990	104432
Q-4 61							
Q-1 62	612.0	104406	3.754	391892	438046	829938	122455
Q-2 62							
Q-3 62	369.0	61885	3.869	239423	293879	533302	110945
Q-4 62							
Q-1 63	118.5	20371	4.162	84774	95289	180063	21436
Q-2 63							
Q-3 63	127.0	21743	3.909	85142	122973	208115	56176
Q-4 63							
Q-1 64	100.5	16975	4.571	77586	98470	176056	39973
Q-2 64							
Q-3 64	79.5	14038	4.415	61973	86479	148452	39452
Q-4 64							
Q-1 65	30.0	5224	4.091	21371	31229	52600	24770
Q-2 65							
Q-3 65	12.0	2091	4.068	8548	12491	21039	9908
Q-4 65							

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04 SECONDARY POWER SUBSYSTEM
SUBD OF WORK TEST/QC

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66		149	4.094	610	1289	1899	708
TOTAL	3404.5	584298		2075069	2421392	4496461	777127

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04 **SECONDARY POWER SUBSYSTEM**
SUBD OF WORK TEST/QC

	MPC	OTHER COST	SUB TOTAL	G & A	IDWA	TOTAL COST
Q-1 58						
Q-2 58						
Q-3 58	1535		47769			47769
Q-4 58						
Q-1 59	1805		102710			102710
Q-2 59						
Q-3 59	827		144127			144127
Q-4 59						
Q-1 60	3082		408851	7790		416641
Q-2 60						
Q-3 60	9513		740122	14228	6655	761005
Q-4 60						
Q-1 61	7761		636823	15538	199305	851666
Q-2 61						
Q-3 61	8825	866	650113	16229	223226	889568
Q-4 61						
Q-1 62	9650	9319	971362	16304		987666
Q-2 62						
Q-3 62	8742	7558	660547	11087		671634
Q-4 62						
Q-1 63	2111	51	203661	3405		207066
Q-2 63						
Q-3 63	5533	171	269995	4514		274509
Q-4 63						
Q-1 64	4261	553	220843	4699		225542
Q-2 64						
Q-3 64	14352	553	202809	4315		207124
Q-4 64						
Q-1 65	7409	-9715	75064	2002		77066
Q-2 65						
Q-3 65	1768	-3385	28830	769		29599
Q-4 65						

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B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04 SECONDARY POWER SUBSYSTEM
SUBD OF WORK TEST/QC

	MPC	OTHER COST	SUB TOTAL	G & A	IDWA	TOTAL COST
0-1 66	146	-278	2475	75		2550
TOTAL	87320	5193	5366101	100955	429186	5896242

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 04
SECONDARY POWER SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58	30.0	5076	5.169	26240	23099	49339
Q-2 58						
Q-3 58	232.5	38960	4.469	174112	152258	326370
Q-4 58						
Q-1 59	400.0	68219	4.229	288483	234271	522754
Q-2 59						
Q-3 59	678.0	119416	4.120	491966	427053	919019
Q-4 59						
Q-1 60	711.0	123209	4.475	551313	461883	1013196
Q-2 60						
Q-3 60	774.0	130110	4.686	609701	483419	1093120
Q-4 60						
Q-1 61	1197.0	204239	4.699	959639	689931	1649570
Q-2 61						
Q-3 61	907.0	164436	4.907	806873	757727	1564600
Q-4 61						
Q-1 62	1333.0	227482	4.998	1136937	1044296	2181233
Q-2 62						
Q-3 62	1258.5	211393	5.031	1063479	1072590	2136069
Q-4 62						
Q-1 63	1088.5	185720	5.622	1044089	1005215	2049304
Q-2 63						
Q-3 63	1108.0	186095	5.535	1030015	1052779	2082794
Q-4 63						
Q-1 64	948.0	161822	5.594	905272	1004382	1909654
Q-2 64						
Q-3 64	436.0	85547	5.929	507240	569675	1076915
Q-4 64						
Q-1 65	159.0	27522	6.158	169489	180264	349753
Q-2 65						

