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AGENA B

STANDARDIZATION STUDY

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Lockheed

MISSILES and SPACE DIVISION

LOCKHEED AIRCRAFT CORPORATION, SUNNYVALE, CALIF.

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1-54, 1-58, 1-64, 1-70, 2-16, 2-18, 2-20, 2-28,

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AGENA B

STANDARDIZATION STUDY

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Letter Contract AF 04(647)-840
Amendment No. 1
Dated 12 June 1961

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FOREWORD

The preparation of the data presented in this report is authorized under the terms of Amendment No. 1 to Contract AF 04(647)-840, dated 12 June 1961, and is in compliance with the tasks set forth in the Agena B Standardization Study Work Statement.

The subject work statement is reprinted verbatim in Pages v through viii. The "tasks" referred to throughout the main text of the study are listed on Pages vi and vii; however, it is recommended that the work statement be read in its entirety so as to be fully acquainted with the ground rules upon which the Agena B Standardization Study is based.

AGENA B STANDARDIZATION STUDY
WORK STATEMENT

May '61

PURPOSE:

This work statement defines the study and design service to be furnished by the Lockheed Missile and Space Division to establish the Standard Agena B configuration.

BACKGROUND:

The Agena vehicle, at present levels of development, exists in many slightly altered configurations. These configurations, in some measure of structure or components, can be traced back to the original WS 117L Program. Concepts of operation formulated at that time still guide most of the development that presently appears as components in the Agena. A preliminary review of program requirements and vehicle configurations indicates that, to a large measure, recent activity to optimize the Agena for the respective missions has been effective mainly on the vehicle assembly level. For the most part, all programs operate with the same equipment or slight modifications thereto with variations in numbers (for redundancy) or in location in the vehicle. Due to differences in installation design that have come about through program optimication, there is now available a large variety of possible equipment installations and structural designs which are already qualified. The merit of study of existing engineering and selection of a standard configuration encompassing all programs offers obvious advantages in economy and reliability. The establishment of a Standard Agena B would not eliminate the need for continuing development in most of the programs. Those programs which are limited by mission objectives to a few flights also recognize the desirability of progressively increasing the capacity of the Agena in terms of factors including reliability, performance versus cost, and proper time phasing. This need is expected to be fulfilled in two manners, (1) by permitting development of mission-peculiar equipment as an integral sub-assembly and (2) by maintaining a block development concept of the Standard Agena bringing in appropriate product improvements, which might include propellant change or function simplification, on a regular schedule compatible with production scheduling and qualification status.

OBJECTIVE:

This study shall establish an Agena B vehicle that will completely fulfill those functions which are common to most programs in an optimum manner considering total mission requirements. These mission requirements include, in addition to performance; reliability, economy, maintainability, operability, and producibility. All are desirable effects that can be associated with the production of standard vehicles. Since a low level of unknowns is an inherent part of standardization, existing engineering and qualified components will be used where possible. The Standard Agena B will not be a standard flight vehicle in all respects, since it is recognized that specific functions dictated by unique mission requirements cannot be forced into an arbitrary standard. However, dependent upon space available, allocation of space to satisfy those functions is permissible as long as such space allocation does not dictate the design. An example of this is the capability for installing the repressurized system.

TASKS:

Specific tasks to be performed include the following:

1. Review all programs and identify all functions performed by the Agena in sufficient detail that independent components or circuitry can be identified or deduced.

2. Classify these functions by degree of use:

   a. All programs (common)

   b. Most programs (common)

   c. Few programs (dissimilar)

3. Classify all components used for common functions in the same manner as Task 2.

4. Identify the following:

   a. Common functions for which common components or circuitry exists.

   b. Common functions for which common components or circuitry does not exist.

   c. The point in the functional chain of common functions at which uncommon conditions commence.

   d. Those components or circuitry which perform common functions and are mechanically identical but electrically dissimilar.

5. Identify any modifications necessary to permit common functions to be performed by common components.

6. Perform preliminary design effort to define the following configurations.

   a. An Agena B vehicle that is derived by collecting those functions necessary for a mission requiring only ascent operation. The components used shall be common as far as possible and shall include those standardizing modifications of Task 5 as much as possible. Functions and components expressly for orbital operation shall not be included.

   b. A standard Agena B that includes all common functions with the inclusion of the standardizing modifications established in Task 5. Design techniques used shall permit orbital operation for those missions requiring such operations.

      (1) Consideration should be given to accessibility, producibility, and maintainability. A wooden mock-up will be made to explore these areas.

7. Using the configurations of Task 6, an engineering estimate shall be made of the additional equipment and structure necessary to perform those functions required by each program mission.

   a. Basis for this estimate should be use of components already designed or built where practical, i.e., repeat of common components for the redundancy function or use of bolt-on structural elements from any program.

8. Comparison of the configurations established by combining Task 6 and Task 7 with the present programmed configurations in terms of performance parameters applicable to the individual subsystems.

   a. Emphasis in this comparison should be between the Standard Agena (Task 6b) and the present programmed vehicles.

   b. The comparison of configurations established by combining Task 6a and 7 with present configurations should be conducted only with missions requiring the Agena to perform strictly as an ascent vehicle.

9. Submission of a cost and time estimate involved in performing the modifications described in Task 5.

10. Submission of an ROM for the engineering and manufacturing effort associated with implementing into each of the several programs the work associated with Task 6 and Task 7.

11. Alterations to the support equipment and launch facilities resulting from the modifications identified in Task 5 will be itemized. The extent of this effort shall be limited to an engineering estimate of the effect of Task 5 on this equipment.

GENERAL CONSIDERATIONS:

For this study, design effort except as specified shall be limited to formulation of design concepts necessary to allow standardization of all Agena subsystems. Change of system concept is not a part of this study.

Vehicle wiring is to be considered as a component in the study; however, the function it fulfills should be stated in terms of other subsystem functions. An example is that Subsystem D control wiring is a function to be handled by the wiring system.

Structural skin and web thickness variations should not be considered as making those components uncommon for Task 6a. In Task 6b structural variations should be considered as modifications. In all cases, variation in location of equipment within airframe components is considered as grounds for determining that equipment installations are dissimilar.

Payload installations requirements of Task 7 are not to consider the external structure which may presently exist as the limiting condition except that a reduction in available volume or shape is not allowed.

Solar array installation on the aft equipment rack in accordance with present engineering is an allowable exception to the objective of mission-peculiar functions not dictating design. However, such exceptions must be readily removable at a manufacturing joint.

PARTICIPATING AGENCIES

It is expected that numerous informal contacts will be made during the period of this study. The Air Force cognizant office shall be the Agena Division (SSZA).

PERFORMANCE PERIOD:

This study shall be completed within three months from go-ahead date.

RESULTS AND REPORTS:

The result of this study shall be a verbal and chart presentation to AFSSD at a time and place to be later established. Twenty-five copies of the document summarizing the study, and containing the task results, will be delivered to AFSSD at least one week prior to the presentation.

CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

ILLUSTRATIONS

ILLUSTRATIONS (Continued)

TABLES

TABLES (Continued)

SECTION 1
INVESTIGATIVE TASKS 1, 2, 3, 4, 5, AND 11

INTRODUCTION

The data resulting from performance of Tasks 1 through 5 are grouped by major vehicle subsystems.

The results of two or more tasks are combined on a single chart where feasible in order to avoid unnecessary repetition.

The necessary modifications to the Aerospace Ground Equipment resulting from the standardization of Agena vehicle equipments are listed in Table 1-12 in compliance with the requirements of Task 11.

STRUCTURES

The requirement for providing maximum equipment accessibility results in an entirely new design approach for the forward and aft equipment racks; consequently, a listing here of the numerous existing major structural components of the several programs is not considered necessary. All of the Standard Agena structure is new with the exception of the propellant tank.

A full description of the proposed structural configuration and a comparison with the several program structural configurations are presented in Section 2 of this report.

PROPULSION

PROPULSION

Tasks 1 and 2 (See Table 1-1)

The majority of the program functions are common during the ground and ascent phases of operation, however, the orbit and recovery functions are dissimilar. The main engine second burn is a common function in the ascent phase of operation, but it is a dissimilar function in the recovery phase. The task is accomplished by the same basic engine with only a few components added for the delayed restart. It is actually the element of time that makes the recovery second burn function a dissimilar one.

Task 3 (See Table 1-2)

A great number of the propulsion components are dissimilar due simply to the location or installation of the parts. These differences lead to a dissimilar routing of tubing and wires which produces an uncommon system.

Most of the programs use solid propellant rockets for ullage orientation, however, some programs use secondary propulsion for this function. The programs using secondary propulsion also have orbit adjust requirements which are satisfied by the same system and are not presently suited to the use of solid propellants.

Tasks 4 and 5 (See Tables 1-3 and 1-4)

Simple modifications of existing components will provide common equipment for almost all of the common program functions supplied by the propulsion system. A relocation of existing parts is the most frequent modification required. The ullage orientation function must be supplied by optional equipment employing either solid propellant rockets or liquid propellant secondary propulsion systems.

The same basic main engine can supply the needs of all the programs with a few simple optional components. The same engine that is used for a single start can be used for a restart mission by adding a second start can and an oxidizer fast shutdown pressure cylinder. This engine can also be used for the dissimilar delayed restart function by adding a simple auxiliary lubrication system.

The delayed restart system also requires the use of isolation valves as optional equipment. This special case demonstrates that some existing components can be modified to provide common equipment for both common and dissimilar functions. The propulsion functions of all the programs can be performed by a set of common components with a few optional items.

Table 1-1
PROGRAM PROPULSION FUNCTIONS

	FUNCTION	Deg. of Use	DISCOVERER 1110	DISCOVERER 1115	DISCOVERER 1124	MIDAS 1201	MIDAS 1204	MIDAS 1209	ADVENT 1501	PROJECT 101A 2120	PROJECT 101B 2202	PROJECT 101B 2203	PROJECT 101B 2207	PROJECT 101B 2210	PROJECT 102 2301	PROJECT 102 2312	PROJECT 201 2401	NASA 6001	NASA 6101	NASA 6201	NASA 6301
	GROUND																				
I	Main propellant fill	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
II	Pressurization fill	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
III	Pyrotechnic installation	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
IV	Secondary propulsion system																				
	Propellant fill	few					x	x									x				
V	Secondary propulsion press system fill	few					x	x									x				
	ASCENT																				
I	Provide Agena destruct syst.	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
II	Booster Agena separation																				
	Booster Agena separation	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Booster retro velocity	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
III	Eject fairings and shrouds	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
IV	Pressurization																				
	Pressure supply	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Pressure regulation	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Pressure relief	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
V	Provide Agena First Burn																				
	Ullage orientation	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Engine start	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Engine shutdown	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
VI	Provide Agena Second Burn																				
	Ullage orientation	most			x (1)	x	x	x	x						x	x		x	x	x	x
	Engine start	most				x	x	x	x						x	x		x	x	x	x
	Engine shutdown	most				x	x	x	x						x	x		x	x	x	x
VII	Propellant Dumping																				
	Fuel vent	most	x	x	x	x	x	x		x					x	x					
	Oxidizer vent	most	x	x	x	x	x	x		x					x	x					
	ORBIT																				
I	Orbit Adjust	few					x	x									x				
	RECOVERY																				
I	Delayed Agena Second Burn																				
	Re-pressurization	few									x	x	x	x			x				
	Ullage orientation	few									x	x	x	x			x				
	Engine start	few									x	x	x	x			x				
	Engine shutdown	few									x	x	x	x			x				
	MISCELLANEOUS																				
I	Payload Separation Retro	few																x			

FORM MSD 1170-1

(1) Ullage rockets only are used for 1124 second burn impulse

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Table 1-2

PROGRAM PROPULSION FUNCTIONS AND COMPONENTS

			DISCOVERER			MIDAS			ADVENT	PROJ 101A	PROJECT 101B				PROJECT 102		PROJ 201	NASA			
	FUNCTION OR COMPONENT	DEG. OF USE	1110	1115	1123	1201	1204	1209	1501	2120	2202	2203	2207	2210	2301	2312	2401	6001	6101	6201	6301
	GROUND																				
I	Main Propellant Fill	all	x	x	x	x	x	x (2)	x	x	x	x	x	x	x	x	x	x	x	x	x
	1309291-503	few				x															
	1309291-505	few								x					x	x					
	1309291-509	few	x																		
	1309291-511	few					x														
	1317451-501	few							x									x			
	1319560	few									x	x	x	x							
	1332845-501	few															x				
	1325483-501	few																	x	x	x
	1309291-515	few		x	x																
II	Pressurization Fill	all	x	x	x	x	x	x (2)	x	x	x	x	x	x	x	x	x	x	x	x	x
	1309807-505	few	x																		
	1309807-507	few	x	x	x																
	1309302	few				x															
	1324607	few					x														
	1318421	few							x									x			
	1311868	few								x											
	1319553	few									x	x	x	x							
	1335376	few													x	x					
	1323224-501	few															x				
	1325722-505	few																	x	x	x
III	Pyrotechnic Installation	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
IV	SPS Propellant and Pressurization Fill	few					x	x									x				
	1322968	few					x	x													
	1325956-501	few															x				
	ASCENT																				
I	Provide Agena Destruct Sys.	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	A. Safe and arm	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	1060598-1	few	x	x	x	x															
	1312289-1	most					x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	B. Shaped Charge	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	1062569-3	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
II	Booster Agena Separation	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	A. Separation Squibs	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	B. Booster Retro Rockets	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	1062410-1	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

(2) New equipment part numbers not assigned yet.

Table 1-2 (Continued)

	FUNCTION OR COMPONENT	DEG. OF USE	DISCOVERER 1110	DISCOVERER 1115	DISCOVERER 1123	MIDAS 1201	MIDAS 1204	MIDAS 1209	ADVENT 1501	PROJ 101A 2120	PROJECT 101B 2202	PROJECT 101B 2203	PROJECT 101B 2207	PROJECT 101B 2210	PROJECT 102 2301	PROJECT 102 2312	PROJ 201 2401	NASA 6001	NASA 6101	NASA 6201	NASA 6301
	ASCENT (Continued)																				
III	Eject Fairings & Shrouds - Provide squibs	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
IV	Pressurization	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	A. Pressure Supply	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	1062174	few	x	x	x	x	x	x													
	1062174-5	few							x	x	x	x	x	x	x	x	x	x	x	x	x
	1062163-3	few									x	x	x	x			x	x			
	B. Regulation and Relief	all	x	x	x	x	x	x (2)	x	x	x	x	x	x	x	x	x	x	x	x	x
	1309807-505	few	x																		
	1309807-507	few	x	x	x																
	1309302	few				x															
	1324607	few					x														
	1318421	few							x									x	x	x	x
	1311868	few								x											
	1319553	few									x	x	x	x							
	1335376	few													x	x					
	1323224-501	few															x				
	1325722-505	few																	x	x	x
V	Provide Agena First Burn	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	A. Ullage orientation	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	1062655-1	few	x																		
	1062655-3	most		x	x	x			x	x	x	x	x	x	x	x		x	x	x	x
	1322968 (SPS)	few					x	x													
	1325956-501 (SPS)	few															x				
	B. Main Engine, Start and Shutdown	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	1062656-1	few				x															
	1062656-3	few	x							x											
	1062656-5	few				x	x	x	x						x	x		x	x	x	x
	1062656-7	few	x	x	x																
	1062656-9	few									x	x (3)	x (3)	x(3)			x(3)				

FORM MSD 1170-1 (3) The (-9) engine is the (-5) engine with an auxiliary lubrication system added to it.

Table 1-2 (Continued)

			DISCOVERER			MIDAS			ADVENT	PROJ 101A	PROJECT 101B				PROJECT 102		PROJ 201	NASA			
		DEG. OF USE	1110	1115	1123	1201	1204	1209	1501	2120	2202	2203	2207	2210	2301	2312	2401	6001	6101	6201	6301
	ASCENT (Continued)																				
VI	Provide Agena Second Burn	most				x	x	x	x						x	x		x	x	x	x
	A. Ullage Orientation	most				x	x	x	x						x	x		x	x	x	x
	1062655-3	few				x			x						x	x		x	x	x	x
	1322968 (SPS)	few					x	x													
	B. Main Engine Start and Shutdown	most				x	x	x	x						x	x		x	x	x	x
	1062656-1	few				x															
	1062656-5	most				x	x	x	x						x	x		x	x	x	x
VII	Propellant Dumping	most	x	x	x	x	x	x(2)		x					x	x					
	1309291-503	few	x			x															
	1309291-505	few								x					x	x					
	1309291-509	few	x																		
	1309291-511	few					x														
	1309291-515	few		x	x																
	ORBIT																				
I	Orbit Adjust	few					x	x									x				
	1322968	few					x	x													
	1325956-501	few															x				
	RECOVERY																				
I	Delayed Agena Second Burn	few									x	x	x	x			x				
	A. Repressurization	few									x	x	x	x			x				
	1319553	few									x	x	x	x							
	1323224-501	few															x				
	B. Ullage Orientation	few									x	x	x	x			x				
	1062655-3	few									x	x	x	x							
	1325956-501	few															x				
	C. Engine Start and Shutdown	few									x	x	x	x			x				
	1062656-9	few									x(3)	x(3)	x(3)	x(3)			x(3)				
	MISCELLANEOUS																				
I	Payload Separation Retro	few																x			
	1062655-3	few																x			

FORM MSD 1170-1

Table 1-3

IDENTIFICATION OF COMMON FUNCTIONS

Phase	Common Function	Common Components Exist	Dissimilar Components Exist	Point in Function Chain Where Uncommon Cond. Commence	Modifications to Permit Common Comp. Usage
Ground	Main Propellant Fill		X	Components	Single Fill Points and Lines For All Programs
	Pressurization Fill		X	Components	Single Sphere And Common Location For All Programs
	Pyrotechnic Installation	X		Installation of Squibs (Location And Number)	
Ascent	Provide Agena Destruct	X		Installation of Component	
	Booster Agena Separation				
	a. Separation Squibs	X		a. Installation of Squibs	
	b. Retro Velocity	X		b. Installation of Retro Rockets	
	Eject Fairings and Shrouds (Provide Squibs)	X		Number and Position of Fairings and Shrouds	
	Pressurization				
	a. Supply		X	a. Components	a. Provide one Sphere with Common Location For All Programs
	b. Regulation and Relief	X		b. Installation of Components	

Table 1-3 (Continued)

Phase	Common Function	Common Components Exist	Dissimilar Components Exist	Point in Function Chain Where Uncommon Cond. Commence	Modifications to Permit Common Comp. Usage
	Provide Agena First Burn a. Ullage Orientation		X	a. Components	a. Provide SPS and Solid Ullage Rockets as Optional Equipment
	b. Engine Start	X		b. Everything Common	
	c. Engine Shutdown		X	c. Components	c. Make oxidizer Fast Shutdown Optional
Ascent	Provide Agena Second Burn a. Ullage Orientation		X	a. Components	a. Make SPS and Solid Ullage Rockets Optional Equipment
	b. Engine Start	X		b. Everything Common	
	c. Engine Shutdown	X		c. Everything Common	
	Propellant Dumping		X	Components	Provide Simple Dump System For All Vehicles
Orbit	No Common Functions				
Recovery	No Common Functions				

Table 1-4

UNCOMMON FUNCTIONS WHICH SHOULD BE INCLUDED IN STANDARD AGENA

Phase	Common Function	Common Components Exist	Dissimilar Components Exist	Point in Function Chain Where Uncommon Cond. Commence	Modifications to Permit Common Comp. Usage
Recovery	Delayed Re-start				
	a. Repres-surization		X	a. Components	a. Make Isolation Valve Optional Equipment
	b. Ullage Orientation		X	b. Components	b. Make SPS and Solid Ullage Rockets Optional
	c. Engine Start	X		c. Time and One Component	c. Add Auxiliary Lube as Optional Equipment
	d. Engine Shutdown	X		d. Everything Common	d. No Modification
Orbit	Orbit Adjust		X	Function	None*

* The orbit adjust requirement is only used on a few vehicles but its components are a part of the secondary propulsion system which is used for the common function of ullage orientation.

ELECTRICAL POWER SYSTEM

ELECTRICAL POWER SYSTEM

Task 1

A review of all programs identifying all functions performed by the Agena in the Electrical Power System category is portrayed on Table 1-5, entitled "Electrical Power System Primary Functions." Six basic programs, Discoverer, MIDAS, Program I, Program 201, Advent, and NASA are covered.

The nuclear category of prime electrical energy source is listed to indicate future developments and will not be discussed further.

Task 2

Table 1-5 also points out the degree of mutuality or dissimilarity that exists in requirements for the various functions in each program, and between programs.

Task 3

Classification of all major components used for common functions in all programs, together with their degree of use, is documented in Table 1-6, "Electrical Power System Primary Function Components."

