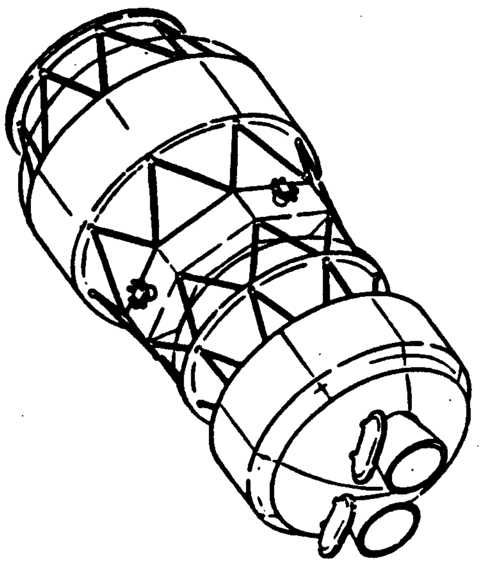
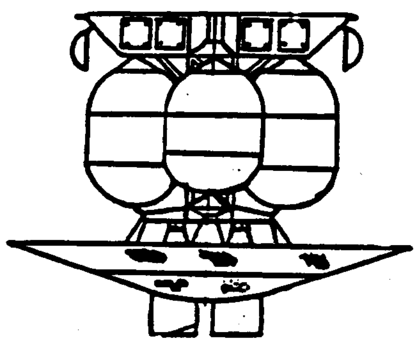
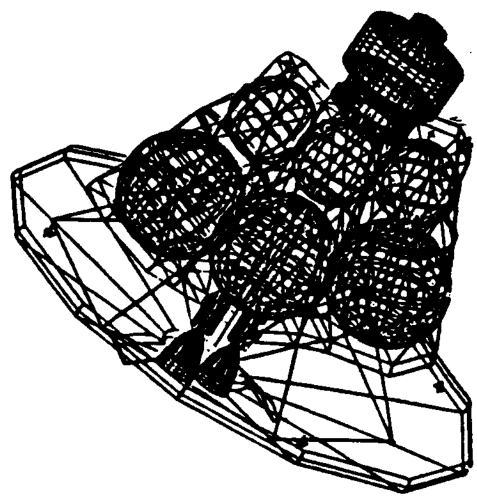
Boeing Aerospace Operations

ORBITAL TRANSFER VEHICLE
Launch Operations Study







(NASA-CR-179791) ORBITAL TRANSFER VEHICLE LAUNCH OPERATIONS STUDY. VOLUME 2: DETAILED SUMMARY (Boeing Aerospace Co.) 181 p N87-10111
CSCL 22D Unclas
G3/14 44216

DETAILED SUMMARY
VOLUME 2 OF 5

MARCH 7, 1986

FINAL REPORT

KENNEDY SPACE CENTER
NAS10-11165

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ABBREVIATIONS AND ACRONYMS

ACC	Aft Cargo Carrier
ASE	Airborne Support Equipment
ATKB	Automated Technology Knowledge Base
BAC	Boeing Aerospace Company
CCAFS	Cape Canaveral Air Force Station
CITE	Cargo Integration Test Equipment
CRYO	Cryogenic
DACC	Dedicated Aft Cargo Carrier
DIA	Diameter
ECS	Environmental Control Station
EPDC	Electrical Panel Distribution Control
EVA	Extra Vehicular Activity
FAC	Facility
GB	Ground Based
GBOTV	Ground Based Orbital Transfer Vehicle
GBPB	Ground Based Payload Bay
GDC	General Dynamics Convair
GEO	Geosynchronous Earth Orbit
GPS	Ground Power Supply
GPU	Ground Power Unit
GSE	Ground Support Equipment
H/B	High Bay
I/F	Interface
INSPEC	Information System in Physics, Electrical & Computer Control
IVA	Intravehicular Activity
KSC	Kennedy Space Center
LEO	Lower Earth Orbit
LPS	Launch Processing System
MCDS	Management Command Data System
MMC	Martin Marietta Corporation
MMSE	Multi Mission Support Equipment
MSFC	Marshall Space Flight Center

ABBREVIATIONS AND ACRONYMS (Continued)

NASA/RECON	NASA/Remote Console
NAV	Navigation
NTIS	National Technology Information System
N2	Nitrogen
O&M	Operations and Maintenance
OHC	Overhead Crane
OIS	Operational Intercomunications System
OMV	Orbital Manuevering Vehicle
OPS	Operations
ORU	Orbital Replaceable Unit
OTV	Orbital Transfer Vehicle
OTVCC	Orbital Transfer Vehicle Control Center
OTVCS	Orbital Transfer Vehicle Control Station
OTVPF	Orbital Transfer Vehicle Processing Facility
PCR	Payload Change-Out Room
PDI	Payload Data Interleaver
PGHM	Payload Ground Handling Mechanism
PI	Payload Interrogator
PLB	Payload Bay
POCC	Payload Operations Control Center
R&D	Research and Development
RCS	Reaction Control System
RF	Radio Frequency
RIS	Requirements Identification Sheet
RMS	Remote Manuevering Structure
RSS	Rotating Service Structure
SB	Space Based
SBOTV	Space Based Orbital Transfer Vehicle
SC	Spacecraft
STE	Special Test Equipment
TBD	To Be Determined
VAB	Vertical Assembly Building
VPF	Vertical Processing Facility
VPHD	Vertical Payload Handling Device
W/S	Workstand

INTRODUCTION

A Final Review presentation for the KSC Orbital Transfer Vehicle Launch Operations Study was made at KSC on Jan 31, 1986 and at MSFC on Feb. 13, 1986. The presentation material used at the MSFC presentation is included with this volume as Appendix A. The cover sheet carries the date of the MSFC meeting but the charts inside the package reflect the first presentation date. Attendance lists for those meetings are included in this volume as Appendix B.

The final vehicle configuration for the KSC OTV Launch Operations Study was to have been established by the OTV Study contractors working for MSFC. Since the MSFC Studies did not arrive at a single vehicle configuration, the KSC Study Team developed a Reference Configuration to be used for the Study. The primary purpose of the Study was to evaluate the impacts of the OTV program on the KSC facilities and launch operations (people, processing times, GSE and possible technology applications) as conducted from either launch site (KSC or the Space Station).

In this overall framework, the Study would:

1. Identify the impacts the OTV configuration would have on the respective facilities, GSE, and manpower required to accomplish pre-launch, launch and post-launch operations for either the Ground Based (KSC) or the Space Based (Space Station) missions.
2. Identify the operational aspects of processing, maintaining, refurbishing and providing spares support for the OTV. Analyze the requirements to determine cost drivers and work with the responsible Center/contractor to minimize the impact.
3. Identify any new approaches to launch operations that must be implimented for Space Based operations. Show which of the approaches can

first be used on the ground to steamline Ground Based operations. This will allow for the development/demonstration of Space Based operational activities on the ground and provide for an orderly transition of those practices from Ground Based to Space Based operations.

Other products coming from the Study were:

1. An in-depth Test Philosophy for Ground and Space Based OTV operations.
2. The initial development of an engineering tool, the Automation Technology Knowledge Base (ATKB), for use in the identification of new technology that could be applied to OTV operations (or any other highly automated activity).
3. The identification of the need for "**commonality**" of sub-system elements used in the development of space hardware (OMV, OTV, Space Station).

TEST PHILOSOPHY

An over-all Test Philosophy as developed for this Study, is shown in its entirety in Appendix A, Section 2, starting at page 40. Its primary objective is to establish an operational baseline for activity that would deliver a vehicle that is: in compliance with engineering configuration requirements; meets all performance requirements; is mission-ready; and accomplish all this with a reduction in the manpower and time required at either launch site. This reduction in overall costs for the recurring vehicle processing will require an extensive application of new technology and some "new approaches" to launch site processing operations.

The over-all Test Philosophy consists of several parts:

A Launch Base Credo developed to highlight the particular items of basic interest to the launch site.

A Test Philosophy section sets down the basic philosophy developed to control the test program. The program will demonstrate that the vehicle meets engineering configuration and performance requirements, reduces processing flow times, and thereby reduces overall operations costs (by reducing the supporting manpower) thru the application of technology advancements.

A Criteria section establishes the Launch Site requirements on the designer for the vehicle capabilities that are needed for operations. These requirements include a vehicle self-test system capable of performance evaluation, fault detection/fault isolation to the ORU, self-test software that is independent of mission software and continuous status checks of all redundant, on-board hardware. The need for a Protoflight vehicle (subsequently refurbished to flight hardware) for verification of transportation system(s) and facility activities as well as use as a personnel training and certification tool is also presented.

A Test Approach section that, in general, lays out several points to be accomplished throughout the Test Flow development. This part of the philosophy was developed with the assumption that all the above criteria requirements had been met.

The vehicle flight systems will have a very high degree of reliability, with a built-in, self-test system having the capability to conduct an automated, self-controlled system evaluation. With the bulk of the checkout capability built into the flight hardware, the equipment must be as reliable as the state-of-the-art can provide. The OTV Control Station and other Ground Support Equipment (GSE) must maximize the use of the automation technology developed, used, and provided by the vehicle designer(s).

Test and Operational planning for the Prelaunch, Launch, Mission/Recovery and

Maintenance/Refurbishment operations must maximize the use of the autonomous system(s) operational and evaluation capabilities provided by the vehicle, GSE, and Space Station Accommodations designer(s).

Equipment **commonality** for Space Station, OMV and OTV programs, while not currently mandated, is very important. Requiring sub-system elements of equipment used by the Space Station, OMV, or OTV to be interchangeable will reduce extensive duplication at both launch sites (KSC and at the Space Station) in many ways.

Sub-system installation and checkout activities would be simplified for follow-on copies of "like" items not only because only one "first set" of installation documentation would have to be developed but also because the crew "learning curve" process should significantly reduce the time required to install, checkout and/or use the follow-on units..

Spares provisioning costs would also be reduced because of the lower number of spare units required. That item by itself provides additional savings because of the reduced requirements for spares storage space and accountability activities. At the Space Station, especially, both space and time are premium items so this item alone is a significant Program cost saver.

An additional, intangible benefit of commonality (or interchangeability) is that as more people use an item, changes will be identified that will optimize and improve that unit for all users.

The vehicle must be able to perform a self test (evaluate mechanical, electrical and electronic systems) in an autonomous fashion and conduct a mission readiness analysis of the flight systems. It must be able (thru fault detection and isolation routines) to isolate problems to the ORU level and report these problems to the

OTV CS-G (or"-S") for verification and corrective action. Redundant, on-board flight hardware will be under continuous, routine self test to verify the health and status of the redundant units. The self test and fault isolation software must be independent of the replacement ORU's and/or the mission peculiar software.

Physical interfaces must be simplified to the maximum extent possible. Mechanical connection of the spacecraft to the OTV must be accomplished by a remotely controllable latch system. All ORU's should be designed in such a way that all physical connections (electrical and mechanical) are accomplished (completed) when/as the package is "installed for use".

A protoflight vehicle (later refurbished as flight hardware) will serve many purposes without actually requiring a separate ground test vehicle. The vehicle will be used to:

1. Verify transportation and handling (T & H) techniques
2. Validate the T & H equipment and procedures
3. Verify the physical fit of the vehicle into the facilities/test stand(s)
4. Verify GSE hook-up (cable lengths/routing/signal & power capability)
5. Verify compatibility of the vehicle /GSE/test stand(s)/OTV CS-G
6. A training tool for:
   a. Personnel training/certification
   b. Validation of mechanical assembly procedures
   c. Certification of the automated system(s) at the launch site
   d. Implementation/validation of new, automated management control and reporting systems.

All of these activities being worked out before the availability of flight hardware at the launch site will help get those kinds of problems resolved and the launch crew trained/certified before the "time critical" prelaunch processing of sensitive, "flight certified" hardware at the launch site. Operational crew familiarity with the vehicle T & H requirements, the T & H equipment, and the flight hardware and its performance (operation) will significantly reduce the potential for "human error" in all facets of vehicle operations.

The vehicle hardware, upon its arrival at the launch site, will be processed using standard techniques, equipment and processes for off-loading, receival, inspection and assembly. Existing KSC contamination control practices and safety requirements for hazardous operations will be followed.

A dedicated OTV processing facility (OTVPF) is desirable because the moves between facilities can be eliminated. There is a considerable savings in the overall crew time allocated to a move as well as a reduction in the risk to flight hardware that must always be factored into any handling operation, change of processing location, etc. Each move would require:

1. Disconnect from a test stand
2. Lift the vehicle out of the test stand and install in a transporter
3. Move to another site
4. Remove from transporter and install in the test stand
5. Hook-up and verify all external connections
6. Run the test
   (for example: cryo load/off-load and then clean/purge the system)
7. Evaluate test results
8. Remove vehicle from test stand and install in transporter
9. Move to next test location
10. Clean both transporter and vehicle to acceptable levels
11. Move the transporter and vehicle into the clean room
12. Remove from transporter and install in the test stand

13. Connect umbilical(s)

14. Verify connection(s)

15. Ready to continue operations

As can be seen from the above, items 1 through 5 and items 8 through 15 would be unnecessary if the total ground activity could be accomplished in a single facility.

While a dedicated facility appears to be the best choice for the OTV program at this point in time, it is recognized that past Programs have provided many of the facilities needed at the launch site in a variety of other, smaller facilities that are scattered around both KSC and CCAFS. It is certainly possible to break the processing flow into many smaller parts to utilize these facilities. That approach; however, would cause a wide difference from the processing flow that is expected to take place at the Space Station. This approach is; therefore, undesirable for the OTV ground flow because not only is it more time consuming (and expensive) but even more importantly, the direct translation of facility-oriented practices from the Space Station to ground operations, or vice versa, could not then be accomplished/correlated directly. The way the Space Based job was to be accomplished on Earth could require several, analytical adjustments before any meaningful correlation between the two activities could be made.

At the time that firm Program schedules and facility requirements are available, a series of Trade Studies should be conducted for each activity. The number of times an operation has to be conducted, the cost of special equipment (plus possible facility upgrading modification costs) and the manhours required in that operation should be "traded" against the cost of providing that capability initially as a part of the dedicated OTV facility. The combination of resulting Trade Studies should determine the most cost-effective way to proceed at that time -- separate facility elements for each activity, or a <u>single</u> facility where all the activities in the trade studies can be accomplished.

Each flight vehicle, Ground Based or Space Based, will be assembled in the OTVPF. No ORU or sub-system level tests will be performed at the launch site (those tests will have been run by the contractor prior to delivery). System level tests will verify the integrity of the flight vehicle and verify flight worthiness. Tests will be <u>initiated</u> from the OTV Control Station (OTV CS) and <u>controlled</u> by the autonomous, OTV on-board system. Test status and problem identification will be reported to the OTVCS for verification (and remedial action if necessary).

Vehicle inspections, once final assembly is completed, will be conducted by remote scanning and imaging systems to the maximum extent possible. Some items like engine nozzles, thermal protection tile repair, etc. may always require some degree of physical access and final inspection prior to use (even at the Space Station launch site).

One cryogenic load test will be conducted per vehicle to validate cryo system integrity (not a load test before every flight in accordance with the current -1986- practice). Even this test should be driven back to the contractor facility to reduce the facility and manpower requirements at the launch site by eliminating this type of "one time per vehicle" test. Providing this facility at the launch site will present a high cost facility and equipment item with a very low use rate in the KSC inventory of facilities. In addition, the facility would require an intensive maintenance activity through long, otherwise inactive, periods between operations. The materials and integrity of the cryo seals, tanks, plumbing and quick-disconnect systems will have to meet high reliability requirements if only limited cryo system integrity testing is to be required during the vehicle lifetime. Systems capability must be available before this objective can be realistically imposed on the Operations arena.

The OTV-CITE interface test will verify compatibility of all OTV-Orbiter interfaces required to support 1) Orbiter launch, 2) OTV deployment and 3) OTV retrieval in LEO in an off-line facility at KSC prior to the payload being moved to the Pad. Since the OTV is reusable, and the CITE test is a **design compatibility validation test**; this test will be run on the Protoflight vehicle (if all electronics and avionics are available) and on the first flight vehicle only.

An RF End-to-End test will be run on the Protoflight vehicle and on the first flight vehicle to verify the operational readiness of all links, in all modes. This test will demonstrate that all Data Processing Centers can process their part of the data and/or transmit (ship) data to each other as required to meet all the operational support requirements (prelaunch, launch, mission, recovery and refurbishment activities).

RF tests on subsequent vehicles will be limited to those links in use between the OTV and the OTVCS-G that are used for normal checkout. Since these links were also a part of the original End-to-End test, the fact that they are operational would indicate that the vehicle data is getting into the system properly. The operational readiness of the other individual parts of the network will be left to those normally responsible for their own system O & M.

No tests will be conducted in the RSS. The RSS will be used as an interim handling station to move the payload (OTV/SC) out of the canister and into the Orbiter payload bay. It is entirely possible that the SC may have additional work that will have to be done in the RSS that cannot be done in an off-line facility. Those requirements will be worked on a case-by-case basis with the individual Programs. This type of activity; however, will be considered as an exception to the norm.

The facility design will utilize standard services to the maximum extent possible;

ie, cranes, power, communications, environmental controls etc. The workspace will be primarily a large-volume space that can be readily adapted to other uses like: multiple vehicles in flow, a combination of ground based and space based vehicles being processed (in sequence or in parallel), or for use by other programs (like an OMV) when not required by the OTV.

The facility should be able to accommodate hazardous vehicle processing to eliminate a variety of moves to other facilities for such items as ordnance installation and removal, RCS system processing, cryo load (if required), or other -- depending upon the specific system requirements in the final configuration of the OTV.

FLOW DIAGRAMS

A series of flow diagrams were developed to show the vehicle processing flow developed to support OTV operations for a total processing cycle. Two types of flows are presented in Appendix A, starting at page 58. The Ground Based flow was developed first. As shown, the flow was broken down into the major elements of preparation, integration, launch, mission and recovery, and maintenance and refurbishment operations. These elements were then expanded into 39 basic tasks to reflect all activities from initial assembly thru the mission, maintenance and storage cycles. When the vehicle was finally placed in the storage cycle, it was ready and waiting for the next mission call-up. This was still not to the detail level that would support the definition of requirements for facilities, manpower, processing times and technology definition.

Additional expansion of each task by use of supporting subtasks provided task definition at a level that did support development of the above requirements.

In all, there are 138 subtasks identified for the Ground Based Flow. The flow diagrams have several special items identified -- some tasks would be deleted entirely (depending upon the acceptance of some groundrules), some tasks would be used the first processing time only for each vehicle and some tasks (like the CITE test for example) would be run only once in the program as a design compatibility validation test.

Several of the Ground Based flow activities are also required in the flow developed for the Space Based operation, and these are identified by a darkened triangle in the upper righthand corner of the major task box(es) on the Ground Based flow. There are only 73 subtasks required for the Space Based flow.

A definite effort was made to use the same basic task number for similiar tasks in the Ground Based flow and the Space Based flow. If the task is identical, it will bear the same subtask number in either flow. If the task is part of the general task, but is slightly different, it will have the same main (or primary) number with a different subtask identifier number. For example: In task 34 -- the first activity is to move the vehicle into the OTVPF. The subtask number for the Ground Based flow is 34.0100 but in the Space Based flow the number is 34.0150. Review of the two sets of RIS's (requirements pages) show that the move on the ground is accomplished with a ground transporter and a tug but at the Space Station the move is accomplished by use of the MRMS (a capability that is provided at the Space Station only). Differences in the tasks at the two locations are shown in a similar manner on <u>all</u> of the Resource sheets. In this manner, identical tasks could be <u>compared</u> exactly and others could be <u>correlated</u> to each other for operational and analytical purposes.

The test boxes in the Space Based flow, since they use the same basic numbering system established for the Ground Based flow, do not necessarily flow in numerical sequence. This is because either the environment or the accommodations provided at the Space Station are different from those on the ground. For example, the cryo storage tanks are built into the "tower" structure of the Space Station adjacent to the OTV Hangar. The vehicle therefore, would be loaded with cryos before it was moved out of the hangar to the "launch site" selected for the Space Station rather than loading the flight cryo tanks at the launch site as would be done in the ground flow.

Optional flow paths that deleted certain activities or entered the flow at different places on subsequent iterations-- depending upon the groundrules -- are shown on the flows along with some additional cautions, comments, and concerns.

As shown later in the manpower review section, a series of sets -- numbers, requirements, facilities, or whatever, could be arrived at depending upon the groundrules imposed. The four sets selected in the manpower section for comparison were:

1. The First Flow -- the total flow as shown in the Ground Based flow.
2. The Nominal Flow -- The First Flow with the moves to the cryo facility and back to the OTV/SC Integration facility deleted (the dedicated facility used as the OTVPF would accommodate both hazardous and integrated operations within the same facility and; therefore, make the move unnecessary).
3. The Recurring Nominal Flow -- subsequent iterations/uses of the Nominal Flow for the same vehicle deletes initial R & I, initial assembly and checkout, cryo load and CITE tests.
4. The Factory Assembly/Checkout -- the final assembly and checkout would be accomplished at the factory by the contractor

(including the cryo integrity test) so that all initial assembly and checkout activities shown on the First Flow would be deleted from the activities to be accomplished at the launch site.

RESOURCE IDENTIFICATION SHEETS (RIS's)

The Resource Identification Sheets (RIS's) were used to collect the information required to detail crew size/skills, time to complete, facility requirements, and GSE/STE for each of the individual subtasks for both GBOTV and SBOTV configurations. See Appendix A, pages 71 thru 73 (3 pages), for a typical Ground Based RIS or pages 74 thru 77 (4 pages) for a typical Space Based RIS.

As the RIS information was compiled and fed into the common data base, reports were generated and reviewed by experienced operational personnel to verify data integrity. Any corrections or additions were then fed back into the data base and the reveiw process iterated until the data satisfied the operational personnel.

This data was then used as prime information to generate reports detailing Manpower, Facility and Equipment requirements, and related Automation Technology for the defined processing flow.

The Manpower reports (see Appendix A for details as shown in Section 7, pages 104 through 164) provide summary and supporting details for crew size/skills, serial time-to-complete each subtask, and total manhours required to complete each subtask as grouped by operational phase -- Preparation, Integration, Launch Ops, Mission/Recovery, or Maintenance/Refurbishment.

The facilities resource(s) reports reflect the details of the facility capability required to ensure support for each individual subtask, and include such items such as: physical size for airlock doors,the airlock itself, the highbay work areas; crane capacity required in either (or both) the airlock and the high bay; the lift height for both airlock and highbay areas; power requirements; cleanliness; E.C.S. (Environmental Control System); Humidity and Temperature; inert gas requirements (GN2, GHe); RF systems support (by frequency bands), and an identification of the fact that a specific subtask contains hazardous operations. A total of 35 individual facility requirements are identified for each subtask. See Appendix A, Section 6, page 91, for an example of the details contained on a RIS facilities page.

GSE/STE resouces required for each subtask are identified under the equipment section of the RIS and include items such as; OTV adapter, breakout boxes, air pallet, special hoisting and handling equipment, and the NASA canister or the OTV transporter.

Each RIS can be coded with a Primary key and a series of Secondary keys. These keys, in turn, are then used by the NASA RECON system to identify the associated technology items contained in that data base.

TECHNOLOGY IDENTIFICATION

Early in the study it was determined that a large amount of information detailing the availability of automation-related technology was available, on-line, in several data bases such as NASA/RECON, NTIS, INSPEC, and others. <u>All</u> of these data bases have a major problem in extracting specific, applicable information that may be directly applied to a particular problem.

A very large amount of New Technology related information is contained in these data bases. Only a small percentage, 1-2%, of the 4.5 to 5 million citations currently contained in the NASA RECON data base are directly related to automation for the time period of 1982 thru 1985. To identify any subset of information, the data base is searched by use of a defined set of key words which are contained in its Thesaurus. In the case of NASA RECON, its Thesaurus contains many (but not anywhere near **all**) of the key words available. This limitation is necessary to keep the Thesaurus, which is distributed in hard copy, to a manageable size. Even then it is usually necessary to sub-divide this information into a number of volumes, usually 1 or 2. The NASA RECON Thesaurus, Vol. 1, for example, has in excess of 800 pages.

Although this makes the reference volume for key words manageable, at least in size, it does introduce another problem of its own, (**data handling**). Use of the supplied thesaurus and its key words will normally yield either NO information or VOLUMES of data that must be manually reviewed. The process of reviewing large amounts of information manually in search of those few items of major interest is very tiring. The engineer rapidly loses interest because the extensive time required to read all that material strains human patience and stamina.

In the case of this Study, the problem was to identify automation technology that would (or could) be used to reduce both serial time and manpower requirements associated with the completion of each subtask activity. A new thesaurus, tailored to the areas of interest, was developed by extracting additional key words from the citations themselves. These additional key words, not presently in the RECON Thesaurus, are then made available for use in searching the on-line data base to provide the study team with realistic, time efficient access to related technology and information. This engineering tool, called the ATKB (Automation Technology Knowledge Base), was evolved as a way to quickly identify available automation technology information in the NASA RECON data base to support Study objectives.

Utilizing this additional set of ordered keys in the form of an expanded thesaurus allowed the study team members to have rapid access to the specific information of interest to them. The alternate method was to expend large amounts of time manually reviewing the information obtained by using the published (**un-expanded**) version of the Thesaurus.

The process of using the expanded thesaurus is straight forward and is to be used on-line with NASA/RECON. Following is a description of how the ATKB Thesaurus would be used. Both Primary and Secondary Keys are listed in the ATKB Thesaurus (see Vol. 4). Using the list of Primary Keys contained in Volume 4, select a Key. Use this key to query NASA/RECON. Depending on the Primary Key you selected, you will end up with a set of citations. The number of citations in this set may be very large. If there are more citations in this set than you wish to review, select one or more related keys from the list of Secondary Keys to help you limit the information selection previously identified by using only the Primary Key. The number of citations associated with each Secondary Key is indicated in the ATKB Thesaurus. While this will give you little or no indication of how many citations will result from the combination of Keys, one does at least have the preliminary information that the number of citation(s) obtained will be no more that the smallest number associated with any of the Keys selected for the sorting process. The system will combine these Keys as a "logic AND set". The result of this is that only those citations having the selected Keys in common will be listed. Once the identified set is of a manageable size, the citations can be reviewed manually by using the NASA/RECON display function.

FACILITY IDENTIFICATION

To aid in identifying the facility resources required to process the GBOTV and/or the SBOTV through the ground facilities at KSC, a software application package was developed using a general purpose Data Base Management System known as Data Flex. This software application uses the facility requirements identified on the second page of each Ground Based RIS set as the basic requirements input. The resources currently available in the KSC facilities considered to be potential candidates for use by the OTV Program were digitized in a format identical to that used for the identification of facility requirements on the RIS's. These individual, detailed Baseline Facilities capabilities are shown in Appendix A, on pages 91-97. The "facility capabilities" were digitized in this format for use in automated, comparison analyses programs developed especially for that purpose.

The software will accummulate a composite set of facility requirements from any sequential numeric grouping of the RIS's. The Tasks were grouped into two task groups, Task Numbers 1 thru 13 and Tasks 34 thru 39 (Refer to pages 98 and 100 in Appendix A). Composite facility requirement(s) were accummulated for each Task Group. The tasks were grouped this way because the identified tasks are the tasks that would be accomplished at KSC in the OTVPF -- they exclude the tasks to be performed at the launch pad since that is a separate, required facility at KSC.

Each composite facility requirement is then compared to each of the Baseline Facility capabilities and generates a relative score that indicates how each facility weighs against the composite requirements (Refer to Appendix A, page 102) in relation to the other facilities in the set. There is no perfect score but a high score is better than a low score. Each requirement can be individually weighted such that a higher priority can be given to selected requirements (such as physical size, crane capacity, or other selection) while maintaining a lower priority for other items like E.C.S, Humidity, or Potable Water. In this manner, if some items being evaluated are more critical, expensive, difficult, or whatever; a sort of games-manship can be played by providing different weighting factors to the various items, depending upon their relative importance in the matter being considered. The system is not presently user-friendly so this games-manship cannot be easily accomplished -- nor can it be done in real time. In the current configuration, the entire program has to be recompiled each time a factor is changed.

Once the system has identified the facility with the "Best Fit", those modifications required to make the "Best Fit" facility match the composite requirements are generated (Refer to pages 99 and 102). The Modifications report identifies the additions that must be made to the "Best Fit" Facility. In numeric fields like "Airlock", "High Bay", etc., the number(s) indicated in the report are those positive deltas in the specific field, for that facility, to bring that particular field up to meet the composite requirement where the number appears. In non-numeric fields like "Paging", "Vacuums", and "Shop Air", etc., an "N" indicates NO modification is required while a "Y" indicates a modification IS required. No indication is currently provided as to how much, if any, a facility exceeds any of the composite facility requirements.

MANPOWER

All manpower numbers: number of heads (by skill), serial time and manhours (each on a per subtask basis) have been accumulated and compiled in spreadsheet format for both the Ground Based and the Space Based flows. This basic data is included as Appendices A and B to Vol 5 so that anyone can run whatever analyses may be of interest or that apply to his/her particular interest or concern.

For purposes of this Study, the spreadsheets were summarized at the task level on separate sheets and the analyses were made on the results shown on those pages. See pages 112, 126, 130, 134, 138 and 152 of Appendix A for the pages developed for Ground Based and for Space Based flows. As is apparent, the flow elements in the original flow that do not apply to the particular flow being considered were only lined out (not deleted) so that whatever deletions were made for analysis purposes would be readily apparent, even to the casual observer.

Different types of displays were then developed to portray the data. Several sets of samples are provided in Appendix A to this document. Some of those provided are:

1. Manpower "line graphs" that show the number of heads in each of three skills; technician, quality and engineering for each subtask, starting on page 106 of Appendix A.
2. Manpower "area charts" that show the same sets of manpower in a "stacked" format that more clearly show crew sizes for those same tasks are provided on the same pages to facilitate comparison.
3. Combined sets of "pie charts" showing Serial Time and Manhours (as two separate charts on the same page) were developed; for example, the Serial Hours and Manhours chart for the GBOTV - FIRST NOMINAL FLOW on page 128 of Appendix A. This type of chart shows both a numeric value and a percentage number of the whole set for each "pie segment" of the chart.
4. A comparison of time and manpower requirements between the Nominal Flow and the Recurring Flow (using the Nominal Flow as the base number) is shown on page 132 of the Appendix. The amount of the

Nominal Flow deleted for the Recurring Flow is shown (as a separated pie section). Both the numeric value and the percentage of the whole set for each "pie segment" on the chart are shown.

SUMMARY

A series of Operational Design Drivers (11) were identified during the Study. These are shown on pages 168 thru 170 in Appendix A. Several of these could have significant impact(s) on Program costs. These recommendations, for example, include such items as: item 1, complete factory assembly and checkout prior to shipment to the ground launch site (KSC) to make significant reductions in time required at the launch site as well as overall manpower required to do the extra work (this would drive front end "vehicle delivery costs" at the contractor plant however); item 9, minimize use of non-standard equipment when orbiter provided equipment is available to support launch and/or recovery operations; and item 10, require commonality (or interchangeability) of subsystem equipment elements that are common to the Space Station, OMV and/or OTV systems.

In addition to these items of interest, several additional items were identified that will require a significant amount of management attention (and direction) to resolve. The more significant of these are probably items 10 through 15 on pages 171 and 172 of Appendix A.

Key elements of the Space Based Processing Plan are shown on page 173 of Appendix A along with comparative costs for ground based labor and Space Station IVA and/or EVA activities. The relationship between these types of manpower and their relative costs will clearly drive the requirement for a vehicle that is highly automated and a Space Station facility that utilizes a very high degree of robotics for repetitive tasks that would otherwise require extensive IVA and EVA support for vehicle processing at the Space Station..

OTV /Space Station operational planning must continue so that the necessary "scar" to support OTV processing concepts can be properly planned and approved for Space Station structure design tasks that will begin their design phase(s) in the near future. It is recognized that the OTV Program "needs" will be quite a while in the future and the actual facility and equipment will probably not be provided, nor the installation(s) take place, until after the Station has been in orbit for some time.

The requirement establishing basic equipment **commonality** (or interchangeability) for the Space Station, OMV and OTV subsystem equipment elements must be put in effect in the immediate future if any significant, over-all cost savings and benefits are to be realized by NASA. Equipment design concepts are rapidly moving forward and the time when this kind of requirement can be effectively implemented by the responsible NASA Centers and their respective contractors is fast disappearing.

APPENDIX A

FINAL PRESENTATION

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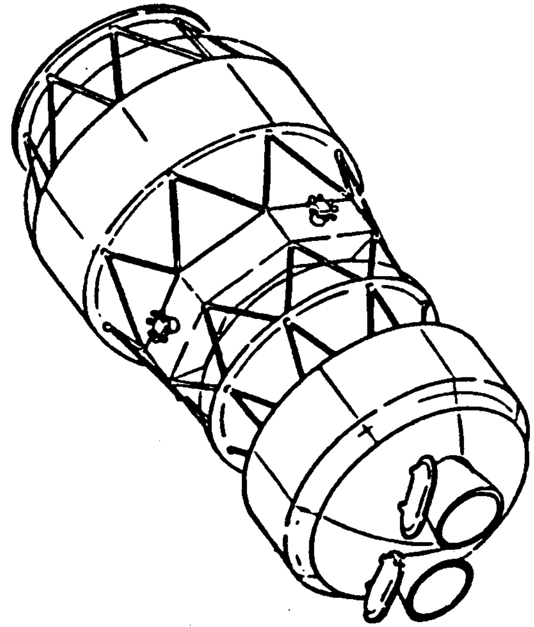
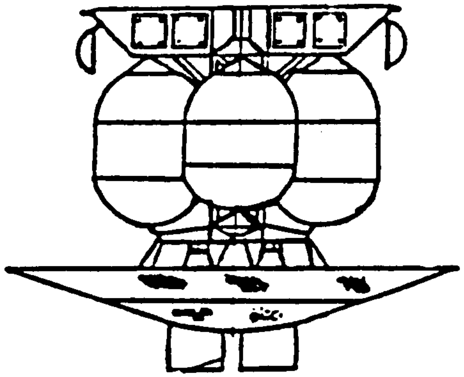
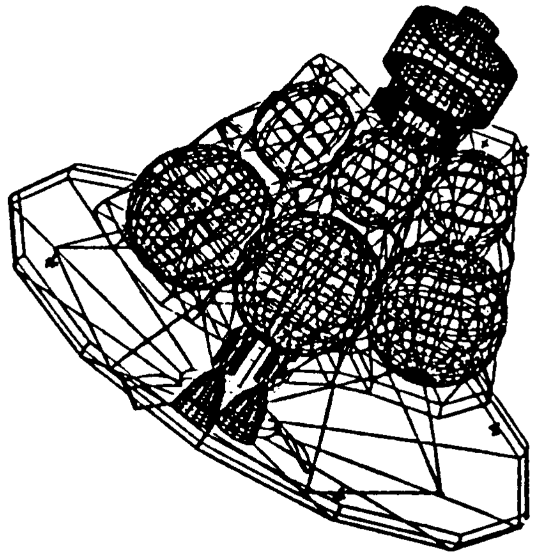
Boeing Aerospace Operations

ORBITAL TRANSFER VEHICLE
Launch Operations Study







FEBRUARY 13, 1986

FINAL REVIEW AT MSFC

KENNEDY SPACE CENTER
NAS10-11165

FINAL PRESENTATION
AGENDA

1. INTRODUCTION .... A. SCHOLZ
2. TEST PHILOSOPHY .... A. SCHOLZ
3. FLOW DIAGRAMS .... A. SCHOLZ
4. RESOURCE IDENTIFICATION SHEETS (RIS's) .. D. LOWRY
5. TECHNOLOGY IDENTIFICATION .... D. LOWRY
6. FACILITY IDENTIFICATION .... D. LOWRY
7. MANPOWER (SERIAL HOURS-MANHOURS) ..... A. SCHOLZ
8. SUMMARY .... A. SCHOLZ

FINAL PRESENTATION
AGENDA

1. INTRODUCTION .... A. SCHOLZ
   BACKGROUND
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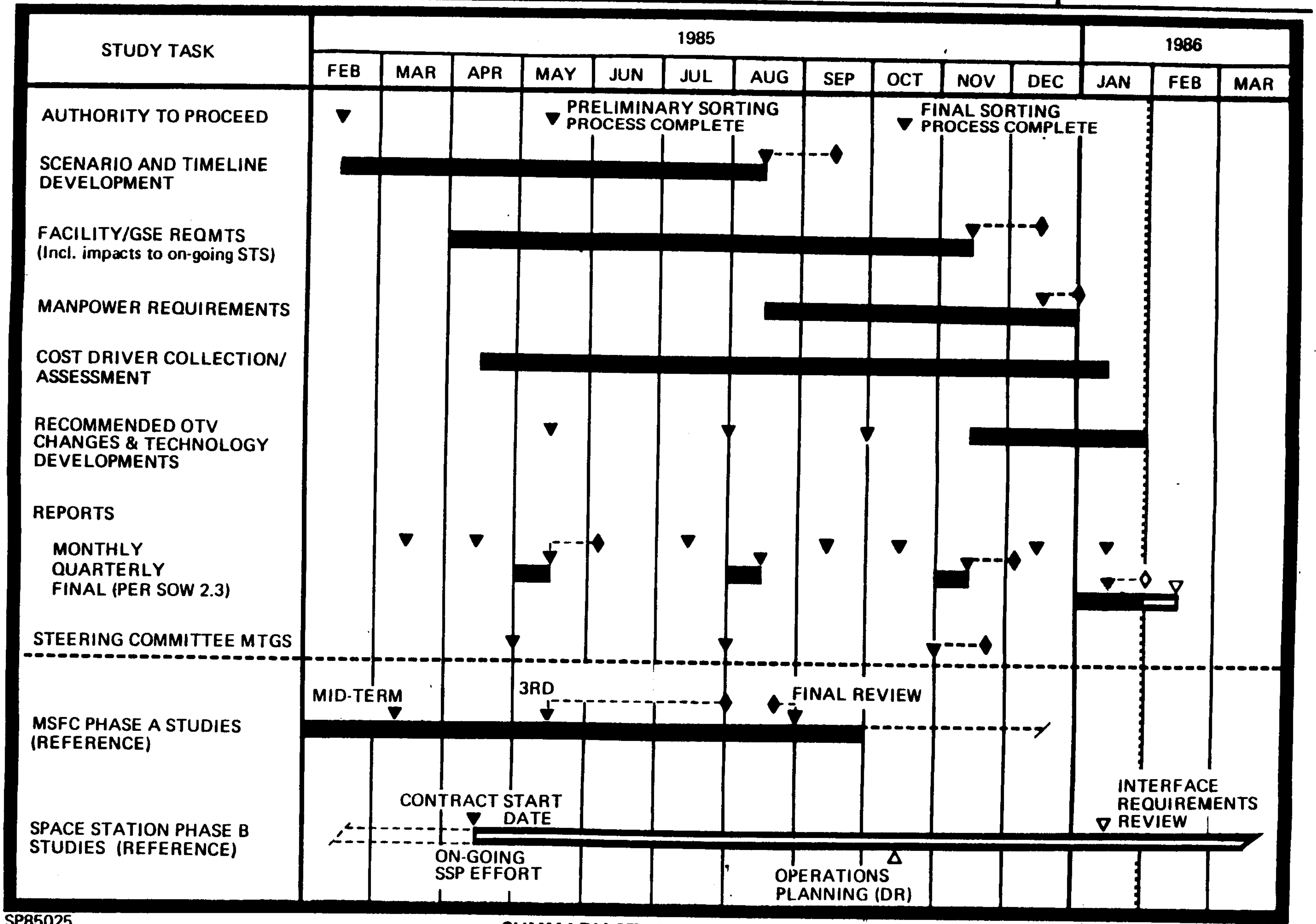
BOEING
OTV LAUNCH
OPERATIONS
STUDY FOR KSC

OTV LAUNCH OPERATIONS STUDY SCHEDULE

PRESENTED AT
KSC
JANUARY 31, 1986



SP85025

SUMMARY STUDY SCHEDULE

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BACKGROUND

SINCE A FINAL OTV REFERENCE CONFIGURATION WAS NOT BEEN ESTABLISHED BY MSFC, THE KSC TEAM ESTABLISHED A BASELINE CONFIGURATION TO BE USED FOR STUDY ACTIVITIES. THIS CONFIGURATION IS A PAYLOAD BAY COMPATIBLE VEHICLE WITH CRYOGENIC PROPELLANTS, PROPELLANT GRADE FUEL CELLS AND A HYPERGOLIC RCS SYSTEM.

BOEING ASSIGNED BOEING/ELS OPERATIONAL PERSONNEL TO THE STUDY TEAM. THE STUDY TEAM MEMBERS WERE INSTRUCTED, AND RECOGNIZED, THE NEED TO APPROACH ALL ELEMENTS OF THS STUDY IN AN OBJECTIVE MANNER TO ENSURE REALISTIC, UNBIASED RESULTS (ANALYSES/REQUIREMENTS/COST DATA/RECOMMENDATIONS).

STUDY BACKGROUND

STUDY REQUIREMENTS:

1) IDENTIFY THE IMPACTS THAT THE APPROVED OTV CONFIGURATION WILL HAVE ON THE RESPECTIVE FACILITIES, GSE AND MANPOWER REQUIRED TO ACCOMPLISH PRE-LAUNCH, LAUNCH AND POST-LAUNCH OPERATIONS FOR GROUND-BASED (KSC) AND SPACE-BASED (SPACE STATION) MISSIONS.

2) IDENTIFY THE OPERATIONAL ASPECTS OF PROCESSING, MAINTAINING, SCHEDULED REFURBISHING AND PROVIDING LOGISTICS SUPPORT FORTHE MSFC VEHICLE CONFIGURATIONS. ANALYZE THOSE OPERATIONAL REQUIREMENTS TO ESTALBISH COST DRIVERS AND WORK WITH KSC, MSFC AND VEHICLE CONTRACTORS TO MINIMIZE OVERALL PROGRAM COSTS.

3) IDENTIFY THE INNOVATIVE APPROACHES TO LAUNCH OPERATIONS THAT MUST BE IMPLEMENTED FOR SPACE-BASED MISSIONS. SHOW WHICH OF THESE APPROACHES CAN BE TRANSLATED TO GROUND APPLICATIONS TO STREAMLINE GROUND-BASED OPERATIONS AND THEREBY PROVIDE AN ORDERLY EVOLUTION FROM GROUND TO SPACE BASED.

STUDY BACKGROUND
(CONT'D)

OTHER PRODUCTS:

TEST AND OPERATIONS PHILOSOPHY FOR GROUND AND SPACE BASED OTVs.

