29

MCDONNELL DOUGLAS

SPACE TUG SYSTEMS STUDY (CRYOGENIC)
SEPTEMBER DATA DUMP

VOLUME 8 Programmatics and Cost
Book 3 Option 3

SEPTEMBER 1973

PREPARED BY: SPACE TUG STUDY TEAM

APPROVED BY: L. Q. Westmoreland
L. Q. WESTMORELAND
STUDY MANAGER

(NASA-CR-179116) SPACE TUG SYSTEMS STUDY (CRYOGENIC). VOLUME 8: PROGRAMMATICS AND COST, BOOK 3, OPTION 3 Data Dump, Sep. 1973 (McDonnell-Douglas Astronautics Co.) 950 p Avail: NTIS

N87-70403

Unclas

00/18 0074241

PREPARED FOR NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MARSHALL SPACE FLIGHT CENTER
UNDER CONTRACT NO. NAS8-29677

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY-WEST

5301 Bolsa Avenue, Huntington Beach, CA 92647

PREFACE

This study report for the Tug Program is submitted by the McDonnell Douglas Astronautics Company (MDAC) to the Government in partial response to Contract Number NAS8-29677.

The current results of this study contract are reported in eight volumes:

Volume 1 — Summary, Program Option 1
Volume 2 — Summary, Program Option 2
Volume 3 — Summary, Program Option 3

These three summary volumes present the highlights of the comprehensive data base generated by MDAC for evaluating each of the three program options. Each volume summarizes the applicable option configuration definition, Tug performance and capabilities, orbital and ground operations, programmatic and cost considerations, and sensitivity studies. The material contained in these three volumes is further summarized in the Data Dump Overview Briefing Manual.

Volume 4 — Mission Accomplishment. (3 Books and 1 Supplement Bound Together)

This volume contains mission accomplishment analysis for each of the three program options and includes the tug system performance, mission capture, and fleet size analysis.

Volume 5 — Systems (3 Books)

This volume presents the indepth design, analysis, trade study, and sensitivity technical data for each of the configuration options and each of the Tug systems i.e., structures, thermal, avionics, and propulsion. Interface with the Shuttle and Tug payloads for each of the three options is defined.

Volume 6 – Operations (3 Books)

This volume presents the results of orbital and ground operations trades and optimization studies for each option in the form of operations descriptions, time lines, support requirements (GSE, manpower, networks, etc.), and resultant costs.

Volume 7 – Safety (3 Books)

This volume contains safety information and data for the Tug Program. Specific safety design criteria applicable to each option are determined and potential safety hazards common to all options are identified.

Volume 8 – Programmatics and Cost (3 Books)

This volume contains summary material on Tug Program manufacture, facilities, vehicle test, schedules, cost, project management SR&T, and risk assessment for each option studied.

These volumes contain the data required for the three options which were selected by the Government for this part of the study and are defined as:

A. Option 1 is a direct development program (I.O.C.: Dec 1979). It emphasizes low DDT&E cost; the deployment requirement is 3500 pounds into geosynchronous orbit, it does not have retrieval capability, and it is designed for a 36-hour mission. MDAC has also prepared data for an alternative to Option 1 which deviates from certain requirements to achieve the lowest practicable DDT&E cost.

B. Option 2 is also a direct development program (I.O.C.: 1983). It emphasizes total program cost effectiveness in addition to low DDT&E cost. The deployment requirement is 3500 pounds minimum into geosynchronous orbit and 3500 pounds minimum retrieval from geosynchronous orbit.

C. Option 3 is a phased development program (I.O.C.: 1979 phased to I.O.C. 1983). It emphasizes minimum initial DDT&E cost and low total program cost. The initial Tug capability will deploy a minimum of

3500 pounds into geosynchronous orbit without retrieval capability, however, through phased development, it will acquire the added capability to retrieve 2200 pounds from geosynchronous orbit. The impact of increasing the retrieval capability to 3500 pounds is also provided.

CONTENTS

1 SCHEDULES
2 VEHICLE TEST PROGRAM
3 FACILITIES PLAN
4 VEHICLE MANUFACTURING
5 SPECIAL PROGRAMMATICS
6 COST DATA
7 FLIGHT SCHEDULES
8 SENSITIVITIES FOR THE PROGRAM OPTION
9 RISK ASSESSMENT
10 SUPPORTING RESEARCH AND TECHNOLOGY (SR&T)
11 SPECIAL COST SENSITIVITIES OPTION 3
12 DOD ACQUISITION APPROACH (AFSCP 800-3)
13 COST ESTIMATING METHODOLOGY
14 OTHER SENSITIVITIES AS DEFINED

INTRODUCTION AND SUMMARY

This report contains detail programmatics and cost data, sensitivities, and trades analyses pertinent to the Space Tug (Cryogenic) Program Option 3. This option, a phased developed Tug with IOC in December 1979, provides initially minimum performance capability but also emphasizes minimum initial DDT&E cost with ability to grow in capability at low total program costs. The data presented are organized in accordance with the Government furnished outline. Data covering the programmatic areas of schedules, vehicle testing, facilities, manufacturing, and attendant costs are presented. The cost data are reported in accordance with the basic requirements of Data Requirement Document No. MF003M, dated 1 May 1971, as modified by study guidelines received from the Government in the course of the study. Additional data are given in the areas of program management plans and risk assessment.

Results of the Option 3 analyses indicate that this version of the Tug can be developed within the study ground rules for a total DDT&E cost of $279 million, $190 million for the Initial, and $89 million for the Final capability. The peak annual funding requirement is $90 million occurring in Government fiscal year 1981. Total production phase cost for an operational fleet of 5 Initial, 11 Final vehicles plus 9 auxiliary (kick)stages required to satisfy the flight schedule, including contingency for expected reliability losses, totals $275 million. Total operations phase cost, for a total of 366 flights is $293 million, yielding an average cost per flight of $0.76 million for the basic reusable Tug flight mode.

Section 1
SCHEDULES

This section presents schedules developed for the Tug Option 3 based on the requirement for a nominal IOC 1 April 1980 (Increment I). The earliest ATP for the DDT&E phase is October 1975. The schedules were derived by iterative analysis of design and development requirements for subsystems and the vehicle main stage, test and evaluation requirements, manufacturing requirements and production rate considerations, as well as operational flight schedule requirements and fleet size.

1.1 SUMMARY SCHEDULE

The project summary schedule for Option 3 is shown in Figure 1.1-1. It features an ATP for the Phase C/D design development in October 1975. Required supporting research and technology for the vehicle design is assumed to have been initiated approximately eighteen months prior to project ATP. Design, development, test and evaluation (DDT&E) requires 54 months up to the first flight on 1 April 1980. This first flight is used to place an operational payload in orbit, having only secondary test objectives associated with monitoring critical subsystem functions by means of added test instrumentation. No dedicated flight test is planned for this Tug option. Subsequent to the first flight, a total of 366 mission flights will have been flown through 1990. 308 flights are launched from ETR and 58 from WTR. (131 Increment I vehicle flights and 231 Increment II vehicle flights.)

Completion of Preliminary Design Review (PDR) is scheduled for March 1977 to establish firm vehicle configurations. A Critical Design Review (CDR) will be completed in January 1978 to assure that design requirements have been met.

The ground test program, described in detail in Section 2, will use subsystem models for concept and design development and qualification. Qualification of subsystems will be complete in January 1979, 39 months after ATP. Some level test articles will be used in the ground test program for subsystem integration and interface verification activities. Two Tug vehicles are required at IOC to support the initial requirement of three flights in the first year of operation. A total of 5 Increment I vehicles and 11 Increment II vehicles are produced over a period of 6.6 years. Included are 4 vehicles (1 Increment I and 3 Increment II)

procured as contingency for expected reliability losses. Vehicles are stored at the launch facility and used as required to support the flight utilization schedule. (Reference Section 7.)

Table 1.1-1 identifies symbols and acronyms used on the summary schedule.

Figure 1.1-1

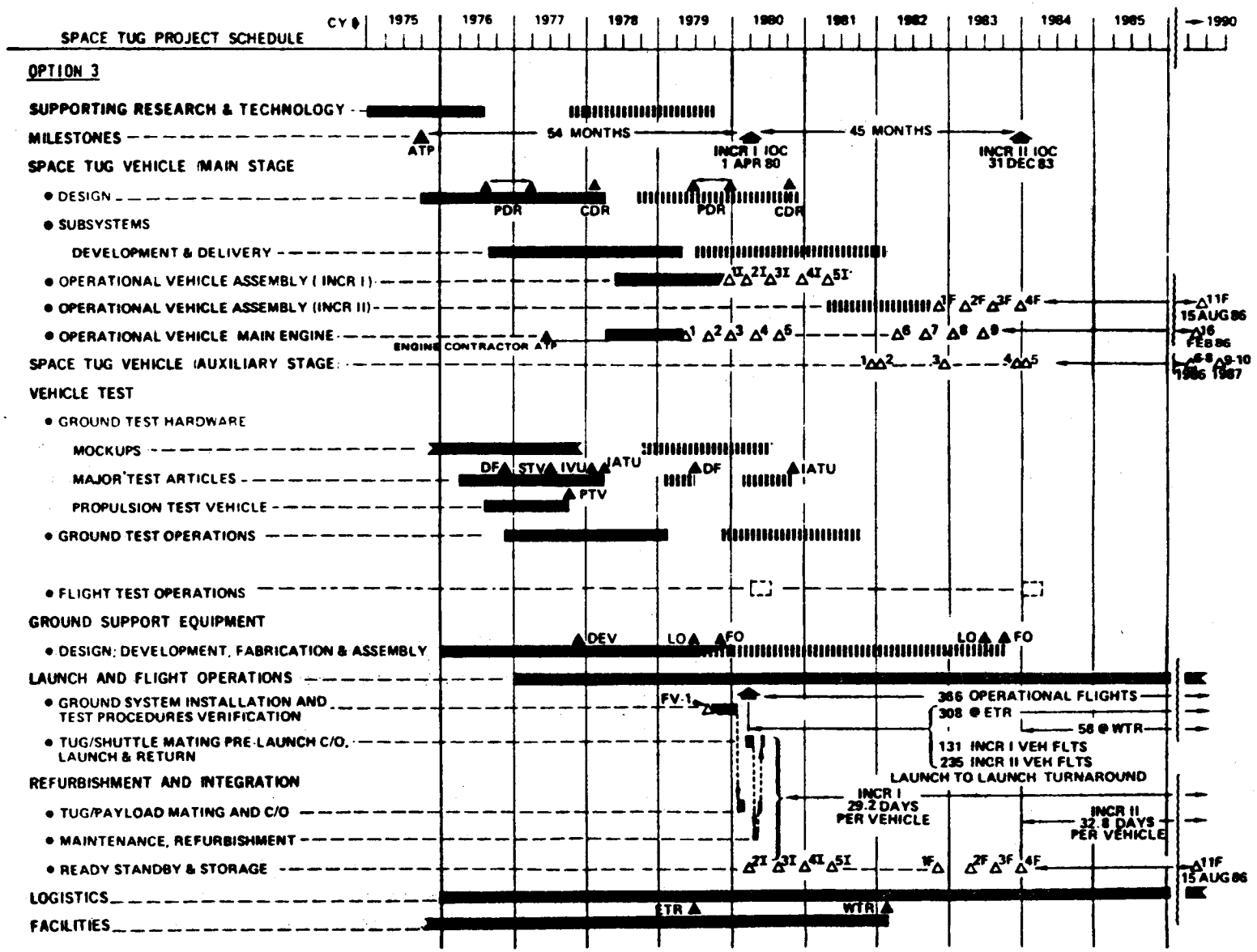

SPACE TUG PROJECT SCHEDULE
CY
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1990
OPTION 3
SUPPORTING RESEARCH & TECHNOLOGY
MILESTONES
ATP
54 MONTHS
INCR I IOC
1 APR 80
45 MONTHS
INCR II IOC
31 DEC 83
SPACE TUG VEHICLE (MAIN STAGE
• DESIGN
PDR
CDR
PDR
CDR
• SUBSYSTEMS
DEVELOPMENT & DELIVERY
• OPERATIONAL VEHICLE ASSEMBLY (INCR I)
• OPERATIONAL VEHICLE ASSEMBLY (INCR II)
• OPERATIONAL VEHICLE MAIN ENGINE
ENGINE CONTRACTOR ATP
SPACE TUG VEHICLE (AUXILIARY STAGE
VEHICLE TEST
• GROUND TEST HARDWARE
MOCKUPS
MAJOR TEST ARTICLES
DF
STV
IVU
IATU
DF
IATU
PROPULSION TEST VEHICLE
PTV
• GROUND TEST OPERATIONS
• FLIGHT TEST OPERATIONS
GROUND SUPPORT EQUIPMENT
• DESIGN; DEVELOPMENT, FABRICATION & ASSEMBLY
DEV
LO
FO
LO
FO
LAUNCH AND FLIGHT OPERATIONS
• GROUND SYSTEM INSTALLATION AND TEST PROCEDURES VERIFICATION
FV-1
366 OPERATIONAL FLIGHTS
308 @ ETR
58 @ WTR
• TUG/SHUTTLE MATING PRE-LAUNCH C/O, LAUNCH & RETURN
131 INCR I VEH FLTS
235 INCR II VEH FLTS
LAUNCH TO LAUNCH TURNAROUND
REFURBISHMENT AND INTEGRATION
• TUG/PAYLOAD MATING AND C/O
INCR I
29.2 DAYS
PER VEHICLE
INCR II
32.8 DAYS
PER VEHICLE
• MAINTENANCE, REFURBISHMENT
• READY STANDBY & STORAGE
15 AUG 86
LOGISTICS
ETR
WTR
FACILITIES

Table 1.1-1

SPACE TUG PROJECT SCHEDULES LEGEND:

▬▬▬	INCREMENT I ACTIVITY
▥▥▥	INCREMENT II ACTIVITY
⬆	– OPERATIONAL LAUNCH
▲	– MILESTONE EVENT
△	– SHIPMENT AND DELIVERY
ATP	– AUTHORITY TO PROCEED
DF	– DEVELOPMENT FIXTURE
DTU	– DYNAMICS TEST UNIT
IATU	– INTEGRATED AVIONICS TEST UNIT
IVU	– INTERFACE VERIFICATION UNIT
PTV	– PROPULSION TEST VEHICLE
FO	– FLIGHT OPERATIONS
LO	– LAUNCH OPERATIONS
STV	– STRUCTURE TEST VEHICLE
INCR	– INCREMENT

A logic network for Option 3 is provided in Figure 1.1-2 supplementing the project summary schedule. This summary network was developed in consonance with the work breakdown structure, the project summary schedule and required flight schedules. It contains a sufficient number of major milestones and key events to insure satisfactory accounting of program requirements, interrelating activities and limiting constraints. The level of detail is governed by the need to account for the key events and identify critical actions or decision points. Event orientation and constraint lines indicate project feasiblity and timely execution.

Depicted on the calendar-oriented network are design, development, test and evaluation of the first flight vehicle, followed by delivery to the launch site, Tug/payload mating, Tug/Shuttle mating and vehicle launch at IOC. Also shown are the related events of procurement, ground support equipment, facilites and tooling. Interface events locate delivery and/or receipt of major hardware and software items critical to the project implementation. Vehicle deliveries to storage at the launch site, site activations at ETR and WTR, vehicle turnaround, and initial launch of each vehicle are indicated in relation to the flight profile requirements and refurbishment activity.

1.2 DEVELOPMENT SCHEDULES

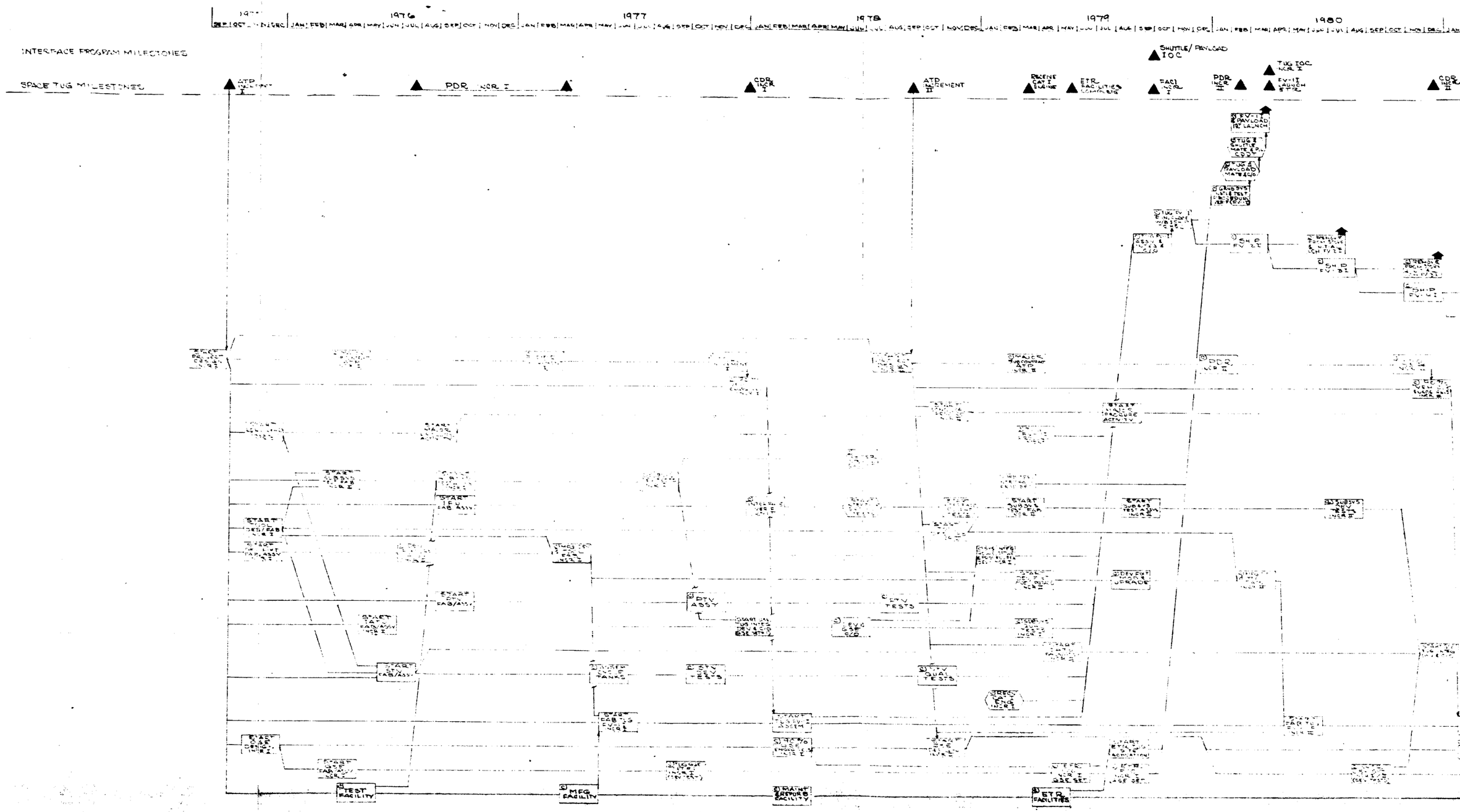
Development schedules are presented in two forms: an overall development schedule interrelating the various project element and test/evaluation activities; and detail subsystem schedules.

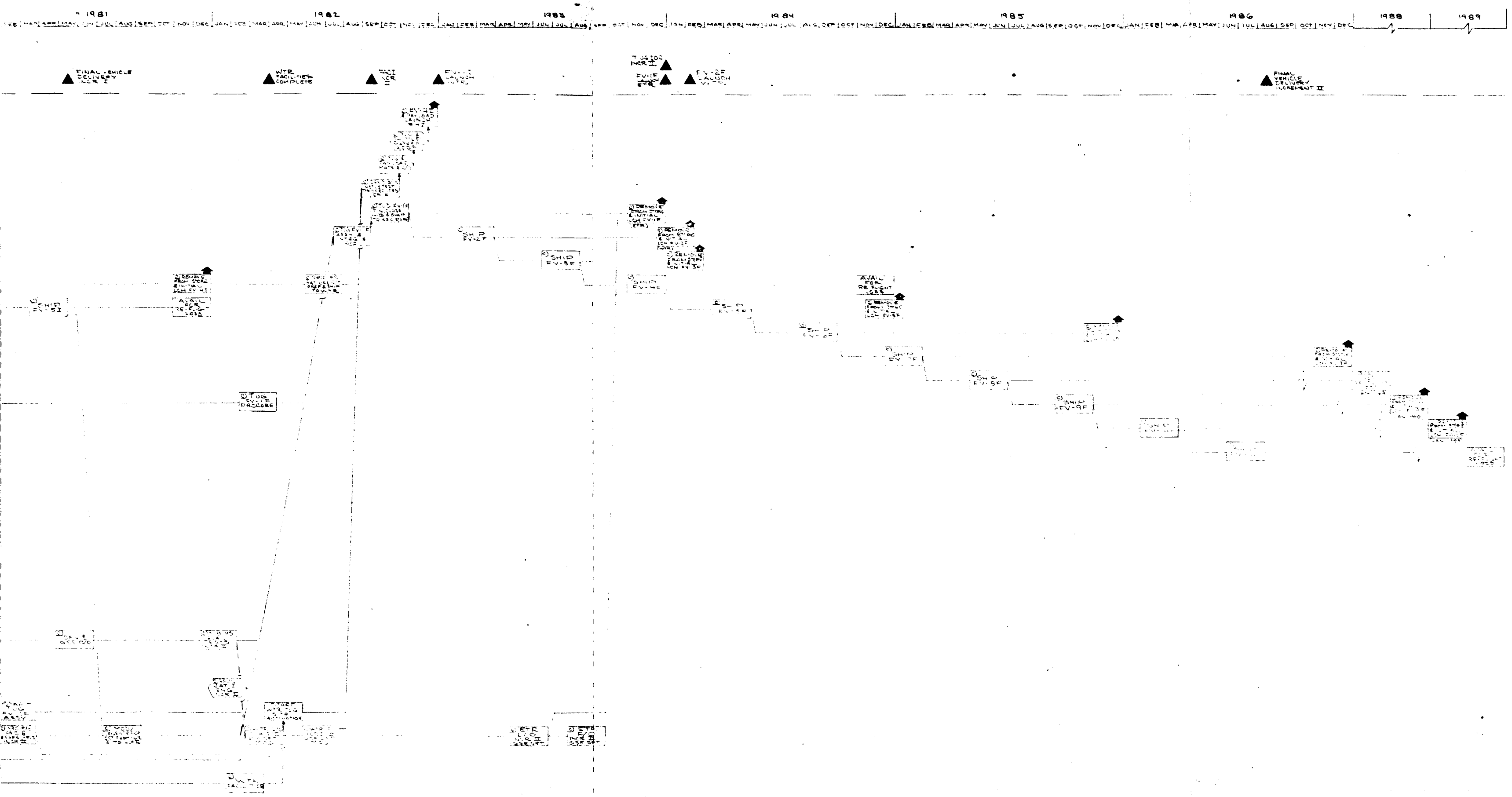
1.2.1 Development Schedule

Figure 1.2-1 is the planned overall development schedule for Tug Option 3. It reflects major engineering development tests, qualification tests, ground support equipment (GSE) development, and software development. Main engine and auxiliary kick stage requirements are reflected in the project summary schedule, Figure 1.1-1. The scheduled activities reflect test planning requirements which are described in detail in Section 2.

1.2.2 Subsystem Schedules

Figures 1.2-2 through 1.2-20 provide development schedules for critical subsystems of the vehicle main stage. The schedules are developed primarily at Level 5 of the WBS except for critical avionics elements which are shown at Level 6.


1976
1977
1978
1979
1980
INTERFACE PROGRAM MILESTONES
SPACE TUG MILESTONES
ATP INCR I
PDR INCR I
CDR INCR I
ATP INCREMENT II
RELEASE CAT I ENGINE
ETR FACILITIES COMPLETE
SHUTTLE/PAYLOAD IOC
FACI INCR I
PDR INCR II
TUG IOC INCR I
EVT LAUNCH SITE
CDR INCR II
EVT PAYLOAD 1ST LAUNCH
STUDY SHUTTLE INTEG. & OPS COST
STUDY PAYLOAD INTEG & OPS
GROUND SYST INTEGRATION & TESTING
STUDY SHUTTLE INTEGRATION
SHIP EVT 1
SHIP EVT 2
SHIP EVT 3
PDR INCR II
SYSTEM INCR II FAC CLOSE ACTIVITY
START DES/FAB INCR I
START DES/FAB INCR II
START DES/FAB INCR III
START DES/FAB INCR IV
START DES/FAB INCR V
START DES/FAB INCR VI
START DES/FAB INCR VII
START DES/FAB INCR VIII
START DES/FAB INCR IX
START DES/FAB INCR X
START DES/FAB INCR XI
START DES/FAB INCR XII
START DES/FAB INCR XIII
START DES/FAB INCR XIV
START DES/FAB INCR XV
START DES/FAB INCR XVI
START DES/FAB INCR XVII
START DES/FAB INCR XVIII
START DES/FAB INCR XIX
START DES/FAB INCR XX
START DES/FAB INCR XXI
START DES/FAB INCR XXII
START DES/FAB INCR XXIII
START DES/FAB INCR XXIV
START DES/FAB INCR XXV
START DES/FAB INCR XXVI
START DES/FAB INCR XXVII
START DES/FAB INCR XXVIII
START DES/FAB INCR XXIX
START DES/FAB INCR XXX
START DES/FAB INCR XXXI
START DES/FAB INCR XXXII
START DES/FAB INCR XXXIII
START DES/FAB INCR XXXIV
START DES/FAB INCR XXXV
START DES/FAB INCR XXXVI
START DES/FAB INCR XXXVII
START DES/FAB INCR XXXVIII
START DES/FAB INCR XXXIX
START DES/FAB INCR XXXX
START DES/FAB INCR XXXXI
START DES/FAB INCR XXXXII
START DES/FAB INCR XXXXIII
START DES/FAB INCR XXXXIV
START DES/FAB INCR XXXXV
START DES/FAB INCR XXXXVI
START DES/FAB INCR XXXXVII
START DES/FAB INCR XXXXVIII
START DES/FAB INCR XXXXIX
START DES/FAB INCR XXXXX
START DES/FAB INCR XXXXXI
START DES/FAB INCR XXXXXII
START DES/FAB INCR XXXXXIII
START DES/FAB INCR XXXXXIV
START DES/FAB INCR XXXXXV
START DES/FAB INCR XXXXXVI
START DES/FAB INCR XXXXXVII
START DES/FAB INCR XXXXXVIII
START DES/FAB INCR XXXXXIX
START DES/FAB INCR XXXXXX
START DES/FAB INCR XXXXXXI
START DES/FAB INCR XXXXXXII
START DES/FAB INCR XXXXXXIII
START DES/FAB INCR XXXXXXIV
START DES/FAB INCR XXXXXXV
START DES/FAB INCR XXXXXXVI
START DES/FAB INCR XXXXXXVII
START DES/FAB INCR XXXXXXVIII
START DES/FAB INCR XXXXXXIX
START DES/FAB INCR XXXXXXX
START DES/FAB INCR XXXXXXXI
START DES/FAB INCR XXXXXXXII
START DES/FAB INCR XXXXXXXIII
START DES/FAB INCR XXXXXXXIV
START DES/FAB INCR XXXXXXXV
START DES/FAB INCR XXXXXXXVI
START DES/FAB INCR XXXXXXXVII
START DES/FAB INCR XXXXXXXVIII
START DES/FAB INCR XXXXXXXIX
START DES/FAB INCR XXXXXXXX
START DES/FAB INCR XXXXXXXXI
START DES/FAB INCR XXXXXXXXII
START DES/FAB INCR XXXXXXXXIII
START DES/FAB INCR XXXXXXXXIV
START DES/FAB INCR XXXXXXXXV
START DES/FAB INCR XXXXXXXXVI
START DES/FAB INCR XXXXXXXXVII
START DES/FAB INCR XXXXXXXXVIII
START DES/FAB INCR XXXXXXXXIX
START DES/FAB INCR XXXXXXXXX
START DES/FAB INCR XXXXXXXXXI
START DES/FAB INCR XXXXXXXXXII
START DES/FAB INCR XXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXV
START DES/FAB INCR XXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXV
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVI
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVIII
START DES/FAB INCR XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXIX
START DES/FAB INCR XXXXXXXXXXXXX



GLOSSARY & SYMBOLS

ATP	AUTHORITY TO PROCEED
CDR	CRITICAL DESIGN REVIEW
CDDT	COUNTDOWN DEMONSTRATION TEST
C/O	CHECKOUT
D F	DEVELOPMENT FIXTURE
ER	ENGINEERING RELEASE
ETR	EASTERN TEST RANGE
FACI	FIRST ACTUAL ZERO G (LIFTOFF)
F/O	FLIGHT OPERATIONS
FV	FLIGHT VEHICLE
GSE	GROUND SUPPORT EQUIP
IATU	INTEGRATED ANCILLARY TEST UNIT
IVU	INTERFACE VERIFICATION UNIT
IOC	INITIAL OPERATIONAL CAPABILITY
LCH	LAUNCH
L/O	LAUNCH OPERATIONS
PDR	PRELIMINARY DESIGN REVIEW
P/L	PAYLOAD
PTV	PROPULSION TEST VEHICLE
STV	STRUCTURE TEST VEHICLE
W/B	WEIGHT & BALANCE
WTR	WESTERN TEST RANGE

INCREMENT I — INITIAL FLIGHT VEHICLE (2)

INCREMENT II — FINAL FLIGHT VEHICLE (5)

COMPLETE

= INTERFACE EVENT

= OPERATIONAL EVENT

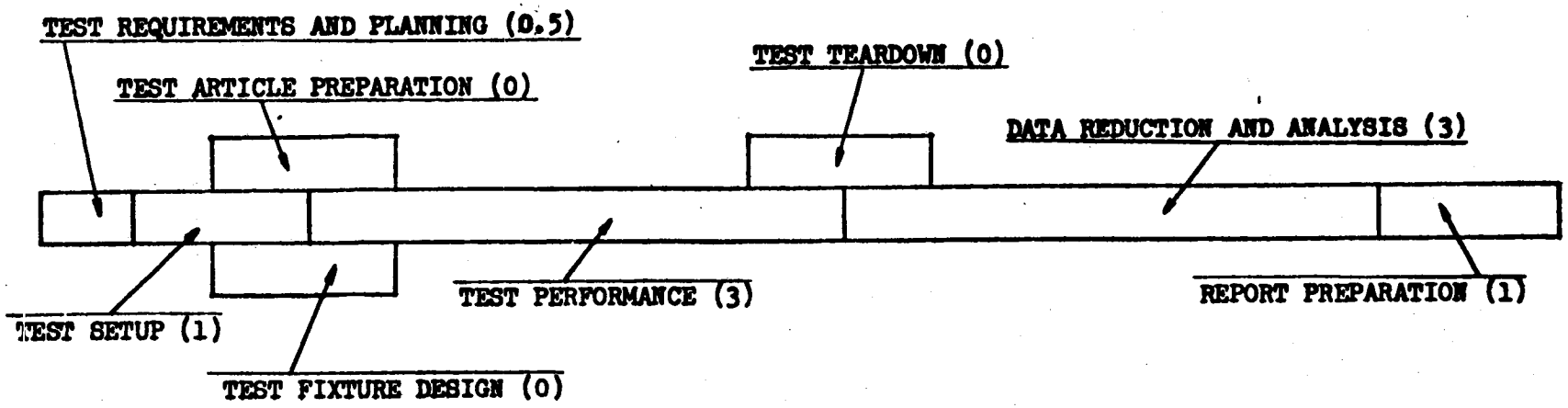
= MILESTONE

SPACE TUG UNION NO. 3 LOGIC NETWORK
FIGURE No. 1.1-2

1-7

2

REFURBISHMENT/REUSE VERIFICATION
ENGINEERING DEVELOPMENT FIXTURE
MAINTAINABILITY (M) EVALUATION
(PHASED FINAL)



TEST MANAGEMENT (0)

REFURBISHMENT/REUSE VERIFICATION
ENGINEERING DEVELOPMENT FIXTURE
MAINTAINABILITY (M) EVALUATION
(PHASED FINAL - OPTION 3S)

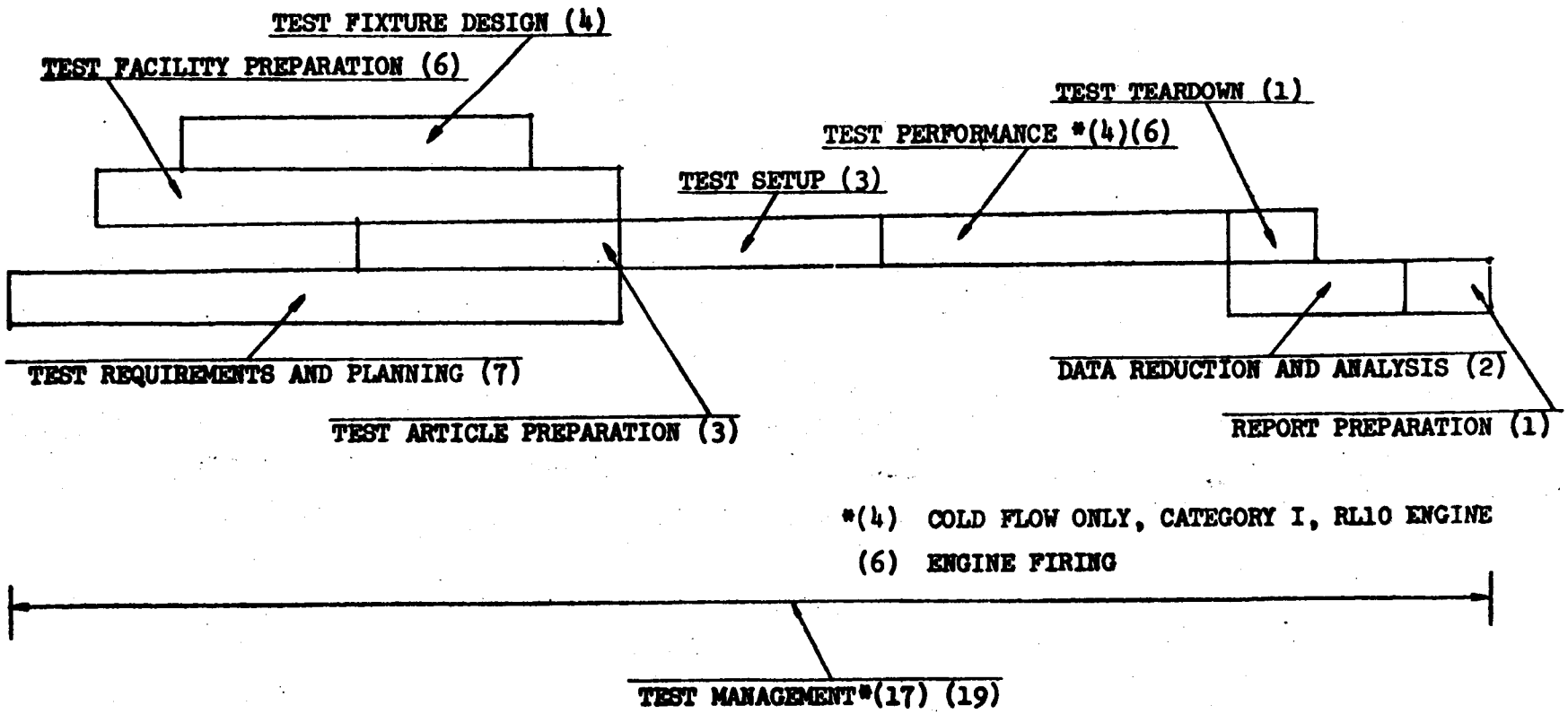
PERSONNEL	MONTHS	MANMONTHS	TYPE PERSONNEL	PERSONNEL-CUM.
Test Management	0	0		
Test Requirements and Planning	0.5	0.5	1 Engineer	1 Engineer
1 M Engineer				
Test Article Preparation	0	0		
Test Fixture Design	0	0		
Test Setup	1	0.5	.5 Engineer	. Engineer
.5 M Engineer				
Test Performance	3	3	1 Engineer	1 Engineer
1 M Engineer				
Tear Down	0	0		
Data Reduction and Analysis	3	1	.33 Engineer	1 Engineer
.33 M Engineer				
Report Preparation	1	0.5	.5 Engineer	1 Engineer
.5 M Engineer				

TOTAL MAN MONTHS: 5.5

PROPULSION TEST VEHICLE

SCHEDULE

(MONTHS)



PROPULSION TEST VEHICLE

Personnel	Months	Man-Months	Type Personnel	Personnel-Cumulative
Test Management	17 (19)	59 (66)	3.5 Engineers	3.5 Engineers
1 Manager 0.5 Branch Manager (Propellant Feed) 0.5 Branch Manager (Fill & Drain) 0.5 Branch Manager (Vent & Relief) 0.5 Branch Manager (Pressurization) 0.5 Branch Manager (Pneumatics/TVC)				
Test Requirements and Planning	7	42	6 Engineers	9.5 Engineers
5 Propulsion Engineers (Feed, F&D, V&R, Press., Pneum/TVC) 0.5 Propulsion GSE Engr. 0.25 Electrical GSE Engr. 0.25 Instrumentation Engr.				
Test Article Preparation	3	42	4 Engineers 8 Technicians 2 Q.C.	13 Engineers 8 Technicians 2 Q.C.
1 Engineer, 2 Technicians — Feed 1 Engineer, 2 Technicians — F&D 0.5 Engineers, 1 Technician — V&R 1 Engineer, 2 Technicians — Press. 0.5 Engineers, 1 Technician — Pneu/TVC 2 Quality Control (Q.C.)				
Test Fixture Design	4	8	2 Engineers	15 Engineers 8 Technicians 2 Q.C.
2 Engineers				

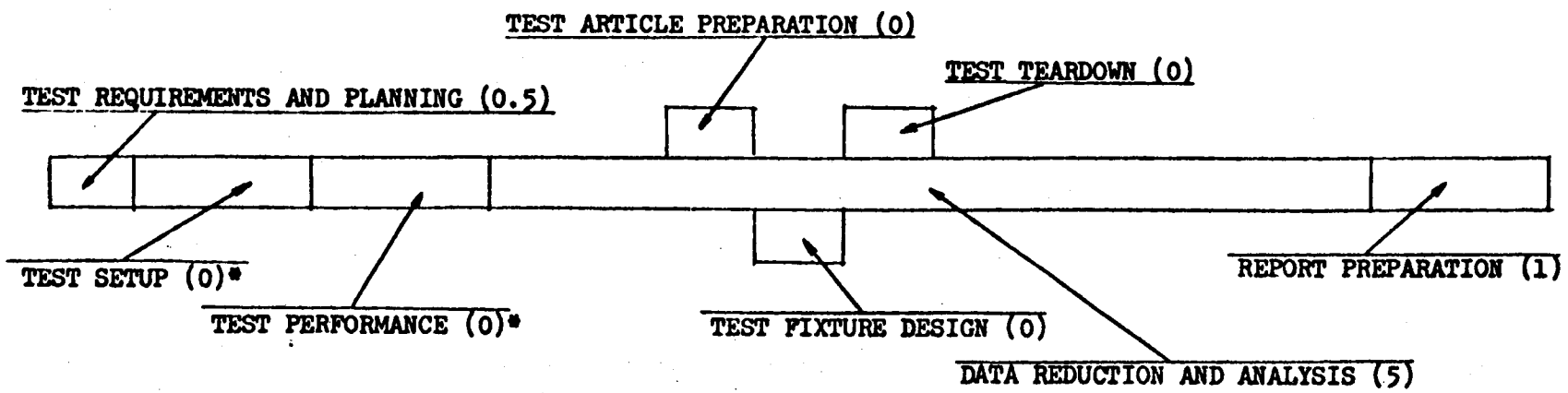
PROPULSION TEST VEHICLE (CONT'D)

Personnel	Months	Man-Months	Type Personnel	Personnel-Cumulative
Test Setup 1 Engineer } LH_2 3 Technicians } 1 Engineer } LO_2 3 Technicians } 1 Engineer } Press. 5 Technicians } Pneu/TVC 2 Engineers } GSE 4 Technicians } 3 Q.C.	3	69	5 Engineers 15 Technicians 3 Q.C.	15 Engineers 15 Technicians 4 Q.C.
Test Performance 4 Engineers (See Test Art. Prep.) 3 Engineers-Facility 15 Technicians (See Test Setup) 1 Engineer } Data 1 Technician } Acquisition 3 Q.C.	4 Cold Flow (6) (Firing)	108 (162)	8 Engineers 16 Technicians 3 Q.C.	16 Engineers 16 Technicians 4 Q.C.
Test Teardown 3 Engineers 10 Technicians 1 Q.C.	1	14	3 Engineers 10 Technicians 1 Q.C.	16 Engineers 16 Technicians 4 Q.C.
Data Reduction and Analysis 5 Engineers (Propulsion) 1 Engineer (Data Acquisition) 3 Engineering Aids	2	18	9 Engineers	16 Engineers 16 Technicians 4 Q.C.
Report Preparation 5 Engineers	1	5	5 Engineers	16 Engineers 16 Technicians 4 Q.C.
TOTAL MAN-MONTHS:	Cold Flow (Firing)	367 (428)		

REFURBISHMENT/REUSE VERIFICATION TEST

PROPULSION TEST VEHICLE

MAINTAINABILITY (M) EVALUATION



TEST MANAGEMENT (0)

*MAINTAINABILITY ENGINEER ACTS AS AN OBSERVER ONLY

REFURBISHMENT/REUSE VERIFICATION

PROPULSION TEST VEHICLE

MAINTAINABILITY (M) EVALUATION

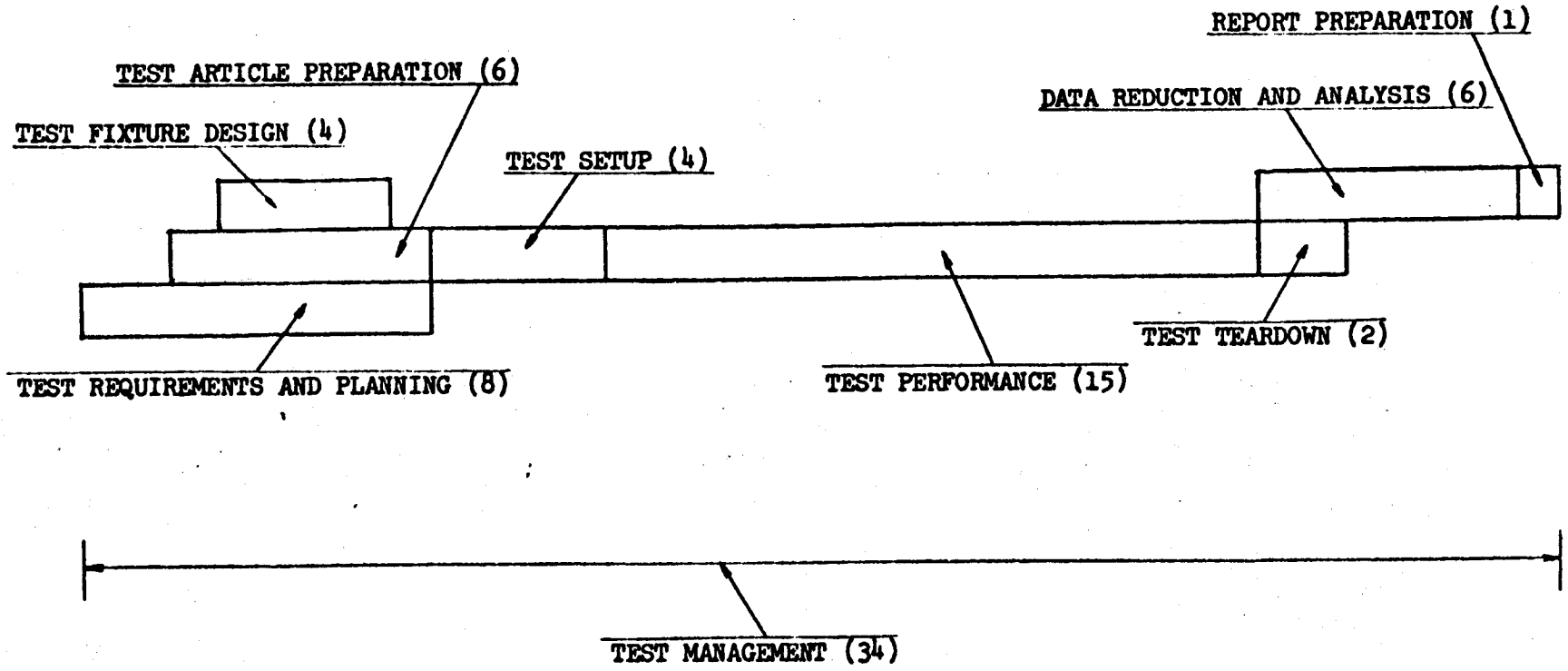
PERSONNEL	MONTHS	MANMONTHS	TYPE PERSONNEL	PERSONNEL-CUM.
Test Management	0	0		
Test Requirements and Planning	.5	.25	.5 Engineer	.5 Engineer
.5 M Engineer				
Test Article Preparation	0	0		
Test Fixture Design	0	0		
Test Setup*	0	0		.5 Engineer
Test Performance*	0	0		.5 Engineer
Tear Down	0	0		
Data Reduction and Analysis	5	1	.2 Engineer	.7 Engineer
.2 M Engineer				
Report Preparation	1	.5	.5 Engineer	1.2 Engineer
.5 M Engineer				
TOTAL MAN MONTHS:		1.75		

*Acts as observer only

INTEGRATED AVIONICS TEST UNIT (IATU)

SCHEDULE

(MONTHS)



INTEGRATED AVIONICS TEST UNIT

PERSONNEL	MONTHS	MANMONTHS	TYPE PERSONNEL	PERSONNEL-CUM.
Test Management	34	136	4 Engineers	4 Engineers
1.0 Manager 0.5 Branch Manager (Data Mgmt Assy) 0.5 Branch Manager (Guid.,Nav. & Cont.) 0.5 Branch Manager (Communications) 0.5 Branch Manager (Instrumentation) 0.5 Branch Manager (Pwr & Distribution) 0.5 Branch Manager (GSE)				
Test Requirements and Planning	8	56	7 Engineers	11 Engineers
1 DMA Engineer 1 GN&C Engineer 1 Comm. Engineer 1 Instr. Engineer 1 Pwr & Dist. Engineer 1 GSE Engineer				
Test Article Preparation	6	192	12 Engineers 13 Technicians 7 Q.C.	12 Engineers 13 Technicians 7 Q.C.
2 DMA Engineers 2 GN&C Engineers 3 Comm. Engineers 1 Instr. Engineer 2 Pwr & Dist. Engineer 1 GSE Engineer 1 Propulsion Engineer 12 Electronic Technicians 1 Mechanical Technician 7 Quality Control (Q.C.)				
Test Fixture Design	4	16	4 Engineers	16 Engineers 13 Technicians 7 Q.C.
4 Engineers				
Test Setup	4	84	4 Engineers 15 Technicians 2 Q.C.	16 Engineers 15 Technicians 7 Q.C.
3.5 Elect Engineers 0.5 Prop. Engineers 12 Elect. Technicians 3 Mech. Technicians 2 Q.C.				

INTEGRATED AVIONICS TEST UNIT
(Continued)

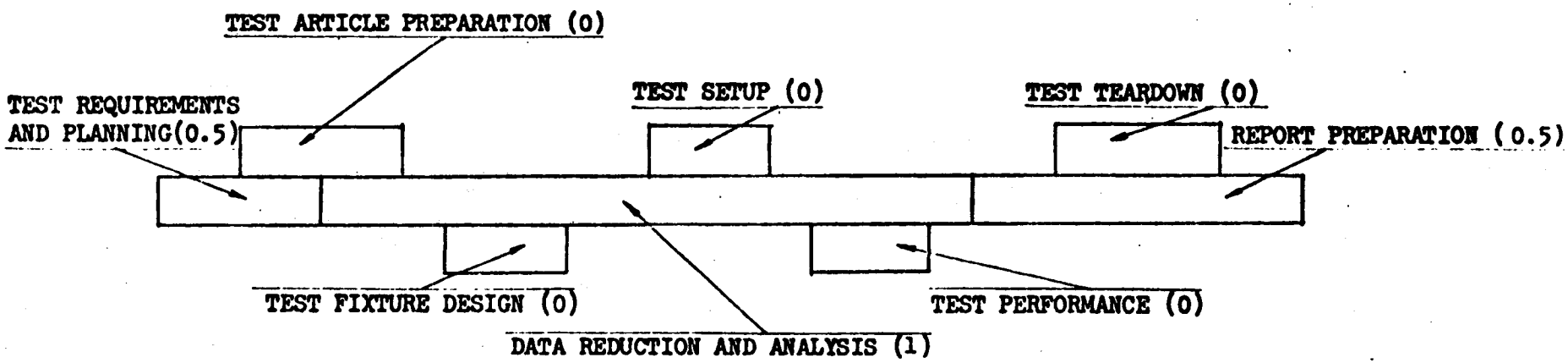
PERSONNEL	MONTHS	MANMONTHS	TYPE PERSONNEL	PERSONNEL-CUM.
Test Performance 7 Elect. Engineers 9 Elect. Technicians 1 Mech. Technician 2 Q.C.	15	285	7 Engineers 10 Technicians 2 Q.C.	16 Engineers 15 Technicians 7 Q.C.
Test Teardown 1.25 Elect Engineers 0.75 Prop. Engineers 6 Elect. Technicians 1 Mech. Technician 1 Q.C.	2	20	2 Engineers 7 Technicians 1 Q.C.	16 Engineers 15 Technicians 7 Q.C.
Data Reduction and Analysis 11 Elect. Engineers (See Test Art. Prep.) 4 Engrg. Assts.	6	90	15 Engineers	16 Engineers 15 Technicians 7 Q.C.
Report Preparation 7 Engineers (See Test Rqmts & Plng)	1	7	7 Engineers	16 Engineers 15 Technicians 7 Q.C.
TOTAL MANMONTHS:		886		

REFURBISHMENT/REUSE VERIFICATION

INTEGRATED AVIONICS TEST UNIT

MAINTAINABILITY (M) EVALUATION

(PHASED FINAL -- OPTION 3S)



TEST MANAGEMENT (0)

REFURBISHMENT/REUSE VERIFICATION

INTEGRATED AVIONICS TEST UNIT

MAINTAINABILITY (M) EVALUATION

(PHASED FINAL — OPTION 3 S)

PERSONNEL	MONTHS	MANMONTHS	TYPE PERSONNEL	PERSONNEL-CUM.
Test Management	0	0		
Test Requirements and Planning	1	.5	.5 Engineer	.5 Engineer
.5 M Engineer				
Test Article Preparation	0	0		
Test Fixture Design	0	0		
Test Setup*	0	0		.5 Engineer
Test Performance*	0	0		.5 Engineer
Tear Down	0	0		
Data Reduction and Analysis	5	1	.2 Engineer	.7 Engineer
.2 M Engineer				
Report Preparation	1	0.5	.5 Engineer	1.2 Engineers
.5 M Engineer				
TOTAL MAN MONTHS:		2		

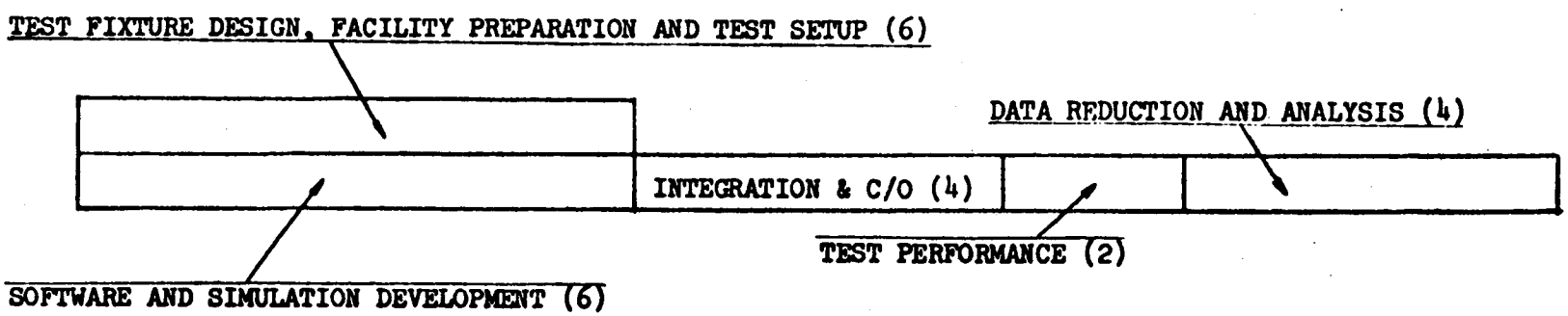
*Acts as observer only

FLIGHT CONTROL SIMULATION

SCHEDULE

(MONTHS)

(DEPLOYMENT AND RETRIEVAL CAPABILITY)



*TEST MANAGEMENT IS ASSOCIATED WITH THE IATU

FLIGHT CONTROL SIMULATION
(Deployment and Retrieval Capability)

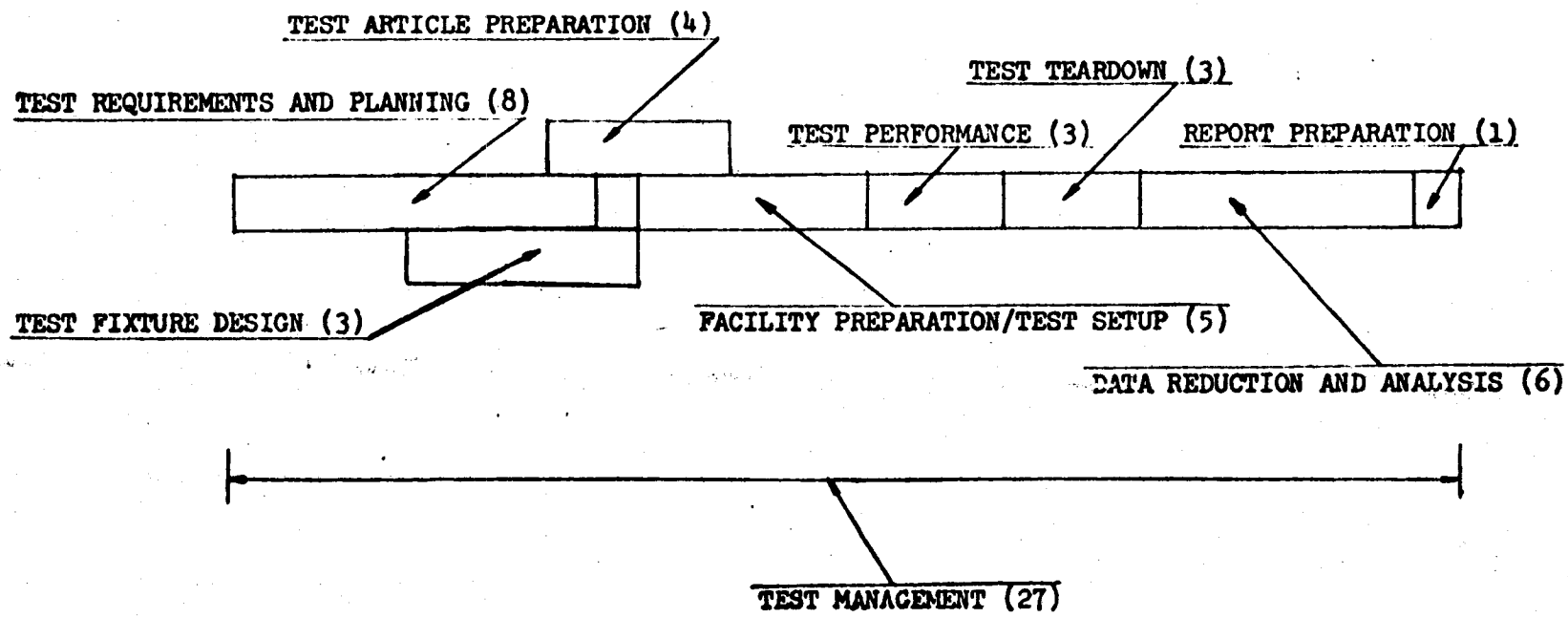
PERSONNEL		MONTHS	MANMONTHS	TYPE PERSONNEL	PERSONNEL-CUM.
Test Management (in IATU)					
Test Requirements and Planning (in IATU)					
Test Article Preparation (in IATU)					
Test Fixture Design/ Facility Preparation/ Test Setup 2 Engineers 1.5 Technicians		6	21	2 Engineers 1.5 Technicians	2 Engineers 1.5 Technicians
Test Performance					
Software & Simulation Dev	1.5 Engr	6	9	1.5 Engineers	4 Engineers 3 Technicians
Integ. & C/O	3.5 Engr 1.5 Tech	4	20	3.5 Engineers 1.5 Technicians	
Test	4 Engr 3 Tech	2	14	4 Engineers 3 Technicians	
			43		
Test Teardown (in Test Performance)					
Data Reduction and Analysis 2 Engineers		4	8	2 Engineers	4 Engineers 3 Technicians
Report Preparation (in IATU)					

TOTAL MANHOURS: 72

THERMAL TEST

SCHEDULE

(MONTHS)



2-129

THERMAL TEST

(Conducted in High Vacuum Test Facility [4557., MSFC)

PERSONNEL	MONTHS	MANMONTHS	TYPE PERSONNEL	PERSONNEL-CUM.
Test Management 1 Manager	27	27	1 Engineer	1 Engineer
Test Requirements and Planning 2 Therm. Analysts 2 Therm. Test Engineers 1 Instrumentation Engineer 0.5 Propulsion Engineer 0.5 Elect. Engineer	8	48	6 Engineers	7 Engineers
Test Article Preparation 2 Therm. Engineers 1 Instrumentation Engineer 0.5 Propulsion Engineer 0.5 Elect. Engineer 6 Technicians 2 Q.C.	4	48	4 Engineers 6 Technicians 2 Q.C.	7 Engineers 6 Technicians 2 Q.C.
Test Fixture Design 1 Engineer	5	5	1 Engineer	9 Engineers 6 Technicians 2 Q.C.
Test Facility Preparation/ Test Setup 1 Therm. Engineer 1 Instrumentation Engineer 1 Data Engineer 0.5 Propulsion Engineer 0.5 Elect. Engineer 7 Technicians 2 Q.C.	5	65	4 Engineers 7 Technicians 2 Q.C.	10 Engineers 7 Technicians 2 Q.C.
Test Performance 2 Therm. Engineers 1 Propulsion Engineer 1 Elect. Engineer 1 Instrumentation Engineer 1 Data Engineer 8 Technicians 4 Q.C.	3	45	6 Engineers 8 Technicians 2 Q.C.	10 Engineers 8 Technicians 2 Q.C.

THERMAL TEST
(Cont.)

(Conducted in High Vacuum Test Facility [4557], MSFC)

PERSONNEL	MONTHS	MANMONTHS	TYPE PERSONNEL	PERSONNEL-CUM.
Test Teardown 0.5 Therm. Engineer 1 Elect. Engineer 1 Instrumentation Engineer 8 Technicians 2 Q.C.	3	34.5	2.5 Engineers 8 Technicians 2 Q.C.	10 Engineers 8 Technicians 2 Q.C.
Data Reduction and Analysis (Same as Planning) +1 Data Engineer 2 Technicians	6	54	7 Engineers 2 Technicians	10 Engineers 9 Technicians 2 Q.C.
Report Preparations (Same as Planning)	1	6	6 Engineers	10 Engineers 9 Technicians 2 Q.C.

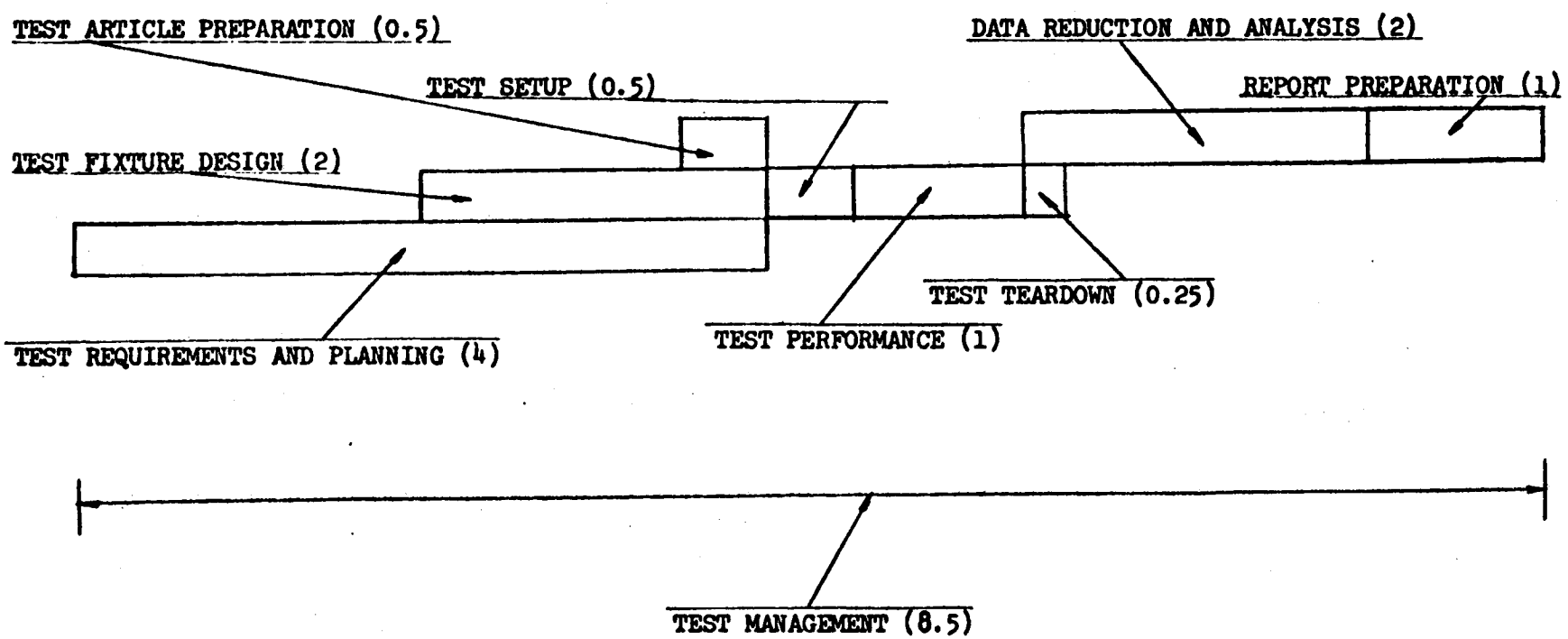
TOTAL MANMONTHS: 332.5

ELECTROMAGNETIC COMPATIBILITY

(FLIGHT TEST ARTICLE - MANUFACTURING SITE)

SCHEDULE

(MONTHS)



ELECTROMAGNETIC COMPATIBILITY
(FLIGHT TEST ARTICLE - MANUFACTURING SITE)

PERSONNEL	MONTHS	MANMONTHS	TYPE PERSONNEL	PERSONNEL-CUM.
Test Management 1 Manager	8.5	8.5	1 Engineer	1 Engineer
Test Requirements and Planning 1 EMC Engineer 0.5 DMA Engr 0.5 GN&C Engr 0.5 Comm. Engr 0.5 Instr. Engr 0.5 Pwr and Dist Engr 0.5 GSE Engr	4	16	4 Engineers	5 Engineers
Test Article Preparation 1 EMC Engineer 0.25 DMA Engr 0.25 GN&C Engr 0.25 Comm. Engr 0.5 Instr. Engr 0.25 Pwr and Dist Engr 0.25 GSE Engr 3 Technicians 2 Q.C.	0.5	3.875	2.75 Engineers 3 Technicians 2 Q.C.	5 Engineers 3 Technicians 2 Q.C.
Test Fixture Design 1 Engineer	2	2	1 Engineer	6 Engineers 3 Technicians 2 Q.C.
Test Setup 1 EMC Engr 3 Technicians 1 Q.C.	0.25	1.25	1 Engineer 3 Technicians 1 Q.C.	6 Engineers 3 Technicians 2 Q.C.
Test Performance 2 EMC Engineers 3 Technicians 1 Q.C.	1	6	2 Engineers 3 Technicians 1 Q.C.	6 Engineers 3 Technicians 2 Q.C.
Test Teardown 1 EMC Engineer 3 Technicians 1 Q.C.	0.25	1.25	1 Engineer 3 Technicians 1 Q.C.	6 Engineers 3 Technicians 2 Q.C.

ELECTROMAGNETIC COMPATIBILITY

(FLIGHT TEST ARTICLE - MANUFACTURING SITE)

PERSONNEL	MONTHS	MANMONTHS	TYPE PERSONNEL	PERSONNEL-CUM.
Data Reduction and Analysis 2.75 Engineers (See Test Art. Prep.) 1 Data Engrg Engr 1 Data Technician	2	9.5	3.75 Engineers 1 Technician	7 Engineers 4 Technicians 2 Q.C.
Report Preparation 4 Engineers (See Test Requirements and Planning)	1	4	4 Engineers	7 Engineers 4 Technicians 2 Q.C.

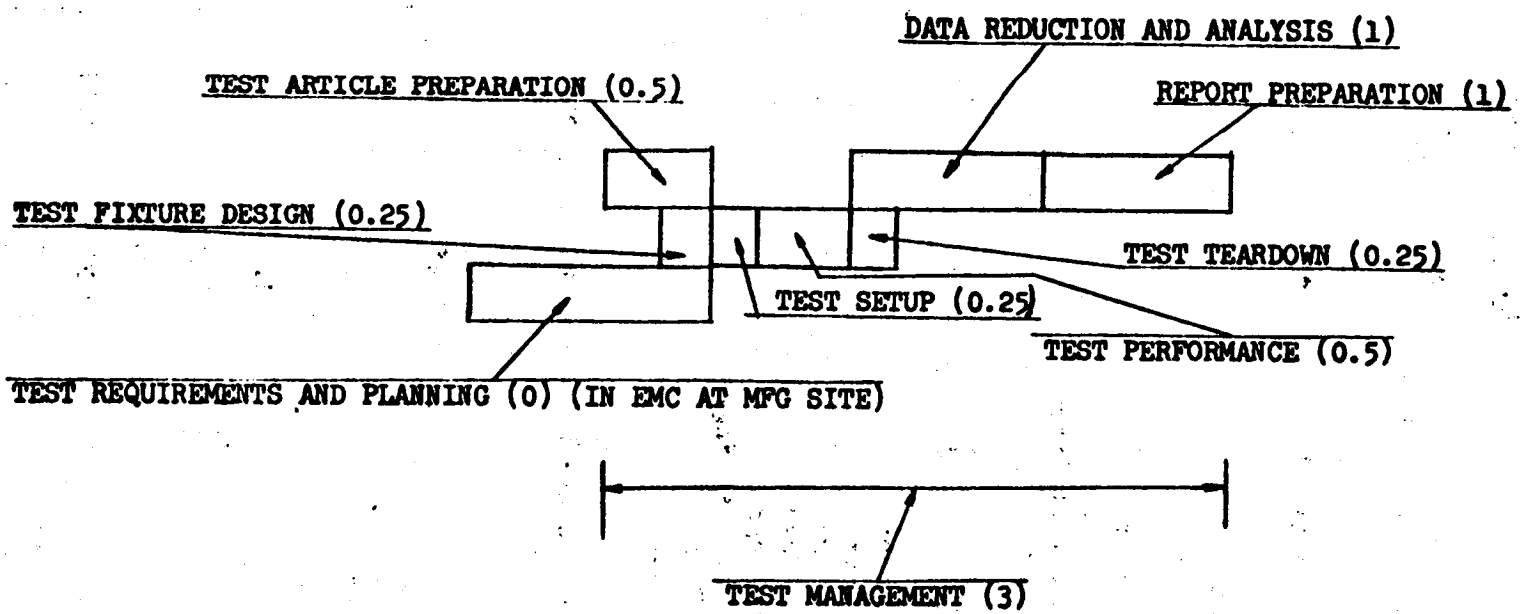
TOTAL MAN MONTHS: 52.375

ELECTROMAGNETIC COMPATIBILITY

(FIRST DELIVERED TUG - LAUNCH SITES)

SCHEDULE

(MONTHS)



ELECTROMAGNETIC COMPATIBILITY

(FIRST DELIVERED TUG - LAUNCH SITES)

PERSONNEL	MONTHS	MANMONTHS	TYPE PERSONNEL	PERSONNEL-CUM.
Test Management 1 Manager	3	3	1 Engineer	1 Engineer
Test Requirements and Planning 1 EMC Engineer 0.5 DMA Engr 0.5 GN&C Engr 0.5 Comm. Engr 0.5 Instr. Engr 0.5 Pwr and Dist Engr 0.5 GSE Engr	0	0	(In Mfg Site Planning)	1 Engineers
Test Article Preparation 1 EMC Engineer 0.25 DMA Engr 0.25 GN&C Engr 0.25 Comm. Engr 0.5 Instr. Engr 0.25 Pwr and Dist Engr 0.25 GSE Engr 3 Technicians 2 Q.C.	0.5	3.875	2.75 Engineers 3 Technicians 2 Q.C.	3.75 Engineers 3 Technicians 2 Q.C.
Test Fixture Design 1 Engineer	0.25	0.25	1 Engineer	4.75 Engineers 3 Technicians 2 Q.C.
Test Setup 1 EMC Engr 3 Technicians 1 Q.C.	0.25	1.25	1 Engineer 3 Technicians 1 Q.C.	4.75 Engineers 3 Technicians 2 Q.C.
Test Performance 2 EMC Engineers 3 Technicians 1 Q.C.	0.5	3	2 Engineers 3 Technicians 1 Q.C.	4.75 Engineers 3 Technicians 2 Q.C.
Test Teardown 1 EMC Engineer 3 Technicians 1 Q.C.	0.25	1.25	1 Engineer 3 Technicians 1 Q.C.	4.75 Engineers 3 Technicians 2 Q.C.

ELECTROMAGNETIC COMPATIBILITY

(FIRST DELIVERED TUG - LAUNCH SITES)

PERSONNEL	MONTHS	MANMONTHS	TYPE PERSONNEL	PERSONNEL-CUM.
Data Reduction and Analysis 2.75 Engineers (See Test Art. Prep.) 1 Data Engrg Engr 1 Data Technician	1	4.75	3.75 Engineers 1 Technician	5.75 Engineers 4 Technicians 2 Q.C.
Report Preparation 4 Engineers (See Test Requirements and Planning)	1	4	4 Engineers	5.75 Engineers 4 Technicians 2 Q.C.

TOTAL MAN MONTHS: 21.375

REFURBISHMENT/REUSE VERIFICATION

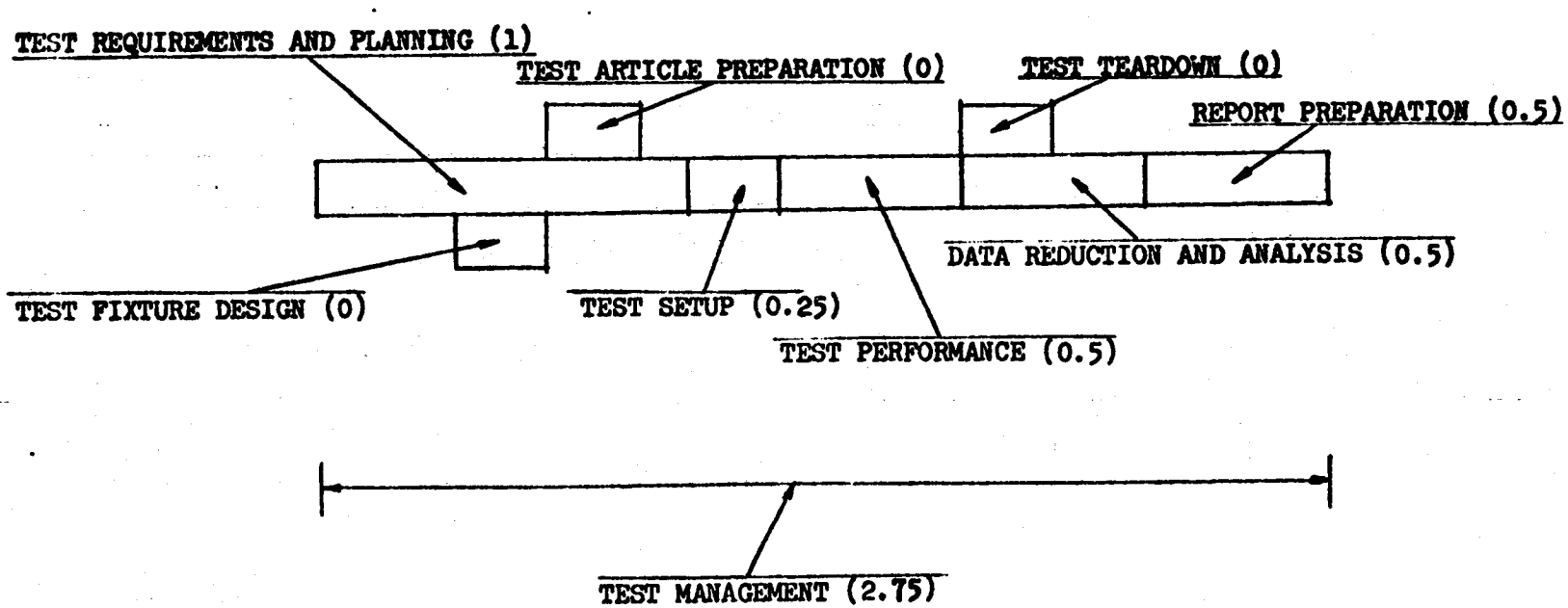
(FLIGHT TEST ARTICLE - ETR)

MAINTENANCE (M) PROCEDURE EVALUATION

SCHEDULE

(MONTHS)

(PHASED FINAL)



REFURBISHMENT/REUSE VERIFICATION

(FLIGHT TEST ARTICLE - ETR)

MAINTENANCE (M) PROCEDURE EVALUATION

(PHASED FINAL -- OPTION 3S)

PERSONNEL	MONTHS	MANMONTHS	TYPE PERSONNEL	PERSONNEL-CUM.
Test Management	2.5	2.5	1 Engineer	1 Engineer
1 Supervision				
Test Requirements and Planning	1	3	3 Engineers	4 Engineers
1 $\overline{M}$ Engineer - Avionics 1 $\overline{M}$ Engineer - Propulsion 1 $\overline{M}$ Engineer - Struct/Mech				
Test Article Preparation	0	0		
Test Fixture Design	0	0		
Test Setup	.5	1	2 Engineer	4 Engineers
1 $\overline{M}$ Engineer - Avionics 1 $\overline{M}$ Engineer - Propulsion 1 $\overline{M}$ Engineer - Struct/Mech				
Test Performance	0.5	6	3 Engineer 6 Technicians 3 Q.C.	4 Engineers 6 Technicians 3 Q.C.
1 $\overline{M}$ Engineer - Avionics 1 $\overline{M}$ Engineer - Propulsion 1 $\overline{M}$ Engineer - Struct/Mech 2 Technicians - Avionics 2 Technicians - Propulsion 2 Technicians - Struct/Mech 3 Quality Control				
Tear Down	0	0		
Data Reduction and Analysis	0.5	1.5	3 Engineers	4 Engineers 6 Technicians 3 Q.C.
1 $\overline{M}$ Engineer - Avionics 1 $\overline{M}$ Engineer - Propulsion 1 $\overline{M}$ Engineer - Struct/Mech				
Report Preparation	0.5	1.5	3 Engineers	4 Engineers 6 Technicians 3 Q.C.
1 $\overline{M}$ Engineer - Avionics 1 $\overline{M}$ Engineer - Propulsion 1 $\overline{M}$ Engineer - Struct/Mech				
TOTAL MANMONTHS:		15.5		

REFURBISHMENT/REUSE VERIFICATION

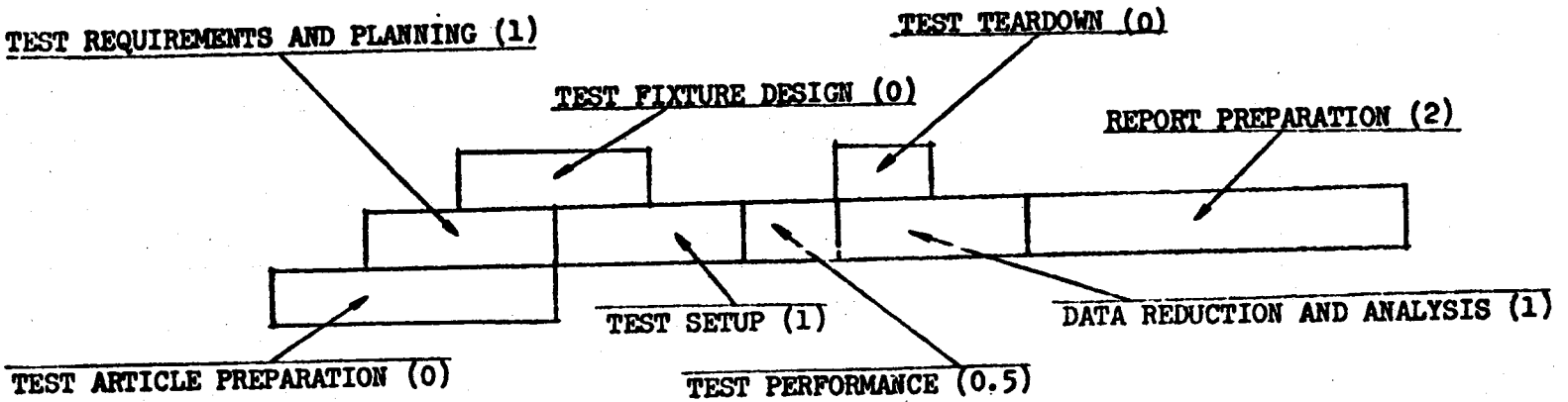
(FLIGHT TEST ARTICLE - ETR)

MAINTAINABILITY (M) DEMONSTRATION

SCHEDULE

(MONTHS)

(PHASED FINAL)



TEST MANAGEMENT (0)

REFURBISHMENT/REUSE VERIFICATION
FLIGHT TEST ARTICLE (ETR)
MAINTAINABILITY (M) DEMONSTRATION
(PHASED FINAL -- OPTION 3 S)

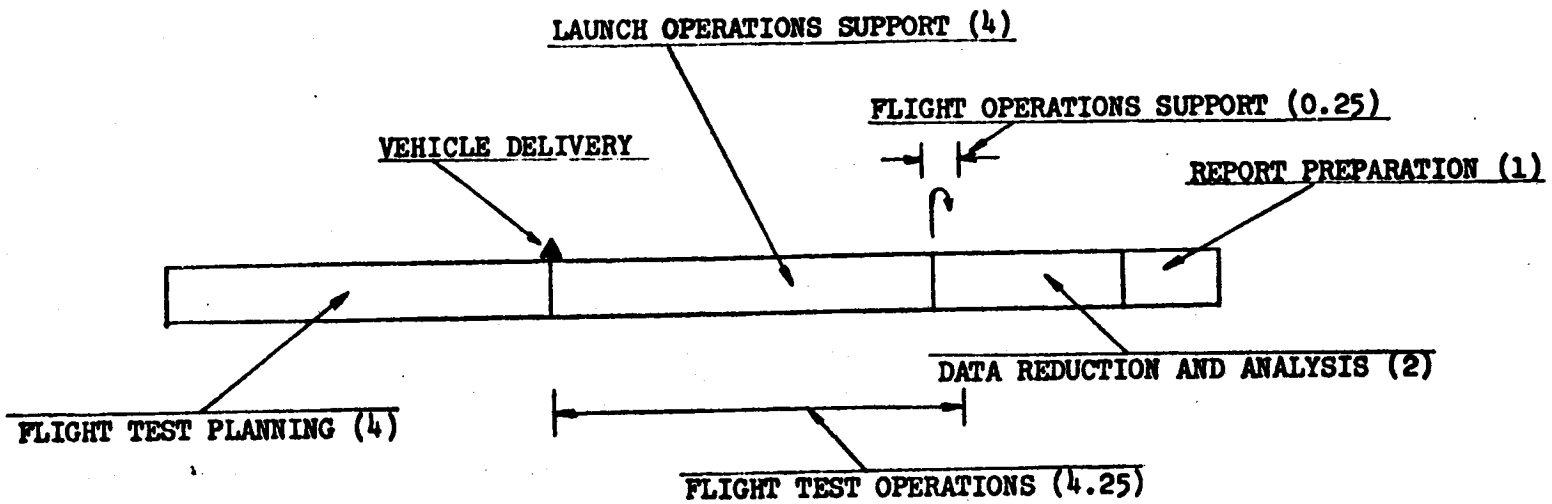
PERSONNEL	MONTHS	MANMONTHS	TYPE PERSONNEL	PERSONNEL-CUM.
Test Management	0	0		
Test Requirements and Planning	1	1	1 Engineer	1 Engineer
1 M Engineer				
Test Article Preparation	0	0		
Test Fixture Design	0	0		
Test Setup	1	0.5	.5 Engineer	1 Engineer
.5 M Engineer				
Test Performance	0.5	0.5	1 Engineer	1 Engineer
1 M Engineer				
Tear Down	0	0		
Data Reduction and Analysis	1	1	1 Engineer	1 Engineer
1 M Engineer				
Report Preparation	2	1.5	.75 Engineer	1 Engineer
.75 M Engineer				
TOTAL MAN MONTHS:		4.5		

FLIGHT TEST OPERATIONS

SCHEDULE

(MONTHS)

(PHASED FINAL)



FLIGHT TEST OPERATIONS

(Conducted Concurrently with Operational Flights -- Phased Final)

(1 FLIGHT)

PERSONNEL	MONTHS	MANMONTHS	TYPE PERSONNEL	PERSONNEL-CUM.
Flight Test Planning	4	36	9 Engineers	9 Engineers
2 Elec. Engineers 2 Prop. Engineers 1 Struct./Mech. Engineer 1 Thermodynamics Engineer 1 Effectiveness Engrg Engr 2 Project Engineers				
Launch Operations Support (WBS 32C-09/10)	4	0		
Flight Operations Support (WBS 32C-11/12)	0.25	0		
Flight Test Operations Support	4.25	30	6 Engineers	9 Engineers
2 Elect. Engineers 2 Prop. Engineers 1 Struct./Mech. Engineer 1 Thermodynamics Engineer 1 Project Engineer		30		
Data Analysis and Evaluation	2	28	14 Engineers 2 Technicians	12 Engineers 2 Technicians
9 Engineers (See Flt. Test Plng.) 3 Data Acquisition Engrs 2 Data Acquisition Techs				
Report Preparation	1	9	9 Engineers	12 Engineers 2 Technicians
9 Engineers (See Flt. Test Plng.)				
TOTAL MANHOURS:		103		

Instrumentation: $100,000 = 0.006 vehicle cost

2.6 ANALYSIS OF TEST PROGRAM

Elements of a test program normally include:

Supporting Research and Technology (SR&T)

Development and qualification testing of the lower hardware assembly levels, i.e., parts, components, subassemblies, and assemblies

Reliability testing of selected items

Repairability/maintainability testing at the Line Replaceable Unit (LRU) level

Development, qualification, maintenance, and maintainability testing of major or vehicle level test articles

Acceptance testing of the lower level hardware

Acceptance testing of the completed Tug

Prelaunch testing

Flight testing of the completed CEI

For purposes of this study, these elements have been organized into their associated operational areas.

2.6.1 Supporting Research and Technology (SR&T)

Depending upon the option,some subsystems require preceding SR&T. The testing program is based, however, upon the assumption that all required SR&T is completed prior to ATP of the Tug Phase C-D. Therefore, SR&T discussions are found in Section 8, Volume 5, and Section 10, Volume 8.

2.6.2 Development and Qualification Testing

This testing is accounted for at two levels; components and assemblies, and vehicle test.

2.6.2.1 Component and Assembly Testing

A goal in this study was to identify as many of the selected components as possible which could be qualified to Tug requirements by means other than testing, i.e.,

A - Analysis

I - Inspection

D - Demonstration

S - Simulation

For those items, identifiable in a conceptual study, achievement of that goal has been reached.

2.6.2.2 Vehicle Test

The bulk of the test program is comprised in this activity, and properly so. When assembly reaches this level, it is approaching, or has become, the Space Tug. This is the first time the lower level hardware has been assembled into the Tug configuration. This is where true Tug development takes place. Discussion of test hardware and operations is located in Section 2.1 and 2.3, respectively. The test programs have been formulated to comply with Tug program requirements of minimum/low DDT&E, demonstrate reusability, etc. It is always possible that less testing can be performed. But it is also a fact of product development life that as the activity which proves that the design/manufacturing process meets the design requirements, i.e., test, is lowered, the risk that the product will perform as required raises. Another view is that as dollars are shoved out of development, they pop up in operations. There is, therefore, a cross over point where further reductions in development/qualification costs are not sound reductions. At the level of design definition available from a conceptual study, the test program described in the foregoing sections reflect an adequate balance between technical assurance and budgetary limitations.

2.6.3 Reliability Testing

As a result of the component selection process, reliability analyses, development and qualification test design, and cost limitations no specific reliability testing is identified for this option.

2.6.4 Reusability Demonstration

Demonstration of the reusability of the Space Tug, and therefore the components of which it consists, bears close resemblance to that of any reusable equipment. Such a demonstration really spans three separate but allied activities: the overall design/test philosophy; component/subassembly level development and qualification testing; and repairability/maintainability testing at all levels of assembly.

2.6.4.1 Design/Test Philosophy

This is a combination of four approaches and is discussed in Section 2.3.

2.6.4.2 Component Testing

Where applicable, critical test conditions or environments are imposed in accelerated life modes or in repeated cycles to assure their survivability within the limits to be specified.

...s testing is commenced early in the program at the component level on the bench and carried through the program utilizing the development fixture, the propulsion test vehicle, the Integrated Avionics Test Unit, and the flight test article. The activity is designed to assure the repairability/maintainability of the line replaceable hardware, accessibility of LRUs within the Tug design and adequacy and effectiveness of procedures. The latter is accomplished first in the development mode by the contractor, followed in the operational test and evaluation mode by the customer.

2.6.5 Acceptance Testing

Items acquired from vendors and subcontractors will be conducted at their facilities under MDAC and customer Q.C. direction. Post manufacturing acceptance testing of the completed CEI will be conducted in the Vehicle Checkout Laboratory (VCL) at MDAC, Huntington Beach. These activities are discussed in Section 4.

2.6.6 Prelaunch Testing

This testing consists of receiving inspections, pre and post mate tests (both spacecraft and orbiter), propellant loading preparations, launch readiness tests and maintenance/refurbishment checkouts. These tests have been formulated to blend within launch site operations procedures, Tug/Spacecraft and Tug/Orbiter interface compatibility, maximum reuse capability, and cost constraints. The activity is discussed in Section 11.3, Volume 6.

2.6.7 Flight Testing

Flight testing has been held to a minimum in terms of engineering information acquisition and of cost. Maximum use must be made of ground test results through analysis emphasizing flight application. Identified flight test objectives are concentrated on those subsystem operations specifically affected by a zero-g environment. Satisfaction of these objectives coupled with the analyses of ground test results will assure verification of the Tug's capability to accomplish assigned missions within the mission envelope, to be specified, of performance and time requirements. While the objectives are not considered of minor significance, the flight tests can be flown on spacecraft-carrying flights, which is beneficial from a cost standpoint.

In addition to the subsystem oriented flight test objectives, one further mission objective is associated with the egress-ingress maneuver, i.e., getting the Tug and its spacecraft out of and back into the orbiter cargo bay. This objective, the subsystem objectives, and the flight test requirements are discussed in Section 2.4.

This testing is commenced early in the program at the component level on the bench and carried through the program utilizing the development fixture, the propulsion test vehicle, the Integrated Avionics Test Unit, and the flight test article. The activity is designed to assure the repairability/maintainability of the line replaceable hardware, accessibility of LRUs within the Tug design and adequacy and effectiveness of procedures. The latter is accomplished first in the development mode by the contractor, followed in the operational test and evaluation mode by the customer.

2.6.5 Acceptance Testing

Items acquired from vendors and subcontractors will be conducted at their facilities under MDAC and customer Q.C. direction. Post manufacturing acceptance testing of the completed CEI will be conducted in the Vehicle Checkout Laboratory (VCL) at MDAC, Huntington Beach. These activities are discussed in Section 4.

2.6.6 Prelaunch Testing

This testing consists of receiving inspections, pre and post mate tests (both spacecraft and orbiter), propellant loading preparations, launch readiness tests and maintenance/refurbishment checkouts. These tests have been formulated to blend within launch site operations procedures, Tug/Spacecraft and Tug/Orbiter interface compatibility, maximum reuse capability, and cost constraints. The activity is discussed in Section 11.3, Volume 6.

2.6.7 Flight Testing

Flight testing has been held to a minimum in terms of engineering information acquisition and of cost. Maximum use must be made of ground test results through analysis emphasizing flight application. Identified flight test objectives are concentrated on those subsystem operations specifically affected by a zero-g environment. Satisfaction of these objectives coupled with the analyses of ground test results will assure verification of the Tug's capability to accomplish assigned missions within the mission envelope, to be specified, of performance and time requirements. While the objectives are not considered of minor significance, the flight tests can be flown on spacecraft-carrying flights, which is beneficial from a cost standpoint.

In addition to the subsystem oriented flight test objectives, one further mission objective is associated with the egress-ingress maneuver, i.e., getting the Tug and its spacecraft out of and back into the orbiter cargo bay. This objective, the subsystem objectives, and the flight test requirements are discussed in Section 2.4.

Section 3
FACILITIES PLAN

The requirements developed by operations analysis in the areas of manufacturing, test, integration, C/O, launch, recovery, refurbishment, and storage were matched against existing, modified, and new facilities on the basis of availability, compatibility, and cost.

It was determined that facilities are not configuration sensitive; cost is not a determinate factor in selection; existing facilities can be utilized for most requirements; and horizontal mating is a preferred method.

3.1 MANUFACTURING FACILITIES

Manufacture and checkout of the Space Tug will be accomplished at the McDonnell Douglas Astronautics Company, Huntington Beach, California, facility.

The Huntington Beach facility was planned and designed from inception to provide fully integrated facility capabilities for space vehicles. Its buildings consist of engineering and administration offices, a Systems Integration Laboratory, Structural Test Laboratory, Space Simulation Laboratory, Production Test Laboratory, Manufacturing and Assembly Building, Insulation Building, Final Assembly and Checkout Building, and other service and support buildings.

Maximum utilization will be made of the existing MDAC and government owned facilities used on the Saturn SIVB Orbital Workshop and other programs in the development and production of the Space Tug. This will include but not be limited to such MDAC facilities as the existing machine shops, sheet metal shops, process shops, electrical/electronic fabrication and assembly, and supporting inspection and test laboratories.

A preliminary list of additional facility requirements identified at this time, for each of the configurations are shown in Table 3.1-1 along with ROM cost and procurement lead time estimates also shown in Volume 6, Book 3, Section 11.5 and in Section 4.3 of this book.

3.2 TEST FACILITIES

Production testing (and checkout) will be done at Huntington Beach in existing laboratories of the McDonnell Douglas Astronautics Company facilities. These

Table 3.1-1

MANUFACTURING AND TEST FACILITIES

MANUFACTURING FACILITIES

	DESCRIPTION	LEAD TIME	ROM COST OPTION 1 & 3	ROM COST OPTION 2
1.	AGING OVEN 20 FT X 20 FT x 8 FT (325°F)	6 MONTHS	30,000	
2.	AUTOCLAVE 16 FT DIA X 12 FT LONG (600°F)	10 MONTHS	130,000	
3.	CHEM-MILL FACILITY 2 TANKS 20 FT X 20 FT X 12 FT	10 MONTHS	200,000	
4.	ANODIZE FACILITY 20 FT X 20 FT X 10 FT TANKS	4 MONTHS	200,000	
5.	CLEAN ROOM/10 TON BRIDGE CRANE 5000 SQ FT (100,000 CLASS)	8 MONTHS	250,000	
6.	ACOUSTIC EMISSION TEST EQUIPMENT (PATE)		150,000	
7.	ACOUSTIC EMISSION TEST EQUIPMENT (PATE)		75,000	
				1,035,000
8.	CURING OVEN 16 FT X 16 FT X 8 FT (600°F)	6 MONTHS		60,000
	T O T A L		1,035,000	1,095,000

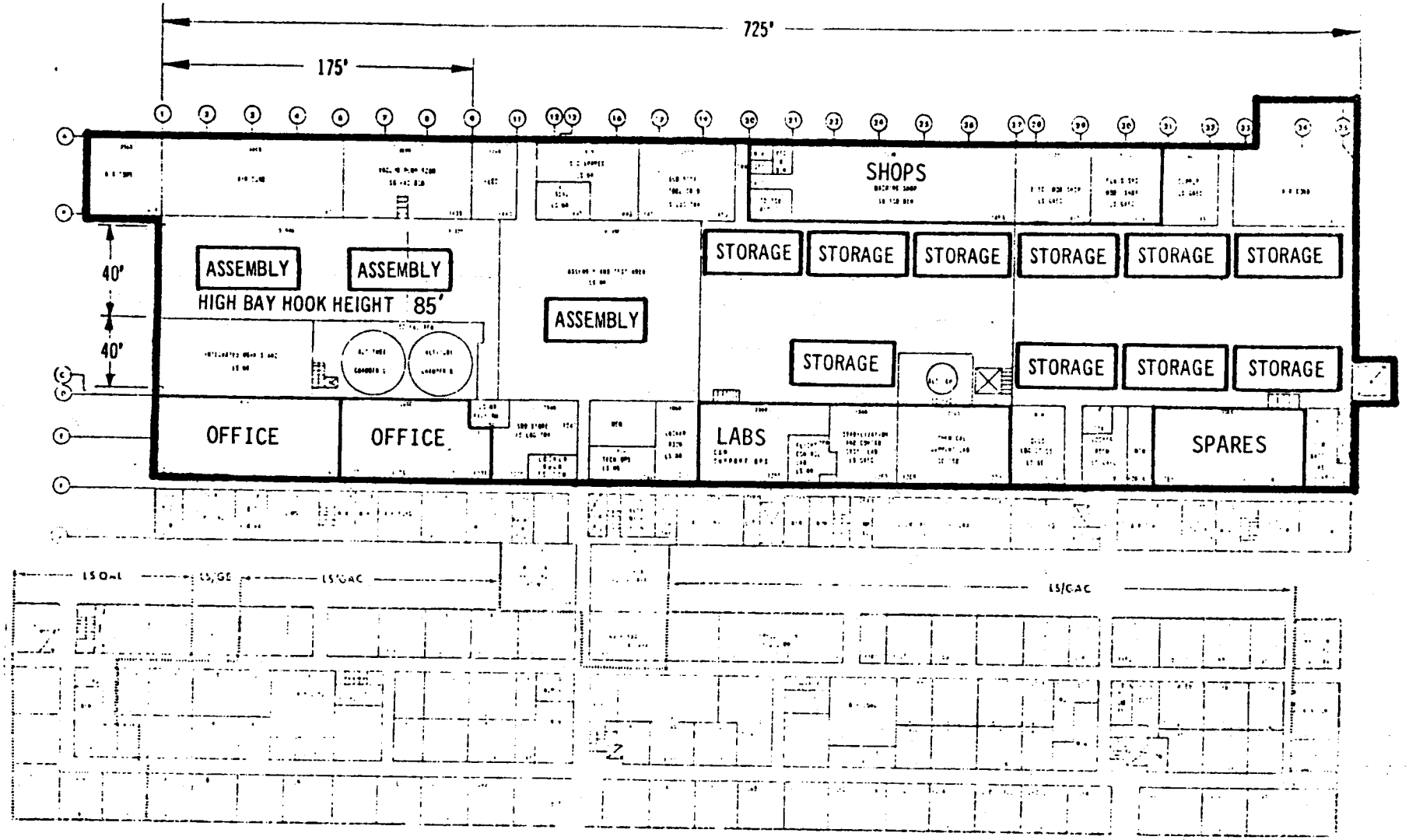
TEST FACILITIES

		NASA	DOD
1.	MDAC HUNTINGTON BEACH LABS	-0-	-0-
2.	NASA HUNTSVILLE HIGH VACUUM FACILITY	-0-	250,000
3.	AEDC TULLAHOMA MARK 4 CHAMBER	1,250,000	-0-

Table 3.3-1

OPERATIONAL FACILITIES SUMMARY

FACILITY	ORIGIN	KSC	WTR
Tug Processing Facility	Modified KSC Bldg M7-355	500,000	
DOD Payload Processing Facility	New	500,000	
Payload Processing Facility	New		750,000
Maintenance and CO Facility	Modified Shuttle Facility	10,000	
Maintenance and CO Facility	Modified Shuttle Facility		10,000
Launch Service Structure	Modified Shuttle Facility	350,000	
Launch Service Structure	Modified Shuttle Facility		350,000
Launch Control Center	Modified Shuttle Facility	10,000	
Launch Control Center	Modified Shuttle Facility		-0-
Safing Facility	Modified Shuttle Facility	-0-	
Safing Facility	Modified Shuttle Facility		-0-
Storable Propellant Facility	Modified Shuttle Facility	-0-	
Storable Propellant Facility	Modified Shuttle Facility		-0-
Vertical Assembly Building	Modified Shuttle Facility	10,000	
Vertical Assembly Building	Modified Shuttle Facility		10,000
		1,380,000	1,120,000



O & C BUILDING FIRST FLOOR, KSC M7-355

SERVICE AREA	24,736 SQ. FT
A&T AREA	48,753 SQ. FT.
A&E AREA	159,730 SQ. FT.
LSC AREA	123,170 SQ. FT.
TUNNEL AREA	12,826 SQ. FT.
TOTAL	369,312 SQ. FT.

NORTH

Table 3.3-2 Tug Processing Facility

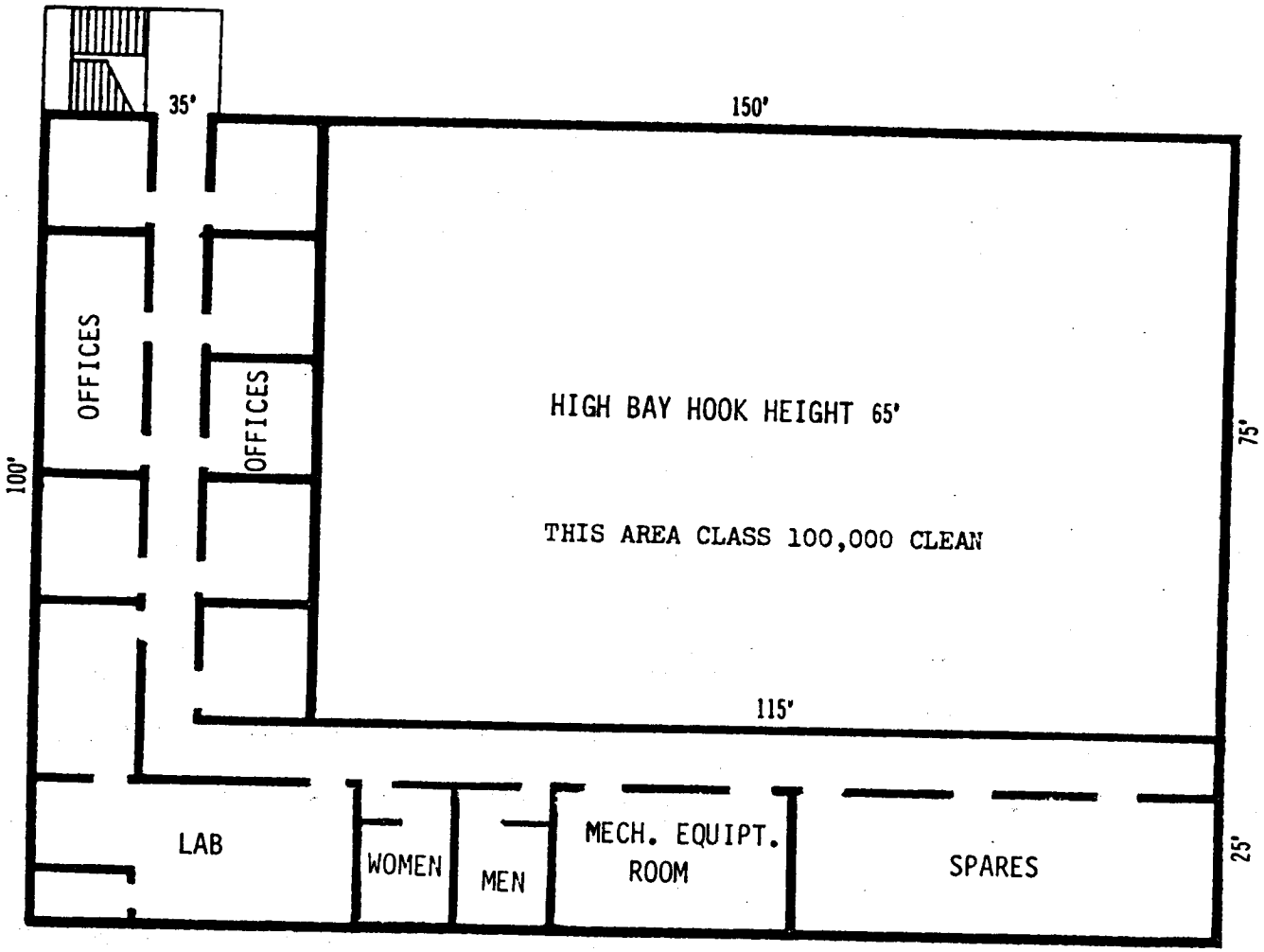


Table 3.3-3 PAYLOAD PROCESSING FACILITY KSC

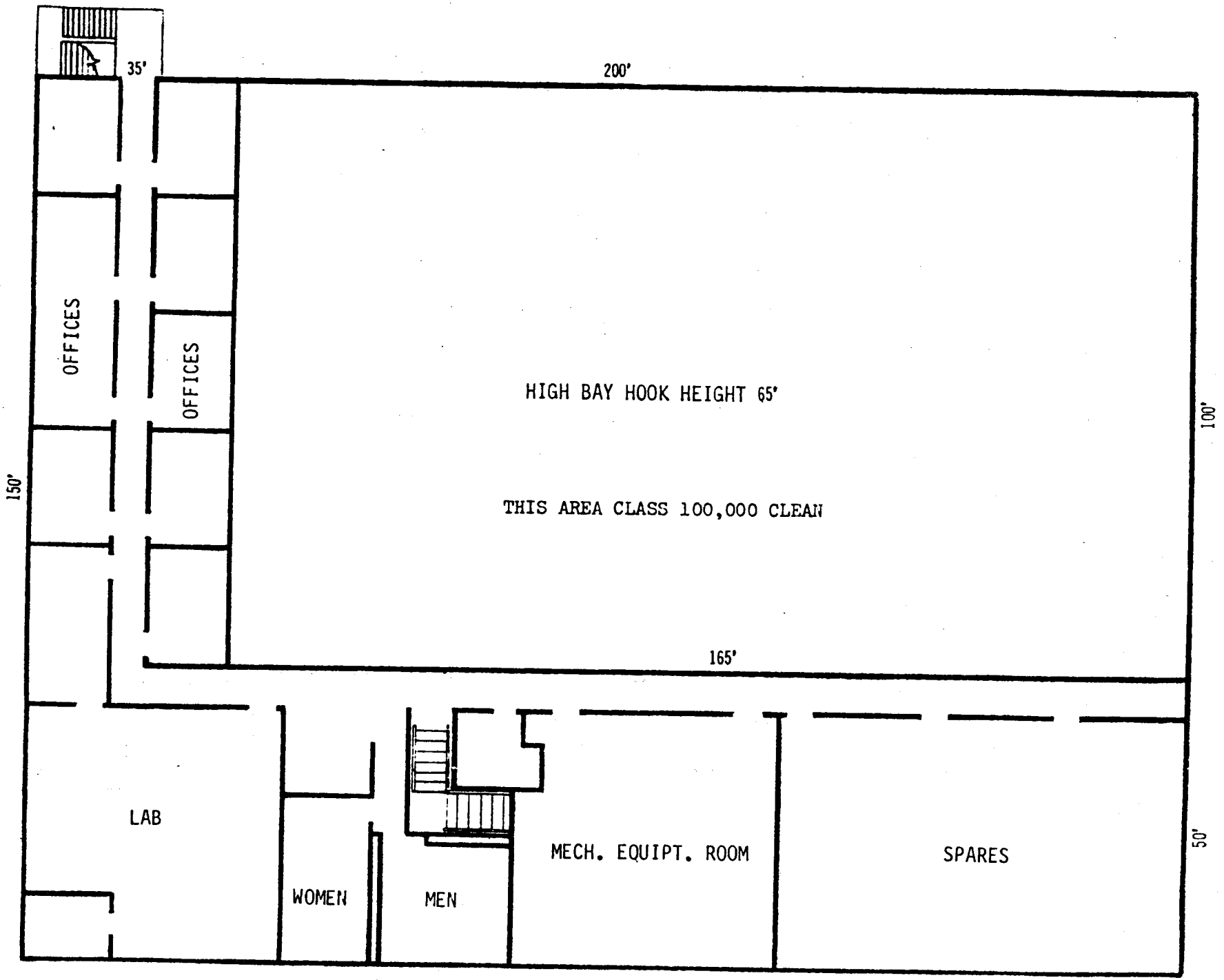


Table 3.3-4 PAYLOAD PROCESSING FACILITY WTR

laboratories, designed and used for space vehicles, will require little or no modification for use in the Space Tug Program.