Task 4

Identification of the degree of use for the various components is shown in Figure 1-1, which can be discussed as follows:

a. Common functions for which common components or circuitry exist are as follows:

Prime Electrical Energy Source, Prelaunch
Unregulated DC Supply
400 cycle 3 Ø Supply (AC)
400 cycle 1 Ø Supply (DC)
Secondary Batteries for Destruct Purposes
Main Power Transfer Switch

A function or component is common only if it applies to all programs and vehicles.

b. Common functions for which common components or circuitry do not exist are as follows:

Electrical Energy Storage
Regulated +28.3v dc Supply
Regulated -28.3v dc Supply
Electrical Energy Distribution
Signal Energy Distribution
Radio Frequency Energy Distribution
Pyrotechnic Energy Distribution
Test Point Distribution

c. The point in the functional chain of common functions at which uncommon conditions commence will be listed for each of the common functions:

(1) All vehicles must of necessity have a primary electrical energy source. However, uncommon conditions occur immediately upon consideration of program missions. For example, the MIDAS Program uses solar arrays for this function, while all others use one or more of a number of types of primary batteries or a basic nuclear source. All of these are dependent upon the total power and program requirements.

(2) All vehicles require storage of electrical energy, however conditions of loading vary greatly so that different batteries are used. The long-life vehicles in the MIDAS Program employ four secondary batteries Type IA. In other programs, the primary batteries can be considered to also store electrical energy.

(3) Electrical energy supply and conversion is common in several respects to all vehicles, until the payload peculiar conditions are considered. For example, NASA Advent, and Program 201 employ the same 110 watt plus 28.3v dc regulator. The remaining programs, with one exception, require the 350 watt size of regulator. The same uncommon conditions exist for the two sizes of minus 28.3v dc regulators. The guidance and control system for all programs excluding the Discoverer, requires two special ±28.0v dc regulators, one for the horizon sensor, and one for the velocity meter. The Discoverer Programs use a computer which requires precision 0.1% 400 cycle per second alternating current. Another class of power supply scheduled for general use on the Discoverer 1123 and up, and planned for MIDAS 1209, is the dc to dc converter type of regulator to furnish ± regulated 28.3v dc power. These vehicles will not use the central 2000 cps power system.

Energy distribution wiring harnesses, whether they are for electrical, signal, radio frequency pyrotechnic, or monitoring functions, are common insofar as the function is concerned, but are all dissimilar between vehicles.

d. Components which perform common functions and are mechanically identical but electrically dissimilar are primarily in the category of state-of-the-art improvement items. For example, the Type IB three-phase 400 cycle inverter differs electrically from the Type IA as it contains a built-in load limiter and has a frequency stability of 0.001% (an improvement of five times over the IA). Type IVA and IVB 2000 cps inverters use a push-pull transistor-type output circuit while the Type IVC uses a bridge circuit for improved reliability. The IVD model of this inverter has a built-in load-limiter and improved inversion efficiency owing to the use of a pulse-width-modulated voltage control circuit. Primary battery Type I includes a built-in diode in the positive lead, while the Type IA battery does not include this feature.

Task 5

Modifications necessary to permit common functions to be performed by common components consist, with one exception, of standardizing on essential functions and components. To this must be added the necessity of recognizing and adopting state-of-the-art changes and the evolving power requirements of the later vehicle designs.

Only one component used in the electrical power system will require modifying. The Type X dc to dc converter regulator (+30/-15w intermittent) will require removal of the 350 watt intermittent portion and repackaging to provide the required +30/-10 watt regulator.

The watt-hour battery requirements extend from 232 to over 27000 watt-hours per mission for short-life vehicles. The exact amount depends upon the mission. One battery would, in many cases, have adequate capacity. However, the need to provide some isolation for the electrical power system dictates that at least two batteries be used. With the large number of qualified primary and secondary batteries available, it is possible to meet all requirements without difficulty. For ascent purposes, two Type VIA batteries would meet all needs. In other cases, where less power is required, two

Type IV batteries could be used with a saving of twenty-two pounds. Battery selection is somewhat analagous to deciding the amount of control gas carried. Long-life vehicles will employ Type IA secondary batteries with a solar array. Type III secondary batteries are used for destruct purposes.

It is apparent from a brief study of the power consumption figures listed in Task 3 that the requirement for 2000 cps power is generally being reduced with the introduction of the more recent designs. For example, Discoverer 1123 and up, Advent, NASA 6101, 6201, and 6301, Program 201, and MIDAS 1209 do not use this type of power. In most cases, 2000 cycle power is used to energize the central 28-volt dc regulators. Dc to dc converter regulators, substantially the same as the Type IX and X used for Discoverer 1123, can replace the 2000 cycle system for most applications. Early model FM/FM Type I telemetry transmitting equipment uses about 80 watts of 2000 cycle power while the later Type II equipment operates directly from the unregulated dc bus. Program I, 2203, uses 2 watts to energize a magnetic amplifier circuit. The simplest type of modification would be to employ 400 cycle power for the above purpose.

It will be necessary to use a common set of components with standard options for each vehicle in order to provide a standard wiring harness. In order to have a reasonable amount of flexibility, it will be necessary to have completely independent wiring modules for the power distribution, signal distribution, pyrotechnic distribution, radio frequency distribution, and test point distribution. Harnesses will have additional connections for optional component wiring.

Wiring harnesses are being handled as a module for prefabrication purposes. Each module will be color coded according to its use, as follows:

Red	Pyrotechnics
Black	dc Power
Brown	ac Power
White	Ground Return

Orange	Telemetry
Purple	Command
Yellow	Test Wiring
Black	Radio Frequency Cabling

Most plugs and sockets will be of the flat type with two rows of contacts, in lieu of the present round type. Inspection will thus be facilitated, weights and size will be reduced, and the later transition to prefabricated flat cabling will be facilitated.

Table 1-5

ELECTRICAL POWER SYSTEM PRIMARY FUNCTIONS

TASKS 1 & 2

			DISCOVERER			MIDAS			ADVENT	PROGRAM I					PROJECT 102		PROGRAM 201	-			
	FUNCTIONS	Deg. of Use	1110	1115	1124	1201	1204	1209	1501	2120	2202	2203	2207	2210	2301	2312	2401	6001	6101	6201	6301
I	Prime Electrical Energy Source																				
	Nuclear	few																			
	Chemical	most	x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x
	Solar	few				x	x	x													
	Prelaunch	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
II	Electrical Energy Storage	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
III	Electrical Energy Supply and Conversion																				
	Unregulated 22-29.3V DC	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Regulated +28.3V DC	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Regulated -28.3V DC	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	400 cycle 115 VAC	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	2000 cycle 115 VAC	most	x	x		x	x			x	x	x			x	x		x			
	Regulated ±28.0V DC	most				x	x	x	x	x	x	x ?	x	x	x	x	x	x	x	x	x
IV	Electrical Energy Distribution	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
V	Signal Energy Distribution	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
VI	Radio Frequency Energy Distribution	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
VII	Pyrotechnic Energy Distr.	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
VIII	Test Point Energy Distr.	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

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Table 1-6

ELECTRICAL POWER SYSTEM PRIMARY FUNCTION COMPONENTS

			DISCOVERER			MIDAS			ADVENT	PROGRAM I					PROJECT 102		PROGRAM 201	NASA			
	FUNCTIONS -- COMPONENTS	Deg. of Use	1110	1115	1124	1201	1204	1209	1501	2120	2202	2203	2207	2210	2301	2312	2401	6001	6101	6201	6301
I	Prime Electrical Energy Source																				
	Nuclear (Snap Programs)																				
	Chemical																				
	Primary Batteries																				
	Type I 1060629 ea (360 A/H - 9100WH)	few								5	5	7	7	6	3	5					
	Type IA 1060905 ea (360 A/H - 9100WH)	few	3	3 or 4	3												2				
	Type IIA 1062170 ea (45 A/H - 1200 WH)	few																1			
	Type IV 1062168 ea (10 A/H - 280 WH)	few																		2	2
	Type VA 1461387 ea (15 A/H - 325 WH) remotely activated	few					1	1			3c	3c	3c	3c							
	Type VI 1062762 ea (70 A/H - 1800 WH)	few	2	2 or 0	3												3				
	Type VIA 1461198 ea (45 A/H - 1200 WH)	few							2										2		
	Solar																				
	Array Assembly	few				1	1	1													
	Prelaunch (+28 VDC) AGE	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Main Power Transfer Switch ea 1062515	all	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
II	Electrical Energy Storage																				
	Secondary Battery																				
	Type IA 1060651-3 ea (22 A/H - 550 WH)	few				4	4	4													
	Type III 1062095 ea (0.225 A/H)	all	2	2	2	2	2	2	4	2	4	4	4	4	4	4	4	4	4	4	4
	1062095 Capsule ea	few																			
	Type VI 1461408 (0.450 A/H)																				

FORM MSD 1170-1 c = capsule

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Table 1-6 (Continued)

		Deg. of Use	DISCOVERER 1110	DISCOVERER 1115	DISCOVERER 1124	MIDAS 1201	MIDAS 1204	MIDAS 1209	ADVENT 1501	PROGRAM I 2120	PROGRAM I 2202	PROGRAM I 2203	PROGRAM I 2207	PROGRAM I 2210	PROJECT 102 2301	PROJECT 102 2312	Program 201 2401	NASA 6001	NASA 6101	NASA 6201	NASA 6301
III (cont)	Electrical Energy Supply and Conversion																				
	2000 CPS Load Limiter ea 1308656	most	1	1		2	2		1	1	1	1						1			
	Less Payload Peculiar																				
	2000 CPS Transfer Relay ea 1060604-3	few				1	1			1	1	1				1					
IV	Electrical Energy Distribution																				
	Direct Current																				
	Unregulated	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Regulated	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Alternating Current																				
	400 CPS 1 ø + 3 ø	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	2000 CPS 1 ø	all	x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
V	Signal Energy Distribution																				
	Telemetry																				
	Low Level	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	High Level	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Command																				
	Activation of Devices	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Operation of Signals	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
VI	Radio Frequency Energy Distribution																				
	VHF	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	UHF	most	x	x	x	x	x	x		x	x	x	x	x	x	x					
	SHF	few							x									x	x	x	x
VII	Pyrotechnic Energy Distribution	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
VIII	Test Point Distribution																				
	Umbilical	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Pad Checkout	all	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
	Systems Test	all	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

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Table 1-6 (Continued)

FUNCTIONS -- COMPONENTS	Deg. of Use	DISCOVERER 1110	DISCOVERER 1115	DISCOVERER 1124	MIDAS 1201	MIDAS 1204	MIDAS 1209	ADVENT 1501	PROGRAM I 2120	PROGRAM I 2202	PROGRAM I 2203	PROGRAM I 2207	PROGRAM I 2210	PROJECT 102 2301	PROJECT 102 2312	PROGRAM 201 2401	NASA 6001	NASA 6101	NASA 6201	NASA 6301
III Electrical Energy Supply and Conversion (cont)																				
400 Cycle 115 VAC (watts)																				
Single Phase																				
Type IA Pwr. Amp 1461173 (100 watt)		27	17 - 27		28*	24*	22*	29	24*	61*	90*	--	28	33	33	24.6	20	26	27	26
Less Payload Peculiar		24	10 - 25		28	24	22	NA	24	24	37	--	--	33	33	NA	NA	NA	NA	NA
Single Phase Regulated ±0.1%																				
Type II, 1 Phase Regulator 1060808 (25 W)		8	8	8																
Less Payload Peculiar		8	8	8																
Transformer 1062708 6.3 V Vel. MTR.					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Three Phase																				
Type IA Inverter (watts) (100/200 W) 1062210		64	59		114*	80*			70*											
Less Payload Peculiar		59	44		40	40			45											
Type IB Inverter (watts) (100/200 W) 1062816				59			104	27		45*	25*	--	-96	115	115	26.9	40	25	25	25
Less Payload Peculiar				44			40	NA		45	25	--	-31	23	23	NA	NA	NA	NA	NA
400 CPS Transfer Relay ea 1060603					2	2	2		2	2	2	2	2							
400 CPS Load Limiter ea 1301794					1	1														
2000 Cycle 115 VAC 1 ø (W)																				
Inverter Type IVA 1062209 (250W)	few	120	120																	
Less Payload Peculiar		66	66																	
Inverter Type IVC 1062860 (250W)	few							0		65*							80			
Less Payload Peculiar										65							NA			
Inverter Type IVD 1461174 (250W)	few										15*		90	144	144*	0		0	0	0
Less Payload Peculiar											15		82	75	75			NA	NA	NA
Inverter Type VIIA 1062676 (400W)	few				212*	101*			121*											
Less Payload Peculiar					191	86			71											

* indicates redundant item

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Table 1-6 (Continued)

FUNCTIONS -- COMPONENTS	Deg. of Use	DISCOVERER			MIDAS			ADVENT	PROGRAM I					PROJECT 102		PROGRAM 201	NASA			
		1110	1115	1124	1201	1204	1209	1501	2120	2202	2203	2207	2210	2301	2312	2401	6001	6101	6201	6201
III Electrical Energy Supply and Conversion																				
Unregulated 22-29.25 VDC	all	←			232 - 29000 (Less MIDAS & Proj I)															→
Watt-Hours																19500	232	583	440	435
Watt-Hours per mission TOTAL		27450	27000 to 29000					1008								NA	NA	NA	NA	NA
Less Payload Peculiar		26211	—					NA												
Watt-Hours per day	few				8500	9370	7800		5887	7534	9173	Unk	Unk	5918	5542					
Less Payload Peculiar					5180	6503	5600		4087	4000	6503	--	--	5218	4966					
Recovery Watt Hours										1225	853									
Regulated +28.3 VDC ±2%(watts)																45	17	11	13	11
Type IA 1060652-3 (110 W)								29								NA	NA	NA	NA	NA
Less Payload Peculiar								NA												
Type III 1062253 (350 W)		119	80-130		324	145			69	70	94		29	108						
Less Payload Peculiar		35	9-50		152	80			69	46	40		18	60						
Regulated -28.3 VDC ±2%(watts)																12.2	2	2	2	2
Type IA 1060750-3 (40 W)								2								NA	NA	NA	NA	NA
Less Payload Peculiar								NA												
Type II 1062471 (100 W)		11	8-20		60	62			24	29	32		78	7	10					
Less Payload Peculiar		5	5-12		2.6	4			19	5	15		10	4	-4					
Regulated ± DC (watts)																				
Type IV ±28.0 ±1%1062695					34	34		34	34	34	30	30	34	34	34	34	34	34	34	34
(+30/-30 watts)					34	34		34	34	34	30	30	34	34	34	34	NA	NA	NA	NA
Less Payload Peculiar					11	11		11	11	11	11	11	11	11	11	11	11	11	11	11
Type VII ±28.0 ±1% 1461001																				
(+12/-6 watts)					11	11		11	11	11	11	11	11	11	11	11				
Less Payload Peculiar																				
Type VIII ±28 ±2% 1461165						21	21													
(+28/-7 watts)																				
Less Payload Peculiar						21	21													
Type IX ±28.3 ±1% 1461397				25/4																
(+60/-20)																				
Less Payload Peculiar				25/4																
Type X ±28.3 ±1% 1461411				310/15																
Payload only																				
(+30/-15, +350 int)																				
Special ±28.3 (100/70)						75/45														

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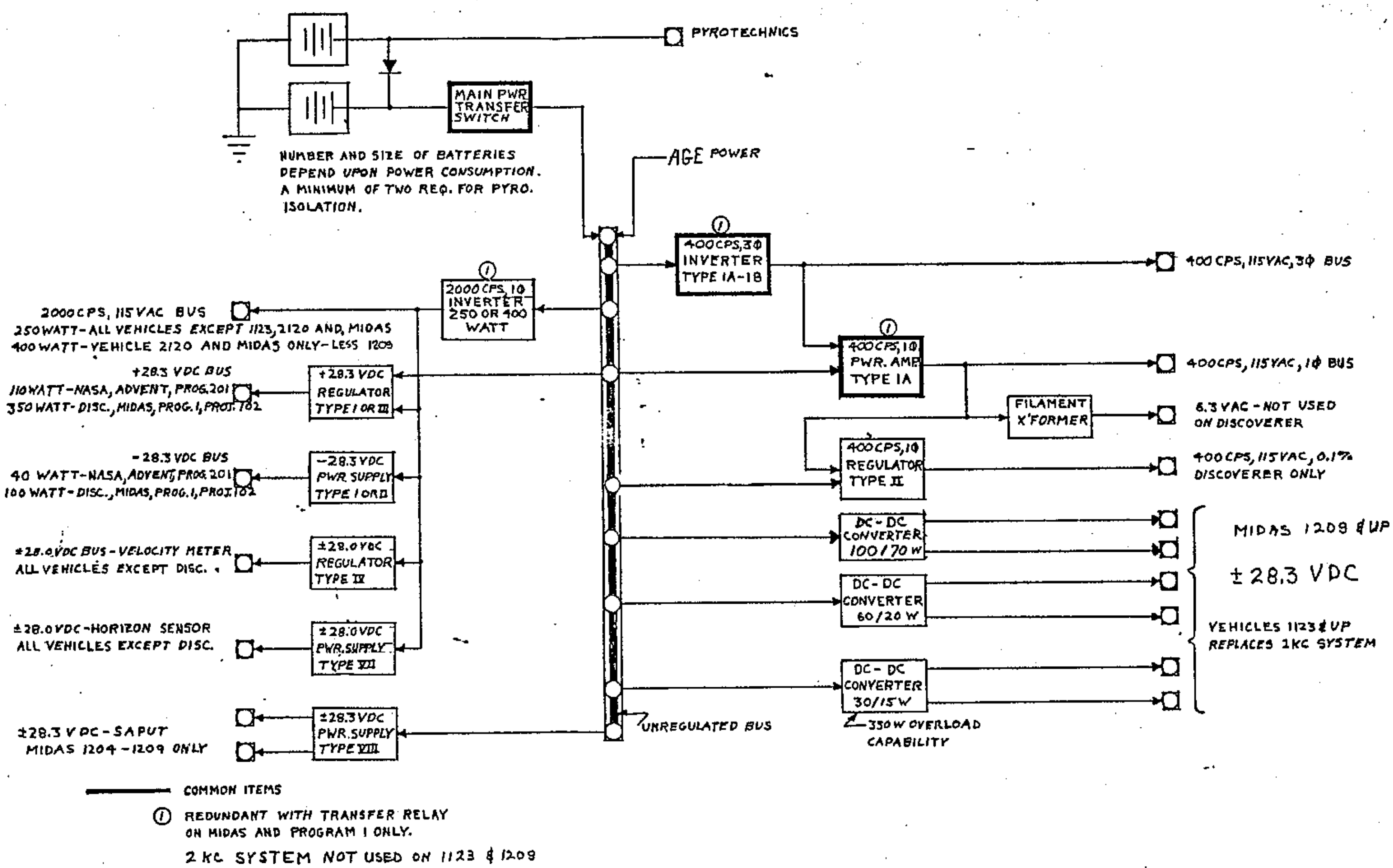

Figure 1-1 Agena Electrical Power System

GUIDANCE AND CONTROLS

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GUIDANCE AND CONTROLS

Tasks 1 and 2

From the listing of the functions performed by the Agena guidance and controls systems (Table 1-7) it can be concluded that all Agena programs require the establishment of orbit conditions and attitude control during ascent. Most of these programs require attitude control on orbit or during coast to apogee of the transfer ellipse and parking orbits. Also, most of the programs require the capability of control during maneuvers on orbit. All programs require programmed switching, but few require attitude indication.

Some obvious conclusions regarding Agena standardization can be drawn from a tabulation of the functions performed by the guidance and controls system. The operating altitude range of the Discoverer and MIDAS vehicles requires that the horizon sensor be used in preference to the horizon scanner because of the greater altitude range of the former instrument. The required accuracy of orbital period calls for the use of the velocity meter in preference to the Discoverer accelerometer-integrator. The required attitude accuracy on orbit for the Project 101-B vehicles demands the use of the Inertial Reference Package (IRP) with the MIG gyro. A gas control system is necessary on orbit to enable the vehicles to maneuver and to overcome the misaligned torques due to orbital period adjust. With the present equipment status, the pulse valves are necessary in order to minimize the gas leakage for prolonged periods of orbit operation; however, for extremely long orbital life, the inertial reaction system (reaction wheels and control moment gyros) is necessary. The use of pulse valves requires the use of the F/C electronics with pulse circuitry. In order to minimize control gas consumption for long time orbital operation, deadband control is necessary in the F/C electronics.

Because of weight considerations, it is not desirable to standardize on one booster guidance system. Instead, the BTL guidance system could be retained for the Thor while the GE guidance system is used for the Atlas. The modifications necessary to accommodate either system could be in the form of a plug-in module in the Agena primary junction box, the proper module being inserted when the Agena booster is selected.

Task 3

Table 1-8 is a breakdown of the guidance and controls equipments which are currently being used for the separate vehicles. From this listing, the items which are used on all or most Agena programs are as follows:

- Inertial Reference Package
- Horizon Sensor
- Flight Controls Electronics
- Primary Junction Box
- Velocity Meter
- Primary Sequence Timer
- Hydraulics Actuator and Package
- Secondary Junction Box
- Nitrogen Supply System
- Pneumatics Control Package

These items of equipment could perform all of the ascent functions and many of the orbital functions.

Task 4

The common function for which common components exist is that of establishing attitude accuracy for Agena ascent. It is possible to accomplish this function by use of the attitude controls components of the Project 101-B vehicles or the advanced MIDAS vehicles since these vehicles will have the capability of satisfying the requirements for all programs throughout the Agena ascent phase of flight. The block diagrams for these systems are shown in Figures 1-2 and 1-3. The components are:

Horizon Sensor
Inertial Reference Package (with MIG gyros)
Flight Controls Electronics
Primary Junction Box
Primary Sequence Timer
Hydraulic Actuator and Package
Secondary Junction Box
Nitrogen Supply System
Pneumatics Control Package

Although these components are common the internal circuitry is not common at present.