DEVELOPMENT OF THE INITIAL AUTOMATION TECHNOLOGY KNOWLEDGE BASE (ATKB) FOR USE IN IDENTIFICATION OF NEW TECHNOLOGY REQUIRED FOR OTV OPERATIONS

IDENTIFICATION OF THE NEED FOR COMMONALITY OF SUB-SYSTEM ELEMENTS USED IN THE DEVELOPMENT OF OTV, OMV, AND SPACE STATION HARDWARE

STUDY BACKGROUND
(CONT'D)

STUDY STATUS

THE SUMMARY STUDY SCHEDULE WAS APPROVED BY THE KSC STUDY MANAGER (CP-FSO) ON MARCH 6, 1985

WE HAVE COMPLETED THE DEVELOPMENT OF SCENARIOS AND TIMELINES USING A GENERIC VEHICLE CONFIGURATION. THESE GENERIC SCENARIOS CAN BE READILY ADAPTED TO THE FINAL OTV CONFIGURATION(S) WHEN AVAILABLE.

FACILITY AND GSE REQUIREMENTS ARE SHOWN ON THE RIS's (REQUIREMENTS IDENTIFICATION SHEETS) DEVELOPED FROM THE SCENARIOS.

WE HAVE IDENTIFIED SEVERAL ITEMS HAVING A SIGNIFICANT AFFECT ON OVERALL LIFE CYCLE COSTS. THE IDENTIFICATION AND COLLECTION OF COST DRIVERS IS ANOTHER DERIVATIVE OF THE ANALYSIS REFLECTED IN THE REQUIREMENTS IDENTIFICATION SHEETS THAT DOCUMENT THE VARIOUS RESULTS.

FINAL PRESENTATION
AGENDA

1. INTRODUCTION .... A. SCHOLZ
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LAUNCH BASE CREDO

MINIMIZE RECURRING LAUNCH OPERATIONS COSTS BY AUTONOMOUS SYSTEM OPERATION

- UTILIZE TECHNOLOGY TO REDUCE MANPOWER AND TIME REQUIRED AT THE LAUNCH SITE TO DEMONSTRATE THAT THE VEHICLE IS IN COMPLIANCE WITH ENGINEERING CONFIGURATION REQUIREMENTS, MEETS PERFORMANCE REQUIREMENTS AND IS READY TO ACCOMPLISH ITS ASSIGNED MISSION
- ENCOURAGE THE DESIGNER(S) TO MAXIMIZE RELIABILITY TO ASSURE TROUBLE FREE OPERATION
- ENCOURAGE THE DESIGNER(S) TO DESIGN FLIGHT SYSTEMS FOR AUTONOMOUS, AUTOMATED CHECKOUT AND OPERATION
- REQUIRE SUPPORT EQUIPMENT DEVELOPMENT TO MAXIMIZE USE OF THE AIRBORNE VEHICLE TECHNOLOGY PROVIDED
- MAXIMIZE THE USE OF THESE BENEFITS IN THE PLANNING AND PREPARATION FOR PRELAUNCH, LAUNCH AND MISSION OPERATIONS.
- STRESS "COMMONALITY" FOR SPACE STATION, OMV AND OTV EQUIPMENTS TO REDUCE EXTENSIVE DUPLICATION AT THE LAUNCH SITE - KSC OR SPACE STATION -- FOR A WIDE VARIETY OF:
  1) INITIAL SUBSYSTEM INSTALLATION AND CHECKOUT ACTIVITIES
  2) SPARES PROVISIONING COSTS - NUMBER OF ELEMENTS REQUIRED OVERALL
  3) EXTRA EQUIPMENT ACCOUNTABILITY ACTIVITIES AND STORAGE ACCOMMODATIONS
  4) OPERATIONAL TRAINING FOR USE OF SIMILAR EQUIPMENT(S) ON THE THREE PROGRAMS
- EQUIPMENT "COMMONALITY" SHOULD LEAD TO OPTIMIZATION THRU APPLICATION AND USE OF COMMON DESIGNS BY THE RESPONSIBLE CENTERS/AGENCIES/CONTRACTORS

OTV TEST PHILOSOPHY

THIS TEST PHILOSOPHY ESTABLISHES CRITERIA AND OVERALL, TEST APPROACH OBJECTIVES

- o VERIFY THAT AN OTV IS FLIGHT READY AND WILL ACCOMPLISH ITS MISSION SUCCESSFULLY
- o REDUCE REDUNDANT TESTING
  - o ELIMINATE REPETITION OR DUPLICATION OF TESTS TO ESTABLISH VEHICLE AND SYSTEM CONFIDENCE.
  - o ESTABLISH OTV SYSTEM CONFIDENCE THROUGH DESIGN, ANALYSIS, FACTORY TEST AND INSPECTION WITH A MINIMUM OF TEST DUPLICATION AT THE LAUNCH SITE.
- o REDUCE PROCESSING FLOW TIMES
  - o REDUCED FLOWTIME REPRESENTS A COST SAVINGS TO THE USER (COMMERCIAL AND THE NASA).
  - o OFFLINE FLOWTIME IS LESS CRITICAL THAN ONLINE BUT IS IMPORTANT IN MAINTAINING OTV PROGRAM SCHEDULES AND MEEETING ONLINE OPERATIONS FOR A SPECIFIC OTV.
  - o ONLINE OPERATIONS ARE CRITICAL IN MAINTAINING OTV/ORBITER LAUNCH SCHEDULES AND OVERALL ORBITER LAUNCH RATE.
- o REDUCE MANPOWER REQUIREMENT FOR GROUND PROCESSING
  - o MANPOWER AVAILABLE FOR GROUND PROCESSING IS LIMITED ONLY BY ACCESSIBILITY TO THE VEHICLE.
  - o MANPOWER AVAILABLE FOR OTV PROCESSING AT THE SPACE STATION IS LIMITED BY THE NUMBER OF QUALIFIED SPACE STATION PERSONNEL
  - o GROUND PROCESSING SHOULD DEMONSTRATE THE CAPABILITY OF ACCOMPLISHING SPACE STATION PROCESSING.

OTV TEST PHILOSOPHY

TEST PHILOSOPHY (CONT'D)

- O REDUCE OVERALL COST
  - o STREAMLINING AND AUTOMATING THE OPERATIONAL FLOW WILL SIGNIFICANTLY REDUCE RECURRING COSTS BY REDUCING TEST SETUP TIME, OPERATIONAL TIME AND MANPOWER.
  - o ADDITIONAL SAVINGS MAY BE REALIZED IN STANDARDIZED TEST DOCUMENTATION, PROVIDING CONTROL DRAWINGS, OPERATIONAL CONTROLS, MANAGEMENT VISIBILITY AND COMPATIBLE CONTRACTS/SCHEDULES FOR CONTRACTOR ELEMENTS.
  - o MANY ELEMENTS IN THE FINAL COST DETERMINATION WILL BE MADE BY THE INDIVIDUAL OTV CONTRACTOR'S POLICIES AND NASA DIRECTIVES; THEREFORE, THIS TEST PHILOSOPHY DOES NOT ADDRESS THOSE IN DETAIL.
- O PROVIDE SYSTEM OPERATIONAL HISTORY
  - o ESTABLISH REFURBISHMENT GUIDELINES
  - o PREDICT FAILURES TO MINIMIZE DOWNTIME
  - o INCREASE OTV AVAILABILITY FOR OPERATIONS
- O THIS PHILOSOPHY WILL BE EXPANDED AND REVISED TO
  - o COVER THOSE AREAS THAT ARE NOT INCLUDED IN THIS ITERATION.
  - o ACCOMMODATE CHANGES DICTATED BY CONTINUING MSFC OTV, SPACE STATION AND OMV STUDIES.

OTV TEST PHILOSOPHY

CRITERIA

- VEHICLE SELF TEST CAPABILITIES
  - SELF TEST SOFTWARE AND PERIPHERAL EQUIPMENT WILL PERFORM MECHANICAL, ELECTRICAL AND ELECTRONIC SYTEMS TEST AND READINESS ANALYSIS IN AN AUTONOMOUS FASHION.
  - FAULT DETECTION/ISOLATION WILL BE GEARED TO MAXIMUM OVERALL SYSTEM AVAILABILITY FOR THE OPERATIONAL LIFE OF THE VEHICLE
  - PERFORM FAULT ISOLATION TO THE ORU LEVEL. FAULT ISOLATION SOFTWARE MUST BE INDEPENDENT OF ORU PECULIAR REPLACEMENT.
  - SOFTWARE FOR ONBOARD SYSTEM SELF TEST AND FAULT ISOLATION MUST BE INDEPENDENT OF MISSION PECULIAR SOFTWARE.
- REDUNDANT FLIGHT HARDWARE (ON-BOARD SYSTEM)
  - WILL BE UNDER CONTINOUS (OR ROUTINE) SELF CHECK
    - VERIFIES TOTAL SYSTEM CAPABILITY AT ANY TIME
    - REDUCES TEST TIME

OTV TEST PHILOSOPHY

CRITERIA (CONT'D)

- 0 OTV-SC PHYSICAL INTERFACES
  - 0 STRUCTURAL ATTACHMENT OF THE SPACE CRAFT TO THE OTV WILL BE BY ACTUATING LATCHES
  - 0 ELECTRICAL CONNECTIONS WILL BE BY SELF LATCHING CONNECTORS.
- 0 PROTOFLIGHT VEHICLE (SUBSEQUENTLY REFURBISHED TO FLIGHT HARDWARE)
  - 0 VERIFICATION OF TRANSPORTATION & HANDLING TECHNIQUES AND FACILITY INTERFACES
    - 0 TRAINING/VALIDATION TOOL
      - PERSONNEL TRAINING/CERTIFICATION
      - VALIDATION OF PROCEDURES FOR FLIGHT HARDWARE MANUAL ASSEMBLY OPERATIONS
      - "DE-BUG" FIRST USE OF TRANSPORTATION AND HANDLING EQUIPMENT
      - CERTIFICATION OF THE AUTOMATED VEHICLE PROCESSING PROGRAM
      - INSTALLATION/IMPLEMENTATION OF NEW, AUTOMATED MANAGEMENT REPORTING AND CONTROL SYSTEMS
    - 0 ENHANCES "LAUNCH ON TIME" PROBABILITY FOR FLIGHT HARDWARE BECAUSE PROBLEMS WILL BE RESOLVED PRIOR TO THE AVAILABILITY OF "FLIGHT CERTIFIED" HARDWARE AT THE LAUNCH SITE

OTV TEST PHILOSOPHY

TEST APPROACH

- O TEST FACILITIES
  - o OTV PROCESSING FACILITY (OTVPF)
    RECEIVAL & INSPECTION/ASSEMBLY/VERIFICATION TESTING
  - o OTV CONTROL STATION (OTV CS-G or -S---- GROUND OR SPACE STATION)
    ALL OTV OPERATIONS AT THE LAUNCH SITE WILL BE CONTROLLED FROM THE OTVCS. THE OTVCS WILL PROVIDE FOR VEHICLE MONITOR AND CONTROL DURING OPERATIONS AND LAUNCH SUPPORT.
- O VEHICLE RECEIVING AT KSC (GROUND BASED AND SPACE BASED)
  - o RECEIVING AND PROCESSING INTO THE OTVPF WILL FOLLOW ESTABLISHED PROCEDURES FOR
    - o CARRIER OFFLOADING AND OTV TRANSPORTER LOADING.
    - o CONVOY TO THE OTVPF.
    - o CLEANING PRIOR TO AND AFTER OTVPF ENTRY.
    - o TRANSPORTER OFFLOAD AND REMOVAL FROM OTVPF.
    - o SAFETY REQUIREMENTS FOR HAZARDOUS OPERATIONS
- O VEHICLE ASSEMBLY
  - o GROUND BASED
    - o ASSEMBLY OF A GROUND BASED VEHICLE WILL UTILIZE LIFTING SLINGS, HANDLING FIXTURES, OVERHEAD CRANES AND TAG LINES.
    - o EXISTING CONTAMINATION CONTROL PRACTICES AND SAFETY REQUIREMENTS FOR HAZARDOUS OPERATIONS WILL BE FOLLOWED

OTV TEST PHILOSOPHY

TEST APPROACH (CONT'D)

- o VEHICLE ASSEMBLY (CONT'D)
  - O SPACE BASED (GROUND ASSEMBLED)
    - o ASSEMBLY WILL FOLLOW THE SAME PHILOSOPHY AS A GROUND BASED VEHICLE.
    - o ADD-ON TANK SETS, NORMALLY INSTALLED AT THE SPACE STATION WILL BE INSTALLED AND REMOVED FOLLOWING, AS CLOSELY AS PRACTICAL, PROCEDURES TO BE USED AT THE SPACE STATION.
    - o THIS WILL REQUIRE A SPACE STATION "OTV HANGAR" MOCKUP TO VERIFY WORK SPACE, ACCESS, AND OVERALL PROCEDURES.
  - O SPACE BASED (SPACE STATION ASSEMBLED)
    - o EACH FLIGHT VEHICLE WILL BE ASSEMBLED IN THE OTVPF FOLLOWING THE SAME PHILOSOPHY AS THE GROUND BASED VEHICLE.
    - o FOLLOWING CRYO LOAD TEST, THE VEHICLE WILL BE DISASSEMBLED TO THE EXTENT NECESSARY FOR TRANSPORT TO THE SPACE STATION AND HANDLED AS A PASSIVE UP-CARGO

OTV TEST PHILOSOPHY

TEST APPROACH (CONT'D)

- VEHICLE CHECKOUT (GROUND BASED AND SPACE BASED)
  - SYSTEM TEST
    - A VEHICLE ACCEPTANCE TEST WILL BE RUN BY THE CONTRACTOR PRIOR TO DELIVERY TO THE LAUNCH SITE.
    - NO PLANNED ORU OR SUB-SYSTEM (e.g., FLIGHT COMPUTER, ENGINE SUB-SYSTEM, AVIONICS SUB-SYSTEM) LEVEL TESTS WILL BE RUN AT THE LAUNCH SITE.
    - PLANNED TESTING AT THE SYSTEM LEVEL ONLY ON AN ASSEMBLED VEHICLE.
    - NO REPETITION OF SYSTEM LEVEL TEST DUE SOLELY TO A CHANGE IN TEST LOCATION (i.e., MOVE FROM OTVPF TO VPF)
    - SYSTEM LEVEL TESTS WILL VERIFY THE INTEGRITY OF THE ASSEMBLED VEHICLE AND CERTIFY FLIGHT WORTHINESS.
      - VERIFY ALL CIRCUITS COMPLETED BY FINAL VEHICLE ASSEMBLY.
      - VERIFY ALL OTV INTERFACES TO THE ORBITER, SC, GROUND SYSTEMS AND SPACE STATION.
      - VERIFY OPERATIONAL STATUS OF ALL SYSTEMS.

OTV TEST PHILOSOPHY

TEST APPROACH (CONT'D)

- o VEHICLE CHECKOUT (CONT'D)
  - o SYSTEM TEST (CONT'D)
    - o A SYSTEM TEST WILL BE INITIATED FROM THE OTV CONTROL STATION (OTVCS)
      - o ONCE INITIATED, TEST WILL BE CONTROLLED BY ON BOARD SELF TEST SOFTWARE AND PERIPHERAL EQUIPMENT.
      - o SYSTEM STATUS WILL BE DETERMINED BY THE SELF TEST SOFTWARE. TEST STATUS AND PROBLEMS WILL BE REPORTED TO THE OTVCS.
  - o VEHICLE INSPECTION (GROUND BASED AND SPACE BASED)
    - o VISUAL INSPECTIONS WILL BE REQUIRED TO VERIFY THOSE ASPECTS OF VEHICLE INTEGRITY THAT CANNOT BE VERIFIED BY PLANNED SYSTEM TESTS.
      - o ENGINE NOZZLES
      - o THERMAL PROTECTION PANELS
      - o RCS MODULES
      - o ETC.

OTV TEST PHILOSOPHY

TEST APPROACH (CONT'D)

- CRYOGENIC LOADING TEST
  - GROUND BASED
    - ONE CRYOGENIC LOAD TEST WILL BE RUN DURING THE FIRST FLOW OF EACH GROUND BASED VEHICLE (ONE TIME PER VEHICLE).
    - THIS ONE TIME TEST WILL DEMONSTRATE THE CRYO SYSTEM INTEGRITY PRIOR TO INITIAL ON-LINE OPERATIONS FOR THAT VEHICLE
  - SPACE BASED
    - EACH VEHICLE WILL BE ASSEMBLED AND CRYOGENIC LOAD TESTED (NOT TO EXCEED ITS LOAD CAPABILITY IN THE "ONE G" ENVIRONMENT).
    - VEHICLES WILL THEN BE DISASSEMBLED (UNLESS IT IS TO BE DELIVERED TO THE SPACE STATION ASSEMBLED) AND INSTALLED IN THE ORBITER.
    - THIS TEST WILL VALIDATE THE CRYO SYSTEM INTEGRITY FOR SPACE BASED VEHICLES.

OTV TEST PHILOSOPHY

TEST APPROACH (CONT'D)

- INTERFACE TESTS
  - OTV-SC
    - OTV INTERFACES WILL BE TESTED PRIOR TO SC MATE TO VERIFY OTV SERVICES TO THE SC.
      - POWER (VOLTAGE ONLY) LEVEL AND SWITCHING
      - DISCRETE COMMAND SIGNALS (AMPLITUDE AND DURATION)
      - SC SEPARATION
    - MECHANICAL INTERFACES
      - NO VERIFICATION OF MECHANICAL INTERFACES WILL BE PERFORMED AT THE LAUNCH SITE.
      - MECHANICAL MATE OF THE OTV AND SC WILL SATISFY MECHANICAL INTERFACE REQUIREMENTS).
  - POST MATE
    - POST MATE TEST WILL VERIFY ALL ELECTRICAL INTERFACES ARE PROPERLY MATED AND DEMONSTRATE THE FUNCTIONAL COMPATIBILITY OF THE OTV AND SC; i.e., POWER SWITCHING, INTERLEAVING AND RETRIEVAL OF THE SC TELEMETRY.

OTV TEST PHILOSOPHY

TEST APPROACH (CONT'D)

- o INTERFACE TESTS (CONT'D)
  - o OTV-CITE INTERFACE (GROUND BASED)
    - o OTV-CITE INTERFACE TEST WILL VERIFY THE PHYSICAL AND FUNCTIONAL COMPATIBILITY OF THE OTV AND CITE (ORBITER) PRIOR TO ONLINE OPERATIONS.
      - o OTV TO STANDARD INTERFACE PANEL CABLE ROUTING.
      - o POWER (CITE POWER WILL BE USED FOR ALL TESTS IN THE VPF)
      - o ALL CIRCUITS TO THE AFT FLIGHT DECK AND THE T-0 UMBILICAL(s)
      - o ALL DATA HANDLING IN ALL MODES. (i.e., CAUTION AND WARNING, MCDS, PI, PDI, PAYLOAD RECORDER WITH CITE PRELAUNCH, LAUNCH AND ON-ORBIT SOFTWARE LOADS.)
      - o SINCE OTV IS A REUSABLE VEHICLE, THE OTV-CITE TEST SHOULD BE CONSIDERED A **DESIGN VALIDATION TEST** AND RUN ON THE FIRST FLIGHT VEHICLE ONLY.

OTV TEST PHILOSOPHY

TEST APPROACH (CONT'D)

- o INTERFACE TESTS (CONT'D)
  - o OTV-ORBITER INTERFACE (GROUND BASED)
    - o OTV-ORBITER INTERFACE TEST WILL VERIFY THAT ALL INTERFACE CONNECTORS ARE PROPERLY MATED AND WILL VERIFY THE FUNCTIONAL COMPATIBILITY OF THE OTV AND THE ORBITER.
      - o OTV-ORBITER INTERFACE TEST WILL FOLLOW THE OTV-CITE INTERFACE TEST PHILOSOPHY. THE SCOPE WILL BE REDUCED TO THE MINIMUM REQUIRED TO VERIFY THE CAPABILITY TO ACHIEVE ORBITER LAUNCH, OTV DEPLOYMENT AND OTV RETREIVAL FROM LEO.
      - o OTV POWER WILL BE PROVIDED BY THE ORBITER FOR ALL TESTS PERFORMED AFTER OTV-INSTALLATION IN THE ORBITER.
  - o OTV-FACILITY INTERFACES
    - o USE PROTOFLIGHT VEHICLE TO VERIFY FACILITY INTERFACES
    - o MINIMIZE FLIGHT HARDWARE INTER- AND INTRA- FACILITY MOVES
    - o MINIMIZE CRYO TEST REQUIREMENTS.

OTV TEST PHILOSOPHY

TEST APPROACH (CONT'D)

- o PAYLOAD BAY OR DACC TEST (GROUND BASED)
  - o IN ADDITION TO THE OTV-ORBITER INTERFACE TESTS, OTV TESTS WILL BE RUN TO VERIFY READINESS FOR FINAL COUNTDOWN AND LAUNCH.
    - o OTV TO GROUND CRYO SYSTEM LEAK AND INTERFACE TEST
    - o OTV SYSTEMS VERIFICATION
    - o OTV MISSION DATA LOAD AND VERIFICATION
    - o FINAL CLOSEOUT
    - o INERTIAL MEASUREMENT UNIT CALIBRATION AND ALIGNMENT
- o ORBITER FINAL COUNTDOWN AND LAUNCH (GROUND BASED)
  - o OTV WILL BE LAUNCH READY AT START OF FINAL COUNTDOWN WITH THE EXCEPTION OF CRYOGENIC LOADING
  - o OTV FINAL COUNTDOWN TESTS WILL
    - o VERIFY OTV READY FOR CRYO LOADING
    - o SUPPORT CRYO LOADING
    - o ACTIVATE AND LOAD TEST FUEL CELLS
    - o COMMIT OTV FOR ORBITER LAUNCH

OTV TEST PHILOSOPHY

TEST APPROACH (CONT'D)

- o PREDEPLOYMENT CHECKOUT (GROUND BASED)
  - o PREDEPLOYMENT CHECKOUT WILL VERIFY OTV AND ORBITER READINESS FOR OTV DEPLOYMENT.
    - o VERIFY OTV SAFETY AND HEALTH STATUS VIA ORBITER CAUTION AND WARNING SYSTEM AND MCDS.
    - o ESTABLISH OTV-ORBITER PI LINK FOR TELEMETRY
    - o ESTABLISH OTV CS-G RF LINKS FOR TELEMETRY AND COMMAND.
    - o COMMIT FOR DEPLOYMENT.
  - o FOR DACC OTV-SC MATE IN LEO, THE DEPLOYMENT SEQUENCE WILL NEED TO BE EXPANDED TO INCLUDE SC DEPLOYMENT AND MATE OPERATIONS

OTV TEST PHILOSOPHY

TEST APPROACH (CONT'D)

- RF END-TO-END TEST
  - AN RF END-TO-END TEST WILL BE RUN ON THE PROTOFLIGHT/FIRST FLIGHT VEHICLE TO VERIFY ALL LINKS IN ALL MODES.
  - ON SUBSEQUENT VEHICLES, THE RF END-TO-END TEST WILL BE LIMITED TO TELEMETRY AND COMMAND CAPABILITY BY RF LINK(S) BETWEEN THE OTV AND THE OTVCS.
- RSS TEST
  - THERE WILL BE NO PLANNED OTV TESTING IN THE RSS (i.e., OTV HEALTH AND STATUS)
- TEST PROCEDURES
  - MANUAL VEHICLE ASSEMBLY AND HANDLING OPERATIONS WILL BE CONTROLLED BY COMPUTERIZED PROCEDURES USING NORMAL MANUFACTURING PLANNING.
  - VEHICLE CHECKOUT PROCEDURES WILL BE COMPUTER TERMINAL DISPLAYED AND CONTROLLED.
  - REAL TIME PROCEDURE BUY-OFF BY QUALITY WILL BE BY CODED READER INPUTS TO TEST CONTROL.
    - A PERMANENT RECORD OF THE COMPLETED PROCEDURE WILL PROVIDE A QUALITY CONTROL AND HISTORICAL RECORD OF THE AUTHORIZATION, SEQUENCING, TEST REQUIREMENT VERIFICATION, PROPER SYSTEM OPERATION AND COMPLETION OF THE COMPUTER CONTROLLED PROCEDURES.

OTV TEST PHILOSOPHY

TEST APPROACH (CONT'D)

- o MISSION SIMULATION TEST
  - o A TRUE MISSION SIMULATION TEST ENTAILS SIMULATED FLIGHT DYNAMICS
  - o IF FLIGHT DYNAMICS CANNOT BE READILY SIMULATED ON THE ASSEMBLED VEHICLE, A MISSION SIMULATION TEST WILL NOT BE PERFORMED.
- o OTV CONTROL STATION - GROUND (OTV CS-G) COMPATIBILITY TEST
  - o NO SPECIFIC COMPATIBILITY TEST WILL BE REQUIRED. (OTV TO OTV CS-G COMPATIBILITY WILL BE VERIFIED DURING OTV PROCESSING AT THE LAUNCH SITE)
  - o DATA ANALYSIS AT THE CHECKOUT STATION IN THE OTV CS-G WILL BE TO CONFIRM SYSTEM FAILURE AND VERIFY ORU NEEDING REPLACEMENT.

OTV TEST PHILOSOPHY

OTV - FACILITY DESIGN GOALS

- DESIGN IN STANDARD SERVICES; i.e., CRANES, POWER, COMMUNICATIONS, CLEANLINESS CONTROL, ETC.
- MAKE UNIQUE HARDWARE PORTABLE; i.e., SPECIAL TEST EQUIPMENT, WORKSTANDS, HANDLING FIXTURES, ETC.
- PROVIDE LARGE VOLUME WORKSPACE THAT CAN BE READILY ADAPTED TO VEHICLE BLOCK CHANGES, GROUND AND SPACE BASED VEHICLE PROCESSING, MULTIPLE VEHICLES IN FLOW, TANKER VEHICLE PROCESSING AND REUSE FOR OTHER PROGRAMS.
- PROVIDE FOR HAZARDOUS VEHICLE PROCESSING

FINAL PRESENTATION
AGENDA

1. INTRODUCTION .... A. SCHOLZ
2. TEST PHILOSOPHY .... A. SCHOLZ
3. FLOW DIAGRAMS .... A. SCHOLZ
   GROUND BASED
   SPACE BASED
4. RESOURCE IDENTIFICATION SHEETS (RIS's) ... D. LOWRY
5. TECHNOLOGY IDENTIFICATION .... D. LOWRY
6. FACILITY IDENTIFICATION .... D. LOWRY
7. MANPOWER (SERIAL HOURS-MANHOURS) ..... A. SCHOLZ
8. SUMMARY .... A. SCHOLZ

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TYPICAL GROUND-BASED OTV FLOW

OTV PREPARATIONS

1. OTV R & I
2. MECH. ASSEMBLY
3. ELECT. ASSEMBLY
4. MECH. SYSTEMS TEST
5. ELEC. SYSTEM TEST
6. OTV INTEGRATED OPERATIONS
7. OTV/CS-G SYSTEMS TEST

1st TIME ONLY FOR EACH OTV

8. MOVE TO CRYO FACILITY
9. CRYO LOAD & DRAIN

OTV / SC INTEGRATION

10. MOVE TO OTV/SC INTEG FACIL.
11. OTV/SC MECH./ELEC. MATE
12. OTV/SC INTEG TEST
13. OTV/SC/CITE INTERFACE TES

LAUNCH PREPARATION

14. CLOSEOUT & MOVE PREPS.
15. INSTALL IN CANISTER
16. INSTALL IN RSS/PGHM
17. ADDITIONAL SUBSYSTEM INST'L
18. LOAD OTV RCS
19. INSTALL P/L IN ORBITER
20. P/L ORBITER INTERFACE
21. SC POCC TESTS
22. FINAL P/L CLOSEOUT
23. OTV-SC LAUNCH PREPS
24. DEPLOY OTV/SC

MISSION OPERATIONS

25. LAUNCH FROM LEO
26. PERFORM MISSION
27. RETURN OTV (GEO TO LEO)
28. OTV/S.S. RENDEZVOUS

RECOVER the VEHICLE

29. OTV RECOVERY
30. RETURN TO LAUNCH SITE
31. REMOVE OTV FROM ORGITER
32. MOVE OTV TO CRYO FACILITY
33. VENT/PURGE CRYO/RCS TANKS

MAINTENANCE/REFURBISHMENT

34. MOVE TO PROCESSING FACILITY
35. PLANNED MAINTENANCE
36. UNPLANNED MAINTENANCE
37. MODIFICATIONS
38. RETEST VERIFICATION
39. STORE FOR CALL-UP

BOEING OTV LAUNCH OPERATIONS STUDY for KSC

GROUND BASED OTV - CRYO

PRESENTED AT **KSC** JAN 31, 1986

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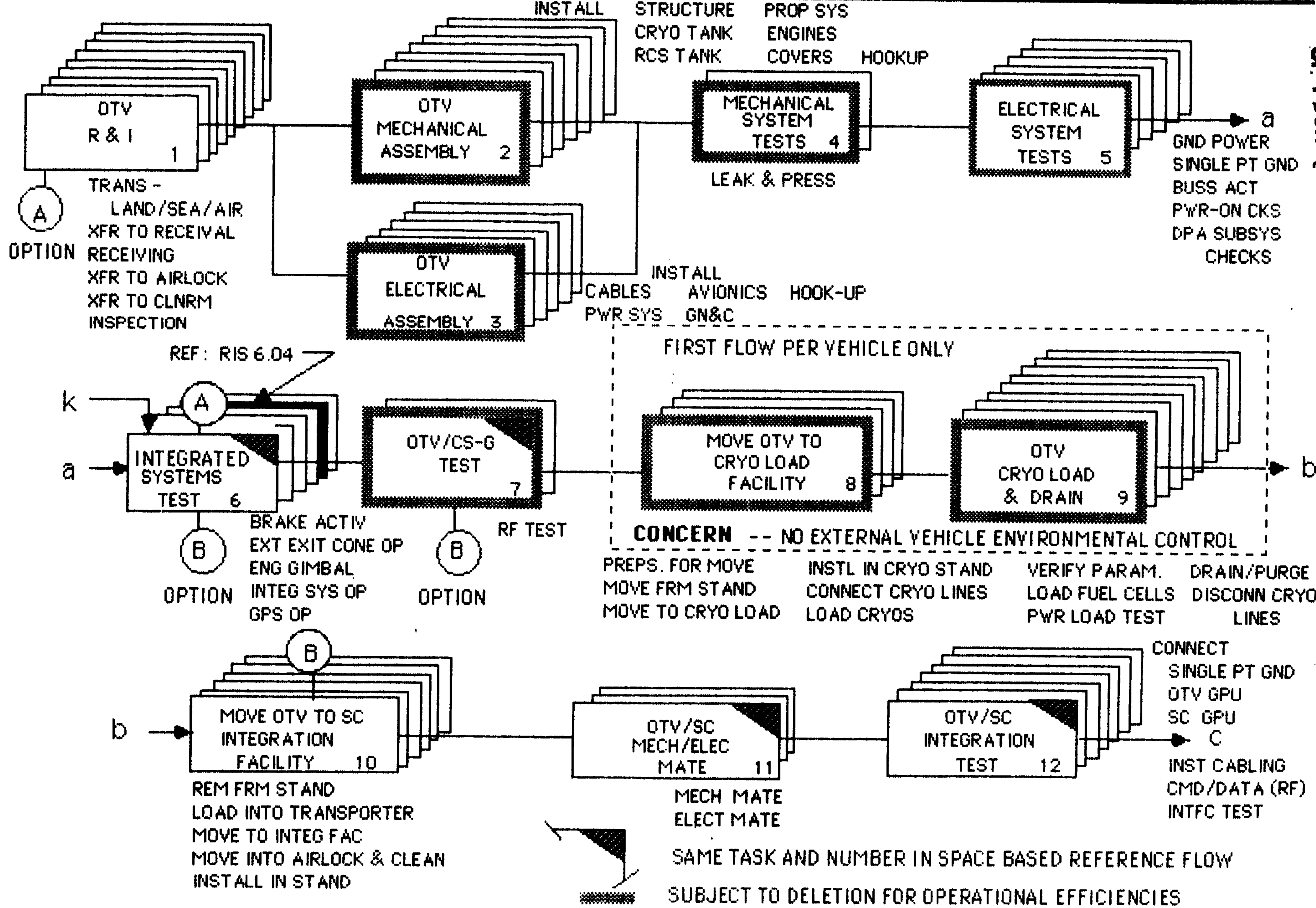

BOEING
OTV LAUNCH
OPERATIONS
STUDY for KSC

GROUND BASED OTV (CONT'D)

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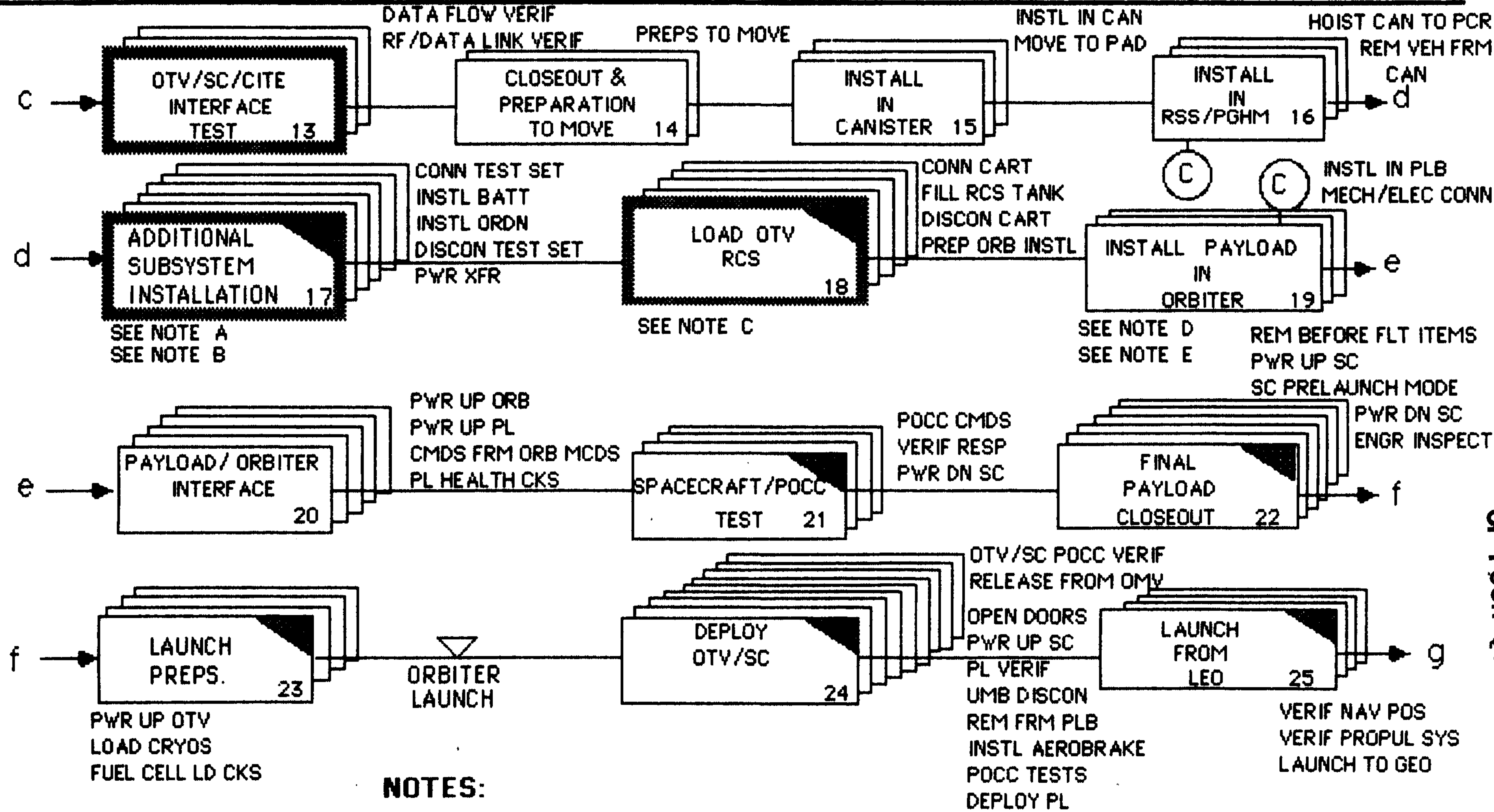
KSC
JAN 31, 1986



NOTES:

A. BATTERY AND ORDNANCE -- REQUIREMENTS AND TYPE PRESENTLY UNDEFINED. INSTALLATION OF EITHER OR BOTH COULD OCCUR ELSEWHERE. DESIGN OBJECTIVE SHOULD BE -- IF THE FUNCTION IS REQUIRED, IT SHOULD BE ACCOMPLISHED OFFLINE.
B. SC PROCESSING REQUIREMENTS IN PCR COULD INFLUENCE TOTAL FLOW TIME.
C. RCS REQUIREMENTS ARE NOT FIRM. DESIGN OBJECTIVE SHOULD BE TO ACCOMPLISH OFFLINE.
D. DESIGN OBJECTIVE SHOULD BE TO ELIMINATE ANY OTV ACCESS REQUIREMENTS IN PLB AFTER PLB INSERTION.
E. OTV REENTRY BRAKING DEVICE PROCESSING -- TBD

SAME TASK AND NUMBER IN SPACE BASED REFERENCE FLOW

SUBJECT TO DELETION FOR OPERATIONAL EFFICIENCIES

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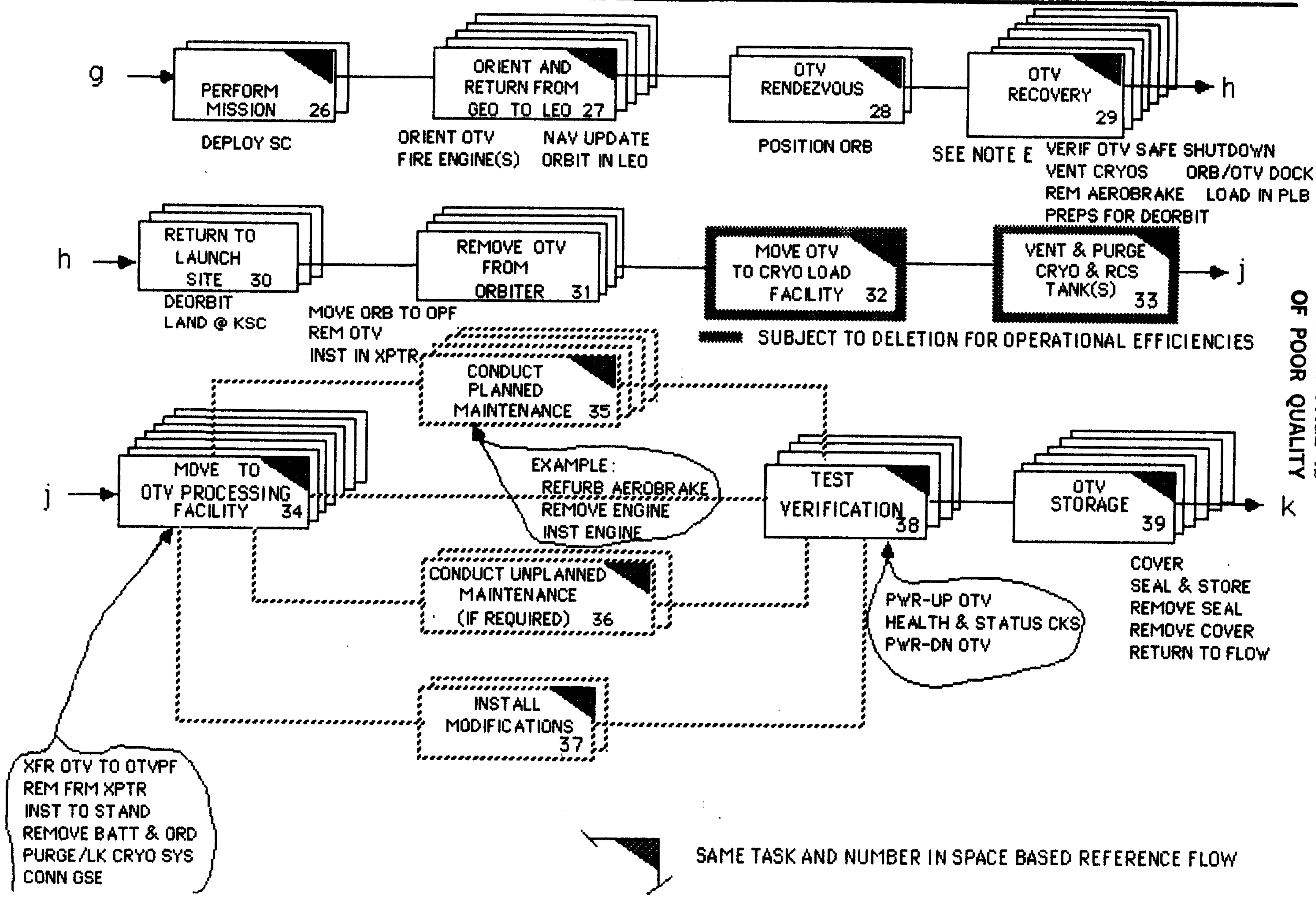
BOEING
OTV LAUNCH
OPERATIONS
STUDY for KSC

GROUND BASED OTV (CONT'D)

