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FEASIBILITY STUDY OF STORAGE CONCEPTS FOR SCOUT AND OTHER NASA SOLID PROPELLANT LAUNCH VEHICLES

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Prepared by
MISSILES AND SPACE DIVISION
LTV AEROSPACE CORPORATION
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By Robert D. Fielder and
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Prepared Under Contract No. NAS1-6748 by
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TABLE OF CONTENTS

PARAGRAPH	TITLE	PAGE
1.0	Summary	1
2.0	Introduction	3
2.1	Background	3
2.2	Scope	3
3.0	Discussion	5
3.1	Task I Develop Selected Storage Concepts	5
3.1.2	Requirements	7
3.1.3	Storage Concepts	11
3.1.4	Evaluation	19
3.2	Task II Determine Optimum Storage Concept	23
3.2.1	Approach	23
3.2.2	Storage Constraints	23
3.2.3	Sensitive Components, Assemblies and Systems	24
3.2.4	Checkout Requirements	30
3.2.5	Operational Factors	38
3.2.6	Analysis	40
3.2.7	Cost Effectiveness	42
3.3	Task III Determine Other Vehicle Applicability	47

PARAGRAPH	TITLE	PAGE
3.3.1	Introduction	47
3.3.2	Storage Constraints	51
3.3.3	Requirements	51
3.3.4	Storage of Large Vehicles	55
3.3.5	Storage of Small Vehicles	56
3.3.6	Cost Analysis	57
4.0	Conclusion	59
5.0	Appendices	
	Appendix A, Functional Flow Block Diagrams	A-1
	Appendix B, Requirement Allocation Sheets	B-1
	Appendix C, Time Line Sheets	C-1
	Appendix D, Trade Studies	D-1
	Appendix E, Temperature and Humidity Limits	E-1
	Appendix F, Heating/Cooling Calculations	F-1
	Appendix G, Reliability Comparison	G-1
6.0	List of References	R-1

LIST OF ILLUSTRATIONS

FIGURE	TITLE	PAGE
1	Gross Level Functional Diagram	6
2	Thirty Vehicle Storage Complex	9
3	Concept 1, Container and Transport Trailer	12
4	Concept 1 Applications	13
5	Concept 2 Storage	15
6	Concept 3 Transporter/Container	17
7	Concept 3 Storage	18
8	Operations Comparison Matrix	20
9	Facility/Equipment Cost Comparison Matrix	21
10	Four Vehicle Storage Complex	43
11	Wallops Island Proposed Storage Site Location	44
12	Vandenberg Air Force Base Proposed Storage Site Location	45
13	NASA Solid Propellant Launch Vehicles	48
14	Vehicle Buildup and Transport Trailers	53
15	Task III Ground Support Equipment	54

FEASIBILITY STUDY OF STORAGE CONCEPTS FOR SCOUT AND OTHER NASA SOLID PROPELLANT LAUNCH VEHICLES

1.0 SUMMARY

A systematic study has been performed to determine the feasibility of storing Scout and other NASA solid propellant launch vehicles in an assembled and flightworthy configuration for long periods of time. The study concludes that long term storage for Scout is feasible where the aggregate storage time encompasses disassembled, assembled and ready-hold levels of storage; and that the other solid propellant launch vehicles in the NASA inventory are compatible with the Scout storage concept.

The study is divided into three tasks. Task I encompasses the storage concepts for the Scout vehicle and an evaluation of the cost involved to implement each concept. Specified concepts considered include 1) a storage container having the capability to support all functions of Scout vehicle processing, 2) a fixed storage container capable of accepting and storing an assembled Scout vehicle by transferring from the Scout transporter, 3) a storage container adapted to the existing Scout transporter, and 4) an environmentally controlled building capable of accepting and storing vehicles on the existing Scout transporter.

Task II encompasses the effect the storage concept has on the Scout vehicle components, assemblies, and systems; and the problems associated with flight-ready storage and storage surveillance. Storage constraints and checkout requirements are combined with operational goals to establish a vehicle processing flow involving storage.

Task III is an examination of the other solid propellant launch vehicles in the NASA inventory for applicability to the Scout storage concept.

The recommended storage concept is a fixed container consisting of an environmentally controlled prefabricated steel building with steel frame supports onto which the Scout and other NASA vehicles are roll transferred for storage. This concept forms the vehicle container portion of a barricaded storage complex proposed for both Wallops Island and Vandenberg Air Force Base and is located as close to the existing Scout Assembly Buildings as safety requirements will allow.

2.0 INTRODUCTION

2.1 BACKGROUND

The capability of drawing out of storage a launch vehicle in a flight ready configuration that enables direct mating to the launcher is an operational goal desired by launch agencies.

Several advantages are attainable through storage of flight ready vehicles. Operational flexibility is provided with an inventory of vehicles ready to adapt to any assigned payload. Accelerated launch rates can be sustained for short periods without increasing manpower requirements. Storage capability provides better utilization of human and material resources by eliminating work load peaks to support vehicle assembly and checkout. Considering prelaunch operations as those functions accomplished in a continuous sequence by field crews to effect a launch, ready vehicles in storage can reduce the prelaunch operations to: 1) removal from storage, 2) preflight pad operations, and 3) launch.

The purpose of this study is to define a storage concept that will satisfy these objectives and that is feasible in terms of performance and cost.

2.2 SCOPE

This study is divided into three tasks;

Task I is a study of the feasibility of selected candidate storage concepts for the Scout vehicle and an evaluation of the cost involved to implement each concept. Long term storage requirements for the vehicle are identified. Candidate concepts are evaluated for feasibility and adaptability with sufficient detail being developed to permit identification of the support equipment, facility, manpower and operational requirements for each concept. Cost estimates for implementing each concept are made using Rough Order of Magnitude (ROM) values based on storage of 30 vehicles.

Task II is basically a follow-on effort to Task I wherein the effect each storage concept has on the Scout vehicle components, assemblies, and systems; the problems associated with flight ready storage and storage surveillance; and the logistics and operational factors of the Scout Program are identified and compared to arrive at a recommended storage method for the Scout vehicle. Each system is reviewed and the storage sensitive items identified. The required checkout to maintain or recertify the flight ready status of each item is determined and an optimum Functional Flow Block Diagram developed which will satisfy the overall aim of the storage requirements. Additional equipment and facilities required are identified. Based on the Functional Flow diagrams, vehicle reliability is computed and compared with the reliability of the existing Scout processing flow. Reliability factors and cost elements developed for the optimum storage concept are then evaluated with the current mode of operation to determine the most cost effective system.

Task III is an examination of the other solid propellant launch vehicles in the NASA inventory to determine how they may be applied to the storage concept developed under Task I and II.

A compilation based on their past launch frequency, is made of the solid rocket launch vehicles in the NASA inventory to identify those vehicles with sufficient usage to warrant storage. The configuration of each vehicle is determined and the simple single stage vehicles eliminated from storage consideration. The storage function and requirements developed under Task I and II are reviewed for compatibility with these vehicles resulting in the development of a conceptual design for storage of these vehicles utilizing the facility and applicable portions of Ground Support Equipment (GSE) conceived during Task I. Cost estimates using ROM values are made for the additional GSE required to accomodate storage of these high usage NASA solid propellant launch vehicles.

The study concludes with a recommended overall storage concept that will satisfy the requirements and can be acquired at reasonable cost.

3.0 DISCUSSION

3.1 TASK I DEVELOP SELECTED STORAGE CONCEPTS

The objective of Task I is to determine the feasibility of several candidate concepts for storing assembled Scout vehicles over a long period of time and to evaluate relative costs of the concepts considered.

Four concepts of assembled vehicle storagewere investigated:

1. Storage in a mobile container having the capability to support vehicle processing functions from build-up to mating the vehicle to the launcher, and to accomodate shipping of the assembled vehicle by air, rail, or highway.

2. Storage in a fixed container capable of accepting the assembled vehicle from its transport vehicle (Scout transporter).

3. Storage in a container adapted to the present Scout transporter.

4. Storage in an environmental controlled building.

Variations of these four concepts are considered and results documented.

Systems Engineering methodology and rationale were employed to develop the storage concepts. A gross level functional base was established by translating customer requirements into functions which must be performed for the storage cycle by all concepts considered. These functions are shown in the functional flow block diagram, figure 1, and include the following:

1.0 In-Plant Operations

2.0 Package Vehicle

3.0 Store Vehicle

4.0 Vehicle Test and Surveillance

5.0 Remove from Storage

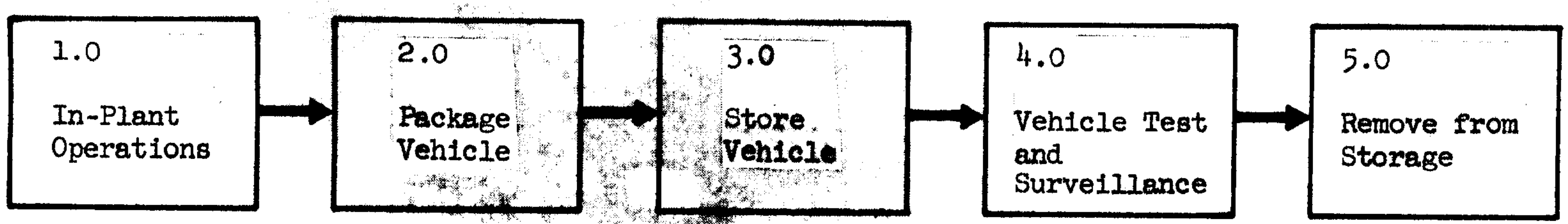


FIGURE 1 GROSS LEVEL FUNCTIONAL DIAGRAM

Requirement Allocation Sheets (RAS), Appendix B, were developed for Function Blocks 2.0 and 3.0. These RAS's identify constraints and definitive requirements for facilities, Ground Support Equipment (GSE), personnel, and procedures. Through reviews of Scout physical configuration, preparation of sketches and layouts, conduct of preliminary structural analysis, and optimization of design selections; each concept is developed sufficiently to identify a feasible and practical solution meeting the requirements listed on the RAS's. Trade Studies are performed where more than one solution is evident. With the concepts thus identified, budgetary cost estimates for concept comparison are made.

3.1.2 Requirements

The following requirements were derived from the storage requirements established by the Contract Statement of Work, (ref. 1)

a. Capacity to store 20-30 launch vehicles for periods of 2 to 3 years.

b. Vehicle checkout complete prior to placement in storage.

c. Store vehicle in air transport configuration, i.e., less 4th stage motor, separation system, payload, heatshield, batteries, and pyrotechnics.

d. Direct mating to launcher, a desirable goal.

e. Maximum use of existing Scout equipment and facilities, especially the Scout transporter.

f. Present Scout launch complex locations preferred for the storage site; however, other locations are not to be excluded from consideration.

g. Ability to determine vehicle flight worthiness during storage period.

These constraints are supplemented by data developed during the study and are reflected in the RAS's. It should be noted at this point that the impact which checkout may have on the storage requirements is not considered during Task I.

3.1.2.1 Facility Requirements - One of the most stringent requirements imposed on a storage facility for ordnance material is the distance between storage buildings or containers, inhabited areas, highways, runways and taxi-ways. The final criteria used herein to develop the Scout storage requirements for quantity distance relationships is the same as used in the Feasibility Study of a Scout Central Ordnance Complex, (COC)(ref.2).

The clear distance requirements to inhabited buildings, highways, runways and taxi-ways and the magazine spacings derived herein are based on the class 7 quantity distance tables of the Explosive Safety Manual, (ref. 3) and requirements of other military explosive safety manuals (ref. 4 and 5); considering the vehicle equivalent as 17 242 pounds of class 7 explosive (50% for Algol propellant, 50% for Castor propellant, and 100% for X-259 propellant). Various storage groupings were considered. Trade Study 001, Appendix D, concluded that the least amount of real estate required for storage of 30 vehicles will occur when storage magazines are grouped into six pads with five vehicles each. This arrangement is shown in figure 2 and depicts the area relationship and clear distance requirements on an unbarricaded facility and a barricaded facility. The prime consideration in the selection of a barricaded facility versus an unbarricaded facility is land acquisition cost which is indeterminable at this time.

A review of the launch sites and the proposed Dallas COC indicate that sufficient clear area does exist at both Wallops Island (W.I.) and the Vandenberg Air Force Base (VAFB) to accommodate either a barricaded or an unbarricaded storage facility; whereas Wallops Station and the proposed Dallas COC do not have sufficient clear area for either type storage facility of this size. Further, additional limitations imposed by a particular site due to local peculiarities which are unknown at this time may require some deviations in the arrangement or grouping.

Facility requirements for a storage complex are essentially the same for each concept, differing only in the immediate area of each pad or group. The following requirements are typical for each concept: 1) access roads and maneuvering aprons, 2) electrical power services, 3) alarm system, 4) restroom facilities, 5) emergency power station, 6) lightning and grounding systems, 7) security fencing, and 8) fire protection. The pad storage areas differ from one concept to another depending on the type storage container involved.

The roadways and aprons are concrete paving capable of supporting a tandem axle load of 80 000 pounds. Roadways within the complex are 24 feet wide with a minimum inside radius of 65 feet. Dimensions of the

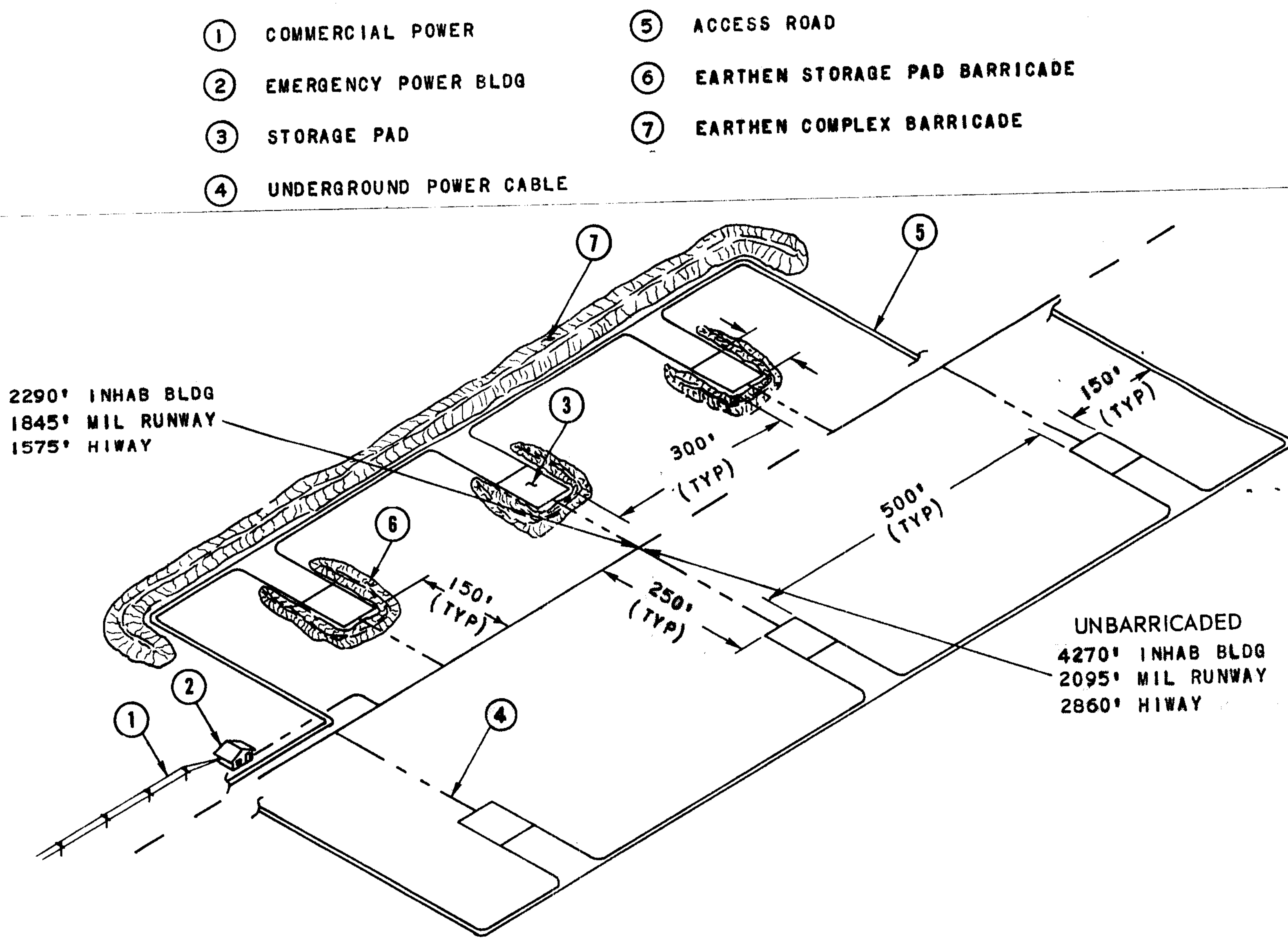


FIGURE 2 THIRTY VEHICLE STORAGE COMPLEX

maneuvering aprons vary slightly for each concept yet provide sufficient space to position transporters and storage containers.

Electrical power service is supplied from local service to a transformer distribution system within the complex. Emergency power is provided by a high voltage automatic engine/generator set. Trade Study 002, Appendix D, concluded that a central engine/generator station is preferred to individual portable emergency generators. The generator will start and assume the load automatically whenever power fails and will transfer back whenever the commercial power resumes.

The alarm system consists of a one circuit alarm cable running from a monitoring station and distributed to each vehicle station. Local alarm devices are provided on each container to aid in fault isolation. The alarm circuit will register if the temperature or humidity is out of limits or if the commercial power supply fails.

Restroom and toilet facilities are provided within the complex; however, this is an optional requirement and is dependent on the remoteness of the storage complex location.

A mast type lightning protection system is provided for each storage pad. A grounding system provides an earth ground point for each vehicle.

The complex is fenced with six feet chain link fence with wire overhangs.

Fire protection will consist of hand operated fire extinguishers located near each vehicle.

3.1.2.2 Environment Control Requirements - Environmental parameters of temperature and relative humidity are the two most critical elements related to storage of an assembled Scout vehicle over long periods of time. Protection from other environments, such as wind, snow, rain, etc., is considered to be inherent with basic container or enclosure design so that the vehicle will be unaffected throughout the storage period.

The temperature and humidity limits to which various components and systems of the Scout vehicle may be exposed are documented in Appendix E. An analysis of this data shows that the guidance system and the rocket motors require the most stringent environmental control. Based on this, a storage environment that will satisfy all Scout systems is between 60°F and 80°F at less than 40% relative humidity.

The heating and cooling load calculations to determine the BTU requirements for the environmental control equipment necessary to maintain the prescribed temperature and humidity for each concept are documented in Appendix F.

Climatic temperature extremes to be expected for the three areas being considered for storage (Wallops Island, Vandenberg Air Force Base and Dallas) are from $-10^{\circ}F$ to $110^{\circ}F$ and from 10% to 100% relative humidity.

3.1.3 Storage Concepts

3.1.3.1 Concept 1 - Mobile Container - This concept uses a storage container and transport trailer having the capability to support all functions of Scout vehicle processing which include vehicle buildup, checkout, storage, air, rail or road transportation; and vehicle loading on the launcher. The container and transport trailer are illustrated in figure 3. The concept in its various applications is illustrated in figure 4.

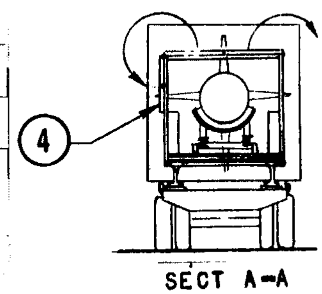
To provide vehicle buildup capability, the container has movable support cradles and restraints similar to the existing air transport Scout transporters. Removable sections and ends as well as hinged container roof are provided for vehicle accessibility. Vehicle buildup and checkout is accomplished in the same manner as is done on the transporter. After checkout, the vehicle is sealed and prepared for storage. The container is closed by installing the removed sections and closing the container top.

The container is so constructed as to provide protection from the elements and equipped with an environmental control unit for temperature and humidity control while in storage. Continuous temperature and humidity surveillance is provided by a self contained recorder and alarm system.

Transportation of the vehicle/container to the storage site is accomplished by a modified 80 feet long flat bed trailer and a truck tractor prime mover. At the storage site the vehicle/container is roll transferred to a storage support structure, and the container air conditioning unit connected to the storage area power supply and monitoring system.

Removal of the vehicle from storage consists of roll transfer of the container from the support structure to the modified flat bed trailer and then it is transported to the launcher.

1. ENVIRONMENTAL CONTROL UNIT
2. REMOVABLE END SECTION
3. VEHICLE RESTRAINT
4. HOIST SLING
5. REMOVABLE ACCESS SECTION
6. POWER WINCH
7. STAGE 4 SUPPORT DOLLY & RAILS
8. ENVIRONMENTAL ALARM UNIT
9. ACCESS DOOR
10. SUPPORT DOLLY
11. TRANSPORTER POSITIONING GEAR
12. CONTAINER/VEHICLE SUPPORT STRUCTURE
13. TRANSPORTER TRAILER
14. ROLL TRANSFER & GUIDE SYSTEM
15. CONTAINER RESTRAINT SYSTEM



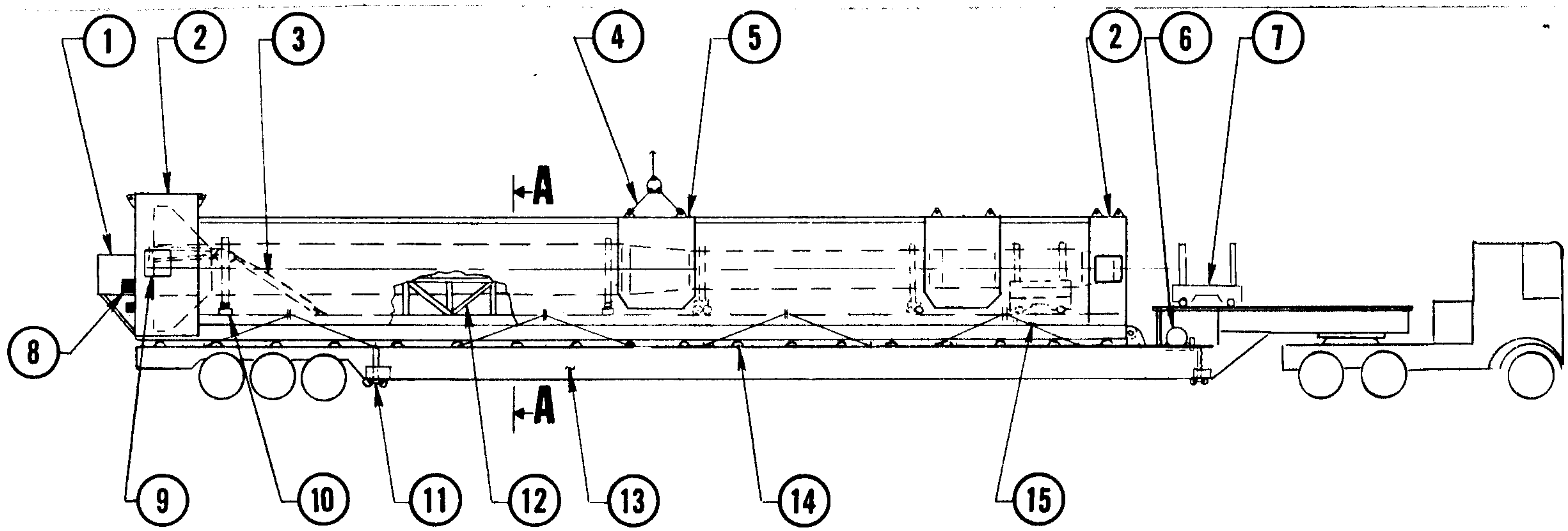


FIGURE 3 CONCEPT 1, CONTAINER & TRANSPORT TRAILER

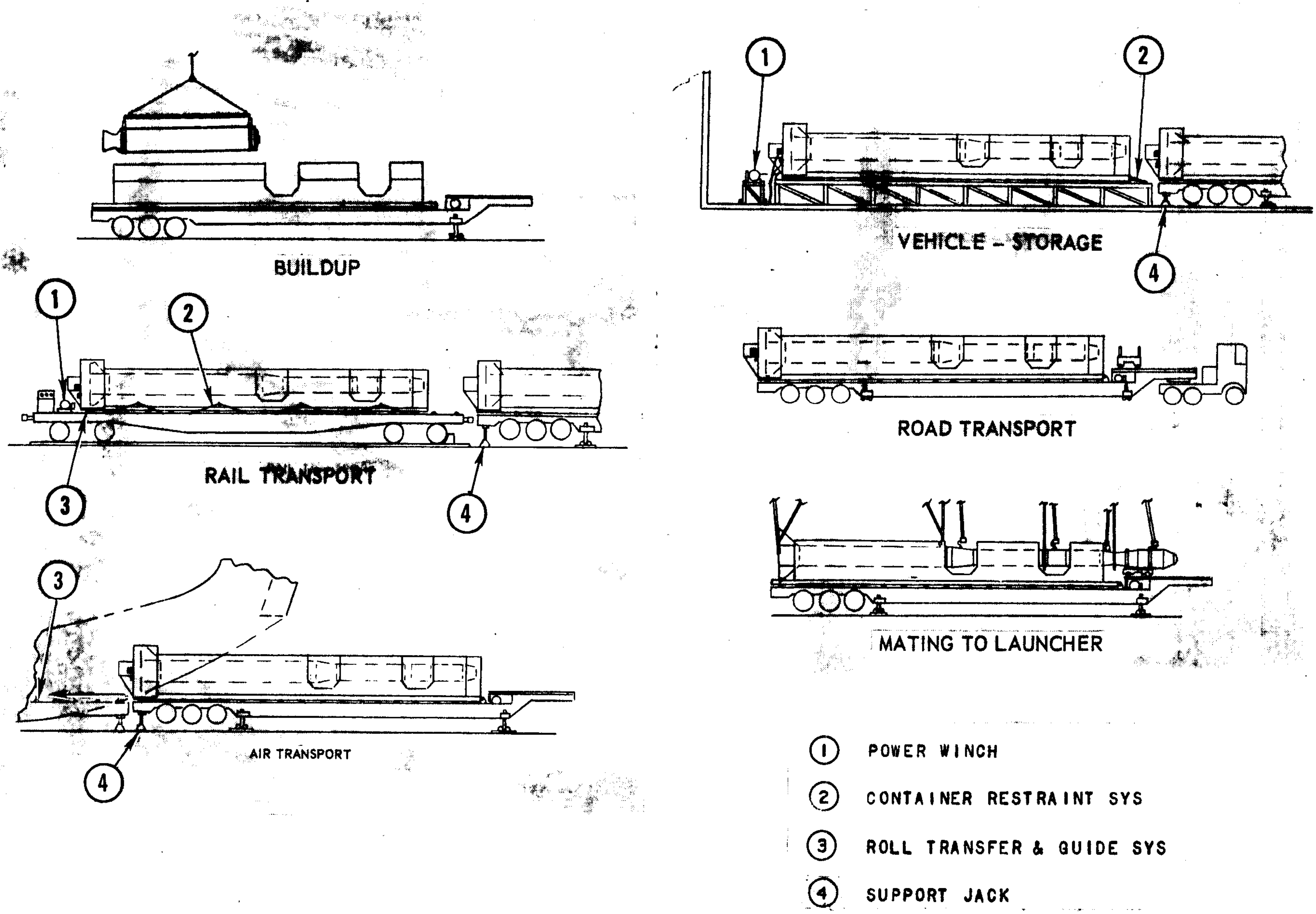


FIGURE 4 CONCEPT 1 APPLICATIONS

Air, rail, or highway mode of transportation may be utilized for long distance moves between storage and launch site. For air shipments, the container is roll transferred from the modified flat bed trailer into a C-133 or C-141 aircraft. For shipments by rail, the container is roll transferred onto a transcontinental railway flat car equipped with a shock mitigating system. Special tie downs similar to that used for vehicles being air transported in accordance with Scout Standard Procedures(ref. 6) are provided. The highway mode utilizes the modified flat bed trailer with a shock mitigating system and a truck-tractor prime mover. A generator power supply is provided for the environmental control system with the rail and highway modes.

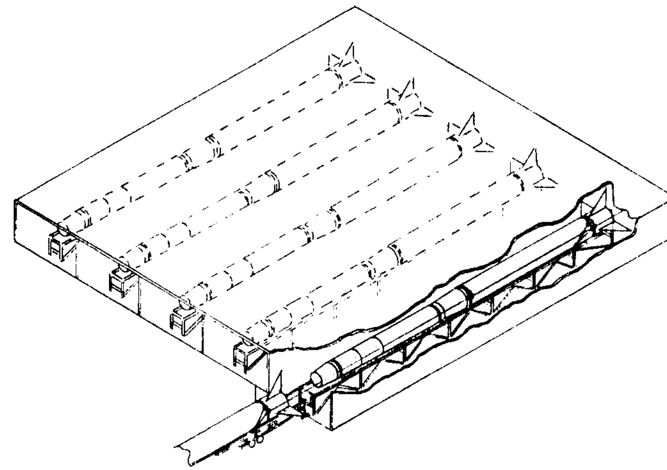
At the launcher all panels are removed from the container and stored. The trailer/container is backed into the shelter and the vehicle is loaded on the launcher in a like manner as now prescribed by Scout Standard Procedures. A rail system mounted at the forward end of the trailer provides the capability of mating the fourth stage to the vehicle.

3.1.3.2 Concept 2 - Fixed Container - This concept is based on a fixed storage container located at the storage complex. The container is capable of accepting and storing an assembled Scout vehicle by transfering from the Scout transporter. Vehicle assembly and handling operations, other than transfer to and from storage, are performed in accordance with the existing Scout Standard Procedures.

Of the several types of fixed storage containers considered, Trade Study 003, Appendix D, selected a light-constructed, prefabricated steel building; and consistent with the storage complex group arrangement, further concluded that each storage building unit would be capable of storing five vehicles. Concurrent with this study, two methods of transfer from the transporter were considered. Trade Study 004, Appendix D, selected the roll transfer system. Modification of the Scout transporter is required to provide the roll transfer capability and consists of extending the transporter rails, adding rollers to the first stage cradles and adding a first stage tie bar. Inside the storage buildings are removable steel framework type support structures with rails that will mate with the modified transporters. A small winch is used to move the vehicle to and from the support structure. Each storage unit is equipped with air conditioning equipment and environmental monitoring and alarm system. This concept is illustrated in figure 5.

Removal from storage is accomplished by a roll transfer operation to the transporter followed by transport operation to launch pad directly or by air transport.

1. POWER WINCH
2. TRANSFER YOKE ASSEMBLY
3. RESTRAINT SYS
4. STORAGE SHED
5. TRANSFER RAILS
6. SUPPORT JACK



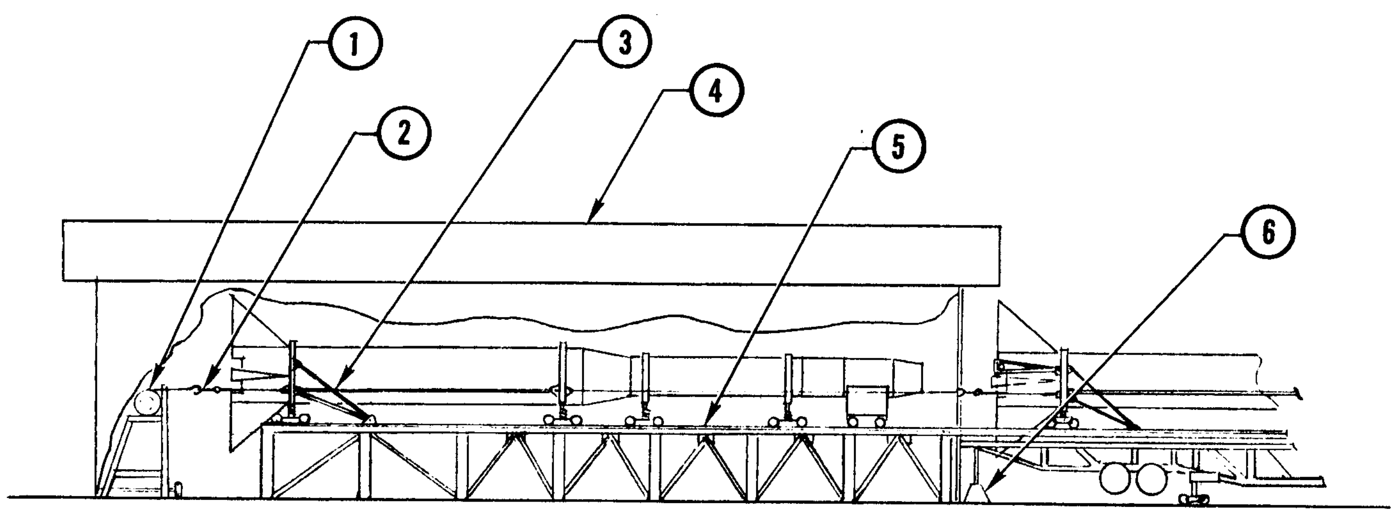


FIGURE 6 CONCEPT 2 STORAGE

3.1.3.3 Concept 3 - Addition of Cover to Vehicle while on Transporter - In this concept the existing Scout transporter is modified by adding a floor, a cover, and an air conditioning unit to form an environmentally controlled container, as shown in figure 6. Trade Study 005, Appendix D, selected a rigid cover in preference to an expendable cocoon cover.