Vehicle PTV tests will be conducted in test cell J4 of the AEDC facility at Tullahoma. Test cell J4 provides an altitude simulation capability lacking in the test facilities at Huntsville. Thermal tests of the vehicle will be accomplished in the NASA High Vacuum facility utilizing an existing scaled down and instrumented tank that will fit the 15 foot diameter chamber. These government facilities are available at no cost or at a nominal fee depending on the using agency (see Table 3.1-1). See also Volume 6, Book 3, Section 11.5.1 and Section 2 of this book.

3.3 OPERATIONS FACILITIES

The requirement for Tug launch facilities at ETR will be satisfied with construction of one new building, by modification and refurbishment of existing buildings and by use of Orbiter facilities that can be expanded or adapted to include Tug service.

At WTR,construction of a new Payload Processing facility together with use of programmed Shuttle facilities expanded to satisfy Tug needs will provide the support required. A tabulation of these facilities' status and cost is presented in Table 3.3-1. Additional information is available in Volume 6, Book 3, Sections 11.5.2 and 11.5.3.

New construction and modification to existing buildings (the first three items of Table 3.3-1) is shown in Tables 3.3-3 and 3.3-4.

3.4 IMPACT OF OPTION SENSITIVITIES

- o Configuration and programmatic sensitivities for the Final Tug to retrieve $\geq$3500 lb from geosynchronous will not impact facilities.
- o Programmatic sensitivity to delay both Initial and Final Tug IOC dates two years (December 31, 1981 to 1985) are reflected in facility schedules discussed in Section 1.7 of this book.

Section 4

VEHICLE MANUFACTURING

The vehicle manufacturing plan of the Space Tug initial configuration and final configuration (see Figure 4-1 & 4-2) contains the Space Tug manufacturing support of the DDT&E requirements, the Space Tug production manufacturing plan, including Peak Rate charts, Manufacturing Flow Plans, tooling required to manufacture the Space Tug per the prescribed rate and the facilities that will be required to accomplish the task. Also included in this section are the problem areas, special processes required, summary analysis and manufacturing philosophy engendered into the manufacturing plan. The impact of the options and the sensitivity to these options are delineated in this section. Factory GSE lists have been made and are also included.

4.1 PLAN/FLOW/TIME

The manufacturing plan/flow/time elements used for the manufacture of the Space Tug are based on the following key factors:

- Low Production requirements
- Low DDT&E costs, with ability to grow
- Low Production Manufacturing Costs
- Low Early Year Funding
- Low Manufacturing Rate Requirement
- Test Article Requirements Support
- Utilization of existing Capital Equipment, GSE, and facilities
- High Reliability and Reuseable requirements of the Space Tug.
- Phased Manufacturing Capability Initial Configuration to Final Configuration

The above noted key factors were considered and incorporated into the Manufacturing plan with the principal motivating factors being the high reliability, reuseability and manufacturing phasing requirement.

4.1.1 Manufacturing Requirements

This section has been divided into two parts to separate the manufacturing requirements for major test articles from those needed for the production of flight articles. No dedicated flight test articles are planned for this program. Schedule requirements for the major test articles are presented in

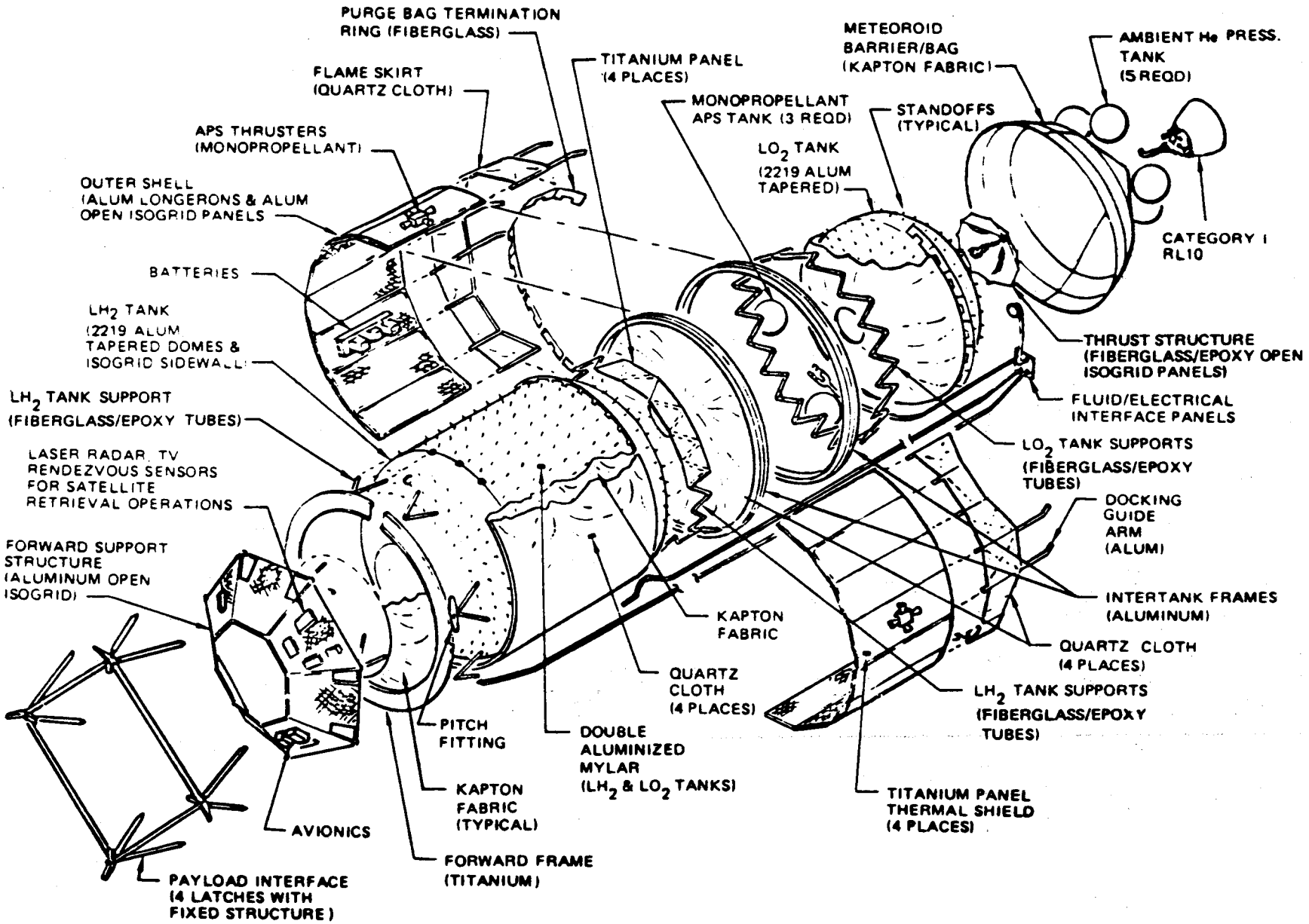


Figure 4-1 Space Tug Configuration – Option 3 Initial

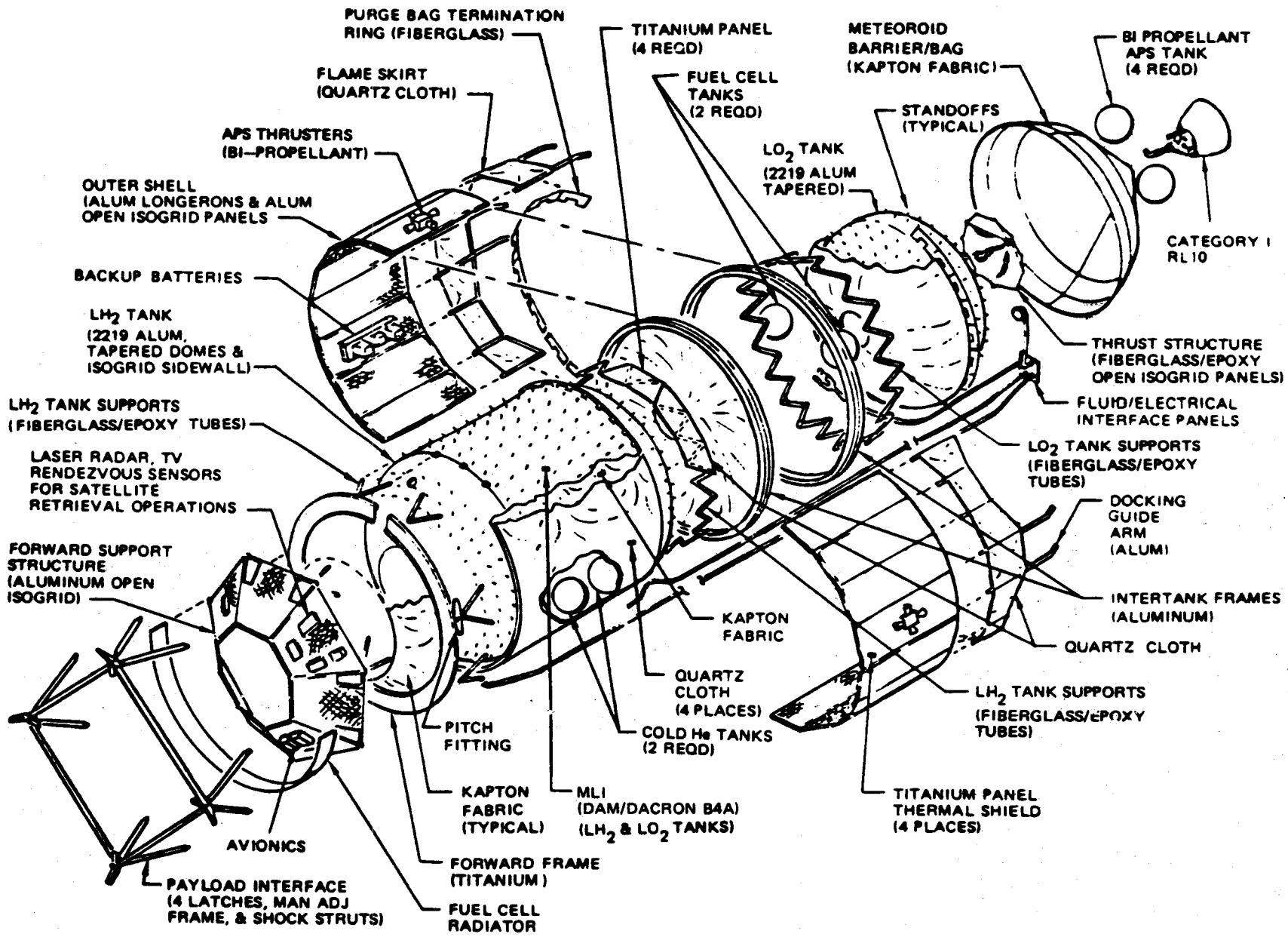


Figure 4-2 Space Tug Configuration —Option 3 Final

Section 1.2. Wherever practical or feasible from a schedule standpoint, manufactured test components will be fabricated during tool proofing to provide lower program cost, reduce Planning effort, provide a greater lead time, and reduce Tooling setup times for test components.

4.1.1.1 Major Test Articles

A. Structural Test Articles

Manufacturing will support the development testing and the qualification testing of structural test hardware by producing one tank set for each of three tests. A tank set consists of an LO_2 tank and an LH_2 tank, as the structural test article is not tested as an assembled entity. Two tank sets will be used during development testing, one for the hydrostatic pressure cycle and one for the hydrostatic pressure burst test. One set of weldment/joining joints will also be produced for development testing.

The third tank set produced will be used for qualification testing during a hydrostatic pressure cycle. One body structure, a thrust structure, and a set of support elements will be produced by manufacturing for qualification testing under static loads: axial, shear and bending. One set of joints will be manufactured also for qualification testing of compression and bending under static loads.

B. Propulsion Test Vehicle (PTV)

Hardware produced by manufacturing for the PTV test includes one each of the following articles: main engine support assembly, structures assembly, interface panel assembly, purge provisions assembly, abort provisions assembly, and one set of electrical and propulsion GSE. The main engine will be GFE for this test. As a cost reduction consideration the LO_2 and the LH_2 tank used in this test will be the previously fabricated Tooling Proof tanks developed to "prove and complete" the tooling required in tank manufacture. Cost savings to the program by using these tanks is consistent with MDAC's policy of low cost and high reliability. Use of these existing tanks is

reflected in the hardware usages schedule for the time-phased production of test articles.

Although the PTV is not a true Space Tug vehicle, being used only to develop and qualify the main engine support assembly and associated interfaces, the components which comprise the PTV will be of production quality to assure that components and interfaces function within the specified limits. The propellant tanks will be fabricated and assembled on production tooling, but will not have the tapered or chemical milled skins used for regular "flight weight" tanks.

C. Integrated Avionics Test Unit (UATU)

Items of test hardware produced to support the IATU test include one avionics subsystem "set" plus spare equivalencies; one set of interfacing hardware (sensors, valves) from such typical subsystems as thermal control, propulsion, and orbiter interface; and one set of electronic GSE and associated software. Associate contractors will supply, in addition, interface verification units for such systems as spacecraft, orbiter, and launch processing. Components comprising this IATU will be of flight production Tug quality, with complete qualification of parts at the component level to assure functional integrity.

D. Flight Control Simulation (Deployment & Retrieval)

Test hardware includes the GN&C subsystem set plus one set of rendezvous, docking and tracking electronics. Simulation will be provided in the On-Line Subsystem Facility (OLSF) at Huntington Beach.

E. Thermal Protection Test

An existing, MSFC-owned, scaled LH_2 tank will be shipped to MDAC for test preparation and for the installation of thermal protection insulation and instrumentation. The tank will be returned to MSFC for test in their High Vacuum Test Facility. MDAC manufacturing will provide one set of scaled Tug thermal protection for the test and install one set of thermal instrumentation.

F. Flight Support Equipment (FSE)

For the Tug/Orbiter FSE with an Interface Verification Unit (IVU), manufacturing will provide: one tilt table, two fluid/electrical interface panels, one abort dump interface panel, and one electrical interface panel. Special test equipment will also be provided to effect zero g mass balancing of the hardware under test.

Interfaces identified are those between associate contractor hardware or customer hardware. Interface hardware furnished to MDAC by an associate contractor for the IVU will be controlled to assure functional fit and alignment by interface master tooling. This master will be produced, controlled and maintained by MDAC to exact specifications, and supplied to the associate contractor for interface control.

4.1.1.2 Flight Articles

MDAC does not plan to provide dedicated flight test articles, as the high reliability and reusability stressed in the initial design, and proven in development tests, will assure flight-worthy hardware. Sixteen flight vehicles will be produced by manufacturing. Five of these flight vehicles will be of the initial configuration and eleven final configurations. These flight vehicles will meet the mission accomplishment requirements outlined in Volume 4, Book 3, Section 2. Manufacture of the flight articles is described in Section 4.1.2, together with the production flow for test, integration, insulation and checkout.

4.1.2 Manufacturing Schedule and Flow

The manufacturing schedule is based on the Production Schedule, shown in Section 1.3, which is the basis also for the manufacturing flow charts, lead time set-back charts, and first tool usage requirements.

The manufacturing flow schedule shown in Figures 4-3 and 4-4 begins with Engineering design effort at ATP, and defines the sequence of activities by Procurement, Planning, Tooling and Manufacturing through detail fabrication, subassembly and assembly, integration and installation, through final checkout and preparation for shipment. Major inspection points such as proof and leak check are also shown in this chart.

The Peak Rate Tree Chart presented in Figure 4-5 shows both detailed manufacturing steps and the units in flow at peak production rate. This chart is the key document that establishes individual unit timing and line position during peak manufacturing rate, and was established by analyzing both tooling and machinery capabilities and the elapsed hours required to maintain a full line at peak rate. When these data are organized into a logical work flow plan, the resulting chart establishes the baseline for manufacturing buildup and factory output to support NASA delivery milestones.

Additional detailed manufacturing sequence flow charts are contained in the Manufacturing Plan which follows in Section 4.1.3. Purchased components and fabricated details are shown in sequence of manufacture from raw material through various stages of processing and assembly to the final checkout position.

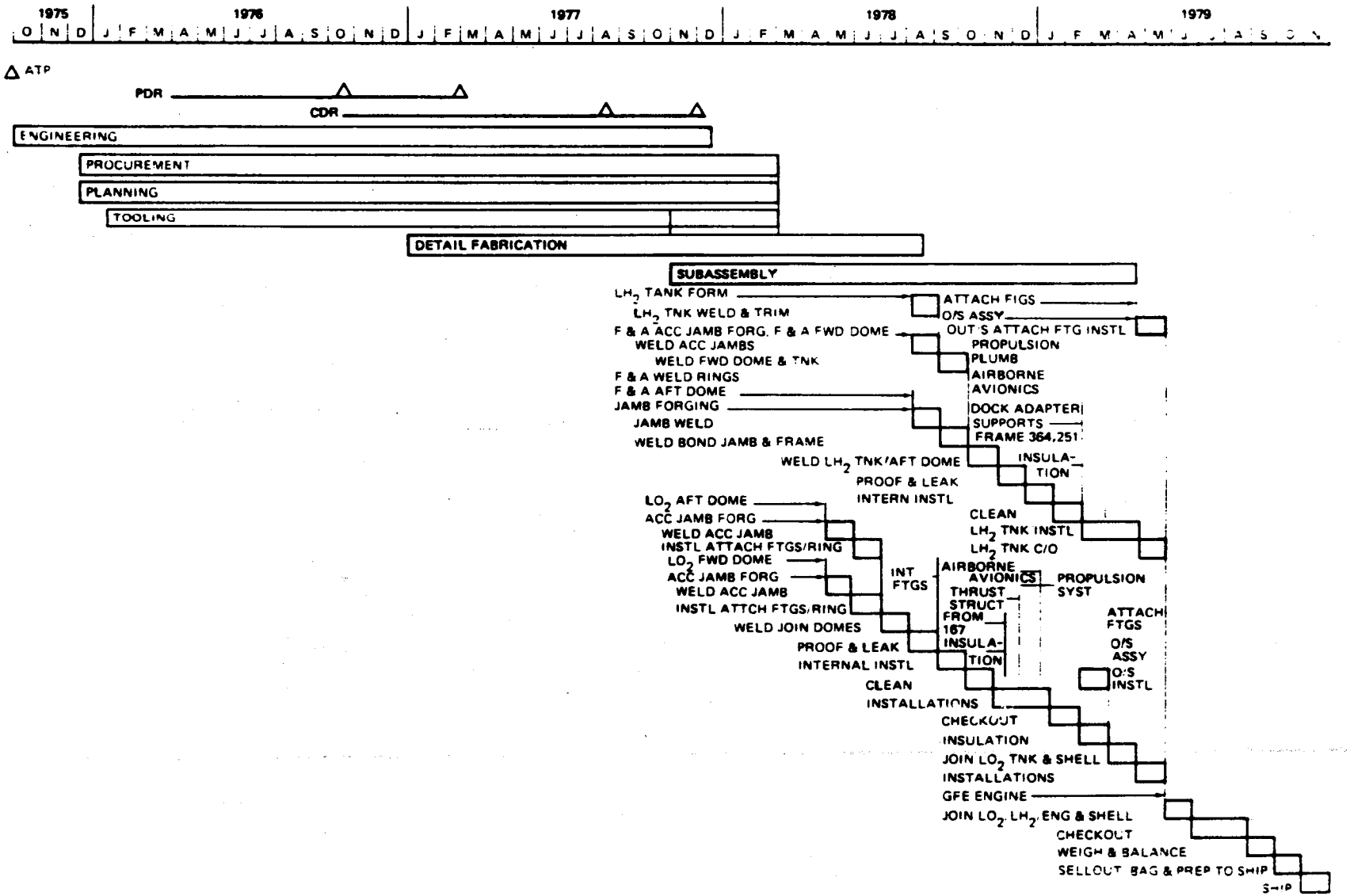


Figure 4-3. Space Tug Manufacturing Plan/Flow/Time — Option 3I

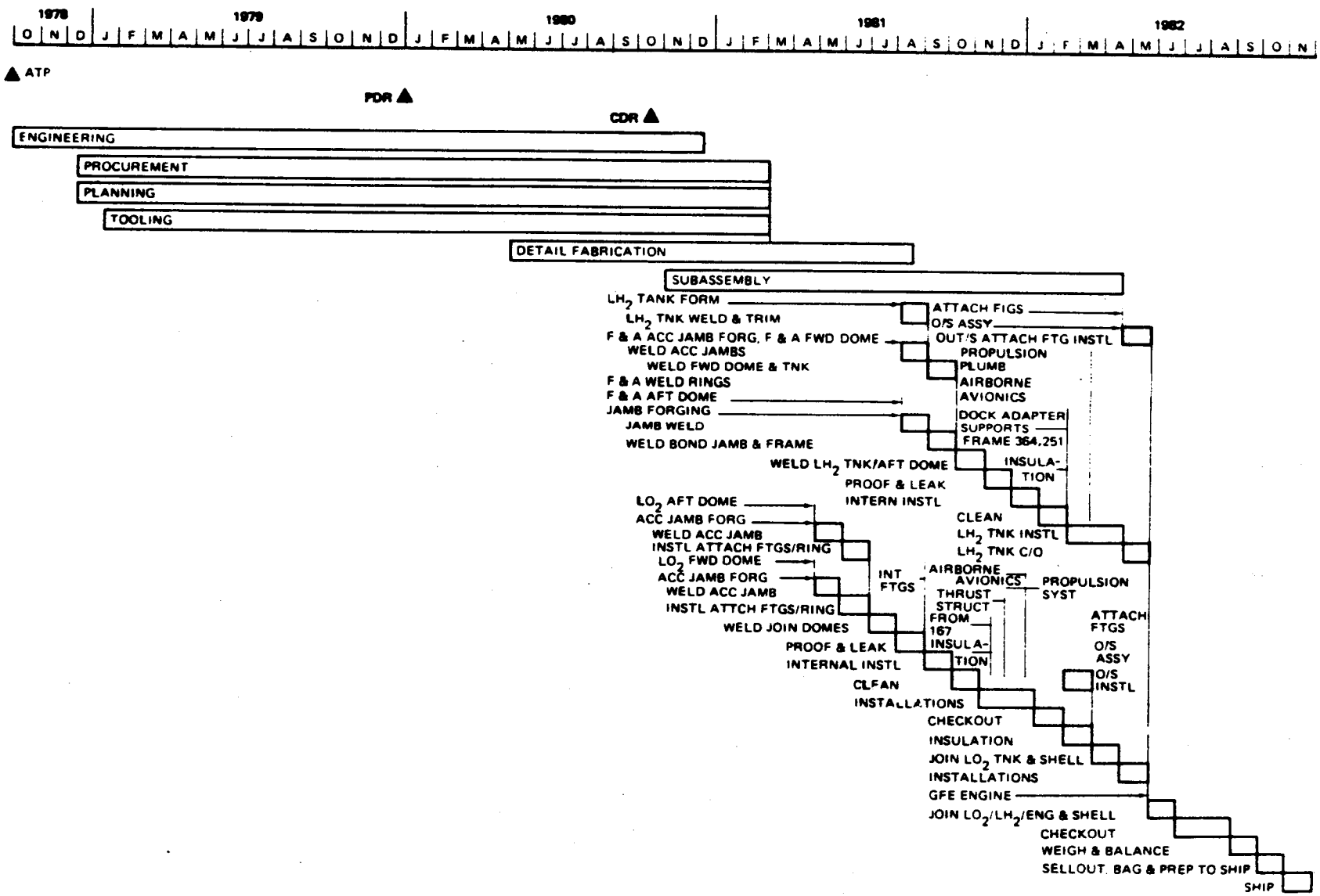


Figure 4-4 . Space Tug Manufacturing Plan/Flow/Time – Option 3F

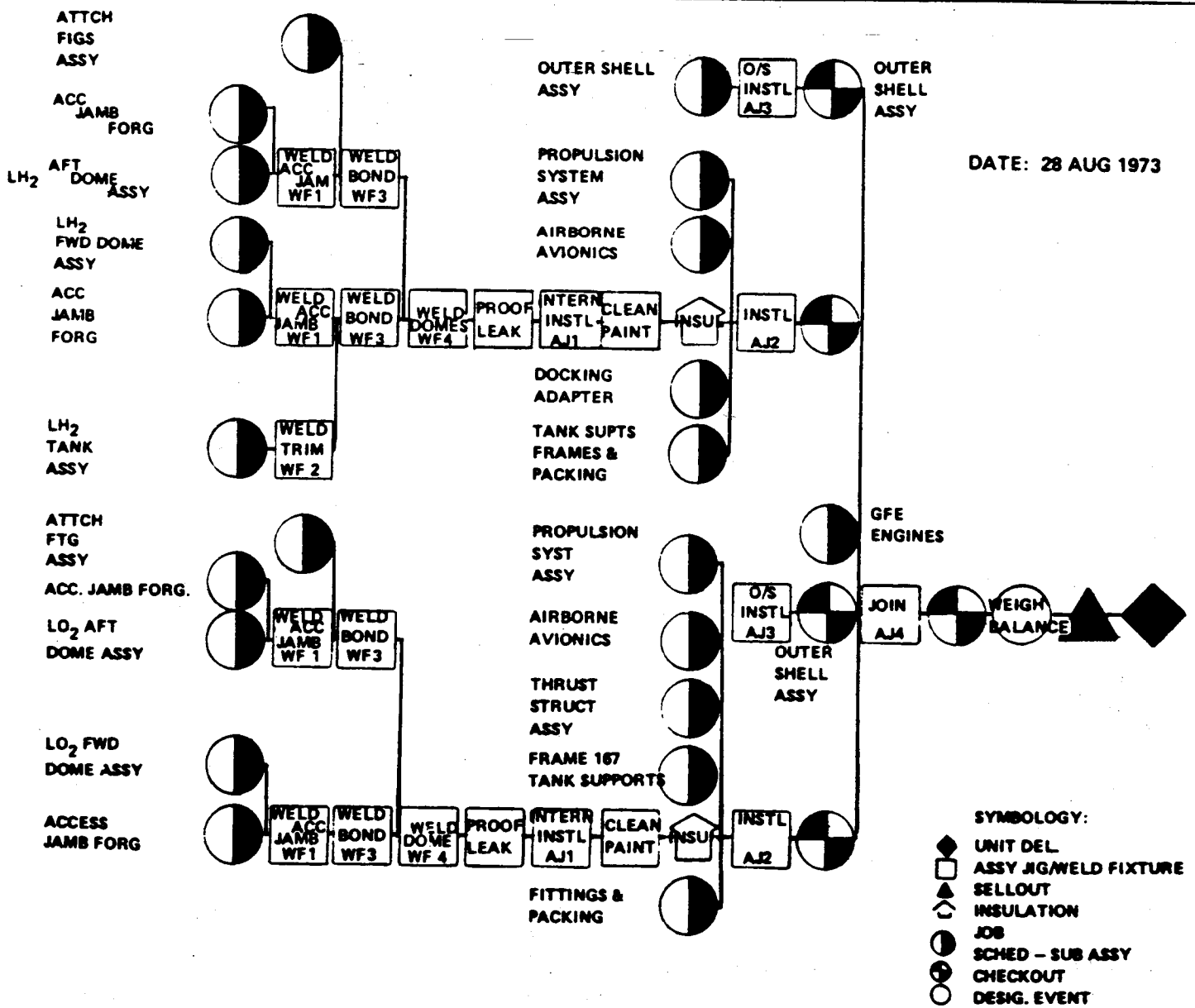


Figure 4-5 Space Tug System Study (Cryogenic) – Peak Rate Tree Chart (Max Rate 4 Per Year) – Option 3

4.18

4.1.3 Manufacturing Plan

The manufacturing plan outlined in this section is structured as follows:

- Fabrication and Subassembly (structures) plan and Flow Plans.
- Tank Bonding and Insulation plan and Flow Plans
- Final Assembly and Final Joining Plan and Flow Plans
- Propulsion Fabrication and Subassembly Plan and Flow Plans
- Avionics Fabrication and Subassembly Plan and Flow Plans.
- Production Acceptance Test Plan

A descriptive narrative of the manufacturing approach for each of the above noted manufacturing tasks and the manufacturing flow plans are delineated in the following sections and in the same numerical order above.

4.1.3.1 Fabrication and Subassembly Plan (Structures)

The fabrication and subassembly requirements for the manufacture of the structural components comprising the space tug are state-of-the-art and will not require the development of unique manufacturing processes. Low cost "soft" tooling i.e., layout templates, router/blocks, drop hammer dies, etc., will be used extensively where practical. The LH_2 and the LO_2 domes will be subcontracted to a vendor that currently has the capability to manufacture a one piece dome. In order to accomplish this task in house the program costs would be higher, ergo the low cost requirement would not be met. The forward frame and the intertank frames will also be subcontract items to a vendor that specializes in this type of manufacture and is low cost oriented.

The fusion joining of the LH_2 tanks and the LO_2 tanks will be accomplished using the latest Tig welding techniques. Note: The welding process employed in the manufacture of the space tug LH_2 and LO_2 tanks is fully discussed in Section 4.5 Summary Analysis/Philosophy.

The manufacturing requirements for the initial space tug components are outlined in the space tug fabrication flow plans, see Figure 4-6 thru 4-10. The final configured space tug components are outlined in the same flow plans except omit those flows that contain an astrisk and use flow plan Figure 4-11.

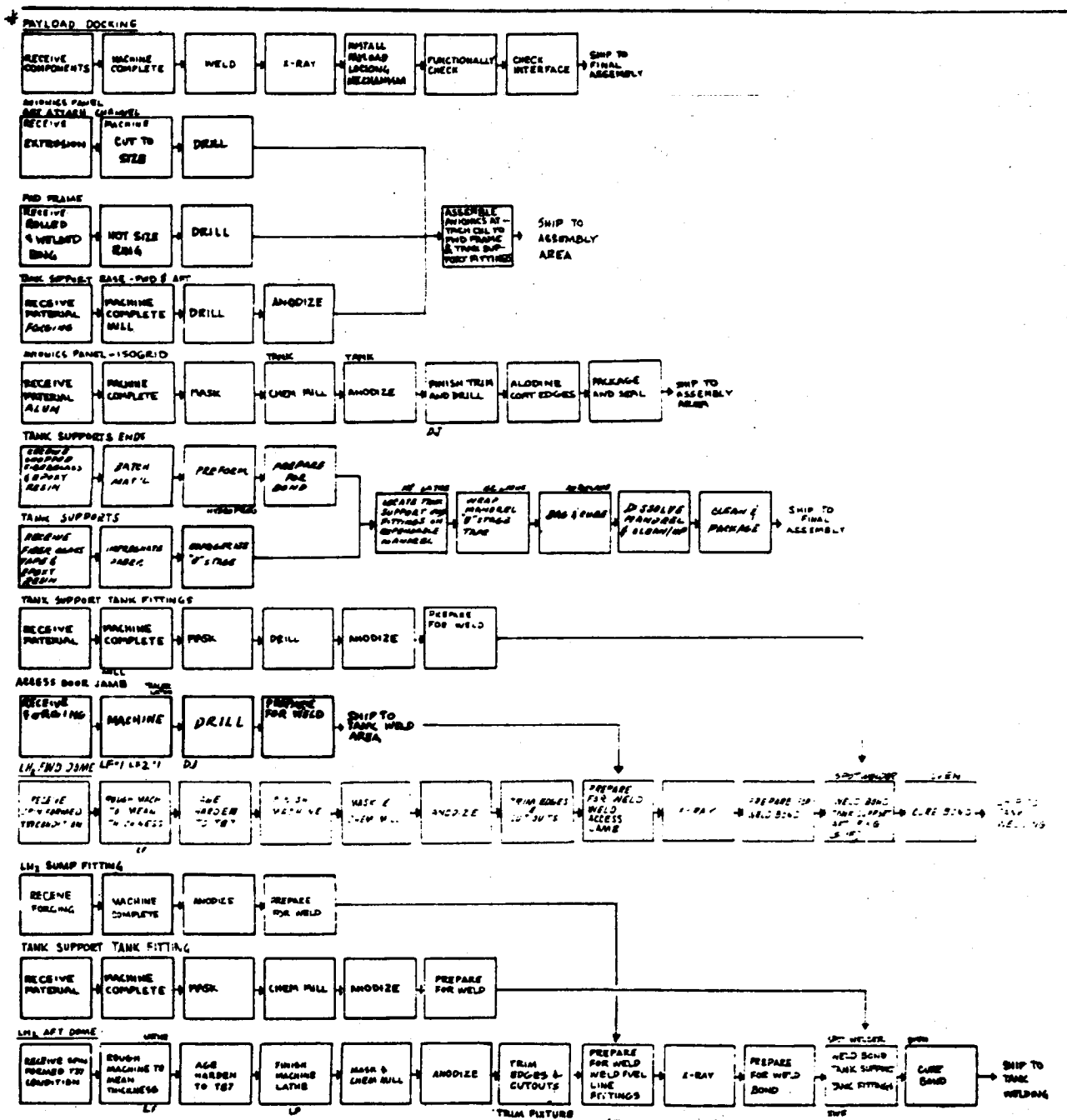


Figure 4-6 Space Tug Fabrication Flow Plan – Option 3 Initial (Page 1 of 5)

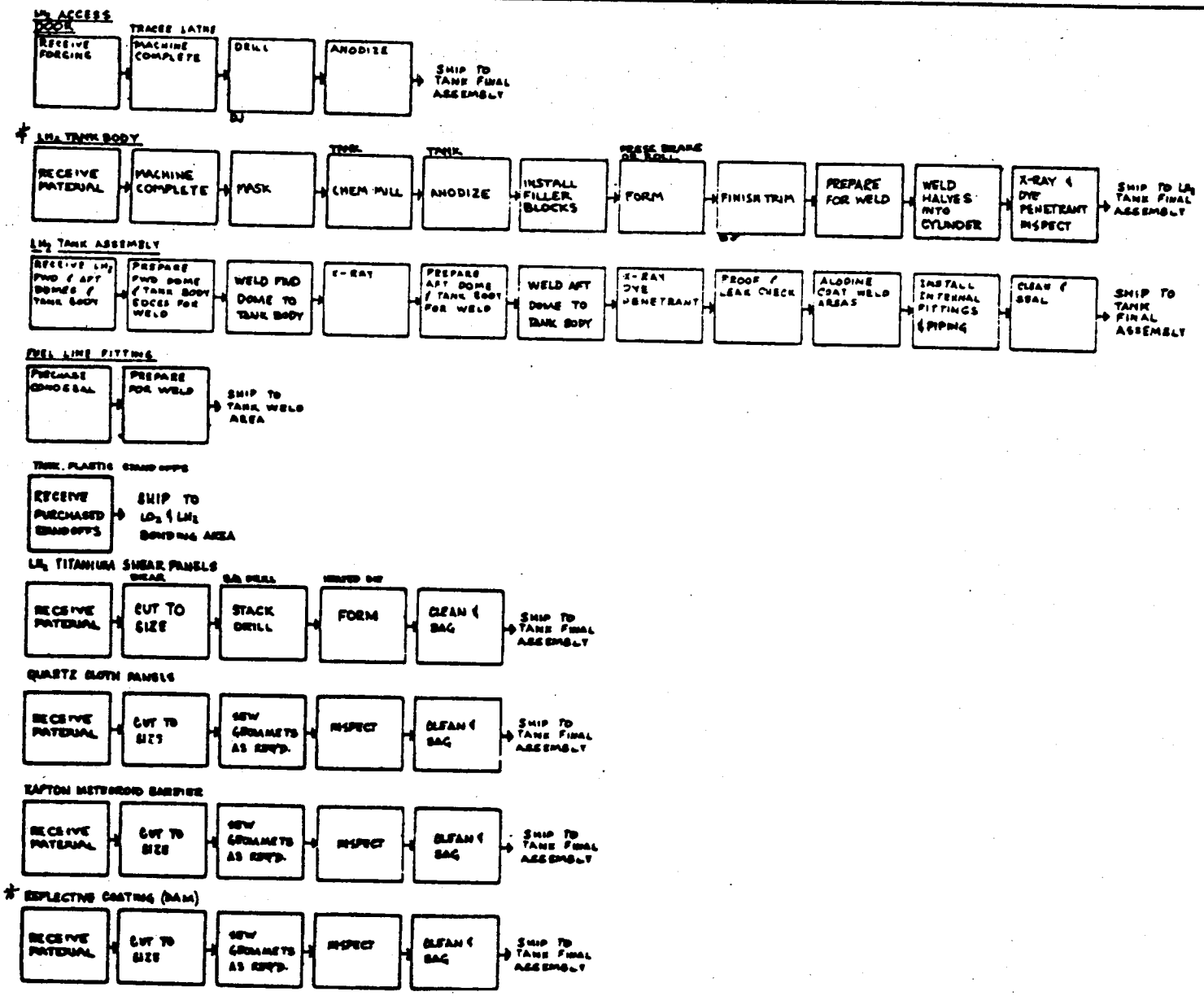


Figure 4-7 Space Tug Fabrication Flow Plan – Option 3 Initial (Page 2 of 5)

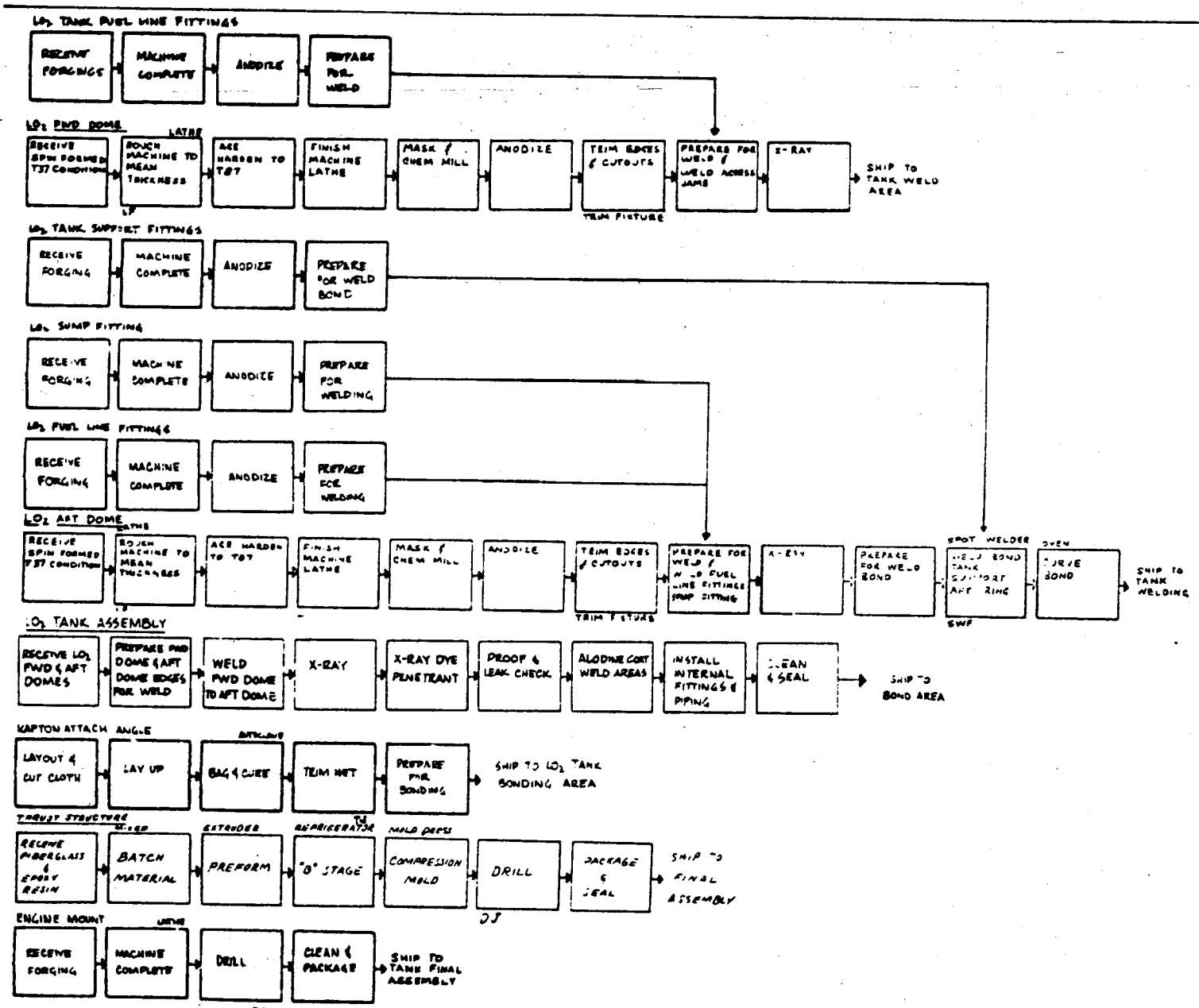


Figure 4-8 Space Tug Fabrication Flow Plan —Option 3 Initial (Page 3 of 5)

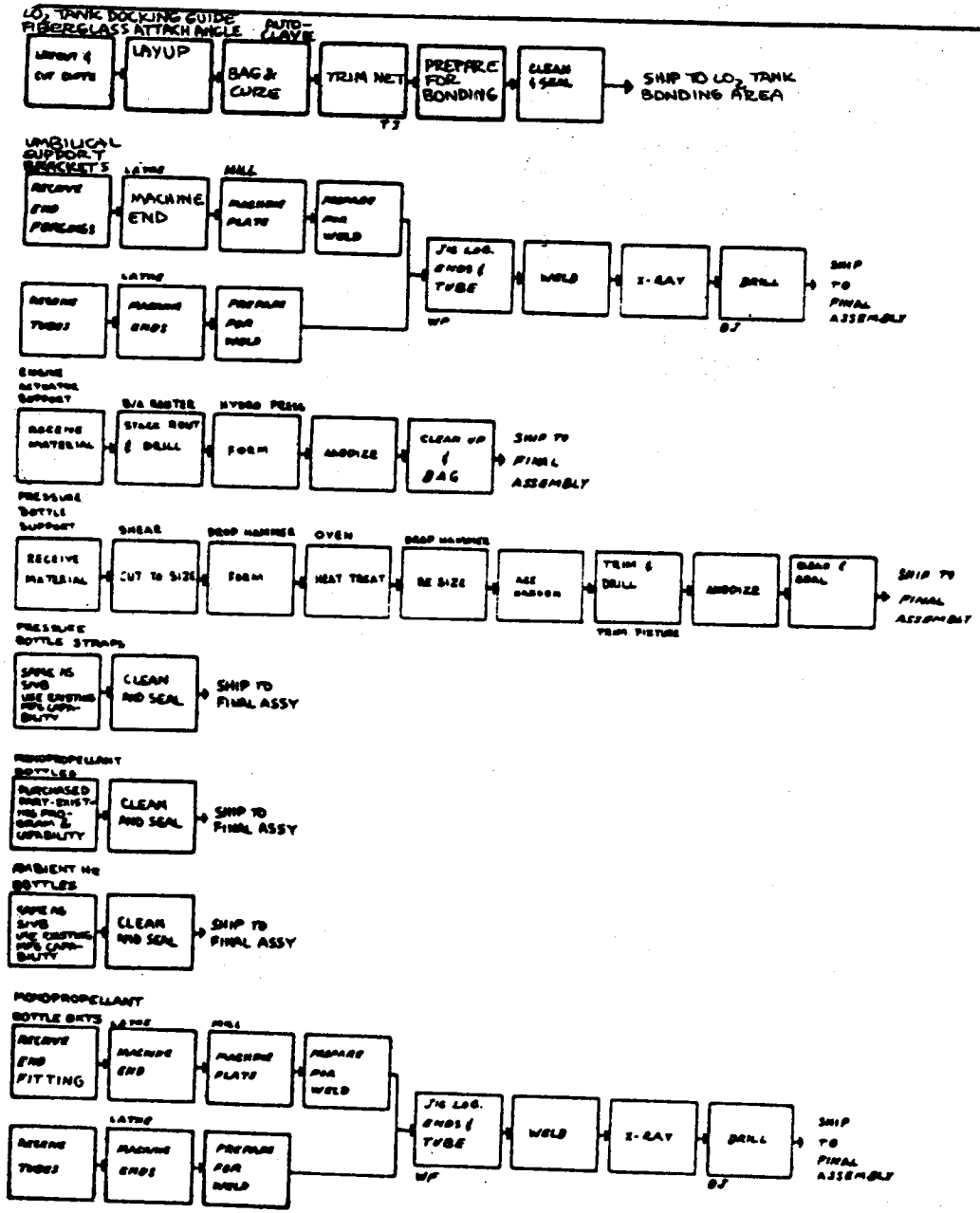


Figure 4-9 Space Tug Fabrication Flow Plan — Option 3 Initial (Page 4 of 5)

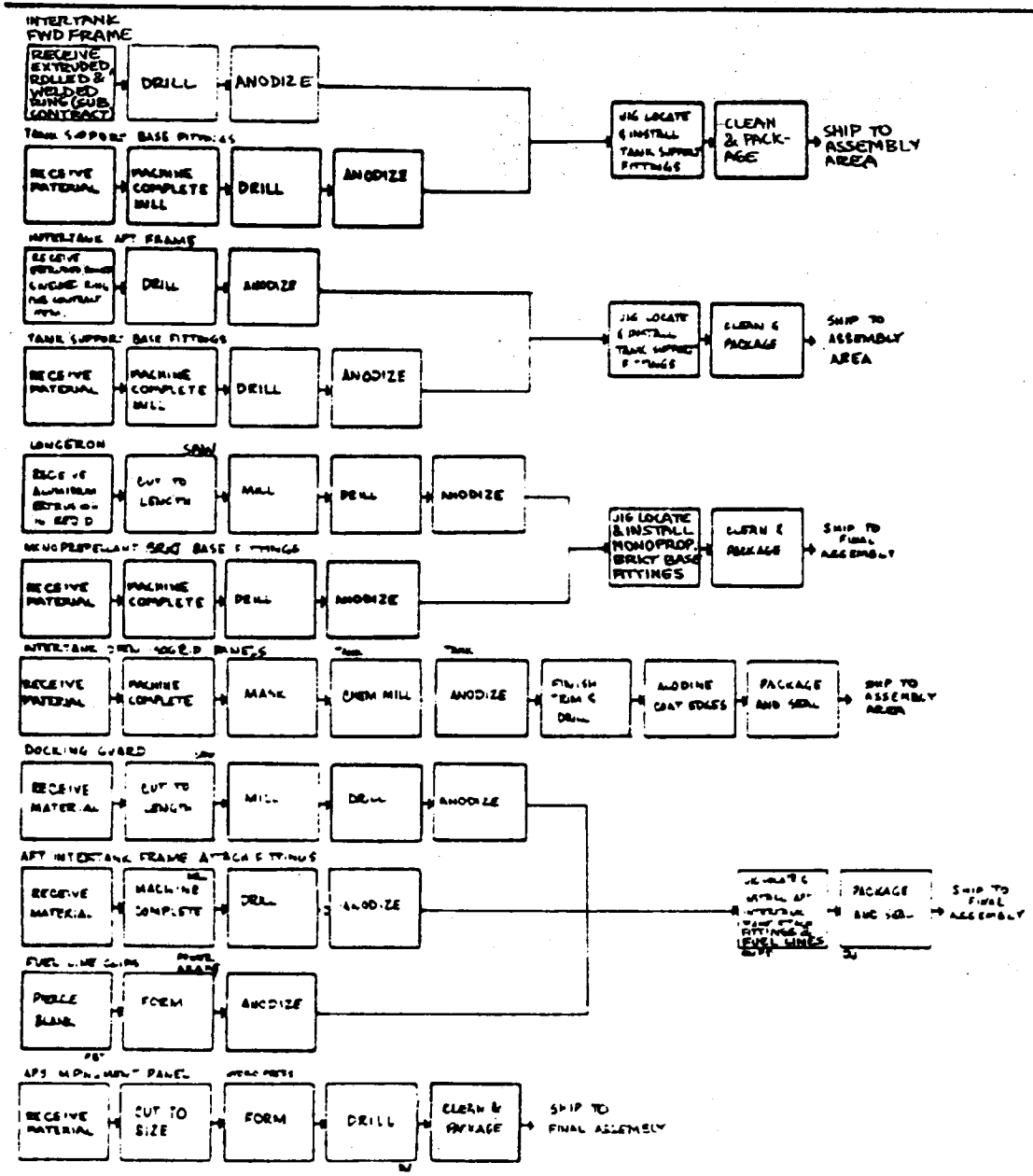


Figure 4-10 Space Tug Fabrication Flow Plan — Option 3 Initial (Page 5 of 5)

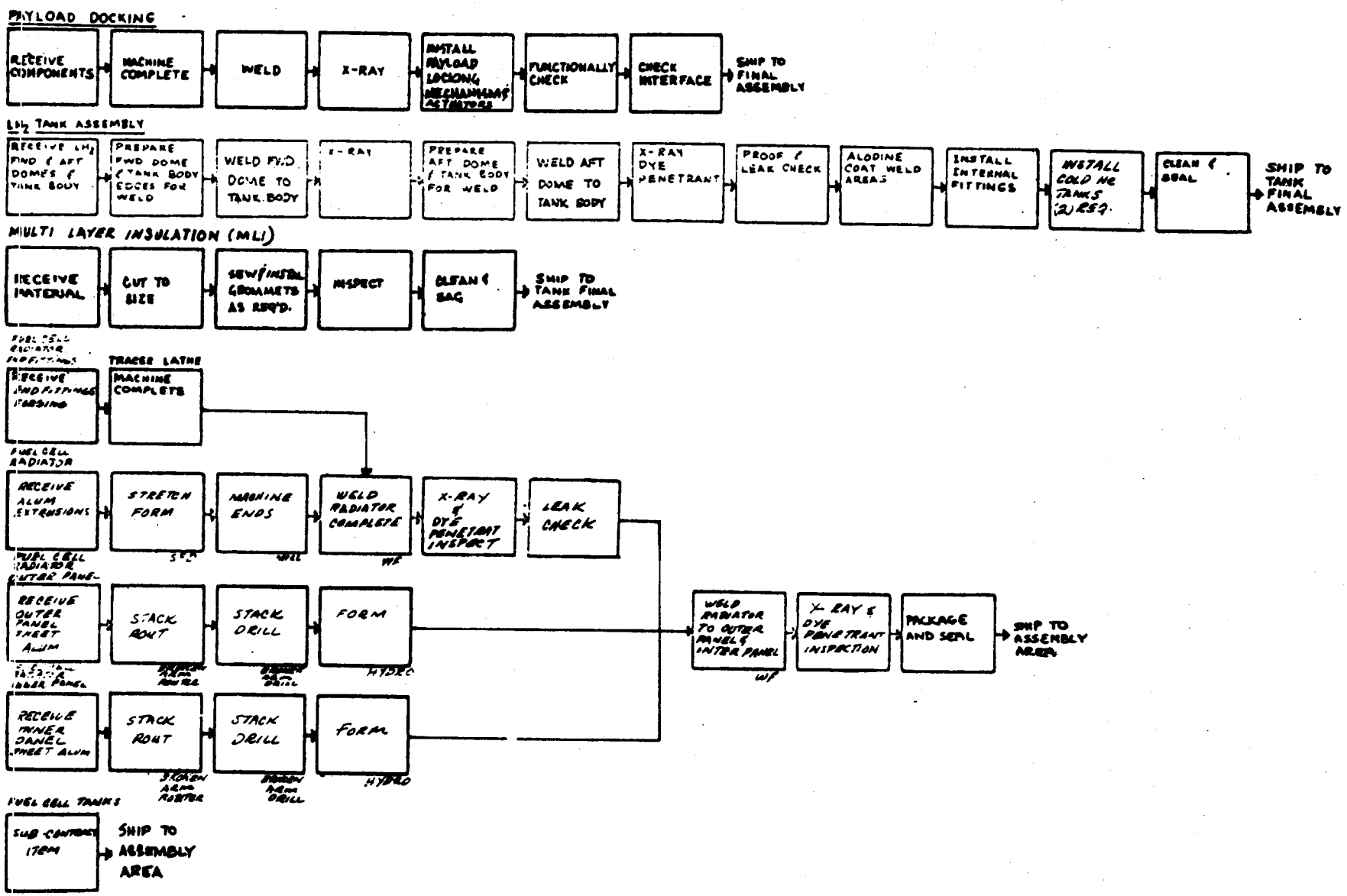


Figure 4-11 Space Tug Fabrication Flow Plan — Option 3 Final

4.1.3.2 Tank Bonding Plan

The tank bonding and insulation plan for the bonding of the insulation and the Kapton purge bag stand-offs is delineated in the space tug fabrication flow plan, see Figures 12 and 13. SIVB technology and new bonding processes currently being developed in-house will be implemented into the tank bonding and insulation plan. The plastic stand-offs will be bonded to the tank wall and domes, the double aluminized mylar (DAM) will be fitted to the tank and will be pierced by the plastic stand-offs and bonded to the tank.

4.1.3.3 Final Assembly and Final Joining Plan

The final assembly and final joining line sequence flow are outlined in the Final-Assembly/Joining flow plan, see Figures 14 and 15. The LO_2 and the LH_2 tanks are built-up as modular assemblies in the horizontal mode. The LO_2 and the LH_2 subassembly jigs are then mated per leader pins and index points and the final joining, installations, and checkout are accomplished. After joining, checkout, integration etc., the space tug is emplaced into a handling fixture for installation of final closeouts. The interface requirements are verified per a master fixture, the center of gravity of the vehicle is established and the completed vehicle is bagged and prepared for shipping.

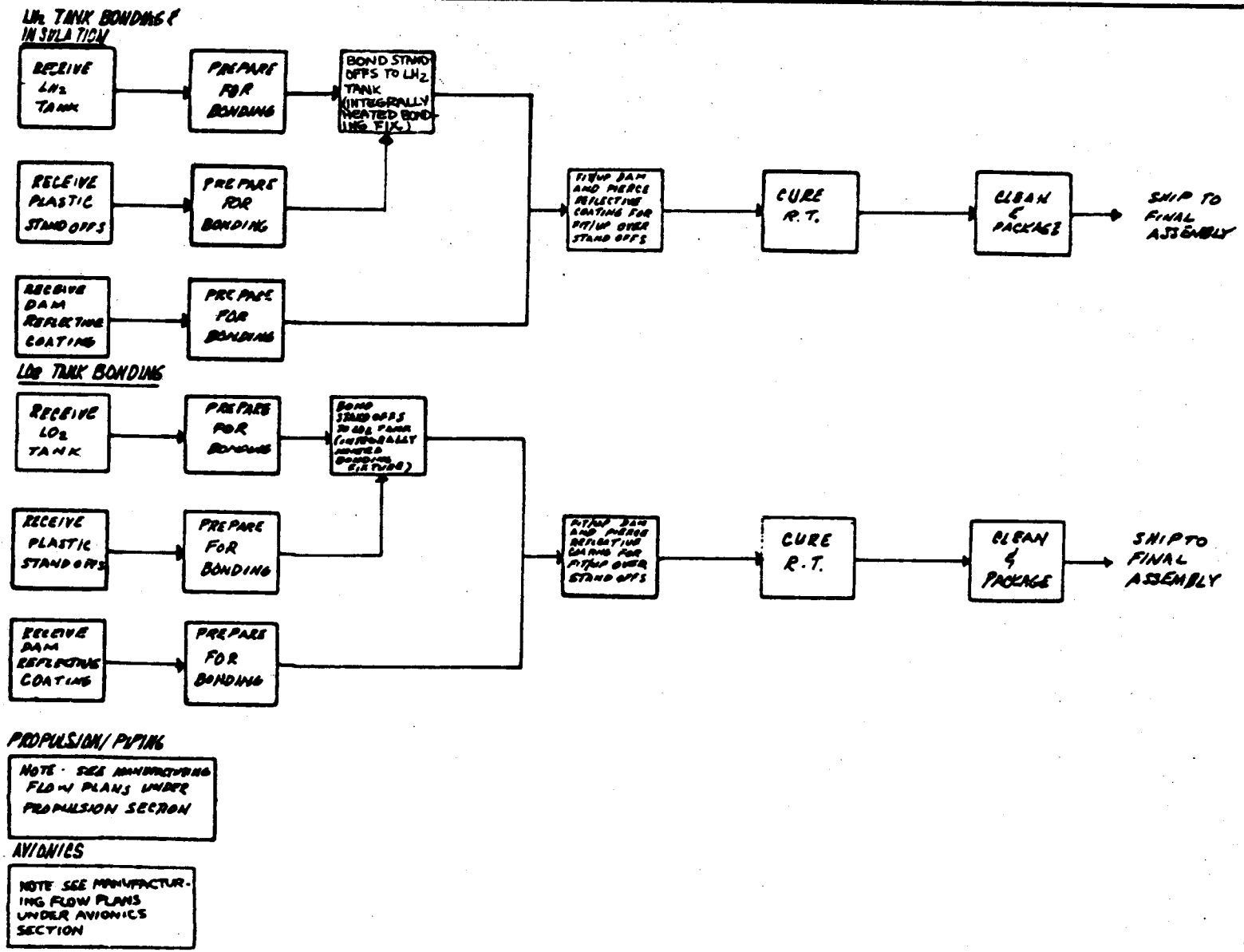


Figure 4-12 Space Tug Bonding and Insulation Flow Plan — Option 3 Initial

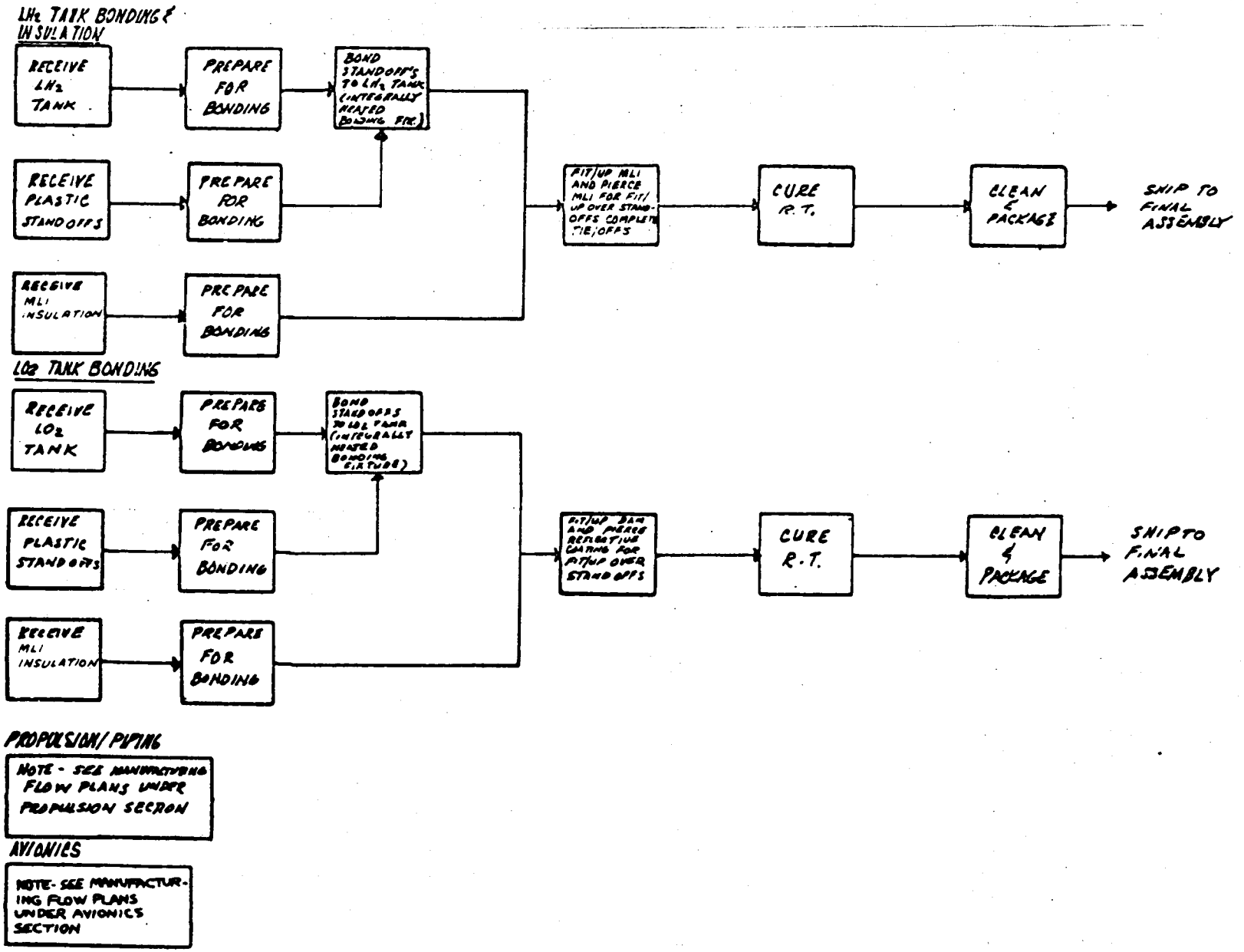


Figure 4-13 Space Tug Bonding and Insulation Flow Plan – Option 3 Final

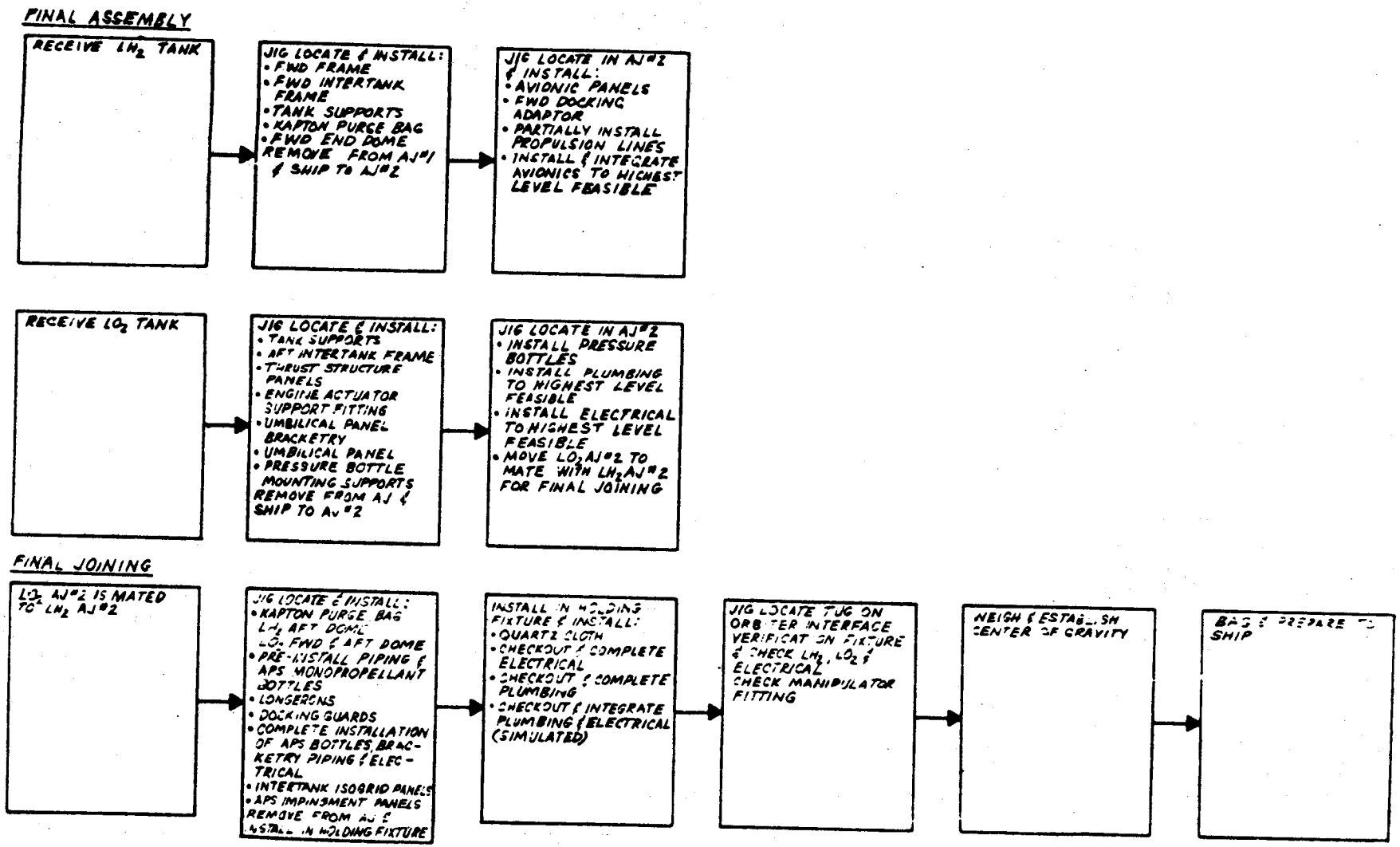


Figure 4-14 Space Tug Final – Assembly/Joining Flow Plan – Option 3 Initial

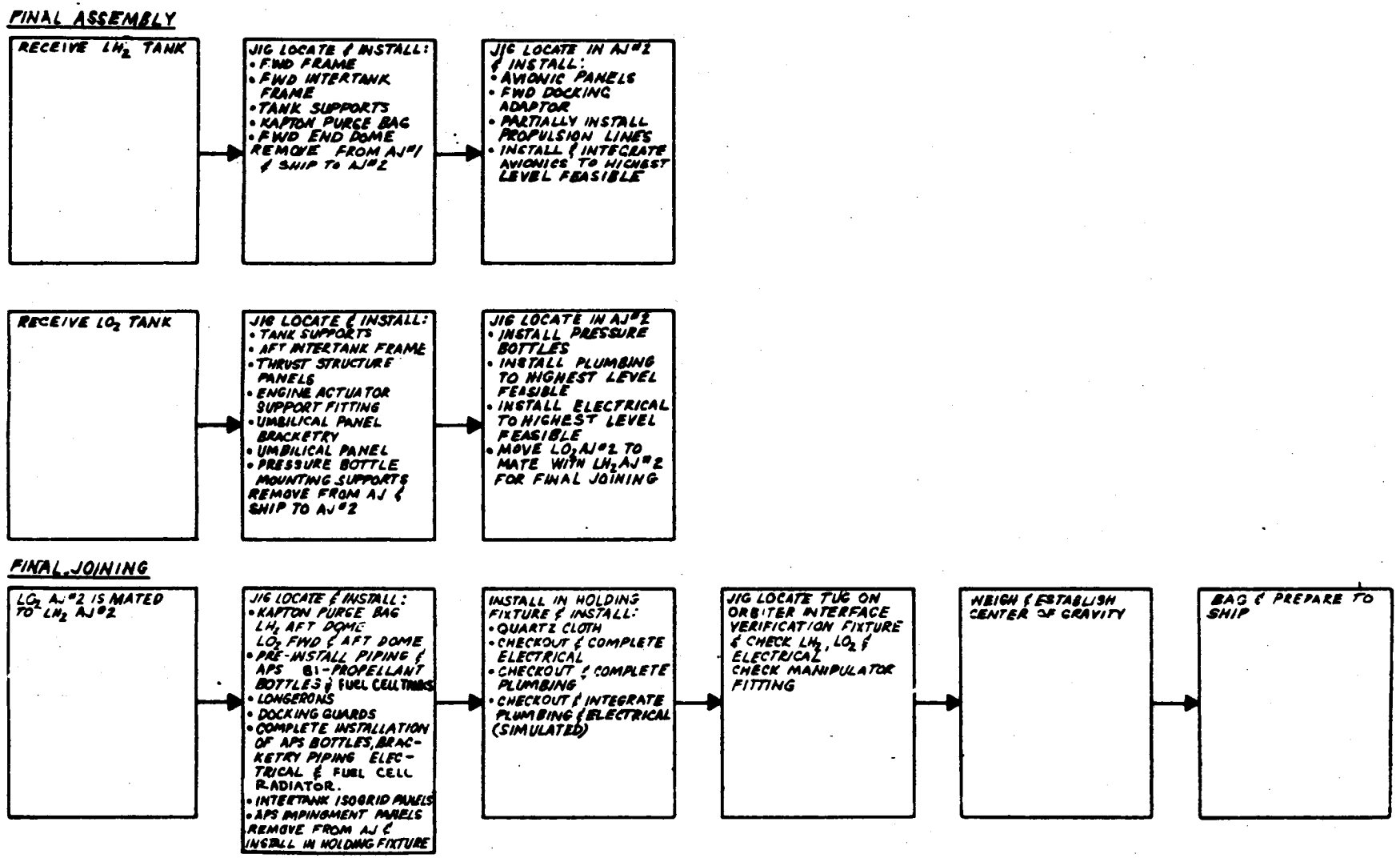


Figure 4-15 Space Tug Final – Assembly/Joining Flow Plan – Option 3 Final

4.1.3.4 Propulsion System

The major components which comprise the LO_2 and LH_2 propulsion ducts systems are as follows:

1. LO_2 Feed Duct and Sump Assembly
2. LO_2 Fill and Drain Duct
3. LO_2 Emergency Dump Duct
4. GO_2 Vent Duct
5. LH_2 Engine Feed Duct
6. LH_2 Fill and Drain Duct
7. GH_2 Vent Ducts

The external portions of all the ducts are 304L corrosive resistant steel (CRES) tubing with approximately 0.030 inch wall thickness. That portion of the duct which passes into the tanks will be 2219 aluminum. Master tooling parts (MTP's) will be developed for each duct to furnish the required manufacturing data for fabrication and weld assembly.

Each duct will be manufactured and tested as an integral unit. Upon installation, each duct system will be subjected to simple leak tests prior to system checkout. Manufacturing requirements are currently state-of-the-art.

The pneumatic system for the Space Tug is presented in Section 4.1.3.4.8.

4.1.3.4.1 LO_2 Feed Duct and Sump Assembly .

The LO_2 feed duct is approximately 4 feet long, formed to connect the LO_2 tank with the engine. The duct assembly is made from four different segments of 2 inch diameter tubing with 3 flex gimbals and 2 flanges. The material is 304L corrosive resistant steel. (see Figures 4-16 thru 4-18)

The sump assembly is approximately 15 inches in diameter at the tank attach flange and has a 2-inch nominal diameter flange on the duct end and is about 15 inches overall. The sump will be made from a "closed die" forging, which will only need minimal cleanup and attach hole drilling prior to assembly with the flange. The material is 2219 aluminum.

The welding operations will be present state-of-the-art. TIG welding processes will be used for the duct, with automatic TIG tube welding equipment, when applicable, typical for both steel and aluminum.

Handling fixtures will be furnished for protective moving, insulation application and storage. The size of the assemblies will allow hand pickup and no slings are anticipated. The flex gimbals will be purchased.

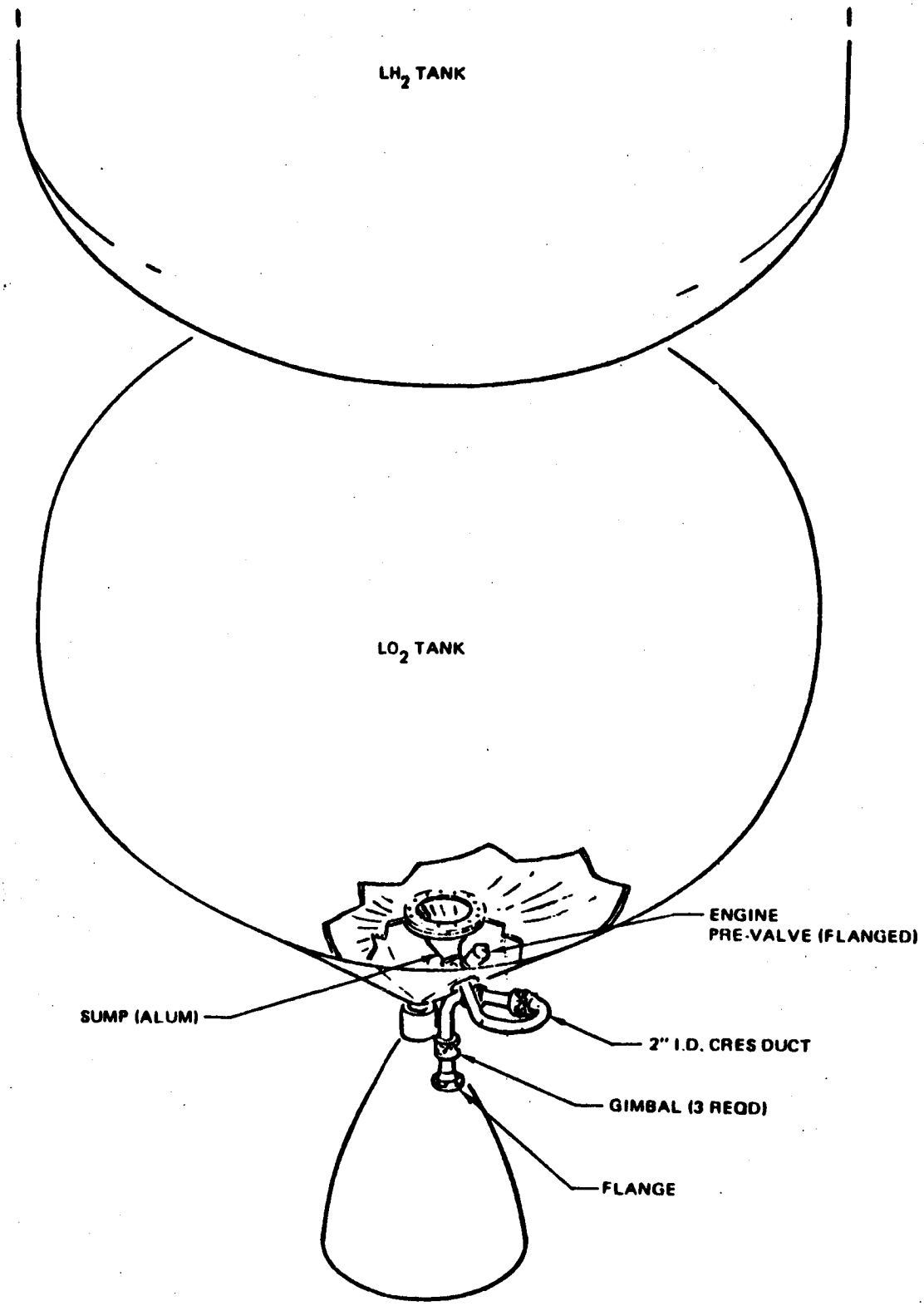


Figure 4-16 LO_2 Engine Feed Duct

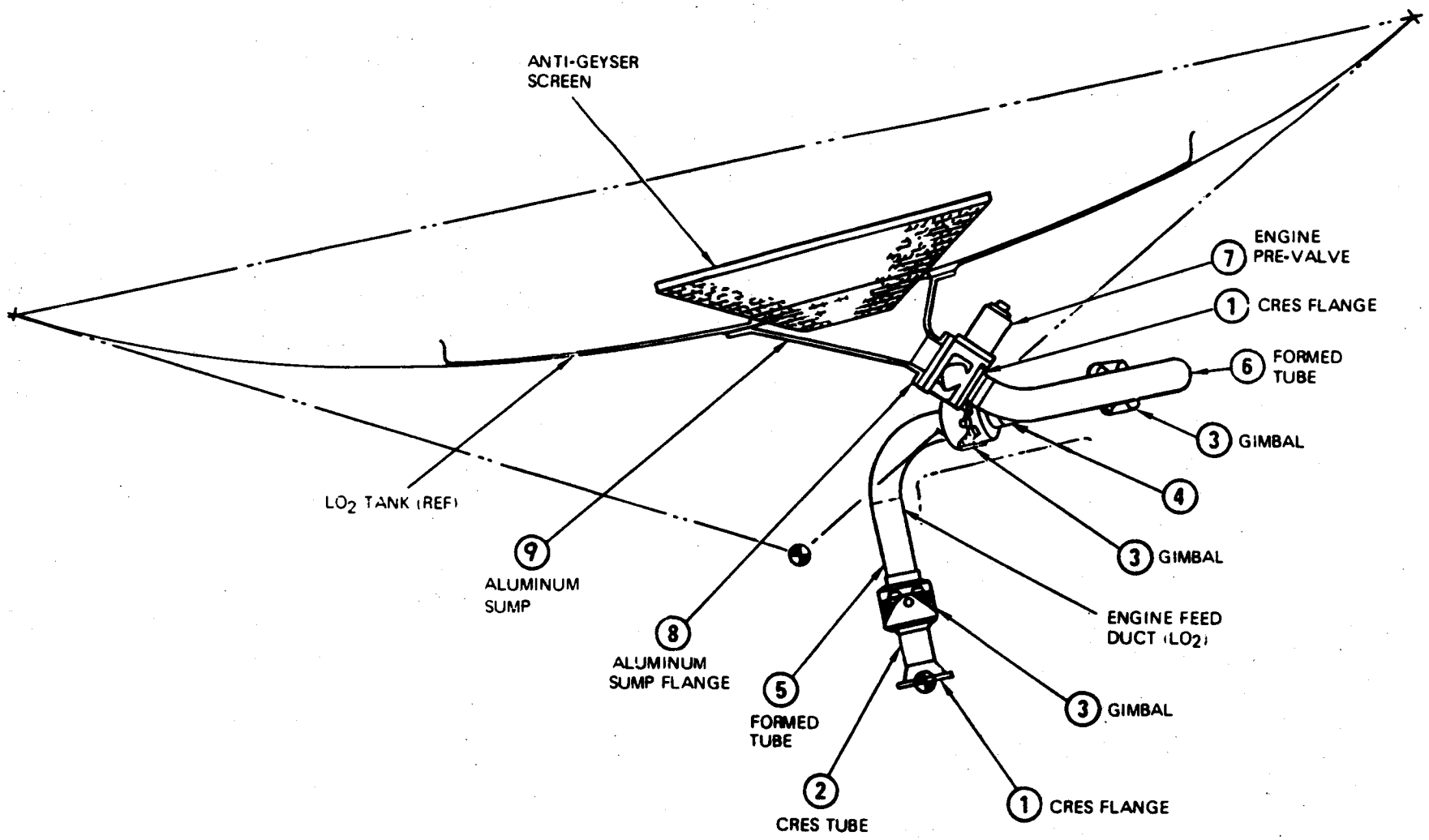


Figure 4-17 LO_2 Feed Duct and Sump Assembly

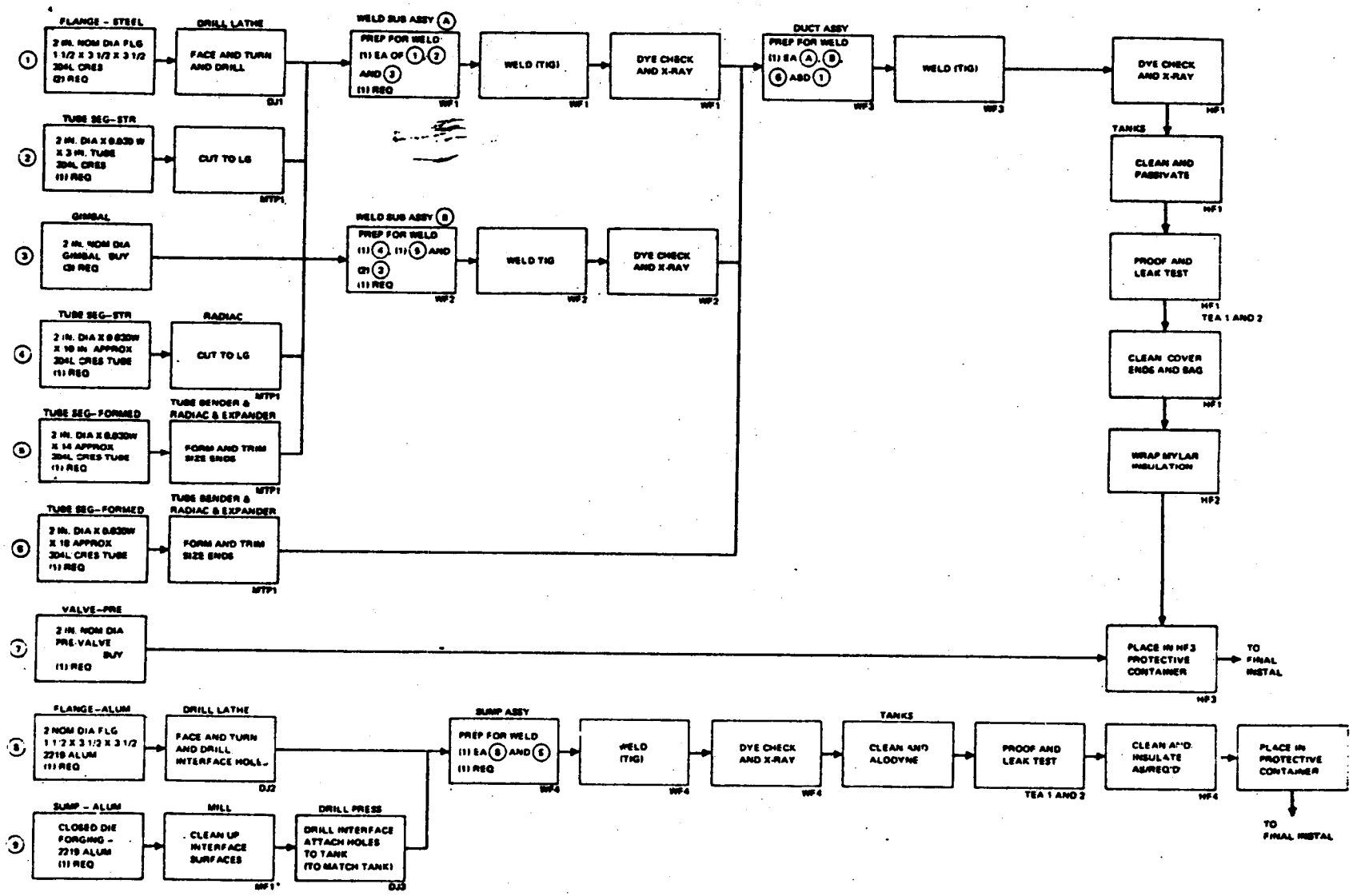


Figure 4-18 Space Tug LO_2 Feed Duct & Sump Assembly Manufacturing Sequence

4.1.3.4.2 LO_2 Fill and Drain Duct

The LO_2 fill and drain duct consists of a short corrosive resistant steel (304L) flex section, and an aluminum (2219) line that interfaces with the CRES flex section and is welded to LO_2 tank aft dome and extends into the LO_2 tank to approximately the aft centerline. (See Figures 4-19 thru 4-21)

The flex section is made from 2-inch diameter tubing with two flex bellows, two flanges and a fill/drain valve. The CRES flex section is about 16 inches long. The aluminum section is made from 2-inch diameter formed tubing with a single flange which interfaces with the flex section. The aluminum section will be welded to the aft LO_2 tank dome during tank assembly.

The welding operations will be present state-of-the-art. Automatic TIG tube welding equipment will be used, when applicable.

Handling fixtures will be furnished for protective storage. No slings (HFH) will be required, as hand pickup is adequate. The flex bellows and control valve will be purchased.

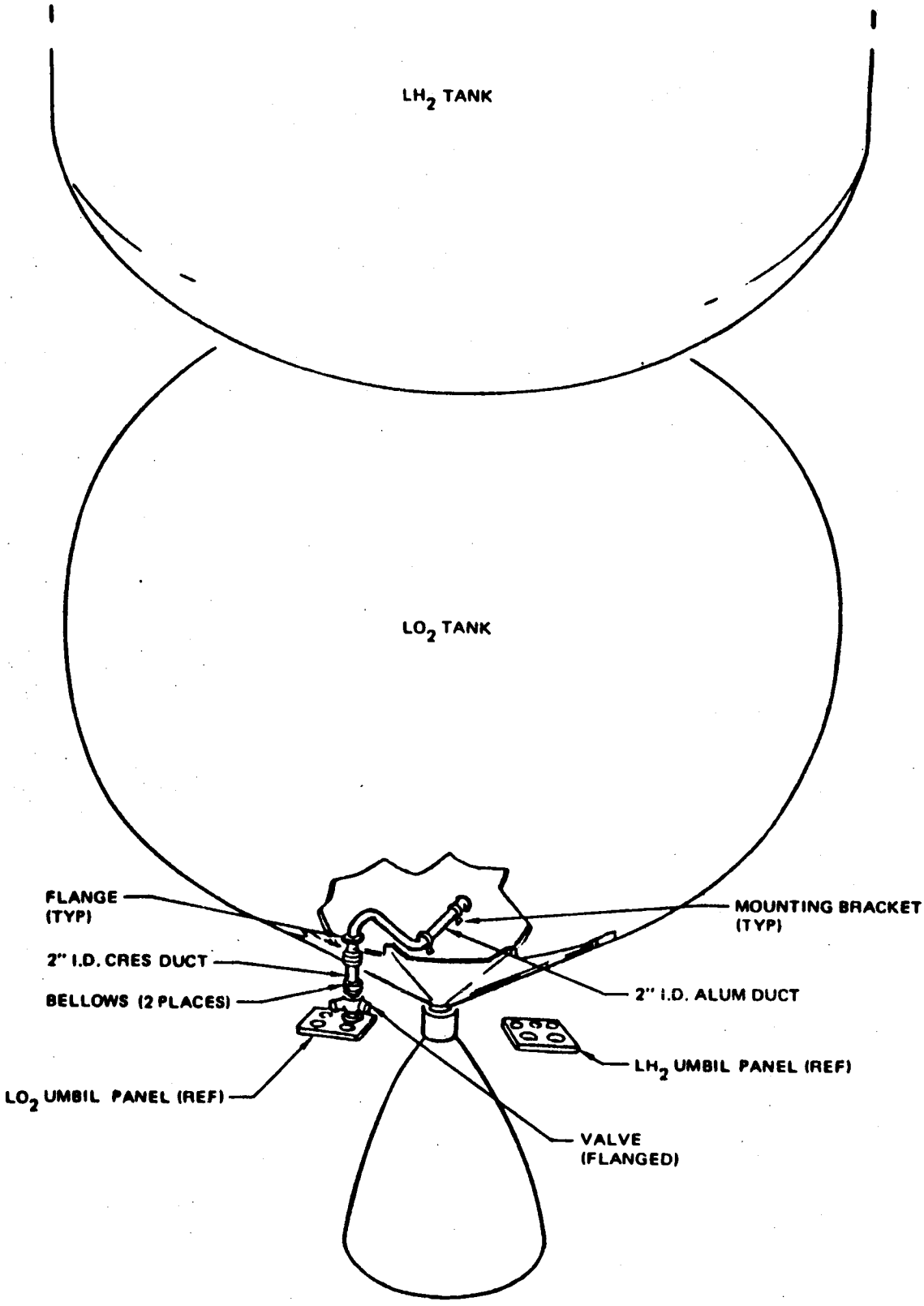


Figure 4-19 LO_2 Fill/Drain Duct

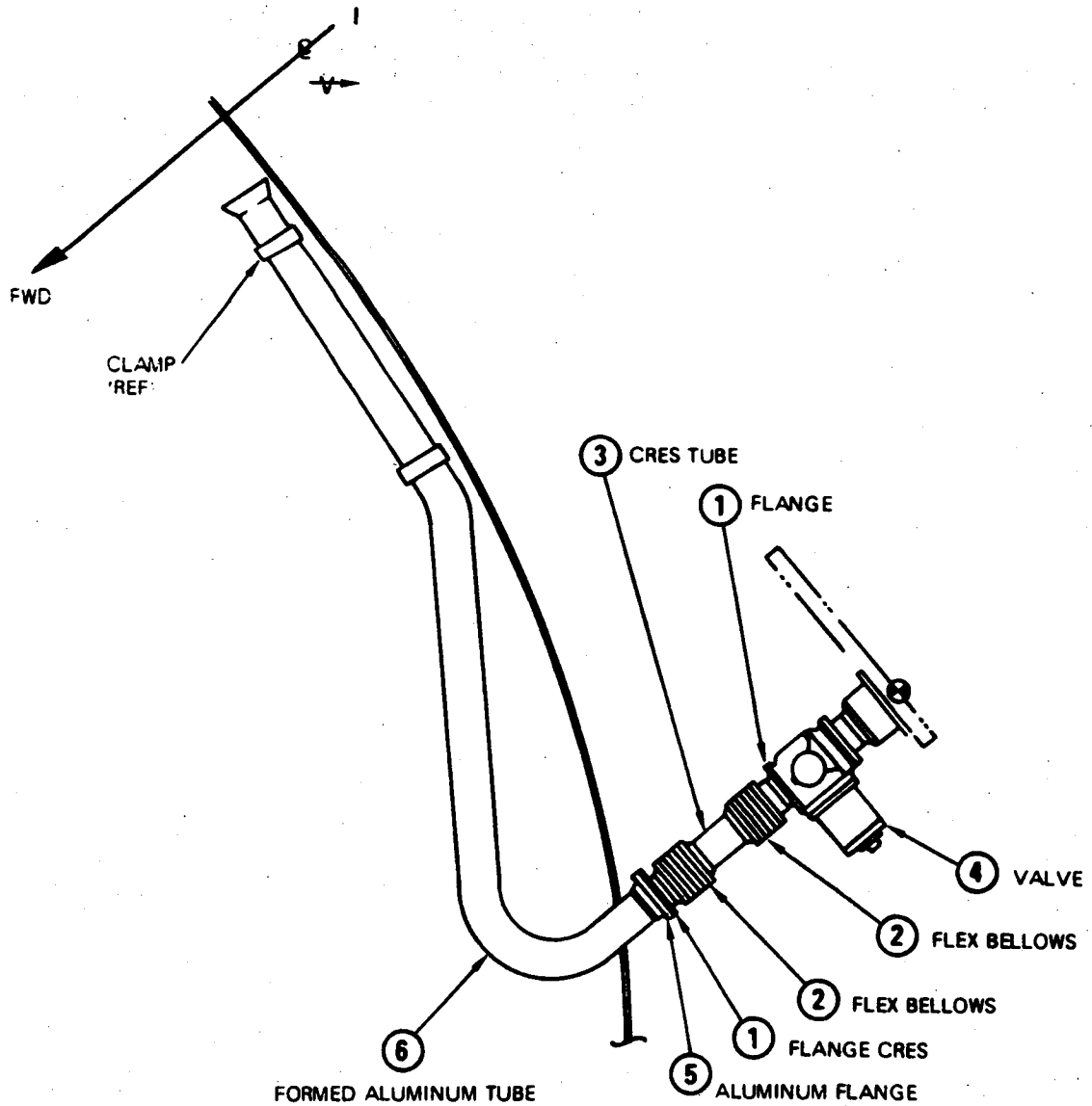


Figure 4-20 LO_2 Fill/Drain

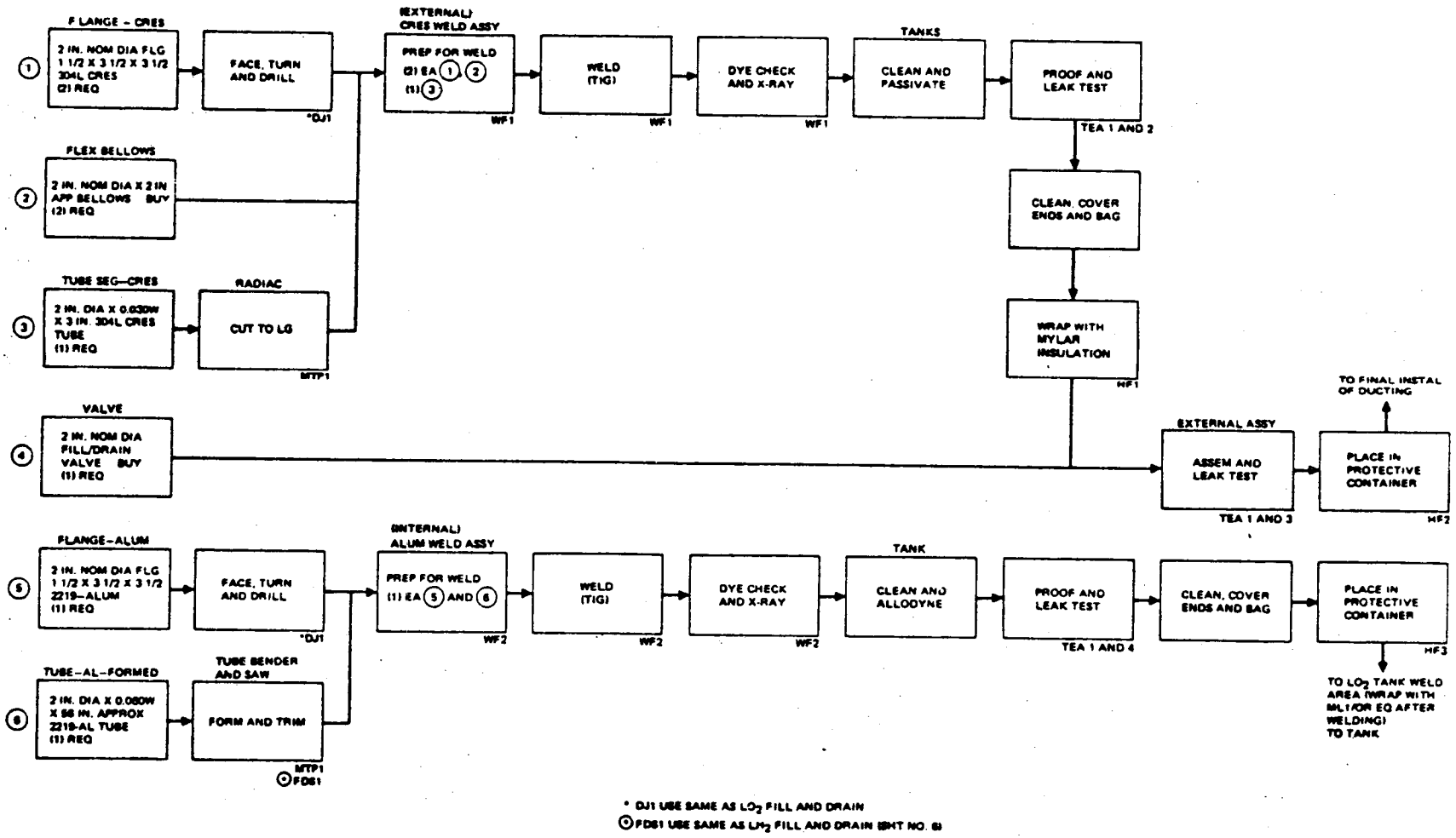


Figure 4-21. Space Tug LO_2 Fill & Drain Duct – Manufacturing Sequence

4.1.3.4.3 LO_2 Emergency Dump Duct

The LO_2 emergency dump duct is approximately 8-feet overall. The duct consists of a corrosive resistant steel flex section and a short aluminum section that will be welded to the LO_2 tank. The flex section is made from 3-inch diameter tubing with six flanges, two flex bellows and two control valves. (See Figures 4-22 thru 4-26).

The welding operations will be present state-of-the-art. Automatic TIG tube welding equipment will be used, where applicable.

Handling fixtures (HF) will be furnished for protective moving, wrapping insulation and storage. The flex sections will be picked up by hand and only one sling (HFH) will be furnished to hoist the complete flex section. The flex bellows and the dump valves will be purchased.