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B-70 AIRCRAFT STUDY

DESIGN/ENGINEERING
4-SYSTEM 1
5-SUBSYSTEM 04
SECONDARY POWER SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	61.5	10269	6.167	63324	66871	130195
Q-4 65						
Q-1 66	4.5	761	6.187	4708	5364	10072
TOTAL	11376.5	1950276		9832880	9231077	19063957

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 04
SECONDARY POWER SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58		3	2.000	6	9	15
Q-2 58						
Q-3 58	15.0	2560	2.784	7127	10373	17500
Q-4 58						
Q-1 59	67.5	11528	2.925	33722	44349	78071
Q-2 59						
Q-3 59	145.5	25594	2.901	74238	104117	178355
Q-4 59						
Q-1 60	283.5	49040	2.992	146719	192583	339302
Q-2 60						
Q-3 60	400.5	67354	3.121	210227	244939	455166
Q-4 60						
Q-1 61	279.0	47648	3.031	144411	175284	319695
Q-2 61						
Q-3 61	219.0	39758	3.064	121836	163283	285119
Q-4 61						
Q-1 62	258.0	44123	3.072	135534	171799	307333
Q-2 62						
Q-3 62	142.5	23872	3.115	74366	103370	177736
Q-4 62						
Q-1 63	60.0	10229	3.318	33937	40778	74715
Q-2 63						
Q-3 63	57.0	9617	3.146	30252	58475	88727
Q-4 63						
Q-1 64	21.0	3675	3.365	12366	18775	31141
Q-2 64						
Q-3 64	18.0	3282	3.390	11125	16480	27605
Q-4 64						
Q-1 65	6.0	1020	3.821	3897	6744	10641
Q-2 65						

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B-70 AIRCRAFT STUDY

SHOP SUPPORT
4-SYSTEM 1
5-SUBSYSTEM 04
SECONDARY POWER SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65	3.0	407	3.806	1549	2691	4240
Q-4 65						
Q-1 66		29	3.793	110	189	299
TOTAL	1975.5	339739		1041422	1354238	2395660

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 04
SECONDARY POWER SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-1 58						
Q-2 58						
Q-3 58	1.5	314	3.287	1032		1032
Q-4 58						
Q-1 59	3.0	616	2.969	1829		1829
Q-2 59						
Q-3 59	4.5	908	2.899	2632		2632
Q-4 59						
Q-1 60	10.5	1826	3.082	5627		5627
Q-2 60						
Q-3 60	21.0	3635	3.521	12800		12800
Q-4 60						
Q-1 61	16.5	2858	3.116	8906		8906
Q-2 61						
Q-3 61	19.5	3409	3.050	10399		10399
Q-4 61						
Q-1 62	16.5	2743	3.216	8822		8822
Q-2 62						
Q-3 62	10.5	1700	3.048	5181		5181
Q-4 62						
Q-1 63	1.5	139	3.158	439		439
Q-2 63						
Q-3 63	4.5	674	3.273	2206		2206
Q-4 63						
Q-1 64	1.5	266	4.383	1166		1166
Q-2 64						
Q-3 64	1.5	194	4.809	933		933
Q-4 64						
Q-1 65	1.5	219	3.447	755		755
Q-2 65						

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

TEST/QC
4-SYSTEM 1
5-SUBSYSTEM 04
SECONDARY POWEP SUBSYSTEM

ON-SITE LABOR

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $
Q-3 65		88	3.432	302		302
Q-4 65						
Q-1 66		6	3.667	22		22
TOTAL	114.0	19595		63051		63051