Assembly and handling of the vehicle is accomplished on the transporter in accordance with existing Scout Standard Procedures. In preparation for storage, the rigid cover is manually rolled into position over the vehicle and secured to the transporter. A truck/tractor prime mover is used to tow the transporter to the storage area. Two storage modes were considered; i.e., store on the transporter or roll transfer to a fixed steel frame support structure. Trade Study 006, Appendix D, selected a fixed steel frame type structure as illustrated in figure 7. A winch is provided to facilitate transfer operations. Modification of the transporter is required to accept the rigid cover and to provide the roll transfer capability. Continuous temperature and humidity surveillance is provided by self contained recorders. While in storage, the air conditioning unit is connected to the storage complex power supply and alarm system.

Removal from storage is accomplished by transfer from the fixed support back to a Scout transporter. The fixed cover is removed prior to the transfer and can remain off if temperature exposure limits will not be exceeded during towing operations to the pad. If required, the cover is repositioned over the vehicle and secured to the transporter for towing and removed prior to entry into shelter at the pad.

3.1.3.4 Concept 4 - Storage in a Building - This concept is based on an environmentally controlled building capable of accepting and storing vehicles on the existing Scout transporter. This concept differs from Concept 2 only in that the vehicle remains on the transporter while in storage.

1 SCOUT TRANSPORTER
2 ENVIRONMENTAL CONTROL UNIT
3 ENVIRONMENTAL ALARM UNIT
4 CHECKOUT CABLE ACCESS DOOR
5 REMOVABLE END SECTION
6 CASTOR JACKS
7 ACCESS PANELS FOR TIE DOWNS
8 ENVIRONMENTAL FLOORING TRANSPORTER

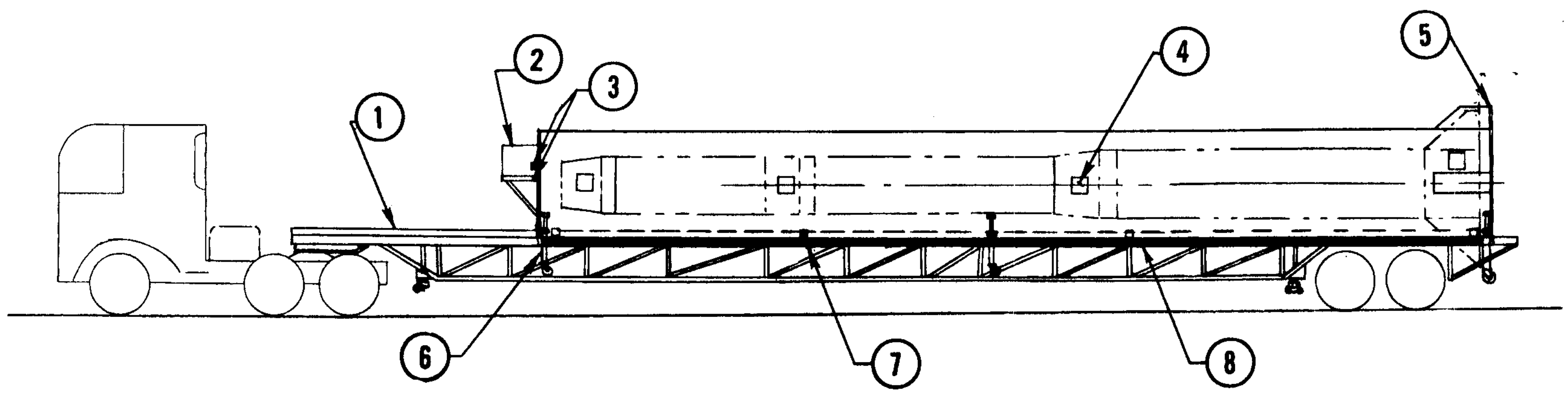
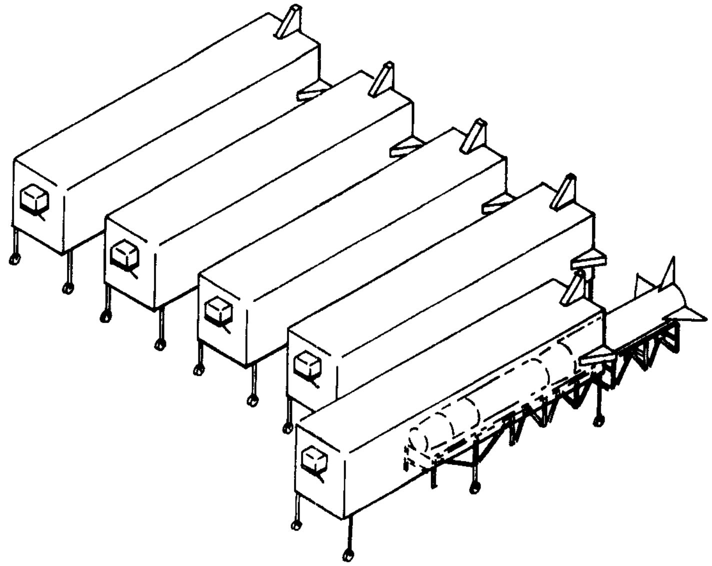


FIGURE 6 CONCEPT 3 TRANSPORTER/CONTAINER

1. POWER WINCH
2. TRANSFER YOKE ASSY
3. RESTRAINT SYS
4. PORTABLE VEHICLE COVER
5. TRANSFER RAILS
6. ENVIROMENTAL CONTROL UNIT
7. SUPPORT JACK



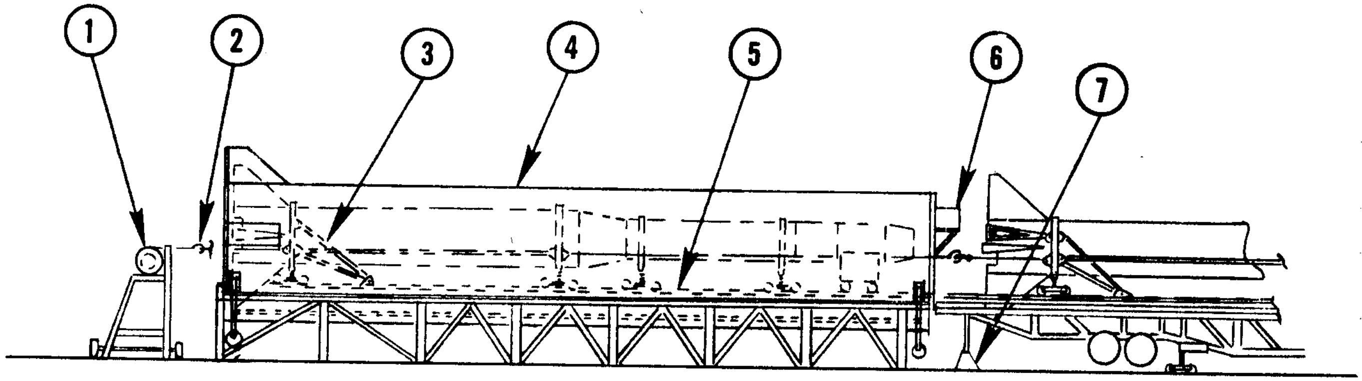


FIGURE 7 CONCEPT 3 STORAGE

3.1.4 Evaluation

To summarize for a comparison; the four concepts thus developed are identified as follows:

Concept 1, a Mobile Container, consisting of a new container and new transporter.

Concept 2, a Fixed Container, consisting of a prefabricated steel building with multiple steel support structures upon which vehicles are roll transferred for storage.

Concept 3, a rigid cover adapted to a steel support structure to form a container; vehicle is roll transferred from transporter to support structure for storage.

Concept 4, Storage in a Building, consisting of a prefabricated steel building with the vehicle remaining on the transporter while in storage.

These concepts are evaluated on the basis of performance, ease of operation, and cost. Figure 8, Operations Comparison Matrix, and Figure 9, Facility Equipment Cost Comparison Matrix, summarize this evaluation based on a storage requirement of 30 vehicles and the data from this task.

Without regard to the impact of subsequent data from Tasks II or III, each concept developed will meet the storage performance requirements and are therefore considered equal in this respect.

Concept 1, affords the least use of existing equipment, requires the greatest amount of new design and procurement, imposes more complexity for vehicle assembly and launcher loading operation, and incurrs the highest cost. Considerable additional cost is required to provide the concept with rail or highway transportation capability. Concept 1 is therefore eliminated from further consideration.

Similarities of Concepts 2 and 4 allow them to be considered as one wherein a choice lies between storage on the transporter or on a support structure. Although the transfer operation in Concept 2 imposes some additional vehicle handling, it is not sufficient to justify the cost of additional transporters on which to store. Concept 4 is therefore eliminated from further consideration.

CONCEPT	OPERATIONS		REMARKS
	PRE-POST STORAGE	STORAGE	
1	1. MATE CONTAINER/TRAILER 2. ASSEMBLE VEHICLE IN CONTAINER 3. CLOSE CONTAINER HINGED TOP SADDLES END CLOSURES 4. ROLL TRANSFER FOR STORAGE 5. OPEN CONTAINER FOR CHECKOUT 6. OPEN CONTAINER AT PAD 7. STORE CONTAINER CLOSURES & SADDLES 8. MATE VEHICLE (IN CONTAINER) TO LAUNCHER	1. ALERT STANDBY 2. SERVICE INSTRUMENTATION FOR 30 CONTAINERS 3. RECORD DATA FOR 30 CONTAINERS	1. VEHICLE EXPOSURE TO AMBIENT LEAST 2. MAXIMUM PROCEDURE CHANGE 3. MAXIMUM DESIGN 4. POOREST ACCESSIBILITY 5. ENVIRONMENTAL CONTROL OPERATION - PER CONTAINER PER VEHICLE 6. LESS LOAD ON VEHICLE TO ROLL TRANSFER 7. STORAGE SPACE REQUIRED AT PAD FOR SADDLES & CLOSURES 8. HOIST REQUIRED TO HANDLE SADDLES AND CLOSURES 9. LEAST USE OF EXISTING EQUIPMENT
2	1. ASSEMBLE VEHICLE ON SCOUT TRANSPORTER PER PRESENT METHOD 2. ROLL TRANSFER VEHICLE TO AND FROM STORAGE 3. MATE VEHICLE TO LAUNCHER PER PRESENT METHOD	1. ALERT STANDBY 2. SERVICE INSTRUMENTATION FOR 6 BLDGS 3. RECORD DATA FOR 6 BLDGS	1. VEHICLE EXPOSED TO AMBIENT DURING TRANSFER OPERATIONS 2. GOOD VEHICLE ACCESSIBILITY 3. MINIMUM PROCEDURE CHANGE 4. LESS THAN MODERATE NEW DESIGN 5. ENVIRONMENTAL CONTROL OPERATION PER BLDG PER 1 TO 5 VEHICLES
3	1. ASSEMBLE VEHICLE ON SCOUT TRANSPORTER MODIFIED TO FORM CONTAINER 2. MANUALLY ROLL COVER OVER VEHICLE & SECURE TO TRANSPORTER 3. REMOVE COVER TO PLACE VEHICLE IN OR OUT OF STORAGE 4. ROLL TRANSFER VEHICLE TO & FROM STORAGE 5. ROLL COVER OVER VEHICLE IN STORAGE 6. REMOVE COVER FOR CHECKOUT 7. REMOVE COVER AT PAD TO MATE VEHICLE WITH LAUNCHER 8. MATE VEHICLE TO LAUNCHER PER PRESENT METHOD 9. STORE COVER AT PAD	1. ALERT STANDBY 2. SERVICE INSTRUMENTATION FOR 30 CONTAINERS 3. RECORD DATA FOR 30 CONTAINERS	1. VEHICLE EXPOSED TO AMBIENT DURING TRANSFER OPERATIONS 2. NEAR MAXIMUM PROCEDURE CHANGE 3. MODERATE NEW DESIGN 4. GOOD ACCESSIBILITY 5. ENVIRONMENTAL CONTROL OPERATION - PER CONTAINER PER VEHICLE
4	1. ASSEMBLE VEHICLE ON SCOUT TRANSPORTER PER PRESENT METHOD 2. PARK TRANSPORTER WITH VEHICLE IN STORAGE 3. MATE VEHICLE PER PRESENT METHOD	1. ALERT STANDBY 2. SERVICE INSTRUMENTATION FOR 6 BLDGS 3. RECORD DATA FOR 6 BUILDINGS	1. VEHICLE EXPOSED TO AMBIENT DURING TRANSFER OPERATIONS 2. MINIMUM PROCEDURE CHANGE 3. MINIMUM NEW DESIGN 4. MOST USE OF EXISTING EQUIPMENT 5. REQUIRES LARGE NUMBER ADDITIONAL TRANSPORTERS 6. GOOD ACCESSIBILITY 7. ENVIRONMENTAL CONTROL OPERATION PER BLDG PER 1 TO 5 VEHICLES

FIGURE 8 OPERATIONS COMPARISON MATRIX

(1)	SURF RR STATION	(5)	SCOUT ORDNANCE ASSEMBLY BUILDING
(2)	SURF GATE	(6)	ORDNANCE BUILDING NUMBER I
(3)	SPIN TEST FACILITY	(7)	PROPOSED 30 VEHICLE STORAGE SITE
(4)	PROPOSED 4 VEHICLE STORAGE SITE	(8)	MESA ROAD

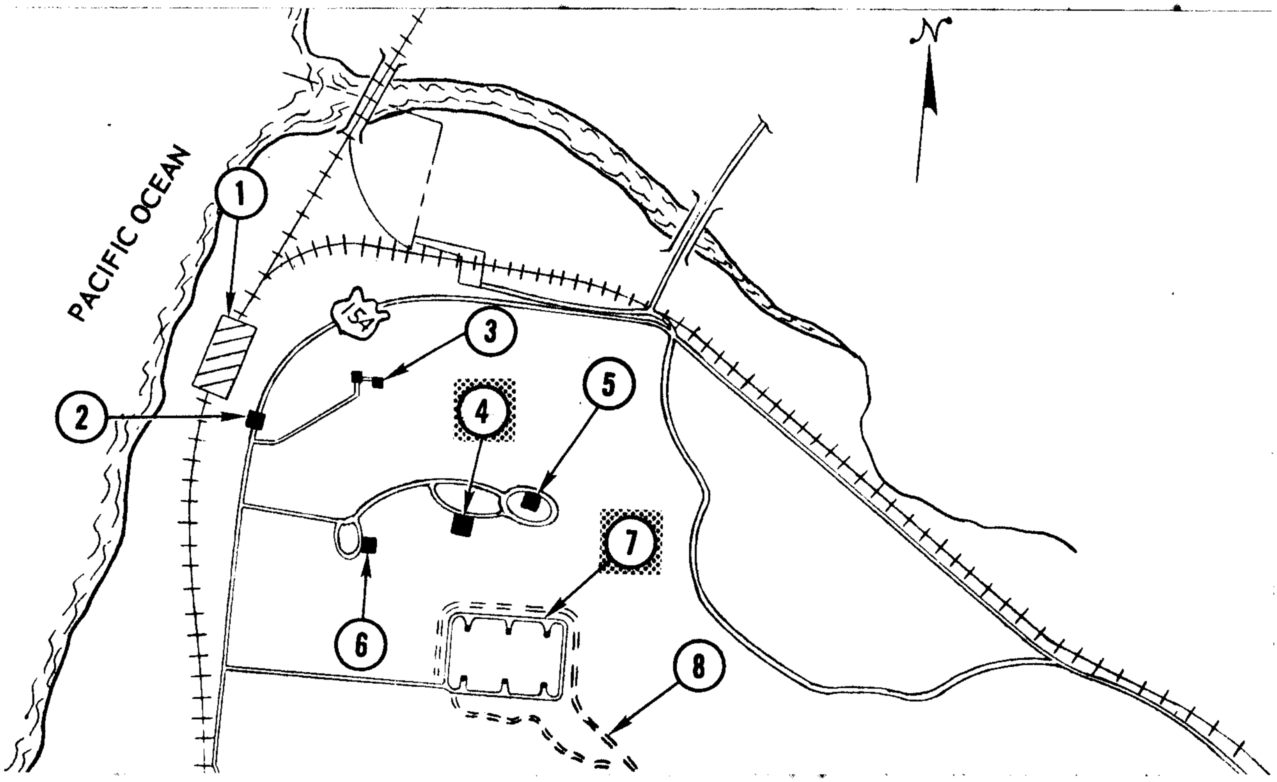


FIGURE 12 VANDENBERG AIR FORCE BASE PROPOSED STORAGE SITE LOCATION

Concept 3 requires a moderate amount of new design and procurement. Long term storage on a transporter/container requires additional transporters as in Concept 4; whereas storage on the support structure/container compares with Concept 2 in the number of transporters required. Storage on the transporter/container offers some flexibility for short term storage; however, this is offset by the disadvantage of increased transporter weight for normal usage. The new design and procurement cost for Concept 3 exceed that of Concept 2.

It is therefore concluded that for the storage of 30 Scout vehicles, the greatest advantage is in Concept 2.

3.2 TASK II DETERMINE OPTIMUM STORAGE CONCEPT

The objective of Task II is to determine the most suitable overall storage concept for the Scout system through a detail study of the effects of long term storage on components, assemblies, and systems; the problems associated with flight worthiness surveillance; the equipment required for surveillance; and the logistics and operational factors of the Scout Program.

3.2.1 Approach

The task began with the identification of existing constraints effecting storage of each Scout component and the listing of these constraints and components by systems. The constraints were appropriately applied as if the components were in the assembled vehicle, system level, configuration. From this listing the storage critical components were regrouped into storage limiting periods reflecting the type checkout and frequency requirements to recertify the components at the system level. Operational requirements and goals are combined with the thus identified storage limitations and checkout requirements and translated into functions. The Gross Level Functional Diagram established during Task I was updated and optimized and the new requirements added to the Requirement Allocation Sheets. Trade studies were performed where more than one solution was evident. Solution of these requirements identify the facility, GSE, manpower and procedure requirements. The resulting storage system concept is compared with the existing operational techniques.

3.2.2 Storage Constraints

The existing storage constraints are embodied in the spares program shelf life and specifications and in engineering judgment for the situations not otherwise covered. The Scout vehicle is presently being stored in three basic configurations; i.e., as production and spares components and subassemblies on the shelf, as transition sections and components in completed sub-assemblies in bonded stores and as assembled vehicles at launch sites. Shelf life for production parts are controlled by a Material Control Section and is based on procurement specifications. Spares shelf life is established and controlled by the Spares Program through a monthly replenishment report (ref. 7). Two specifications have been released for storage of transition sections, components, and parts. Specification 309-76(ref. 8) is for 90 day storage and Specification 309-78(ref. 9) is for one year storage. Although these constraints do not specifically apply to the storage of an assembled vehicle, they do provide a point of departure. Assembled vehicles have been held for extended periods at the launch sites. Vehicle 138 in particular was held in a ready status for over four months to determine the effects of storage on an assembled vehicle. Storage was conducted as outlined in the Program Plan for S-138R (ref. 10) and S-138 Field Process (ref. 11). Subsequent checks found no degradation in system integrity. More recently, LTV TWX (ref. 12) established a short term storage policy for assembled Scout vehicles and has been applied to vehicles S-151 and S-152.

Obsolescence is a factor to be considered in long term storage. This condition was previously experienced by the Scout Program and required vehicles to be returned to the factory for modification and recertification. As a result, a new checkout philosophy and vehicle processing flow was formulated and implemented by standard procedures. Objectives of this philosophy were to reduce the time between in-plant checkout and launch, to control the frequency and degree of checkout performed, to reduce processing time in the field and to provide a vehicle for launch that is manufactured to the latest configuration. Long term storage in the field in an assembled vehicle, checked out, configuration opposes this philosophy.

The total environment considered for storage includes those parameters which may be induced as a result of placing the vehicle into storage, testing and surveillance during storage, and removal of vehicle from storage as well as the ambient conditions of storage itself. The environmental parameters for storage and surveillance were identified and the necessary control requirements were established during Task I. The environmental parameters expected to be encountered by placing vehicles into or removing them from storage are no greater than that now experienced in moving the Scout vehicle between the assembly building, launch pad or during air transport.

3.2.3 Sensitive Components, Assemblies and Systems

Applying constraints thus identified, each system was reviewed to determine those components which may not adapt to long term storage. The review was conducted on components with effectivity prior to vehicle S-163. Subsequent components will adapt better to long term storage due to improved shelf life.

3.2.3.1 Telemetry System - Shelf life for components in the Telemetry System are as follows:

PART NUMBER	COMPONENT	SHELF LIFE
401-40009-7	Junction Box, Trans. A, T/M	36 Months
401-10005-5	Relay/Junction Box, Trans. B, T/M	36 Months
401-10018-9	Relay/Junction Box, Trans. C, T/M	36 Months
2001571101 2001571201	Potentiometer Potentiometer	Visual 12 Months Functional 36 Months
ISD 1078	Phase Sensitive Demodulator Package	12 Months
PS-137-1	DC-DC Converter	12 Months
PS-161	Voltage Regulator	12 Months
OAK 652739-100A	Solenoid Operated Switch (Int./Ext. Power)	12 Months
8G64, 8G65	Chamber Pressure Switches	24 Months
6607-6-20	N_2 Line Pressure Switch	12 Months
72517-0-4-752 72517-0-8-752 72517-0-35-752	Head Cap Pressure Transducers Hydraulic Pressure Transducers N_2 Line Pressure Transducers	Visual 12 Months Functional 36 Months
842TA-60-75	Pressure Transducer H_2O_2	Functional 6 Months Stability 12 Months
B9016-0502 A9016-0501	Accelerometers	12 Months

As indicated, the most critical component is the hydrogen peroxide pressure transducer; requiring retest at 6 month intervals due to past history of twist tube leakage. Future procurement incorporates an improved model; however, retest is expected to continue at 6 month intervals until a high confidence level is established.

3.2.3.2 Ignition and Separation Electrical System - All components in the Ignition and Separation Electrical System have a shelf life of 36 months. The ignition destruct battery is the only battery installed in the vehicles during storage.

3.2.3.3 Destruct System - Components in the Destruct System having a shelf life of 36 months or less are as follows:

PART NUMBER	COMPONENT	SHELF LIFE
Motorola MCR-1058	Command Destruct Receiver	24 Months
23 001358-23 -24	Auto-Destruct Lanyard Switch	36 Months
23 000356-21	Auto-Destruct Pressure Switch	24 Months
23-000397-4	Destruct Junction Box	24 Months

3.2.3.4 Radar Beacon System - The radar beacon assembly is the only component in this system having a shelf life. At six month intervals a burn-in operation must be performed to maintain proper operating characteristics of the magnetron. At twelve month intervals a functional checkout should be performed to reverify quality acceptance of the component.

3.2.3.5 Reaction Control System - Shelf life for components in the Reaction Control System are as follows:

PART NUMBER	COMPONENT	SHELF LIFE
23-002859-3	H_2O_2 Decomposition Chamber	18 Months
23-002858-21	40 Lb. Motor Valve Assembly	18 Months
23-003288-5	500 Lb. Motor Valve Assembly	18 Months
WK 892710	H_2O_2 Tank Assembly	12 Months

PART NUMBER	COMPONENT	SHELF LIFE
23-002856-6	2 Lb. Motor Valve Assembly	18 Months
23-002858-19	14 Lb. Motor Valve Assembly	18 Months
23-002858-21	48 Lb. Motor Valve Assembly	18 Months
MAGH 210753	Thrust Reduction Valve	24 Months
23-000445-1	H_2O_2 Bypass Restrictor	36 Months
SYM 56138-1	N_2 Charge Quick Disconnect	18 Months
WK 873323	N_2 Relief Valve	18 Months
SYM 46354-1	Regulated N_2 Quick Disconnect	18 Months
23-003372-1	H_2O_2 Tank Assembly	12 Months
SYM 46254-1	H_2O_2 Bleed Quick Disconnect	18 Months
SYM 46154-1	H_2O_2 Charge Disconnect	18 Months
WK 874040	H_2O_2 Relief Valve	18 Months

Soft valve seats, "O" rings that lose resilience, and dissimilar metals in contact, present potential storage problems for the Reaction Control System. During normal operations and checkout, high malfunction rates have been experienced with the 500 lb. motor valve and the nitrogen regulator shut-off valve. The hydrogen peroxide tanks are subject to bladder leakage. The one year storage specification requires the 500 lb. motor/valve assembly to be stored disassembled and the hydrogen peroxide tank expulsion tube assembly to be loosened sufficiently to relieve the load on the bladder material. The 500 lb. motor/valve assemblies in spares are stored assembled. Hydrogen peroxide tanks in spares are presently being stored with the expulsion tube tight; however, it is anticipated for future procurement of tanks, tube will be delivered in the loosened condition. Spare nitrogen regulator shut-off valves which have been individually set for the particular vehicle section are shipped with each vehicle. These are recycled and readjusted for each vehicle. It is anticipated that parts passivated per process specifications will remain in an acceptable condition while in storage.

3.2.3.6 Hydraulic Control System - Components of the Hydraulic Control System having a shelf life of 36 months or less are as follows:

PART NUMBER	COMPONENT	SHELF LIFE
17410-1	Hydraulic Reservoir	24 Months
1430-70B-51	Pressure Switch	24 Months
165WE00211	Motor Pump	24 Months
1008511	High Pressure Relief Valve	24 Months
DMG-109C1	Servo Actuator	18 Months
1112-598943	Low Pressure Relief Valve	24 Months
S9-210-2610-6	Swivel Fittings	36 Months

Overall review reveals that the most critical component is the Servo Actuator and the most critical part is the Buna N "O" rings used in all but one of the above listed components. Specifications 309-78, One Year Storage, requires the hydraulic system to be serviced with MIL-H-6083 preservation fluid.

3.2.3.7 Guidance System - Components of the Guidance System having shelf life of 36 months or less are as follows:

PART NUMBER	COMPONENT	SHELF LIFE
DAG69A1	Body Bending Filter	24 Months
DHG80B2	Intervalometer	12 Months
DRG87E1	Programmer	24 Months
DDG93A1	Diode Unit	36 Months
DRG95A1	Power Switching Relay Unit	36 Months
DGG122C3	Guidance Unit Assembly (IRP)	12 Months
DGG188A1	Rate Gyro Unit	12 Months
DSG30A1	Inverter	24 Months

PART NUMBER	COMPONENT	SHELF LIFE
DEG211C3	Amplifier-Demodulator, Poppet Valve	24 Months
DEG233C1	Servo Amplifier	24 Months

As noted, the shortest storage period is 12 months for the IRP, Rate Gyro Unit, and Intervalometer; however, FY67 Procurement Specifications for these items increase the storage life requirement to 24 months. Another factor in storing the guidance system in a "ready" configuration for extended periods involves the flight profile. Each vehicle is programmed for a particular payload mission which is controlled by elements of the guidance control systems. These components are matched through gain and timing adjustments during vehicle assembly processing in-plant to establish base line data for subsequent checkouts in the field. The system is re-verified during checkout in the field by comparison with the in-plant data. Present checkout philosophy limits the amount of adjustment and/or change in profile during field operations. In the present processing flow, identification and finalization of the flight profile is scheduled to occur no later than 45 days prior to vehicle launch.

3.2.3.8 Propulsion Systems - Although the fourth stage FW4S motor has a shelf life of one year; it is omitted here as it is not a part of the storage configuration established in paragraph 3.1.2. Of the remaining propulsion/pyrotechnic system components, the Castor motor and igniter are the only items with shelf life of less than 3 years. The current shelf life of one year for this motor and igniter has been extended in some instances to 18 months by the NASA Rocket Motor Review Board (RMRB). It is anticipated that the shelf life will be extended to 3 years in the near future.

There is now a requirement that any motor which has been in storage over 90 days prior to release for use in the vehicle will be given a receiving inspection per Scout Standard Procedures. This inspection cannot be accomplished with vehicle in the assembled configuration. A modified inspection must be developed, or justified by a study, have the requirement deleted.

The predominant problem encountered in long time storage in the horizontal position is grain sag. Extensive storage experience on Scout motors has not been attained as few motors have reached 3 years in age. Oldest motors in the current inventory range from 3 years for some X259 motors, 2 years for some Algols, to less than 1 year for Castor motors. Further, no test program has been established to determine effects of long term storage.

3.2.3.9 Structural and Mechanical Systems - Component review of the Scout Structural and Mechanical Systems revealed only one potential problem area; corrosion caused by dissimilar metals in contact with one another.

Other than the components in the Reaction Control System, the Scout vehicle has not experienced corrosion problems. However, the spin breakout torque test is recommended to assure the absence of corrosion and/or contamination in the spin bearing and to verify that the fourth stage electrical disconnects are functioning properly. The test should be accomplished during the ready checkout in the field by rotating the upper D skirt and noting the force required from breakout through two complete revolutions of the spin table. The action of the disconnects and the rotational force should compare closely with the previous tests. The breakout test should be accomplished after completion of the ignition system resistance checks. Subsequent to the breakout test, the fourth stage ignition system resistance readings must be repeated to verify proper connection of the fourth stage disconnects.

The design requirements for the springs in the mechanical systems are such that long term storage under loaded condition does not induce permanent set. For the one year storage Specification 309-78, springs are stored unloaded as assembly operations are not complete at this storage point.

3.2.4 Checkout Requirements

As indicated in the preceding paragraphs, certain components as spares have storage constraints limiting the shelf life to intervals of 6, 12, 18, 24, and 36 months. At the expiration of the applicable shelf life period; each component may, after completing a prescribed checkout, be considered quality acceptable for another period. It should be noted in this regard that except for the beacon burn-in at six month intervals, the prescribed checkouts are not required to be accomplished at the expiration of the shelf life period, but rather are required prior to use after the expiration of the shelf life period.

The following tables group these storage sensitive components into the time limiting periods; thus providing insight into the frequency and type checkout required to maintain component "flight ready" status.