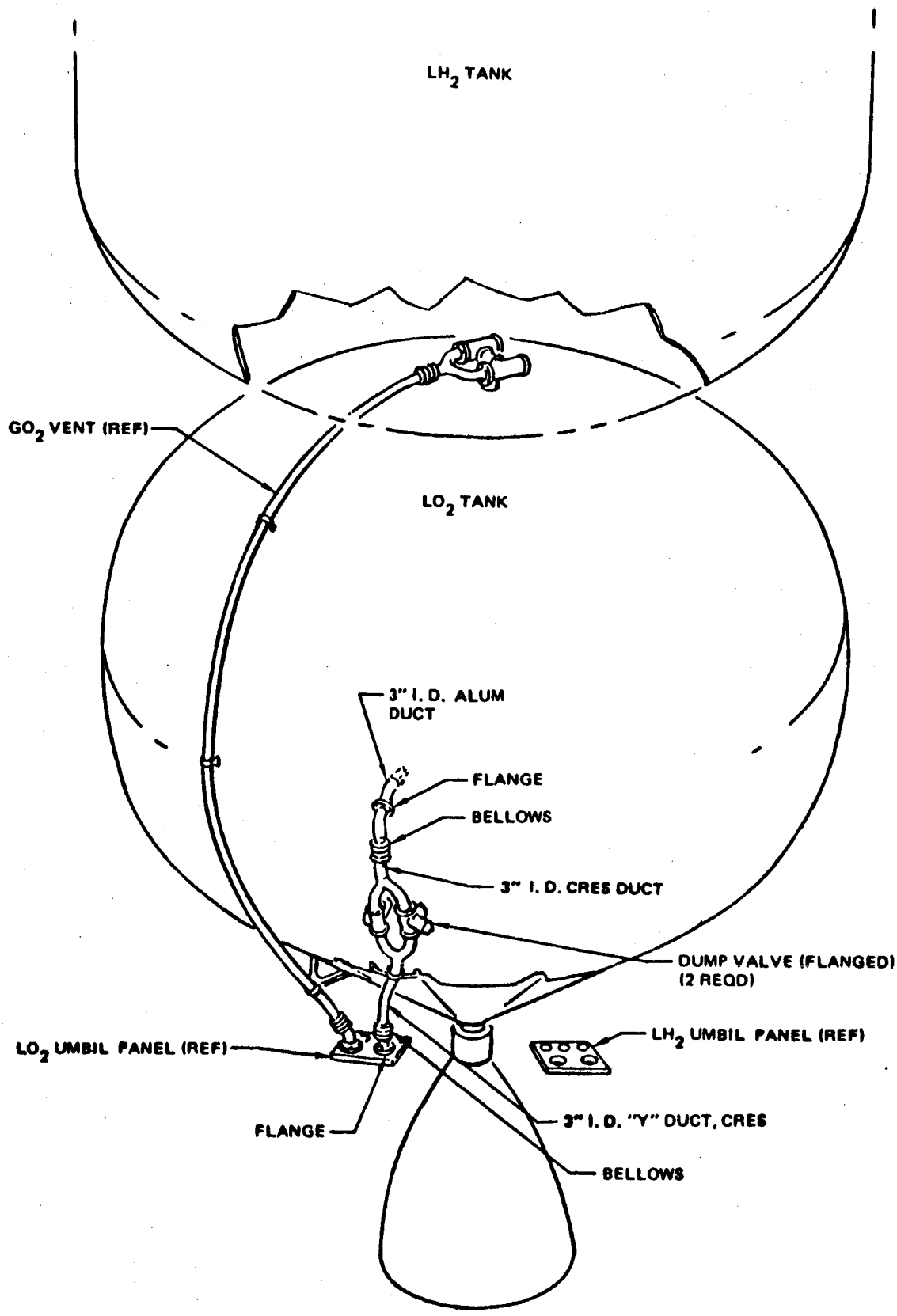


Figure 4-22 Emergency Dump Duct

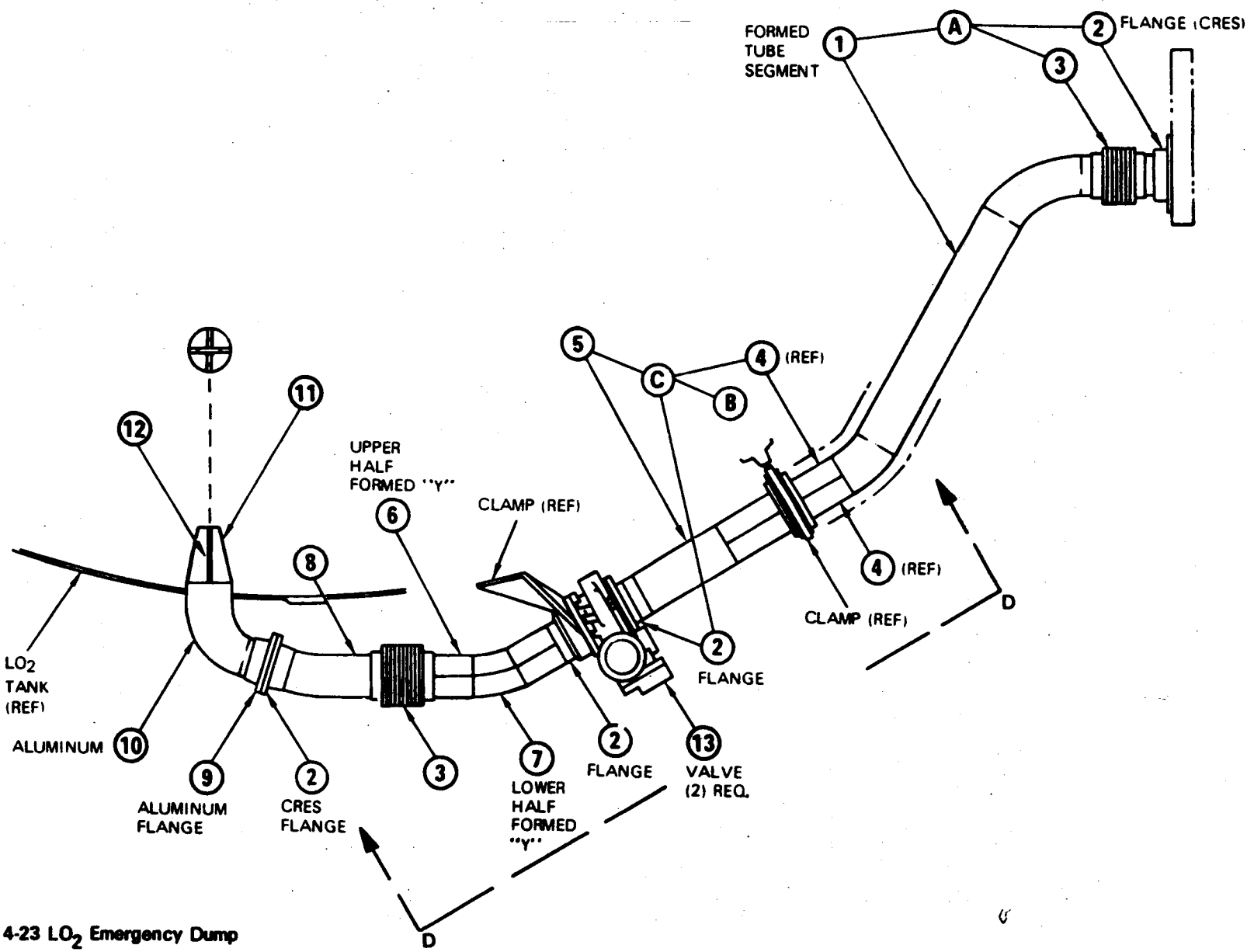


Figure 4-23 LO_2 Emergency Dump

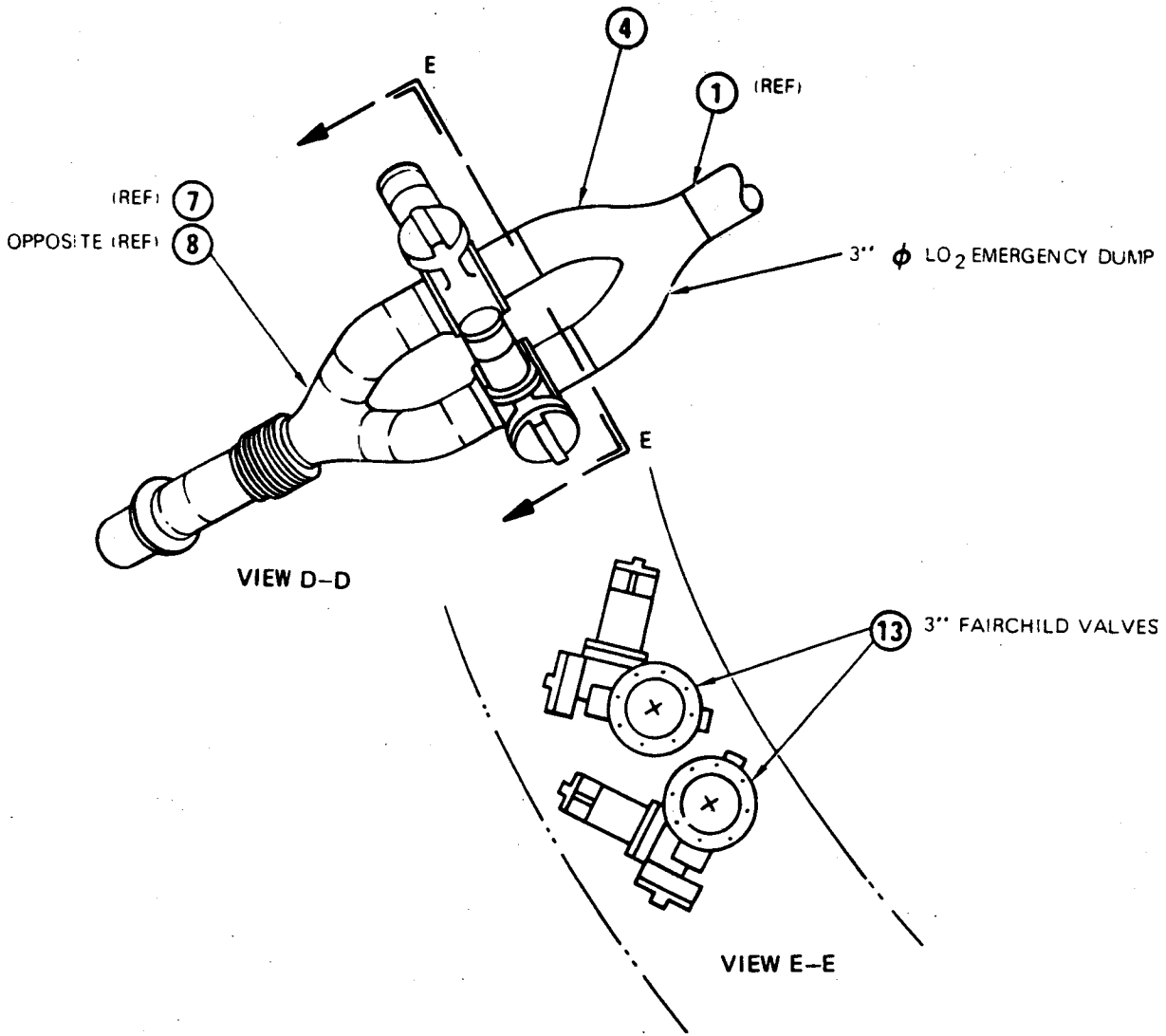


Figure 4-24 LO_2 Emergency Dump

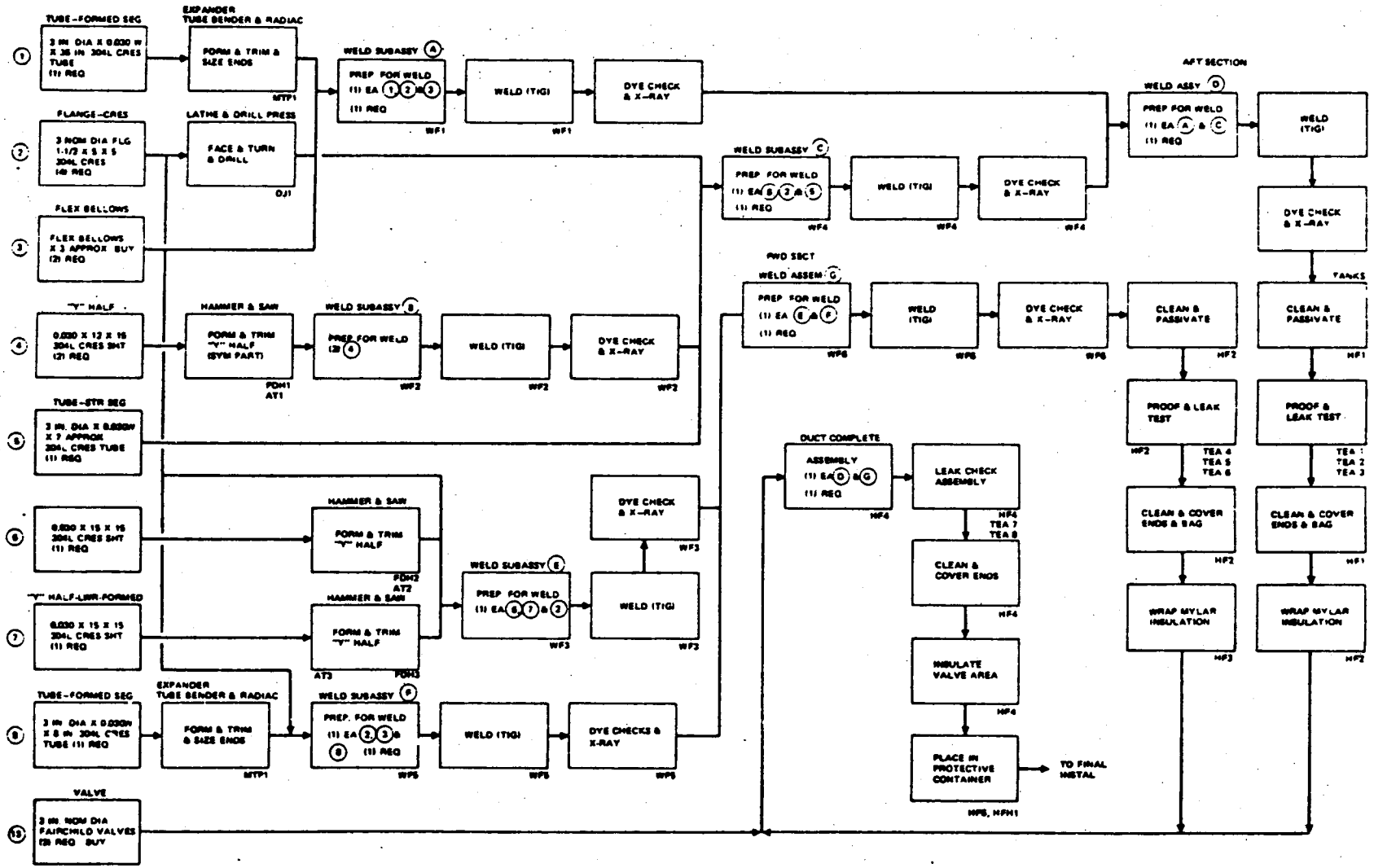


Figure 4-25. Space Tug LO_2 Emergency Dump Duct Manufacturing Sequence (Sheet 1 of 2)

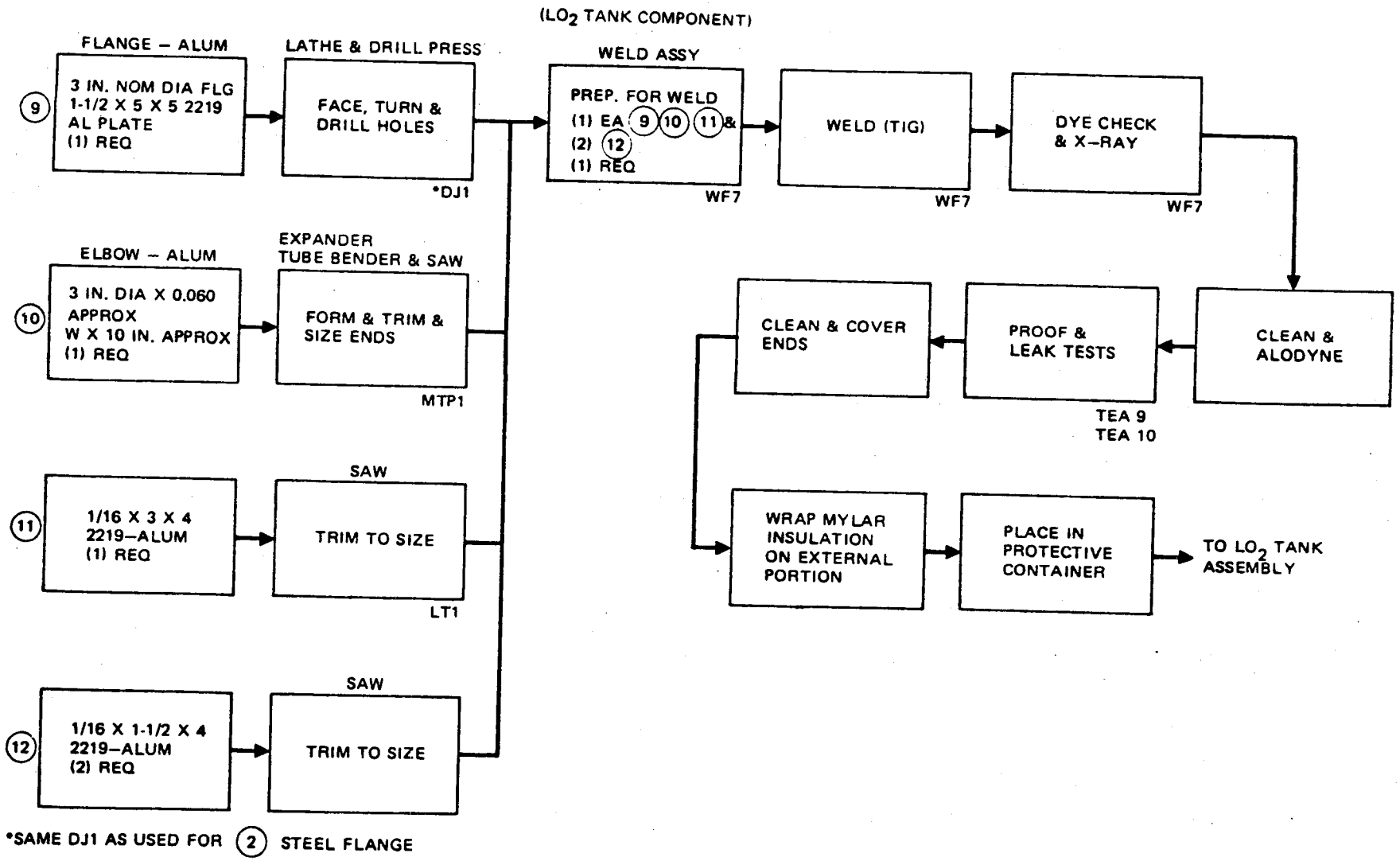


Figure 4-26. Space Tug LO_2 Emergency Dump Duct Manufacturing Sequence (Sheet 2 of 2)

4.1.3.4.4 GO_2 Vent Duct

The gaseous oxygen vent is approximately 15 feet long, formed to connect the LO_2 umbilical to the forward centerline of the LO_2 tank. The forward end of the duct is divided into a "Y" shape with two flanges to attach to the two vent valves. The duct assembly is made from 2 inch diameter tubing with two flex bellows, 3 flanges and two vent valves. The material is 304L corrosive resistant steel. (See Figures 4-27 thru 4-29)

The welding operations will be present state-of-the-art. Automatic TIG tube welding equipment will be used, except where not applicable.

Handling fixtures (HF) will be furnished for transportation, insulation wrapping and storage. The assembly will be picked up by a handling fixture sling (HFH), to simplify handling. The flex bellows and vent valves will be purchased.

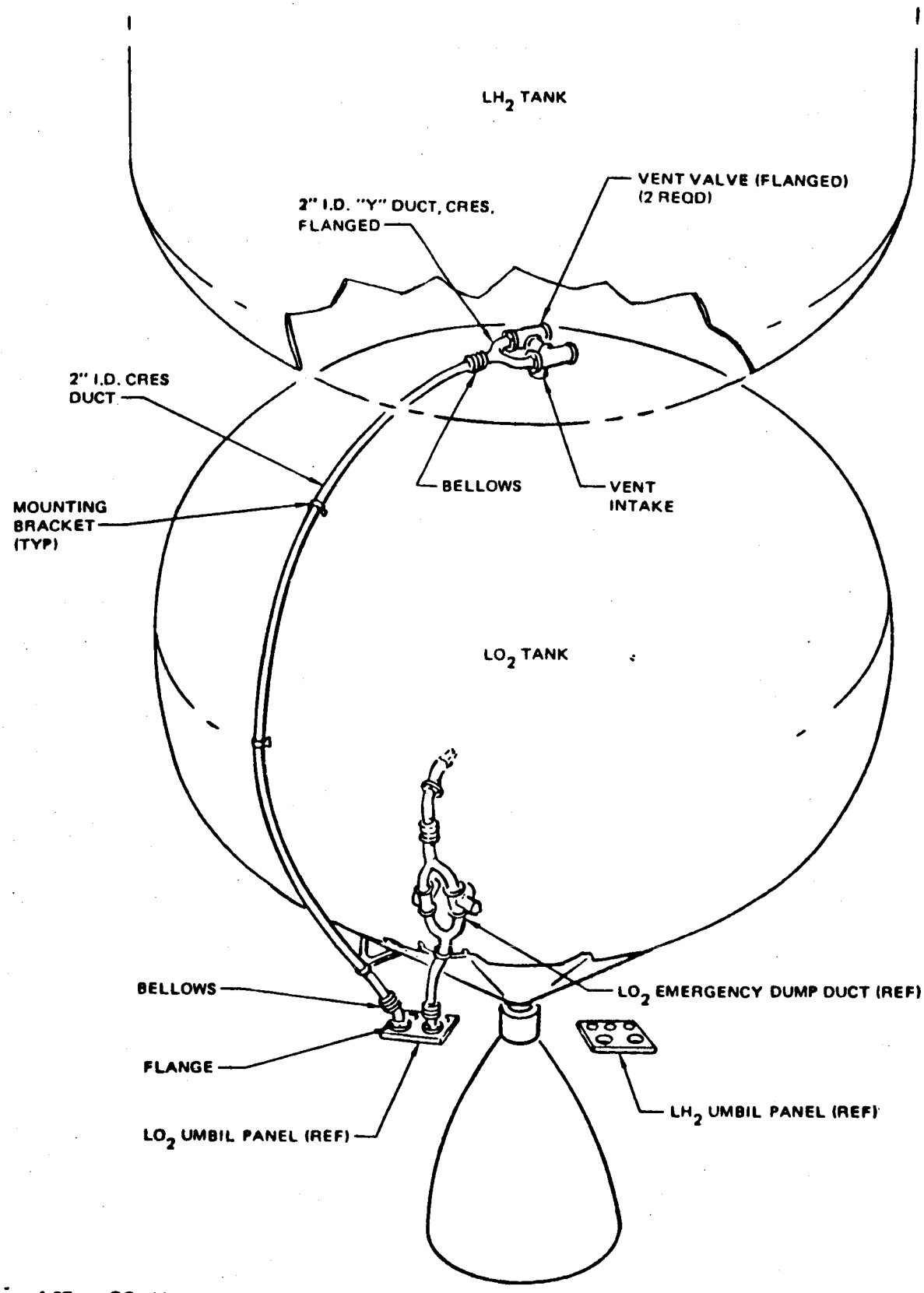


Figure 4-27 GO_2 Vent Duct

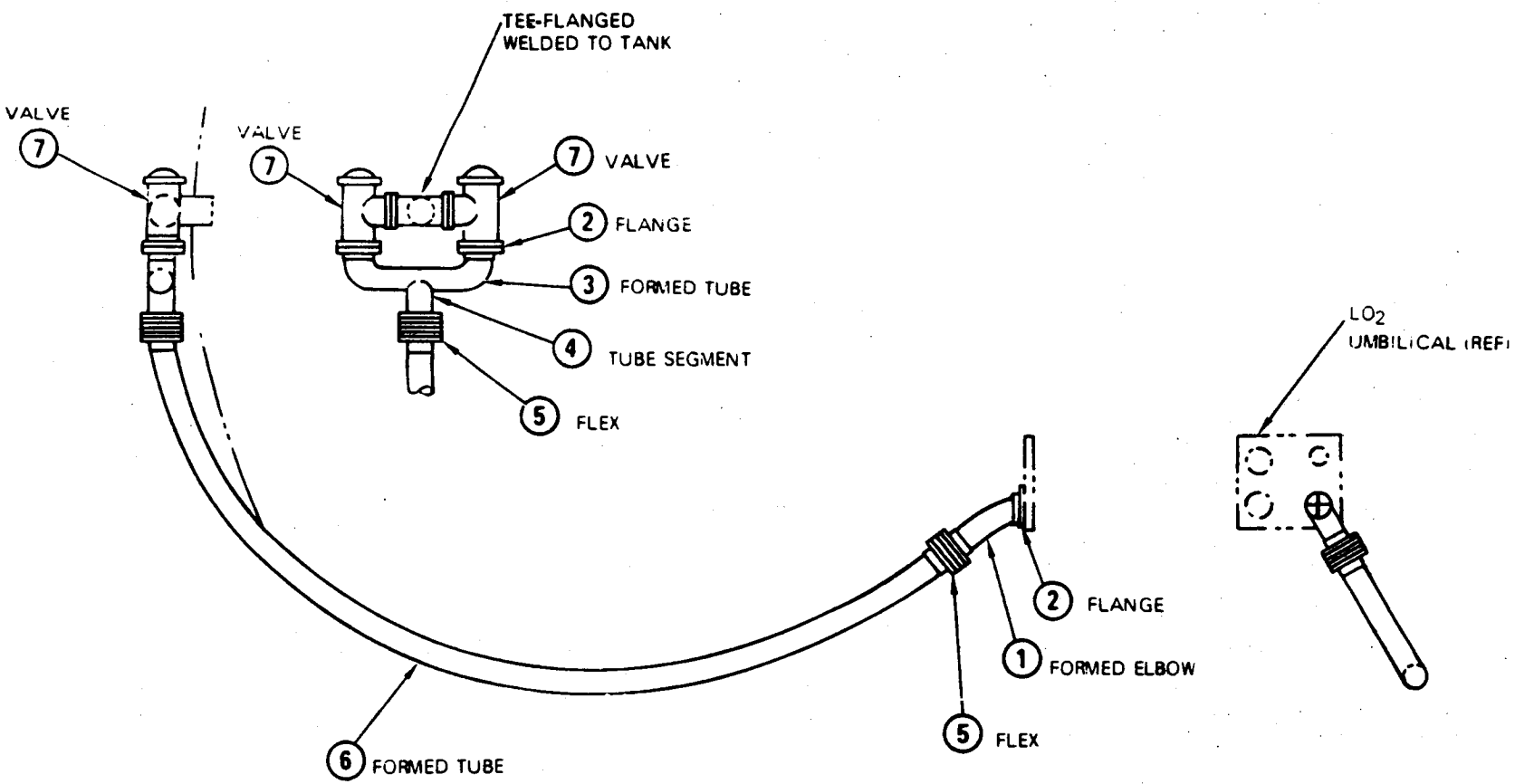


Figure 4-28 GO_2 Vent Duct

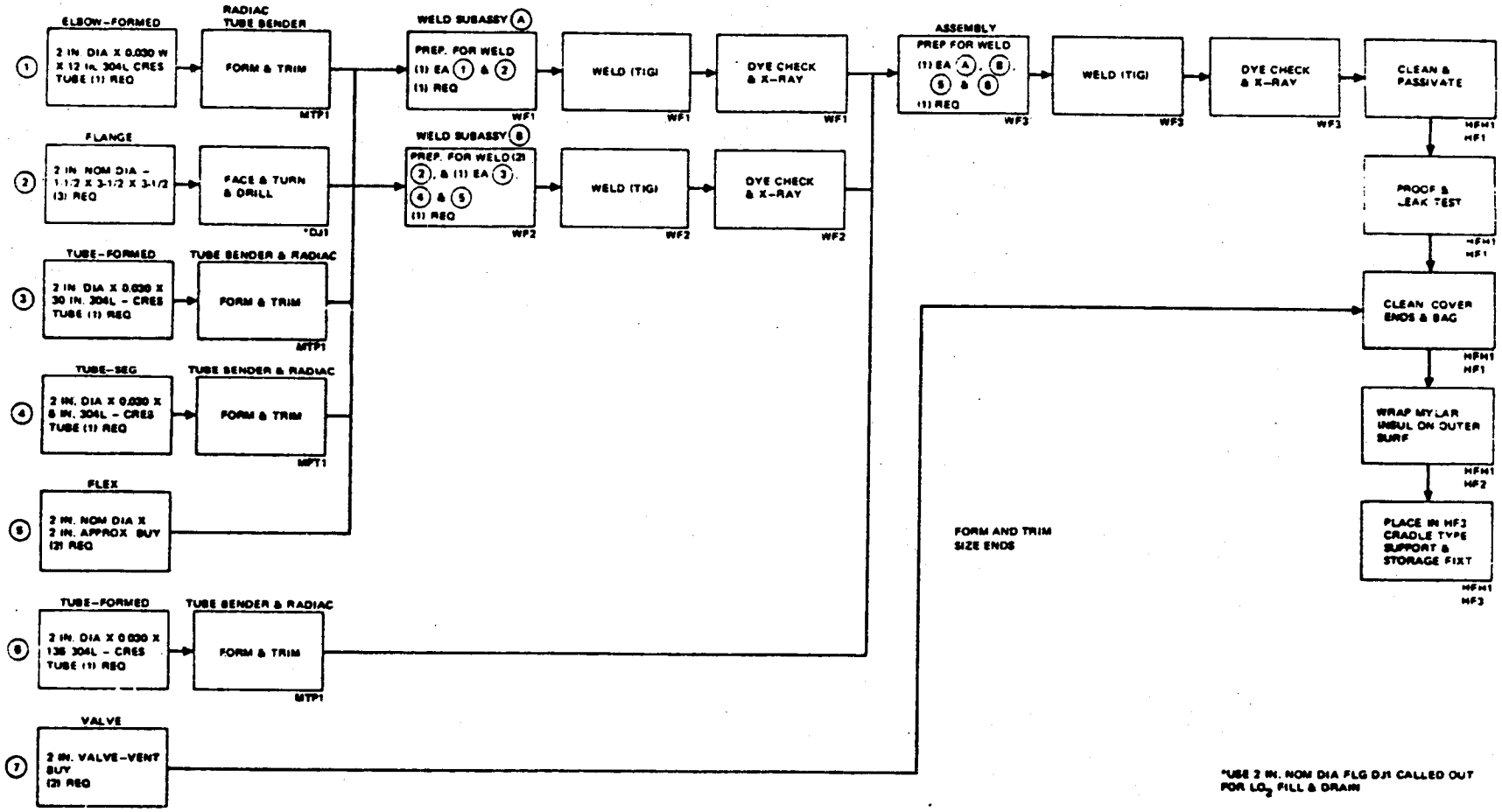


Figure 4-29. Space Tug GO_2 Vent Duct Manufacturing Sequence

4.1.3.4.5 LH_2 Engine Feed Duct

The LH_2 engine feed duct, with the exception of a small single-walled duct aft of the pre-valve, is vacuum jacketed. Vacuum jacketed ducting is within our manufacturing capability, however a cost tradeoff will be necessary to determine if we should make or buy the vacuum jacketed ducting. (See Figure 4-30 thru 4-32)

The LH_2 engine feed duct consists of three sections, refer to illustration: Section A includes the pre-valve and extends to the engine connection. This section is of single-wall construction, insulated with wrapped mylar or equivalent materials. Section B extends from the LH_2 tank sump to the approximate half breadth of the LO_2 tank. This section is double-walled, vacuum jacketed construction. Section C extends from approximately the LO_2 tank half breadth to the pre-valve. This duct section is also double-walled, vacuum jacketed construction. All three sections will use 304L corrosive resistant steel tubing. The flex bellows, pre-valve, burst disks and vacuum fittings will be purchased.

The vacuum jacketed duct sections will require more complex weld fixtures than the single walled ducts, and a precise sequence of assembly must be followed.

Each duct section will be proof and leak tested individually and after they are assembled, a simple leak test is required to assure the interface sealing reliability.

The welding operations will be present state-of-the-art. Automatic TIG tube welding equipment will be used, except where not applicable.

Handling fixtures (HF) will be furnished for transportation and storage. The large assemblies will be picked up by handling fixture--hoist (HFH) to prevent damage to the assemblies.

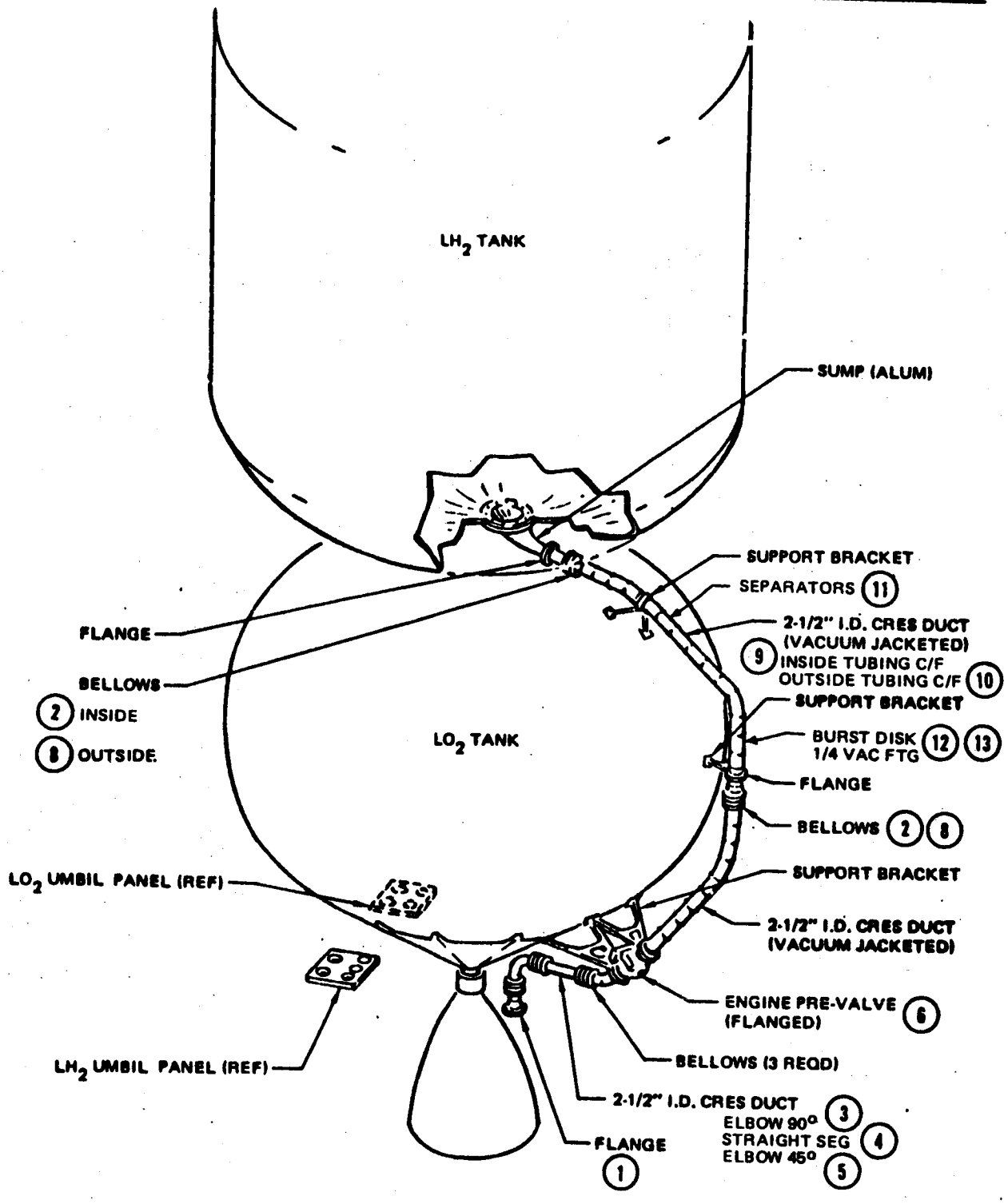


Figure 4-30 LH_2 Engine Feed Duct

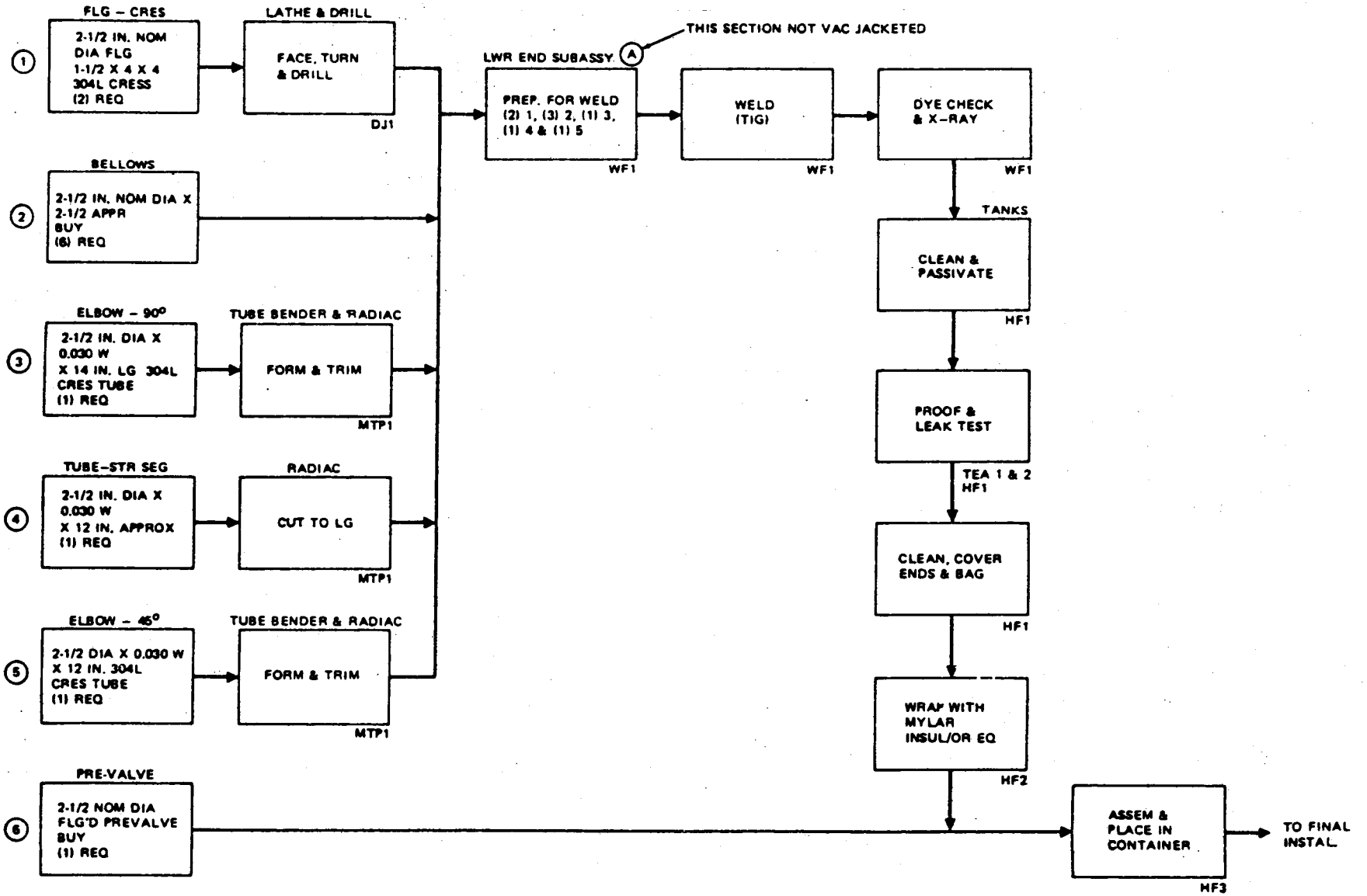


Figure 4-31 . Space Tug LH_2 Feed Duct – Lwr Section Manufacturing Sequence (Sheet 1 of 2)

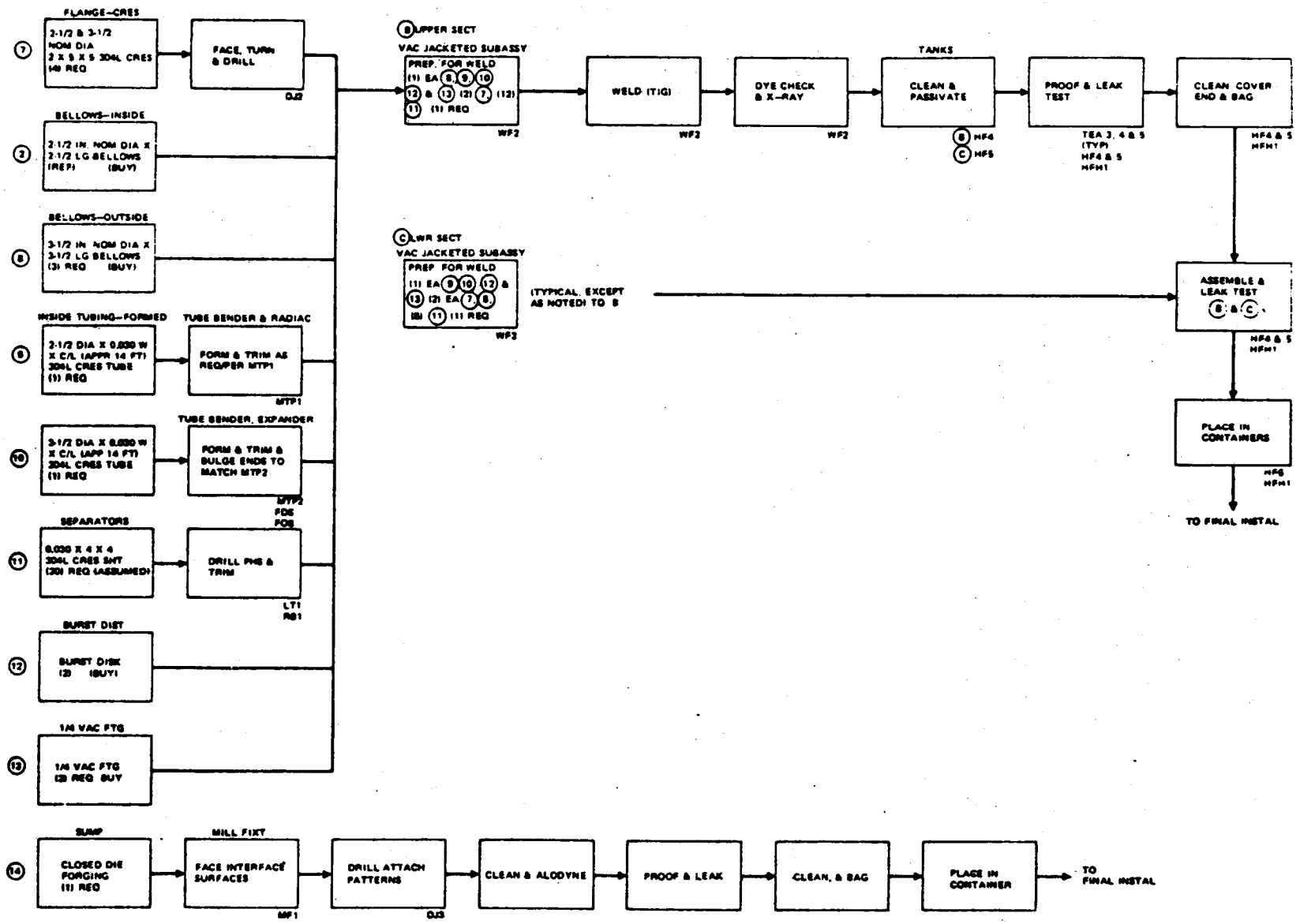


Figure 4-32. Space Tug LH_2 Feed Duct – Vac Jacked Section Manufacturing Sequence (Sheet 2 of 2)

Refurbishment

Intermediate and final checkout will be performed on all factory refurbished or modified vehicles in a similar manner as the initial factory checkout. Additional testing may involve specialized modification/rework tests not normally done in the initial checkout. Such tests are evident where structural modification or repairs are necessary. Remote site acoustic emission evaluation of tank quality is also anticipated. A very minimum of acceptance tests on refurbished vehicles would be a repeat of the original factory final checkout.

Data accumulated will be statistically compared with original and mission performance data to assist in the quality evaluation for future refurbishment duty cycle rework requirements.

Configuration I

Batteries will not be received at the factory, but will be delivered directly to the launch site. Either battery simulators, or special batteries installed for the purpose of Tug checkout will be used for in-plant tests.

Configuration F

Fuel cells will be tested upon receipt from the manufacturer in a specially designed facility to safely distribute, control, and vent hazardous gases. High purity oxygen, hydrogen, and nitrogen will be required to facilitate checkout. Adequate safeguards and procedures will ensure minimum risk to personnel and equipment during operations. Fuel cells will be functioned again after installation as a part of the Tug vehicle final checkout.

FACTORY CHECKOUT - TUG VEHICLE

Configuration I

Final system checkout will be as thorough as practical prior to shipment of each Tug vehicle from the factory. Launch, mission profile, and recovery operations will be simulated as close as practical in a factory ambient environment to exercise all on-board functional systems without actual propellant loading.

Checkout will be performed to go, no-go limit criteria controlled from manufacturing GSE. This checkout will in part simulate the launch checkout performed prior to launch.

4.1.3.6 Production Acceptance Test Plan

MANUFACTURING IN-PROCESS TESTS - STRUCTURAL/MECHANICAL

Tank Structures

Propellant tanks will be proof and leak tested after basic assembly, but prior to further buildup. Each individual tank assembly will be connected to a hydrostatic test facility where it will undergo a proof pressure test.

The LH_2 tank will be filled with water while simultaneously submerged with water in an outer tank to prevent over-stressing of the aft dome due to static head pressure of the internal water. All LH_2 tanks will be tested with a uniform differential pressure in this manner.

The LO_2 tanks will be tested in the same facility, but will not be submerged during the test.

Structural integrity historical data formation will start at the time of tank proof tests by the real time monitoring and recording of acoustical emissions emanating from minute plastic deformation and fractures occurring upon initial pressurization. Emission quantity and rate recorded during the pressurization cycle will serve to uncover trends in structural weaknesses, and provide a real-time analysis of potential failures. Automated data handling will permit ongoing interpretation and warning during the proof test cycle should crack growth rates exceed a pre-determined level. Permanent test records will then provide a data base to be used in subsequent test result correlation.

During tug mid-life refurbishment operations, additional static pressure tests will be performed with further examination of acoustical emission data. This data will be correlated with the initial proof test data, enabling a more thorough structural integrity evaluation and life forecast per stage.

Initial leak tests will be performed on each tank assembly after proof tests. All leak tests will be done pneumatically using ambient gaseous helium as a trace gas with the test pressure not to exceed a 4:1 design burst ratio. All weld seams and each through fastener will be checked for leakage. Leak detection will be by the use of portable helium sniffers with clearly defined go, no-go acceptance requirements.

Tank leak checks will not be done during mid-life refurbishment unless the tanks are stripped of all insulation and sufficient reason exists.

Pneumatic Installations

Each pneumatic duct, line, and component joint will be leak tested after assembly with gaseous helium, pressurized to expected operating pressures except where some segments may exceed a 4:1 design burst ratio. No pneumatic testing will be performed at less than 4:1 unless sufficient shelter and shrapnel screening is provided.

Electronic Assemblies

Electronic black box subassemblies (PCB's, thick film substrates, etc.) will be tested on existing government owned automatic testers. Boards will be tested prior to and after conformal coating. Specialized test programs will be developed to thoroughly exercise each circuit and interrelated components prior to next assembly.

Final black box assemblies will be tested after all assembly operations are completed to ensure operability within go, no-go acceptance limits.

Major Subcontractor Hardware

Flight articles produced by a major subcontractor will be acceptance tested at the supplier prior to delivery. In-plant checkout capability will be necessary, however, to fault isolate subsystems to the black box level in parallel with vehicle checkout. Supplier system test sets may be required if practical.

All test operations will be performed by automated computer controlled GSE with go, no-go analysis displayed and printed on reproducible hard copy. This factory checkout GSE will be of the same design as the launch site GSE. Primary differences in factory checkout and launch checkout will include additional data recording at the factory to establish certain instrumentation calibration bases for mission purposes, payload simulation, more thorough leak rate evaluation, and the obvious absence of flight propellants.

Initial test program software will be developed and proven in the Integrated Avionics Test Unit (IATU) prior to first vehicle application. Subsequent software configurations will likewise be routinely verified in the final checkout position or offline prior to use.

Configuration F

Factory checkout of configurations with autonomous on-board checkout capability will be similar to those requiring a limit check, except that the manufacturing GSE will load and control the on-board computer and monitor the results instead of directly controlling all activity. Test results will likewise be recorded on reproducible hard copy.

4.1.3.4.6 LH_2 Fill/Drain Duct

The LH_2 fill/drain extends from the LH_2 umbilical panel up to and into the LH_2 tank. The duct is composed of many subassemblies which will make up ten (10) complete sections, as follows:

Aft "Y" section (D)
Forward "Y" section (F)
Inboard flex section (G)
Outboard flex section (H)
Forward vacuum jacketed section
Aft vacuum jacketed section
Inboard tank penetration (L) (aluminum)
Inboard tank penetration (N) (aluminum)
Outboard-inside flange extension into LH_2 tank (O) (aluminum)
(See Figure 4-33 thru 4-41)

The ducts will be made from 3046 corrosive resistant steel tubing, except that any duct which penetrates and/or extends into the LH_2 tank will be 2219 aluminum tubing. The flex bellows, valves, burst disks and vacuum fittings will be purchased. The vacuum jacketed duct sections will require more complex weld fixtures than the single walled ducts, and a precise sequence of assembly must be followed.

Each duct section will be proof and leak tested individually after assembly, while a simple leak test is required to leak test the interface sealing.

The welding operations will be present state-of-the-art. Automatic TIG tube welding equipment will be used, except where not applicable.

Handling fixtures (HF) will be furnished for transportation and storage. The large assemblies will be picked up by handling fixture-hoist (HFH) to prevent damage to the assemblies.

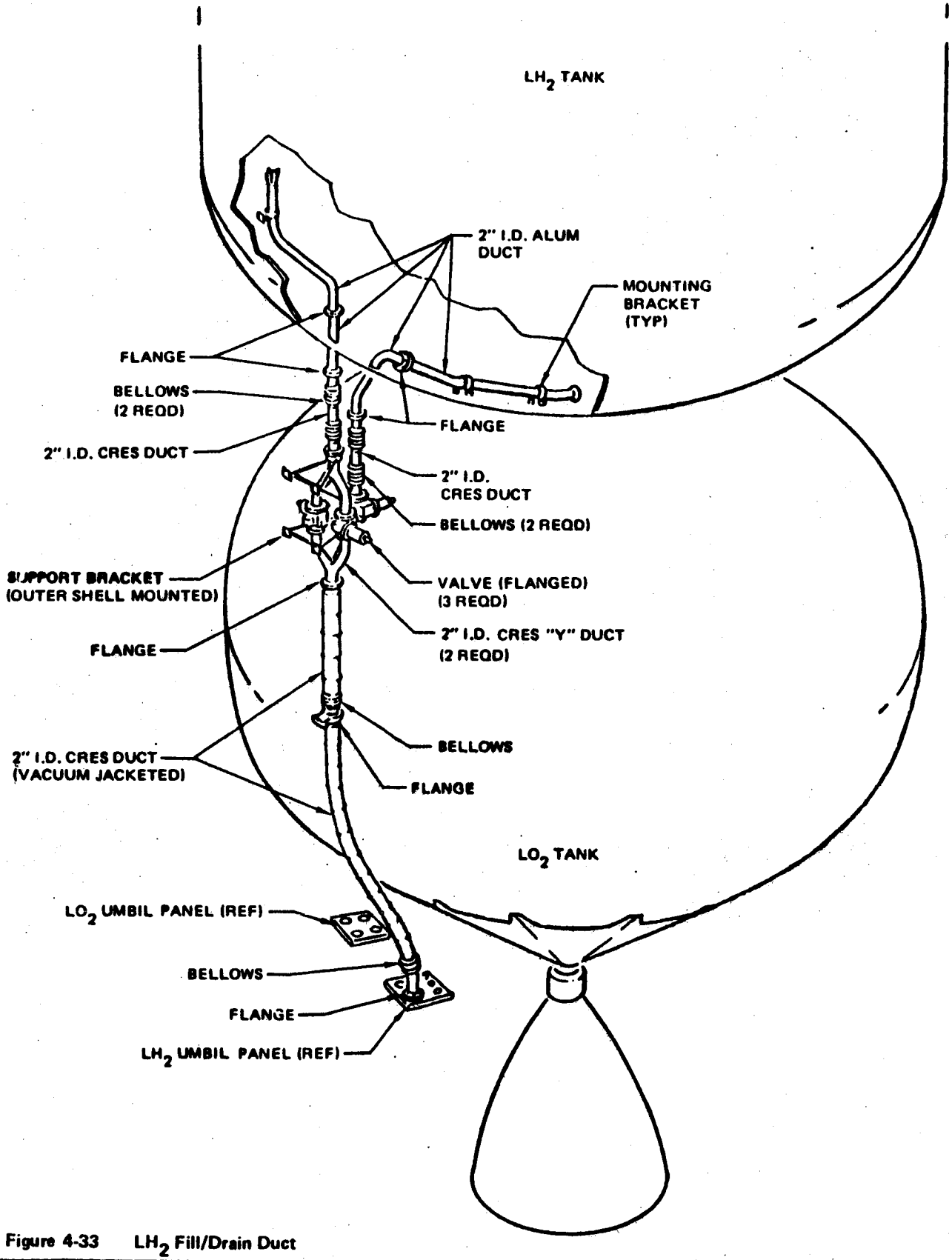


Figure 4-33 LH_2 Fill/Drain Duct

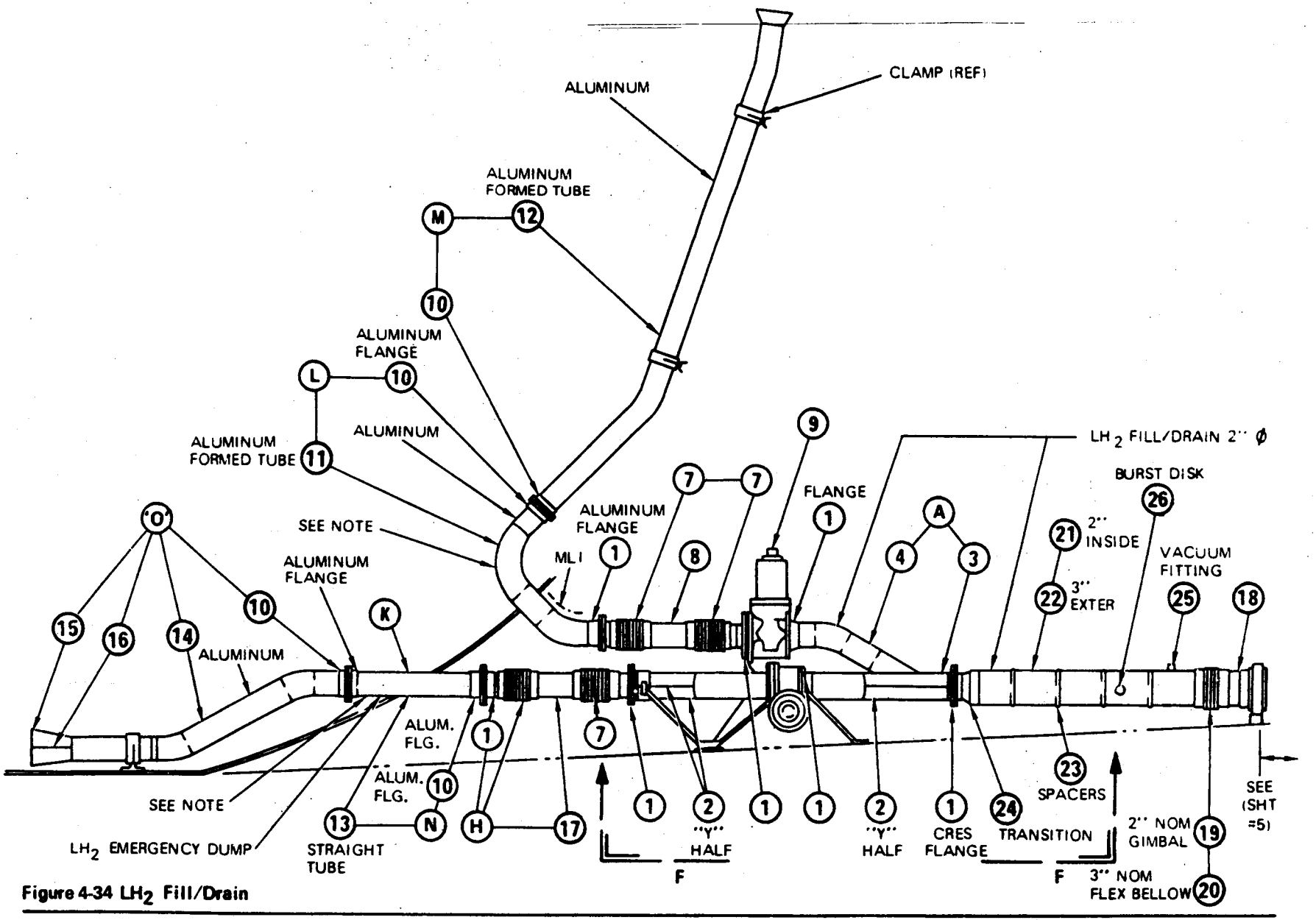


Figure 4-34 LH_2 Fill/Drain

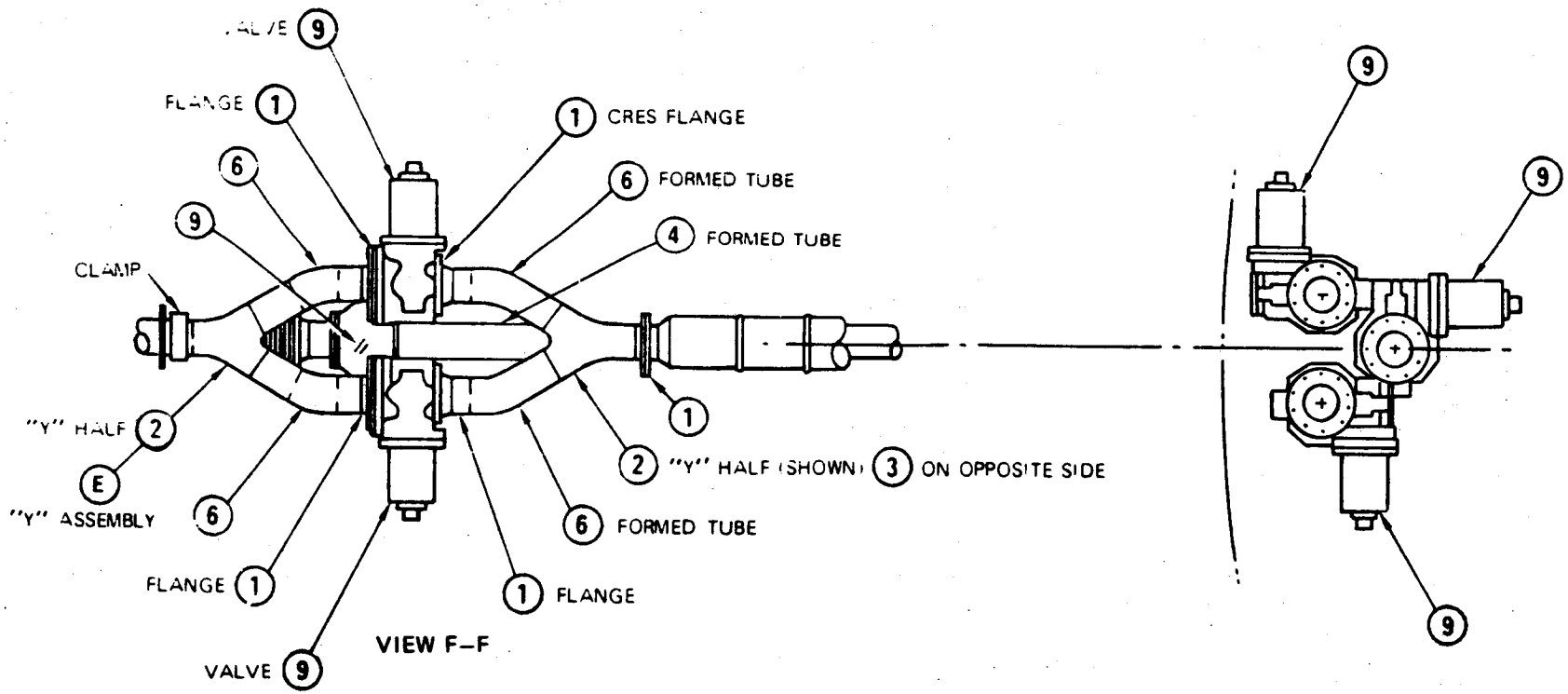


Figure 4-35 LH_2 Fill/Drain

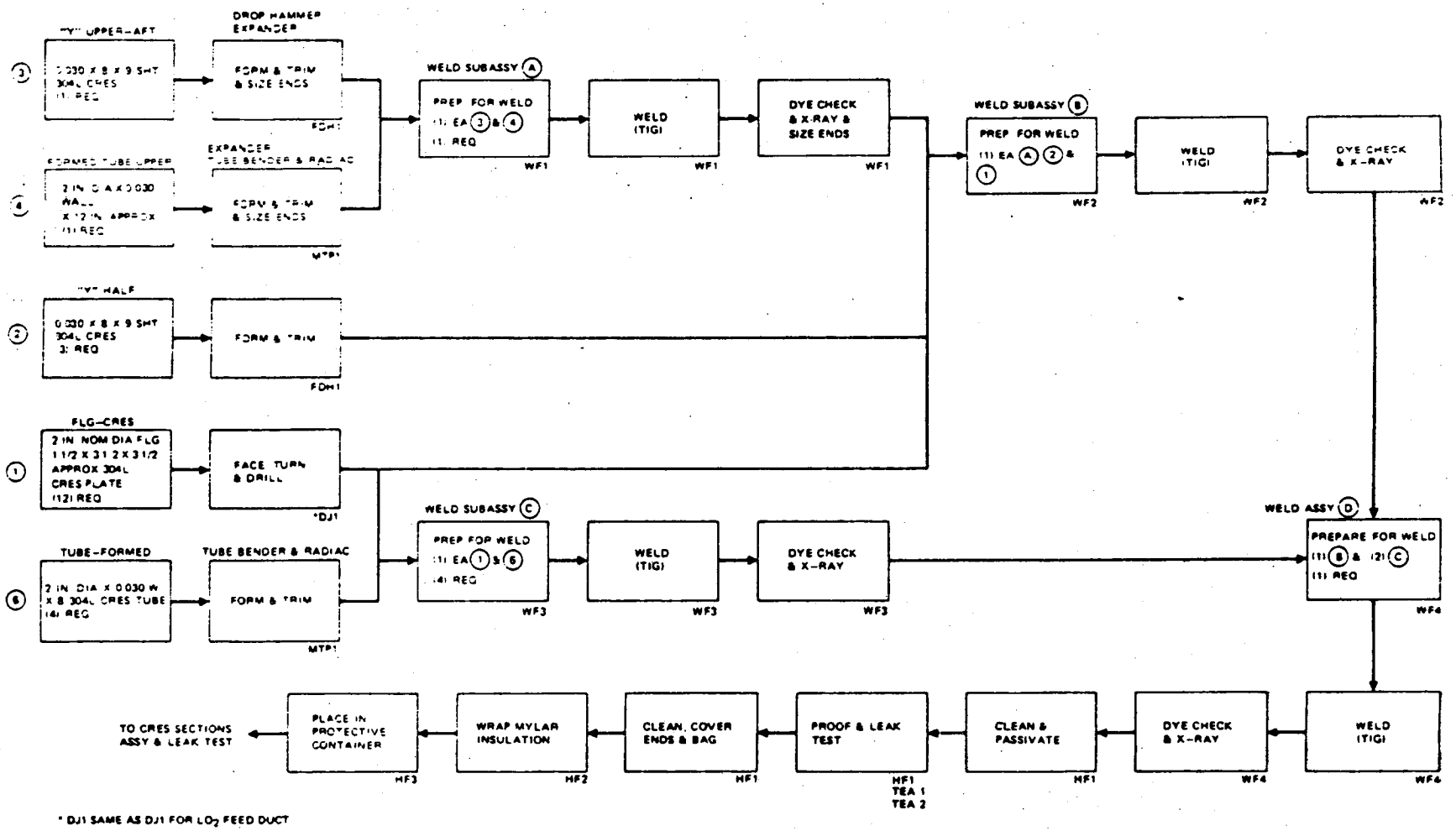


Figure 4-36. Space Tug LH_2 Fill & Drain Duct Manufacturing Sequence (Sheet 1 of 6)

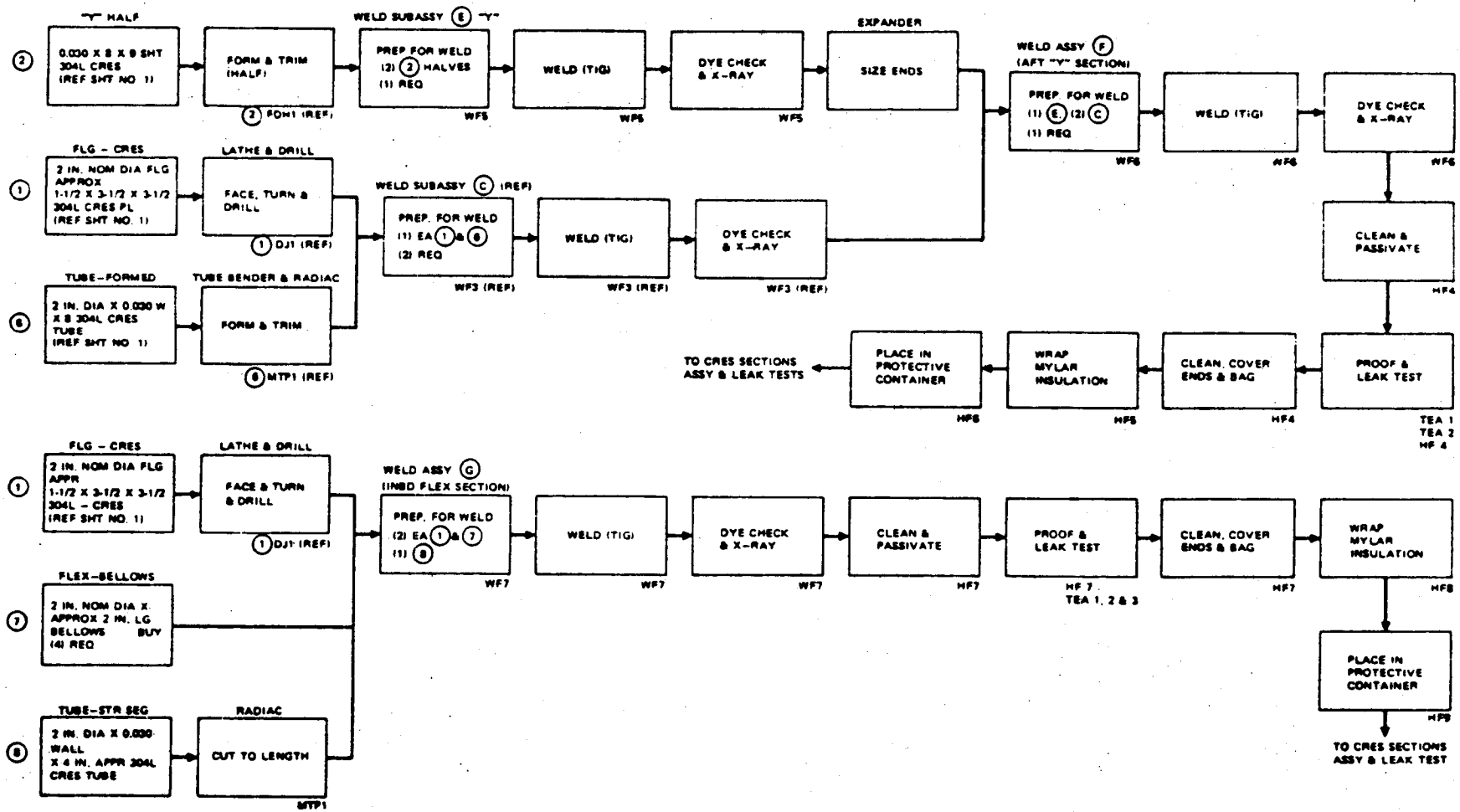


Figure 4-37. Space Tug LH_2 Fill & Drain Duct Manufacturing Sequence (Sheet 2 of 6)

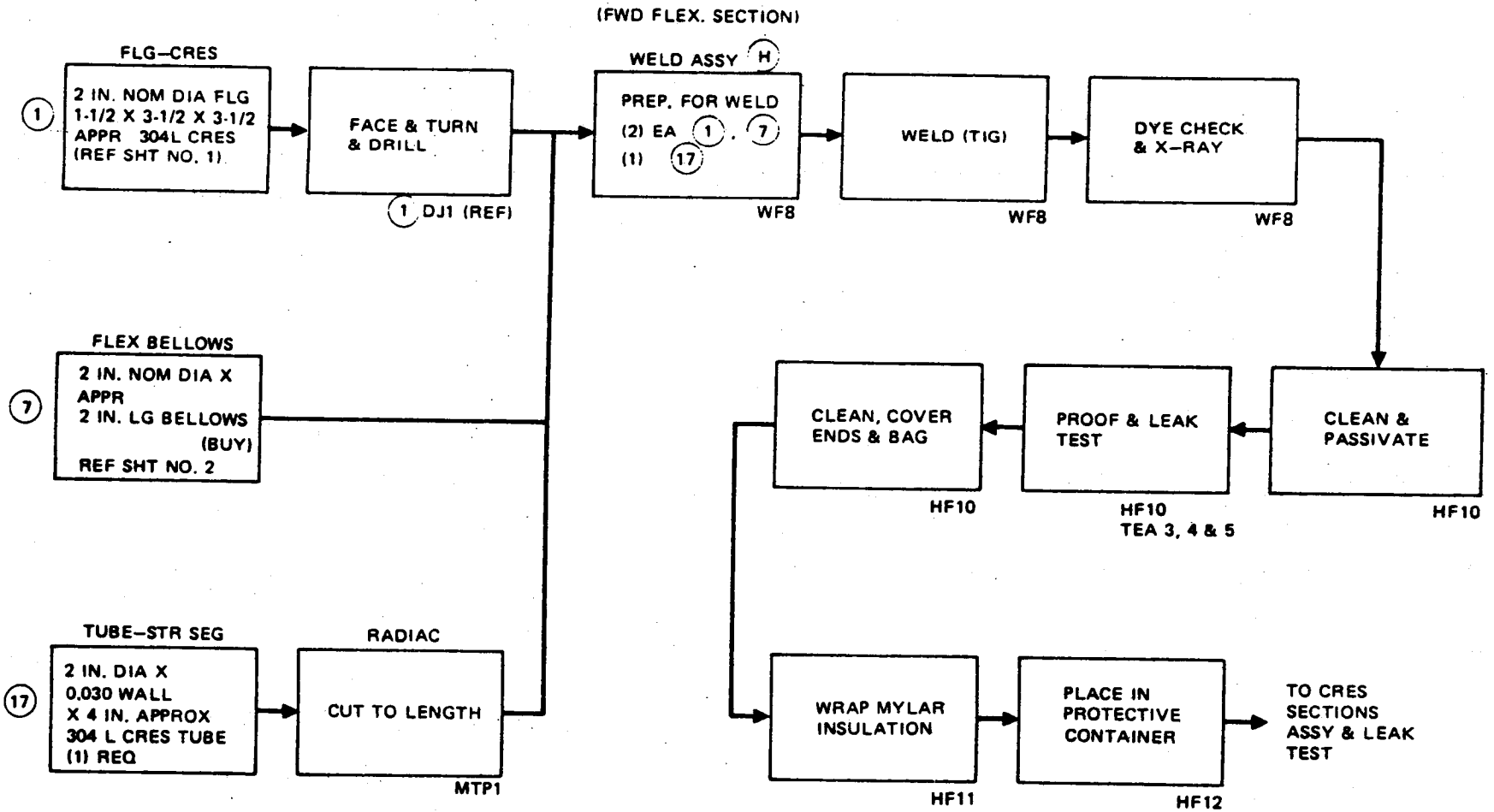


Figure 4-38. Space Tug LH_2 Fill & Drain Duct Manufacturing Sequence (Sheet 3 of 6)

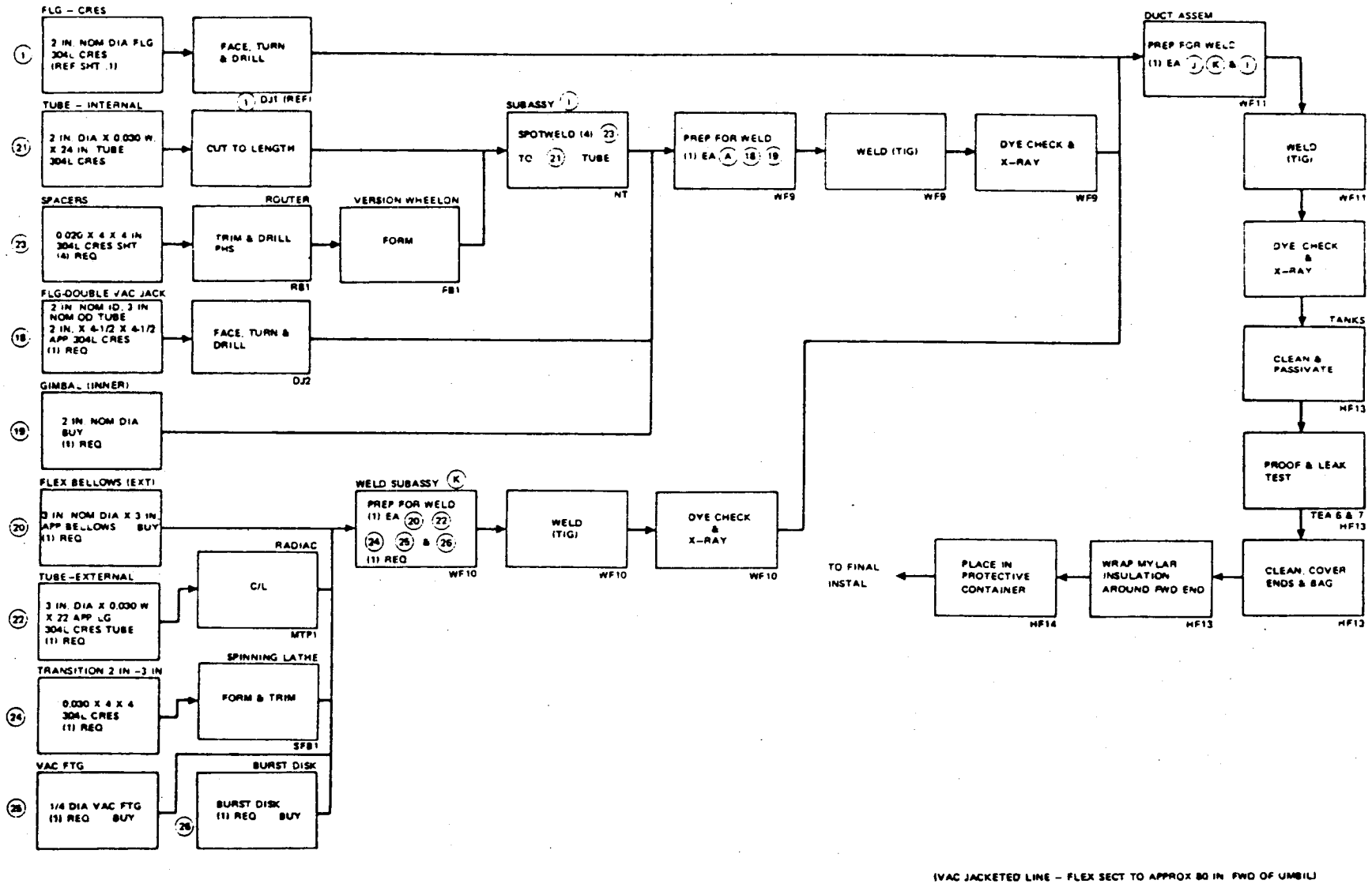


Figure 4-39. Space Tug LH_2 Fill & Drain Duct Manufacturing Sequence (Sheet 4 of 6)

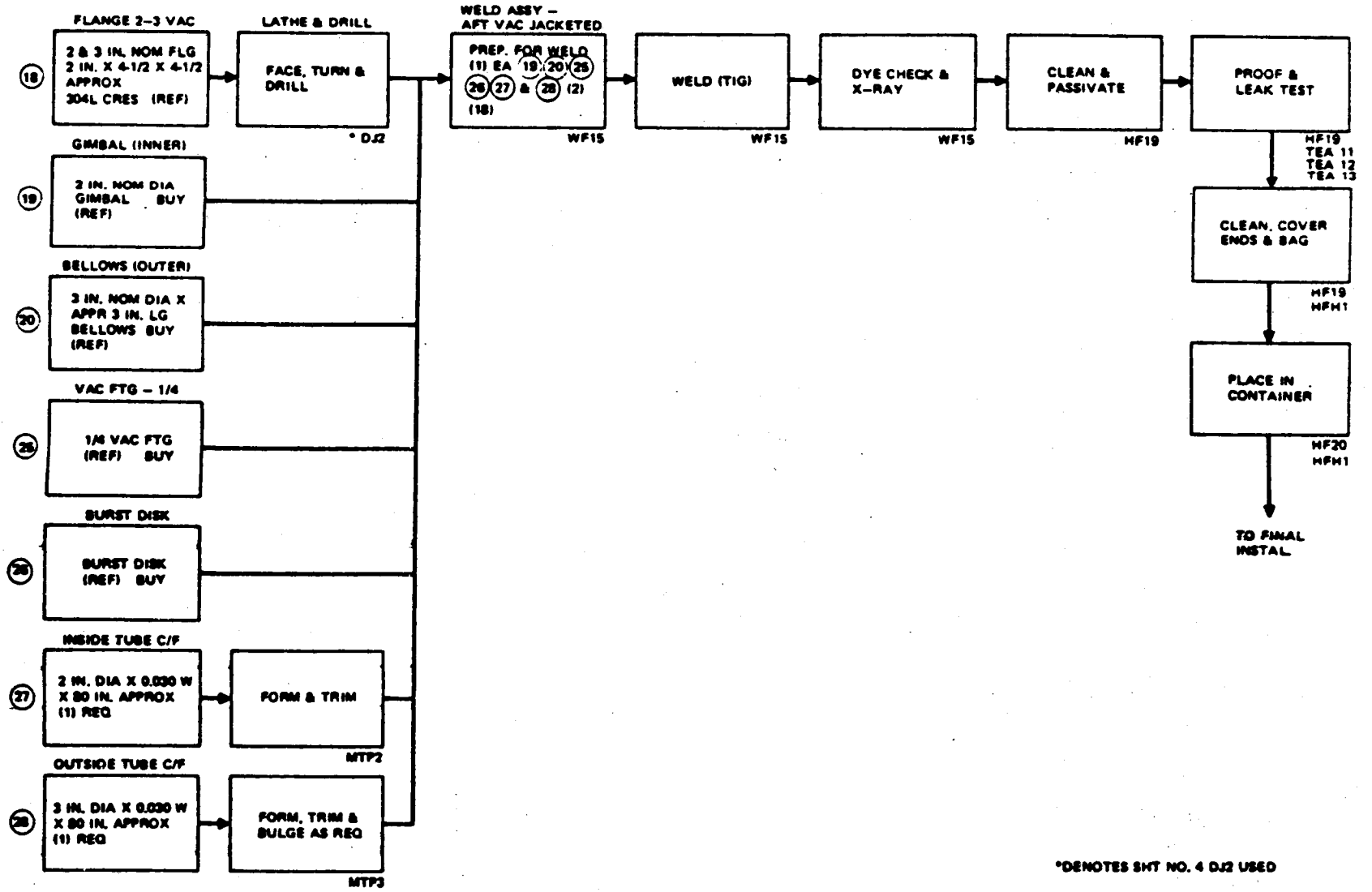


Figure 4-40. Space Tug LH_2 Fill & Drain Duct Manufacturing Sequence (Sheet 5 of 6)

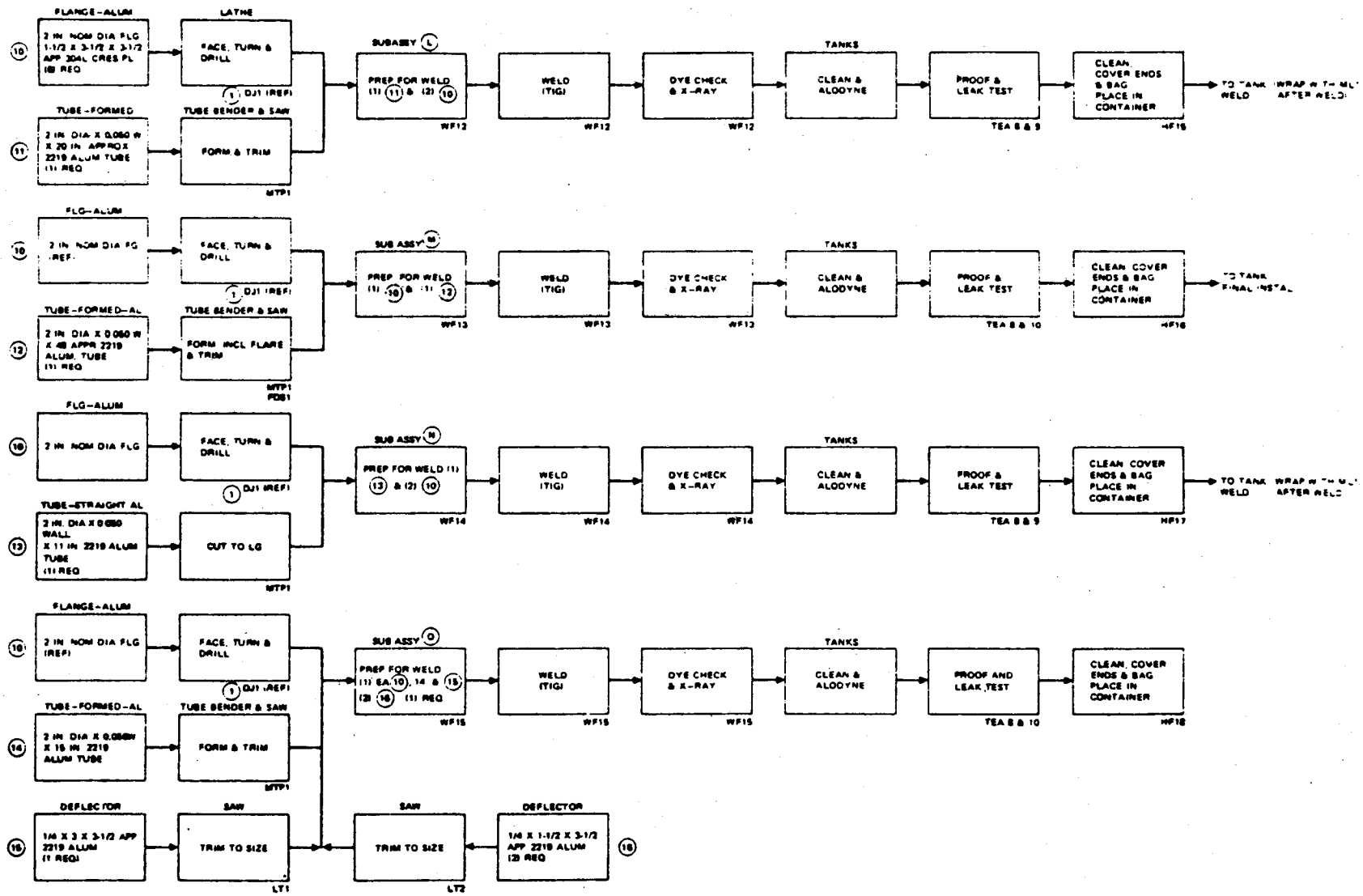


Figure 4-41. Space Tug LH_2 Fill & Drain Duct – Alum Sections Manufacturing Sequence (Sheet 6 of 6)

4.1.3.4.7 GH_2 Vent Ducts

The GH_2 vent system consists of 2 separate sections, namely the vertical and horizontal sections. The vertical section extends from the hydrogen umbilical to the forward centerline of the hydrogen tank. The horizontal section connects to the forward end of the vertical section and extends along the hydrogen dome to the upper side while in a horizontal position. The vertical section is approximately 30-feet long, while the horizontal section is approximately 9-feet long. Both sections consist of flanges, flex bellows, and 2-inch diameter tubing. The forward end of the vertical section has three flanges, with two flanges attaching to vent valves and the other to the horizontal section. (See Figure 4-42 thru 4-45)

The welding operations will be present state-of-the-art. Automatic TIG tube welding equipment will be used, except where not applicable.

Handling fixtures (HF) will be furnished for protectively moving, insulation wrapping and storage. A handling fixture hoist (HFH) will be furnished for the vertical section, however the horizontal section will be picked up by hand. The flex bellows and valves will be purchased.

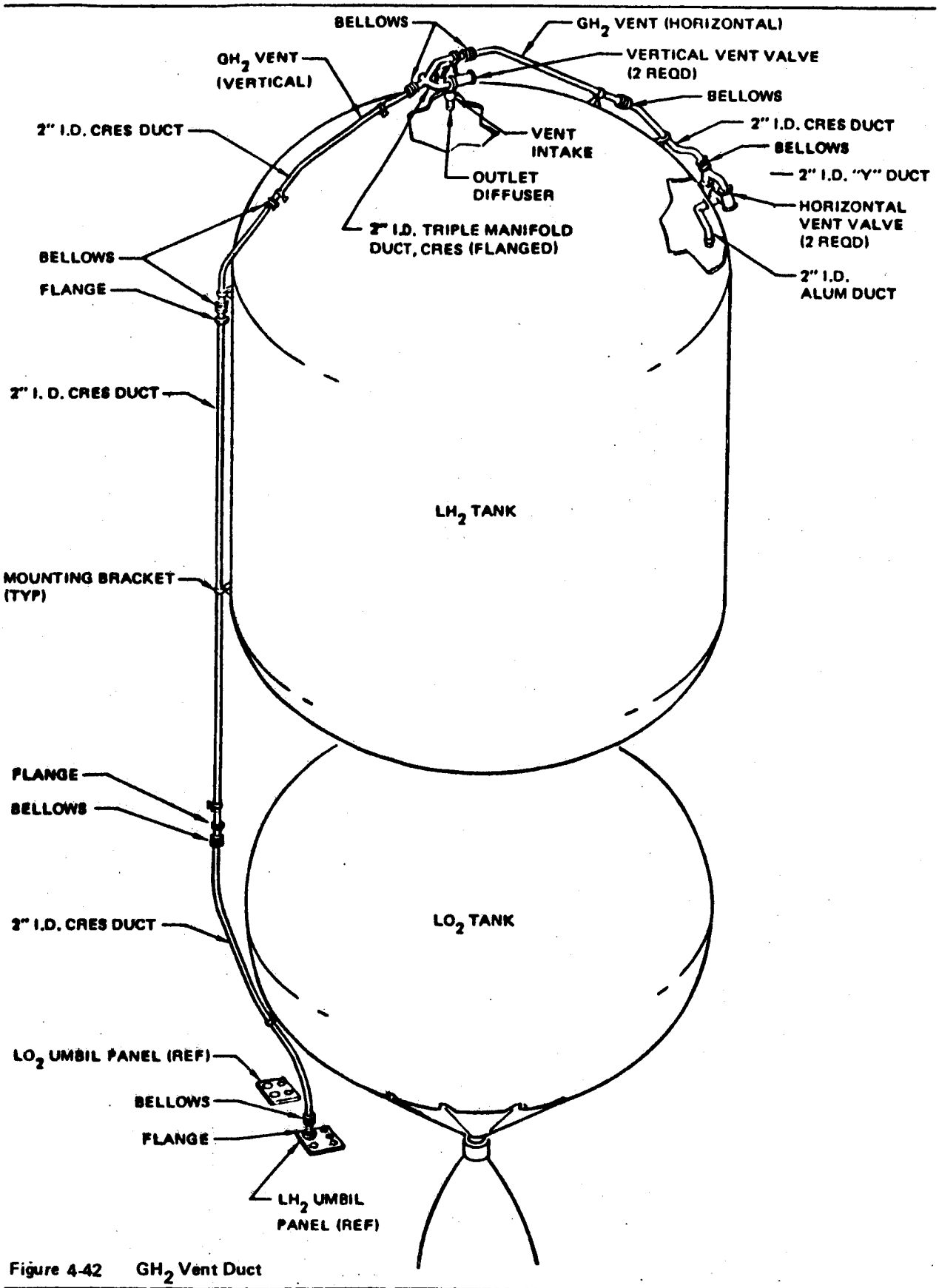


Figure 4-42 GH_2 Vent Duct

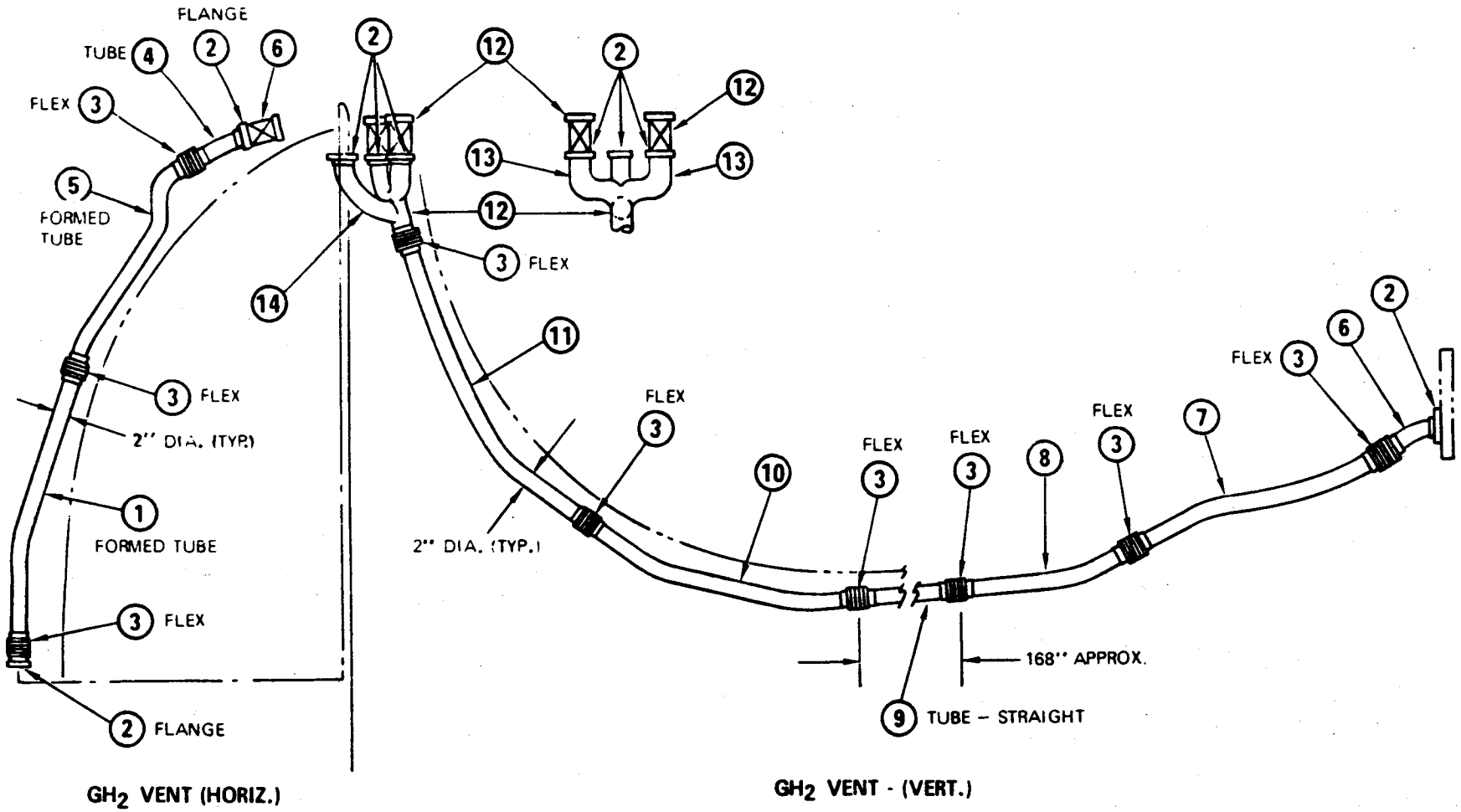


Figure 4-43 GH_2 Vent Duct

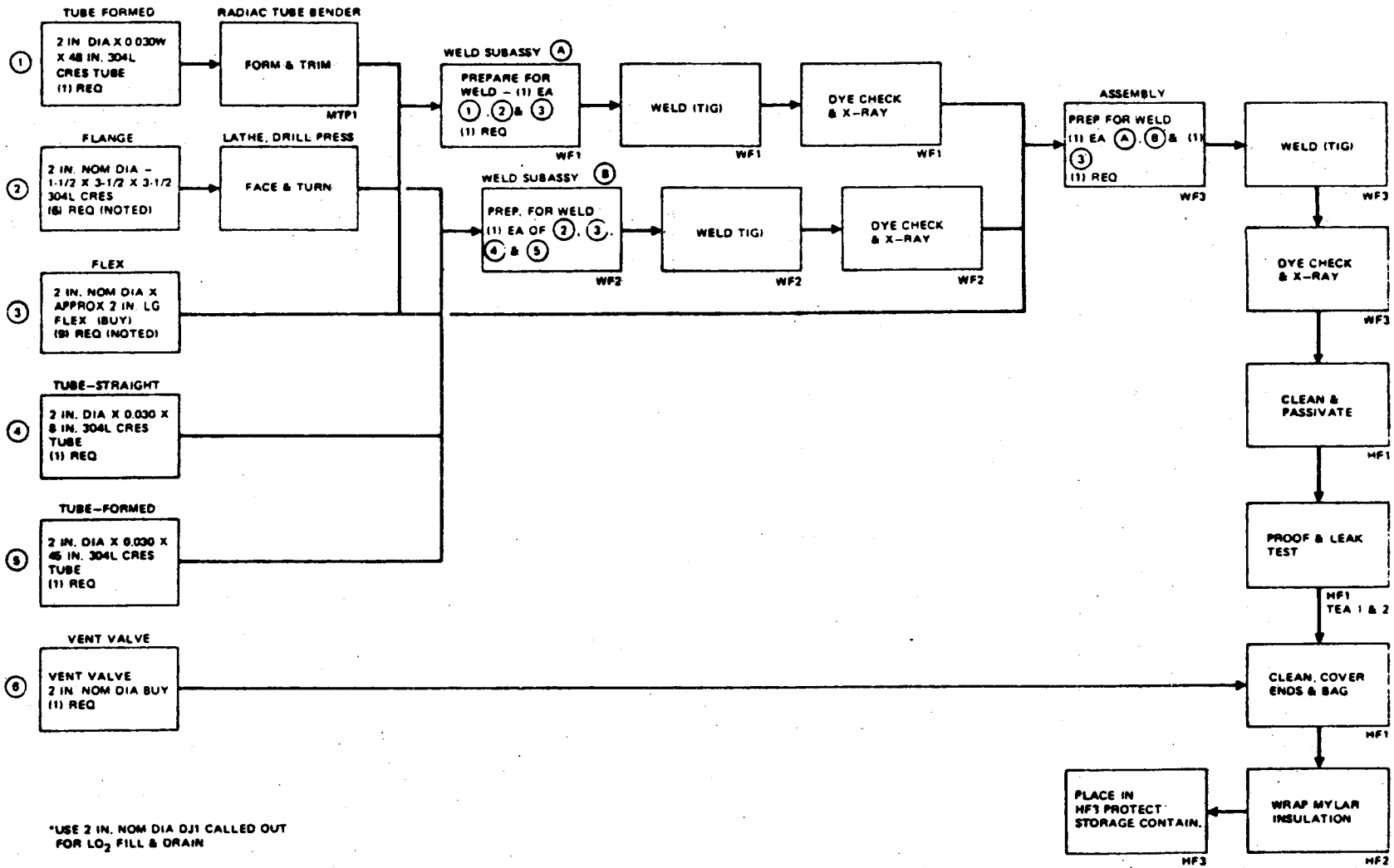


Figure 4-44. Space Tug GH_2 Vent – Horiz Section Manufacturing Sequence (Sheet 1 of 2)

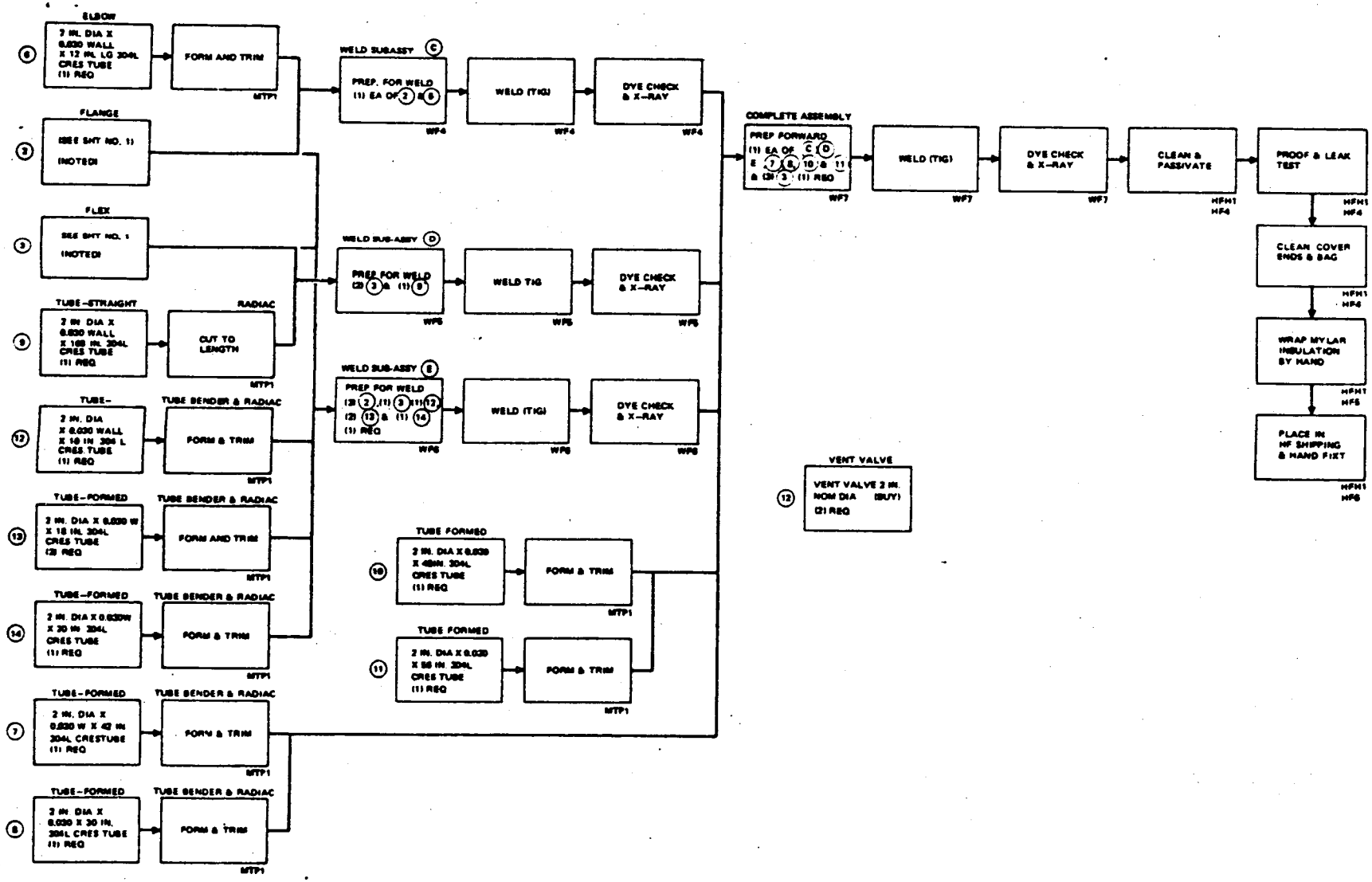


Figure 4-45. Space Tug GH_2 Vent – Vert. Section Manufacturing Sequence (Sheet 2 of 2)

4.1.3.4.8 Pneumatic (Helium) System

The pneumatic system consists of titanium storage bottles filled with helium and with 1/4 inch and 1/2 inch diameter tubing connecting the bottles to control valves for the following systems:

- LH_2 Feed
- LH_2 Fill and Drain
- GH_2 Vent
- LO_2 Feed
- LO_2 Fill and Drain
- LO_2 Emergency Dump
- GO_2 Vent

The tubing will be thin-walled corrosive resistant steel (304L) and will be brazed (or welded) in place, upon installation. The lengths and bend radii will be controlled by bend radius templets (BRT).

The pneumatic systems for the various configurations will be very similar except for the location of the pressure bottles, and resulting plumbing requirements. The ambient configuration bottles are located on the thrust structure, while the "cold" configuration bottles are located in the LO_2 tank. The cold configuration requires a helium heater at the umbilical, with additional plumbing.

4.1.3.5 Avionics Fabrication, Assembly, and Installation

The avionics fabrication, assembly and installation manufacturing concept is based on the use of modular electrical/electronic units. Typically, a module consists of a housing with 5-layer thick film hybrid assemblies, state-of-the art at MDAC, connected by a 4-layer flexible printed wiring harness. The modules are mounted on baseplates with an interconnecting wire harness to comprise a complete tested unit ready for installation on the vehicle support structure. Purchased assemblies will be adapted to the support structure by fabricated mounts. Instrumentation transducers that are integral to the vehicle structure or other subsystems will be installed during the relevant assembly operations. All other transducers, electrical/electronic units and interconnecting cable assemblies will be installed during and after final assembly of the vehicle. Items comprising the avionics subsystem are tabulated below.

Quantity	Unit	Quantity	Unit
50	Interconnecting Cables	1	RF MUX
10	MIU's	1	SGLS/USB Transponder
1	Data Control Unit	1	CMD Decoder
1	PCM Formatter	1	COMSEC. Equipment
1	GSE/ORB 1/F Unit	2	Tape Recorders
1	Spectrum Converter	1	High Gain Antenna
1	Computer	1	AGZU Primary Battery
6	Instrumentation Power Supply	1	NICAD Backup Battery
2	Startracker - Strapdown	1	NICAD Backup Battery
2	IMU - Tuned Rotor	1	Power Dist. Assembly-Hybrid
1	Mod/Demod Processor	1	Power Amplifier
1	OMNI - Directional Antenna	200	Transducers
1	Microwave Circuitry Installation		

The manufacturing and assembly concept will require minimum tooling. The manufacturing flow plans for the avionic components are depicted in Figures 4-46 and 4-47.

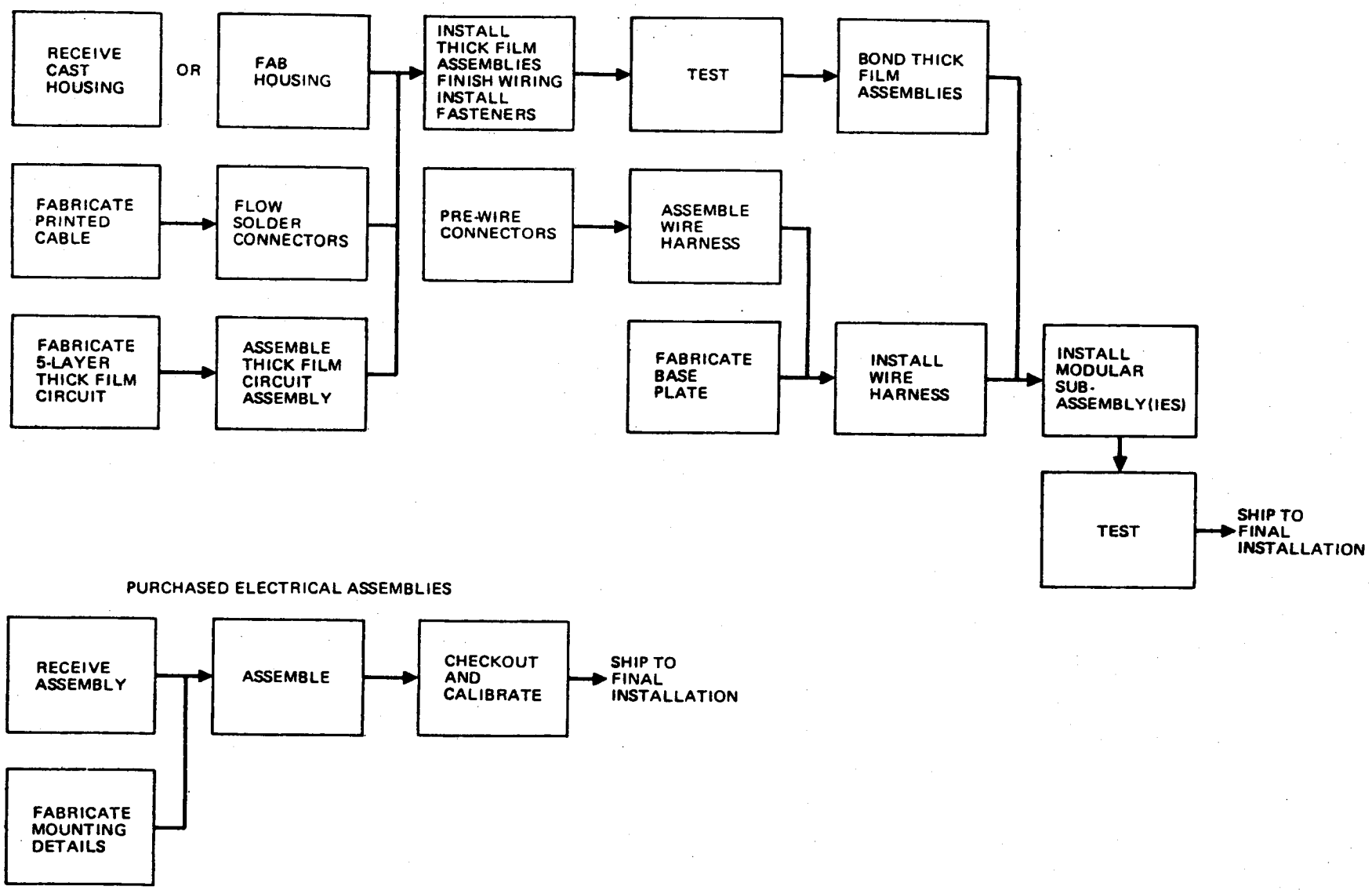


Figure 4-46. Electrical Assemblies

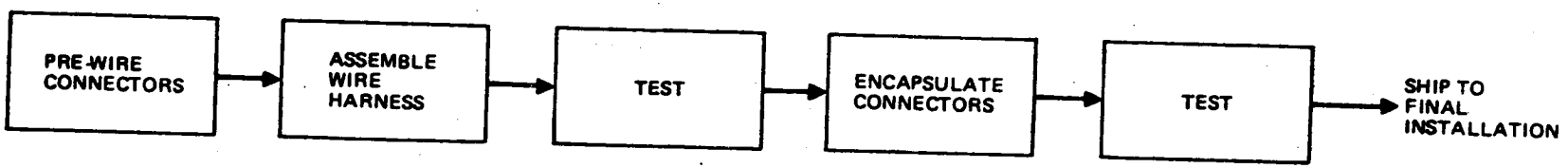


Figure 4-47. Interconnecting Cables

4.2 TOOLING REQUIREMENTS

Tooling requirements generated by the fabrication and assembly flow plans previously outlined in Section 4.1.3 are presented in the following list, as are the tools needed to produce and/or modify items of Ground Support Equipment used for factory checkout. Tooling abbreviations are defined in the glossary of definitions.

TOOL DESIGNATIONS	TOOL NOMENCLATURE	TOOL DESIGNATIONS	TOOL NOMENCLATURE
AJ	Assembly Jig	MF	Mill Fixture
AT	Apply Templet	MMT	Master Masking Templet
ATP	Auxiliary Tool Production	MT	Masking Templet
BJ	Bonding Jig	MTP	Master Tooling Part
BRT	Bend Radius Templet	NMT	Negative Masking Templet
CT	Contour Templet	PLM	Plastic Laminating Mold
DD	Draw Die	PMT	Positive Masking Templet
DJ	Drill Jig	PT	Profile Templet
FB	Form Block	PTE	Production Test Equipment
FDH	Form Die-Hammer	RB	Router Block
FDS	Form Die-Swage	SFB	Spin Form Block
HF	Handling Fixture	SWF	Spotweld Fixture
HFH	Handling Fixture-Hoist	TEA	Test Equipment Accessory
LF	Lathe Fixture	TJ	Trim Jig
LT	Layout Templet	WF	Weld Fixture
MCM	Machine Control Medium	WJB	Wire Jig Board

TOOL LIST

ITEM	PART NOMENCLATURE	QUANTITY	TOOL NOMENCLATURE
1	Payload Docking	1	WF
		1	AJ
		1	ATP
		3	TEA
2	Avionics Panel	1	AJ
		1	DJ
		1	SFD (HOT)
		1	MF
		1	LT
		2	AT
3	Avionics Panel - Isogrid	1	MF
		1	MCM
		1	MT
4	Tank Support Ends	1	CMD
		1	PLM
		1	BF
5	Tank Support Tank Fittings	1	MF
		1	MT
		1	DJ
6	LH_2 Forward Dome	4	LF
		1	SWF
		1	DJ
		1	MT
		2	HF
		1	HFH
		1	AT
		1	WF

TOOL LIST

ITEM	PART NOMENCLATURE	QUANTITY	TOOL NOMENCLATURE
7	LH_2 Aft Dome	1	MF
		1	DJ
		2	MT
		2	LF
		2	HF
		1	TJ
		1	WF
		1	SWF
8	LH_2 Access Door	1	LF
		1	PT
		1	DJ
9	LH_2 Tank Body	1	MF
		1	MT
		1	CT
		1	WF
		1	HF
		1	HFH
10*	LH_2 Tank Assembly	1	WF
		2	HF
		1	HFH
		8	TEA
		2	PTE
11	LH_2 Titanium Shear Panels	1	LT
		1	AT
		1	FB
12	Quartz Cloth Panels	1	LT
13	Kapton Meteoroid Barrier	1	LT

TOOL LIST

ITEM	PART NOMENCLATURE	QUANTITY	TOOL NOMENCLATURE
14	Reflective Coating (DAM)	1	LT
15	LO_2 Tank Duct Attach Fittings	1	LF
		1	PT
16	LO_2 Forward Dome	2	LF
		1	MT
		2	HF
		1	HFH
		1	TJ
		1	WF
17	LO_2 Aft Dome	2	MF
		1	PT
		3	LF
		2	DJ
		1	DD
		1	MT
		1	WF
		1	SWF
		3	HF
		1	HFH
18	LO_2 Tank Assembly	1	WF
		2	HF
		1	HFH
		8	TEA
		2	PTE
19	LO_2 Tank Kapton Attach Angle	1	LT
20	Thrust Structure	1	PLM
		1	CMD
		1	DJ
		1	HF

TOOL LIST

ITEM	PART NOMENCLATURE	QUANTITY	TOOL NOMENCLATURE
21	Engine Mount	1	LF
		1	DJ
		1	HF
22	LO_2 Tank Docking Guard Attach Angle (Fibreglass)	1	PLM
		1	TJ
		1	HF
23	Umbilical Support Brackets	1	LF
		1	MF
		1	WF
		1	DJ
24	Engine Actuator Support	1	LT
		1	RB
		1	FB
25	Pressure Bottle Support	1	LT
		1	FDH
		1	TJ
		1	HF
26	Pressure Bottle Straps	-	Use SIVB Mfg Capability
27	Monopropellant Bottles	-	Use SIVB Mfg Capability
28	Ambient Helium Bottles	-	Use SIVB Mfg Capability
29	Monopropellant Bottle Brackets	2	LF
		1	WF
		1	DJ

TOOL LIST

ITEM	PART NOMENCLATURE	QUANTITY	TOOL NOMENCLATURE
30	Intertank Forward Frame	1	AT
		1	MF
		1	DJ
		1	AJ
31	Intertank Aft Frame	1	AT
		1	MF
		1	DJ
		1	AJ
32	Longeron and Monopropellant Bracket Fittings	1	LT
		1	AT
		1	MF
		1	DJ
		1	AJ
33	Intertank Open Isogrid Panels	1	MF
		1	MCM
		1	MT
		1	DJ
34	Docking Guard Aft Intertank Frame Attach Fittings and Fuel Line Clips	2	LT
		1	AT
		1	MF
		1	DJ
		1	AJ
35	APS Impingement Panel	1	LT
		1	FB
		1	AT
36	LH_2 Tank Bonding and Insulation	1	BJ
		1	HF
		1	HFH

TOOL LIST

ITEM	PART NOMENCLATURE	QUANTITY	TOOL NOMENCLATURE
37	LO_2 Tank Bonding	1	BJ
		1	HF
		1	HFH

* All tools are also common to Option 3 Final, except those with asterisk (*).
(* tools not applicable to Option 3 Final).