The common functions for which common components or circuitry do not exist are discussed below.

Establishment of Orbit Conditions. For this function, both the BTL and GE guidance systems are used. The velocity meter and accelerometer integrator perform the same function, but they are dissimilar; however, the former instrument could perform functions not possible with the latter device.

Establishment of Attitude Accuracy (on Orbit). No one system has the capability of establishing the vehicle attitude control in all the required vehicle orientations, nor do all systems have the capability for long life on orbit, as is required of the MIDAS vehicles.

The sequence timers are not identical for all programs.

An examination of the block diagrams (Figures 1-2 through 1-11) indicates that the point in the functional chain at which most uncommon conditions occur is the primary junction box. It is here that the circuitry which accommodates either the BTL or GE guidance system is located. Also, the circuitry which controls the vehicle orientation on orbit is switched through this unit. Gain changes, time constant and deadband switching occur here. It is through this unit that Project 101-B roll-yaw steering and the MIDAS inertia reaction system are incorporated in the Agena control system. Maneuvers on orbit are switched through this device as well.

The IRP contains circuitry for gyro compassing which is not standard with the various programs. The flight controls electronics contains non-linear gain, deadband control, and pulse circuitry which is non-standard, while the gas valves are both proportional and pulsed.

The timers are peculiar to the particular program.

Of the components which perform common functions, many are neither mechanically nor electrically similar. Those which are mechanically similar but electrically dissimilar are the IRP and horizon sensor.

Task 5

The modifications necessary to common components in order to perform common functions are largely confined to the primary junction box, IRP, and F/C electronics.

Ascent

To perform the common ascent functions, the primary junction box must accommodate the commands of either the BTL or GE guidance system of the Agena booster. In addition, this unit must be readily adaptable to gain, time constant, and deadband changes by insertion of a plug-in module. A standard gyro compassing mode for long coast phases must also be established.

The alignment of guidance and control equipment must be standardized. This requires one or more alignable unit(s) which necessitates modification of the packaging.

The flight controls electronics must be modified to accept a set of standard gains, time constants, etc.

The secondary junction box will require small changes to accommodate the standard telemetry.

An ascent timer, peculiar to each mission, must be readily inserted into the system.

Orbit

The modifications in the primary junction box necessary to perform the orbital functions are:

a. Provide for a plug-in module which will modify the ascent attitude control to conform to the mission peculiar orbit attitude control requirements; such as, gyro compassing on orbit, roll-yaw steering unit, control moment gyro input, pitch reaction wheel control, recovery maneuvers, etc.

b. Provide for gain, time constant, and deadband changes by means of a plug-in module.

Modifications are required in the IRP and F/C electronics to accept the signals from the primary junction box.

A mission peculiar timer is necessary in many cases; hence, the primary junction box must accept these signals.

The secondary junction box must conform to the standard orbital telemetry requirement; therefore, some modifications are necessary

Note on Block Diagram

The differences which exist in Figures 1-2 through 1-11 are not as great as appearances would indicate. The differences which exist in the block diagrams for coast phases for NASA and Discoverer with the MIDAS and Project 101-B are mostly due to the gas valve orientation; the valve clusters being on a horizontal axis for the former programs and on a vertical axis for the latter. Another apparent difference exists in the gyro-compassing mode for MIDAS and Discoverer (not shown) as compared with other programs. MIDAS and Discoverer utilize a simplified mode of gyro-compassing;

whereas, refinements were incorporated into other programs as additions to the MIDAS-Discoverer method. Hence, by standardizing on the refined gyro compassing (with small modifications), for all programs, all vehicle requirements can be met.

Table 1-7

FUNCTIONS OF GUIDANCE AND CONTROLS

			DISCOVERER			MIDAS			ADVENT	PROJECT 101	PROJECT 101B				PROJECT 102		PROJECT 201	NASA			
	FUNCTION	Deg. of Use	1110	1115	1124	1201	1204	1209	1501	2120	2202	2203	2206	2210	2301	2312	2401	6001	6101	6201	6301
I	ESTABLISH ORBIT CONDITION																				
	Period	all	93.8±1.4	91.0 ±1	91.0 ±1 MAX	168	168	168			90.89	90.89	90.89	90.8	91.93	91.93	88.65±.22	88.4	105	107.4	109.4
	Max Velocity-to-be-gained	all-	17331	NA	NA										15909	15909	10300	10455	16292	16905	16481
	Max Velocity Adjust	most				NA	125 fps		NA		NA	NA	NA	NA	162.86	162.86	1500±3 Max OA	NA	NA	NA	NA
	Min Velocity Adjust	most					.1 fps		NA		NA	NA	NA	NA			100 ±.5 Mn1 ±.1				
	Altitude	all	165	130	113	1850±50															
	Nom						2000±44	2000±44		261±35	173	173	173		200	200	123.8	100	540±43	600±40	650
	Max				200						221	221	221				137	115	560	615	665
	Min				105						125	125	125	172±2			105	85	520	585	635
	Injection																117±2.2				
	Eccentricity	all	NA	NA	NA	.01	.007	.005	.01	.01				.003	.01	.01		.0042	.0050	.0037	.0037
	Inclination	all		81.8°	70°-90°	90°±2°	90°±.5°	90°±.5°	33.5°±3°	83°±1°	90°±1°	90°±1°	90°±1°	90°±.5°	82° Retro	82° Retro	92±0.7 PRO	29±40° PRO	80±1° PRO	80.5 Retro	70-80° PRO
	Time of Launch (Window)	all	12:00 - 5:00 PST			Twilight (±45 min)	Random (±45min)	Random (±20min)	Traj Depend.	12:00±1 PST	12:00±1 PST	12:00±1 PST	12:00±1 PST	12:00±1 PST	12:00±2 PST	12:00±2 PST	11:00±1/3 PST	0200 -1800 EST	0330 +1-0 PST	2300 +1-0 PST	0200 +4-2 PST
	Timer Start		t=0	t=0	t=0	273	App 270	App 270	274	App 275	274	274	274	274	t=0	t=0		273	0	0	0
	Booster Guid		BTL	BTL	BTL	GE	GE	GE	GE	GE	GE	GE	GE	GE	BTL	BTL	GE	GE	BTL	BTL	BTL
						Altitude Requires Horizon Sensor	Vel. and Period Adj. Require V.M., Also Requires Gas System										Vel. Adjust. and Period Require Velocity Meter				

FORM MSD 1170-1

Table 1-7 (Continued)

FUNCTION	Deg. of Use	DISCOVERER 1110	DISCOVERER 1115	DISCOVERER 1124	MIDAS 1201	MIDAS 1204	MIDAS 1209	ADVENT 1501	PROJECT 101 2120	PROJECT 101B 2202	PROJECT 101B 2203	PROJECT 101B 2206	PROJECT 101B 2210	PROJECT 102 2301	PROJECT 102 2312	PROJECT 201 2401	NASA 6001	NASA 6101	NASA 6201	NASA 6301
II ESTABLISH ATTITUDE ACCURACY																				
(Ascent - all)																				
(Orbit - most)																				
Pitch)		6°max±1°	6°max±1°	6°max±1°													3.2°	6°	6.3°	5.5°
Roll) 1st Coast	all	NA	NA	NA													±3°	±3	±3	±3
Yaw)		±.3°	±.3°	±.3°													±1.2	±1	±1	±1
Pitch)		6°max±1°	6°max±1°	6°max±1°		10°max±.3	10°max±.3			10°max±.4	10°max±.4	10°max±.4	10°max±.4			8 max	±0.5°	±.5	±.5	±.5
Roll) 1st Burn	all	±1.5°	±1.5°	±1.5°						±0.5°							±3	±3	±3	±3
Yaw)		±1.0°	±1.0°	±1.0°		±.5	±.5			±0.6°							±1.5	±1.8	±1.8	±1.8
Pitch)		NA	NA	NA					NA	NA	NA	NA				NA	±1	±1	±1	±1
Roll) 2nd Coast	few																±3	±3	±3	±3
Yaw)																	±4.7	±3.4	±3.4	±3.4
Pitch)						±.5	±.5										±0.5	±0.5	±0.5	±0.5
Roll) 2nd Burn	few	NA	NA	NA					NA	NA	NA	NA				NA	±3	±3	±3	±3
Yaw)						±1°	±1°										±4.5	±3.2	±3.2	±3.2
Pitch)		1.5 °2°	1.5 °2°	1.5 ±2°	90°±1°	90°±1°	90°±1°	±.86	90°±1°	±2°	±0.5°	±0.5°	±2°	90°±10°	90°±10°	±.85°	±1°	±1°	±1°	±1°
Roll)		±3°	±3°	±3°	±1°	±1°	±1°	±3.52	±1°	±2°	±0.5°	±0.5°	±2°	±10°	±10°	±.85°	±3	±3	±3	±3
Yaw)		180 ±3.5°	180±3.5°	180±3.5°	±1°	±1°	±1°	± .86	±1°	±2°	±0.5°	±0.5°	±2°	±10°	±10°	±1.0°	±5	±3.4	±3.4	±3.4
Yaw Bias) Orbit (fine)	most							(END			±0.3°	±0.3°	NA				(END CONDITIONS)			
)								COND)												
Pitch Rate)										180°/hr	40°/hr	40°/hr	180°/hr	100°/hr	100°/hr	108°/hr				
Roll Rate)										"	"	"	"	"	"	"				
Yaw Rate)										"	60°/hr	60°/hr	"	--	--	"				
Pitch)										±3°	±3°	±3°	±3°			±3°nom				
Roll) Orbit	few	NA	NA	NA						±3°	±3°	±3°	±3°			±3°nom				
Yaw) (coarse)										±3°	±3°	±3°	±3°			±3°nom				
											ACCURACY REQUIRES MIG GYROS (MOD IIIA, IRP) AND RATE CIRCUITRY									

NASA columns: ESTIMATED ACCURACY

FORM MSD 1175-1

Table 1-7 (Continued)

FUNCTION		Deg. of Use	DISCOVERER 1110	DISCOVERER 1115	DISCOVERER 1124	MIDAS 1201	MIDAS 1204	MIDAS 1209	ADVENT 1501	PROJECT 101 2120	PROJECT 101B 2202	PROJECT 101B 2203	PROJECT 101B 2206	PROJECT 101B 2210	PROJECT 102 2301	PROJECT 102 2312	PROJECT 201 2401	NASA 6001	NASA 6101	NASA 6201	NASA 6301
III	ESTABLISH ATTITUDE ACCURACY WITH MANEUVERS (Orbit - most)																				
	Pitch)											±2°	±2°	NA							
	Roll) Roll Steering	few	NA	NA	NA	NA	NA	NA	NA	NA		15°±30° ±2°					NA				
	Yaw)											±2°									
	Yaw Yaw steering	few	NA	NA	NA	NA	NA	NA	NA	NA		3.58° cos(LAT)		NA			NA				
	Pitch)																±1.5°				
	Roll) Orb. Adj. (fwd)	few	NA	NA	NA	NA	✓	✓	NA	NA				NA			±1.5°				
	Yaw)																±2.0°				
	Pitch)																±1.5°				
	Roll) Orb. Adj. (rear)	few	NA	NA	NA	NA	✓	✓	NA	NA				NA			±1.5°				
	Yaw)																180±5.5°				
	Pitch)		-51°±4°	-51°±4°	-51°±4°						-55°±1.5°	-55±1.5°	-55±1.5°	-60±1.5°			-60nom±1.5°				
	Roll) Recovery	few	0 ±3°	0 ±3°	0 ±3°	NA	NA	NA	NA	NA	±1.5	±1.5	±1.5	±1.5°			±1.5°				
	Yaw)		180 ±5°	180 ±5°	180 ±5°						180±1.5°			180±1.5°			180±1.5°				
	Pitch)										36°±3°	36°±3°	36°±3°	36°±3°							
	Roll) Special	few	NA	NA	NA				NA	NA	±3°							3°/sec	1°/sec	3°/sec	NA
	Yaw) Maneuvers										180°±3°							END	CONDITIONS		
																		FOR 6101: Attitude at separation perpendicular to ecliptic plane ±5°			

ORBIT PERIOD ADJ. REQUIRES VEL. METER AND GAS SYSTEM

FORM MSD 1126-1

Table 1-7 (Continued)

			DISCOVERER			MIDAS			ADVENT	PROJECT 101	PROJECT 101B				PROJECT 102		PROJECT 201	NASA			
	FUNCTION	Deg. of Use	1110	1115	1124	1201	1204	1209	1501	2120	2202	2203	2206	2210	2301	2312	2401	6001	6101	6201	6301
IV	PERFORM PROGRAMMED SWITCHING (Ascent - all) (Orbit - most)																				
	Ascent Oper. Time	all	753	750	750	4228	App 4500	App4500	5774	520	489.5	441	App 450	App 490	3510	3510	554	1920 L.O.	3595 L.O.	3610 L.O.	3577 L.O.
	Total Timer Cap		2000	2000	2000	6000	6000	6000	7000		2x2000	2x2000	2x2000	2x 2000	6000	6000	2x2000	2x2000	6000	6000	6000
	No. Switching Functions		24	24	24	24	24	24	22		48	48	48	48	24	24	28	48 (two timers for 6001)	24	24	24
	Special Functions																Orbit Adjust 4 events				
V	Attitude Indication	few							NA	P ±.1° R ±.1° Y NA	P ±.1° R ±.1° Y NA	P ±.3° R ±.3° Y NA	P ±.3° R ±.3° Y NA	P ±.3° R ±.3° Y NA	P ±.5° R ±.5°	P ±.5° R ±.5°	Diagnostic				
VI	Life on Orbit	most	4 days	4 days	4 days	45 days	90 days	6 mos	none	120 day	4 days	5 days	5-8 day	6 days	4.5 day	7.5 day	5 days	30 min	30 min	15 min	15 min
	(notes)						LONG LIFE REQUIRES WHEEL SYSTEM				LIFE & WEIGHT REQUIRES F/C ELECTR. WITH DEADBAND, ALSO LOW LEAKAGE PULSE GAS VALVES										

FORM MSD 1170-1

Table 1-8

GUIDANCE AND CONTROLS EQUIPMENT UTILIZATION

		DISCOVERER		MIDAS			ADVENT	PROJECT 101A	PROJECT 101B				PROJECT 102		PROJECT 201	NASA			
	Deg. of Use	1115	1124	1201	1204	1209	1501	2120	2202	2203	2206	2210	2301	2312	2401	6001	6101	6201	6301
Electronic Assembly F/C System	all																		
1318619																x	x	x	x
1310199								x											
1315252									x	x	x	x							
1314713		x	x																
1304574				x															
1317312					x	x													
1325253							x												
1332155													x						
1334724														x					
1325125															x				
Junction Box Pri. or Guidance Computer	all																		
1317316					x	x													
1314716		x	x																
1309660				x															
1315255									x			x							
1321473										x	x								
1325126															x				
1318368																x	x	x	x
1310256								x											
1325251							x												
1332156													x						
1334725														x					
Junction Box, Secondary, Guid.	all																		
1314730		x	x																
1309661				x															
1317320					x	x													
1325252							x												
1313624																x	x	x	x
1334726														x					
1325127															x				
1315258									x			x							
1321474										x	x								
1310257								x											
1332157													x						
IRP	all																		
1062256-3				x				x	x			x				x			
1062256-5										x									
1062256-7					x	x							x				x		x
1062256-9											x				x				
1062256-11							x							x				x	
1062256-13		x	x																

FORM MSD 1170-1

Table 1-8 (Continued)

	Deg. of Use	DISCOVERER		MIDAS			ADVENT	PROJECT 101A	PROJECT 101B				PROJECT 102		PROJECT 201	NASA				
		1115	1124	1201	1204	1209	1501	2120	2202	2203	2206	2210	2301	2312	2401	6001	6101	6201	6301	-
Velocity Meter	most																			
1461045-1							x			x	x		x	x	x	x	x	x	x	
1062654-1				x				x	x			x								
1461045-3					x	x														
Horizon Scanner	few																			
1062467-15		x	x																	
Horizon Sensor	most																			
1325425				x																
1062479-5					x	x	x		x	x	x	x	x	x	x					
1062479								x								x	x	x	x	
Sequence Timer, Primary	most																			
1334727														x						
1325129															x					
1313625																x				
1317616																	x	x	x	
1309662				x																
1317324					x	x														
1315261									x			x								
1321477										x	x									
1310258								x												
1332158													x							
1325254							x													
Hydraulic Package & Act.	all																			
(Integrated Hydraulic Package)																				
1062525-1							x									x	x	x	x	
1062525-3		x	x						x	x	x	x	x	x	x					
1310913				x	x															
Hydraulic Actuators	all																			
1062509																x	x	x	x	
1062509-1		x	x				x		x	x	x	x	x	x	x					
1062509-3		x	x				x		x	x	x	x	x	x	x					
Reaction Wheel Electr.	few																			
1062652				x				x												
1315322					x	x														
Assy.																				
1062651				x				x												
1062706-1					x	x														

FORM MSD 1179-1

Table 1-8 (Continued)

	Deg. of Use	DISCOVERER 1115	DISCOVERER 1124	MIDAS 1201	MIDAS 1204	MIDAS 1209	ADVENT 1501	PROJECT 101A 2120	PROJECT 101B 2202	PROJECT 101B 2203	PROJECT 101B 2206	PROJECT 101B 2210	PROJECT 102 2301	PROJECT 102 2312	PROJECT 201 2401	NASA 6001	NASA 6101	NASA 6201	NASA 6301	
Control Moment Gyro	few																			
Yaw																				
1062611-5								x												
1062611-1				x	x	x														
Roll																				
1062611-5								x												
1062611-3				x	x	x														
Junction Box, Secondary Guidance #2	few																			
1321476										x	x									
1311882									x			x								
Roll-Yaw Steering Unit	few																			
1321479										x	x									
Sequence Timer, Secondary	few																			
1317613																x				
Sun Position Amplifier	few																			
1313376		x	x																	
1322849									x	x	x	x			x					
Sun Position Indicator	few																			
1304566		x	x						x	x	x	x			x					
Sequence Timer Receiver	few																			
-- 1315265									x			x								
1321478										x	x									
1325130															x					
Nitrogen System (Controller Th	all																			
1062318-9																	x	x	x	
1461316															x					
1060550-11		x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	
1062318-5																x				
1062667-1					x				x	x	x	x	x							
1060715-4		x	x	x			x													
1461316-1						x														
1461360														x						
Pneumatic Control Package	all																			
1062668					x	x			x	x	x	x	x	x						
1062500-1		x	x	x			x									x	x	x	x	
1062668-1															x					

FORM NSD 1170-1

Table 1-8 (Continued)

		DISCOVERER		MIDAS			ADVENT	PROJECT 101A	PROJECT 101B				PROJECT 102		PROJECT 201	NASA				
	Deg. of Use	1115	1124	1201	1204	1209	1501	2120	2202	2203	2206	2210	2301	2312	2401	6001	6101	6201	6301	
Ampl Assy Horizon Sensor Head 1323480-501	few						x													
Orbital Timer 1461179-1	few				x	x														