6 MONTHS STORAGE LIFE

COMPONENT	LIMITING AUTHORITY	CHECKOUT REQUIREMENTS
H_2O_2 Pressure Transducer	Spares	Retest
Radar Beacon	Spares	Burn-in per Specification

12 MONTHS STORAGE LIFE

COMPONENT	LIMITING AUTHORITY	CHECKOUT REQUIREMENTS
Telemetry Transmitter	Spares	Functional Test
PSD Package	Spares	Functional Test
Mixer Amplifier	Spares	Functional Test
Pam Commutation Switch	Spares	Retest
Phase Sensitive Demodulator Package	Spares	Functional Test
DC-DC Converter	Spares	Functional Test
Voltage Regulator	Spares	Functional Test
N_2 Line Pressure Switch	Spares	Functional Test
Transducer Headcap Press.	Spares	Visual and Leak Test
Transducer Hyd. Press.	Spares	Visual and Leak Test
Transducer N_2 Press.	Spares	Visual and Leak Test
Potentiometer	Specification	Visual Inspection

12 MONTHS STORAGE LIFE (Cont'd)

COMPONENT	LIMITING AUTHORITY	CHECKOUT REQUIREMENTS
Accelerometer	Spares Specification	Retest Not Stored in Vehicle
Radar Beacon Assembly	Specification	Functional Test, Do Not Store Within 4" of Ferrous Metal
H_2O_2 Tank Assy. -B	Spares Specification	Retest Expulsion Tube Assembly Screws Loose
H_2O_2 Tank Assy -C	Spares Specification	Retest Expulsion Tube Assy. Screws loose
Intervalometer	Spares	Retest
IRP	Spares Specification	Functional Check Not Stored in Vehicle
500 Lb. Motor Valve	Specification	Motor Chamber, Valve, and Inlet Filter Disassembled, stored as "Matched Set"
D Separation Springs	Specification	Stored in Matched Sets Not Installed
Spin Bearing	Specification	Upper and Lower "D" Section not Assembled-Bearing Not Installed
Hydraulic System	Specification	System Filled with MIL-H-6083 Preservative Hydraulic Fluid
Command Destruct Receiver	Specification	Not Stored in Vehicle

12 MONTHS STORAGE LIFE (Cont'd)

COMPONENT	LIMITING AUTHORITY	CHECKOUT REQUIREMENTS
Rate Gyro Unit	Spares Specification	Retest Not Stored in Vehicle

18 MONTHS STORAGE LIFE

COMPONENT	LIMITING AUTHORITY	CHECKOUT REQUIREMENTS
N_2 Relief Valve	Spares	Retest
H_2O_2 Relief Valve	Spares	Retest
H_2O_2 Decomposition Chamber	Spares	Retest
500 Lb. Motor Valve	Spares	Retest
2 Lb. Motor Valve Assembly	Spares	Retest
14 Lb. Motor Valve Assembly	Spares	Retest
40 Lb. Motor Valve Assembly	Spares	Retest
48 Lb. Motor Valve Assembly	Spares	Retest
Servo Actuator	Specification	Function and Leak Test
Castor Motor	NASA RMRB	Inspect RMRB
Igniter	NASA RMRB	Inspect RMRB

24 MONTHS STORAGE LIFE

COMPONENT	LIMITING AUTHORITY	CHECKOUT REQUIREMENTS
Chamber Press. Switch	Spares	Retest
Thrust Reduction Valve	Spares	Retest
Hydraulic Reservoir	Spares	Leak Check Retest
Hydraulic Press. Switch	Spares	Retest
Hydraulic Motor Pump	Spares	Retest
High Press. Relief Valve	Spares	Retest
Low Press. Relief Valve	Spares	Retest
Auto-Dest. Press. Switch	Spares	Retest
Destruct J Box	Spares	Retest
Body Bending Filter	Spares	Retest
Programmer	Spares	Retest
Amplifier Demodulator	Spares	Retest
Servo Amplifier	Spares	Retest
Inverter	Spares	Retest
Command Destruct Receiver	Spares	Retest

36 MONTHS STORAGE LIFE

COMPONENT	LIMITING AUTHORITY	CHECKOUT REQUIREMENTS
J Box T/M	Spares	Retest
Relay/J Box B. TM	Spares	Retest
Relay/J Box C. TM	Spares	Retest
Potentiometer	Spares	Functional Test
By-Pass Restrictor	Spares	Functional Test
Hyd. Swivel Fitting	Spares	Functional Test
Auto-Destruct Lanyard Switch	Spares	Visual Inspection
Dest. Relay Assy.	Spares	Functional Test
Power Control Relay Box	Spares	Retest
Arming Relay Assembly	Spares	Functional Test
Diode Unit	Spares	Retest
Power Switching Relay	Spares	Retest

Storage limitations and checkout requirements established herein are based primarily on the storage and quality recertification requirements for components in the Spares Program. The reasoning being that if a spare component can be held in stores for a specified period and remain acceptable for use during that entire period; it is reasonable to expect that same component to remain in an acceptable condition while stored within a vehicle, all other conditions equal, for a like period of time. Further, if the quality functional acceptance of the spare can be re-established at the expiration of the storage period with a specified checkout or retest; then an equivalent checkout or retest should be capable of re-establishing the quality functional acceptance of the like component in a vehicle, all other things being equal.

Any consideration of checkout requirements must include a checkout philosophy which will provide assurance that the flight hardware is in satisfactory condition at lift off to accomplish the flight mission. All checkouts from acceptance of components at the factory through vehicle launch are considered in this study. Checkout, as used herein, identifies the requirements to establish or ascertain whether an item is properly functioning or that the operating parameters have been met after integrating the item with multiple systems. Such a checkout philosophy has been adopted by the Scout Program Office and has been implemented through Scout Standard Procedures and the Configuration Control Management System. Presented therein are the requirements that a vehicle buildup be accomplished in Dallas, and all required adjustments to the components be made during the in-plant bench and transition level checkouts. Additionally, the field shall reassemble the vehicle for flight and recheck all systems to verify Dallas readings and to requalify the vehicle after shipment. Any discrepancies noted shall be corrected by readjustment or replacement in accordance with policies defined by configuration control document, (ref. 13).

Checkout requirements having the greatest impact on long term storage of the Scout vehicle encompass the Guidance System and specifically the flight profile. To support normal vehicle processing, the flight profile must be finalized a minimum of 45 days prior to scheduled launch date. In-plant, the Guidance System is checked out and adjusted at the bench level to establish base line quantitative data. This data is then verified at the system level at both Dallas and the field. When a fault is discovered at the system level, the system is returned to the bench level for fault isolation. A change in flight profile that effects both the timer and programmer in a vehicle in the field requires the Guidance System components to be returned to Dallas for rewire and recheck at the bench level. Where flight profiles are not known in sufficient time to meet Dallas checkout and shipping schedules, checkout of the Guidance System is accomplished with the vehicle assigned components set up with a test profile. Recently, a test programmer and timer were used in lieu of the vehicle assigned components. When these situations occur, the vehicle is shipped to the field short its assigned guidance components; the components being held at Dallas until flight profile is known. Normal vehicle buildup continues in the field except that systems checkout is delayed until the guidance components, checked out at the bench level with flight profile, are received from Dallas. While the merits of this philosophy have not been fully realized, it has been successfully demonstrated and there is no evidence that changes are in order at this time.

Other checkouts which have an almost equal impact on long term storage concerns the Reaction Control System in the areas of motor valves, hydrogen peroxide tank bladders and passivation. Except for motor valve operating characteristics, which cannot be verified in any manner other than hot firing, the existing process flow and standard procedures are capable of detecting and isolating malfunctions in the Reaction Control System.

Replacing a motor valve in the field is not prohibited, but neither is it a desirable situation due to the loss of motor valve characteristics data. In-plant, subsequent to hot firing when a motor valve assembly must be replaced, a replacement valve is individually hot fired on a motor before installation.

System leak checks are performed timely enough to permit unscheduled maintenance without jeopardizing launch schedules. However, stability tests performed during the same test period as hot firings are not repeated prior to launch and although some indication of a contaminated system would be detected during the countdown fueling operation, detection at that time would seriously delay the launch.

Until sufficient data has been gained in the areas of motor valve characteristics and system stability deterioration during periods of extended storage, retest and stability checks should continue to be a storage determinant and launch should occur within 18 months of hot firing and stability acceptance. Based on this determinant, and factory processing time, a vehicle could therefore be in field processing, including storage, for periods of approximately 14 months without retest of motor valve characteristics or system stability.

Based on the constraints thus identified, it can be concluded that vehicles in storage for more than 6 months in a flight-ready status will require additional checkout prior to launch.

3.2.5 Operational Factors

The background information in the Statement of Work for this study states, "The capability of drawing out of storage a launch vehicle in a flight-ready configuration that enables direct mating to the launcher is an operational goal desired by launch agencies. Such a capability would reduce the time required for prelaunch operations, provide an inventory of vehicles ready to adapt to an assigned payload, eliminate manpower peaks to support vehicle assembly, and produce needed flexibility of the launch agency to support changes in mission assignments." This, then, in its broadest sense, expresses the operational goals to be achieved through storage.

In approaching the stated goals, some definition must be established for the flight-ready configuration. True flight-ready configuration does not occur in the existing standard flow until the vehicle has completed dress rehearsal. However, requirements of the Statement of Work for this study establish the storage configuration as an assembled vehicle minus payload, separation system, heatshield, fourth stage, batteries and pyrotechnic initiators; having completed checkout of its systems to establish readiness for launch. This storage configuration matches that of a vehicle in the existing standard flow that has completed the "all systems test" with the flight profile. The vehicle at this time is acceptable to proceed directly to the launcher for launch operations per Scout Standard Procedures, Vol. VI, or to be loaded on an aircraft for air transport and thence to the launcher. Storage in this configuration is identified and used in the functional flow diagrams herein as a "ready hold" status to more adequately identify the vehicle status and to differentiate from the other storage conditions.

From an operational point of view, storage or hold periods are most likely to be imposed at the natural break points in the field processing flow pattern. To a certain degree, storage is occurring now at these points every time a vehicle is processed. A storage period is employed at receiving when the field build up rate is below the factory shipping rate. Another storage period is employed when the build up rate is greater than the launch rate. Other holding periods occur at the completion of the vehicle assembly operations where the guidance components are not available for checkout due to lack of a flight profile and at the completion of vehicle checkout with a flight profile where the launch schedule does not require an immediate launch.

Provisions for storage at these points provides operational flexibility, a more stable work load for the field crew, and dampens the rates for acceleration and deceleration of factory checkouts to meet launch rates.

The amount of storage required by field processing in each case is therefore dependent on the launch rate versus factory shipment rate and finalization of the flight profile.

For any constant shipping rate and launch rate, the time required to reach a given storage capacity can be expressed as:

$$T_c = \frac{C}{R_S - R_L}$$

where: T_c = Time in months to reach capacity

C = Vehicle storage capacity

R_S = Shipping rate in vehicles per month

R_L = Launch rate in vehicles per month

Likewise, with a constant shipping rate and launch rate, the age of the oldest vehicle remaining in storage after any number of months can be expressed as:

$$A_S = \frac{T(R_S - R_L)}{R_S}$$

where: A_S = Age in months of oldest vehicle in storage

T = Number of months after first vehicle is shipped

When any given storage capacity has been reached; for any launch rate, the age of the last vehicle launched can be expressed as:

$$A_L = \frac{C}{R_L}$$

where:

A_L = Age of last vehicle launched.

Based on these equations; with a storage capacity of 30 vehicles, a shipping rate of 2 vehicles per month, and a launch rate of 9 vehicles per year or .75 vehicles per month; storage capacity is reached at the end of 24 months, at which time the age of the oldest vehicle then in storage is 15 months and the age of the last vehicle when it is launched will be 40 months. Under these conditions the storage complex will have been filled one time only during the 64- month span resulting in very small utilization of the facility.

With the same shipping and launch rates and a storage capacity of 5 vehicles, storage capacity is reached in 4 months, the age of the oldest vehicle then in storage is 2.5 months and the age of the last vehicle when it is launched will be 6.6 months. These conditions provide more usage of the storage complex for the dollars invested.

3.2.6 Analysis

Storage constraints and checkout requirements can now be combined with the operational goals and translated into functions. Through a reiterative process the Gross Level Functional Base developed for Task I was updated to include these functions. Trade Study 008, Appendix D, was performed to optimize the functional flow resulting in the Top Level Functional Flow Block Diagram shown in Appendix A. First and Second Level Functional Diagrams are included to further amplify the top level diagram. Requirements derived from an anlysis of these functions are reflected in the Requirements Allocations Sheets, Appendix B. The Time Lines shown in Appendix C present the functions against a time base and depicts the sequential relationship of the functions.

These functional diagrams, requirements, and time lines delineate a storage concept for a Scout vehicle encompassing four periods of storage between the completion of manufacturing and vehicle launch. Storage capability is provided to accumulate and store completed sections when the manufacturing rate exceeds the factory checkout rate. A second storage period is provided to accumulate and store the vehicle sections received in the field when the factory shipping rate exceeds the field vehicle assembly rate. A third storage period is provided for assembled vehicles lacking a finalized flight profile. Lastly, a ready hold period is established to provide vehicles in a state of readiness to permit direct mating with the launcher. Three levels of storage are employed, i.e., disassembled vehicle, assembled vehicle not checked out, and assembled vehicle checked out in ready hold. The total accumulated controlled storage under these conditions can total 36 months or more.

The storage concepts developed in Task I were reviewed at this time to determine the impact of the findings thus far in Task II. Concept 2, a fixed container capable of accepting the assembled vehicle from its transport vehicle, continued to be the most effective method for storage of the Scout vehicle.

To meet the checkout requirements, Trade Study 007, Appendix D, was conducted to determine whether it is more practical to provide mobile GSE to cycle from one stored vehicle location to another or to cycle assembled vehicles from a storage area through a central checkout facility. The conclusion favored the permanent checkout location utilizing the existing Scout Standard System Test (S^3T) equipment.

Compliance with some of the constraints imposed by Specification 309-78, One Year Storage, which have been proven adequate when followed by in-plant system tests would, however, make storage in the assembled vehicle configuration unacceptable for vehicle processing. This is brought about by the additional disassembly and reassembly operations, the invalidating of previous checks requiring subsequent rechecks, and the overall resultant loss of reliability. The advantage lies with long term storage in the disassembled configuration. In this configuration fewer surfaces are mated, less disassembly is required to perform modification or corrective maintenance, and better visibility for inspection is available.

Additionally, the use of preservation fluid in the hydraulic system requires further investigation. In the existing processing flow; the preservation fluid, MIL-H-6083 required for storage by Specification 309-78, is drained during the factory checkout and the system serviced with MIL-H-5606 hydraulic fluid. In order to apply the intent of the one year storage specification requirement to the Scout long term storage concept, the preservation fluid should remain in the system until Ready Checkout in the field.

Several combinations of shipping and launch rates were assumed to determine a maximum number of vehicles which might be expected to be in storage at one time and a maximum length of time any one vehicle might be required to remain in storage.

To provide operational flexibility consistent with predicted launch requirements without allowing storage time to become excessive to the point of losing reliability; the maximum number of vehicles in storage in the field should not exceed the annual launch rate.

The most rapid launch rate considered was 3 successive launches at 10-day intervals from a single site. Assuming the timely finalization of flight profiles, the minimum number of vehicles required to support this operation is one vehicle in ready hold status and two vehicles in an assembled storage status. With a fourth vehicle in accumulate storage status, i.e., all vehicle components received in the field and ready for receiving inspection, the launch rate could be sustained through four vehicles. With air transport available on call, launches can be supported at multiple sites with vehicles stored at a single site. However, more operational flexibility is attainable with storage capability at each launch site and the complete reliance on aircraft availability is eliminated.

Assuming vehicle buildup and checkout is to be accomplished in the existing assembly buildings, the only additional facility necessary to meet operational/storage requirements is a storage building with a minimum capacity of 3 vehicles. However, the marginal cost is determined to be sufficiently low as to justify a 4 vehicle storage facility as shown in figure 10 and thus provide additional storage and operational flexibility.

Rough Order of Magnitude cost for a four vehicle complex would total $450 000; with $310 000 for Facility and $140 000 for GSE. Cost of an additional complex for the other launch site would be approximately 15 percent less than the first one due to Engineering design having been completed.

The requirements and criteria for a 4 vehicle storage complex are essentially the same as those developed for the 30 vehicle complex in Task I. The quantity distance requirements for the 4 vehicle storage permit its being located closer to buildup/checkout/launch areas and thus reduce transport/transfer time and distance.

A re-examination of Wallops Island and Vandenberg Air Force Base indicate that the selected 4 vehicle storage concept is compatible with the existing facilities and could be located as shown in figures 11 and 12. A possible location for a 30 vehicle storage complex at each site is included. The clear distance requirements permitting storage of 4 additional vehicles at the Dallas COC cannot be met in its proposed location.

3.2.7 Cost Effectiveness

Elements of recurring cost involved with vehicle storage can now be examined to establish a comparison between the proposed storage concept and the existing operational techniques. The addition of the storage function to the present processing flow increases rather than eliminates or realigns operations; furthermore, the adding of operations to any established routine tends to reduce calculated reliability. Although some cost trade offs are possible, comparison is not so much one of the proposed system cost versus existing system cost but rather what is to be gained with the proposed storage system versus the dollars spent.

The addition of the storage function to the existing processing flow increases Dallas operations wherein the Guidance Bench and System Checkouts are now usually performed with flight profile, they would then be performed with a test profile requiring the bench checkout to be repeated when the flight profile is identified. The factory checkout operation has a two vehicle per month output capability scheduled as required to meet established

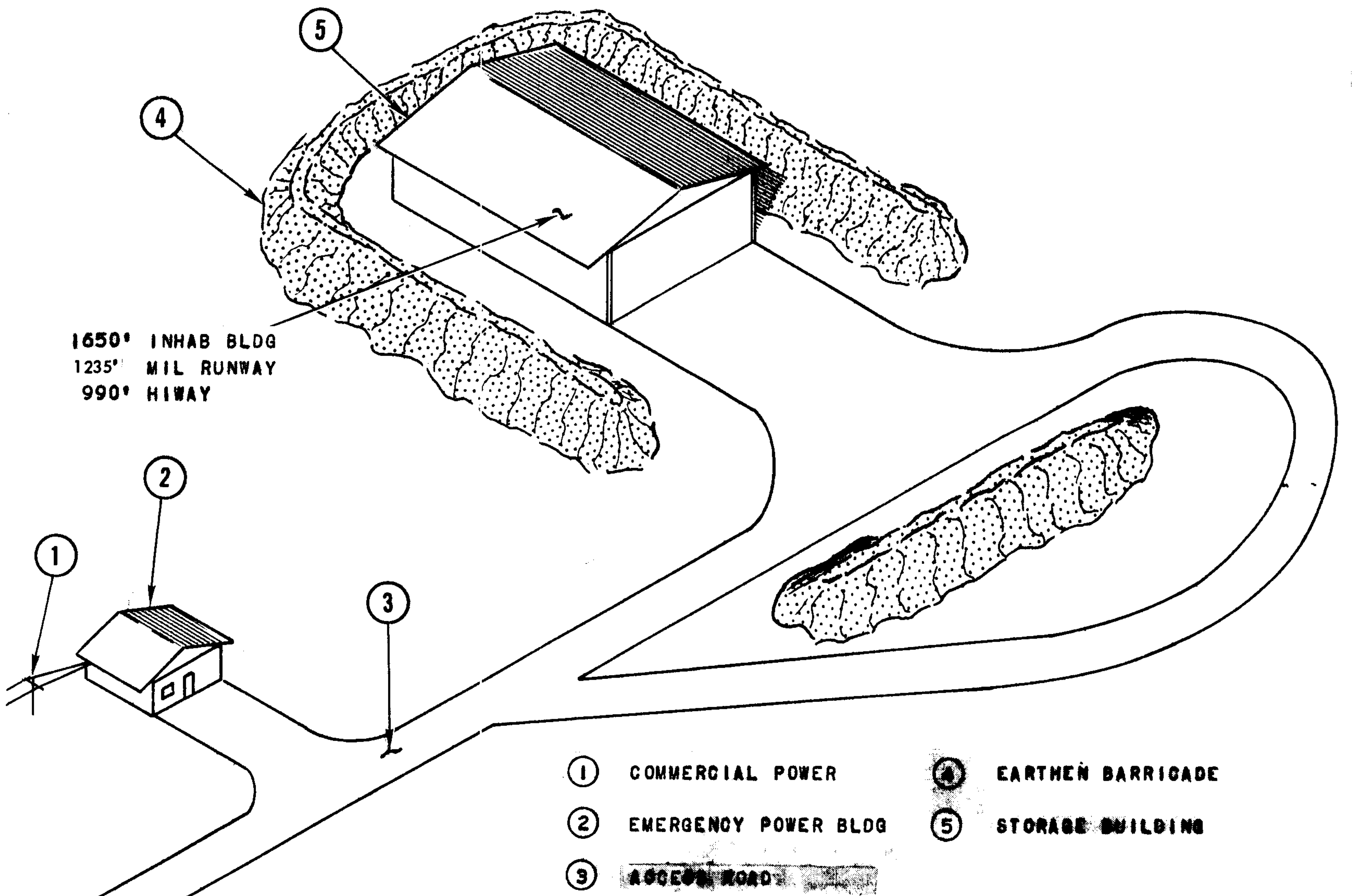


FIGURE 10 FOUR VEHICLE STORAGE COMPLEX

1	FOUR VEHICLE STORAGE COMPLEX	6	THIRTY VEHICLE STORAGE COMPLEX
2	SCOUT ASSEMBLY SHOP	7	DYNAMIC BALANCING FACILITY
3	ASSEMBLY SHOP NO. 4	8	SCOUT LAUNCH AREA
4	ASSEMBLY SHOP NO. 5	9	BLOCKHOUSE NO. 3
5	ASSEMBLY SHOP NO. 6		

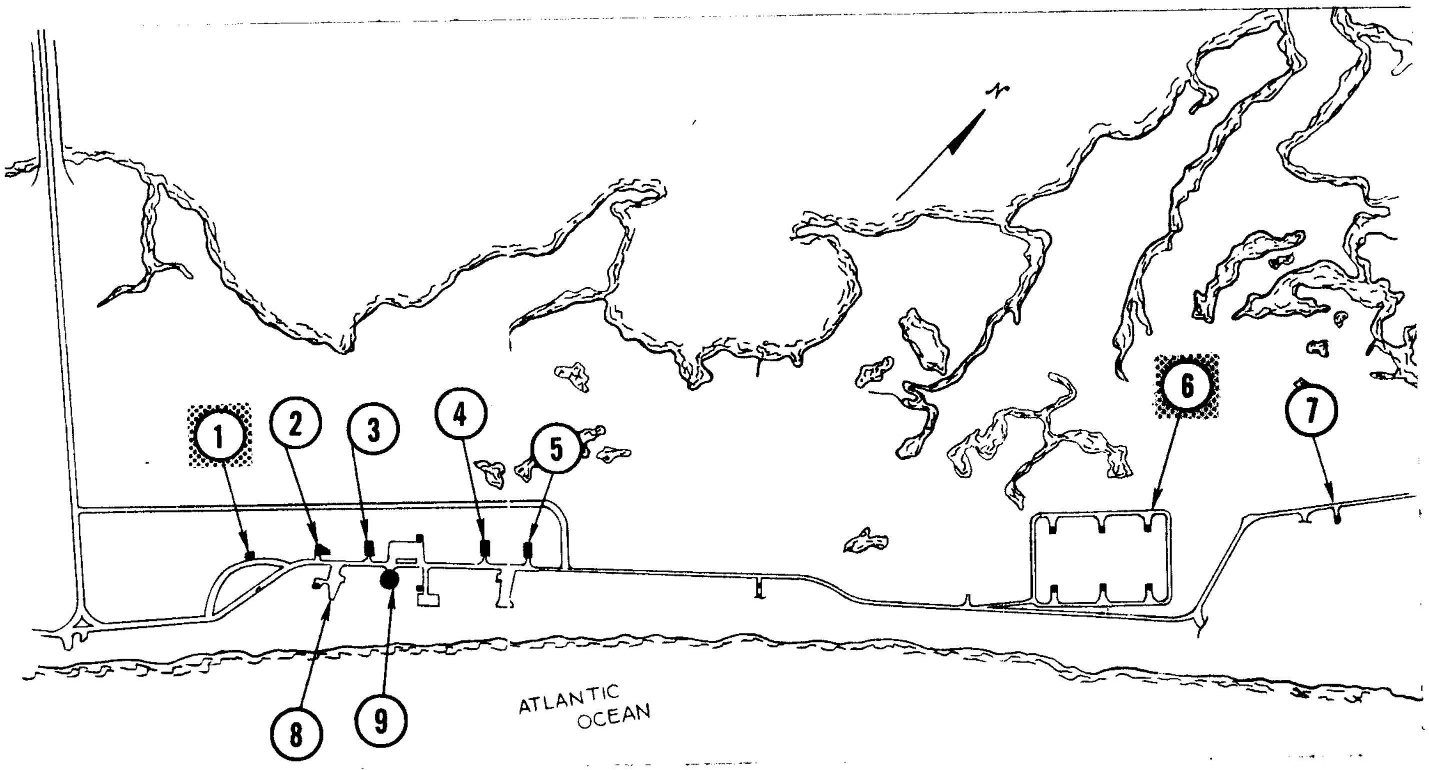


FIGURE 11 WALLOPS ISLAND PROPOSED STORAGE SITE LOCATION

CONCEPT	FACILITY	GROUND SUPPORT EQUIPMENT N – NEW DESIGN ED – EXISTING DESIGN C – CURRENT USE	COST
1	1. 6 STORAGE PADS 5 VEH PER PAD 2. CONTAINERS (30) 7'x7'x65' 3. SITEWORK 4. BARRICADE 5. PAVING 6. SECURITY FENCE 7. FOUNDATION 8. POWER & ALARM 9. WINCH SYSTEM 10. LIGHTNING/GROUNDING SYSTEM 11. ACCESS ROADS 12. FIRE PROTECTION 13. REST ROOM FAC	1. 30 SUPPORT STRUCTURES (N) 2. 30 CONTAINERS (N) 3. 4 TRAILERS (N) 4. 30 ENVIRONMENTAL UNITS (N) 5. 2 OVERHEAD CRANES (ED) 6. STORAGE SHELVES IN SHELTER (N) 7. PRIME MOVER WITH WINCH (C) MODIFIED	FACILITY $ 900 000 GSE 3 900 000 TOTAL $4 800 000 SPECIAL GSE FOR TRANSPORTATION $3 800 000 GRAND TOTAL $8 600 000
2	1. 6 STORAGE PADS 5 VEH PER PAD 2. CONTAINERS (6 BLDGS) 60' x 75' 3. SITEWORK 4. BARRICADE 5. PAVING 6. SECURITY FENCE 7. FOUNDATION 8. POWER & ALARM 9. WINCH SYSTEM 10. LIGHTNING/GROUNDING SYSTEM 11. ACCESS ROADS 12. FIRE PROTECTION 13. REST ROOM FAC	1. 30 SUPPORT STRUCTURES (N) 2. 5 TRANSPORTERS (C) MODIFIED 3. ALGOL CRADLE ROLL CAPABILITY (N) 4. 25 SETS VEHICLE CRADLES (ED) 5. PRIME MOVER WITH WINCH (C) MODIFIED	FACILITY $1 300 000 GSE 1 000 000 TOTAL $2 300 000
3	1. 6 STORAGE PADS 5 VEH PER PAD 2. CONTAINERS (30) 7'x7'x65' 3. SITEWORK 4. BARRICADE 5. PAVING 6. SECURITY FENCE 7. FOUNDATION 8. POWER & ALARM 9. WINCH SYSTEM 10. LIGHTNING/GROUNDING SYSTEM 11. ACCESS ROADS 12. FIRE PROTECTION 13. REST ROOM FAC	1. 30 SUPPORT STRUCTURES (N) 2. 30 RIGID COVERS (N) 3. 5 TRANSPORTERS (C) MODIFIED 4. ALGOL CRADLE ROLL CAPABILITY (N) 5. INSULATED FLOOR FOR TRANSPORTER (N) 6. 30 ENVIRONMENTAL UNITS (N) 7. PRIME MOVER WITH WINCH (C) MODIFIED	FACILITY $ 900 000 GSE 2 400 000 TOTAL $3 300 000
4	1. 6 STORAGE PADS 5 VEH PER PAD 2. CONTAINERS (6 BLDGS) 60' x 90' 3. SITEWORK 4. BARRICADE 5. PAVING 6. SECURITY FENCE 7. FOUNDATION 8. POWER & ALARM 9. WINCH SYSTEM 10. LIGHTNING/GROUNDING SYSTEM 11. ACCESS ROADS 12. FIRE PROTECTION 13. REST ROOM FAC	1. 5 TRANSPORTERS (C) 2. 25 TRANSPORTERS WITH CRADLES (ED) 3. PRIME MOVER (C)	FACILITY $1 300 000 GSE 2 300 000 TOTAL $3 600 000

FIGURE 9 FACILITY/EQUIPMENT COST COMPARISON MATRIX

launch dates. Working against a launch schedule on a single vehicle basis often entails rapid acceleration or deceleration of operations to maintain schedule and results in undesirable manpower loading. Some programs may even require reaction time faster than the factory can respond. Likewise, unscheduled maintenance jeopardizes schedules and causes peaks in work loads. A storage facility provides an "accumulator effect" and relieves these schedule pressures.

In like manner, the addition of the storage function to the existing processing flow increases the quantity of field operations wherein the transferring of vehicles to and from a storage complex is not now performed. The field operation is sized for a one vehicle per month launch capability from each site and is also scheduled as required to meet established launch dates. Here again working against a launch schedule on a single vehicle basis causes unbalanced work loads and denies the field crew operational flexibility.

It can be said that as the launch rate increases, schedule pressures increase, creating the need for operational flexibility.

The proposed storage system achieves the stated operational goals at reasonable initial cost and virtually no recurring cost as the better utilization of manpower and resources tend to offset the additional operations.

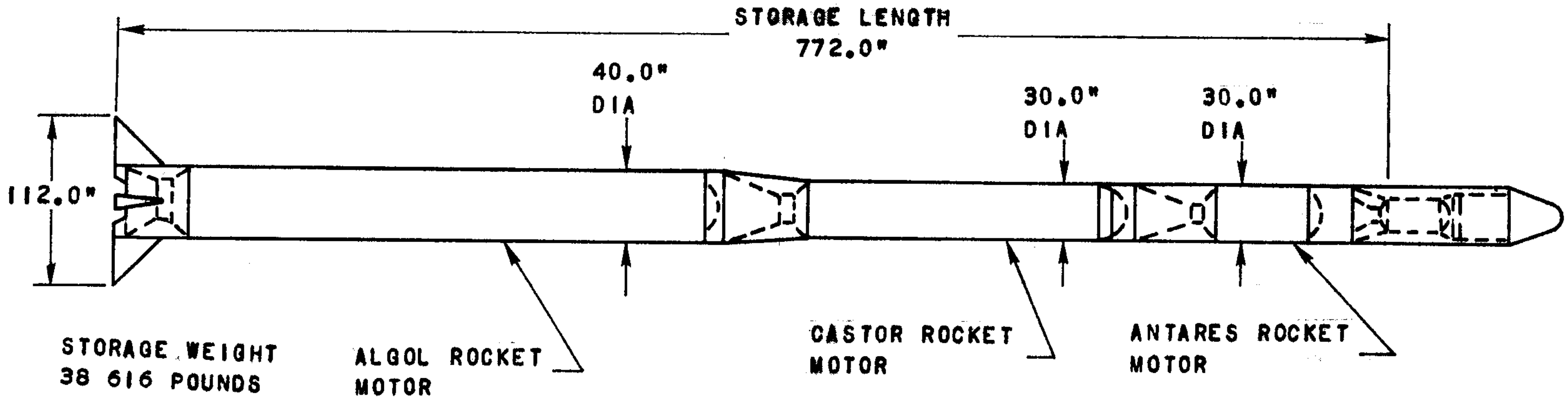
3.3 TASK III DETERMINE OTHER VEHICLE APPLICABILITY

3.3.1 Introduction

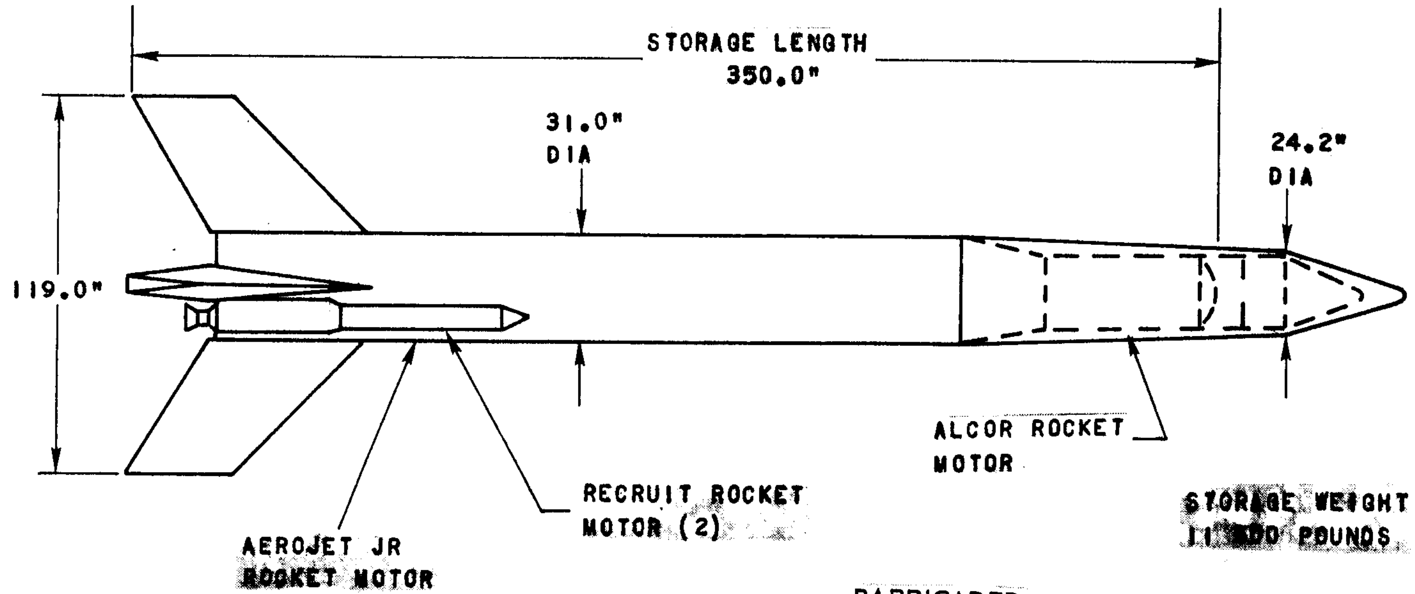
The objective of Task III is to examine other solid propellant launch vehicles in the NASA inventory to determine the feasibility of storing them in the same complex as that developed in Task I, Concept 2 for Scout. The vehicles examined and their vital statistics are compared with those of the Scout vehicle in figure 13. Components examined with the respective vehicles are identified as follows:

COMPONENTS	PART NUMBERS	VEHICLE
Timer	1060-10G-1ST-SPDT 1060-10G-60T-SPDT	NIKE Tomahawk
Ledex Assembly	D-00435	NIKE Tomahawk
Safe/Arm Relay	TL 17D	Pacemaker
Timer	1060-8E-90T-6SPDT	Pacemaker
Timer	1060-5G-90T-3SPDT 1060-5E-1ST-2SPDT	Javelin
Pressure Switch	ES 4-5	Javelin
Vega Beacon	207C	Pacemaker
Pressure Switch Assy.	076646	Astrobee 1500

Such things as system checks, physical characteristics, and temperature and humidity requirements have been examined to determine their adaptability to the Scout storage concept. Component storage and operational requirements for each individual vehicle were reviewed but were not studied in depth. No exact length of storage time or amount of system monitoring required for each vehicle has been determined. It is not the intention herein to determine the optimum storage method for these vehicles but rather to assure that there is at least one concept which is suitable, feasible, and acceptable.