PRESENTED AT
KSC
JAN 31, 1986



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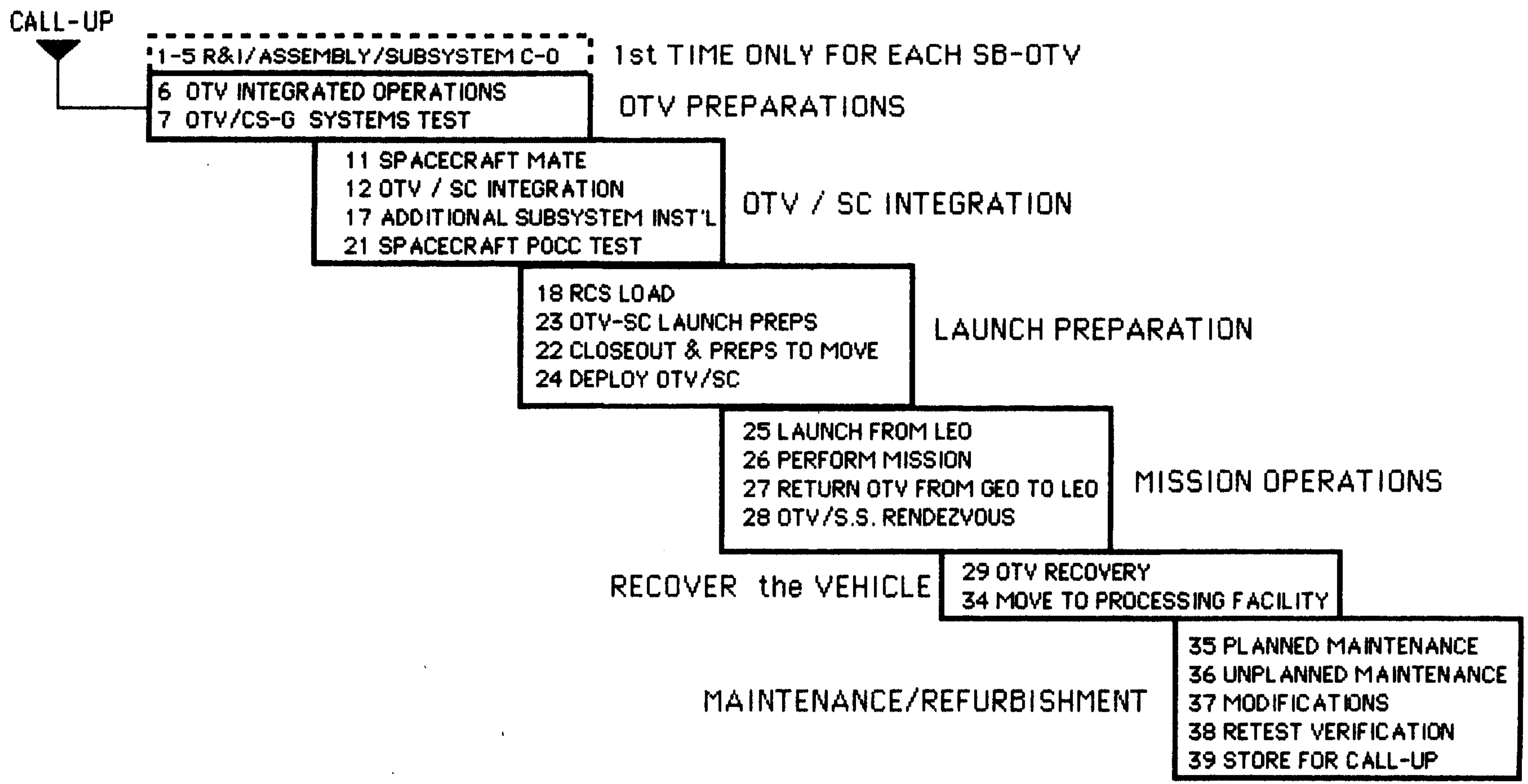
BOEING OTV LAUNCH OPERATIONS STUDY for KSC

TYPICAL SPACE-BASED OTV FLOW

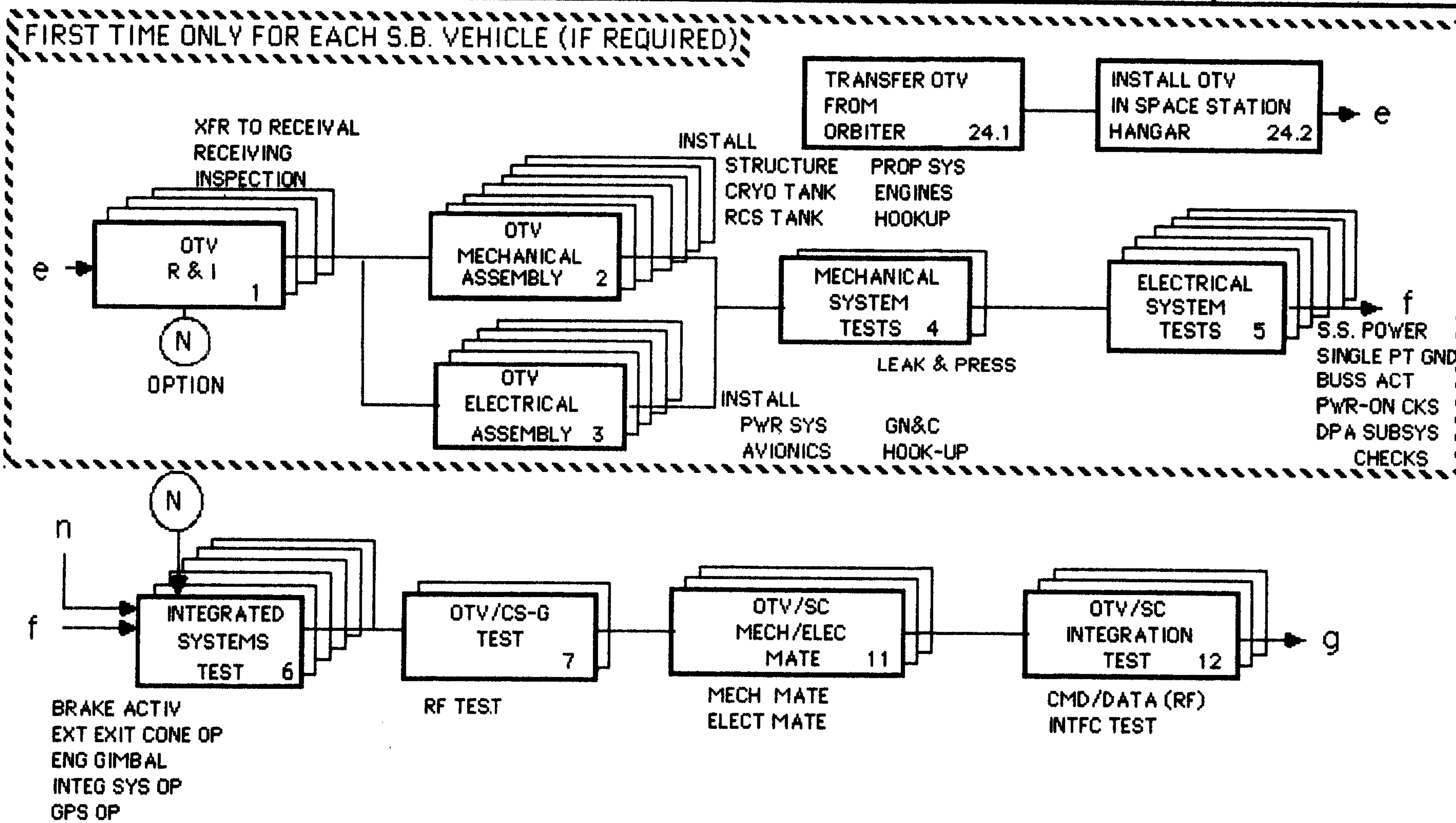
PRESENTED AT KSC JAN 31, 1986



BOEING OTV LAUNCH OPERATIONS STUDY for KSC

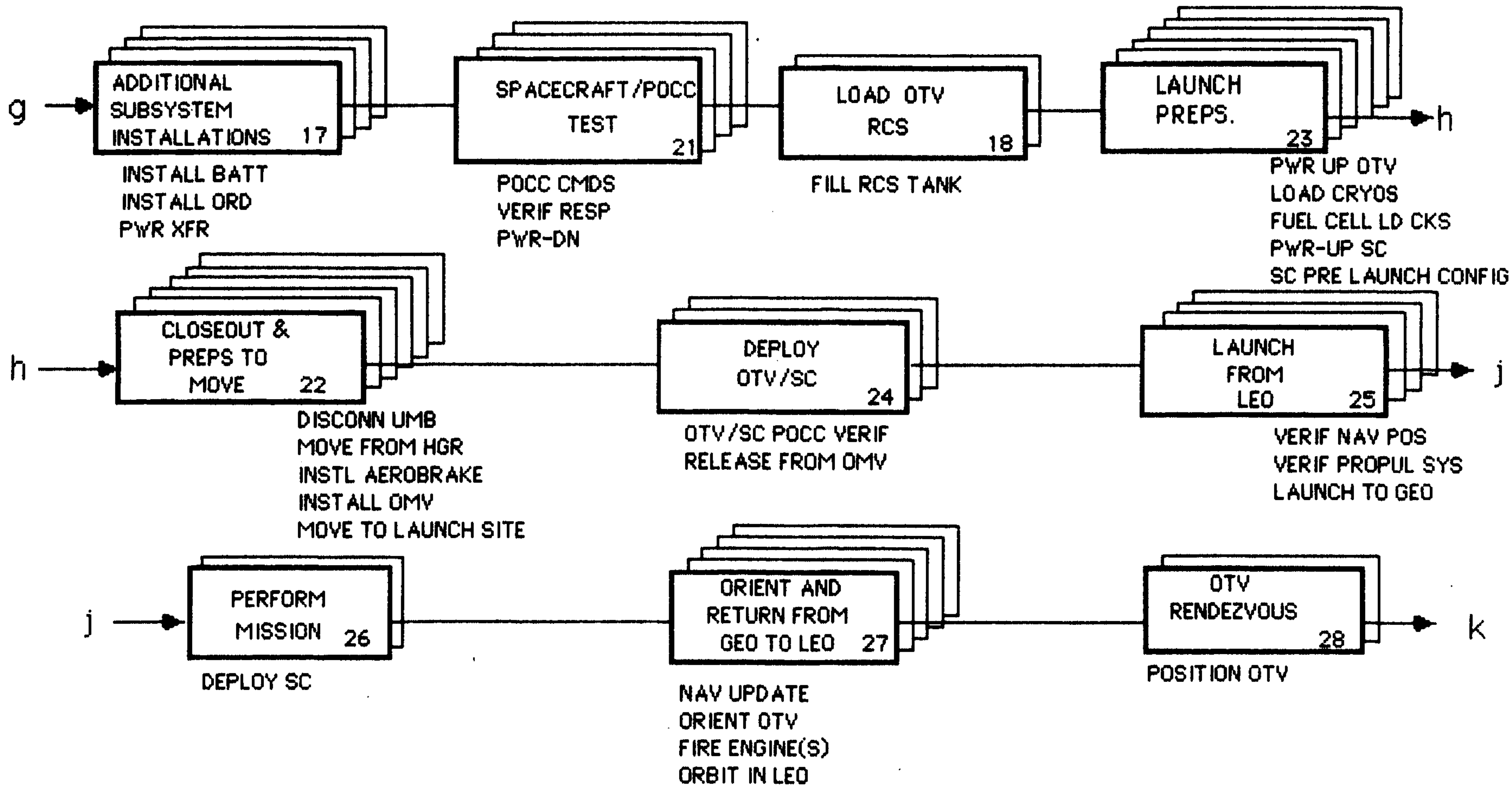
SPACE BASED OTV - CRYO

PRESENTED AT **KSC** JAN 31, 1986

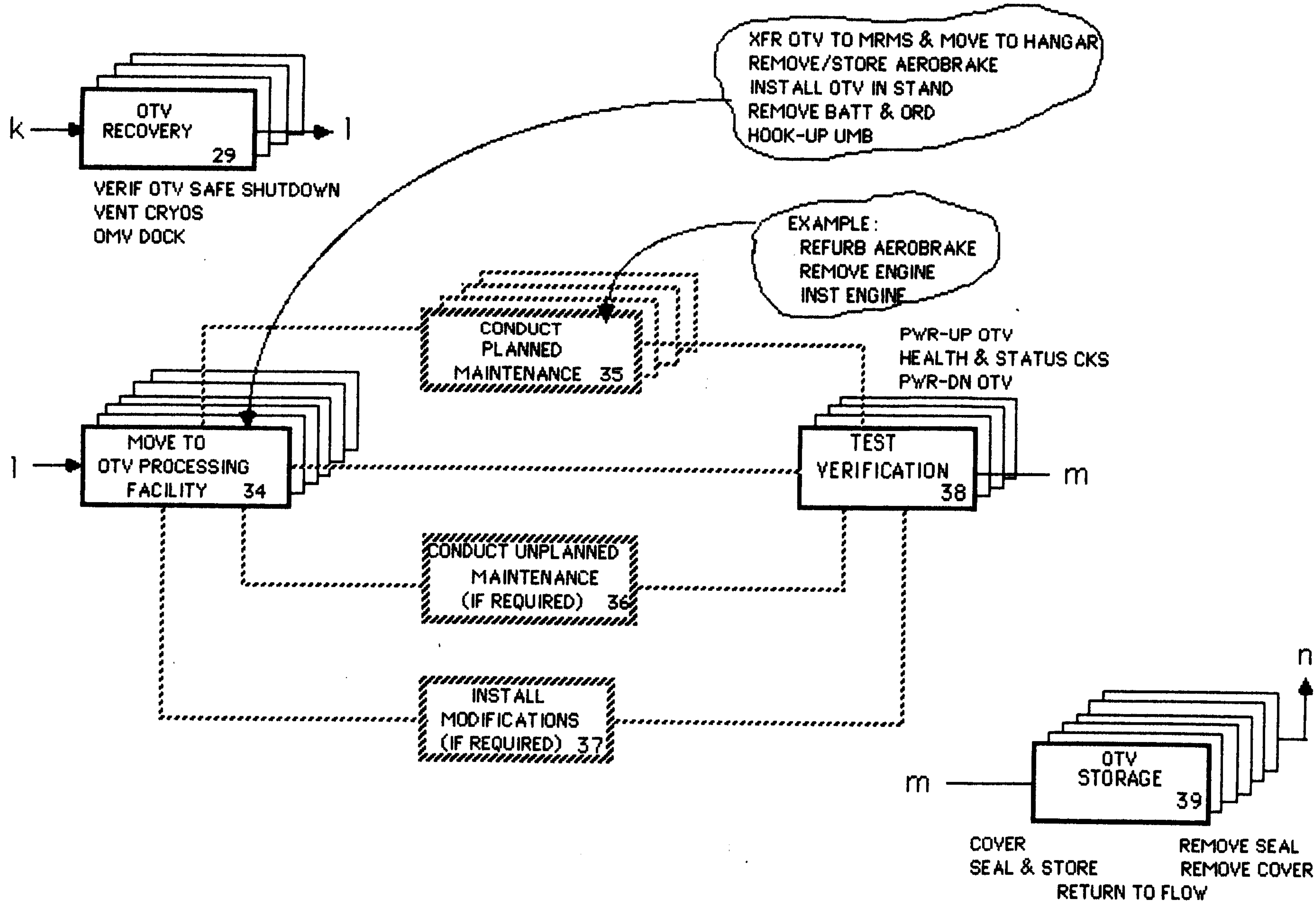


FUNCTIONAL FLOW BLOCK IDENTIFICATION NUMBERS ARE CONSISTENT WITH THE FLOW FOR THE GROUND BASED PAYLOAD BAY CRYO CONFIGURATION. TASKS WITH DECIMAL NUMBERS ARE NEW FUNCTIONS ON THIS FLOW -- MISSING NUMBERS ARE G.B. OTV FUNCTIONS NOT REQUIRED FOR THE S.B. FLOW.

SPACE BASED OTV (CONT'D)



SPACE BASED OTV (CONT'D)



FINAL PRESENTATION
AGENDA

1. INTRODUCTION .... A. SCHOLZ
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4. RESOURCE IDENTIFICATION SHEETS (RIS's) .. D. LOWRY
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   - SPACE BASED
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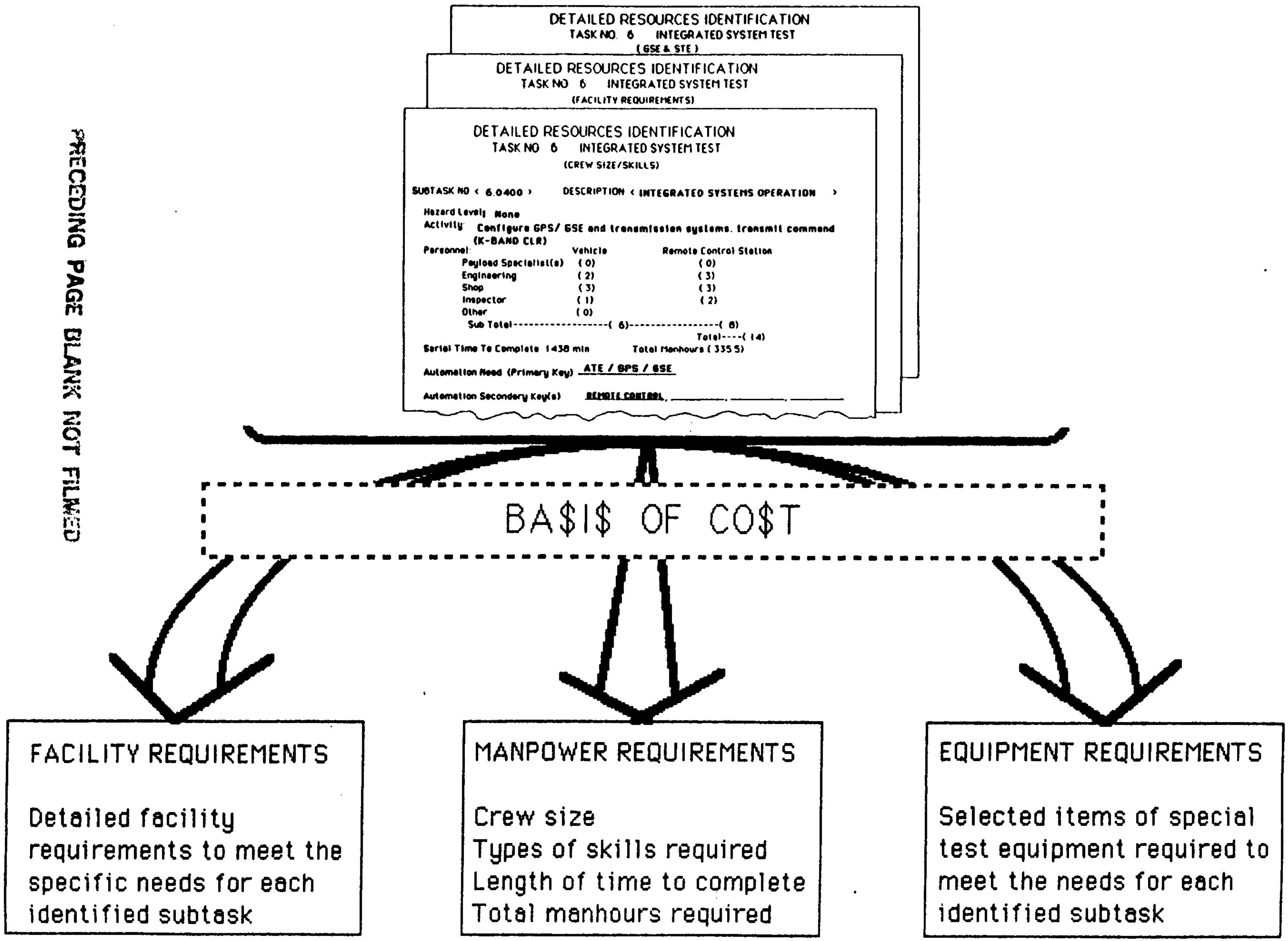
BOEING
OTV LAUNCH
OPERATIONS
STUDY for KSC

RESOURCES IDENTIFICATION SHEETS

PRESENTED AT
KSC
JAN 31, 1986



RESOURCE IDENTIFICATION

DETAILED RESOURCES IDENTIFICATION
TASK NO: 6 INTEGRATED SYSTEM TEST

SUBTASK NO: < **6.0400** > DESCRIPTION: < **INTEGRATION SYSTEMS OPERATION** >

Hazard Level: **1 None**

Activity: **Configure GPS/OTV GSE and transmission systems. transmit command (K-BAND CLR)**

Personnel:	Vehicle	Control Station
Payload Specialist(s)	(0)	(0)
Engineering	(2)	(2)
Shop	(2)	(2)
Inspector	(1)	(2)
Other	(0)	
Sub Total	(5)	(6)
	Total	(11)

Serial Time To Complete: 1438 min Total Manhours (263.6)

Automation Need: (Primary Key) **REMOTE CONTROL**

Automation Secondary Key(s) **GPS**, **ATE**, **GSE**, ______

______, ______, ______, ______

______, ______, ______, ______

RESOURCE IDENTIFICATION
(CONT'D)

DETAILED RESOURCES IDENTIFICATION

TASK NO: 6 INTEGRATED SYSTEM TEST

DETAILED FACILITY RESOURCES (TASK NO: 6.0400)

Physical Size:

					Crane Capacity:	
Air Lock:	40	40	50	[W/D/H][ft]	10 Ton	45 Ft.Hook Height
Doors:	35	45		[W/H][ft]		
High Bay:	70	100	85	[W/D/H][ft]	20 Ton	70 Ft.Hook Height

Standard Commerical Power: Y   Instrumentation Power [Uninterrupted]: Y

Cleanliness:	100K	E.C.S: Humidity: 50 +/- 5 %		Temperature: 70 +/- 5 F	
Closed Circuit Television:	NA	Power Cutoff:	Y	Facility GN2:	NA
Fuel/Oxidizer Disposal:	NA	Helium Supply:	NA	Shop Air:	NA
Fire Protection/Deluge *:	A	Shower/Eye Wash:	NA	Vacuum:	NA
Lightning Protection:	Y	Potable Water:	NA	Paging:	NA
Commerical Telephone:	NA	RF System **:	C	OIS:	Y
Personnel Airlock:	Y	Grounding:	Y	Explosion Proof:	NA

OPTIONS:

	*	**
Y . . . YES	A . . . FIRE PROTECTION	A . . . S BAND & C BAND
N . . . NO	B . . . DELUGE	B . . . Ku BAND
NA . . NOT APPLICABLE	C . . . BOTH	C . . . BOTH
TD . . TO BE DETERMINED	D . . . NONE	D . . . NONE

RESOURCES IDENTIFICATION
(CONT'D)

DETAILED RESOURCES IDENTIFICATION

TASK NO: 6 INTEGRATED SYSTEM TEST

DETAILED EQUIPMENT RESOURCES (TASK NO: 6.0400)

Special Tool Kit: NA	Slings: NA	OTV Adapter: NA
Breakout Boxes: Y	Adapter Cables: Y	Ground Power Unit: Y
Air Pallet: NA	Work Stands: Y	Special Hoisting Equip: N
NASA Canister: N	OTV Canister: N	

Legend For Data Input

Fire Protection/Deluge= A: fire protection
or B: deluge
or C: both
or N: none

RF System= A: S Band & C Band
or B: Ku Band
or C: both
or N: none

Hazard Level:= 1: None
or 2: Local Clear
or 3: Area Clear
or 4: Facility Clear

Others= Y : Yes
N : No
NA : Not Applicable
TD : To Be Determined

SPACE BASED OTV DETAILED RESOURCES IDENTIFICATION

TASK NO: 6 INTEGRATED SYSTEM TEST

SUBTASK NO: <**6.0400** > DESCRIPTION: <**INTEGRATED SYSTEM OPERATIONS** >

ACTIVITY: **CONFIGURE GPS/OTV GSE AND TRANSMISSION SYSTEMS. TRANSMIT COMMAND (K-BAND CLR)**

Personnel:	SPACE STATION		GROUND STATION	
	STATION SPECIALIST(S) IVA	(2)	CS-G	(6)
	STATION SPECIALIST(S) EVA	(0)		
	Sub Total	(2)		(6)
			Total	(8)

Serial Time To Complete: 1440 min Total Manhours (192.0)

SC-POCC Support Required: (Y)

AUTOMATION NEED: (Primary Key) **REMOTE CONTROL**

AUTOMATION SECONDARY KEY(S) **GPS**, **ATE**, **GSE**, ____,
____, ____, ____, ____,
____, ____, ____, ____,

SBOTV RESOURCE IDENTIFICATION
(CONT'D)

SPACE BASED OTV ACCOMMODATIONS

CONTROL STATION - SPACE STATION(CS-S) SUBTASK NO: **6.0400**

OTV Control & monitor system: Y Tracking: N Data Dump: Y

EVA MONITOR:
Audio: N ,Video: N ,Telemetry: N

OTV HANGER REMOTE CONTROL:
Door(s): N ,Lights: Y TV(signature data auto scan): Y
FSS latch/unlatch: Y RR Umbilical control: N

TRAINING VIDEO SYSTEM: MRMS teleoperation control: N
On-board: N ,Up-link: N

Handling and Postioning Aid (HPA) teleoperation: N

OMV support: N Prop. load & drain computer system: N

ORU Bar code data base: N Paging: Y MPAC: N

Planning work station (computer): Y

SBOTV RESOURCE IDENTIFICATION
(CONT'D)

SPACE BASED OTV ACCOMMODATIONS

OTV HANGER SUBTASK NO: **6.0400**

Aerobrake storage fitting: N

Personnel EVA door: N

HPA's (local & teleoperated): N

ORU storage lockers: N

Thermal control system: N

OTV flight support structure: N

MPAC connection: N

Hand & foot restraints: N

Tool lockers: N

SBOTV RESOURCE IDENTIFICATION
(CONT'D)

SPACE BASED OTV ACCOMMODATIONS

PROPELLANT SERVICING FACILITY AND EQUIPMENT   SUBTASK NO: **6.0400**

PROPELLANT SERVICING FACILITY:

Standard Servicing Interface (remote latch/unlatch): N
Remote Control Remateable Quick Disconnects,
Fill/drain/vent/pressurization: N
Fuel cell fill/drain/purge/pressurization: N
Propellant metering system: N

EQUIPMENT:

EVA Personnel equipment: N	EVA equipment box: N	Support Equipment: N
Portable MPAC: N	Lights: N	Bar code reader: N
Video Cameras: N	Tools manual/power: N	

External ORU storage boxes: N

SC electrical/mechanical interface simulator: N

FINAL PRESENTATION
AGENDA

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4. RESOURCE IDENTIFICATION SHEETS (RIS's) .. D. LOWRY

5. TECHNOLOGY IDENTIFICATION .... D. LOWRY
   - ATKB
     - CONCEPT
     - DEVELOPMENT
     - POTENTIAL
   - ATKB THESAURUS

6. FACILITY IDENTIFICATION .... D. LOWRY

7. MANPOWER (SERIAL HOURS-MANHOURS) .... A. SCHOLZ

8. SUMMARY .... A. SCHOLZ

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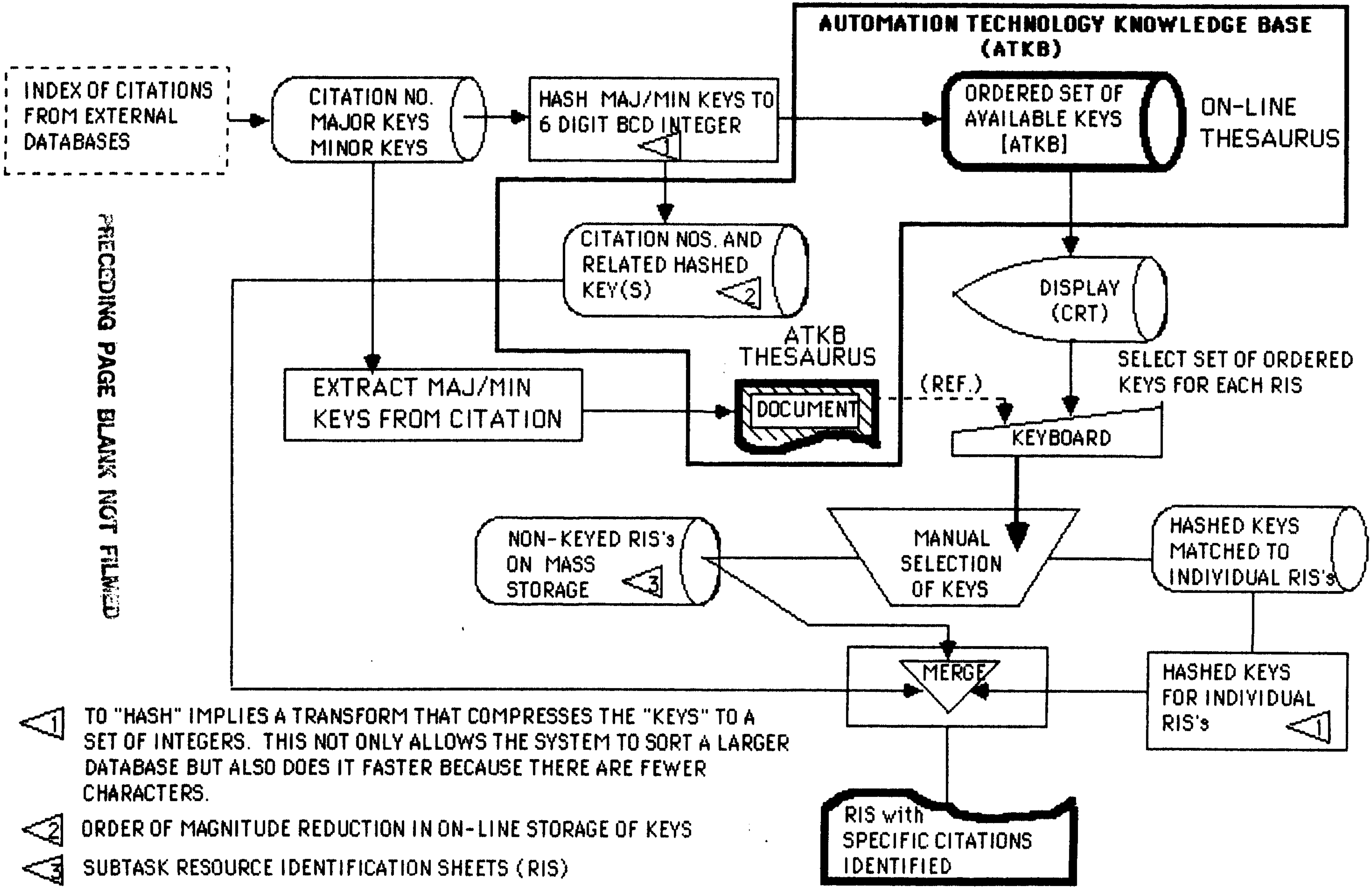
BOEING
OTV LAUNCH
OPERATIONS
STUDY for KSC

PROCESSING FLOW for TECHNOLOGY IDENTIFICATION

PRESENTED AT
KSC
JAN. 31, 1986



1. TO "HASH" IMPLIES A TRANSFORM THAT COMPRESSES THE "KEYS" TO A SET OF INTEGERS. THIS NOT ONLY ALLOWS THE SYSTEM TO SORT A LARGER DATABASE BUT ALSO DOES IT FASTER BECAUSE THERE ARE FEWER CHARACTERS.
2. ORDER OF MAGNITUDE REDUCTION IN ON-LINE STORAGE OF KEYS
3. SUBTASK RESOURCE IDENTIFICATION SHEETS (RIS)

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SUBTASK RESOURCES DEFINITION

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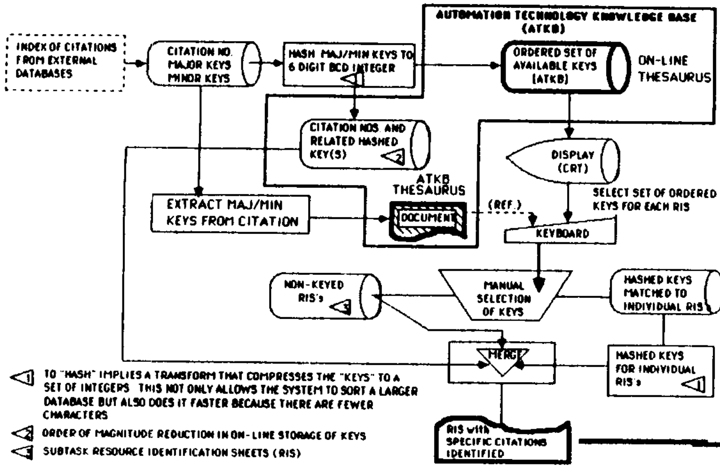
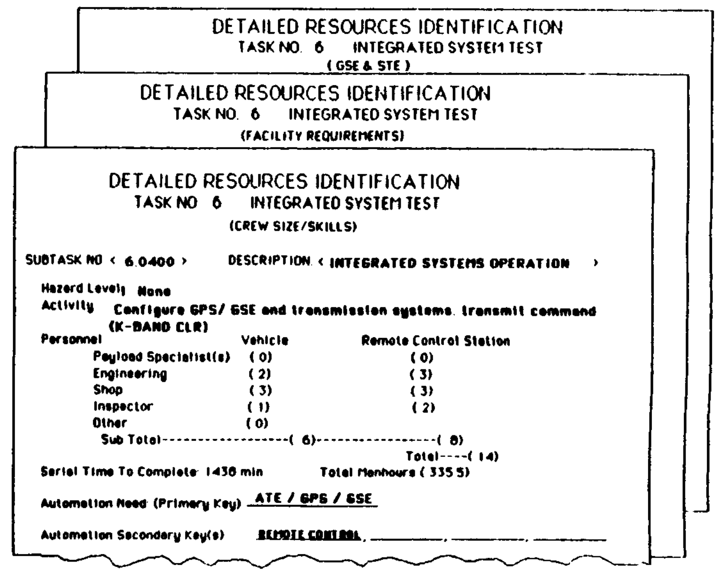



DETAILED RESOURCES IDENTIFICATION
TASK NO. 6 INTEGRATED SYSTEM TEST
(GSE & STE)

DETAILED RESOURCES IDENTIFICATION
TASK NO. 6 INTEGRATED SYSTEM TEST
(FACILITY REQUIREMENTS)

DETAILED RESOURCES IDENTIFICATION
TASK NO 6 INTEGRATED SYSTEM TEST
(CREW SIZE/SKILLS)

SUBTASK NO < 6.0400 > DESCRIPTION < INTEGRATED SYSTEMS OPERATION >

Hazard Level: None
Activity: Configure GPS/ GSE and transmission systems, transmit command (K-BAND CLR)

Personnel	Vehicle	Remote Control Station
Payload Specialist(s)	(0)	(0)
Engineering	(2)	(3)
Shop	(3)	(3)
Inspector	(1)	(2)
Other	(0)	
Sub Total	(6)	(8)

Total----(14)

Serial Time To Complete: 1430 min Total Manhours (335.5)

Automation Need (Primary Key) ATE / GPS / GSE

Automation Secondary Key(s) REMOTE CONTROL

The ATKB contains approximately 50,000 automation oriented citations extracted from the NASA/RECON database. Development of a more definitive ATKB Thesaurus provides the engineer with the capability to quickly identify pertinent information in the database that could be used in the specific task that he is working on at the time. This centralization of current information of this type , coupled with the easy access aspect provided by the ATKB Thesaurus sets up an engineering tool that will greatly expand the capability of almost any engineering staff. Each set of subtask RIS's contains not only the definiton of the necessary facility capabilities, but also identifies the special test equipment, numbers of personnel--by gross skill level, serial task time completion estimates, the total manhours required to complete that particular subtask and identifies automation "keys" leading to technology that could potentially accomplish that specific subtask in a more cost-effective, efficient manner.

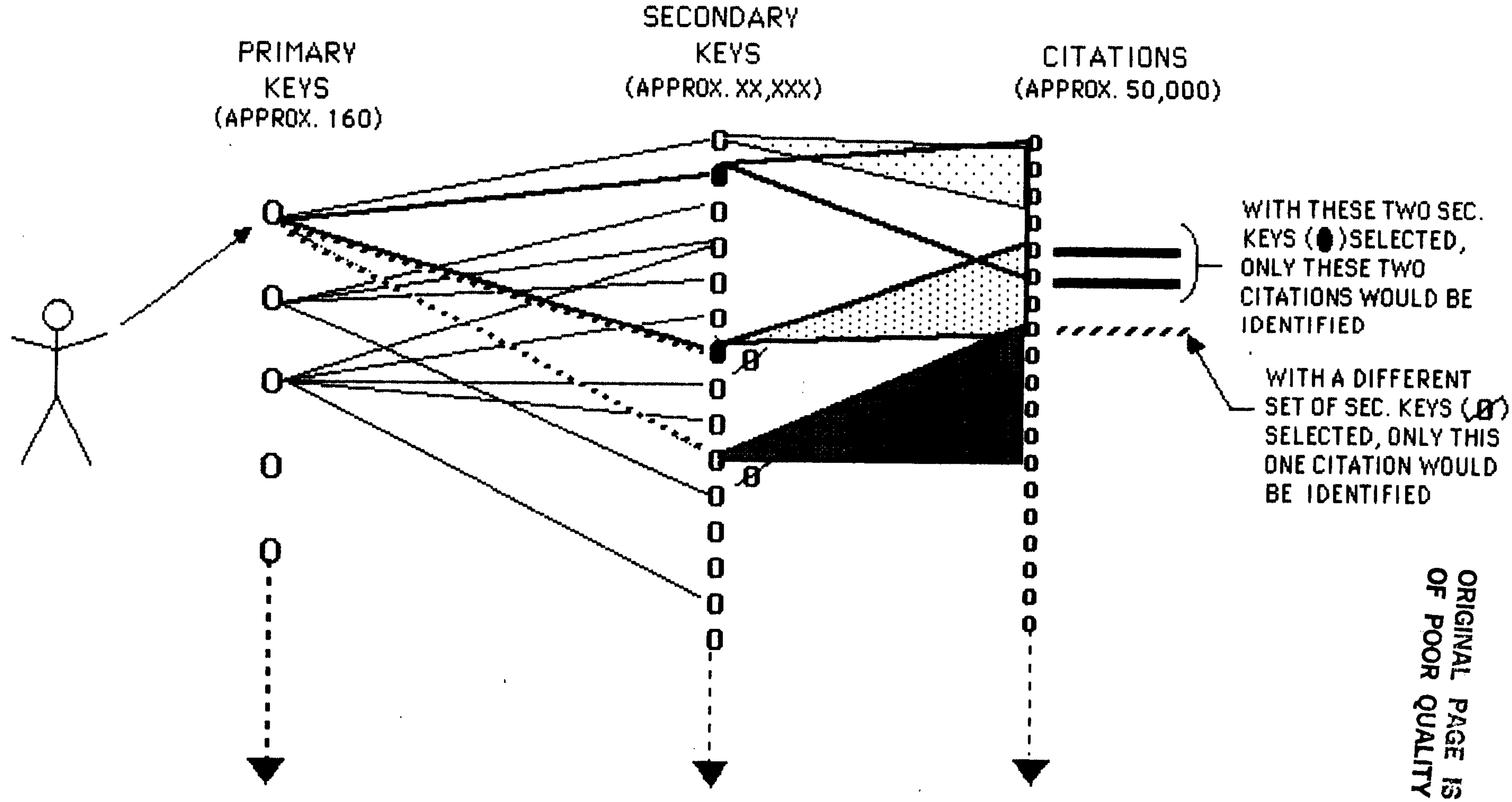
AIKB
SORTING SYSTEM OPERATION

SEQUENTIAL OPERATION:

1. Machine displays PRIMARY KEYS and shows number of associated Citations.
2. Select a PRIMARY KEY from the field displayed on the CRT (system accepts only one PRIMARY KEY at a time).
3. Machine displays Secondary Keys and shows number of associated citations.
4. Select Secondary Key(s) from the field displayed on the CRT.
5. Find all Citations associated with the Secondary Key(s) and build a set of citations per Secondary Key.
6. Because the citation sets are "AND'ed together", only those citations containing the combination of Secondary Keys selected will be displayed. (If the sets were "OR'ed together" all Citations using the selected Secondary Key(s) would be identified.)

AI KB
KEYS/CITATIONS SORTING SYSTEM

SIMPLIFIED SORTING SYSTEM EXPLANATION



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ATKB Thesaurus Example
(Task 6.04)

Primary Key: REMOTE CONTROL

Secondary Key(s):
AUTOMATIC TEST EQUIPMENT.....(18)*
COMPUTER DESIGN.............(427)
COMPUTER PROGRAMS...........(542)
COMPUTER TECHNIQUES.........(349)
CONTROL BOARDS................(4)
COMPUTERIZED SIMULATION.....(187)
COMPATIBILITY................(14)
DATA LINKS...................(32)
FIBER OPTICS.................(44)
GROUND SUPPORT EQUIPMENT.....(12)*
GROUND POWER SUBSYSTEM........(6)*
INTEGRATED MISSION CONTROL...(10)
INTERFACES...................(80)
MANUAL CONTROL...............(18)
MAN MACHINE SYSTEMS.........(237)
MANIPULATORS.................(94)
TELEOPERATORS................(17)

NOTE: Approximately 100 Secondary Keys for this Primary Key

* Defines Secondary Keys selected. the Keys are "ANDed" together so only those citations common to all three Keys would be identified.