FORM MSD 1170-1

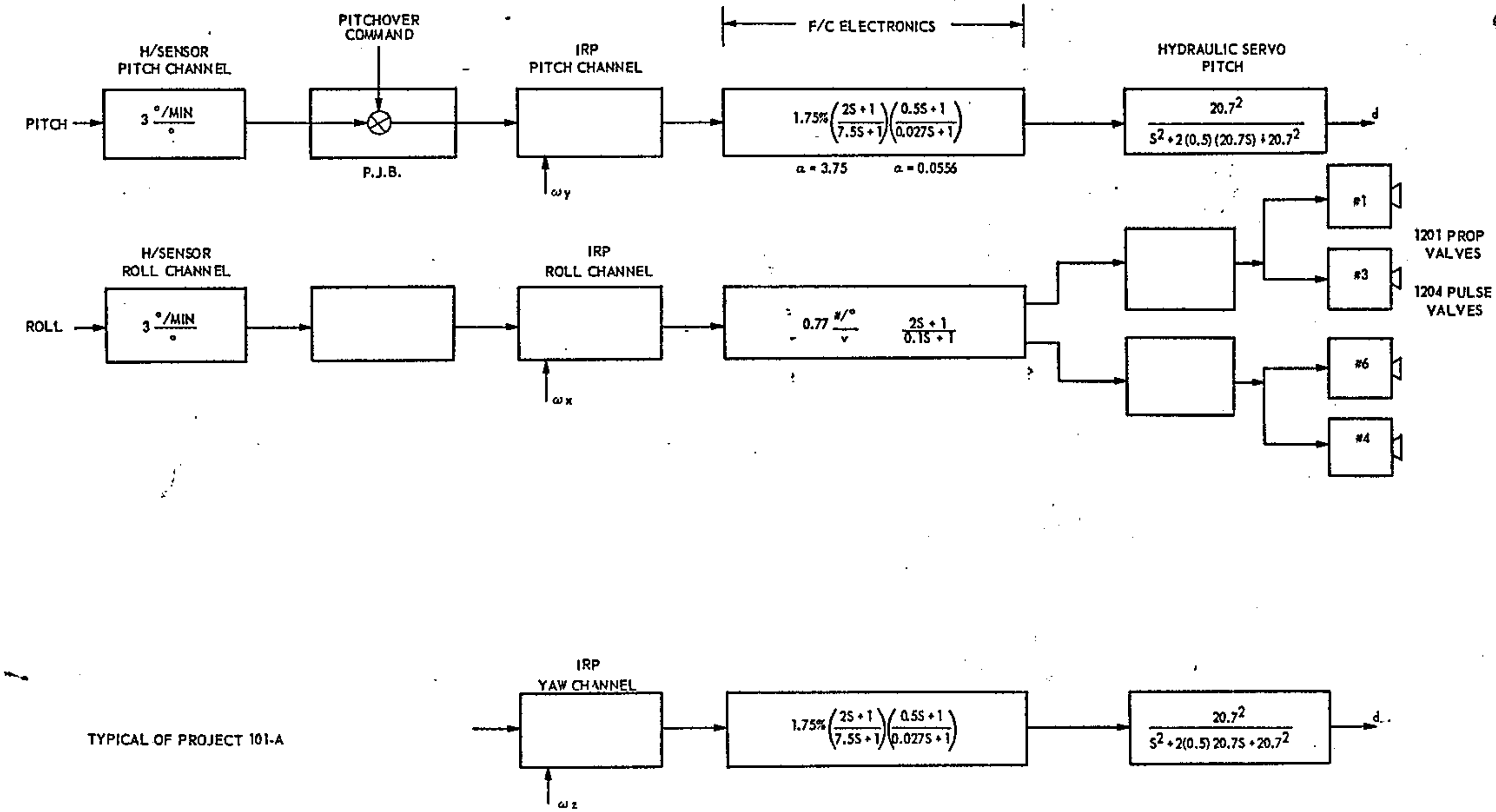

Figure 1-2 MIDAS Agena Engine Burn

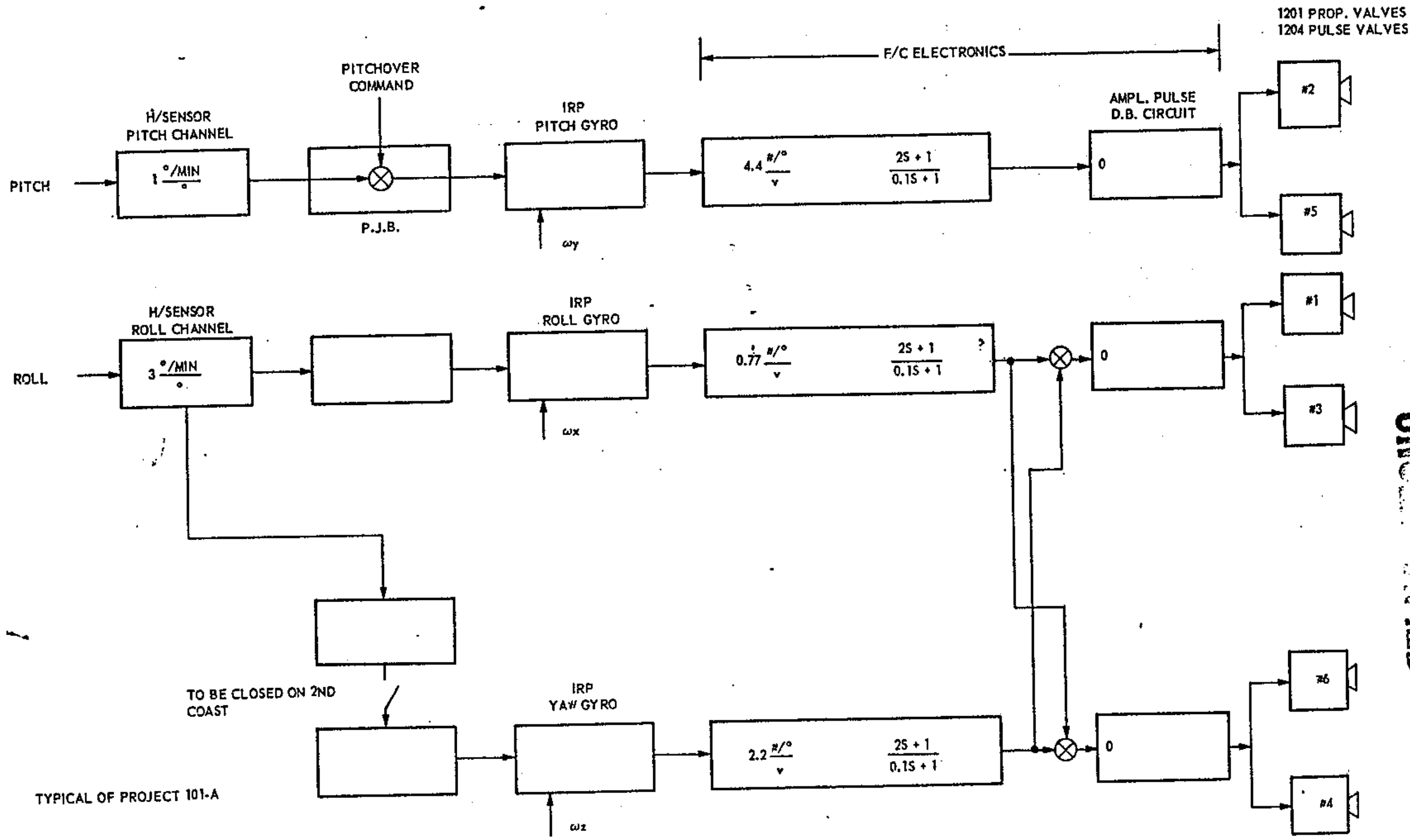

Figure 1-3, MIDAS Coast, Guidance and Control

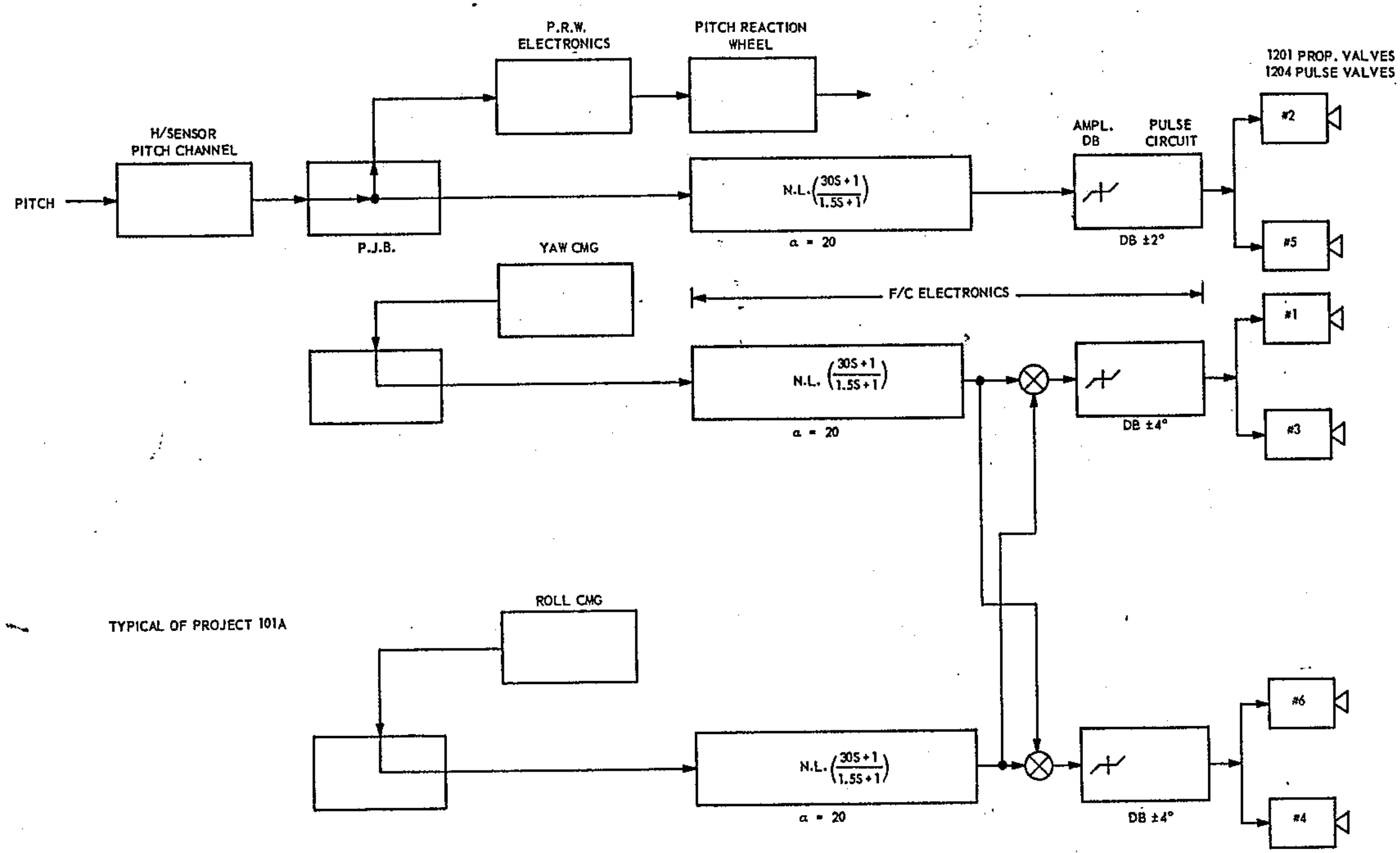

Figure 1-4 MIDAS Orbit, Guidance and Control

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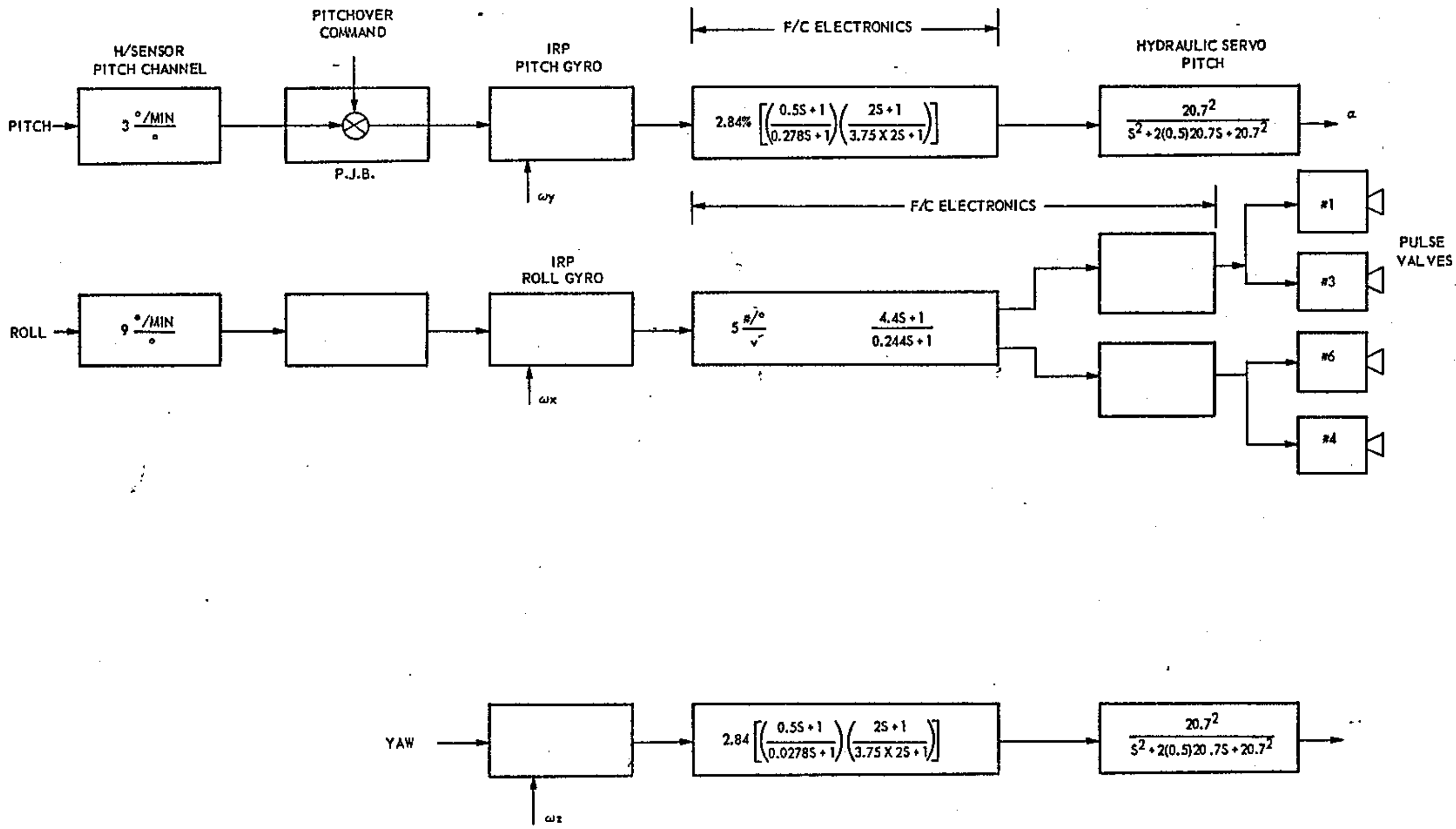

Figure 1-5 Program 101-B and 201 Agena Engine Burn

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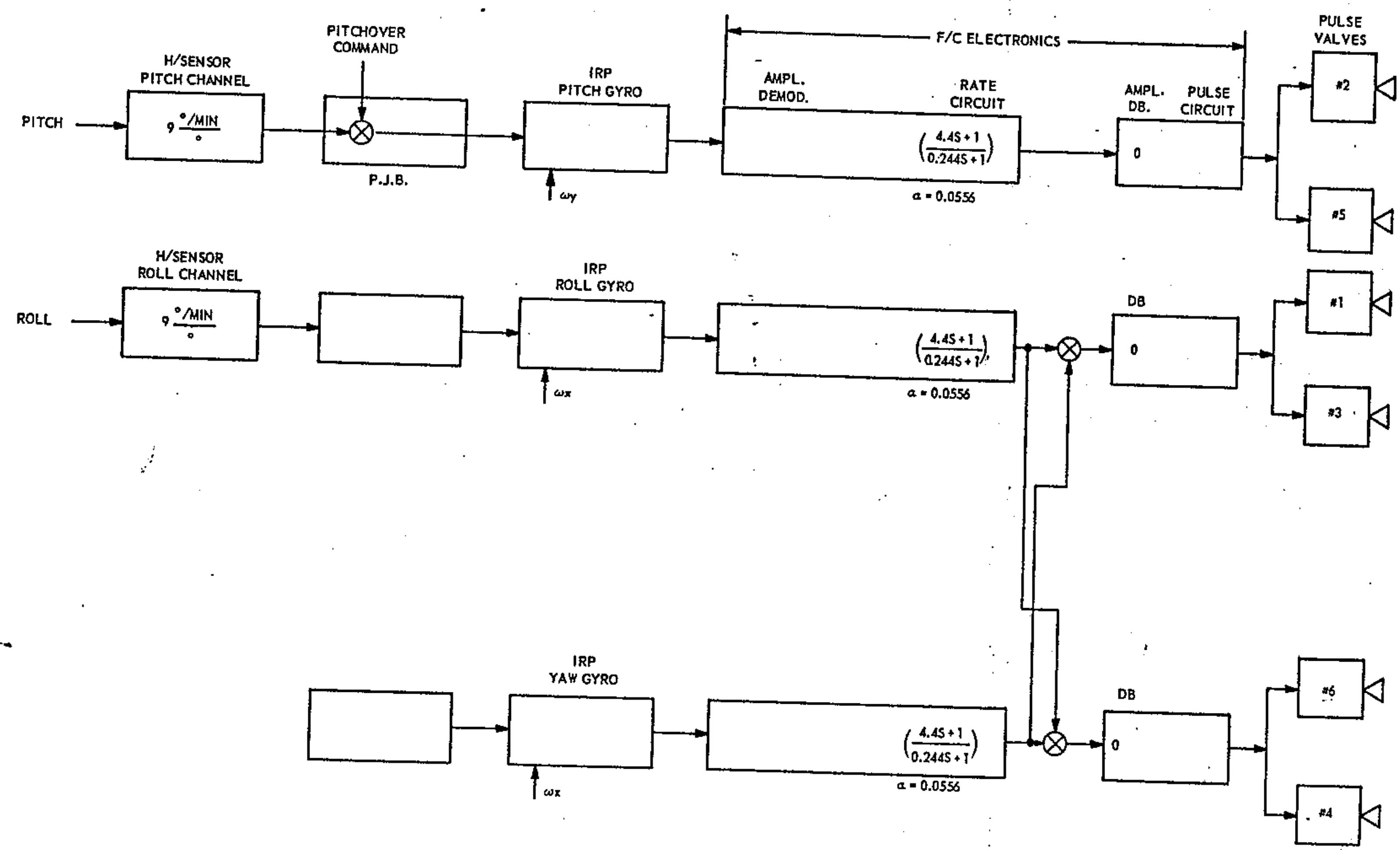