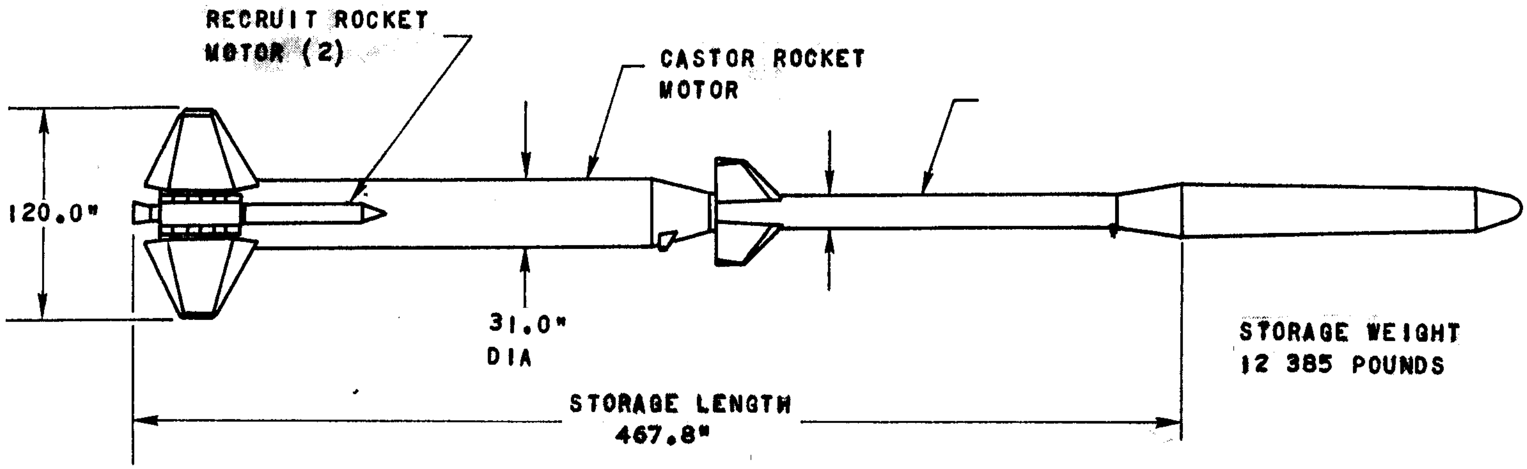
SCOUT



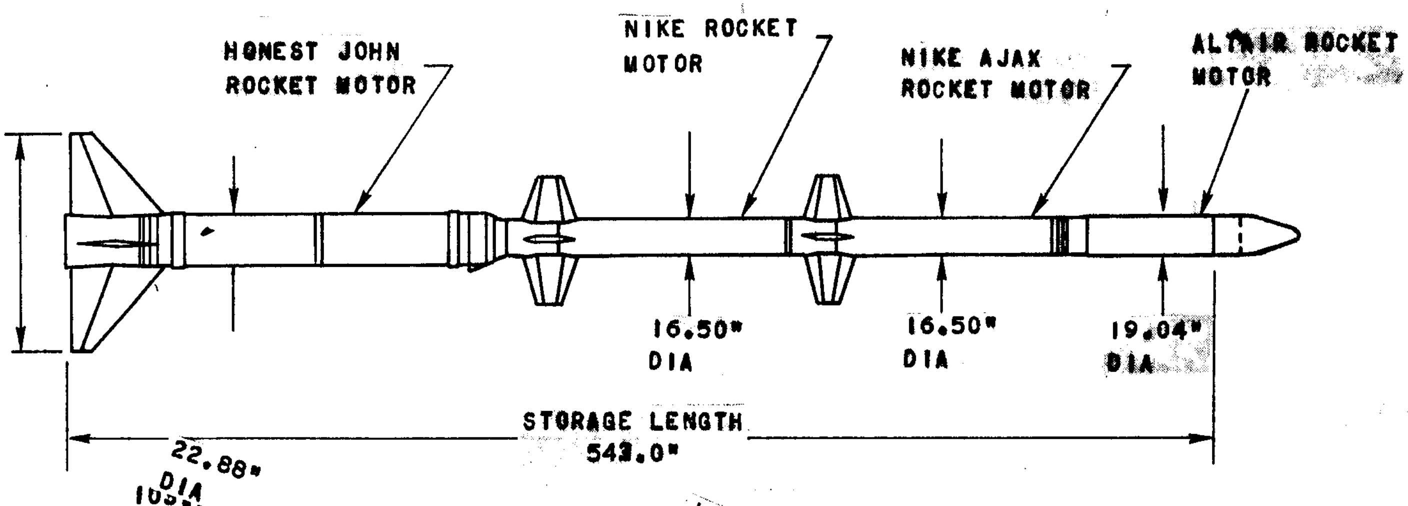
ASTROBEE 1500

BARRICADED
(SHEET 1)

FIGURE 13 NASA SOLID PROPELLANT LAUNCH VEHICLES

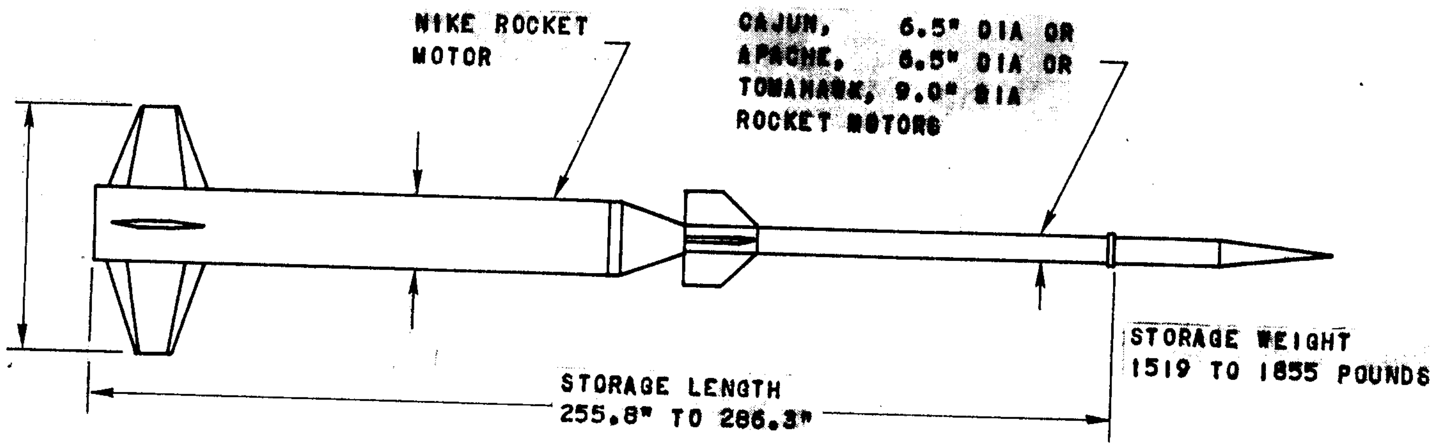


TRAILBLAZER II

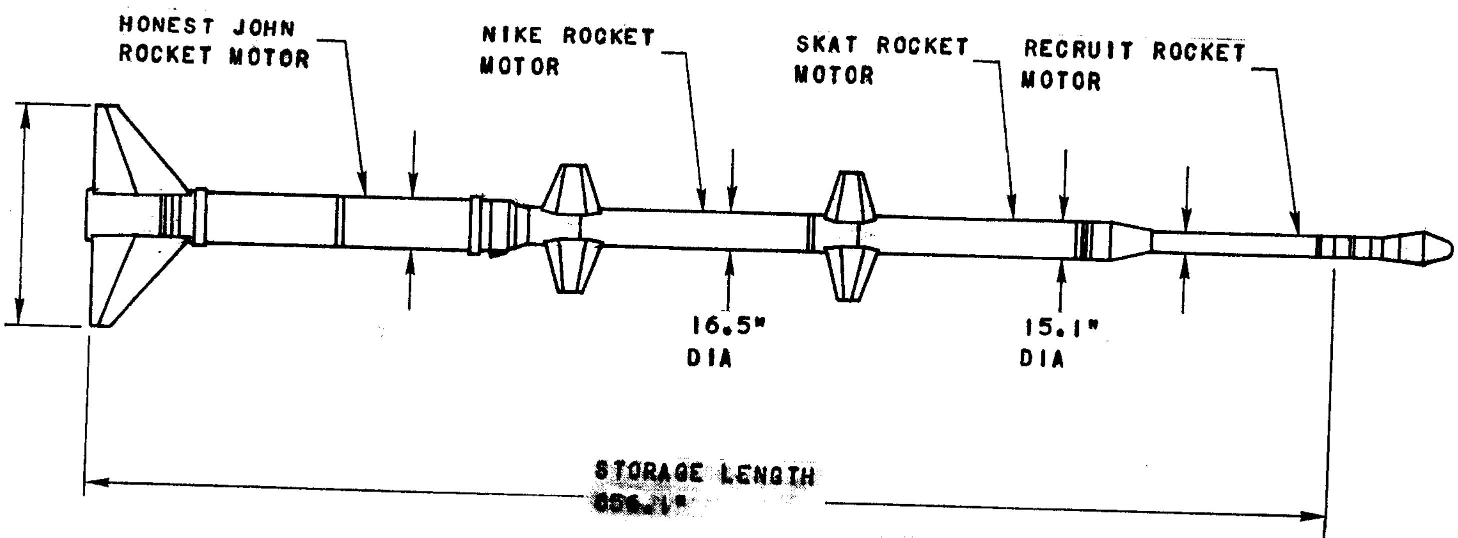


JAVELIN

FIGURE 13 NASA SOLID PROPELLANT LAUNCH VEHICLES (SHEET 2)



NIKE FAMILY



PACEMAKER

FIGURE 13 NASA SOLID PROPELLANT LAUNCH VEHICLES (SHEET 3)

3.3.2 Storage Constraints

The components and assemblies for these vehicles do not have storage constraints imposed by either a spares shelf life program or specifications. Assemblies are currently being held in various storage conditions prior to vehicle assembly, and storage time is contingent upon Engineering judgment and program requirements. No components, assemblies or systems were identified which might not adapt to long term storage. No constraint is imposed by checkout requirements and in most cases, particularly the smaller vehicles, checkout is accomplished subsequent to vehicle assembly on the launcher using blockhouse and/or portable equipment. Although all components are not readily accessible for corrective maintenance while in the assembled vehicle configuration, the number of components in this category are few and offer no storage constraints. Further, from an operational viewpoint it appears impractical to store the small vehicles in an assembled vehicle configuration where less time is required for build up on the launcher than would be required to remove the assembled vehicle from storage and transport it to the launcher.

3.3.3 Requirements

3.3.3.1 Facility - The storage concept conceived to meet the requirements for a Scout vehicle, the largest and most complicated solid vehicle presently in the NASA inventory, will meet or exceed the environmental storage requirements of all the other vehicles considered herein. None of the vehicles considered, either singularly or combined, constitute an explosive class in sufficient quantity as to require more clear distance than that prescribed for the Scout storage complex. With a storage envelope per vehicle of 10 feet x 10 feet x 75 feet and a maximum gross weight capacity of 16 000 pounds supported by any one cradle, the complex has the capacity to accept any of the other solid propellant launch vehicles. In some instances, two of the smaller vehicles can be accepted in the available storage envelope.

3.3.3.2 Ground Support Equipment - In addition to the ground support equipment now on inventory for the various solid propellant launch vehicles and the proposed GSE for Task I, Concept 2 complex, the following ground support equipment is required:

a. Lowboy transporter, a 50 foot long, commercially available, lowboy transporter modified to accept Scout cradles on rails at a height compatible for mating vehicle to the launcher horizontal boom.

b. 4000A Airlog dolly, GFE.

c. 3500 Airlog dolly adapter, GFE.

d. 3500 Airlog dolly adapter pad, a "V" shaped bracket with formed cushion support attached to the open end of the "V".

e. Scout cradle adapter, a curved hard-rubber pad which mounts in the Scout cradle assembly to adapt the cradle to the diameter of the motor to be supported. (Cradles available with storage complex.)

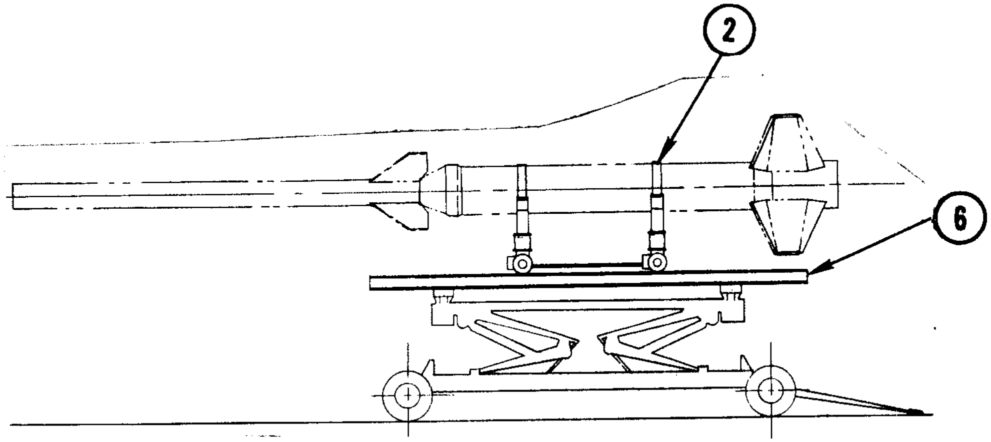
f. Restraint, required on large vehicles to hold the vehicle securely in the cradles. A set of two is required for each large vehicle during transport and storage operations.

g. Transfer tie bar, required to locate and hold cradles together during roll transfer operations of vehicles with drag separated stages.

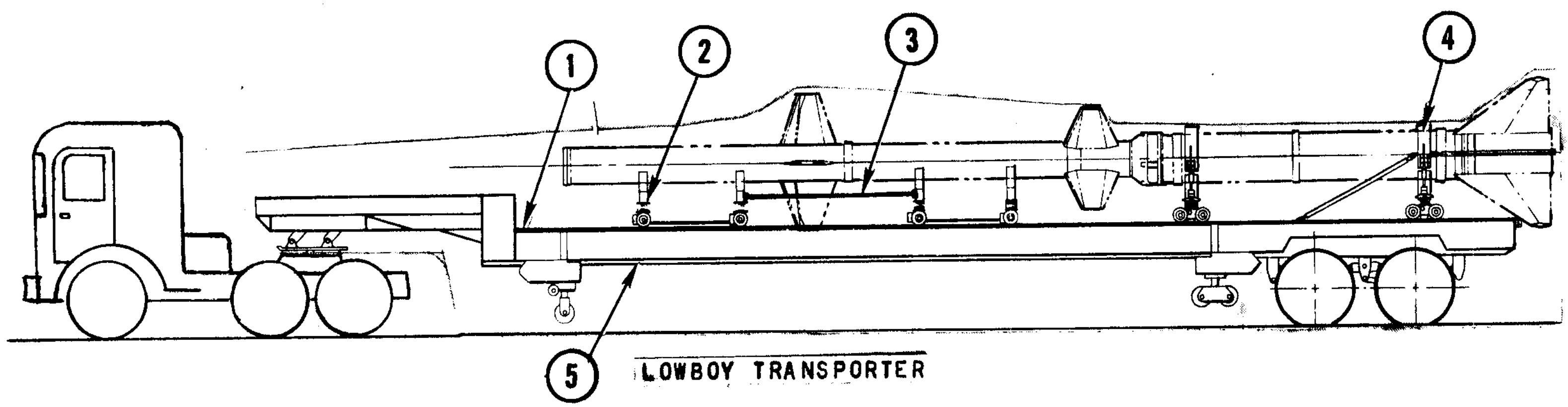
This equipment is depicted in figures 14 and 15.

One problem area was encountered in the roll transfer operation between the lowboy transporter for these vehicles and the storage support structure for the Scout vehicle. The centerline of the Scout vehicle is 100 inches above ground level to mate with its launcher while these vehicles are only 80 inches above ground level to mate with their launcher. This then means that to accomplish the transfer operation for storage, the transporter level for these vehicles must be adjusted to meet the rails on the Scout support structure or the rails adjusted to meet the transporter level. Several solutions are possible. To have the storage support rails fixed, one solution could be to use a ramp or ramps in front of any given bay in the storage complex. The lowboy transporter would then be low enough for mating vehicles to the horizontal boom of the launcher and the ramp would raise the height of the transporter sufficiently to allow for mating with the storage complex rails. Another solution could be to modify the Scout transporter so that the wheel carriage assembly could be removed with reasonable ease.

1. TRANSFER RAILS
2. SCOUT TRANSPORTER OR 3500 AIRLOG ADAPTER
3. TRANSFER TIE BAR
4. VEHICLE RESTRAINTS
5. LOWBOY TRAILER
6. 4000A AIRLOG DOLLY



AIRLOG DOLLY TRANSPORTER



LOWBOY TRANSPORTER

FIGURE 14 VEHICLE BUILDUP & TRANSPORT TRAILERS

1. SCOUT 1ST STAGE CRADLE
2. CRADLE ADAPTER
3. SCOUT 2ND STAGE CRADLE
4. SCOUT 3RD STAGE CRADLE
5. SCOUT 4TH STAGE CRADLE
6. ADJUSTABLE RAIL
7. JACKING DEVICE
8. RAIL BASE

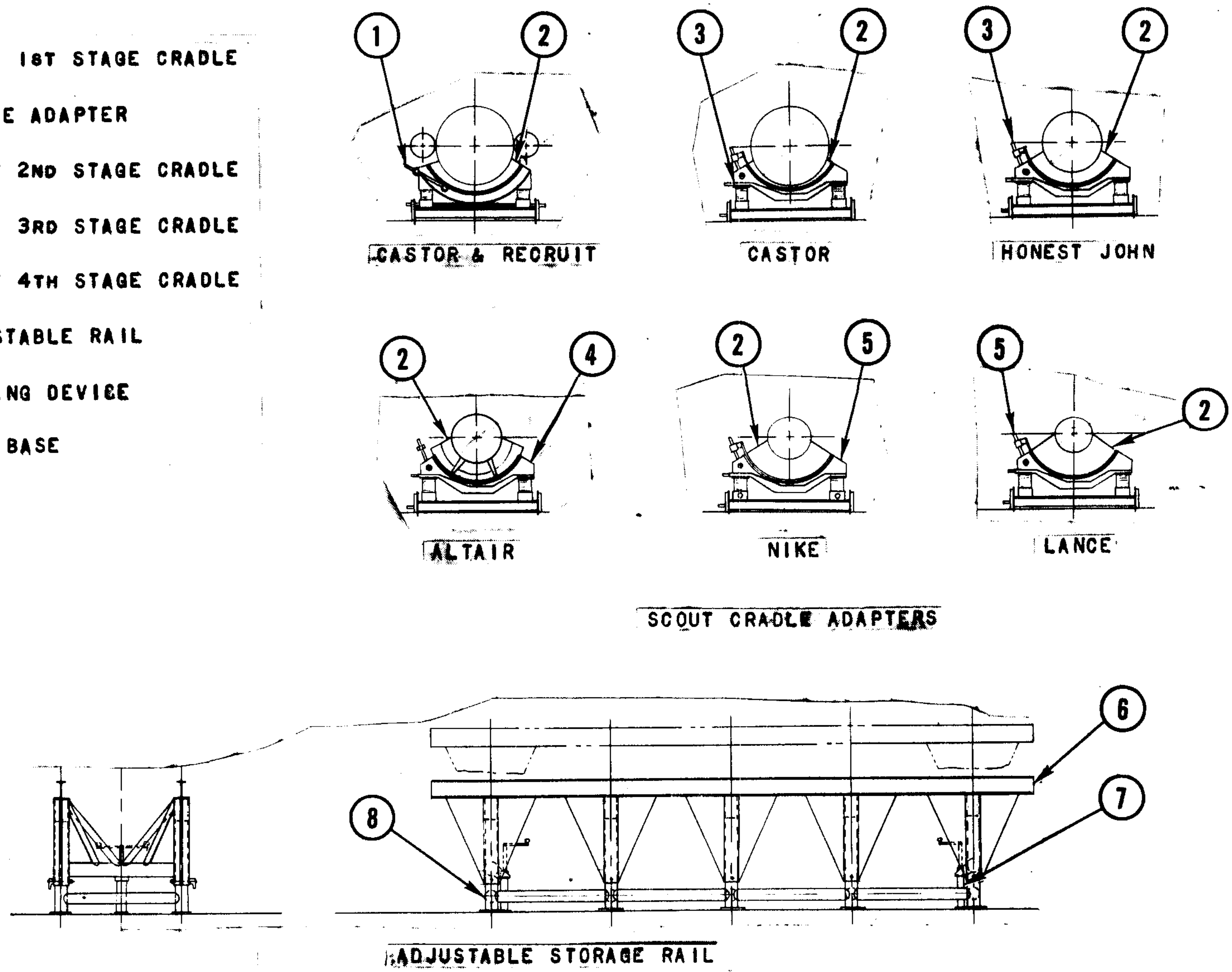


FIGURE 15 TASK III GROUND SUPPORT EQUIPMENT

This would allow the transporter to be lowered below its existing limits to mate with the lower launch boom structure for vehicles other than Scout. A third solution could be to raise the horizontal boom of the launcher for these vehicles. Another solution, perhaps the best, could be to provide adjustable height rails for the storage support structure. Without the benefit of a trade study, this method is used in the ensuing discussion and is shown in figure 15.

3.3.4 Storage of Large Vehicles

For the purposes of this study, a large vehicle is defined as a solid launch vehicle which weighs more than 8000 pounds and/or is comprised of three or more stages.

In order to store a large vehicle, the following ground support equipment would be utilized: a lowboy transporter, Scout cradles with cradle adapters as required for buildup and storage, and a set of restraints.

Preparation for vehicle buildup would consist of arranging for use of a lowboy transporter, installing the correct number of cradles on the transporter, and changing cradle adapters as necessary to obtain adaptation to vehicle motor diameter(s). It would also be necessary to adjust the height of the storage bay rails to the height of the lowboy transporter rails.

If the vehicle were larger than 44 inches in diameter, special cradles could be designed with new insertable adapters to accommodate the increased diameter, but as long as the vehicle would fit within the previously described storage envelope, the storage concept could be applied.

Once the vehicle had been built up and checked out on the lowboy transporter, the vehicle, less the payload section would be transported to the storage facility. The transporter would be backed up to the rails in the bay of the storage facility and the transporter and facility rails locked together. The winch in the bay would then be connected to the storage yoke assembly. With cradle wheels unlocked, the vehicle and cradles are then roll transferred from the transporter rails onto the facility rails.

Once the storage period was terminated, as determined by launch needs, the process for loading the vehicle into the storage bay would be reversed for loading the vehicle onto the transporter. The transporter would then be used to take the vehicle to the launch pad and to support the vehicle until it was mated with the launcher. Once the vehicle was mated with the launcher, the adjustable cradles would be lowered to allow the launcher to support the full weight of the vehicle. The transporter could then be removed from the pad area and made ready for use with another vehicle. The payload could be mated with the vehicle at this time to complete vehicle assembly.

3.3.5 Storage of Small Vehicles

For the purposes of this study, a small vehicle is defined as a solid launch vehicle which weighs less than 8000 pounds and is comprised of less than three stages.

It is possible and in most cases desirable to process the small vehicles in exactly the same way as the larger vehicles; however, other methods are available which utilize existing GFE, i.e., the 4000A Airlog dolly and the 3500 Airlog dolly adapter. One combination includes the 4000A Airlog dolly and the 3500 Airlog dolly adapter with modified adapter pads; another combination includes the 4000A Airlog dolly and Scout cradles with modified cradle adapter pads. In each case the adapter pads are designed for buildup and storage of specific vehicles. A tiedown is required with both the Scout cradles and the 3500 Airlog dolly adapter to secure the vehicle during transport.

Preparation for vehicle buildup would consist of arranging for use of a 4000A Airlog dolly and installing either a 3500 Airlog dolly adapter with specifically designed pads or the correct number of Scout cradles with adapters designed for the specific vehicle. With this equipment, it would not be necessary to raise or lower the rails in the storage complex as with the lowboy transporter since the 4000A Airlog dolly has sufficient adjustment capabilities to use either rail height.

The method used for loading the small vehicles into and out of the storage complex bay would be essentially the same as that used for vehicles on the lowboy transporter except that due to the smaller size and weight, the small vehicles would not need to be winched into the bay. Also it would be possible to store two small vehicles on the same set of complex rails, depending upon the length of the vehicles.

Once the storage period was terminated and the vehicle transported to the launcher, the dolly would support the vehicle until it was mated with the launcher. The cradles would be lowered or the pads of the 3500 dolly adapater would be retracted to allow the launcher to support the full weight of the vehicle. Once this had been accomplished, the dolly could be removed from the pad area and made ready for use with another vehicle. The payload could be mated with the vehicle at this time to complete vehicle assembly.

3.3.6 Cost Analysis

The following is the estimated unit cost of the additional ground support equipment required to allow vehicles other than Scout to use the proposed storage complex:

Lowboy transporter	$ 25000	each
3500 Airlog dolly adapter pads	$ 2000	per set
Scout cradle adapters	$ 500	each
Restraints	$ 1000	per set
Tie bars	$ 200	per set
4000A Airlog dolly	GFE	
3500 Airlog dolly adapters	GFE	
Scout Cradles (available with storage complex)		

A storage complex specifically acquired for these vehicles would have the same basic requirements as those prescribed in Task I for a 30 vehicle storage complex for Scout. However, due to the physical size and propellant composition of these vehicles the storage complex size can be reduced resulting in a 15% to 20% reduction in facility cost. To this can be added the required AGE selected from the above unit cost data to determine the ROM cost of a storage complex specifically for the other vehicles in NASA inventory excluding Scout. It is readily apparent that the greatest advantage lies in joint occupancy by increasing the utilization and decreasing the per vehicle acquisition cost of the complex.

While feasibility has been the main concern, cost effectiveness has not been fully developed. Existing launch requirements coupled with vehicle simplicity do not indicate ready storage of these vehicles to be highly beneficial; however, full recognition of the benefits which might be available with storage capability is attainable only through further amplification and definitization of customer operational and storage requirements.

4.0 CONCLUSION

Based on the foregoing analysis, it is concluded that storage for extended periods of time for solid propellant vehicles such as Scout and others in the NASA inventory is both feasible and practical.

To implement the storage concept conceived in this study for Scout, the following recommendations are submitted:

a. Scout vehicle processing flow involving storage should encompass four periods of storage between the completion of manufacturing and vehicle launch. Three levels of vehicle assembly should be employed during the storage periods.

   The total accumulated time in these controlled storage conditions can total 36 months or more.

b. The recommended storage container is a fixed container consisting of an environmentally controlled prefabricated steel building with steel frame supports onto which the vehicle is roll transferred for storage.

c. Vehicle processing in the field should utilize the existing Assembly and Checkout Facilities in conjunction with the storage complex.

d. The total number of vehicles in process, including storage, at a launch site should not exceed the planned annual launch rate. Based on the existing and projected launch rates, the desired operational flexibility is attainable with a four vehicle capacity storage complex at each launch site.

e. The major portion of the total storage time should be accumulated in a disassembled transition level configuration. To obtain the desired operational goals and remain consistent with the existing checkout philosophy, the aggregate time for vehicle processing at a launch site; i. e., receipt of vehicle subassemblies through launch, should be limited to 14 months. Based on the existing knowledge and experience, the "Ready Hold" storage period should be limited to 6 months; and within the 14 month field time, only two "Ready Hold" periods of maximum length should be allowed. At the end of the second period, the vehicle should be assigned another payload, recycled through "Ready Checkout", and launched prior to the expiration of the allowable field processing time. Vehicles remaining in the field for periods in excess of the 14 months should be updated by incorporating outstanding modifications and recertified.

f. A more versatile method for programming the flight profile should be developed.

g. A test program should be initiated aimed at improving the storage characteristics of the Reaction Control System, particularly in the area of hot motor firing requirements, tank bladders and 500 pound motor/valve assemblies.

h. A modified inspection should be developed to inspect rocket motors prior to use which have been in storage over 90 days or the requirement waived.

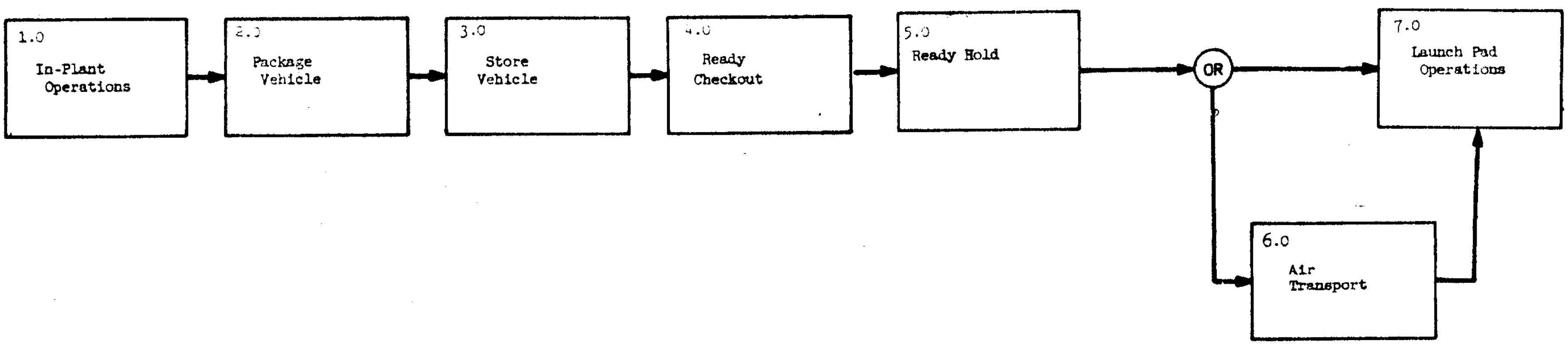
i. The necessity for the use of preservation fluid in the hydraulic system should be evaluated.

The other vehicles in the NASA inventory, having less demanding storage requirements than Scout, are readily adaptable to a storage system conceived for Scout. Mixing these vehicles with Scout in a common storage complex is not only compatible but desirable; since the increase in utilization will decrease the per vehicle acquisition cost of the complex.