OPTION 3 FINAL

TOOL LIST

ITEM	PART NOMENCLATURE	QUANTITY	TOOL NOMENCLATURE
1	LH_2 Tank Assembly	1	WF
		1	IF
		2	HF
		8	TEA
		2	PTE
2	Fuel Cell Radiator & Attach Fittings	1	SFD
		1	MF
		2	WF
		2	TEA
		1	PTE
		2	FB
		2	AT
		2	LT
		2	RB
		1	HF
		1	HFH

NOTE:

Option 3 Final also includes tools listed on Option 3 Initial, except omit items asterisked (*).

4.3 FACILITIES

Detailed analysis and evaluation of program facility requirements to support a minimum cost DDT&E effort and low, early-year funding for Option 1 has determined that existing MDAC facilities can be utilized for most requirements. This evaluation was based on a "bottoms up" analysis of operation's requirements for manufacturing, test, integration, and checkout, and program needs were then matched against lists of existing modified, and new facilities. The basis for final determination was the availability and compatibility of identified items, and the predicted cost of supplemental equipment and modifications for adaptability.

Production facilities were evaluated using the horizontal mating method as the preferred approach. Facilities identified are not configuration sensitive, and cost alone was not the sole determinant in the selection of support equipment.

4.3.1 Manufacturing Facilities

Manufacture, assembly and checkout of the Space Tug will be accomplished at the McDonnell Douglas Astronautics Company (MDAC) facility in Huntington Beach, California. This facility was so planned and designed from its inception as to provide fully integrated capabilities for the production of space vehicles. Buildings include provisions for engineering and administrative offices, a Systems Integration Laboratory, Structural Test Laboratory, Space Simulation Laboratory, Production Test Laboratory, a manufacturing and assembly building, insulation building, a final assembly and checkout building, and other service and support facilities.

During development and production of the Space Tug, maximum utilization will be made of existing MDAC and government-owned facilities used on the Saturn S-IVB program and the Orbital Workshop. Full program support will be provided by existing machine shops, sheet metal shops, processing equipment, electrical/electronic fabrication and assembly facilities, and supporting inspection and test laboratories.

A preliminary list of additional facility requirements identified at this time for each of the configurations is shown in the table in Section 3.1. Also included are tentative costs and estimates of procurement lead times. A

100,000 class clean room for final assembly is listed in these requirements to satisfy contract requirements.

4.3.2 Test Facilities

Existing laboratories and facilities at MDAC in Huntington Beach will be utilized for production testing and checkout operations. Little or no modification of these laboratories will be required for Space Tug program use, as these facilities were designed for use on space vehicle hardware and assemblies.

Propulsion Test Vehicle (PTV) tests will be conducted in test cell J4 at the AEDC facility in Tullahoma. This test cell will provide the altitude simulation capability lacking in the test facilities at Huntsville. Thermal tests of the vehicle will be accomplished in the NASA high-vacuum facility, utilizing an existing scaled-down and instrumented tank that will fit the 15 foot diameter chamber. These government facilities are available for program use at no cost or at a nominal fee, depending on the using agency.

4.4 Special Requirements

The special requirements of the Space Tug manufacturing plan is the fabrication of the single piece LH_2 and LO_2 domes tooling and the procurement of the test sets of domes for testing. All other manufacturing requirements are state-of-the-art.

4.5 Summary - Analysis/Philosophy

This section contains the analysis and philosophy engendered into the Space Tug manufacturing plan.

4.5.1 Analysis

The analysis of the Space Tug manufacturing plan illustrates the following requirements were achieved:

- Minimum DDT&E with planned growth ability.
- Manufacturing methods and processes employed are state-of-the-art.
- Low tooling costs - standard tools and "soft" tooling utilized to the maximum.
- Cost effective production with high reliability.
- Manufacturing rate is compatible with the scheduled delivery requirements.
- Manufacturing program pre-planned and phased to insure low total program costs.

4.5.2 Philosophy

- 0.97 reliability factor
- Minimum DDT&E with planned growth ability
- Reuseable vehicle
- Recycle capability
- Low program cost
- Low early year funding
- Pre-planned and phased manufacturing program

In order to meet these requirements the following manufacturing philosophies have been instilled into the manufacturing plan of the Space Tug.

1. Automate where economically feasible to reduce manufacturing manpower requirements. Areas of automation are as follows:
   a) Numerically controlled machining of all machined components. Programmed dwell cycles for change and design revisions.
2. Fusion joining of the LO_2 and the LH_2 tanks will be accomplished automatically using the latest TIG welding techniques, i.e., electronics sensing devices, closed circuit television and other monitoring devices.
3. The fabrication of the LH_2 and LO_2 aluminum 2219 Cassinian tapered domes are purchased as single piece spin-formed domes in a T37 condition, machined in-house to a nominal thickness and taper chem-milled.
4. Reduction of components will be the concept for this manufacturing plan. Extruded and welded stub frames, and large sheet stock will be used.
5. Commonality and multi-use parts will be the manufacturing and engineering objectives of this plan, i.e., tank supports, tank support fittings.
6. A tool master program will be used on all field joints and verification matching interfaces.
7. "Soft" tooling will be used where practical and economical.
8. Tools designed and fabricated to accept phased-in final configuration with a minimum of rework.

4.6 IMPACT OF OPTION SENSITIVITIES

The impact of the option sensitivities to the manufacturing plan are outlined in this section. These options are as follows:

1. Configuration and programmatic sensitivities for the Final Tug to retrieve 3500 lb from geosynchronous.

2. Programmatic sensitivity to delay both Initial and Final Tug IOC dates 2 years (December 31, 1981 to 1985).

The impact of each of the above sensitivities is delineated in the following sections and in the same numerical order.

4.6.1 Configuration and Programmatic Sensitivities For the Final Tug to Retrieve 3500 lb From Geosynchronous

The configuration and programmatic sensitivities for the final Tug to retrieve 3500 lb from geosynchronous does not impact manufacturing.

4.6.2 IOC Delay of 2 Years for the Initial and Final Tug

The IOC delay of 2 years for the initial and final tug will have the following impacts on manufacturing:

Initial Tug

1. DDT&E accomplished on a one shift basis.
2. Long leadtime procurement schedule extended.
3. Facility activation schedule extended.
4. Low manufacturing rate.

Final Tug

1. Continuous DDT&E effort on a one shift basis
2. The manufacturing rate of 2.8 produces peaks and valleys in the production flow.
3. Procurement effort extended.
4. Facility activation extended.

4.7 GSE Requirements

This section defines the Ground Support Equipment (GSE) required for factory checkout only. The items listed below will be used in-plant to support checkout operations during acceptance testing, but do not represent the total complement of GSE required for the Space Tug program.

A schematic depicting GSE interconnection and Tug hookup for final system checkout is shown in Figure 4-48 and 4-49.

		Figure
1.	APS Breakout Control Box	4-50
2.	Space Tug Simulator	4-51
3.	Spacecraft Simulator	4-52
4.	Propellant or Pneumatic Control Console	4-53
5.	Propulsion Pneumatic Console	4-54
6.	Propellant Utilization Component Test Set	4-55
7.	Printed Circuit Card Component Test Set	4-56
8.	Power System Test Set	4-57
9.	Orbiter Simulator	4-58
10.	Signal Conditioning Unit	4-59
11.	Guidance and Navigation Test Set	4-60
12.	Guidance and Navigation System Checkout Kit	4-61
13.	Digital Events Recorder	4-62
14.	Data Management Test Set	4-63
15.	Communication System Test Set	4-64
16.	Checkout Cable Kit	4-65

The following pages identify the unique applications of the listed items, and show quantity requirements, the functional requirements, and a brief description of the equipment. Where applicable, the similarity to existing items of other MDAC-designed GSE is noted for comparison.

Included in the Tool List in Section 4.2 are the tools required to produce (or to modify existing) items of GSE for factory checkout use. Refer to Section 6.11.6 for a description of all operational GSE required to support the Space Tug program. The percentage of reworked and new GSE is also noted, as is a description of refurbishment requirements.

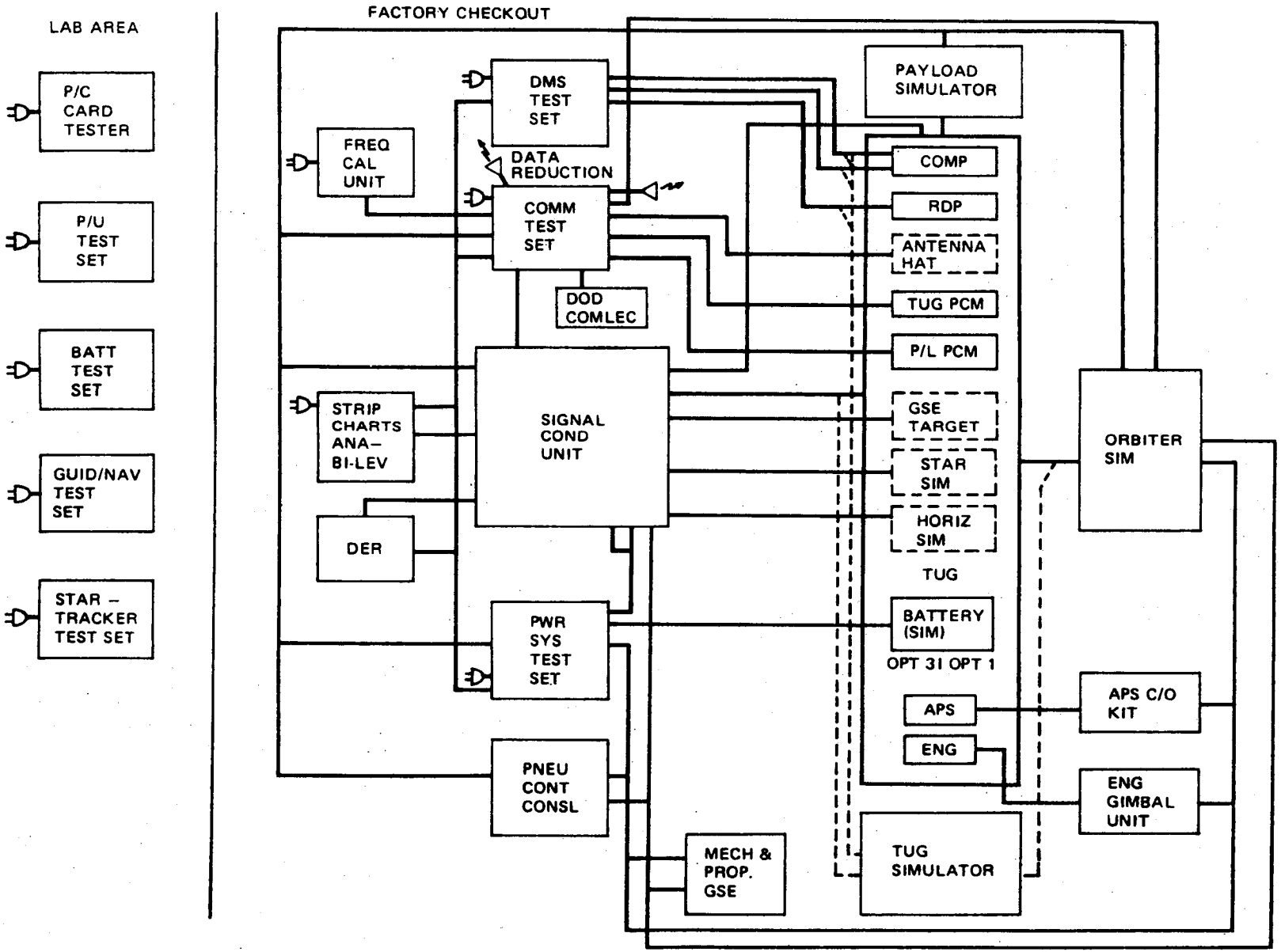


Figure 4-48. GSE Interconnection/Tug Hookup–Final

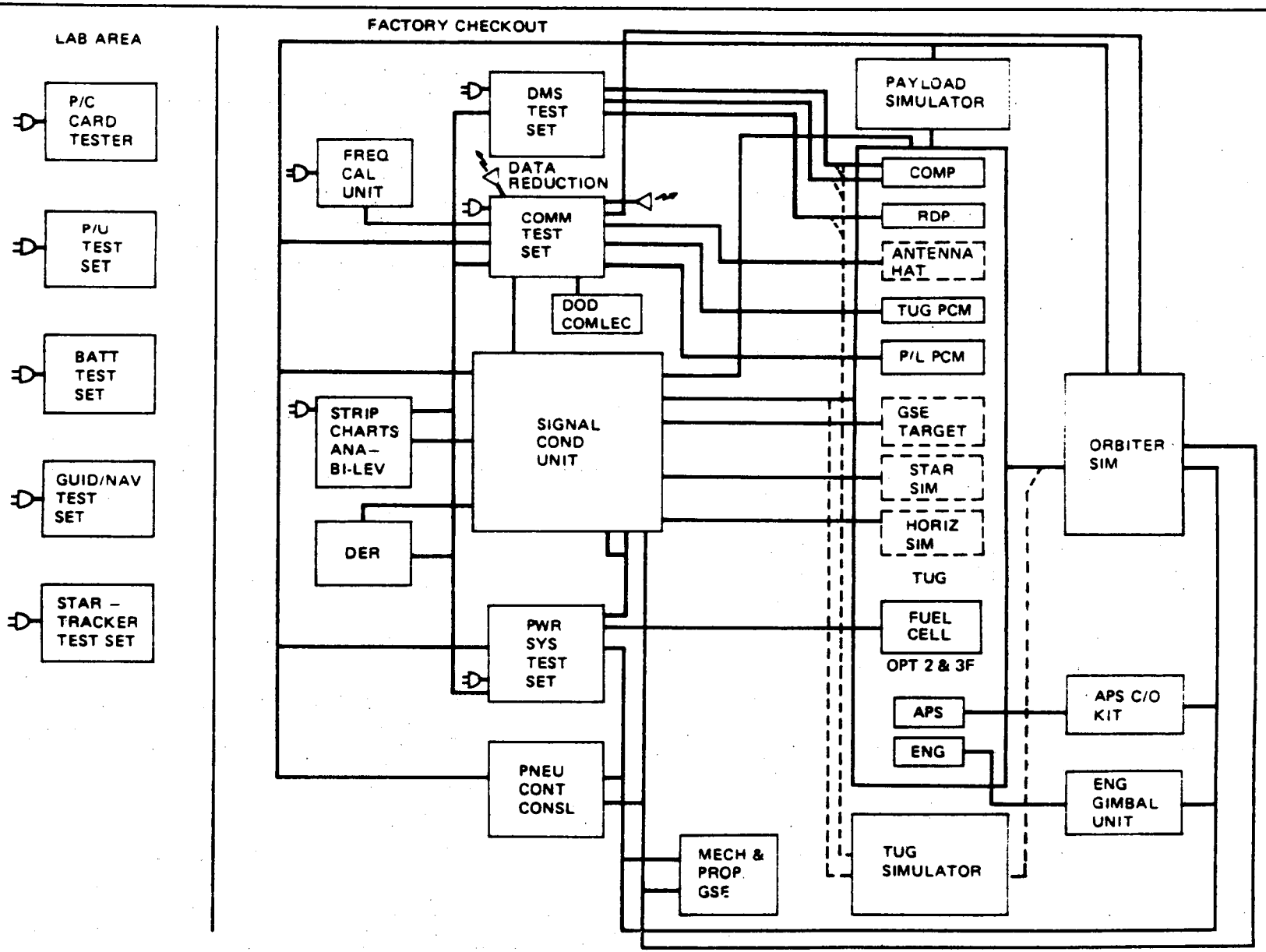
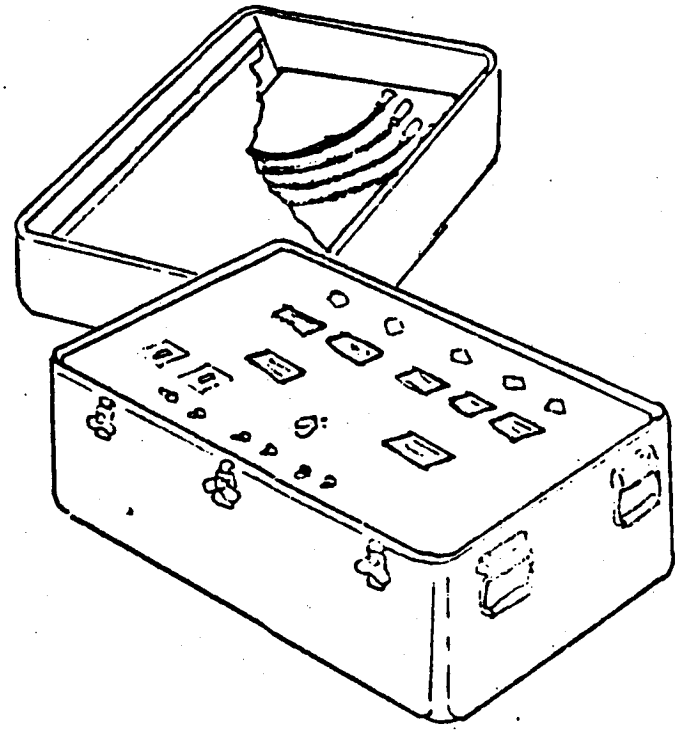


Figure 4-49. GSE Interconnection/Tug Hookup – Final



APS BREAKOUT CONTROL BOX

FUNCTIONAL REQUIREMENTS:

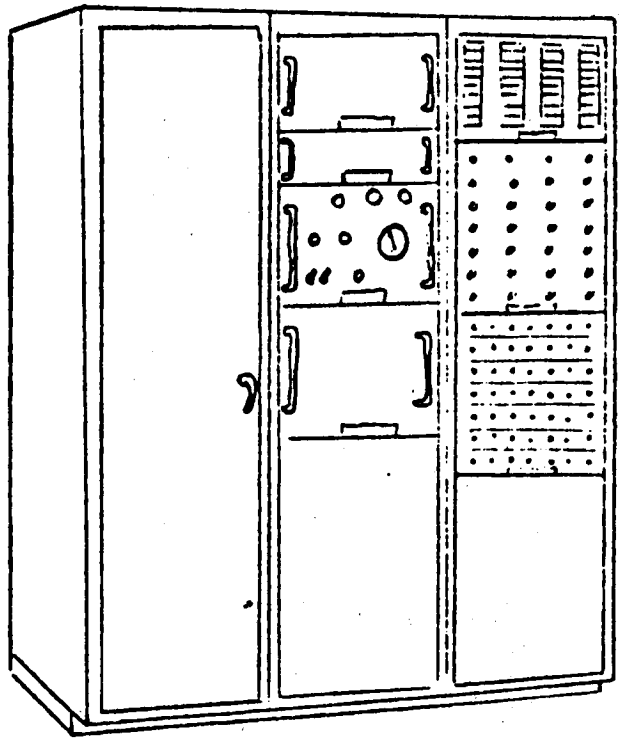
Provides individual electrical control of the APS thruster valves and isolation valves for checkout.

EQUIPMENT DESCRIPTION:

Twelve cable assemblies, suitcase assembly which contains one momentary sw., five push button indicator sw., one toggle sw., six indicator lamps, two circuit breakers, one six-bank wafer sw., five fuses, twelve connectors, and associated wiring. (Similar to DSV-7-106).

FACTORY REQUIREMENTS: 1

Figure 4-50



SPACE TUG SIMULATOR

FUNCTIONAL REQUIREMENTS:

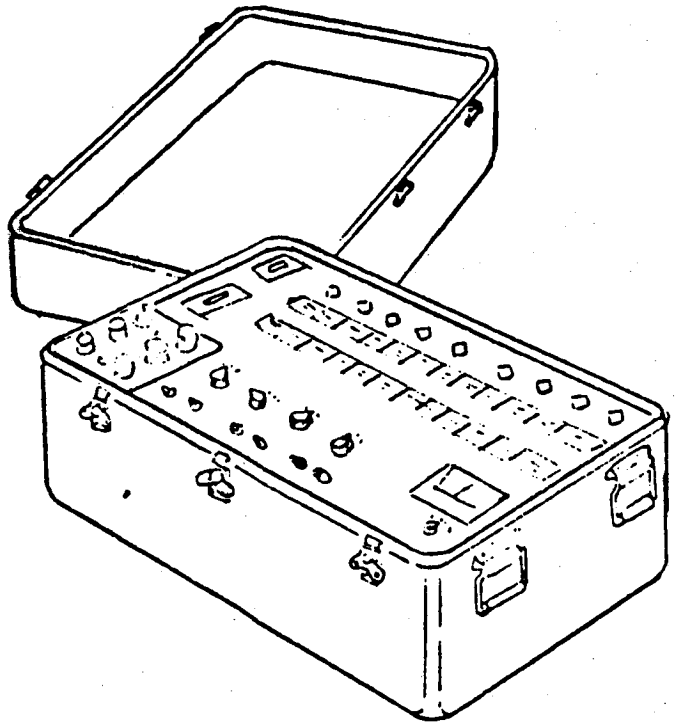
Functionally simulates Tug electrical parameters for verification of GSE, payloads and Shuttle interfaces.

EQUIPMENT DESCRIPTION:

3 Bay console interfacing with computer complex containing logic cards, encoder, decoder, and load test, test point assembly, indicator panels, logic power supply, path panel (similar to DSV-4B-132).

FACTORY REQUIREMENTS: 1

Figure 4-51



SPACECRAFT SIMULATOR

FUNCTIONAL REQUIREMENT:

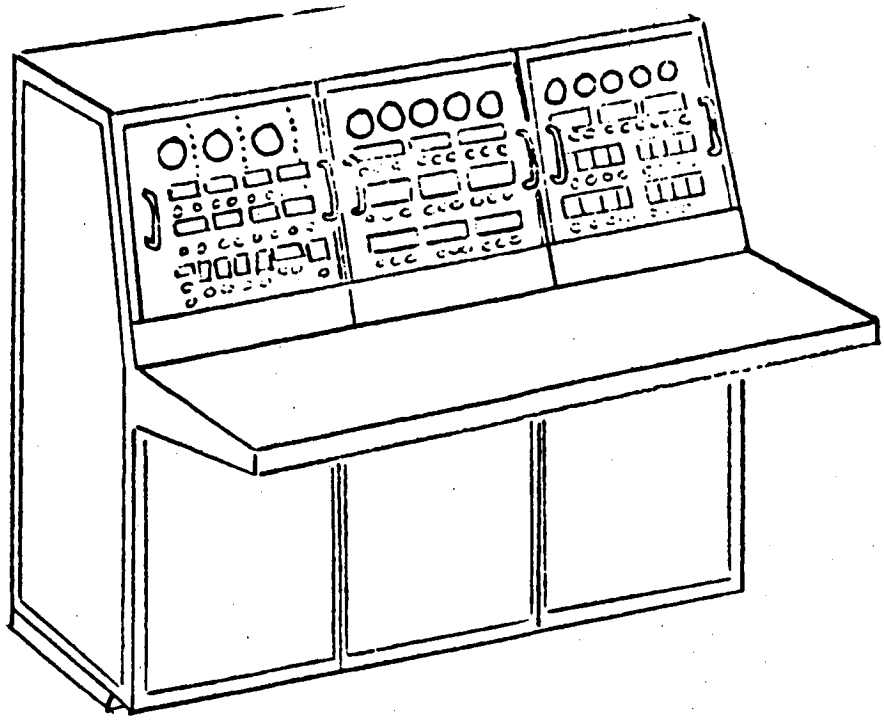
Functionally simulates Tug/Spacecraft interface for verification of electrical parameters.

EQUIPMENT DESCRIPTION:

Portable tester containing encoder, decoder and load test circuits.

FACTORY REQUIREMENTS: 1

Figure 4-52



PROPELLANT OR PNEUMATIC CONTROL CONSOLE

FUNCTIONAL REQUIREMENTS:

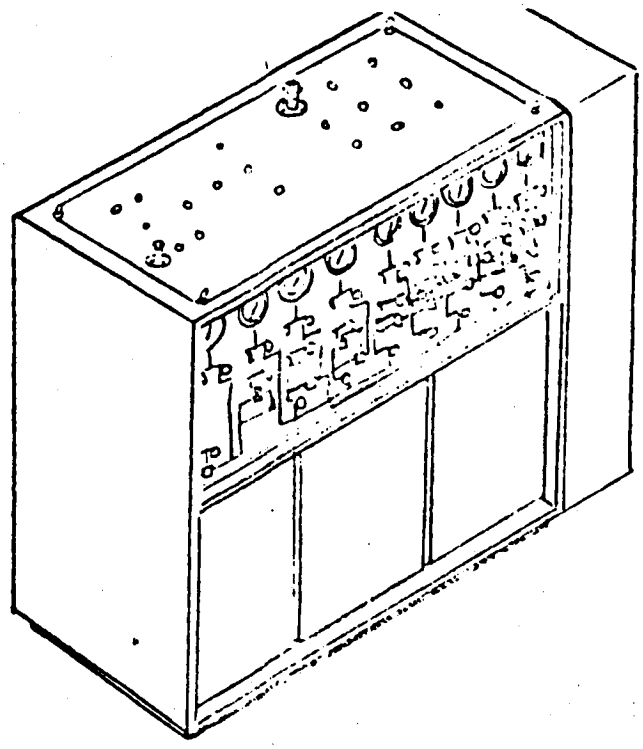
Controls and pneumatic regulated gas supplies for vehicle pressurization of pneumatics and propellant systems. Used for checkout, purge, and pressure checks and loading of pneumatics into Tug vehicle. Monitors propellant loading and unloading. Capable of semi-automatic or manual loading of propellants.

EQUIPMENT DESCRIPTION:

Three bay console with intercom, light and indicators, switches, and alpha numerical display, and associated circuitry. (Similar to DSV-4B-233.)

FACTORY REQUIREMENTS: 1

Figure 4-53



PROPULSION PNEUMATIC CONSOLE
(CHECKOUT)

FUNCTIONAL REQUIREMENTS:

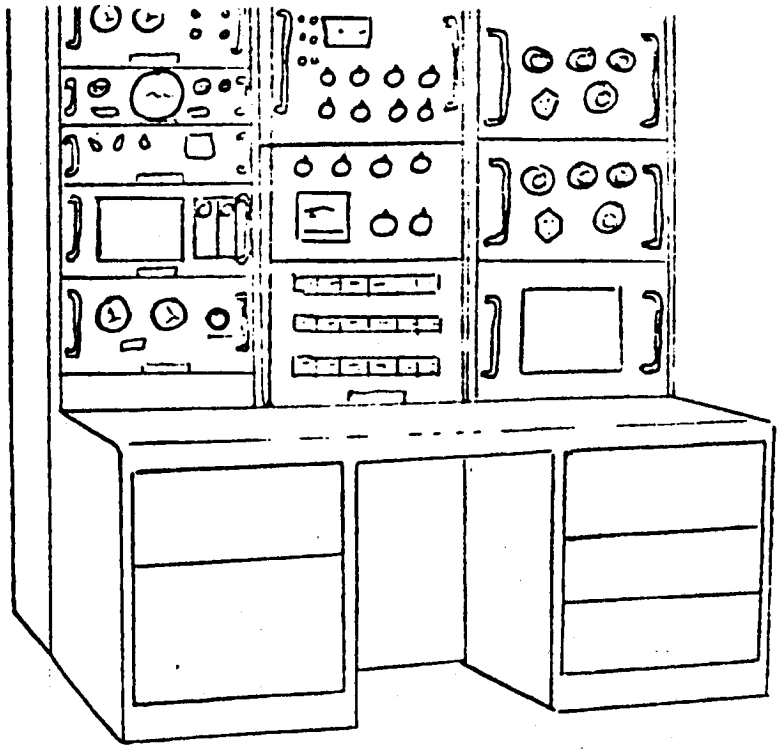
Provide regulated gas supplies to vehicle for pressurization of pneumatic and propellant systems. Used for leak and functional checks, purging, pressure draining, and application of blanket pressures.

EQUIPMENT DESCRIPTION:

Pneumatic console such as DSV-4B-321 modified as required for special Tug requirements.

FACTORY REQUIREMENTS: 1

Figure 4-54



PROPELLANT UTILIZATION COMPONENT TEST SET

FUNCTIONAL REQUIREMENTS:

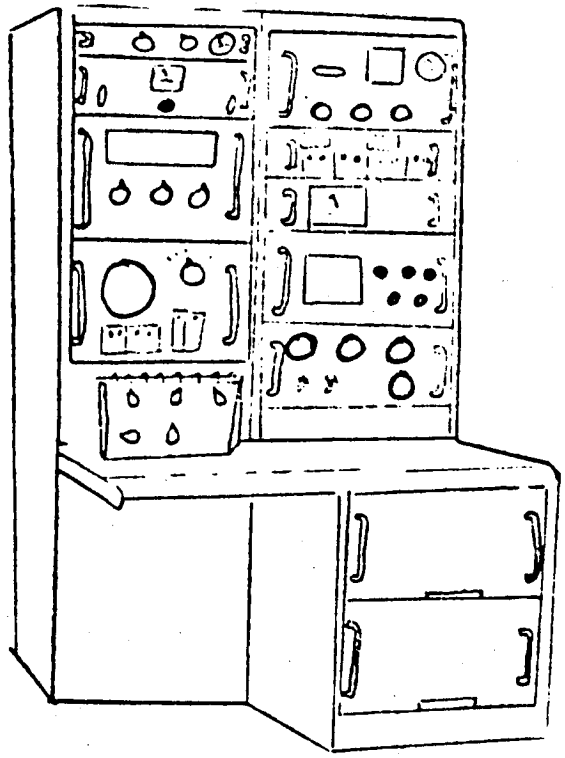
Tests and calibrates P.U. electronics assembly adjustments.

EQUIPMENT DESCRIPTION:

Similar to DSV-4B-112

FACTORY REQUIREMENTS: 1

Figure 4-55



PRINTED CIRCUIT CARD COMPONENT TEST SET

FUNCTIONAL REQUIREMENTS:

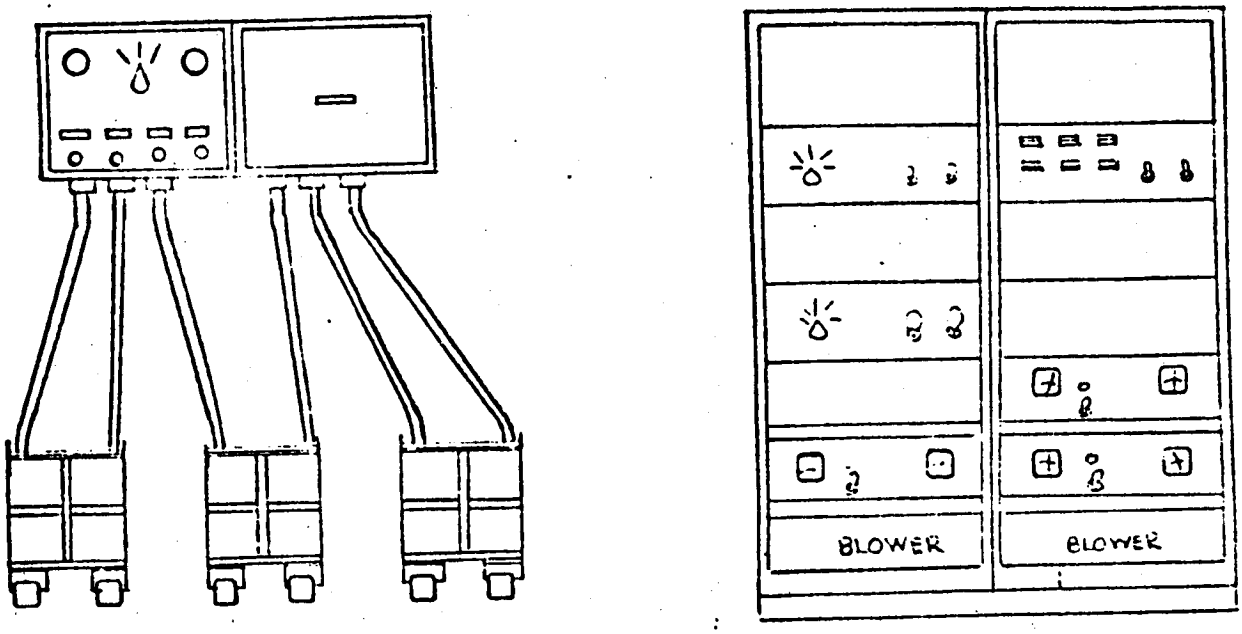
Tests printed circuit cards and isolates difficulties to component level. Provides voltages, input stimuli, and loads. Monitors outputs of cards being tested.

EQUIPMENT DESCRIPTION:

Similar to DSV-4B-104

FACTORY REQUIREMENTS: 1

Figure 4-56



POWER SYSTEM TEST SET

FUNCTIONAL REQUIREMENTS:

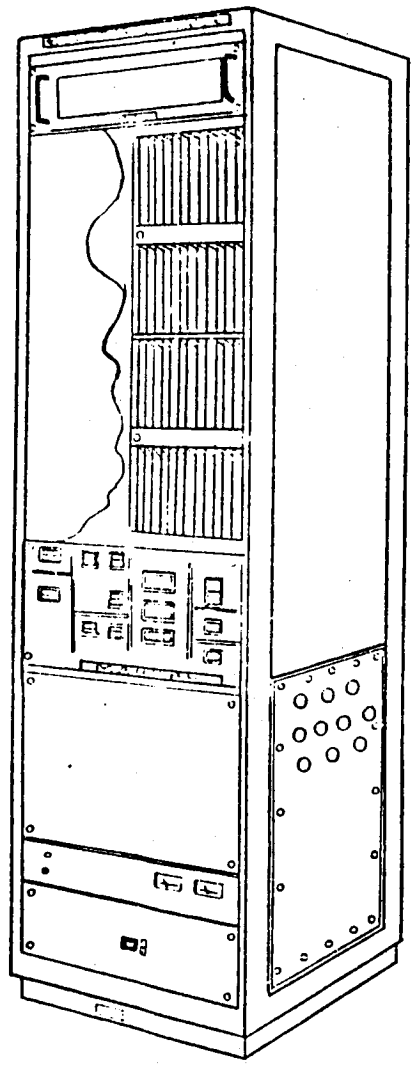
Provide means to load fuel cells and vehicle power distribution system. Provide ground power sources for vehicle and GSE. Provide emergency power in event facility power malfunction.

EQUIPMENT DESCRIPTION:

Two bay rack of electrical equipment containing two independent programmable power supplies for vehicle power, one programmable power supply for GSE power, and programmable loads for vehicle power system C/O, a backup battery unit is provided for emergency power.

FACTORY REQUIREMENTS: 1

Figure 4-57



ORBITER SIMULATOR

NAME: ORBITER SIMULATOR

FUNCTIONAL REQUIREMENTS:

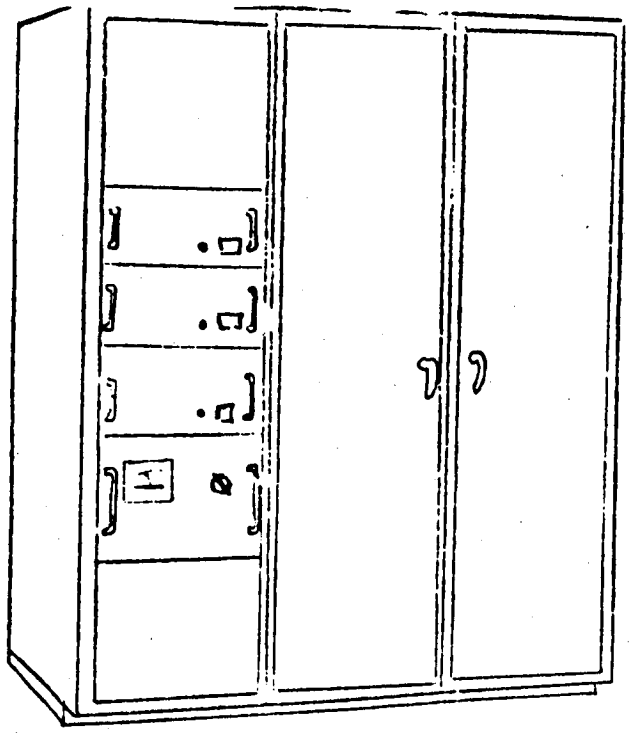
Functionally simulates orbiter/Tug interfaces for verification of electrical parameters.

EQUIPMENT DESCRIPTION:

Portable test set containing encoder, decoder and load test circuits. Contains switches and indicator lights.

FACTORY REQUIREMENTS: 1

Figure 4-58



SIGNAL CONDITIONING UNIT

FUNCTIONAL REQUIREMENTS:

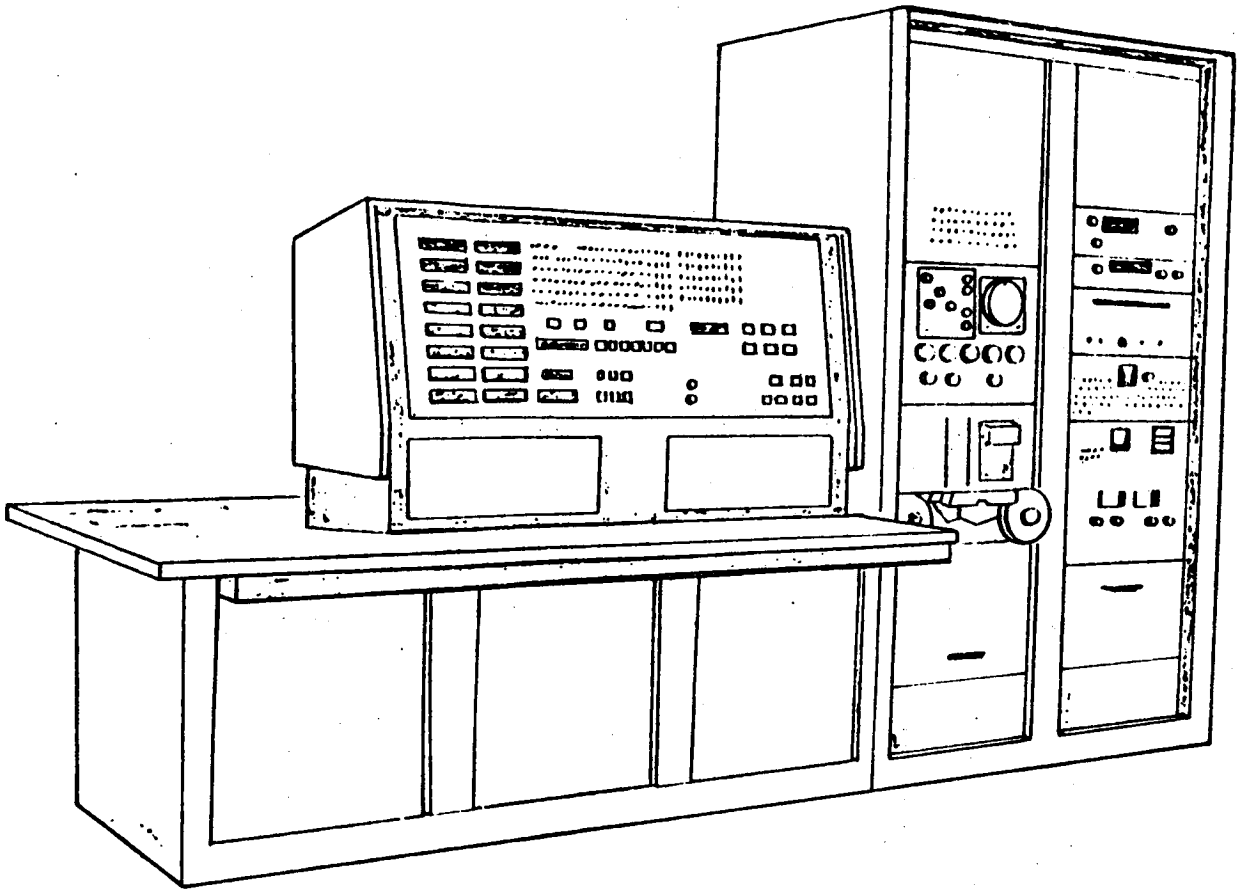
Interfaces between Tug vehicle and GSE for signal and power conditioning, and distribution.

EQUIPMENT DESCRIPTION:

Consists of a 3 bay console which contains junction box, (1) 1032 point patch panel assembly, (10) isolation amplifiers, (1) 4 row relay-plane, (10) buffer amplifiers, (1) logic power supply, and (20) connectors and associated wiring. (Similar to DSV-3B-133).

FACTORY REQUIREMENTS: 1

Figure 4-59



GUIDANCE AND NAVIGATION TEST SET

NAME: GUIDANCE AND NAVIGATION TEST SET

FUNCTIONAL REQUIREMENTS:

Monitors and verifies checkout of IMU and GC. It provides calibration, alignment and simulation of navigation programs. Capable of simulations of all flight programs.

EQUIPMENT DESCRIPTION:

Rate table and associated electronic bays which include display panel, control panel, oscilloscope, universal counter, digital voltmeter, interface (DIU) assembly, power supplies, digital printer paper tape punch, test point control panel, downlink display panel, etc. (Available from Delta Program.)

FACTORY REQUIREMENTS: 1

Figure 4-60

NAME: GUIDANCE AND NAVIGATION SYSTEM CHECKOUT KIT (PICTORIAL VIEW OMITTED)

FUNCTIONAL REQUIREMENTS:

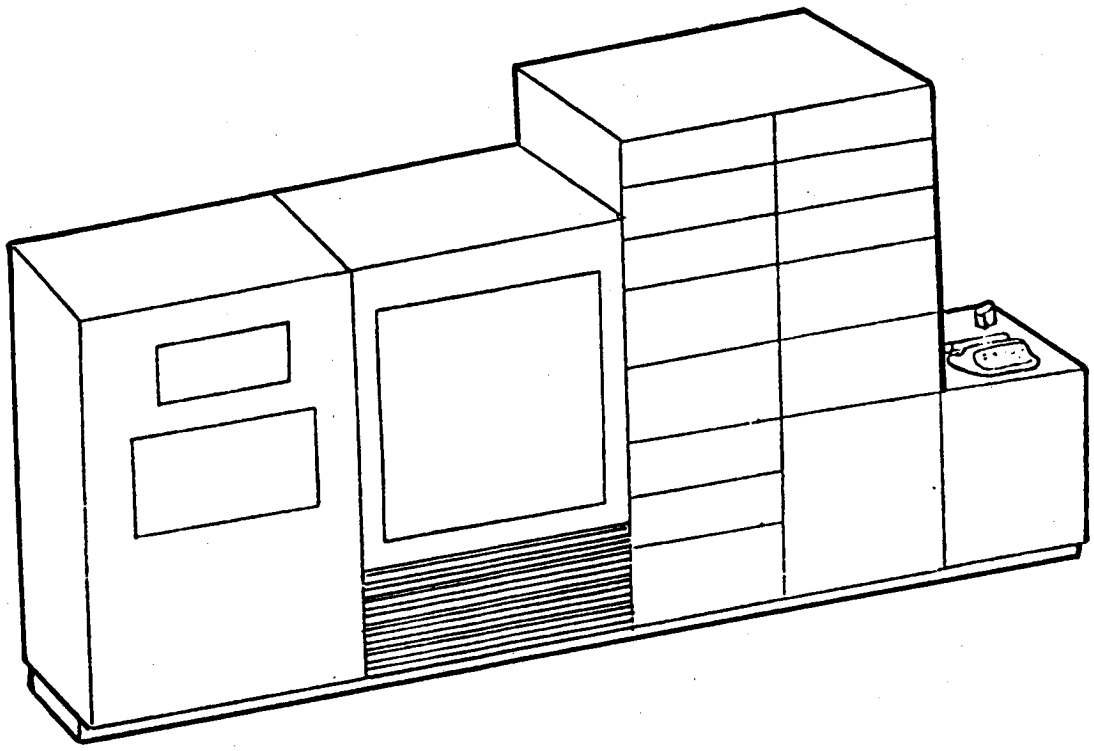
Interfaces between Tug IMU and GC and the laboratory test equipment. Also provides mounting of IMU to rate table.

EQUIPMENT DESCRIPTION:

Consists of IMU holding fixture and cables. (Available from Delta Program.)

FACTORY REQUIREMENTS: 1

Figure 4-61



DIGITAL EVENTS RECORDER (DER)

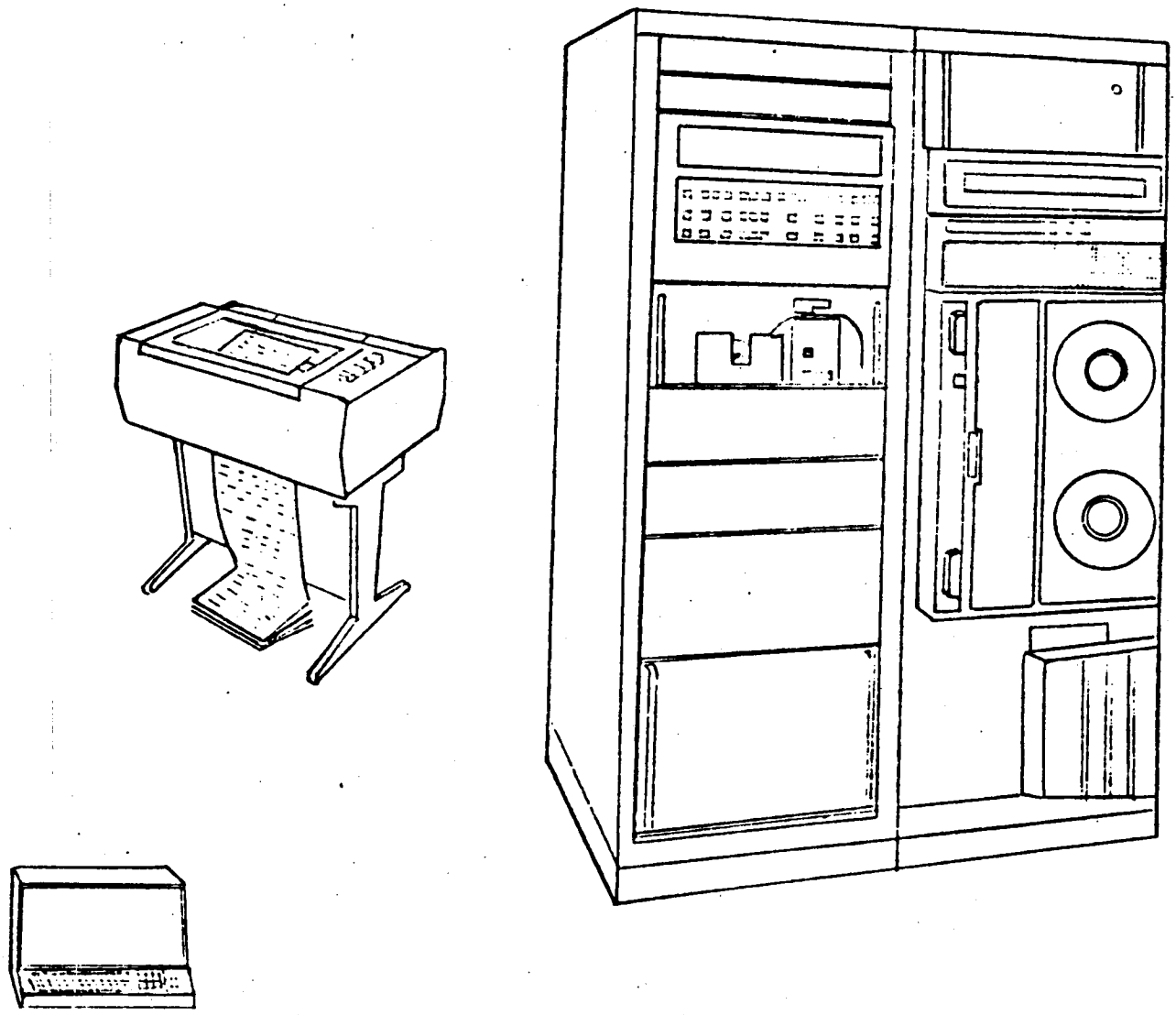
FUNCTIONAL REQUIREMENTS:

Collects discrete status (on/off) data and compares data against previously recorded information. Prints or tape punches output results for permanent record.

EQUIPMENT DESCRIPTION: Similar to DSV-4B-289

FACTORY REQUIREMENTS: 1 GFE

Figure 4-62



DATA MANAGEMENT TEST SET

FUNCTIONAL REQUIREMENTS:

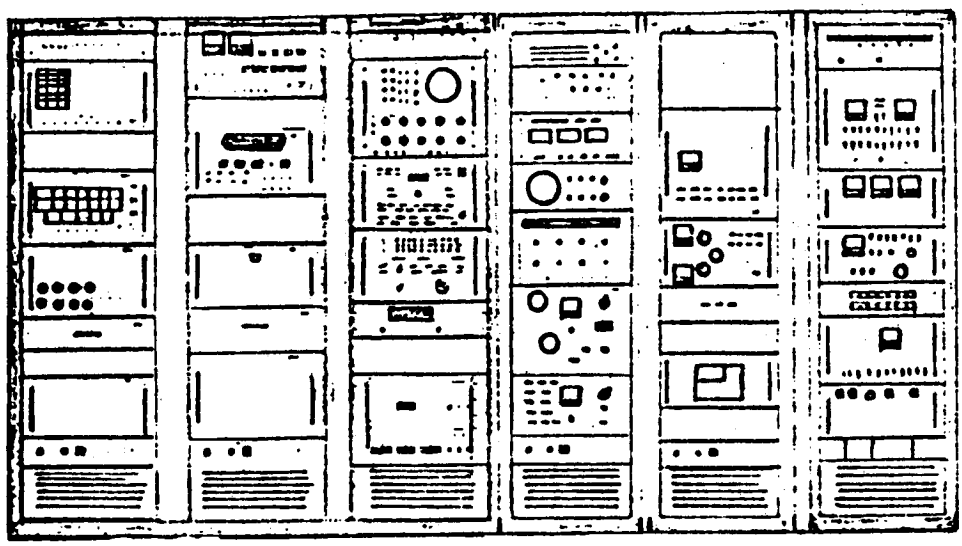
Controls operation of DMS computer and monitors computer status, initials program loading and verification, performs functional verification of DMS command and control functions, interface with other T/S for dedicated displays, verify selected subsystem parameters as program.

EQUIPMENT DESCRIPTION:

Portable console interfacing with computer for program verification and DMS memory dump C/O, paper tape memory loader, tape reader, DMS computer control and status panel, dedicated display panel for DMS function and programmable display for other subsystem functions (GNC, Comm, Power, and Prop.) - CRT

FACTORY REQUIREMENTS: 1

Figure 4-63



COMMUNICATION SYSTEM TEST SET

Functional Requirements

Receives, demodulates PCM data from spacecraft, provides for output to computer storage, contains display for visual data monitoring of incoming signals and routing of data to external areas for further processing. Can be controlled locally or through computer.

Equipment Description

NOMENCLATURE	QTY	FACTORY	LAUNCH	DE-ORBIT	REMARKS
X-Y Recorder	1	X		*	*Equipment to be
Sweep Oscillator	1	X		*	made available
Signal Generator	1	X		*	at launch complex
VSWR Meter	1	X		*	in the event of
RF Power Meter	1	X		*	transmission
RF Misc. Equipment	TBD	X		*	failures.
Frequency Counter	1	X		X	Similar to DSV-
Frequency Converter	1				4B-123 and DSV-
S-Band Test Transmitter	2				4B-125
S-Band Test Receiver	2				
S-Band FM Receiver	1				
Payload PCM Demodulator	1				

Figure 4-64

Equipment Description (Cont'd)

NOMENCLATURE	QTY	FACTORY	LAUNCH	DE-ORBIT	REMARKS
SGLS/NASA PCM Demodulator	1				
PCM Decommutator	2				
PRN Ranging Assembly (SGLS/NASA)	2				
Error Rate Measuring Unit	1				
Command Signal Conditioner (SGLS/NASA)	2				
Regulated Power Supply	2				
Logic Power Supply	2				
PCM Simulator	1				
Oscilloscope	1				
Calibration Test Panel	1				
Manual Control Panel	1				
RF Switch Panel	1				
Source Selector Panel	1				
RF Attenuator Panel	1				
Quick Loop Panel	2				
Voice Communication Panel	3				
RMS Voltmeter	1				
Circuit Breaker Panel	2				
Patch Panel	1				
Analog Strip Chart	3				Similar to DSV-
Bilevel Strip Chart	3				4B-240, DSV-4B-
FM Oscillograph	2				238, DSV-4B-239
Digital to Analog Converters	80				
Gaivanometer Drive Amplifiers	6				

Factory Requirements: 1

NAME: CHECKOUT CABLE KIT (PICTORIAL VIEW OMITTED)

FUNCTIONAL REQUIREMENTS:

Provides interconnects between test sets, vehicle, power, etc.

EQUIPMENT DESCRIPTION:

Consists of all cable, (power, RF, signal) required to support Tug Unique checkout in all areas. Cable network - 70 cable assemblies (80 ft) long - (35) 60 pin cables; (18) 4 pin cables; (5) 39 pin cables; 7 coax cables; (5) 24 pin cables; breakout cables and general breakout box. Similar to DSV-4B-726A.

FACTORY REQUIREMENTS: 1

Figure 4-65

Section 5
SPECIAL PROGRAMMATICS

The three subsections to Section 5 address innovations in program implementation, managment innovations, and potential government task sharing capabilities.

5.1 PROGRAM IMPLEMENTATION INNOVATIONS

Our approach on Program Option 3, as it is for the Space Tug project, is to minimize costs and still meet minimum acceptable performance. We consider that a planned evolutionary growth in capability for the Tug is a major innovation. The phased approach allows meeting the minimum DDT&E costs and annual funding constraints and accomplishes an orderly growth to required capability. In the test area, we are doing several things to accomplish the objectives and reduce costs, e.g., the first flight of Option 2 is an operational flight to place a payload into its assigned orbit with only secondary test objectives (accomplished with added instrumentation) to prove out the operational effectiveness of the Tug/Shuttle interfaces. This will eliminate a dedicated Shuttle flight for Tug test purposes.

In the program management approach using available tools and techniques developed for use on DOD, NASA, as well as commercial programs from throughout the MDC corporate family. The program management innovations are discussed in the following subsection 5.3.

5.2 PROGRAM MANAGEMENT FOR THE SPACE TUG PROJECT

MDAC's management approach to the Space Tug project is to apply the tools and techniques most appropriate to ensure project control at an acceptable cost level. Our approach includes reaffirming the Government's management requirements so that we can be appropriately responsive to their needs. MDAC's available management tools and techniques have evolved during extensive development and use with both NASA and DoD programs as well as on Douglas' commercial aircraft programs.

As demonstrated during the Space Tug Phase A Systems Study, the MDAC management philosophy emphasizes "cost planning." This cost planning, which will continue throughout all phases of program definition and beyond, will result in cost-awareness/cost-avoidance attitudes that are essential to effective project cost control. Cost planning is not limited to the prime contractor's role, but will extend through the working relationships to the Government and to the suppliers to establish clear-cut cost objectives and the management plans appropriate for achieving these objectives.

MDAC's cost-awareness/cost-avoidance philosophy on Space Tug emphasizes the identification of and the avoidance of all unnecessary costs. This will call for close contractor/Government working relationships and teamwork to define and manage to only those effective project requirements. The net effect of the application of this philosophy is to develop the Space Tug with only the necessary equipment, material, and labor, and hence at lower costs.

Actions that highlight the MDAC low-cost management approach on Space Tug include:

- Develop (in concert with the customer) well-defined mission performance parameters and cost objectives early in DDT&E.
- Assign highly capable personnel with applicable experience.
- Develop well-defined program plans based upon essential technical and management requirements to accomplish the mission. These program plans will be brief and concise and directive in nature to provide clear management direction and assessment without excess detail.
- Provide closely coupled contractor/Government working relationships including collocation of counterparts and task-sharing where effective.

- Develop specific contractual clauses that provide motivation to both contractor and Government to achieve the lowest cost consistent with excellence of performance and tight schedule requirements.
- Operate critical change control under strict criteria (is it functionally necessary — it is cost-effective) for accept/reject decision.
- Apply management systems responsible to the needs of contractor/Government and provide timely visibility into potential problem areas to avoid vulnerability to unplanned cost or schedule delays.
- Procure "Buy" items, particularly off-the-shelf material and subsystems components, from lowest-cost, technically capable suppliers.

Features of several of the more crucial management systems are presented below:

- Performance Measurement System (PMS)
  The MDAC PMS is an on-line approved system currently in use on the Air Force ACE program, the Army SAFEGUARD/Spartan and Site Defense programs, and the Navy Harpoon program. Our experiences show that a low-cost and effective PMS requires a realistic WBS structure, ability to selectively apply BCWS/BCWP and variance analyses, ability to adjust the levels of reporting and control to the magnitude of the cost risk represented by the WBS elements, and to provide management reports at meaningful time intervals.
- Cost-Per-Flight (CPF) Management Controls
  CPF controls have been developed that are closely integrated with the PMS and the change control system. Based upon MDAC's life-cycle-cost-modeling technology, CPF provides cost goals (targets) throughout the WBS. CPF provides continuing predictive capability for total cost, and impact assessment, and variance projections against lower-level WBS element cost targets as well as total project cost. Multi-discipline specialists work closely together to develop the cost estimates leading to the CPF targets. The task and functional managers are accountable for successful attainment of CPF goals, including development of the options and trade analyses necessary to

recover should unfavorable variances appear. One of the keys to achieving low-cost objectives is to understand the impact of decisions on program costs — a primary purpose of CPF.

- Configuration and Change Management (CM)

  The goal of CM is to effectively define contract item configuration and to manage change. On Space Tug, once a configuration is defined, it is imperative that strict criteria, by which a proposed change can be evaluated and accepted/rejected rapidly and effectively, be established. The configuration control board chaired by the program manager will use the CPF analysis to know the impact of changes against the CPF targets and the cost budgets. There is a corollary to the use of strict change criteria which implies that to avoid unnecessary costs, the mission requirements are well defined and the design team can design it right the first time to minimize change.

- Information Management (IM)

  The most effective as well as lowest-cost IM system makes maximum use of informal direct communication between designated contractor/Government counterparts for daily decision-making. This informal interchange is backed up by the formal contractual reporting system, which provides documentation of the key data and decision/action items for historical reference. The contracted data procurement document (DRD) and data requirements list (DRL) will make maximum use of internal data whever possible. In addition, MDAC's accessioning and deferred delivery methods will offer the customer up-to-date information on available internal documentation while minimizing the need for routine submission of data.

- Procurement Management

  MDAC's approach to make-or-buy, source selection, and procurement is to make use of existing proven industry capabilities while maintaining focus on the CPF targets. CPF targets are passed on to subcontractors and suppliers with appropriate contract incentives. Supplier reports are integrated into our PMS and CPF project reviews with a minimum of reprocessing. In accord with our internal information management system, the customer will have direct access to subcontractor/supplier data.

- Engineering Management

  MDAC's design team has extensive and successful cryogenic launch vehicle experience. A single organization will perform analyses, integration, and design tasks supported by functional specialists, as required (tooling, manufacturing, quality, test, logistics, etc) who are involved from project inception. Supporting this multi-discipline team approach is the recommendation for collocating contractor/customer/supplier representatives to encourage face-to-face daily dialogue. Cost-per-flight targets are assigned down to the lowest practical level of the WBS, and the design team will have specific Design-to-Cost (DTC) training. As the design concept evolves, senior engineers will be part of the team that will review the mission requirements, the design requirements, the detailed specifications, and the design drawings to ensure a thorough evaluation of alternatives to emphasize low-life-cycle costs, standard parts, and off-the-shelf hardware. Critical technical performance parameters, e.g., CPF, are selected for status reporting to provide most-meaningful technical progress assessment. Parameters are tracked by time-dependent trend data or single-point events and are measured by analysis or test with variances reported in time for corrective action with minimum cost/schedule impact. In addition to the above, the Engineering and the Manufacturing releases are closely coordinated (jointly signed off) before release to ensure full understanding and communication of each others' requirements and intentions.

In summary, application of MDAC's cost-awareness/cost-avoidance philosophy will enable Space Tug to avoid unnecessary material and labor costs. We will:

A. Understand the essential mission and program requirements, specifically:
   1. Technical
   2. Management
   3. Cost

B. Design and manage to meet the essential life-cycle requirements and the CPF targets

C. Test to verify design but minimize test hardware requirements and testing activities.

5.3 TASK SHARING

A library of both NASA and Air Force facilities and capabilities has been established by MDAC at MSFC and documentation indexes are available. Our review of these reference materials has identified potential areas for government task sharing on Space Tug. These areas are summarized on Table 5.3-1. Tables 5.3-2 through 5.3-8 contain the NASA and the Air Force Documentation Indexes. Table 5.3-9 summarizes the investigation into the MSFC S-IVB Battleship Test Stand conversion. Tables 5.3-10 and 5.3-11 summarizes the investigation into the AEDC Test Chamber capabilities. Table 5.3-12 presents a summary of the items reviewed for potential task sharing at AEDC.

Table 5.3-1 GOVERNMENT TASK SHARING CAPABILITY AREAS

ORGANIZATION / TASK/WBS ELEMENT	NASA				DOD			
	MSFC	JSC	KSC(ETR)	LeRC	WPAFB	AEDC	WTR	SAMSO
DESIGN, DEVELOP PROTOTYPE								
320.03.03 AVIONICS	X	X			X			
320.03.04 PROPULSION	X	X		X				
TEST								
320.03.04 PROPULSION	X	X		X		X		
320.03.03 AVIONICS	X	X			X			
FACILITIES EVALUATION/MODIFICATION								
320.06 FACILITIES			X				X	
MISSION PLANNING								
320.11.01	X	X						SPECIFIC PLANNING
MISSION SUPPORT								
320.11.02	X	X	X				X	X

Table 5.3-2

FACILITIES & CAPABILITIES RESOURCES DOCUMENTS ACQUISITION

DOCUMENTATION INDEXES
MULTIPLE LISTINGS

ALL NASA, AIRFORCE, OTHER GOVERNMENT & INDUSTRY FACILITIES

- NASA TECHNICAL FACILITIES CATALOG - NHB 8800.5, MARCH 1967, VOLUMES I AND II
- MDAC HYFAX REPORT
  - NASA N72-12182 - WINDTUNNELS - CR 1874
  - NASA N72-13233 - PROPULSION - CR 1875
  - NASA N72-12183 - STRUCTURES - CR 1876
  - NASA N72-14274 - FLT SIMULATORS - CR 1877
- AFSC-M-DH-1-3 PERSONNEL SUBSYSTEM (MUST BE UTILIZED WITHIN THE CONFINES OF THE REDSTONE SCIENTIFIC INFORMATION CENTER)

MCDONNELL
DOUGLAS
ASTRONAUTICS
COMPANY

Table 5.3-3

DOCUMENTATION INDEXES

NASA

AMES

- RESEARCH FACILITIES SUMMARY
- SEE ALL NASA, AIR FORCE, OTHER GOVERNMENT & INDUSTRY FACILITIES LISTING

FLIGHT RESEARCH CENTER

- CONTACT DISCUSSED THEIR HIGH TEMPERATURE LOADS LABORATORY AND HANGAR TYPE FACILITIES
- SEE ALL NASA, AIR FORCE, OTHER GOVERNMENT & INDUSTRY FACILITIES LISTING

GIFSS

- LACK OF INTEREST DEMONSTRATED
- ALL NASA, AIR FORCE, OTHER GOVERNMENT & INDUSTRY FACILITIES LISTING

GSFC

- CONTACT INDICATED NOTHING WAS AVAILABLE AT EITHER OF THE GODDARD FACILITIES
- SEE ALL NASA, AIR FORCE, OTHER GOVERNMENT & INDUSTRY FACILITIES LISTING

Table 5.3-4

DOCUMENTATION INDEXES

NASA

JPL

- (SEE ALL NASA, AIR FORCE, OTHER GOVERNMENT & INDUSTRY FACILITIES LISTING)

JSC

- THE BLUE BOOK OF ORGANIZATION FUNCTIONS KEY PERSONNEL
- MAJOR TEST FACILITIES OF THE ENGINEERING & DEVELOPMENT DIRECTORATE
- (SEE ALL NASA, AIR FORCE, OTHER GOVERNMENT & INDUSTRY FACILITIES LISTING)

KSC

- ORGANIZATION FUNCTIONS KEY PERSONNEL - GP-768 - JANUARY 1, 1973 (REV. 1/73)
- KSC ORGANIZATION MANAGEMENT NOTICES - KN 1142.1 - 1 - 25
- FACILITIES DESCRIPTIONS, KSC/ETR, MAY 15, 1971, TR-1080, REV 1
- SUPPORT SERVICES HANDBOOK, AUGUST 11, 1971, KHB 8610-1A/AD
- (SEE ALL NASA, AIR FORCE, OTHER GOVERNMENT & INDUSTRY FACILITIES LISTING)

Table 5.3-5

DOCUMENTATION INDEXES

NASA

LeRC

- HAVE NEVER PUT TOGETHER A FACILITY HANDBOOK
- WORLD'S LARGEST SPACE CHAMBER - 100 FT. DIAMETER BY 120 FT. HIGH, BUILT FOR NUCLEAR - PLUM BROOK STATION
- SEE ALL NASA, AIR FORCE, OTHER GOVERNMENT & INDUSTRY FACILITIES DOCUMENT

LRC

- SEE ALL NASA, AIR FORCE, OTHER GOVERNMENT & INDUSTRY FACILITIES DOCUMENT

MSFC

- MSFC ORGANIZATION HANDBOOK
  - S&E LAB ORGANIZATION CHARTS
- TECHNICAL FACILITIES AND EQUIPMENT DIGEST
- ASTRIONICS LABORATORY FACILITIES AND CAPABILITIES
- MACHINE TOOL MANUFACTURING MASTER INDEX, VOLUME I
- MACHINE TOOL MANUFACTURING MASTER INDEX, VOLUME II
- MSFC EQUIPMENT AVAILABILITY LISTING, JANUARY, 1973

MCDONNELL
DOUGLAS
ASTRONAUTICS
COMPANY

DOCUMENTATION INDEXES

NASA

MSFC (CONTINUED)

- SATURN/SKYLAB/ENGINES CONFIGURATION MANAGEMENT MANUAL - NO. MM8040. 10A DATED FEBRUARY 17, 1970
- NASA MISSISSIPPI TEST FACILITY
- MICHOUD ASSEMBLY FACILITY
- SEE ALL NASA, AIR FORCE, OTHER GOVERNMENT & INDUSTRY FACILITIES LISTING

WHITE SANDS

- SEE ALL NASA, AIR FORCE, OTHER GOVERNMENT & INDUSTRY FACILITIES LISTING
- WHITE SANDS TEST FACILITY

Table 5.3-7

DOCUMENTATION INDEXES

AIR FORCE

AEDC

- TECHNICAL FACILITIES HANDBOOK, 9TH EDITION
- DOD FUNDING POLICY & REQUIRED BUDGET ACTION FOR FY 75
- TEST HIGHLIGHTS, ALL ISSUES
- ASSORTED LETTERS ON NEW TESTING CAPABILITIES AT AEDC
- S-IVB BATTLESHIP TEST FACILITY, COMPLETE INFORMATION

AFSCP

- ACQUISITION MANAGEMENT, A GUIDE FOR PROGRAM MANAGEMENT - AFSCP-800-3

WPAFB

- DESCRIPTIONS OF AFAPL/PO IN-HOUSE FACILITIES
- AIR FORCE AVIONICS LABORATORY, TECHNICAL PROGRAMS & CONTACTS. THE DYNAMIC ANALYZER COMPLEX MISSION & CAPABILITY
- MISSION ORGANIZATION ACCOMPLISHMENTS
- AIR FORCE MATERIALS LABORATORY, MISSION ORGANIZATION AND ACCOMPLISHMENTS
- AEROSPACE POWER FACILITIES
- TECHNICAL PROGRAM AND CONTACTS
- SEE ALL NASA, AIR FORCE OTHER GOVERNMENT & INDUSTRY FACILITIES LISTING

Table 5.3-8

DOCUMENTATION INDEXES (CONTINUED)

AIR FORCE

EAFB

- AIR FORCE ROCKET PROPULSION LABORATORY FACILITY BROCHURE
- SEE ALL NASA, AIR FORCE, OTHER GOVERNMENT & INDUSTRY FACILITIES LISTING

GRIFFISS AIR FORCE BASE

- ROME AIR DEVELOPMENT CENTER
- SEE ALL NASA, AIR FORCE, OTHER GOVERNMENT & INDUSTRY FACILITIES LISTING

Table 5.3-9

GOVERNMENT FACILITY INVESTIGATION

FACILITY:

- MSFC S-IVB BATTLESHIP TEST STAND/CONVERSION TO SPACE TUG FACILITY

DISCUSSION:

- SUFFICIENT PROPELLANT, GAS, INSTRUMENTATION AND ETC. FOR COLD FLOW AND STATIC FIRING
- MODIFICATION REQUIRED
  - REMOVE EXISTING TANKAGE
  - MODIFY EXISTING THRUST SUPPORT RING AND WORK PLATFORMS
  - MODIFY FACILITY PROPELLANT, GAS & INSTRUMENTATION INTERFACE TO VEHICLE
  - ADDITION OF ALTITUDE SIMULATION SYSTEM
  - ROM QUOTE TO BE MADE

Table 5.3-10

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY

GOVERNMENT FACILITIES INVESTIGATION

FACILITY:

AEDC MARK I CHAMBER

LOCATION:

TULLAHOMA, TENN.

DISCUSSION:

- ADEQUATE DYNAMIC TEST CAPABILITY EXCEPT FOR ACOUSTICS
- LIMITED TO LN_2 AND SMALL QUANITY OF LH_2
- GOOD SOLAR HEAT SIMULATION CAPABILITY
- GOOD SPACE ENVIRONMENT SIMULATION CAPABILITY, BUT SLOW PUMP DOWN RATE
- GOOD INSTRUMENTATION CAPABILITY
- ROM QUOTE MADE

MCDONNELL
DOUGLAS
ASTRONAUTICS
COMPANY

Table 5.3-11

GOVERNMENT FACILITIES INVESTIGATION

FACILITY:

AEDC J-3 AND J-4 TEST CHAMBER

LOCATION:

TULLAHOMA, TENN.

DISCUSSION:

- GOOD ALTITUDE ENGINE FIRING TEST FACILITIES AT 75,000 FT.
- GOOD PROPELLANT, GAS, INSTRUMENTATION AND ETC. CAPABILITY
- NO DYNAMIC AND SPACE HEAT SIMULATION CAPABILITY
- REACTIVATION REQUIRED
- J-3 TOO SMALL FOR TUG VEHICLE TESTING
- ROM QUOTE MADE

SECTION 6

COST DATA

This section contains cost estimates for each program phase (DDT&E), production and operations) by WBS element and subdivisions of work. Also included are: funding estimates for each program phase by WBS element; total program funding distribution; cost per flight data; and technical characteristics data.

Since subsection 6.2 contains first unit production costs through Level 7 for WBS 320-03 Vehicle Main Stage on Cost Data Form A(2) recurring (production), the Level 7 information is not repeated by itself in Subsection 6.8. Instead Subsection 6.8 is being used as the most convenient location for the LEADER II cost model printout for costs of each program phase and the otal program, as well as: costs for first production unit costs through Level 7; and initial spares and operational spares costs through Level 6.

6.1 DDT&E PER WBS ELEMENTS

This subsection contains cost estimates for each WBS element through Level 7, as appropriate, displayed on Cost Data Form A(1), nonrecurring (DDT&E). The definitions of each column are as follows:

Identification Number: The appropriate WBS code corresponding to the item of cost.

WBS Identification: The alphanumeric nomenclature of the item from the WBS.

WBS Level: The level at which the cost is accumulated:

Level 3	-	Project
Level 4	-	System/Module
Level 5	-	Subsystem
Level 6	-	Assembly
Level 7	-	Component

Expected Cost: The cost estimate for the WBS item. For production and operations items, the WBS item cost is the total cumulative cost for the number of units quantified in the "number of units" column.

Confidence Rating: The value of (1), lowest, through (4), highest, representing the estimator's confidence in the estimate shown in the WBS item cost column. The value is obtained by reviewing the Government criteria contained

OPTION 3

INITIAL

COST DATA FORMS A(1)

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32001	PROJECT MGMT.	4	6.86	3.0	60	54	0
32002	SYS. ENGR. & INT.	4	14.50	3.0	60	54	40
32003	VEH MAIN STAGE	4	101.09	3.8	55	54	60
32004	VEH AUX. STAGE	4	1.63	3.0	35	44	50
32005	LOGISTICS	4	1.66	3.0	39	45	0
32006	FACILITIES	4	5.17	3.0	76	53	50
32007	GRND. SUPT. EQUIP	4	27.65	4.0	66	51	40
32008	VEHICLE TEST	4	21.20	3.0	54	48	41
32009	LAUNCH OPNS. WTR	4	.00	3.0	39	45	0
32010	LAUNCH OPNS ETR	4	.00	3.0	39	45	0
32011	FLIGHT OPNS NASA	4	5.92	3.0	41	35	60
32012	FLIGHT OPNS DOD	4	4.20	3.0	41	35	60
32013	REFURB &INTEG WTR	4	.11	3.0	39	45	0
32014	REFURB &INTEG ETR	4	.11	3.0	39	45	0
320	TOTAL	3	190.10	3.5	77	54	50

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T O	T S	SPREAD FUNCT.
32001	PROJECT MGMT.	4	6.86	3.0	60	54	0
3200101	COST/PERF. MGMT.	5	4.71	3.0	60	54	0
3200102	PROJ. DIRECTION	5	2.02	3.0	60	54	0
3200103	INFORM. MGMT.	5	.13	3.0	60	54	0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32002	SYS. ENGN. & INT.	4	14.50	3.0	60	54	40
3200201	TUG SYS. ENGR.	5	11.60	3.0	60	54	40
3200202	SHUTTLE I/F	5	.73	3.0	60	54	40
3200203	PAYLOAD I/F	5	2.17	3.0	60	54	40

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32003	VEH MAIN STAGE	4	101.09	3.8	55	54	60
3200301	STRUCTURES	5	17.71	4.0	45	54	60
3200302	THERMAL CONTROL	5	1.44	3.0	43	54	57
3200303	AVIONICS	5	25.59	4.0	48	54	58
3200304	PROPULSION	5	32.67	4.0	45	54	59
3200305	ORBITER I/F	5	12.59	3.0	55	54	68
3200306	DROP TANKS	5	.00	3.0	0	0	0
3200307	FINAL ASSY & C/O	5	11.11	3.0	51	54	59
320030101	FUEL TK & SUPT	6	4.85	4.0	45	54	60
320030102	OXID. TK & SUPT	6	2.62	4.0	45	54	60
320030103	BODY STRUCTURE	6	4.09	4.0	45	54	60
320030104	THRUST STRUCTURE	6	1.38	4.0	45	54	60
320030105	METEOROID SHIELD	6	.98	4.0	45	54	60
320030106	PAYLOAD I/F	6	2.47	4.0	45	54	60
320030107	INSTL. ASSY & C/O	6	1.31	4.0	45	54	60
320030201	FUEL TANK INSL	6	.16	3.0	43	54	60
320030202	OXID. TANK INSL.	6	.08	3.0	43	54	60
320030203	INSL. PURGE SYS.	6	1.13	3.0	43	54	56
320030204	THERM CONT. SYS.	6	.00	3.0	0	0	0
320030205	INSTL ASSY & C/O	6	.07	3.0	43	54	57
320030301	DATA MGMT. 3	6	9.75	4.0	48	54	59
320030302	G N & C	6	1.47	4.0	48	54	60
320030303	COMMUNICATIONS	6	5.89	4.0	48	54	57
320030304	INSTRUMENTATION	6	2.08	4.0	48	54	60
320030305	ELECT. POWER	6	.14	4.0	48	54	56
320030306	PWR. DIST. & CONT	6	.88	4.0	48	54	60
320030307	INSTL. ASSY & C/O	6	5.38	4.0	48	54	60
320030401	MAIN ENGINE 3	6	13.00	4.0	45	54	60
320030402	MAIN ENG. SUPT	6	12.08	4.0	45	54	57
320030403	ACPS ENGINE	6	.41	4.0	45	54	57
320030404	ACPS ENG. SUPT	6	3.62	4.0	45	54	59
320030405	INSTL. ASSY & C/O	6	1.56	4.0	45	54	59
320030501	STRUCTURES	6	4.01	3.0	55	54	69
320030502	I/F PANELS	6	6.47	3.0	55	54	68
320030503	PURGE PROV.	6	.00	3.0	0	0	0
320030504	ABORT PROV.	6	1.17	3.0	55	54	68
320030505	INSTL. ASSY & C/O	6	.93	3.0	55	54	68
320030701	FINAL ASSY	6	8.41	3.0	51	54	59
320030702	C/O	6	2.70	3.0	51	54	59
32003010101	LH2 DOMES	7	1.70	4.0	45	54	60
32003010102	LH2 CYLINDER	7	2.24	4.0	45	54	60
32003010103	LH2 SUPPORTS	7	.91	4.0	45	54	60
32003010201	LO2 DOMES	7	1.99	4.0	45	54	60
32003010202	LO2 SUPPORTS	7	.63	4.0	45	54	60
32003010301	FWD AFT SKIRT	7	.00	4.0	0	0	0
32003010302	INTERTANK	7	1.98	4.0	45	54	60

STUDY TITLE: SPACE TUG SYS. STY (GRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPHEAD FUNCT.
32003010303	SDWL SHELL	7	2.11	4.0	45	54	60
32003030101	COMPUTER	7	5.41	4.0	48	54	59
32003030102	DATA DISTR.	7	.00	4.0	0	0	0
32003030103	EQ. THERM CONT.	7	.75	4.0	48	54	54
32003030104	CIRCUITRY 3	7	.54	4.0	48	54	60
32003030105	SOFTWARE	7	2.33	4.0	48	54	60
32003030106	SOFTWARE	7	.00	4.0	0	0	0
32003030107	SOFTWARE	7	.00	4.0	0	0	0
32003030108	INSTL, ASSY & C/O	7	.72	4.0	48	54	59
32003030201	I M U	7	.72	4.0	48	54	60
32003030202	TRACKING/ELECT 3	7	.65	4.0	48	54	60
32003030203	RLN DEZ&DOCKING 3	7	.00	4.0	0	0	0
32003030204	INSTL, ASSY & C/O	7	.11	4.0	48	54	60
32003030301	M/W CIRC +RF MUX	7	2.20	4.0	48	54	56
32003030302	TRANSPONDERS 3	7	.87	4.0	48	54	60
32003030303	POWER AMP.	7	.39	4.0	48	54	60
32003030304	ANTENNA	7	.36	4.0	48	54	55
32003030305	DEC/ENC+MOD/DEM	7	1.12	4.0	48	54	57
32003030306	TAPE RECORDER	7	.27	4.0	48	54	55
32003030307	P/L INTER EQUIP	7	.24	4.0	48	54	60
32003030308	INSTL, ASSY & C/O	7	.44	4.0	48	54	57
32003030401	DATA SENSORS	7	.06	4.0	48	54	60
32003030402	SIGNAL COND.	7	.14	4.0	48	54	57
32003030403	CIRCUITRY	7	1.75	4.0	48	54	60
32003030404	INSTL, ASSY & C/O	7	.15	4.0	48	54	60
32003030501	BATTERY	7	.13	4.0	48	54	56
32003030502	FUEL CELL 3	7	.00	4.0	0	0	0
32003030503	INSTL, ASSY & C/O	7	.01	4.0	48	54	56
32003030601	DISTR.	7	.81	4.0	48	54	60
32003030602	TANKS SYSTEM 3	7	.00	4.0	0	0	0
32003030603	INSTL, ASSY & C/O	7	.07	4.0	48	54	60

STUDY TITLE: SPACE TUG SYS. STY (GRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32004	VEH AUX. STAGE	4	1.63	3.0	35	44	50
3200401	VEH AUX. STAGE	5	1.62	3.0	35	44	50

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32005	LOGISTICS	4	1.66	3.0	39	45	0
3200501	TRANSP. & HDLG.	5	.00	3.0	0	0	0
3200502	TRAINING	5	1.37	3.0	39	45	01
3200503	INV CO						
T.0	5	.29	3.0	39	45	0	
320050201	SIM. & EQUIP.	6	.00	3.0	39	45	0
320050202	GROUND CREW	6	1.37	3.0	39	45	0

01-9

S

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32000	FACILITIES	4	5.17	3.0	76	53	50
3200601	MANUFACTURING	5	1.12	3.0	76	53	50
3200602	TEST	5	1.50	3.0	76	53	50
3200603	ATR MAINT. & REF.	5	1.02	3.0	76	53	50
3200604	ETR LAUNCH	5	.39	3.0	76	53	50
3200605	WTR MAINT. & REF.	5	.77	3.0	76	53	50
3200606	WTR LAUNCH	5	.38	3.0	76	53	50
320060101	DES./CONST.	6	1.09	3.0	76	53	50
320060102	ACTIV./MAINT.	6	.02	3.0	76	53	50
320060201	DES./CONST.	6	1.50	3.0	76	53	50
320060202	ACTIV./MAINT.	6	.00	3.0	0	0	0
320060301	DES./CONST.	6	1.00	3.0	76	53	50
320060302	ACTIV./MAINT.	6	.02	3.0	76	53	50
320060401	DES./CONST.	6	.38	3.0	76	53	50
320060402	ACTIV./MAINT.	6	.01	3.0	76	53	50
320060501	DES./CONST.	6	.75	3.0	76	53	50
320060502	ACTIV./MAINT.	6	.01	3.0	76	53	50
320060601	DES./CONST. 3	6	.37	3.0	76	53	50
320060602	ACTIV./MAINT. 3	6	.01	3.0	76	53	50

STUDY TITLE: SPACE TUG SYS, STY (GRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T O	T S	SPREAD FUNCT.
32007	GRND. SUPT. EQUIP	4	27.65	4.0	66	51	40
3200701	MFG. GSE	5	6.89	4.0	66	51	40
3200702	ETH GSE	5	10.24	4.0	66	51	40
3200703	WTR GSE	5	9.57	4.0	66	51	40
3200704	FLT OPS GSE(NASA)	5	.48	4.0	66	51	40
3200705	FLT OPS GSE(DOD)	5	.48	4.0	66	51	40
320070101	HARDWARE	6	4.42	4.0	66	51	40
320070102	SITE ACTIV.	6	.09	4.0	66	51	40
320070103	MAINT.	6	.00	4.0	0	0	0
320070104	SOFTWARE	6	2.38	4.0	66	51	40
320070201	HARDWARE	6	6.49	4.0	66	51	40
320070202	SITE ACTIV.	6	2.14	4.0	66	51	40
320070203	MAINT.	6	.00	4.0	0	0	0
320070204	SOFTWARE	6	1.61	4.0	66	51	40
320070301	HARDWARE	6	6.03	4.0	66	51	40
320070302	SITE ACTIV.	6	1.99	4.0	66	51	40
320070303	MAINT.	6	.00	4.0	0	0	0
320070304	SOFTWARE	6	1.55	4.0	66	51	40
320070401	HARDWARE 3	6	.00	4.0	0	0	0
320070402	SITE ACTIV. 3	6	.00	4.0	0	0	0
320070404	SOFTWARE 3	6	.47	4.0	66	51	40
320070501	HARDWARE 3	6	.00	4.0	0	0	0
320070502	SITE ACTIV. 3	6	.00	4.0	0	0	0
320070504	SOFTWARE 3	6	.47	4.0	66	51	40

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T U	T S	SPREAD PUNCT.
32008	VEHICLE TEST	4	21.20	3.0	54	48	41
3200801	GND TEST HDWE.	5	13.96	3.0	33	48	40
3200802	GND TEST OPNS.	5	6.39	3.0	33	40	40
3200804	FLT. TEST OPNS	5	.85	3.0	12	6	50
320080101	PTV TEST	6	3.22	3.0	33	48	40
320080102	MAJOR TEST ART.	6	10.26	3.0	33	48	40
320080103	MOCKUPS	6	.48	3.0	33	48	40

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32009	LAUNCH OPNS. #TR	4	.00	3.0	0	0	0
3200901	LNCH SITE SVCES	5	.00	3.0	0	0	0
3200902	TUG/SHTL MATING	5	.00	3.0	0	0	0
3200903	PRELAUNCH C/O	5	.00	3.0	0	0	0
3200904	COUNTDOWN	5	.00	3.0	0	0	0
3200905	PRLNTS. & GASES	5	.00	3.0	0	0	0
3200906	POST FLT. SAFING	5	.00	3.0	0	0	0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32010	LAUNCH OPNS ETR	4	.00	3.0	0	0	0
3201001	LNCH SITE SVCES	5	.00	3.0	0	0	0
3201002	TUG/SHTL MATING	5	.00	3.0	0	0	0
3201003	PRELAUNCH C/O	5	.00	3.0	0	0	0
3201004	COUNTDOWN	5	.00	3.0	0	0	0
3201005	PRLNTS & GASES	5	.00	3.0	0	0	0
3201006	POST FLT. SAFING	5	.00	3.0	0	0	0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DUTBE)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32011	FLIGHT OPNS NASA	4	5.92	3.0	41	35	60
3201101	MISSION PLG.	5	2.70	3.0	41	35	60
3201102	FLT. CONTROL	5	.41	3.0	41	35	60
3201103	FLT. EVAL.	5	.00	3.0	0	0	0
3201104	FLT. SUPT. SFTWRE	5	2.81	3.0	41	35	60

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32012	FLIGHT OPNS DOD	4	4.20	3.0	41	35	60
3201201	MISSION PLG	5	1.92	3.0	41	35	60
3201202	FLT. CONTROL	5	.29	3.0	41	35	60
3201203	FLT. EVAL.	5	.00	3.0	0	0	0
3201204	FLT. SUPT. SFTWRE	5	1.99	3.0	41	35	60

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DUT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T U	T S	SPREAD FUNCT.
32013	REFURB & INTEG WTR	4	.11	3.0	39	45	0
3201301	SCH MAINT & REF	5	.00	3.0	0	0	0
3201302	UNSCH MAINT & REF	5	.00	3.0	0	0	0
3201303	POST MAINT C/O	5	.00	3.0	0	0	0
3201304	TUG/PL MAING &/CO	5	.00	3.0	0	0	0
3201305	REFURB RQMTS PLG	5	.11	3.0	39	45	0
3201306	DEPOT MAINT	5	.00	3.0	0	0	0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32014	REFURB &INTEG ETR	4	.11	3.0	39	45	0
3201401	SCH MAINT & REF	5	.00	3.0	0	0	0
3201402	UNSCH MAINT & REF	5	.00	3.0	0	0	0
3201403	POST MAINT C/O	5	.00	3.0	0	0	0
3201404	TUG/PL MATING,C/O	5	.00	3.0	0	0	0
3201405	REFURB RQMTS PLG	5	.11	3.0	39	45	0
3201406	DEPOT MAINT	5	.00	3.0	0	0	0

OPTION 3

FINAL

COST DATA FORMS A(1)

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDTAE)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32001	PROJECT MGMT.	4	3.00	3.0	69	63	0
32002	SYS. ENGR. & INT.	4	7.05	3.0	65	63	30
32003	VEH MAIN STAGE	4	49.48	3.9	48	63	58
32004	VEH AUX. STAGE	4	.00	3.0	30	54	50
32005	LOGISTICS	4	2.34	3.0	48	57	0
32006	FACILITIES	4	.00	3.0	60	63	50
32007	GRND. SUPT. EQUIP	4	4.77	4.0	60	60	40
32008	VEHICLE TEST	4	14.15	3.0	63	57	40
32009	LAUNCH OPNS. WTR	4	.00	3.0	48	48	0
32010	LAUNCH OPNS ETR	4	.00	3.0	48	48	0
32011	FLIGHT OPNS NASA	4	4.62	3.0	48	42	60
32012	FLIGHT OPNS DOD	4	3.18	3.0	48	42	60
32013	REFURB &INTEG WTR	4	.11	3.0	48	48	0
32014	REFURB &INTEG ETR	4	.11	3.0	48	48	0
320	TOTAL	3	88.82	3.6	69	63	48

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 9-29677

COST DATA FORM - A(1)
NON-RECURRING (DOTAL)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32001	PROJECT MGMT.	4	3.00	3.0	69	63	0
3200101	COST/PERF. MGMT.	5	2.06	3.0	69	63	0
3200102	PROJ. DIRECTION	5	.88	3.0	69	63	0
3200103	INFORM. MGMT.	5	.06	3.0	69	63	0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (UDTNE)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32002	SYS. ENGR. & INT.	4	7.05	3.0	63	63	30
3200201	TUG SYS. ENGR.	5	5.04	3.0	63	63	30
3200202	SHUTTLE I/F	5	.05	3.0	63	63	30
3200203	PAYLOAD I/F	5	1.06	3.0	63	63	30

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32003	VEH MAIN STAGE	4	49.48	3.9	48	63	58
3200301	STRUCTURES	5	3.22	4.0	48	63	60
3200302	THERMAL CONTROL	5	.08	3.0	45	63	50
3200303	AVIONICS	5	24.14	4.0	45	63	58
3200304	PROPULSION	5	18.38	4.0	48	63	59
3200305	ORBITER I/F	5	.00	3.0	48	63	50
3200306	DROP TANKS	5	.00	3.0	0	0	0
3200307	FINAL ASSY & C/O	5	3.67	3.0	48	63	59
320030101	FUEL TK & SUPT	6	.00	4.0	48	63	52
320030102	OXID. TK & SUPT	6	.00	4.0	48	63	52
320030103	BODY STRUCTURE	6	.00	4.0	48	63	55
320030104	THRUST STRUCTURE	6	.00	4.0	48	63	50
320030105	METEOROID SHIELD	6	.00	4.0	0	0	0
320030106	PAYLOAD I/F	6	2.98	4.0	48	63	60
320030107	INSTL. ASSY & C/O	6	.24	4.0	48	63	60
320030201	FUEL TANK INSL	6	.05	3.0	45	63	50
320030202	OXID. TANK INSL.	6	.03	3.0	45	63	50
320030203	INSL. PURGE SYS.	6	.00	3.0	45	63	50
320030204	THERM CONT. SYS.	6	.00	3.0	0	0	0
320030205	INSTL ASSY & C/O	6	.00	3.0	45	63	50
320030301	DATA MGMT. 3	6	8.74	4.0	45	63	59
320030302	G N & C	6	3.74	4.0	45	63	59
320030303	COMMUNICATIONS	6	.00	4.0	45	63	50
320030304	INSTRUMENTATION	6	.00	4.0	45	63	52
320030305	ELECT. POWER	6	6.57	4.0	45	63	57
320030306	PWR. DIST. & CONT	6	.03	4.0	45	63	50
320030307	INSTL. ASSY & C/O	6	5.05	4.0	45	63	60
320030401	MAIN ENGINE 3	6	.00	4.0	48	63	50
320030402	MAIN ENG. SUPT	6	5.83	4.0	48	63	59
320030403	ACPS ENGINE	6	.94	4.0	48	63	58
320030404	ACPS ENG. SUPT	6	10.74	4.0	48	63	59
320030405	INSTL. ASSY & C/O	6	.87	4.0	48	63	59
320030501	STRUCTURES	6	.00	3.0	48	63	50
320030502	I/F PANELS	6	.00	3.0	48	63	50
320030503	PURGE PROV.	6	.00	3.0	0	0	0
320030504	ABORT PROV.	6	.00	3.0	48	63	50
320030505	INSTL. ASSY & C/O	6	.00	3.0	0	0	0
320030701	FINAL ASSY	6	2.29	3.0	48	63	59
320030702	C/O	6	1.37	3.0	48	63	59
32003010101	LH2 DOMES	7	.00	4.0	48	63	50
32003010102	LH2 CYLINDER	7	.00	4.0	48	63	50
32003010103	LH2 SUPPORTS	7	.00	4.0	48	63	50
32003010201	LO2 DOMES	7	.00	4.0	48	63	50
32003010202	LO2 SUPPORTS	7	.00	4.0	48	63	50
32003010301	FWD AFT SKIRT	7	.00	4.0	0	0	0
32003010302	INTERTANK	7	.00	4.0	48	63	50

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T O	T S	SPREAD FUNCT.
32003010303	SD&L SHELL	7	.00	4.0	48	63	50
32003030101	SCU	7	4.50	4.0	45	63	59
32003030102	DATA DISTR.	7	.00	4.0	0	0	0
32003030103	EQ. THERM CONT.	7	.00	4.0	45	63	50
32003030104	CIRCUITRY 3	7	.00	4.0	45	63	50
32003030105	SOFTWARE	7	3.60	4.0	45	63	60
32003030106	SOFTWARE	7	.00	4.0	0	0	0
32003030107	SOFTWARE	7	.00	4.0	0	0	0
32003030108	INSTL. ASSY & C/O	7	.65	4.0	45	63	59
32003030201	I M U	7	2.81	4.0	45	63	59
32003030202	TRACKING/ELECT 3	7	.00	4.0	45	63	50
32003030203	REN DEZ&DOCKING 3	7	.65	4.0	45	63	57
32003030204	INSTL. ASSY & C/O	7	.28	4.0	45	63	58
32003030301	M/W CIRC +RF MUX	7	.00	4.0	45	63	50
32003030302	TRANSPONDERS 3	7	.00	4.0	45	63	50
32003030303	POWER AMP.	7	.00	4.0	45	63	50
32003030304	ANTENNA	7	.00	4.0	45	63	50
32003030305	DEC/ENC+MOD/DEM	7	.00	4.0	45	63	50
32003030306	TAPE RECORDER	7	.00	4.0	45	63	50
32003030307	P/L INTER EQUIP	7	.00	4.0	45	63	50
32003030308	INSTL. ASSY & C/O	7	.00	4.0	0	0	0
32003030401	DATA SENSORS	7	.00	4.0	45	63	50
32003030402	SIGNAL COND.	7	.00	4.0	45	63	50
32003030403	CIRCUITRY	7	.00	4.0	45	63	50
32003030404	INSTL. ASSY & C/O	7	.00	4.0	0	0	0
32003030501	BATTERY	7	.00	4.0	0	0	0
32003030502	FUEL CELL 3	7	6.08	4.0	45	63	57
32003030503	INSTL. ASSY & C/O	7	.49	4.0	45	63	57
32003030601	DISTR.	7	.03	4.0	45	63	50
32003030602	TANKS SYSTEM 3	7	.00	4.0	0	0	0
32003030603	INSTL. ASSY & C/O	7	.00	4.0	45	63	50

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32004	VEH AUX. STAGE	4	.00	3.0	0	0	0
3200401	VEH AUX. STAGE	5	.00	3.0	0	0	0

STUDY TITLE: SPACE TUG SYS. STY (CHY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32005	LOGISTICS	4	2.34	3.0	48	57	0
3200501	TRANSP. & HDLG.	5	.00	3.0	0	0	0
3200502	TRAINING	5	1.18	3.0	48	57	0
3200503	INV CONT. & WHSNG	5	1.16	3.0	48	57	0
320050201	SIM. & EQUIP.	6	.00	3.0	48	57	0
320050202	GROUND CREW	6	1.18	3.0	48	57	0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDTAE)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32006	FACILITIES	4	.00	3.0	0	0	0
3200601	MANUFACTURING	5	.00	3.0	0	0	0
3200602	TEST	5	.00	3.0	0	0	0
3200603	ETR MAINT. & REF.	5	.00	3.0	0	0	0
3200604	ETR LAUNCH	5	.00	3.0	0	0	0
3200605	WTR MAINT. & REF.	5	.00	3.0	0	0	0
3200606	WTR LAUNCH	5	.00	3.0	0	0	0
320060101	DES./CONST.	6	.00	3.0	0	0	0
320060102	ACTIV./MAINT.	6	.00	3.0	0	0	0
320060201	DES./CONST.	6	.00	3.0	0	0	0
320060202	ACTIV./MAINT.	6	.00	3.0	0	0	0
320060301	DES./CONST.	6	.00	3.0	0	0	0
320060302	ACTIV./MAINT.	6	.00	3.0	0	0	0
320060401	DES./CONST.	6	.00	3.0	0	0	0
320060402	ACTIV./MAINT.	6	.00	3.0	0	0	0
320060501	DES./CONST.	6	.00	3.0	0	0	0
320060502	ACTIV./MAINT.	6	.00	3.0	0	0	0
320060601	DES./CONST. 3	6	.00	3.0	0	0	0
320060602	ACTIV./MAINT. 3	6	.00	3.0	0	0	0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFIG RATING	T D	T S	SPREAD FUNCT.
32007	GRND. SUPT. EQUIP	4	4.77	4.0	60	60	40
3200701	MFG. GSE	5	1.94	4.0	60	60	40
3200702	ETR GSE	5	.94	4.0	60	60	40
3200703	WTR GSE	5	.95	4.0	60	60	40
3200704	FLT OPS GSE(NASA)	5	.43	4.0	60	60	40
3200705	FLT OPS GSE(DOD)	5	.43	4.0	60	60	40
320070101	HARDWARE	6	1.69	4.0	60	60	40
320070102	SITE ACTIV.	6	.03	4.0	60	60	40
320070103	MAINT.	6	.00	4.0	0	0	0
320070104	SOFTWARE	6	.21	4.0	60	60	40
320070201	HARDWARE	6	.60	4.0	60	60	40
320070202	SITE ACTIV.	6	.20	4.0	60	60	40
320070203	MAINT.	6	.00	4.0	0	0	0
320070204	SOFTWARE	6	.10	4.0	60	60	40
320070301	HARDWARE	6	.61	4.0	60	60	40
320070302	SITE ACTIV.	6	.20	4.0	60	60	40
320070303	MAINT.	6	.00	4.0	0	0	0
320070304	SOFTWARE	6	.10	4.0	60	60	40
320070401	HARDWARE 3	6	.00	4.0	0	0	0
320070402	SITE ACTIV. 3	6	.00	4.0	0	0	0
320070404	SOFTWARE 3	6	.47	4.0	60	60	40
320070501	HARDWARE 3	6	.00	4.0	0	0	0
320070502	SITE ACTIV. 3	6	.00	4.0	0	0	0
320070504	SOFTWARE 3	6	.47	4.0	60	60	40

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DOTAE)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32008	VEHICLE TEST	4	14.15	3.0	63	57	40
3200801	GND TEST HDWE.	5	8.70	3.0	36	57	40
3200802	GND TEST OPNS.	5	5.00	3.0	36	57	40
3200804	FLT. TEST OPNS	5	.46	3.0	12	6	50
320080101	PTV TEST	6	.00	3.0	36	57	40
320080102	MAJOR TEST ART.	6	8.31	3.0	36	57	40
320080103	MOCKUPS	6	.38	3.0	36	57	40

STUDY LF1 SPACE TUG SYS. STY (CRY)
CONTRACT NO.1 NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDTAE)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32009	LAUNCH OPNS. WTR	4	.00	3.0	0	0	0
3200901	LNCH SITE SVCES	5	.00	3.0	0	0	0
3200902	TUG/SHTL MATING	5	.00	3.0	0	0	0
3200903	PRELAUNCH C/O	5	.00	3.0	0	0	0
3200904	COUNTDOWN	5	.00	3.0	0	0	0
3200905	PRLNTS. & BASES	5	.00	3.0	0	0	0
3200906	POST FLT. SAFING	5	.00	3.0	0	0	0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32010	LAUNCH OPNS ETR	4	.00	3.0	0	0	0
3201001	LNCH SITE SVCES	5	.00	3.0	0	0	0
3201002	TUG/SHTL MATING	5	.00	3.0	0	0	0
3201003	PRELAUNCH C/O	5	.00	3.0	0	0	0
3201004	COUNTDOWN	5	.00	3.0	0	0	0
3201005	PRLNTS & GASES	5	.00	3.0	0	0	0
3201006	POST FLT. SAFING	5	.00	3.0	0	0	0

STUDY: LEI SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DOTAE)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32011	FLIGHT OPNS NASA	4	4.62	3.0	48	42	60
3201101	MISSION PLG.	5	4.10	3.0	48	42	60
3201102	FLT. CONTROL	5	.28	3.0	48	42	60
3201103	FLT. EVAL.	5	.00	3.0	0	0	0
3201104	FLT. SUPT. SFTWRE	5	.24	3.0	48	42	60

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32012	FLIGHT OPNS DOD	4	3.18	3.0	48	42	60
3201201	MISSION PLG	5	2.82	3.0	48	42	60
3201202	FLT. CONTROL	5	.19	3.0	48	42	60
3201203	FLT. EVAL.	5	.00	3.0	0	0	0
3201204	FLT. SUPT. SFTWRE	5	.16	3.0	48	42	60

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32013	REFURB &INTEG WTR	4	.11	3.0	48	48	0
3201301	SCH MAINT & REF	5	.00	3.0	0	0	0
3201302	UNSCH MAINT & REF	5	.00	3.0	0	0	0
3201303	POST MAINT C/O	5	.00	3.0	0	0	0
3201304	TUG/PL MAING &/CO	5	.00	3.0	0	0	0
3201305	REFURB RQMTS PLG	5	.11	3.0	48	48	0
3201306	DEPOT MAINT	5	.00	3.0	0	0	0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(1)
NON-RECURRING (DDT&E)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	EXPECTED COST	CONFID RATING	T D	T S	SPREAD FUNCT.
32014	REFURB &INTEG ETR	4	.11	3.0	48	48	0
3201401	SCH MAINT & REF	5	.00	3.0	0	0	0
3201402	UNSCH MAINT & REF	5	.00	3.0	0	0	0
3201403	POST MAINT C/O	5	.00	3.0	0	0	0
3201404	TUG/PL MATING,C/O	5	.00	3.0	0	0	0
3201405	REFURB RQMTS PLG	5	.11	3.0	48	48	0
3201406	DEPOT MAINT	5	.00	3.0	0	0	0

in Table 6.1-1 and subjectively selecting the code considered to be most applicable. At summary levels the confidence rating values are weighted averages of the confidence ratings of constitutent WBS elements at subordinate levels.

Td: The time in months required to perform an activity. For nonrecurring (DDT&E) activity, the Td is the time required from Authorization to Proceed (ATP) with Phase C (nonrecurring/DDT&E) through completion of designs, development, test and evaluation, which usually is at FACI-First Article Configuration Inspection. Td for production generally is the time from the start of ground system installation and test procedures verification through completion of flight evaluation and preparation of ground system and flight vehicles for long term storage.

Ts: The lead time in months measured from the start of Td to the Initial Operational Capability (IOC), the launch milestone date.