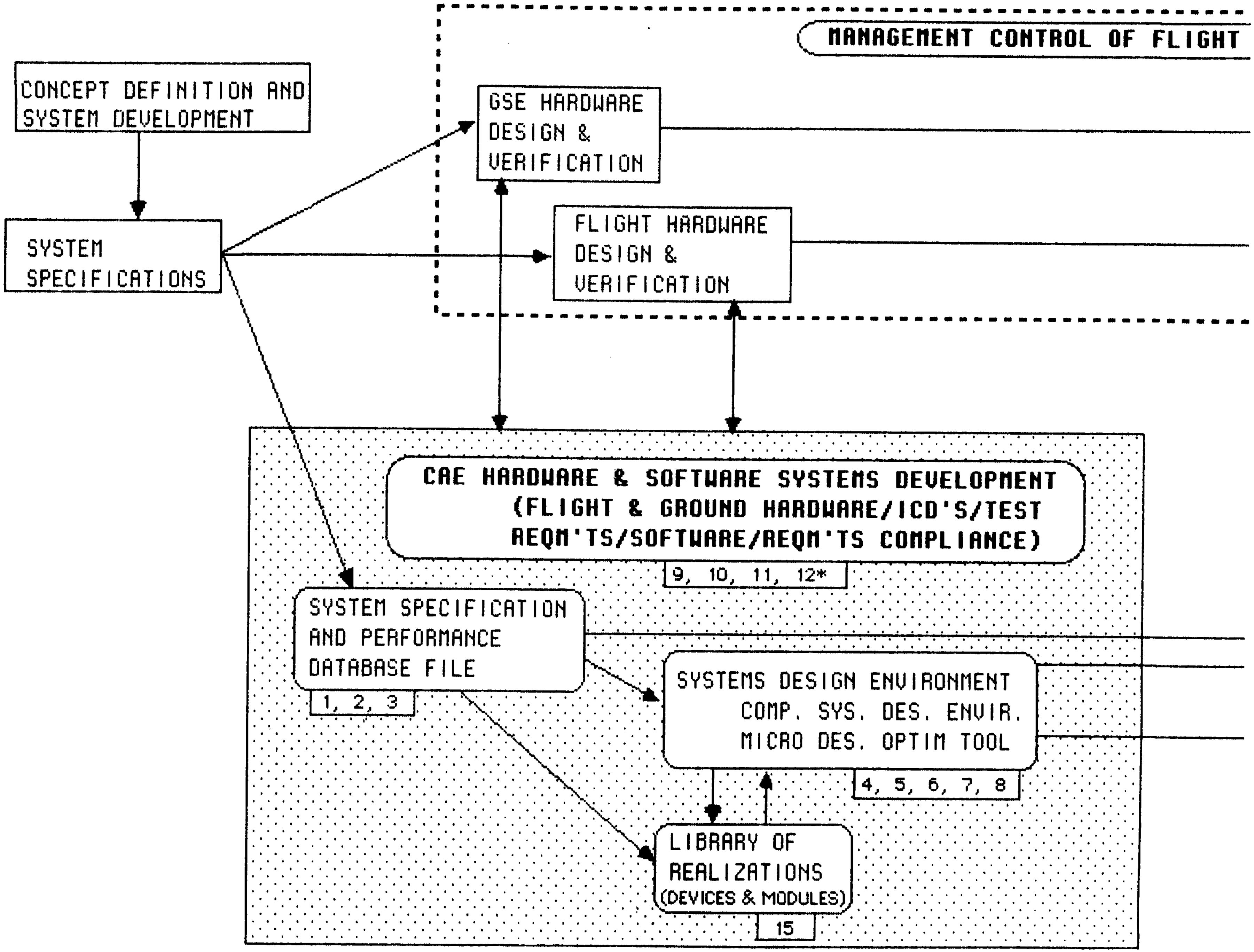
Use of the ATKB THESAURUS will allow you to select the appropriate PRIMARY and SECONDARY KEYS to reduce the amount of material to be reviewed to the six pertinent citations listed below

Selected Citations From NASA/RECON for task No. 6.04

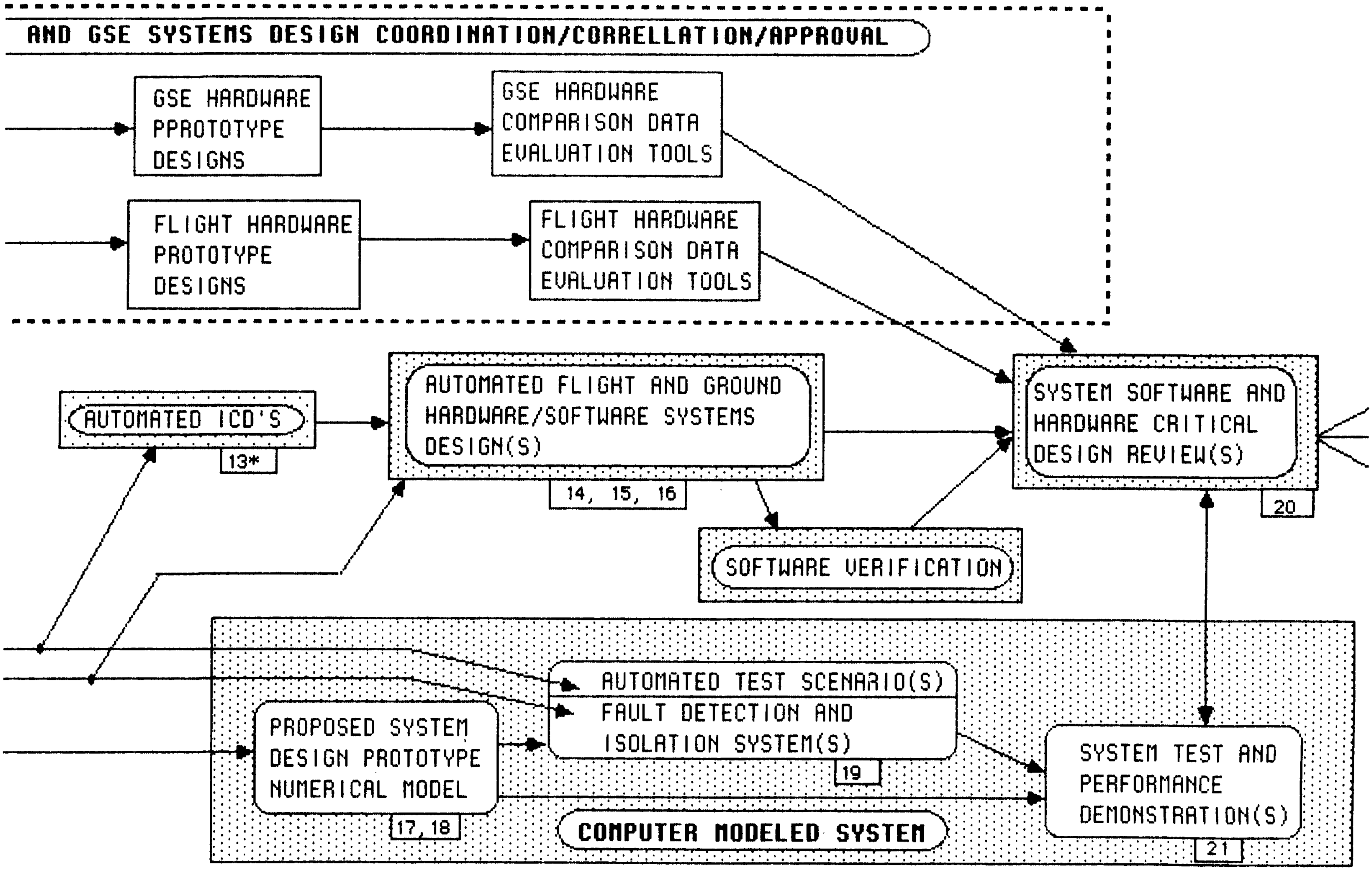
CITATION NOS.

82N26696	84N27782	83K10702
83N11806	82N19109	85X72339

COMPUTER AIDED SYSTEM (HARDWARE/SOFTWARE/DOCUMENTATION)



DEVELOPMENT MODEL



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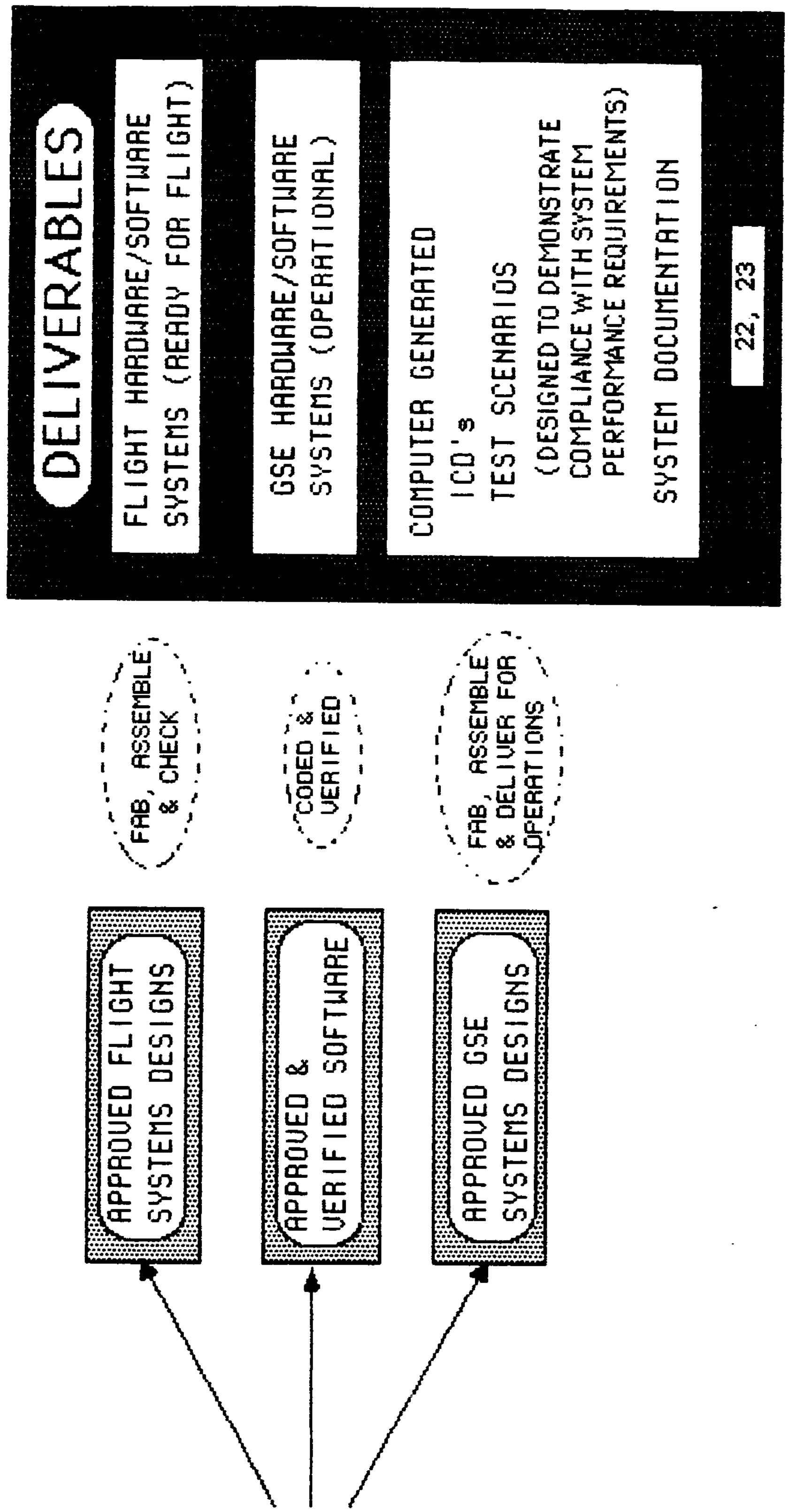

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5. TECHNOLOGY IDENTIFICATION .... D. LOWRY
6. FACILITY IDENTIFICATION .... D. LOWRY
   - SELECTED FACILITIES (DIGITIZED)
   - REQUIREMENTS PER PHASE OF FLOW
   - "BEST FIT" and MODIFICATIONS REQUIRED
7. MANPOWER (SERIAL HOURS-MANHOURS) ..... A. SCHOLZ
8. SUMMARY .... A. SCHOLZ

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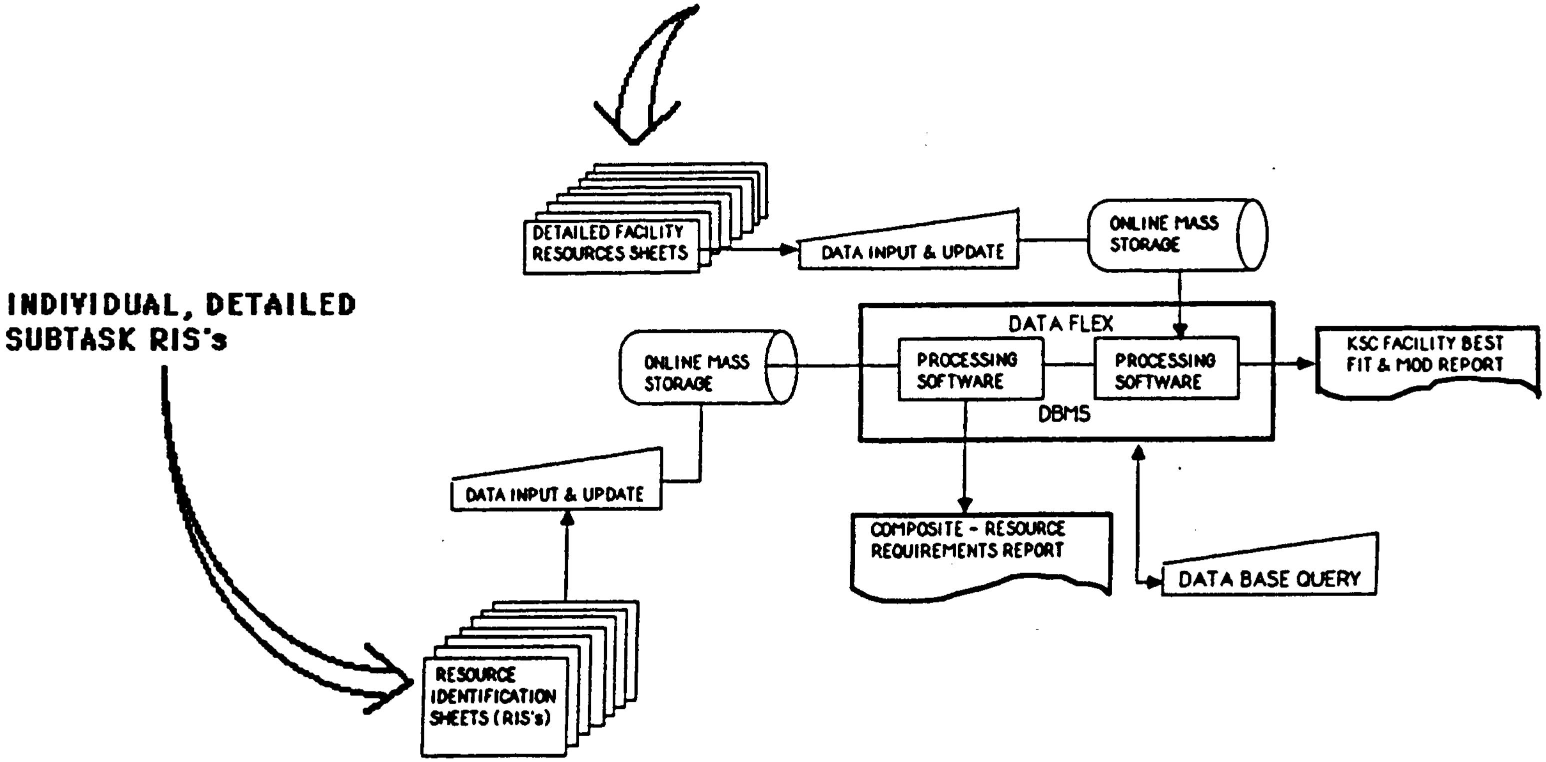
FACILITY REQUIREMENTS/MODIFICATIONS

Software applications programs have been developed that will accummulate the total set of facility requirements from a sequential grouping of the RIS's and print that set of composite requirments as a separate report. The system will also compare those composite requirements with the digitized facility capabilities of the available launch site facilities, determine which facility comes closest to meeting the requirements ("best fit"), and develop a report showing what modifications must be made to the existing facility to make it meet the stipulated requirements.



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BASELINE DIGITIZED FACILITY CAPABILITY

CARGO HAZARDOUS SERVICING FACILITY

DETAILED <CARGO HAZ SERV FACIL> FACILITY RESOURCES

Physical Size:					Crane Capacity:	
Air Lock:	54	80	81	[W/D/H][ft]	15 Ton	75 Ft.Hook Height
Doors:	35	75		[W/H][ft]		
High Bay:	65	152	94	[W/D/H][ft]	50 Ton	85 Ft.Hook Height

Standard Commerical Power: Y

Instrumentation Power [Uninterrupted]: Y

Cleanliness: 100K

E.C.S: Humidity: 50 +/- 5 %

Temperature: 75 +/- 5 F

Closed Circuit Television: Y	Power Cutoff: Y	Facility GN2: Y
Fuel/Oxidizer Disposal: Y	Helium Supply: Y	Shop Air: Y
Fire Protection/Deluge: C	Shower/Eye Wash: Y	Vacuum: Y
Lightning Protection: Y	Potable Water: Y	Paging: Y
Commerical Telephone: Y.	RF System: A	OIS: Y
Personnel Airlock: Y	Grounding: Y	Explosion Proof: N

BASELINE DIGITIZED FACILITY CAPABILITY

HANGAR AM FACILITY

DETAILED <HANGAR AM > FACILITY RESOURCES

Physical Size:		Crane Capacity:	
Air Lock:	0 0 0 [W/D/H][ft]	0 Ton	0 Ft.Hook Height
Doors:	16 34 [W/H][ft]		
High Bay:	63 70 35 [W/D/H][ft]	5 Ton	36 Ft.Hook Height

Standard Commerical Power: Y   Instrumentation Power [Uninterrupted]: Y

Cleanliness: 100K   E.C.S: Humidity: 45 +/- 5 %   Temperature: 75 +/- 5 F

Closed Circuit Television: Y   Power Cutoff: Y   Facility GN2: N

Fuel/Oxidizer Disposal: N   Helium Supply: N   Shop Air: Y

Fire Protection/Deluge: N   Shower/Eye Wash: N   Vacuum: N

Lightning Protection: Y   Potable Water: Y   Paging: Y

Commerical Telephone: Y   RF System: C   OIS: Y

Personnel Airlock: N   Grounding: Y   Explosion Proof: N

BASELINE DIGITIZED FACILITY CAPABILITY

HANGAR AO FACILITY

DETAILED <HANGAR AO > FACILITY RESOURCES

Physical Size:					Crane Capacity:	
Air Lock:	25	29	50	[W/D/H][ft]	10 Ton	47 Ft.Hook Height
Doors:	24	39		[W/H][ft]		
High Bay:	45	175	50	[W/D/H][ft]	10 Ton	48 Ft.Hook Height

Standard Commerical Power: Y   Instrumentation Power [Uninterrupted]: Y

Cleanliness: 100K   E.C.S: Humidity: 50 +/- 5 %   Temperature: 75 +/- 3 F

Closed Circuit Television: Y   Power Cutoff: Y   Facility GN2: N

Fuel/Oxidizer Disposal: N   Helium Supply: N   Shop Air: Y

Fire Protection/Deluge: A   Shower/Eye Wash: N   Vacuum: Y

Lightning Protection: Y   Potable Water: Y   Paging: Y

Commerical Telephone: Y   RF System: C   OIS: Y

Personnel Airlock: Y   Grounding: Y   Explosion Proof: N

BASELINE DIGITIZED FACILITY CAPABILITY

HANGAR S FACILITY

DETAILED <HANGAR S > FACILITY RESOURCES

Physical Size:					Crane Capacity:	
Air Lock:	14	20	19	[W/D/H][ft]	2 Ton	19 Ft.Hook Height
Doors:	16	20		[W/H][ft]		
High Bay:	45	55	17	[W/D/H][ft]	5 Ton	20 Ft.Hook Height

Standard Commerical Power: Y   Instrumentation Power [Uninterrupted]: Y

Cleanliness: 100K   E.C.S: Humidity: 50 +/- 5 %   Temperature: 76 +/- 3 F

Closed Circuit Television: N   Power Cutoff: Y   Facility GN2: Y

Fuel/Oxidizer Disposal: N   Helium Supply: Y   Shop Air: Y

Fire Protection/Deluge: A   Shower/Eye Wash: Y   Vacuum: Y

Lightning Protection: Y   Potable Water: Y   Paging: Y

Commerical Telephone: Y   RF System: C   OIS: Y

Personnel Airlock: Y   Grounding: Y   Explosion Proof: N

BASELINE DIGITIZED FACILITY CAPABILITY

HANGER AE FACILITY

DETAILED <HANGER AE > FACILITY RESOURCES

Physical Size:					Crane Capacity:	
Air Lock:	25	40	17	[W/D/H][ft]	2 Ton	20 Ft.Hook Height
Doors:	14	36		[W/H][ft]		
High Bay:	43	51	34	[W/D/H][ft]	6 Ton	38 Ft.Hook Height

Standard Commerical Power: Y   Instrumentation Power [Uninterrupted]: Y

Cleanliness: 10K   E.C.S: Humidity: 55 +/- 5 %   Temperature: 72 +/- 3 F

Closed Circuit Television: Y   Power Cutoff: Y   Facility GN2: Y

Fuel/Oxidizer Disposal: N   Helium Supply: N   Shop Air: Y

Fire Protection/Deluge: A   Shower/Eye Wash: N   Vacuum: Y

Lightning Protection: Y   Potable Water: Y   Paging: Y

Commerical Telephone: Y   RF System: C   OIS: Y

Personnel Airlock: Y   Grounding: Y   Explosion Proof: N

BASELINE DIGITIZED FACILITY CAPABILITY

SAEF 2 FACILITY

DETAILED <SAEF 2 > FACILITY RESOURCES

Physical Size:					Crane Capacity:	
Air Lock:	41	58	52	[W/D/H][ft]	10 Ton	45 Ft.Hook Height
Doors:	21	39		[W/H][ft]		
High Bay:	49	99	74	[W/D/H][ft]	10 Ton	65 Ft.Hook Height

Standard Commerical Power: Y   Instrumentation Power [Uninterrupted]: N

Cleanliness: 100K   E.C.S: Humidity: 45 +/- 5 %   Temperature: 75 +/- 3 F

Closed Circuit Television: Y   Power Cutoff: Y   Facility GN2: Y

Fuel/Oxidizer Disposal: Y   Helium Supply: N   Shop Air: Y

Fire Protection/Deluge: A   Shower/Eye Wash: Y   Vacuum: Y

Lightning Protection: Y   Potable Water: Y   Paging: Y

Commerical Telephone: Y   RF System: A   OIS: Y

Personnel Airlock: Y   Grounding: Y   Explosion Proof: Y

BASELINE DIGITIZED FACILITY CAPABILITY

VERTICAL PROCESSING FACILITY

DETAILED <VERT PROCESSING FAC > FACILITY RESOURCES

Physical Size:					Crane Capacity:	
Air Lock:	42	74	74	[W/D/H][ft]	10 Ton	69 Ft.Hook Height
Doors:	26		72	[W/H][ft]		
High Bay:	71	143	105	[W/D/H][ft]	25 Ton	95 Ft.Hook Height

Standard Commerical Power: Y   Instrumentation Power [Uninterrupted]: Y

Cleanliness: 100K   E.C.S: Humidity: 45 +/- 5 %   Temperature: 75 +/- 3 F

Closed Circuit Television: Y   Power Cutoff: Y   Facility GN2: Y

Fuel/Oxidizer Disposal: Y   Helium Supply: Y   Shop Air: Y

Fire Protection/Deluge: C   Shower/Eye Wash: Y   Vacuum: Y

Lightning Protection: Y   Potable Water: Y   Paging: Y

Commerical Telephone: Y   RF System: C   OIS: Y

Personnel Airlock: Y   Grounding: Y   Explosion Proof: N

DETAILED COMPOSITE FACILITY RESOURCES

Task Nos. 1 to 13

Detailed Composite Facility Resources For Task No. 1 to 13

	Physical Size:				Crane Capacity:	
Air Lock:	40	40	50	[W/D/H][ft]	10 Ton	45 Ft.Hook Height
Doors:	35	45		[W/H][ft]		
High Bay:	70	100	85	[W/D/H][ft]	25 Ton	20 Ft.Hook Height

Standard Commerical Power: Y

Instrumentation Power [Uninterrupted]: Y

Cleanliness: 100K	E.C.S: Humidity: 50 +/- 5 %	Temperature: 70 +/- 5 F
Closed Circuit Television: Y	Power Cutoff: Y	Facility GN2: Y
Fuel/Oxidizer Disposal: Y	Helium Supply: Y	Shop Air: Y
Fire Protection/Deluge: C	Shower/Eye Wash: Y	Vacuum: Y
Lightning Protection: Y	Potable Water: Y	Paging: Y
Commerical Telephone: Y	RF System: C	OIS: Y
Personnel Airlock: Y	Grounding: Y	Explosion Proof: Y

DETAILED COMPOSITE FACILITY RESOURCES
Task Nos. 1 to 13
(CONT'D)

The following additions to the CARGO HAZ SERV FACIL are required to exaclty fit those requirements as defined in tasks No. 1 to 13:

	Physical Size:				Crane Capacity:	
Air Lock:	0	0	0	[W/D/H][ft]	0 Ton	0 Ft.Hook Height
Doors:	0	0		[W/H][ft]		
High Bay:	5	0	0	[W/D/H][ft]	0 Ton	0 Ft.Hook Height

Standard Commerical Power: N — Instrumentation Power [Uninterrupted]: N

Cleanliness: OK	E.C.S: Humidity: 0 +/- 0 %	Temperature: 0 +/- 0 F
Closed Circuit Television: N	Power Cutoff: N	Facility GN2: N
Fuel/Oxidizer Disposal: N	Helium Supply: N	Shop Air: N
Fire Protection/Deluge: A	Shower/Eye Wash: N	Vacuum: N
Lightning Protection: N	Potable Water: N	Paging: N
Commerical Telephone: N	RF System: C	OIS: N
Personnel Airlock: N	Grounding: N	Explosion Proof: Y

Legend: The NUMBERS indicated in this report are those POSITIVE deltas required

"N"= NO mod. required — "Y"= A mod. IS required

Fire Protection/Deluge= A: fire protection
B: deluge
C: both
N: none

RF System= A: S Band & C Band
B: Ku Band
C: both
N: none

DETAILED COMPOSITE FACILITY RESOURCES

Task Nos. 34 to 39

Detailed Composite Facility Resources For Task No. 34 to 39

	Physical Size:		Crane Capacity:	
Air Lock:	40 40 50	[W/D/H][ft]	10 Ton	45 Ft.Hook Height
Doors:	35 45	[W/H][ft]		
High Bay:	70 100 85	[W/D/H][ft]	25 Ton	20 Ft.Hook Height

Standard Commerical Power: Y	Instrumentation Power [Uninterrupted]: Y	
Cleanliness: 100K	E.C.S: Humidity: 50 +/- 5 %	Temperature: 70 +/- 5 F
Closed Circuit Television: Y	Power Cutoff: Y	Facility GN2: Y
Fuel/Oxidizer Disposal: Y	Helium Supply: Y	Shop Air: Y
Fire Protection/Deluge: C	Shower/Eye Wash: Y	Vacuum: NA
Lightning Protection: Y	Potable Water: Y	Paging: Y
Commerical Telephone: Y	RF System: A	OIS: Y
Personnel Airlock: Y	Grounding: Y	Explosion Proof: Y

DETAILED COMPOSITE FACILITY RESOURCES

Task Nos. 34 to 39

(CONT'D)

The following additions to the CARGO HAZ SERV FACIL are required to exaclty fit those requirements as defined in tasks No. 34 to 39:

	Physical Size:				Crane Capacity:	
Air Lock:	0	0	0	[W/D/H][ft]	0 Ton	0 Ft.Hook Height
Doors:	0	0		[W/H][ft]		
High Bay:	5	0	0	[W/D/H][ft]	0 Ton	0 Ft.Hook Height

Standard Commerical Power: N   Instrumentation Power [Uninterrupted]: N

Cleanliness: OK   E.C.S: Humidity: 0 +/- 0 %   Temperature: 0 +/- 0 F

Closed Circuit Television: N	Power Cutoff: N	Facility GN2: N
Fuel/Oxidizer Disposal: N	Helium Supply: N	Shop Air: N
Fire Protection/Deluge: N	Shower/Eye Wash: N	Vacuum: NA
Lightning Protection: N	Potable Water: N	Paging: N
Commerical Telephone: N	RF System: N	OIS: N
Personnel Airlock: N	Grounding: N	Explosion Proof: Y

Legend: The NUMBERS indicated in this report are those POSITIVE deltas needed
"N"= NO mod. is required   "Y"= A mod. IS required

Fire Protection/Deluge= A: fire protection
B: deluge
C: both
N: none

RF System= A: S Band & C Band
B: Ku Band
C: both
N: none

DETAILED COMPOSITE FACILITY RESOURCES
EVALUATION

The following facilites were evaluated:

Task Nos. 1 - 13

No.	Facility	Score
1	CARGO HAZ SERV FACIL	58
2	HANGAR AM	21
3	HANGAR AO	36
4	HANGAR S	25
5	HANGAR AE	28
6	SAEF 2	42
7	VERT PROCESSING FAC	58

Task Nos. 34 - 39

No.	Facility	Score
1	CARGO HAZ SERV FACIL	58
2	HANGAR AM	19
3	HANGAR AO	34
4	HANGAR S	24
5	HANGAR AE	26
6	SAEF 2	42
7	VERT PROCESSING FAC	56

The best fit KSC facility for tasks No. 1 to 13 is the CARGO HAZ SERV FACIL

The best fit KSC facility for tasks No. 34 to 39 is the CARGO HAZ SERV FACIL

NOTE:
1) There is no perfect score but a high score is better than a low score.
2) Scores are relative to the requirements
3) Each individual facility requirement can be "weighted" relative to other requirements to highlight high cost items or items of special interest.

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FINAL PRESENTATION
AGENDA

1. INTRODUCTION .... A. SCHOLZ
2. TEST PHILOSOPHY .... A. SCHOLZ
3. FLOW DIAGRAMS .... A. SCHOLZ
4. RESOURCE IDENTIFICATION SHEETS (RIS's) ... D. LOWRY
5. TECHNOLOGY IDENTIFICATION .... D. LOWRY
6. FACILITY IDENTIFICATION .... D. LOWRY
7. MANPOWER (SERIAL HOURS-MANHOURS) ..... A. SCHOLZ
    - GROUND BASED
        - FIRST FLOW
        - NOMINAL FLOW/RECURRING FLOW
        - FIRST FLOW (FACTORY ASSEMBLY/CHECKOUT)
    - SPACE BASED
        - NOMINAL FLOW/RECURRING FLOW
8. SUMMARY .... A. SCHOLZ

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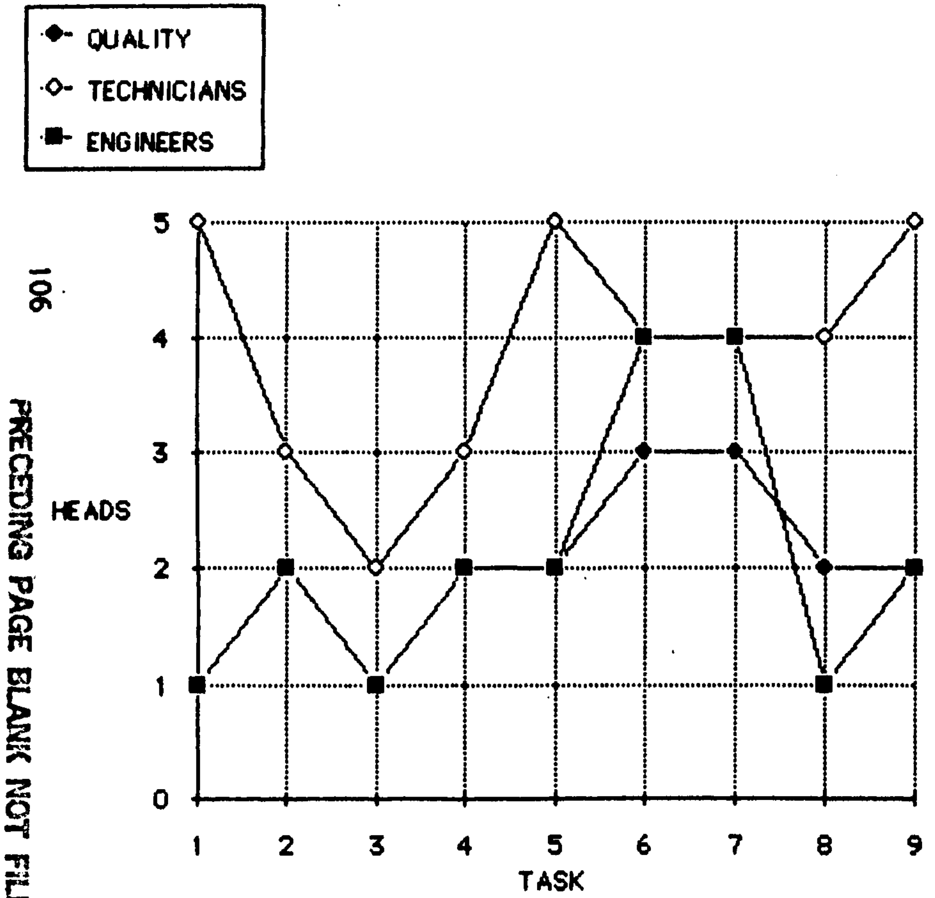
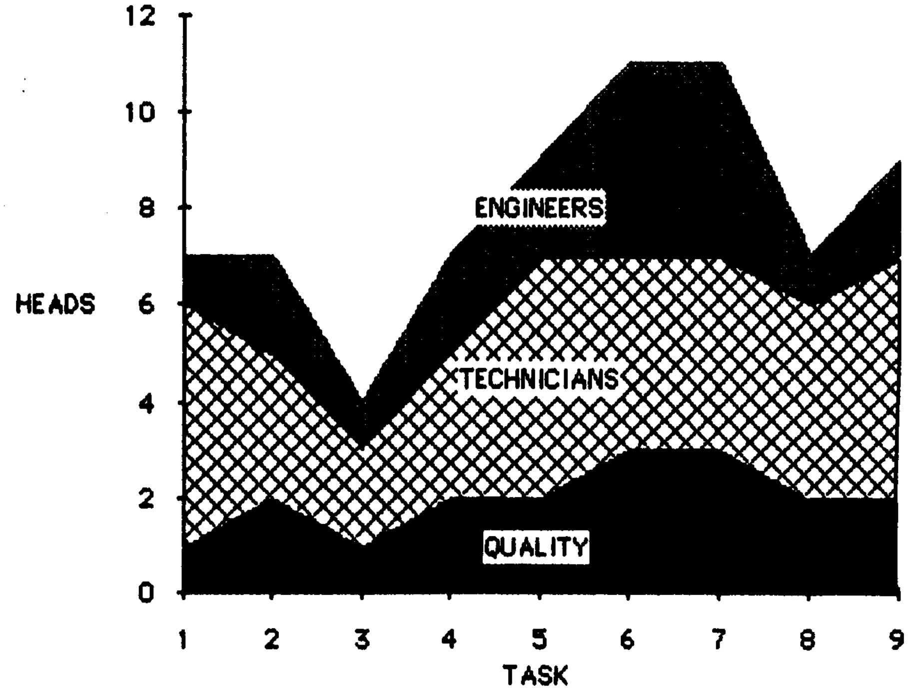
GBOTV MANPOWER

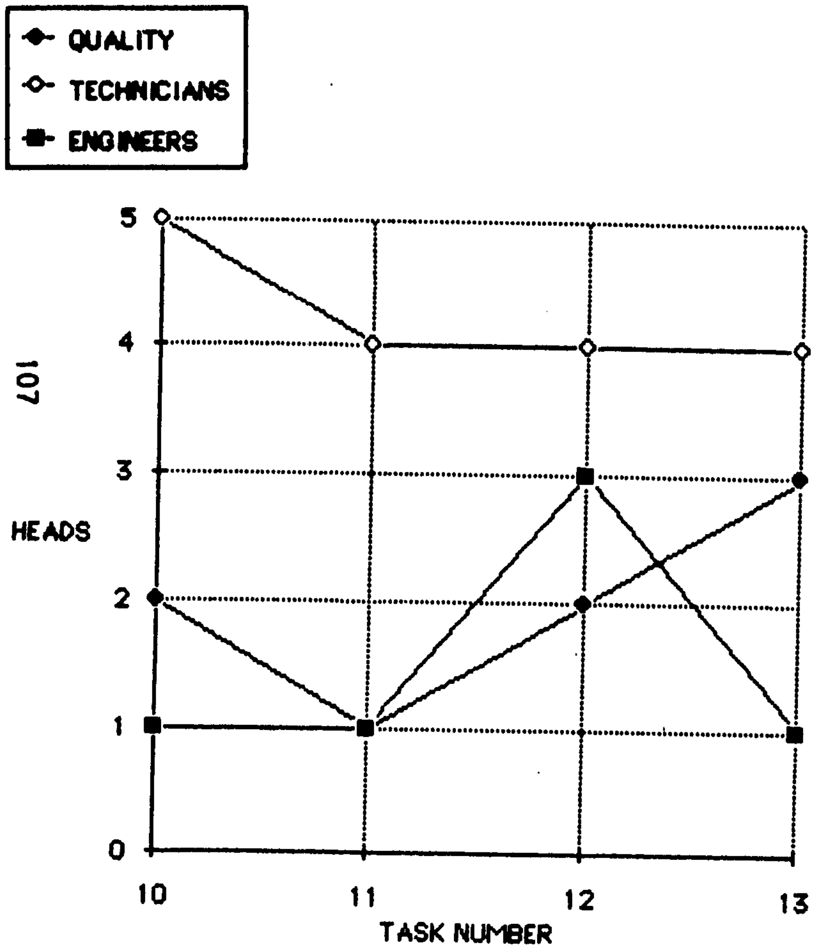
PREPARATIONS

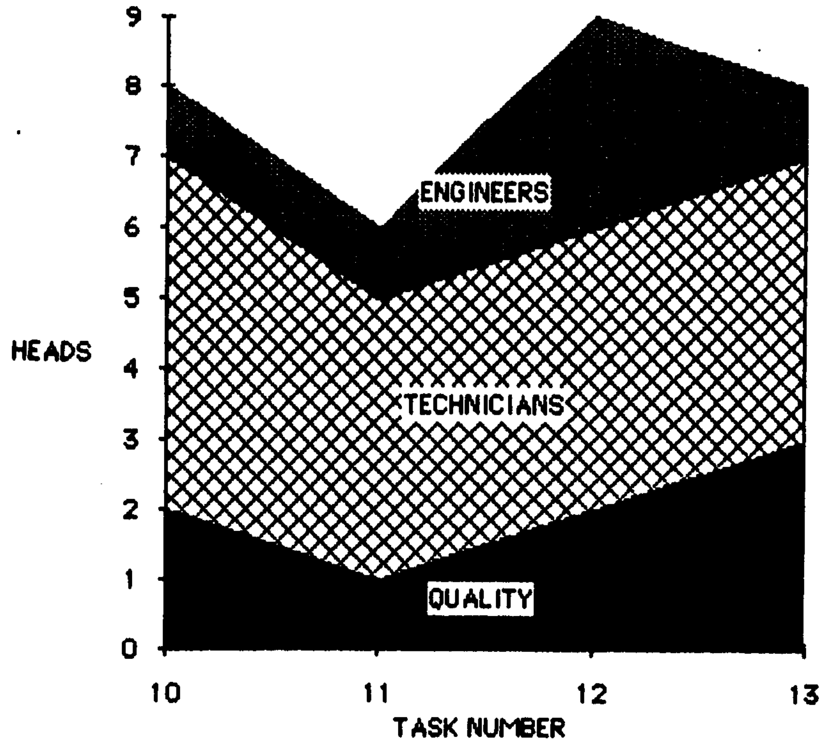




GBOTV MANPOWER

OTV/SC INTEGRATION





GBOTV MANPOWER

LAUNCH PREPARATIONS

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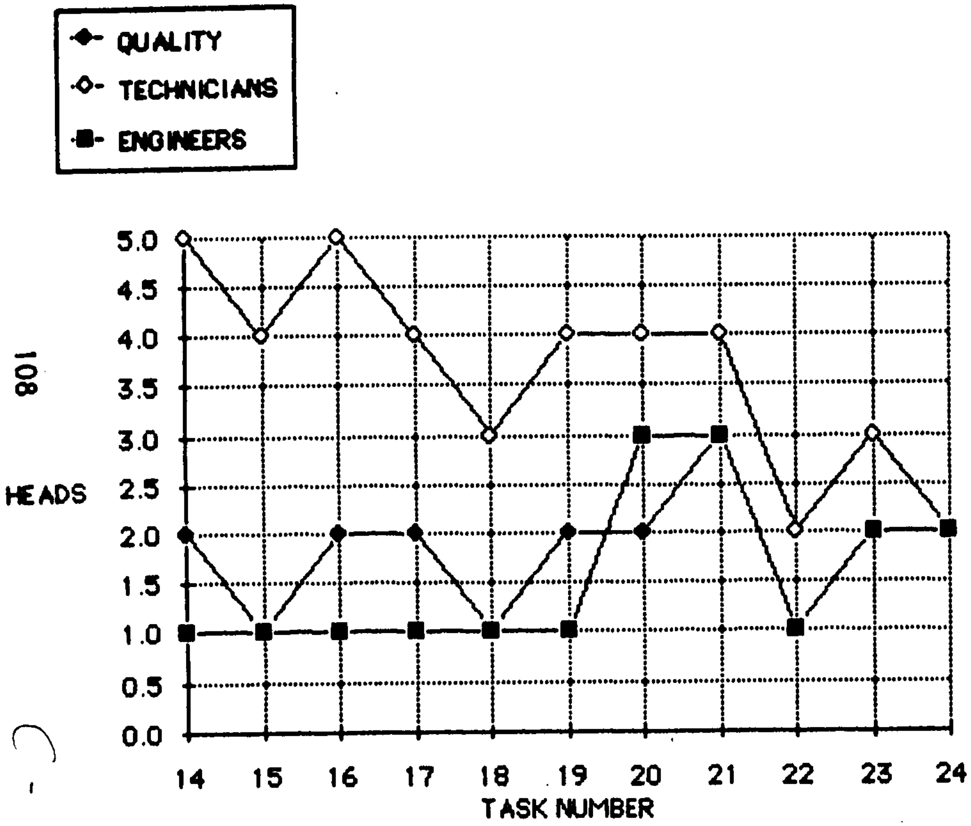
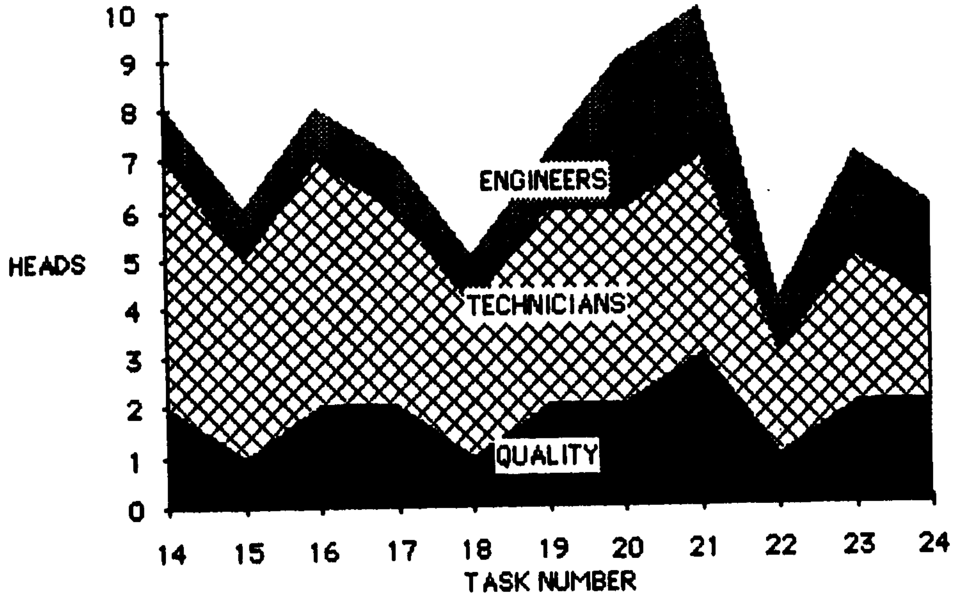