The selected storage concept defined herein identifies a feasible storage system that satisfies the recognized requirements and is consistent with the basic checkout and operational philosophy established for Scout, thus assuring flight hardware in a satisfactory condition at lift off. A four vehicle capacity storage complex could be attained within 6 months from go ahead and at a cost of approximately $450 000. It is, therefore, recommended that the full usefulness of the storage capability deemed feasible by this study be pursued through the further definitization of the manufacture - storage - launch requirements leading to the acquisition of the optimum storage complex.

APPENDIX A

FUNCTIONAL FLOW BLOCK DIAGRAMS



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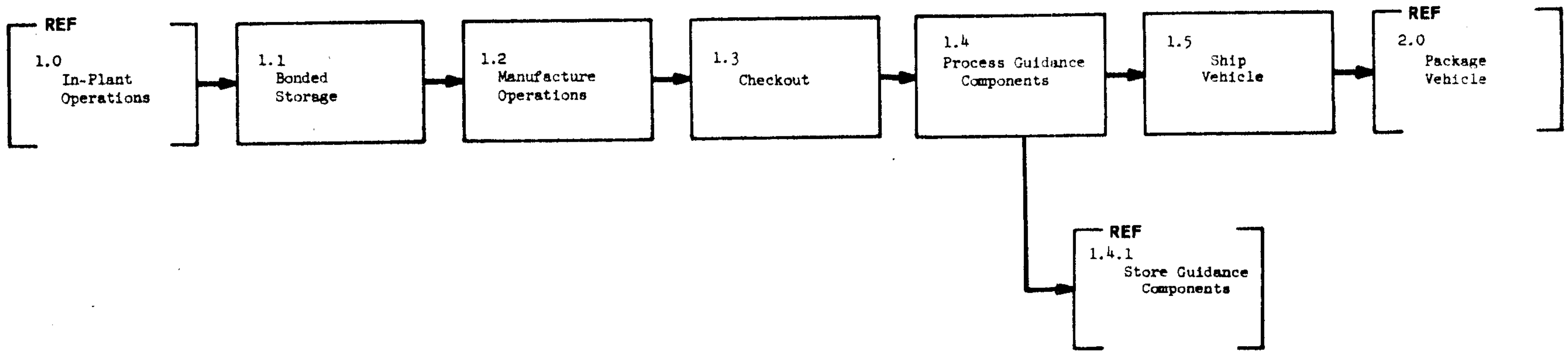
TOP LEVEL FUNCTIONAL DIAGRAM



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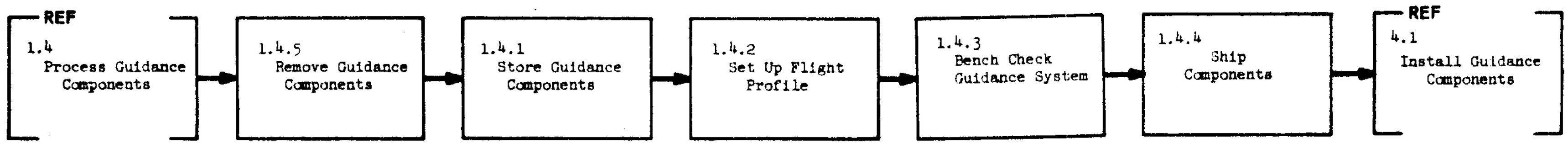
FIRST LEVEL FUNCTIONAL DIAGRAM
IN-PLANT OPERATIONS FUNCTION 1.0



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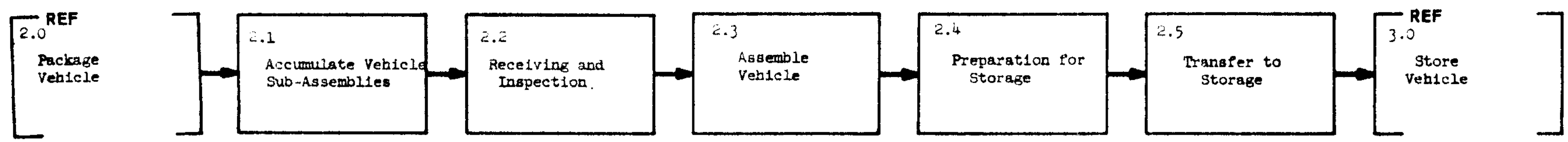
SECOND LEVEL FUNCTIONAL DIAGRAM
REMOVE GUIDANCE COMPONENTS FUNCTION 1.4



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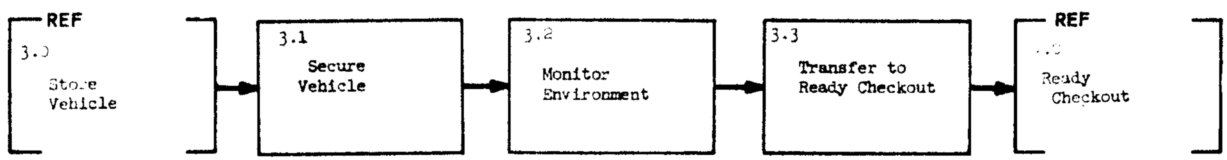
FIRST LEVEL FUNCTIONAL DIAGRAM
PACKAGE VEHICLE FUNCTION 2.0



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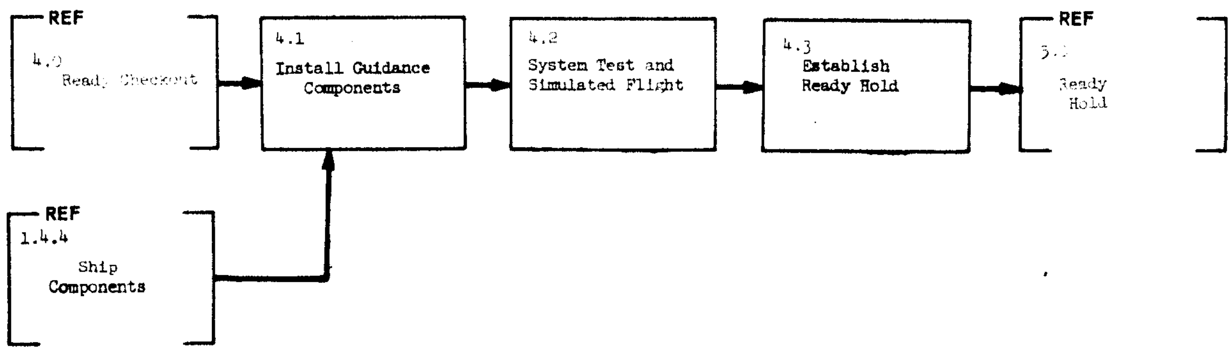
FIRST LEVEL FUNCTIONAL DIAGRAM
STORE VEHICLE FUNCTION 3.0



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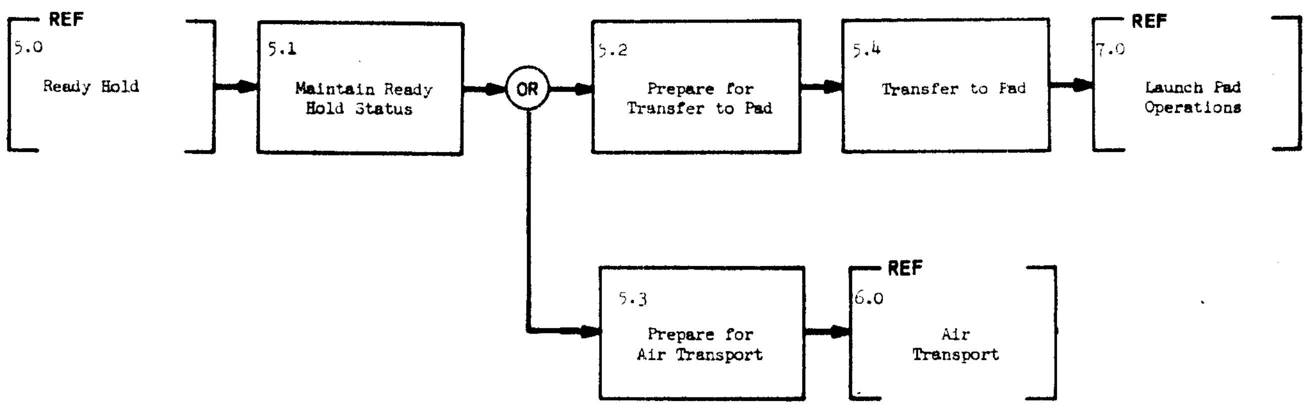
FIRST LEVEL FUNCTIONAL DIAGRAM
READY CHECKOUT FUNCTION 4.0



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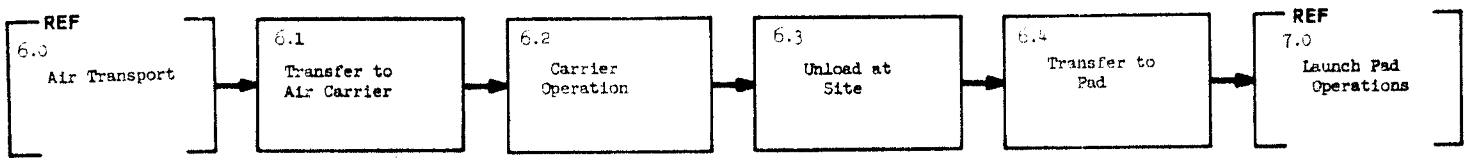
FIRST LEVEL FUNCTIONAL DIAGRAM
READY HOLD FUNCTION 5.0



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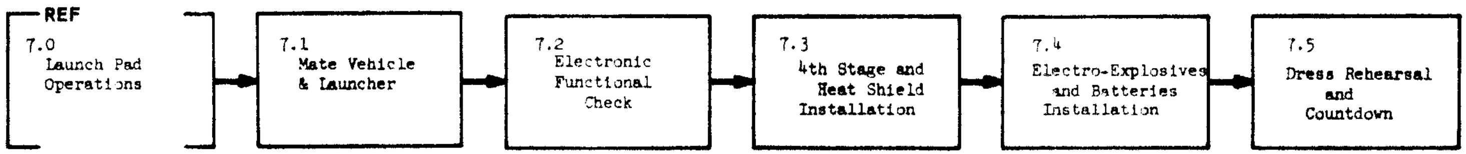
FIRST LEVEL FUNCTIONAL DIAGRAM
AIR TRANSPORT FUNCTION 6.0



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FIRST LEVEL FUNCTIONAL DIAGRAM
LAUNCH PAD OPERATIONS FUNCTION 7.0

APPENDIX B

REQUIREMENT ALLOCATION SHEETS

MISSILES AND SPACE DIVISION
LTV Aerospace Corporation
P. O. Box 6267
Dallas, Texas 75222

REQUIREMENTS ALLOCATION SHEET

FUNCTIONAL DIAGRAM TITLE AND NO. 1.0 IN-PLANT OPERATIONS OR

NOMENCLATURE AND NO. OF CEI

FUNCTION NAME AND NUMBER	DESIGN REQUIREMENTS	FACILITY	EQUIPMENT IDENTIFICATION: NOMENCLATURE	EQUIPMENT IDENTIFICATION: CEI OR DETAIL SPEC OR INDEX OR MASTER CONTROL NUMBER	PERSONNEL AND TRAINING EQUIPMENT REQUIREMENTS: TASKS	TIME REQ.	PERFORMANCE REQUIREMENTS	TNG & TNG EQUIP. REQ.	PROCEDURAL DATA REQUIREMENTS
1.0 IN-PLANT OPERATIONS	There is a requirement to manufacture Scout vehicle components at an even rate consistent with customer procurement requirements.	Factory							
1.1 BONDED STORAGE	There is a requirement to accumulate completed components when manufacture completion rate exceeds checkout rate.	Factory Bonded Stores				16 mos.			Job Operation Sheets (JOS)
	There is a requirement to operate the radar beacon every six months		Factory Test Equipment						
1.2 MANUFACTURE OPERATIONS	There is a requirement to incorporate required modifications to update vehicle configuration prior to final acceptance.	Factory			Incorporate Mod. Kits	2.5 mos.			
1.3 CHECKOUT	There is a requirement to check-out the vehicle prior to shipment to the field.	Factory	S^3T Equipment		Final acceptance checkout of vehicle and systems	3.0 mos.			Standard Procedure Vol. IV & Vol. V
	Checkout rate should be at a level rate consistent with launch requirements.								
	Checkout must conform with existing policies and procedures.								
	When flight profile is not known at time of checkout, a test profile will be used.								
1.4.5 REMOVE GUIDANCE COMPONENTS	Where test profile is used for checkout, the guidance components will be removed and held in storage until flight profile is finalized.	Factory Bonded Stores				4 hrs			

REVISION	DATE	APPROVAL	DOCUMENT NUMBER	PAGE NUMBER

3-87176 R1

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REQUIREMENTS ALLOCATION SHEET

FUNCTIONAL DIAGRAM TITLE AND NO. 1.0
IN-PLANT OPERATIONS ___ OR
NOMENCLATURE AND NO. OF CEI ___

FUNCTION NAME AND NUMBER	DESIGN REQUIREMENTS	FACILITY	EQUIPMENT IDENTIFICATION: NOMEN-CLATURE	EQUIPMENT IDENTIFICATION: CEI OR DETAIL SPEC OR INDEX OR MASTER CONTROL NUMBER	PERSONNEL AND TRAINING EQUIPMENT REQUIREMENTS: TASKS	TIME REQ	PERFORMANCE REQUIREMENTS	TNG & TNG EQUIP. REQ.	PROCEDURAL DATA REQUIREMENTS
1.4.1 STORE GUIDANCE COMPONENTS	Guidance components shall be packaged per applicable storage specification requirements and held in bonded stores.	Factory							
1.4.2 SET UP FLIGHT PROFILE	There is a requirement to program guidance components per applicable flight profile.	Factory			Wire Programmer and Timer	9 days			Standard Procedure & Special Engr. Instructions (SEI)
1.4.3 BENCH CHECK GUIDANCE SYSTEM	There is a requirement to bench check and accept the guidance system per standard procedure.	Factory	S^3T		Bench check Guidance Systems	5 days	3 personnel		Standard Procedures 4-3-7 4-3-6
1.4.4 SHIP COMPONENTS	There is a requirement to package and ship the guidance components to launch site.	Factory	Common Carrier		Package and Ship Components	1 day			Standard Procedures Volume IV
1.5 SHIP VEHICLE	There is a requirement to prepare for shipment and to ship the vehicle components and sub-assemblies to launch sites.	Factory	Common Carrier			14 days			Standard Procedures Volume IV

REVISION	DATE	APPROVAL	DOCUMENT NUMBER	PAGE NUMBER

3-67176 R1

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REQUIREMENTS ALLOCATION SHEET

FUNCTIONAL DIAGRAM TITLE AND NO. 2.0 PACKAGE VEHICLE OR

NOMENCLATURE AND NO. OF CEI

FUNCTION NAME AND NUMBER	DESIGN REQUIREMENTS	FACILITY	EQUIPMENT IDENTIFICATION: NOMENCLATURE	EQUIPMENT IDENTIFICATION: CEI OR DETAIL SPEC OR INDEX OR MASTER CONTROL NUMBER	PERSONNEL AND TRAINING EQUIPMENT REQUIREMENTS: TASKS	TIME REQ.	PERFORMANCE REQUIREMENTS	TNG & TNG EQUIP. REQ.	PROCEDURAL DATA REQUIREMENTS
2.1 ACCUMULATE VEHICLE SUB-ASSEMBLIES	There is a requirement to accumulate and hold in storage in shipping containers, subassemblies between receipt and start of vehicle processing. Storage environmental requirements are the same as for storage Function 3.0.	Storage Area	Existing Sling & Hoisting Equipment		Off load from common carrier & position in storage area				No procedure change required.
					Conduct shipping inspection.				Use Vol. III Procedures for Motors
2.2 RECEIVING & INSPECTION	There is a requirement to conduct a Receiving and Inspection function on sub-assemblies received at launch site.	Existing Buildings	Existing Equipment		Open containers & conduct R & I per Standard Procedures.	5 Days			Volume III & IV Standard Procedures
2.3 ASSEMBLE VEHICLE	There is a requirement to assemble the vehicle on a transporter or in a container capable of being transported.	Existing Assembly Buildings			Assemble Vehicle	10 Days	16 Personnel		Scout Standard Procedures Volume V
	The cradle support structure must be compatible with current motor/stage cradles, must be capable of supporting Scout vehicle, and must be capable of adjusting for stage mating.								
	Vehicle is to be assembled as prescribed in Scout Standard Procedures Vol. V minus fourth stage, payload, heatshield.								
	Grounding provisions are required to ground vehicle motors to transporter/container to earth ground.	Earth Ground	Grounding Cables						
	For Concept 1, the vehicle must be assembled in its storage container.		Figure 3 and Figure 4						

REVISION	DATE	APPROVAL	DOCUMENT NUMBER	PAGE NUMBER

3-87178 R1

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REQUIREMENTS ALLOCATION SHEET

FUNCTIONAL DIAGRAM TITLE AND NO. 2.0 PACKAGE VEHICLE OR NOMENCLATURE AND NO. OF CEI

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2.3 ASSEMBLE VEHICLE (CONT.)	For Concept 3 the vehicle must be assembled on a modified Scout transporter forming a container base.		Figure 6						
	For Concepts 2 and 4 the vehicle must be assembled on the existing Scout transporter.								
2.4 PREPARATION FOR STORAGE	At the completion of assembly the vehicle must be prepared for storage. To accomplish this function, the following is required:				Prepare for storage similar to Standard Procedure 5-7-9 and 5-9-1	1 Day	10 Personnel		Modify Standard Procedure Volume V
	Remove ground support equipment not required for storage.								
	Protect all disconnected electrical connectors.								
	Cover open reaction control motor nozzles.								
	Install vehicle doors and panels								
	Secure cradles and install vertical and horizontal restraints.								
	For Concepts 1 & 3 Remove fin tips and stow								
	Cover forward end of "D"Section								
	Cover all small openings								
	For Concepts 2 & 4 Cover vehicle with protective cover.		Existing Canvas Cover						

REVISION	DATE	APPROVAL	DOCUMENT NUMBER	PAGE NUMBER

3-67176 R1

MISSILES AND SPACE DIVISION
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REQUIREMENTS ALLOCATION SHEET

FUNCTIONAL DIAGRAM TITLE AND NO. 2.0 PACKAGE VEHICLE OR
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2.4 PREPARATION FOR STORAGE (CONT.)	For Concept 1 the container must be closed prior to removal from Assembly Building.					1 Day	10 Personnel		New Procedures
	Container lids must be manually folded over to close top of container in area of motors.				Manually close lid Secure lid				
	Saddle type closures are required to close container above Transition Section "B" & "C"	Overhead Crane (1 ton capacity)	Sling		Hoist saddles with sling and crane position & install				
	Box type closures are required to close container ends.				Hoist & Install forward and aft closures Hoist & Install air conditioning unit on aft closure.				
	For Concept 3 a cover shall be placed over the vehicle and attached to the transporter to form a container. Trade Study 005 selected a rigid cover		Cover Figure 6		*Manually roll cover into position over vehicle *Secure cover to transporter	0.5 Day	10 Personnel		New Procedure
2.5 TRANSFER TO STORAGE	There is a requirement to transport the storage container/vehicle from the Assembly Bldg. to the Storage area.	Access Roads Figure 2	Transporter Trailer	Figure 4 Concept 1 Figure 5 Concepts 2 & 4 Figure 6 Concept 3	Transfer vehicle to storage	4 Hrs.	6 Personnel		New Procedure
	The transporter/container must restrain the vehicle during transfer.								
	A heavy duty truck tractor will be the prime mover.		Truck Tractor						

REVISION	DATE	APPROVAL	DOCUMENT NUMBER	PAGE NUMBER

3-67176 R1

MISSILES AND SPACE DIVISION
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REQUIREMENTS ALLOCATION SHEET

FUNCTIONAL DIAGRAM TITLE AND NO. 2.0 PACKAGE VEHICLE OR

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2.5 TRANSFER TO STORAGE (CONT.)	Transporter trailer must have King pin and air brake connections compatible with prime mover.								
	Time in transit outside environmental controlled areas shall not permit vehicle to exceed the time-temperature exposure limits per Standard Procedure Volume III.								
	Transport mode must mitigate shock loads within established limits.								
	Escort is required for travel on public roads.		Escort Vehicle						
	Transport Function must conform to Safety Regulations AFM 127-100								
	There is a requirement to position the vehicle in the storage area where the storage function is to occur.	Maneuvering Aprons at Storage Area							
	The prime mover will not remain in storage.				Disconnect Prime Mover				
	Except for Concept 4, the vehicle container is to be roll transferred from transporter trailer to storage support structure. Reference Trade Study 004 & 006.		Storage Support Figure 5		Roll Transfer Vehicle/Container				
	Except for Concept 4, the transporter must be positioned in line with storage support to permit straight movement transfer.	Vee Rails to align transport trailer							

REVISION	DATE	APPROVAL	DOCUMENT NUMBER	PAGE NUMBER

3-87176 R1

MISSILES AND SPACE DIVISION
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REQUIREMENTS ALLOCATION SHEET

FUNCTIONAL DIAGRAM TITLE AND NO. 2.0 PACKAGE VEHICLE OR

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2.5 TRANSFER TO STORAGE (CONT.)	Except for Concept 4, a winch is required to facilitate transfer operation.	Winch (1500 pounds)							
	Communication is required between winch operator and transporter trailer winch.		Two-way Communication System (Hard wire)						

REVISION	DATE	APPROVAL	DOCUMENT NUMBER	PAGE NUMBER

3-87176 R1

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REQUIREMENTS ALLOCATION SHEET

FUNCTIONAL DIAGRAM TITLE AND NO. 3.0 STORE VEHICLE OR

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3.0 STORE VEHICLE	Assembled vehicles must be stored to provide a surge capability between assembly and launch sufficient to assure meeting launch turn around requirement and operational flexibility.								
	Storage function shall meet safety criteria of AFM 127-100, OP 5, AMCR-385-224, Amend. 12								
	Storage shall have a capacity for 20-30 vehicles for up to 3 years.	Storage Complex Figure 2. 6 storage pads with capacity to store 5 Scout vehicles each. Trade Study 001.							
	During this function, protection from sand, rain, wind, and dust must be provided.								
	Vehicle environment must be maintained between 60° and 80°F at ambient temperatures from -10° to 110°F. Humidity shall be maintained at less than 40%.	Environmental Control Unit							
	Emergency environmental conditioning is required.		Spare Air Conditioning Units						
	10 foot-candles of light shall be provided.	Explosion proof lighting							
	Emergency power for environmental system is required.	Central emergency power supply. Trade Study 002							
	There is a requirement for personnel access to vehicle during storage.								

REVISION	DATE	APPROVAL	DOCUMENT NUMBER	PAGE NUMBER

3-87176 R1

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REQUIREMENTS ALLOCATION SHEET

FUNCTIONAL DIAGRAM TITLE AND NO. 3.0 STORE VEHICLE OR

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3.0 STORE VEHICLE (CONT.)	Ground provisions are required to ground vehicle/container to earth ground.	Earth Ground	Grounding Cables						
	Concept 1, storage shall be in a transportable container.		Container Figure 3						
	Concept 2 storage shall be in a fixed container capable of accepting vehicle from Scout transporter. Reference Trade Study 003.		Container Figure 5						
	Concept 3 storage shall be in a container adaptable to the Scout transporter, reference Trade Study 005		Container Figure 6						
	Concept 4 storage shall be in an environmental controlled building with vehicle remaining on Scout transporter.	Pre. Fab. Steel Building							
3.1 SECURE VEHICLE	Containers for Concepts 1 & 3 require tie-down provisions to secure container to storage pad base to prevent inadvertent movement during storage function	Pad Eyes at Each Vehicle Location	Structure/ Container Restraint System		Tie-Down Vehicle				
	There is a requirement to activate the environmental control and alarm systems.				Connect Environmental Control System to Complex Power Supply and activate system				New Procedure

REVISION	DATE	APPROVAL	DOCUMENT NUMBER	PAGE NUMBER

3-87176 R1

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REQUIREMENTS ALLOCATION SHEET

FUNCTIONAL DIAGRAM TITLE AND NO. 3.0 STORE VEHICLE OR
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3.2 MONITOR ENVIRON-MENT	There is a requirement to monitor storage environment								
	The environmental controls shall have a monitoring system and an alarm system.	Continually Manned Station (Guard, Fire, Etc.)	Environ-mental Alarm System						
	The monitoring system shall pro-vide temperature and humidity presentation to allow periodic surveillance and continuous recording.		Humidity and tem-perature instru-ments at each vehicle container		Monitor environmental system Standby alert				
	The alarm system shall alert personnel when environmental limits are being approached and in sufficient time to permit corrective action to be taken to prevent exceeding the limits.				Extra duty for per-sonnel at already continually manned station (fire, guard, etc.)				
	The monitoring system shall in-clude a data recording system to provide permanent record of temperature and humidity condi-tions within the vehicle storage container.		Instr. recorder at each stored vehicle container (8-day)		Service recorders and collect & re-cord environmental data weekly.	16 hr. wk.	Q.C.		
3.3 TRANSFER TO READY CHECKOUT	There is a requirement to transfer the storage container/vehicle from storage area to check out area. Requirements for this function are the same as 2.5.								

REVISION	DATE	APPROVAL	DOCUMENT NUMBER	PAGE NUMBER

3-67176 R1

MISSILES AND SPACE DIVISION
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REQUIREMENTS ALLOCATION SHEET

FUNCTIONAL DIAGRAM TITLE AND NO. 4.0 READY CHECKOUT OR
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4.0 READY CHECKOUT	There is a requirement to checkout vehicle system prior to ready-hold storage.	S^3T Checkout Area	S^3T Equipment			10 Day	16 Personnel		
	For Concept 1, it will be necessary to remove saddles and end closures to gain access to vehicle.	Overhead Hoist (1 ton capacity)	Slings		Remove saddles Remove fwd. closure Remove aft closure & air conditioner				
	For Concept 3, it will be necessary to remove cover to gain access.				Disconnect cover from transporter. Raise on castors and manually roll from over vehicle.				
	There is a requirement for space to store the removed equipment.	Storage Capability			Store equipment				
4.1 INSTALL GUIDANCE COMPONENTS	There is a requirement to install the guidance components which have been programmed with the applicable flight profile. The guidance components shall have completed a guidance system bench check at Dallas prior to installation		Hand Tools		Install Components	4 Hrs.	3 Personnel		Modify Standard Procedures to Include All Guidance Components.
	There is a requirement to install fin tips.				Install Fin Tips	4 Hrs.	3 Personnel		
4.2 SYSTEM TEST & SIMULATED FLIGHT	There is a requirement to perform system tests and a simulated flight to determine flight worthy condition of vehicle.	S^3T Checkout Area	S^3T Equipment		System Test All System Test	8 Days	10 Personnel		Scout Standard Procedures Volume V

REVISION	DATE	APPROVAL	DOCUMENT NUMBER	PAGE NUMBER

3-87178 R1

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REQUIREMENTS ALLOCATION SHEET

FUNCTIONAL DIAGRAM TITLE AND NO. 4.0 READY CHECKOUT OR

NOMENCLATURE AND NO. OF CEI

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4.3 ESTABLISH READY HOLD	There is a requirement to prepare the vehicle for a ready hold period. To accomplish this function the following is required:								
	Disconnect ground support equipment and install protective caps	S^3T Area			Secure vehicle Similar to Procedure 5-9-1	1 Day	10 Personnel		Modify Standard Procedures
	Cover open reaction control motor nozzles								
	Install doors and panels								
	Secure cradles								
	Cover forward end of "D" section								
	Cover all small openings								
	Maintain vehicle/container/transporter ground to earth ground.								
	This function could be accomplished by repeating Blocks 2.4, 2.5 and 3.0	Storage Complex Figure 2							

REVISION	DATE	APPROVAL	DOCUMENT NUMBER	PAGE NUMBER

3-87176 R1

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REQUIREMENTS ALLOCATION SHEET

FUNCTIONAL DIAGRAM TITLE AND NO. 6.0
AIR TRANSPORT OR
NOMENCLATURE AND NO. OF CEI

FUNCTION NAME AND NUMBER	DESIGN REQUIREMENTS	FACILITY	EQUIPMENT IDENTIFICATION: NOMEN-CLATURE	EQUIPMENT IDENTIFICATION: CEI OR DETAIL SPEC OR INDEX OR MASTER CONTROL NUMBER	PERSONNEL AND TRAINING EQUIPMENT REQUIREMENTS: TASKS	TIME REQ.	PERFORMANCE REQUIREMENTS	TNG & TNG EQUIP. REQ.	PROCEDURAL DATA REQUIREMENTS
6.0 AIR TRANSPORT	There is a requirement to transport the vehicle via aircraft from storage point to launch site. Transporter/container must meet established air transport requirements for environment, structure, handling, physical size, etc.								
6.1 TRANSFER TO AIR CARRIER	The vehicle and transporter/container must be capable of loading into an aircraft per the established air transport requirements.		Transporter /Container Figure 4 Concept 1		Load vehicle on aircraft	.5 Day	10 Personnel		Standard Procedure 5-9-2
6.2 CARRIER OPERATIONS	Container/transporter must meet the established air transport requirements for inflight operations				Monitor vehicle Environment During Transport		Carrier crew Traveling Monitor		Standard Procedure 5-9-3
6.3 UNLOAD AT SITE	The vehicle and transporter/container must be capable of off loading from aircraft per established air transport requirements				Off load vehicle from Aircraft	.5 Days	10 Personnel		Standard Procedure 5-9-4
6.4 TRANSFER TO PAD	There is a requirement to transfer the vehicle/container from the air strip to pad area and position vehicle for mating with the launcher. The requirements are the same as Block 2.5.				Transfer vehicle to Pad	4 Hrs.	6 Personnel		Standard Procedure 5-9-5

REVISION	DATE	APPROVAL	DOCUMENT NUMBER	PAGE NUMBER

3-87178 R1

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REQUIREMENTS ALLOCATION SHEET

FUNCTIONAL DIAGRAM TITLE AND NO. – 7.0 LAUNCH PAD OPERATIONS OR

NOMENCLATURE AND NO. OF CEI

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7.0 LAUNCH PAD OPERATIONS	Requirements for this function shall be the same as that prescribed in Volume VI, Scout Standard Procedures.	Blockhouse	Launcher Blockhouse Consoles Shelter		Launch Pad ops.	6 days	10 Personnel		Standard Procedures Vol. VI
7.1 MATE VEHICLE & LAUNCHER	There is a requirement to mate the vehicle to the launcher and conduct prelaunch checkout.				Mate vehicle to launcher.	4 hrs	10 Personnel		
	The transporter/container must be capable of mating vehicle to launcher. Transporter/Container/vehicle must be capable of adjustments, fore and aft, lateral and vertical and rotational.								
	For Concept1, it is a requirement to gain access to vehicle by removing end closures and saddles and manually opening lids. Temporary storage space is required for closures and saddles.		Hoist (1 ton cap) Transporter /Container Figure 4						
	For Concept 3, there is a requirement to remove the cover prior to entering shelter. Cover is disconnected from transporter and manually rolled from over vehicle. Storage space is required for cover.		Transporter /Container Figure 7						
	The transporter/container must provide for fourth stage mating with vehicle.				Mate fourth stage similar to Standard Procedure 6-3-10				Standard Procedure

REVISION	DATE	APPROVAL	DOCUMENT NUMBER	PAGE NUMBER

3-87176 R1

APPENDIX C

TIME LINE SHEETS

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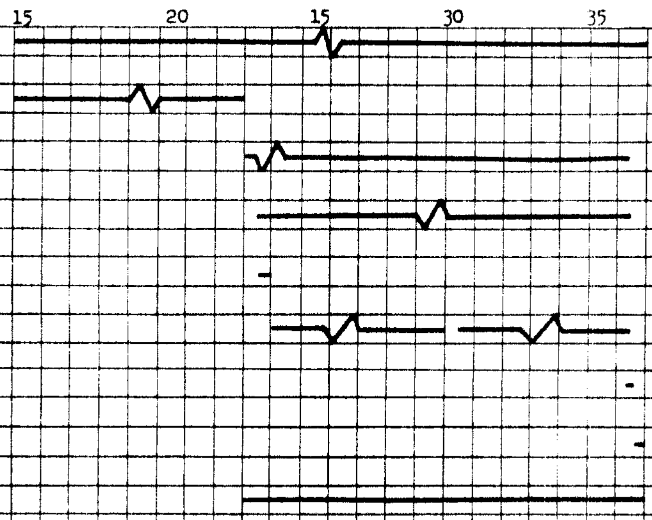
TIME LINE SHEET	FUNCTION: TOP LEVEL FUNCTIONAL DIAGRAM FOR 36 MONTH SPAN TIME SINCE MANUFACTURE	LOCATION	TYPE OF MAINTENANCE (IF APPLICABLE)

SOURCE OF FUNCTION	FUNCTION & CORRESPONDING TASKS (IF APPLICABLE)	TIME (months) (BAR CHART)
	Time Since Manufacture	36 mos.
1.0	In-Plant Operations	22 mos.
2.0	Package Vehicle	.35 mos + Acmum Time (13.35 mos. max)
3.0	Store Vehicle	13 mos max
4.0	Ready Checkout	.35 mos.
5.0	Ready Hold	6 mos (2 max)
6.0	Air Transport	.03 mos
7.0	Launch Pad Operations	.2 mos
	Maximum Time in Field	14 mos max.