Spread Function: An index number representing a cost distribution curve which the estimator recommends for the time phasing of costs over the Td time span. The index number represents the percentage of total cost (of the WBS item for the program phase) expected to be expended in 50 percent of the Td time span. At summary levels the spread functions are weighted averages of the

Table 6.1-1
CONFIDENCE LEVEL GROUPS FOR COST ESTIMATES

	CONFIDENCE LEVEL 1 LOW	CONFIDENCE LEVEL 2 MEDIUM LOW	CONFIDENCE LEVEL 3 MEDIUM HIGH	CONFIDENCE LEVEL 4 HIGH
ESTIMATING CONDITIONS	Estimating Time and Information Access Completely inadequate amount of time provided to make the estimate or there is a complete lack of access to useful data sources. Ground Rules and Assumptions No guidance was provided on ground rules and all assumptions made by the estimator were arbitrary.	Estimating Time and Information Access A very short due date or major problems of access to available data tend to make this estimate highly uncertain. Ground Rules and Assumptions Very little guidance was provided relative to ground rules. Most of the assumptions made by the estimator were considered quite arbitrary.	Estimating Time and Information Access A more accurate estimate could have been made if freer access or more time had been available to research known data sources. Ground Rules and Assumptions Ground rules were generally adequate. Many of the assumptions were authenticated but a substantial number are considered questionable.	Estimating Time and Information Access There were minor problems of access to available data and there was generally sufficient time to define and cost the item. Ground Rules and Assumptions Major ground rules were provided and most of the assumptions were authenticated.
NATURE OF THE ITEM	State-of-the-Art The item is substantially beyond the current state-of-the-art. Major development work is required. Production Experience No production of any kind has been started.	State-of-the-Art The item is slightly beyond the state-of-the-art and some development work will be required. Production Experience Experimental laboratory fabrication of a similar item is in process.	State-of-the-Art The item is within the state-of-the-art but no commercial counterpart exists. Production Experience A prototype of the item has been produced.	State-of-the-Art The item will involve a minor modification of commercial or standard aerospace issue items. Production Experience the item has been produced in limited quantity.
ITEM DESCRIPTION	Specification Status No work on a specification has started. Operating Program Characteristics None of the OPC for using the item have been formulated.	Specification Status Work on a specification is in an early stage and only general requirements are identified. Operating Program Characteristics The general outline of the OPC under which the item will be used has been only tentatively defined and many specific details are lacking.	Specification Status A specification for the item has not been completed but a specification on a similar item is available. Operating Program Characteristics The general outline of the OPC has been formulated but many specific details are lacking.	Specification Status A specification for the item has been prepared but is under review or revision. Operating Program Characteristics The OPC have been substantially defined but are under review or revision.
COST METHODS AND DATA	Methods The estimate is almost a poor guess and little or no confidence can be placed in it. Data An almost total lack of current and reliable relevant data make the cost estimate completely uncertain.	Methods A highly arbitrary rule-of-thumb has been used. Data The data used to make the estimate highly suspect, very sparse in quantity, and characterized by major inconsistencies.	Methods A commonly used rule-of-thumb cost factor but with no supporting backup has been used. Data The data used have been obtained from official or standard sources. Notable inconsistencies, lack of currency, gaps in data reduce the confidence in the estimate.	Methods The basic method used to derive the cost is well documented but no double-check or authentication has been possible Data The data used are generally relevant and from a reputable source. They are incomplete, preliminary, or not completely current however.

spread functions of constituent WBS elements at subordinate levels.

6.2 PRODUCTION PER WBS ELEMENTS

This subsection contains cost estimates for each WBS element through Level 7, as appropriate, displayed on Cost Data Form A(2), recurring (production). The definitions of each colum are as follows:

Identification Number: The appropriate WBS code corresponding to the item of cost.

WBS Identification: The alphanumeric nomenclature of the item from the WBS.

WBS Level: The level at which the cost is accumulated:

Level 3	-	Project
Level 4	-	System/Module
Level 5	-	Subsystem
Level 6	-	Assembly
Level 7	-	Component

First Unit (T1) Cost: The production cost of the theoretical first hardware unit. It is considered to be the y-axis intercept of the learning curve on a log-log plot. The LEADER II cost model prints out this cost under the title of "Memo T1" for WBS 320-03 Vehicle Main Stage and subordinate elements thereof.

Number of Units: The quantity of units for each WBS item used in the production and operations phases of the program.

Expected Cost: The cost estimate for the WBS item. For

OPTION 3

INITIAL

COST DATA FORMS A(2)

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(2)
RECURRING (PRODUCTION)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	1ST UNIT COST T1	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
32001	PROJECT MGMT.	4	1.0	.00	2.48	1	.00	3.0	24	-6	0	100
32002	SYS. ENGR. & INT.	4	1.0	.00	23.68	1	.00	3.0	36	18	0	100
32003	VEH MAIN STAGE	4	3.4	14.68	58.45	1	14.68	3.7	69	45	42	90
32004	VEH AUX. STAGE	4	1.0	.00	12.19	1	.00	3.0	57	12	40	100
32005	LOGISTICS	4	1.0	.00	.16	1	.00	3.0	24	4	0	100
32006	FACILITIES	4	1.0	.00	.44	1	.00	3.0	90	21	0	100
32007	GRND. SUPT. EQUIP	4	1.0	.00	1.20	1	.00	4.0	96	21	0	100
32008	VEHICLE TEST	4	1.0	.00	.00	1	.00	3.0	12	-3	50	100
320	TOTAL	3	.6	14.68	98.59	2	14.68	3.4	120	45	30	95

2-42

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(2)
RECURRING (PRODUCTION)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WUS IDENTIFICATION	WUS LEVEL	NO. OF UNITS	1ST UNIT COST T1	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
32001	PROJECT MGMT.	4	1.0	.00	2.48	1	.00	3.0	24	-6	0	100
3200101	COST/PERF. MGMT.	5	1.0	.00	1.69	1	.00	3.0	24	-6	0	100
3200102	PROJ. DIRECTION	5	1.0	.00	.74	1	.00	3.0	24	-6	0	100
3200103	INFORM. MGMT.	5	1.0	.00	.05	1	.00	3.0	24	-6	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(2)
RECURRING (PRODUCTION)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO.OF UNITS	1ST UNIT COST T1	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
32002	SYS. ENGR. & INT.	4	1.0	.00	23.68	1	.00	3.0	36	18	0	100
3200201	TUG SYS. ENGR.	5	1.0	.00	2.98	1	.00	3.0	36	18	0	100
3200202	SHUTTLE I/F	5	1.0	.00	.75	1	.00	3.0	36	18	0	100
3200203	PAYLOAD I/F	5	1.0	.00	1.49	1	.00	3.0	36	18	0	100
3200204	SUST. ENGR.	5	1.0	.00	18.46	1	.00	3.0	36	18	0	100

STUDY LE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(2)
RECURRING (PRODUCTION)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	1ST UNIT COST T1	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
32003	VEH MAIN STAGE	4	5.4	14.68	58.45	1	14.68	3.7	69	45	42	90
3200301	STRUCTURES	5	5.0	1.73	6.69	1	1.73	4.0	56	45	40	90
3200302	THERMAL CONTROL	5	5.0	.48	1.85	1	.48	3.0	53	42	40	90
3200303	AVIONICS	5	5.2	4.58	18.37	1	4.58	4.0	49	38	40	90
3200304	PROPULSION	5	6.3	3.35	14.84	1	3.35	4.0	56	45	40	90
3200305	ORBITER I/F	5	5.2	2.30	9.14	1	2.30	3.0	66	42	50	90
3200306	DROP TANKS	5	5.0	.00	.00	1	.00	3.0	0	0	0	100
3200307	FINAL ASSY & C/O	5	5.0	2.24	7.53	1	2.24	3.0	43	25	40	90
320030101	FUEL TK & SUPT	6	5.0	.47	1.86	1	.47	4.0	56	45	40	90
320030102	OXID. TK & SUPT	6	5.0	.19	.76	1	.19	4.0	56	45	40	90
320030103	BODY STRUCTURE	6	5.0	.10	.39	1	.10	4.0	56	45	40	90
320030104	THRUST STRUCTURE	6	5.0	.06	.25	1	.06	4.0	56	45	40	90
320030105	METEOROID SHIELD	6	5.0	.43	1.70	1	.43	4.0	56	45	40	90
320030106	PAYLOAD I/F	6	5.0	.33	1.29	1	.33	4.0	56	45	40	90
320030107	INSTL. ASSY & C/O	6	5.0	.13	.43	1	.13	4.0	56	45	40	90
320030201	FUEL TANK INSL	6	5.0	.11	.42	1	.11	3.0	53	42	40	90
320030202	OXID. TANK INSL.	6	5.0	.05	.20	1	.05	3.0	53	42	40	90
320030203	INSL. PURGE SYS.	6	5.0	.30	1.18	1	.30	3.0	53	42	40	90
320030204	THERM CONT. SYS.	6	5.0	.00	.00	1	.00	3.0	0	0	0	90
320030205	INSTL ASSY & C/O	6	5.0	.02	.08	1	.02	3.0	53	42	40	90
320030301	DATA MGMT. 3	6	5.3	1.02	4.20	1	1.02	4.0	49	38	40	90
320030302	G N & C	6	5.0	1.12	4.41	1	1.12	4.0	49	38	40	90
320030303	COMMUNICATIONS	6	5.2	1.83	7.44	1	1.83	4.0	49	38	40	90
320030304	INSTRUMENTATION	6	5.0	.18	.70	1	.18	4.0	49	38	40	90
320030305	ELECT. POWER	6	7.0	.05	.32	1	.05	4.0	49	38	40	95
320030306	PWR. DIST. & CONT	6	5.0	.03	.16	1	.03	4.0	49	38	40	95
320030307	INSTL. ASSY & C/O	6	5.0	.34	1.15	1	.34	4.0	49	38	40	90
320030401	MAIN ENGINE	6	7.8	.70	3.97	1	.70	4.0	56	45	40	90
320030402	MAIN ENG. SUPT	6	5.0	1.63	6.37	1	1.63	4.0	56	45	40	90
320030403	ACPS ENGINE	6	13.0	.12	1.06	1	.12	4.0	56	45	40	90
320030404	ACPS ENG. SUPT	6	5.0	.74	2.89	1	.74	4.0	56	45	40	90
320030405	INSTL. ASSY & C/O	6	5.0	.16	.54	1	.16	4.0	56	45	40	90
320030501	STRUCTURES	6	5.1	.36	1.43	1	.36	3.0	66	42	50	90
320030502	I/F PANELS	6	5.2	1.49	6.03	1	1.49	3.0	66	42	50	90
320030503	PURGE PROV.	6	6.0	.00	.00	1	.00	3.0	0	0	0	90
320030504	ABORT PROV.	6	5.0	.28	1.11	1	.28	3.0	66	42	50	90
320030505	INSTL. ASSY & C/O	6	5.0	.17	.57	1	.17	3.0	66	42	50	90
320030701	FINAL ASSY	6	5.0	1.87	6.27	1	1.87	3.0	43	25	40	90
320030702	C/O	6	5.0	.37	1.25	1	.37	3.0	43	25	40	90
32003010101	LH2 DOMES	7	1.0	.08	.00	1	.08	4.0	0	0	0	90
32003010102	LH2 CYLINDER	7	1.0	.08	.00	1	.08	4.0	0	0	0	90
32003010103	LH2 SUPPORTS	7	24.0	.31	.00	1	.31	4.0	0	0	0	90
32003010201	LO2 DOMES	7	1.0	.08	.00	1	.08	4.0	0	0	0	90
32003010202	LO2 SUPPORTS	7	16.0	.12	.00	1	.12	4.0	0	0	0	90
32003010301	FWD AFT SKIRT	7	1.0	.00	.00	1	.00	4.0	0	0	0	90
32003010302	INTERTANK	7	1.0	.05	.00	1	.05	4.0	0	0	0	90

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(2)
RECURRING (PRODUCTION)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	1ST UNIT COST T1	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
32003010303	SD#L SHELL	7	1.0	.05	.00	1	.05	4.0	0	0	0	90
32003030101	COMPUTER	7	1.0	.02	.00	1	.02	4.0	0	0	0	100
32003030102	DATA DISTR.	7	1.0	.00	.00	1	.00	4.0	0	0	0	100
32003030103	EQ. THERM CONT.	7	1.0	.11	.00	1	.11	4.0	0	0	0	90
32003030104	CIRCUITRY 3	7	1.0	.03	.00	1	.03	4.0	0	0	0	90
32003030108	INSTL. ASSY & C/O	7	1.0	.08	.00	1	.08	4.0	0	0	0	100
32003030201	I M U	7	2.0	.71	.00	1	.71	4.0	0	0	0	90
32003030202	TRACKING/ELECT	7	2.0	.32	.00	1	.32	4.0	0	0	0	90
32003030203	REN DEZ& DOCKING	7	1.0	.00	.00	1	.00	4.0	0	0	0	90
32003030204	INSTL. ASSY & C/O	7	1.0	.08	.00	1	.08	4.0	0	0	0	100
32003030301	M/W CIRC +RF MUX	7	1.0	.40	.00	1	.40	4.0	0	0	0	90
32003030302	TRANSPONDERS 3	7	1.0	.43	.00	1	.43	4.0	0	0	0	90
32003030303	POWER AMP.	7	2.0	.18	.00	1	.18	4.0	0	0	0	90
32003030304	ANTENNA	7	1.0	.09	.00	1	.09	4.0	0	0	0	90
32003030305	DEC/ENC+MOD/DEM	7	1.0	.37	.00	1	.37	4.0	0	0	0	90
32003030306	TAPE RECORDER 3	7	2.0	.15	.00	1	.15	4.0	0	0	0	90
32003030307	P/L INTER EQUIP	7	1.0	.08	.00	1	.08	4.0	0	0	0	90
32003030308	INSTL. ASSY & C/O	7	1.0	.14	.00	1	.14	4.0	0	0	0	100
32003030401	DATA SENSORS	7	34.0	.04	.00	1	.04	4.0	0	0	0	90
32003030402	SIGNAL COND.	7	5.0	.04	.00	1	.04	4.0	0	0	0	90
32003030403	CIRCUITRY	7	1.0	.09	.00	1	.09	4.0	0	0	0	90
32003030404	INSTL. ASSY & C/O	7	1.0	.01	.00	1	.01	4.0	0	0	0	100
32003030501	BATTERY	7	1.0	.05	.00	1	.05	4.0	0	0	0	95
32003030502	FUEL CELL	7	1.0	.00	.00	1	.00	4.0	0	0	0	95
32003030503	INSTL. ASSY & C/O	7	1.0	.00	.00	1	.00	4.0	0	0	0	100
32003030601	DISTR.	7	1.0	.03	.00	1	.03	4.0	0	0	0	95
32003030602	TANKS SYSTEM	7	1.0	.00	.00	1	.00	4.0	0	0	0	95
32003030603	INSTL. ASSY & C/O	7	1.0	.00	.00	1	.00	4.0	0	0	0	100

STUDY TITLE: SPACE TUG SYS. STY (GRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(2)
RECURRING (PRODUCTION)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO.OF UNITS	1ST UNIT COST	T1	EXPECTED COST	REP UNIT	REF UNIT COST	CONFID RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
32004	VEH AUX. STAGE	4	1.0		.00	12.19	1	.00	3.0	57	12	40	100
3200401	VEH AUX. STAGE	5	1.0		.00	12.19	1	.00	3.0	57	12	40	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(2)
RECURRING (PRODUCTION)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO.OF UNITS	1ST UNIT COST T1	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T O	T S	SPREAD FUNCT.	LEARN INDEX
32005	LOGISTICS	4	1.0	.00	.16	1	.00	3.0	24	4	0	100
3200501	TRANSP. & HDLG.	5	1.0	.00	.15	1	.00	3.0	24	4	0	100
3200502	TRAINING	5	1.0	.00	.00	1	.00	3.0	0	0	0	100
3200503	INV CONT. & WHSNG	5	1.0	.00	.00	1	.00	3.0	0	0	0	100
320050201	SIM. & EQUIP.	6	1.0	.00	.00	1	.00	3.0	0	0	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTR. T NO.1 NAS 8-24677

COST DATA FORM - 412
RECURRING (PRODUCTION)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	1ST UNIT COST T1	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T 0	T 3	SPREAD PUNCT.	LEARN INDEX
32006	FACILITIES	4	1.0	.00	.44	1	.00	3.0	96	21	0	100
3200601	MANUFACTURING	5	1.0	.00	.44	1	.00	3.0	96	21	0	100
3200602	TEST	5	1.0	.00	.00	1	.00	3.0	0	0	0	100
320060101	DES./CONST.	6	1.0	.00	.00	1	.00	3.0	0	0	0	100
320060102	ACTIV./MAINT.	6	1.0	.00	.44	1	.00	3.0	96	21	0	100
320060201	DES./CONST.	6	1.0	.00	.00	1	.00	3.0	0	0	0	100
320060202	ACTIV./MAINT.	6	1.0	.00	.00	1	.00	3.0	0	0	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(2)
RECURRING (PRODUCTION)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	1ST UNIT COST T1	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T O	T S	SPREAD FUNCT.	LEARN INDEX
32007	GRND. SUPT. EQUIP	4	1.0	.00	1.20	1	.00	4.0	96	21	0	100
3200701	MFG. GSE	5	1.0	.00	1.20	1	.00	4.0	96	21	0	100
320070101	HARDWARE	6	1.0	.00	.00	1	.00	4.0	0	0	0	100
320070102	SITE ACTIV.	6	1.0	.00	.00	1	.00	4.0	0	0	0	100
320070103	MAINT.	6	1.0	.00	1.20	1	.00	4.0	96	21	0	100

29-7

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(2)
RECURRING (PRODUCTION)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	1ST UNIT COST T1	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
32008	VEHICLE TEST	4	1.0	.00	.00	1	.00	3.0	0	0	0	100

15-7

OPTION 3

FINAL

COST DATA FORMS A(2)

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29877

COST DATA FORM # A(2)
RECURRING (PRODUCTION)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	1ST UNIT COST T1	EXPECTED COST	REF UNIT	REF UNIT COST	CONFIG RATING	T O	T S	SPREAD FUNCT.	LEARN INDEX
32001	PROJECT MGMT.	4	1.0	.00	5.25	1	.00	3.0	34	6	0	100
32002	SYS. ENGR. & INT.	4	1.0	.00	44.06	1	.00	3.0	54	26	0	100
32003	VEH MAIN STAGE	4	11.4	17.40	120.50	1	17.40	3.3	85	57	40	91
32004	VEH AUX. STAGE	4	1.0	.00	4.97	1	.00	3.0	72	24	0	100
32005	LOGISTICS	4	1.0	.00	.35	1	.00	3.0	30	6	0	100
32006	FACILITIES	4	1.0	.00	.00	1	.00	3.0	48	24	0	100
32007	GRND. SUPT. EQUIP	4	1.0	.00	1.68	1	.00	4.0	60	36	0	100
32008	VEHICLE TEST	4	1.0	.00	.00	1	.00	3.0	12	-6	50	100
320	TOTAL	3	.7	17.40	176.81	4	17.40	3.6	105	57	27	93

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 9-29677

COST DATA FORM - A(2)
RECURRING (PRODUCTION)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	1ST UNIT COST T1	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
32001	PROJECT MGMT.	4	1.0	.00	5.25	1	.00	3.0	34	6	0	100
3200101	COST/PERF. MGMT.	5	1.0	.00	3.57	1	.00	3.0	34	6	0	100
3200102	PROJ. DIRECTION	5	1.0	.00	1.56	1	.00	3.0	34	6	0	100
3200103	INFORM. MGMT.	5	1.0	.00	.11	1	.00	3.0	34	6	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(2)
RECURRING (PRODUCTION)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	1ST UNIT COST T1	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
32002	SYS. ENGR. & INT.	4	1.0	.00	44.06	1	.00	3.0	54	26	0	100
3200201	TUG SYS. ENGR.	5	1.0	.00	6.42	1	.00	3.0	54	26	0	100
3200202	SPITTLE I/F	5	1.0	.00	1.61	1	.00	3.0	54	26	0	100
3200203	PAYLOAD I/F	5	1.0	.00	3.21	1	.00	3.0	54	26	0	100
3200204	SUST. ENGR.	5	1.0	.00	32.82	1	.00	3.0	54	26	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 9-24077

COST DATA FORM - A121
RECURRING (PRODUCTION)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	1ST UNIT COST T1	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T O	T S	SPREAD PUNCT.	LEARN INDEX
32003	VEH MAIN STAGE	4	11.6	17.40	120.50	1	17.40	3.8	85	57	40	90
3200301	STRUCTURES	5	11.0	1.99	15.02	1	1.99	4.0	57	45	40	90
3200302	THERMAL CONTROL	5	11.0	.45	3.67	1	.45	3.0	69	57	40	90
3200303	AVIONICS	5	12.0	5.77	48.72	1	5.77	4.0	72	57	40	91
3200304	PROPULSION	5	11.6	4.20	32.95	1	4.20	4.0	66	54	40	90
3200305	ORBITER I/F	5	5.2	2.30	2.20	1	2.30	3.0	54	42	48	90
3200306	DROP TANKS	5	11.0	.00	.00	1	.00	3.0	0	0	0	100
3200307	FINAL ASSY & C/O	5	11.0	2.65	17.94	1	2.65	3.0	54	26	40	90
320030101	FUEL TK & SUPT	6	11.0	.47	3.63	1	.47	4.0	57	45	40	90
320030102	OXID. TK & SUPT	6	11.0	.19	1.49	1	.19	4.0	57	45	40	90
320030103	BODY STRUCTURE	6	11.0	.10	.77	1	.10	4.0	57	45	40	90
320030104	THRUST STRUCTURE	6	11.0	.06	.49	1	.06	4.0	57	45	40	90
320030105	METEOROID SHIELD	6	11.0	.43	3.32	1	.43	4.0	57	45	40	90
320030106	PAYLOAD I/F	6	11.0	.57	4.39	1	.57	4.0	57	45	40	90
320030107	INSTL. ASSY & C/O	6	11.0	.15	.94	1	.15	4.0	57	45	40	90
320030201	FUEL TANK INSL	6	11.0	.11	.81	1	.11	3.0	69	57	40	90
320030202	OXID. TANK INSL.	6	11.0	.05	.40	1	.05	3.0	69	57	40	90
320030203	INSL. PURGE SYS.	6	11.0	.30	2.31	1	.30	3.0	69	57	40	90
320030204	THERM CONT. SYS.	6	11.0	.00	.00	1	.00	3.0	0	0	0	90
320030205	INSTL ASSY & C/O	6	11.0	.02	.15	1	.02	3.0	69	57	40	90
320030301	DATA MGMT.	6	11.4	1.50	11.74	1	1.50	4.0	72	57	40	90
320030302	G N & C	6	12.0	.87	7.17	1	.87	4.0	72	57	40	90
320030303	COMMUNICATIONS	6	11.1	1.83	14.16	1	1.83	4.0	72	57	40	90
320030304	INSTRUMENTATION	6	11.0	.18	1.36	1	.18	4.0	72	57	40	90
320030305	ELECT. POWER	6	14.2	.93	11.07	1	.93	4.0	72	57	40	95
320030306	PWR. DIST. & CONT	6	11.0	.03	.32	1	.03	4.0	72	57	40	95
320030307	INSTL. ASSY & C/O	6	11.0	.43	2.90	1	.43	4.0	72	57	40	91
320030401	MAIN ENGINE	6	13.9	.70	6.49	1	.70	4.0	66	54	40	90
320030402	MAIN ENG. SUPT	6	11.0	2.00	15.26	1	2.00	4.0	66	54	40	90
320030403	ACPS ENGINE	6	11.0	.18	1.36	1	.18	4.0	66	54	40	90
320030404	ACPS ENG. SUPT	6	11.0	1.12	8.56	1	1.12	4.0	66	54	40	90
320030405	INSTL. ASSY & C/O	6	11.0	.20	1.28	1	.20	4.0	66	54	40	90
320030501	STRUCTURES	6	5.1	.36	.32	1	.36	3.0	54	42	50	90
320030502	I/F PANELS	6	5.2	1.49	1.50	1	1.49	3.0	54	42	48	90
320030503	PURGE PROV.	6	6.0	.00	.00	1	.00	3.0	0	0	0	90
320030504	ABORT PROV.	6	5.0	.28	.25	1	.28	3.0	54	42	50	90
320030505	INSTL. ASSY & C/O	6	5.0	.17	.15	1	.17	3.0	54	42	50	90
320030701	FINAL ASSY	6	11.0	2.21	14.95	1	2.21	3.0	54	26	40	90
320030702	C/O	6	11.0	.44	2.99	1	.44	3.0	54	26	40	90
32003010101	LH2 DOMES	7	1.0	.08	.00	1	.08	4.0	0	0	0	90
32003010102	LH2 CYLINDER	7	1.0	.08	.00	1	.08	4.0	0	0	0	90
32003010103	LH2 SUPPORTS	7	24.0	.31	.00	1	.31	4.0	0	0	0	90
32003010201	LO2 DOMES	7	1.0	.08	.00	1	.08	4.0	0	0	0	90
32003010202	LO2 SUPPORTS	7	16.0	.12	.00	1	.12	4.0	0	0	0	90
32003010301	FWD AFT SKIRT	7	1.0	.00	.00	1	.00	4.0	0	0	0	90
32003010302	INTERTANK	7	1.0	.05	.00	1	.05	4.0	0	0	0	90

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(2)
RECURRING (PRODUCTION)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO.OF UNITS	1ST UNIT COST T1	EXPECTED COST	REF UNIT	REF UNIT COST	COMPID RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
32003010303	SDAL SHELL	7	1.0	.05	.00	1	.05	4.0	0	0	0	90
32003030101	SCU	7	1.0	1.25	.00	1	1.25	4.0	0	0	0	100
32003030102	DATA DISTR.	7	1.0	.00	.00	1	.00	4.0	0	0	0	100
32003030103	E3. THERM CONT.	7	1.0	.11	.00	1	.11	4.0	0	0	0	90
32003030104	CIRCUITRY 3	7	1.0	.03	.00	1	.03	4.0	0	0	0	90
32003030105	INSTL. ASSY & C/O	7	1.0	.11	.00	1	.11	4.0	0	0	0	100
32003030201	I M U	7	2.0	.38	.00	1	.33	4.0	0	0	0	90
32003030202	TRACKING/ELECT	7	2.0	.32	.00	1	.32	4.0	0	0	0	90
32003030203	REN DEZA DOCKING	7	1.0	.11	.00	1	.11	4.0	0	0	0	90
32003030204	INSTL. ASSY & C/O	7	1.0	.06	.00	1	.06	4.0	0	0	0	100
32003030301	M/W CIRC +RF MUX	7	1.0	.40	.00	1	.40	4.0	0	0	0	90
32003030302	TRANSPONDERS 3	7	1.0	.43	.00	1	.43	4.0	0	0	0	90
32003030303	POWER AMP.	7	2.0	.18	.00	1	.16	4.0	0	0	0	90
32003030304	ANTENNA	7	1.0	.09	.00	1	.09	4.0	0	0	0	90
32003030305	DEC/ENC+MOD/DEM	7	1.0	.37	.00	1	.37	4.0	0	0	0	90
32003030306	TAPE RECORDER 3	7	2.0	.15	.00	1	.15	4.0	0	0	0	90
32003030307	P/L INTER EQUIP	7	1.0	.08	.00	1	.08	4.0	0	0	0	90
32003030308	INSTL. ASSY & C/O	7	1.0	.14	.00	1	.14	4.0	0	0	0	100
32003030401	DATA SENSORS	7	34.0	.04	.00	1	.04	4.0	0	0	0	90
32003030402	SIGNAL COND.	7	5.0	.04	.00	1	.04	4.0	0	0	0	90
32003030403	CIRCUITRY	7	1.0	.09	.00	1	.09	4.0	0	0	0	90
32003030404	INSTL. ASSY & C/O	7	1.0	.01	.00	1	.01	4.0	0	0	0	100
32003030501	BATTERY	7	1.0	.00	.00	1	.00	4.0	0	0	0	95
32003030502	FUEL CELL	7	1.0	.86	.00	1	.86	4.0	0	0	0	95
32003030503	INSTL. ASSY & C/O	7	1.0	.07	.00	1	.07	4.0	0	0	0	100
32003030601	DISTR.	7	1.0	.03	.00	1	.03	4.0	0	0	0	95
32003030602	TANKS SYSTEM	7	1.0	.00	.00	1	.00	4.0	0	0	0	95
32003030603	INSTL. ASSY & C/O	7	1.0	.00	.00	1	.00	4.0	0	0	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 9-29677

COST DATA FORM - A(2)
RECURRING (PRODUCTION)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	1ST UNIT COST T1	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T 0	T S	SPREAD PUNCT.	LEARN INDEX
32004	VEH AUX. STAGE	4	1.0	.00	4.97	1	.00	3.0	72	24	0	100
3200401	VEH AUX. STAGE	5	1.0	.00	4.97	1	.00	3.0	72	24	0	100

STUDY TITLE: SPACE TUG SYS. STY (CHY)
CONTRACT NO.: NAS 8-29577

COST DATA FORM # A(2)
RECURRING (PRODUCTION)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	1ST UNIT COST	TI	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T O	T S	SPREAD FORM.	LEARN INDEX
32005	LOGISTICS	4	1.0	.00		.35	1	.00	3.0	30	6	0	100
3200501	TRANSP. & HDLG.	5	1.0	.00		.35	1	.00	3.0	30	6	0	100
3200502	TRAINING	5	1.0	.00		.00	1	.00	3.0	0	0	0	100
3200503	INV CONT. & WHSNG	5	1.0	.00		.00	1	.00	3.0	0	0	0	100
320050201	SIM. & EQUIP.	6	1.0	.00		.00	1	.00	3.0	0	0	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29877

COST DATA FORM - A(2)
RECURRING (PRODUCTION)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	1ST UNIT COST T1	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T O	T S	SPREAD FUNCT.	LEARN INDEX
32006	FACILITIES	4	1.0	.00	.00	1	.00	3.0	0	0	0	100
3200601	MANUFACTURING	5	1.0	.00	.00	1	.00	3.0	0	0	0	100
3200602	TEST	5	1.0	.00	.00	1	.00	3.0	0	0	0	100
320060101	DES./CONST.	6	1.0	.00	.00	1	.00	3.0	0	0	0	100
320060102	ACTIV./MAINT.	6	1.0	.00	.00	1	.00	3.0	0	0	0	100
320060201	DES./CONST.	6	1.0	.00	.00	1	.00	3.0	0	0	0	100
320060202	ACTIV./MAINT.	6	1.0	.00	.00	1	.00	3.0	0	0	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(2)
RECURRING (PRODUCTION)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	1ST UNIT COST T1	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T O	T S	SPREAD FUNCT.	LEARN INDEX
32007	GRND. SUPT. EQUIP	4	1.0	.00	1.68	1	.00	4.0	60	36	0	100
3200701	MFG. GSE	5	1.0	.00	1.68	1	.00	4.0	60	36	0	100
320070101	HARDWARE	6	1.0	.00	.00	1	.00	4.0	0	0	0	100
320070102	SITE ACTIV.	6	1.0	.00	.00	1	.00	4.0	0	0	0	100
320070103	MAINT.	6	1.0	.00	1.68	1	.00	4.0	60	36	0	100

19-2

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29977

COST DATA FORM - A(2)
RECURRING (PRODUCTION)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	1ST UNIT COST T1	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T O	T S	SPREAD FUNCT.	LEARN INDEX
32008	VEHICLE TEST	4	1.0	.00	.00	1	.00	5.0	0	0	0	100

6-62

production and operations items, the WBS item cost is the total cumulative cost for the number of units quantified in the "number of units" column.

Reference Unit: The production sequence number of the first unit that is used in the recurring phase of the program.

Confidence Rating: A value of (1), lowest, through (4), highest, representing the estimators confidence in the estimate shown in the WBS item cost column. The value is obtained by reviewing the Government criteria contained in Table 6.2-1 and subjectively selecting the code considered to be most applicable. At summary levels the confidence rating values are weighted averages of the confidence ratings of constituent WBS elements at subordinate levels.

Reference Unit Cost: The cost of the reference unit. At subordinate levels the cost is the specific cost of the reference unit. At summary levels the cost is the weighted average of the constituent subordinate reference units.

Td: The time in months required to perform an activity. For nonrecurring (DDT&E) activity, the Td is the time required from Authorization to Proceed (ATP) with Phase C (nonrecurring/DDT&E) through completion of designs, development, test and evaluation, which usually is at FACI-First

Table 6.2-1

CONFIDENCE LEVEL GROUPS FOR COST ESTIMATES

	CONFIDENCE LEVEL 1 LOW	CONFIDENCE LEVEL 2 MEDIUM LOW	CONFIDENCE LEVEL 3 MEDIUM HIGH	CONFIDENCE LEVEL 4 HIGH
ESTIMATING CONDITIONS	Estimating Time and Information Access Completely inadequate amount of time provided to make the estimate or there is a complete lack of access to useful data sources. Ground Rules and Assumptions No guidance was provided on ground rules and all assumptions made by the estimator were arbitrary.	Estimating Time and Information Access A very short due date or major problems of access to available data tend to make this estimate highly uncertain. Ground Rules and Assumptions Very little guidance was provided relative to ground rules. Most of the assumptions made by the estimator were considered quite arbitrary.	Estimating Time and Information Access A more accurate estimate could have been made if freer access or more time had been available to research known data sources. Ground Rules and Assumptions Ground rules were generally adequate. Many of the assumptions were authenticated but a substantial number are considered questionable.	Estimating Time and Information Access There were minor problems of access to available data and there was generally sufficient time to define and cost the item. Ground Rules and Assumptions Major ground rules were provided and most of the assumptions were authenticated.
NATURE OF THE ITEM	State-of-the-Art The item is substantially beyond the current state-of-the-art. Major development work is required. Production Experience No production of any kind has been started.	State-of-the-Art The item is slightly beyond the state-of-the-art and some development work will be required. Production Experience Experimental laboratory fabrication of a similar item is in process.	State-of-the-Art The item is within the state-of-the-art but no commercial counterpart exists. Production Experience A prototype of the item has been produced.	State-of-the-Art The item will involve a minor modification of commercial or standard aerospace issue items. Production Experience The item has been produced in limited quantity.
ITEM DESCRIPTION	Specification Status No work on a specification has started. Operating Program Characteristics None of the OPC for using the item have been formulated.	Specification Status Work on a specification is in an early stage and only general requirements are identified. Operating Program Characteristics The general outline of the OPC under which the item will be used has been only tentatively defined and many specific details are lacking.	Specification Status A specification for the item has not been completed but a specification on a similar item is available. Operating Program Characteristics The general outline of the OPC has been formulated but many specific details are lacking.	Specification Status A specification for the item has been prepared but is under review or revision. Operating Program Characteristics The OPC have been substantially defined but are under review or revision.
COST METHODS AND DATA	Methods The estimate is almost a poor guess and little or no confidence can be placed in it. Data An almost total lack of current and reliable relevant data make the cost estimate completely uncertain.	Methods A highly arbitrary rule-of-thumb has been used. Data The data used to make the estimate highly suspect, very sparse in quantity, and characterized by major inconsistencies.	Methods A commonly used rule-of-thumb cost factor but with no supporting backup has been used. Data The data used have been obtained from official or standard sources. Notable inconsistencies, lack of currency, gaps in data reduce the confidence in the estimate.	Methods The basic method used to derive the cost is well documented but no double-check or authentication has been possible Data The data used are generally relevant and from a reputable source. They are incomplete, preliminary, or not completely current however.

Article Configuration Inspection. Td for production generally is the time from PDR-Preliminary Design Release through flight article(s) assembly and acceptance. Td for operations generally is the time from the start of ground system installation and test procedures verification through completion of flight evaluation and preparation of ground system and flight vehicles for long term storage.

Ts: The lead time in months is measured from the start of Td to the Initial Operational Capability (IOC). The launch milestone date.

Spread Function: An index number representing a cost distribution curve which the estimator recommends for the time phasing of costs over the Td time span. The index number represents the percentage of total cost (of the WBS item for the program phase) expected to be expended in 50 percent of the Td time span. At summary levels the spread functions are weighted averages of the spread functions of constituent WBS elements at subordinate levels.

Learning Index: A numerical index of a learning rate related to the recurring cost. A straight line cumulative average index is used in these calculations. At summary levels the learning indices of constituent WBS elements at subordinate levels.

Launch Milestone Date: The date used in conjunction with Ts.

6.3 OPERATIONS PER WBS ELEMENTS

This subsection contains cost estimates for each WBS element through Level 6, as appropriate, displayed on Cost Data Form A(3), recurring (operations). The definitions of each column is as follows:

Identification Number: The appropriate WBS code corresponding to the item of cost.

WBS Identification: The alphanumeric nomenclature of the item from the WBS.

WBS Level: The level at which the cost is accumulated:

Level 3	-	Project
Level 4	-	System/Module
Level 5	-	Subsystem
Level 6	-	Assembly
Level 7	-	Component

Number of Units: The quantity of units for each WBS item used in the production and operations phases of the program.

Expected Cost: The cost estimate for the WBS item. For production and operations items, the WBS item cost is the total cumulative cost for the number of units quantified in the "number of units" column.

Reference Unit: The production sequence number of the

OPTION 3

INITIAL

COST DATA FORMS A(3)

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T 0	T 5	SPREAD FUNCT.	LEARN INDEX
32001	PROJECT MGMT.	4	1.0	2.26	1	.00	3.0	39	-6	0	100
32002	SYS. ENGR. & INT.	4	1.0	3.31	1	.00	3.0	39	-6	0	100
32003	VEH MAIN STAGE 3	4	.0	8.45	14	.00	3.9	45	0	0	92
32004	VEH AUX. STAGE	4	1.0	.00	1	.00	3.0	45	0	0	100
32005	LOGISTICS	4	1.0	2.51	1	.00	3.0	45	0	0	100
32006	FACILITIES	4	1.0	1.21	1	.00	3.0	129	0	0	100
32007	GRND. SUPT. EQUIP	4	1.0	6.30	1	.00	4.0	129	0	0	100
32009	LAUNCH OPNS. WTR	4	1.0	1.85	1	.00	3.0	18	-27	0	100
32010	LAUNCH OPNS ETR	4	1.0	12.25	1	.00	3.0	51	6	0	100
32011	FLIGHT OPNS NASA	4	1.0	13.84	1	.00	3.0	51	6	0	100
32012	FLIGHT OPNS DOD	4	1.0	10.03	1	.00	3.0	39	-6	0	100
32013	REFURB &INTEG WTR	4	1.0	2.77	5	.00	3.0	18	-27	0	100
32014	REFURB &INTEG ETR	4	1.0	23.79	5	.00	3.0	51	6	0	100
320	TOTAL	3	.0	88.56	5	.00	3.2	135	6	0	100

STOP

COMPUTE TIME 28.906
READY

#

89-9

STUDY .TLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T 0	T S	SPREAD FUNCT.	LEARN INDEX
32001	PROJECT MGMT.	4	1.0	2.26	1	.00	3.0	39	-6	0	100
3200101	COST/PERF. MGMT.	5	1.0	1.48	1	.00	3.0	39	-6	0	100
3200102	PROJ. DIRECTION	5	1.0	.71	1	.00	3.0	39	-6	0	100
3200103	INFORM. MGMT. 3	5	1.0	.06	1	.00	3.0	39	-6	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
32002	SYS. ENGR. & INT.	4	1.0	3.31	1	.00	3.0	39	-6	0	100
3200204	SUST. ENGR. 3	5	1.0	3.31	1	.00	3.0	39	-6	0	100

C-70

STUD. TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO.OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T O	T S	SPREAD FUNCT.	LEARN INDEX
32003	VEH MAIN STAGE 3	4	.0	8.45	14	.00	3.9	45	0	0	92
3200301	STRUCTURES	5	.2	.21	14	.00	4.0	45	0	0	90
3200302	THERMAL CONTROL	5	.0	.06	14	.00	3.0	45	0	0	90
3200303	AVIONICS 3	5	.1	4.92	14	.00	4.0	45	0	0	94
3200304	PROPULSION	5	.0	2.72	14	.00	4.0	45	0	0	90
3200305	ORBITER I/F	5	.0	.54	6	.00	3.0	45	0	0	90
3200306	DROP TANKS	5	.0	.00	14	.00	3.0	0	0	0	100
3200307	FINAL ASSY & C/O	5	.0	.00	14	.00	3.0	0	0	0	100
320030101	FUEL TK & SUPT	6	.0	.00	14	.00	4.0	0	0	0	90
320030102	OXID. TK & SUPT	6	.0	.00	14	.00	4.0	0	0	0	90
320030103	BODY STRUCTURE	6	.0	.00	14	.00	4.0	0	0	0	90
320030104	THRUST STRUC	6	.0	.00	14	.00	4.0	0	0	0	90
320030105	METEOROID SH	6	.0	.00	14	.00	4.0	0	0	0	90
320030106	PAYLOAD I/F	6	.0	.00	14	.00	4.0	0	0	0	90
320030107	INSTL. ASSY & C/O	6	.0	.00	14	.00	4.0	0	0	0	100
320030201	FUEL TANK INSL	6	.2	.02	14	.00	3.0	45	0	0	90
320030202	OXID. TANK INSL.	6	.4	.01	14	.00	3.0	45	0	0	90
320030203	INSL. PURGE SYS.	6	.2	.03	14	.00	3.0	45	0	0	90
320030204	THERM CONT. SYS.	6	.0	.00	14	.00	3.0	0	0	0	90
320030205	INSTL. ASSY & C/O	6	.0	.00	14	.00	3.0	0	0	0	100
320030301	DATA MGMT. 3	6	1.0	1.19	14	.00	4.0	45	0	0	90
320030302	G N & C	6	.1	.05	14	.00	4.0	45	0	0	90
320030303	COMMUNICATIONS	6	.5	.61	14	.00	4.0	45	0	0	90
320030304	INSTRUMENTATION	6	1.0	.21	14	.00	4.0	45	0	0	90
320030305	ELECT. POWER	6	79.0	2.86	14	.00	4.0	45	0	0	95
320030306	PWR. DIST. & CONT	6	.2	.01	14	.00	4.0	45	0	0	95
320030307	INSTL. ASSY & C/O	6	.0	.00	14	.00	4.0	0	0	0	100
320030401	MAIN ENGINE	6	3.6	1.57	14	.00	4.0	45	0	0	90
320030402	MAIN ENG. SUPT	6	.4	.45	14	.00	4.0	45	0	0	90
320030403	ACPS ENGINE	6	8.2	.60	14	.00	4.0	45	0	0	90
320030404	ACPS ENG. SUPT	6	.2	.10	14	.00	4.0	45	0	0	90
320030405	INSTL. ASSY & C/O	6	.0	.00	14	.00	4.0	0	0	0	100
320030501	STRUCTURES	6	.1	.03	6	.00	3.0	45	0	0	90
320030502	I/F PANELS	6	.5	.49	6	.00	3.0	45	0	0	90
320030503	PURGE PROV.	6	1.0	.00	6	.00	3.0	0	0	0	90
320030504	ABORT PROV.	6	.1	.02	6	.00	3.0	45	0	0	90
320030505	INSTL. ASSY & C/O	6	.0	.00	6	.00	3.0	0	0	0	100
320030701	FINAL ASSY	6	.0	.00	14	.00	3.0	0	0	0	100
320030702	C/O	6	.0	.00	14	.00	3.0	0	0	0	100
32003030105	SOFTWARE 3	7	1.0	.83	14	.00	4.0	45	0	0	100

STUDY TITLE: SPACE TUG STS, STY (GRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
32004	VEH AUX. STAGE	4	1.0	.00	1	.00	3.0	0	0	0	100

C-2

STU. TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T O	T S	SPREAD FUNCT.	LEARN INDEX
32005	LOGISTICS	4	1.0	2.51	1	.00	3.0	45	0	0	100
3200501	TRANSP. & HDLG.	5	1.0	.10	1	.00	3.0	45	0	0	100
3200502	TRAINING	5	1.0	1.37	1	.00	3.0	45	0	0	100
3200503	INV CONT. & WHSNG	5	1.0	1.04	1	.00	3.0	45	0	0	100
320050201	SIM. & EQUIP.	6	1.0	.00	1	.00	3.0	0	0	0	100
320050202	GROUND CREW	6	1.0	1.37	1	.00	3.0	45	0	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T 0	T 5	SPREAD FUNCT.	LEARN INDEX
32006	FACILITIES	4	1.0	1.21	1	.00	3.0	129	0	0	100
3200603	ETR MAINT. & REF.	5	1.0	.55	1	.00	3.0	129	0	0	100
3200604	ETR LAUNCH	5	1.0	.21	1	.00	3.0	129	0	0	100
3200605	WTR MAINT. & REF.	5	1.0	.30	1	.00	3.0	129	0	0	100
3200606	WTR LAUNCH	5	1.0	.15	1	.00	3.0	129	0	0	100
320060301	DES./CONST.	6	1.0	.00	1	.00	3.0	0	0	0	100
320060302	ACTIV./MAINT.	6	1.0	.55	1	.00	3.0	129	0	0	100
320060401	DES./CONST.	6	1.0	.00	1	.00	3.0	0	0	0	100
320060402	ACTIV./MAINT.	6	1.0	.21	1	.00	3.0	129	0	0	100
320060501	DES./CONST.	6	1.0	.00	1	.00	3.0	0	0	0	100
320060502	ACTIV./MAINT.	6	1.0	.30	1	.00	3.0	129	0	0	100
320060601	DES./CONST. 3	6	1.0	.00	1	.00	3.0	0	0	0	100
320060602	ACTIV./MAINT. 3	6	1.0	.15	1	.00	3.0	129	0	0	100

STUDY TITLE: SPACE TUG SYS. STY (GRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
32007	GRND. SUPT. EQUIP	4	1.0	6.30	1	.00	4.0	129	0	0	100
3200701	MFG. GSE 3	5	1.0	.00	1	.00	4.0	0	0	0	100
3200702	ETR GSE	5	1.0	2.46	1	.00	4.0	129	0	0	100
3200703	WTR GSE	5	1.0	1.67	1	.00	4.0	129	0	0	100
3200704	FLT OPS GSE(NASA)	5	1.0	1.09	1	.00	4.0	129	0	0	100
3200705	FLT OPS GSE(DOD)	5	1.0	1.09	1	.00	4.0	129	0	0	100
320070104	SOFTWARE 3	6	1.0	.00	1	.00	4.0	0	0	0	100
320070201	HARDWARE	6	1.0	.00	1	.00	4.0	0	0	0	100
320070202	SITE ACTIV.	6	1.0	.00	1	.00	4.0	0	0	0	100
320070203	MAINT.	6	1.0	2.08	1	.00	4.0	129	0	0	100
320070204	SOFTWARE	6	1.0	.37	1	.00	4.0	45	0	0	100
320070301	HARDWARE	6	1.0	.00	1	.00	4.0	0	0	0	100
320070302	SITE ACTIV.	6	1.0	.00	1	.00	4.0	0	0	0	100
320070303	MAINT.	6	1.0	1.63	1	.00	4.0	129	0	0	100
320070304	SOFTWARE 3	6	1.0	.04	1	.00	4.0	12	-33	0	100
320070403	MAINT. 3	6	1.0	.00	1	.00	4.0	0	0	0	100
320070404	SOFTWARE 3	6	1.0	1.09	1	.00	4.0	45	0	0	100
320070503	MAINT. 3	6	1.0	.00	1	.00	4.0	0	0	0	100
320070504	SOFTWARE 3	6	1.0	1.09	1	.00	4.0	45	0	0	100

STUDY TITLE: SPACE TUG SYS. STY (GHY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
32009	LAUNCH OPNS. WTR	4	1.0	1.85	1	.00	3.0	18	-27	0	100
3200901	LNCH SITE SVCES	5	1.0	.67	1	.00	3.0	18	-27	0	100
3200902	TUG/SHTL MATING	5	1.0	.22	1	.00	3.0	18	-27	0	100
3200903	PRELAUNCH C/O	5	1.0	.27	1	.00	3.0	18	-27	0	100
3200904	COUNTDOWN	5	1.0	.36	1	.00	3.0	18	-27	0	100
3200905	PRLNTS. & GASES	5	1.0	.05	1	.00	3.0	18	-27	0	100
3200906	POST FLT. SAFING	5	1.0	.28	1	.00	3.0	18	-27	0	100

STUDY(TLE: SPACE TUG SYS. STY (CRY)
CONTRAL(NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
32U10	LAUNCH OPNS ETR	4	1.0	12.25	1	.00	3.0	51	6	0	100
3201001	LNCH SITE SVCES	5	1.0	4.56	1	.00	3.0	51	6	0	100
3201002	TUG/SHTL MATING	5	1.0	1.39	1	.00	3.0	51	6	0	100
3201003	PRELAUNCH C/O	5	1.0	1.72	1	.00	3.0	51	6	0	100
3201004	COUNTDOWN	5	1.0	2.24	1	.00	3.0	51	6	0	100
3201005	PRLNTS & GASES	5	1.0	.48	1	.00	3.0	51	6	0	100
3201006	POST FLT. SAFING	5	1.0	1.85	1	.00	3.0	51	6	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T 0	T 5	SPREAD FUNCT.	LEARN INDEX
32011	FLIGHT OPNS NASA	4	1.0	13.84	1	.00	3.0	51	6	0	100
3201101	MISSION PLG.	5	1.0	2.36	1	.00	3.0	51	6	0	100
3201102	FLT. CONTROL	5	1.0	7.84	1	.00	3.0	51	6	0	100
3201103	FLT. EVAL.	5	1.0	2.14	1	.00	3.0	51	6	0	100
3201104	FLT. SUPT. SFTWRE	5	1.0	1.51	1	.00	3.0	51	6	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T 0	T 3	SPREAD FUNCT.	LEARN INDEX
32012	FLIGHT OPNS DOD	4	1.0	10.03	1	.00	3.0	39	-6	0	100
3201201	MISSION PLG 3	5	1.0	1.67	1	.00	3.0	39	-6	0	100
3201202	FLT. CONTROL	5	1.0	5.84	1	.00	3.0	39	-6	0	100
3201203	FLT. EVAL.	5	1.0	1.42	1	.00	3.0	39	-6	0	100
3201204	FLT. SUPT. SFTWRE	5	1.0	1.09	1	.00	3.0	39	-6	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T 0	T 5	SPREAD FUNCT.	LEARN INDEX
32013	REFURB &INTEG WTR	4	1.0	2.77	6	.00	3.0	18	-27	0	100
3201301	SCH MAINT & REF	5	1.0	.38	1	.00	3.0	18	-27	0	100
3201302	UNSCH MAINT & REF	5	1.0	.09	1	.00	3.0	18	-27	0	100
3201303	POST MAINT C/O	5	1.0	.05	1	.00	3.0	18	-27	0	100
3201304	TUG/PL MAING &/CO	5	1.0	.21	1	.00	3.0	18	-27	0	100
3201305	REFURB RQMTS PLG	5	1.0	.10	1	.00	3.0	18	-27	0	100
3201306	DEPOT MAINT	5	8.0	1.94	7	.00	3.0	18	-27	0	100

STUDY 1..LE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO.OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T 0	T 5	SPREAD FUNCT.	LEARN INDEX
32014	REFURB &INTEG ETR	4	1.0	23.79	6	.00	3.0	51	6	0	100
3201401	SCH MAINT & REF	5	1.0	2.56	1	.00	3.0	51	6	0	100
3201402	UNSCH MAINT & REF	5	1.0	.63	1	.00	3.0	51	6	0	100
3201403	POST MAINT C/O	5	1.0	.13	1	.00	3.0	51	6	0	100
3201404	TUG/PL MATING,C/O	5	1.0	1.60	1	.00	3.0	51	6	0	100
3201405	REFURB RUMTS PLO	5	1.0	.72	1	.00	3.0	51	6	0	100
3201406	DEPOT MAINT	5	75.0	18.15	7	.00	3.0	51	6	0	100

OPTION 3

FINAL

COST DATA FORMS A(3)

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM # A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE \ OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO.OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFIG RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
32001	PROJECT MGMT.	4	1.0	5.92	1	.00	3.0	84	0	0	100
32002	SYS. ENGR. & INT.	4	1.0	7.13	1	.00	3.0	84	0	0	100
32003	VEH MAIN STAGE 3	4	.0	12.73	14	.00	3.9	84	0	0	93
32004	VEH AUX. STAGE	4	1.0	.00	1	.00	3.0	84	0	0	100
32005	LOGISTICS	4	1.0	5.53	1	.00	3.0	84	0	0	100
32006	FACILITIES	4	1.0	.00	1	.00	3.0	84	0	0	100
32007	GRND. SUPT. EQUIP	4	1.0	3.91	1	.00	4.0	84	0	0	100
32009	LAUNCH OPNS. WTR	4	1.0	14.62	1	.00	3.0	84	0	0	100
32010	LAUNCH OPNS ETR	4	1.0	35.87	1	.00	3.0	84	0	0	100
32011	FLIGHT OPNS NASA	4	1.0	31.94	1	.00	3.0	84	0	0	100
32012	FLIGHT OPNS DOD	4	1.0	24.31	1	.00	3.0	84	0	0	100
32013	REFURB & INTEG WTR	4	1.0	13.77	8	.00	3.0	84	0	0	100
32014	REFURB & INTEG ETR	4	1.0	48.70	8	.00	3.0	84	0	0	100
320	TOTAL	3	.0	204.46	8	.00	3.1	84	0	0	100

STOP

COMPUTE TIME 18.154
READY

E8-9

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 9-20077

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T O	T S	SPREAD FUNCT.	LEARN INDEX
32001	PROJECT MGMT.	4	1.0	5.92	1	.00	3.0	84	0	0	100
3200101	COST/PERF. MGMT.	5	1.0	3.89	1	.00	3.0	84	0	0	100
3200102	PROJ. DIRECTION	5	1.0	1.58	1	.00	3.0	84	0	0	100
3200103	INFORM. MGMT. 3	5	1.0	.17	1	.00	3.0	84	0	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
~~32002~~	~~SYS. ENGR. & INT.~~	~~4~~	~~1.0~~	~~7.13~~	~~1~~	~~.00~~	~~3.0~~	~~84~~	~~0~~	~~0~~	~~100~~
3200204	SUST. ENGR. 3	5	1.0	7.13	1	.00	3.0	84	0	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T U	T S	SPREAD FUNCT.	LEARN INDEX
32003	VEH MAIN STAGE 3	4	.0	12.73	14	.00	3.9	54	0	0	95
3200301	STRUCTURES	5	.1	.07	14	.00	4.0	72	0	0	90
3200302	THERMAL CONTROL	5	.0	.10	14	.00	3.0	72	0	0	90
3200303	AVIONICS 3	5	.1	9.57	14	.00	4.0	84	0	0	94
3200304	PROPULSION	5	.0	2.37	14	.00	4.0	72	0	0	90
3200305	ORBITER I/F	5	.0	.62	6	.00	3.0	72	0	0	90
3200306	CROP TANKS	5	.0	.00	14	.00	3.0	0	0	0	100
3200307	FINAL ASSY & C/O	5	.0	.00	14	.00	3.0	0	0	0	100
320030101	FUEL TK & SUPT	6	.0	.00	14	.00	4.0	0	0	0	90
320030102	OXID. TK & SUPT	6	.0	.00	14	.00	4.0	0	0	0	90
320030103	BODY STRUCTURE	6	.0	.00	14	.00	4.0	0	0	0	90
320030104	THRUST STRUC	6	.0	.00	14	.00	4.0	0	0	0	90
320030105	METEOROID SH	6	.0	.00	14	.00	4.0	0	0	0	90
320030106	PAYLOAD I/F	6	.0	.00	14	.00	4.0	0	0	0	90
320030107	INSTL. ASSY & C/O	6	.0	.00	14	.00	4.0	0	0	0	100
320030201	FUEL TANK INSL	6	.1	.01	14	.00	3.0	72	0	0	90
320030202	OXID. TANK INSL.	6	.1	.00	14	.00	3.0	72	0	0	90
320030203	INSL. PURGE SYS.	6	.5	.09	14	.00	3.0	72	0	0	90
320030204	THERM CONT. SYS.	6	.0	.00	14	.00	3.0	0	0	0	90
320030205	INSTL. ASSY & C/O	6	.0	.00	14	.00	3.0	0	0	0	100
320030301	DATA MGMT. 3	6	1.0	3.23	14	.00	4.0	84	0	0	98
320030302	G N & C	6	.7	.36	14	.00	4.0	72	0	0	90
320030303	COMMUNICATIONS	6	2.9	3.02	14	.00	4.0	72	0	0	90
320030304	INSTRUMENTATION	6	.3	.03	14	.00	4.0	72	0	0	90
320030305	ELECT. POWER	6	4.1	2.92	14	.00	4.0	72	0	0	95
320030306	PWR. DIST. & CONT	6	.1	.00	14	.00	4.0	72	0	0	95
320030307	INSTL. ASSY & C/O	6	.0	.00	14	.00	4.0	0	0	0	100
320030401	MAIN ENGINE	6	2.6	1.06	14	.00	4.0	72	0	0	90
320030402	MAIN ENG. SUPT	6	.5	.62	14	.00	4.0	72	0	0	90
320030403	ACPS ENGINE	6	1.0	.10	14	.00	4.0	72	0	0	90
320030404	ACPS ENG. SUPT	6	.9	.60	14	.00	4.0	72	0	0	90
320030405	INSTL. ASSY & C/O	6	.0	.00	14	.00	4.0	0	0	0	100
320030501	STRUCTURES	6	.1	.03	6	.00	3.0	72	0	0	90
320030502	I/F PANELS	6	.5	.57	6	.00	3.0	72	0	0	90
320030503	PURGE PROV.	6	1.0	.00	6	.00	3.0	0	0	0	90
320030504	ABORT PROV.	6	.1	.02	6	.00	3.0	72	0	0	90
320030505	INSTL. ASSY & C/O	6	.0	.00	6	.00	3.0	0	0	0	100
320030701	FINAL ASSY	6	.0	.00	14	.00	3.0	0	0	0	100
320030702	C/O	6	.0	.00	14	.00	3.0	0	0	0	100
32003030105	SOFTWARE 3	7	1.0	2.87	14	.00	4.0	84	0	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO.OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
32004	VEH AUX. STAGE	4	1.0	.00	1	.00	3.0	0	0	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 9-2977

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T D	T S	SPREAD PUNCT.	LEARN INDEX
32005	LOGISTICS	4	1.0	5.53	1	.00	3.0	84	0	0	100
3200501	TRANSP. & HDLG.	5	1.0	.23	1	.00	3.0	84	0	0	100
3200502	TRAINING	5	1.0	1.15	1	.00	3.0	84	0	0	100
3200503	INV CONT. & WHSNG	5	1.0	4.11	1	.00	3.0	84	0	0	100
320050201	SIM. & EQUIP.	6	1.0	.00	1	.00	3.0	0	0	0	100
320050202	GROUND CREW	6	1.0	1.18	1	.00	3.0	84	0	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T O	T S	SPREAD FUNCT.	LEARN INDEX
32006	FACILITIES	4	1.0	.00	1	.00	3.0	0	0	0	100
3200603	ETR MAINT. & REF.	5	1.0	.00	1	.00	3.0	0	0	0	100
3200604	ETR LAUNCH	5	1.0	.00	1	.00	3.0	0	0	0	100
3200605	WTR MAINT. & REF.	5	1.0	.00	1	.00	3.0	0	0	0	100
3200606	WTR LAUNCH	5	1.0	.00	1	.00	3.0	0	0	0	100
320060301	DES./CONST.	6	1.0	.00	1	.00	3.0	0	0	0	100
320060302	ACTIV./MAINT.	6	1.0	.00	1	.00	3.0	0	0	0	100
320060401	DES./CONST.	6	1.0	.00	1	.00	3.0	0	0	0	100
320060402	ACTIV./MAINT.	6	1.0	.00	1	.00	3.0	0	0	0	100
320060501	DES./CONST.	6	1.0	.00	1	.00	3.0	0	0	0	100
320060502	ACTIV./MAINT.	6	1.0	.00	1	.00	3.0	0	0	0	100
320060601	DES./CONST. 3	6	1.0	.00	1	.00	3.0	0	0	0	100
320060602	ACTIV./MAINT. 3	6	1.0	.00	1	.00	3.0	0	0	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29577

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
32007	GRND. SUPT. EQUIP	4	1.0	3.91	1	.00	4.0	84	0	0	100
3200701	MFG. GSE 3	5	1.0	.00	1	.00	4.0	0	0	0	100
3200702	ETR GSE	5	1.0	1.34	1	.00	4.0	84	0	0	100
3200703	WTR GSE	5	1.0	.40	1	.00	4.0	84	0	0	100
3200704	FLT OPS GSE(NASA)	5	1.0	1.09	1	.00	4.0	84	0	0	100
3200705	FLT OPS GSE(DOD)	5	1.0	1.09	1	.00	4.0	84	0	0	100
320070104	SOFTWARE 3	6	1.0	.00	1	.00	4.0	0	0	0	100
320070201	HARDWARE	6	1.0	.00	1	.00	4.0	0	0	0	100
320070202	SITE ACTIV.	6	1.0	.00	1	.00	4.0	0	0	0	100
320070203	MAINT.	6	1.0	.15	1	.00	4.0	84	0	0	100
320070204	SOFTWARE	6	1.0	1.18	1	.00	4.0	84	0	0	100
320070301	HARDWARE	6	1.0	.00	1	.00	4.0	0	0	0	100
320070302	SITE ACTIV.	6	1.0	.00	1	.00	4.0	0	0	0	100
320070303	MAINT.	6	1.0	.15	1	.00	4.0	84	0	0	100
320070304	SOFTWARE 3	6	1.0	.25	1	.00	4.0	84	0	0	100
320070403	MAINT. 3	6	1.0	.00	1	.00	4.0	0	0	0	100
320070404	SOFTWARE 3	6	1.0	1.09	1	.00	4.0	84	0	0	100
320070503	MAINT. 3	6	1.0	.00	1	.00	4.0	0	0	0	100
320070504	SOFTWARE 3	6	1.0	1.09	1	.00	4.0	84	0	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29577

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO.OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T O	T S	SPREAD FUNCT.	LEARN INDEX
32009	LAUNCH OPNS. WTR	4	1.0	14.62	1	.00	3.0	84	0	0	100
3200901	LNCH SITE SVCES	5	1.0	5.43	1	.00	3.0	84	0	0	100
3200902	TUG/SATL MATING	5	1.0	1.70	1	.00	3.0	84	0	0	100
3200903	PRELAUNCH C/O	5	1.0	1.95	1	.00	3.0	84	0	0	100
3200904	COUNTDOWN	5	1.0	3.08	1	.00	3.0	84	0	0	100
3200905	PRLNTS. & GASES	5	1.0	.32	1	.00	3.0	84	0	0	100
3200906	POST FLT. SAFING	5	1.0	2.15	1	.00	3.0	84	0	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 9-29977

COST DATA FORM - 4(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T O	T S	SPREAD PUNCT.	LEARN INDEX
32010	LAUNCH OPNS ETR	4	1.0	35.87	1	.00	3.0	84	0	0	100
3201001	LNCH SITE SVCES	5	1.0	13.01	1	.00	3.0	84	0	0	100
3201002	TUG/SHTL MATING	5	1.0	3.74	1	.00	3.0	84	0	0	100
3201003	PRELAUNCH C/O	5	1.0	4.55	1	.00	3.0	84	0	0	100
3201004	COUNTDOWN	5	1.0	7.54	1	.00	3.0	84	0	0	100
3201005	PRLNTS & GASES	5	1.0	1.51	1	.00	3.0	84	0	0	100
3201006	POST FLT. SAFING	5	1.0	5.52	1	.00	3.0	84	0	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29877

COST DATA FORM # A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
32011	FLIGHT OPNS NASA	4	1.0	31.94	1	.00	3.0	84	0	0	100
3201101	MISSION PLG.	5	1.0	6.86	1	.00	3.0	84	0	0	100
3201102	FLT. CONTROL	5	1.0	13.94	1	.00	3.0	84	0	0	100
3201103	FLT. EVAL.	5	1.0	7.68	1	.00	3.0	84	0	0	100
3201104	FLT. SUPT. SFTWRE	5	1.0	3.47	1	.00	3.0	84	0	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T D	T S	SPREAD FUNCT.	LEARN INDEX
32012	FLIGHT OPNS DOD	4	1.0	24.31	1	.00	3.0	84	0	0	100
3201201	MISSION PLG 3	5	1.0	5.73	1	.00	3.0	84	0	0	100
3201202	FLT. CONTROL	5	1.0	9.51	1	.00	3.0	84	0	0	100
3201203	FLT. EVAL.	5	1.0	6.43	1	.00	3.0	84	0	0	100
3201204	FLT. SUPT. SFTWRE	5	1.0	2.64	1	.00	3.0	84	0	0	100

469

STUDY TITLE: SPACE TUG SYS. STY (CHY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO.OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T O	T S	SPREAD FUNCT.	LEARN. [illegible]
32013	REFURB & INTEG WTR	4	1.0	13.77	6	.00	3.0	84	0	0	100
3201301	SCH MAINT & REF	5	1.0	3.20	1	.00	3.0	84	0	0	100
3201302	UNSCH MAINT & REF	5	1.0	.64	1	.00	3.0	84	0	0	100
3201303	POST MAINT C/O	5	1.0	.16	1	.00	3.0	84	0	0	100
3201304	TUG/PL MAING A/CO	5	1.0	2.24	1	.00	3.0	84	0	0	100
3201305	REFURB RQMTS PLB	5	1.0	.77	1	.00	3.0	84	0	0	100
3201306	DEPOT MAINT	5	50.0	6.77	12	.00	3.0	84	0	0	100

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO.: NAS 8-29677

COST DATA FORM - A(3)
RECURRING (OPERATIONS)

DATE: SEPTEMBER 11, 1973
PAGE OF

IDENTIFICATION NUMBER	WBS IDENTIFICATION	WBS LEVEL	NO. OF UNITS	EXPECTED COST	REF UNIT	REF UNIT COST	CONFID RATING	T O	T S	SPREAD PCT.	LEARN INDEX
32014	REFURB & INTEG ETR	4	1.0	44.70	8	.00	3.0	84	0	0	100
3201401	SCH MAINT & REF	5	1.0	7.58	1	.00	3.0	84	0	0	100
3201402	UNSCH MAINT & REF	5	1.0	1.47	1	.00	3.0	84	0	0	100
3201403	POST MAINT C/O	5	1.0	.38	1	.00	3.0	84	0	0	100
3201404	TUG/PL MATING, C/O	5	1.0	5.36	1	.00	3.0	84	0	0	100
3201405	REFURB RQMTS PLG	5	1.0	1.80	1	.00	3.0	84	0	0	100
3201406	DEPOT MAINT	5	237.0	32.11	12	.00	3.0	84	0	0	100

first unit that is used in the recurring phase of the program.

Confidence Rating: A value of (1), lowest, through (4), highest, representing the estimator's confidence in the estimate shown in the WBS item cost colum. The value is obtained by reviewing the Government criteria contained in Table 6.3-1 and subjectively selecting the code considered to be most applicable. At summary levels the confidence rating values are weighted averages of the confidence ratings of constituent WBS elements at subordinate levels.

Reference Unit Cost: The cost of the reference unit. At subordinate levels the cost is the specific cost of the reference unit. At summary levels the cost is the weighted average of the constituent subordinate reference units.

Td: The time in months required to perform an activity. For nonrecurring (DDT&E activity, the Td is the time required from Authorization to Proceed (ATP) with Phase C (nonrecurring/ DDT&E) through completion of designs, development, test and evaluation, which usually is at FACI-First Article Configuration Inspection. Td for production generally is the time from PDR-Preliminary Design Release through flight article(s) assembly and acceptance. Td for operations generally is the time from the start of ground system installation and test procedures verification through completion of flight evaluation and preparation of ground system and flight

Table 6.3-1

CONFIDENCE LEVEL CRITERIA FOR COST ESTIMATES

	CONFIDENCE LEVEL 1 LOW	CONFIDENCE LEVEL 2 MEDIUM LOW	CONFIDENCE LEVEL 3 MEDIUM HIGH	CONFIDENCE LEVEL 4 HIGH
ESTIMATING CONDITIONS	Estimating Time and Information Access Completely inadequate amount of time provided to make the estimate or there is a complete lack of access to useful data sources. Ground Rules and Assumptions No guidance was provided on ground rules and all assumptions made by the estimator were arbitrary.	Estimating Time and Information Access A very short due date or major problems of access to available data tend to make this estimate highly uncertain. Ground Rules and Assumptions Very little guidance was provided relative to ground rules. Most of the assumptions made by the estimator were considered quite arbitrary.	Estimating Time and Information Access A more accurate estimate could have been made if freer access or more time had been available to research known data sources. Ground Rules and Assumptions Ground rules were generally adequate. Many of the assumptions were authenticated but a substantial number are considered questionable.	Estimating Time and Information Access There were minor problems of access to available data and there was generally sufficient time to define and cost the item. Ground Rules and Assumptions Major ground rules were provided and most of the assumptions were authenticated.
NATURE OF THE ITEM	State-of-the-Art The item is substantially beyond the current state-of-the-art. Major development work is required. Production Experience No production of any kind has been started.	State-of-the-Art The item is slightly beyond the state-of-the-art and some development work will be required. Production Experience Experimental laboratory fabrication of a similar item is in process.	State-of-the-Art The item is within the state-of-the-art but no commercial counterpart exists. Production Experience A prototype of the item has been produced.	State-of-the-Art The item will involve a minor modification of commercial or standard aerospace issue items. Production Experience The item has been produced in limited quantity.
ITEM DESCRIPTION	Specification Status No work on a specification has started. Operating Program Characteristics None of the OPC for using the item have been formulated.	Specification Status Work on a specification is in an early stage and only general requirements are identified. Operating Program Characteristics The general outline of the OPC under which the item will be used has been only tentatively defined and many specific details are lacking.	Specification Status A specification for the item has not been completed but a specification on a similar item is available. Operating Program Characteristics The general outline of the OPC has been formulated but many specific details are lacking.	Specification Status A specification for the item has been prepared but is under review or revision. Operating Program Characteristics The OPC have been substantially defined but are under review or revision.
COST METHODS AND DATA	Methods The estimate is almost a poor guess and little or no confidence can be placed in it. Data An almost total lack of current and reliable relevant data make the cost estimate completely uncertain.	Methods A highly arbitrary rule-of-thumb has been used. Data The data used to make the estimate highly suspect, very sparse in quantity, and characterized by major inconsistencies.	Methods A commonly used rule-of-thumb cost factor but with no supporting backup has been used. Data The data used have been obtained from official or standard sources. Notable inconsistencies, lack of currency, gaps in data reduce the confidence in the estimate.	Methods The basic method used to derive the cost is well-documented but no double-check or authentication has been possible Data The data used are generally relevant and from a reputable source. They are incomplete, preliminary, or not completely current however.

vehicles for long term storage.

Ts: The lead time in months measured from the start of Td to the Initial Operational Capability (IOC), the launch milestone date.

Spread Function: An index number representing a cost distribution curve which the estimator recommends for the time phasing of costs over the Td time span. The index number represents the percentage of total cost (of the WBS item for the program phase) expected to be expended in 50 percent of the Td time span. At summary levels the spread functions are weighted averages of the spread functions of constituent WBS elements at subordinate levels.

Learning Index: A numerical index of a learning rate related to the recurring cost. A straight line cumulative average index is used in these calculations. At summary levels the learning index is the weighted average of the learning indices of constituent WBS elements at subordinate levels.

Launch Milestone Date: The date used in conjunction with Ts.

First Unit (T1) Cost: The production cost of the theoretical First Hardware Unit. It is considered to be the y-axis intercept of the learning curve on a Log-Log plot. The LEADER II Cost Model prints out this cost under the title of "Memo T1" for WBS 320-03-Vehicle Main Stage and subordinate elements thereof.

6.4 DDT&E Funding Distribution

This subsection contains the time-phaseed cost estimates required to accomplish the DDT&E phase of the program for each WBS element. Funding by Government Fiscal Year is displayed on Cost Data Form-C through WBS Level 7.

OPTION 3

INITIAL

COST DATA FORMS C

DDT&E

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 5 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
32001	PROJECT MGMT.	1.0	1.4	1.4	1.4	1.4	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.3	2.3	4.5	4.7	2.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	11.4	39.8	37.3	12.2	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.3	.9	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.5	.5	.5	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.1	.6	1.2	1.5	1.2	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.1	2.5	6.4	8.5	7.3	2.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.1	4.8	11.1	4.4	.9	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32010	LAUNCH OPNS ETR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32011	FLIGHT OPNS NASA	.0	.0	1.9	2.8	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	1.3	2.0	.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32014	REFURB &INTEG ETR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320	TOTAL PROJ PHASE	13.0	52.3	66.6	38.4	15.9	4.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS. STY (CRY) — FUNDING SCHEDULE — DATE: SEPTEMBER 11, 1973

CONTRACT NO: NAS 8-29677 — DATA FORM C — PAGE: 1 OF

X NON RECURRING(DDT&E) — RECURRING(PRODUCTION) — RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
320	TOTAL PROJ PHASE	13.0	82.3	66.6	38.4	15.9	4.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
32001	PROJECT MGMT.	1.0	1.4	1.4	1.4	1.4	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200101	COST/PERF. MGMT.	.7	.9	.9	.9	.9	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200102	PROJ. DIRECTION	.3	.4	.4	.4	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200103	INFORM. MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.3	2.3	4.5	4.7	2.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200201	TUG SYS. ENGR.	.2	1.8	3.6	3.8	2.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200202	SHUTTLE I/F	.0	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200203	PAYLOAD I/F	.0	.3	.7	.7	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	11.4	39.8	37.3	12.2	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200301	STRUCTURES	2.2	7.4	6.5	1.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200302	THERMAL CONTROL	.2	.7	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200303	AVIONICS	2.7	9.7	9.6	3.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200304	PROPULSION	3.8	13.6	12.2	3.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200305	ORBITER I/F	1.6	4.6	4.1	2.0	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200307	FINAL ASSY & C/O	1.0	3.8	4.2	2.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.3	.9	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200401	VEH AUX. STAGE	.0	.3	.9	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.5	.5	.5	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200501	TRANSP. & HDLG.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200502	TRAINING	.0	.4	.4	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200503	INV CONT. & WHSNG	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.1	.6	1.2	1.5	1.2	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200601	MANUFACTURING	.0	.1	.3	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200602	TEST	.0	.2	.4	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200603	ETR MAINT. & REF.	.0	.1	.2	.3	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200604	ETR LAUNCH	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200605	WTR MAINT. & REF.	.0	.1	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200606	WTR LAUNCH	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.1	2.5	6.4	8.5	7.3	2.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200701	MFG. GSE	.0	.6	1.6	2.1	1.8	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200702	ETR GSE	.0	.9	2.4	3.1	2.7	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200703	WTR GSE	.0	.9	2.2	3.0	2.5	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200704	FLT OPS GSE(NASA)	.0	.0	.1	.2	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200705	FLT OPS GSE(DOD)	.0	.0	.1	.2	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.1	4.8	11.1	4.4	.9	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200801	GND TEST HDWE.	.1	4.5	8.0	1.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200802	GND TEST OPNS.	.0	.3	3.1	2.9	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200804	FLT. TEST OPNS	.0	.0	.0	.0	.8	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200901	LNCH SITE SVCES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200902	TUG/SHTL MATING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200903	PRELAUNCH C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200904	COUNTDOWN	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200905	PRLNTS. & GASES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200906	POST FLT. SAFING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

F1-7

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 2 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
32010	LAUNCH OPNS ETR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201001	LNCH SITE SVCES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201002	TUG/SHTL MATING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201003	PRELAUNCH C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201004	COUNTDOWN	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201005	PRLNTS & GASES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201006	POST FLT. SAFING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32011	FLIGHT OPNS NASA	.0	.0	1.9	2.8	1.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201101	MISSION PLG.	.0	.0	.9	1.3	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201102	FLT. CONTROL	.0	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201103	FLT. EVAL.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201104	FLT. SUPT. SFTWRE	.0	.0	.9	1.3	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	1.3	2.0	.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201201	MISSION PLG	.0	.0	.6	.9	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201202	FLT. CONTROL	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201203	FLT. EVAL.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201204	FLT. SUPT. SFTWRE	.0	.0	.6	.9	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201301	SCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201302	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201303	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201304	TUG/PL MAING &/CO	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201305	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201306	DEPOT MAINT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32014	REFURB &INTEG ETR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201401	SCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201402	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201403	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201404	TUG/PL MATING,C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201405	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201406	DEPOT MAINT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030101	FUEL TK & SUPT	.6	2.0	1.8	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030102	OXID. TK & SUPT	.3	1.1	1.0	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030103	BODY STRUCTURE	.5	1.7	1.5	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030104	THRUST STRUCTURE	.2	.6	.5	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030105	METEOROID SHIELD	.1	.4	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030106	PAYLOAD I/F	.3	1.0	.9	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030107	INSTL, ASSY & C/O	.2	.5	.5	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030201	FUEL TANK INSL	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030202	OXID. TANK INSL.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030203	INSL. PURGE SYS.	.1	.5	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030204	THERM CONT. SYS.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030205	INSTL ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030301	DATA MGMT. 3	1.0	3.7	3.7	1.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030302	G N & C	.2	.5	.5	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030303	COMMUNICATIONS	.6	2.2	2.3	.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 3 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
320030304	INSTRUMENTATION	.2	.8	.8	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030305	ELECT. POWER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030306	PWR. DIST. & CONT	.1	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030307	INSTL. ASSY & C/O	.0	2.1	2.0	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030401	MAIN ENGINE 3	1.6	5.5	4.8	1.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030402	MAIN ENG. SUPT	1.3	5.0	4.6	1.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030403	ACPS ENGINE	.0	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030404	ACPS ENG. SUPT	.7	2.3	2.1	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030405	INSTL. ASSY & C/O	.2	.7	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030501	STRUCTURES	.5	1.5	1.3	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030502	I/F PANELS	.8	2.3	2.1	1.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030503	PURGE PROV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030504	ABORT PROV.	.1	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030505	INSTL. ASSY & C/O	.1	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030701	FINAL ASSY	.8	2.9	3.2	1.5	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030702	C/O	.2	.9	1.0	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320050201	SIM. & EQUIP.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320050202	GROUND CREW	.0	.4	.4	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060101	DES./CONST.	.0	.1	.3	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060102	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060201	DES./CONST.	.0	.2	.4	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060202	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060301	DES./CONST.	.0	.1	.2	.3	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060302	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060401	DES./CONST.	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060402	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060501	DES./CONST.	.0	.1	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060502	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060601	DES./CONST. 3	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060602	ACTIV./MAINT. 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070101	HARDWARE	.0	.4	1.0	1.4	1.2	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070102	SITE ACTIV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070103	MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070104	SOFTWARE	.0	.2	.6	.7	.5	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070201	HARDWARE	.0	.6	1.5	2.0	1.7	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070202	SITE ACTIV.	.0	.2	.5	.6	.6	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070203	MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070204	SOFTWARE	.0	.1	.4	.5	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070301	HARDWARE	.0	.5	1.4	1.9	1.6	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070302	SITE ACTIV.	.0	.2	.5	.6	.5	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070303	MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070304	SOFTWARE	.0	.1	.4	.5	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070401	HARDWARE 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070402	SITE ACTIV. 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070404	SOFTWARE 3	.0	.0	.1	.2	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070501	HARDWARE 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 4 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
~~320070502~~	~~SITE ACTIV. 3~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~
320070504	SOFTWARE 3	.0	.0	.1	.2	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080101	PTV TEST	.0	1.0	1.8	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~320080102~~	~~MAJOR TEST ART.~~	~~.0~~	~~3.3~~	~~5.9~~	~~1.1~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~
320080103	MOCKUPS	.0	.2	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003010101	LH2 DOMES	.2	.7	.6	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~32003010102~~	~~LH2 CYLINDER~~	~~.3~~	~~.9~~	~~.8~~	~~.2~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~
32003010103	LH2 SUPPORTS	.1	.4	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003010201	LO2 DOMES	.2	.8	.7	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~32003010202~~	~~LO2 SUPPORTS~~	~~.1~~	~~.3~~	~~.2~~	~~.1~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~
32003010301	FWD AFT SKIRT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003010302	INTERTANK	.2	.8	.7	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~32003010303~~	~~SDWL SHELL~~	~~.3~~	~~.9~~	~~.8~~	~~.2~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~
32003030101	COMPUTER	.6	2.0	2.0	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030102	DATA DISTR.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~32003030103~~	~~EQ. THERM CONT.~~	~~.1~~	~~.3~~	~~.3~~	~~.1~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~
32003030104	CIRCUITRY 3	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030105	SOFTWARE	.3	.9	.9	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~32003030106~~	~~SOFTWARE~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~
32003030107	SOFTWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030108	INSTL. ASSY & C/O	.1	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~32003030201~~	~~I M U~~	~~.1~~	~~.3~~	~~.3~~	~~.1~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~
32003030202	TRACKING/ELECT 3	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030203	REN DEZ&DOCKING 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~32003030204~~	~~INSTL. ASSY & C/O~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~
32003030301	M/W CIRC +RF MUX	.2	.8	.9	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030302	TRANSPONDERS 3	.1	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~32003030303~~	~~POWER AMP.~~	~~.0~~	~~.2~~	~~.1~~	~~.1~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~
32003030304	ANTENNA	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030305	DEC/ENC+MOD/DEM	.1	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030306	TAPE RECORDER	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030307	P/L INTER EQUIP	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030308	INSTL. ASSY & C/O	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~32003030401~~	~~DATA SENSORS~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~
32003030402	SIGNAL COND.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030403	CIRCUITRY	.2	.7	.6	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~32003030404~~	~~INSTL. ASSY & C/O~~	~~.0~~	~~.1~~	~~.1~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~
32003030501	BATTERY	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030502	FUEL CELL 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~32003030503~~	~~INSTL. ASSY & C/O~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~
32003030601	DISTR.	.1	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030602	TANKS SYSTEM 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~32003030603~~	~~INSTL. ASSY & C/O~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~

OPTION 3

TOTAL

COST DATA FORMS C

DDT&E

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 5 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94
32001	PROJECT MGMT.	.4	.5	.5	.5	.5	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.1	.7	1.6	2.3	2.0	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	5.4	19.6	18.6	5.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.1	.6	.6	.6	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.5	1.3	1.6	1.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.0	3.6	7.5	2.6	.0	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32010	LAUNCH OPNS ETR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32011	FLIGHT OPNS NASA	.0	.0	.9	1.9	1.5	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	.6	1.3	1.0	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32013	REFURB & INTEG WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32014	REFURB & INTEG ETR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320	TOTAL PROJ PHASE	6.1	25.6	31.7	16.6	6.7	2.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

Box 7

STUDY 1. LEO SPACE TUG SYS. STY (CRY) — FUNDING SCHEDULE — DATE: SEPTEMBER 11, 1976

CONTRACT NO: NAS 8-29677 — DATA FORM C — PAGE: 1 OF

X NON RECURRING(DDT&E) — RECURRING(PRODUCTION) — RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94
320	TOTAL PROJ PHASE	6.1	25.6	31.7	16.6	6.7	2.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32001	PROJECT MGMT.	.4	.5	.5	.5	.5	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200101	COST/PERF. MGMT.	.3	.4	.4	.4	.4	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200102	PROJ. DIRECTION	.1	.2	.2	.2	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200103	INFORM. MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.1	.7	1.6	2.3	2.0	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200201	TUG SYS. ENGR.	.1	.5	1.3	1.8	1.6	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200202	SHUTTLE I/F	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200203	PAYLOAD I/F	.0	.1	.3	.4	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	5.4	19.6	18.6	5.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200301	STRUCTURES	.3	1.2	1.2	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200302	THERMAL CONTROL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200303	AVIONICS	2.8	10.0	9.0	2.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200304	PROPULSION	1.9	6.9	6.9	2.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200305	ORBITER I/F	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200307	FINAL ASSY & C/O	.4	1.4	1.4	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200401	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.1	.6	.6	.6	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200501	TRANSP. & HDLG.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200502	TRAINING	.1	.3	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200503	INV CONT. & WHSNG	.1	.3	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200601	MANUFACTURING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200602	TEST	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200603	ETR MAINT. & REF.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200604	ETR LAUNCH	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200605	WTR MAINT. & REF.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200606	WTR LAUNCH	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.5	1.3	1.6	1.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200701	MFG. GSE	.0	.2	.5	.6	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200702	ETR GSE	.0	.1	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200703	WTR GSE	.0	.1	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200704	FLT OPS GSE(NASA)	.0	.1	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200705	FLT OPS GSE(DOD)	.0	.1	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.0	3.6	7.5	2.6	.0	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200801	GND TEST HDWE.	.0	2.3	4.7	1.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200802	GND TEST OPNS.	.0	1.3	2.7	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200804	FLT. TEST OPNS	.0	.0	.0	.0	.0	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200901	LNCH SITE SVCES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200902	TUG/SHTL MATING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200903	PRELAUNCH C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200904	COUNTDOWN	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200905	PRLNTS. & GASES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200906	POST FLT. SAFING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

601-9

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 2 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94
32010	LAUNCH OPNS ETR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201001	LNCH SITE SVCES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201002	TUG/SHTL MATING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201003	PRELAUNCH C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201004	COUNTDOWN	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201005	PRLNTS & GASES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201006	POST FLT. SAFING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32011	FLIGHT OPNS NASA	.0	.0	.9	1.9	1.5	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201101	MISSION PLG.	.0	.0	.8	1.7	1.3	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201102	FLT. CONTROL	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201103	FLT. EVAL.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201104	FLT. SUPT. SFTWRE	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	.6	1.3	1.0	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201201	MISSION PLG	.0	.0	.5	1.2	.9	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201202	FLT. CONTROL	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201203	FLT. EVAL.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201204	FLT. SUPT. SFTWRE	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201301	SCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201302	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201303	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201304	TUG/PL MAING &/CO	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201305	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201306	DEPOT MAINT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32014	REFURB &INTEG ETR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201401	SCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201402	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201403	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201404	TUG/PL MATING,C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201405	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201406	DEPOT MAINT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030101	FUEL TK & SUPT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030102	OXID. TK & SUPT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030103	BODY STRUCTURE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030104	THRUST STRUCTURE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030105	METEOROID SHIELD	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030106	PAYLOAD I/F	.3	1.2	1.1	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030107	INSTL. ASSY & C/O	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030201	FUEL TANK INSL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030202	OXID. TANK INSL.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030203	INSL. PURGE SYS.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030204	THERM CONT. SYS.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030205	INSTL ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030301	DATA MGMT. 3	1.0	3.6	3.2	.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030302	G N & C	.4	1.5	1.4	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030303	COMMUNICATIONS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 3 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94
320030304	INSTRUMENTATION	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030305	ELECT. POWER	.7	2.7	2.5	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030306	PWR. DIST. & CONT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030307	INSTL. ASSY & C/O	.6	2.1	1.9	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030401	MAIN ENGINE 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030402	MAIN ENG. SUPT	.6	2.2	2.2	.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030403	ACPS ENGINE	.1	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030404	ACPS ENG. SUPT	1.1	4.1	4.1	1.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030405	INSTL. ASSY & C/O	.1	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030501	STRUCTURES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030502	I/F PANELS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030503	PURGE PROV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030504	ABORT PROV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030505	INSTL. ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030701	FINAL ASSY	.2	.9	.9	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030702	C/O	.1	.5	.5	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320050201	SIM. & EQUIP.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320050202	GROUND CREW	.1	.3	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060101	DES./CONST.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060102	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060201	DES./CONST.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060202	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060301	DES./CONST.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060302	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060401	DES./CONST.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060402	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060501	DES./CONST.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060502	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060601	DES./CONST. 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060602	ACTIV./MAINT. 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070101	HARDWARE	.0	.2	.5	.6	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070102	SITE ACTIV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070103	MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070104	SOFTWARE	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070201	HARDWARE	.0	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070202	SITE ACTIV.	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070203	MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070204	SOFTWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070301	HARDWARE	.0	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070302	SITE ACTIV.	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070303	MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070304	SOFTWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070401	HARDWARE 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070402	SITE ACTIV. 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070404	SOFTWARE 3	.0	.1	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070501	HARDWARE 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 4 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94
320070502	SITE ACTIV. 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070504	SOFTWARE 3	.0	.1	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080101	PTV TEST	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080102	MAJOR TEST ART.	.0	2.2	4.5	1.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080103	MOCKUPS	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003010101	LH2 DOMES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003010102	LH2 CYLINDER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003010103	LH2 SUPPORTS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003010201	LO2 DOMES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003010202	LO2 SUPPORTS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003010301	FWD AFT SKIRT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003010302	INTERTANK	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003010303	SDWL SHELL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030101	SCU	.5	1.9	1.7	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030102	DATA DISTR.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030103	EQ. THERM CONT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030104	CIRCUITRY 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030105	SOFTWARE	.4	1.5	1.3	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030106	SOFTWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030107	SOFTWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030108	INSTL, ASSY & C/O	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030201	I M U	.3	1.2	1.0	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030202	TRACKING/ELECT 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030203	REN DEZ&DOCKING 3	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030204	INSTL, ASSY & C/O	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030301	M/W CIRC +RF MUX	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030302	TRANSPONDERS 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030303	POWER AMP.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030304	ANTENNA	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030305	DEC/ENC+MOD/DEM	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030306	TAPE RECORDER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030307	P/L INTER EQUIP	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030308	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030401	DATA SENSORS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030402	SIGNAL COND.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030403	CIRCUITRY	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030404	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030501	BATTERY	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030502	FUEL CELL 3	.7	2.5	2.3	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030503	INSTL, ASSY & C/O	.1	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030601	DISTR.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030602	TANKS SYSTEM 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030603	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

OPTION 3

FINAL

COST DATA FORMS C

DDT&E

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 12, 1973
PAGE: 5 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
32001	PROJECT MGMT.	1.0	1.4	1.4	1.8	1.9	.8	.5	.5	.5	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.3	2.3	4.5	4.8	3.3	1.7	2.3	2.0	.4	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	11.4	39.8	37.3	17.6	20.0	18.6	5.7	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.3	.9	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.5	.5	.6	.7	.6	.6	.4	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.1	.6	1.2	1.5	1.2	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.1	2.5	6.4	8.5	7.8	4.1	1.6	1.1	.1	.0	.0	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.1	4.8	11.1	4.4	4.5	7.6	2.6	.0	.5	.0	.0	.0	.0	.0	.0	.0
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32010	LAUNCH OPNS ETR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32011	FLIGHT OPNS NASA	.0	.0	1.9	2.8	1.1	.9	1.9	1.5	.3	.0	.0	.0	.0	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	1.3	2.0	.8	.6	1.3	1.0	.2	.0	.0	.0	.0	.0	.0	.0
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32014	REFURB &INTEG ETR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320	TOTAL PROJ PHASE	13.0	52.3	66.6	44.5	41.5	35.7	16.7	6.7	2.2	.0	.0	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS. STY (GRY) — FUNDING SCHEDULE — DATE: SEPTEMBER 12, 1973

CONTRACT NO: NAS 8-29677 — DATA FORM C — PAGE: 1 OF

X NON RECURRING(DDT&E) — RECURRING(PRODUCTION) — RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
320	TOTAL PROJ PHASE	13.0	52.3	66.6	44.5	41.5	35.7	16.7	6.7	2.2	.0	.0	.0	.0	.0	.0	.0
32001	PROJECT MGMT.	1.0	1.4	1.4	1.8	1.9	.8	.5	.5	.5	.0	.0	.0	.0	.0	.0	.0
3200101	COST/PERF. MGMT.	.7	.9	.9	1.2	1.3	.6	.4	.4	.4	.0	.0	.0	.0	.0	.0	.0
3200102	PROJ. DIRECTION	.3	.4	.4	.5	.6	.3	.2	.2	.2	.0	.0	.0	.0	.0	.0	.0
3200103	INFORM. MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.3	2.3	4.5	4.8	3.3	1.7	2.3	2.0	.4	.0	.0	.0	.0	.0	.0	.0
3200201	TUG SYS. ENGR.	.2	1.8	3.6	3.9	2.6	1.4	1.8	1.6	.3	.0	.0	.0	.0	.0	.0	.0
3200202	SHUTTLE I/F	.0	.1	.2	.2	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200203	PAYLOAD I/F	.0	.3	.7	.7	.5	.3	.4	.3	.1	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	11.4	39.8	37.3	17.6	20.0	18.6	5.7	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200301	STRUCTURES	2.2	7.4	6.5	1.9	1.2	1.2	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200302	THERMAL CONTROL	.2	.7	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200303	AVIONICS	2.7	9.7	9.6	6.3	10.0	9.0	2.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200304	PROPULSION	3.8	13.6	12.2	4.9	6.9	6.9	2.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200305	ORBITER I/F	1.6	4.6	4.1	2.0	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200307	FINAL ASSY & C/O	1.0	3.8	4.2	2.4	1.5	1.4	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.3	.9	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200401	VEH AUX. STAGE	.0	.3	.9	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.5	.5	.6	.7	.6	.6	.4	.0	.0	.0	.0	.0	.0	.0	.0
3200501	TRANSP. & HDLG.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200502	TRAINING	.0	.4	.4	.5	.4	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0
3200503	INV CONT. & WHSNG	.0	.1	.1	.2	.3	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.1	.6	1.2	1.5	1.2	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200601	MANUFACTURING	.0	.1	.3	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200602	TEST	.0	.2	.4	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200603	ETR MAINT. & REF.	.0	.1	.2	.3	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200604	ETR LAUNCH	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200605	WTR MAINT. & REF.	.0	.1	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200606	WTR LAUNCH	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.1	2.5	6.4	8.5	7.8	4.1	1.6	1.1	.1	.0	.0	.0	.0	.0	.0	.0
3200701	MFG. GSE	.0	.6	1.6	2.1	2.0	1.2	.6	.4	.1	.0	.0	.0	.0	.0	.0	.0
3200702	ETR GSE	.0	.9	2.4	3.1	2.8	1.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0
3200703	WTR GSE	.0	.9	2.2	3.0	2.6	1.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0
3200704	FLT OPS GSE(NASA)	.0	.0	.1	.2	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200705	FLT OPS GSE(DOD)	.0	.0	.1	.2	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.1	4.8	11.1	4.4	4.5	7.6	2.6	.0	.5	.0	.0	.0	.0	.0	.0	.0
3200801	GND TEST HDWE.	.1	4.5	8.0	1.4	2.3	4.7	1.6	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200802	GND TEST OPNS.	.0	.3	3.1	2.9	1.4	2.7	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200804	FLT. TEST OPNS	.0	.0	.0	.0	.8	.1	.0	.0	.5	.0	.0	.0	.0	.0	.0	.0
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200901	LNCH SITE SVCES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200902	TUG/SHTL MATING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200903	PRELAUNCH C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200904	COUNTDOWN	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200905	PRLNTS. & GASES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200906	POST FLT. SAFING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 12, 1973
PAGE: 2 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
32010	LAUNCH OPNS ETR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201001	LNCH SITE SVCES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201002	TUG/SHTL MATING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201003	PRELAUNCH C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201004	COUNTDOWN	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201005	PRLNTS & GASES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201006	POST FLT. SAFING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32011	FLIGHT OPNS NASA	.0	.0	1.9	2.8	1.1	.9	1.9	1.5	.3	.0	.0	.0	.0	.0	.0	.0
3201101	MISSION PLG.	.0	.0	.9	1.3	.5	.8	1.7	1.3	.3	.0	.0	.0	.0	.0	.0	.0
3201102	FLT. CONTROL	.0	.0	.1	.2	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
3201103	FLT. EVAL.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201104	FLT. SUPT. SFTWRE	.0	.0	.9	1.3	.5	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	1.3	2.0	.8	.8	1.3	1.0	.2	.0	.0	.0	.0	.0	.0	.0
3201201	MISSION PLG	.0	.0	.6	.9	.4	.5	1.2	.9	.2	.0	.0	.0	.0	.0	.0	.0
3201202	FLT. CONTROL	.0	.0	.1	.1	.1	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
3201203	FLT. EVAL.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201204	FLT. SUPT. SFTWRE	.0	.0	.6	.9	.4	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201301	SCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201302	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201303	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201304	TUG/PL MAING &/CO	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201305	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201306	DEPOT MAINT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32014	REFURB &INTEG ETR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201401	SCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201402	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201403	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201404	TUG/PL MATING,C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201405	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201406	DEPOT MAINT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030101	FUEL TK & SUPT	.6	2.0	1.8	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030102	OXID. TK & SUPT	.3	1.1	1.0	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030103	BODY STRUCTURE	.5	1.7	1.5	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030104	THRUST STRUCTURE	.2	.6	.5	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030105	METEOROID SHIELD	.1	.4	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030106	PAYLOAD I/F	.3	1.0	.9	.5	1.2	1.1	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030107	INSTL, ASSY & C/O	.2	.5	.5	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030201	FUEL TANK INSL	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030202	OXID. TANK INSL.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030203	INSL. PURGE SYS.	.1	.5	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030204	THERM CONT. SYS.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030205	INSTL ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030301	DATA MGMT. 3	1.0	3.7	3.7	2.3	3.6	3.2	.8	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030302	G N & C	.2	.5	.5	.6	1.5	1.4	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030303	COMMUNICATIONS	.8	2.2	2.3	.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 12, 1973
PAGE: 3 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
320030304	INSTRUMENTATION	.2	.8	.8	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030305	ELECT. POWER	.0	.0	.0	.7	2.7	2.5	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030306	PWR. DIST. & CONT	.1	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030307	INSTL. ASSY & C/O	.6	2.1	2.0	1.3	2.1	1.9	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030401	MAIN ENGINE 3	1.6	5.5	4.8	1.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030402	MAIN ENG. SUPT	1.3	5.0	4.6	1.8	2.2	2.2	.8	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030403	ACPS ENGINE	.0	.2	.2	.1	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030404	ACPS ENG. SUPT	.7	2.3	2.1	1.6	4.1	4.1	1.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030405	INSTL. ASSY & C/O	.2	.7	.6	.2	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030501	STRUCTURES	.5	1.5	1.3	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030502	I/F PANELS	.8	2.3	2.1	1.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030503	PURGE PROV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030504	ABORT PROV.	.1	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030505	INSTL. ASSY & C/O	.1	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030701	FINAL ASSY	.8	2.9	3.2	1.7	1.0	.9	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030702	C/O	.2	.9	1.0	.6	.3	.5	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
320050201	SIM. & EQUIP.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320050202	GROUND CREW	.0	.4	.4	.5	.4	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0
320060101	DES./CONST.	.0	.1	.3	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060102	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060201	DES./CONST.	.0	.2	.4	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060202	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060301	DES./CONST.	.0	.1	.2	.3	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060302	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060401	DES./CONST.	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060402	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060501	DES./CONST.	.0	.1	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060502	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060601	DES./CONST. 3	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060602	ACTIV./MAINT. 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070101	HARDWARE	.0	.4	1.0	1.4	1.4	1.0	.6	.4	.1	.0	.0	.0	.0	.0	.0	.0
320070102	SITE ACTIV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070103	MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070104	SOFTWARE	.0	.2	.6	.7	.6	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070201	HARDWARE	.0	.6	1.5	2.0	1.8	.9	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0
320070202	SITE ACTIV.	.0	.2	.5	.6	.6	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070203	MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070204	SOFTWARE	.0	.1	.4	.5	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070301	HARDWARE	.0	.5	1.4	1.9	1.7	.8	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0
320070302	SITE ACTIV.	.0	.2	.5	.6	.5	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070303	MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070304	SOFTWARE	.0	.1	.4	.5	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070401	HARDWARE 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070402	SITE ACTIV. 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070404	SOFTWARE 3	.0	.0	.1	.2	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0
320070501	HARDWARE 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 12, 1973
PAGE: 4 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
320070502	SITE ACTIV. 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070504	SOFTWARE 3	.0	.0	.1	.2	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0
320080101	PTV TEST	.0	1.0	1.8	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080102	MAJOR TEST ART.	.0	3.3	5.9	1.1	2.2	4.5	1.6	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080103	MOCKUPS	.0	.2	.3	.1	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003010101	LH2 DOMES	.2	.7	.6	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003010102	LH2 CYLINDER	.3	.9	.8	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003010103	LH2 SUPPORTS	.1	.4	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003010201	LO2 DOMES	.2	.8	.7	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003010202	LO2 SUPPORTS	.1	.3	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003010301	FWD AFT SKIRT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003010302	INTERTANK	.2	.8	.7	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003010303	SDWL SHELL	.3	.9	.8	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030101	COMPUTER	.6	2.0	2.0	1.2	1.9	1.7	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030102	DATA DISTR.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030103	EQ. THERM CONT.	.1	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030104	CIRCUITRY 3	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030105	SOFTWARE	.3	.9	.9	.7	1.5	1.3	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030106	SOFTWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030107	SOFTWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030108	INSTL. ASSY & C/O	.1	.3	.3	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030201	I M U	.1	.3	.3	.4	1.2	1.0	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030202	TRACKING/ELECT 3	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030203	REN DEZ&DOCKING 3	.0	.0	.0	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030204	INSTL. ASSY & C/O	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030301	M/W CIRC +RF MUX	.2	.8	.9	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030302	TRANSPONDERS 3	.1	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030303	POWER AMP.	.0	.2	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030304	ANTENNA	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030305	DEC/ENC+MOD/DEM	.1	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030306	TAPE RECORDER	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030307	P/L INTER EQUIP	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030308	INSTL. ASSY & C/O	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030401	DATA SENSORS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030402	SIGNAL COND.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030403	CIRCUITRY	.2	.7	.6	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030404	INSTL. ASSY & C/O	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030501	BATTERY	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030502	FUEL CELL 3	.0	.0	.0	.7	2.5	2.3	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030503	INSTL. ASSY & C/O	.0	.0	.0	.1	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030601	DISTR.	.1	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030602	TANKS SYSTEM 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003030603	INSTL. ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

6.5 Production Funding Distribution

This subsection contains the time-phased cost estimates to accomplish the Production phase of the program for each WBS element. Funding by Government Fiscal Year is displayed on Cost Data Form-C through WBS Level 7.