Figure 1-6 Program 101-B and 201 Coast

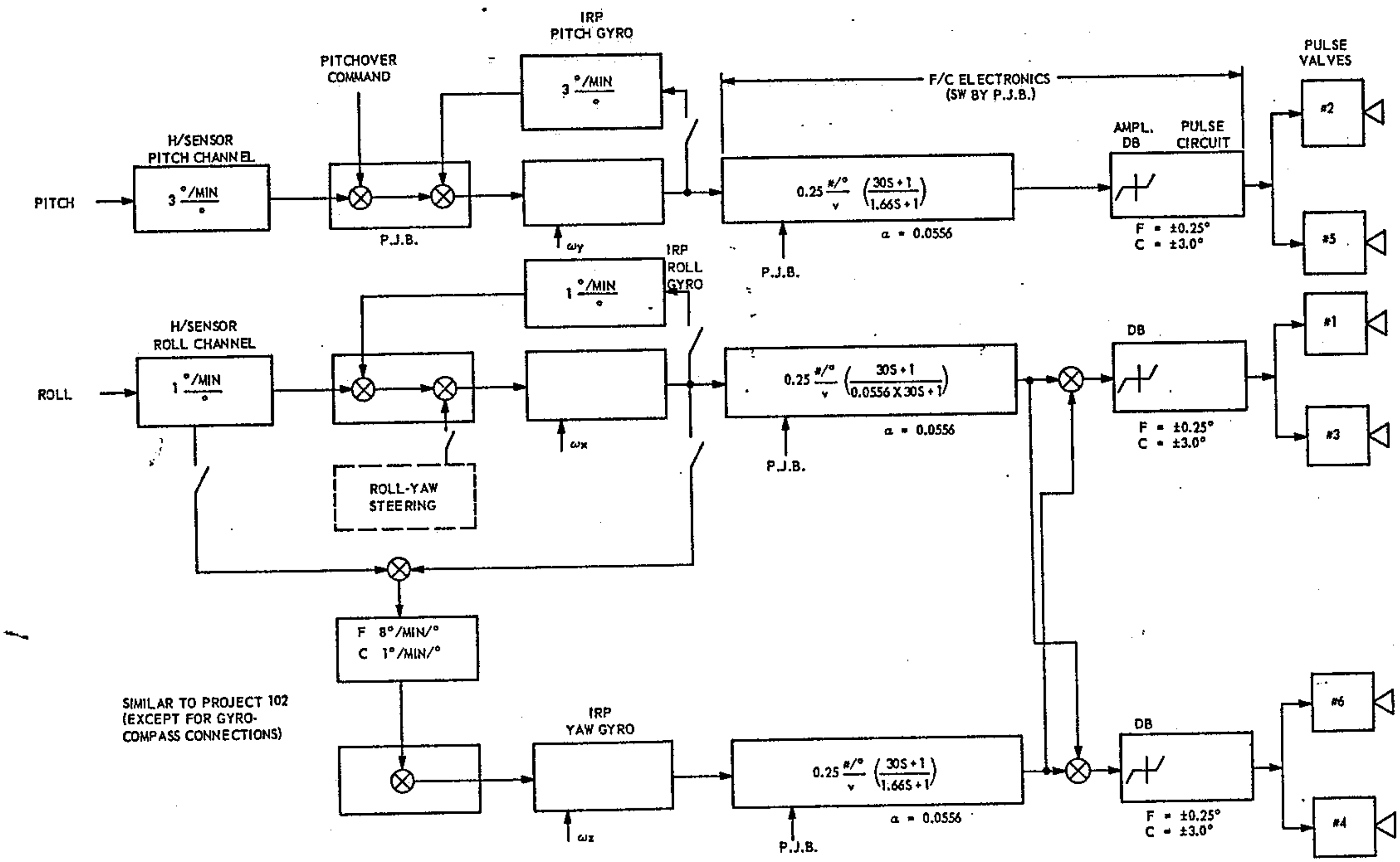

Figure 1-7 Program 101-B and 201 Orbit

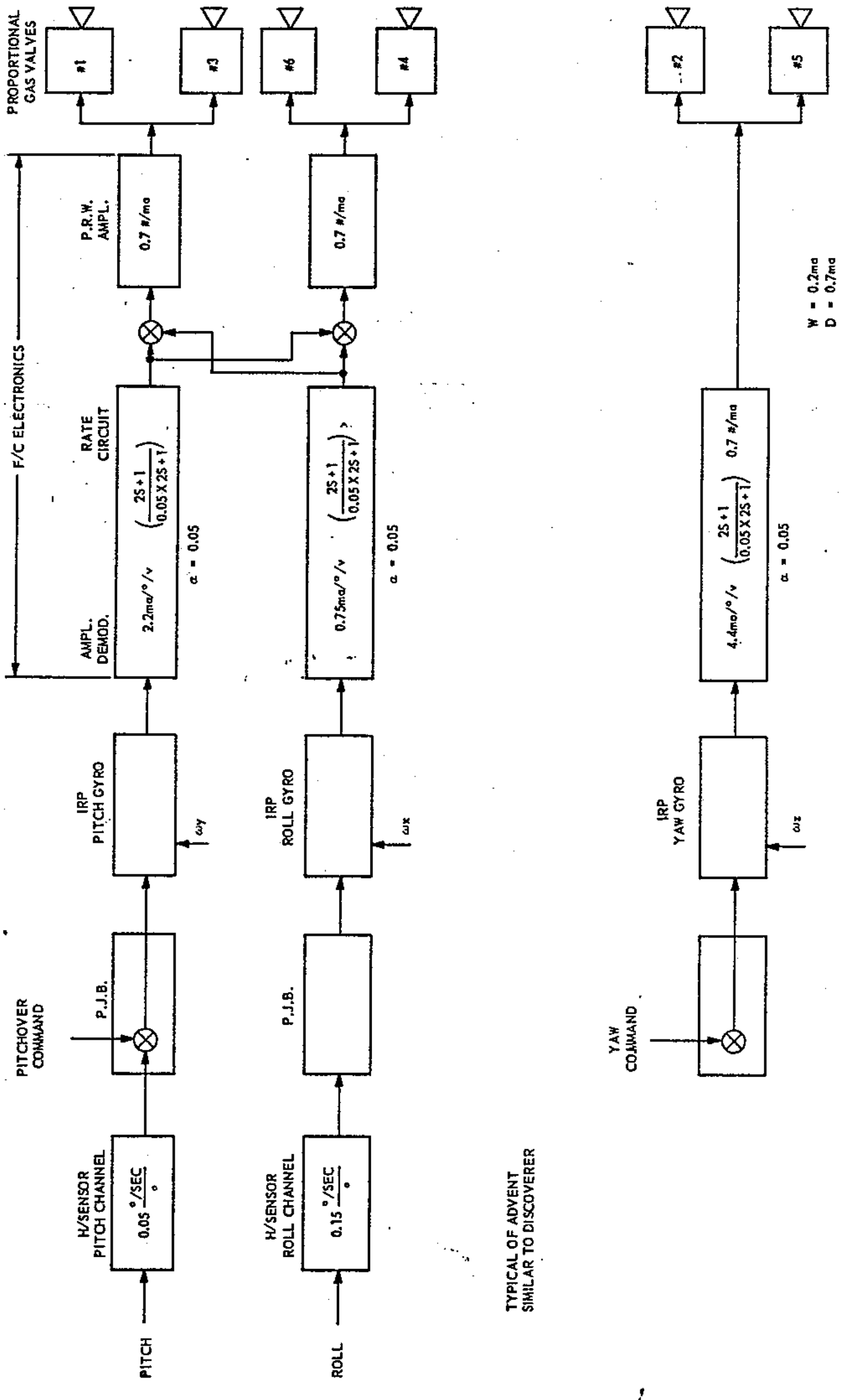

Figure 1-8 NASA First Coast

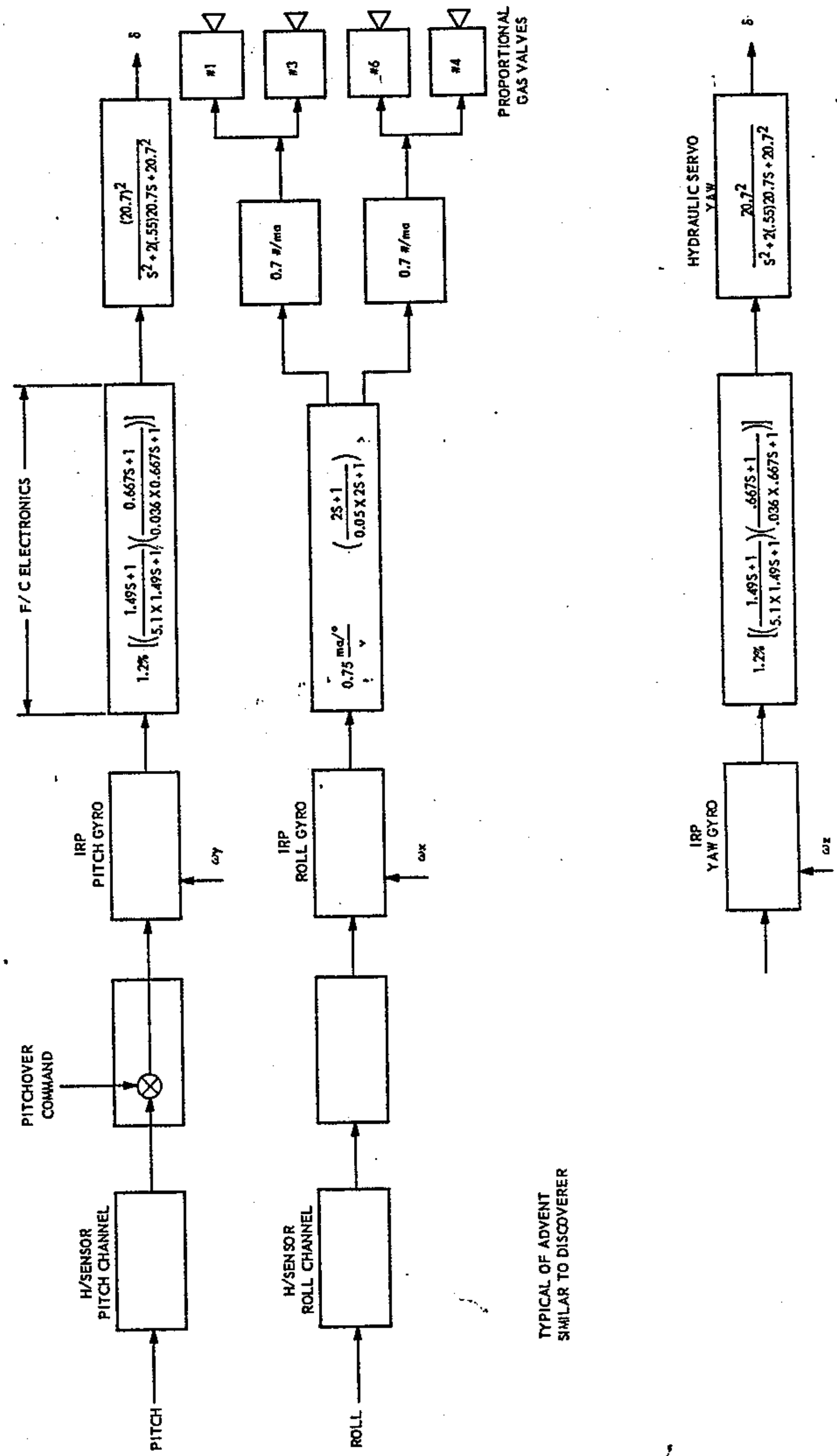

Figure 1-9 NASA Agena Engine Burn

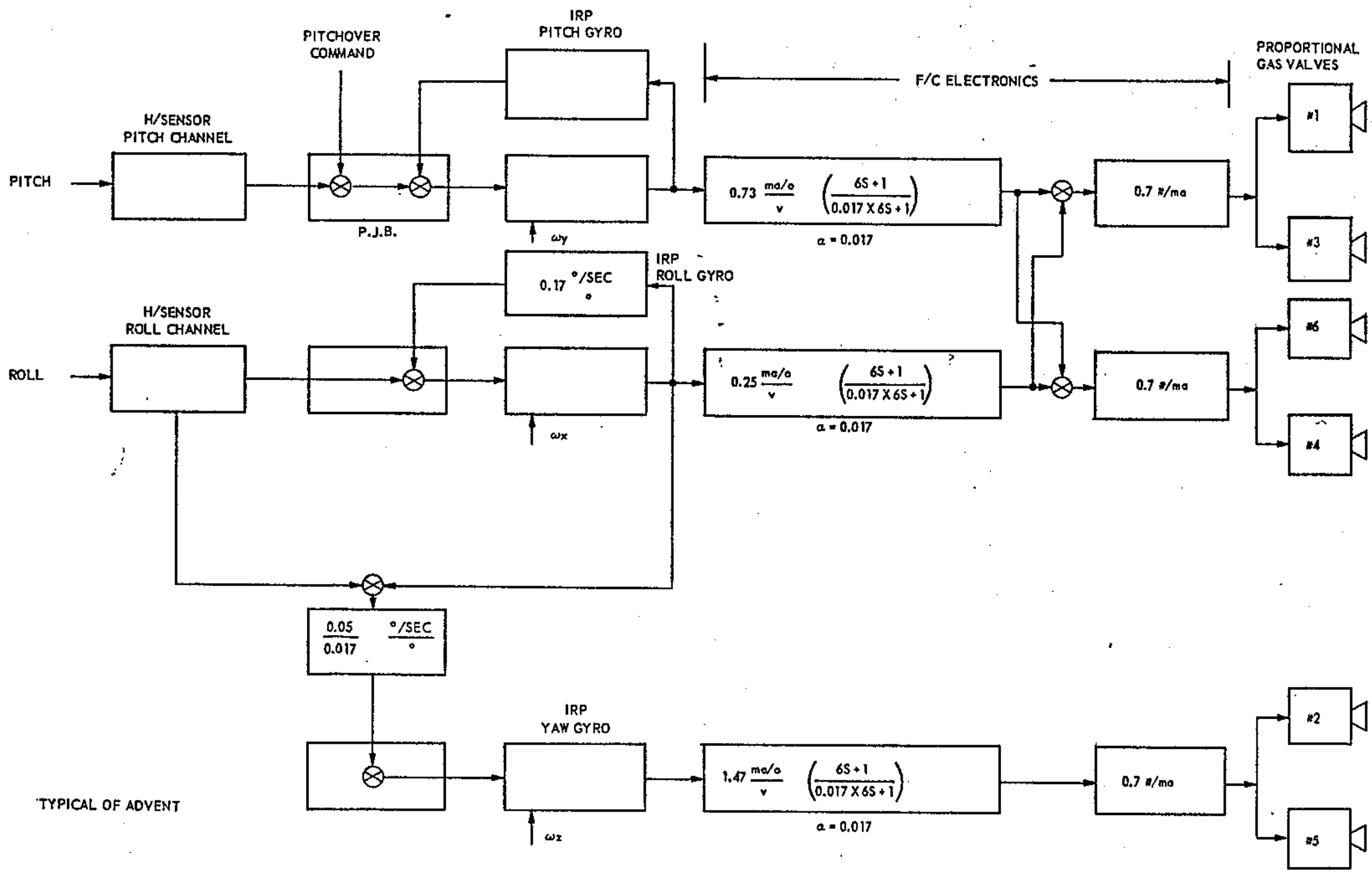

Figure 1-10 NASA Second Coast

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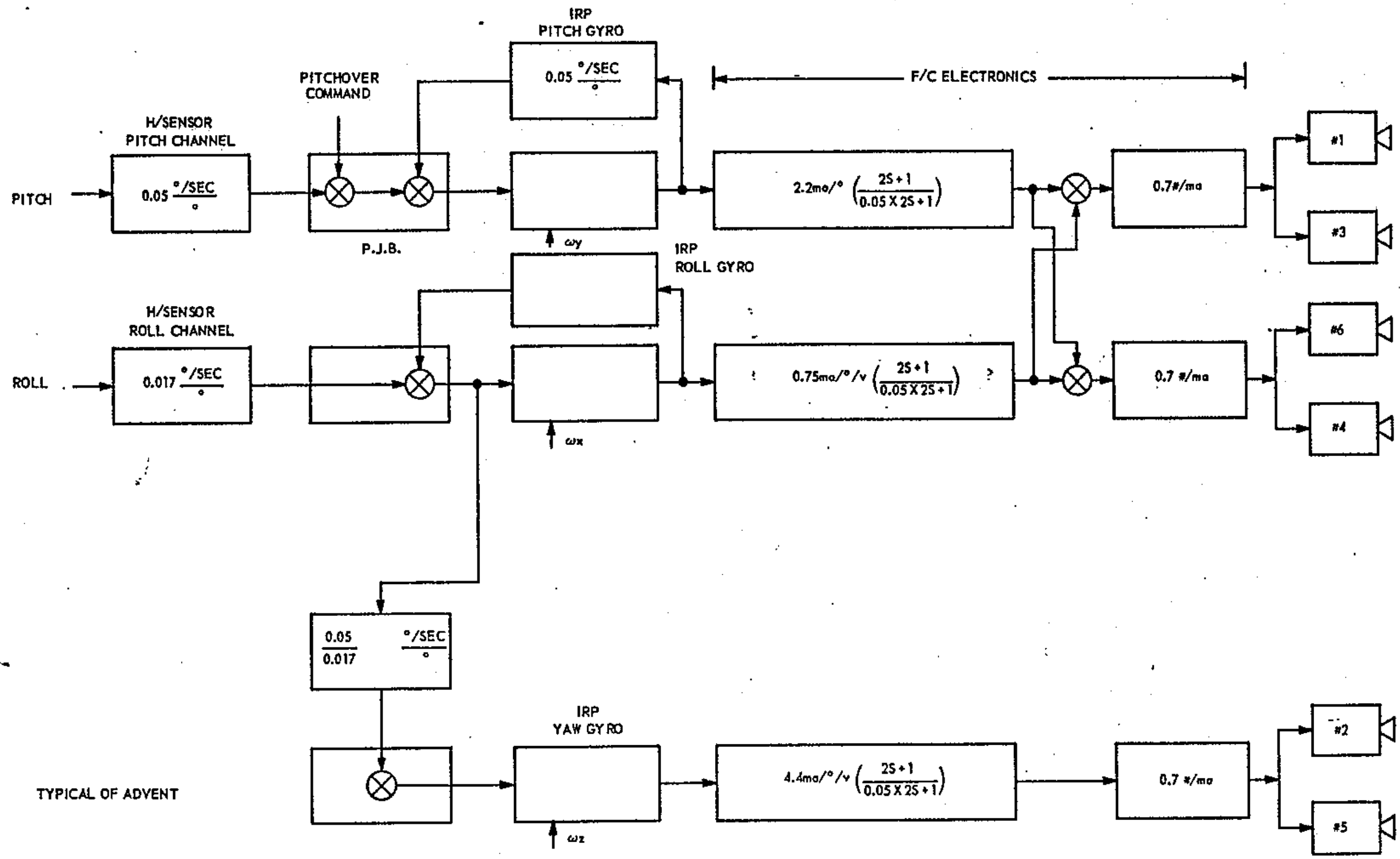

TYPICAL OF ADVENT

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COMMUNICATION AND CONTROL

COMMUNICATION AND CONTROL

Tasks 1 Through 3

The functions performed by the Agena have been reviewed for all programs in sufficient detail that individual equipment, components and, in some instances, circuitry are identified. The basic functions discerned are telemetry, acquisition, tracking, command, and RF propagation, and are correlated in detail in Table 1-9. It can be noted that the functions are relatively common for all or at least most programs and that the equipment utilized to perform these functions is of similar types. Individual configurations and minute circuitry, however, vary extensively from vehicle to vehicle. (See Table 1-10.) Extensiveness of component usage is summarizes as follows:

a. Telemetry and test instrumentation
   (1) FM/FM UTLM Type I - all programs
   (2) FM/FM UTLM Type II - to replace Type I
   (3) GP-PAM - MIDAS 1209 and up and Project 101-B, 2203 and up, and MIDAS 1209 and up.

   NOTE: Instrumentation requirements vary among programs, but transducer types and output signals to telemeters are relatively standardized.

b. Acquisition and tracking
   (1) Acquisition transmitter - most programs
   (2) S-band transponder - Discoverer, MIDAS, and Program I
   (3) C-band transponder - NASA

c. Command and control
   (1) S-band decoder and interim programmer - Discoverer and Program I
   (2) LODAP and UHF receiver - MIDAS 1201 and Project 101-A
   (3) MOP I and UHF receiver - MIDAS 1204 and up

Task 4

It may be concluded from the foregoing study that common functions using common components and circuitry are instrumentation and acquisition. Similarly, common functions not using common components and circuitry are telemetry, tracking, command, and RF propagation. A comparison of common functions with common and uncommon conditions was made and is included in Table 1-11. Components which perform common functions and are mechanically identical but electrically dissimilar are the S- and C- band beacons.

Task 5

Modifications to present equipment or development of new items required for the Standard Agena are discussed in the following paragraphs.

New flat plugs and flat plug wiring concept have been incorporated into all equipment as detailed in electrical power supply section. In particular, optional equipment such as S-band, C-band or other beacons shall be provided with common mounting and electrical interfaces so that the vehicle may accept any one as required by the individual mission without need for special implementation. Other optional items too shall be provided with necessary cabling, plugs, etc., to permit ready adaption to Agena interface connectors.

Repackaging of the PAM telemetry system has been studied and is feasible. This would eliminate numerous interconnecting cables and connectors and reduce total weight by approximately 25%. The shape would also be more ideal and the total volume would reduce from 1300 to 450 cubic inches.

A new modular power control unit is being developed under the MIDAS contract and will be available for Standard Agena use. It will employ from 5 to 10 relays and 4 time delay circuits. One or more of these may be strategically located within clusters of equipment to minimize wiring lengths and related system complexity. The units are anticipated to weigh approximately 8 ounces each.

A new concept in orbit antenna is being contemplated wherein space provision is provided on the minus X and plus X axis to house inflatable-extensible arrays to be developed for peculiar missions. At least two configurations would be required; one for horizontally-oriented and one for vertically-oriented satellites. A study has been completed by LMSC Antenna Lab for Wright Air Development Center with positive results. Qualification testing of a large three-element yaggi array for low frequency space use is currently in process.