REVISION	DATE	APPROVAL	DOCUMENT NO.	PAGE NO.

8-67178 R1

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TIME LINE SHEET	FUNCTION 1.0 IN-PLANT OPERATIONS	LOCATION	TYPE OF MAINTENANCE (IF APPLICABLE)

SOURCE OF FUNCTION	FUNCTION & CORRESPONDING TASKS (IF APPLICABLE)	TIME (months) (BAR CHART)
1.0	In-Plant Operations	22 mos.
1.1	Bonded Stores	16 mos.
1.2	Manufacturing Operations	2.5 mos.
1.3	Checkout	3.0 mos.
1.4	Process Guidance Components	.5 mos.
1.5	Ship Vehicle	.5 mos.

REVISION	DATE	APPROVAL	DOCUMENT NO.	PAGE NO.

8-67178 R1

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TIME LINE SHEET	FUNCTION: 2.0 Package vehicle & 3.0 Store	LOCATION:	TYPE OF MAINTENANCE (IF APPLICABLE):

SOURCE OF FUNCTION	FUNCTION & CORRESPONDING TASKS (IF APPLICABLE)	TIME (days) (BAR CHART)
2.0 + 3.0	Maximum Aggregate Time	400 days (13 1/2 mos)
2.1	Accumulate Vehicle Sub Assembly	390 days max
2.2	Receiving & Inspection	5 days
2.3	Assemble Vehicle	10 days
2.4	Preparation for Storage	.5 day
2.5	Transfer to Storage	.5 day
3.0	Store Vehicle	390 day max
3.1	Secure Vehicle	.5 day
3.2	Monitor Environment	as required
3.3	Transfer to Checkout	.5 day

REVISION	DATE	APPROVAL	DOCUMENT NO.	PAGE NO.

S-67179 R1

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TIME LINE SHEET	FUNCTION: 4.0 Ready Checkout & 5.0 Ready Hold	LOCATION	TYPE OF MAINTENANCE (IF APPLICABLE)

SOURCE OF FUNCTION	FUNCTION & CORRESPONDING TASKS (IF APPLICABLE)	TIME (Days) (BAR CHART) 5, 10, 15, 20, 25, 205
4.0	Ready Checkout	10 day
1.4.2	Set Up Flight Profile	10 day
1.4.3	Bench Check Guid. System	5 day
1.4.4	Ship Components	1 day
4.1	Install Components	1 day
4.2	Systems Tests & All System	8 day
4.3	Establish Ready Hold	1 day
5.0	Ready Hold	180 day
5.2 or 5.3	Prep. for Air Transport or Transfer to Pad	1 day

REVISION	DATE	APPROVAL	DOCUMENT NO.	PAGE NO.

8-67178 R1

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TIME LINE SHEET	FUNCTION: 7.0 Launch Pad Operations	LOCATION	TYPE OF MAINTENANCE (IF APPLICABLE)

SOURCE OF FUNCTION	FUNCTION & CORRESPONDING TASKS (IF APPLICABLE)	TIME (days) (BAR CHART) 5 10
5.2	Preparation for Transfer to Pad	1 day
5.3	Preparation for Air Transport	1 day
6.0	Air Transport	1 day
7.0	Launch Pad Operations	6 days

REVISION	DATE	APPROVAL	DOCUMENT NO.	PAGE NO.

2-87178 R1

APPENDIX D

TRADE STUDIES

TRADE STUDY LOG

TRADE STUDY NUMBER	SUBJECT	RELATED TRADE STUDIES	CONCLUSIONS	PAGE NUMBER
001	Storage grouping	002	Six pads with five vehicles per pad	D-3
002	Central or individual emergency power supply	001	Central emergency power	D-5
003	Optimum fixed storage container	004	Prefabricated steel building	D-7
004	Optimum transfer method	003	Roll transfer	D-12
005	Rigid or cacoon cover	003	Rigid	D-14
006	Store on transporter vs. support structure	004-005	Support	D-16
007	Mobile vs. fixed checkout equipment	002-008	Fixed	D-20
008	Optimum checkout sequence		Checkout function follows storage function and precedes ready hold function	D-24

MISSILES AND SPACE DIVISION LTV Aerospace Corporation P. O. Box 6267 Dallas, Texas 75222	TITLE Storage Grouping	TRADE STUDY REPORT NO. 001 DATE 14 November 1966

1. **SCOPE**

This is a trade study to select the grouping of Scout vehicles at a storage site with 30 vehicle capacity.

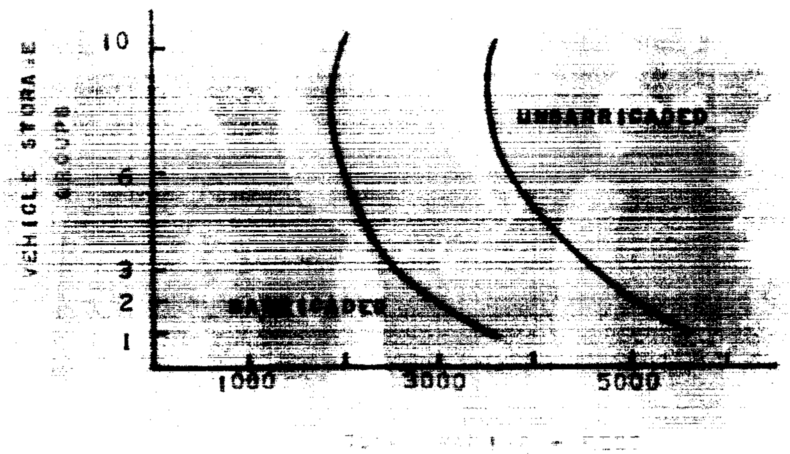
2. **FUNCTIONAL AND TECHNICAL REQUIREMENTS**

a. Clear area must comply with the quantity-distance tables of the AFM 127-100 Explosive Safety Manual, (ref 3).

b. Facility cost to be a minimum and is to consider the cost of land acquisition.

3. **DISCUSSION**

The assembled first three stages of a Scout vehicle have a "TNT Equivalent" of 17,242 pounds of class 7 explosive (50% for Algol propellant, 50% for Castor propellant, and 100% for X259 propellant). Five groupings of 30 vehicles were selected varying from one group of 30 to 10 groups of 3. The clear distance requirements for both a barricaded and an un-barricaded storage facility were determined using the quantity-distance tables of the AFM 127-100 Explosive Safety Manual. A plot of the groups versus clear distance is shown below.



Each storage group requires site work and facility installation and construction; consequently, it is desirable to have the number of groups

ORIGINATOR	APPROVAL	PAGE	OF
		1	2

3-57181 R1

at a minimum.

The least clear radius required for storage of 30 vehicles is 1,900 feet for a barricaded complex using 8 groups, or 3,400 feet for an unbarricaded complex using 9 groups.

Any increase in the number of groups requires acquisition of additional land and additional facilities. A reduction in the number of groups requires acquisition of additional land but less facilities.

Storage groups of six increases the clear radius requirements for both type complexes by only 100 feet. Thus for a barricaded site, a 25% reduction in storage groups increases the clear area required by 12%; and for an unbarricaded site, a 33% group reduction results in a clear area increase of 6%. By further reducing the group to 3, or an approximate 65% grouping decrease for each type site, increases the clear area required by 72%.

From this it is apparent that unless land is readily available and at low cost, storage groups of six provide the overall lowest cost for facilities and land acquisition.

4. CONCLUSION

From the foregoing discussion, the storing of 6 groups of 5 vehicles each is determined to be the optimum storage grouping arrangement.

MISSILES AND SPACE DIVISION LTV Aerospace Corporation P. O. Box 6267 Dallas, Texas 75222	TITLE Central Emergency Generator Vs. Individual Portable Emergency Generators for Storage Site Emergency Power	TRADE STUDY REPORT NO. 002 DATE 23 November 1966

1. **SCOPE**

This trade study presents an evaluation of a central emergency generator vs. individual portable generators at each building for furnishing emergency power to the Storage Site.

2. **FUNCTIONAL AND TECHNICAL REQUIREMENTS**

a. Emergency generator supplies electrical power to operate the heating/air conditioning system in the event of a power failure.

b. Emergency generator should be in operation within four hours of a power failure.

c. Electrical capacity of the unit should be sufficient to operate all environmental control units at maximum capacity.

d. Emergency generator must comply with the safety requirements of: AFM 127-100, Explosive Safety Manual, AMCR 385-224, Air Material Command Safety Manual, and OPS-5, Ammunition Ashore, Handling, Storing, and Shipping.

3. **DISCUSSION**

Consideration was given to a portable stand-by power generator for each storage building versus a central emergency generator station. The portable unit consists of a diesel powered generator mounted on a 4 wheeled trailer. It requires manual starting and frequent checks by an operator while it is in operation; the fuel supply is sufficient for a few hours operation. The portable generator has a metal cover that cannot withstand long term outside storage. Its unit cost is $12,000 and a total cost for the storage site of $ 72,000.

The central unit includes a diesel powered generator, and power switch board enclosed in a light constructed building. It can be set for automatic operation such that it will immediately start and assume the electrical load in case of a power failure. In addition, it has an exercise circuit such that the unit will run 30 minutes every day to verify proper operation as well as operate the equipment for increased reliability. The generator can operate more than a day on a tank of fuel and does not require an operator; however, periodic checks should be made to verify proper operation. The central emergency generator would be located outside the storage area and therefore could not be classified as a safety hazard. Total cost for this installation is $80,000.

ORIGINATOR	APPROVAL	PAGE	OF
		1	2

3-57181 R1

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TITLE	TRADE STUDY REPORT NO.	DATE
Central Emergency Generator Vs. Individual Portable Emergency Generators for Storage Site Emergency Power	002	23 November 1966

4. **COMPARISON MATRIX**

Functional Requirements	Central Unit	Portable Unit
1. Cost	$80,000	$72,000
2. Reliability	Daily automatic operation protected from exposure	Operation depends on maintenance crew exposed to elements
3. Safety	Located out of the storage area	Internal combustion engine operated within storage area
4. Maintenance	One unit to maintain larger and more complex	Six units to maintain
5. Operation	Automatically operate in case of power failure Will run days on a tank of fuel	Must be manually started with operator surveillance Will run an hour on a tank of fuel Unit may be used elsewhere when storage site is not filled

5. **CONCLUSION**

The many operating advantages of a central emergency generator out weigh its 10% greater cost, therefore a central unit should be used for stand-by electrical power at the storage site.

ORIGINATOR	APPROVAL	PAGE	OF
		2	2

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TITLE

FIELD STORAGE CONTAINER SELECTION

TRADE STUDY REPORT NO. 003

DATE 18 November 1966

1.0 Scope

This is a trade study to select the optimum fixed container for storing assembled Scout vehicles for 2 to 3 years.

2.0 Functional and Technical Requirements

(a) The container must be able to receive an assembled Scout vehicle by the roll transfer method.

(b) It must comply with the safety requirements of the Explosive Safety Manual, AFM 127-100 (ref 3).

(c) It must be capable of long term outside storage with minimum maintenance.

(d) It must protect the vehicle from vermin and the elements; rain, salt spray and blowing sand.

(e) It must be sufficiently insulated to prevent rapid loss of conditioned air in the event of an air conditioning unit failure and to prevent excessive cost for maintaining environmental control. The "U" factor (BTU/Hr./Ft.^{2}/^{o}F) should be .3 or lower.

3.0 Discussion

Fixed containers for holding vehicles as considered herein range from the box, carton or crate type to the building warehouse type.

Five materials for container construction were considered.

1. Inflatable structure
2. Plastic envelope
3. Wood
4. Metal
5. Masonry

3.1 Inflatable Structure

The inflatable structure is made from flexible coated fabric that forms a balloon-like envelope which is supported and stabilized by maintaining a small pressure differential within the enclosure. To maintain the pressure differential, redundant inflation blowers are provided and constant surveillance of the structure and inflation equipment is necessary.

Once the inflatable structure or "air shelter" is erected, access must be accomplished through an airlock. The airlock required for an assembled Scout vehicle would equal the length of the storage building. The airlock could be removed and replaced when needed or the "air shelter" could be erected over the

ORIGINATOR	APPROVAL	PAGE	OF
		1	5

3-57181 R1

vehicle after it is prepared for storage. However, either operation will require an eight man erection crew a full day to accomplish it.

The thin fabric skin of the "air shelter" provides poor vehicle protection and insulation characteristics. Its initial cost is low; however, its maintenance cost is excessive. The "air shelter" serves best as a quickly assembled, temporary type structure. More than one vehicle may be stored in an air shelter with moderate savings; however, an airlock must be used.

3.2 Plastic Envelope

The stored vehicle is sprayed with a liquid asphalt based material which hardens and forms a waterproof protective cover. This material has very little insulating properties, requiring that a frame work of insulating material be built over the vehicle before the envelope is applied.

The plastic envelope must be sprayed at 70°F and 60% relative humidity necessitating a spray building large enough to accommodate an assembled Scout. This dictates that the vehicle be cocooned on the transporter or on a special portable storage stand. The operation of "cocooning" a vehicle requires 4 men two days.

Once covered, the cocoon must be cut away for vehicle accessibility and then reapplied. Unit cost for the spray envelope is low; however, the initial cost of the spray facility makes this type of container expensive unless many hundreds of applications are made.

Cocoon type storage provides poor protection for the vehicle from the elements and wild life.

3.3 Wood

A frame container or building has low initial cost. It requires infrequent maintenance, provides fair vehicle protection, and insulation may be added to give it good insulating characteristics. Though the Explosive Safety Manual, AFM 127-100, (ref 3), does not forbid frame structures for explosive storage, they should be avoided. Frame structures are classified as temporary because of their relatively short life expectancy. Multiple vehicle storage can be accommodated in a frame structure with substantial savings.

3.4 Metal

A metal container would require special design and this expense would eliminate it from consideration. There are many prefabricated metal buildings available which can be considered as fulfilling the requirements for a vehicle container and it is this type building that will be considered. Considerable savings may be realized by increasing the building size to provide multiple vehicle storage.

Metal/styrofoam sandwich-constructed prefab buildings have excellent heat transfer characteristics; with baked on enamel finishes for long service life and low maintenance. They may be dismantled and used elsewhere if the need arises. Once the building requirements are defined, the building fabricator will provide the necessary architect and engineering information as part of the purchase price.

3.5 Masonry

A storage container or buildings of concrete or cinder block or brick is rugged and long lasting, requiring minimum maintenance. It is fireproof but has only fair heat transfer characteristics. Construction costs are the same or slightly lower than a prefabricated building of the same size, depending on the locale. All architect and engineering information must be provided.

3.6 Multiple Vehicle Storage

As recommended by Trade Study 001, storage of vehicles in groups of five is ideal. Multiple storage is not possible for the cocoon type storage; however, in the other cases investigated considerable savings may be realized by enlarging the storage container to accommodate five vehicles. While a vehicle is being placed in a storage container or building, the other vehicles sharing the storage building are exposed to ambient conditions. This is not considered a problem as long as the vehicle being stored has the same, or more severe, temperature limitations since it is exposed for a greater length of time.

In considering fixed containers, it should be understood that a single vehicle, fixed or roll transferable container must be designed and fabricated whereas a building for one or more vehicles can be obtained with little or no design costs involved and some of the fabrication completed. A building as the fixed container is therefore considered to be the more practical approach.

3.7 Comparison Matrix

The following matrix presents a comparison of the characteristics of the materials considered.

	INFLATABLE STRUCTURE	PLASTIC ENVELOPE	WOOD	METAL	MASONRY
Construction Cost	Lowest of those considered.	High initial cost because spray facility required high usage rate which would reduce unit cost.	Low, detailed architectural and engineering information required	Approximately 10% higher than wood. No detailed information needed.	Same as prefab metal. Detailed architectural and engineering information required.
Maintenance	Highest of any considered by a factor of 10	None required.	Requires caulking and painting every 2yrs.	Slight	Slight
Life Expectancy	Few Months	Three years.	Ten Years.	Twenty years.	Twenty years.
Vehicle Protection	Poor - Combustible	Poor - Semi-Fire Resistant	Good - Combustible	Excellent Fire Resistant	Excellent Fire Resistant
Heat Transfer Characteristics	Poor U = 1.2	Insulation must be added before cocoon is sprayed on vehicle	Good U = .3	Excellent U - .1	Fair U = .4
Salvageable	Yes; can be used elsewhere with minimum tear-down and assembly time.	No	No; materials may have some value, however.	Yes; may be readily dismantled and re-assembled elsewhere.	No
Vehicle Operations	Requires excessive time to position vehicle in air shelter and remove.	Cocoon must be removed for vehicle accessibility.	Good	Good	Good
Vehicle Capacity	Up to five may be stored but cycling vehicles in and out of shelter requires airlock.	One only	Moderate savings for multiple storage.	Good savings for multiple storage.	Good savings for multiple storage

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4.0 Conclusion

Based on the foregoing analysis, it is concluded that a metal prefabricated building of sufficient size for multiple Scout vehicle storage be utilized as the storage container.

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TITLE	TRADE STUDY REPORT NO.
SELECTION OF METHOD FOR TRANSFERRING ASSEMBLED SCOUT FROM TRANSPORTER TO STORAGE STAND	004
	DATE November 15, 1966

1.0 Scope

The purpose of this study is to determine the optimum method for transfer of an assembled Scout from the transporter to a storage stand.

2.0 Functional and Technical Requirements

1) The transfer operation should not impose any excessive loads on the vehicle.

2) It should comply with the safety requirements of the Explosive Safety Manual, AFM 127-100.

3) This operation should require no more than 8 men 4 hours to complete.

3.0 Discussion

Two methods of assembled vehicle transfer from the Scout transporter to the storage stand are considered: a hoisting operation and roll transfer.

3.1 Vehicle Hoisting

This method involves maneuvering the transporter/vehicle into the storage area and along side the vehicle storage container. Using a mobile crane, the roof of the container is removed or folded back. A large truss-type strong back and two 50-ton capacity mobile cranes are used for the vehicle hoisting operation. This operation requires eight men six hours.

The strong back is a 15,000 pound steel truss type structure which attaches to the vehicle in the same manner as the Mark II launcher. A large pad area is needed for the hoisting operation to accommodate the mobile cranes. Two are required to prevent swinging about the pitch axis because of the high moment of inertia of the vehicle. The load size and the acute angle of the crane boom during the hoisting operation require their having a capacity of 50 tons. The roof of the container must be removed to provide access to the storage stand when hoisting or lowering the vehicle.

3.2 Roll Transfer

This technique requires maneuvering the transporter/vehicle guided by vee-rails to close alignment in an end-to-end position in relation to the storage support structure. Roll transfer is accomplished by using two 5000 pound capacity winches, a traveling one permanently located in storage facility and the other temporarily attached to transporter, to roll the Scout resting on its cradles onto the storage stand in the same manner as the 4th stage is mated to

ORIGINATOR	APPROVAL	PAGE	OF
		1	2

3-57181 R1

to the vehicle in Procedure 6-3-10 of the Scout Standard Procedures. This operation requires six men 4 hours.

The existing Scout transporters must be modified for this operation by adding rollers to the first stage cradles, adding pad to accept winch at forward end of transporter, and extending the transporter cradle rails to the aft end of the transporter.

3.3 Comparison

The hoist transfer operation requires more time, facilities and GSE than roll transfer. The hoisting operation must be accomplished under ideal weather conditions by experienced operators. It is less safe and more likely to impose excessive loads to the Scout vehicle than roll transfer.

4.0 Conclusion

It is recommended that assembled Scout vehicles be transferred from the vehicle transporter to the storage stand by the roll-transfer method.

MISSILES AND SPACE DIVISION LTV Aerospace Corporation P. O. Box 6267 Dallas, Texas 75222	TITLE RIGID OR COCOON COVER FOR A SCOUT STORED ON A TRANSPORTER	TRADE STUDY REPORT NO. 005 DATE November 23, 1966

1.0 Scope

This is a trade study to select an environmentally controlled cover for an assembled Scout while stored on a transporter.

2.0 Functional and Technical Requirements

a) The cover must comply with the safety requirements of the Explosive Safety Manual, AFM 127-100.

b) It must be capable of long term outside storage with minimum maintenance.

c) It must protect the vehicle from vermin and the elements; rain, salt spray and blowing sand.

d) Cover removal or replacement must be accomplished without exposing the vehicle to the elements longer than four hours.

e) The container must be sufficiently insulated to prevent rapid loss of conditioned air in the event of an air conditioning unit failure and to prevent excessive cost for maintaining environmental control. The "U" factor (BTU/Hr./Ft.^{2}/°F) should be .3 or lower.

3.0 Discussion

3.1 The rigid cover is a box-like structure with an open bottom and supported by six adjustable castor jacks. This container is manually rolled over the vehicle and attached to the transporter to form a weather tight enclosure. The transporter must be modified to add an insulated floor at the transporter walkway and latching provisions for attaching the container to the transporter. The cover contains a heating/air conditioning system with internal ducts for distribution. The cover installation requires eight men two hours.

The cover is fabricated from metal/styrofoam sandwich material which has excellent heat transfer characteristics, U = 0.1 and baked on enamel finish for long service life and low maintenance. The metal cover will provide excellent vehicle protection throughout the storage life. Since it attaches to the transporter it can be installed in the checkout building to provide environmental portection for the vehicle during transportation.

There is no existing design for this type cover, consequently design and fabrication will be expensive. Transporter modifications will require additional design and the modification will add 1,800 pounds to the total weight. A container storage area must be provided when they are not in use; the vehicle

ORIGINATOR	APPROVAL	PAGE	OF
		1	2

storage area or any convenient outside location would suffice. The container will be designed with doors for vehicle accessibility in certain areas or the cover can be easily removed for complete accessibility.

3.2 The cocoon cover is formed when a vehicle/transporter that is ready for storage is sprayed with a liquid asphalt based material which hardens and forms a waterproof protective cover. The material has very poor insulating properties requiring that a frame work of insulating material be placed around the vehicle before the cocoon is applied.

The plastic envelope must be sprayed at 70°F and 60% relative humidity necessitating a spray building large enough to accommodate a Scout on its transporter. The cocooning operation requires 4 men 2 days. Once covered, the cocoon must be cut away for vehicle accessibility and then reapplied. Unit cost for the spray envelope is low; however, the initial cost of the spray facility makes this type container expensive unless many hundreds of applications are made.

3.3 The rigid cover provides a more permanent storage cover. It offers better protection to the vehicle both while in storage and during transportation. In addition vehicle accessibility is readily available.

The cocoon enclosure does not require any design, has a low installation cost; however, the high maintenance cost, short useful life and poor vehicle accessibility offset this advantage.

4.0 Conclusion

From this analysis it is recommended that a rigid cover be used for Scout storage on the transporter.

MISSILES AND SPACE DIVISION LTV Aerospace Corporation P. O. Box 6267 Dallas, Texas 75222	TITLE STORAGE OF AN ASSEMBLED SCOUT VEHICLE ON ITS TRANSPORTER VS. A STORAGE STAND.	TRADE STUDY REPORT NO. 006 DATE November 23, 1966

1.0 Scope

This trade study presents a comparison of storing assembled Scouts on their transporters or on a specially designed support stand.

2.0 Functional and Technical Requirements

a) The storage stand must be of sufficient strength to support an assembled Scout with a safety factor of 4 as required by Military Standard MIL-S-8512B.

b) It must be able to receive an assembled Scout by the roll transfer method.

c) The storage device must not require maintenance or repair during a three year storage period.

d) Placing the vehicle in storage should not expose it to the elements longer than four hours.

3.0 Discussion

3.1 Storage of an assembled Scout vehicle on the existing transporter poses no problems. The transporter has as its limiting structural design requirement, air transportation of an assembled Scout; this is a much more severe loading condition than static storage. Construction of the transporter is such that no maintenance or repair would be necessary during the storage period.

Positioning vehicle in the storage is straight forward and for the purpose of this comparison can be considered as not requiring any time.

3.2 The Scout storage stand consists of two vertical trusses 70 inches high and positioned 48 inches apart and bolted to the storage pad. Each is capped with the same type rails that are used on the transporters for supporting the vehicle cradles. When not used for storing assembled Scouts, the rails may be removed and the cleared area used for storage at the transition level.

The vehicle/transporter is aligned with the storage stand and the vehicle, resting on its support cradles, is roll transferred onto the stand using two 5,000 pound capacity winches, one handling winch and one portable winch. The cradle locks are set and the vehicle can remain in this position until required for launch. The roll transfer operation requires 6 men 4 hours to complete.

The storage stand is made from a standard steel section of the type used in heavy construction and made from extruded steel angles welded together. These

ORIGINATOR	APPROVAL	PAGE	OF
		1	4

sections are low cost, readily available and require no maintenance. In order to accomplish roll transfer, the existing transporters must be modified by adding rollers and rail locks to the first stage cradles, adding pad to accept winch assembly, and extending the transporter cradle rails to the aft end of the transporter. One additional set of cradles is required for each storage stand. The five existing transporters are sufficient to support this storage concept for up to 15 vehicles.

3.3 Storage of assembled vehicles on the Scout transporter requires the least vehicle handling. No new design or special techniques are required; however, one additional transporter is required for each stored vehicle.

Storage on the specially constructed stand requires a moderate amount of new design to modify the existing transporters and to develop the roll transfer system. The five existing transporters would require modification and one set of cradles would be required for each stored vehicle. In addition, two winches must be provided at each storage pad; a facility winch and a portable winch.

Based on the cost of a new transporter as being 10, the cost of the roll transfer technique is as follows:

1. New design	1.2
2. Transporter modification	.7 each
3. Two winches	.6
4. Storage stand	.6 each
5. Vehicle cradles	3.5 per set.

After the existing five transporters have been used for storage, the cost for increasing the storage capacity is 10.0 per vehicle. Cost of storage on the storage stand levels out at 4.1 after the first five vehicles when the initial design and transporter modification have been completed and the storage pad winches obtained.

One transporter for each vehicle in storage is not enough to satisfy the various operational requirements: vehicle processing, air transport and the return of an empty transporter at the completion of the air transport operation.

Figure 1 is a plot of the unit cost factor vs. the vehicle storage capacity for both storage on the transporter and the storage stand. The additional number of transporters required to support operation over and above the number required for full capacity storage is excluded from consideration, thus providing a more direct comparison for storage purposes. Figure 1 indicates that it is less expensive to store assembled Scout vehicles on the transporter only if the number of vehicles to be stored is less than seven.

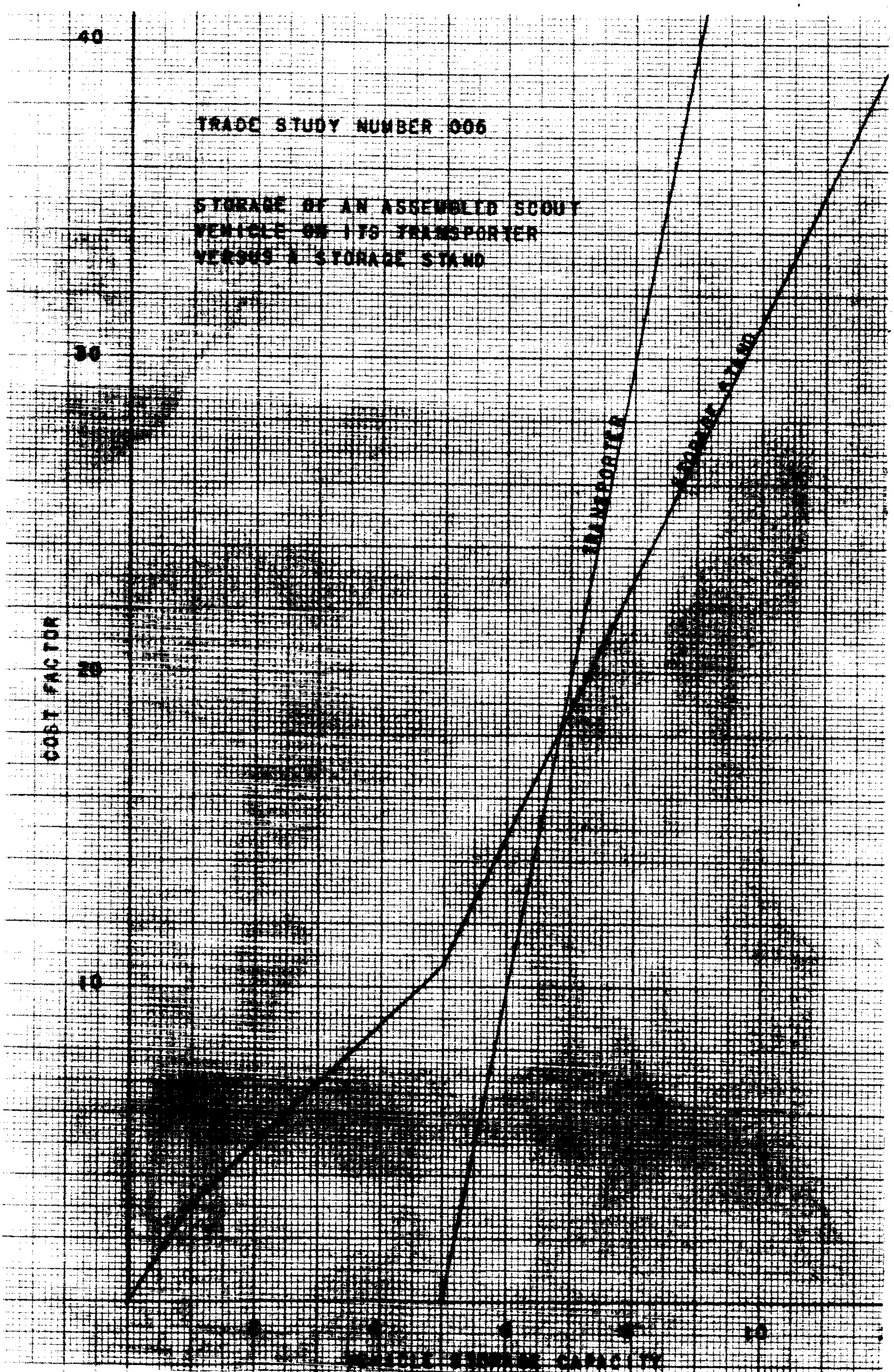

FIGURE 1 COST COMPARISON PAGE 3 OF 4

4.0 Conclusion

Based on the foregoing analysis, it is recommended that assembled Scout vehicles be stored on a storage stand where more than six vehicles are to be in storage. Further, the cost differential is so great above 15 vehicles in storage that acquisition of 2 additional transporters to support a 30 vehicle operation is insignificant.

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TITLE
MOBILE VS. FIXED
CHECKOUT EQUIPMENT

TRADE STUDY REPORT NO.
007

DATE
4 January 1967

1.0 Scope

This trade study report presents an evaluation of a mobile vs. a fixed checkout capability for test and surveillance of assembled Scout vehicles being stored for extended periods

2.0 Functional and Technical Requirements

a) The mobile equipment must be functionally identical to the current Scout Standard Systems Test (S^3T) equipment for checking out assembled Scout vehicles.

b) Mobile equipment must be packaged in a standard trailer that will mate with available truck/tractors and will comply with the Interstate Commerce Commission regulations.

c) Mobile van must be large enough to accommodate all the necessary equipment and eight operators.

d) Mobile van must be environmentally controlled to 75° $\pm$ 3°F, with outside temperature extremes of 20°F to 100°F. The cooling capacity must be adequate to cool all electronic equipment while operating at the temperature extreme.

e) The dividing head and rate table must be mounted such that they will receive no extraneous vibrations.

f) The mobile checkout equipment must comply with the safety requirements of the Explosive Safety Manual, AFM-127-100, (ref 3).