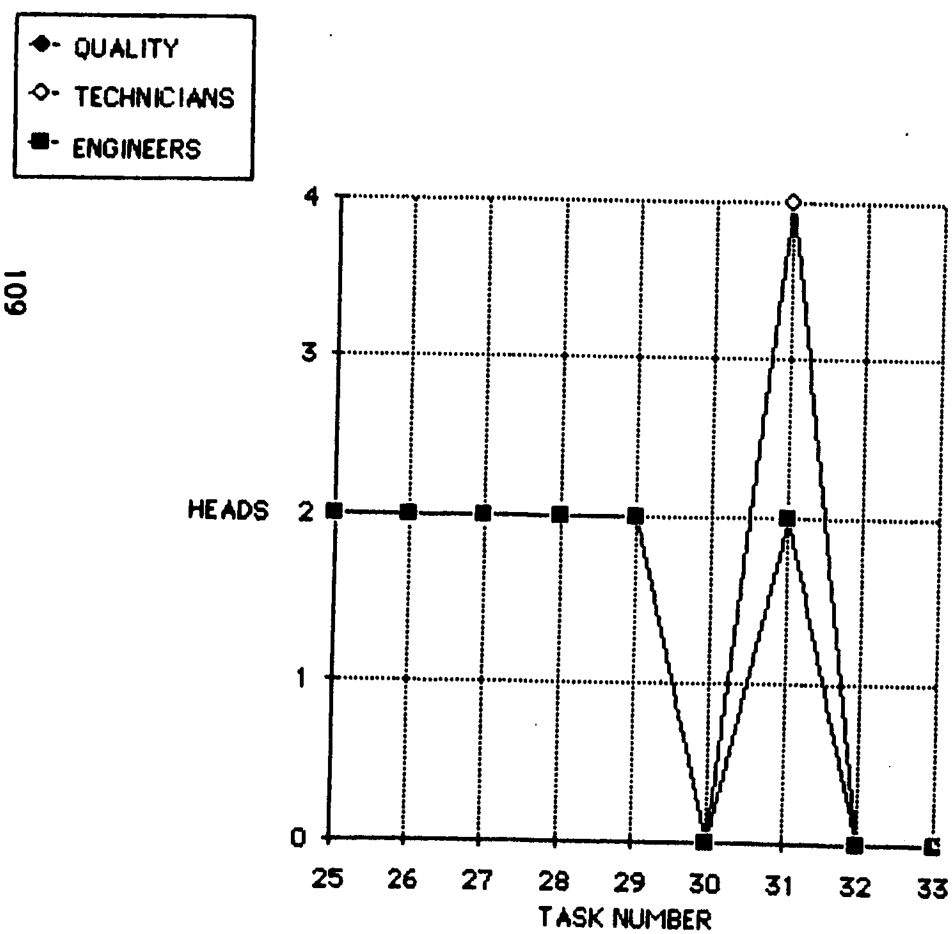
C-2

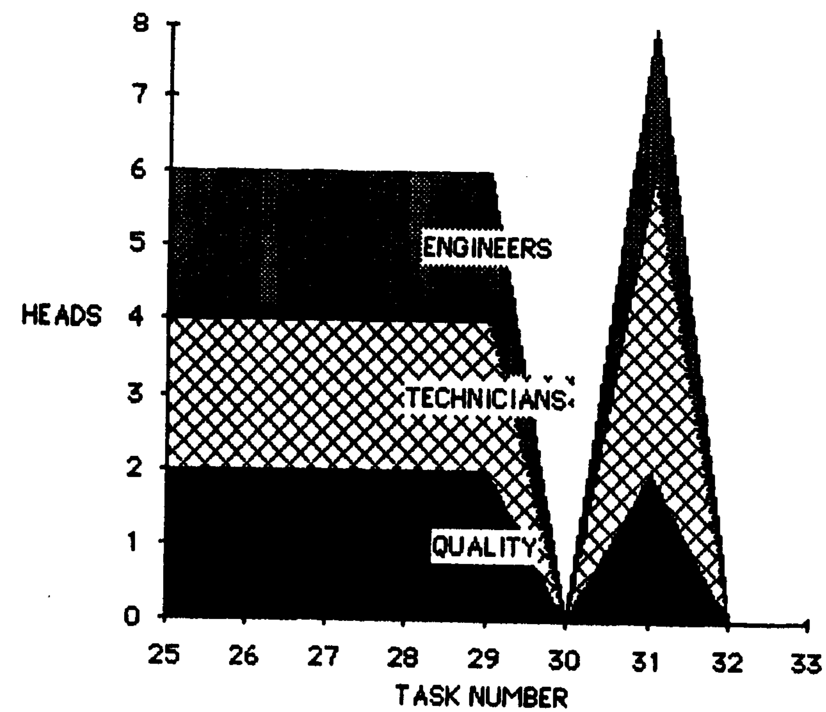
BOEING
OTV LAUNCH
OPERATIONS
STUDY for KSC

GBOTV MANPOWER

PRESENTED
KSC
JAN 31, 1986

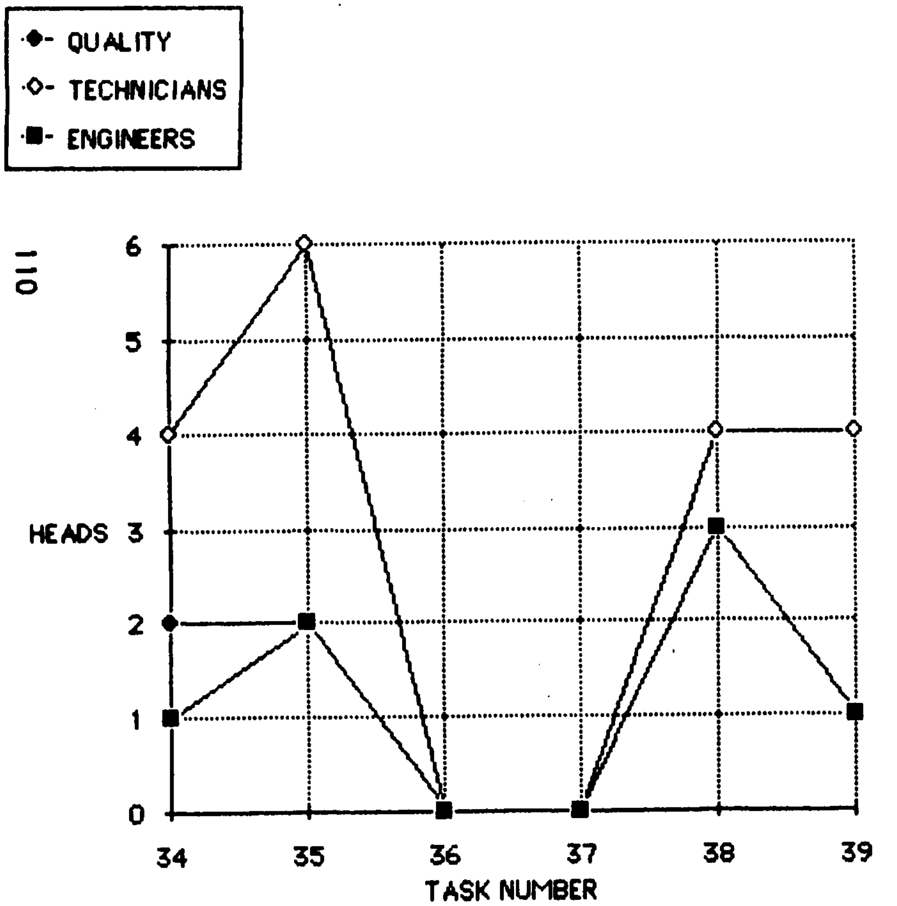
MISSION AND RECOVERY

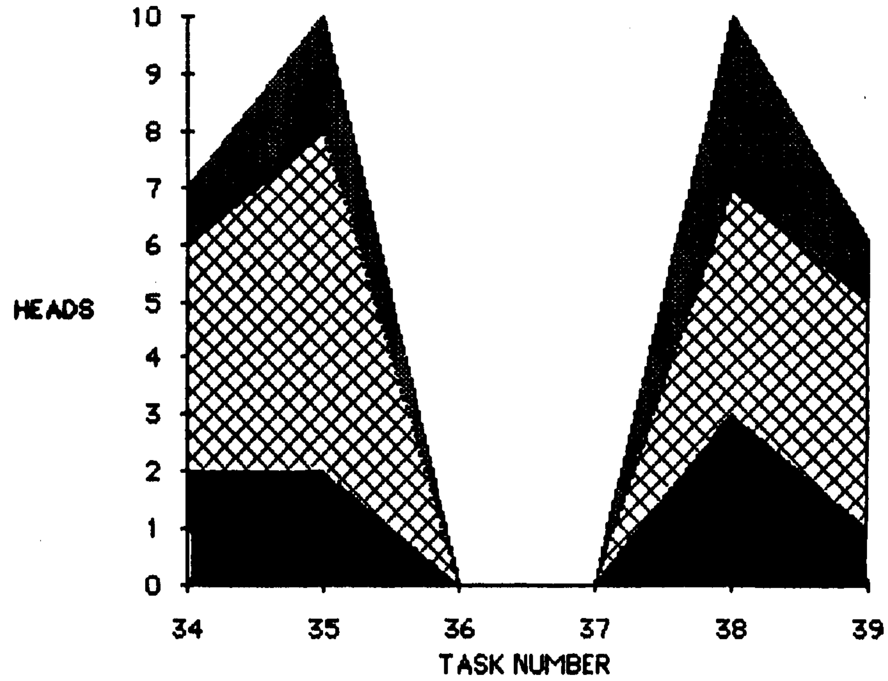




GBOTV MANPOWER

MAINTENANCE AND REFURBISHMENT





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GBOTV MANPOWER PER TASK

FIRST FLOW

PREPARATIONS

TASK	SER TIME	MH	
1	132	528	RECEIVING
2	56	480	MECHANICAL ASSEMBLY
3	27	135	ELECTRICAL ASSEMBLY
4	23	138	MECHANICAL SYS TEST
5	12	73	ELECTRICAL SYS TEST
6	50	590	OTV INTEG SYS TEST
7	16	176	OTV/CS-G TEST
8	17	120	MOVE TO CRYO LOAD FAC.
9	26	174	CRYO LOAD

LAUNCH PREPS.

TASK	SER TIME	MH	
14	12	96	PREPS TO MOVE
15	8	52	INSTALL IN CAN
16	10	80	INSTALL IN RSS
17	14	104	ADDN'L SUBSYS INSTALLATION
18	14	80	LOAD OTV RCS
19	7	53	INSTALL IN ORBITER
20	10	91	PL/ORB INTFC TEST
21	7	70	SC POCC TEST
22	11	21	FINAL PL CLOSEOUT
23	9	62	LAUNCH PREPS
24	13	79	DEPLOY OTV/SC

OTV/SC INTEGRATION

TASK	SER TIME	MH	
10	13	98	MOVE TO OTV/SC INTEG FAC
11	12	88	OTV/SC MECH/ELEC MATE
12	14	116	OTV/SC INTEG TEST
13	28	280	OTV/SC/CITE INTEG TEST

MISSION & RECOVERY

TASK	SER TIME	MH	
25	6	36	LAUNCH FROM LEO
26	1	6	DEPLOY SC
27	7	42	ORIENT & RET TO LEO
28	4	24	RENDEZVOUS
29	15	43	OTV RECOVERY
30	0	0	DEORBIT
31	7	40	MOVE ORB TO OPF
32	0	0	MOVE TO CRYO FACIL
33	0	0	VENT TANKS

MAINTENANCE & REFURBISHMENT

TASK	SER TIME	MH	
34	19	120	MOVE TO OTVPF
35	26	260	MAINTENANCE
36	0	0	UNPLANNED MAINT.
37	0	0	MODS.
38	3	30	RETEST VERIF.
39	7	40	STORAGE

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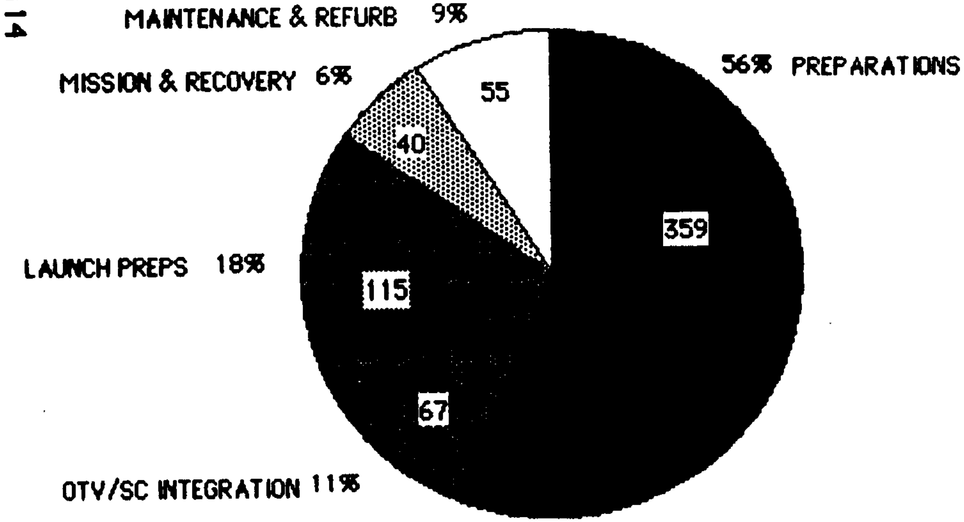
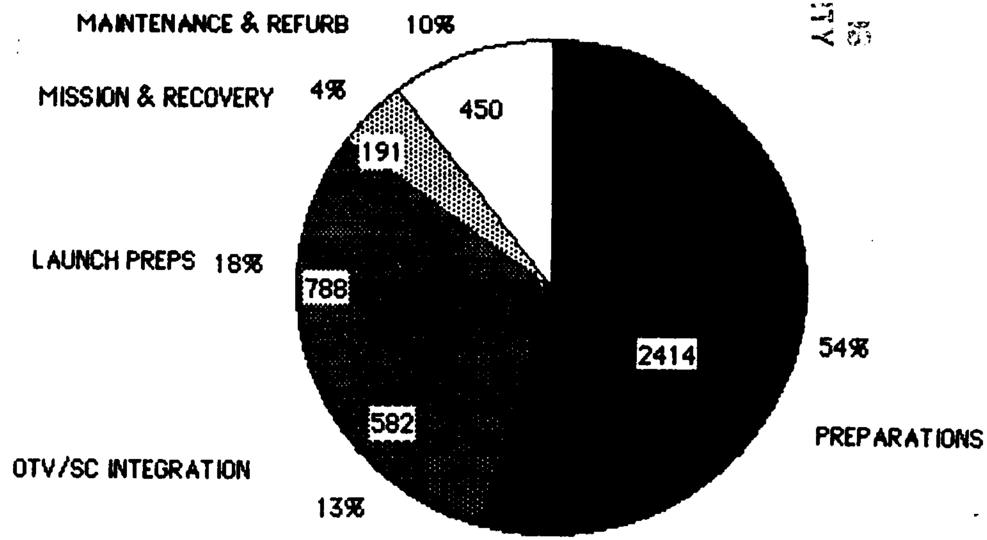
BOEING OTV LAUNCH OPERATIONS STUDY for KSC	GBOTV - FIRST FLOW SERIAL TIME AND MANHOURS	PRESENTED AT KSC JAN 31, 1986

SERIAL TIME



MANHOURS



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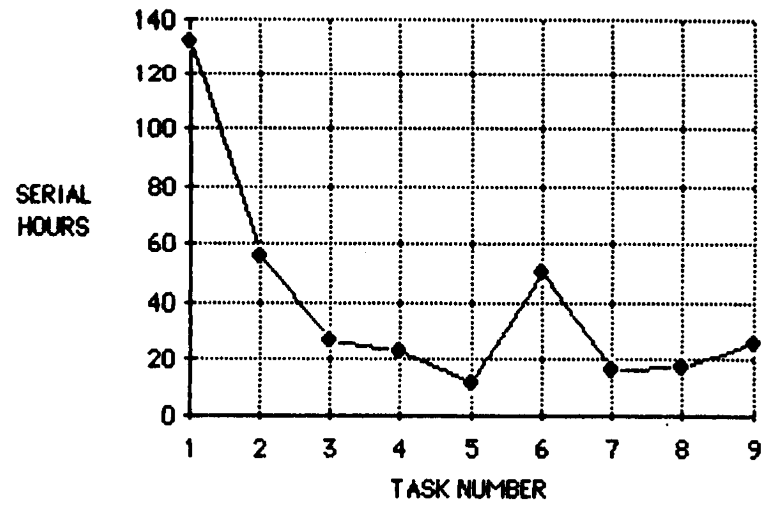
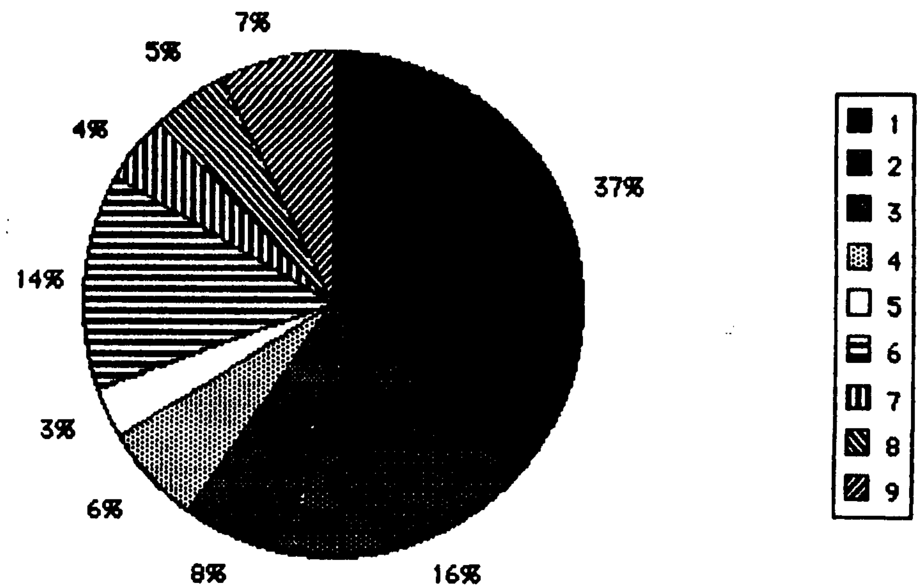
GBOTV SERIAL HOURS
FIRST FLOW

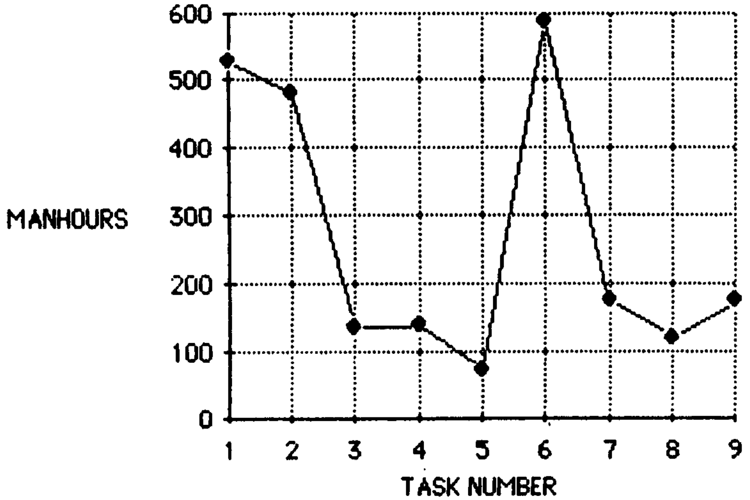
PREPARATIONS

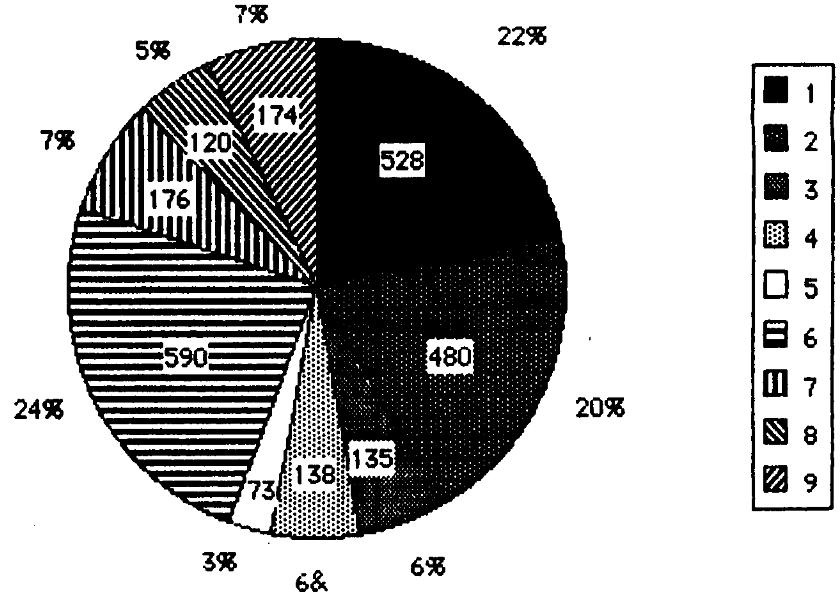




GBOTV .1ANHOURS
FIRST FLOW

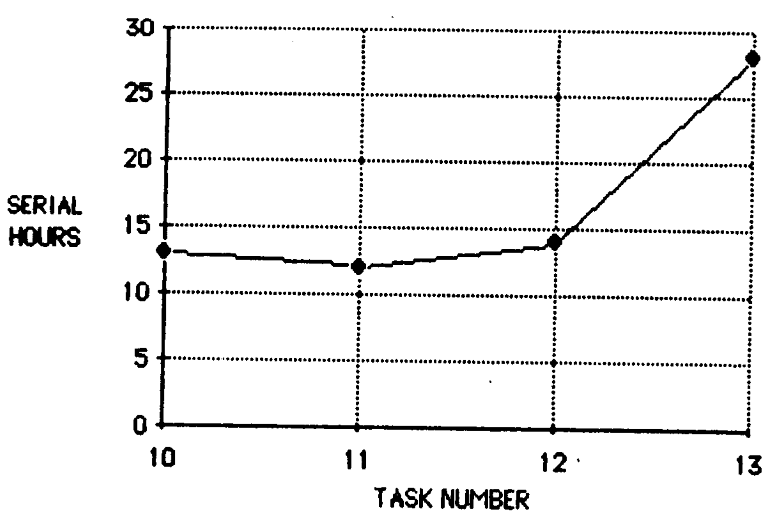
PREPARATIONS

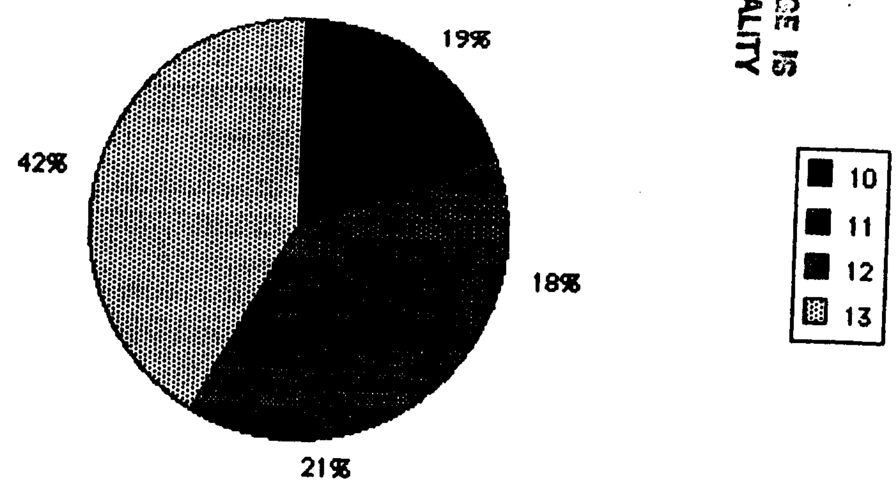




GBOTV SERIAL HOURS
FIRST FLOW

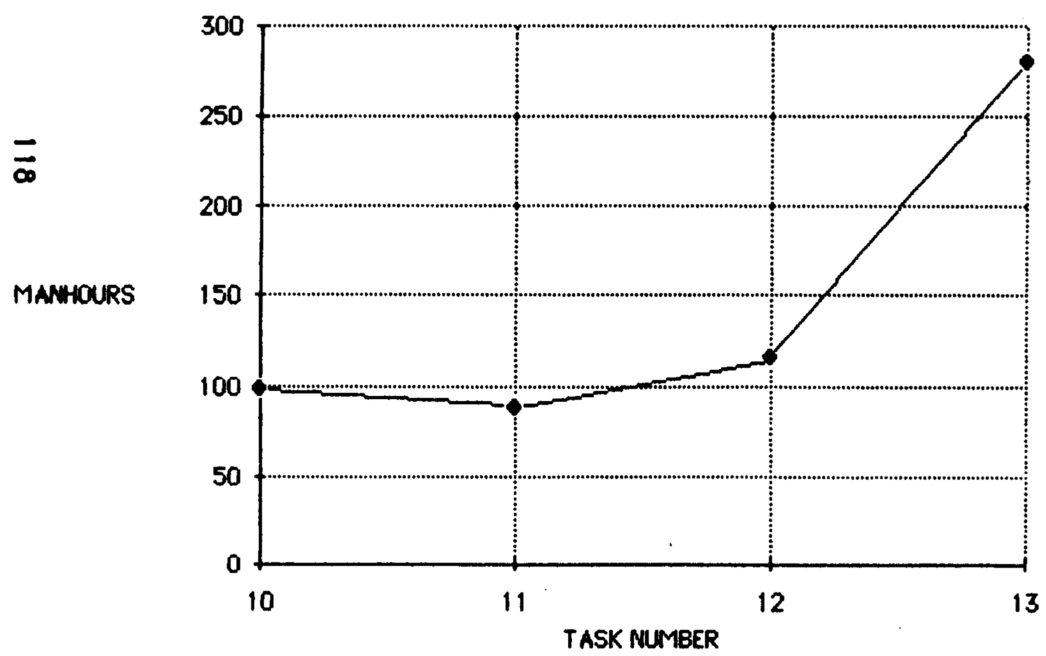
OTV/SC INTEGRATION

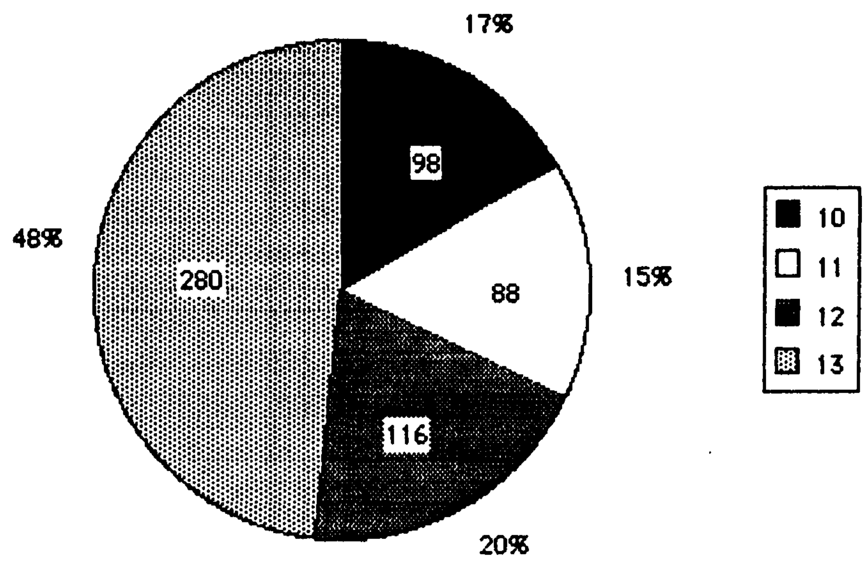




GBOTV I ,ANHOURS
FIRST FLOW

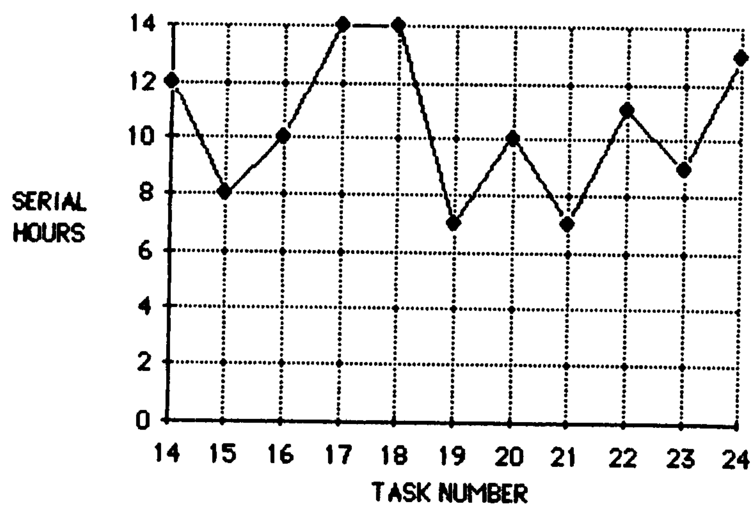
OTV/SC INTEGRATION

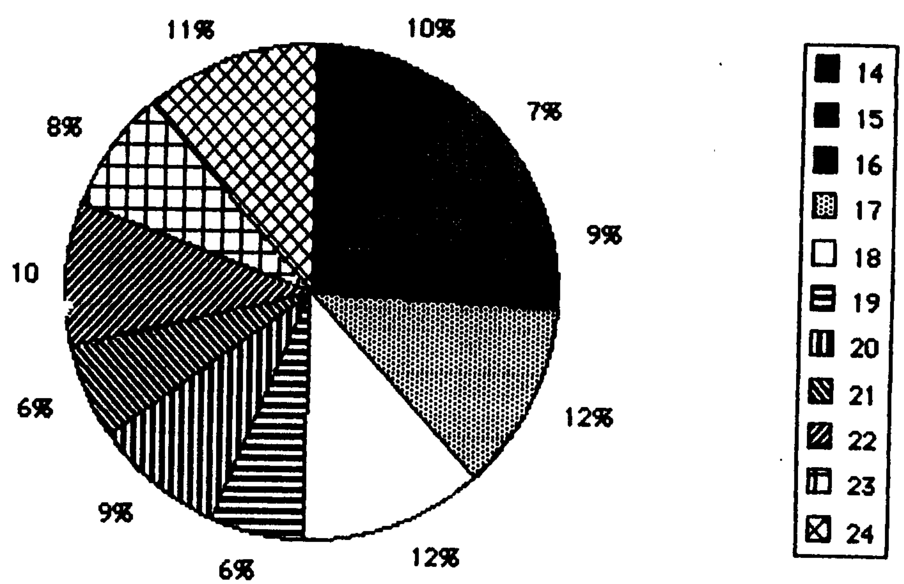




GBOTV SERIAL HOURS
FIRST FLOW

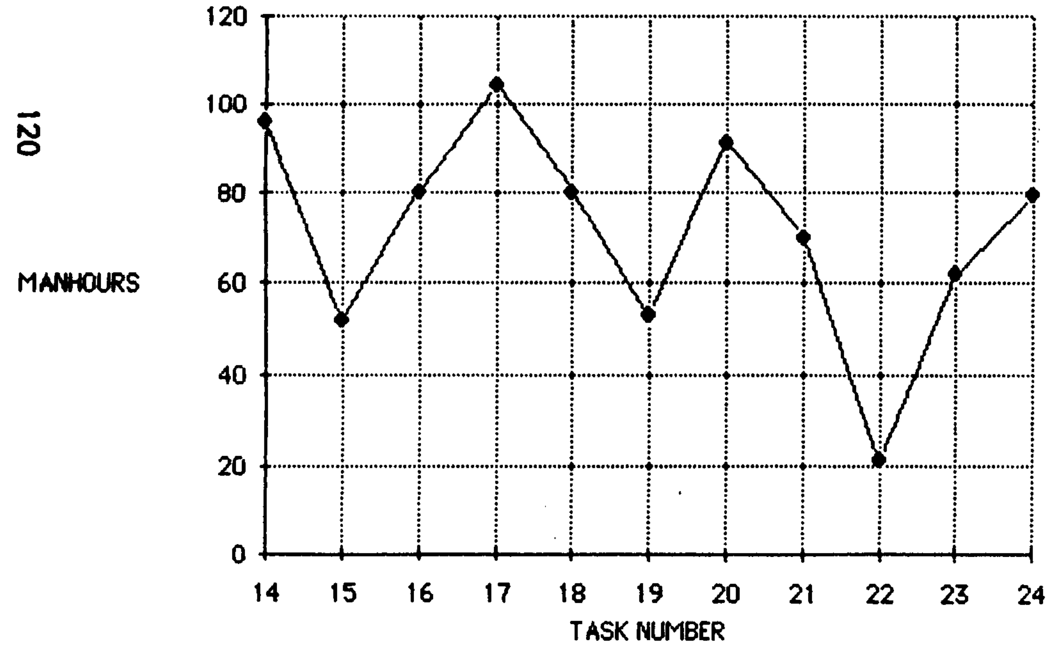
LAUNCH PREPARATIONS

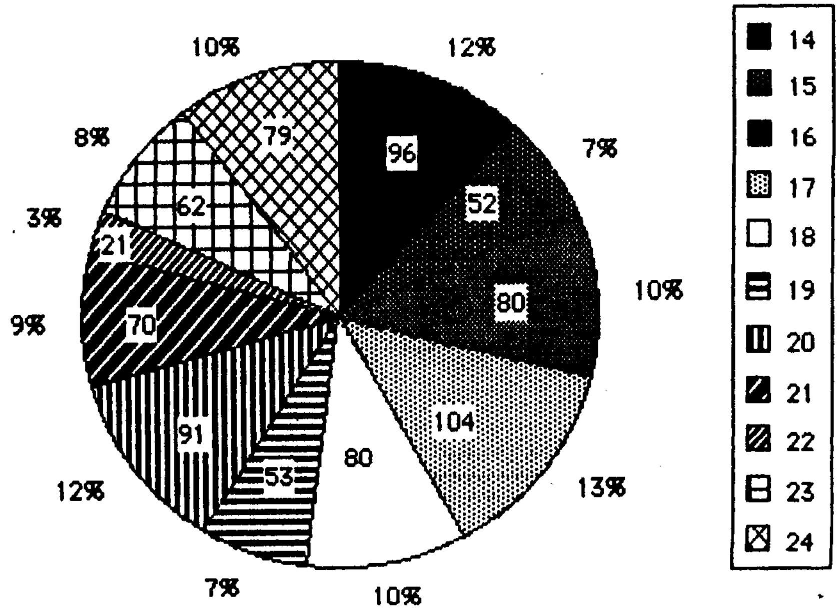




GBOTV MANHOURS
FIRST FLOW

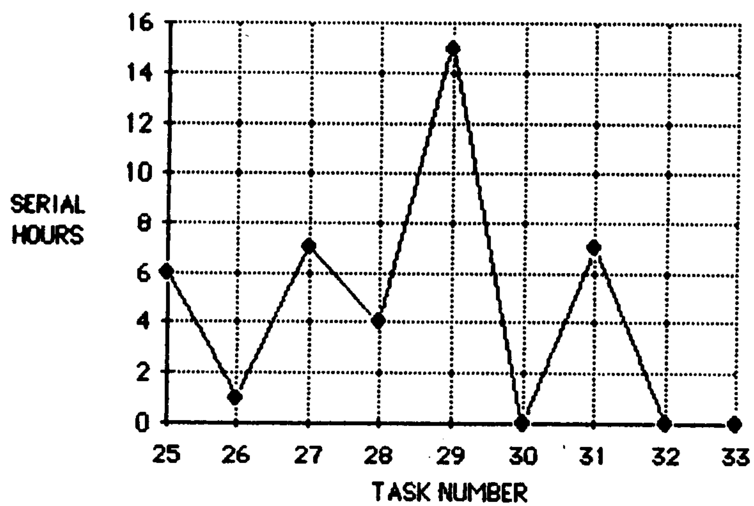
LAUNCH PREPARATIONS

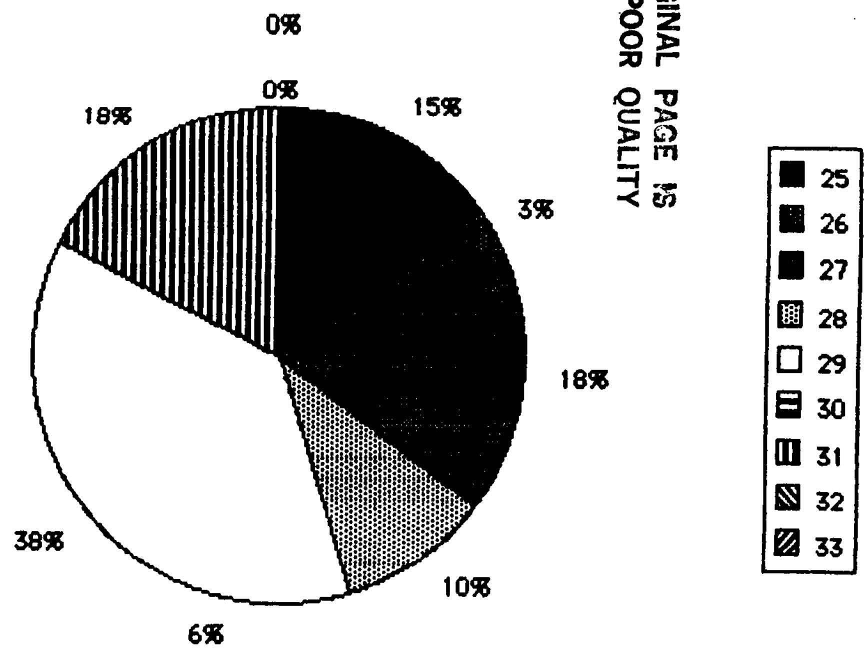




GBOTV SERIAL HOURS
FIRST FLOW

MISSION AND RECOVERY





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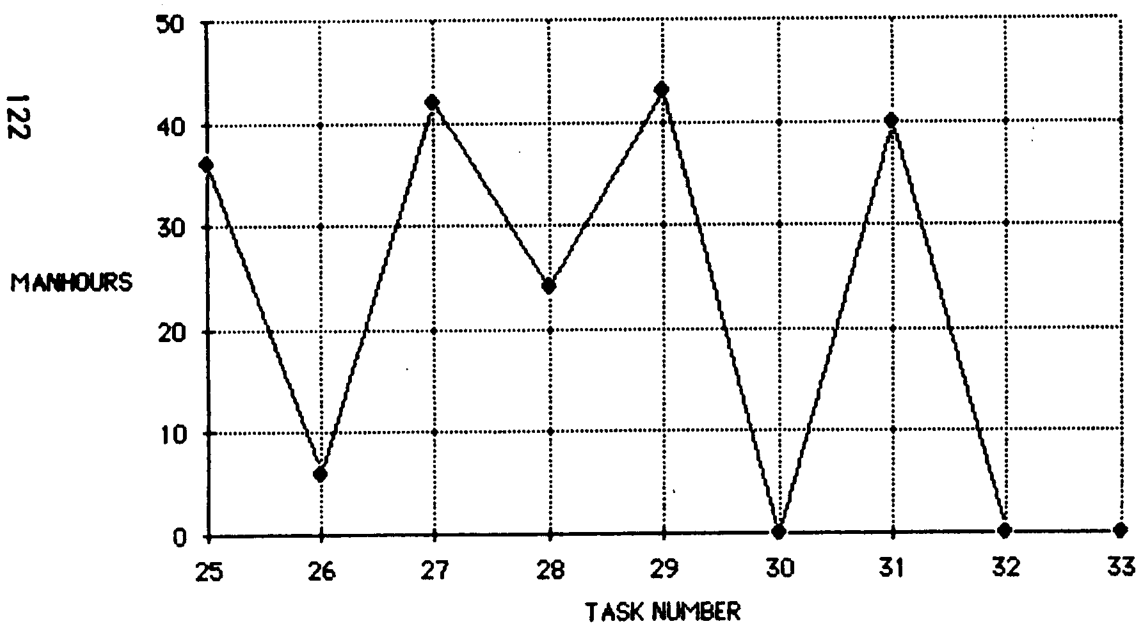
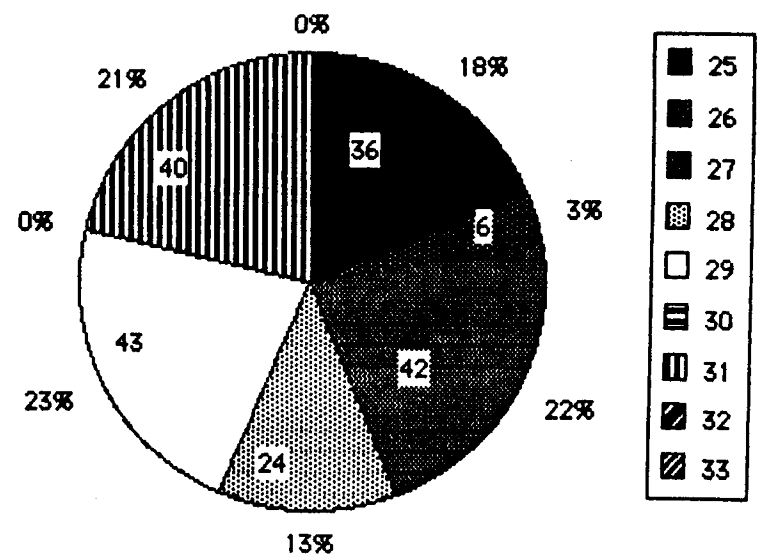
GBOTV MANHOURS
FIRST FLOW