OPTION 3

INITIAL

COST DATA FORMS C

PRODUCTION

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 9 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
32001	~~PROJECT MGMT.~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.9~~	~~1.2~~	~~.5~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~
32002	SYS. ENGR. & INT.	.0	.0	.0	5.9	7.9	7.9	2.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	.0	1.4	10.1	19.9	19.7	7.1	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~32004~~	~~VEH AUX. STAGE~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~1.0~~	~~3.3~~	~~4.4~~	~~3.1~~	~~.4~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~
32005	LOGISTICS	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~32007~~	~~GRND. SUPT. EQUIP~~	~~.0~~	~~.0~~	~~.0~~	~~.1~~	~~.1~~	~~.1~~	~~.1~~	~~.1~~	~~.1~~	~~.1~~	~~.1~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~	~~.0~~
32008	VEHICLE TEST	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320	TOTAL PROJ PHASE	.0	1.4	10.1	26.0	28.9	19.5	8.1	3.6	.6	.2	.2	.0	.0	.0	.0	.0

6-24

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 6 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
320	TOTAL PROJ PHASE	.0	1.4	10.1	26.0	28.9	19.5	8.1	3.8	.8	.2	.2	.0	.0	.0	.0	.0
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.9	1.2	.3	.0	.0	.0	.0	.0	.0	.0	.0
3200101	COST/PERF. MGMT.	.0	.0	.0	.0	.0	.6	.8	.2	.0	.0	.0	.0	.0	.0	.0	.0
3200102	PROJ. DIRECTION	.0	.0	.0	.0	.0	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200103	INFORM. MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.0	.0	5.9	7.9	7.9	2.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200201	TUG SYS. ENGR.	.0	.0	.0	.7	1.0	1.0	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200202	SHUTTLE I/F	.0	.0	.0	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200203	PAYLOAD I/F	.0	.0	.0	.4	.5	.5	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	.0	1.4	10.1	19.9	19.7	7.1	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200301	STRUCTURES	.0	.3	1.6	2.4	1.9	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200302	THERMAL CONTROL	.0	.1	.4	.7	.5	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200303	AVIONICS	.0	.1	3.1	7.0	6.6	1.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200304	PROPULSION	.0	.7	3.5	5.4	4.3	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200305	ORBITER I/F	.0	.2	1.5	2.8	2.8	1.5	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200307	FINAL ASSY & C/O	.0	.0	.0	1.5	3.4	2.5	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	1.0	3.3	4.4	3.1	.4	.0	.0	.0	.0	.0	.0	.0
3200401	VEH AUX. STAGE	.0	.0	.0	.0	1.0	3.3	4.4	3.1	.4	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200501	TRANSP. & HDLG.	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200502	TRAINING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200503	INV CONT. & WHSNG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200601	MANUFACTURING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200602	TEST	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0
3200701	MFG. GSE	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030101	FUEL TK & SUPT	.0	.1	.4	.7	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030102	OXID. TK & SUPT	.0	.0	.2	.3	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030103	BODY STRUCTURE	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030104	THRUST STRUCTURE	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030105	METEOROID SHIELD	.0	.1	.4	.6	.5	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030106	PAYLOAD I/F	.0	.1	.3	.5	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030107	INSTL. ASSY & C/O	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030201	FUEL TANK INSL	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030202	OXID. TANK INSL.	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030203	INSL. PURGE SYS.	.0	.0	.3	.4	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030204	THERM CONT. SYS.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030205	INSTL ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030301	DATA MGMT. 3	.0	.0	.7	1.6	1.5	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030302	G N & C	.0	.0	.7	1.7	1.6	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030303	COMMUNICATIONS	.0	.0	1.2	2.8	2.7	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030304	INSTRUMENTATION	.0	.0	.1	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030305	ELECT. POWER	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030306	PWR. DIST. & CONT	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 7 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
320030307	INSTL, ASSY & C/O	.0	.0	.2	.4	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030401	MAIN ENGINE 3	.0	.2	.9	1.4	1.2	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030402	MAIN ENG. SUPT	.0	.3	1.5	2.3	1.9	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030403	ACPS ENGINE	.0	.1	.3	.4	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030404	ACPS ENG. SUPT	.0	.1	.7	1.0	.8	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030405	INSTL, ASSY & C/O	.0	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030501	STRUCTURES	.0	.0	.2	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030502	I/F PANELS	.0	.1	1.0	1.9	1.9	1.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030503	PURGE PROV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030504	ABORT PROV.	.0	.0	.2	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030505	INSTL, ASSY & C/O	.0	.0	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030701	FINAL ASSY	.0	.0	.0	1.3	2.9	2.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030702	C/O	.0	.0	.0	.3	.6	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320050201	SIM. & EQUIP.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060101	DES./CONST.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060102	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060201	DES./CONST.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060202	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070101	HARDWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070102	SITE ACTIV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070103	MAINT.	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0
3200204	SUST. ENGR.	.0	.0	.0	4.6	6.2	6.2	1.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200803	FLT. TEST HDWE.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080301	STRUCTURES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080302	THERMAL CONTROL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080303	AVIONICS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080304	PROPULSION	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080305	ORBITER I/F	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080307	FINAL ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030101	FUEL TK & SUPT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030102	OXID. TK & SUPT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030103	BODY STRUCTURE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030104	THRUST STRUCTURE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030105	METEOROID SHIELD	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030106	PAYLOAD I/F	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030107	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030201	FUEL TANK INSL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030202	OXID TANK INSL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030203	INSL PURGE SYS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030204	THERM CONT SYS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030205	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030301	DATA MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030302	G N & C	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030303	COMMUNICATIONS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030304	INSTRUMENTATION	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

6-19

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 8 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
32008030305	ELECT. POWER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030306	PWR DIST. & CONT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030307	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030401	MAIN ENGINE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030402	MAIN ENG SUPT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030403	ACPS ENGINE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030404	ACPS ENG SUPT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030405	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030501	STRUCTURES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030502	I/F PANELS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030503	PURGE PROV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030504	ABORT PROV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030505	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030701	FINAL ASSY	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030702	C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

6-24

OPTION 3

FINAL

COST DATA FORMS C

PRODUCTION

STUDY TITLE: SPACE TUG SYS, STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1978

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	1.9	1.9	1.6	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.0	.0	6.5	9.8	9.8	9.8	8.1	.0	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	.0	3.5	15.4	28.2	34.2	27.4	9.9	1.9	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.4	.8	.8	.8	.8	.8	.4	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.0	.2	.3	.3	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320	TOTAL PROJ PHASE	.0	3.5	15.6	35.5	45.1	40.3	22.9	12.7	.8	.4	.0	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 6 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94
320	TOTAL PROJ PHASE	.0	3.5	15.6	35.5	45.1	40.3	22.9	12.7	.8	.4	.0	.0	.0	.0	.0	.0
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	1.9	1.9	1.6	.0	.0	.0	.0	.0	.0	.0	.0
3200101	COST/PERF. MGMT.	.0	.0	.0	.0	.0	1.3	1.3	1.1	.0	.0	.0	.0	.0	.0	.0	.0
3200102	PROJ. DIRECTION	.0	.0	.0	.0	.0	.6	.6	.5	.0	.0	.0	.0	.0	.0	.0	.0
3200103	INFORM. MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.0	.0	6.5	9.8	9.8	9.8	8.1	.0	.0	.0	.0	.0	.0	.0	.0
3200201	TUG SYS. ENGR.	.0	.0	.0	.9	1.4	1.4	1.4	1.2	.0	.0	.0	.0	.0	.0	.0	.0
3200202	SHUTTLE I/F	.0	.0	.0	.2	.4	.4	.4	.3	.0	.0	.0	.0	.0	.0	.0	.0
3200203	PAYLOAD I/F	.0	.0	.0	.5	.7	.7	.7	.6	.0	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	.0	3.5	15.4	28.2	34.2	27.4	9.9	1.9	.0	.0	.0	.0	.0	.0	.0	.0
3200301	STRUCTURES	.0	.0	1.3	4.1	5.3	3.8	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200302	THERMAL CONTROL	.0	.2	.6	1.0	1.0	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200303	AVIONICS	.0	2.2	7.9	12.8	13.7	9.7	2.4	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200304	PROPULSION	.0	1.1	5.4	9.4	10.0	6.4	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200305	ORBITER I/F	.0	.0	.2	.7	.8	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200307	FINAL ASSY & C/O	.0	.0	.0	.3	3.3	6.4	6.0	1.9	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.4	.8	.8	.8	.8	.8	.4	.0	.0	.0	.0	.0	.0
3200401	VEH AUX. STAGE	.0	.0	.0	.4	.8	.8	.8	.8	.8	.4	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200501	TRANSP. & HDLG.	.0	.0	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200502	TRAINING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200503	INV CONT. & WHSNG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200601	MANUFACTURING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200602	TEST	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.0	.2	.3	.3	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0
3200701	MFG. GSE	.0	.0	.2	.3	.3	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030101	FUEL TK & SUPT	.0	.0	.3	1.0	1.3	.9	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030102	OXID. TK & SUPT	.0	.0	.1	.4	.5	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030103	BODY STRUCTURE	.0	.0	.1	.2	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030104	THRUST STRUCTURE	.0	.0	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030105	METEOROID SHIELD	.0	.0	.3	.9	1.2	.8	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030106	PAYLOAD I/F	.0	.0	.4	1.2	1.6	1.1	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030107	INSTL. ASSY & C/O	.0	.0	.1	.2	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030201	FUEL TANK INSL	.0	.0	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030202	OXID. TANK INSL.	.0	.0	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030203	INSL. PURGE SYS.	.0	.1	.4	.6	.7	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030204	THERM CONT. SYS.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030205	INSTL ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030301	DATA MGMT. 3	.0	.5	1.9	3.1	3.3	2.3	.6	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030302	G N & C	.0	.3	1.2	1.9	2.0	1.4	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030303	COMMUNICATIONS	.0	.7	2.3	3.7	4.0	2.8	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030304	INSTRUMENTATION	.0	.1	.2	.4	.4	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030305	ELECT. POWER	.0	.5	1.8	2.9	3.1	2.2	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030306	PWR. DIST. & CONT	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

C-7

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 7 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94
320030307	INSTL, ASSY & C/O	.0	.1	.5	.8	.8	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030401	MAIN ENGINE 3	.0	.2	1.1	1.8	2.0	1.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030402	MAIN ENG. SUPT	.0	.5	2.5	4.3	4.6	3.0	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030403	ACPS ENGINE	.0	.0	.2	.4	.4	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030404	ACPS ENG. SUPT	.0	.3	1.4	2.4	2.6	1.7	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030405	INSTL, ASSY & C/O	.0	.0	.2	.4	.4	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030501	STRUCTURES	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030502	I/F PANELS	.0	.0	.1	.5	.6	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030503	PURGE PROV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030504	ABORT PROV.	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030505	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030701	FINAL ASSY	.0	.0	.0	.3	2.8	5.3	5.0	1.6	.0	.0	.0	.0	.0	.0	.0	.0
320030702	C/O	.0	.0	.0	.1	.6	1.1	1.0	.3	.0	.0	.0	.0	.0	.0	.0	.0
320050201	SIM. & EQUIP.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060101	DES./CONST.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060102	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060201	DES./CONST.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060202	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070101	HARDWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070102	SITE ACTIV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070103	MAINT.	.0	.0	.2	.3	.3	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0
3200204	SUST. ENGR.	.0	.0	.0	4.9	7.3	7.3	7.3	0.1	.0	.0	.0	.0	.0	.0	.0	.0
3200803	FLT. TEST HDWE.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080301	STRUCTURES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080302	THERMAL CONTROL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080303	AVIONICS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080304	PROPULSION	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080305	ORBITER I/F	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080307	FINAL ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030101	FUEL TK & SUPT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030102	OXID. TK & SUPT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030103	BODY STRUCTURE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030104	THRUST STRUCTURE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030105	METEOROID SHIELD	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030106	PAYLOAD I/F	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030107	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030201	FUEL TANK INSL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030202	OXID TANK INSL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030203	INSL PURGE SYS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030204	THERM CONT SYS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030205	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030301	DATA MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030302	G N & C	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030303	COMMUNICATIONS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030304	INSTRUMENTATION	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 8 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94
32008030305	ELECT. POWER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030306	PWR DIST. & CONT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030307	INSTL. ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030401	MAIN ENGINE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030402	MAIN ENG SUPT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030403	ACPS ENGINE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030404	ACPS ENG SUPT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030405	INSTL. ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030501	STRUCTURES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030502	I/F PANELS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030503	PURGE PROV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030504	ABORT PROV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030505	INSTL. ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030701	FINAL ASSY	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030702	C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

6C1-8

OPTION 3

TOTAL

COST DATA FORMS C

PRODUCTION

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 12, 1973
PAGE: 9 OF

NON RECURRING(DDT&E)

X RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.9	1.2	.5	1.9	1.9	1.6	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.0	.0	5.9	7.9	7.9	8.5	9.8	9.8	9.8	8.1	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	.0	1.4	10.1	19.9	23.2	22.5	28.5	34.2	27.4	9.9	1.9	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	1.0	3.5	4.8	3.9	1.2	.8	.0	.0	.4	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.1	.1	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.0	.0	.1	.1	.3	.4	.4	.4	.4	.3	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320	TOTAL PROJ PHASE	.0	1.4	10.1	26.0	32.4	35.1	43.6	48.7	40.9	23.1	12.9	.8	.4	.0	.0	.0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 18, 1973
PAGE: 6 OF

NON RECURRING(DDT&E)

X RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
320	TOTAL PROJ PHASE	.0	1.4	10.1	26.0	32.4	35.1	43.6	48.7	40.9	23.1	12.9	.8	.4	.0	.0	.0
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.9	1.2	.3	1.9	1.9	1.6	.0	.0	.0	.0	.0
3200101	COST/PERF. MGMT.	.0	.0	.0	.0	.0	.6	.8	.2	1.3	1.3	1.1	.0	.0	.0	.0	.0
3200102	PROJ. DIRECTION	.0	.0	.0	.0	.0	.3	.3	.1	.6	.6	.5	.0	.0	.0	.0	.0
3200103	INFORM. MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.0	.0	5.9	7.9	7.9	8.5	9.8	9.8	9.8	8.1	.0	.0	.0	.0	.0
3200201	TUG SYS. ENGR.	.0	.0	.0	.7	1.0	1.0	1.1	1.4	1.4	1.4	1.2	.0	.0	.0	.0	.0
3200202	SHUTTLE I/F	.0	.0	.0	.2	.2	.2	.3	.4	.4	.4	.3	.0	.0	.0	.0	.0
3200203	PAYLOAD I/F	.0	.0	.0	.4	.5	.5	.6	.7	.7	.7	.6	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	.0	1.4	10.1	19.9	23.2	22.5	28.5	34.2	27.4	9.9	1.9	.0	.0	.0	.0	.0
3200301	STRUCTURES	.0	.3	1.6	2.4	1.9	1.7	4.1	5.3	3.8	.3	.0	.0	.0	.0	.0	.0
3200302	THERMAL CONTROL	.0	.1	.4	.7	.8	.7	1.0	1.0	.6	.1	.0	.0	.0	.0	.0	.0
3200303	AVIONICS	.0	.1	3.1	7.0	8.8	9.4	12.8	13.7	9.7	2.4	.0	.0	.0	.0	.0	.0
3200304	PROPULSION	.0	.7	3.5	5.4	5.4	6.4	9.4	10.0	6.4	.9	.0	.0	.0	.0	.0	.0
3200305	ORBITER I/F	.0	.2	1.5	2.8	2.8	1.7	.9	.8	.4	.0	.0	.0	.0	.0	.0	.0
3200306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200307	FINAL ASSY & C/O	.0	.0	.0	1.5	3.4	2.5	.4	3.3	6.4	6.0	1.9	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	1.0	3.3	4.8	3.9	1.2	.8	.8	.8	.4	.0	.0	.0
3200401	VEH AUX. STAGE	.0	.0	.0	.0	1.0	3.3	4.8	3.9	1.2	.8	.8	.8	.4	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.1	.1	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0
3200501	TRANSP. & HDLG.	.0	.0	.0	.0	.1	.1	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0
3200502	TRAINING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200503	INV CONT. & WHSNG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200601	MANUFACTURING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200602	TEST	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.0	.0	.1	.1	.3	.4	.4	.4	.4	.3	.0	.0	.0	.0	.0
3200701	MFG. GSE	.0	.0	.0	.1	.1	.3	.4	.4	.4	.4	.3	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030101	FUEL TK & SUPT	.0	.1	.4	.7	.6	.4	1.0	1.3	.9	.1	.0	.0	.0	.0	.0	.0
320030102	OXID. TK & SUPT	.0	.0	.2	.3	.2	.2	.4	.5	.4	.1	.0	.0	.0	.0	.0	.0
320030103	BODY STRUCTURE	.0	.0	.1	.1	.1	.1	.2	.3	.2	.0	.0	.0	.0	.0	.0	.0
320030104	THRUST STRUCTURE	.0	.0	.0	.1	.1	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0
320030105	METEOROID SHIELD	.0	.1	.4	.6	.5	.4	.9	1.2	.8	.1	.0	.0	.0	.0	.0	.0
320030106	PAYLOAD I/F	.0	.1	.3	.5	.4	.3	1.2	1.6	1.1	.2	.0	.0	.0	.0	.0	.0
320030107	INSTL. ASSY & C/O	.0	.0	.1	.1	.1	.1	.2	.3	.2	.0	.0	.0	.0	.0	.0	.0
320030201	FUEL TANK INSL	.0	.0	.1	.1	.1	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0
320030202	OXID. TANK INSL.	.0	.0	.0	.1	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0
320030203	INSL. PURGE SYS.	.0	.0	.3	.4	.5	.5	.6	.7	.4	.1	.0	.0	.0	.0	.0	.0
320030204	THERM CONT. SYS.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030205	INSTL ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030301	DATA MGMT. 3	.0	.0	.7	1.6	2.0	2.3	3.1	3.3	2.3	.6	.0	.0	.0	.0	.0	.0
320030302	G N & C	.0	.0	.7	1.7	1.9	1.6	1.9	2.0	1.4	.4	.0	.0	.0	.0	.0	.0
320030303	COMMUNICATIONS	.0	.0	1.2	2.8	3.4	2.9	3.7	4.0	2.8	.7	.0	.0	.0	.0	.0	.0
320030304	INSTRUMENTATION	.0	.0	.1	.3	.4	.3	.4	.4	.3	.1	.0	.0	.0	.0	.0	.0
320030305	ELECT. POWER	.0	.0	.1	.1	.6	1.8	2.9	3.1	2.2	.5	.0	.0	.0	.0	.0	.0
320030306	PWR. DIST. & CONT	.0	.0	.0	.1	.1	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0

C-47

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 12, 1973
PAGE: 7 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
320030307	INSTL, ASSY & C/O	.0	.0	.2	.4	.5	.6	.8	.8	.6	.1	.0	.0	.0	.0	.0	.0
320030401	MAIN ENGINE 3	.0	.2	.9	1.4	1.4	1.4	1.8	2.0	1.3	.2	.0	.0	.0	.0	.0	.0
320030402	MAIN ENG. SUPT	.0	.3	1.5	2.3	2.4	2.9	4.3	4.6	3.0	.4	.0	.0	.0	.0	.0	.0
320030403	ACPS ENGINE	.0	.1	.3	.4	.3	.3	.4	.4	.3	.0	.0	.0	.0	.0	.0	.0
320030404	ACPS ENG. SUPT	.0	.1	.7	1.0	1.1	1.6	2.4	2.6	1.7	.2	.0	.0	.0	.0	.0	.0
320030405	INSTL, ASSY & C/O	.0	.0	.1	.2	.1	.2	.4	.4	.3	.0	.0	.0	.0	.0	.0	.0
320030501	STRUCTURES	.0	.0	.2	.4	.4	.2	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0
320030502	I/F PANELS	.0	.1	1.0	1.9	1.9	1.1	.6	.6	.3	.0	.0	.0	.0	.0	.0	.0
320030503	PURGE PROV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030504	ABORT PROV.	.0	.0	.2	.3	.3	.2	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
320030505	INSTL, ASSY & C/O	.0	.0	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030701	FINAL ASSY	.0	.0	.0	1.3	2.9	2.0	.4	2.8	5.3	5.0	1.6	.0	.0	.0	.0	.0
320030702	C/O	.0	.0	.0	.3	.6	.4	.1	.6	1.1	1.0	.3	.0	.0	.0	.0	.0
320050201	SIM. & EQUIP.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060101	DES./CONST.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060102	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060201	DES./CONST.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060202	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070101	HARDWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070102	SITE ACTIV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070103	MAINT.	.0	.0	.0	.1	.1	.3	.4	.4	.4	.4	.3	.0	.0	.0	.0	.0
3200204	SUST. ENGR.	.0	.0	.0	4.6	6.2	6.2	6.4	7.3	7.3	7.3	6.1	.0	.0	.0	.0	.0
3200803	FLT. TEST HDWE.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080301	STRUCTURES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080302	THERMAL CONTROL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080303	AVIONICS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080304	PROPULSION	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080305	ORBITER I/F	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320080307	FINAL ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030101	FUEL TK & SUPT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030102	OXID. TK & SUPT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030103	BODY STRUCTURE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030104	THRUST STRUCTURE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030105	METEOROID SHIELD	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030106	PAYLOAD I/F	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030107	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030201	FUEL TANK INSL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030202	OXID TANK INSL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030203	INSL PURGE SYS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030204	THERM CONT SYS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030205	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030301	DATA MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030302	G N & C	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030303	COMMUNICATIONS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030304	INSTRUMENTATION	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 12, 1973
PAGE: 8 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
32008030305	ELECT. POWER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030306	PWR DIST. & CONT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030307	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030401	MAIN ENGINE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030402	MAIN ENG SUPT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030403	ACPS ENGINE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030404	ACPS ENG SUPT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030405	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030501	STRUCTURES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030502	I/F PANELS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030503	PURGE PROV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030504	ABORT PROV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030505	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030701	FINAL ASSY	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008030702	C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

6.6 Operations Funding Distribution

This subsection contains the time-phased cost estimates required to accomplish the Operations phase of the program for each WBS element. Funding by Government Fiscal Year is displayed on Cost Data Form C through WBS Level 6, except for recurring software for the Data Management Assembly (WBS 320-03-03-01-05) which is reported and funded at Level 7.

OPTION 3

INITIAL

COST DATA FORMS C

OPERATIONS

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 13 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.5	.7	.7	.4	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.0	.0	.0	.0	.8	1.0	1.0	.5	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	.0	.0	.0	.0	.6	2.2	2.2	2.2	1.1	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.2	.7	.7	.7	.3	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
32007	GRND. SUPT. EQUIP	.0	.0	.0	.0	.3	1.0	1.0	1.0	.7	.3	.3	.3	.3	.3	.3	.2
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.0	1.3	.7	.0	.0	.0	.0	.0	.0	.0
32010	LAUNCH OPNS ETR	.0	.0	.0	.0	2.2	2.9	2.9	2.9	1.4	.0	.0	.0	.0	.0	.0	.0
32011	FLIGHT OPNS NASA	.0	.0	.0	.0	2.4	3.2	3.2	3.2	1.6	.0	.0	.0	.0	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	.0	.0	.0	2.3	3.1	3.1	1.5	.0	.0	.0	.0	.0	.0	.0
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	.0	.0	1.9	.9	.0	.0	.0	.0	.0	.0	.0
32014	REFURB &INTEG ETR	.0	.0	.0	.0	4.2	5.6	5.6	5.6	2.8	.0	.0	.0	.0	.0	.0	.0
320	TOTAL PROJ PHASE	.0	.0	.0	.0	9.8	19.4	20.6	23.8	12.1	.4	.4	.4	.4	.4	.4	.2

```
*STOP*

COMPUTE TIME 54.940
READY

*
*BYE
```

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
320	TOTAL PROJ PHASE	.0	.0	.0	.0	9.8	19.4	20.6	23.8	12.1	.4	.4	.4	.4	.4	.4	.2
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.5	.7	.7	.4	.0	.0	.0	.0	.0	.0	.0
3200101	COST/PERF. MGMT.	.0	.0	.0	.0	.0	.3	.5	.5	.2	.0	.0	.0	.0	.0	.0	.0
3200102	PROJ. DIRECTION	.0	.0	.0	.0	.0	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0
3200103	INFORM. MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.0	.0	.0	.0	.8	1.0	1.0	.5	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	.0	.0	.0	.0	.6	2.2	2.2	2.2	1.1	.0	.0	.0	.0	.0	.0	.0
3200301	STRUCTURES	.0	.0	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200302	THERMAL CONTROL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200303	AVIONICS	.0	.0	.0	.0	.3	1.3	1.3	1.3	.7	.0	.0	.0	.0	.0	.0	.0
3200304	PROPULSION	.0	.0	.0	.0	.2	.7	.7	.7	.4	.0	.0	.0	.0	.0	.0	.0
3200305	ORBITER I/F	.0	.0	.0	.0	.0	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0
3200306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200307	FINAL ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.2	.7	.7	.7	.3	.0	.0	.0	.0	.0	.0	.0
3200501	TRANSP. & HDLG.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200502	TRAINING	.0	.0	.0	.0	.1	.4	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0
3200503	INV CONT. & WHSNG	.0	.0	.0	.0	.1	.3	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
3200603	ETR MAINT. & REP.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200604	ETR LAUNCH	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200605	WTR MAINT. & REP.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200606	WTR LAUNCH	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.0	.0	.0	.3	1.0	1.0	1.0	.7	.3	.3	.3	.3	.3	.3	.2
3200701	MFG. GSE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200702	ETR GSE	.0	.0	.0	.0	.1	.3	.3	.3	.2	.2	.2	.2	.2	.2	.2	.1
3200703	WTR GSE	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
3200704	FLT OPS GSE(NASA)	.0	.0	.0	.0	.1	.3	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0
3200705	FLT OPS GSE(DOD)	.0	.0	.0	.0	.1	.3	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.0	1.3	.7	.0	.0	.0	.0	.0	.0	.0
3200901	LNCH SITE SVCES	.0	.0	.0	.0	.0	.0	.0	.5	.2	.0	.0	.0	.0	.0	.0	.0
3200902	TUG/SHTL MATING	.0	.0	.0	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0
3200903	PRELAUNCH C/O	.0	.0	.0	.0	.0	.0	.0	.2	.1	.0	.0	.0	.0	.0	.0	.0
3200904	COUNTDOWN	.0	.0	.0	.0	.0	.0	.0	.5	.1	.0	.0	.0	.0	.0	.0	.0
3200905	PRLNTS. & GASES	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200906	POST FLT. SAFING	.0	.0	.0	.0	.0	.0	.0	.2	.1	.0	.0	.0	.0	.0	.0	.0
32010	LAUNCH OPNS ETR	.0	.0	.0	.0	2.2	2.9	2.9	2.9	1.4	.0	.0	.0	.0	.0	.0	.0
3201001	LNCH SITE SVCES	.0	.0	.0	.0	.8	1.1	1.1	1.1	.5	.0	.0	.0	.0	.0	.0	.0
3201002	TUG/SHTL MATING	.0	.0	.0	.0	.2	.3	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0
3201003	PRELAUNCH C/O	.0	.0	.0	.0	.3	.4	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0
3201004	COUNTDOWN	.0	.0	.0	.0	.4	.5	.5	.5	.3	.0	.0	.0	.0	.0	.0	.0
3201005	PRLNTS & GASES	.0	.0	.0	.0	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0
3201006	POST FLT. SAFING	.0	.0	.0	.0	.3	.4	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0
32011	FLIGHT OPNS NASA	.0	.0	.0	.0	2.4	3.2	3.2	3.2	1.6	.0	.0	.0	.0	.0	.0	.0
3201101	MISSION PLG.	.0	.0	.0	.0	.4	.6	.6	.6	.3	.0	.0	.0	.0	.0	.0	.0
3201102	FLT. CONTROL	.0	.0	.0	.0	1.4	1.8	1.8	1.8	.9	.0	.0	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 11 OF

NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
3201103	FLT. EVAL.	.0	.0	.0	.0	.4	.5	.5	.5	.2	.0	.0	.0	.0	.0	.0	.0
3201104	FLT. SUPT. SFTWRE	.0	.0	.0	.0	.3	.4	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	.0	.0	.0	2.3	3.1	3.1	1.5	.0	.0	.0	.0	.0	.0	.0
3201201	MISSION PLG	.0	.0	.0	.0	.0	.4	.5	.5	.3	.0	.0	.0	.0	.0	.0	.0
3201202	FLT. CONTROL	.0	.0	.0	.0	.0	1.3	1.8	1.8	.9	.0	.0	.0	.0	.0	.0	.0
3201203	FLT. EVAL.	.0	.0	.0	.0	.0	.3	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0
3201204	FLT. SUPT. SFTWRE	.0	.0	.0	.0	.0	.3	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	.0	.0	1.9	.9	.0	.0	.0	.0	.0	.0	.0
3201301	SCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.3	.1	.0	.0	.0	.0	.0	.0	.0
3201302	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0
3201303	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0
3201304	TUG/PL MAING A/CO	.0	.0	.0	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0
3201305	REFURB ROMTS PLG	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0
3201306	DEPOT MAINT	.0	.0	.0	.0	.0	.0	.0	1.3	.6	.0	.0	.0	.0	.0	.0	.0
32014	REFURB &INTEG ETR	.0	.0	.0	.0	4.2	5.6	5.6	5.6	2.8	.0	.0	.0	.0	.0	.0	.0
3201401	SCH MAINT & REF	.0	.0	.0	.0	.5	.6	.6	.6	.3	.0	.0	.0	.0	.0	.0	.0
3201402	UNSCH MAINT & REF	.0	.0	.0	.0	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0
3201403	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201404	TUG/PL MATING C/O	.0	.0	.0	.0	.3	.4	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0
3201405	REFURB ROMTS PLG	.0	.0	.0	.0	.1	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0
3201406	DEPOT MAINT	.0	.0	.0	.0	3.2	4.3	4.3	4.3	2.1	.0	.0	.0	.0	.0	.0	.0
320030101	FUEL TK & SUPT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030102	OXID. TK & SUPT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030103	BODY STRUCTURE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030104	THRUST STRUCTURE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030105	METEOROID SHIELD	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030106	PAYLOAD I/F	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030107	INSTLY ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030201	FUEL TANK INSL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030202	OXID. TANK INSL.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030203	INSL. PURGE SYS.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030204	THERM CONT. SYS.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030205	INSTL ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030301	DATA MGMT. 3	.0	.0	.0	.0	.1	.3	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0
320030302	G N & C	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030303	COMMUNICATIONS	.0	.0	.0	.0	.0	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0
320030304	INSTRUMENTATION	.0	.0	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
320030305	ELECT. POWER	.0	.0	.0	.0	.2	.8	.8	.8	.4	.0	.0	.0	.0	.0	.0	.0
320030306	PWR. DIST. & CONT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030307	INSTLY ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030401	MAIN ENGINE 3	.0	.0	.0	.0	.1	.4	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0
320030402	MAIN ENG. SUPT	.0	.0	.0	.0	.0	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0
320030403	ACPS ENGINE	.0	.0	.0	.0	.0	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0
320030404	ACPS ENG. SUPT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030405	INSTLY ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030501	STRUCTURES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 12 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
~~320030502~~	~~I/F PANELS~~	.0	.0	.0	.0	.0	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0
320030503	PURGE PROV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030504	ABORT PROV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~320030505~~	~~INSTL. ASSY & C/O~~	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030701	FINAL ASSY	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030702	C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~320050201~~	~~SIM. & EQUIP.~~	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320050202	GROUND CREW	.0	.0	.0	.0	.1	.4	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0
320060301	DES./CONST.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~320060302~~	~~ACTIV./MAINT.~~	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060401	DES./CONST.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060402	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~320060501~~	~~DES./CONST.~~	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060502	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060601	DES./CONST. 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~320060602~~	~~ACTIV./MAINT. 3~~	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070104	SOFTWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070201	HARDWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
~~320070202~~	~~SITE ACTIV.~~	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070203	MAINT.	.0	.0	.0	.0	.0	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.1
320070204	SOFTWARE	.0	.0	.0	.0	.0	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0
~~320070301~~	~~HARDWARE~~	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070302	SITE ACTIV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070303	MAINT.	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
320070304	SOFTWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070404	SOFTWARE 3	.0	.0	.0	.0	.1	.3	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0
320070504	SOFTWARE 3	.0	.0	.0	.0	.1	.3	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0
~~32003030105~~	~~SOFTWARE~~	.0	.0	.0	.0	.1	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0
3200204	SUST. ENGR.	.0	.0	.0	.0	.0	.8	1.0	1.0	.5	.0	.0	.0	.0	.0	.0	.0
320070403	MAINT. 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070503	MAINT. 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

OPTION 3

FINAL

COST DATA FORMS C

OPERATIONS

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 13 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.4	.9	.9	.9	.9	.9	.9	.4	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.0	.0	.0	.0	.5	1.0	1.0	1.0	1.0	1.0	1.0	.5	.0	.0	.0
32003	VEH MAIN STAGE	.0	.0	.0	.0	.0	1.0	2.1	2.1	2.1	2.1	2.1	1.3	.2	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.0	.4	.8	.8	.8	.8	.8	.8	.4	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.0	.0	.0	.0	.3	.6	.6	.6	.6	.6	.6	.3	.0	.0	.0
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	1.0	2.1	2.1	2.1	2.1	2.1	2.1	1.0	.0	.0	.0
32010	LAUNCH OPNS ETR	.0	.0	.0	.0	.0	2.6	5.1	5.1	5.1	5.1	5.1	5.1	2.6	.0	.0	.0
32011	FLIGHT OPNS NASA	.0	.0	.0	.0	.0	2.3	4.6	4.6	4.6	4.6	4.6	4.6	2.3	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	.0	.0	.0	1.7	3.5	3.5	3.5	3.5	3.5	3.5	1.7	.0	.0	.0
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0	.0	.0	.0
32014	REFURB &INTEG ETR	.0	.0	.0	.0	.0	3.3	7.0	7.0	7.0	7.0	7.0	7.0	3.3	.0	.0	.0
320	TOTAL PROJ PHASE	.0	.0	.0	.0	.0	14.7	29.5	29.5	29.5	29.5	29.5	28.7	13.9	.0	.0	.0

STOP

COMPUTE TIME 50.832
READY

#B-X

C-41-7

STUDY TITLE: SPACE TUG SYS. STY (GHY) — FUNDING SCHEDULE — DATE: SEPTEMBER 11, 1975

CONTRACT NO: NAS 8-29677 — DATA FORM C — PAGE: 10 OF

NON RECURRING(DDT&E) — RECURRING(PRODUCTION) — X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94
320	TOTAL PROJ PHASE	.0	.0	.0	.0	.0	14.7	29.5	29.5	29.5	29.5	29.5	28.7	13.9	.0	.0	.0
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.4	.9	.9	.9	.9	.9	.9	.4	.0	.0	.0
3200101	COST/PERF. MGMT.	.0	.0	.0	.0	.0	.3	.6	.6	.6	.6	.6	.6	.3	.0	.0	.0
3200102	PROJ. DIRECTION	.0	.0	.0	.0	.0	.1	.3	.3	.3	.3	.3	.3	.1	.0	.0	.0
3200103	INFORM. MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.0	.0	.0	.0	.5	1.0	1.0	1.0	1.0	1.0	1.0	.5	.0	.0	.0
32003	VEH MAIN STAGE	.0	.0	.0	.0	.0	1.0	2.1	2.1	2.1	2.1	2.1	1.3	.2	.0	.0	.0
3200301	STRUCTURES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200302	THERMAL CONTROL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200303	AVIONICS	.0	.0	.0	.0	.0	.8	1.5	1.5	1.5	1.5	1.5	1.0	.2	.0	.0	.0
3200304	PROPULSION	.0	.0	.0	.0	.0	.2	.4	.4	.4	.4	.4	.2	.0	.0	.0	.0
3200305	ORBITER I/F	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0
3200306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200307	FINAL ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.0	.4	.8	.8	.8	.8	.8	.8	.4	.0	.0	.0
3200501	TRANSP. & HDLG.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200502	TRAINING	.0	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.2	.1	.0	.0	.0
3200503	INV CONT. & WHSNG	.0	.0	.0	.0	.0	.3	.6	.6	.6	.6	.6	.6	.3	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200603	ETR MAINT. & REF.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200604	ETR LAUNCH	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200605	WTR MAINT. & REF.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200606	WTR LAUNCH	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.0	.0	.0	.0	.3	.6	.6	.6	.6	.6	.6	.3	.0	.0	.0
3200701	MFG. GSE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200702	ETR GSE	.0	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.2	.1	.0	.0	.0
3200703	WTR GSE	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.0	.0	.0	.0
3200704	FLT OPS GSE(NASA)	.0	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.2	.1	.0	.0	.0
3200705	FLT OPS GSE(DOD)	.0	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.2	.1	.0	.0	.0
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	1.0	2.1	2.1	2.1	2.1	2.1	2.1	1.0	.0	.0	.0
3200901	LNCH SITE SVCES	.0	.0	.0	.0	.0	.4	.8	.8	.8	.8	.8	.8	.4	.0	.0	.0
3200902	TUG/SHTL MATING	.0	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.2	.1	.0	.0	.0
3200903	PRELAUNCH C/O	.0	.0	.0	.0	.0	.1	.3	.3	.3	.3	.3	.3	.1	.0	.0	.0
3200904	COUNTDOWN	.0	.0	.0	.0	.0	.2	.4	.4	.4	.4	.4	.4	.2	.0	.0	.0
3200905	PRLNTS. & GASES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200906	POST FLT. SAFING	.0	.0	.0	.0	.0	.2	.3	.3	.3	.3	.3	.3	.2	.0	.0	.0
32010	LAUNCH OPNS ETR	.0	.0	.0	.0	.0	2.6	5.1	5.1	5.1	5.1	5.1	5.1	2.6	.0	.0	.0
3201001	LNCH SITE SVCES	.0	.0	.0	.0	.0	.9	1.9	1.9	1.9	1.9	1.9	1.9	.9	.0	.0	.0
3201002	TUG/SHTL MATING	.0	.0	.0	.0	.0	.3	.5	.5	.5	.5	.5	.5	.3	.0	.0	.0
3201003	PRELAUNCH C/O	.0	.0	.0	.0	.0	.3	.7	.7	.7	.7	.7	.7	.3	.0	.0	.0
3201004	COUNTDOWN	.0	.0	.0	.0	.0	.5	1.1	1.1	1.1	1.1	1.1	1.1	.5	.0	.0	.0
3201005	PRLNTS & GASES	.0	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.2	.1	.0	.0	.0
3201006	POST FLT. SAFING	.0	.0	.0	.0	.0	.4	.8	.8	.8	.8	.8	.8	.4	.0	.0	.0
32011	FLIGHT OPNS NASA	.0	.0	.0	.0	.0	2.3	4.6	4.6	4.6	4.6	4.6	4.6	2.3	.0	.0	.0
3201101	MISSION PLG.	.0	.0	.0	.0	.0	.5	1.0	1.0	1.0	1.0	1.0	1.0	.5	.0	.0	.0
3201102	FLT. CONTROL	.0	.0	.0	.0	.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 11 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94
3201103	FLT. EVAL.	.0	.0	.0	.0	.0	.5	1.1	1.1	1.1	1.1	1.1	1.1	.5	.0	.0	.0
3201104	FLT. SUPT. SFTWRE	.0	.0	.0	.0	.0	.2	.5	.5	.5	.5	.5	.5	.2	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	.0	.0	.0	1.7	3.5	3.5	3.5	3.5	3.5	3.5	1.7	.0	.0	.0
3201201	MISSION PLG	.0	.0	.0	.0	.0	.4	.8	.8	.8	.8	.8	.8	.4	.0	.0	.0
3201202	FLT. CONTROL	.0	.0	.0	.0	.0	.7	1.4	1.4	1.4	1.4	1.4	1.4	.7	.0	.0	.0
3201203	FLT. EVAL.	.0	.0	.0	.0	.0	.5	.9	.9	.9	.9	.9	.9	.5	.0	.0	.0
3201204	FLT. SUPT. SFTWRE	.0	.0	.0	.0	.0	.2	.4	.4	.4	.4	.4	.4	.2	.0	.0	.0
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0	.0	.0	.0
3201301	SCH MAINT & REF	.0	.0	.0	.0	.0	.2	.5	.5	.5	.5	.5	.5	.2	.0	.0	.0
3201302	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.0	.0	.0	.0
3201303	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201304	TUG/PL MAING &/CO	.0	.0	.0	.0	.0	.2	.3	.3	.3	.3	.3	.3	.2	.0	.0	.0
3201305	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.0	.0	.0
3201306	DEPOT MAINT	.0	.0	.0	.0	.0	.5	1.0	1.0	1.0	1.0	1.0	1.0	.5	.0	.0	.0
32014	REFURB &INTEG ETR	.0	.0	.0	.0	.0	3.5	7.0	7.0	7.0	7.0	7.0	7.0	3.5	.0	.0	.0
3201401	SCH MAINT & REF	.0	.0	.0	.0	.0	.5	1.1	1.1	1.1	1.1	1.1	1.1	.5	.0	.0	.0
3201402	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.2	.1	.0	.0	.0
3201403	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.0	.0	.0	.0
3201404	TUG/PL MATING,C/O	.0	.0	.0	.0	.0	.4	.8	.8	.8	.8	.8	.8	.4	.0	.0	.0
3201405	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.1	.3	.3	.3	.3	.3	.3	.1	.0	.0	.0
3201406	DEPOT MAINT	.0	.0	.0	.0	.0	2.3	4.6	4.6	4.6	4.6	4.6	4.6	2.3	.0	.0	.0
320030101	FUEL TK & SUPT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030102	OXID. TK & SUPT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030103	BODY STRUCTURE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030104	THRUST STRUCTURE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030105	METEOROID SHIELD	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030106	PAYLOAD I/F	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030107	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030201	FUEL TANK INSL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030202	OXID. TANK INSL.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030203	INSL. PURGE SYS.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030204	THERM CONT. SYS.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030205	INSTL ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030301	DATA MGMT. 3	.0	.0	.0	.0	.0	.2	.5	.5	.5	.5	.5	.5	.2	.0	.0	.0
320030302	G N & C	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0
320030303	COMMUNICATIONS	.0	.0	.0	.0	.0	.2	.5	.5	.5	.5	.5	.2	.0	.0	.0	.0
320030304	INSTRUMENTATION	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030305	ELECT. POWER	.0	.0	.0	.0	.0	.2	.5	.5	.5	.5	.5	.2	.0	.0	.0	.0
320030306	PWR. DIST. & CONT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030307	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030401	MAIN ENGINE 3	.0	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.1	.0	.0	.0	.0
320030402	MAIN ENG. SUPT	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0
320030403	ACPS ENGINE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030404	ACPS ENG. SUPT	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0
320030405	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030501	STRUCTURES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 11, 1973
PAGE: 12 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93	FY 94
320030502	I/F PANELS	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0
320030503	PURGE PROV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030504	ABORT PROV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030505	INSTLY ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030701	FINAL ASSY	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030702	C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320050201	SIM. & EQUIP.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320050202	GROUND CREW	.0	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.2	.1	.0	.0	.0
320060301	DES./CONST.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060302	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060401	DES./CONST.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060402	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060501	DES./CONST.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060502	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	PPB.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060601	DES./CONST. 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060602	ACTIV./MAINT. 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070104	SOFTWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070201	HARDWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070202	SITE ACTIV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070203	MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070204	SOFTWARE	.0	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.2	.1	.0	.0	.0
320070301	HARDWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070302	SITE ACTIV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070303	MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070304	SOFTWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070404	SOFTWARE 3	.0	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.2	.1	.0	.0	.0
320070504	SOFTWARE 3	.0	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.2	.1	.0	.0	.0
32003030105	SOFTWARE	.0	.0	.0	.0	.0	.2	.4	.4	.4	.4	.4	.4	.2	.0	.0	.0
3200204	SUST. ENGR.	.0	.0	.0	.0	.0	.5	1.0	1.0	1.0	1.0	1.0	1.0	.5	.0	.0	.0
320070403	MAINT. 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070503	MAINT. 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

OPTION 3

TOTAL

COST DATA FORMS C

OPERATIONS

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 12, 1973
PAGE: 13 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.5	.7	.7	.8	.9	.9	.9	.9	.9	.9	.4
32002	SYS. ENGR. & INT.	.0	.0	.0	.0	.0	.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	.5
32003	VEH MAIN STAGE	.0	.0	.0	.0	.6	2.2	2.2	2.2	2.1	2.1	2.1	2.1	2.1	2.1	1.3	.2
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.2	.7	.7	.7	.7	.8	.8	.8	.8	.8	.8	.4
32006	FACILITIES	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
32007	GRND. SUPT. EQUIP	.0	.0	.0	.0	.3	1.0	1.0	1.0	1.0	.9	.9	.9	.9	.9	.9	.5
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.0	1.3	1.7	2.1	2.1	2.1	2.1	2.1	2.1	1.0
32010	LAUNCH OPNS ETR	.0	.0	.0	.0	2.2	2.9	2.9	2.9	4.0	5.1	5.1	5.1	5.1	5.1	5.1	2.6
32011	FLIGHT OPNS NASA	.0	.0	.0	.0	2.4	3.2	3.2	3.2	3.9	4.6	4.6	4.6	4.6	4.6	4.6	2.3
32012	FLIGHT OPNS DOD	.0	.0	.0	.0	.0	2.3	3.1	3.1	3.2	3.5	3.5	3.5	3.5	3.5	3.5	1.7
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	.0	.0	1.9	1.9	2.0	2.0	2.0	2.0	2.0	2.0	1.0
32014	REFURB &INTEG ETR	.0	.0	.0	.0	4.2	5.6	5.6	5.6	6.3	7.0	7.0	7.0	7.0	7.0	7.0	3.5
320	TOTAL PROJ PHASE	.0	.0	.0	.0	9.8	19.4	20.6	23.8	26.8	29.9	29.9	29.9	29.9	29.9	29.1	14.1

STOP

COMPUTE TIME 57.274
READY

#

L-N7

STUDY TITLE: SPACE TUG SYS. STY (GRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 18, 1973

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
320	TOTAL PROJ PHASE	.0	.0	.0	.0	9.8	19.4	20.6	23.8	26.8	29.9	29.9	29.9	29.9	29.9	29.1	14.1
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.5	.7	.7	.8	.9	.9	.9	.9	.9	.9	.4
3200101	COST/PERF. MGMT.	.0	.0	.0	.0	.0	.3	.5	.5	.5	.6	.6	.6	.6	.6	.6	.3
3200102	PROJ. DIRECTION	.0	.0	.0	.0	.0	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.1
3200103	INFORM. MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.0	.0	.0	.0	.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	.5
32003	VEH MAIN STAGE	.0	.0	.0	.0	.6	2.2	2.2	2.2	2.1	2.1	2.1	2.1	2.1	2.1	1.3	.2
3200301	STRUCTURES	.0	.0	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200302	THERMAL CONTROL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200303	AVIONICS	.0	.0	.0	.0	.3	1.3	1.3	1.3	1.5	1.5	1.5	1.5	1.5	1.5	1.0	.2
3200304	PROPULSION	.0	.0	.0	.0	.2	.7	.7	.7	.6	.4	.4	.4	.4	.4	.2	.0
3200305	ORBITER I/F	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.0	.0
3200306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200307	FINAL ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.2	.7	.7	.7	.7	.8	.8	.8	.8	.8	.8	.4
3200501	TRANSP. & HDLG.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200502	TRAINING	.0	.0	.0	.0	.1	.4	.4	.4	.3	.2	.2	.2	.2	.2	.2	.1
3200503	INV CONT. & WHSNG	.0	.0	.0	.0	.1	.3	.3	.3	.4	.6	.6	.6	.6	.6	.6	.3
32006	FACILITIES	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
3200603	ETR MAINT. & REP.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200604	ETR LAUNCH	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200605	WTR MAINT. & REP.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200606	WTR LAUNCH	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.0	.0	.0	.3	1.0	1.0	1.0	1.0	.9	.9	.9	.9	.9	.9	.5
3200701	MFG. GSE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200702	ETR GSE	.0	.0	.0	.0	.1	.3	.3	.3	.3	.4	.4	.4	.4	.4	.4	.2
3200703	WTR GSE	.0	.0	.0	.0	.0	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.1
3200704	FLT OPS GSE(NASA)	.0	.0	.0	.0	.1	.3	.3	.3	.2	.2	.2	.2	.2	.2	.2	.1
3200705	FLT OPS GSE(DOD)	.0	.0	.0	.0	.1	.3	.3	.3	.2	.2	.2	.2	.2	.2	.2	.1
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.0	1.3	1.7	2.1	2.1	2.1	2.1	2.1	2.1	1.0
3200901	LNCH SITE SVCES	.0	.0	.0	.0	.0	.0	.0	.5	.6	.8	.8	.8	.8	.8	.8	.4
3200902	TUG/SHTL MATING	.0	.0	.0	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.2	.2	.1
3200903	PRELAUNCH C/O	.0	.0	.0	.0	.0	.0	.0	.2	.2	.3	.3	.3	.3	.3	.3	.1
3200904	COUNTDOWN	.0	.0	.0	.0	.0	.0	.0	.5	.5	.4	.4	.4	.4	.4	.4	.2
3200905	PRLNTS. & GASES	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200906	POST FLT. SAFING	.0	.0	.0	.0	.0	.0	.0	.2	.3	.3	.3	.3	.3	.3	.3	.2
32010	LAUNCH OPNS ETR	.0	.0	.0	.0	2.2	2.9	2.9	2.9	4.0	5.1	5.1	5.1	5.1	5.1	5.1	2.6
3201001	LNCH SITE SVCES	.0	.0	.0	.0	.8	1.1	1.1	1.1	1.4	1.9	1.9	1.9	1.9	1.9	1.9	.9
3201002	TUG/SHTL MATING	.0	.0	.0	.0	.2	.3	.3	.3	.5	.5	.5	.5	.5	.5	.5	.3
3201003	PRELAUNCH C/O	.0	.0	.0	.0	.3	.4	.4	.4	.5	.7	.7	.7	.7	.7	.7	.3
3201004	COUNTDOWN	.0	.0	.0	.0	.4	.5	.5	.5	.8	1.1	1.1	1.1	1.1	1.1	1.1	.5
3201005	PRLNTS & GASES	.0	.0	.0	.0	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.1
3201006	POST FLT. SAFING	.0	.0	.0	.0	.3	.4	.4	.4	.6	.8	.8	.8	.8	.8	.8	.4
32011	FLIGHT OPNS NASA	.0	.0	.0	.0	2.4	3.2	3.2	3.2	3.9	4.6	4.6	4.6	4.6	4.6	4.6	2.3
3201101	MISSION PLG.	.0	.0	.0	.0	.4	.6	.6	.6	.8	1.0	1.0	1.0	1.0	1.0	1.0	.5
3201102	FLT. CONTROL	.0	.0	.0	.0	1.4	1.8	1.8	1.8	1.9	2.0	2.0	2.0	2.0	2.0	2.0	1.0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29577

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 12, 1973
PAGE: 11 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
3201103	FLT. EVAL.	.0	.0	.0	.0	.4	.5	.5	.5	.7	1.1	1.1	1.1	1.1	1.1	1.1	.5
3201104	FLT. SUPT. SFTWRE	.0	.0	.0	.0	.3	.4	.4	.4	.4	.5	.5	.5	.5	.5	.5	.2
32012	FLIGHT OPNS DOD	.0	.0	.0	.0	.0	2.3	3.1	3.1	3.2	3.5	3.5	3.5	3.5	3.5	3.5	1.7
3201201	MISSION PLG	.0	.0	.0	.0	.0	.4	.5	.5	.7	.8	.8	.8	.8	.8	.8	.4
3201202	FLT. CONTROL	.0	.0	.0	.0	.0	1.3	1.8	1.8	1.6	1.4	1.4	1.4	1.4	1.4	1.4	.7
3201203	FLT. EVAL.	.0	.0	.0	.0	.0	.3	.4	.4	.7	.9	.9	.9	.9	.9	.9	.5
3201204	FLT. SUPT. SFTWRE	.0	.0	.0	.0	.0	.3	.3	.3	.4	.4	.4	.4	.4	.4	.4	.2
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	.0	.0	1.9	1.9	2.0	2.0	2.0	2.0	2.0	2.0	1.0
3201301	SCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.3	.3	.5	.5	.5	.5	.5	.5	.2
3201302	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.1	.0	.1	.1	.1	.1	.1	.1	.0
3201303	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0
3201304	TUG/PL MAING &/CO	.0	.0	.0	.0	.0	.0	.0	.1	.3	.3	.3	.3	.3	.3	.3	.2
3201305	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1
3201306	DEPOT MAINT	.0	.0	.0	.0	.0	.0	.0	1.3	1.1	1.0	1.0	1.0	1.0	1.0	1.0	.5
32014	REFURB &INTEG ETR	.0	.0	.0	.0	4.2	5.6	5.6	5.6	6.3	7.0	7.0	7.0	7.0	7.0	7.0	3.5
3201401	SCH MAINT & REF	.0	.0	.0	.0	.5	.6	.6	.6	.8	1.1	1.1	1.1	1.1	1.1	1.1	.5
3201402	UNSCH MAINT & REF	.0	.0	.0	.0	.1	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.1
3201403	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.0
3201404	TUG/PL MATING,C/O	.0	.0	.0	.0	.3	.4	.4	.4	.6	.8	.8	.8	.8	.8	.8	.4
3201405	REFURB RQMTS PLG	.0	.0	.0	.0	.1	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.1
3201406	DEPOT MAINT	.0	.0	.0	.0	3.2	4.3	4.3	4.3	4.4	4.6	4.6	4.6	4.6	4.6	4.6	2.3
320030101	FUEL TK & SUPT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030102	OXID. TK & SUPT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030103	BODY STRUCTURE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030104	THRUST STRUCTURE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030105	METEOROID SHIELD	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030106	PAYLOAD I/F	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030107	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030201	FUEL TANK INSL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030202	OXID. TANK INSL.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030203	INSL. PURGE SYS.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030204	THERM CONT. SYS.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030205	INSTL ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030301	DATA MGMT. 3	.0	.0	.0	.0	.1	.3	.3	.3	.4	.5	.5	.5	.5	.5	.5	.2
320030302	G N & C	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.0	.0
320030303	COMMUNICATIONS	.0	.0	.0	.0	.0	.2	.2	.2	.3	.5	.5	.5	.5	.5	.2	.0
320030304	INSTRUMENTATION	.0	.0	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
320030305	ELECT. POWER	.0	.0	.0	.0	.2	.8	.8	.8	.6	.5	.5	.5	.5	.5	.2	.0
320030306	PWR. DIST. & CONT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030307	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030401	MAIN ENGINE 3	.0	.0	.0	.0	.1	.4	.4	.4	.3	.2	.2	.2	.2	.2	.1	.0
320030402	MAIN ENG. SUPT	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.0	.0
320030403	ACPS ENGINE	.0	.0	.0	.0	.0	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0
320030404	ACPS ENG. SUPT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.0	.0
320030405	INSTL, ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030501	STRUCTURES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 12, 1973
PAGE: 12 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
320030502	I/F PANELS	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.0	.0
320030503	PURGE PROV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030504	ABORT PROV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030505	INSTL. ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030701	FINAL ASSY	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320030702	C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320050201	SIM. & EQUIP.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320050202	GROUND CREW	.0	.0	.0	.0	.1	.4	.4	.4	.3	.2	.2	.2	.2	.2	.2	.1
320060301	DES./CONST.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060302	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060401	DES./CONST.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060402	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060501	DES./CONST.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060502	ACTIV./MAINT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060601	DES./CONST. 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320060602	ACTIV./MAINT. 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070104	SOFTWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070201	HARDWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070202	SITE ACTIV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070203	MAINT.	.0	.0	.0	.0	.0	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.1
320070204	SOFTWARE	.0	.0	.0	.0	.0	.1	.1	.1	.2	.2	.2	.2	.2	.2	.2	.1
320070301	HARDWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070302	SITE ACTIV.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070303	MAINT.	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
320070304	SOFTWARE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070404	SOFTWARE 3	.0	.0	.0	.0	.1	.3	.3	.3	.2	.2	.2	.2	.2	.2	.2	.1
320070504	SOFTWARE 3	.0	.0	.0	.0	.1	.3	.3	.3	.2	.2	.2	.2	.2	.2	.2	.1
3200030103	SOFTWARE	.0	.0	.0	.0	.1	.2	.2	.2	.3	.4	.4	.4	.4	.4	.4	.2
3200204	SUST. ENGR.	.0	.0	.0	.0	.0	.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	.5
320070403	MAINT. 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320070503	MAINT. 3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

6.7 Total Program Funding Distribution

This subsection presents summary charts for the following WBS elements:

WBS No.	Level	Identification
320	3	Total Space Tug Project
320-03	4	Vehicle Main Stage
320-04	4	Vehicle Auxiliary Stage
320-07	4	Ground Support Equipment
320-08	4	Vehicle Test
320-03-01	5	Structures
320-03-02	5	Thermal Control
320-03-03	5	Avionics
320-03-04	5	Propulsion
320-03-05	5	Orbiter Interface
320-03-09	5	Final Assembly and Checkout

Each summary chart highlights the relationship of cost estimates to technical characteristics and schedules. It also presents an overview of the funding annually and cumulatively by Government Fiscal Year.

No summary chart is presented for WBS 320-03-06 - Drop Tanks, since no drop tanks are required or costed for this program option.

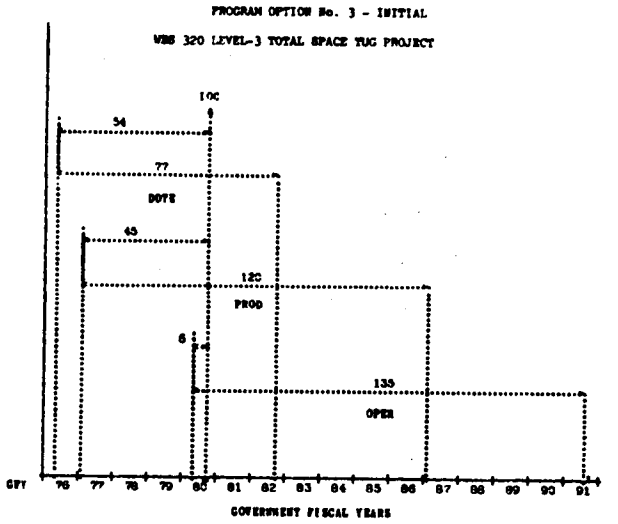
TECHNICAL CHARACTERISTICS - OPTION NO. 3 - INITIAL
WBS 320-03 SPACE TUG VEHICLE MAIN STAGE

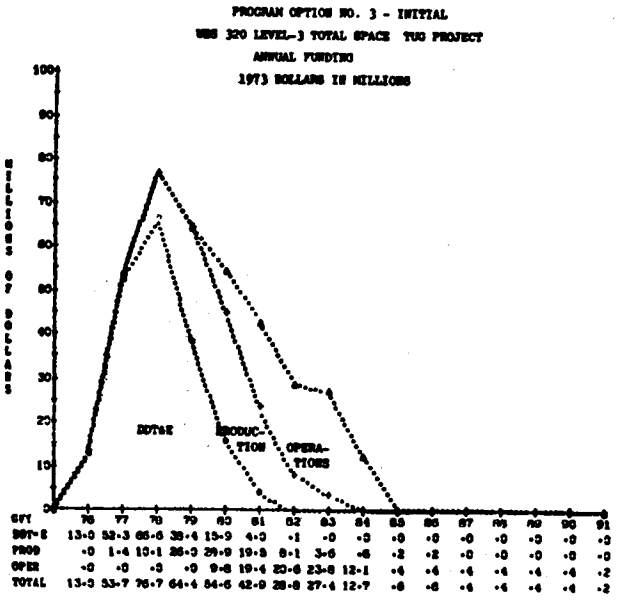
TECHNICAL DESCRIPTION

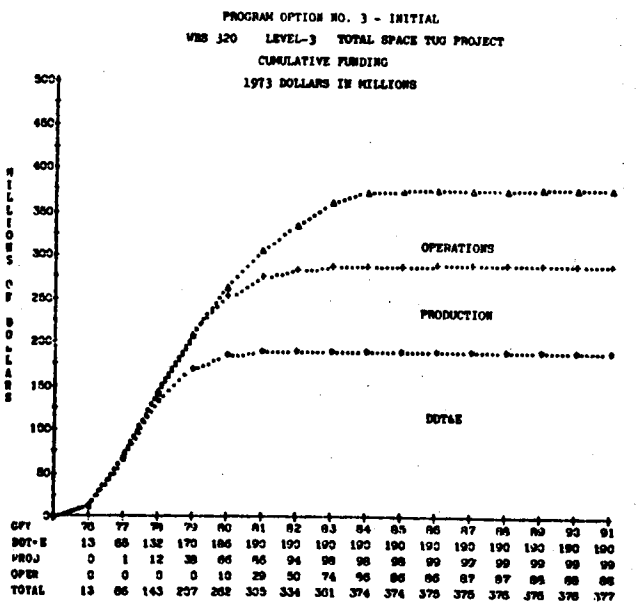
TOTAL LENGTH	390.8 IN. (32.5 FT.)
MAXIMUM DIAMETER	176.0 IN. (14.7 FT.)
TOTAL WEIGHT (WITH 10% CONTINGENCY)	6602 LBS.
MAXIMUM PAYLOAD CAPABILITY	2200 LBS (SYNCHRONOUS ORBIT)
RETRIEVAL CAPABILITY	NONE
CONFIGURATION	LOAD CARRYING TANK (LCT)

STAGE CHARACTERISTICS

SUBSYSTEMS/ELEMENTS	
STRUCTURES	2219 ALUM.; BOOT - OPEN ISOGRID; TANKS - TAPERED DOMES
THERMAL CONTROL	DAN COATING/KAPTON PURGE BAG
AVIONICS	INS, GN&C, COMM., INSTR., ELECT. POWER, POWER DISTR.
PROPULSION	CAT. I - RL10; AMB. He PRESS.; TRANSTAGE MONOPROP. ACPS
ORBITER INTERFACE	TILT TABLE; TRUNNION; INTERFACE PANELS; ABORT PROVISIONS
FINAL ASSEMBLY AND CHECKOUT	
EXISTING MISSION	PAYLOAD DEPLOYMENT
LAUNCH SITES/FLIGHTS	ETR/ 74 AND WTR/ 8
NO. PRODUCTION UNITS	5
FOR OPERATIONS	4
FOR RELIABILITY	1







Cost Summary — Program Option No. 3 — Initial

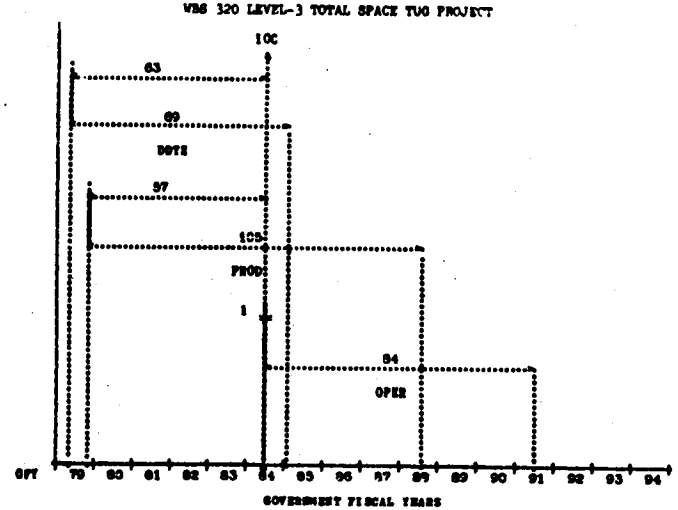
TECHNICAL CHARACTERISTICS – OPTION NO. 3

WBS 320 TOTAL SPACE TUG PROJECT

MAJOR HARDWARE	
SPACE TUG VEHICLE MAIN STAGE	12 VEHICLES
SPACE TUG VEHICLE AUXILIARY STAGE	5 STAGES
OTHER SYSTEM ELEMENTS	
PROJECT MANAGEMENT	
SYSTEMS ENGINEERING & INTEGRATION	
LOGISTICS	TRANSP., TRAINING, SIMULATION
FACILITIES	FACTORY, TEST, ETR, WTR
GROUND SUPPORT EQUIPMENT	FACTORY, ETR, WTR
VEHICLE TEST	FTV, MAJOR TEST ARTICLES
LAUNCH OPERATIONS – WTR	46 LAUNCHES
LAUNCH OPERATIONS – ETR	179 LAUNCHES
FLIGHT OPERATIONS – NASA	117 FLIGHTS
FLIGHT OPERATIONS – DOD	105 FLIGHTS
REFURBISHMENT & MAINTENANCE – WTR	46 REFURBS.
REFURBISHMENT & MAINTENANCE – ETR	179 REFURBS.

PROGRAM OPTION NO. 3 - FINAL

WBS 320 LEVEL-3 TOTAL SPACE TUG PROJECT

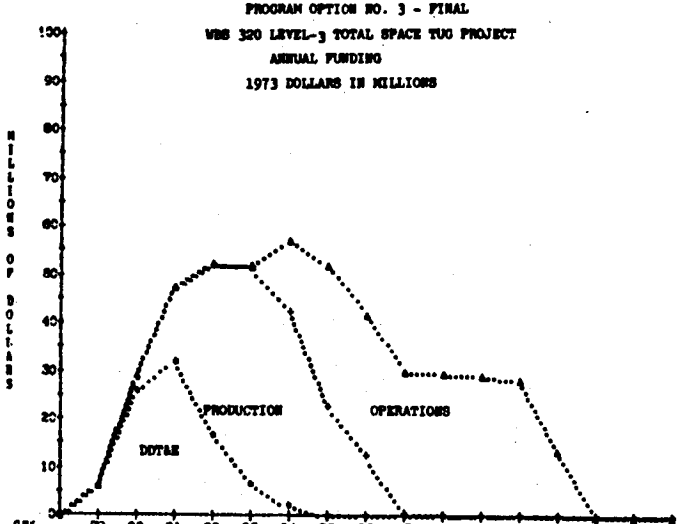


PROGRAM OPTION NO. 3 - FINAL

WBS 320 LEVEL-3 TOTAL SPACE TUG PROJECT

ANNUAL FUNDING

1973 DOLLARS IN MILLIONS



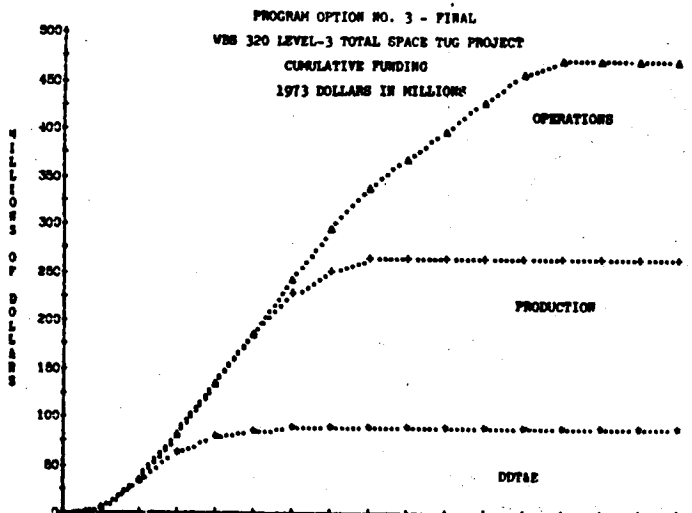
GFY	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
DDT&E	6.1	25.6	31.7	16.6	6.7	2.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	3.5	15.6	38.5	45.1	40.3	22.9	12.7	.8	.4	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.0	14.7	29.5	29.5	29.5	29.5	29.5	28.7	13.9	.0	.0	.0
TOTAL	6.1	29.1	47.3	52.1	51.8	57.2	52.4	42.2	30.3	29.9	29.5	28.7	13.9	.0	.0	.0

PROGRAM OPTION NO. 3 - FINAL

WBS 320 LEVEL-3 TOTAL SPACE TUG PROJECT

CUMULATIVE FUNDING

1973 DOLLARS IN MILLIONS



GFY	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
DDT&E	6	32	63	80	87	89	89	89	89	89	89	89	89	89	89	89
PROD	0	4	19	58	100	145	163	176	176	177	177	177	177	177	177	177
OPER	0	0	0	0	0	15	44	74	103	133	162	191	205	205	205	205
TOTAL	6	36	82	134	186	243	295	338	368	398	427	456	470	470	470	470

Cost Summary – Program Option No. 3 – Final

TECHNICAL CHARACTERISTICS - OPTION NO. 3 TOTAL

WBS 320 - LEVEL-3 TOTAL SPACE TUG PROJECT

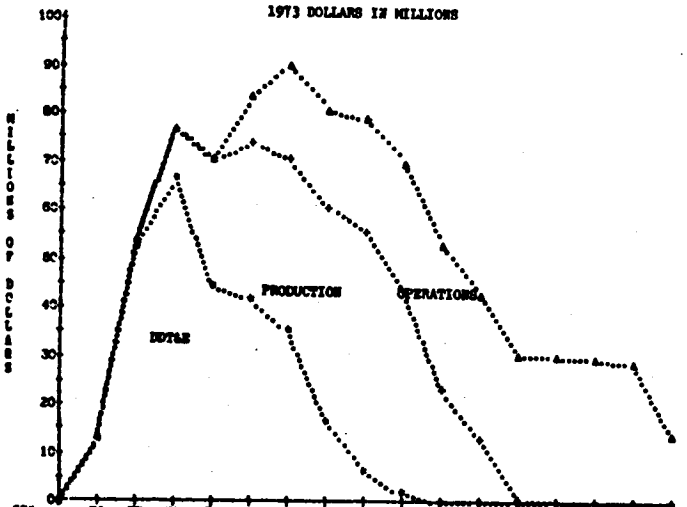
THE TECHNICAL CHARACTERISTICS ARE EQUIVALENT TO THE SUM OF THE INCREMENTAL CHARACTERISTICS. HOWEVER, A MERE SUMMATION WOULD NOT BE MEANINGFUL. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE CHARACTERISTICS FOR THE INITIAL PHASE AND THE FINAL PHASE.

PROGRAM OPTION NO. 3 TOTAL

WBS 320 LEVEL-3 TOTAL SPACE TUG PROJECT

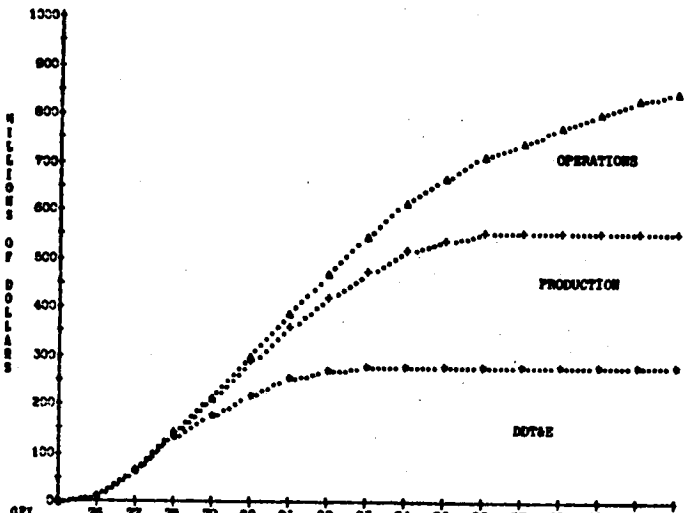
A COMPOSITE SCHEDULE WOULD NOT BE MEANINGFUL, SINCE TWO IOC DATES WOULD BE REFERENCED FOR THE T_S AND T_D VALUES. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE SCHEDULES FOR THE INITIAL PHASE AND THE FINAL PHASE.

PROGRAM OPTION NO. 3 - TOTAL
WBS 320 LEVEL-3 TOTAL SPACE TUG PROJECT
ANNUAL FUNDING
1973 DOLLARS IN MILLIONS



CPY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	13.0	52.3	66.6	44.5	41.5	35.7	16.7	6.7	2.2	.0	.0	.0	.0	.0	.0	.0
PROD	.0	1.4	12.1	26.0	32.4	35.1	43.6	48.7	40.9	23.1	12.9	.8	.4	.0	.0	.0
OPER	.0	.0	.0	.0	9.8	19.4	20.6	23.8	26.8	29.9	29.9	29.9	29.9	29.9	29.1	14.1
TOTAL	13.0	53.7	78.7	70.5	83.7	90.2	80.9	79.2	69.9	53.0	42.8	30.7	30.3	29.9	29.1	14.1

PROGRAM OPTION NO. 3 - TOTAL
WBS 320 LEVEL-3 TOTAL SPACE TUG PROJECT
CUMULATIVE FUNDING
1973 DOLLARS IN MILLIONS



CPY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	13	66	132	176	218	254	270	277	279	279	279	279	279	279	279	279
PROD	0	1	12	38	70	105	149	197	238	261	274	275	275	275	275	275
OPER	0	0	0	0	10	29	50	74	100	130	160	190	220	250	279	293
TOTAL	13	66	143	213	297	387	468	547	617	670	713	744	774	804	833	847

Cost Summary — Program Option No. 3 — Total

PROGRAM OPTION NO. 3 INITIAL – WBS 320 LEVEL-4 VEHICLE MAIN STAGE – COST SUMMARY

TECHNICAL CHARACTERISTICS - OPTION NO. 3 - INITIAL

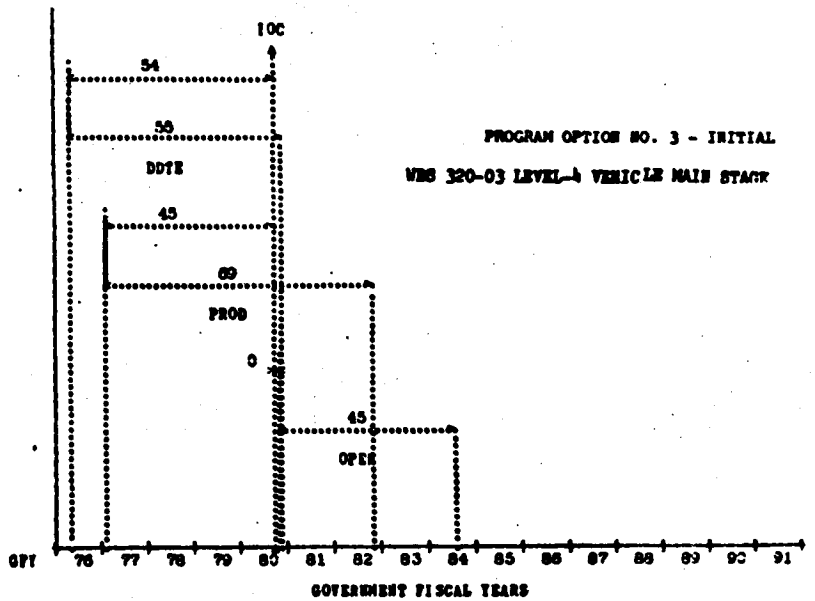
WBS 320-03 SPACE TUG VEHICLE MAIN STAGE

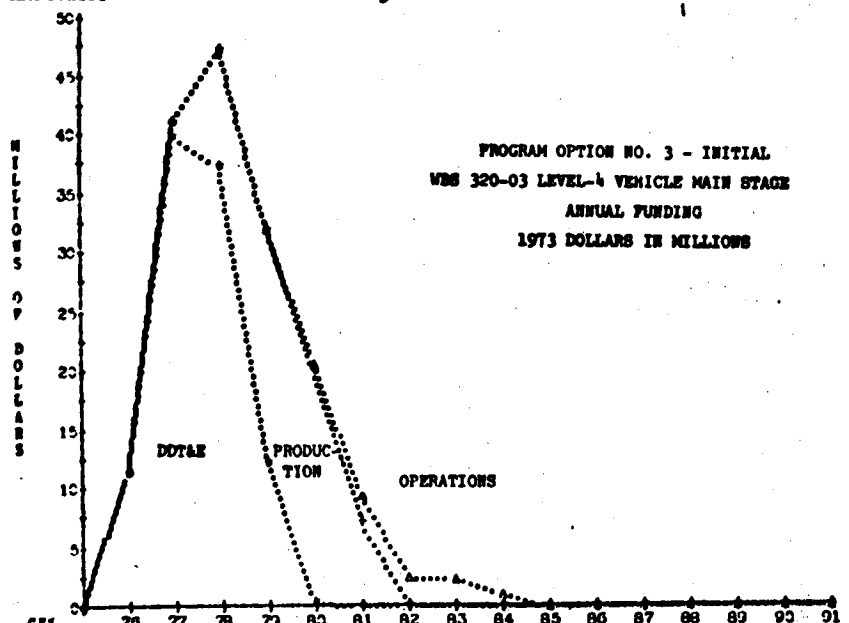
TECHNICAL DESCRIPTION

TOTAL LENGTH	398.8 IN. (32.5 FT.)
MAXIMUM DIAMETER	176.0 IN. (14.7 FT.)
TOTAL WEIGHT (WITH 10% CONTINGENCY)	6602 LBS.
MAXIMUM PAYLOAD CAPABILITY	2200 LBS (SYNCHRONOUS ORBIT)
RETRIEVAL CAPABILITY	NONE
CONFIGURATION	LOAD CARRYING TANK (LCT)

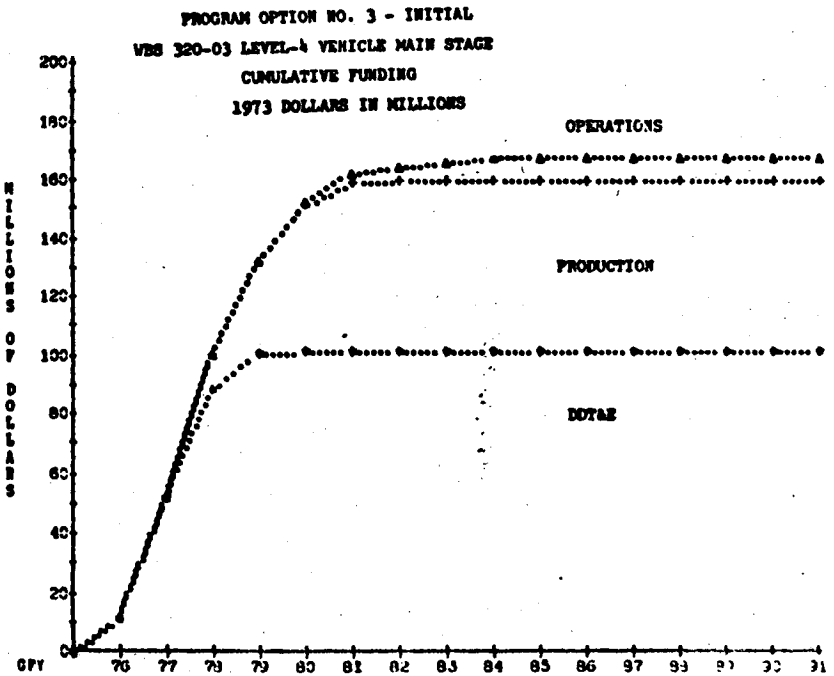
STAGE CHARACTERISTICS

SUBSYSTEMS/ELEMENTS	
STRUCTURES	2219 ALUM.; BODY - OPEN ISOGRID; TANKS - TAPERED DOMES
THERMAL CONTROL	DAM COATING/KAPTON PURGE BAG
AVIONICS	DMS, GN&C, COMM., INSTR., ELECT. POWER, POWER DISTR.
PROPULSION	CAT. I - RL10; AMB. He PRESS.; TRANSTAGE MONOPROP. ACPS
ORBITER INTERFACE	TILT TABLE; TRUNNION; INTERFACE PANELS; ABORT PROVISIONS
FINAL ASSEMBLY AND CHECKOUT	
SIZING MISSION	PAYLOAD DEPLOYMENT
LAUNCH SITES/FLIGHTS	ETR/190 AND WTR/32
NO. PRODUCTION UNITS	13
FOR OPERATIONS	10
FOR RELIABILITY	3





FY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT+E	11.4	30.8	37.3	12.2	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	1.4	10.1	19.9	19.7	7.1	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.6	2.2	2.2	2.2	1.1	.0	.0	.0	.0	.0	.0	.0
TOTAL	11.4	41.2	47.4	32.1	20.7	9.3	2.5	2.2	1.1	.0	.0	.0	.0	.0	.0	.0



FY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT+E	11	41	89	101	101	101	101	101	101	101	101	101	101	101	101	101
PROD	0	1	12	31	51	58	58	58	58	58	58	58	58	58	58	58
OPER	0	0	0	0	1	3	5	7	8	8	8	8	8	8	8	8
TOTAL	11	42	100	132	152	162	164	166	167	167	167	167	167	167	167	167

PROGRAM OPTION NO. 3 FINAL – WBS 320-03 LEVEL-4 VEHICLE MAIN STAGE – COST SUMMARY

TECHNICAL CHARACTERISTICS – OPTION NO. 3 – FINAL

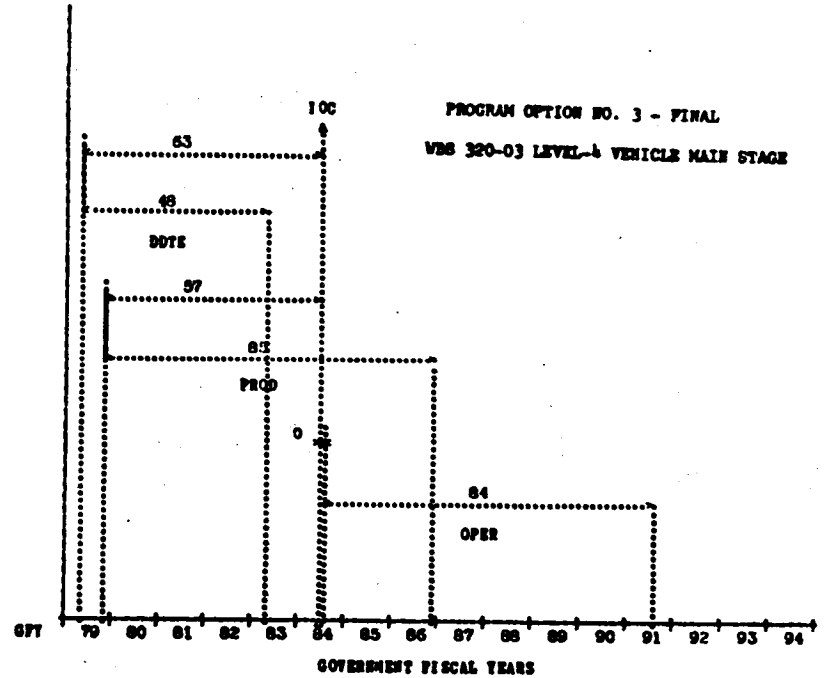
WBS 320-03 SPACE TUG VEHICLE MAIN STAGE

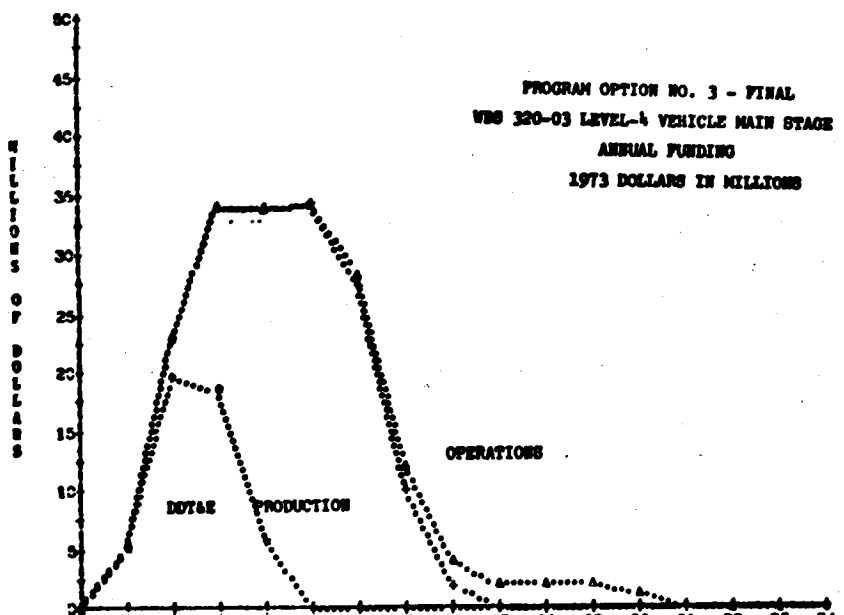
TECHNICAL DESCRIPTION

TOTAL LENGTH	419.8 IN. (35.0 FT.)
MAXIMUM DIAMETER	176.0 IN. (14.7 FT.)
TOTAL WEIGHT (WITH 10% CONTINGENCY)	5598 LBS.
MINIMUM PERFORMANCE	RETRIEVE ≥ 3500 LB. FROM GEO SYNCHRONOUS ORBIT
CONFIGURATION	LOAD CARRYING SHELL (LCS)

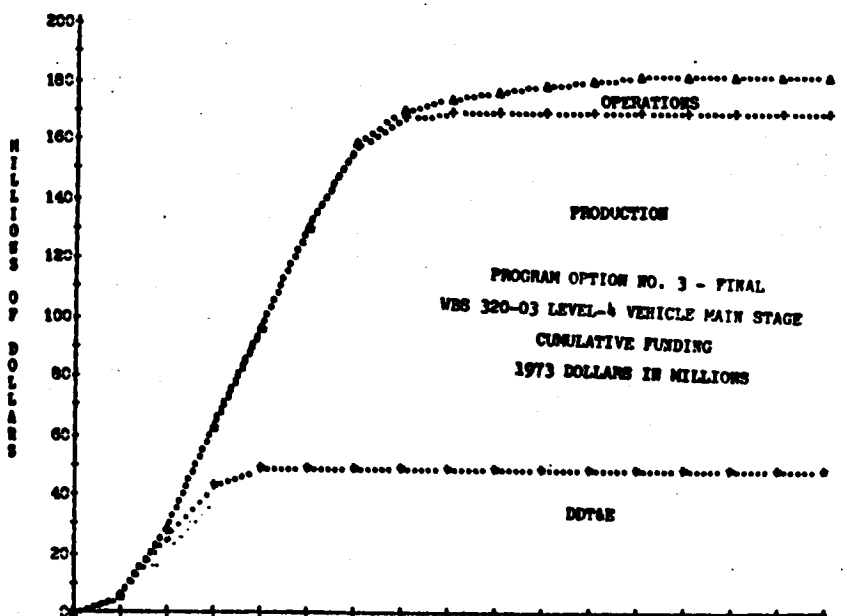
STAGE CHARACTERISTICS

SUBSYSTEMS/ELEMENTS	
STRUCTURES	GRAPHITE EPOXY; BODY-HONEYCOMB; TANKS-TAPERED DOMES
THERMAL CONTROL	BI-PERFORMANCE MLI AND PURGE SYSTEM
AVIONICS	DMS, GN&C, COMM., INSTR., ELECT. POWER, POWER DISTR.
PROPULSION	CAT. II – RLIO; STORABLE BI-PROPELLANT ACPS
ORBITER INTERFACE	TILT TABLE; TRUNNION; INTERFACE PANELS; ABORT PROVISIONS
FINAL ASSEMBLY AND CHECKOUT	
SIZING MISSION	PAYLOAD DEPLOYMENT
LAUNCH SITES/FLIGHTS	ETR/177 AND WTR/45
NO. PRODUCTION UNITS	12
FOR OPERATIONS	9
FOR RELIABILITY	3





GFY	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
DDT-E	5.4	17.6	18.6	5.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	3.5	15.4	28.2	34.2	27.4	9.9	1.9	.0	.0	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.0	1.0	2.1	2.1	2.1	2.1	2.1	1.3	.2	.0	.0	.0
TOTAL	5.4	23.1	34.0	33.9	34.2	28.4	12.0	4.0	2.1	2.1	2.1	1.3	.2	.0	.0	.0



GFY	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
DDT-E	5	23	44	49	49	49	49	49	49	49	49	49	49	49	49	49
PROD	0	4	19	47	81	109	119	120	120	120	120	120	120	120	120	120
OPER	0	0	0	0	0	1	3	5	7	9	12	13	13	13	13	13
TOTAL	5	28	62	96	130	158	170	174	177	179	181	182	182	182	182	182

7-51-9

PROGRAM OPTION NO. 3 TOTAL – WBS 320-03 LEVEL-4 VEHICLE MAIN STAGE – COST SUMMARY

TECHNICAL CHARACTERISTICS - OPTION NO. 3 TOTAL
WBS 320-03 LEVEL-4 VEHICLE MAIN STAGE

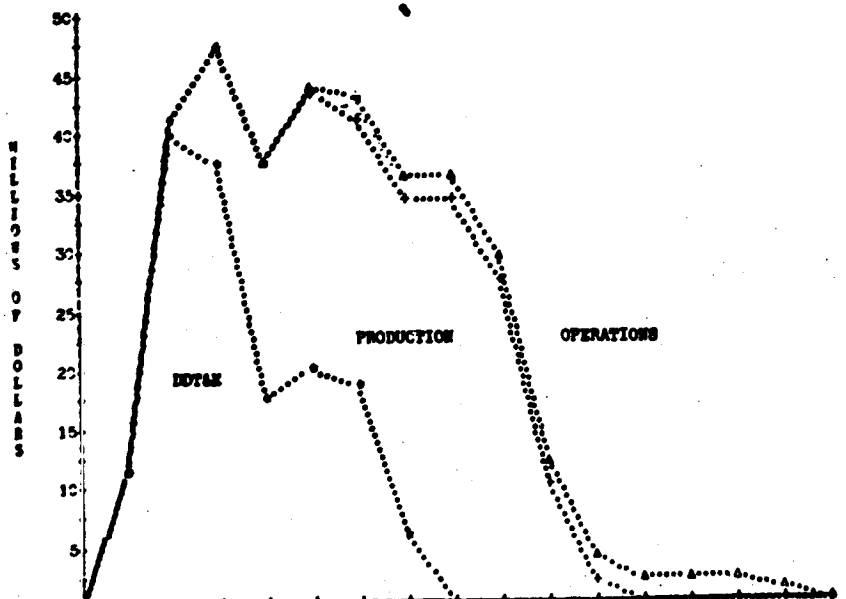
THE TECHNICAL CHARACTERISTICS ARE EQUIVALENT TO THE SUM OF THE INCREMENTAL CHARACTERISTICS. HOWEVER, A MERE SUMMATION WOULD NOT BE MEANINGFUL. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE CHARACTERISTICS FOR THE INITIAL PHASE AND THE FINAL PHASE.

PROGRAM OPTION NO. 3 TOTAL

WBS 320-03 LEVEL-4 VEHICLE MAIN STAGE

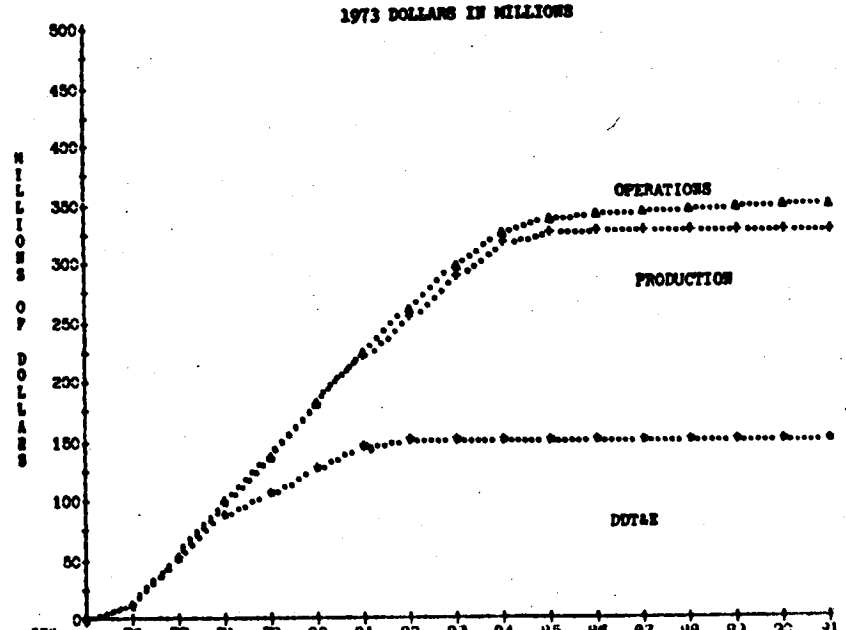
A COMPOSITE SCHEDULE WOULD NOT BE MEANINGFUL, SINCE TWO IOC DATES WOULD BE REFERENCED FOR THE T_S AND T_B VALUES. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE SCHEDULES FOR THE INITIAL PHASE AND THE FINAL PHASE.

PROGRAM OPTION NO. 3 - TOTAL
WBS 320-03 LEVEL-4 VEHICLE MAIN STAGE
ANNUAL FUNDING
1973 DOLLARS IN MILLIONS



FY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	11.4	30.9	37.3	17.6	20.0	18.6	5.7	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	1.4	10.1	19.9	23.2	22.8	28.5	34.2	27.4	9.9	1.9	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.6	2.2	2.2	2.2	2.1	2.1	2.1	2.1	2.1	2.1	1.3	.2
TOTAL	11.4	41.2	47.4	37.5	43.8	43.3	36.4	36.4	29.5	12.0	4.0	2.1	2.1	2.1	1.3	.2

PROGRAM OPTION NO. 3 - TOTAL
WBS 320-03 LEVEL-4 VEHICLE MAIN STAGE
CUMULATIVE FUNDING
1973 DOLLARS IN MILLIONS



FY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	11	81	89	106	126	145	150	150	150	150	150	150	150	150	150	150
PROD	0	1	12	31	55	77	106	140	167	177	179	179	179	179	179	179
OPER	0	0	0	0	1	3	5	7	9	11	14	16	18	20	21	21
TOTAL	11	82	100	137	181	224	260	297	326	338	342	344	347	349	350	350

PROGRAM OPTION NO. 3 INITIAL – WBS 320-04 LEVEL-4 VEHICLE AUXILIARY STAGE – COST SUMMARY

TECHNICAL CHARACTERISTICS – OPTION NO. 3 – INITIAL

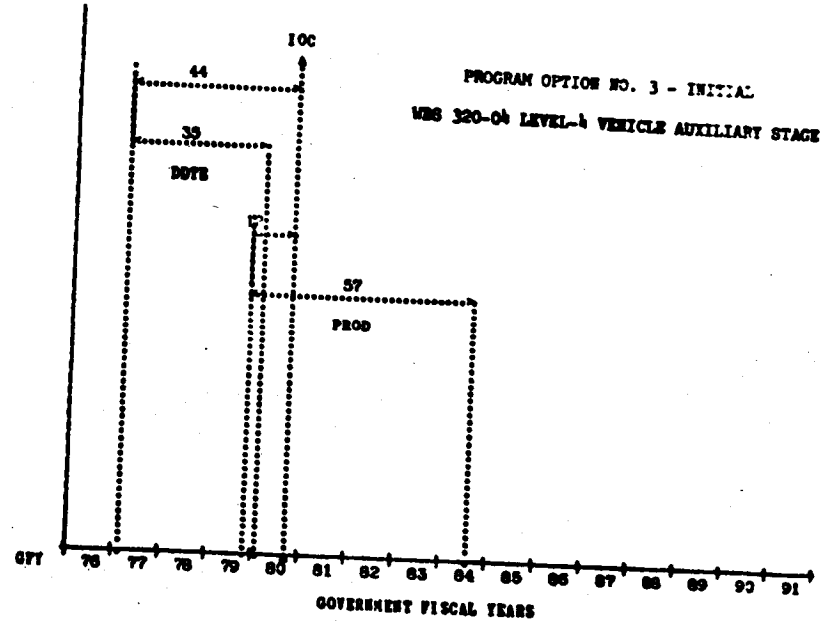
WBS 320-04 SPACE TUG VEHICLE AUXILIARY STAGE

TECHNICAL DESCRIPTION

KICK STAGE TO PAYLOAD OPEN TRUSS WEIGHT	80 LB

STAGE CHARACTERISTICS

SOLID ROCKET MOTOR (SRM)	POLARIS A-3 (2ND STAGE) WITH GUIDANCE
SPM TECHNOLOGY	MINIMUM MODIFICATION
NO. KICKSTAGE MISSIONS	9
NO. TRUSS ASSEMBLIES REQUIRED	9 (EXPENDABLE)
NO. SRM'S REQUIRED	9 (EXPENDABLE)

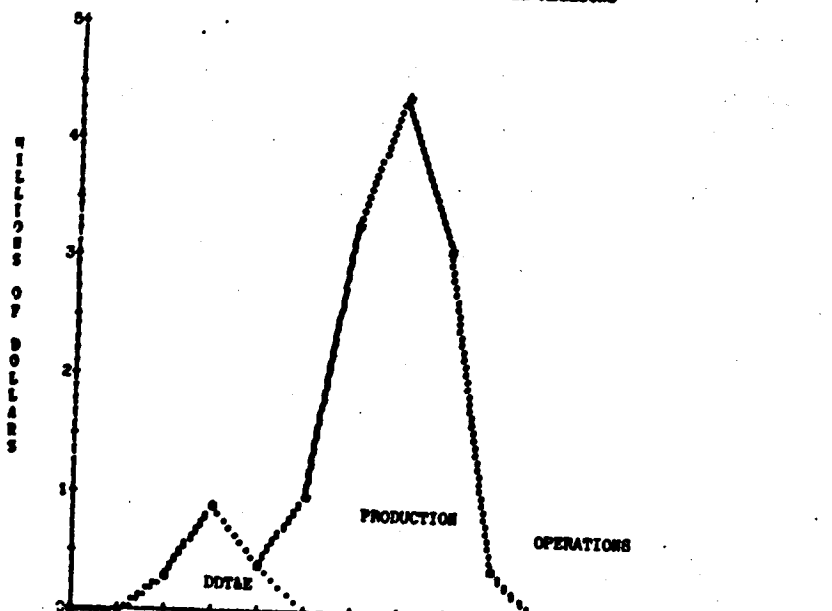


PROGRAM OPTION NO. 3 – INITIAL

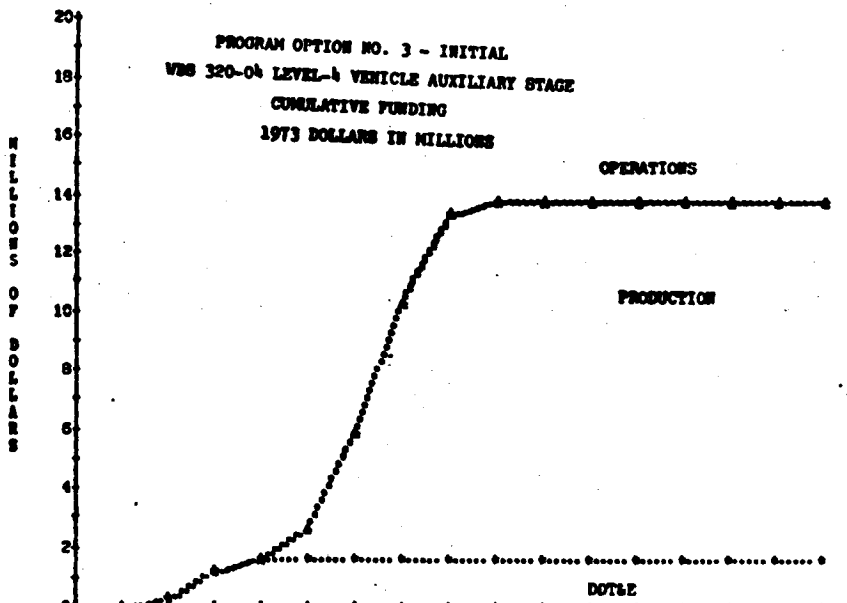
WBS 320-04 LEVEL-4 VEHICLE AUXILIARY STAGE

ANNUAL FUNDING

1973 DOLLARS IN MILLIONS



GFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT+E	.0	.3	.9	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.0	.0	.0	1.0	3.3	4.4	3.1	.4	.0	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	.3	.9	.4	1.0	3.3	4.4	3.1	.4	.0	.0	.0	.0	.0	.0	.0



GFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT+E	.0	.3	1.2	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
PROD	.0	.0	.0	.0	1.0	4.3	8.7	11.8	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	.3	1.2	1.6	2.6	5.9	10.3	13.4	13.8	13.8	13.8	13.8	13.8	13.8	13.8	13.8

PROGRAM OPTION NO. 3 FINAL – WBS 320-04 LEVEL-4 VEHICLE AUXILIARY STAGE – COST SUMMARY

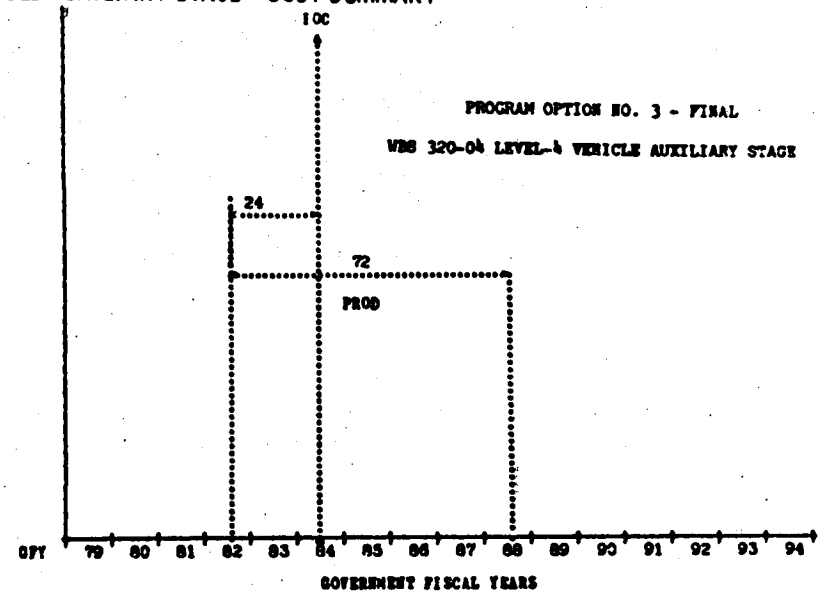
TECHNICAL CHARACTERISTICS – OPTION NO. 3 - FINAL
WBS 320-04 SPACE TUG VEHICLE AUXILIARY STAGE

TECHNICAL DESCRIPTION

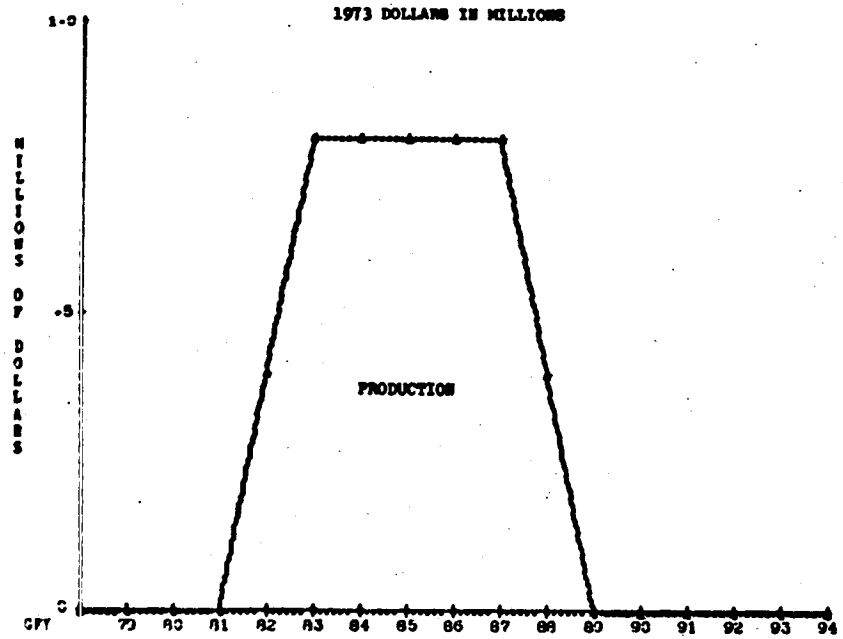
KICK STAGE TO PAYLOAD OPEN TRUSS WEIGHT	80 LB

STAGE CHARACTERISTICS

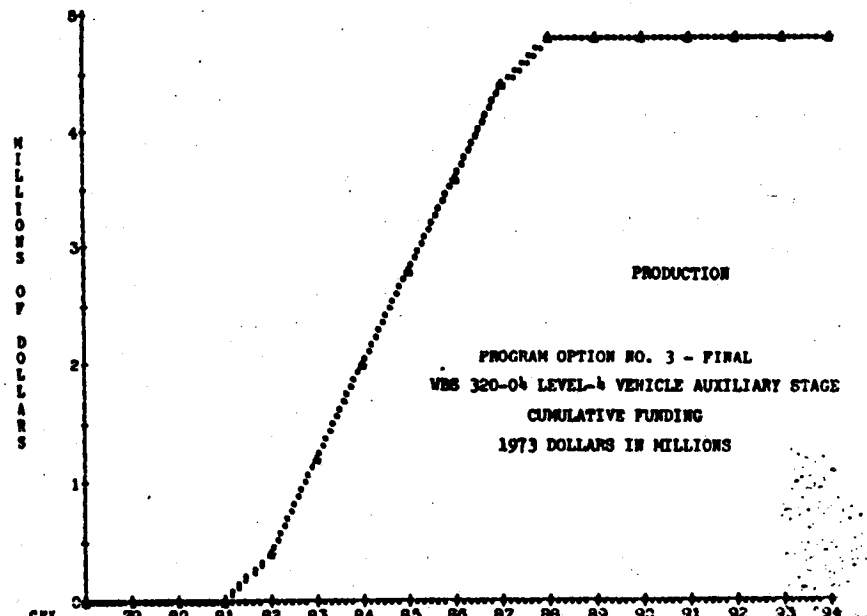
SOLID ROCKET MOTOR (SRM)	POLARIS A-3 (2ND STAGE) WITH GUIDANCE
SRM TECHNOLOGY	MINIMUM MODIFICATION
NO. KICKSTAGE MISSIONS	9
NO. TRUSS ASSEMBLIES REQUIRED	9 (EXPENDABLE)
NO. SRM'S REQUIRED	9 (EXPENDABLE)



PROGRAM OPTION NO. 3 - FINAL
WBS 320-04 LEVEL-4 VEHICLE AUXILIARY STAGE
ANNUAL FUNDING
1973 DOLLARS IN MILLIONS



GFY	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
DDT+E	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.0	.0	.4	.8	.8	.8	.8	.8	.4	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	.0	.0	.4	.8	.8	.8	.8	.8	.4	.0	.0	.0	.0	.0	.0



PROGRAM OPTION NO. 3 - FINAL
WBS 320-04 LEVEL-4 VEHICLE AUXILIARY STAGE
CUMULATIVE FUNDING
1973 DOLLARS IN MILLIONS

GFY	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
DDT+E	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.0	.0	.4	1.2	2.0	2.8	3.6	4.4	4.8	4.8	4.8	4.8	4.8	4.8	4.8
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	.0	.0	.4	1.2	2.0	2.8	3.6	4.4	4.8	4.8	4.8	4.8	4.8	4.8	4.8

551-9

PROGRAM OPTION NO. 3 TOTAL – WBS 320-04 LEVEL-4 VEHICLE AUXILIARY STAGE – COST SUMMARY

TECHNICAL CHARACTERISTICS - OPTION NO. 3 TOTAL

WBS 320-04 LEVEL-4 VEHICLE AUXILIARY STAGE

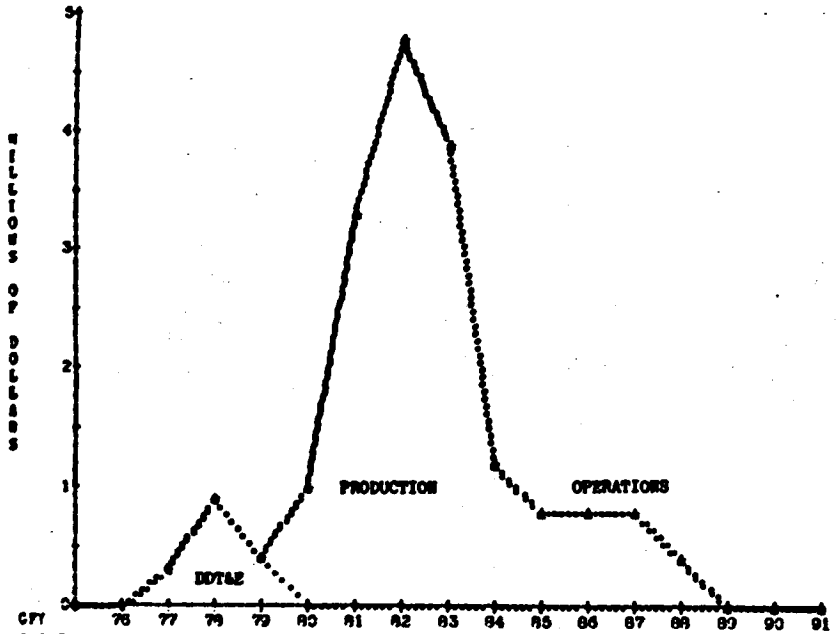
THE TECHNICAL CHARACTERISTICS ARE EQUIVALENT TO THE SUM OF THE INCREMENTAL CHARACTERISTICS. HOWEVER, A MERE SUMMATION WOULD NOT BE MEANINGFUL. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE CHARACTERISTICS FOR THE INITIAL PHASE AND THE FINAL PHASE.