Table 1-9

AGENA VEHICLE FUNCTIONS, COMMUNICATION AND CONTROL
TASKS 1, 2 AND 3

	DISCOVERER			MIDAS			ADVENT	PROJ 101A	PROJECT 101B				IA	PROJECT 102		PROJ 201	NASA				DEGREE OF USE				CONCLUSIONS
																						COMPONENTS			
FUNCTION	1110	1115	1124	1201	1204	1209	1501	2120	2202	2203		2206	2210	2301	2312	2401	6001	6101	6201	6301	FNCTN	ALL	MOST	FEW	
1. TELEMETRY:																									
Type	FM-FM UTLM	FM-FM UTLM	FM-FM UTLM Type II	FM-FM UTLM	FM-FM UTLM Status	GP-PAM Status& Failure	FM-FM UTLM Type II	FM-FM UTLM P-PAM	FM-FM UTLM	FM-FM UTLM	GP-PAM	GP-PAM	FM-FM UTLM	FM-FM UTLM	FM-FM UTLM Type II	FM-FM UTLM Type II	FM-FM UTLM	FM-FM UTLM	FM-FM UTLM	FM-FM UTLM	All	FM-FM UTLM		GP-PAM	Both FM-FM UTLM & GP-PAM have been designed for this application. GP-PAM is a more advanced system with more information bandwidth at less power than FM-FM.
No. channels cont. or main M-X (channels-points x rps)	13	13	13	13	12	*	9	12	12	11	16	*	12	13	*	14	9	9	9	9					
Hi level sampled (0-5V) a. Pressure b. Voltages c. Acceleration d. Gyros e. Tell-tales	4-60x5	4-60x5	3-60x5	4-60x5 2-60x1	5-ch 2-60x5		2-60x5	1-60x1 2-60x5	3-60x5	3-60x5	3-16x128		3-60x5	4-60x1		2-60x5 2-60x1	2-60x5	2-60x5	2-60x5	2-60x5					
Lo level sampled (0-50) a. Temperature b. Strain c. Current	1-60x1	1-60x1	1-60x1	1-60x.4	1-60x1			1-60x.4	1-60x1		64 ch		1-60x1	1-60x1		1-60x1 1-60x5									
Transmitter	8w VHF	8w VHF	8w VHF	8w VHF	8w VHF	8w VHF	16w VHF	8w	8w VHF	8w VHF	8w VHF	8w VHF	8w VHF	8w VHF	8w VHF	8w VHF	8w VHF	8w	8w VHF	8w	All		8w VHF	16 w	8 watt sufficient for all prgms. Could use 2w if GP-PAM is selected.
2. ACQUISITION VHF	Acq. trans.	Acq. trans.	Acq. trans.					Acq. trans.	Acq. trans.	Acq. trans.			Acq. trans.	Acq. trans.	Acq. trans.						All		Acq. trans.	VHF T/M	Any VHF transmitter on vehicle can be used for acquisition.
3. TRACKING: Radar Beacon	S-band	S-band	S-band	S-band			C-band	S-band	S-band	S-band			S-band	S-band	S-band		C-band	C-band	C-band	C-band	All		S-band bcn	C-band bcn	Component selection depends upon mission requirements and range req.
Doppler				APL Doppler	STL Doppler	STL Doppler						400 MC Doppler													
4. COMMAND CONTROL: Real time command	S-band bcn & decoder	S-band bcn & decoder	S-band bcn & decoder	LODAP UHF Rec	MOP-1-UHF Rec	MOP-1 UHF Rec	No rqmt	S-band bcn & DIG UHF cmd Receiver	S-band bcn & decoder	S-band beacon & decoder		UHF cmd Receiver	S-band decoder	S-band decoder	S-band decoder		No rqmt	No rqmt	No rqmt	No rqmt	Most				System depends upon payload requirements
Stored time command	Interim progmr (13STC)	Interim progmr	Interim progmr	LODAP UHF recvr	MOP-1 UHF	MOP-1 UHF recvr	No rqmt	LODAP	Interim progmr	Cmd Pro & interim progmr		Interim progmr Cmd progmr	Interim progmr	Interim progmr	Interim progmr		No rqmt	No rqmt	No rqmt	No rqmt					

* Information not available

Table 1-9 (Continued)

COMPONENT AND PART NO.	DESCRIPTION	OPERATING ALT. N.M.	3 db BEAM-WIDTH	MAX. GAIN db	DISCOVERER 1110	DISCOVERER 1115	DISCOVERER 1124	MIDAS 1201	MIDAS 1204	MIDAS 1209	ADVENT 1501	PROJ 101A 2120	PROJECT 1013 2202	PROJECT 1013 2203	PROJECT 1013 2206	1A 2210	PROJ. 102 2301	PROJ. 102 2312	PROJ 201 2401	NASA 6001	NASA 6101	NASA 6201	NASA 6301	DEGREE OF USE FNCTN	COMPONENT ALL	COMPONENT MOST	COMPONENT FEW	CONCLUSIONS
VHF																												
Ascent																								All				The basic design is the same for all VHF ascent antennas. The difference between 1310511 and 1310511-505 is due to a difference in veh. skin thickness. The differences in basic nos. are due to various cavity shapes, which are req. because of various equip space reqmnts of the various programs. In the Std. Agena where equip space reqmnts are standard, a std. antenna design will be used.
VHF, 1310511-505	Cavity-backd slot	-	Roll plane - 70° Pitch plane - 180°	+6															x								x	
VHF, 1038650	Cavity-backd slot	-	Roll plane - 70° Pitch plane - 180°	+6				x																			x	
VHF, 1310263	Cavity-backd slot	-	Roll plane - 70° Pitch plane - 180°	+6								x															x	
VHF, * 1310511	Cavity-backd slot	1	Roll plane - 70° Pitch plane	+6	x	x	x		x	x	x		x	x	x	x	x	x		x	x	x	x			x		
Orbit																								Few				The 1024060-509 monopole is the latest improvement of the basic 1024060 antenna. The electrical design of all units is the same; only the mech. characteristics have been improved. The YAGI, 1319154, was for a specialized application.
VHF, 1024060	Monopole	300	Azimuth-omni-directional Elevation - 2 lobes, 80°	+4			x																				x	
VHF, 1024060-507	Monopole	300-2000	Azimuth-omni-directional Elevation - 2 lobes, 80°	+4	x	x			x																		x	
VHF, 1024060-509 1323116-501	Monopole	300	Azimuth-omni-directional Elevation - 2 lobes, 80°	+4									x	x	x	x			x								x	
VHF, 1319154	3 El. YAGI	2000	E - Plane - 70° H - Plane - 130	+8					x																		x	
S-BAND																												
Ascent Beacon, 1312878	Recessed stub	-	Azimuth - omni-directional Elevation - 2 lobes, 80°	+4	x (Ascent & orbit)	x	x										x	x						Few			x	
Orbit Beacon, 1310492		2000	E - Plane - 70° H - Plane - 100	+4				x																Few			x	
Ascent/Orbit Beacon, 1303915	Recessed stub	300-2000	Azimuth - omni-directional Elevation - 2 lobes, 80°	+4				x				x												Few			x	
Beacon, ** 1320570	Open wave guide	300	Roll plane - 70° Pitch plane	+6									x	x		x								Few			x	

** Recommended by Antenna Lab. for ascent in Standard Agena B

Table 1-9 (Continued)

COMPONENT AND PART NO.	DESCRIPTION	OPERATING ALT. N.M.	3 db BEAM-WIDTH	MAX. GAIN db	DISCOVERER 1110	DISCOVERER 1115	DISCOVERER 1124	MIDAS 1201	MIDAS 1204	MIDAS 1209	ADVENT 1501	PROJ 101A 2120	PROJECT 101B 2202	PROJECT 101B 2203	PROJECT 101B 2206	1A 2210	PROJ. 102 2301	PROJ. 102 2312	PROJ 201 2401	NASA 4001	NASA 5101	NASA 6201	NASA 6301	DEGREE OF USE FNCTN	DEGREE OF USE COMPONENT ALL	DEGREE OF USE COMPONENT MOST	DEGREE OF USE COMPONENT FEW	CONCLUSIONS
Doppler, 1319155	Monopole, 2 ea fed out of phase	2000	Omni-directional	0				x	x	x																	x	
C-BAND																												
Ascent/Orbit Beacon, 1313847	Recessed stub		Azimuth - omni-directional Elevation - 2 lobes, 80°	+4							x									x	x	x	x	Few			x	
MULTIBAND																												
Orbit																												
VHF/S-band, 1309008	Stacked monopole	300	Azimuth - omni-directional Elevation - 2 lobes, 80°	+4								x					x	x						Few			x	
VHF/UHF, 1310508	VHF-mono-pole	2000	VHF - azimuth - omni-directional Elevation - 2 lobes, 80°	+4				x																Few				
	UHF long wire		UHF - azimuth - omni-directional - 2 lobes close to axis, 40°	+7				x																				
ASCENT/ORBIT/ RE-ENTRY																												
VHF/S-band 1313855	Cavity-backed slot	300-2000	Omni-directional, 3 ea w/ pwr divider used in capsule	0				x																Few			x	
TO BE DESIGNED UHF Ascent 1309009												x												Few			x	
UHF Ascent Antenna (400 Mc)															x									Few			x	
UHF Orbit Ant (400Mc)															x									Few			x	
VHF/Monopole 2 ea									x	x														Few			x	

Table 1-10

EQUIPMENT CROSS CORRELATION
COMMUNICATION AND CONTROL (VEHICLE ONLY)

		DISCOVERER			MIDAS			ADVENT	PROJ 101A	PROJECT 101B				PROJECT 102		PROJ 201	NASA			
COMPONENT	PART NUMBER	1110	1115	1124	1201	1204	1209	1501	2120	2202	2203	2206	2210	2301	2312	2401	6001	6101	6201	6301
1. TELEMETER																				
Telemeter	1323131							x												
UTLM FM/FM	1313690																			
	thru 94																x			
UTLM FM/FM	1304936-501								x											
UTLM FM/FM Type I	1304923-501									x										
UTLM FM/FM Type I	1304924-501										x									
	thru 925-501										x									
UTLM FM/FM Type I	1304937-501													x						
UTLM FM/FM	1024987-501												x							
UTLM FM/FM	1304935-501				x	x	x													
UTLM FM/FM	1024981-501				x															
UTLM FM/FM	1024982-501				x															
UTLM FM/FM	1318638-501					x														
UTLM FM/FM	1319143-501					x														
UTLM FM/FM	1319144-501					x														
UTLM FM/FM Type I	1024983-501	x																		
UTLM FM/FM Type I	1024984-501	x																		
UTLM FM/FM Type I	1024985-501	x																		
UTLM FM/FM Type I	1024986-501	x																		
UTLM FM/FM Type I	1304949-501	x																		
UTLM FM/FM Type I	1320258		x																	
UTLM FM/FM Type I	thru 61		x																	
UTLM FM/FM	1311501		x	x																
UTLM FM/FM Type II	1313413															x				
AMR 106-Mod & detector assy.	1300701				x	x				x			x							
AMR 104	1304545								x											
AMR 100D	1304585				x	x				x			x							
PAM multiplexer type F	1308994								x											
AMR 110	1309073								x		x	x		x	x					
AMR Prog. Mod III	1309298				x	x			x		x	x	x	x	x					
AMR 109A tape recorder	1314784															x				
Signal Conditioner Type III	1310471								x					x	x					
VHF data transmitter	1062799				x	x	x													
VHF data transmitter Type III	1312565										x	x								
VHF data xmtr assy Type IV	1315375													x	x					
VHF PAM/FM gen purp xmitter	1313861					x	x													
VHF FM transmitter status T/M	1461022-7					x	x													
VHF PAM/FM xmttr (status T/ M)	1319100					x	x													
Status telemeter						x														
Failure telemeter						x														
Status/failure telemeter							x													

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Table 1-10 (Continued)

COMPONENT	PART NUMBER	DISCOVERER 1110	DISCOVERER 1115	DISCOVERER 1124	MIDAS 1201	MIDAS 1204	MIDAS 1209	ADVENT 1501	PROJ 101A 2120	PROJECT 101B 2202	PROJECT 101B 2203	PROJECT 101B 2206	PROJECT 101B 2210	PROJECT 102 2301	PROJECT 102 2312	PROJ 201 2401	NASA 6001	NASA 6101	NASA 6201	NASA 6301
1. TELEMETER (CONTINUED)																				
Telemeter	1313695																	x	x	x
PAM multiplexer GP	1318889										x	x								
PAM multiplexer GP	1318890										x	x								
PAM multiplexer GP	1318891										x	x								
PAM multiplexer GP	1318892										x	x								
PAM multiplexer GP	1318893										x	x								
PAM multiplexer GP	1318894										x	x								
PAM multiplexer GP	1318895										x	x								
PAM multiplexer Type G-B	1305110				x															
PAM multiplexer, gen purpose	1318884					x	x													
PAM multiplexer, gen purpose	1318888						x													
PAM multiplexer, gen purpose	1318940						x													
PAM multiplexer, gen purpose	1318941						x													
PAM multiplexer, gen purpose	1318943						x													
PAM multiplexer, gen purpose	1318947						x													
PAM data multiplexer	1319098					x	x													
PAM status multiplexer	1319476					x	x													
PAM sub multiplexer	1309577				x	x														
Hi response PAM FM multiplexer	1307826				x															
Hi resp PAM/FM transmitter	1319831				x															
Hi resp PAM/FM function sw.	1311420				x															
Hi resp PAM/FM power supply and transmitter	1313831				x															
Hi resp tape recorder	1600416-1				x															
Tape recorder filter assy.	1313706									x			x							
2. ACQUISITION																				
VHF acquisition transmitter	1062354-3	x	x	x					x	x	x		x	x	x					
3. TRACKING																				
C-band beacon	1062910							x									x	x	x	x
S-band beacon power supply	1062340				x															
S-band beacon transponder	1062341				x															
S-band beacon transponder	1062562	x	x	x					x	x	x	x	x	x	x					
VHF Doppler diplexer	1062801-1				x															
4. (a) REAL TIME COMMAND																				
S-band beacon decoder	1062563	x	x	x					x	x	x		x	x	x					
Command programmer IA	1333155										x	x								

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Table 1-10 (Continued)

COMPONENT	PART NUMBER	DISCOVERER			MIDAS			ADVENT	PROJ 101A	PROJECT 101B				PROJECT 102		PROJ 201	NASA			
		1110	1115	1124	1201	1204	1209	1501	2120	2202	2203	2206	2210	2301	2312	2401	6001	6101	6201	6301
4. (b) STORED TIME COMMAND																				
Interim programmer	1461312													x						
Interim programmer	1461413														x					
Interim programmer	Type IV											x								
Interim programmer	1062614-3			x																
Interim programmer	1062281										x									
Interim programmer Mod II	1062614	x	x							x			x							
Interim programmer	1305301				x															
Sequence programmer	1305330-503								x											
Sequence programmer	1305336				x															
MIDAS orbital programmer	Type I					x	x													
PCU Type II	1310368								x											
PCU Type III	1310738				x															
PCU Type IV	1312934										x									
PCU Type VI	1317279				x															
PCU Type IX	1318854					x														
PCU Type X	1325396						x													
PCU Type XI or XII														x	x	x				
Power distribution box	1319785									x			x							
Power distribution box	Type XV											x								
De-coder for sgl event timer	1317267				x															
MIDAS Orbital Programmer						x	x													
5. ANTENNAS & RF COMPONENTS																				
VHF ascent antenna	1310511-505															x				
VHF orbit antenna	1024060			x																
VHF orbit antenna	1024060-507	x	x			x														
VHF orbit antenna	1024060-509									x	x	x	x							
VHF orbit antenna	1323116-501															x				
VHF orbit antenna	1319154					x														
VHF orbit antenna	1322316					x														
VHF T/M exit antenna	1038650-503				x															
VHF exit antenna	1310511	x	x	x		x	x	x		x	x	x	x	x	x		x	x	x	x
UHF/VHF/S-band orbit antenna	1309008								x					x	x					
VHF/S-band ant, ascent orb & re-entry cavity backed	1313855									x	x									
UHF/VHF omni antenna	1310508				x															
400 MC ascent antenna	-					x	x													
Beacon exit antenna	1312878	x	x	x																
S-band beacon slot antenna	1320570									x	x		x							
Beacon orbit antenna	1310492				x															
C-band beacon antenna	1313847							x												
Parasitic antenna	1314598																x	x	x	x
VHF antenna multiplexer	1062243			x	x	x	x		x	x	x	x		x	x					

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Table 1-10 (Continued)

COMPONENT	PART NUMBER	1110	1115	1124	1201	1204	1209	1501	2120	2202	2203	2206	2210	2301	2312	2401	6001	6101	6201	6301
5. ANTENNAS & RF COMPONENTS (CONTINUED)																				
UHF/VHF antenna diplexer	1308969				x															
VHF diplexer	MT-234	x	x	x																
RF transmission line switch	1062649					x	x													
VHF exit/orbit antenna switch	1600299-1	x	x	x												x				
Coax switch SP DT latching	1600207-1				x	x	x													
3 Ch multicoupler	1062815												x							
RF coupler	1600277-1								x	x	x		x	x	x					
S-band power divider	1613857-2									x	x		x							
Power divider	1322315					x	x													
Coaxial termination	1600193-1					x	x		x	x	x		x	x	x					
Coaxial filter 216 MC	1600307-1	x	x																	
Coaxial filter	1062634-1	x	x																	
UHF/VHF rotary joint	1318853				x															
VHF monopole						x	x													

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Table 1-11

COMPARISON OF COMMON FUNCTIONS AND UNCOMMON CONDITIONS
COMMUNICATION AND CONTROL, TASK 4-C

	DISCOVERER			MIDAS			ADVENT	PROJ 101A	PROJECT 101B				PROJECT 102		PROJ 201	NASA			
	1110	1115	1124	1201	1204	1209	1501	2120	2202	2203	2206	2210	2301	2312	2401	6001	6101	6201	6301
1. Telemetry																			
FM/FM UTLM Type I	x	x		x	x			x	x	x		x	x			x	x	x	x
FM/FM UTLM Type II			x				x							x	x				
Status Tlm					x	x													
Failure Tlm						x													
GP-PAM Tlm						x				x	x								
PAM Tlm Type F								x											
Transmitter 8w	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x
Transmitter 16w							x												
2. Acquisition																			
Acquisition transmitter, 1/4w	x	x	x	-	-	-	-	x	x	x	-	x	x	x	-	-	-	-	-
3. Tracking																			
S-band transponder	x	x	x	x				x	x	x		x	x	x					
C-band transponder							x									x	x	x	x
APL Doppler				x															
STL Doppler					x	x													
400 Mc Doppler											x								
4. Command Control																			
S-band decoder	x	x	x					x	x	x		x	x	x					
Interim programmer	x	x	x						x	x	x	x	x	x					
LODAP and UHF receiver				x				x											
MOP I and UHF receiver					x	x													
Command programmer and UHF receiver										x	x								
5. RF Propagation	NOTE: This information is illustrated ideally by "Agena Vehicle Function", chart, pg.																		

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TASK 11

Table 1-12

AGE Equipment, Task 11

GROUND HANDLING EQUIPMENT	Part No.
a. New equipment:	
(1) Yoke, Handling - Vehicle	
(2) Vehicle Storage Container with environmental control apparatus	
(3) Container Handling Dolly	
b. Modified equipment	
(1) Fitting, 2X Tank Hoist Tilt Sling	1508956
(2) Dolly, Engine Removal	1586389
(3) Dolly, Handling - Adapter	1508169
c. Existing equipment that may be used as is:	
(1) Beam, Yoke	1586113
(2) Beam, Horizontal Hoist - Vehicle	1512162
(3) Sling, Verticle Hoisting - Vertical	1082125
(4) Sling, Vehicle, Tilt	1503703
(5) Fitting, Adapter Hoist - Tilt Sling	1508955
(6) Sling, Yoke Removal, Vertical Vehicle	1506526
(7) Sling, Yoke Removal, Horizontal - Vehicle	1585926
(8) Workstand, Vertical	1503450
(9) Vertical Assembly Fixture	1506501
(10) Stand, Engine Maintenance	1062204
(11) Sling, Engine Hoisting	1082276
(12) Dolly, Handling - Vehicle	1503447
(13) Tow Bar - Vehicle Handling Dolly	1506532
(14) Dolly, Holding - Vehicle	1589531
(15) Stand, Pitch and Roll - Vehicle	1503443
(16) Tilt and Roll Equipment - Vehicle	1510878
(17) Alignment Equipment - Vehicle	1503915
(18) Stand, C.G./Moment of Inertia	1506710

(19) Fitting, C.G./Moment of Inertia - Vehicle 1589507

(20) Transporter, Vehicle 1503448

SUBSYSTEM CHECKOUT EQUIPMENT

a. SS/B

(1) New equipment - None

(2) Modified equipment - None

(3) Existing equipment that may be used as is:

(a) Mass Spectrometer - Leak Detector 1501253

(b) Pressurization and Tankage Checkout Console - Leak Detector 1500978

(c) Propulsion System Checkout Console 1082017-505

(d) Flow Rate Meter Assembly 1087058

(e) Secondary Propulsion System Checkout Console 1589589

b. SS/C

(1) New equipment

(a) Primary Battery Charger

(2) Modified equipment - None

(3) Existing equipment that may be used as is:

(a) Patchboard Adapter Console 1500407

(b) Vehicle Wiring Analyzer DIT-MCO Model 2000

(c) Auxiliary Power Checkout Unit 1082073-303

(d) Universal Power Supply Type II 1505605

(e) Vehicle Power Monitor Equipment 1501920

(f) Battery Discharge Load Tester - Type II 1588688

(g) SS/C Monitor Console 1514971

(h) Battery Console 1501606

(i) Solar Collector Checkout Console (Optional) 1500454

c. SS/D (Guidance)

(1) New equipment - None

(2) Modified equipment - None

(3) Existing equipment that may be used as is:

(a)	Rate/Servo Table - Type II	1506146
(b)	Guidance Checkout Console Type II	1512303
(c)	IRP Holding Fixture - Type II	1507965
(d)	IRP Gyro Alignment Fixture - Type II	1507575
(e)	Low Pressure Nitrogen Test Cart - Type I	1509691
(f)	Horizon Sensor Checkout Console - Model II	1062589
(g)	Optical Alignment Equipment	1502424
(h)	Guidance Computer Checkout Console - Type II	1505060
(i)	Velocity Meter Checkout Console	1511635-503
(j)	Event Recorder Console	1502427
(k)	Guidance Loop Bench Checkout Console - Type II	1585585
(l)	SS/D Installation Test Console - Type V	1512770

d. SS/D (Flight Control)

(1) New equipment - None

(2) Modified equipment - None

(3) Existing equipment that may be used as is:

(a)	Flight Control Checkout Console, Type II	1062552
(b)	Hydraulic Package Power Supply	1062330
(c)	Hydraulic Test Cart, Type II	1062637
(d)	Hydraulic Cleaner Cart, Type II	1510612
(e)	Hydraulic Power-Package Test Cart	1512360
(f)	High Pressure Nitrogen Test Cart	1509797
(g)	Portable Clean Room	1062641
(h)	Sanborn 150 Recorder Console	

e. SS/H (C&C)

(1) New equipment - None

(2) Modified equipment - None

(3) Existing equipment to be used as is:

(a)	Beacon Transponder/Decoder Checkout Console, Type V	1515953 (Opt. Eq.)
(b)	VHF Exit Antenna Coupler Install.	1501588

(c)	PAM/FM Data Link Checkout Console MIDAS Type II	1507295
(d)	PAM General Purpose Demultiplexer Console	1589940
(e)	VHF Antenna Coupler Install.	1509987
(f)	Beacon Antenna Coupler Install.	1087285
(g)	Secondary/Interim Programmer Checkout Console	1501105 (Opt. Eq.)
(h)	UHF/VHF Omni-Orbit Antenna Coupler Install.	1510806
(i)	Orbit Beacon Antenna Coupler Install.	1510809
(j)	DC Power Supply, 28v	

SYSTEMS CHECKOUT EQUIPMENT

a. New equipment - None

b. Modified equipment

(1)	Control and Indicator Console	1590866
(2)	Signal Distribution and Monitor Console	1590868
(3)	Pulse Amplitude Modulation Console	1592124
(4)	Subsystem C Console	1514971
(5)	Universal Power Supply Type II	1505605
(6)	VHF T/M Data Link Test and Monitor Console	1068140

c. Existing equipment to be used as is:

(1)	Command Beacon Console	1062956
(2)	Squib Monitor Console	1592513
(3)	Sanborn Recorders	1591956
(4)	Power Station Console	1504002
(5)	Battery Console	1501606
(6)	Vehicle RF Function Generator	1586950

NOTES ON NEW AND MODIFIED EQUIPMENT

Yoke, Handling - Vehicle (New Design)

Will be similar to 1585908 consisting of an aft yoke similar to 1510567-501 and a forward yoke similar to 1585582.