3.0 Discussion

3.1 Mobile Checkout Capability

One method of accomplishing checkout of stored assembled vehicles is to provide mobility of the present Scout equipment. This mobile capability would allow transporting the test equipment to each vehicle storage location for test and checkout.

To implement this plan the existing electronic test equipment in the assembly area would require installation in a test van. Approximate size of the van required would be 50 feet x 8 feet. Air conditioning, lighting, and electrical power distribution support systems would be required in the van.

The present J-box/cable plant in the assembly area would be mounted along one wall of the test van, with possible roll up cables to extend to Base "A" during test.

ORIGINATOR | APPROVAL | PAGE 1 OF 4

Additional time and handling operations would be required to transport and set up items such as the hydraulic power cart, nitrogen service cart, Base "A" 28 volt power source (Christie), and the guidance test fixtures (dividing head and rate table). The guidance test fixtures would require firm foundations to earth reference at each vehicle location to eliminate random vibration inputs from external sources.

This concept would require more space in the storage areas to allow positioning of test van and equipment around the vehicle. Each storage site would require adequate electrical services to supply power for the test equipment.

Potential hazard from explosion would be increased under the concepts of this study due to each storage "pad" containing a possible five vehicles.

3.2 Permanent Location Checkout Capability

The permanent location concept for vehicle checkout makes use of existing Scout assembly/checkout building and test equipment. The vehicle would be cycled through the assembly building during build up, transported to the storage area, back to the assembly building for "ready hold" checkout and possibly returned to storage if not utilized for a mission within four to six months. Additional transporters would be required to provide the flexibility necessary to accomplish storage transport, ready-hold, buildup, checkout, and air transport capabilities for a thirty vehicle storage site.

Building space at the storage area would be minimal for this method of operation due to elimination of area required to position test equipment around the vehicle.

This operation presents less hazardous environment during checkout (only one vehicle) but presents possible problems during inclement weather that could delay or halt transfer operations.

4.0 Comparison Matrix

4.1 In evaluating the two methods of checkout, the following items were considered for comparison in each technique:

a) Handling operations
b) New or modified equipment required
c) Facilities
d) Safety
e) Reliability
f) Cost

The following matrix presents line item comparison of these parameters:

MISSILES AND SPACE DIVISION LTV Aerospace Corporation P. O. Box 6267 Dallas, Texas 75222	TITLE MOBILE VS. FIXED CHECKOUT EQUIPMENT	TRADE STUDY REPORT NO. 007 DATE 4 January 1967

FUNCTION	MOBILE CONCEPT	PERMANENT CONCEPT
1. New or Modified Equipment	a. Require mobile equipment van, approx. 50 ft. x 8 ft., equipped with 10 ton air conditioning ducted air system, electrical power distribution system for test equipment, and interior lighting system. b. Modification to van for test set installation and test cable routing. c. Modification to van for installation of S^3T cable plant and J-boxes. d. New or modified Griswold and Rate Table stands for use at storage area. e. Cable storage bins installation in van.	a. Two new transporters, less cradles, modified for roll transfer (assumed cradles available per Concept 2 of Task I, this study).
2. Handling Requirements Over Present Flow	a. Transport test van and position in storage area. b. Griswold and rate table position set up and aligned. c. Hydraulic cart, N_2 pressure cart, Christie power supply, D section cooling air compressor transport and position in storage area. d. J-box to vehicle cable connection (J-box end only) e. J-box to vehicle cable disconnect and stowage after checkout f. Requires interruption and down time of existing equipment for mod. and instl.	a. Transporter make ready and positioning for vehicle loading. b. Roll transfer vehicle to transporter. c. Transport vehicle to checkout area. d. Position vehicle in test area. e. Return transport and roll transfer to storage (required for ready hold if vehicle is not scheduled for pad use after checkout)
3. Facilities	a. Additional space required at each vehicle storage location for positioning test van and equip. b. Additional electrical power service required at each storage pad to provide power for checkout equipment.	a. Minimum space required for each vehicle in storage area. b. Minimum electrical power capacity required at each storage pad. c. Utilizes existing checkout facility.

ORIGINATOR	APPROVAL	PAGE	OF
		3	4

3-57181 R1

FUNCTION	MOBILE CONCEPT	PERMENENT CONCEPT
4. Safety	a. More hazardous operation due to checkout in environment of possible 5 vehicles.	a. No increase of hazard over present operations.
5. Reliability	a. Possible decrease in reliability of checkout equipment due to exposure to transportation environment. b. No change in vehicle reliability.	a. Decrease in vehicle reliability due to additional transport and roll transfer operations. b. No change in test equipment reliability.
6. Cost	a. GSE: Modified van with equipment installed $100,000 b. Facilities: Additional space in storage building and power capacity $200,000 c. Total $300,000	a. GSE: Two new Transporters less cradles $150,000 b. Facilities: No change --- c. Total $150,000

As shown in the above matrix, mobile checkout capability provides more flexible operations, exhibits best vehicle reliability, but costs more and involves more hazardous operations. Permanent checkout location costs less, creates no additional hazardous operations, but could result in reduced reliability as determined by the reliability comparison, Appendix G. However, unless the Scout launch rate increases considerably over that experienced in past years, there should be no occasion to cycle the vehicle to the storage area after checkout for a launch. Therefore the possibility of inducing the reduced reliability due to excess transportation and roll transfer operations is minute.

5.0 Conclusion

Based on the foregoing analysis, it is concluded that the permanent checkout location utilizing existing facilities is the optimum for Scout processing until such time that launch rates exceed 2.0 per month.

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TITLE	TRADE STUDY REPORT NO.
Optimum Sequence for Check-Out Function	008
	DATE: 12 January 1967

1. SCOPE

This trade study presents an evaluation of the operational sequence for the checkout function that is accomplished between the receipt of the vehicle in the field and mating the vehicle to the launcher.

2. FUNCTIONAL AND TECHNICAL REQUIREMENTS

a. The checkout shall assure readiness for launch

b. Capability of removing from storage a launch vehicle in flight-ready configuration that enables direct mating to launcher is a goal

c. Minimum pre-launch operations

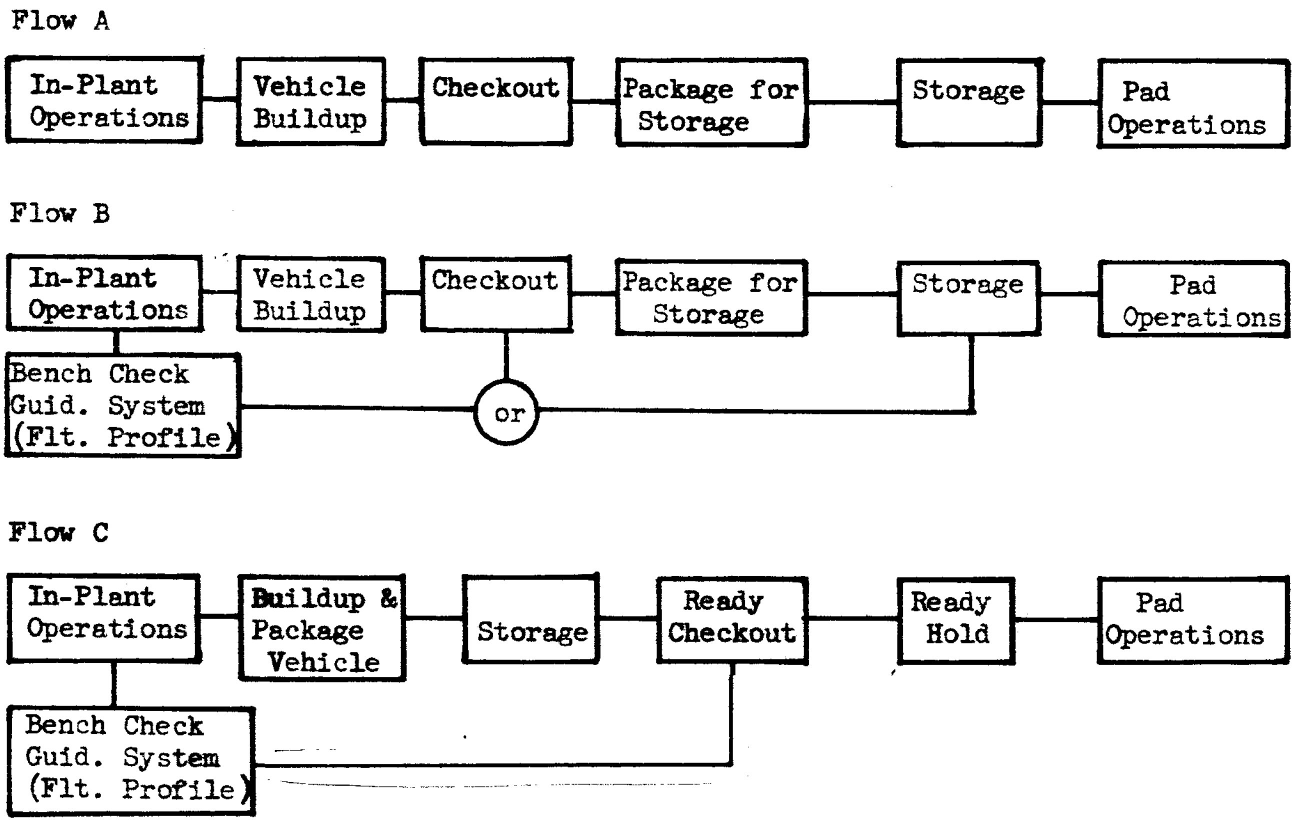
d. Operational flexibility

3. DISCUSSION

During Task I of the Scout Storage Study a functional flow diagram was established without regard to the impact of checkout requirements. Essentially that flow assumed that vehicle processing in the field would comply with Standard Procedure flow through the "All System Test" at which time the new preparation for storage function would begin. It further assumed that additional checks would be made during the storage function to determine or assure the vehicles flight-worthy status. This flow is depicted as Flow "A".

When Task II was started, it became apparent that other sequences for the checkout function were possible, and might be more desirable. Functional flows B and C were developed and compared with Flow A to determine optimum checkout function sequence.

ORIGINATOR	APPROVAL	PAGE	OF
		1	3



A basic checkout philosophy based on standard procedures has been long sought and is now in effect. Policies established during implementation of these procedures included the following:

In-plant, the Guidance System is adjusted at the bench level to establish base line quantitative data. This data is then verified at the system level at both Dallas and the field. When a problem is encountered at system level the system is returned to the bench level. A change in flight profile effecting both Timer and Programmer requires the system to be returned to Dallas for rewire and recheck at bench level.

Since this policy has not been disproved to date, it is applied in this study.

Lead time for finalization of the flight profile, set up and bench check of Guidance System has been a problem that will become greater with long term storage. The later the flight profile can be wired and checked out, the greater the operational flexibility.

In each of these flows it has been assumed that the flight profile will not be known at time of Dallas check out and that a test profile will be used. Flow A & B require checkouts prior to storage. A checkout at this point will assure that the vehicle system's integrity has not deteriorated as a result of shipment and/or buildup and that the systems are flight-worthy at the beginning of the storage period. For the vehicle to be capable of being removed from storage in a flight worthy condition and moved directly to the pad, the flight profile must be known at this time or must be configured and checked out later during the storage period. Assuming the flight profile is not known, checkout can be accomplished with the same test profile used at Dallas. A systems checkout capable of verifying previous checkouts requires the guidance components as system verification without them omits enough of the total vehicle integrity to make checkout impractical. Vehicles shipped with guidance components set up with test profile must have these components cycled back to Dallas for flight profile and bench check if present philosophy is continued. Installation of flight profile and bench check by field crews would eliminate this recycling. The former requires additional handling, shipping and process time; the latter contradicts the established philosophy and will not provide Dallas base-line data for field checks. In both instances the additional operations degrade vehicle reliability as shown in reliability comparisons, Appendix G.

In Flow C, Dallas checkout is accomplished with a test profile and the guidance system components (timer, programmer, inverter, IRP, PVE, rate gyro package, and filter) removed and placed in storage in-plant. Vehicle components shipped to the field are accumulated, assembled and placed in storage until such time as the flight profile is finalized. At this time the system components are removed from in-plant storage, programmer and timer set up with flight profile, entire system bench checked and shipped to the field. On receipt in the field, the components are installed and the total vehicle system (ignition destruct, radar beacon, telemetry, and guidance) checked out. Flight worthy condition of the vehicle is established at this time and the vehicle is placed in a ready hold status. In this status the vehicle can be moved directly to the pad for launch operations or to carrier for transport to another site.

This flow is in line with the present processing flow and philosophy. Flight profile can be finalized as late as 30 days before launch. A vehicle in the ready hold status is 10 days from launch.

4. CONCLUSION

Based on the foregoing analysis, it is concluded that Flow C will provide the optimum sequence for the checkout function.

APPENDIX E

TEMPERATURE AND HUMIDITY LIMITS

APPENDIX E

TEMPERATURE AND HUMIDITY LIMITS

GUIDANCE SYSTEM

COMPONENTS	HIGH TEMPERATURE	LOW TEMPERATURE	RELATIVE HUMIDITY
IRP M-H DGG122C3 & F1	158°F	32°F	Sealed
Rate Gyro Unit M-H DGG188A1 & E1	158°F	32°F	Sealed
Intervalometer M-H DHG80B2 & G1	158°F	32°F	Semi-Seal
Programmer M-H DRG87E1 & J1	158°F	32°F	Not Effected
PVE M-H DEG211C3 & F1	158°F	32°F	90%
Inverter M-H DSG30A1 & E1	158°F	32°F	95%, 24 Hr.
Servo Ampl. M-H DEG233C1 & D1	158°F	32°F	Sealed
Diode Unit M-H DDG93A1 & B1	160°F	0°F	Semi-Seal Rain Test
Guid. Relay Box M-H DRG95A1 & B1	160°F	0°F	Semi-Seal
Actuator-Hyd. M-H DMG109C1 & D1	100°F	32°F	Sealed
Body Bending Filter DAG69A1 & B1	158°F	32°F	Sealed

TELEMETRY SYSTEM

COMPONENTS	HIGH TEMPERATURE	LOW TEMPERATURE	RELATIVE HUMIDITY
Accelerometer A 9016-0501 A 9016-0502 LA 530250 LA 460250	160°F	0°F	90%
Chamber Press. Switch 8G64, 8G65	160°F	0°F	90%
Thermister G540, G541 K749, K750	160°F	0°F	90%
Telemetry Transmitter TDD 1010A TDD 1064AN1	160°F	0°F	90%
Junction Box Assy. 23-003244-2 401-10005-3, -5 401-10009-7 401-10018-1, -9	160°F	0°F	90%
Pressure Transducer 42517-0-4-752 42517-0-8-752 42517-0-35-752 824-TA-60-75 23-003352-1 2007253703 2007253705 890-A-60-75	160°F	0°F	90%
Position Potentiometer 2001571101 2001571201 2001575801 2001575901	160°F	0°F	90%
N_2 Pressure Switch 6607-6-20	160°F	0°F	90%

TELEMETRY SYSTEM (Continued)

COMPONENTS	HIGH TEMPERATURE	LOW TEMPERATURE	RELATIVE HUMIDITY
Hyd. Pressure Switch 1430-70B-51 1430-70B-244	160°F	0°F	90%
Radar Beacon CVRT-61B 302C-2A-2	160°F	-65°F	Sealed Unit
C/D Receiver MCR 105B, -3 MCR 1015C-1, -3	203°F	-85°F	Sealed Unit

IGNITION/DESTRUCT AND ELECTRICAL SYSTEM

COMPONENTS	HIGH TEMPERATURE	LOW TEMPERATURE	RELATIVE HUMIDITY
Dest. Sys. Press Switch 23-000356-21	350°F	-40°F	95%
Lower "B" Ign. Arming Relay Assy. 23-000387-4	160°F	-35°F	95%
Dest. Sys. J-Box Assembly 23-000397-4 23-003500-1	176°F	-67°F	95%
Lower "C" Ign. Arming Relay Assy. 23-002068-2, -3	160°F	-35°F	95%
Relay - Leach LR-9225-6707	257°F	-94°F	Sealed
Battery Assembly Eagle-Picher 23-002588-1, -2	170°F	0°F	100%
Lanyard Switch 23-003457-9, -10	199°F	-85°F	95%

IGNITION/DESTRUCT AND ELECTRICAL SYSTEM (Continued)

COMPONENTS	HIGH TEMPERATURE	LOW TEMPERATURE	RELATIVE HUMIDITY
Lower "D" Ign. Arm Relay Assy. 23-002564-4	160°F	-35°F	95%
Rotary Switch Ignition 23-002069-6	160°F	0°F	95% at 49°C for 48 Hr.
Dest. Sys. Relay Assembly 23-003460-1 23-003501-1	160°F	0°F	95%
PCR Box 401-10380-8	160°F	0°F	95%
Connectors Bendix - Type PT & PC	235°F	-67°F	95%
Connectors Cannon - Type DAM, DBM, DCM, DDM, DEM	185°F	-67°F	95%
Connectors Deutsch - Type DB	257°F	-67°F	95%
Connectors Deutsch - Type DM	250°F	-67°F	95%
Connectors MS 25183	265°F	-67°F	95%

HYDRAULIC SYSTEM

COMPONENTS	HIGH TEMPERATURE	LOW TEMPERATURE	RELATIVE HUMIDITY
Relief Valve 1112-598943	275°F	0°F	95%, 160°F, 6 Hrs.
Relief Valve 1008511	275°F	0°F	95%, 160°F, 6 Hrs.
Hyd. Pump 165WE 00211	275°F	0°F	95%, 160°F, 6 Hrs.
Hyd. Reservoir 17410-1	275°F	0°F	95%, 160°F, 6 Hrs.
Magnetic Filter AM 2.5-000	275°F	0°F	95%, 160°F, 6 Hrs.
Plumbing Components	275°F	0°F	95%, 160°F, 6 Hrs.
Valve Assy. CVC 4202-3	275°F	0°F	95%, 160°F, 6 Hrs.

REACTION CONTROL SYSTEM

COMPONENTS	HIGH TEMPERATURE	LOW TEMPERATURE	RELATIVE HUMIDITY
H_2O_2 Tank Assy. WK 892710 WK 892711	160°F	20°F	95%
N_2 Relief Valve WK 873323	160°F	0°F	95%
N_2 Tank Assembly 23-003322-1, -2	160°F	0°F	95%
H_2O_2 Relief Valve 23-003321-1	160°F	20°F	95%
H_2O_2 Decom. Chamber WK 892975	160°F	20°F	95%
40 Lb. R Motor Assy. 23-002858-21	160°F	20°F	95%
500 Lb. R Motor Assy. 23-003288-5	160°F	20°F	95%

REACTION CONTROL SYSTEM (Continued)

COMPONENTS	HIGH TEMPERATURE	LOW TEMPERATURE	RELATIVE HUMIDITY
N_2 Ref S/D Valve MAGH 225324-1, -2	160°F	0°F	95%
N_2 Charge Valve SYM 56138	275°F	20°F	95%
H_2O_2 Fill Valve SYM 46154	160°F	20°F	95%
H_2O_2 Bleed Valve SYM 46254	160°F	20°F	95%
REG N_2 Valve SYM 46354	275°F	20°F	95%
Insulation Blanket TMH 209H-23924	1200°F	-300°F	Moisture Resistant
14 Lb. - 3 Lb. Motor Assembly 23-002848-19	160°F	20°F	95%
2 Lb. Motor Assembly 23-002856-6	160°F	20°F	95%
Thrust Reduction Valve MAGH 210753	160°F	20°F	95%

VEHICLE ROCKET MOTORS AND STRUCTURE

COMPONENTS	HIGH TEMPERATURE	LOW TEMPERATURE	RELATIVE HUMIDITY
Vehicle Structure	160°F	-240°F	Not Effected

ALGOL MOTOR AND COMPONENTS

COMPONENTS	HIGH TEMPERATURE	LOW TEMPERATURE	RELATIVE HUMIDITY
Algol Motor 383638	90°F	50°F	40%
Algol Igniter 363931	90°F	50°F	40%
Algol Initiator Holex 3184	90°F	50°F	40%

CASTOR MOTOR AND COMPONENTS

COMPONENTS	HIGH TEMPERATURE	LOW TEMPERATURE	RELATIVE HUMIDITY
Castor Motor R42223	110°F	30°F	40%
Castor Igniter R41728	110°F	30°F	40%
Castor Initiator M-124 Mod 1	110°F	30°F	40%

ANTARES MOTOR AND COMPONENTS

COMPONENTS	HIGH TEMPERATURE	LOW TEMPERATURE	RELATIVE HUMIDITY
Antares Motor 2594-1-02-0001	90°F	50°F	40%
Antares Igniter 259A-2-05-0001	90°F	50°F	40%
Antares Initiator SD60ED	90°F	50°F	40%

APPENDIX F

HEATING/COOLING CALCULATIONS

APPENDIX F

HEATING AND COOLING LOAD CALCULATIONS

Calculations for heating and cooling loads anticipated for various concepts were based on the following extreme ambient conditions:

1. Low Temperature: -10°F
2. High Temperature: 110°F
3. Relative Humidity: 10% to 100%.

Assumptions made relative to all concepts considered were:

1. Allow 10% safety factor in calculating cooling loads.
2. Allow 10% margin for quick warm-up heating loads.
3. Container positioned for maximum solar exposure.

Design limits for controlled environment in the storage container or area:

1. Temperature: 70°F $\pm$ 10°F
2. Relative Humidity: Less than 40%
3. Heat Transfer Coefficient: "U" Factor = 0.1 BTU/Hr./°F/Ft.^{2}

Concepts 1 and 3 Cooling:

Container Size: 63.3 Ft. Long x 6.25 Ft. Wide x 6.7 Ft. High

Sensible Heat:

Transmission: Area x "U" Factor x Δ T = Heat Gain
- Area = Exposed wall or roof area in Ft.^{2}
- "U" Factor = Wall material heat transmission factor in BTU/Hr./Ft.^{2}/°F
- T = Adjusted temperature difference from inside container to outside wall and considers outside ambient plus container outside wall temperature increase due to solar radiation, in °F.

East Wall:	424 Ft.^{2}	x .1 BTU/Hr./Ft.^{2}/°F x 37°F =	1569 BTU/Hr.
West Wall:	424 Ft.^{2}	x .1 BTU/Hr./Ft.^{2}/°F x 45°F =	1908 BTU/Hr.
South Wall:	42 Ft.^{2}	x .1 BTU/Hr./Ft.^{2}/°F x 55°F =	231 BTU/Hr.
North Wall:	42 Ft.^{2}	x .1 BTU/Hr./Ft.^{2}/°F x 30°F =	126 BTU/Hr.
Roof:	396 Ft.^{2}	x .1 BTU/Hr./Ft.^{2}/°F x 87°F =	3237 BTU/Hr.
Floor:	396 Ft.^{2}	x .1 BTU/Hr./Ft.^{2}/°F x 30°F =	1188 BTU/Hr.
	1724	Sub Total	8259 BTU/Hr.

Infiltration:

10 CFM x 1.08 BTU/Hr./CFM/°F x 30°F =	324 BTU/Hr.
Sub Total	8583 BTU/Hr.

Condener Fan:

1/2 HP x 2547 BTU/Hr./HP	=	1,274 BTU/Hr.
Total Sensible Heat		9,857 BTU/Hr.

Latent Heat:

Infiltration:

10 CFM x 242 x .2 (.68)	=	329 BTU/Hr.
Sub Total		10,186 BTU/Hr.
Safety Factor 10%	=	1,019 BTU/Hr.
TOTAL HEAT LOAD		11,205 BTU/Hr.

Concept 1, Heating:

Transmission Loss:

Area x "U" Factor x Δ T = Heat Loss

1724 Ft.^{2} x 0.1 BTU/Hr./Ft.^{2}/°F x 80°F	=	13,792 BTU/Hr.

Infiltration:

10 CFM x 1.08 BTU/Hr./CFM/°F x 80°F	=	864 BTU/Hr.
Sub Total		14,656 BTU/Hr.
Safety Factor 10%		1,465 BTU/Hr.
TOTAL HEAT LOSS		16,121 BTU/Hr.

Concept 2, Cooling:

Container Size: 60 Ft. Wide x 75 Ft. Long x 20 Ft. High

Sensible Heat:

Transmission:

East Wall:	1200 Ft.^{2} x .1 BTU/Hr./Ft.^{2}/°F x 37°F	=	4,400 BTU/Hr.
West Wall:	1200 Ft.^{2} x .1 BTU/Hr./Ft.^{2}/°F x 45°F	=	5,400 BTU/Hr.
South Wall:	1500 Ft.^{2} x .1 BTU/Hr./Ft.^{2}/°F x 55°F	=	8,250 BTU/Hr.
North Wall:	1500 Ft.^{2} x .1 BTU/Hr./Ft.^{2}/°F x 30°F	=	4,500 BTU/Hr.
Roof:	4500 Ft.^{2} x .1 BTU/Hr./Ft.^{2}/°F x 87°F	=	39,150 BTU/Hr.
	9900 Sub Total		61,700 BTU/Hr.

Infiltration:

500 CFM x 1.08 BTU/Hr./CFM/°F x 30°F	=	16,200 BTU/Hr.

Lights and Power:

10,000 Watts x 3.4 BTU/Hr./Watt	=	34,000 BTU/Hr.

Personnel:

10 men x 200 BTU/Hr./Man = 2,000 BTU/Hr.

Total Sensible Heat = 113,900 BTU/Hr.

Latent Heat:

Infiltration:

500 CFM x 242 x .2 (.68) = 16,430 BTU/Hr.

Personnel:

10 men x 250 BTU/Hr./Man = 2,500 BTU/Hr.

Total Latent Heat = 18,930 BTU/Hr.

Sub Total = 132,830 BTU/Hr.

Safety Factor 10% = 13,280 BTU/Hr.

TOTAL HEAT LOAD = 146,110 BTU/Hr.

Concept 2, Heating:

Transmission Loss:

9,900 Ft.^{2} x 0.1 BTU/Hr./Ft.^{2}/°F x 80°F = 79,200 BTU/Hr.

Infiltration:

500 CFM x 1.08 BTU/Hr./CFM/°F x 80°F = 43,200 BTU/Hr.

Sub Total = 122,400 BTU/Hr.

Safety Factor 10% = 12,240 BTU/Hr.

TOTAL HEAT LOSS = 134,640 BTU/Hr.

Concept 4, Cooling:

Building Size: 60 Ft. Wide x 90 Ft. Long x 20 Ft. High

Sensible Heat:

Transmission:

East Wall:	1200 $Ft.^2$ x 0.1 BTU/Hr./$Ft.^2$/°F x 37°F	=	4,400 BTU/Hr.
West Wall:	1200 $Ft.^2$ x 0.1 BTU/Hr./$Ft.^2$/°F x 45°F	=	5,400 BTU/Hr.
South Wall:	1800 $Ft.^2$ x 0.1 BTU/Hr./$Ft.^2$/°F x 55°F	=	9,900 BTU/Hr.
North Wall:	1800 $Ft.^2$ x 0.1 BTU/Hr./$Ft.^2$/°F x 30°F	=	5,400 BTU/Hr.
Roof:	5400 $Ft.^2$ x 0.1 BTU/Hr./$Ft.^2$/°F x 87°F	=	46,980 BTU/Hr.
	11,400 Sub Total		72,080 BTU/Hr.

Infiltration:
500 CFM x 1.08 BTU/Hr./CFM/°F x 30°F = 16,200 BTU/Hr.

Lights and Power:
10,000 Watts x 3.4 BTU/Hr./Watt = 34,000 BTU/Hr.

Personnel:
10 men x 200 BTU/Hr./Man = 2,000 BTU/Hr.

Total Sensible Heat = 124,280 BTU/Hr.

Latent Heat:

Infiltration:
500 CFM x 242 Gr./Lb. x .2 x (.68) = 16,430 BTU/Hr.

Personnel:
10 men x 250 BTU/Hr./Man = 2,500 BTU/Hr.

Total Latent Heat = 18,900 BTU/Hr.
Sub Total 143,210 BTU/Hr.

Safety Factor 10%: = 14,320 BTU/Hr.

TOTAL HEAT GAIN = 157,530 BTU/Hr.

Concept 4, Heating:

Transmission:
11,400 $Ft.^2$ x 0.1 BTU/Hr./$Ft.^2$/°F x 80°F = 91,200 BTU/Hr.

Infiltration:
500 CFM x 1.08 BTU/Hr./CFM/°F x 80°F = 43,200 BTU/Hr.
Sub Total 134,400 BTU/Hr.

Safety Factor 10% = 13,440 BTU/Hr.

TOTAL HEAT LOSS = 147,840 BTU/Hr.

APPENDIX G

RELIABILITY COMPARISON

APPENDIX G

RELIABILITY COMPARISON

1.0 Objective

The objective of this study is to compare the reliability of the processing flow that was developed for vehicles stored for long periods in the assembled condition to the current operating method. Secondary objectives are to show the effect of repetitive checkouts, both in place and at S^3T area, on prelaunch reliability and to show the effect of air transport on a vehicle being processed under the proposed storage system.

2.0 Discussion

Selection of a basic storage processing technique was made by adding a storage period between vehicle build up and systems tests in the existing vehicle flow defined by Vol. 1 of the Scout Standard Procedures, (ref. 6). This represents minimum processing required for a stored vehicle and serves as a starting point for any additional processing operations. The extreme, or maximum vehicle storage processing selected is a monthly system test of a stored vehicle at the S^3T area. To evaluate and compare the two storage operations with one another and the existing mode, the most severe storage conditions were selected as follows:

a) In-plant storage for five months
b) Assembled ready-hold storage for twelve months
c) Guidance program change during storage.

The methodology used for computing the relative reliability of stored vehicles versus the existing flow was taken from the Feasibility Study of a Scout Central Ordnance Complex, (ref. 2).

Operational sequence charts were made for the maximum and minimum storage processing using the above storage conditions. These charts list in sequence all operations and activities that are necessary to accomplish vehicle processing. Each operation is identified by its functional block number and title and contains a short description of the function. The existing flow, taken from the Central Ordnance Complex Study is updated to reflect the improved reliability experienced by the Scout program. In addition, functional block numbers and titles have been added for ease of comparison.

The existing processing flow is depicted by Case Number 1. The minimum storage processing is depicted by Case Number 2. Maximum storage processing is depicted by Case Number 5.

Two other processing sequence variations are compared. The first variation adds an additional program change and an air transport operation to the minimum storage flow as depicted by Case Number 3. The second variation compares the effect of using portable checkout equipment, thus allowing all checkouts to be made in storage rather than transferring to S^3T area. Processing with portable equipment is depicted by Case Number 4, figure 4.

An analysis of the likelihood of inducing vehicle failure by each of these five process flows was conducted and a summary of the various cases and their resulting prelaunch reliability factor is listed below.

Rocket motor processing does not change because of assembled vehicle storage. The reliability input data for the rocket motors was taken from the COC Study and is included in the analysis of each of the cases.

CASE	STORAGE DURATION	VEHICLE OPERATIONS	PRELAUNCH RELIABILITY
Case 1	No Storage	Current Method of Processing	0.964
Case 2	5 Months as Transition in Dallas	One Guidance Program Change	0.956
	12 Months Assembled in Ready-Hold Condition	Two Vehicle All Systems Checkouts	
Case 3	5 Months as Transition in Dallas	Two Guidance Program Changes	0.951
	12 Months Assembled in Ready-Hold Condition	Three Vehicle All Systems Checkouts	
		Air Transport to Launch Site	
Case 4	5 Months as Transition in Dallas	One Guidance Program Change	0.944
	12 Months Assembled in Ready-Hold Condition	Twelve Vehicle All Systems Checkouts Portable Equipment	
Case 5	5 Months as Transition in Dallas	One Guidance Program Change	0.932
	12 Months Assembled in Ready-Hold Condition	Twelve Vehicle All Systems Checkouts - Fixed Equipment	

The Sequence of Operations and Reliability Input Data Charts, for each case, identify each operation as either a non-checkout cycle (NCC) or checkout cycle (CC) and include the probability estimates for not inducing failure (P_F), detecting failures (P_D), and repairing failure (P_R) as well as probability that repair of past checkout discrepancies did not induce an additional failure (P_{FF}) and that this failure is detectable in a later operation (P_{DD}).