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04
SECONDARY POWER SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 58	30.0	5079	5.168	26246	23108	49354	179
Q-2 58							
Q-3 58	249.0	41834	4.357	182271	162631	344902	27548
Q-4 58							
Q-1 59	470.5	80363	4.032	324034	278620	602654	21316
Q-2 59							
Q-3 59	828.0	145918	3.898	568836	531170	1100006	17720
Q-4 59							
Q-1 60	1005.0	174075	4.042	703659	654466	1358125	16855
Q-2 60							
Q-3 60	1195.5	201099	4.141	832728	728358	1561086	72454
Q-4 60							
Q-1 61	1492.5	254745	4.369	1112956	865215	1978171	92089
Q-2 61							
Q-3 61	1145.5	207603	4.524	939108	921010	1860118	104467
Q-4 61							
Q-1 62	1607.5	274348	4.670	1281293	1216095	2497388	122708
Q-2 62							
Q-3 62	1411.5	236565	4.824	1143026	1175960	2318986	111426
Q-4 62							
Q-1 63	1150.0	196088	5.500	1078465	1045993	2124458	24719
Q-2 63							
Q-3 63	1169.5	196386	5.410	1062473	1111254	2173727	70705
Q-4 63							
Q-1 64	970.5	165763	5.543	913804	1023157	1941961	41318
Q-2 64							
Q-3 64	505.5	89023	5.833	519298	586155	1105453	45723
Q-4 64							
Q-1 65	166.5	28761	6.055	174141	187008	361149	25354
Q-2 65							
Q-3 65	64.5	10764	6.055	65175	69562	134737	9990
Q-4 65							

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B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04
SECONDARY POWER SUBSYSTEM

	MAN-MONTHS	LABOR HOURS	LABOR RATE	LABOR DOLLARS	BURDEN DOLLARS	LABOR + BURDEN $	ENGR MATL
Q-1 66	4.5	796	6.080	4840	5553	10393	708
TOTAL	13466.0	2309610		10937353	10585315	21522668	805279

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B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04
SECONDARY POWER SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	IOWA
Q-1 58		179	10		49543		
Q-2 58							
Q-3 58	119071	146619	2562	933	495016		
Q-4 58							
Q-1 59	119071	140387	4961	94	748096		
Q-2 59							
Q-3 59	238142	255862	8007	35	1363910		
Q-4 59							
Q-1 60	3881141	3897996	232483	8570	5497174	104738	
Q-2 60							
Q-3 60	2545564	2618018	160561	8872	4348537	82969	6655
Q-4 60							
Q-1 61	4430743	4522832	134717	11992	6647712	127238	199305
Q-2 61							
Q-3 61	2058135	2162602	67794	7917	4098431	80309	223226
Q-4 61							
Q-1 62	3400708	3523416	117750	26852	6165406	103486	
Q-2 62							
Q-3 62	3424537	3535963	117518	71482	6043949	101447	
Q-4 62							
Q-1 63	5303653	5328372	227647	54282	7734759	129325	
Q-2 63							
Q-3 63	2094079	2164784	74262	69807	4482580	74947	
Q-4 63							
Q-1 64	1390528	1431846	195378	67080	3636265	77372	
Q-2 64							
Q-3 64		45723	16633	10622	1178431	25074	
Q-4 64							
Q-1 65		25354	7564	-5831	388256	10358	
Q-2 65							
Q-3 65		9990	1783	-2331	144179	3847	
Q-4 65							

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B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04
SECONDARY POWER SUBSYSTEM

	SUBC	TOTAL MATERIAL	MPC	OTHER COST	SUB TOTAL	G & A	IOWA
Q-1 66		708	146	-167	11080	334	
TOTAL	29005372	29810651	1369796	330209	53033324	921444	429186

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B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04
SECONDARY POWER SUBSYSTEM

		TOTAL COST
Q-1	58	49543
Q-2	58	
Q-3	58	495016
Q-4	58	
Q-1	59	748096
Q-2	59	
Q-3	59	1363910
Q-4	59	
Q-1	60	5601912
Q-2	60	
Q-3	60	4438191
Q-4	60	
Q-1	61	6974255
Q-2	61	
Q-3	61	4401966
Q-4	61	
Q-1	62	6268892
Q-2	62	
Q-3	62	6145396
Q-4	62	
Q-1	63	7864084
Q-2	63	
Q-3	63	4557527
Q-4	63	
Q-1	64	3713637
Q-2	64	
Q-3	64	1203505
Q-4	64	
Q-1	65	398614
Q-2	65	
Q-3	65	148026
Q-4	65	

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TIME PHASED EXPEND.
B-70 AIRCRAFT STUDY

4-SYSTEM 1
5-SUBSYSTEM 04
SECONDARY POWER SUBSYSTEM

	TOTAL COST
Q-1 66	11414
TOTAL	54383954