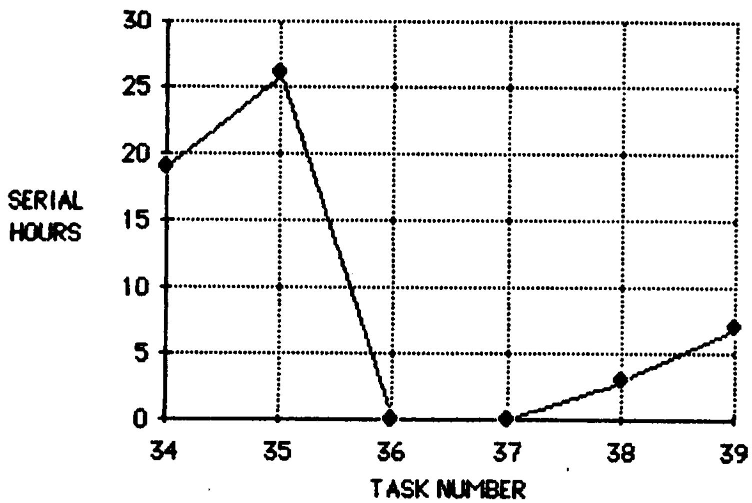
MISSION AND RECOVERY

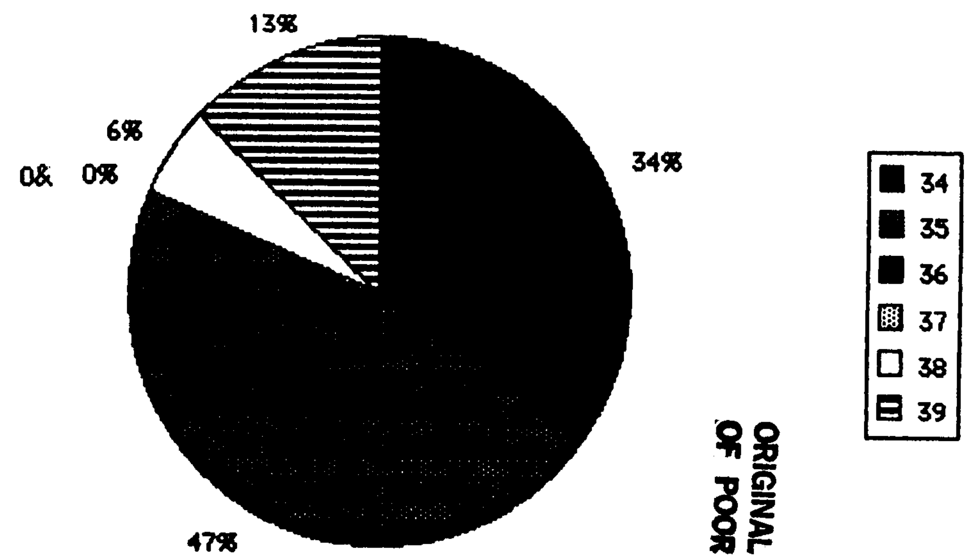




GBOTV SERIAL HOURS
FIRST FLOW

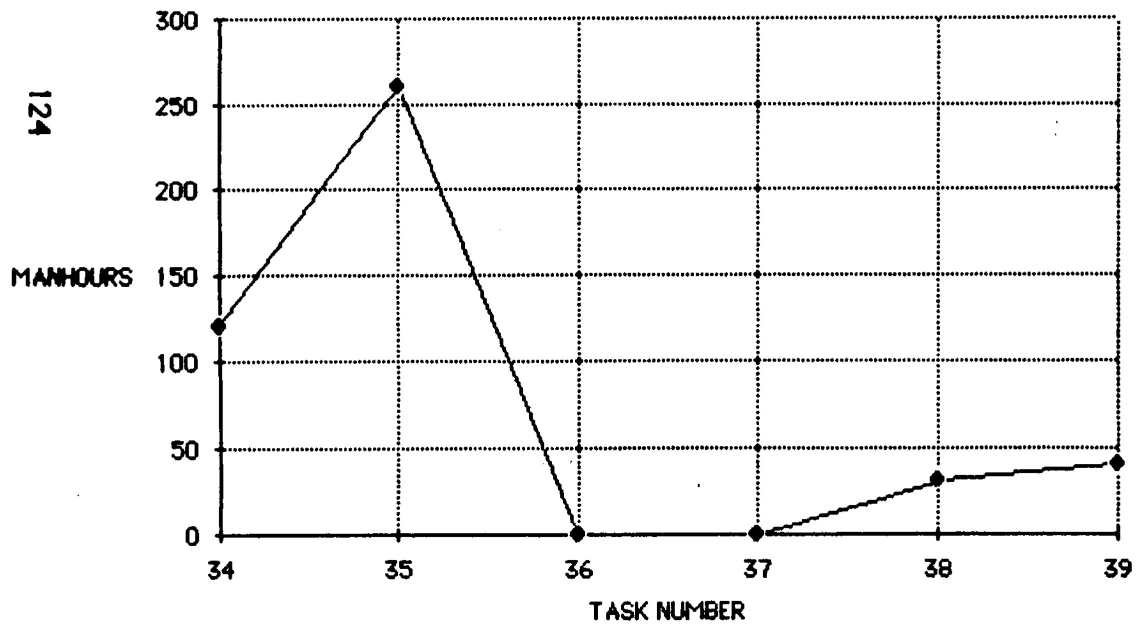
MAINTENANCE AND REFURBISHMENT

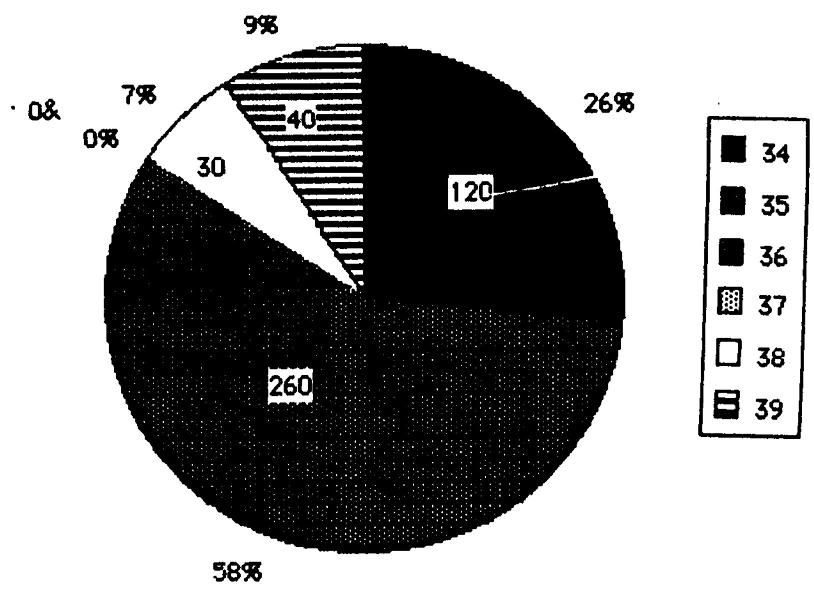




GBOTV MANHOURS
FIRST FLOW

MAINTENANCE AND REFURBISHMENT





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BOEING OTV LAUNCH OPERATIONS STUDY for KSC

GBOTV MANPOWER PER TASK

NOMINAL FLOW

PRESENTED AT KSC
JAN 31, 1986

PREPARATIONS

TASK	SER	TIME/MH	
1	132	528	RECEIVING
2	56	480	MECHANICAL ASSEMBLY
3	27	135	ELECTRICAL ASSEMBLY
4	23	138	MECHANICAL SYS TEST
5	12	73	ELECTRICAL SYS TEST
6	50	590	OTV INTEG SYS TEST
7	16	176	OTV/CS-G TEST
~~8~~	~~17~~	~~120~~	~~MOVE TO CRYO LOAD FAC.~~
9	26	174	CRYO LOAD

LAUNCH PREPS.

TASK	SER	TIME/MH	
14	12	96	PREPS TO MOVE
15	8	52	INSTALL IN CAN
16	10	80	INSTALL IN RSS
17	14	104	ADDN'L SUBSYS INSTALLATION
18	14	80	LOAD OTV RCS
19	7	53	INSTALL IN ORBITER
20	10	91	PL/ORB INTFC TEST
21	7	70	SC POCC TEST
22	11	21	FINAL PL CLOSEOUT
23	9	62	LAUNCH PREPS
24	13	79	DEPLOY OTV/SC

OTV/SC INTEGRATION

TASK	SER	TIME/MH	
~~10~~	~~13~~	~~98~~	~~MOVE TO OTV/SC INTEG FAC~~
11	12	88	OTV/SC MECH/ELEC MATE
12	14	116	OTV/SC INTEG TEST
13	28	280	OTV/SC/CITE INTEG TEST

MISSION & RECOVERY

TASK	SER	TIME/MH	
25	6	36	LAUNCH FROM LEO
26	1	6	DEPLOY SC
27	7	42	ORIENT & RET TO LEO
28	4	24	RENDEZVOUS
29	15	43	OTV RECOVERY
30	0	0	DEORBIT
31	7	40	MOVE ORB TO OPF
32	0	0	MOVE TO CRYO FACIL
33	0	0	VENT TANKS

MAINTENANCE & REFURBISHMENT

TASK	SER	TIME/MH	
34	19	120	MOVE TO OTVPF
35	26	260	MAINTENANCE
36	0	0	UNPLANNED MAINT.

TASK	SER	TIME/MH	
37	0	0	MODS.
38	3	30	RETEST VERIF.
39	7	40	STORAGE

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BOEING
OTV LAUNCH
OPERATIONS
STUDY for KSC

GBOTV - FIRST NOMINAL FLOW
SERIAL TIME AND MANHOURS

PRESENTED AT
KSC
JAN 31, 1986

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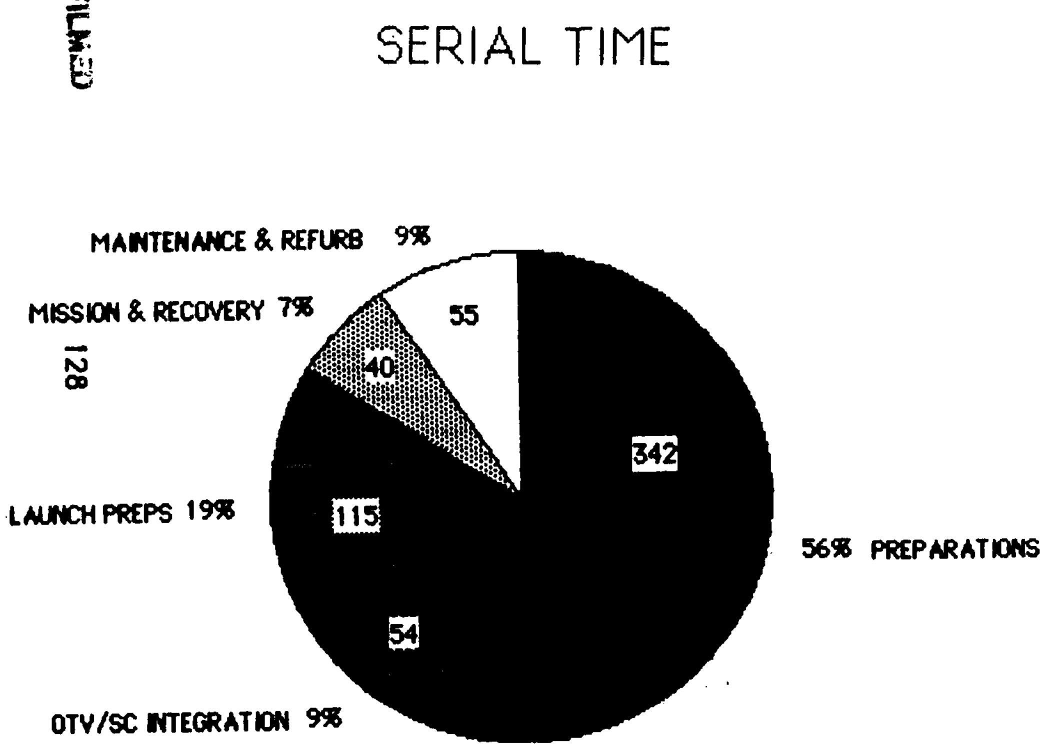

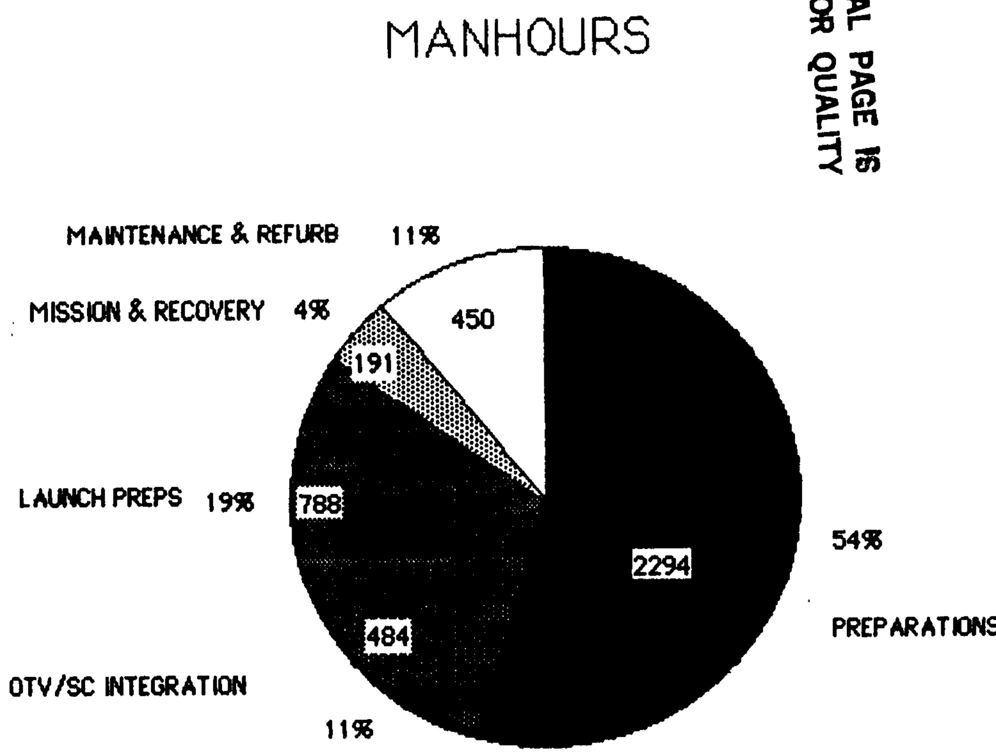

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BOEING OTV LAUNCH OPERATIONS STUDY for KSC

GBOTV MANPOWER PER TASK

RECURRING NOMINAL FLOW

PRESENTED AT KSC JAN 31, 1986

PREPARATIONS

TASK	SER TIME	MH	
~~1~~	~~132~~	~~528~~	~~RECEIVING~~
~~2~~	~~56~~	~~480~~	~~MECHANICAL ASSEMBLY~~
~~3~~	~~27~~	~~135~~	~~ELECTRICAL ASSEMBLY~~
~~4~~	~~23~~	~~130~~	~~MECHANICAL SYS TEST~~
~~5~~	~~12~~	~~73~~	~~ELECTRICAL SYS TEST~~
6	50	590	OTV INTEG SYS TEST
~~7~~	~~16~~	~~176~~	~~OTV/CS-G TEST~~
~~8~~	~~17~~	~~120~~	~~MOVE TO CRYO LOAD FAC.~~
~~9~~	~~26~~	~~174~~	~~CRYO LOAD~~

LAUNCH PREPS.

TASK	SER TIME	MH	
14	12	96	PREPS TO MOVE
15	8	52	INSTALL IN CAN
16	10	80	INSTALL IN RSS
17	14	104	ADDN'L SUBSYS INSTALLATION
18	14	80	LOAD OTV RCS
19	7	53	INSTALL IN ORBITER
20	10	91	PL/ORB INTFC TEST
21	7	70	SC POCC TEST
22	11	21	FINAL PL CLOSEOUT
23	9	62	LAUNCH PREPS
24	13	79	DEPLOY OTV/SC

OTV/SC INTEGRATION

TASK	SER TIME	MH	
~~10~~	~~13~~	~~98~~	~~MOVE TO OTV/SC INTEG FAC~~
11	12	88	OTV/SC MECH/ELEC MATE
12	14	116	OTV/SC INTEG TEST
~~13~~	~~28~~	~~280~~	~~OTV/SC/CITE INTEG TEST~~

MISSION & RECOVERY

TASK	SER TIME	MH	
25	6	36	LAUNCH FROM LEO
26	1	6	DEPLOY SC
27	7	42	ORIENT & RET TO LEO
28	4	24	RENDEZVOUS
29	15	43	OTV RECOVERY
30	0	0	DEORBIT
31	7	40	MOVE ORB TO OPF
32	0	0	MOVE TO CRYO FACIL
33	0	0	VENT TANKS

MAINTENANCE & REFURBISHMENT

TASK	SER TIME	MH	
34	19	120	MOVE TO OTVPF
35	26	260	MAINTENANCE
36	0	0	UNPLANNED MAINT.
37	0	0	MODS.
38	3	30	RETEST VERIF.
39	7	40	STORAGE

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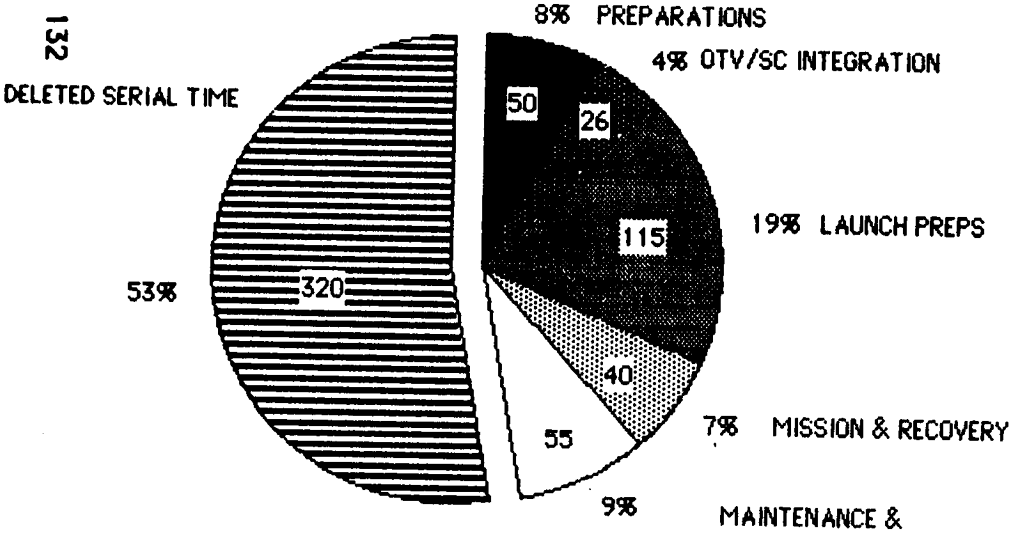
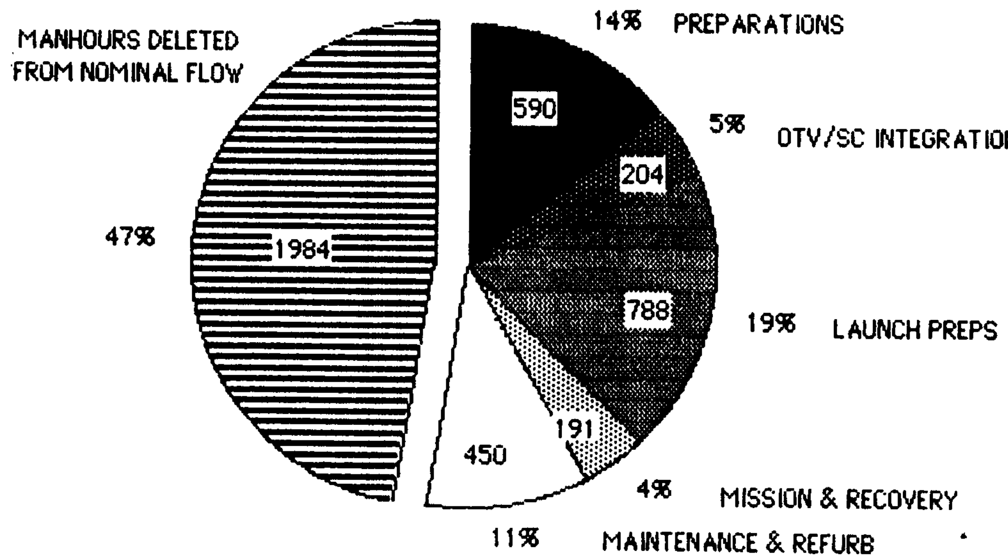
GBOTV - RECURRING FLOW

SERIAL TIME AND MANHOURS

SERIAL TIME



MANHOURS



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GBOTV MANPOWER PER TASK- FIRST FLOW
(FACTORY ASSEMBLY/CHECKOUT)

PRESENTED AT
KSC
JAN 31, 1986

PREPARATIONS

TASK	SER	TIME/MH	
1	132	528	RECEIVING
~~2~~	~~56~~	~~480~~	~~MECHANICAL ASSEMBLY~~
~~3~~	~~27~~	~~135~~	~~ELECTRICAL ASSEMBLY~~
~~4~~	~~23~~	~~130~~	~~MECHANICAL SYS TEST~~
~~5~~	~~12~~	~~73~~	~~ELECTRICAL SYS TEST~~
6	~~50~~ 24	~~590~~ 264	OTV INTEG SYS TEST
~~7~~	~~16~~	~~176~~	~~OTV/CS-G TEST~~
~~8~~	~~17~~	~~120~~	~~MOVE TO CRYO LOAD FAC.~~
~~9~~	~~26~~	~~174~~	~~CRYO LOAD~~

OTV/SC INTEGRATION

TASK	SER	TIME/MH	
~~10~~	~~13~~	~~98~~	~~MOVE TO OTV/SC INTEG FAC~~
11	12	88	OTV/SC MECH/ELEC MATE
12	14	116	OTV/SC INTEG TEST
13	28	280	OTV/SC/CITE INTEG TEST

LAUNCH PREPS.

TASK	SER	TIME/MH	
14	12	96	PREPS TO MOVE
15	8	52	INSTALL IN CAN
16	10	80	INSTALL IN RSS
17	14	104	ADDN'L SUBSYS INSTALLATION
18	14	80	LOAD OTV RCS
19	7	53	INSTALL IN ORBITER
20	10	91	PL/ORB INTFC TEST
21	7	70	SC POCC TEST
22	11	21	FINAL PL CLOSEOUT
23	9	62	LAUNCH PREPS
24	13	79	DEPLOY OTV/SC

MISSION & RECOVERY

TASK	SER	TIME/MH	
25	6	36	LAUNCH FROM LEO
26	1	6	DEPLOY SC
27	7	42	ORIENT & RET TO LEO
28	4	24	RENDEZVOUS
29	15	43	OTV RECOVERY
30	0	0	DEORBIT
31	7	40	MOVE ORB TO OPF
32	0	0	MOVE TO CRYO FACIL
33	0	0	VENT TANKS

MAINTENANCE & REFURBISHMENT

TASK	SER	TIME/MH	
34	19	120	MOVE TO OTVPF
35	26	260	MAINTENANCE
36	0	0	UNPLANNED MAINT.
37	0	0	MODS.
38	3	30	RETEST VERIF.
39	7	40	STORAGE

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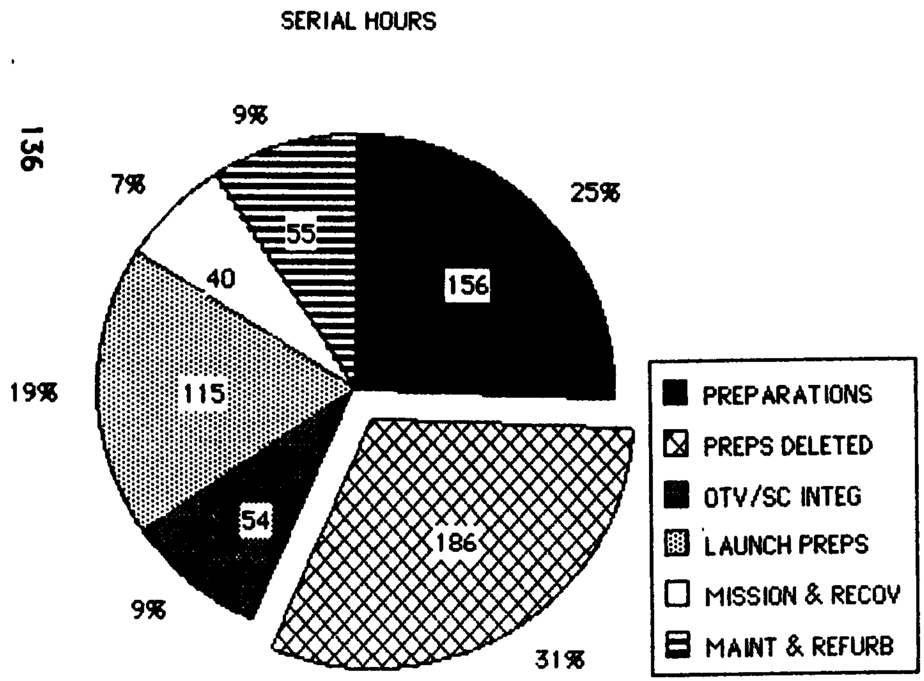
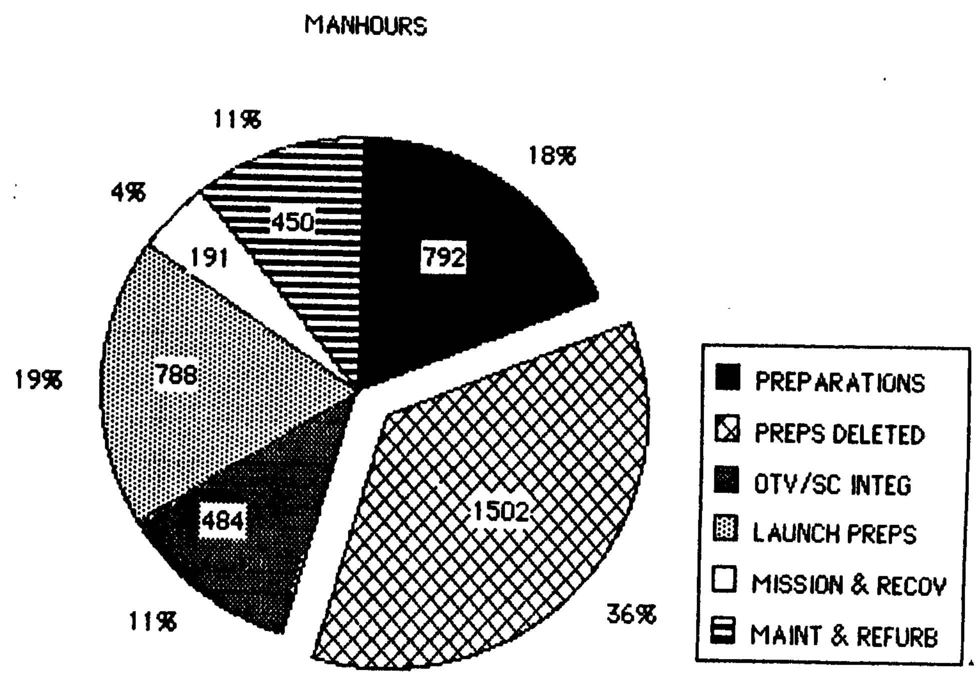
GBOTV - FIRST FLOW
FACTORY ASSEMBLY & CHECKOUT

SERIAL TIME AND MANHOURS





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SPACE BASED OTV MANPOWER PER TASK

(FIRST FLOW)

TASK	SER TIME	IVA	EVA	PREPARATIONS
1	9	19	8	RECEIVING
2	43	86		MECHANICAL ASSEMBLY
3	19	32		ELECTRICAL ASSEMBLY
4	23	46		MECHANICAL SYS TEST
5	12	23		ELECTRICAL SYS TEST
6	33	66		OTV INTEG SYS TEST
7	16	32		OTV/CS-G TEST

TASK	SER TIME	IVA	EVA	MISSION & RECOVERY
25	6	12		LAUNCH FROM LEO
26	1	2		DEPLOY SC
27	7	14		ORIENT & RET TO LEO
28	4	8		RENDEZVOUS
29	7	14		OTV RECOVERY
34	29	46	24	MOVE TO OTVPF

TASK	SER TIME	IVA	EVA	OTV/SC INTEGRATION
11	10	10	20	OTV/SC MECH/ELEC MATE
12	7	14		OTV/SC INTEG TEST
17	11	22		ADDN'L SUBSYS INSTALLATION
21	7	14		SC POCC TEST

MAINTENANCE & REFURBISHMENT				
TASK	SER TIME	IVA	EVA	
35	22	44		MAINTENANCE
36	0	0		UNPLANNED MAINT
37	0	0		MODS.
38	3	6		RETEST VERIF.
39	4	4	8	STORAGE

TASK	SER TIME	IVA	EVA	LAUNCH PREPS.
18	2	4		LOAD OTV RCS
23	16	31		LAUNCH PREPS
22	26	52		FINAL PL CLOSEOUT
24	6	12		DEPLOY OTV/SC

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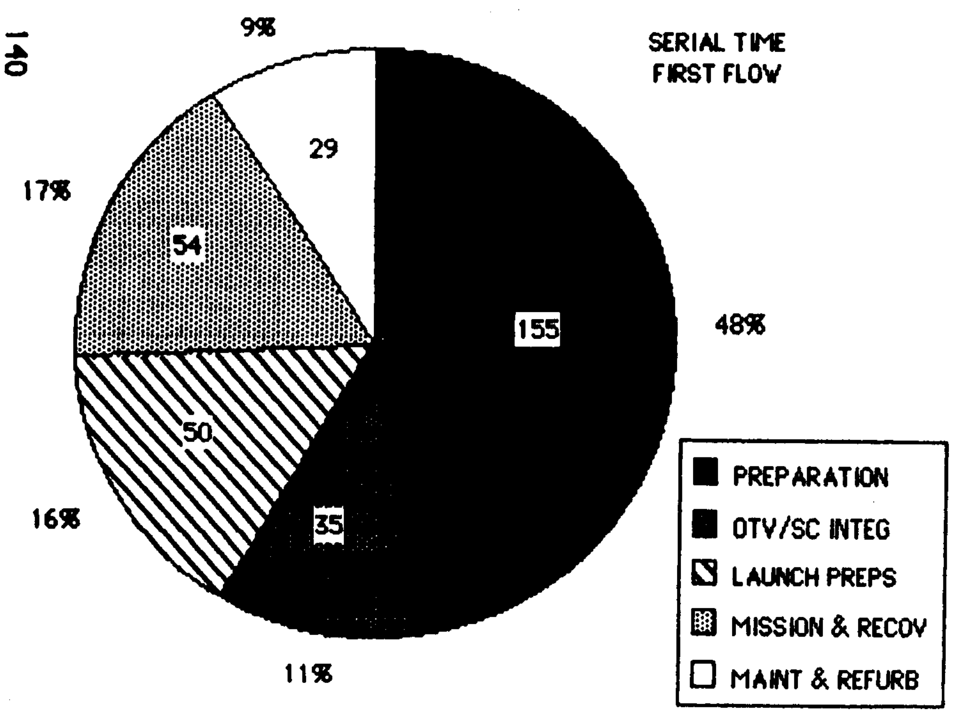
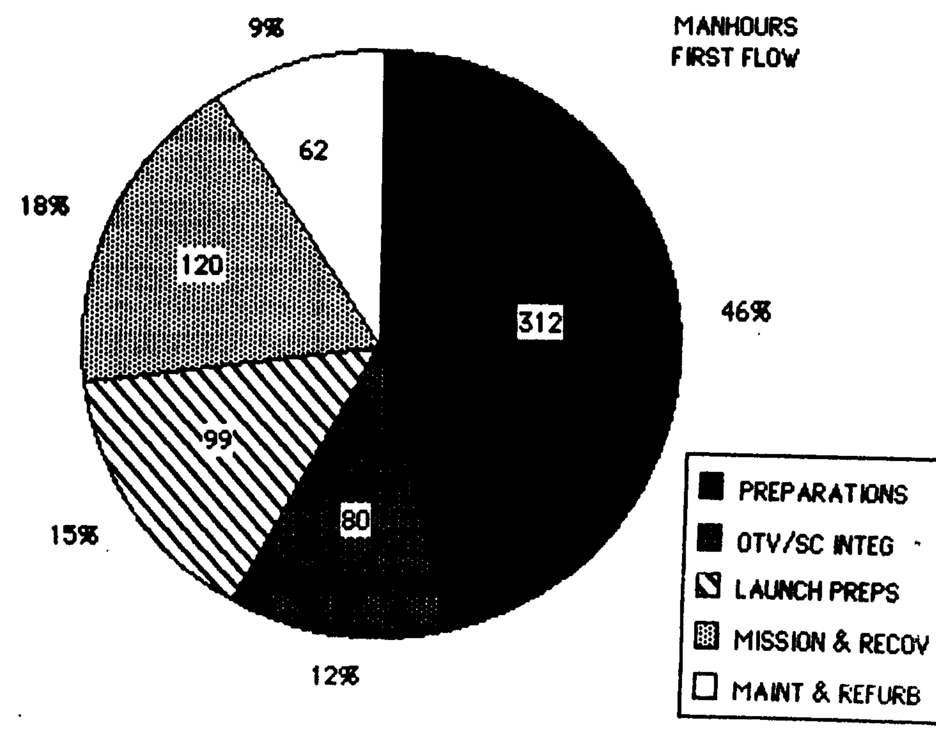
SBOTV - FIRST NOMINAL FLOW

SERIAL TIME AND MANHOURS

SERIAL TIME



MANHOURS



BOEING
UTV LAUNCH
OPERATIONS
STUDY for KSC

SBOTV SERIAL HOURS
FIRST NOMINAL FLOW

PRESEN. , AT
KSC
JAN 31, 1986

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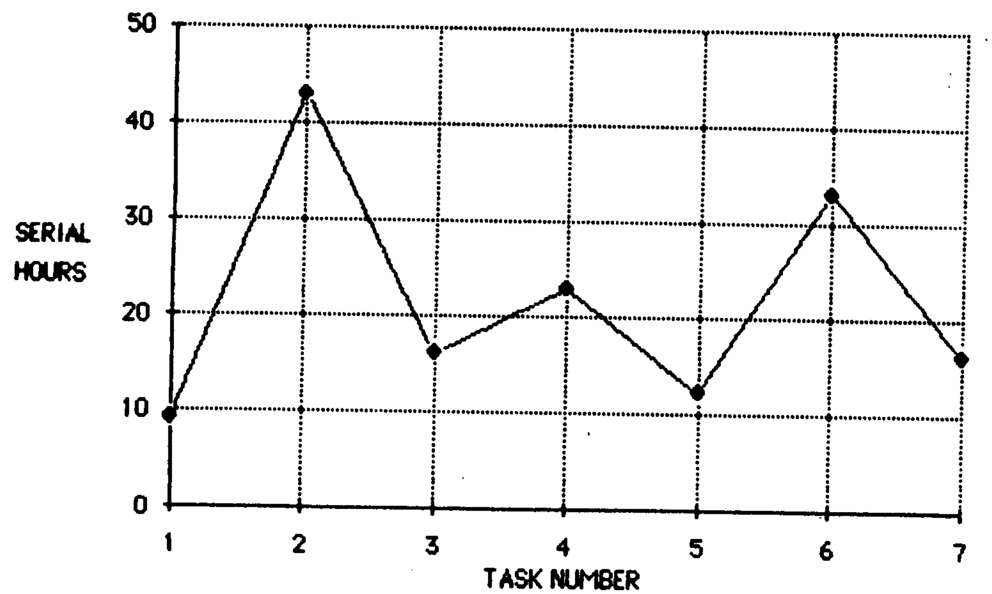
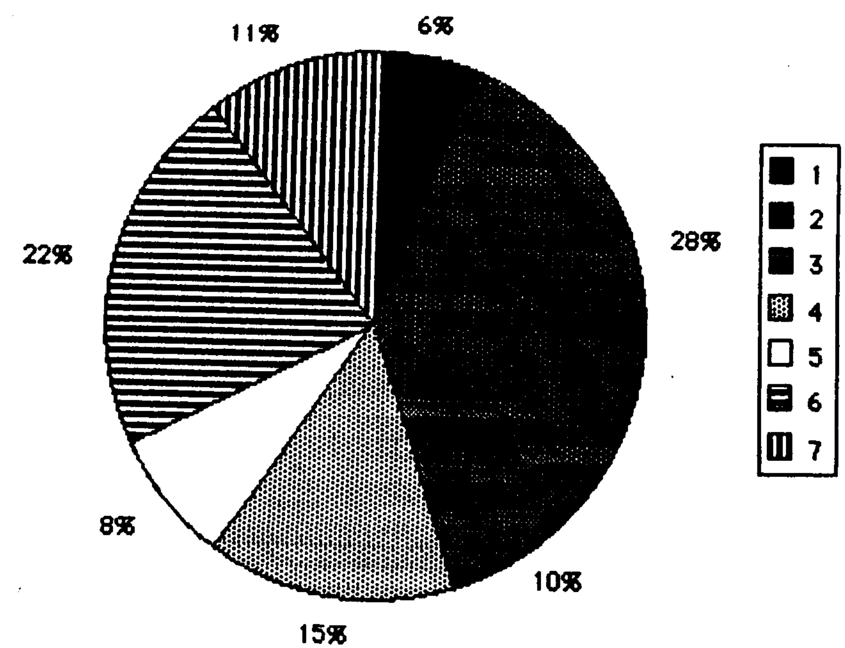
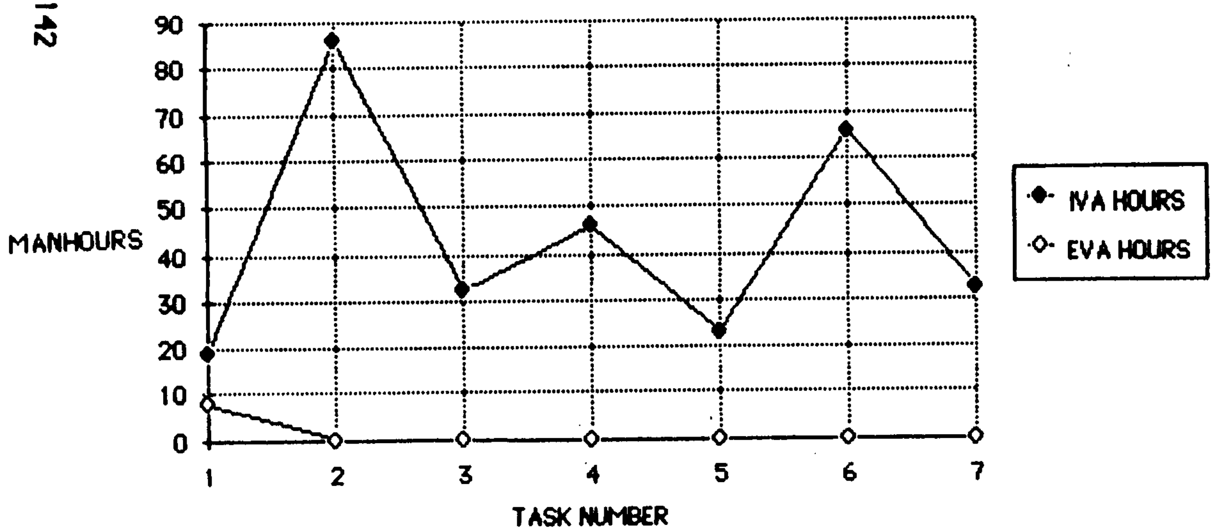
PREPARATIONS