System Checkout Equipment

1. Control and Indicator Console 1590866 (Modified)

   This console may be used with a few simple modifications. The following panels may require modification to accommodate the new vehicle requirements:

   C&C Monitor Panel

   Vehicle Power Control Panel

   Telemetry Control Panel

   The following panels may be removed from the consoles:

   Orbital Flight Control Panel

   Subsystem J Control Panel

2. Signal Distribution and Monitor Console 1590865 (Modified)

   This console may be used with very little or no modification. Squib simulation requirements may be less.

3. Pulse Amplitude Modulation Console 1592124 (Modified)

   This console may be used with modifications reducing the number of channels handled from 24 to 16.

4. Subsystem C Console 1514971 (Modified)

   Console may be used with little modifications, removing that portion that handles 2000 cps ac power.

5. Universal Power Supply Type II 1505605 (Modified)

   This console may be used "as is." The portion handling 2000 cps power will be excess.

6. VHF T/M Data Link Test and Monitor Console 1068140

   The monitoring portion of this console is not needed and may be removed if desired.

SECTION 2
PRELIMINARY DESIGN AND PROGRAM INTEGRATION, TASKS 6, 7, AND 8

STRUCTURES

The primary objective of this study is to design a standard vehicle to structurally accommodate all existing Thor and Atlas boosted Agena payloads and their respective trajectories. In addition, the following features are considered as necessary and as such form the basis of the structural philosophy pursued in the design.

Serviceability

a. Full and quick accessibility for inspection of all equipment

b. Full accessibility for installation and removal of any unit of equipment, and where time is a premium, ready access by unfastening quick release attachments (one foot spacing) on large access doors.

c. Ability to service, handle, and transport the vehicle in the factory with or without the payload attached, and without the large access doors installed

d. Ability to maintain operating environment of the equipment during ground operations.

Schedule

a. Use of materials and shapes that are available now

b. Standard proven manufacturing operations and shop practices

c. Simple standard aircraft construction

d. No special tooling beyond what is used now

e. All structure readily accessible for fabrication and easy inspection

f. A structure that permits easy installation of equipment.

Cost

a. Maximum use of standard materials which, in addition to being economical, require a minimum of material testing while affording a maximum degree of reliability

b. Use of simple sections or shapes readily made by existing tooling, and requiring a minimum of machining

c. Items as listed under Schedule.

Performance

a. Minimum weight such that every Agena vehicle will equal or surpass its present performance

b. Maximum reliability (which is inherent in a standardized unit)

c. Simple determinate structure to insure maximum efficiency (minimum weight) and reliability

d. Maximum use of structural mass to satisfy thermal requirements for equipment with a minimum of non-structural "heat-sink" material as required locally.

STRUCTURAL PHILOSOPHY

As stated in the Introduction, the structural philosophy is governed by the requirements listed under the four main headings:

Serviceability
Schedule
Cost
Performance

The main structural objective now is to design a structure that is compatible with the various listed goals.

Forward and Aft Equipment Racks

To provide the necessary degree of serviceability, large access doors with a minimum of quick disconnect attachments are required. This requirement defines the greater part of the skin covering in the forward rack area as

The primary structure, then, in satisfying flight conditions, is also capable of accommodating ground handling operating loads with little or no weight penalty.

Although the doors are non-structural, the basic strength required to withstand air pressures provides sufficient skin thickness to limit the temperatures on the skin to acceptable values. Magnesium sheet reinforced with magnesium stiffeners and edge members provides the necessary strength for minimum weight. The magnesium edge members which are attached at one-foot spacing to the interior structure, transmit very little heat to the interior structure during ascent and prior to booster cutoff. The thermal gradient from the sheet to the edge members is such that the expansion of the door relative to the interior structure is readily provided for by oversize holes, as required for applied load deflection.

Consistent with the advantages previously listed under Serviceability, Schedule, Cost, and Performance, an open truss interior structure in the forward rack area is the most efficient geometry to transmit the loads imposed by the vehicle payloads and shrouds.

Standard extrusions such as bulb I's, channels, tees, angles, etc., appear desirable and provide sections with the following advantages:

a. Structurally efficient stabilized sections (inherent in an extrusion which is tailored to the required geometry)
b. Open section for ease and simplicity of attachment
c. Adaptability to machining off flanges as required to suit decrease in loading
d. Flexibility for mounting equipment.

Square and rectangular extrusions are also structurally efficient. However, much of their efficiency may be lost due to end connections, gussets, and attachments. Use of gussets, for example, means that tubes must be the same height and width unless shims are used. If it is shown that certain members are more efficient as tubes, then tube shapes could be used in conjunction with other extruded shapes.

Preliminary indications show that the interior structure is essentially at room temperature during maximum loading. Hence, there is a wide choice of materials, all of which can be stressed approximately to their maximum room temperature values. Most interior members are uni-axially loaded. Efficiency then depends on selecting a cross-section shape such that crippling, column action and buckling instability of individual legs occurs approximately simultaneously with compressive yield. For members whose level of loading and length are such that this can be accomplished, and using density to compressive yield strength as a criterion, aluminum extrusions are about 40% more efficient than the best magnesium extrusions.

A study of materials shows that for the loads imposed on the forward rack by various payloads, 7075-T6 aluminum extrusions are first choice with ZK60A-T5 magnesium extrusions second choice. The potential of aluminum can be fully realized in the design of the longerons which account for about 50% of the interior structure weight. It appears that aluminum extrusions are also more efficient for the remaining interior members of the forward rack, although the full 40% advantage may not be realized. It should be understood that for relatively long members with light loading, magnesium extrusions may be more efficient and should then be used. There is no structural objection to using both aluminum and magnesium. (This combination has been efficiently used for internal floor structures in the Constellation.)

Another significant advantage in using aluminum is that the thermal conductivity of high strength aluminum is almost 100% more effective than that of high strength magnesium ZK60A, and is also greater than that of the best high temperature magnesium.

In the aft rack, members are relatively long due to geometry and are quite lightly loaded. Therefore, minimum gages appear to require high strength magnesium, ZK60A, as the basic material. Channel shaped extrusions appear to be most efficient from all considerations.

The basic philosophy followed with regard to the integral thermal environment of equipment in the forward rack is to utilize the structural material mass for thermal paths to distribute equipment generated heat. Where particular equipment components generate heat in excess of the capacity of the structural mass, local "thermal pads" will be provided. Of the materials considered, lithium is very efficient, but requires development in protecting it from reaction with air, before practical application. Beryllium is almost as efficient, and is readily applicable. A most interesting material is parafin wax. For now, beryllium is the material choice.

For the aft rack where the amount, and variety of equipment depends upon the particular vehicle mission, the philosophy followed is to shield individual tray modules as required. Equipment with narrow temperature limits may require local heating or cooling.

Vehicle stiffness requirements, to assure that the natural frequency of the Standard Agena in combination with the various payloads is compatible with limits necessary for guidance and control, are satisfied by the cross-sectional areas required for strength. Stiffness for bending and axial load are virtually equivalent to those attained for previous vehicles by monocoque structure. Stiffness for shear loads, although somewhat less than that provided by monocoque structure, is sufficient. Longitudinal stringers provide the stiffness for bending and axial load. Structural doors on the X axis provide stiffness for shear loads applied parallel to the Y axes. Internal truss structure provides stiffness for shear loads applied parallel to the X axes.

Booster Adapter

A large percentage of the philosophy stated previously under Forward and Aft Equipment Racks applies also to the booster adapter. Although the relative amount of non-structural door area to structural skin or door area is appreciably less than for the forward rack,the requirement of accessibility still suggests a stringer skin combination. Booster separation using primacord appears desirable and therefore accentuates the requirements for non-structural doors. In this area, however, shear loads as well as axial loads and bending moments are taken through the external stringer-skin combination.

Magnesium sheet reinforced with magnesium stiffeners and edge members provides the necessary strength to withstand air pressures for the non-structural doors. Magnesium sheet attached structurally to the stringers provides strength at temperature required for the remainder of the surface structure.

Preliminary indications show that the temperature of the stringers would not exceed 250°F. Therefore, 7075-T6 extrusions are considered to be the best choice. This is based on the relatively high level of loading imposed and assumes choice of a section shape such that these stringers can be stressed to a high percentage of the compressive yield strength.

DESCRIPTION OF STRUCTURE

Forward Rack (See Fig. 2-1)

The forward rack, 60" diameter, extends from the interface at SS 244.5 to the tank joint at SS 294.08. Eight equally spaced attach points at the periphery on the forward face of the ring at SS 244.5 provide attachment for the payloads and shrouds of Agena vehicles, either directly or through an adapter or mission peculiar rack. Provision is also made through four attach points at SS 248.5, for support of payloads that attach to the interior at the interface. Two large hinged non-structural access doors provide a means of readily inspecting all equipment, and replacement of all equipment except for the antennas, and the PAM and IRP units. These latter two units are located respectively on the plus and minus X axes, and provision for installation and replacement of each is accomplished by removal of structural doors. Directly aft of each of these doors is a structural door frame to which an antenna is attached. Circumferentially on each side of the IRP structural door is a non-structural door enclosing the horizon sensors and which is ejected at booster-Agena separation. The remainder of the surface skin is structural. The interior structure consists of eight longerons bounding an open truss framework.

Attachment of payloads and shrouds and access through structural and non-structural doors are shown by the attached figures. (Ref. Figures 2-2 and 2-3.)

Aft Rack (Ref. Fig. 2-4)

The aft rack has three equipment versions:

a. Minimum equipment (ascent version)
b. Maximum equipment (orbited version)
c. Solar array.

The design achieves the objective of accommodating each version without a weight penalty. This is accomplished by using a basic structure for the ascent version to which the addition of two side beams provides the necessary support and strength for miscellaneous equipment trays for the other two versions.

Basic Structure

The basic structure consists of two channel shaped beams, one located on the plus X-axis and the other on the minus X-axis. These two beams extend approximately 50 inches aft of the engine thrust cone where they are attached to a common ring. Each beam is supported by the thrust cone on the forward end and by two parallel diagonals at the aft end. Each diagonal extends forward and attaches to the engine thrust cone at the plus and minus Y-axis respectively. In short, the structure is basically two cantilevered trusses.

Additional Structure. To accommodate the equipment trays, two beams are added to the basic structure, one on the plus Y-axis and one on the minus Y-axis. Each beam extends from the common aft ring to a point on the engine thrust cone where the diagonals are attached.

Four sets of rollers are mounted on the channel shaped beam at the aft ring, and four more at the engine thrust cone. Ullage rockets are supported at the aft ring.

Booster Adapter. The booster adapter, 60" in diameter except at the skirt, extends from the separation place at SS 388.55 aft to the Thor/Agena interface at SS 492.01. A separate conical Atlas adapter skirt would then extend the adapter to SS 530 to the Atlas/Agena interface.

Eight equally spaced longerons attached to structural skin extend the full adapter length.

Hinged non-structural access doors between stringers provide ready access for installation, replacement and inspection of equipment on the aft rack.

CRITICAL DESIGN CONDITIONS

Forward Rack and Booster Adapter. A preliminary study of loading conditions for various Agena vehicles shows that the loads produced by Nimbus and Advent are critical for flight.

The longerons are critical for Nimbus wind condition (max. α q). The internal structure in the forward rack area is primarily critical for the above Nimbus condition and for Advent booster burnout condition. The variation of loading for either of these conditions is approximately within 10% of the other.

Growth potential of the Standard Agena forward rack is such that a 20% increase in loads would result in a weight increase of approximately 10 pounds. This provision permits a greater choice of trajectories and/or new payloads as desired.

Ground Handling. Advent is the only existing vehicle which has its payload attached to the interior structure. This condition is not as critical as the flight condition. Hence, ground handling with all doors, structural and non-structural, removed can be satisfied without any weight penalty.

Temperature Environment (Ref. Fig. 2-5). A study of the temperatures produced on the existing Agena vehicles by aerodynamic heating indicates that:

a. The complete structure is essentially at room temperature when maximum flight loads are experienced. This is the maximum αq condition.

b. An effective skin thickness of .045" magnesium results in a maximum temperature of 600°F. This is the temperature to which the non-structural skins are subjected. However, the highest temperature attained during appreciable air pressure loadings is approximately 320°F.

c. An effective skin thickness of .060" magnesium results in a maximum temperature of 490°F. This is the maximum temperature to which the structural skin is subjected. At this temperature, the critical loading condition is produced by booster cutoff. The actual stress level is low and well within the allowable stresses of this material for short time duration.

d. The surfaces are painted to provide the necessary emissivity factor required for the interior environment during orbit.

e. When the sensor non-structural doors are ejected, a thin foil shield is used to protect the equipment during orbit.

Aft Rack. The critical design conditions are:

a. Maximum axial loads due to booster at booster cutoff

b. Maximum lateral loads due to lateral load factors of 3 g ultimate for ground handling operations, and maximum roller reactions during separation of booster adapter

c. Sufficient rigidity to satisfy dynamic and vibration requirements

d. Thermal requirements during orbit.

STRUCTURAL LOAD PATHS

Forward Rack (Ref. Fig. 2-1). Moments, shears, and axial loads resulting from the shroud and payloads are resisted at the interface ring at SS 244.5, except for vehicles whose payload attaches to the interior structure at SS 248.5. In the latter case, only the shroud loads are resisted at the interface ring.

Moments and Axial Loads. The interface ring at SS 244.5 is attached by a web to a ring at SS 248.5 and thereby forms a beam structure, which is attached to eight equally spaced fittings on the perimeter of the interface. Each fitting is attached to a longeron which extends to the tank joint at SS 294.08. Axial loads and moments produce concentrated tension loads and distributed compressive loading. The tension loads are transmitted directly through the fitting to the longeron, whereas the distributed compressive loading is carried by beam action on the interface ring to the fittings and thence to the longerons. Axial loads resulting from an internally supported payload are transmitted through the internal truss structure to the longerons. All longeron loads are transmitted by shear transfer to the skin between SS 283 and SS 294.08 to produce a distributed loading at the tank joint.

Shears. The shear loads at the interface can be resisted by any two pairs of diametrically opposed fittings. However, the preferable pairs are located on the plus and minus X axes.

Shears Applied at the Interface Perimeter. Shears applied parallel to the Y-axis are transmitted by the fitting bolts through the fittings to the structural doors located along the X axes. Shears applied parallel to the X-axis are transmitted by the fitting belts through the fittings, the internal truss diagonals, and the ring at SS 283 to the skin aft of SS 283.

Shears Applied at the Interior Payload Attach Points. Shears applied parallel to either the X axis or the Y axes are transmitted through the internal truss structure and the ring at SS 283 to the skin aft of SS 283.

Aft Rack (Ref. Fig. 2-4). Fore and aft loads are transmitted by the channel shaped columns or struts directly into the engine thrust cone.

Lateral loads parallel to the X-axes are transmitted by the diagonals to the thrust cone; lateral loads parallel to the Y-axes are transmitted by cantilever beam action of the channel-shaped beams.

All structure is basically open truss framework:

a. Affording full accessibility to the engine and components
b. Providing minimum weight design with standard material and shapes for each version
c. Fulfilling the objectives listed under "Discussion"

Booster Adapter

Axial loading and bending moments are reacted through the longerons and structural skin combination. Shears are reacted through the structural skin only, where required, doublers are provided around the non-structural door openings.

SUMMARY

The primary objectives of this study, as stated previously, have been accomplished by the design presented in this report. The basic features discussed under "Serviceability," "Schedule," and "Cost" thus accomplished are:

a. Ready access to equipment for inspection, maintenance, or replacement through large non-structural doors with quick-acting attachments spaced on approximately one foot centers.
b. Ease of manufacture, assembly, handling, and replacement of equipment by arranging given subsystem equipment and all wiring in modules.
c. Simple construction through use of standard materials, shapes tooling, and shop practice.

The basic features discussed under "Performance" are more difficult to evaluate. Direct comparison with previous vehicle design may be quite misleading since the basic ground rules are different. However, a table showing weights of component structure is presented (Ref. Table 2-9). The inherent increase in weight of the interior truss structure of the forward rack over a comparable monocoque design is considerably offset by using structural mass to distribute heat and by using high strength aluminum or magnesium extrusions where temperature environments permit.

The key point of reliability is considered inherent in this design where simplicity and proven materials, methods, etc., are used to a large extent and where standardization will permit large numbers of vehicles to be produced.

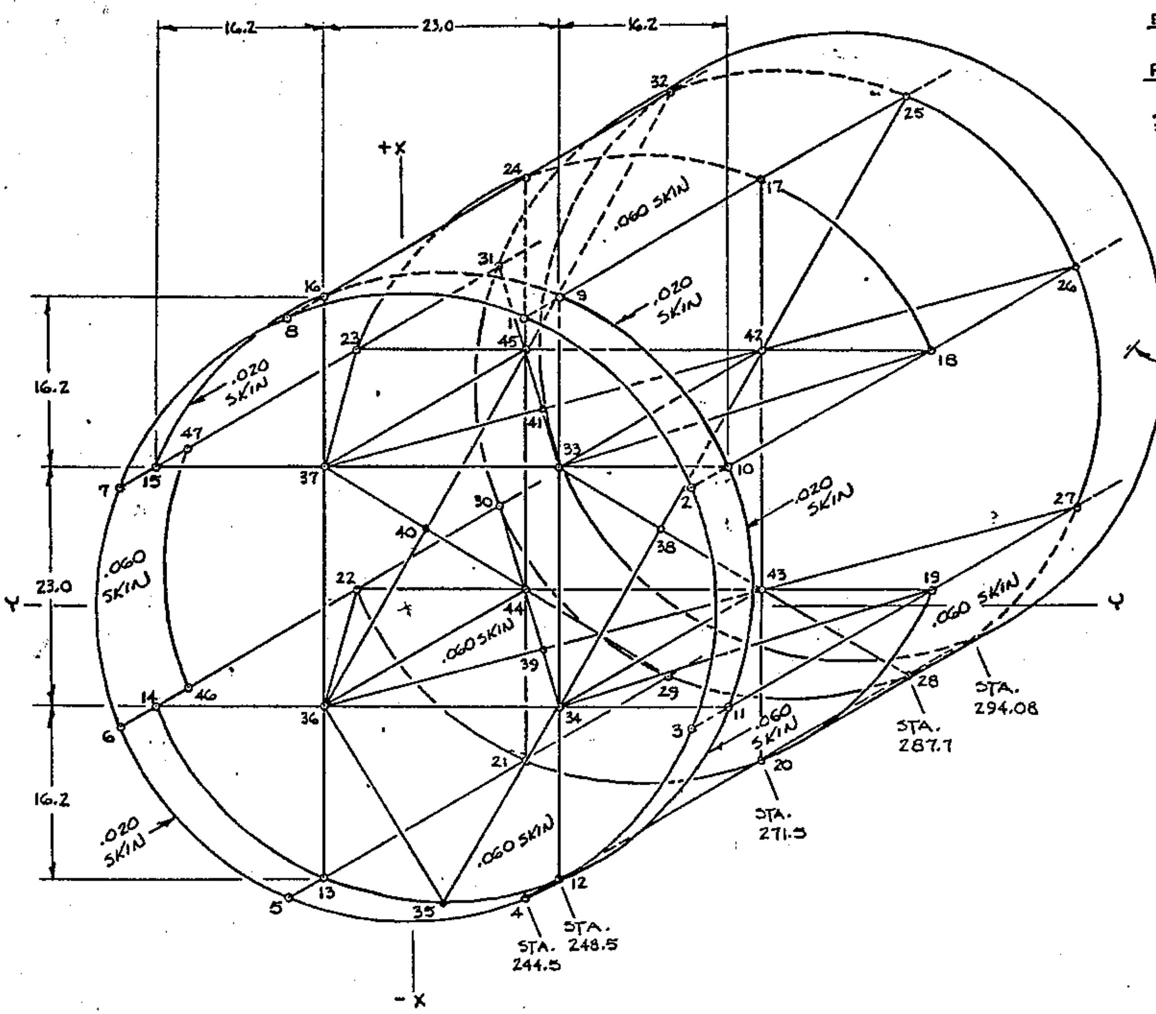
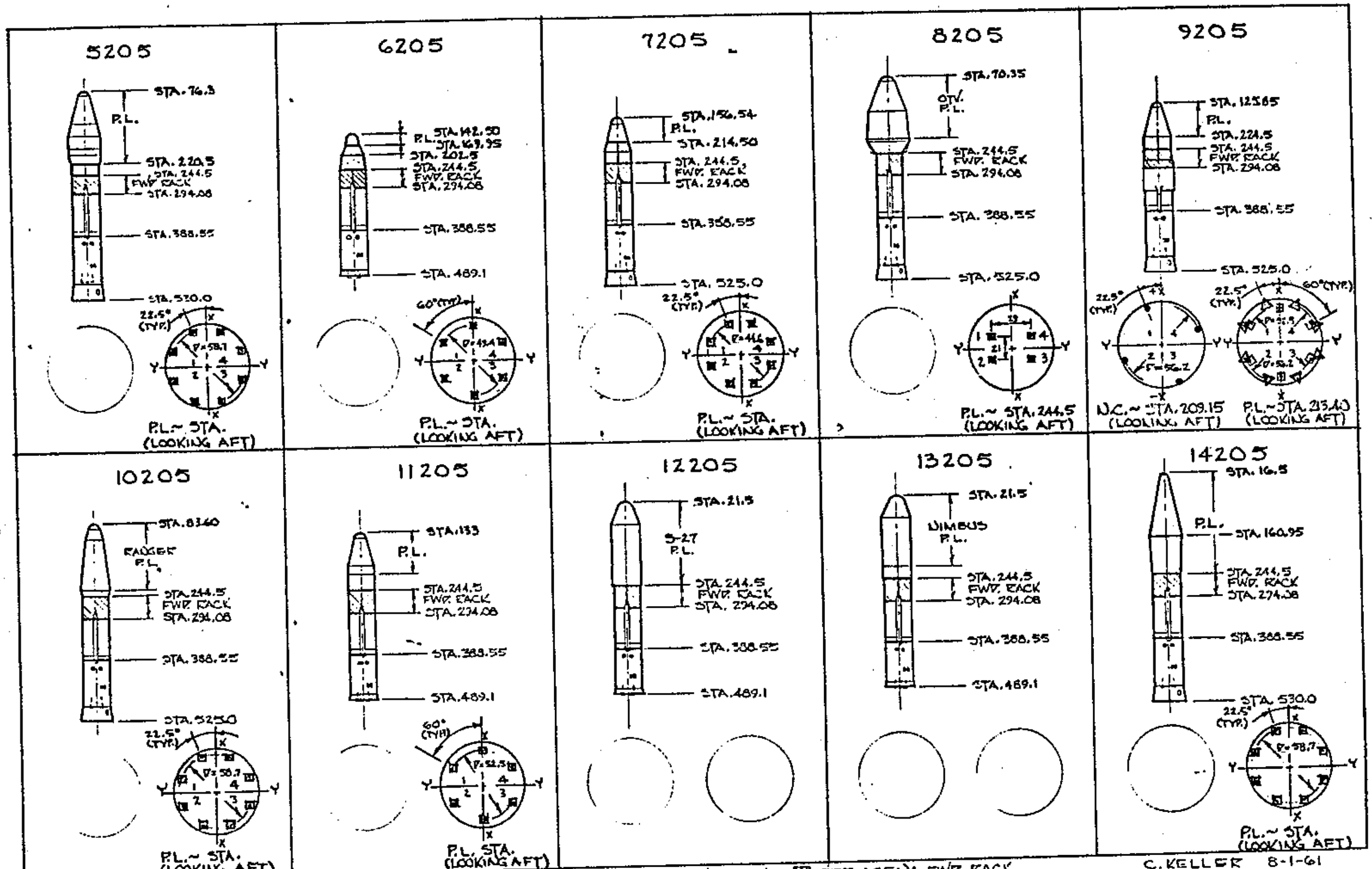