PROGRAM OPTION NO. 3 - TOTAL

WBS 320-04 LEVEL-4 VEHICLE AUXILIARY STAGE

ANNUAL FUNDING

1973 DOLLARS IN MILLIONS



CFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT-E	.0	.3	.9	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.0	.0	.0	1.0	3.3	4.8	3.9	1.2	.8	.8	.8	.4	.0	.0	.0
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	.3	.9	.4	1.0	3.3	4.8	3.9	1.2	.8	.8	.8	.4	.0	.0	.0

PROGRAM OPTION NO. 3 TOTAL

WBS 320-04 LEVEL-4 VEHICLE AUXILIARY STAGE

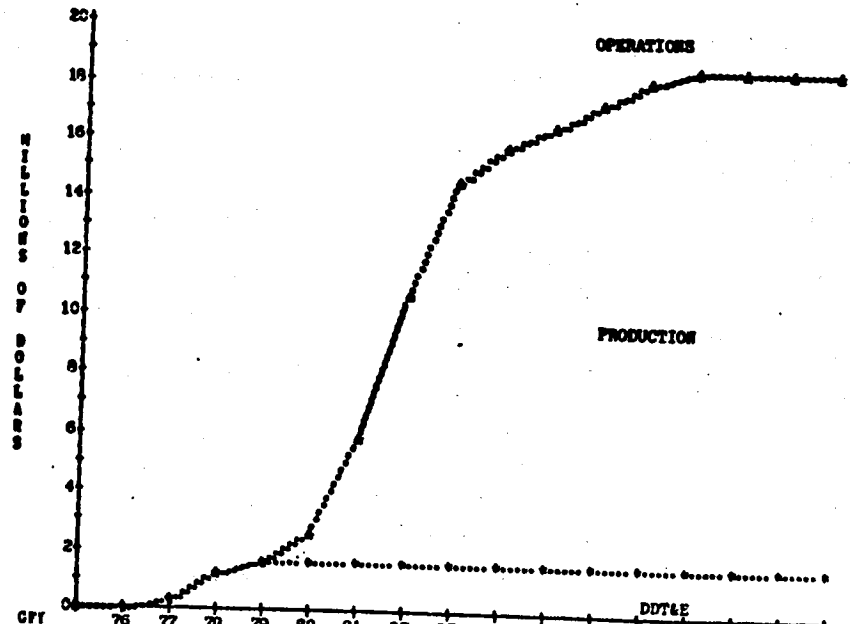
A COMPOSITE SCHEDULE WOULD NOT BE MEANINGFUL, SINCE TWO IOC DATES WOULD BE REFERENCED FOR THE T_S AND T_D VALUES. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE SCHEDULES FOR THE INITIAL PHASE AND THE FINAL PHASE.

PROGRAM OPTION NO. 3 - TOTAL

WBS 320-04 LEVEL-4 VEHICLE AUXILIARY STAGE

CUMULATIVE FUNDING

1973 DOLLARS IN MILLIONS



CFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT-E	.0	.3	1.2	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
PROD	.0	.0	.0	.0	1.0	4.3	9.1	13.0	14.2	15.0	15.8	16.6	17.0	17.0	17.0	17.0
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	.3	1.2	1.6	2.6	5.9	10.7	14.6	15.8	16.6	17.4	18.2	18.6	18.6	18.6	19.6

PROGRAM OPTION NO. 3 INITIAL – WBS 320-07 LEVEL-4 GROUND SUPPORT EQUIPMENT – COST SUMMARY

TECHNICAL CHARACTERISTICS - OPTION NO. 3 - INITIAL

WBS 320-07 GROUND SUPPORT EQUIPMENT

GSE METHODOLOGY

GROUND RULE

MAXIMIZING USE OF EXISTING S-IVB/SKYLAB GSE IS ASSUMED. COSTS OF GSE NOT SIMILAR TO S-IVB/SKYLAB GSE ARE BASED ON AN "AVERAGE UNIT COST OF S-IVB GSE," DERIVED BY DIVIDING THE TOTAL COST OF S-IVB GSE BY THE NUMBER OF GSE UNITS INCLUDED IN THAT COST. THE COST OF AN AVERAGE UNIT OF S-IVB GSE HAS BEEN ALLOCATED TO "NON-RECURRING" AND "RECURRING" PORTIONS BASED ON RATIO OF THESE ELEMENTS FOR THE TOTAL S-IVB GSE. COSTS FOR SPACE TUG GSE UNITS HAS BEEN ESTIMATED AS A PERCENTAGE OF THE BASE.

GSE CHARACTERISTICS

GSE LOCATIONS

MANUFACTURING FACILITY

ETR

WTR

NASA FLIGHT OPERATIONS

DOD FLIGHT OPERATIONS CENTER

TYPES

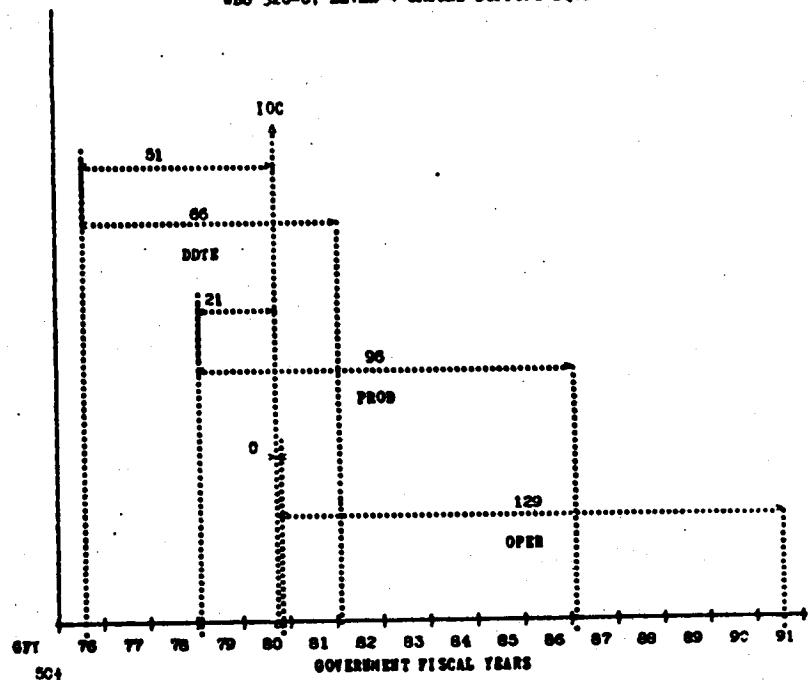
BOTH HARDWARE AND SOFTWARE

REQUIREMENT

SUPPORT OF DEVELOPMENT QUALIFICATION AND ACCEPTANCE TESTING, SPACE TUG FABRICATION, SPACE TUG TRANSPORTATION AND HANDLING, INTEGRATION OF TUG AND PAYLOAD, AND INTEGRATION OF TUG AND ORBITER.

PROGRAM OPTION NO. 3 - INITIAL

WBS 320-07 LEVEL-4 GROUND SUPPORT EQUIPMENT

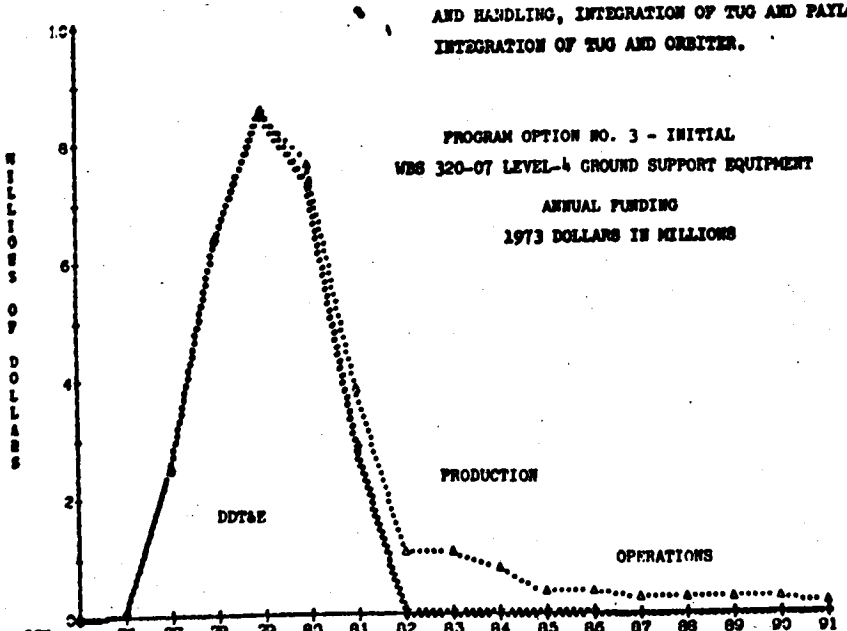


PROGRAM OPTION NO. 3 - INITIAL

WBS 320-07 LEVEL-4 GROUND SUPPORT EQUIPMENT

ANNUAL FUNDING

1973 DOLLARS IN MILLIONS



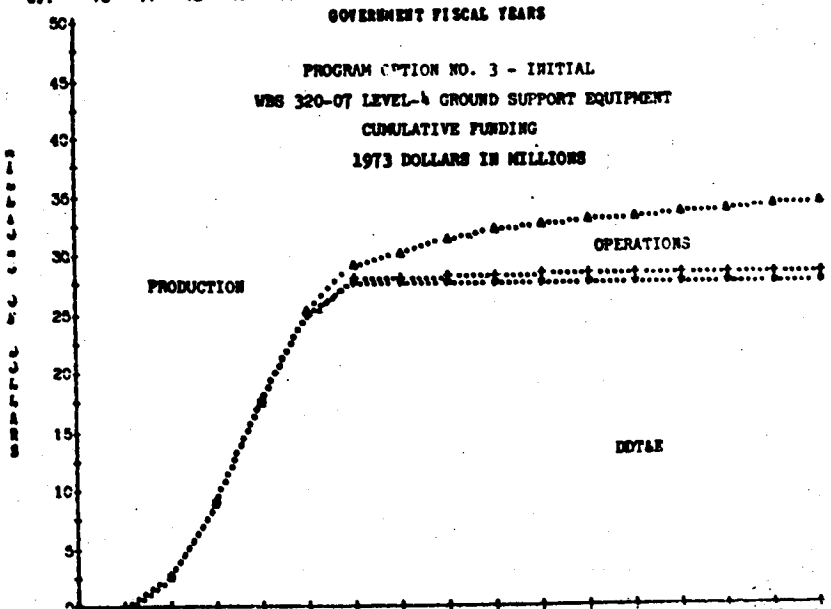
GFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	.1	2.5	6.4	8.5	7.3	2.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.3	1.0	1.0	1.0	.7	.3	.3	.3	.3	.3	.3	.2
TOTAL	.1	2.5	6.4	8.6	7.7	3.9	1.1	1.1	.8	.4	.4	.3	.3	.3	.3	.2

PROGRAM OPTION NO. 3 - INITIAL

WBS 320-07 LEVEL-4 GROUND SUPPORT EQUIPMENT

CUMULATIVE FUNDING

1973 DOLLARS IN MILLIONS



GFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	.1	2.6	9.0	17.5	24.8	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6	27.6
PROD	.0	.0	.0	.1	.2	.3	.4	.5	.6	.7	.8	.8	.8	.8	.8	.8
OPER	.0	.0	.0	.0	.3	1.3	2.3	3.3	4.0	4.3	4.6	4.9	5.2	5.5	5.8	6.0
TOTAL	.1	2.6	9.0	17.6	25.3	29.2	30.3	31.4	32.2	32.6	33.0	33.3	33.6	33.9	34.2	34.4

PROGRAM OPTION NO. 3 FINAL – WBS 320-07 LEVEL-4 GROUND SUPPORT EQUIPMENT – COST SUMMARY

GSE METHODOLOGY

GROUND RULE

TECHNICAL CHARACTERISTICS – OPTION NO. 3 - FINAL

WBS 320-07 GROUND SUPPORT EQUIPMENT

MAXIMIZING USE OF EXISTING S-IV B/SKYLAB GSE IS ASSUMED. COSTS OF GSE NOT SIMILAR TO S-IV B/SKYLAB GSE ARE BASED ON AN "AVERAGE UNIT COST OF S-IV B GSE," DERIVED BY DIVIDING THE TOTAL COST OF S-IV B GSE BY THE NUMBER OF GSE UNITS INCLUDED IN THAT COST. THE COST OF AN AVERAGE UNIT OF S-IV B GSE HAS BEEN ALLOCATED TO "NON-RECURRING" AND "RECURRING" PORTIONS BASED ON THE RATIO OF THESE ELEMENTS FOR THE TOTAL S-IV B GSE. COSTS FOR SPACE TUG GSE UNITS HAS BEEN ESTIMATED AS A PERCENTAGE OF THE BASE

GSE CHARACTERISTICS

GSE LOCATIONS

MANUFACTURING FACILITY

ETR

WTR

NASA FLIGHT OPERATIONS CENTER

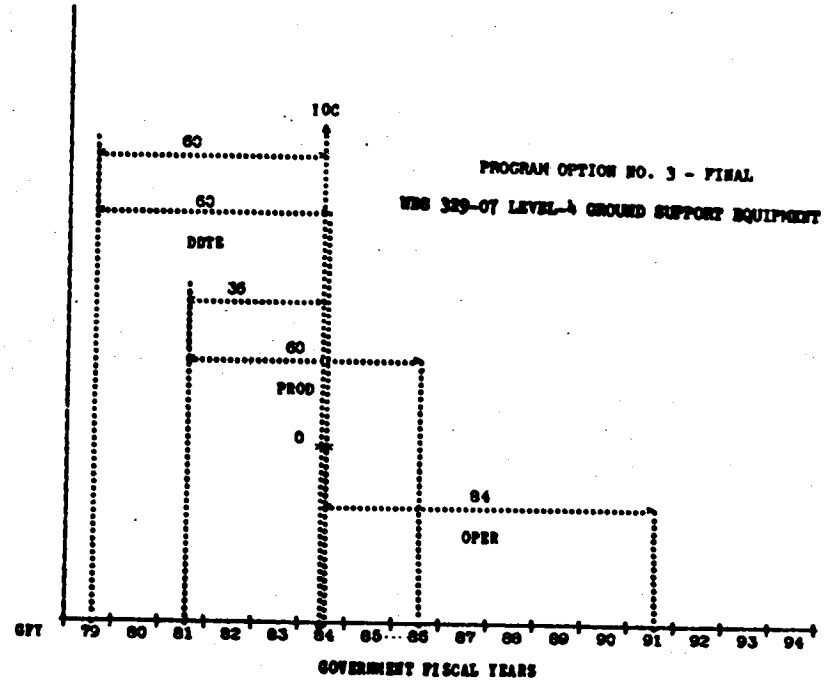
DOD FLIGHT OPERATIONS CENTER

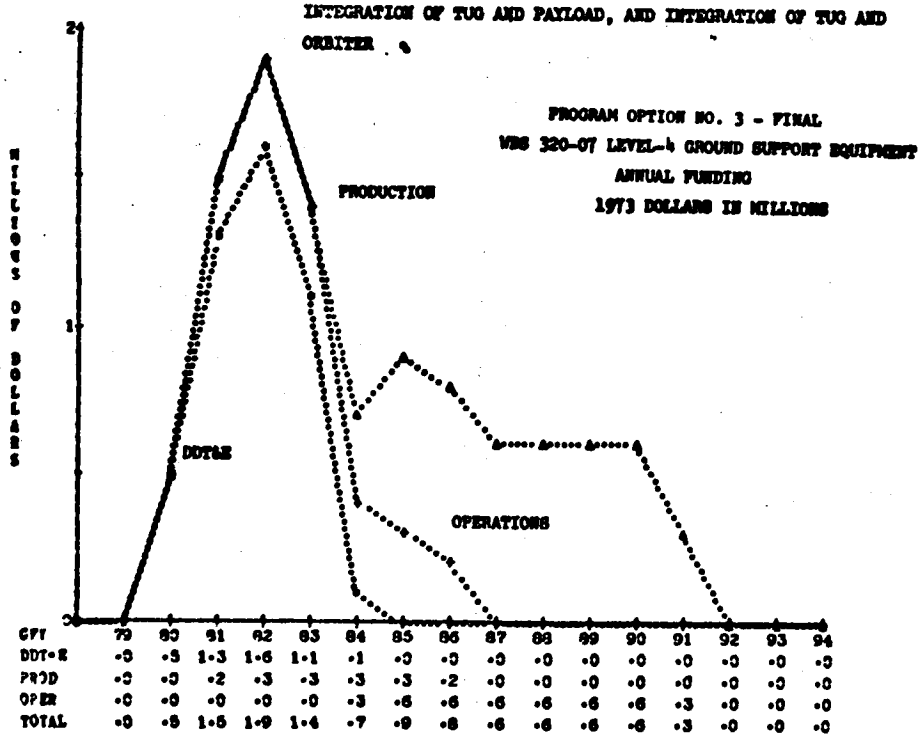
TYPES

BOTH HARDWARE AND SOFTWARE

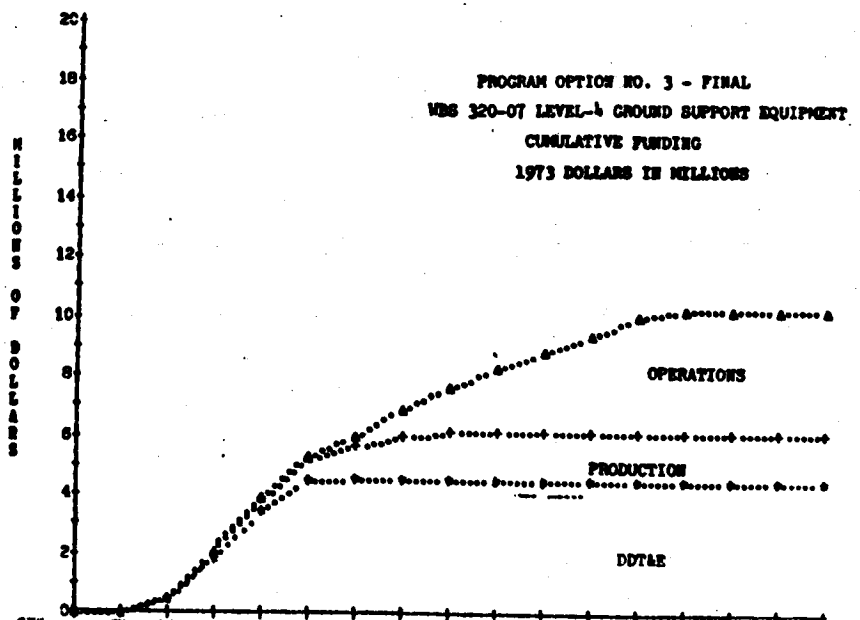
REQUIREMENT

SUPPORT OF DEVELOPMENT QUALIFICATION AND ACCEPTANCE TESTING, SPACE TUG FABRICATION, SPACE TUG TRANSPORTATION AND HANDLING, INTEGRATION OF TUG AND PAYLOAD, AND INTEGRATION OF TUG AND ORBITER





GFY	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
DDT+E	.0	.5	1.3	1.6	1.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.0	.2	.3	.3	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.0	.3	.6	.6	.6	.6	.6	.6	.3	.0	.0	.0
TOTAL	.0	.5	1.5	1.9	1.4	.7	.9	.8	.6	.6	.6	.6	.3	.0	.0	.0



GFY	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
DDT+E	.0	.5	1.8	3.4	4.5	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
PROD	.0	.0	.2	.5	.8	1.1	1.4	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
OPER	.0	.0	.0	.0	.0	.3	.9	1.5	2.1	2.7	3.3	3.9	4.2	4.2	4.2	4.2
TOTAL	.0	.5	2.0	3.9	5.3	6.0	6.9	7.7	8.3	8.9	9.5	10.1	10.4	10.4	[illegible]	10.4

PROGRAM OPTION NO. 3 TOTAL – WBS 320-07 LEVEL-4 GROUND SUPPORT EQUIPMENT – COST SUMMARY

TECHNICAL CHARACTERISTICS - OPTION NO. 3 TOTAL

WBS 320-07 LEVEL-4 GROUND SUPPORT EQUIPMENT

THE TECHNICAL CHARACTERISTICS ARE EQUIVALENT TO THE SUM OF THE INCREMENTAL CHARACTERISTICS. HOWEVER, A MERE SUMMATION WOULD NOT BE MEANINGFUL. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE CHARACTERISTICS FOR THE INITIAL PHASE AND THE FINAL PHASE.

PROGRAM OPTION NO. 3 TOTAL

WBS 320-07 LEVEL-4 GROUND SUPPORT EQUIPMENT

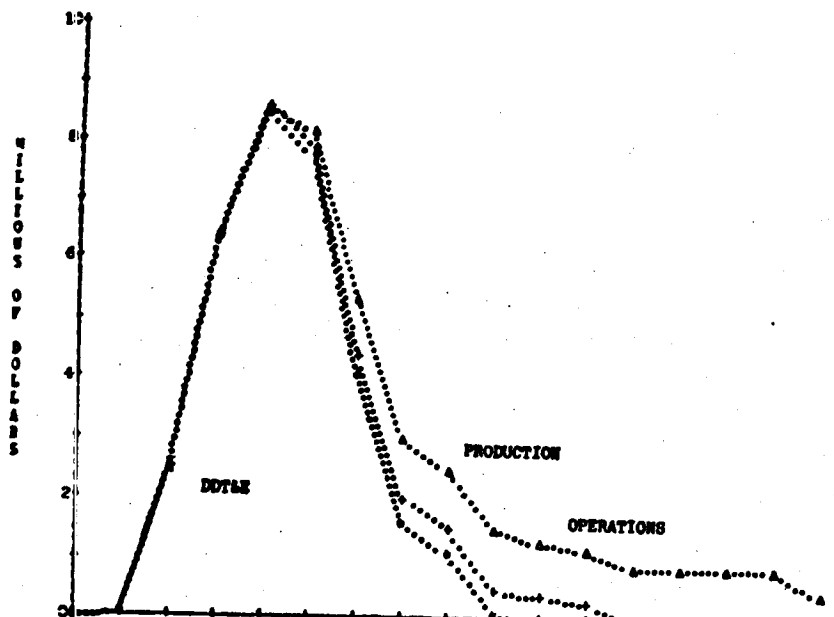
A COMPOSITE SCHEDULE WOULD NOT BE MEANINGFUL, SINCE TWO IOC DATES WOULD BE REFERENCED FOR THE T_S AND T_D VALUES. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE SCHEDULES FOR THE INITIAL PHASE AND THE FINAL PHASE.

PROGRAM OPTION NO. 3 - TOTAL

WBS 320-07 LEVEL-4 GROUND SUPPORT EQUIPMENT

ANNUAL FUNDING

1973 DOLLARS IN MILLIONS



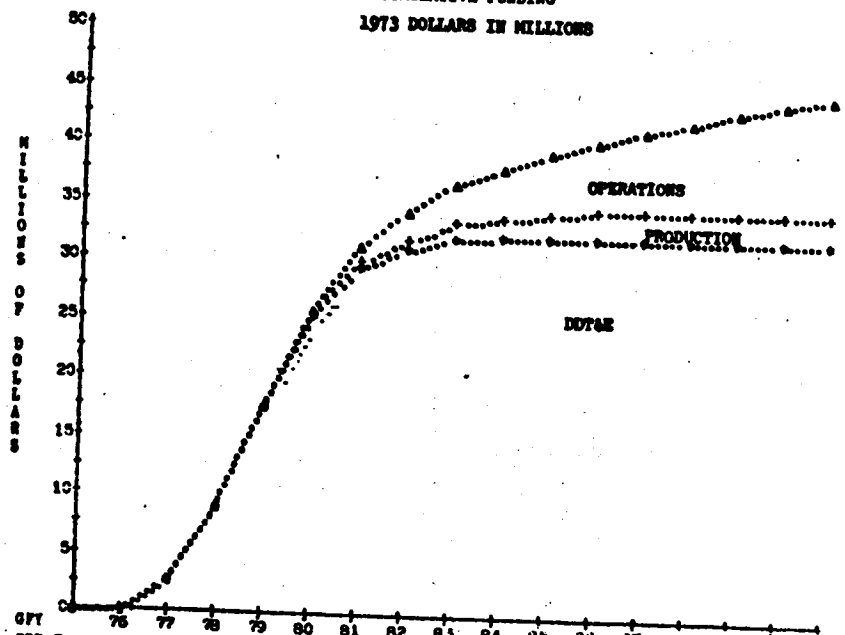
CFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT•E	•1	2•5	6•4	8•5	7•6	4•1	1•6	1•1	•1	•0	•0	•0	•0	•0	•0	•0
PROD	•0	•0	•0	•1	•1	•3	•4	•4	•4	•4	•3	•0	•0	•0	•0	•0
OPER	•0	•0	•0	•0	•3	1•0	1•0	1•0	1•0	•9	•9	•9	•9	•9	•9	•8
TOTAL	•1	2•8	6•4	8•6	8•2	5•4	3•0	2•5	1•5	1•3	1•2	•9	•9	•9	•9	•8

PROGRAM OPTION NO. 3 - TOTAL

WBS 320-07 LEVEL-4 GROUND SUPPORT EQUIPMENT

CUMULATIVE FUNDING

1973 DOLLARS IN MILLIONS



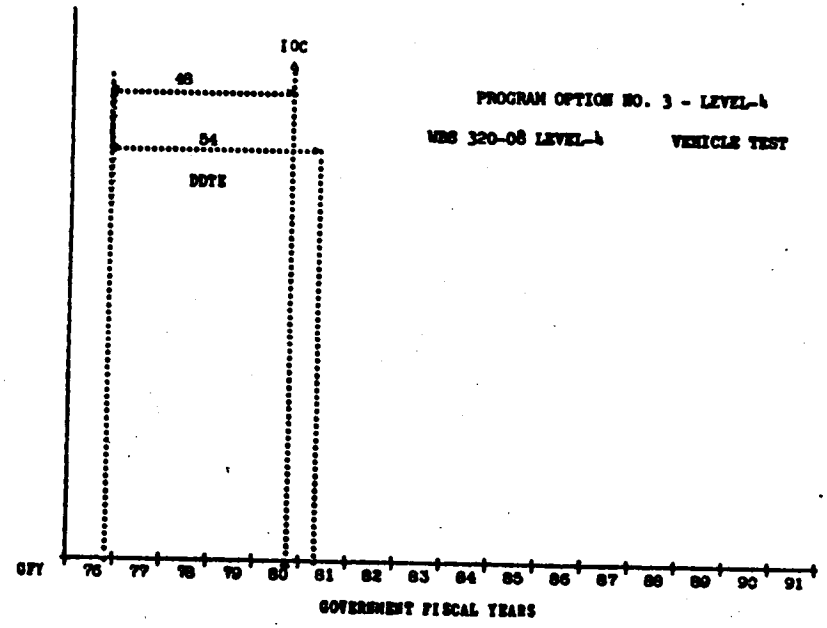
CFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT•E	•1	2•6	9•0	17•5	25•3	29•4	31•0	32•1	32•2	32•2	32•2	32•2	32•2	32•2	32•2	32•2
PROD	•0	•0	•0	•1	•2	•5	•9	1•3	1•7	2•1	2•4	2•4	2•4	2•4	2•4	2•4
OPER	•0	•0	•0	•0	•3	1•3	2•3	3•3	4•3	5•2	6•1	7•0	7•9	8•8	9•7	10•2
TOTAL	•1	2•6	9•0	17•6	25•8	31•2	34•2	36•7	39•2	39•5	40•7	41•6	42•5	43•4	44•3	44•8

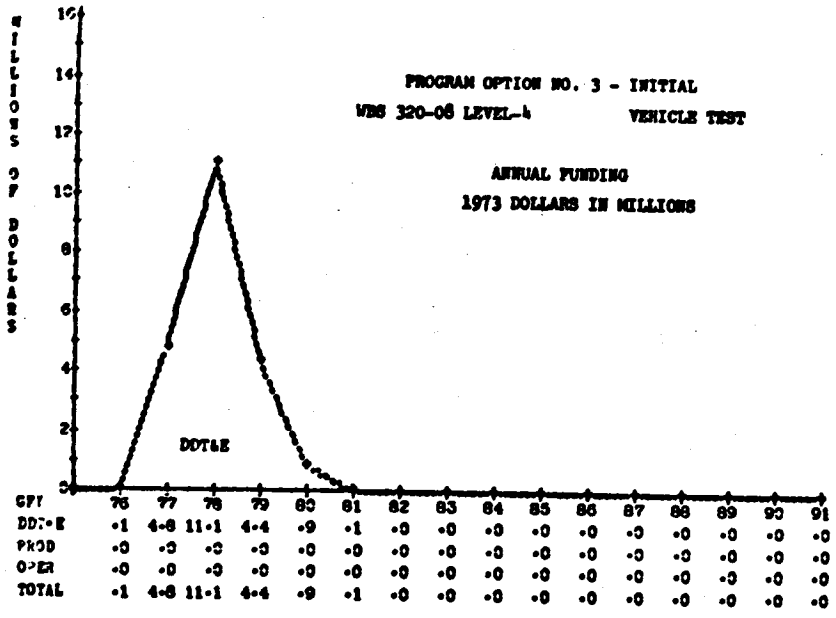
PROGRAM OPTION NO. 3 INITIAL – WBS 320-08 LEVEL-4 VEHICLE TEST – COST SUMMARY

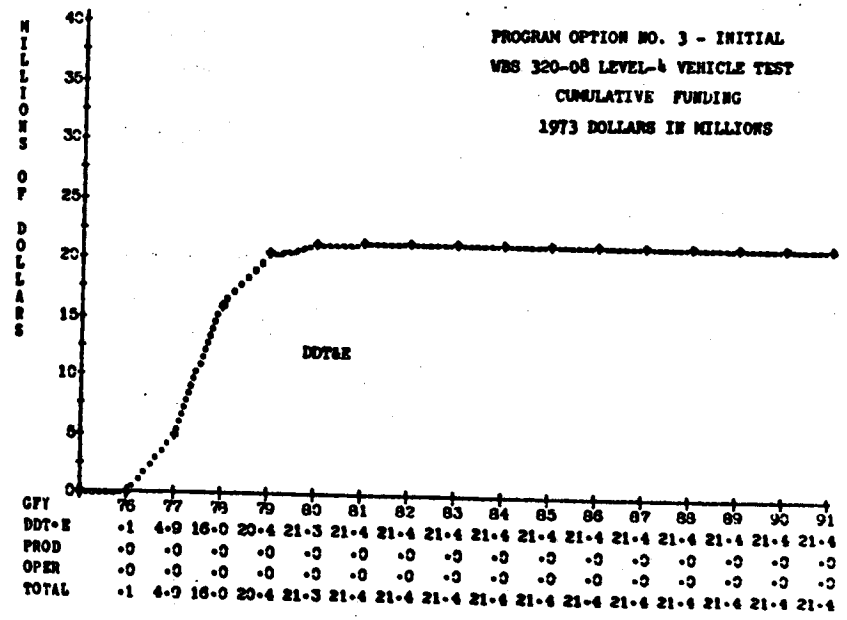
TECHNICAL CHARACTERISTICS - OPTION NO. 3 - INITIAL

WBS 320-08 VEHICLE TEST

DESCRIPTORS	CHARACTERISTICS
TYPES OF TESTING	PROPULSION TEST VEHICLE
	MAJOR TEST ARTICLE
	MOCKUPS
TEST CATAGORIES	GROUND TEST HARDWARE
	FLIGHT TEST INSTRUMENTATION
	GROUND TEST OPERATIONS
	FLIGHT TEST OPERATIONS



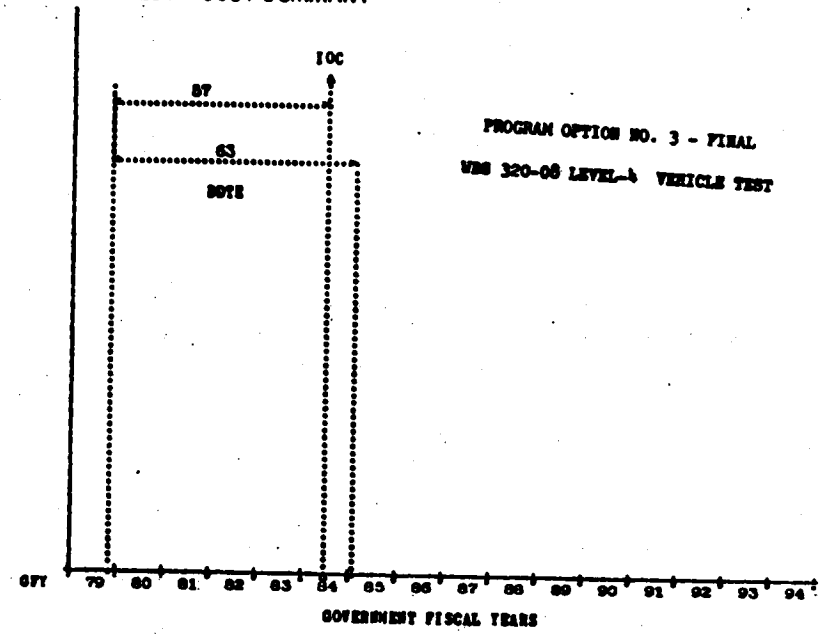




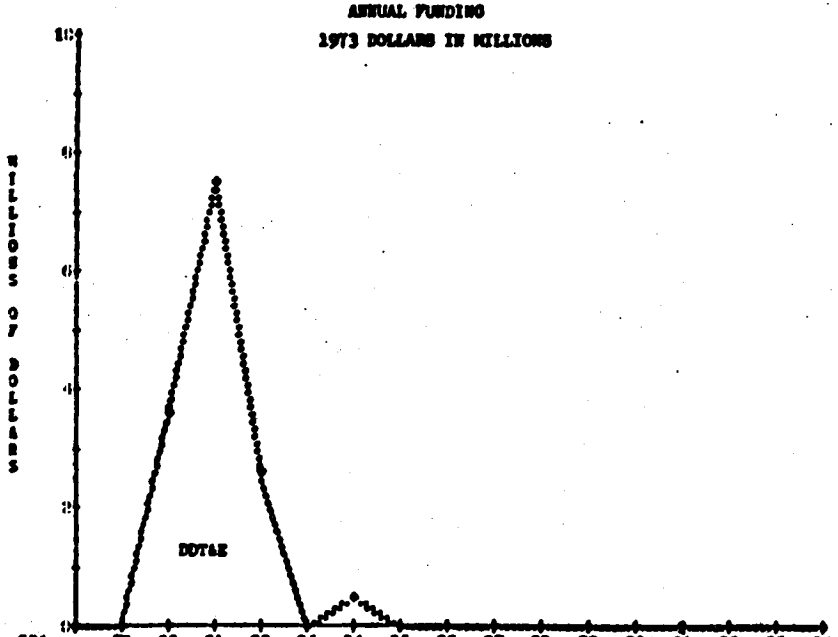
PROGRAM OPTION NO. 3 FINAL – WBS 320-08 LEVEL-4 VEHICLE TEST – COST SUMMARY

TECHNICAL CHARACTERISTICS – OPTION NO. 3 - FINAL
WBS 320-08 VEHICLE TEST

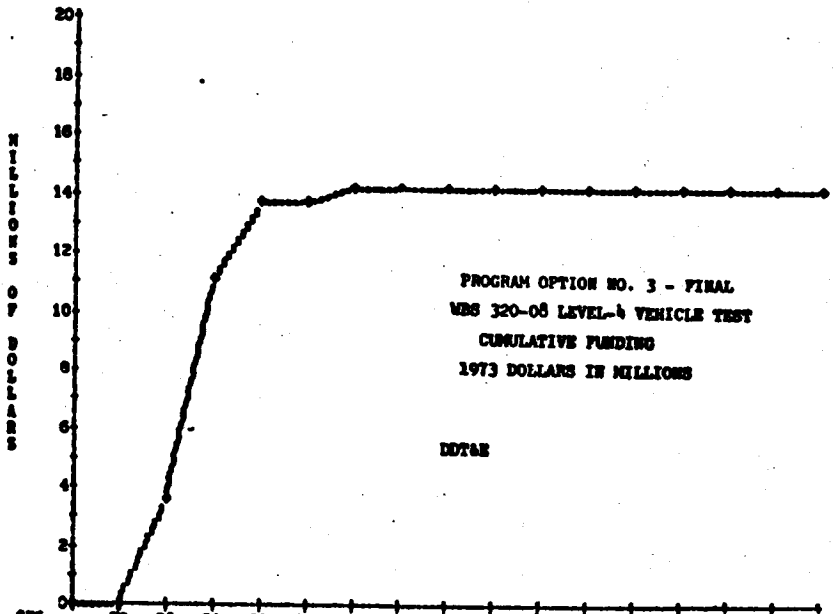
DESCRIPTORS	CHARACTERISTICS
TYPES OF TESTING	PROPULSION TEST VEHICLE MAJOR TEST ARTICLE MOCKUPS
TEST CATAGORIES	GROUND TEST HARDWARE FLIGHT TEST INSTRUMENTATION GROUND TEST OPERATIONS FLIGHT TEST OPERATIONS



PROGRAM OPTION NO. 3 - FINAL
WBS 320-08 LEVEL-4 VEHICLE TEST
ANNUAL FUNDING
1973 DOLLARS IN MILLIONS



GFY	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
DDT&E	.0	3.6	7.5	2.6	.0	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	3.6	7.5	2.6	.0	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0



GFY	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
DDT&E	.0	3.6	11.1	13.7	13.7	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2
PROD	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	3.6	11.1	13.7	13.7	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2	14.2

PROGRAM OPTION NO. 3 TOTAL – WBS 320-08 LEVEL-4 VEHICLE TEST – COST SUMMARY

TECHNICAL CHARACTERISTICS - OPTION NO. 3 TOTAL

WBS 320-08 LEVEL-4 VEHICLE TEST

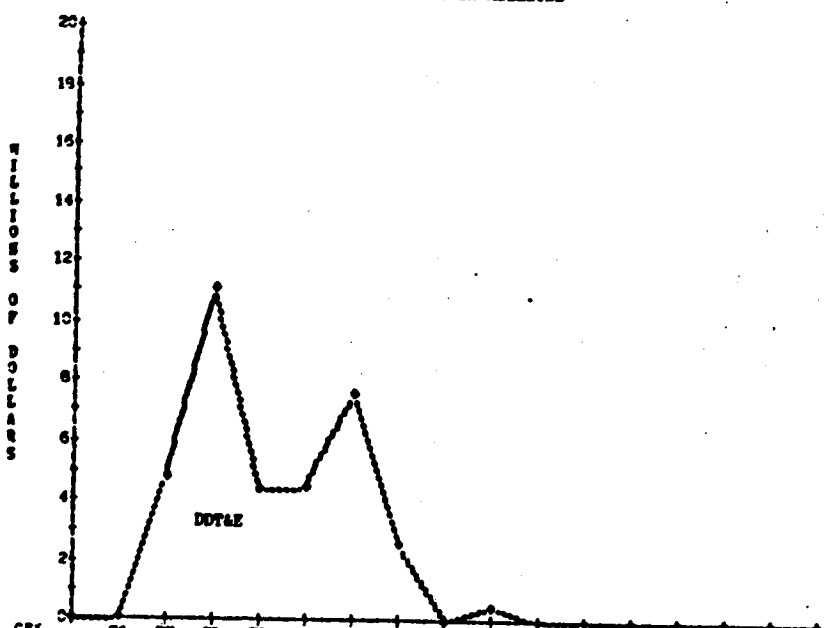
THE TECHNICAL CHARACTERISTICS ARE EQUIVALENT TO THE SUM OF THE INCREMENTAL CHARACTERISTICS. HOWEVER, A MERE SUMMATION WOULD NOT BE MEANINGFUL. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE CHARACTERISTICS FOR THE INITIAL PHASE AND THE FINAL PHASE.

PROGRAM OPTION NO. 3 TOTAL

WBS 320-08 LEVEL-4 VEHICLE TEST

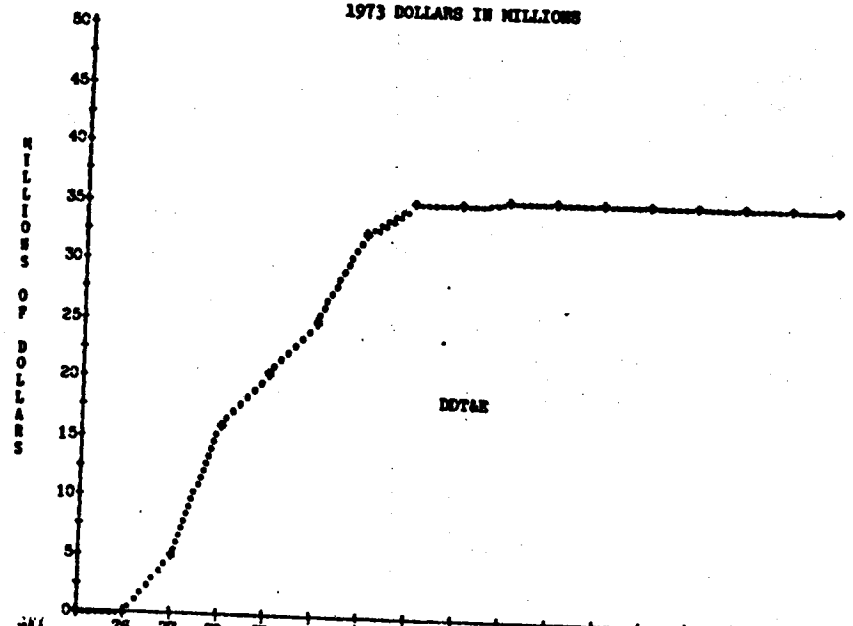
A COMPOSITE SCHEDULE WOULD NOT BE MEANINGFUL, SINCE TWO IOC DATES WOULD BE REFERENCED FOR THE T_S AND T_D VALUES. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE SCHEDULES FOR THE INITIAL PHASE AND THE FINAL PHASE.

PROGRAM OPTION NO. 3 - TOTAL
WBS 320-08 LEVEL-4 VEHICLE TEST
ANNUAL FUNDING
1973 DOLLARS IN MILLIONS



CFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	.1	4.8	11.1	4.4	4.5	7.6	2.6	.0	.5	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.1	4.8	11.1	4.4	4.5	7.6	2.6	.0	.5	.0	.0	.0	.0	.0	.0	.0

PROGRAM OPTION NO. 3 - TOTAL
WBS 320-08 LEVEL-4 VEHICLE TEST
CUMULATIVE FUNDING
1973 DOLLARS IN MILLIONS



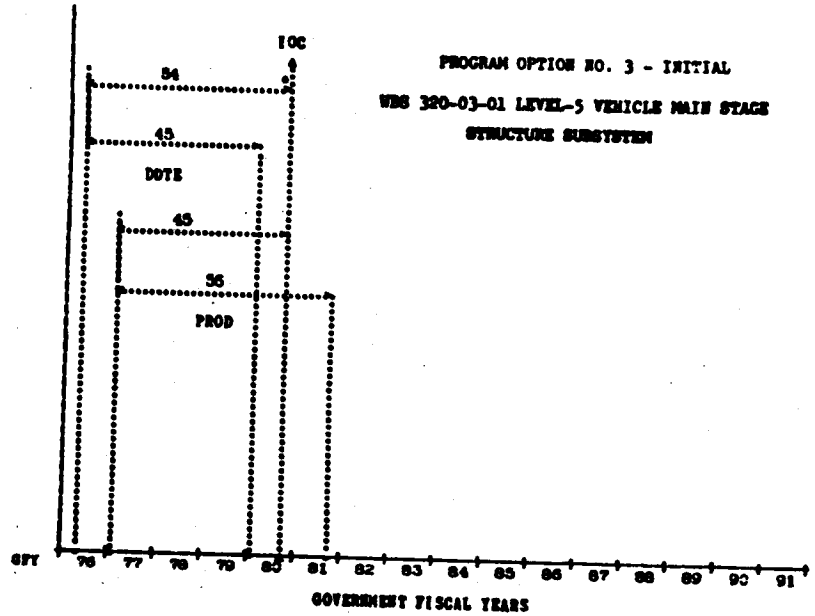
CFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	.1	4.9	16.0	20.4	24.9	32.5	35.1	35.1	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.5
PROD	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.1	4.9	16.0	20.4	24.9	32.5	35.1	35.1	35.6	35.6	35.6	35.6	35.6	35.6	35.6	35.5

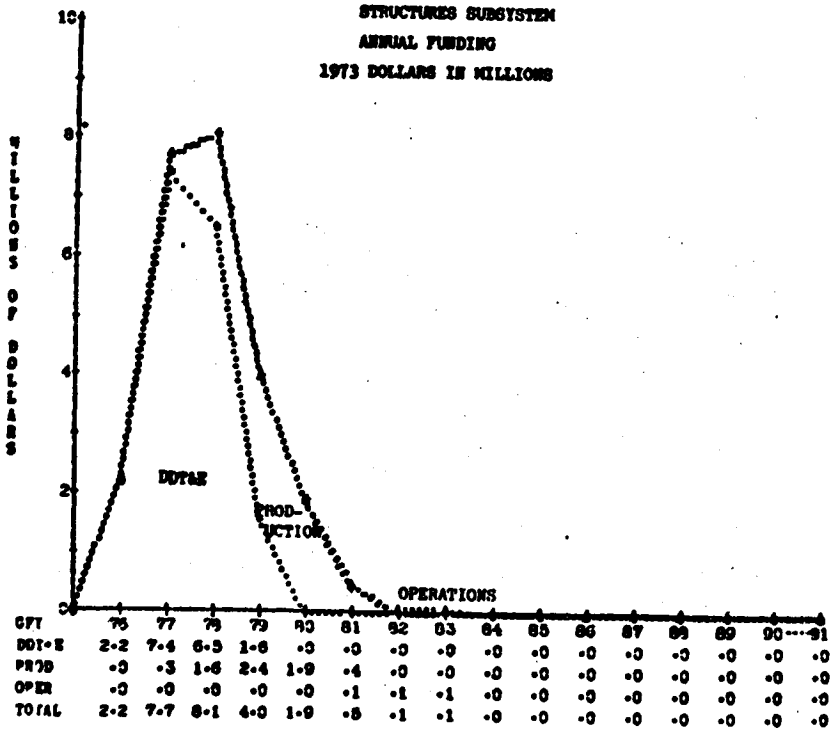
PROGRAM OPTION NO. 3 INITIAL – WBS 320-03-01 LEVEL-5 VEHICLE MAIN STAGE STRUCTURES SUBSYSTEM – COST SUMMARY

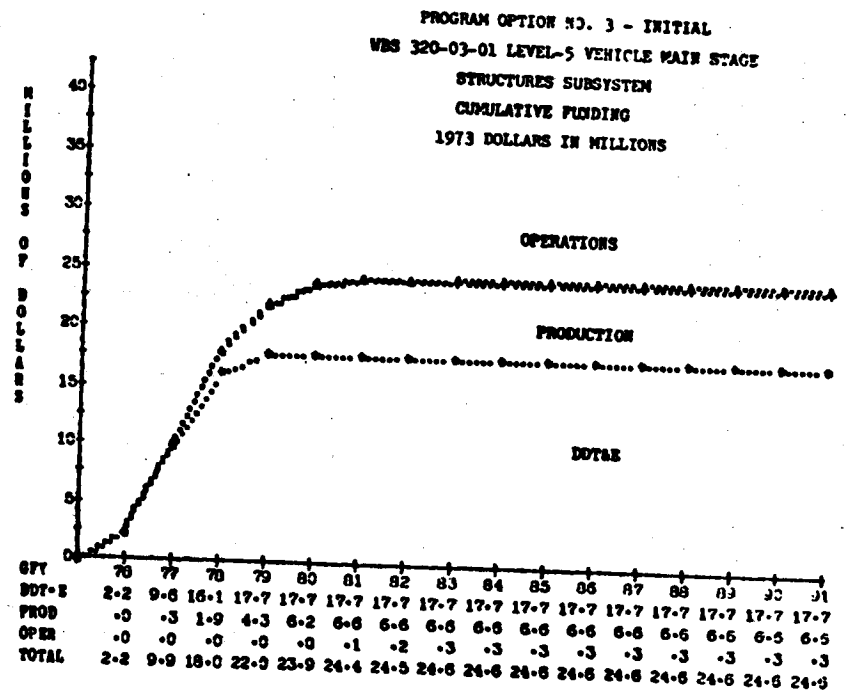
TECHNICAL CHARACTERISTICS – OPTION NO. 3 – INITIAL

WBS 320-03-01 STRUCTURES

DESCRIPTORS	COST WEIGHTS	CHARACTERISTICS
STRUCTURE SUBSYSTEM	2494 LBS	
SUBSYSTEM ASSEMBLIES		
LH_2 FUEL TANK	742 LBS	DOMES – 2219 ALUM., TAPERED; SIDEWALL – 2219 ALUM., CLOSED ISOGRID; SUPPORTS – TITANIUM TUBES
LOX TANK	314 LBS	DOMES – 2219 ALUM., TAPERED; SUPPORTS – TITANIUM TUBES
BODY STRUCTURE	1027 LBS	LONGERONS – 2219 ALUM.; SHEAR PANELS – 2219 ALUM., OPEN ISOGRID; SUPPORTS – TITANIUM TUBULAR TRUSS
THRUST STRUCTURE	106 LBS	TITANIUM OPEN ISOGRID
METEOROID SHIELD	77 LBS	6 MIL DACRON BARRIER/BAG
PAYLOAD INTERFACE	128 LBS	
TUG TO PAYLOAD SQUARE FRAME TRUSS	100 LBS	ALUM. TUBE TRUSSES, 3 REQ. (REUSABLE FOR 9 KICKSTAGE MISSIONS



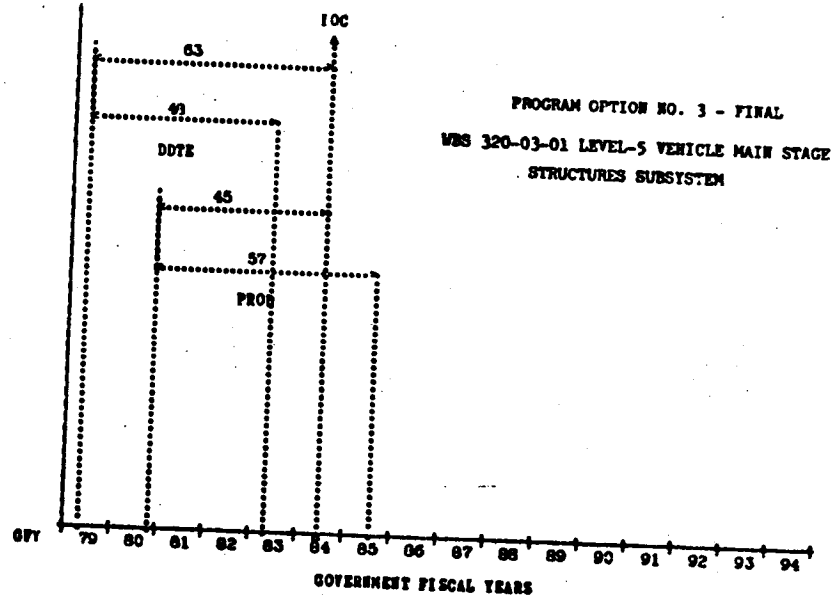




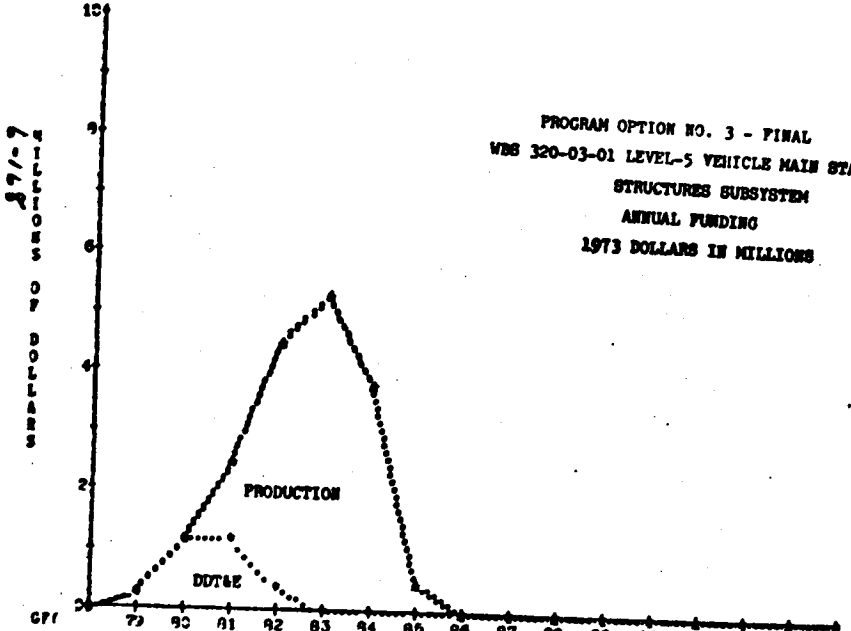
PROGRAM OPTION NO. 3 FINAL – WBS 320-03-01 LEVEL-5 VEHICLE MAIN STAGE
STRUCTURES SUBSYSTEM – COST SUMMARY

TECHNICAL CHARACTERISTICS – OPTION NO. 3 - FINAL
WBS 320-03-01 STRUCTURES

DESCRIPTORS	COST WEIGHTS	CHARACTERISTICS
STRUCTURE SUBSYSTEM	1092 LBS.	
SUBSYSTEM ASSEMBLIES		
LH_2 FUEL TANK	498 LBS.	DOMES – 2219 ALUM., TAPERED; SIDEWALL – 2219 ALUM., MONOCOQUE; SUPPORTS – FIBERGLASS TUBES.
LOX TANK	286 LBS.	DOMES – 2219 ALUM., TAPERED; SUPPORTS – FIBERGLASS TUBES.
BODY STRUCTURE	874 LBS.	LONGERONS – HONEYCOMB; SHEAR PANELS – GRAPHITE EPOXY HONEYCOMB; SUPPORTS – TITANIUM TUBULAR TRUSS.
THRUST STRUCTURE	113 LBS.	TITANIUM OPEN ISOGRID
METEOROID SHIELD		BETA CLOTH
PAYLOAD INTERFACE	321 LBS.	
TUG TO PAYLOAD SQUARE FRAME TRUSS	100 LBS.	ALUM. TUBE TRUSSES, 3 REQ. (REUSABLE FOR 9 KICKSTAGE MISSIONS.)

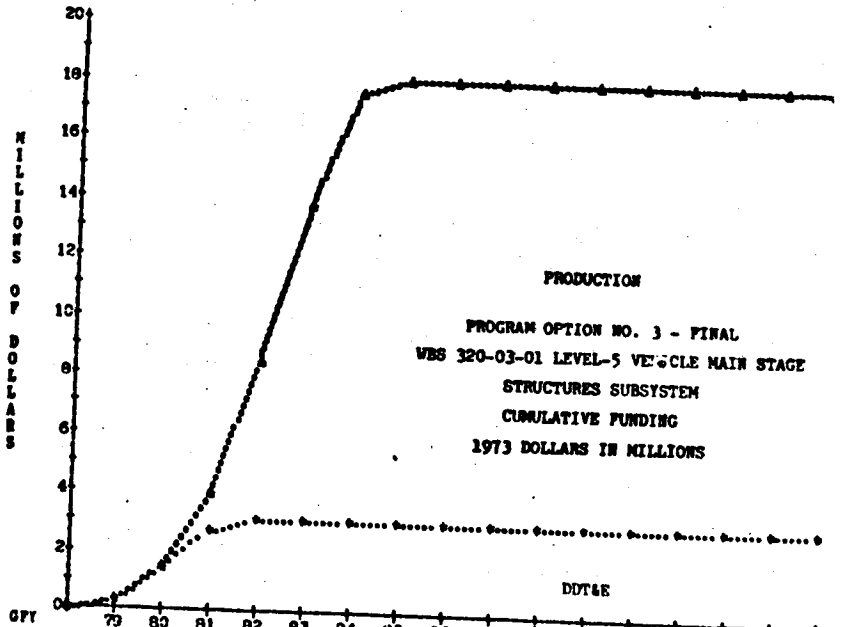


PROGRAM OPTION NO. 3 - FINAL
WBS 320-03-01 LEVEL-5 VEHICLE MAIN STAGE
STRUCTURES SUBSYSTEM



PROGRAM OPTION NO. 3 - FINAL
WBS 320-03-01 LEVEL-5 VEHICLE MAIN STAGE
STRUCTURES SUBSYSTEM
ANNUAL FUNDING
1973 DOLLARS IN MILLIONS

GFY	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
DDT&E	.3	1.2	1.2	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.0	1.3	4.1	5.3	3.8	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.3	1.2	2.5	4.5	5.3	3.8	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0



PROGRAM OPTION NO. 3 - FINAL
WBS 320-03-01 LEVEL-5 VEHICLE MAIN STAGE
STRUCTURES SUBSYSTEM
CUMULATIVE FUNDING
1973 DOLLARS IN MILLIONS

GFY	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
DDT&E	.3	1.5	2.7	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
PROD	.0	.0	1.3	5.4	10.7	14.5	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.3	1.5	4.0	8.5	13.8	17.6	18.1	18.1	18.1	18.1	18.1	18.1	18.1	19.1	19.1	19.1

PROGRAM OPTION NO. 3 TOTAL – WBS 320-03-01 LEVEL-5 VEHICLE MAIN STAGE STRUCTURES SUBSYSTEM – COST SUMMARY

TECHNICAL CHARACTERISTICS - OPTION NO. 3 TOTAL

WBS 320-03-01 LEVEL-5 VEHICLE MAIN STAGE
STRUCTURES SUBSYSTEM

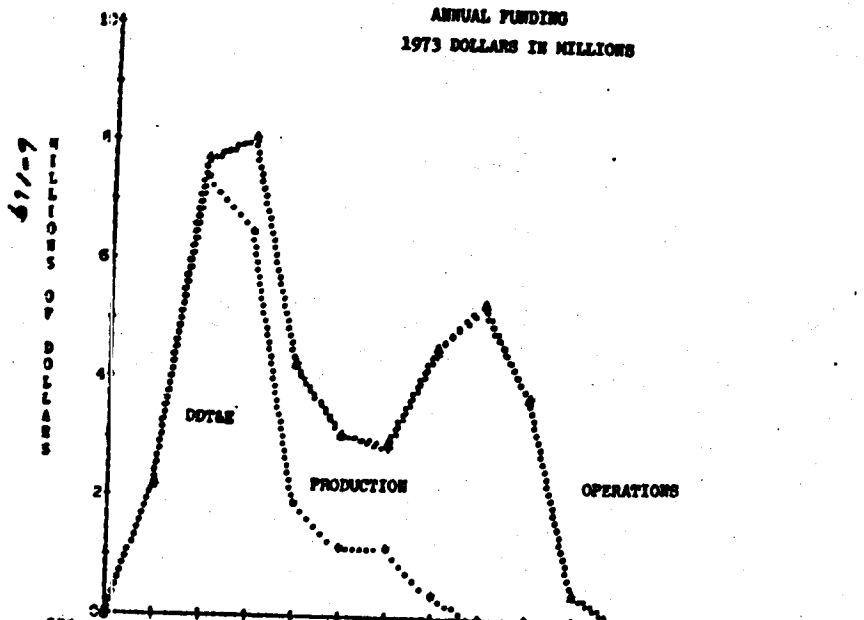
THE TECHNICAL CHARACTERISTICS ARE EQUIVALENT TO THE SUM OF THE INCREMENTAL CHARACTERISTICS. HOWEVER, A MERE SUMMATION WOULD NOT BE MEANINGFUL. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE CHARACTERISTICS FOR THE INITIAL PHASE AND THE FINAL PHASE.

PROGRAM OPTION NO. 3 TOTAL

WBS 320-03-01 LEVEL-5 VEHICLE MAIN STAGE-
STRUCTURES SUBSYSTEM

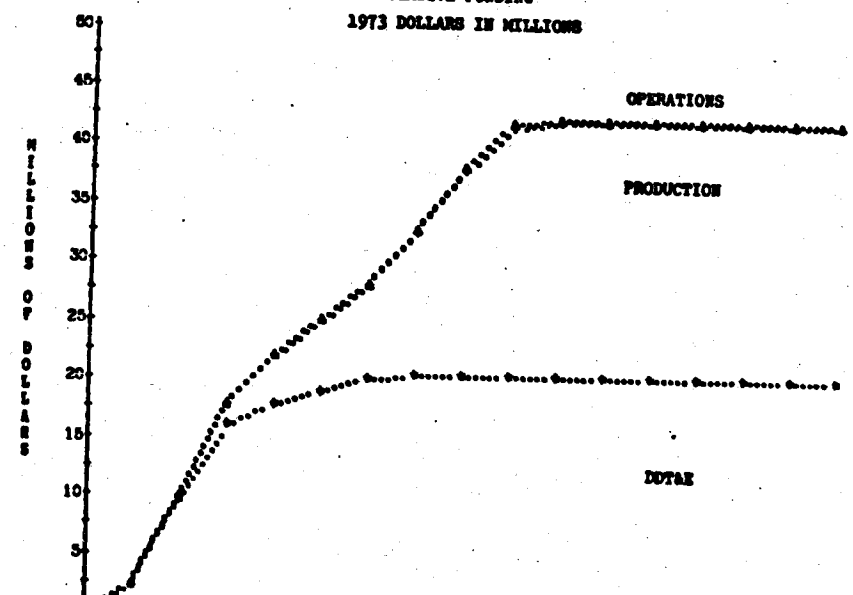
A COMPOSITE SCHEDULE WOULD NOT BE MEANINGFUL, SINCE TWO IOC DATES WOULD BE REFERENCED FOR THE T_S AND T_D VALUES. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE SCHEDULES FOR THE INITIAL PHASE AND THE FINAL PHASE.

PROGRAM OPTION NO. 3 - TOTAL
WBS 320-03-01 LEVEL-5 VEHICLE MAIN STAGE
STRUCTURES SUBSYSTEM
ANNUAL FUNDING
1973 DOLLARS IN MILLIONS



CFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	2.2	7.4	6.5	1.9	1.2	1.2	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.3	1.6	2.4	1.9	1.7	4.1	8.3	3.8	.5	.0	.0	.0	.0	.0	.0
OPER	.0	.3	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	2.2	7.7	8.1	4.3	3.1	3.0	4.6	8.4	3.8	.5	.0	.0	.0	.0	.0	.0

PROGRAM OPTION NO. 3 - TOTAL
WBS 320-03-01 LEVEL-5 VEHICLE MAIN STAGE
STRUCTURES SUBSYSTEM
CUMULATIVE FUNDING
1973 DOLLARS IN MILLIONS

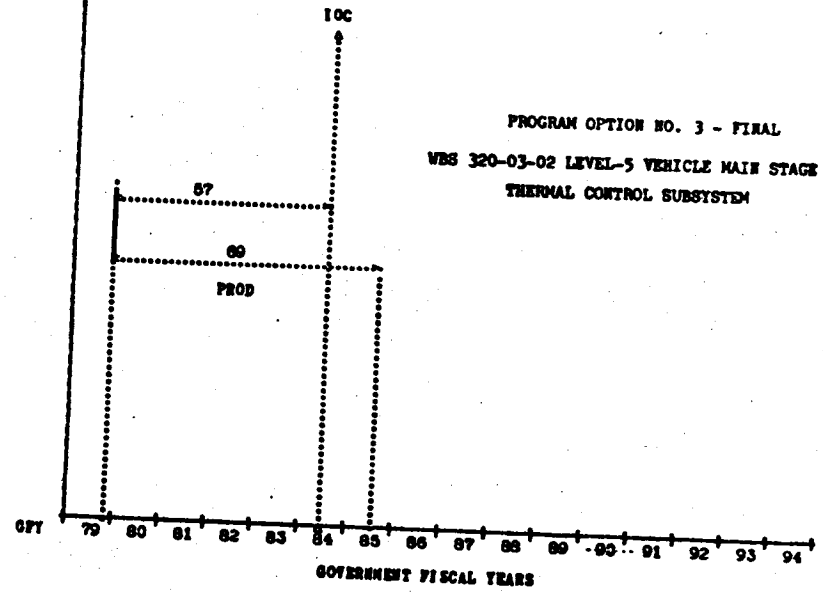


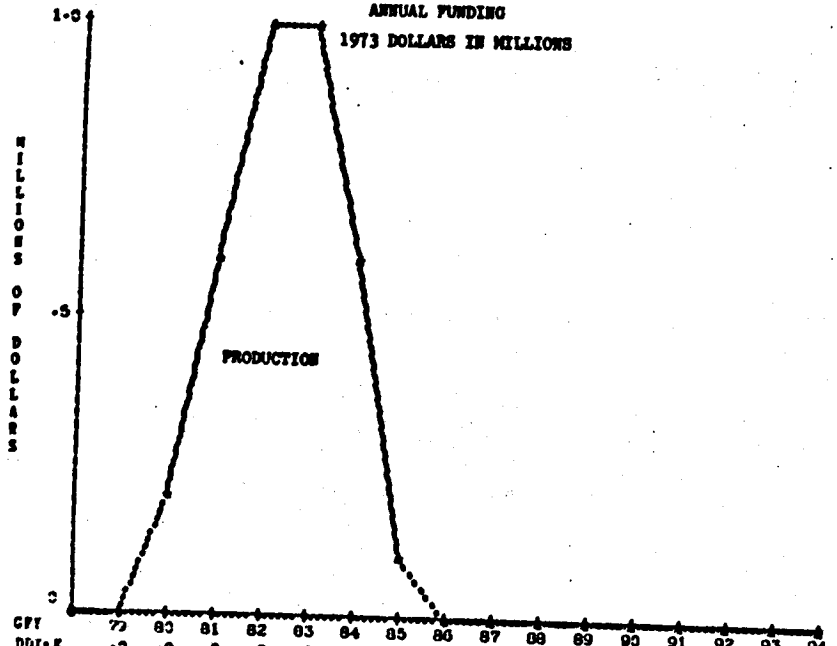
CFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	2.2	9.6	16.1	18.0	[illegible]	[illegible]	[illegible]	20.8	20.8	20.8	20.8	20.9	20.8	20.9	20.9	20.9
PROD	.0	.3	1.9	4.3	6.2	7.9	12.0	17.3	21.1	21.6	21.6	21.6	21.6	21.6	21.6	21.6
OPER	.0	.0	.0	.0	.0	.1	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3
TOTAL	2.2	9.9	18.0	22.3	26.4	29.4	33.0	38.4	42.2	42.7	42.7	42.7	42.7	42.7	42.7	42.7

PROGRAM OPTION NO. 3 FINAL – WBS 320-03-02 LEVEL-5 VEHICLE MAIN STAGE THERMAL CONTROL SUBSYSTEM – COST SUMMARY

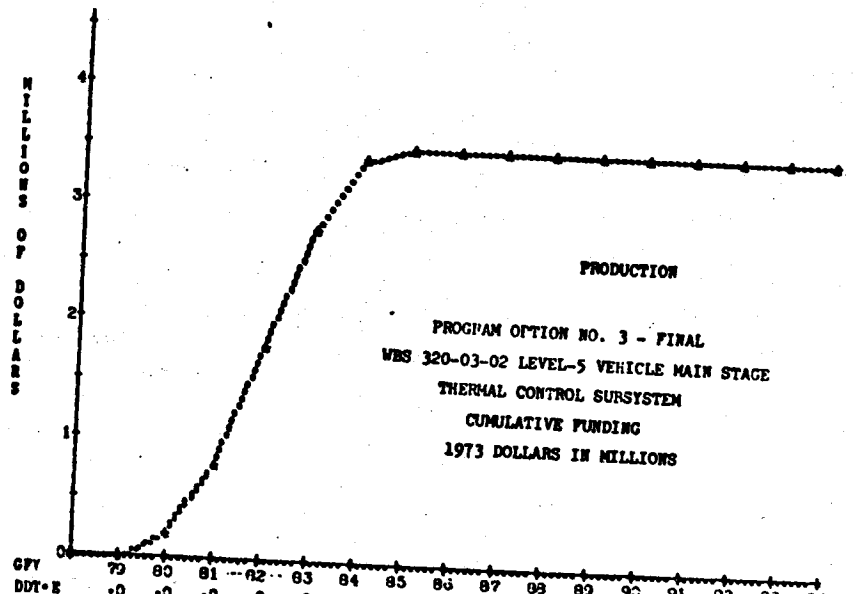
TECHNICAL CHARACTERISTICS – OPTION NO. 3 - FINAL
WBS 320-03-02 THERMAL CONTROL

DESCRIPTORS	COST WEIGHT	CHARACTERISTIC
THERMAL CONTROL SUBSYSTEM	307 LBS.	HI-PERFORMANCE MLI AND PURGE SYSTEM





GFY	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
DDT+E	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.2	.6	1.0	1.0	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	.2	.6	1.0	1.0	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0

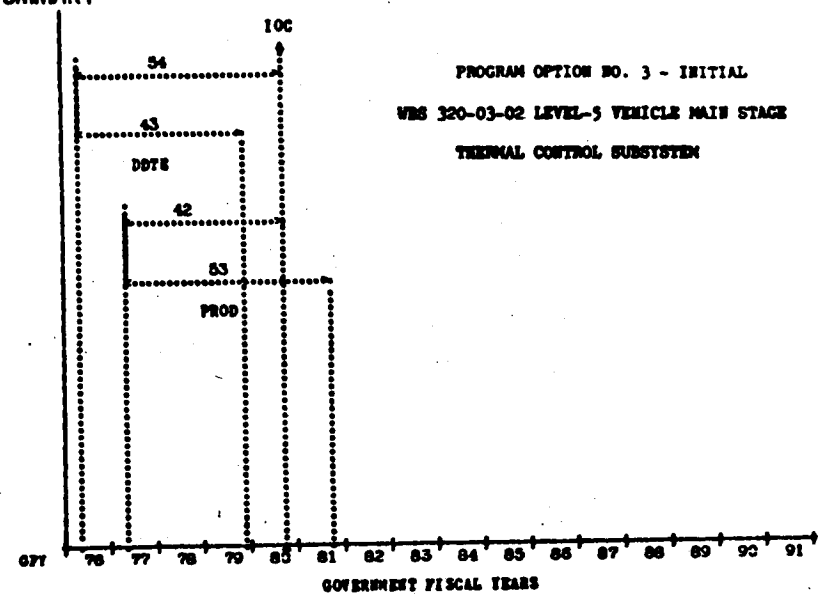


GFY	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
DDT+E	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.2	.8	1.8	2.8	3.4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	.2	.8	1.8	2.8	3.4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5

PROGRAM OPTION NO. 1 – WBS 320-03-02 LEVEL-5 VEHICLE MAIN STAGE THERMAL CONTROL SUBSYSTEM – COST SUMMARY

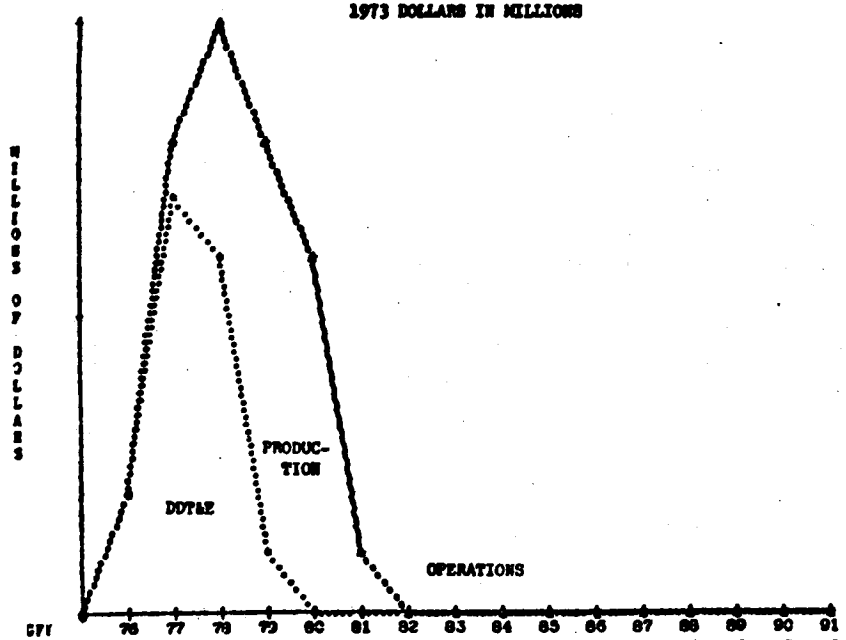
TECHNICAL CHARACTERISTICS - OPTION NO. 3 - INITIAL
WBS 320-03-02 THERMAL CONTROL

DESCRIPTORS	COST WEIGHT	CHARACTERISTICS
THERMAL CONTROL SUBSYSTEM	90 LBS	DAM COATING/KAPTON PURGE BAG/0.25 DACRON NET; STANDOFFS - FIBERGLASS; PURGE BAG/BARRIER



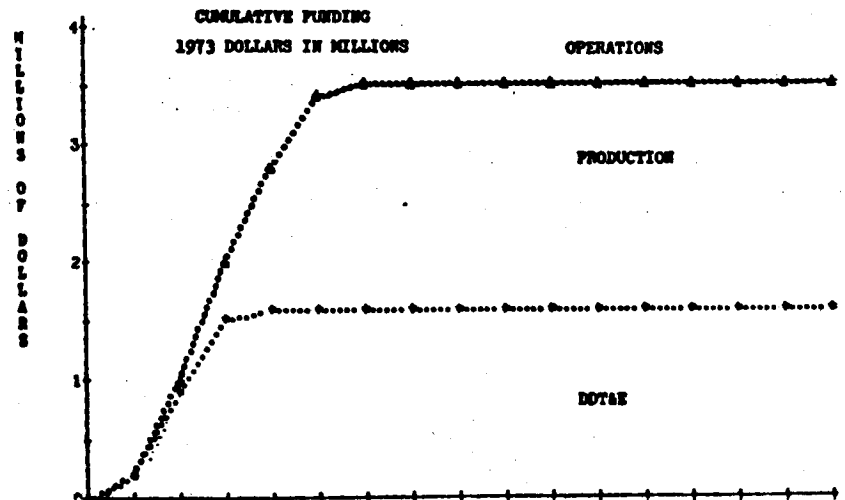
PROGRAM OPTION NO. 3 - INITIAL
WBS 320-03-02 LEVEL-5 VEHICLE MAIN STAGE
THERMAL CONTROL SUBSYSTEM

PROGRAM OPTION NO. 3 - INITIAL
WBS 320-03-02 LEVEL-5 VEHICLE MAIN STAGE
THERMAL CONTROL SUBSYSTEM
ANNUAL FUNDING
1973 DOLLARS IN MILLIONS



GFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	.2	.7	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.1	.4	.7	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.2	.8	1.0	.8	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

PROGRAM OPTION NO. 3 - INITIAL
WBS 320-03-02 LEVEL-5 VEHICLE MAIN STAGE
THERMAL CONTROL SUBSYSTEM
CUMULATIVE FUNDING
1973 DOLLARS IN MILLIONS



GFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	.2	.9	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
PROD	.0	.1	.5	1.2	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.2	1.0	2.0	2.8	3.4	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5

14-7

PROGRAM OPTION NO. 3 TOTAL – WBS 320-03-02 LEVEL-5 VEHICLE MAIN STAGE THERMAL CONTROL SUBSYSTEM – COST SUMMARY

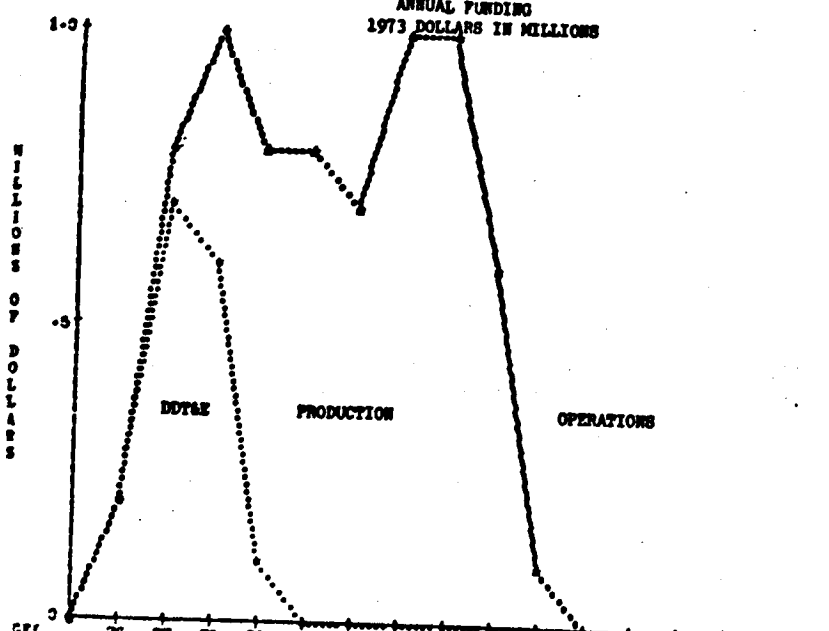
TECHNICAL CHARACTERISTICS - OPTION NO. 3 TOTAL
WBS 320-03-02 LEVEL-5 VEHICLE MAIN STAGE-
THERMAL CONTROL SUBSYSTEM

THE TECHNICAL CHARACTERISTICS ARE EQUIVALENT TO THE SUM OF THE INCREMENTAL CHARACTERISTICS. HOWEVER, A MERE SUMMATION WOULD NOT BE MEANINGFUL. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE CHARACTERISTICS FOR THE INITIAL PHASE AND THE FINAL PHASE.

PROGRAM OPTION NO. 3 TOTAL
WBS 320-03-02 LEVEL-5 VEHICLE MAIN STAGE-
THERMAL CONTROL SUBSYSTEM

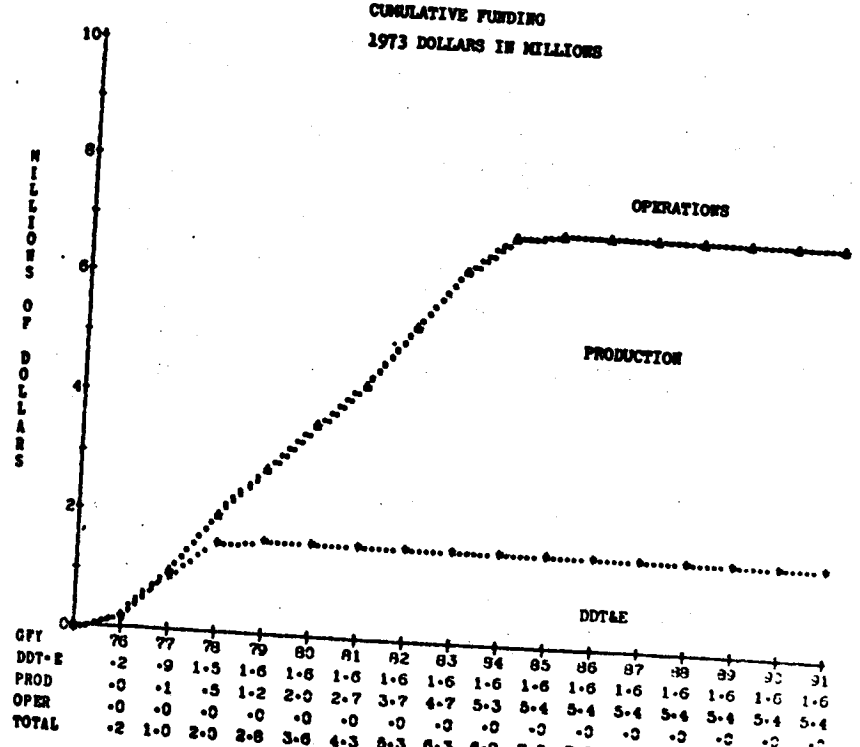
A COMPOSITE SCHEDULE WOULD NOT BE MEANINGFUL, SINCE TWO IOC DATES WOULD BE REFERENCED FOR THE T_S AND T_D VALUES. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE SCHEDULES FOR THE INITIAL PHASE AND THE FINAL PHASE.

PROGRAM OPTION NO. 3 - TOTAL
WBS 320-03-02 LEVEL-5 VEHICLE MAIN STAGE
THERMAL CONTROL SUBSYSTEM
ANNUAL FUNDING
1973 DOLLARS IN MILLIONS



CFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT+E	.2	.7	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.1	.4	.7	.8	.7	1.0	1.0	.6	.1	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.2	.8	1.0	.8	.8	.7	1.0	1.0	.6	.1	.0	.0	.0	.0	.0	.0

PROGRAM OPTION NO. 3 - TOTAL
WBS 320-03-02 LEVEL-5 VEHICLE MAIN STAGE
THERMAL CONTROL SUBSYSTEM
CUMULATIVE FUNDING
1973 DOLLARS IN MILLIONS

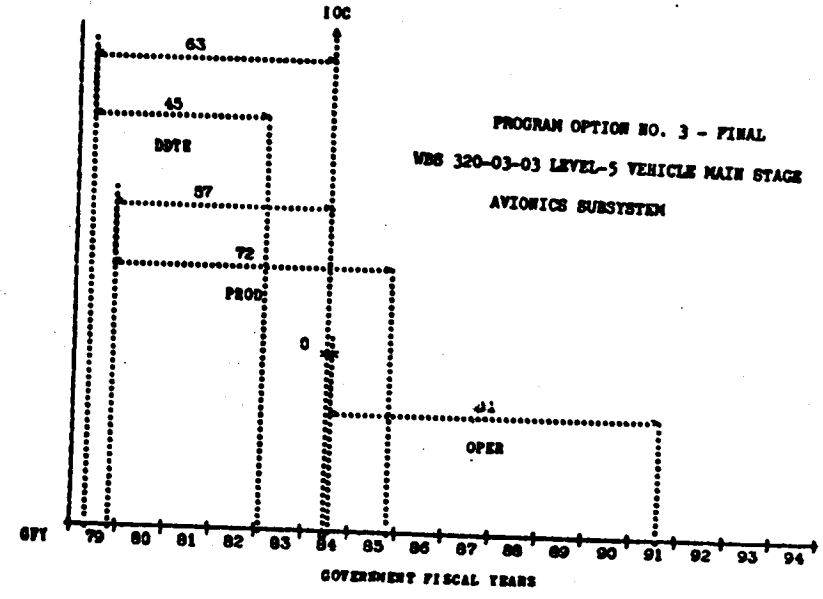


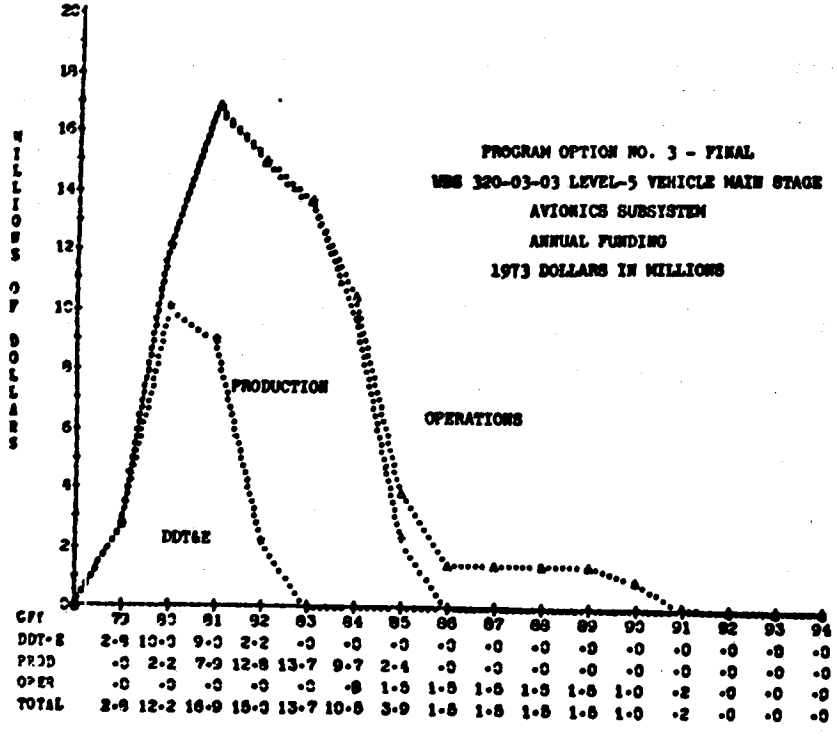
CFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT+E	.2	.9	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
PROD	.0	.1	.5	1.2	2.0	2.7	3.7	4.7	5.3	5.4	5.4	5.4	5.4	5.4	5.4	5.4
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.2	1.0	2.0	2.8	3.6	4.3	5.3	6.3	6.9	7.0	7.0	7.0	7.0	7.0	7.0	7.0

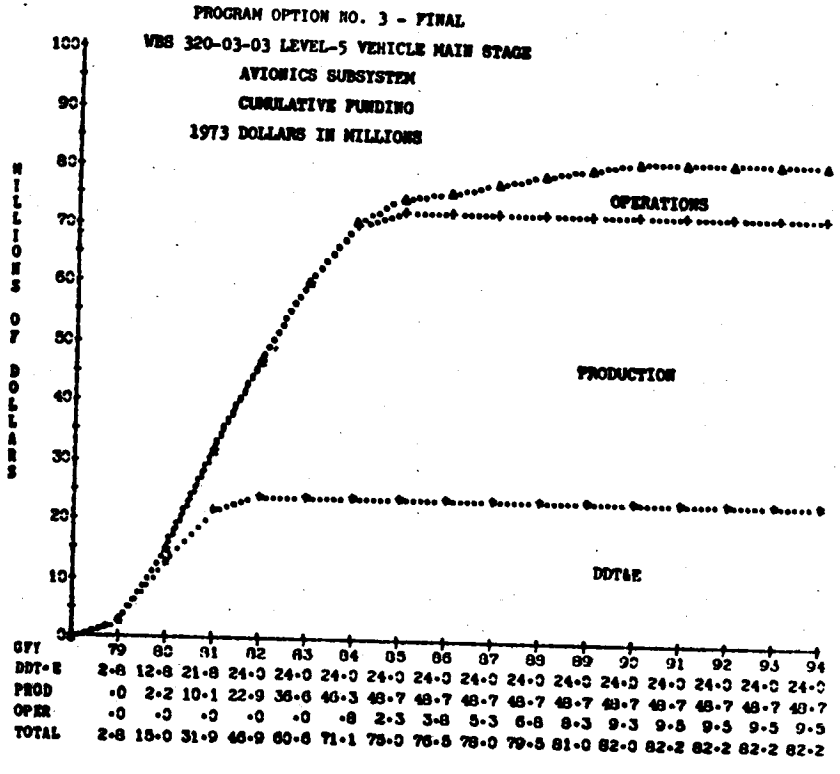
PROGRAM OPTION NO. 3 FINAL – WBS 320-03-03 LEVEL-5 VEHICLE MAIN STAGE
AVIONICS SUBSYSTEM – COST SUMMARY

TECHNICAL CHARACTERISTICS – OPTION NO. 3 - FINAL
WBS 320-03-03 AVIONICS

DESCRIPTORS	CHARACTERISTICS
AVIONICS SUBSYSTEM	
DATA MANAGEMENT	COMPUTER (16 BIT – 24K), EQUIP. THERMAL CONTROL, CIRCUITRY, SOFTWARE
GUIDANCE, NAVIGATION, AND CONTROL COMMUNICATIONS	MICROWAVE CIRCUITRY AND RF MULTIPLEXER, TRANSPONDERS, POWER AMP, ANTENNA, DEC/ENC AND MOD/DEM, TAPE RECORDER, P/L INTERFACE EQUIP.
INSTRUMENTATION	DATA SENSORS, SIGNAL COND, CIRCUITRY
ELECTRICAL POWER	FUEL CELL
POWER DISTRIBUTION AND CONTROL	DISTRIBUTION





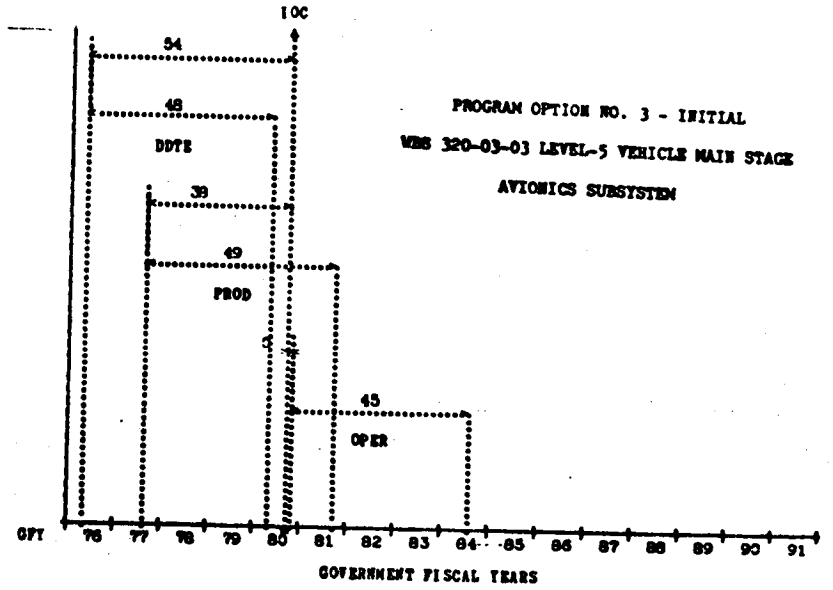


PROGRAM OPTION NO. 3 INITIAL – WBS 320-03-03 LEVEL-5 VEHICLE MAIN STAGE AVIONICS SUBSYSTEM – COST SUMMARY

TECHNICAL CHARACTERISTICS – OPTION NO. 3 – INITIAL

WBS 320-03-03 AVIONICS

DESCRIPTORS	CHARACTERISTICS
AVIONICS SUBSYSTEM	
DATA MANAGEMENT	COMPUTER (16 BIT – 24K), THERMAL CONTROL, CIRCUITRY, SOFTWARE
GUIDANCE, NAVIGATION, AND CONTROL	IMU, TRACKING/ELECT.
COMMUNICATIONS	MICROWAVE CIRCUITRY + RF MULTIPLEXER, TRANSPONDERS, POWER AMP, ANTENNA, DEC/ENC + MOD/DEM, TAPE RECORDER, F/L INTERFACE EQUIP.
INSTRUMENTATION	DATA SENSORS, SIGNAL COND, CIRCUITRY
ELECTRICAL POWER	BATTERY
POWER DISTRIBUTION AND CONTROL	DISTRIBUTION, TANKS SYSTEM



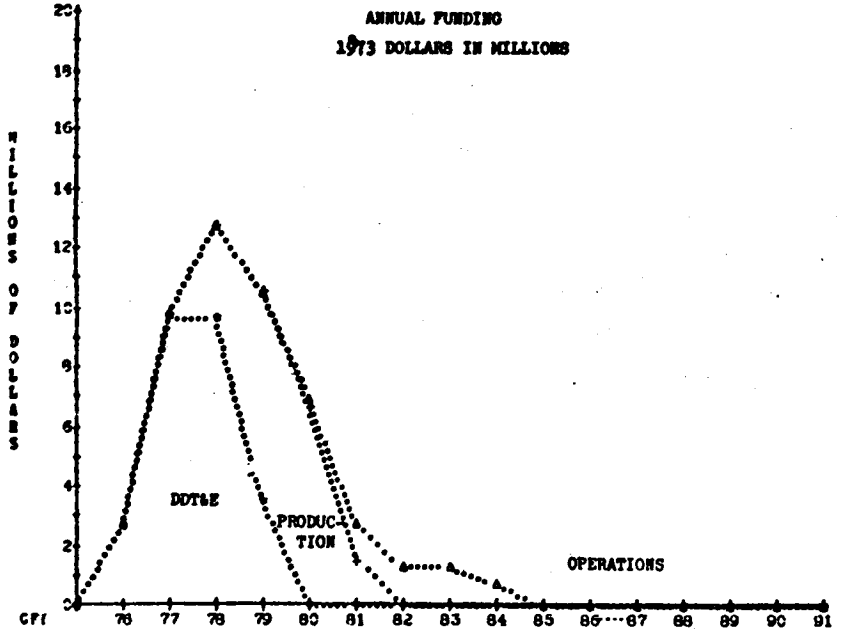
PROGRAM OPTION NO. 3 – INITIAL

WBS 320-03-03 LEVEL-5 VEHICLE MAIN STAGE

AVIONICS SUBSYSTEM

ANNUAL FUNDING

1973 DOLLARS IN MILLIONS



GFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT+E	2.7	9.7	9.6	3.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.1	3.1	7.0	6.6	1.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.3	1.3	1.3	1.3	.7	.0	.0	.0	.0	.0	.0	.0
TOTAL	2.7	9.8	12.7	10.5	6.9	2.8	1.3	1.3	.7	.0	.0	.0	.0	.0	.0	.0

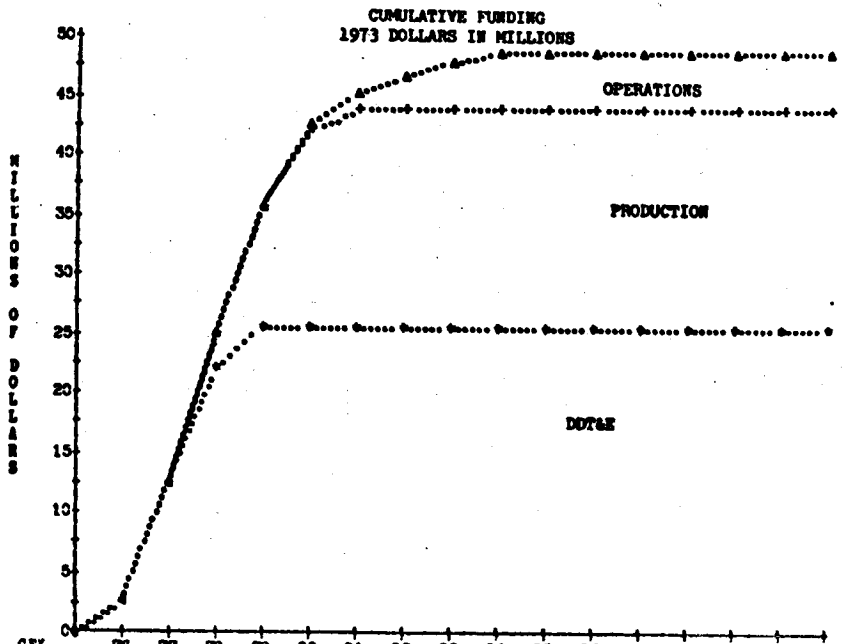
PROGRAM OPTION NO. 3 – INITIAL

WBS 320-03-03 LEVEL-5 VEHICLE MAIN STAGE

AVIONICS SUBSYSTEM

CUMULATIVE FUNDING

1973 DOLLARS IN MILLIONS



GFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT+E	2.7	12.4	22.0	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5	25.5
PROD	.0	.1	3.2	10.2	16.9	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3
OPER	.0	.0	.0	.0	.3	1.6	2.9	4.2	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9
TOTAL	2.7	12.5	25.2	35.7	42.6	45.4	46.7	48.0	48.7	48.7	48.7	48.7	48.7	48.7	48.7	48.7

PROGRAM OPTION NO. 3 TOTAL – WBS 320-03-03 LEVEL-5 VEHICLE MAIN STAGE AVIONICS SUBSYSTEM – COST SUMMARY

TECHNICAL CHARACTERISTICS - OPTION NO. 3 TOTAL

WBS 320-03-03 LEVEL-5 VEHICLE MAIN STAGE-

AVIONICS SUBSYSTEM

THE TECHNICAL CHARACTERISTICS ARE EQUIVALENT TO THE SUM OF THE INCREMENTAL CHARACTERISTICS. HOWEVER, A MERE SUMMATION WOULD NOT BE MEANINGFUL. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE CHARACTERISTICS FOR THE INITIAL PHASE AND THE FINAL PHASE.

PROGRAM OPTION NO. 3 TOTAL

WBS 320-03-03 LEVEL-5 VEHICLE MAIN STAGE-

AVIONICS SUBSYSTEM

A COMPOSITE SCHEDULE WOULD NOT BE MEANINGFUL, SINCE TWO IOC DATES WOULD BE REFERENCED FOR THE T_S AND T_D VALUES. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE SCHEDULES FOR THE INITIAL PHASE AND THE FINAL PHASE.