It is emphasized that results and conclusions derived from this analysis technique are only as accurate as input data estimates which are based on Engineering judgement and experience. More significant than the absolute value of these estimates is their relationship to one another. That is, the relationship represented by the estimates in comparing each storage flow to the current flow; or, in comparing one operation to another within the same flow is of much greater importance than the absolute value of each individual estimate.

The end result of this analytical comparison of current and storage processing flow is expressed in terms of the probability of the particular processing flow not inducing a failure in the Scout vehicle which could result in mission failure. The analysis assumes that procedures and methods used in checkout and handling in either processing flow are adequate and will reveal all defects in components or systems due to manufacturing or material errors. This technique does not evaluate whether or not the quantity and types of testing are optimum. Also, this technique does not compare field environment to factory environment, nor can it compare test equipment maintenance or personnel capability.

Again, it is emphasized that this analysis only evaluates and compares the probability of the checkout and handling induced failures which would result in mission failure for each processing flow.

The COC (ref. 2) discusses in detail the mechanics of the analysis technique and computer routine employed. Reference to that document should be made if an understanding of the equations and their logic are of interest. For the sake of brevity, they are not included herein.

3.0 Conclusion

The reliability analysis indicated the basic storage processing to have the highest prelaunch reliability of the four storage cases investigated. As defined earlier, this basic processing is the existing Scout processing flow with storage added. As storage time is reduced, the prelaunch reliability of a stored vehicle approaches that of the existing Scout flow, 0.964. Increasing the assembled vehicle storage time to its maximum, 14 months, and changing the vehicle program while in storage reduces the prelaunch reliability to 0.956. These two cases represent maximum and minimum storage conditions so that any stored vehicle would have a prelaunch reliability from 0.956 to 0.964.

SEQUENCE OF OPERATIONS AND RELIABILTY INPUT DATA

CASE NUMBER 1; EXISTING SCOUT OPERATIONS

PROCESS STAGE NUMBER AND NAME	SEQUENCE OF OPERATIONS ACTIVITY	RECOMP SUB-ROUTINE		RELIABILITY INPUT DATA				
		NCC	CC	P_F	P_D	P_R	P_{FF}	P_{DD}
1.2 Manufacturing Operations	At 6 month intervals operate beacon.		x	.98	.99	.99	.99	.9
1.2 Manufacturing Operations	Conduct section level checkout and bench system tests.		x	.98	.99	.99	.99	.9
1.2 Manufacturing Operations	Install missing components in transition section and inspect.	x		.98	.99	-	-	-
1.3 Checkout	Assemble transition section on dummy motors, connect electrically.	x		.97	.99			
1.3 Checkout	Conduct assembled vehicle checkout and simulated flight.		x	.95	.99	.98	.99	.9
1.3 Checkout	Disconnect transition sections electrically and remove from dummy motors.	x		.96	.99	-	-	-
1.4.5 Remove Guid. Comp.	Remove guidance system components.	x		.98	.99	-	-	-
1.5 Ship Vehicle	Pack for shipping, less guidance components.	x		.98	.99	-	-	-
1.5 Ship Vehicle	Load on truck for shipment to launch facility.	x		.98	.99	-	-	-
1.5 Ship Vehicle	Transport to launch facility by surface transportation.	x		.97	.99	-	-	-
2.1 Accum. Vehicle	Unload truck at field storage facility.	x		.98	.99	-	-	-
2.1 Accum. Vehicle	Store at storage facility for 0.2 months.	x		.999	.99	-	-	-
2.2 Receiving Inspection	Unpack transition section and rocket motors.	x		.98	.99	-	-	-
2.3 Vehicle Assembly	Conduct receiving inspection and assemble transition sect. on live motors.	x		.97	.99	-	-	-
3.3 Transfer to Checkout	Transfer vehicle to checkout area.	x		.97	.99	-	-	-
1.4.3 Guid Bench Check	At Dallas, remove guidance components from storage, set for a specific mission and bench test.		x	.98	.99	.98	.99	.9
1.4.4 Ship Components	Transport guidance components to field via air.	x		.98	.99	-	-	-

SEQUENCE OF OPERATIONS AND RELIABILTY INPUT DATA

CASE NUMBER 1; EXISTING SCOUT OPERATIONS

PROCESS STAGE NUMBER AND NAME	SEQUENCE OF OPERATIONS/ACTIVITY	RECOMP SUB-ROUTINE		RELIABILITY INPUT DATA				
		NCC	CC	P_F	P_D	P_R	P_{FF}	P_{DD}
4.2 Systems Test	Install guidance components and checkout vehicle.		x	.96	.99	.98	.99	.9
4.3 Establish Ready Hold	Transfer vehicle from checkout area to "Ready-Hold" area.	x		.97	.99	-	-	-
5.1 Maintain Ready Hold	Maintain vehicle in "Ready-Hold" for 0.2 months.	x		.998	.99	-	-	-
5.4 Transfer to Pad	Transfer vehicle to launch pad.	x		.99	.99	-	-	-
7.0 Launch Pad Operations	Conduct assembled vehicle pre-launch operations. Conduct final checkout on launcher.		x	.95	.99	.98	.99	.9

SEQUENCE OF OPERATIONS AND RELIABILTY INPUT DATA

CASE NUMBER 2; MAXIMUM STORAGE WITH PROGRAM CHANGE

PROCESS STAGE NUMBER AND NAME	SEQUENCE OF OPERATIONS/ACTIVITY	RECOMP SUB-ROUTINE		RELIABILITY INPUT DATA				
		NCC	CC	P_F	P_D	P_R	P_{FF}	P_{DD}
1.0 In-Plant Operations	Inspect transition sections.	x		.99	.99	-	-	-
1.1 Bonded Storage	Place transition sections in Dallas Bonded Stores for 5 months.	x		.999	.99	-	-	-
1.1 Bonded Storage	Store selected components in Dallas for 5 months.	x		.965	.99	-	-	-
1.2 Manufacturing Operations	At 6 month intervals operate beacon.		x	.98	.99	.99	.99	.9
1.2 Manufacturing Operations	Conduct section level checkout and bench system tests.		x	.98	.99	.99	.99	.9
1.2 Manufacturing Operations	Install missing components in transition section and inspect.	x		.98	.99	-	-	-
1.3 Checkout	Assemble transition section on dummy motors, connect electrically.	x		.97	.99			
1.3 Checkout	Conduct assembled vehicle checkout and simulated flight.		x	.95	.99	.98	.99	.9
1.3 Checkout	Disconnect transition sections electrically and remove from dummy motors.	x		.96	.99	-	-	-
1.4.5 Remove Guid. Comp.	Remove guidance system components.	x		.98	.99	-	-	-
1.5 Ship Vehicle	Pack for shipping, less guidance components.	x		.98	.99	-	-	-
1.4.1 Store Guid. Comp.	Store guidance components for 2 months.	x		.992	.99	-	-	-
1.5 Ship Vehicle	Load on truck for shipment to launch facility.	x		.98	.99	-	-	-
1.5 Ship Vehicle	Transport to launch facility by surface transportation	x		.97	.99	-	-	-
2.1 Accum. Vehicle	Unload truck at field storage facility.	x		.98	.99	-	-	-
2.1 Accum. Vehicle	Store at storage facility for 0.5 months.	x		.998	.99	-	-	-
2.2 Receiving Inspection	Unpack transition section and rocket motors.	x		.98	.99	-	-	-

SEQUENCE OF OPERATIONS AND RELIABILTY INPUT DATA

CASE NUMBER 2; MAXIMUM STORAGE WITH PROGRAM CHANGE (cont'd)

PROCESS STAGE NUMBER AND NAME	SEQUENCE OF OPERATIONS ACTIVITY	RECOMP SUB-ROUTINE		RELIABILITY INPUT DATA				
		NCC	CC	P_F	P_D	P_R	P_{FF}	P_{DD}
2.3 Vehicle Assembly	Conduct receiving inspection and assemble transition sect. on live motors.	x		.97	.99	-	-	-
3.0 Store Vehicle	Store assembled vehicle for 1.5 months, less guidance components.	x		.991	.99	-	-	-
3.3 Transfer to Checkout	Transfer vehicle to checkout area.	x		.97	.99	-	-	-
1.4.3 Guid. Bench Check	At Dallas, remove guidance components from storage, set for a specific mission and bench test.		x	.98	.99	.98	.99	.9
1.4.4 Ship Components	Transport guidance components to field via air.	x		.98	.99	-	-	-
4.2 Systems Test	Install guidance components and checkout vehicle.		x	.96	.99	.98	.99	.9
4.3 Establish Ready Hold	Transfer vehicle from checkout area to "Ready-Hold" area.	x		.97	.99	-	-	-
5.1 Maintain Ready Hold	Maintain vehicle in "Ready-Hold" for 6 months.	x		.944	.99	-	-	-
5.2 Prepare for Transfer	Transfer vehicle to checkout area from "Ready-Hold" area.	x		.97	.99	-	-	-
1.4.3 Bench Check Guid.	Remove guidance components from the vehicle and return to Dallas. Set up for a new mission and bench test.	x		.98	.99	.99	.99	.9
1.4.4 Ship Components	Transport guidance components from storage site to Dallas and return.		x	.98	.99			
4.2 System Test	Install guidance components and checkout vehicle.		x	.96	.99	.98	.99	.9
4.3 Establish Ready Hold	Transfer vehicle from checkout area to "Ready-Hold" area.	x		.97	.99	-	-	-
5.1 Maintain Ready Hold	Maintain vehicle in "Ready-Hold" for 6 months.	x		.944	.99	-	-	-
5.4 Transfer to Pad	Transfer vehicle from storage area to launch pad.	x		.99	.99	-	-	-
7.0 Launch Pad Operations	Conduct assembled vehicle pre-launch operations. Conduct final checkout on launcher.		x	.95	.99	.98	.99	.9

SEQUENCE OF OPERATIONS AND RELIABILTY INPUT DATA

CASE NUMBER 3; MAXIMUM VEHICLE STORAGE WITH PROGRAM CHANGE AND AIR TRANSPORT

PROCESS STAGE NUMBER AND NAME	SEQUENCE OF OPERATIONS ACTIVITY	RECOMP SUB-ROUTINE		RELIABILITY INPUT DATA				
		NCC	CC	P_F	P_D	P_R	P_{FF}	P_{DD}
1.0 In-Plant Operations	Inspect transition sections.	x		.99	.99	-	-	-
1.1 Bonded Storage	Place transition sections in Dallas Bonded Stores for 5 months.	x		.999	.99	-	-	-
1.1 Bonded Storage	Store selected components in Dallas for 5 months.	x		.965	.99	-	-	-
1.2 Manufacturing Operations	At 6 month intervals operate beacon.		x	.98	.99	.99	.99	.9
1.2 Manufacturing Operations	Conduct section level checkout and bench system tests.		x	.98	.99	.99	.99	.9
1.2 Manufacturing Operations	Install missing components in transition section and inspect.	x		.98	.99	-	-	-
1.3 Checkout	Assemble transition section on dummy motors, connect electrically.	x		.97	.99			
1.3 Checkout	Conduct assembled vehicle checkout and simulated flight.		x	.95	.99	.98	.99	.9
1.3 Checkout	Disconnect transition sections electrically and remove from dummy motors.	x		.96	.99	-	-	-
1.4.5 Remove Guid. Comp.	Remove guidance system components.	x		.98	.99	-	-	-
1.5 Ship Vehicle	Pack for shipping, less guidance components.	x		.98	.99	-	-	-
1.4.1 Store Guid. Comp.	Store Guidance components for 2 months.	x		.992	.99	-	-	-
1.5 Ship Vehicle	Load on truck for shipment to launch facility.	x		.98	.99	-	-	-
1.5 Ship Vehicle	Transport to launch facility by surface transportation.	x		.97	.99	-	-	-
2.1 Accum. Vehicle	Unload truck at field storage facility.	x		.98	.99	-	-	-
2.1 Accum. Vehicle	Store at storage facility for 0.5 months.	x		.999	.99	-	-	-
2.2 Receiving Inspection	Unpack transition section and rocket motors.	x		.98	.99	-	-	-

SEQUENCE OF OPERATIONS AND RELIABILTY INPUT DATA

CASE NUMBER 3; MAXIMUM VEHICLE STORAGE WITH PROGRAM CHANGE AND AIR TRANSPORT (cont'd)

PROCESS STAGE NUMBER AND NAME	SEQUENCE OF OPERATIONS/ACTIVITY	RECOMP SUB-ROUTINE		RELIABILITY INPUT DATA				
		NCC	CC	P_F	P_D	P_R	P_{FF}	P_{DD}
2.3 Vehicle Assembly	Conduct receiving inspection and assemble transition sect. on live motors.	x		.97	.99	-	-	-
3.0 Store Vehicle	Store assembled vehicle for 1.5 months, less guidance components.	x		.991	.99	-	-	-
3.3 Transfer to Checkout	Transfer vehicle to checkout area.	x		.97	.99	-	-	-
1.4.3 Guid. Bench Check	At Dallas, remove guidance components from storage, set for a specific mission and bench test.		x	.98	.99	.99	.99	.9
1.4.4 Ship Components	Transport guidance components to field via air.	x		.98	.99	-	-	-
4.2 System Test	Install guidance components and checkout vehicle.		x	.96	.99	.98	.99	.9
4.3 Establish Ready Hold	Transfer vehicle from checkout area to "Ready-Hold" area.	x		.97	.99	-	-	-
5.1 Maintain Ready Hold	Maintain vehicle in "Ready-Hold" for 6 months.	x		.944	.99	-	-	-
5.2 Prepare for Transfer	Transfer vehicle to checkout area from "Ready-Hold" area.	x		.97	.99	-	-	-
1.4.3 Bench Check Guid.	Remove guidance components from the vehicle and return to Dallas. Set up for a new mission and bench test.		x	.98	.99	.99	.99	.9
1.4.4 Ship Components	Transport guidance components from storage site to Dallas and return.	x		.98	.99	-	-	-
4.2 System Test	Install guidance components and checkout vehicle.		x	.96	.99	.98	.99	.9
4.3 Establish Ready Hold	Transfer vehicle from checkout area to "Ready-Hold" area.	x		.97	.99	-	-	-
5.1 Maintain Ready Hold	Maintain vehicle in "Ready-Hold" for 6 months.	x		.944	.99	-	-	-
5.2 Prepare for Transfer	Transfer vehicle to checkout area from "Ready-Hold" area.	x		.97	.99	-	-	-
1.4.3 Bench Check Guid.	Remove guidance components from the vehicle and return to Dallas. Set up for a new mission and bench test.		x	.98	.99	.99	.99	.9
1.4.4 Ship Components	Transport guidance components from storage site to Dallas and return v/air	x		.98	.99	-	-	-

SEQUENCE OF OPERATIONS AND RELIABILTY INPUT DATA

CASE NUMBER 3; MAXIMUM VEHICLE STORAGE WITH PROGRAM CHANGE AND AIR TRANSPORT (cont'd)

PROCESS STAGE NUMBER AND NAME	SEQUENCE OF OPERATIONS/ACTIVITY	RECOMP SUB-ROUTINE		RELIABILITY INPUT DATA				
		NCC	CC	P_F	P_D	P_R	P_{FF}	P_{DD}
4.2 System Test	Install guidance components and checkout vehicle.		x	.96	.99	.98	.99	.9
6.1 Transfer to Air Carrier	Move assembled vehicle and transporter to airport and load onto aircraft.	x		.97	.99	-	-	-
6.2 Carrier Operation	Fly assembled vehicle to another launch facility.	x		.95	.99	-	-	-
6.4 Transfer to Pad	Unload assembled vehicle transporter from aircraft and transfer to launcher. Load vehicle on launcher.	x		.98	.99	-	-	-
7.0 Launch Pad Operations	Conduct assembled vehicle pre-launch operations. Conduct final checkout on launcher.		x	.95	.99	.98	.99	.9

SEQUENCE OF OPERATIONS AND RELIABILTY INPUT DATA

CASE NUMBER 4; MAXIMUM STORAGE WITH INPLACE CHECKOUT EACH MONTH

PROCESS STAGE NUMBER AND NAME	SEQUENCE OF OPERATIONS/ACTIVITY	RECOMP SUB-ROUTINE		RELIABILITY INPUT DATA				
		NCC	CC	P_F	P_D	P_R	P_{FF}	P_{DD}
1.0 In-Plant Operations	Inspect transition sections.	x		.99	.99	-	-	-
1.1 Bonded Stores	Place transition sections in Dallas Bonded Stores for 5 months.	x		.999	.99	-	-	-
1.1 Bonded Stores	Store selected components in Dallas for 5 months.	x		.965	.99	-	-	-
1.2 Manufacturing Operations	At 6 month intervals operate beacon.		x	.98	.99	.99	.99	.9
1.2 Manufacturing Operations	Conduct section level checkout and bench system tests.		x	.98	.99	.99	.99	.9
1.2 Manufacturing Operations	Install missing components in transition section and inspect.	x		.98	.99	-	-	-
1.3 Checkout	Assemble transition section on dummy motors, connect electrically.	x		.97	.99			
1.3 Checkout	Conduct assembled vehicle checkout and simulated flight.		x	.95	.99	.98	.99	.9
1.3 Checkout	Disconnect transition sections electrically and remove from dummy motors.	x		.96	.99	-	-	-
1.4.5 Remove Guid. Comp.	Remove guidance system components.	x		.98	.99	-	-	-
1.5 Ship Vehicle	Pack for shipping, less guidance components.	x		.98	.99	-	-	-
1.4.1 Store Guid. Comp.	Store guidance components for 2 months.	x		.992	.99	-	-	-
1.5 Ship Vehicle	Load on truck for shipment to launch facility.	x		.98	.99	-	-	-
1.5 Ship Vehicle	Transport to launch facility by surface transportation.	x		.97	.99	-	-	-
2.1 Accum. Vehicle	Unload truck at field storage facility.	x		.98	.99	-	-	-
2.1 Accum. Vehicle	Store at storage facility for 0.5 months.	x		.999	.99	-	-	-
2.2 Receiving Inspection	Unpack transition section and rocket motors.	x		.98	.99	-	-	-

SEQUENCE OF OPERATIONS AND RELIABILTY INPUT DATA

CASE NUMBER 4; MAXIMUM STORAGE WITH INPLACE CHECKOUT EACH MONTH (cont'd)

PROCESS STAGE NUMBER AND NAME	SEQUENCE OF OPERATIONS/ACTIVITY	RECOMP SUB-ROUTINE		RELIABILITY INPUT DATA				
		NCC	CC	P_F	P_D	P_R	P_{FF}	P_{DD}
2.3 Vehicle Assembly	Conduct receiving inspection and assemble transition sect. on live motors	x		.97	.99	-	-	-
3.0 Store Vehicle	Store assembled vehicle for 1.5 months, less guidance components.	x		.991	.99	-	-	-
1.4.3 Guid. Bench Check	At Dallas, remove guidance components from storage, set for a specific mission and bench test.		x	.98	.99	.98	.99	.9
1.4.4 Ship Components	Transport guidance components to field via air.	x		.98	.99	-	-	-
4.2 Systems Test	Install guidance components and checkout vehicle.		x	.96	.99	.98	.99	.9
5.1 Maintain Ready Hold	Maintain vehicle in "Ready-Hold" for 6 months.	x		.944	.99	-	-	-
4.2 Systems Test	Checkout vehicle in place.		x	.96	.99	.98	.99	.9
4.2 Systems Test	Checkout vehicle in place.		x	.96	.99	.98	.99	.9
4.2 Systems Test	Checkout vehicle in place.		x	.96	.99	.98	.99	.9
4.2 Systems Test	Checkout vehicle in place.		x	.96	.99	.98	.99	.9
4.2 Systems Test	Checkout vehicle in place.		x	.96	.99	.98	.99	.9
1.4.3 Bench Check Guid.	Remove guidance components from the vehicle and return to Dallas. Set up for a new mission and bench test.		x	.98	.99	.99	.99	.9
1.4.4 Ship Components	Transport guidance components from storage site to Dallas and return.	x		.98	.99	-	-	-
4.2 Systems Test	Install guidance components and checkout vehicle.		x	.96	.99	.98	.99	.9
5.1 Maintain Ready Hold	Maintain vehicle in "Ready-Hold" for 6 months.	x		.944	.99	-	-	-
4.2 Systems Test	Checkout vehicle in place.		x	.96	.99	.98	.99	.9
4.2 Systems Test	Checkout vehicle in place.		x	.96	.99	.98	.99	.9

SEQUENCE OF OPERATIONS AND RELIABILTY INPUT DATA

CASE NUMBER 4; MAXIMUM STORAGE WITH INPLACE CHECKOUT EACH MONTH (cont'd)

PROCESS STAGE NUMBER AND NAME	SEQUENCE OF OPERATIONS/ACTIVITY	RECOMP SUB-ROUTINE		RELIABILITY INPUT DATA				
		NCC	CC	P_F	P_D	P_R	P_{FF}	P_{DD}
4.2 Systems Test	Checkout vehicle in place.		x	.96	.99	.98	.99	.9
4.2 Systems Test	Checkout vehicle in place.		x	.96	.99	.98	.99	.9
4.2 Systems Test	Checkout vehicle in place.		x	.96	.99	.98	.99	.9
5.4 Transfer to Pad	Transfer vehicle from storage area to launch pad.	x		.99	.99	-	-	-
7.0 Launch Pad Operations	Conduct assembled vehicle pre-launch operations. Conduct final checkout on launcher.		x	.95	.99	.98	.99	.9

SEQUENCE OF OPERATIONS AND RELIABILTY INPUT DATA

CASE NUMBER 5; MAXIMUM STORAGE WITH CHECKOUT EACH MONTH AT THE S^3T AREA

PROCESS STAGE NUMBER AND NAME	SEQUENCE OF OPERATIONS/ACTIVITY	RECOMP SUB-ROUTINE		RELIABILITY INPUT DATA				
		NCC	CC	P_F	P_D	P_R	P_{FF}	P_{DD}
1.0 In-Plant Operations	Inspect transition sections.	x		.99	.99	-	-	-
1.1 Bonded Stores	Place transition sections in Dallas Bonded Stores for 5 months.	x		.999	.99	-	-	-
1.1 Bonded Stores	Store selected components in Dallas for 5 months.	x		.965	.99	-	-	-
1.2 Manufacturing Operations	At 6 month intervals operate beacon.		x	.98	.99	.99	.99	.9
1.2 Manufacturing Operations	Conduct section level checkout and bench system tests.		x	.98	.99	.99	.99	.9
1.2 Manufacturing Operations	Install missing components in transition section and inspect.	x		.98	.99	-	-	-
1.3 Checkout	Assemble transition section on dummy motors, connect electrically.	x		.97	.99			
1.3 Checkout	Conduct assembled vehicle checkout and simulated flight.		x	.95	.99	.98	.99	.9
1.3 Checkout	Disconnect transition sections electrically and remove from dummy motors.	x		.96	.99	-	-	-
1.4.5 Remove Guid. Comp.	Remove guidance system components.	x		.98	.99	-	-	-
1.5 Ship Vehicle	Pack for shipping, less guidance components.	x		.98	.99	-	-	-
1.4.1 Store Guid. Comp.	Store guidance components for 2 months.	x		.992	.99	-	-	-
1.5 Ship Vehicle	Load on truck for shipment to launch facility.	x		.98	.99	-	-	-
1.5 Ship Vehicle	Transport to launch facility by surface transportation.	x		.97	.99	-	-	-
2.1 Accum. Vehicle	Unload truck at field storage facility.	x		.98	.99	-	-	-
2.1 Accum. Vehicle	Store at storage facility for 0.5 months.	x		.999	.99	-	-	-
2.2 Receiving Inspection	Unpack transition section and rocket motors.	x		.98	.99	-	-	-

SEQUENCE OF OPERATIONS AND RELIABILTY INPUT DATA

CASE NUMBER 5; MAXIMUM STORAGE WITH CHECKOUT EACH MONTH AT THE S^3T AREA (cont'd)

PROCESS STAGE NUMBER AND NAME	SEQUENCE OF OPERATIONS/ACTIVITY	RECOMP SUB-ROUTINE		RELIABILITY INPUT DATA				
		NCC	CC	P_F	P_D	P_R	P_{FF}	P_{DD}
2.3 Vehicle Assembly	Conduct receiving inspection and assemble transition sect. on live motor.	x		.97	.99	-	-	-
3.0 Store Vehicle	Store assembled vehicle for 1.5 months, less guidance components.	x		.991	.99	-	-	-
3.3 Transfer to Checkout	Transfer vehicle to checkout area.	x		.97	.99	-	-	-
1.4.3 Guid. Bench Check	At Dallas, remove guidance components from storage, set for a specific mission and bench test.		x	.98	.99	.98	.99	.9
1.4.4 Ship Components	Transport guidance components to field via air.	x		.98	.99	-	-	-
4.2 Systems Test	Install guidance components and checkout vehicle.		x	.96	.99	.98	.99	.9
4.3 Establish Ready Hold	Transfer vehicle from checkout area to "Ready-Hold" area.	x		.97	.99	-	-	-
5.1 Maintain Ready Hold	Maintain vehicle in "Ready-Hold" for 6 months.	x		.944	.99	-	-	-
5.2 Prepare for Transfer	Transfer vehicle to checkout area from "Ready-Hold" area.	x		.97	.99	-	-	-
4.2 Systems Test	Checkout vehicle.		x	.96	.99	.98	.99	.9
4.3 Establish Ready Hold	Transfer vehicle from checkout area to "Ready-Hold" area.	x		.97	.99	-	-	-
5.2 Prepare for Transfer	Transfer vehicle to checkout area from "Ready-Hold" area.	x		.97	.99	-	-	-
4.2 Systems Test	Checkout vehicle.		x	.96	.99	.98	.99	.9
4.3 Establish Ready Hold	Transfer vehicle from checkout area to "Ready-Hold" area.	x		.97	.99	-	-	-
5.2 Prepare for Transfer	Transfer vehicle to checkout area from "Ready-Hold" area.	x		.97	.99	-	-	-
4.2 Systems Test	Checkout vehicle.		x	.96	.99	.98	.99	.9
4.3 Establish Ready Hold	Transfer vehicle from checkout area to "Ready-Hold" area.	x		.97	.99	-	-	-

SEQUENCE OF OPERATIONS AND RELIABILTY INPUT DATA

CASE NUMBER 5; MAXIMUM STORAGE WITH CHECKOUT EACH MONTH AT THE S^3T AREA (cont'd)

PROCESS STAGE NUMBER AND NAME	SEQUENCE OF OPERATIONS ACTIVITY	RECOMP SUB-ROUTINE		RELIABILITY INPUT DATA				
		NCC	CC	P_F	P_D	P_R	P_{FF}	P_{DD}
5.2 Prepare for Transfer	Transfer vehicle to checkout area from "Ready-Hold" area.	x		.97	.99	-	-	-
4.2 Systems Test	Checkout vehicle.		x	.96	.99	.98	.99	.9
4.3 Establish Ready Hold	Transfer vehicle from checkout area to "Ready-Hold" area.	x		.97	.99	-	-	-
5.2 Prepare for Transfer	Transfer vehicle to checkout area from "Ready-Hold" area.	x		.97	.99	-	-	-
4.2 Systems Test	Checkout vehicle.		x	.96	.99	.98	.99	.9
4.3 Establish Ready Hold	Transfer vehicle from checkout area to "Ready-Hold" area.	x		.97	.99	-	-	-
5.2 Prepare for Transfer	Transfer vehicle to checkout area from "Ready-Hold" area.	x		.97	.99	-	-	-
1.4.3 Bench Check Guid.	Remove guidance components from the vehicle and return to Dallas. Set up for a new mission and bench test.		x	.98	.99	.99	.99	.9
1.4.4 Ship Components	Transport guidance components from storage site to Dallas and return.	x		.93	.99	-	-	-
4.2 System Test	Install guidance components and checkout vehicle.		x	.96	.99	.98	.99	.9
4.3 Establish Ready Hold	Transfer vehicle from checkout area to "Ready-Hold" area.	x		.97	.99	-	-	-
5.1 Maintain Ready Hold	Maintain vehicle in "Ready-Hold" for 6 months.	x		.944	.99	-	-	-
5.2 Prepare for Transfer	Transfer vehicle to checkout area from "Ready-Hold" area.	x		.97	.99	-	-	-
4.2 Systems Test	Checkout vehicle.		x	.96	.99	.98	.99	.9
4.3 Establish Ready Hold	Transfer vehicle from checkout area to "Ready-Hold" area.	x		.97	.99	-	-	-
5.2 Prepare for Transfer	Transfer vehicle to checkout area from "Ready-Hold" area.	x		.97	.99	-	-	-
4.2 Systems Test	Checkout vehicle.		x	.96	.99	.98	.99	.9

SEQUENCE OF OPERATIONS AND RELIABILTY INPUT DATA

CASE NUMBER 5; MAXIMUM STORAGE WITH CHECKOUT EACH MONTH AT THE S^3T AREA (cont'd)

PROCESS STAGE NUMBER AND NAME	SEQUENCE OF OPERATIONS ACTIVITY	RECOMP SUB-ROUTINE		RELIABILITY INPUT DATA				
		NCC	CC	P_F	P_D	P_R	P_{FF}	P_{DD}
4.3 Establish Ready Hold	Transfer vehicle from checkout area to "Ready-Hold" area.	x		.97	.99	-	-	-
5.2 Prepare for Transfer	Transfer vehicle to checkout area from "Ready-Hold" area.	x		.97	.99	-	-	-
4.2 Systems Test	Checkout vehicle.		x	.96	.99	.98	.99	.9
4.3 Establish Ready Hold	Transfer vehicle from checkout area to "Ready-Hold" area.	x		.97	.99	-	-	-
5.2 Prepare for Transfer	Transfer vehicle to checkout area from "Ready-Hold" area.	x		.97	.99	-	-	-
4.2 Systems Test	Checkout vehicle.		x	.96	.99	.98	.99	.9
4.3 Establish Ready Hold	Transfer vehicle from checkout area to "Ready-Hold" area.	x		.97	.99	-	-	-
5.2 Prepare for Transfer	Transfer vehicle to checkout area from "Ready-Hold" area.	x		.97	.99	-	-	-
4.2 Systems Test	Checkout vehicle.		x	.96	.99	.98	.99	.9
4.3 Establish Ready Hold	Transfer vehicle from checkout area to "Ready-Hold" area.	x		.97	.99	-	-	-
5.4 Transfer to Pad	Transfer vehicle from storage area to launch pad.	x		.99	.99	-	-	-
7.0 Launch Pad Operations	Conduct assembled vehicle pre-launch operations. Conduct final checkout on launcher.		x	.95	.99	.98	.99	.9

6.0 REFERENCES

1. National Aeronautics and Space Administration Contract NAS1-6748, dated 24 October 1966.

2. Feasibility Study of a Scout Central Ordnance Complex, LTV Report No. 3-15000/6R-12, dated 11 February 1966.

3. Explosive Safety Manual, AFM 127-100, dated 20 April 1964.

4. Air Material Command Safety Manual, AMCR 385-224 dated June 1964.

5. Handling, Storing and Shipping Ammunition Ashore, OPS-5, dated August 1957.

6. Scout Standard Procedures Manual
   Volume I Administration and Vehicle Manual, LTV Report No. 23-161
   Volume II Ground Support Equipment Manual, LTV Report No. 23-162
   Volume III Rocket Motors and Pyrotechnics Manual, LTV Report No. 23-163
   Volume IV Receiving, Bench, and Transition Tests, LTV Report No. 23-164
   Volume V Vehicle Assembly and Tests, LTV Report No. 23-165
   Volume VI Launch Operations, LTV Report No. 23-166

7. Monthly Replenishment Requirements Report, LTV Report No. 3-30000/6T-42 as of 30 November 1966.

8. Specification for Preparation of Components, Individual Systems and Transition Sections for Short Term Storage (90 days maximum), LTV Specification 309-76, dated 31 March 1964.

9. Specification for One-Year Storage, LTV Specification 309-78E, dated 9 January 1967.

10. Program Plan for S-138R After Completion of Dallas Checkout Enclosure (1) to LTV Letter 3-15000/5L-235, dated 15 April 1965.

11. S-138 Field Process - Contract NAS1-3615, NASA MSG S-9387 dated 20 May 1965.

12. Short Term Storage of Assembled Scout Vehicles, Contract NAS1-4664-EHA, LTV TWX 3-15000/6T-959.

13. Configuration Control Operating System for Scout, LTV Report No. 3-15000/5R-240, dated 1 November 1966.

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