Figure 2-1 Standard Agena Forward Rack Structure



LEGEND: • NOSE CONE ATTACH. ▫ PAYLOAD ATTACH. △ EXIST. ATTACH. TO FWD. RACK. ▨ STD. AGENA FWD. RACK ▧ ADAPTER & P.L. PECULIAR KA.

Figure 2-2 Standard Agena Payload and Shroud Attachment

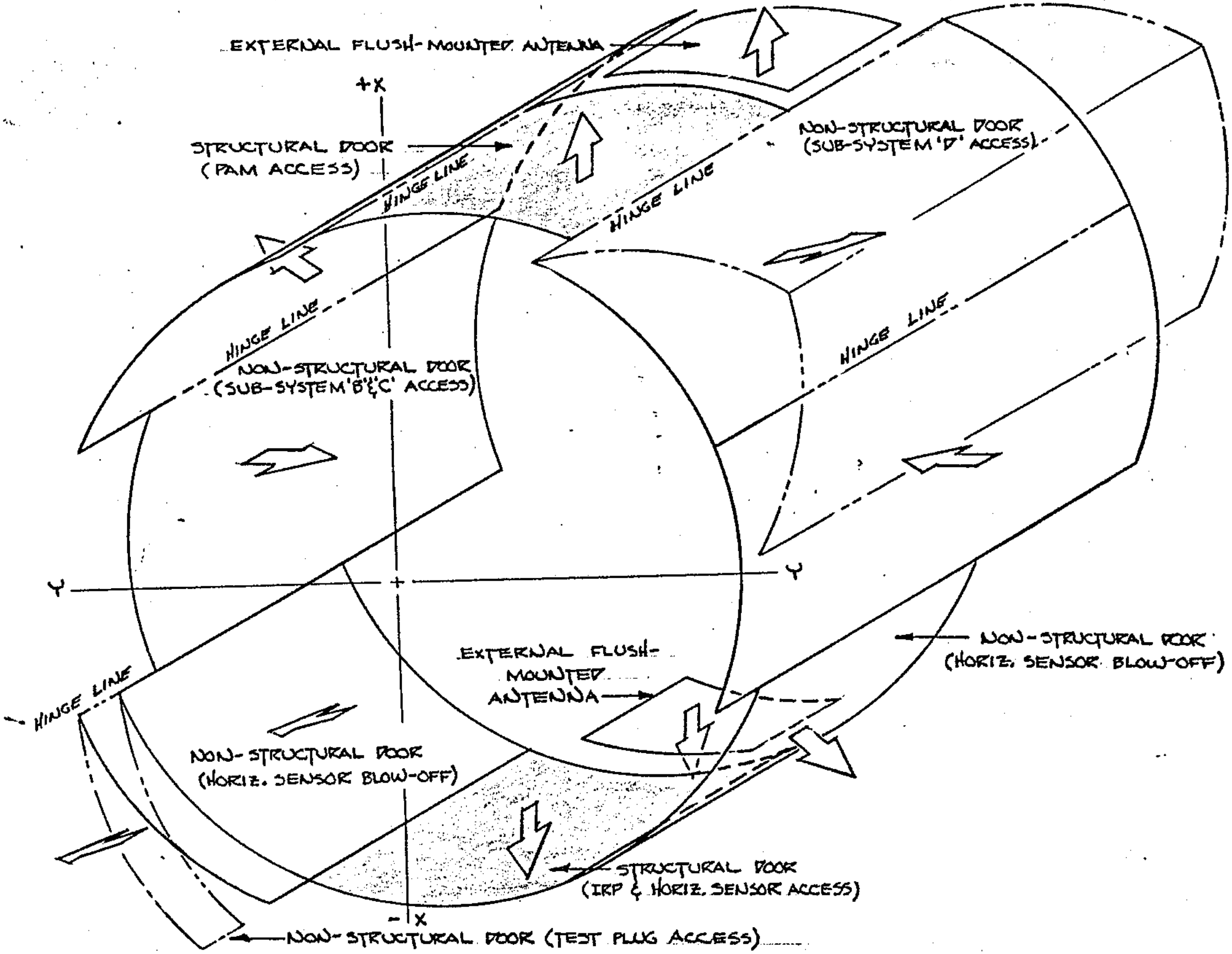


Figure 2-3 Standard Agena Access Doors

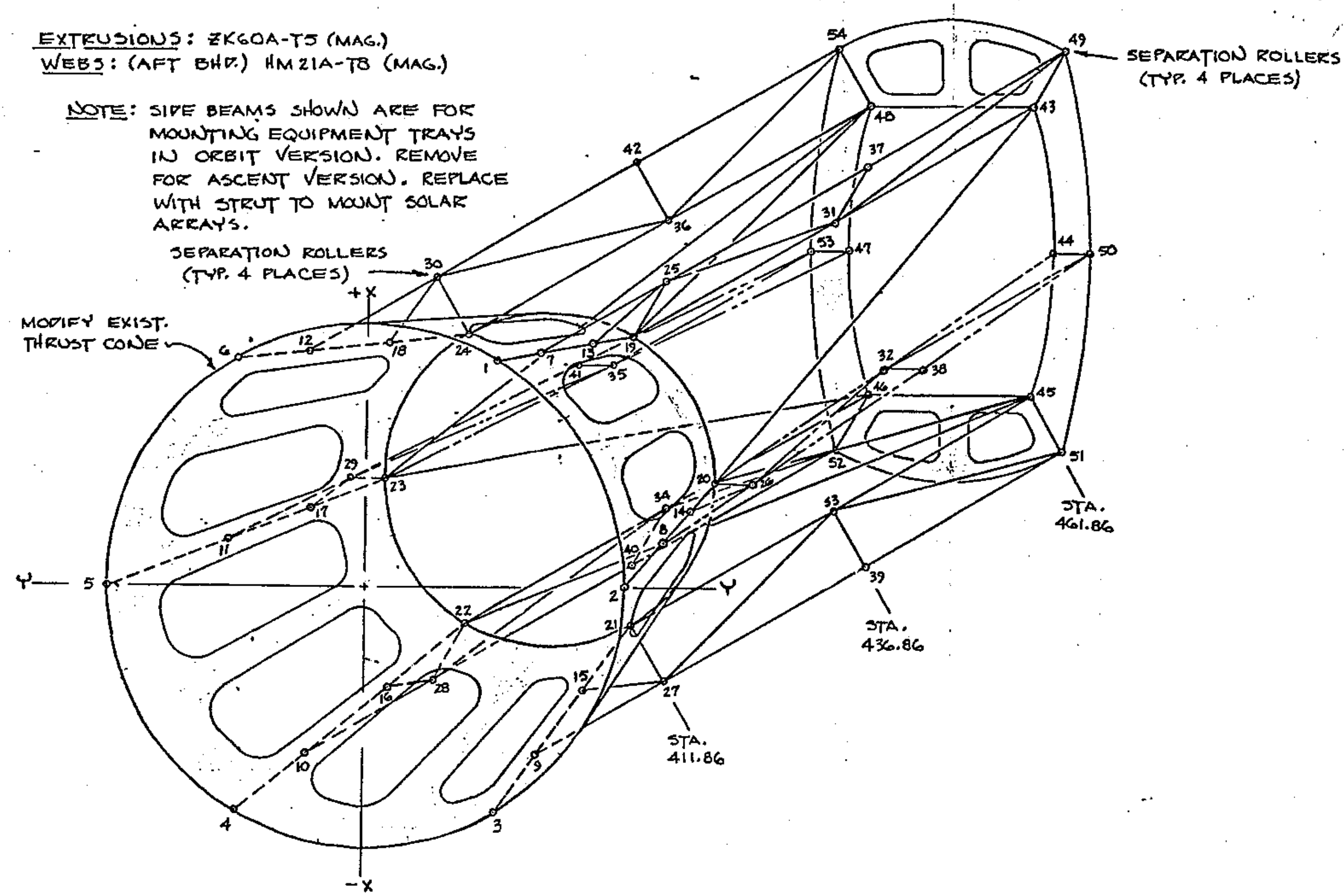


Figure 2-4 Standard Agena Aft Rack Structure

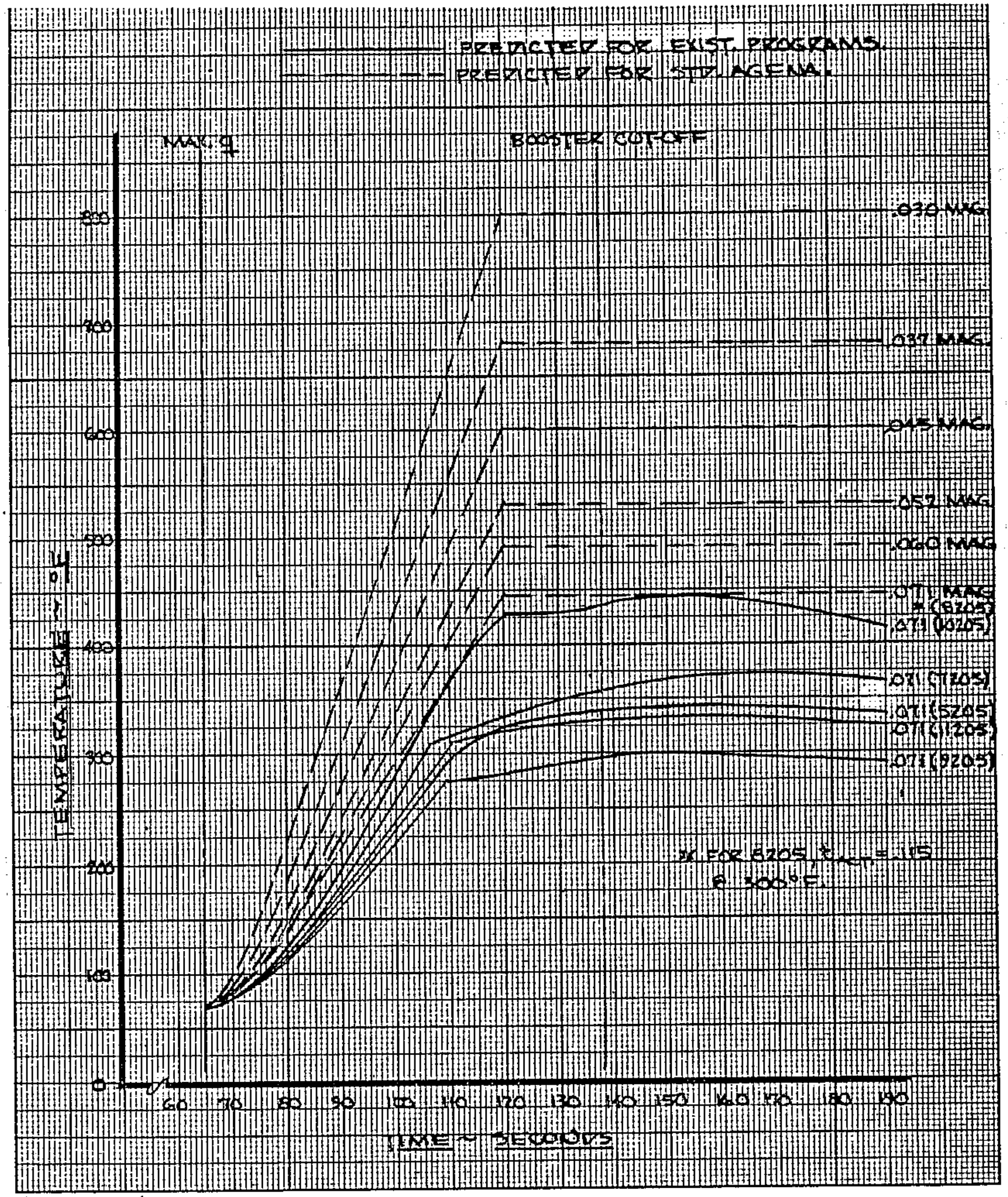


Figure 2-5 Standard Agena Forward Rack Temperature Environment

Table 2-1

STANDARD AGENA EQUIPMENT LIST

Item	Part No. or DCD No.	No. Req.
STRUCTURE - BASIC EQUIPMENT		
Forward body and equipment rack	new	1
Propellant tank (modified clip locations)	1319109-( )	1
Aft body and engine thrust cone	new	1
Aft equipment rack	new	1
Fairings over tank section	new	2
Fairings over separation fittings	new	3
Booster adapter (Thor)	new	1
STRUCTURE - OPTIONAL EQUIPMENT		
Booster adapter extension (Atlas)	new	
Equipment mounting trays - aft rack	new	
PROPULSION - BASIC EQUIPMENT		
Engine, BAC 8096	1062656-7	1
Propellant feed and load system	new	1
Propellant pressurization valve package	new	1
Propellant pressurization gas bottle	1062174-5	1
Destruct system - shaped charge	1062569-3	1
- initiator	1312289	1
Booster retrorockets	1062410-1	2
PROPULSION - OPTIONAL EQUIPMENT		
Secondary propulsion system	(re-packaged)	
Ullage orientation rockets	1062655-3	
Engine restart kit:		
Starter can	(8096-474510-1)	
Fast shutdown valve (oxidizer)	(8096-472010-3)	
Delayed restart kit:		
Starter can	(8096-474510-1)	
Fast shutdown valve (oxidizer)	(8096-472010-3)	
Isolation valve - oxidizer	1062804-1	
Isolation valve - fuel	1062804-1	
Pressurization isolation valve	Not avail.	
Auxiliary lube system	Not avail.	
Alternate helium bottle, 19" dia.	New	
ELECTRICAL POWER - BASIC EQUIPMENT		
Inverter, 400 cps, 3ϕ, 115v ac, Type IB	1062816	1
Power amplifier, 400 cps, 1ϕ, 115v ac, Type IA	1461173	1

Table 2-1 (Continued)

Item	Part No. or DCD No.	No. Req.
GUIDANCE AND CONTROLS - BASIC EQUIPMENT		
Inertial reference package, Mod III A	1062256-9	1
Horizon sensor, Barnes	1461004	1
Velocity meter, Mod II	1461045-1	1
Flight controls electronic package	1317312	1
Primary junction box	new	1
Secondary junction box	1317320 (mod)	1
Sequence timer - ascent (mod per EM 949)	1317324	1
Pneumatic control system:		
Thrust controller	1461316	2
Control package	1062668-1	1
Valve - quick disconnect	1060550-11	1
Control gas storage bottle, 2200 cu. in.	1062643-1	1
Hydraulic control system:		
Hydraulic power package	1062525-3	1
Actuator	1062509-1	1
GUIDANCE AND CONTROLS - OPTIONAL EQUIPMENT		
Pitch reaction wheel	1062706-1	
Electronics - pitch reaction wheel	1315322	
Control moment gyro	1062611-1	
Control moment gyro	1062611-3	
Auxiliary sequence timer	1321478	
Auxiliary sequence timer	1325130	
Roll-yaw steering unit	1461337	
Control gas storage bottles:		
900 cu in.	1062508-1	
1728 cu in.	1062163-3	
2200 cu in. (spherical)	1062174-5	
2200 cu in. (cyl)	1062643-1	
COMMUNICATION AND CONTROL - BASIC EQUIPMENT		
Transmitter - VHF	1062837	1
dc-dc converter	1062851	1
PAM junction box	new	1
Control multiplexer (40 KC) (16 channel)	1335846-50	1
Sub-multiplexer (128 channel), Type II	1311928-503	1

Table 2-1 (Continued

Item	Part No. or DCD No.	No. Req.
dc to dc converter (+60/-20W) Type IX	1461397	1
dc to dc converter (+30/10W), Type X	1461411 (mod)	1
Switch - main power transfer	1062515	1
Switch - dc relay	1062316	2
Filament transformer (velocity meter) 6.3v	1062708	1
Disconnect - adapter	1060735-1	1
Receptacle - umbilical	1062494-1	1
Wiring harnesses (per mockup)	new	as req.
Secondary battery (destruct system), Type III	1062095	4
ELECTRICAL POWER - OPTIONAL EQUIPMENT		
Primary batteries - Space provisions for one Type I or IA and one Type IIA, IV, V, or VI in forward rack, or two Type II, IV, V, or VI. Additional space provisions in the aft rack for up to eight batteries of any of the above types without modification of the rack.		
Type I	1060629G	
Type IA	1060905E	
Type IIA	1062170	
Type IV	1062168	
Type VA	1461387	
Type VI	1062762	
Type VI A	1461198	
Secondary batteries - Rechargeable battery for use with solar array or other dc generating equipment), Type IA	1066651-3	
Secondary battery (destruct), Type VI (Equivalent to two type III's)	1461408	
Solar array installation:	1312121	
Solar collector assembly, Type III-2	1309632	
Control junction box (2)	1062835	
Solar sensor (2), Type II	1062836-1	
Sun seek sensor, Type II	1308900	
Voltage limiter box (4)	1310386	
Solar array drive assembly (2), Type I	1062659	
Stepping motor (4), Type I	1062658	
Extension rate motor, Type I	1461074	
Flex harness (2), Type II		

Table 2-1 (Continued)

Item	Part No. or DCD No.	No. Req.
Sub-multiplexer (64 channel), Type III	1311929-503	1
Signal conditioner	1318811-501	1
Signal conditioner	1318810-501	1
RF switch (coaxial)	1600299-1	1
VHF ascent antenna	1310511	1
COMMUNICATION AND CONTROL - OPTIONAL EQUIPMENT		
Beacon transponder	1062562	
Beacon decoder	1062563	
RF switch (coaxial) (3)	1600299-1	
RF power divider	1613857-1	
RF power divider	1613857-3	
Power divider, Type MT-434		
VHF power amplifier	1062861	
Acquisition transmitter, Philco	1024504	
Antenna multicoupler	1062243	
Interim programmer, Type 6	1062281	
VHF orbit antenna	new	
Beacon ascent antenna	1303915-503	
Beacon ascent antenna	1311847	
Beacon orbit antenna	new	
Power control unit	new	