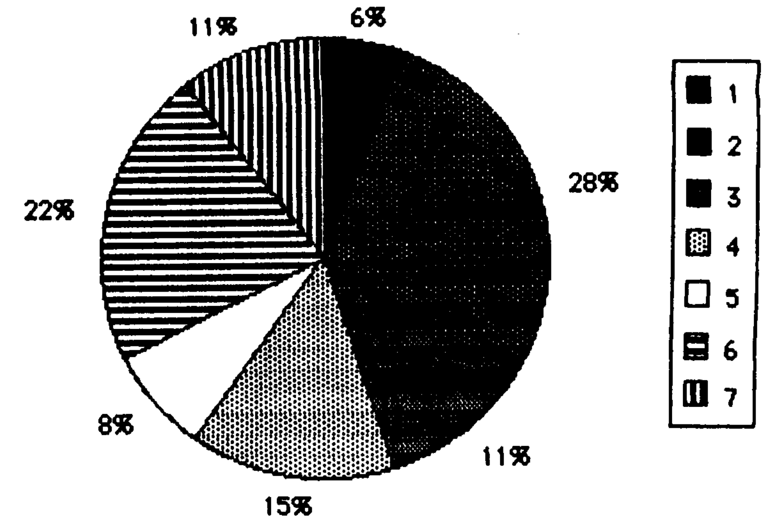




SBOTV MANHOURS
FIRST NOMINAL FLOW

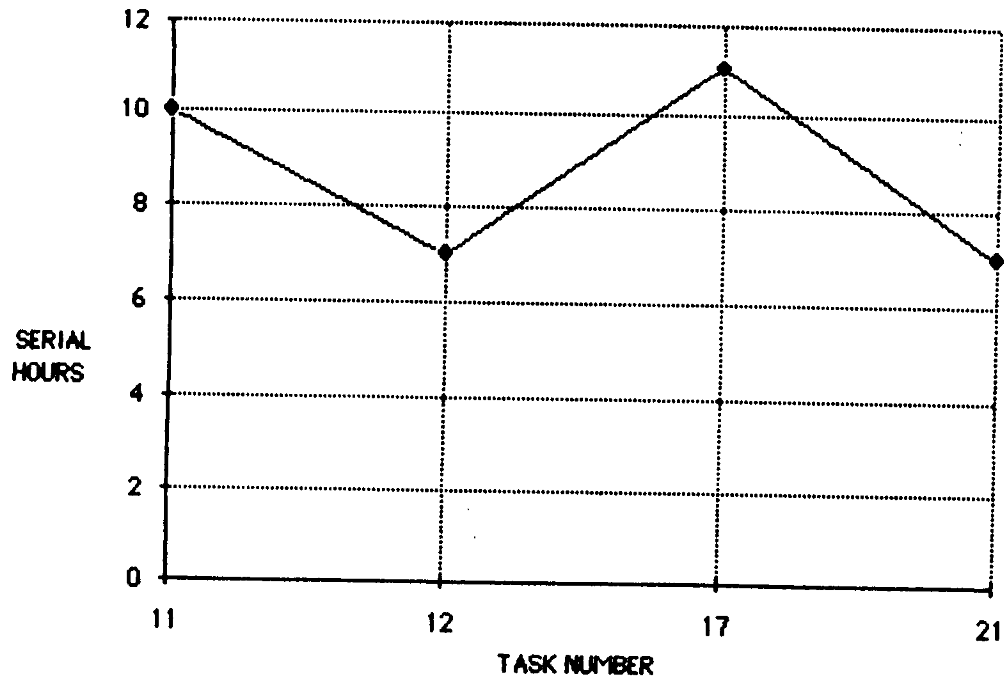
PREPARATIONS

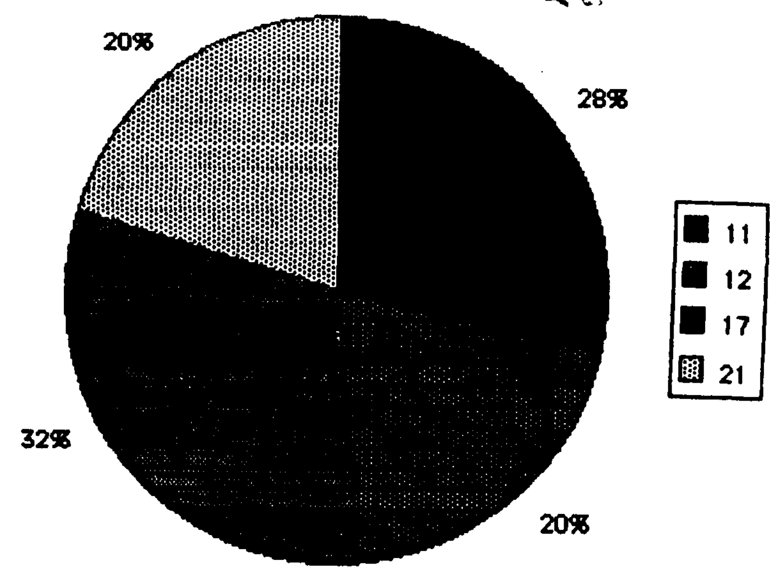




SBOTV SERIAL HOURS
FIRST NOMINAL FLOW

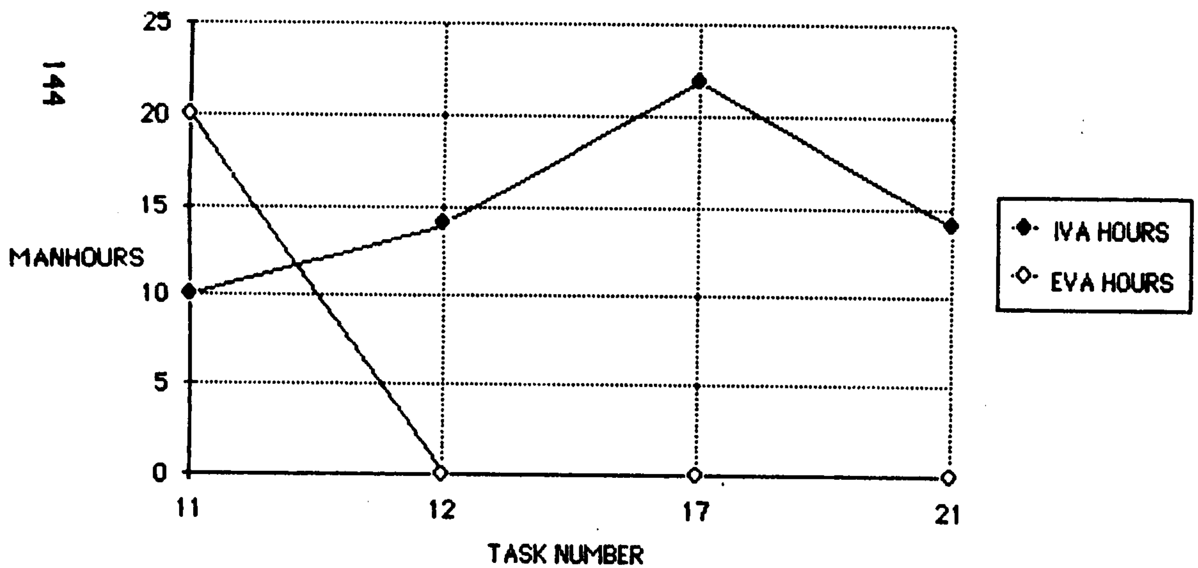
OTV/SC INTEGRATION

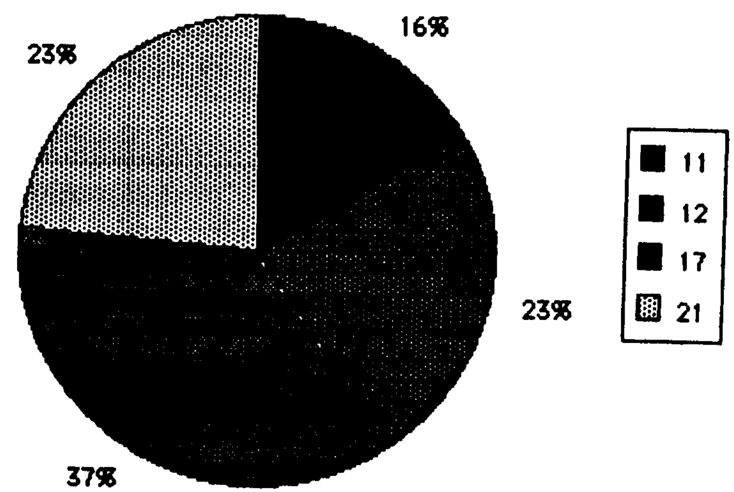




SBOTV MANHOURS
FIRST NOMINAL FLOW

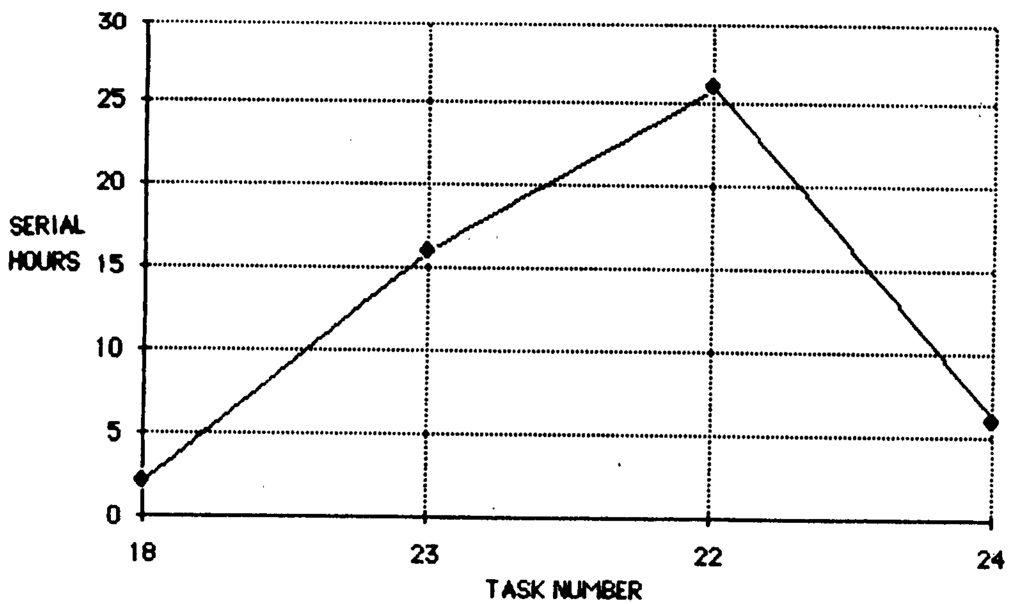
OTV/SC INTEGRATION

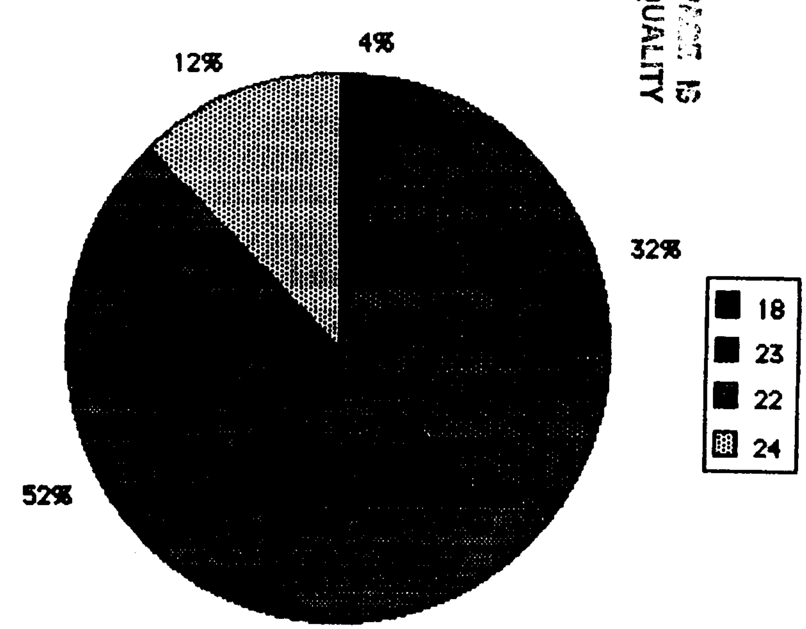




SBOTV SERIAL HOURS
FIRST NOMINAL FLOW

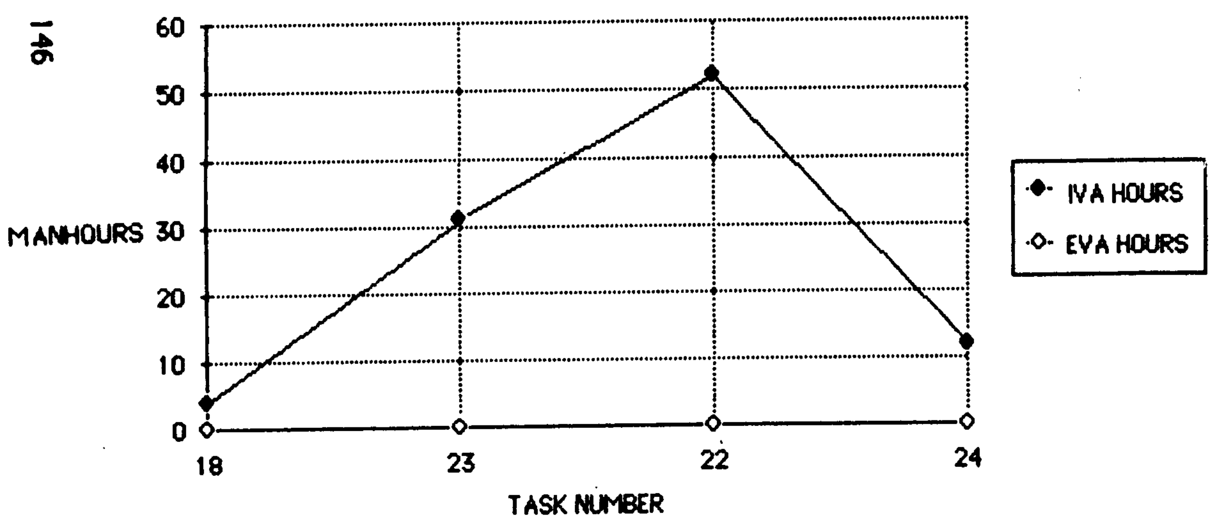
LAUNCH PREPARATIONS

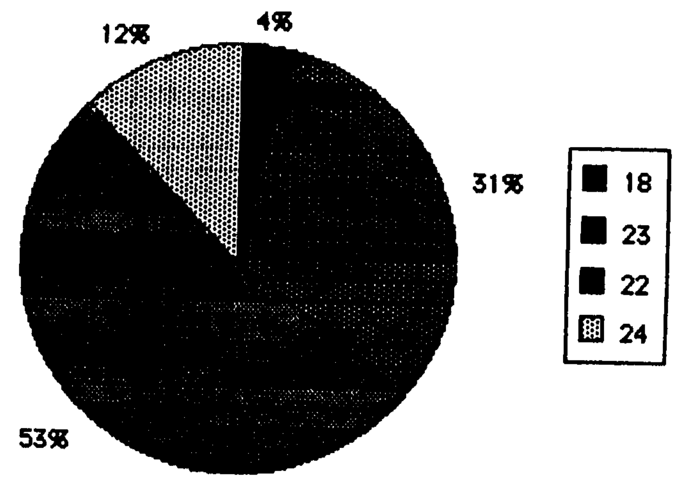




BOEING **JTV LAUNCH** **OPERATIONS** **STUDY for KSC**	SBOTV . 1ANHOURS FIRST NOMINAL FLOW	PRESEN D AT **KSC** JAN 31, 1986

LAUNCH PREPARATIONS



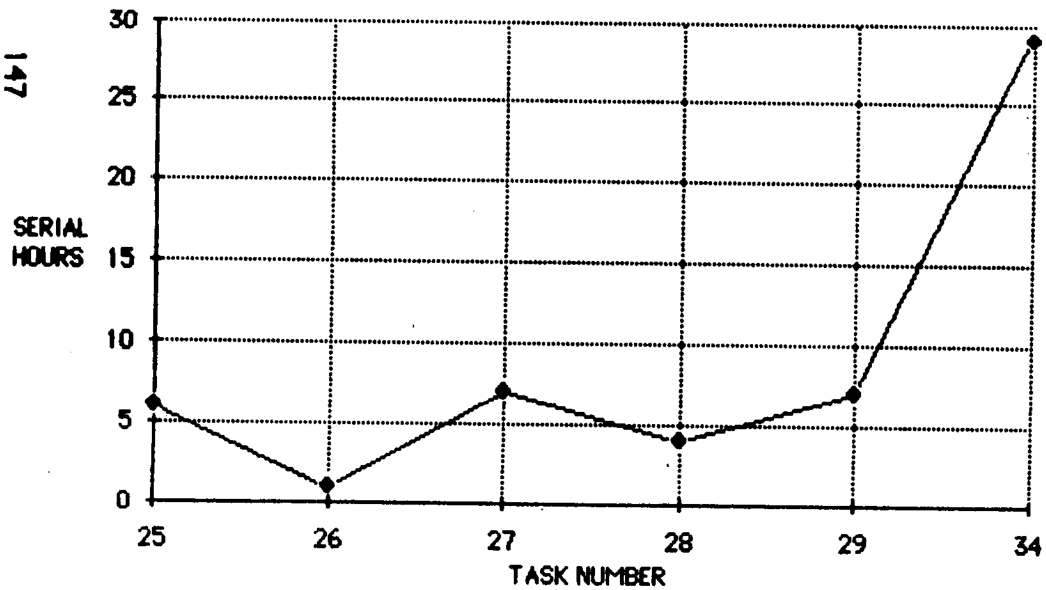


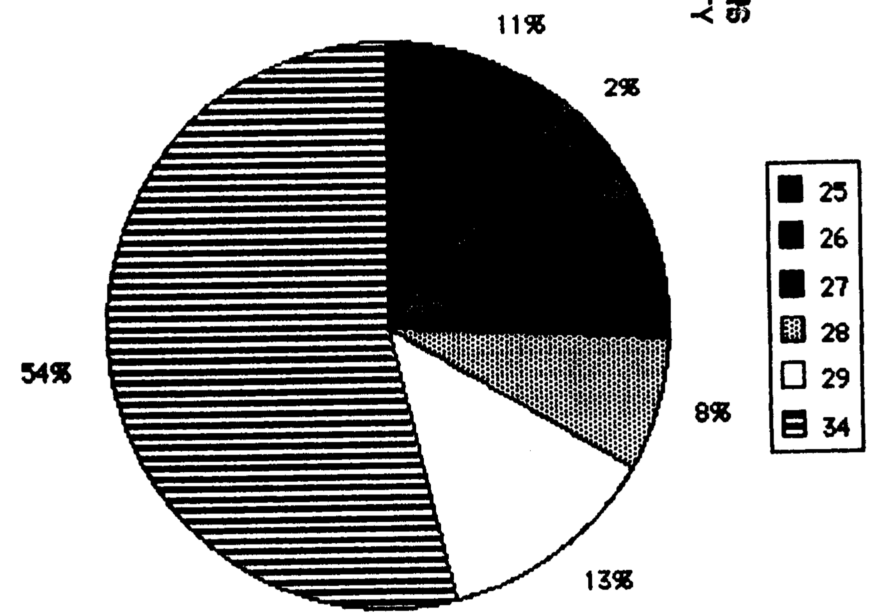
BOEING
uTV LAUNCH
OPERATIONS
STUDY for KSC

SBOTV SERIAL HOURS
FIRST NOMINAL FLOW

PRESENTED AT
KSC
JAN 31, 1986

MISSION AND RECOVERY





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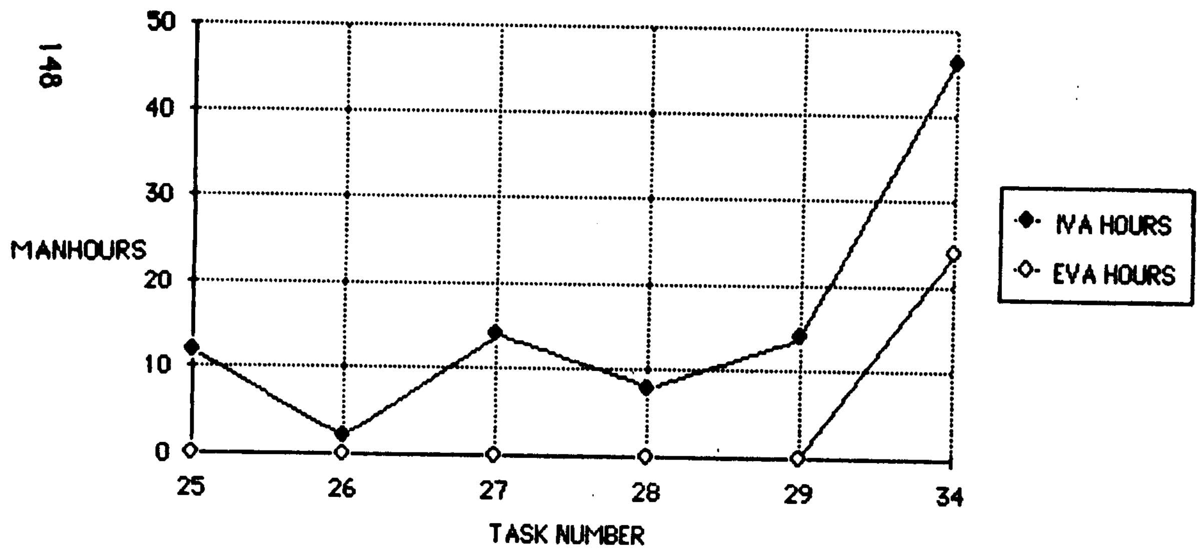
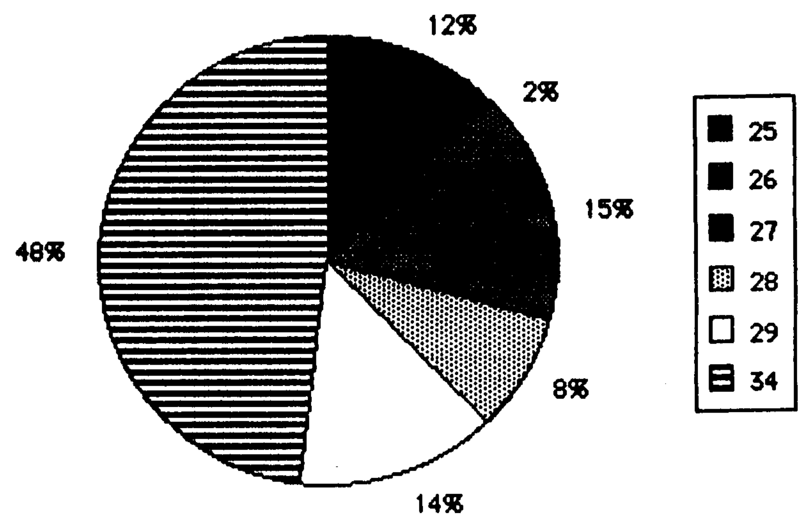
SBOTV MANHOURS
FIRST NOMINAL FLOW

MISSION AND RECOVERY





SBOTV SERIAL HOURS
FIRST NOMINAL FLOW

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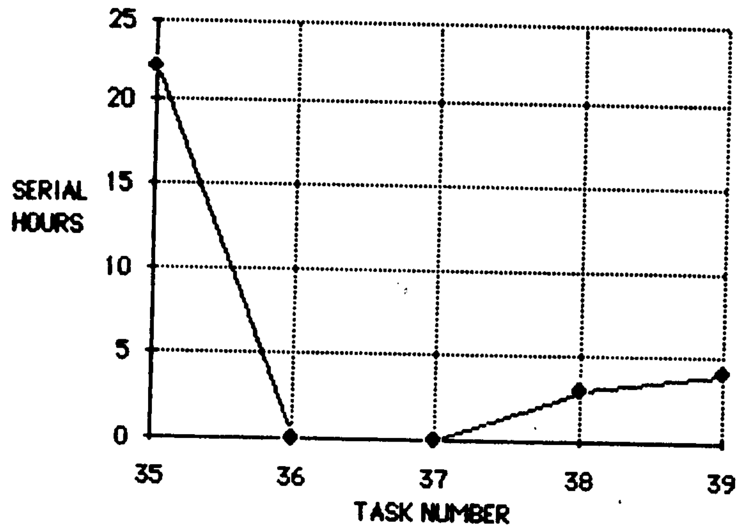
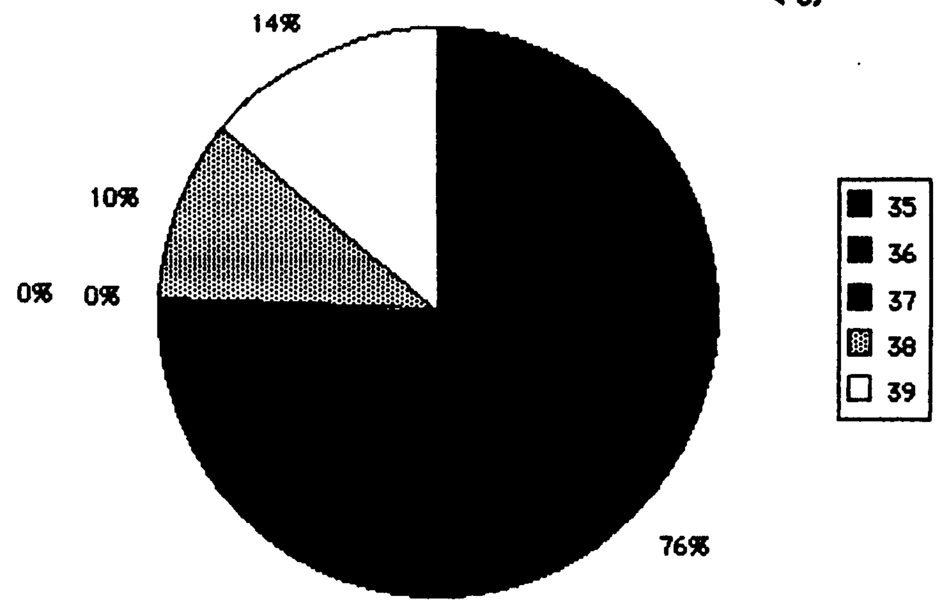
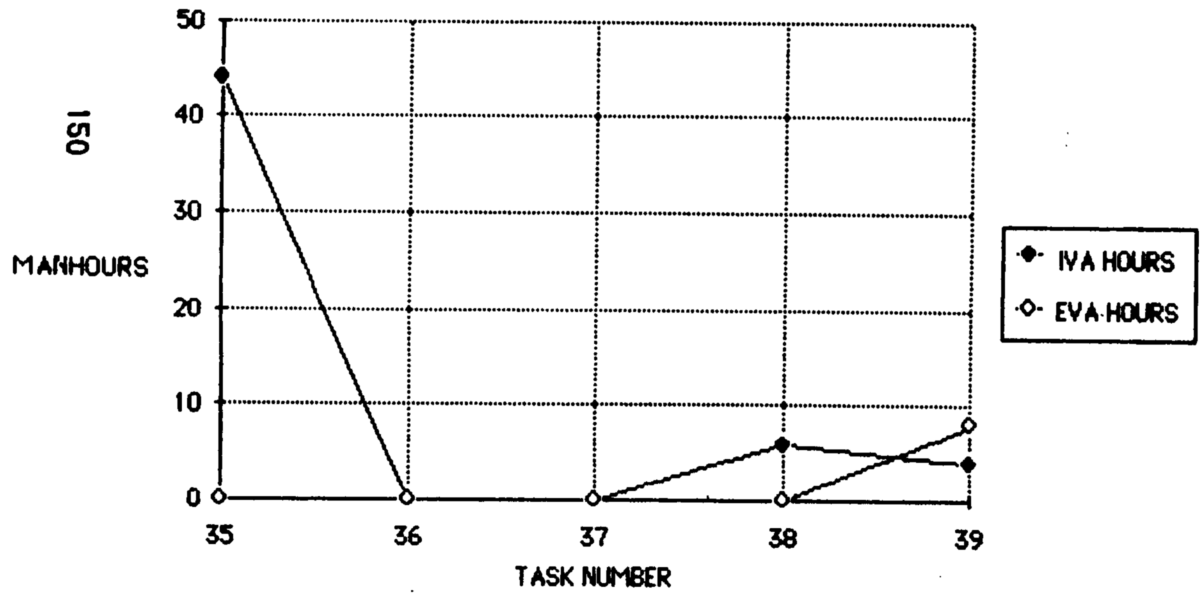
MAINTENANCE AND REFURBISHMENT

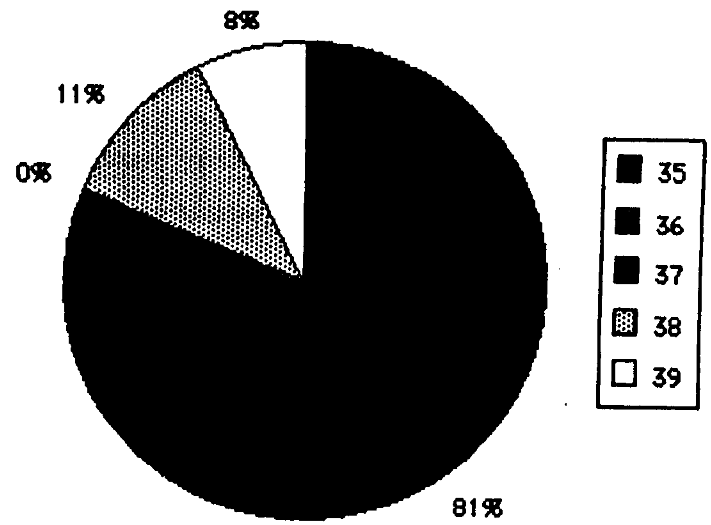




SBOTV MANHOURS
FIRST NOMINAL FLOW

MAINTENANCE AND REFURBISHMENT





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SPACE BASED OTV MANPOWER PER TASK

(RECURRING FLOW)

TASK	SER TIME	IVA	EVA	PREPARATIONS
~~1~~	~~9~~	~~19~~	~~8~~	~~RECEIVING~~
~~2~~	~~43~~	~~86~~		~~MECHANICAL ASSEMBLY~~
~~3~~	~~19~~	~~32~~		~~ELECTRICAL ASSEMBLY~~
~~4~~	~~23~~	~~46~~		~~MECHANICAL SYS TEST~~
~~5~~	~~12~~	~~23~~		~~ELECTRICAL SYS TEST~~
6	33	66		OTV INTEG SYS TEST
~~7~~	~~16~~	~~32~~		~~OTV/CS-G TEST~~

TASK	SER TIME	IVA	EVA	MISSION & RECOVERY
25	6	12		LAUNCH FROM LEO
26	1	2		DEPLOY SC
27	7	14		ORIENT & RET TO LEO
28	4	8		RENDEZVOUS
29	7	14		OTV RECOVERY
34	29	46	24	MOVE TO OTVPF

TASK	SER TIME	IVA	EVA	OTV/SC INTEGRATION
11	10	10	20	OTV/SC MECH/ELEC MATE
12	7	14		OTV/SC INTEG TEST
17	11	22		ADDN'L SUBSYS INSTALLATION
21	7	14		SC POCC TEST

MAINTENANCE & REFURBISHMENT				
TASK	SER TIME	IVA	EVA	
35	22	44		MAINTENANCE
36	0	0		UNPLANNED MAINT
37	0	0		MODS.
38	3	6		RETEST VERIF.
39	4	4	8	STORAGE

TASK	SER TIME	IVA	EVA	LAUNCH PREPS.
18	2	4		LOAD OTV RCS
23	16	31		LAUNCH PREPS
22	26	52		FINAL PL CLOSEOUT
24	6	12		DEPLOY OTV/SC

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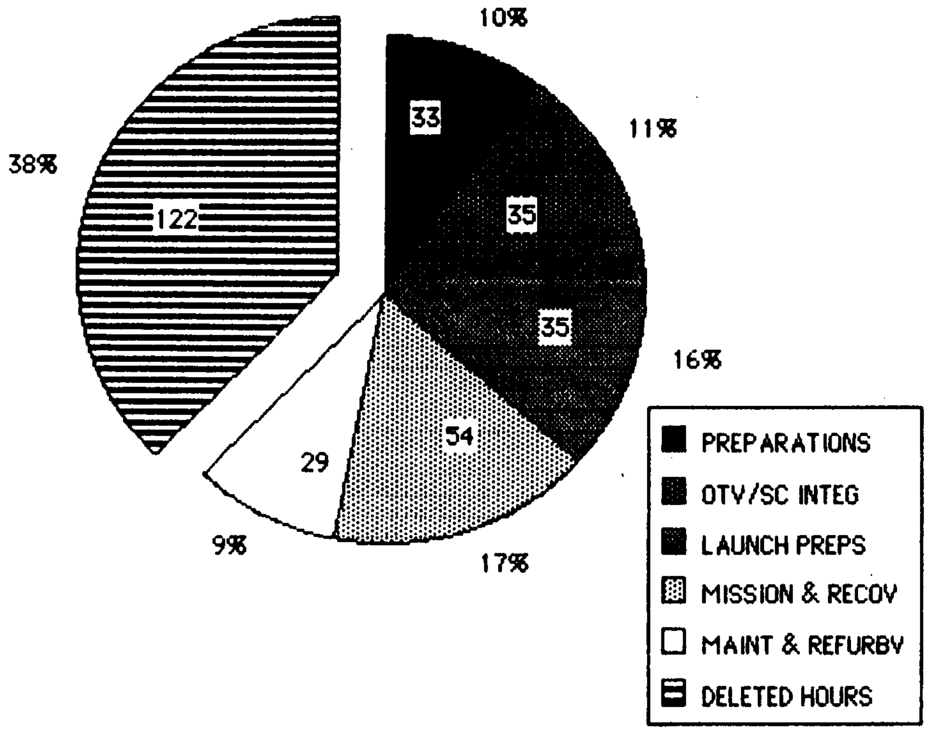
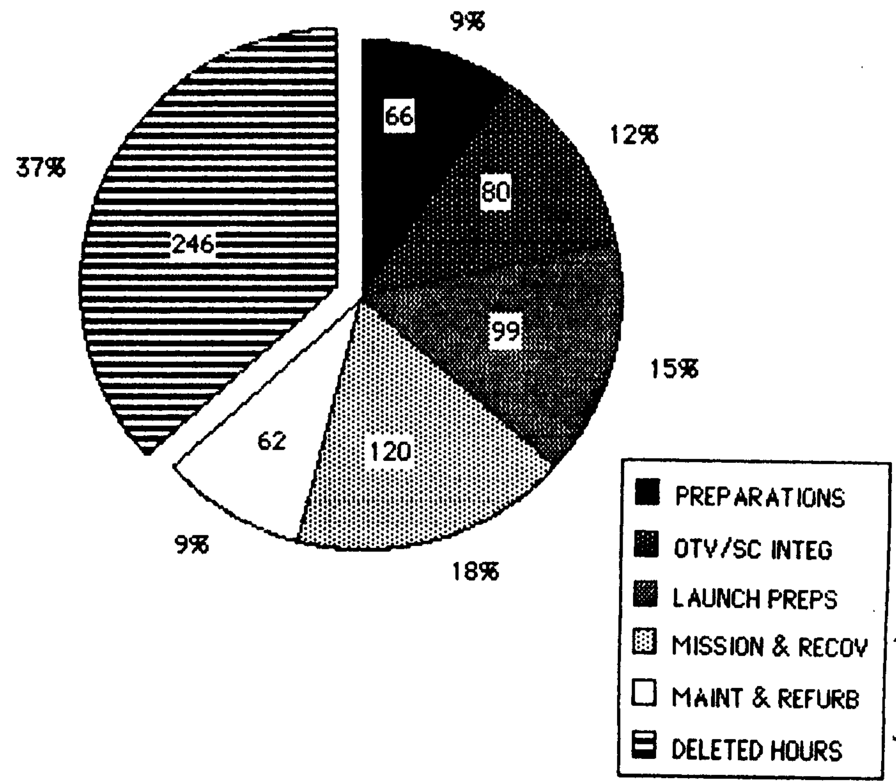
SBOTV - RECURRING FLOW
SERIAL TIME AND MANHOURS

SERIAL TIME

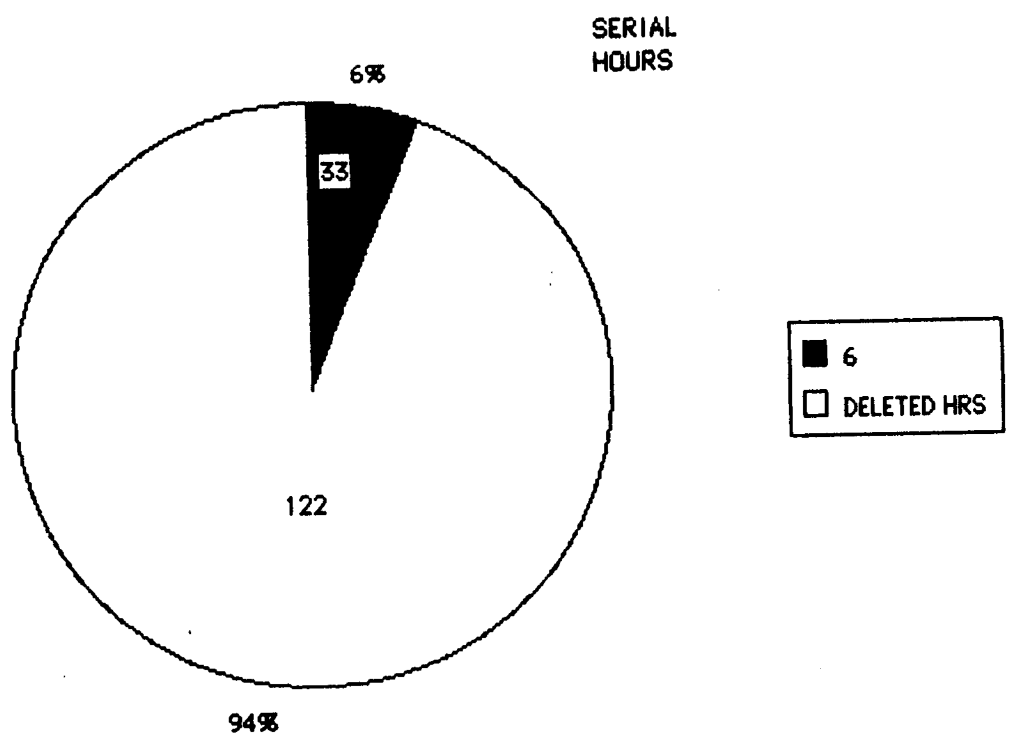


MANHOURS



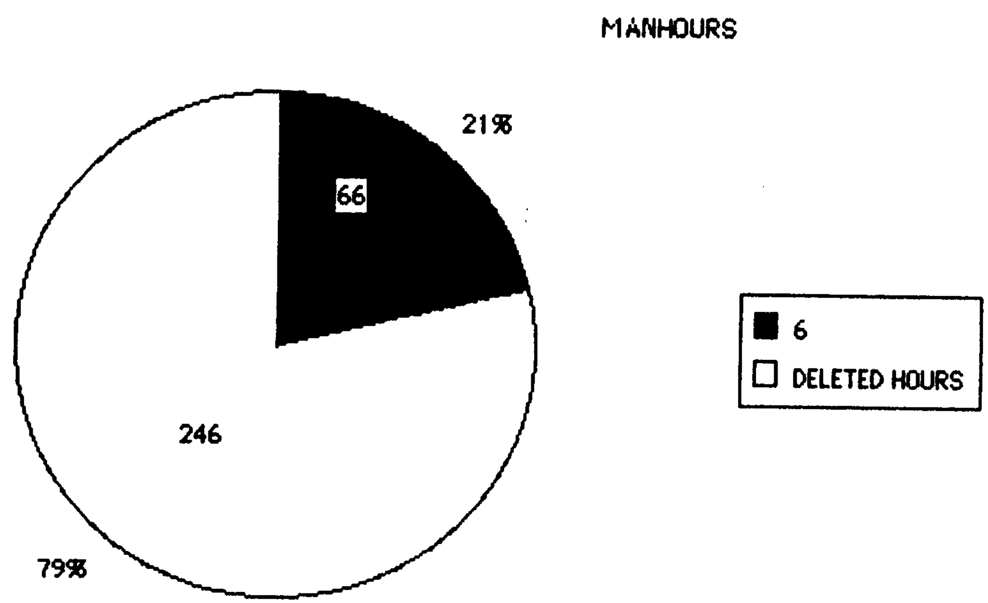
SBOTV SERIAL HOURS
RECURRING FLOW

PREPARATIONS



BOEING uTV LAUNCH OPERATIONS STUDY for KSC	SBOTV MANHOURS RECURRING FLOW	PRESEN AT KSC JAN 31, 1986

PREPARATIONS



BOEING **UTV LAUNCH** **OPERATIONS** **STUDY for KSC**	# SBOTV SLRIAL HOURS RECURRING FLOW	PRESEN AT **KSC** JAN 31, 1986

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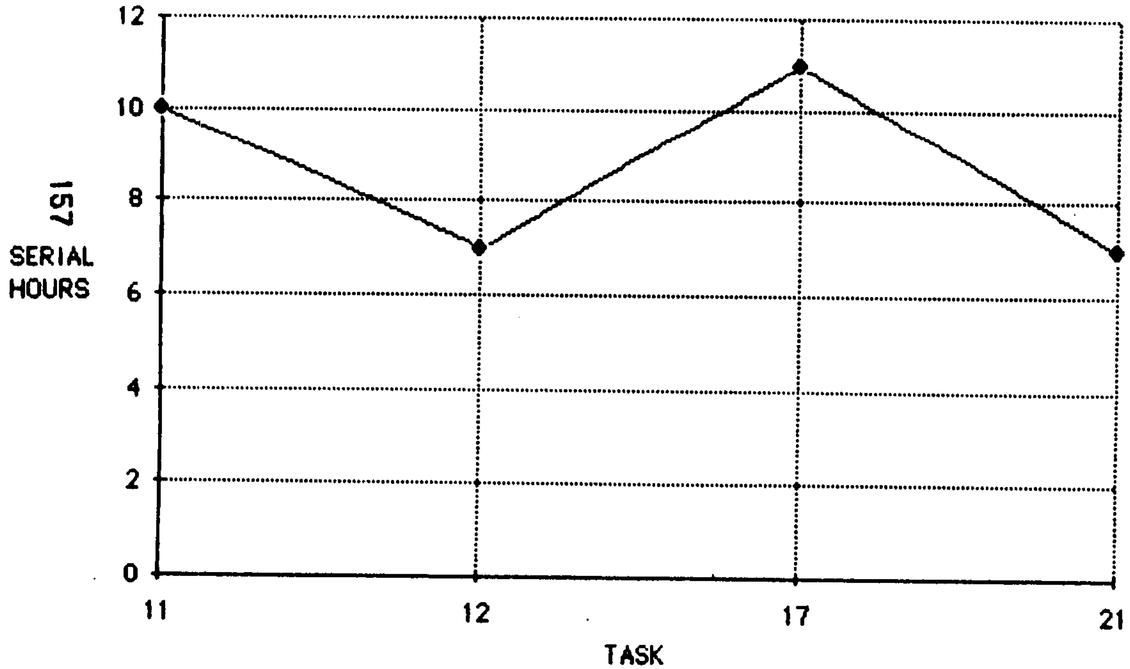
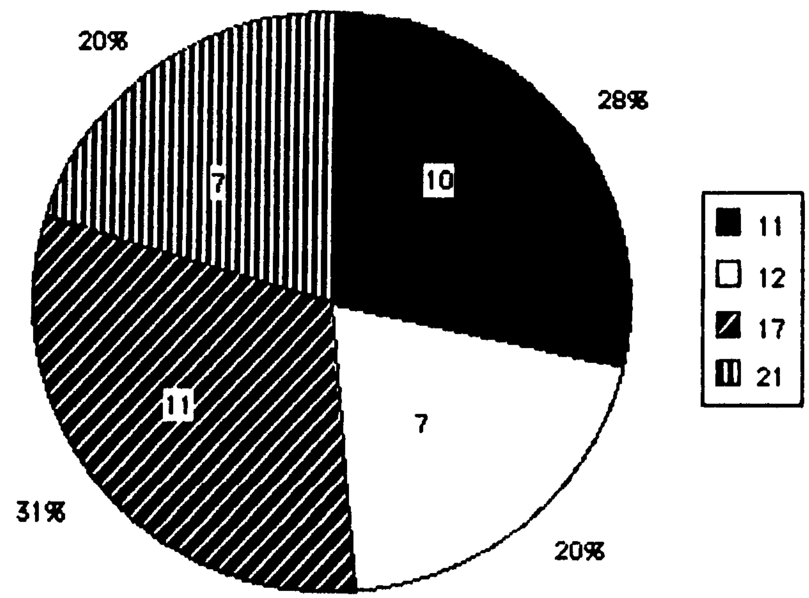
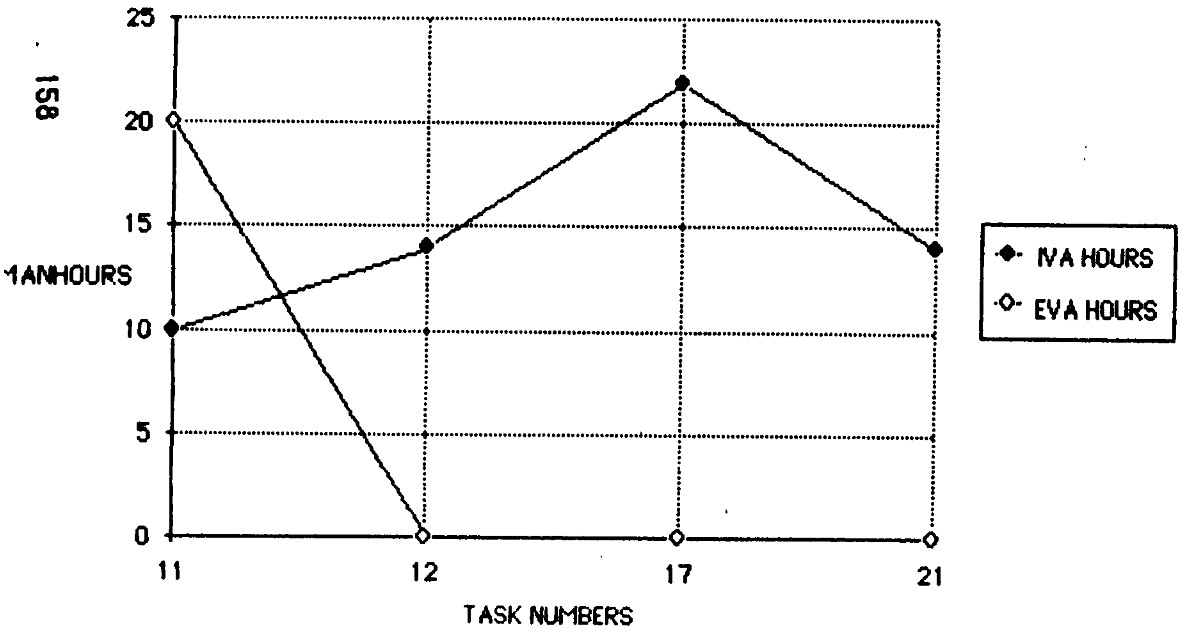
OTV/SC INTEGRATION

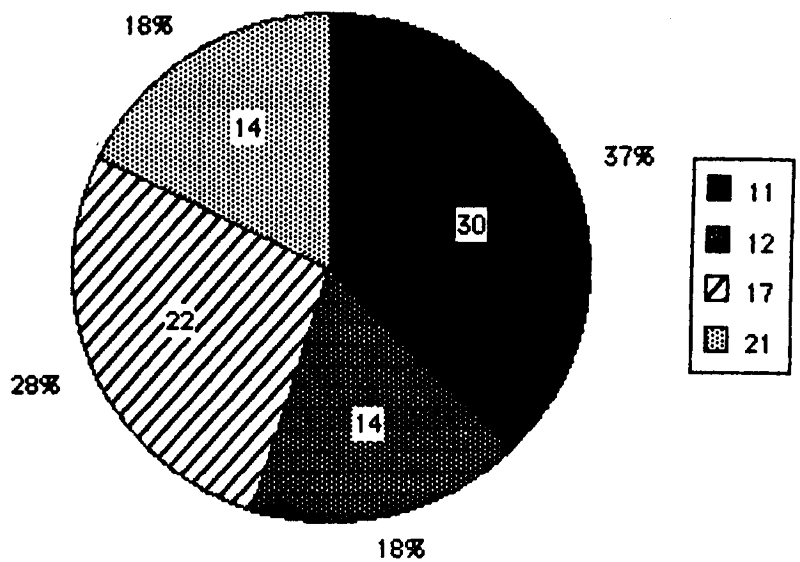




SBOTV MANHOURS
RECURRING FLOW

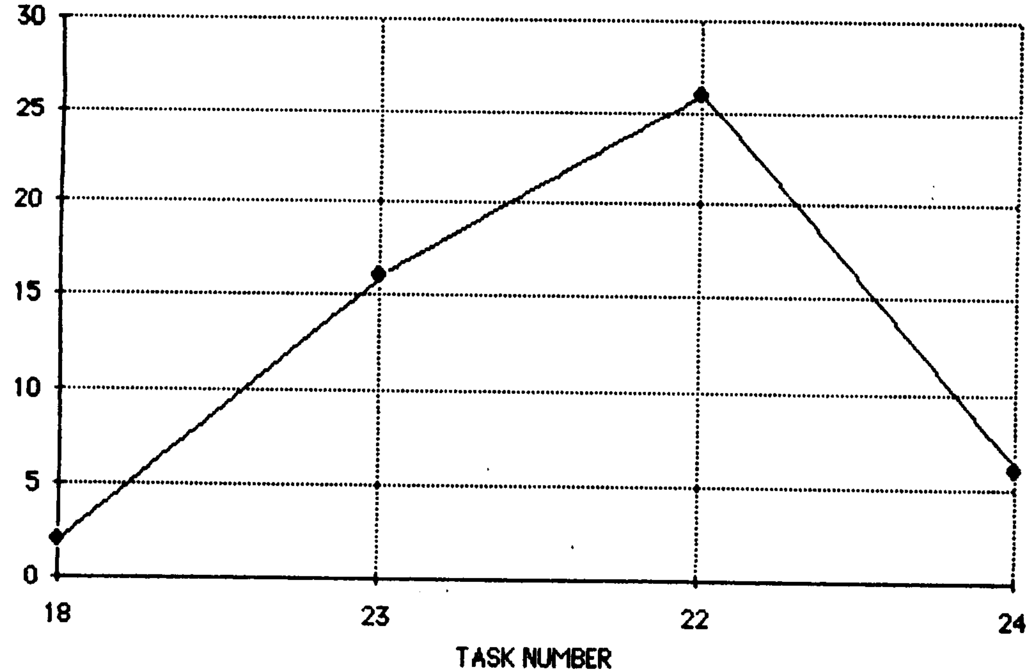
OTV/SC INTEGRATION

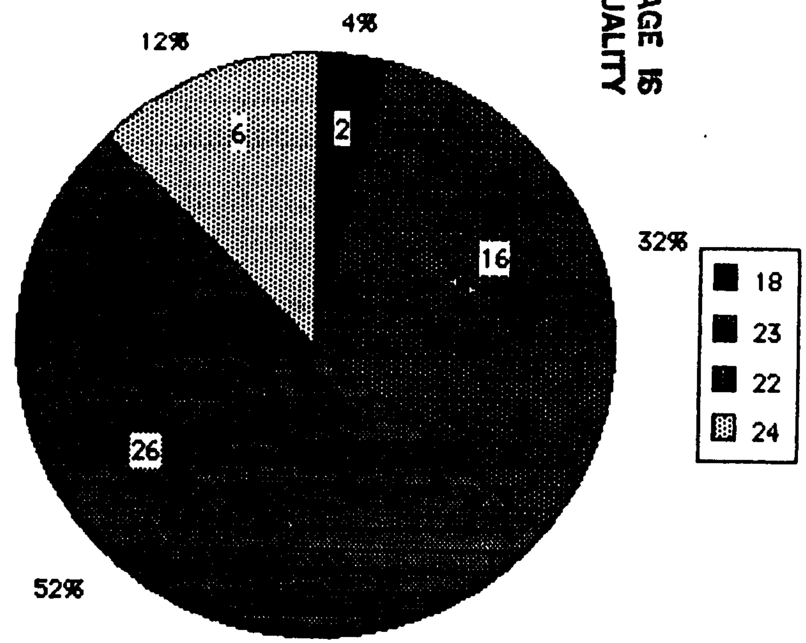




SBOTV SERIAL HOURS
RECURRING FLOW

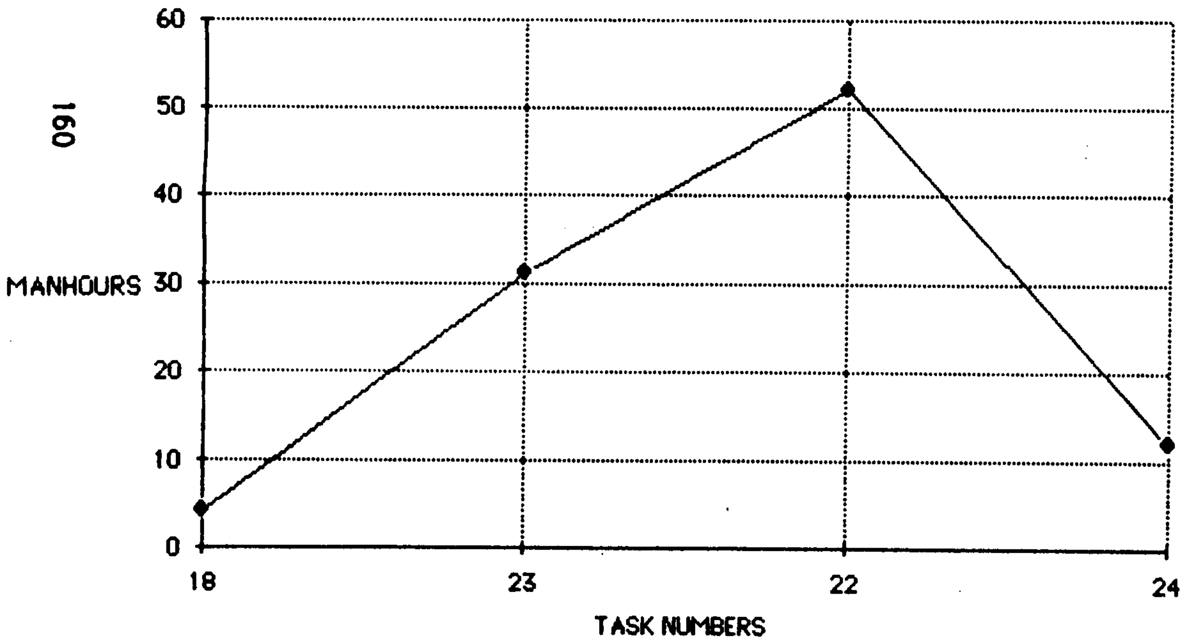
LAUNCH PREPARATIONS

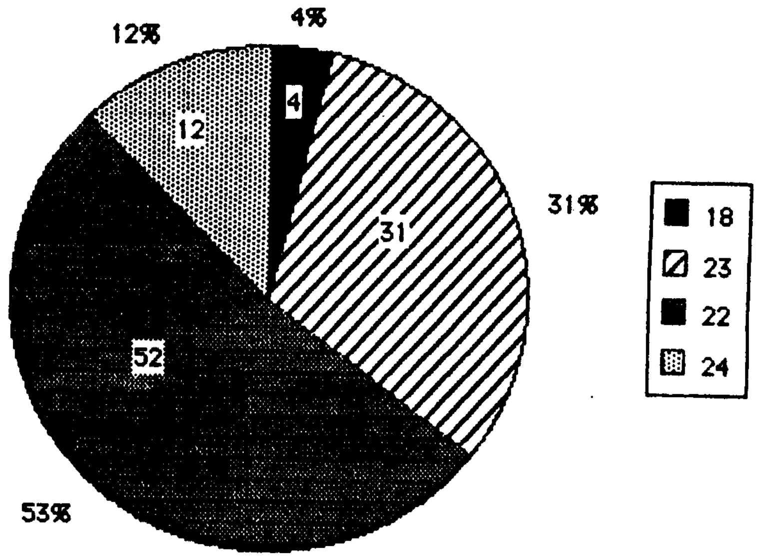




BOEING JTV LAUNCH OPERATIONS STUDY for KSC	SBOTV MANHOURS RECURRING FLOW	PRESENTED AT KSC JAN 31, 1986

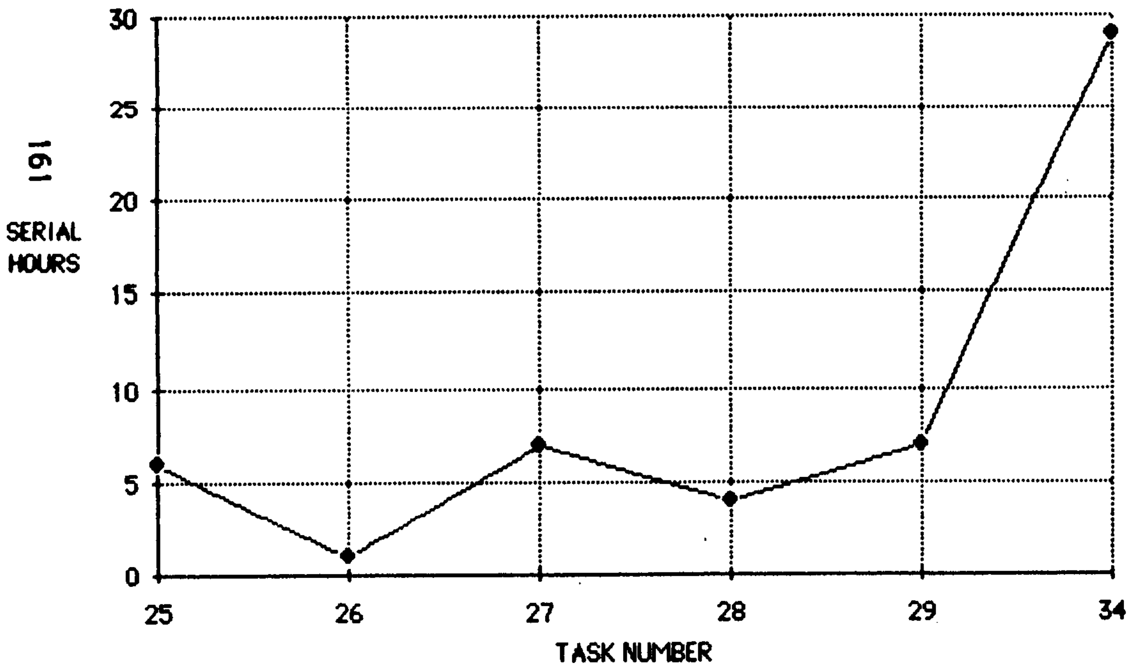
LAUNCH PREPARATIONS

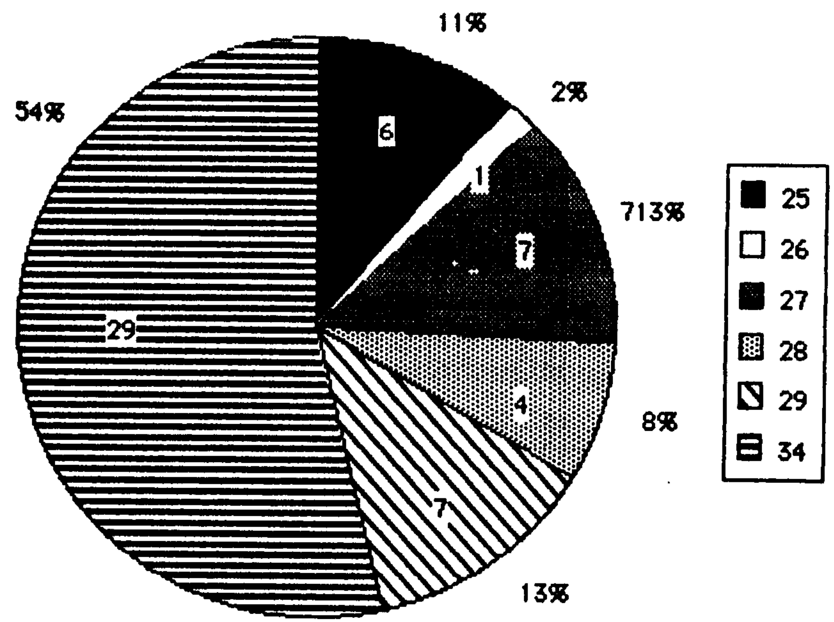




SBOTV SERIAL HOURS
RECURRING FLOW

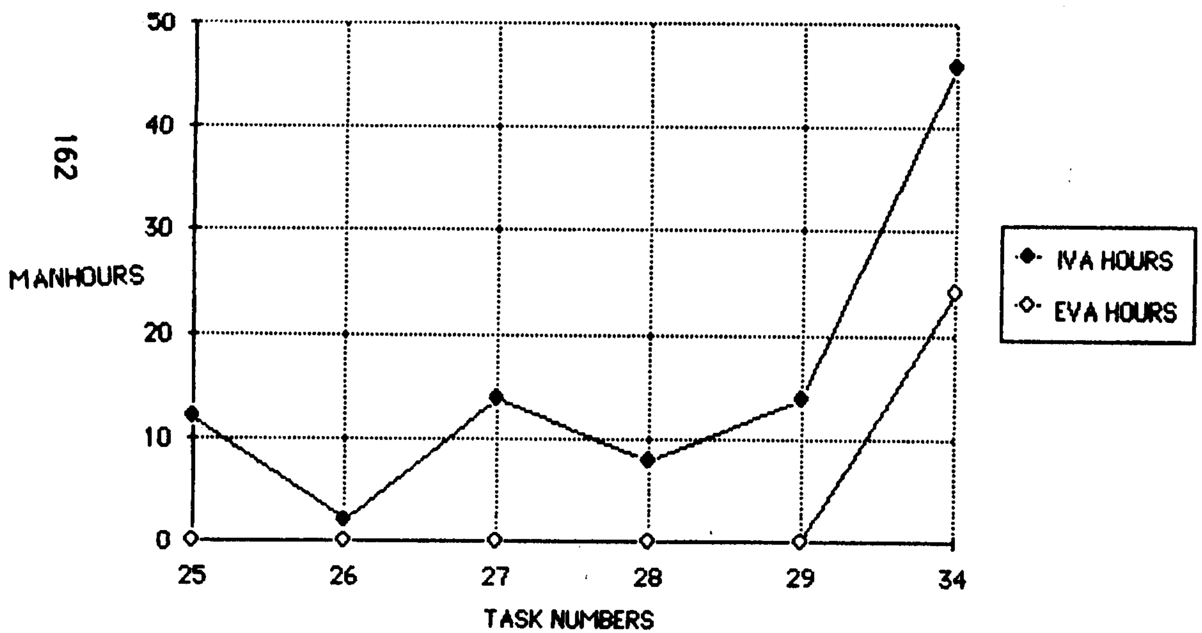
MISSION AND RECOVERY

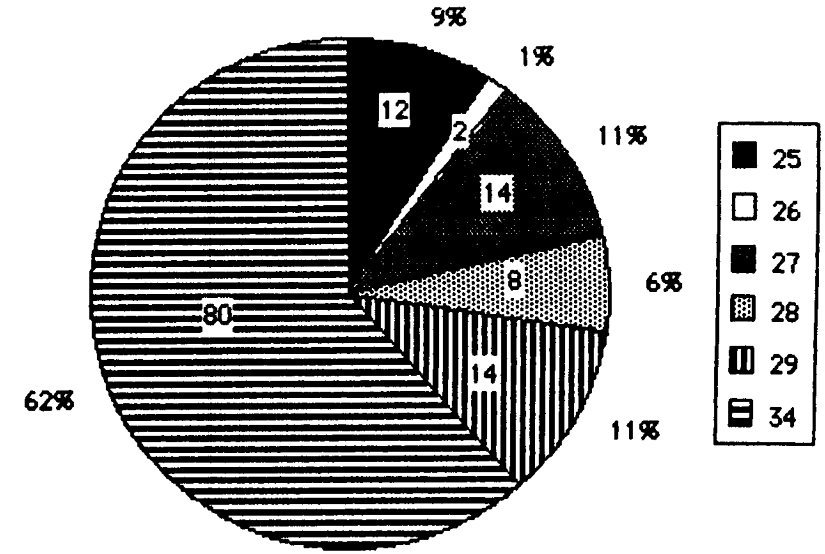




SBOTV .1ANHOURS
RECURRING FLOW

MISSION AND RECOVERY





BOEING
OTV LAUNCH
OPERATIONS
STUDY for KSC

SBOTV SERIAL HOURS
RECURRING FLOW

PRESENTED AT
KSC
JAN 31, 1986

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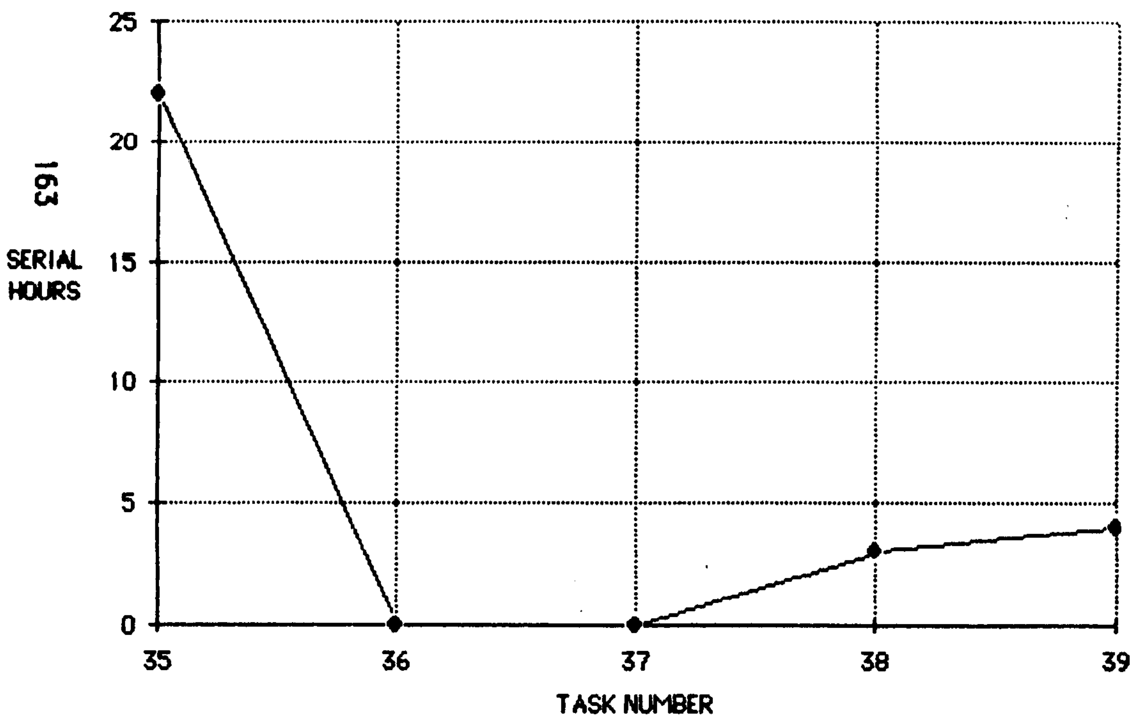
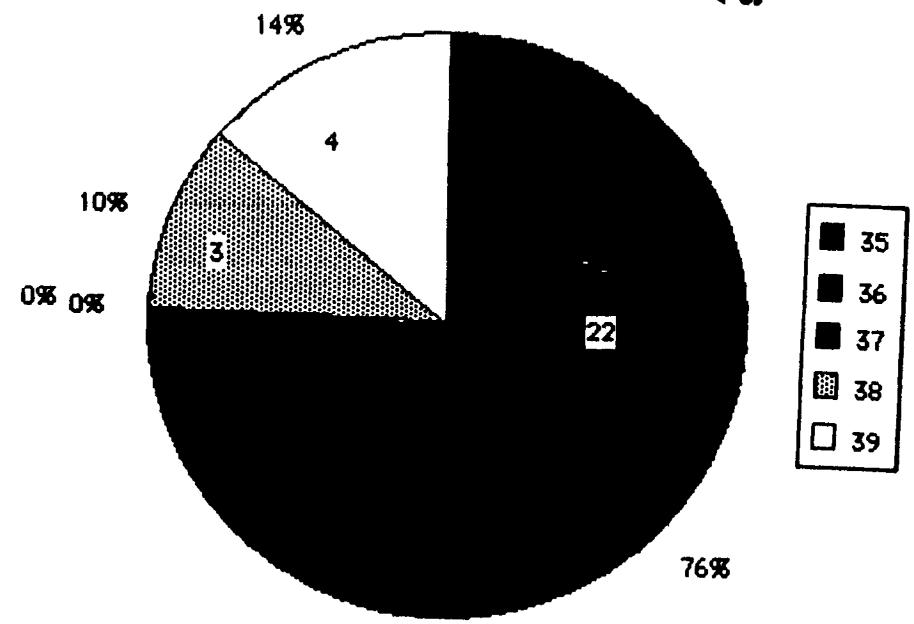
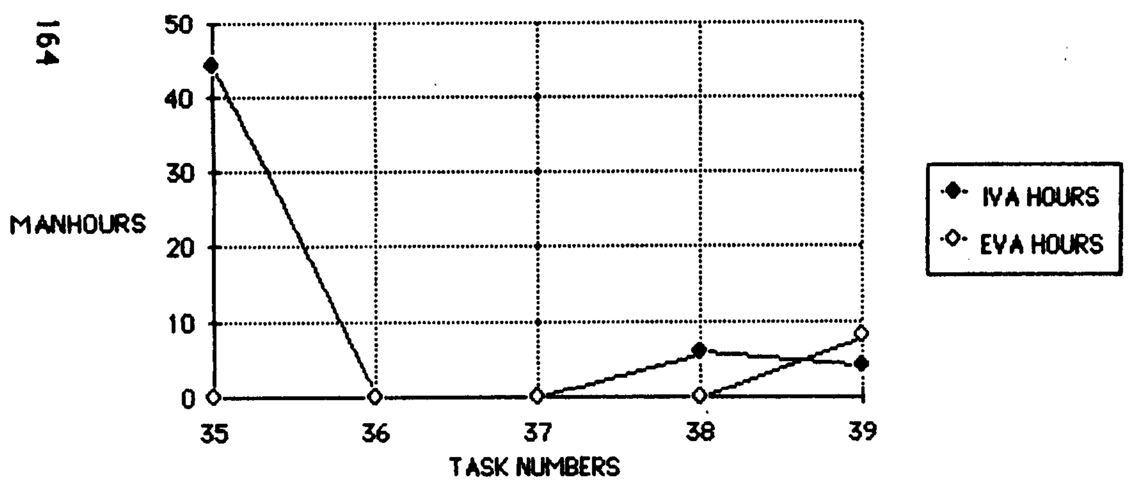
MAINTENANCE AND REFURBISHMENT

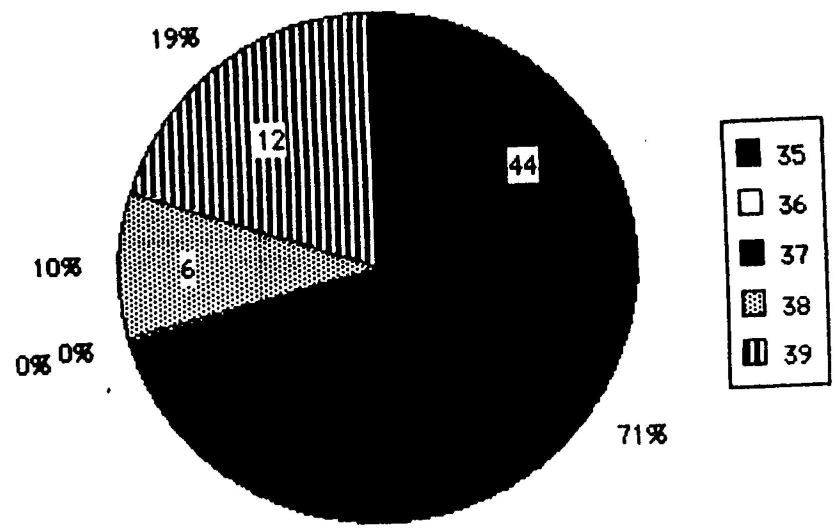




SBOTV MANHOURS
RECURRING FLOW

MAINTENANCE AND REFURBISHMENT





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BOEING
OTV LAUNCH
OPERATIONS
STUDY for KSC

FINAL PRESENTATION
AGENDA

PRESENTED AT
KSC
JAN 31, 1986

1. INTRODUCTION .... A. SCHOLZ
2. TEST PHILOSOPHY .... A. SCHOLZ
3. FLOW DIAGRAMS .... A. SCHOLZ
4. RESOURCE IDENTIFICATION SHEETS (RIS's) ... D. LOWRY
5. TECHNOLOGY IDENTIFICATION .... D. LOWRY
6. FACILITY IDENTIFICATION .... D. LOWRY
7. MANPOWER (SERIAL HOURS-MANHOURS) ..... A. SCHOLZ
8. SUMMARY .... A. SCHOLZ

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OPERATIONAL DESIGN DRIVERS

OBJECTIVE:

IDENTIFY OPERATIONAL AREAS THAT CAN CONTRIBUTE TO A REDUCTION IN OVERALL LIFE CYCLE COSTS

1. SHIP OTV's FROM FACTORY TO LAUNCH SITE FULLY ASSEMBLED
   - ELIMINATE ASSEMBLY AND RETEST OPERATIONS AT LAUNCH SITE (EXCEPT FOR DACC)
   - DEVELOP TRANSPORT CAPABILITY - PREFERABLY VIA AIR

2. MINIMIZE OPERATIONS IN ON-LINE FACILITIES
   - BATTERY INSTALLATION,
   - ORDNANCE INSTALLATION
   - RCS LOAD
   - PAYLOAD TEST (IN RSS OR PAYLOAD BAY)
   - MINIMIZE NUMBER OF CRYO LOAD TESTS

3. ELIMINATE MOVE TO CRYO FACILITY FOR POST MISSION DRAIN & PURGE

OPERATIONAL DESIGN DRIVERS
(CONT'D)

OBJECTIVE: (CONT'D)

IDENTIFY OPERATIONAL AREAS THAT CAN CONTRIBUTE TO A REDUCTION IN OVER-ALL LIFE CYCLE COSTS

4. PROVIDE NO PAYLOAD SERVICES FROM OTV
   - ELIMINATE SUPPORT OF SPACECRAFT POWER, DATA INTERLEAVING AND DISCRETES
5. GUIDANCE SYSTEM CONCEPTS
   - ELIMINATE/MINIMIZE SYSTEM WARMUP REQUIREMENTS
   - ELIMINATE/MINIMIZE CALIBRATION REQUIREMENTS
6. ELIMINATE ORDNANCE INSTALLATION FOR ACTIVATION OR SEPARATION
7. PROVIDE STRUCTURAL HARDPOINTS TO ACCOMMODATE DACC MODULE HANDLING
8. PROVIDE FOR EASE OF MAINTENANCE BY PROVIDING GOOD ACCESSABILITY
   - REMOVE AND REPLACE ANY ORU WITHOUT REMOVING ANY OTHER ORU
   - MAKE ORU's EASILY ACCESSIBLE -- ACCESS PANELS SHOULD NOT BE REQUIRED
   - USE EASY MOUNT AND CONNECT ORU's

OPERATIONAL DESIGN DRIVERS
(CONT'D)

OBJECTIVE: (CONT'D)

IDENTIFY OPERATIONAL AREAS THAT CAN CONTRIBUTE TO A REAL REDUCTION IN OVER-ALL LIFE CYCLE COSTS

9. MINIMIZE AIRBORNE SUPPORT EQUIPMENT (ASE)
    - USE ORBITER RMS FOR DEPLOYMENT
    - PROVIDE MINIMUM ORBITER MECHANICAL/ELECTRICAL INTERFACES
    - USE ORBITER STANDARD SWITCH PANEL(S) INSTEAD OF UNIQUE CONTROL PANELS FOR CONTROL OF OTV FUNCTIONS BY ORBITER PERSONNEL

10. PROVIDE FOR **COMMONALITY** OF ORU's WITH SPACE STATION AND OMV
    - EASE OF MAINTENANCE
    - REDUCE OPERATIONAL TRAINING REQUIREMENTS
    - SIMPLIFY SPARING
        - REDUCE NUMBER OF UNITS REQUIRED AT THE SPACE STATION
        - REDUCE STORAGE ACCOMMODATIONS AND ACCOUNTABILITY REQMTS.

11. PASSIVE THERMAL PROTECTION SYSTEM SHOULD BE RUGGEDIZED AND MADE EASY TO HANDLE TO REDUCE REPAIRS AND FACILITATE REPLACEMENT AT THE SPACE STATION

"-- OPPORTUNITIES --??"

ADDITIONAL PROBLEMS/QUESTONS IDENTIFIED REQUIRING ANSWERS

1. OTV Mission model --- (have Rev 8 dated Mar. 31, 1985) -- latest?
2. Fleet size ---- ???
3. Avionics in general -- can system warmup time requirements be eliminated?
4. What kind of activities and how extensive will the aerobrake processing and refurb work at KSC be?
5. RCS system definiton -- currently stated to be a "hyper" system -- technology developments - mono or dual - built-in tanks with external loading capability provided - what vol. propellants req'd?
6. Will a cryo leak test be required after each flight for the first few vehicles to demonstrate cryo system integrity -- (can forecasted technology developments in cryo plumbing/tanks/seals make repetitive leak tests unnecessary and obsolete?) -- test to be eliminated once hardware confidence is developed (our test philosophy states that the test will not be required) -- is this a technology problem -or- mindset?
7. Will there be an engine shop (ground based) -- & engine spares -- at KSC?
8. Will a rerun of CITE tests be required after major mods?
9. Will CITE-type tests be required for the DACC configured GBOTV and if so, what kind of tests would they be?
10. Will some type of Space Station/OTV compatibility test be required prior to launch of the hardware from KSC?

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" -- OPPORTUNITIES -- ??"
(CONT'D)

11. Will OMV/OTV/Space Station subsystem commonality be designed into, and provided with, the hardware system(s)?
12. A high level of A.I. must be designed into the OTV to make the Space Based job "do-able" (to reduce manpower and operations time requirements). Will this technology be available in time to support the program and will it be provided?
13. Testing strategy :
    - How will the testing strategy for A.I. and automated systems checkout and operation be developed?
    - Will the strategy/checkout/flight software -- be V&V'd at KSC, a special vendor facility, -- or?
14. Will KSC have simulation facilities? -- could be used to --
    - Support real-time problem solving
    - Provide astronaut/technician hands-on training/evaluation
    - Set up a means to accomplish ground-based "runs" on space assembly tasks
15. Will -- or could -- these simulation facilities be joint-use facilities with a combination of OMV/OTV/Space Station systems? Who will control/operate/maintain the facility and its useage?

KEY ELEMENTS OF SPACE PROCESSING PLAN for SPACE BASED OTV

SIMPLIFIED STRUCTURAL INTERFACE(S)

MINIMIZE MECHANICAL AND ELECTRICAL CONNECTIONS AT INTERFACES

AUTONOMOUS VEHICLE SELF-CHECK -- USING BUILT-IN-TEST-EQUIPMENT (BITE) AND AUTOMATED FAULT ANALYSIS/FAULT ISOLATION

ROBOTICS FOR REPETITIVE TASKS

AUTOMATED TEST PROCEDURES/DOCUMENTATION METHODOLOGY

SUBSYSTEM EQUIPMENT COMMONALITY WITH OTHER PROGRAMS; ie, SPACE STATION/OMV/OTV

THE DRIVER -- MOTIVATOR -- CO$T

$16,000 PER HOUR IVA (SPACE PROCESSING) VERSUS $96,000 PER YEAR (GROUND PROCESSING)	ONE MANHOUR IVA IS EQUIVALENT TO TWO MANMONTHS GROUND PROCESSING
$122,000 PER HOUR EVA (SPACE PROCESSING) VERSUS $96,000 PER YEAR (GROUND PROCESSING)	ONE MANHOUR EVA IS EQUIVALENT TO 1.27 MANYEARS GROUND PROCESSING
$122,000 PER HOUR EVA (SPACE PROCESSING) VERSUS $16,000 PER HOUR IVA (SPACE PROCESSING)	ONE MANHOUR EVA IS EQUIVALENT TO 7.63 MANHOURS IVA

SUMMARY

OTV/SPACE STATION OPERATIONS PLANNING SHOULD CONTINUE SO THAT THE NEAR-TERM NEED TO DEFINE ACCOMMODATIONS AT THE SPACE STATION CAN BE COMPLETED. THE "SCAR" NECESSARY TO SUPPORT THOSE ACCOMMODATIONS REQUIREMENTS NEEDS TO BE DESIGNED INTO THE BASIC SPACE STATION STRUCTURE AND SYSTEMS DESIGN(S) -- EVEN THOUGH THE OTV ACCOMMODATIONS HARDWARE MAY NOT BE PROVIDED/INSTALLED UNTIL AFTER THE STATION IS PLACED IN LOW EARTH ORBIT.

OTV LAUNCH SITE FACILITY PLANNING SHOULD PROCEED TO MAKE SURE THAT:

1. THE REQUIRED TECHNOLOGY IS AVAILABLE AT THE LAUNCH SITE WHEN NEEDED
2. THE LAUNCH SITE FACILITIES PLANNING PROPERLY SUPPORTS COST OF FACILITIES (C of F) PLANNING ACTIVITES
3. THE FACILITIES ARE DEVELOPED, AVAILABLE AND PUT ONLINE IN A COST EFFECTIVE TIMELY MANNER TO SUPPORT VEHICLE PROCESSING

SUMMARY
(CONT'D)

NASA MUST DEVELOP, AND PUT IN PLACE, A SET OF BASIC EQUIPMENT **COMMONALITY** REQUIREMENTS TO INSURE COMMON APPROACHES TO EQUIPMENT DESIGN, INSTALLATION, CHECKOUT, MAINTENANCE, SPARES PROVISIONING/CONTROL, AND VEHICLE PROCESSING FOR THE THE SPACE STATION, OMV AND OTV.

SOME OF THIS DESIGN ACTIVITY (FOR THE SPACE STATION AND THE OMV) WILL BE INITIATED IN THE VERY NEAR FUTURE. IF THE FULL BENEFITS OF "COMMONALITY" ARE TO BE ACHIEVED, IMMEDIATE ATTENTION/ACTION IS REQUIRED.

IN ORDER TO REALIZE THE SIGNIFICANT OVERALL COST SAVINGS THAT COULD RESULT FROM COMMONALITY FOR OMV,OTV, AND SPACE STATION EQUIPMENTS, SYSTEMS,AND OPERATIONAL PRACTICES; NASA MUST MAKE AND IMPLEMENT A DECISION EARLY IN THE DEVELOPMENT CYCLE AT THE PROGRAM LEVEL TO MAKE COMMONALITY A BASIC PROGRAM REQUIREMENT.

CONCLUSIONS

THE OTV PROGRAM WILL PROVIDE AN ADVANCED STATE-OF-THE-ART VEHICLE CAPABLE OF OPERATING IN A HIGHLY AUTONOMOUS MODE THAT WILL TAX THE CAPABILITY OF THE LAUNCH SITE (KSC OR SPACE STATION) TO HAVE THE APPROPRIATE FACILITIES, CREWS AND EQUIPMENT AVAILABLE FOR VEHICLE CHECKOUT AND OPERATIONAL CONTROL.

OPERATIONAL COSTS **($$$$$$)** WILL DRIVE SPACE STATION OPERATIONS) TO A HIGHLY AUTONOMOUS MODE OF OPERATION THAT WILL REQUIRE A VERY HIGH DEGREE OF AUTOMATION -- NOT CURRENTLY AVAILABLE IN THE MARKETPLACE. ONE SHOULD EXPECT TO SEE THIS SAME LEVEL OF AUTOMATION EARLY IN THE PROGRAM ON THE GROUND BASED VERSION OF THE VEHICLE FOR SYSTEM OPERATIONAL VERIFICATION PRIOR TO DEDICATION TO SPACE OPERATIONS.

SUPPORT OF THIS TYPE OF PROGRAM WILL REQUIRE A **DEDICATED** FACILITY THAT WILL BE INVOLVED WITH ALL OTV PROCESSING TO ELIMINATE COSTLY INTER-FACILITY MOVES.

1. THE FACILITY SHOULD HAVE THE CAPABILITY TO COMPLETELY CHECKOUT THE HIGHLY AUTOMATED SYSTEMS USED BY THE OTV AND VERIFY THEIR READINESS FOR TRANSPORT TO LEO AND THEIR SUBSEQUENT MISSION ASSIGNMENT(S).

2. THE FACILITY SHOULD HAVE THE CAPABILITY TO SUPPORT HAZARDOUS PROCESSING (FUEL CELL OPERATION, PARTIAL CRYO LOAD, ORDNANCE HANDLING, ETC.). A DEDICATED FACILITY WOULD ELIMINATE COSTLY MOVES TO OTHER FACILITIES TO ACCOMMODATE THESE OPERATIONS.

3. IF THE FACILITY IS "DEDICATED" THEN THE PROCESSING/LAUNCH/MISSION/STORAGE PHASE AND NEXT CYCLE START-UP IS SIMPLIFIED. MANPOWER REQUIREMENTS ARE ALSO REDUCED BECAUSE OF THE ELIMINATION OF ANY SPECIAL MOVES TO A SEPARATE STORAGE FACILITY AND THE NEED TO RETURN TO THE PROCESSING FACILITY.

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APPENDIX B

FINAL PRESENTATION ATTENDEES

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ORBITAL TRANSFER VEHICLE LAUNCH OPERATIONS STUDY

FINAL PRESENTATION--KSC-- JAN. 31, 1986

ATTENDEES	ORGANIZATION/ MAIL CODE	PHONE	DESIRE FINAL REPORT
BILL CASE	MMC-G	867-4535	YES
BILL SHAPBELL	KSC/SS-OCO	867-4176	YES
TOM DUNCAN	MMC-G	867-3142	NO
CHARLES GARNER	MMC-30	867-7737	YES
BRUCE LARSEN	PT-FPO	867-2780	NO
DENNIS MATTHEWS	PT-FPO	867-2780	NO
ANDY ANDERSON	SS-SEI	867-4773	NO
JIM HARRELL	PT-PAT	867-2544	NO
GEORGE MOSAKOWSKI	PT-PMO	867-3494	NO
BILL DICKINSON	PT-FPO	867-2780	YES
JIM SPEARS	PT-TPO	867-7705	YES
WENDELL CLARK	BAC-HSV	895-7474	YES
DEAN MOREHEAD	BAO-ELS	853-7447	YES
JOHN TWIGG	CP-FSO	867-4670	YES
CHUCK McEACHERN	CS-SED-3	867-4787	NO
PAUL KOLASKY	CP-FSO	867-4670	YES
BILL KETCHUM	GD/SSD CI-7103	547-7153	YES
LYLE BARNEY	MDAC-KSC	867-4959	YES
HOWELL HILTON	KSC/DF-PEO-C	867-3210	YES
DAVE MOJA	PT	867-3494	NO
DAVID LOWRY	FC-51	853-6001	YES

ORBITAL TRANSFER VEHICLE LAUNCH OPERATIONS STUDY

FINAL PRESENTATION--MSFC-- FEB. 13, 1986

ATTENDEES	ORGANIZATION/ MAIL CODE	PHONE
JOHN TWIGG	KSC/CP-FSO	823-4670
M. DILLARD	MSFC-KAZI	453-4955
DON PERKINSON	MSFC-PD24	453-4195
JOE LOWERY	MSFC-PD33	453-4259
JAMES SANDERS	PD13	453-3229
AL HARAWAY	BOEING-HSV	895-7137
BART BARISA	MSFC/PD34	453-3937
GARY JOHNSON	MSFC/PF20	453-0167
MILT PAGE	MSFC/PF20	453-0167
LEE VARNADO	MSFC/PF20	453-0167
KEITH CHANDLER	BOEING-FC	783-0220
DON SAXTON	MSFC/PF20	453-0167
BILL DICKINSON	KSC/PT-FPO	823-2780
B. RUTHERFORD	MSFC/PP03	453-0467
UWE HUCTER	MSFC/PD22	453-4263
DONALD BISHOP	MSFC/PP04	453-4024
CARMINE De SANCTIS	MSFC/PS02	453-3430
W. A. FERGUSON	MSFC/PP02	453-3713
RODGER ROMANS	MSFC/PP04	453-4024
JIM STEINCAMP	MSFC/PD34	453-3938