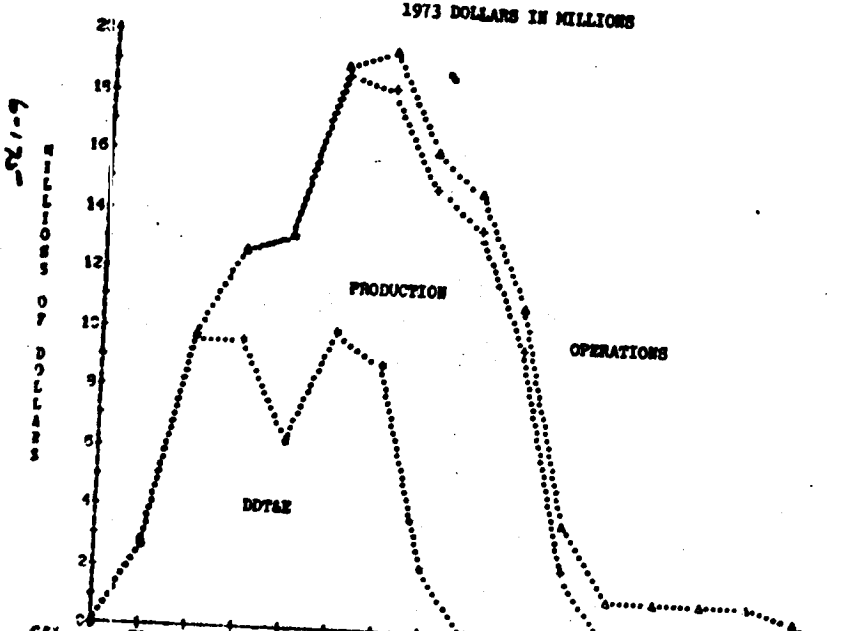
PROGRAM OPTION NO. 3 - TOTAL

WBS 320-03-03 LEVEL-5 VEHICLE MAIN STAGE

AVIONICS SUBSYSTEM

ANNUAL FUNDING

1973 DOLLARS IN MILLIONS



CFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	2.7	9.7	3.6	6.3	10.0	9.0	2.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.1	3.1	7.0	8.8	9.4	12.8	13.7	9.7	2.4	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.3	1.3	1.3	1.3	1.5	1.5	1.5	1.5	1.5	1.5	1.0	.2
TOTAL	2.7	9.8	12.7	13.3	19.1	19.7	16.3	15.0	11.2	3.9	1.5	1.5	1.5	1.5	1.0	.2

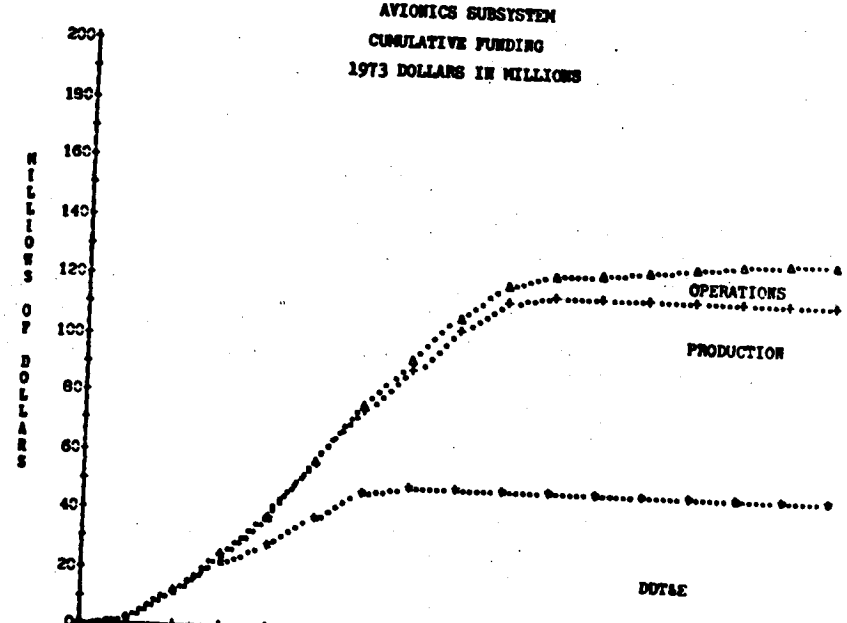
PROGRAM OPTION NO. 3 - TOTAL

WBS 320-03-03 LEVEL-5 VEHICLE MAIN STAGE

AVIONICS SUBSYSTEM

CUMULATIVE FUNDING

1973 DOLLARS IN MILLIONS



CFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	3	12	22	28	38	47	49	49	49	49	49	49	49	49	49	49
PROD	0	0	3	10	19	28	41	55	65	67	67	67	67	67	67	67
OPER	0	0	0	0	0	2	3	4	6	7	9	10	12	13	14	14
TOTAL	2	12	25	38	57	77	93	108	119	123	125	126	128	129	130	130

PROGRAM OPTION NO. 3 FINAL – WBS 320-03-04 LEVEL-5 VEHICLE MAIN STAGE
PROPULSION SUBSYSTEM – COST SUMMARY

TECHNICAL CHARACTERISTICS – OPTION NO. 3 – FINAL

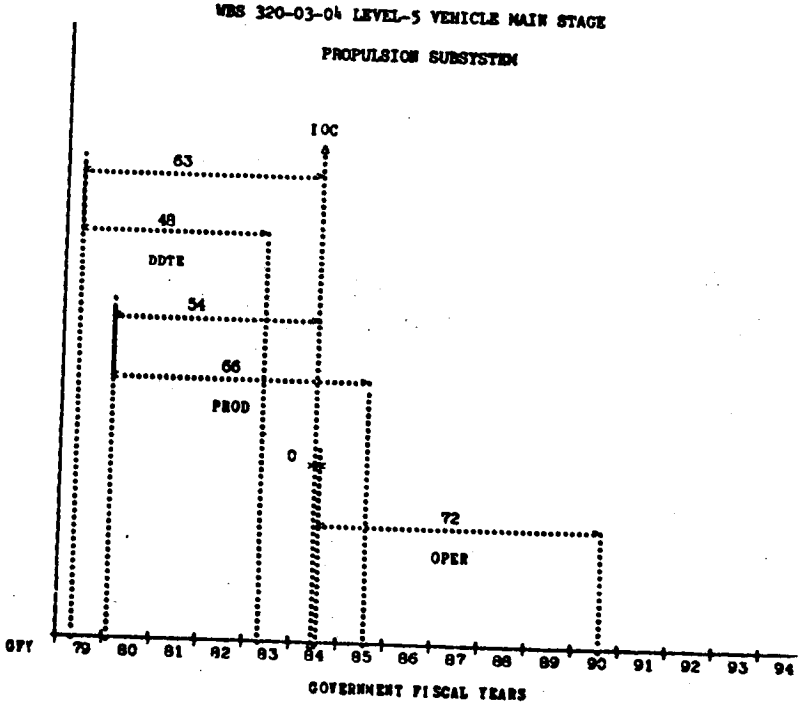
WBS 320-03-04 PROPULSION

DESCRIPTORS	COST WEIGHT	CHARACTERISTICS
PROPULSION SUBSYSTEM	1277 LBS.	
SUBSYSTEM ASSEMBLIES		
MAIN ENGINE	476 LBS.	CAT. II-RLIO, GFE
TVC	52 LBS.	APOLLO SPS
PRESSURIZATION		NOT A PRODUCTION ITEM
FEED	154 LBS.	DEVELOPED COMPONENTS
FILL AND DRAIN	50 LBS.	DEVELOPED COMPONENTS
VENT	180 LBS.	DEVELOPED COMPONENTS
PROPELLANT UTILIZATION	36 LBS.	CLOSED LOOP CAPACITANCE PROBE
PNEUMATICS	51 LBS.	DEVELOPED COMPONENTS WITH 1.0 FT^3 BOTTLE
PROPELLANT ORIENTATION		PROPELLANTS SETTLED BY USING MAIN ENGINE TANK HEAD IDLE MODE THRUST
LO_2 ABORT DUMP	78 LBS.	VALVES AND 3-INCH DISCONNECT AND UNJACKETED DUCTING
ENGINE AND FEEDLINE CHILLDOWN		CONDITION BOTH FEEDLINE AND ENGINE WHILE OPERATING ENGINE IN TANK HEAD IDLE MODE
ACPS (INCLUDING THRUSTORS)	200 LBS.	STORABLE BI-PROPELLANT ACPS – DEVELOPED HARDWARE INCLUDING THRUSTORS
THRUSTORS		8-25 LBF AND 8-100 LBF THRUSTORS
MAIN ENGINE EOR		6.0 TO 1.0

PROGRAM OPTION NO. 3 – FINAL

WBS 320-03-04 LEVEL-5 VEHICLE MAIN STAGE

PROPULSION SUBSYSTEM



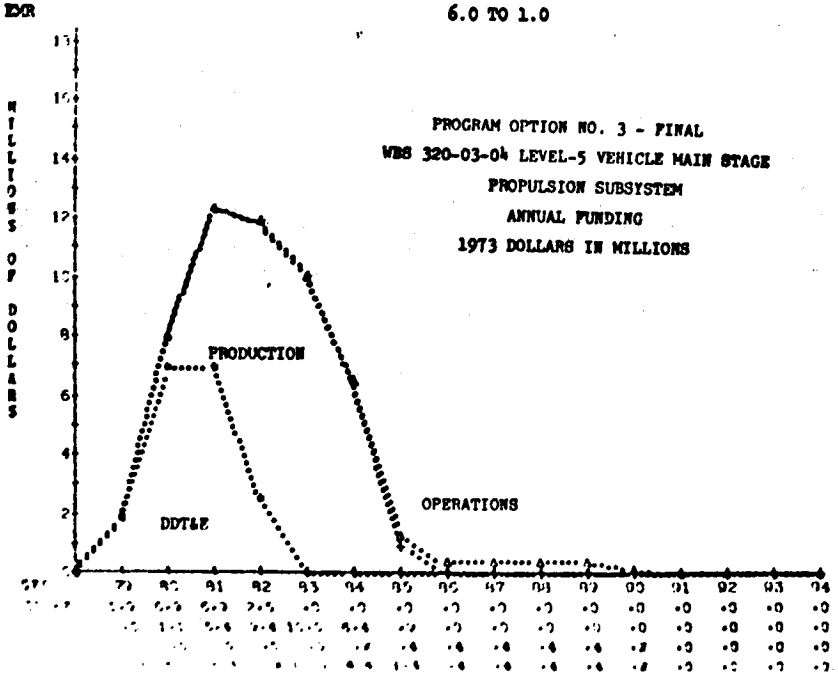
PROGRAM OPTION NO. 3 – FINAL

WBS 320-03-04 LEVEL-5 VEHICLE MAIN STAGE

PROPULSION SUBSYSTEM

ANNUAL FUNDING

1973 DOLLARS IN MILLIONS



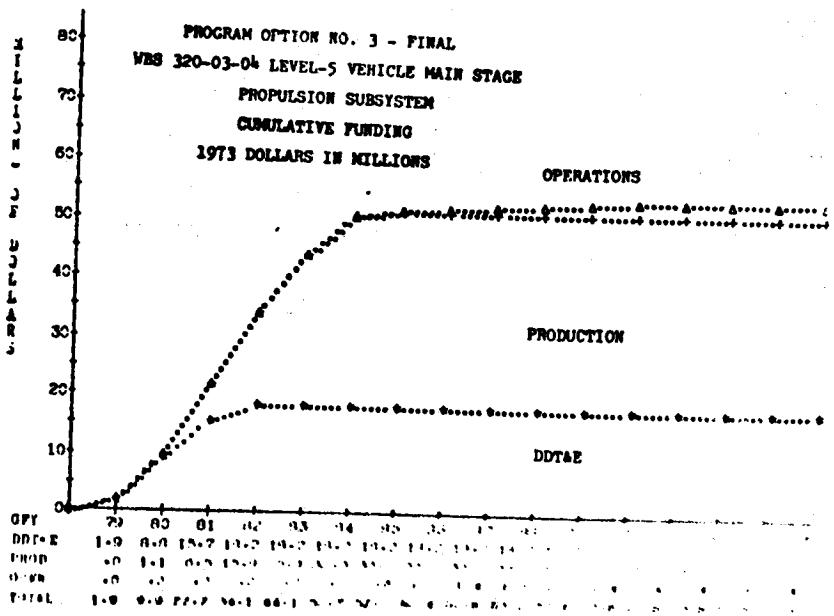
PROGRAM OPTION NO. 3 – FINAL

WBS 320-03-04 LEVEL-5 VEHICLE MAIN STAGE

PROPULSION SUBSYSTEM

CUMULATIVE FUNDING

1973 DOLLARS IN MILLIONS

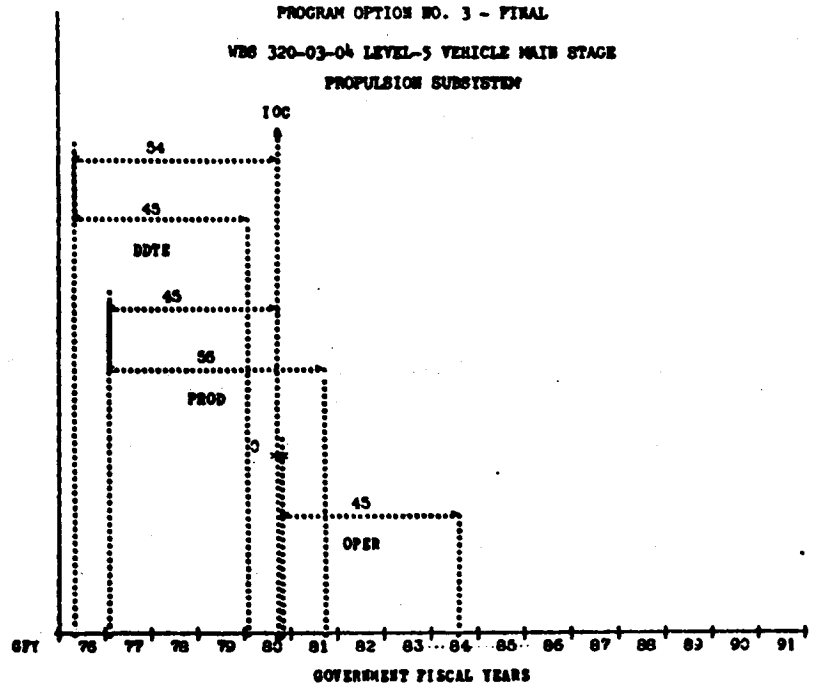


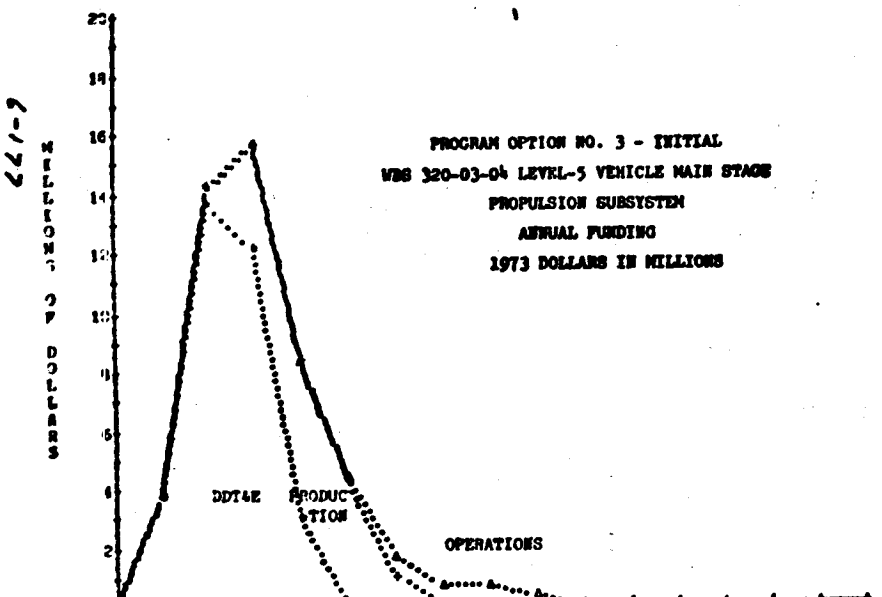
ROGRAM OPTION NO. 3 INITIAL – WBS 320-03-04 LEVEL-5 VEHICLE MAIN ...GE PROPULSION SUBSYSTEM – COST SUMMARY

TECHNICAL CHARACTERISTICS – OPTION NO. 3 – INITIAL

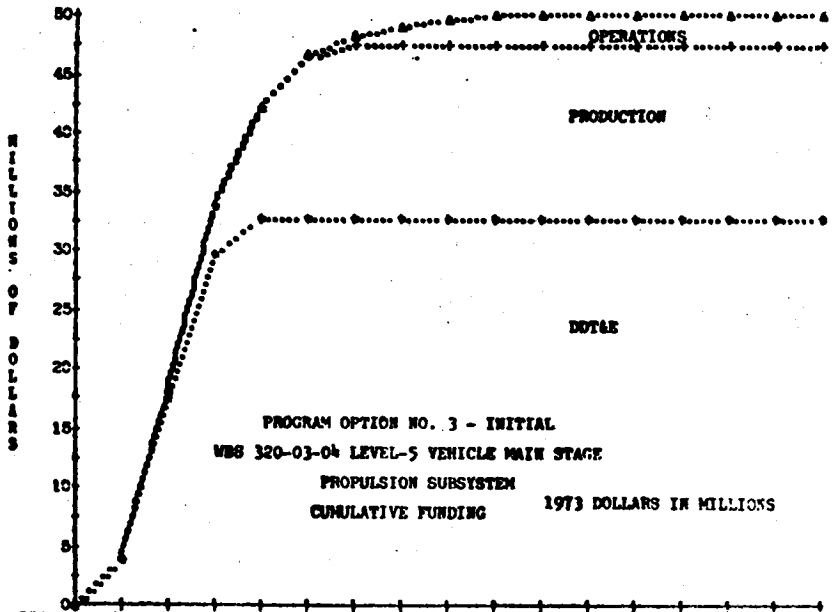
WBS 320-03-04 PROPULSION

DESCRIPTION	COST WEIGHT	CHARACTERISTICS
PROPULSION SUBSYSTEM	1729 LBS	
SUBSYSTEM ASSEMBLIES		
MAIN ENGINE	347 LBS	CAT I – RL10, GPE
T/C	52 LBS	APOLLO SPS
PRESSURIZATION	680 LBS	S-IVB DERIVATIVE AMBIENT HELIUM + ENGINE GH_2 BLEED (INCLUDES LVM AND 5-4.5 FT^3 BOTTLES)
FEED	62 LBS	DEVELOPED COMPONENTS
FILL AND DRAIN	50 LBS	DEVELOPED COMPONENTS
VENT	180 LBS	DEVELOPED COMPONENTS
PROPELLANT UTILIZATION	36 LBS	CLOSED LOOP CAPACITANCE PROBE
PERIMATICS		SUPPLIED BY AMB. He PRESS. ASSEMBLY
PROPELLANT ORIENTATION		PROPELLANTS SETTLED BY FIRING TWO AFT POINTING 27/16 THRUSTORS
LO_2 ABORT DUMP	78 LBS	VALVES AND 3 INCH DISCONNECT AND UNJACKETED DUCTING
ENGINE AND FEEDLINE CHILLDOWN		BLEED PROPELLANTS TRICKLED THROUGH FEEDLINE AND ENGINE WHILE FIRING ACPS THRUSTORS FOR PROPELLANT SETTLING.
ACPS (INCLUDING THRUSTORS)	264 LBS	BLOWDOWN MONOPROPELLANT (N_2H_4) – DEVELOPED, 70,000 LB-SEC.
THRUSTORS		16-25 LBF MR-30 TANGENTIAL THRUSTORS REQ.
MAIN ENGINE EOR		5.5 TO 1.0





GFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT+E	3.8	13.6	12.2	3.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.7	3.5	5.4	4.3	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.2	.7	.7	.7	.4	.0	.0	.0	.0	.0	.0	.0
TOTAL	3.8	14.3	15.7	8.4	4.5	1.7	.7	.7	.4	.0	.0	.0	.0	.0	.0	.0



GFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT+E	3.8	17.4	29.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6	32.6
PROD	.0	.7	4.2	9.6	13.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9
OPER	.0	.0	.0	.0	.2	.9	1.6	2.3	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
TOTAL	3.8	18.1	33.8	42.2	46.7	48.4	49.1	49.8	50.2	50.2	50.2	50.2	50.2	50.2	50.2	50.2

PROGRAM OPTION NO. 3 TOTAL – WBS 320-03-04 LEVEL-5 VEHICLE MAIN STAGE PROPULSION SUBSYSTEM – COST SUMMARY

TECHNICAL CHARACTERISTICS - OPTION NO. 3 TOTAL

WBS 320-03-04 LEVEL-5 VEHICLE MAIN STAGE-

PROPULSION SUBSYSTEM

THE TECHNICAL CHARACTERISTICS ARE EQUIVALENT TO THE SUM OF THE INCREMENTAL CHARACTERISTICS. HOWEVER, A MERE SUMMATION WOULD NOT BE MEANINGFUL. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE CHARACTERISTICS FOR THE INITIAL PHASE AND THE FINAL PHASE.

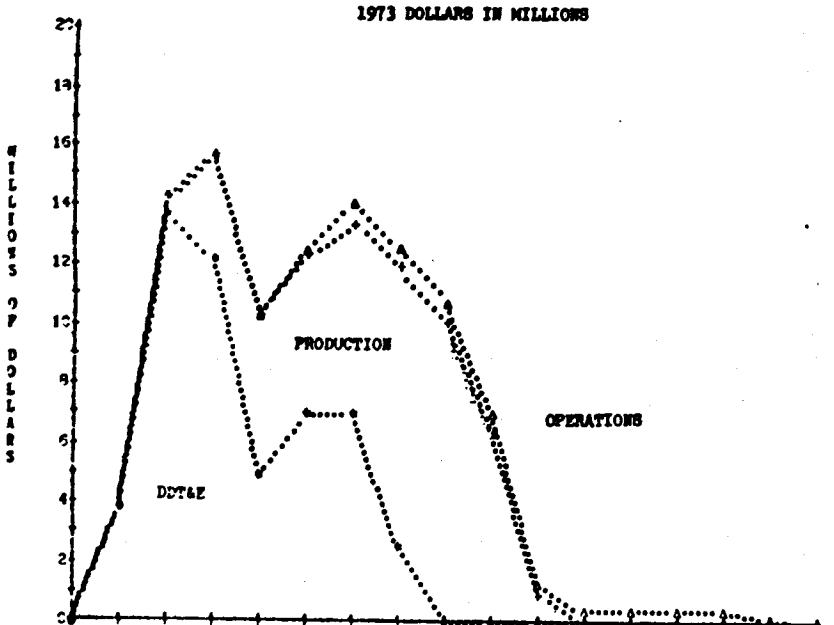
PROGRAM OPTION NO. 3 - TOTAL

WBS 320-03-04 LEVEL-5 VEHICLE MAIN STAGE

PROPULSION SUBSYSTEM

ANNUAL FUNDING

1973 DOLLARS IN MILLIONS



CFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	3.8	13.6	12.2	4.9	6.9	6.9	2.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.7	3.5	8.4	5.4	6.4	9.4	10.0	6.4	.9	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.2	.7	.7	.7	.6	.4	.4	.4	.4	.4	.2	.0
TOTAL	3.8	14.3	15.7	13.3	12.5	14.0	12.6	10.7	7.0	1.3	.4	.4	.4	.4	.2	.0

PROGRAM OPTION NO. 3 TOTAL

WBS 320-03-04 LEVEL-5 VEHICLE MAIN STAGE-

PROPULSION SUBSYSTEM

A COMPOSITE SCHEDULE WOULD NOT BE MEANINGFUL, SINCE TWO IOC DATES WOULD BE REFERENCED FOR THE T_S AND T_D VALUES. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE SCHEDULES FOR THE INITIAL PHASE AND THE FINAL PHASE.

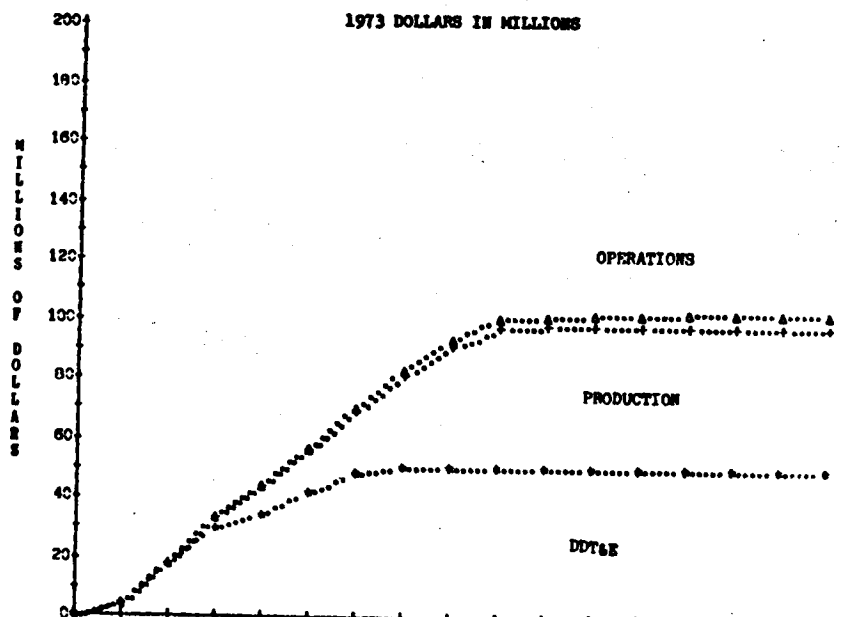
PROGRAM OPTION NO. 3 - TOTAL

WBS 320-03-04 LEVEL-5 VEHICLE MAIN STAGE

PROPULSION SUBSYSTEM

CUMULATIVE FUNDING

1973 DOLLARS IN MILLIONS

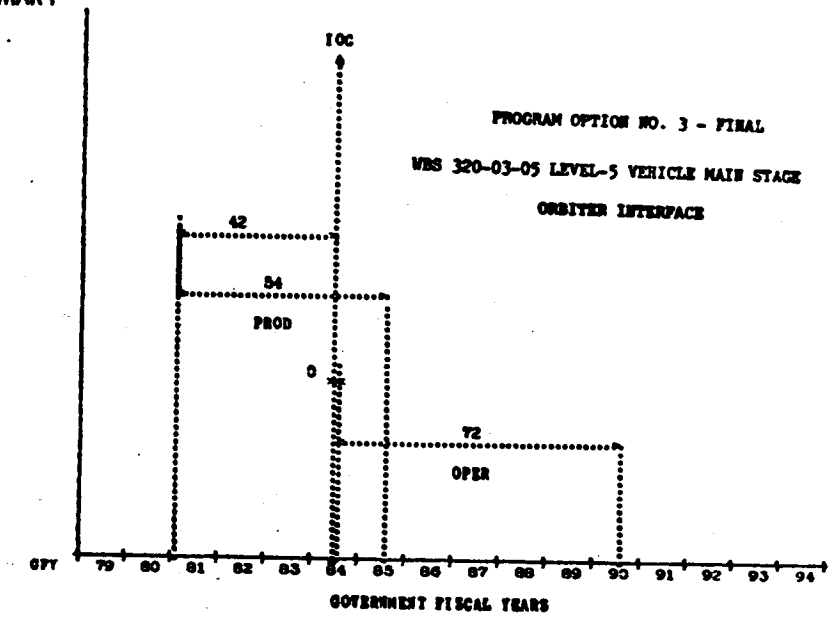


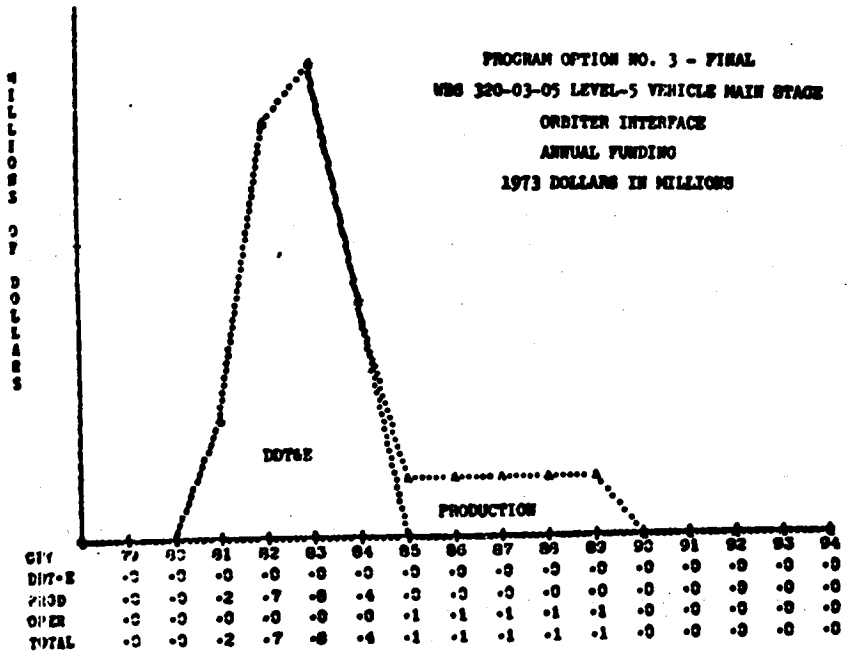
CFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	4	17	30	34	41	48	51	51	51	51	51	51	51	51	51	51
PROD	0	1	4	10	15	21	31	41	47	48	48	48	48	48	48	48
OPER	0	0	0	0	0	1	2	2	3	3	4	4	4	5	5	5
TOTAL	3	18	33	44	56	70	83	93	100	102	102	102	103	103	103	103

PROGRAM OPTION NO. 3 FINAL – WBS 320-03-05 LEVEL-5 VEHICLE MAIN STAGE
ORBITER INTERFACE — COST SUMMARY

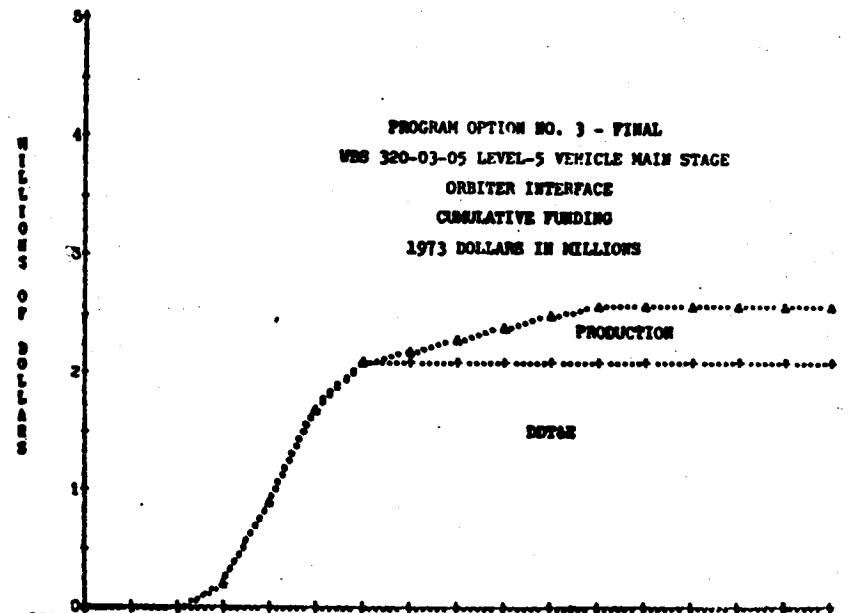
TECHNICAL CHARACTERISTICS – OPTION NO. 3 - FINAL
WBS 320-03-05 ORBITER INTERFACE

DESCRIPTORS	COST WEIGHT	CHARACTERISTICS
TUG ANCILLARY EQUIPMENT	2402 LBS	
STRUCTURES	1112 LBS	TILT TABLE AND TRUNNION
INTERFACE PANELS	1195 LBS	ELECTRICAL UMBILICAL PANEL
		FLUID UMBILICAL PANEL
		TUG CONTROL AND DISPLAY PANEL
		C&W COMPARATOR AND DISPLAY PANEL
		A/D CONVERTER AND MUX
		DIGITAL RECORDER
		END EFFECTORS AND T/V LIGHTING
		CABLES
		DISTRIBUTORS
ABORT PROVISIONS	53 LBS	





GFY	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
DDT•E	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0
PROD	•0	•0	•2	•7	•8	•4	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0
OPER	•0	•0	•0	•0	•0	•0	•1	•1	•1	•1	•1	•0	•0	•0	•0	•0
TOTAL	•0	•0	•2	•7	•8	•4	•1	•1	•1	•1	•1	•0	•0	•0	•0	•0



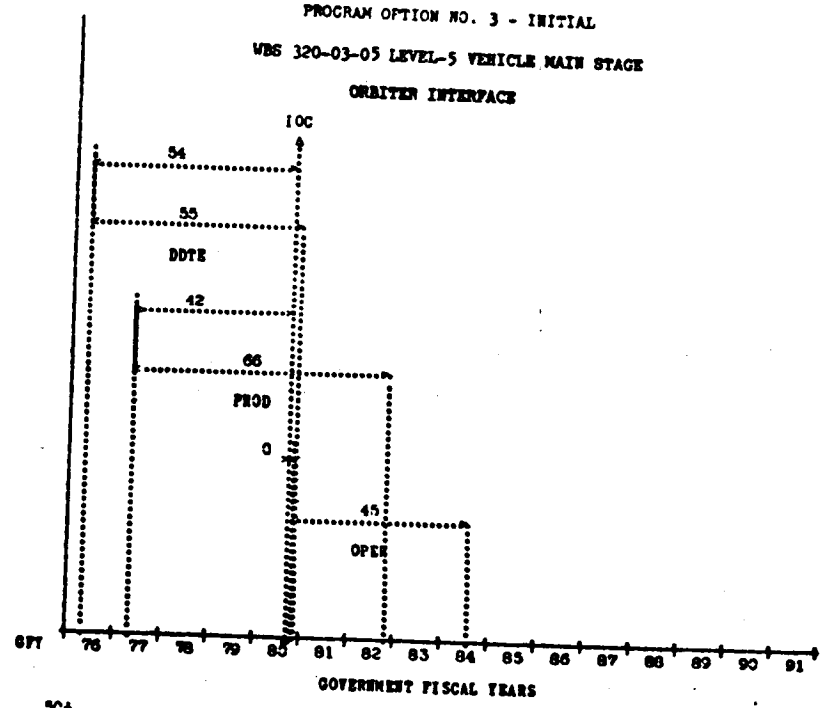
GFY	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
DDT•E	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0
PROD	•0	•0	•2	•9	1•7	2•1	2•1	2•1	2•1	2•1	2•1	2•1	2•1	2•1	2•1	2•1
OPER	•0	•0	•0	•0	•0	•0	•1	•2	•3	•4	•5	•5	•5	•5	•5	•5
TOTAL	•0	•0	•2	•9	1•7	2•1	2•2	2•3	2•4	2•5	2•6	2•6	2•6	2•6	2•6	2•6

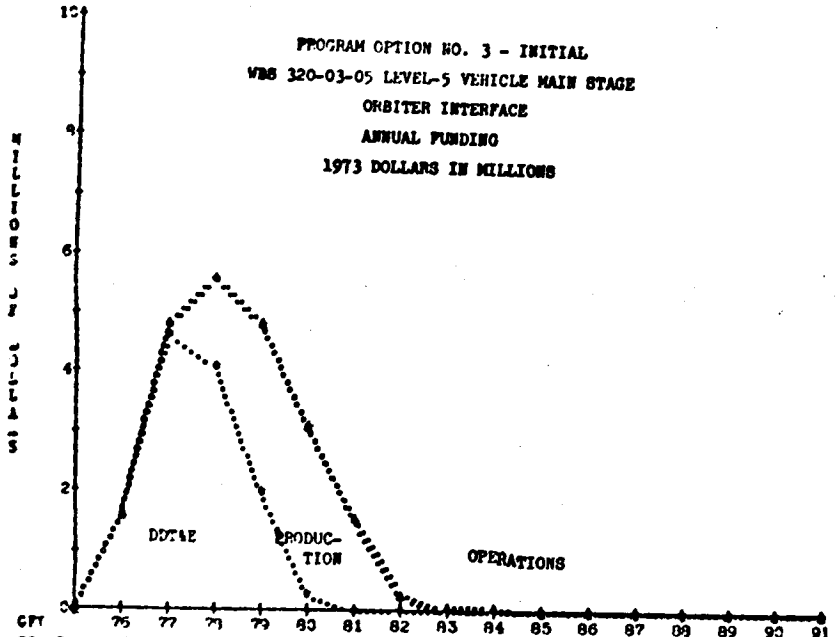
PROGRAM OPTION NO. 3 INITIAL – WBS 320-03-05 LEVEL-5 VEHICLE MAIN STAGE ORBITER INTERFACE – COST SUMMARY

TECHNICAL CHARACTERISTICS - OPTION NO. 3 - INITIAL

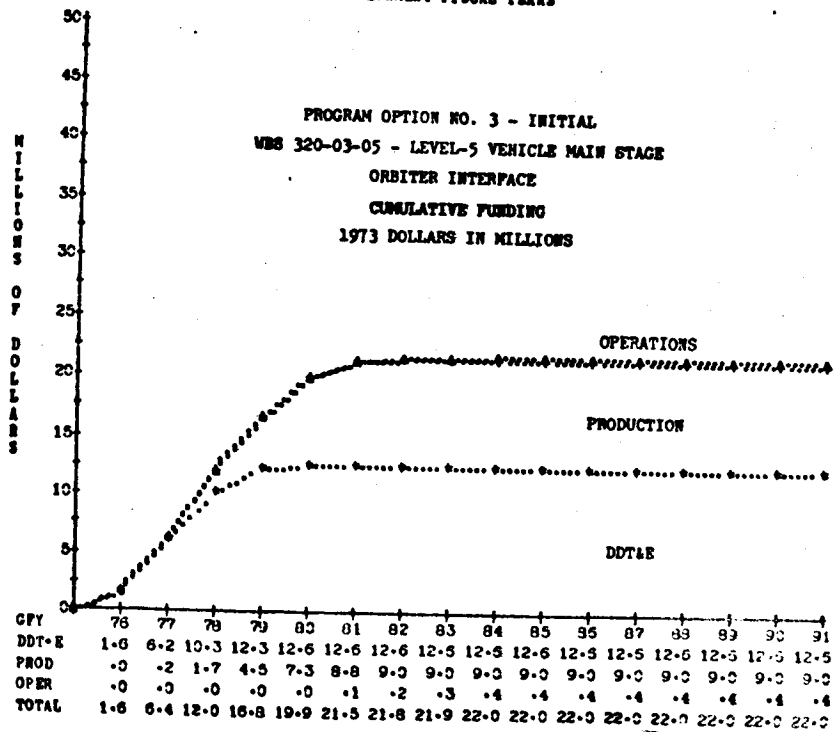
WBS 320-03-05 ORBITER INTERFACE

DESCRIPTORS	COST WEIGHT	CHARACTERISTICS
TUG ANCILLARY EQUIPMENT	2402 LBS	
STRUCTURES	1112 LBS	TILT TABLE AND TRUNNION
INTERFACE PANELS	1195 LBS	ELECTRICAL UMBILICAL PANEL
		FLUID UMBILICAL PANEL
		TUG CONTROL AND DISPLAY PANEL
		C&W COMPARATOR AND DISPLAY PANEL
		A/D CONVERTER AND MUX
		DIGITAL RECORDER
		END EFFECTORS AND T/V LIGHTING
		CABLES
		DISTRIBUTORS
ABORT PROVISIONS	95 LBS	





GFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT+E	1.6	4.0	4.1	2.0	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.2	1.5	2.8	2.8	1.5	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.0	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0
TOTAL	1.6	4.8	5.6	4.8	3.1	1.6	.3	.1	.1	.0	.0	.0	.0	.0	.0	.0



GFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT+E	1.6	6.2	10.3	12.3	12.6	12.6	12.6	12.5	12.5	12.6	12.5	12.5	12.6	12.5	12.5	12.5
PROD	.0	.2	1.7	4.5	7.3	8.8	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
OPER	.0	.0	.0	.0	.0	.1	.2	.3	.4	.4	.4	.4	.4	.4	.4	.4
TOTAL	1.6	6.4	12.0	16.8	19.9	21.5	21.8	21.9	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0

PROGRAM OPTION NO. 3 TOTAL – WBS 320-03-05 LEVEL-5 VEHICLE MAIN STAGE
ORBITER INTERFACE – COST SUMMARY

TECHNICAL CHARACTERISTICS - OPTION NO. 3 TOTAL

WBS 320-03-05 LEVEL-5 VEHICLE MAIN STAGE-

ORBITER INTERFACE

THE TECHNICAL CHARACTERISTICS ARE EQUIVALENT TO THE SUM OF THE INCREMENTAL CHARACTERISTICS. HOWEVER, A MERE SUMMATION WOULD NOT BE MEANINGFUL. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE CHARACTERISTICS FOR THE INITIAL PHASE AND THE FINAL PHASE.

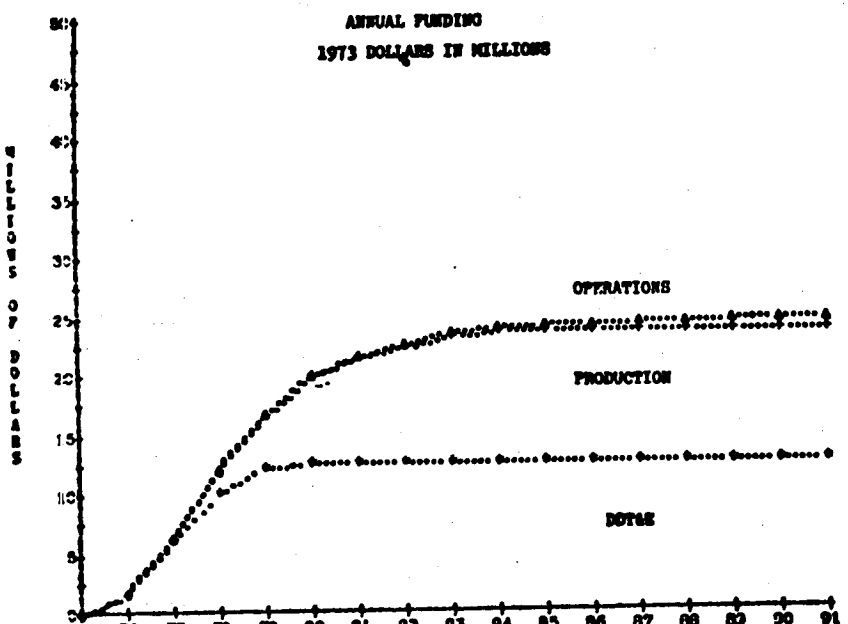
PROGRAM OPTION NO. 3 TOTAL

WBS 320-03-05 VEHICLE MAIN STAGE-

ORBITER INTERFACE

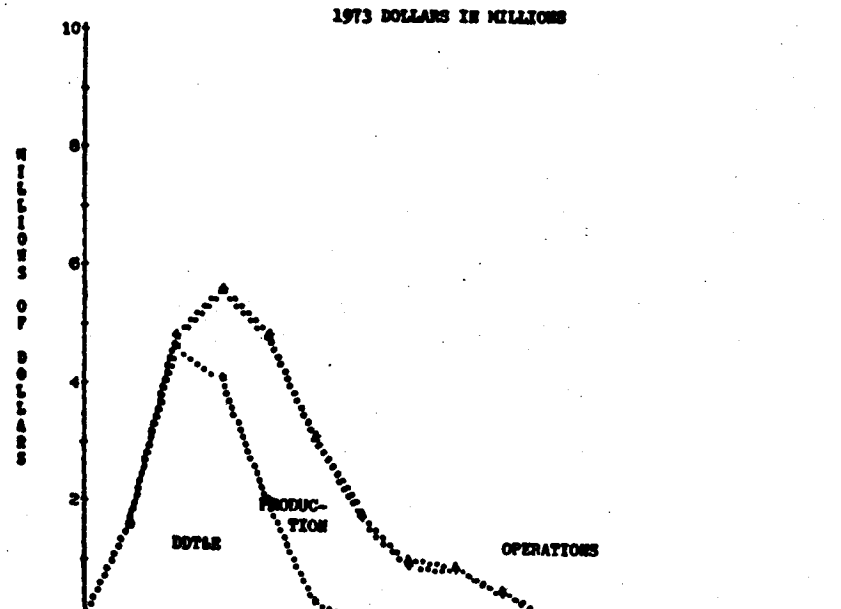
A COMPOSITE SCHEDULE WOULD NOT BE MEANINGFUL, SINCE TWO IOC DATES WOULD BE REFERENCED FOR THE T_S AND T_D VALUES. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE SCHEDULES FOR THE INITIAL PHASE AND THE FINAL PHASE.

PROGRAM OPTION NO.3 - TOTAL
WBS 320-03-05 LEVEL-5 VEHICLE MAIN STAGE
ORBITER INTERFACE
ANNUAL FUNDING
1973 DOLLARS IN MILLIONS



CFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	1.6	6.2	10.3	12.3	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
PROD	.0	.2	1.7	4.5	7.3	9.0	9.9	10.7	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1
OPER	.0	.0	.0	.0	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	.9	.9
TOTAL	1.6	6.4	12.0	16.8	19.9	21.7	22.7	23.6	24.1	24.2	24.3	24.4	24.5	24.6	24.6	24.6

PROGRAM OPTION NO. 3 - TOTAL
WBS 320-03-05 LEVEL-5 VEHICLE MAIN STAGE
ORBITER INTERFACE
ANNUAL FUNDING
1973 DOLLARS IN MILLIONS



CFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	1.6	4.6	4.1	2.0	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.2	1.5	2.9	2.9	1.7	.9	.8	.4	.0	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.0	.0
TOTAL	1.6	4.9	5.6	4.8	3.1	1.8	1.0	.9	.5	.1	.1	.1	.1	.1	.0	.0

PROGRAM OPTION NO. 3 INITIAL – WBS 320-03-07 LEVEL-5 VEHICLE MAIN STAGE FINAL ASSEMBLY AND CHECKOUT – COST SUMMARY

TECHNICAL CHARACTERISTICS - OPTION NO. 3 - INITIAL

WBS 320-03-07 FINAL ASSEMBLY AND CHECKOUT

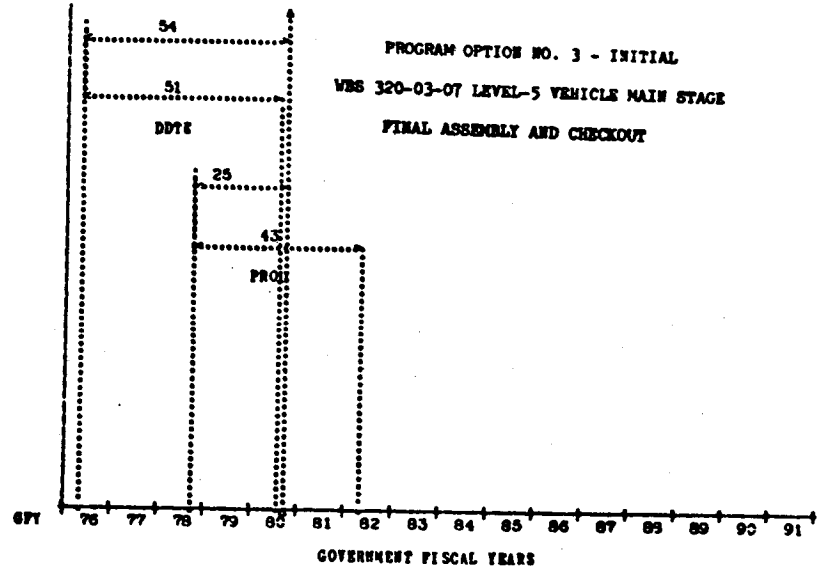
TECHNICAL DESCRIPTION

MANUFACTURING RESPONSIBILITY

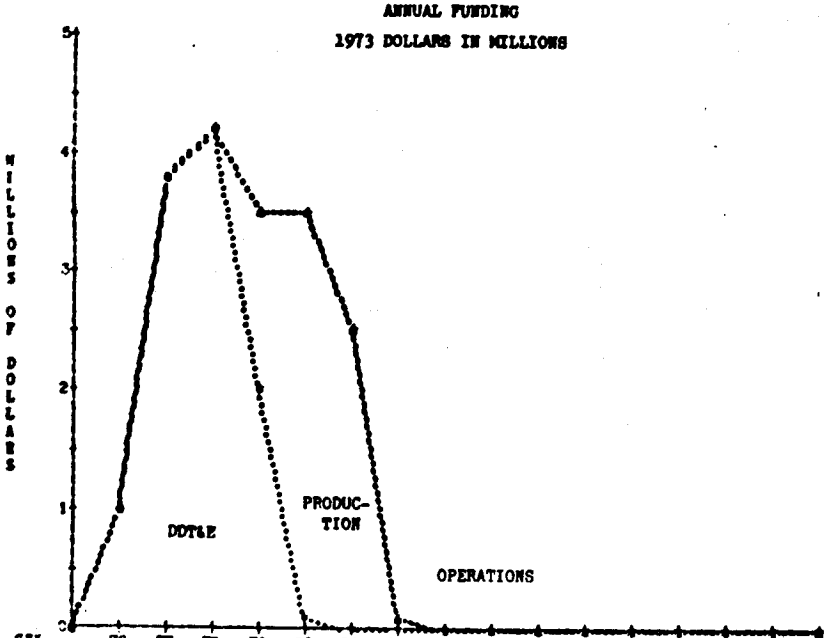
PROVIDE ALL MATERIAL FOR 13 MAIN STAGES

FABRICATE, ASSEMBLE, AND ACCEPTANCE TEST 13 MAIN STAGES, INCLUDING SUBSYSTEMS, ASSEMBLIES, AND COMPONENTS

PROVIDE QUALITY ASSURANCE, PRODUCTION CONTROL CALIBRATION AND OTHER SUPPORT FOR PRODUCTION OPERATIONS

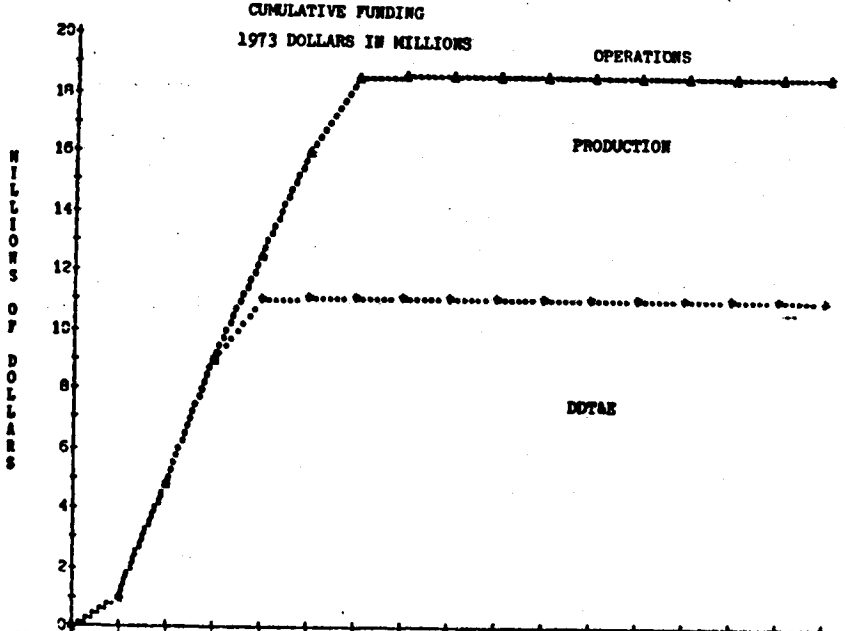


PROGRAM OPTION NO. 3 - INITIAL
WBS 320-03-07 LEVEL-5 VEHICLE MAIN STAGE
FINAL ASSEMBLY AND CHECKOUT
ANNUAL FUNDING
1973 DOLLARS IN MILLIONS



GFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT•E	1•0	3•8	4•2	2•0	•1	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0
PROD	•0	•0	•0	1•5	3•4	2•5	•1	•0	•0	•0	•0	•0	•0	•0	•0	•0
OPER	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0
TOTAL	1•0	3•8	4•2	3•5	3•5	2•5	•1	•0	•0	•0	•0	•0	•0	•0	•0	•0

PROGRAM OPTION NO. 3 - INITIAL
WBS 320-03-07 LEVEL-5 VEHICLE MAIN STAGE
FINAL ASSEMBLY AND CHECKOUT
CUMULATIVE FUNDING
1973 DOLLARS IN MILLIONS



GFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT•E	1•0	4•8	9•0	11•0	11•1	11•1	11•1	11•1	11•1	11•1	11•1	11•1	11•1	11•1	11•1	11•1
PROD	•0	•0	•0	1•5	4•9	7•4	7•5	7•5	7•5	7•5	7•5	7•5	7•5	7•5	7•5	7•5
OPER	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0	•0
TOTAL	1•0	4•8	9•0	12•5	16•0	18•5	18•6	18•6	18•6	18•6	18•6	19•6	18[illegible]	[illegible]	[illegible]	[illegible]

PROGRAM OPTION NO. 3 FINAL – WBS 320-03-07 LEVEL-5 VEHICLE MAIN STAGE FINAL ASSEMBLY AND CHECKOUT – COST SUMMARY

TECHNICAL CHARACTERISTICS – OPTION NO. 3 - FINAL
WBS 320-03-07 FINAL ASSEMBLY AND CHECKOUT

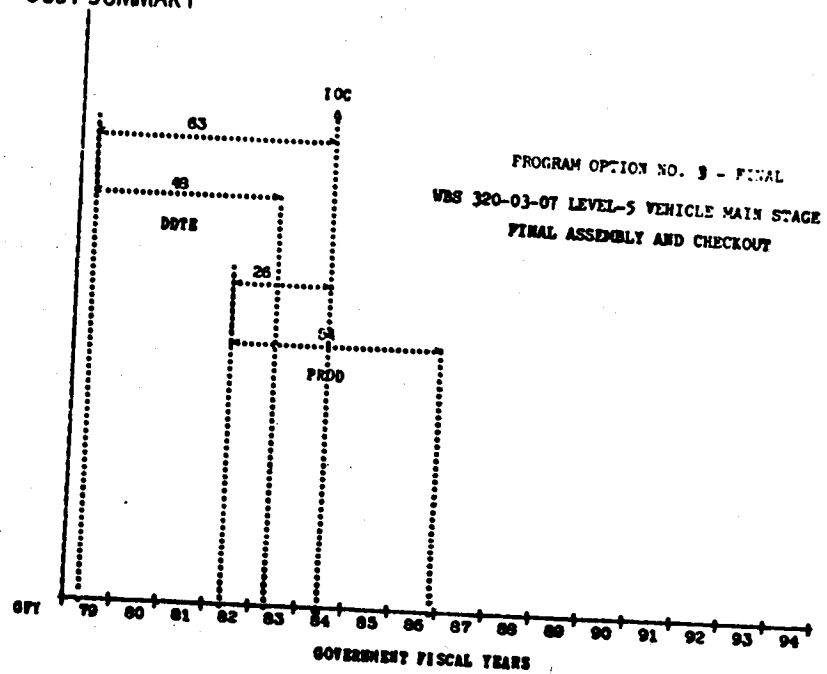
TECHNICAL DESCRIPTION

MANUFACTURING RESPONSIBILITY

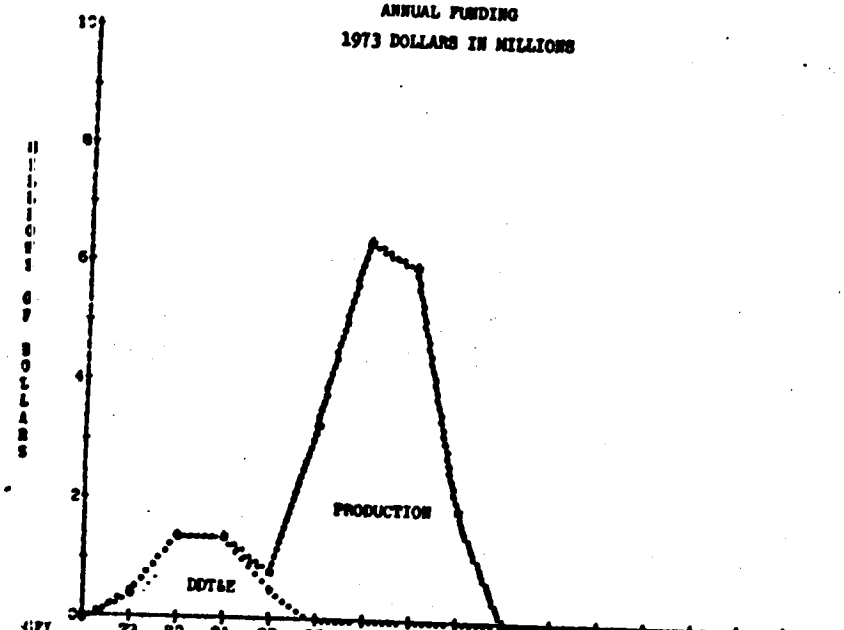
PROVIDE ALL MATERIAL FOR 13 MAIN STAGES

FABRICATE, ASSEMBLE, AND ACCEPTANCE TEST 13 MAIN STAGES, INCLUDING SUBSYSTEMS, ASSEMBLIES, AND COMPONENTS

PROVIDE QUALITY ASSURANCE, PRODUCTION CONTROL CALIBRATION AND OTHER SUPPORT FOR PRODUCTION OPERATIONS

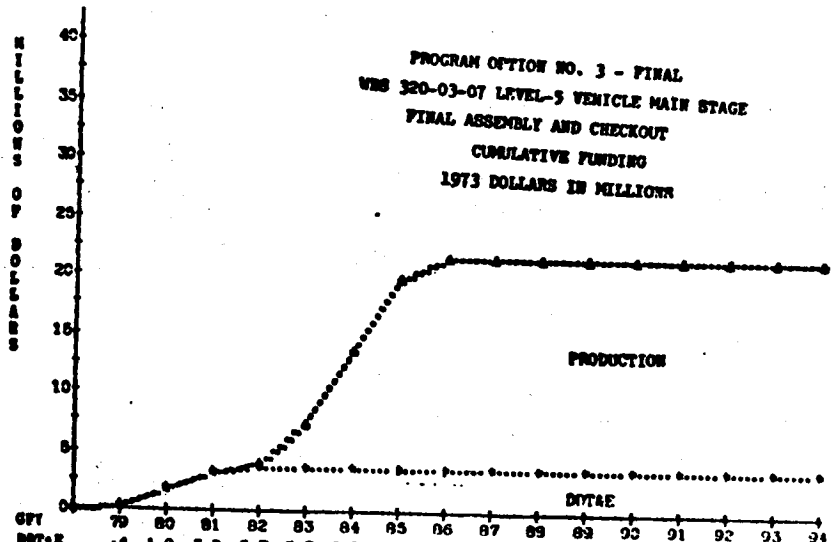


PROGRAM OPTION NO. 3 - FINAL
WBS 320-03-07 LEVEL-5 VEHICLE MAIN STAGE
FINAL ASSEMBLY AND CHECKOUT
ANNUAL FUNDING
1973 DOLLARS IN MILLIONS



GFY	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
DDT&E	.4	1.4	1.4	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.0	.0	.3	3.3	6.4	6.0	1.9	.0	.0	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.4	1.4	1.4	.6	3.3	6.4	6.0	1.9	.0	.0	.0	.0	.0	.0	.0	.0

PROGRAM OPTION NO. 3 - FINAL
WBS 320-03-07 LEVEL-5 VEHICLE MAIN STAGE
FINAL ASSEMBLY AND CHECKOUT
CUMULATIVE FUNDING
1973 DOLLARS IN MILLIONS



GFY	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
DDT&E	.4	1.8	3.2	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
PROD	.0	.0	.0	.3	3.6	10.0	16.0	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.4	1.8	3.2	4.0	7.3	13.7	19.7	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6

PROGRAM OPTION NO. 3 TOTAL – WBS 320-03-07 LEVEL-5 VEHICLE MAIN STAGE FINAL ASSEMBLY AND CHECKOUT – COST SUMMARY

TECHNICAL CHARACTERISTICS - OPTION NO. 3 TOTAL

WBS 320-03-07 LEVEL-5 VEHICLE MAIN STAGE-

FINAL ASSEMBLY AND CHECKOUT

THE TECHNICAL CHARACTERISTICS ARE EQUIVALENT TO THE SUM OF THE INCREMENTAL CHARACTERISTICS. HOWEVER, A MERE SUMMATION WOULD NOT BE MEANINGFUL. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE CHARACTERISTICS FOR THE INITIAL PHASE AND THE FINAL PHASE.

PROGRAM OPTION NO. 3 TOTAL

WBS 320-03-07 LEVEL-5 VEHICLE MAIN STAGE-

FINAL ASSEMBLY AND CHECKOUT

A COMPOSITE SCHEDULE WOULD NOT BE MEANINGFUL, SINCE TWO IOC DATES WOULD BE REFERENCED FOR THE T_S AND T_D VALUES. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE SCHEDULES FOR THE INITIAL PHASE AND THE FINAL PHASE.

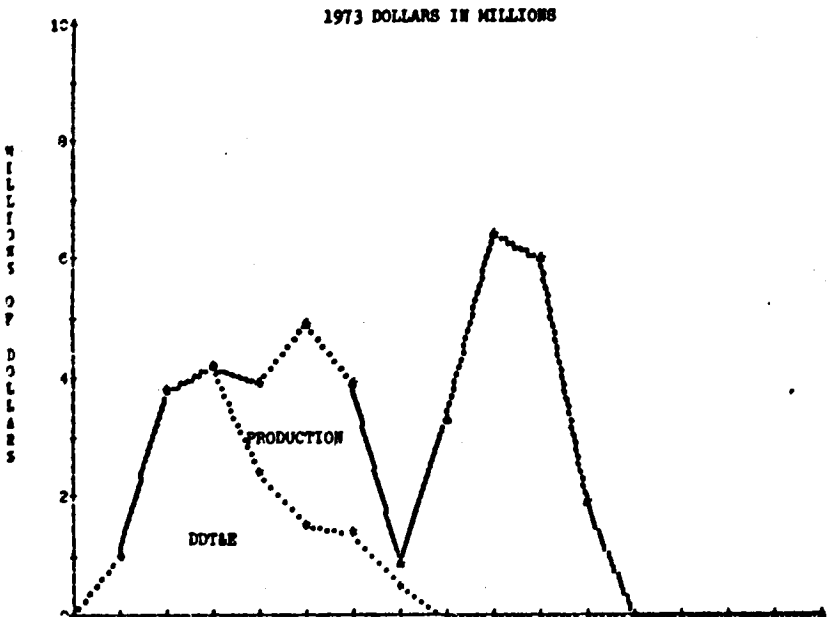
PROGRAM OPTION NO. 3 - TOTAL

WBS 320-03-07 LEVEL-5 VEHICLE MAIN STAGE

FINAL ASSEMBLY AND CHECKOUT

ANNUAL FUNDING

1973 DOLLARS IN MILLIONS



GFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	1.0	3.8	4.2	2.4	1.5	1.4	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.0	.0	1.5	3.4	2.5	.4	3.3	6.4	6.0	1.9	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	1.0	3.8	4.2	3.9	4.9	3.9	.9	3.3	6.4	6.0	1.9	.0	.0	.0	.0	.0

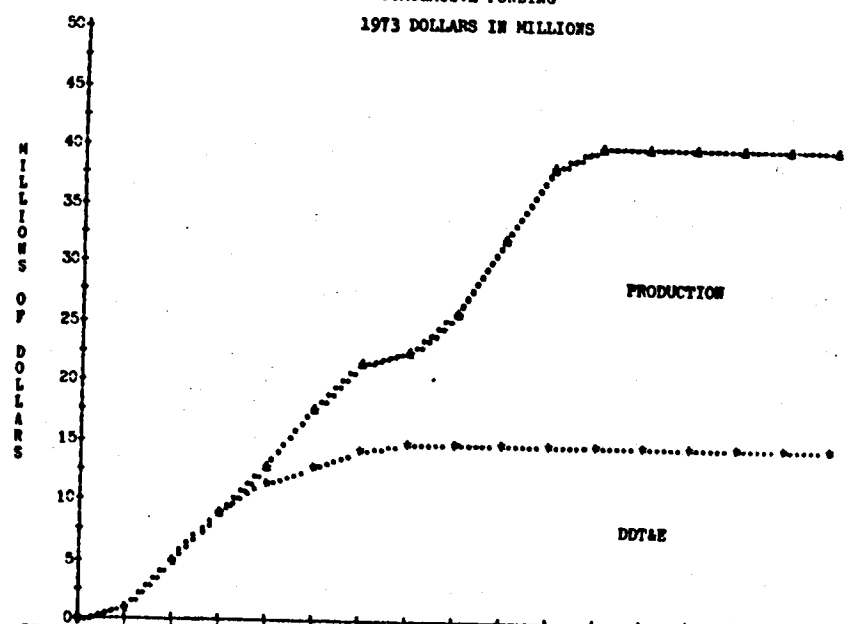
PROGRAM OPTION NO. 3 - TOTAL

WBS 320-03-07 LEVEL-5 VEHICLE MAIN STAGE

FINAL ASSEMBLY AND CHECKOUT

CUMULATIVE FUNDING

1973 DOLLARS IN MILLIONS



GFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	1.0	4.8	9.0	11.4	12.9	14.3	14.9	14.8	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9
PROD	.0	.0	.0	1.5	4.9	7.4	7.9	11.1	17.5	23.5	25.4	25.4	25.4	25.4	25.4	25.4
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	1.0	4.8	9.0	12.9	17.8	21.7	22.8	25.9	32.3	38.3	40.2	40.2	40.2	40.2	40.2	40.2

6-18-9

PROGRAM OPTION NO. 3 FINAL – WBS 320-03-07 LEVEL-5 VEHICLE MAIN STAGE FINAL ASSEMBLY AND CHECKOUT – COST SUMMARY

TECHNICAL CHARACTERISTICS – OPTION NO. 3 - FINAL
WBS 320-03-07 FINAL ASSEMBLY AND CHECKOUT

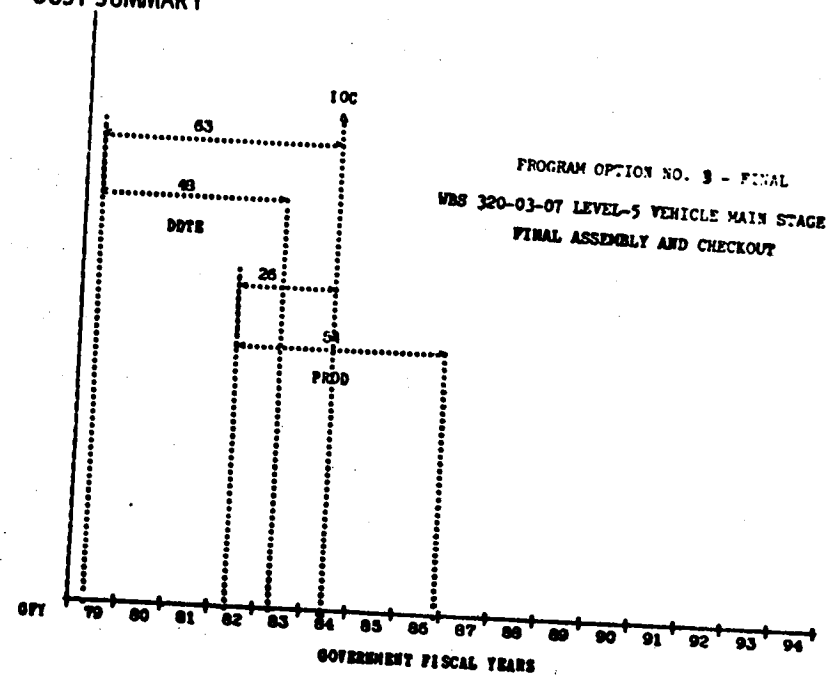
TECHNICAL DESCRIPTION

MANUFACTURING RESPONSIBILITY

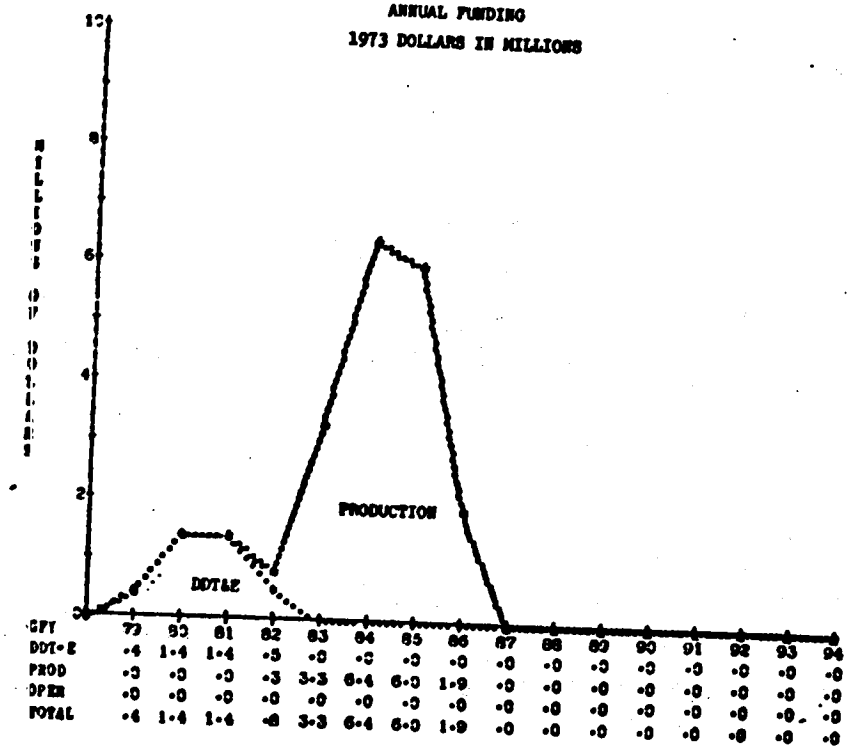
PROVIDE ALL MATERIAL FOR 13 MAIN STAGES

FABRICATE, ASSEMBLE, AND ACCEPTANCE TEST 13 MAIN STAGES, INCLUDING SUBSYSTEMS, ASSEMBLIES, AND COMPONENTS

PROVIDE QUALITY ASSURANCE, PRODUCTION CONTROL CALIBRATION AND OTHER SUPPORT FOR PRODUCTION OPERATIONS

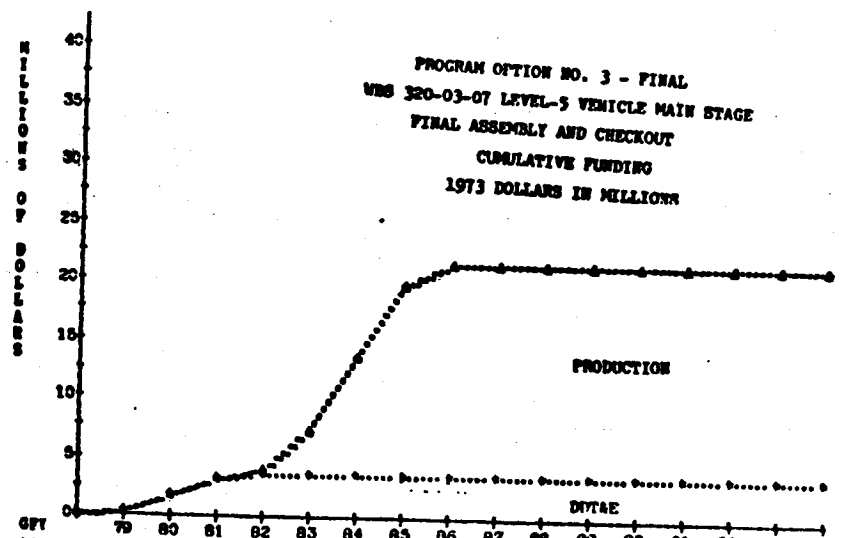


PROGRAM OPTION NO. 3 - FINAL
WBS 320-03-07 LEVEL-5 VEHICLE MAIN STAGE
FINAL ASSEMBLY AND CHECKOUT
ANNUAL FUNDING
1973 DOLLARS IN MILLIONS



GFY	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
DDT+E	.4	1.4	1.4	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.0	.0	.3	3.3	6.4	6.0	1.9	.0	.0	.0	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.4	1.4	1.4	.8	3.3	6.4	6.0	1.9	.0	.0	.0	.0	.0	.0	.0	.0

PROGRAM OPTION NO. 3 - FINAL
WBS 320-03-07 LEVEL-5 VEHICLE MAIN STAGE
FINAL ASSEMBLY AND CHECKOUT
CUMULATIVE FUNDING
1973 DOLLARS IN MILLIONS



GFY	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
DDT+E	.4	1.8	3.2	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
PROD	.0	.0	.0	.3	3.6	10.0	16.0	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9	17.9
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.4	1.8	3.2	4.0	7.3	13.7	19.7	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6	21.6

E8/-9

PROGRAM OPTION NO. 3 TOTAL – WBS 320-03-07 LEVEL-5 VEHICLE MAIN STAGE FINAL ASSEMBLY AND CHECKOUT – COST SUMMARY

TECHNICAL CHARACTERISTICS - OPTION NO. 3 TOTAL

WBS 320-03-07 LEVEL-5 VEHICLE MAIN STAGE-

FINAL ASSEMBLY AND CHECKOUT

THE TECHNICAL CHARACTERISTICS ARE EQUIVALENT TO THE SUM OF THE INCREMENTAL CHARACTERISTICS. HOWEVER, A MERE SUMMATION WOULD NOT BE MEANINGFUL. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE CHARACTERISTICS FOR THE INITIAL PHASE AND THE FINAL PHASE.

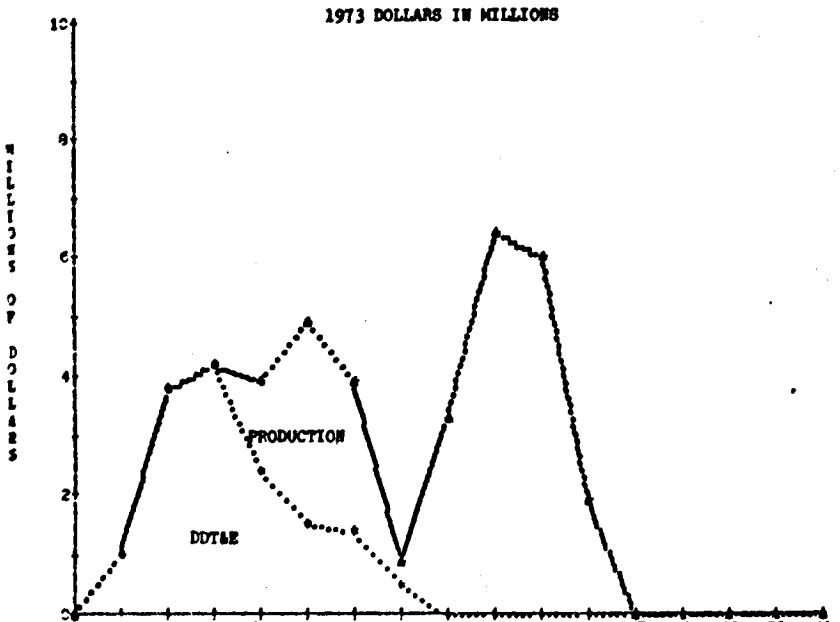
PROGRAM OPTION NO. 3 TOTAL

WBS 320-03-07 LEVEL-5 VEHICLE MAIN STAGE-

FINAL ASSEMBLY AND CHECKOUT

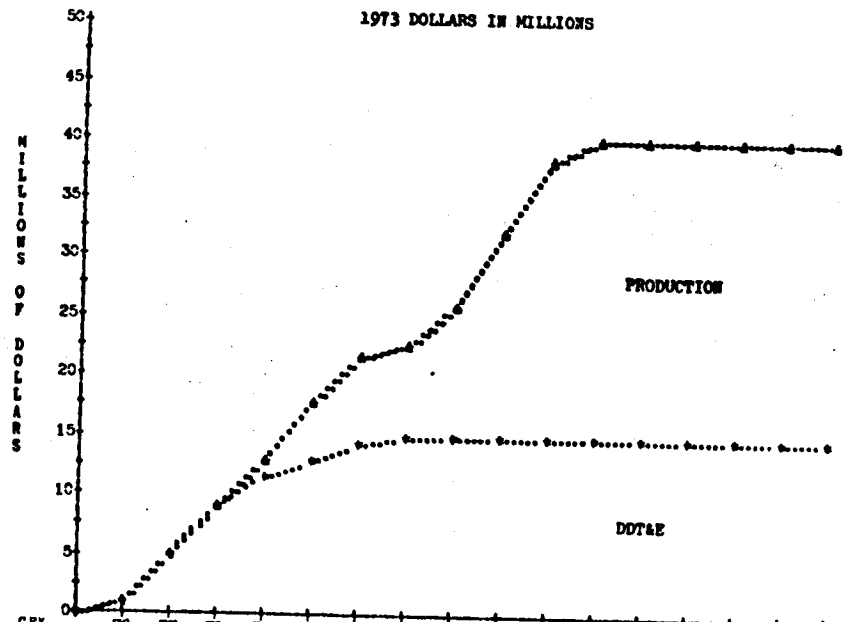
A COMPOSITE SCHEDULE WOULD NOT BE MEANINGFUL, SINCE TWO IOC DATES WOULD BE REFERENCED FOR THE T_S AND T_D VALUES. THEREFORE, REFERENCE IS MADE TO THE RESPECTIVE SCHEDULES FOR THE INITIAL PHASE AND THE FINAL PHASE.

PROGRAM OPTION NO. 3 - TOTAL
WBS 320-03-07 LEVEL-5 VEHICLE MAIN STAGE
FINAL ASSEMBLY AND CHECKOUT
ANNUAL FUNDING
1973 DOLLARS IN MILLIONS



GFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	1.0	3.8	4.2	2.4	1.5	1.4	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
PROD	.0	.0	.0	1.5	3.4	2.5	.4	3.3	6.4	6.0	1.9	.0	.0	.0	.0	.0
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	1.0	3.8	4.2	3.9	4.9	3.9	.9	3.3	6.4	6.0	1.9	.0	.0	.0	.0	.0

PROGRAM OPTION NO. 3 - TOTAL
WBS 320-03-07 LEVEL-5 VEHICLE MAIN STAGE
FINAL ASSEMBLY AND CHECKOUT
CUMULATIVE FUNDING
1973 DOLLARS IN MILLIONS



GFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DDT&E	1.0	4.8	9.0	11.4	12.9	14.3	14.9	14.8	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9
PROD	.0	.0	.0	1.5	4.9	7.4	7.9	11.1	17.5	23.5	25.4	25.4	25.4	25.4	25.4	25.4
OPER	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	1.0	4.8	9.0	12.9	17.8	21.7	22.6	25.9	32.3	38.3	40.2	40.2	40.2	40.2	40.2	40.2

6.17

6.8 First Unit Production Cost per WBS

It is understood that the intent of this subsection is a presentation of first unit production costs through WBS Level 7. Since these costs are presented as part of Cost Data Form-A (2) recurring (Production) in subsection 6.2 above, reference is made to that subsection rather than merely duplicate the Level-7 data in this subsection.

Instead, this subsection is being used as the most convenient location for the LEADER II cost model printout for costs of each program phase and the total program, as well as costs for first production unit costs through Level 7, and initial spares and operational spares costs through Level 6.

OPTION 31 5 VEHICLES TUG 300IR 9/11/73 12:20 PM

WBS	COST ELEMENT C	EDAD (MIL)	GTM (MIL)	FTM (MIL)	TOTAL ODT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
10	TOTAL PROJECT MGMT	6.86	.00	.00	6.86	.00	2.48	.00	2.48	2.26	.00	2.26	11.60
20	TOTAL SYS. ENGR. &	14.50	.00	.00	14.50	.00	23.68	.00	23.68	3.31	.00	3.31	41.50
30	TOTAL VEH MAIN STA	89.79	11.30	.00	101.09	14.68	55.85	2.59	58.45	.83	7.62	8.45	167.99
40	TOTAL VEH AUX. STA	1.62	.00	.00	1.62	.00	12.19	.00	12.19	.00	.00	.00	13.81
50	TOTAL LOGISTICS	1.66	.00	.00	1.66	.00	.15	.00	.15	2.51	.00	2.51	4.32
60	TOTAL FACILITIES	5.17	.00	.00	5.17	.00	.44	.00	.44	1.21	.00	1.21	6.81
70	TOTAL GRND. SUPT.	27.65	.00	.00	27.65	.00	1.20	.00	1.20	6.30	.00	6.30	35.15
80	TOTAL VEHICLE TEST	.00	20.35	.85	21.20	.00	.00	.00	.00	.00	.00	.00	21.20
90	TOTAL LAUNCH OPNS.	.00	.00	.00	.00	.00	.00	.00	.00	1.85	.00	1.85	1.85
100	TOTAL LAUNCH OPNS	.00	.00	.00	.00	.00	.00	.00	.00	12.25	.00	12.25	12.25
110	TOTAL FLIGHT OPNS	5.92	.00	.00	5.92	.00	.00	.00	.00	13.84	.00	13.84	19.76
120	TOTAL FLIGHT OPNS	4.20	.00	.00	4.20	.00	.00	.00	.00	10.03	.00	10.03	14.23
130	TOTAL REFURB &INTE	.11	.00	.00	.11	.00	.00	.00	.00	2.77	.00	2.77	2.88
140	TOTAL REFURB &INTE	.11	.00	.00	.11	.00	.00	.00	.00	23.79	.00	23.79	23.90
	TOTAL	157.60	31.65	.85	190.10	14.68	96.00	2.59	98.59	80.94	7.62	88.56	377.26

OPTION 31 5 VEHICLES TUG 300IR 9/11/73 12:20 PM

WBS	COST ELEMENT	C	EDAD (MIL)	BTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
10	PROJECT MGMT.	3												
11	COST/PERF. MGMT.	3	4.71	.00	.00	4.71	.00	1.69	.00	1.69	1.48	.00	1.48	7.88
12	PROJ. DIRECTION	3	2.02	.00	.00	2.02	.00	.74	.00	.74	.71	.00	.71	3.47
13	INFORM. MGMT.	3	.13	.00	.00	.13	.00	.05	.00	.05	.06	.00	.06	.25
	TOTAL PROJECT MGMT		6.86	.00	.00	6.86	.00	2.48	.00	2.48	2.26	.00	2.26	11.60
	TOTAL		6.86	.00	.00	6.86	.00	2.48	.00	2.48	2.26	.00	2.26	11.60

OPTION 31 5 VEHICLES TUG 300IR 9/11/73 12:20 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
20	SYS. ENGR. & INT.	3												
21	TUG SYS. ENGR.	3	11.60	.00	.00	11.60	.00	2.98	.00	2.98	.00	.00	.00	14.58
22	SHUTTLE I/F	3	.73	.00	.00	.73	.00	.75	.00	.75	.00	.00	.00	1.48
23	PAYLOAD I/F	3	2.17	.00	.00	2.17	.00	1.49	.00	1.49	.00	.00	.00	3.66
24	SUST. ENGR.	3	.00	.00	.00	.00	.00	18.46	.00	18.46	3.31	.00	3.31	21.77
	TOTAL SYS. ENGR. &		14.50	.00	.00	14.50	.00	23.68	.00	23.68	3.31	.00	3.31	41.50
	TOTAL		14.50	.00	.00	14.50	.00	23.68	.00	23.68	3.31	.00	3.31	41.50

881-7

OPTION 31 5 VEHICLES TUG 300IR 9/11/73 12:20 PM

WBS	COST ELEMENT	C	EO&D (MIL)	OTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
30	VEH MAIN STAGE	3												
31	STRUCTURES	3	17.71	.00	.00	17.71	1.73	6.69	.00	6.69	.00	.21	.21	24.60
32	THERMAL CONTROL	3	.93	.51	.00	1.44	.48	1.88	.00	1.88	.00	.06	.06	3.38
33	AVIONICS	3	22.25	3.54	.00	25.59	4.58	17.83	.55	18.37	.83	4.09	4.92	48.88
34	PROPULSION	3	28.35	4.32	.00	32.67	3.35	13.02	1.82	14.84	.00	2.72	2.72	50.22
35	ORBITER I/F	3	10.29	2.30	.00	12.59	2.30	8.91	.23	9.14	.00	.54	.54	22.27
36	DROP TANKS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
37	FINAL ASSY & C/O	3	10.27	.84	.00	11.11	2.24	7.53	.00	7.53	.00	.00	.00	18.63
	TOTAL VEH MAIN STA		89.79	11.30	.00	101.09	14.68	55.85	2.59	58.45	.83	7.62	8.45	167.99
	TOTAL		89.79	11.30	.00	101.09	14.68	55.85	2.59	58.45	.83	7.62	8.45	167.99

5&2

LEVEL 6

WBS	COST ELEMENT	C	EQAU (MIL)	8TH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
3101	FUEL TK & SUPT	3	4.85	.00	.00	4.85	.47	1.86	.00	1.86	.00	.00	.00	6.71
3102	OXID. TK & SUPT	3	2.62	.00	.00	2.62	.19	.76	.00	.76	.00	.00	.00	3.38
3103	BODY STRUCTURE	3	4.09	.00	.00	4.09	.10	.39	.00	.39	.00	.00	.00	4.49
3104	THRUST STRUCTURE	3	1.38	.00	.00	1.38	.06	.25	.00	.25	.00	.00	.00	1.63
3105	METEOROID SHIELD	3	.98	.00	.00	.98	.43	1.70	.00	1.70	.00	.00	.00	2.68
3106	PAYLOAD I/F	3	2.47	.00	.00	2.47	.33	1.29	.00	1.29	.00	.00	.00	3.76
3107	INSTL. ASSY & C/O	3	1.31	.00	.00	1.31	.13	.43	.00	.43	.00	.00	.00	1.74
31	STRUCTURE		17.71	.00	.00	17.71	1.73	6.69	.00	6.69	.00	.00	.00	24.39
3201	FUEL TANK INSL	3	.16	.00	.00	.16	.11	.42	.00	.42	.00	.02	.02	.60
3202	OXID. TANK INSL.	3	.08	.00	.00	.08	.05	.20	.00	.20	.00	.01	.01	.30
3203	INSL. PURGE SYS.	3	.64	.40	.00	1.13	.30	1.18	.00	1.18	.00	.03	.03	2.34
3204	THERM CONT. SYS.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
3205	INSTL ASSY & C/O	3	.04	.02	.00	.07	.02	.08	.00	.08	.00	.00	.00	.15
32	THERMAL CONTROL		.93	.51	.00	1.44	.48	1.88	.00	1.88	.00	.06	.06	3.38
3301	DATA MGMT.	3	8.41	1.34	.00	9.75	1.02	4.01	.19	4.20	.83	.36	1.19	15.13
3302	G N & C	3	1.47	.00	.00	1.47	1.12	4.39	.01	4.41	.00	.05	.05	5.93
3303	COMMUNICATIONS	3	4.26	1.62	.00	5.89	1.83	7.18	.26	7.44	.00	.61	.61	13.94
3304	INSTRUMENTATION	3	2.04	.04	.00	2.08	.18	.70	.00	.70	.00	.21	.21	2.98
3305	ELECT. POWER	3	.09	.05	.00	.14	.05	.24	.08	.32	.00	2.86	2.86	3.32
3306	PWR. DIST. & CONT	3	.85	.03	.00	.88	.03	.16	.00	.16	.00	.01	.01	1.04
3307	INSTL. ASSY & C/O	3	5.13	.25	.00	5.38	.34	1.15	.00	1.15	.00	.00	.00	6.53
33	AVIONICS		22.25	3.34	.00	25.59	4.58	17.83	.55	18.37	.83	4.09	4.92	48.88
3401	MAIN ENGINE	3	13.0	.00	.00	13.00	.70	2.74	1.23	3.97	.00	1.57	1.57	18.54
3402	MAIN ENG. SUPT	3	8.83	3.25	.00	12.08	1.63	6.37	.00	6.37	.00	.45	.45	CSJ
PS,		3	.28	.12	.00	.41	.12	.48	.59	1.06	.00	.60	.60	2.07 3403
3404	ACPS ENG. SUPT	3	4.88	.74	.00	5.62	.74	2.89	.00	2.89	.00	.10	.10	8.62
3405	INSTL. ASSY & C/O	3	1.35	.21	.00	1.56	.16	.54	.00	.54	.00	.00	.00	2.09
34	PROPULSION		28.35	4.32	.00	32.67	3.35	13.02	1.82	14.84	.00	2.72	2.72	50.22
3501	STRUCTURES	3	3.65	.36	.00	4.01	.36	1.41	.01	1.43	.00	.03	.03	5.47
3502	I/F PANELS	3	4.99	1.49	.00	6.47	1.49	5.82	.21	6.03	.00	.49	.49	13.00
3503	PURGE PROV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
3504	ABORT PROV.	3	.89	.28	.00	1.17	.28	1.10	.01	1.11	.00	.02	.02	2.30
3505	INSTL. ASSY & C/O	3	.76	.17	.00	.93	.17	.57	.00	.57	.00	.00	.00	1.51
35	ORBITER I/F		10.29	2.30	.00	12.59	2.30	8.91	.23	9.14	.00	.54	.54	22.27

LEVEL 6

WBS	COST ELEMENT	C	EDSD (MIL)	OTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
3701	FINAL ASSY	3	7.88	.52	.00	8.41	1.87	6.27	.00	6.27	.00	.00	.00	14.68
3702	C/O	3	2.39	.31	.00	2.70	.37	1.25	.00	1.25	.00	.00	.00	3.95
37	FINAL ASSY & C/O		10.27	.84	.00	11.11	2.24	7.53	.00	7.53	.00	.00	.00	18.63

LEVEL 7

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DUT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
310101	LH2 DOMES	3	1.70	.00	.00	1.70	.08	.00	.00	.00	.00	.00	.00	1.70
310102	LH2 CYLINDER	3	2.24	.00	.00	2.24	.08	.00	.00	.00	.00	.00	.00	2.24
310103	LH2 SUPPORTS	3	.91	.00	.00	.91	.31	.00	.00	.00	.00	.00	.00	.91
3101	FUEL TK & SUPT		4.85	.00	.00	4.85	.47	.00	.00	.00	.00	.00	.00	4.85
310201	LO2 DOMES	3	1.99	.00	.00	1.99	.08	.00	.00	.00	.00	.00	.00	1.99
310202	LO2 SUPPORTS	3	.63	.00	.00	.63	.12	.00	.00	.00	.00	.00	.00	.63
3102	OXID. TK & SUPT		2.62	.00	.00	2.62	.19	.00	.00	.00	.00	.00	.00	2.62
310301	FWD AFT SKIRT	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
310302	INTERTANK	3	1.98	.00	.00	1.98	.05	.00	.00	.00	.00	.00	.00	1.98
310303	SDWL SHELL	3	2.11	.00	.00	2.11	.05	.00	.00	.00	.00	.00	.00	2.11
3103	BODY STRUCTURE		4.09	.00	.00	4.09	.10	.00	.00	.00	.00	.00	.00	4.09
330101	COMPUTER	3	4.59	.82	.00	5.41	.82	.00	.00	.00	.00	.00	.00	5.41
330102	DATA DISTR.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330103	EQ. THERM CONT.	3	.33	.42	.00	.75	.11	.00	.00	.00	.00	.00	.00	.75
330104	CIRCUITRY	3	.33	.00	.00	.54	.03	.00	.00	.00	.00	.00	.00	.54
330105	SOFTWARE	3	2.33	.00	.00	2.33	.00	.00	.00	.00	.83	.00	.83	3.16
330106	SOFTWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330107	SOFTWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330108	INSTL. ASSY & C/O3		.62	.10	.00	.72	.08	.00	.00	.00	.00	.00	.00	.72
3301	DATA MGMT.		8.41	1.34	.00	9.75	1.02	.00	.00	.00	.83	.00	.83	10.58
330201	I M U	3	.71	.00	.00	.72	.71	.00	.00	.00	.00	.00	.00	.72
330202	TRACKING/ELECT	3	.65	.00	.00	.65	.32	.00	.00	.00	.00	.00	.00	.65
330203	REN DEZ&DOCKING	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330204	INSTL. ASSY & C/O3		.11	.00	.00	.11	.08	.00	.00	.00	.00	.00	.00	.11
3302	G N & C		1.47	.00	.00	1.47	1.12	.00	.00	.00	.00	.00	.00	1.47
330301	M/W CIRC +RF MUX	3	1.40	.80	.00	2.20	.40	.00	.00	.00	.00	.00	.00	2.20
330302	TRANSPONDERS	3	.87	.00	.00	.87	.43	.00	.00	.00	.00	.00	.00	.87
330303	POWER AMP.	3	.38	.00	.00	.39	.18	.00	.00	.00	.00	.00	.00	.39
330304	ANTENNA	3	.18	.18	.00	.36	.09	.00	.00	.00	.00	.00	.00	.36
330305	DEC/ENC+MOD/DEM	3	.75	.37	.00	1.12	.37	.00	.00	.00	.00	.00	.00	1.12
330306	TAPE RECORDER	3	.12	.15	.00	.27	.15	.00	.00	.00	.00	.00	.00	.27
330307	P/L INTER EQUIP	3	.24	.00	.00	.24	.08	.00	.00	.00	.00	.00	.00	.24
330308	INSTL. ASSY & C/O3		.32	.12	.00	.44	.14	.00	.00	.00	.00	.00	.00	.44
3303	COMMUNICATIONS		4.26	1.62	.00	5.89	1.83	.00	.00	.00	.00	.00	.00	5.89

LEVEL 7

WBS	COST ELEMENT	C	EDSD (MIL)	OTH (MIL)	FTH (MIL)	TOTAL DUTSE (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
330401	DATA SENSORS	3	.06	.00	.00	.06	.04	.00	.00	.00	.00	.00	.00	.06
330402	SIGNAL COND.	3	.10	.04	.00	.14	.04	.00	.00	.00	.00	.00	.00	.14
330403	CIRCUITRY	3	1.73	.00	.00	1.73	.09	.00	.00	.00	.00	.00	.00	1.73
330404	INSTL. ASSY & C/O	3	.15	.00	.00	.15	.01	.00	.00	.00	.00	.00	.00	.15
3304	INSTRUMENTATION		2.04	.04	.00	2.08	.18	.00	.00	.00	.00	.00	.00	2.08
330501	BATTERY	3	.08	.05	.00	.13	.05	.00	.00	.00	.00	.00	.00	.13
330502	FUEL CELL	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330503	INSTL. ASSY & C/O	3	.01	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.01
3305	ELECT. POWER		.09	.05	.00	.14	.05	.00	.00	.00	.00	.00	.00	.14
330601	DISTR.	3	.78	.03	.00	.81	.03	.00	.00	.00	.00	.00	.00	.81
330602	TANKS SYSTEM	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330603	INSTL. ASSY & C/O		.06	.00	.00	.07	.00	.00	.00	.00	.00	.00	.00	.07
3306	PWR. DIST. & CONT		.85	.03	.00	.88	.03	.00	.00	.00	.00	.00	.00	.88

ORION 3I 5 VEHICLES TUG 3001R 9/11/73 12:20 PM

WBS	COST ELEMENT	C	EDBD (MIL)	BTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
40	VEH AUX. STAGE	3												
41	VEH AUX. STAGE	3	1.62	.00	.00	1.62	.00	12.19	.00	12.19	.00	.00	.00	13.81
	TOTAL VEH AUX. STA		1.62	.00	.00	1.62	.00	12.19	.00	12.19	.00	.00	.00	13.81
	TOTAL		1.62	.00	.00	1.62	.00	12.19	.00	12.19	.00	.00	.00	13.81

A1-7

OPTION 31 5 VEHICLES TUG 3001R 9/11/73 12:00 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
50	LOGISTICS	3												
51	TRANSP. & HDLG.	3	.00	.00	.00	.00	.00	.15	.00	.15	.10	.00	.10	.25
52	TRAINING	3	1.37	.00	.00	1.37	.00	.00	.00	.00	1.37	.00	1.37	2.74
53	INV CONT. & WHSNG	3	.29	.00	.00	.29	.00	.00	.00	.00	1.04	.00	1.04	1.33
	TOTAL LOGISTICS		1.66	.00	.00	1.66	.00	.15	.00	.15	2.51	.00	2.51	4.32
	TOTAL		1.66	.00	.00	1.66	.00	.15	.00	.15	2.51	.00	2.51	4.32

5647

LEVEL 6

WBS	COST ELEMENT	C	EURO (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DOT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
5201	SIM. & EQUIP.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
5202	GROUND CREW	3	1.37	.00	.00	1.37	.00	.00	.00	.00	1.37	.00	1.37	2.74
52	TRAINING		1.37	.00	.00	1.37	.00	.00	.00	.00	1.37	.00	1.37	2.74

OPTION 31 5 VEHICLES TUG 300IR 9/11/73 12:20 PM

WBS	COST ELEMENT	C	EDØD (MIL)	6TH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
60	FACILITIES	3												
61	MANUFACTURING	3	1.12	.00	.00	1.12	.00	.44	.00	.44	.00	.00	.00	1.56
62	TEST	3	1.50	.00	.00	1.50	.00	.00	.00	.00	.00	.00	.00	1.50
63	ETR MAINT. & REF.	3	1.02	.00	.00	1.02	.00	.00	.00	.00	.55	.00	.55	1.57
64	ETR LAUNCH	3	.39	.00	.00	.39	.00	.00	.00	.00	.21	.00	.21	.60
65	WTR MAINT. & REF.	3	.76	.00	.00	.76	.00	.00	.00	.00	.30	.00	.30	1.06
66	WTR LAUNCH	3	.38	.00	.00	.38	.00	.00	.00	.00	.15	.00	.15	.53
	TOTAL FACILITIES		5.17	.00	.00	5.17	.00	.44	.00	.44	1.21	.00	1.21	6.81
	TOTAL		5.17	.00	.00	5.17	.00	.44	.00	.44	1.21	.00	1.21	6.81

LEVEL 6

WBS	COST ELEMENT	C	ED&U (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPHS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPHS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
6101	DES./CONST.	3	1.09	.00	.00	1.09	.00	.00	.00	.00	.00	.00	.00	1.09
6102	ACTIV./MAINT.	3	.02	.00	.00	.02	.00	.44	.00	.44	.00	.00	.00	.46
61	MANUFACTURING		1.12	.00	.00	1.12	.00	.44	.00	.44	.00	.00	.00	1.56
6201	DES./CONST.	3	1.50	.00	.00	1.50	.00	.00	.00	.00	.00	.00	.00	1.50
6202	ACTIV./MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
62	TEST		1.50	.00	.00	1.50	.00	.00	.00	.00	.00	.00	.00	1.50
6301	DES./CONST.	3	1.00	.00	.00	1.00	.00	.00	.00	.00	.00	.00	.00	1.00
6302	ACTIV./MAINT.	3	.02	.00	.00	.02	.00	.00	.00	.00	.55	.00	.55	.57
63	ETR MAINT. & REF.		1.02	.00	.00	1.02	.00	.00	.00	.00	.55	.00	.55	1.57
6401	DES./CONST.	3	.38	.00	.00	.38	.00	.00	.00	.00	.00	.00	.00	.38
6402	ACTIV./MAINT.	3	.01	.00	.00	.01	.00	.00	.00	.00	.21	.00	.21	.22
64	ETR LAUNCH		.39	.00	.00	.39	.00	.00	.00	.00	.21	.00	.21	.60
6501	DES./CONST.	3	.75	.00	.00	.75	.00	.00	.00	.00	.00	.00	.00	.75
6502	ACTIV./MAINT.	3	.01	.00	.00	.01	.00	.00	.00	.00	.30	.00	.30	.31
65	WTR MAINT. & REF.		.76	.00	.00	.76	.00	.00	.00	.00	.30	.00	.30	1.06
6601	DES./CONST.	3	.37	.00	.00	.37	.00	.00	.00	.00	.00	.00	.00	.37
6602	ACTIV./MAINT.	3	.01	.00	.00	.01	.00	.00	.00	.00	.15	.00	.15	.16
66	WTR LAUNCH		.38	.00	.00	.38	.00	.00	.00	.00	.15	.00	.15	.53

OPTION 3I 5 VEHICLES TUG 300IK 9/11/73 12:20 PM

WUS	COST ELEMENT	C	EDDD (MIL)	OTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
70	GRND. SUPT. EQUIPS													
71	MFG. GSE	3	6.89	.00	.00	6.89	.00	1.20	.00	1.20	.00	.00	.00	8.09
72	ETR GSE	3	10.24	.00	.00	10.24	.00	.00	.00	.00	2.46	.00	2.46	12.70
73	WTR GSE	3	9.57	.00	.00	9.57	.00	.00	.00	.00	1.67	.00	1.67	11.24
74	FLT OPS GSE(NASA)		.47	.00	.00	.47	.00	.00	.00	.00	1.09	.00	1.09	1.56
75	FLT OPS GSE(DOD)		.47	.00	.00	.47	.00	.00	.00	.00	1.09	.00	1.09	1.56
	TOTAL GRND. SUPT.		27.65	.00	.00	27.65	.00	1.20	.00	1.20	6.30	.00	6.30	35.15
	TOTAL		27.65	.00	.00	27.65	.00	1.20	.00	1.20	6.30	.00	6.30	35.15

561-7

LEVEL 6

WBS	COST ELEMENT	C	EDGD (MIL)	OTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
7101	HARDWARE	3	4.42	.00	.00	4.42	.00	.00	.00	.00	.00	.00	.00	4.42
7102	SITE ACTIV.	3	.09	.00	.00	.09	.00	.00	.00	.00	.00	.00	.00	.09
7103	MAINT.	3	.00	.00	.00	.00	.00	1.20	.00	1.20	.00	.00	.00	1.20
7104	SOFTWARE	3	2.38	.00	.00	2.38	.00	.00	.00	.00	.00	.00	.00	2.38
71	MFG. GSE		6.89	.00	.00	6.89	.00	1.20	.00	1.20	.00	.00	.00	8.09
7201	HARDWARE	3	6.49	.00	.00	6.49	.00	.00	.00	.00	.00	.00	.00	6.49
7202	SITE ACTIV.	3	2.14	.00	.00	2.14	.00	.00	.00	.00	.00	.00	.00	2.14
7203	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	2.08	.00	2.08	2.08
7204	SOFTWARE	3	1.61	.00	.00	1.61	.00	.00	.00	.00	.37	.00	.37	1.98
72	ETR GSE		10.24	.00	.00	10.24	.00	.00	.00	.00	2.46	.00	2.46	12.70
7301	HARDWARE	3	6.03	.00	.00	6.03	.00	.00	.00	.00	.00	.00	.00	6.03
7302	SITE ACTIV.	3	1.99	.00	.00	1.99	.00	.00	.00	.00	.00	.00	.00	1.99
7303	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	1.63	.00	1.63	1.63
7304	SOFTWARE	3	1.55	.00	.00	1.55	.00	.00	.00	.00	.04	.00	.04	1.59
73	WTR GSE		9.57	.00	.00	9.57	.00	.00	.00	.00	1.67	.00	1.67	11.24
7401	HARDWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7402	SITE ACTIV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7403	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7404	SOFTWARE	3	.47	.00	.00	.47	.00	.00	.00	.00	1.09	.00	1.09	1.56
74	HARDWA(S) SUBTOTAL		.47	.00	.00	.47	.00	.00	.00	.00	1.09	.00	1.09	1.56
7501	HARDWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7502	SITE ACTIV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7503	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7504	SOFTWARE	3	.47	.00	.00	.47	.00	.00	.00	.00	1.09	.00	1.09	1.56
75	HARDWA(S) SUBTOTAL		.47	.00	.00	.47	.00	.00	.00	.00	1.09	.00	1.09	1.56

OPTION 3I 5 VEHICLES TUG 300IR 9/11/73 12:20 PM

WBS	COST ELEMENT	C	EDSD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
80	VEHICLE TEST	3												
81	GND TEST HDWE.	3	.00	13.96	.00	13.96	.00	.00	.00	.00	.00	.00	.00	13.96
82	GND TEST OPNS.	3	.00	6.39	.00	6.39	.00	.00	.00	.00	.00	.00	.00	6.39
83	FLT. TEST HDWE.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
84	FLT. TEST OPNS	3	.00	.00	.85	.85	.00	.00	.00	.00	.00	.00	.00	.85
	TOTAL VEHICLE TEST		.00	20.35	.85	21.20	.00	.00	.00	.00	.00	.00	.00	21.20
	TOTAL		.00	20.35	.85	21.20	.00	.00	.00	.00	.00	.00	.00	21.20

LEVEL 6

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
8101	PTV TEST	3	.00	3.22	.00	3.22	.00	.00	.00	.00	.00	.00	.00	3.22
8102	MAJOR TEST ART.	3	.00	10.26	.00	10.26	.00	.00	.00	.00	.00	.00	.00	10.26
8103	MOCKUPS	3	.00	.48	.00	.48	.00	.00	.00	.00	.00	.00	.00	.48
81	GND TEST HDWE.		.00	13.96	.00	13.96	.00	.00	.00	.00	.00	.00	.00	13.96
8301	STRUCTURES	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8302	THERMAL CONTROL	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8303	AVIONICS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8304	PROPULSION	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8305	ORBITER I/F	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8306	DROP TANKS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8307	FINAL ASSY & C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
83	FLT. TEST HDWE.		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

LEVEL 7

WBS	COST ELEMENT	C	ED&D (MIL)	OTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
830102	OXID. TK & SUPT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830103	BODY STRUCTURE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830104	THRUST STRUCTURE		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830105	METEOROID SHIELD	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830106	PAYLOAD I/F	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830107	INSTL, ASSY & C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8301	STRUCTURES		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830201	FUEL TANK INSL	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830202	OXID TANK INSL	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830203	INSL PURGE SYS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830204	THERM CONT SYS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830205	INSTL, ASSY & C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8302	THERMAL CONTROL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830301	DATA MGMT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830302	G N & C	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830303	COMMUNICATIONS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830304	INSTRUMENTATION	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830305	ELECT. POWER	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830306	PWR DIST. & CONT	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830307	INSTL, ASSY & C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8303	AVIONICS		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830401	MAIN ENGINE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830402	MAIN ENG SUPT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830403	ACPS ENGINE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830404	ACPS ENG SUPT	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830405	INSTL, ASSY & C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8304	PROPULSION		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830501	STRUCTURES	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830502	I/F PANELS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830503	PURGE PROV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830504	ABORT PROV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830505	INSTL, ASSY & C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8305	ORBITER I/F		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

LEVEL 7

WBS	COST ELEMENT	C	EUOD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPKS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPKS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
830701	FINAL ASSY	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830702	C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8307	FINAL ASSY & C/O		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

OPTION 3I 5 VEHICLES TUG 300IR 9/11/73 12:20 PM

WBS	COST ELEMENT	C	EDGD (MIL)	6TH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
90	LAUNCH OPNS. WTR	3												
91	LNCH SITE SVCES	3	.00	.00	.00	.00	.00	.00	.00	.00	.67	.00	.67	.67
92	TUG/SHTL MATING	3	.00	.00	.00	.00	.00	.00	.00	.00	.22	.00	.22	.22
93	PRELAUNCH C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.27	.00	.27	.27
94	COUNTDOWN	3	.00	.00	.00	.00	.00	.00	.00	.00	.36	.00	.36	.36
95	PRLNTS. & GASES	3	.00	.00	.00	.00	.00	.00	.00	.00	.05	.00	.05	.05
96	POST FLT. SAFING	3	.00	.00	.00	.00	.00	.00	.00	.00	.28	.00	.28	.28
	TOTAL LAUNCH OPNS.		.00	.00	.00	.00	.00	.00	.00	.00	1.85	.00	1.85	1.85
	TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	1.85	.00	1.85	1.85

OPTION 31 - 8 VEHICLES TUG 300IR 9/11/73 12:20 PM

WBS	COST ELEMENT	C	ED&D (MIL)	OTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
100	LAUNCH OPNS ETR	3												
101	LNCH SITE SVCES	3	.00	.00	.00	.00	.00	.00	.00	.00	4.56	.00	4.56	4.56
102	TUG/SHTL MATING	3	.00	.00	.00	.00	.00	.00	.00	.00	1.39	.00	1.39	1.39
103	PRELAUNCH C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	1.72	.00	1.72	1.72
104	COUNTDOWN	3	.00	.00	.00	.00	.00	.00	.00	.00	2.24	.00	2.24	2.24
105	PRLNTS & GASES	3	.00	.00	.00	.00	.00	.00	.00	.00	.48	.00	.48	.48
106	POST FLT. SAFING	3	.00	.00	.00	.00	.00	.00	.00	.00	1.85	.00	1.85	1.85
	TOTAL LAUNCH OPNS		.00	.00	.00	.00	.00	.00	.00	.00	12.25	.00	12.25	12.25
	TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	12.25	.00	12.25	12.25

OPTION 31 6 VEHICLES TUG 300IH 9/11/73 12:20 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
110	FLIGHT OPNS NASA	3												
111	MISSION PLG.	3	2.70	.00	.00	2.70	.00	.00	.00	.00	2.36	.00	2.36	5.07
112	FLT. CONTROL	3	.41	.00	.00	.41	.00	.00	.00	.00	7.84	.00	7.84	8.25
113	FLT. EVAL.	3	.00	.00	.00	.00	.00	.00	.00	.00	2.14	.00	2.14	2.14
114	FLT. SUPT. SFTWRE	3	2.81	.00	.00	2.81	.00	.00	.00	.00	1.51	.00	1.51	4.32
	TOTAL FLIGHT OPNS		5.92	.00	.00	5.92	.00	.00	.00	.00	13.84	.00	13.84	19.76
	TOTAL		5.92	.00	.00	5.92	.00	.00	.00	.00	13.84	.00	13.84	19.76

OPTION 3I 5 VEHICLES TUG 300IN 9/11/75 12:20 PM

WBS	COST ELEMENT	C	EDSD (MIL)	GTM (MIL)	FTM (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
120	FLIGHT OPNS DOD	3												
121	MISSION PLG	3	1.92	.00	.00	1.92	.00	.00	.00	.00	1.67	.00	1.67	3.59
122	FLT. CONTROL	3	.29	.00	.00	.29	.00	.00	.00	.00	5.84	.00	5.84	6.13
123	FLT. EVAL.	3	.00	.00	.00	.00	.00	.00	.00	.00	1.42	.00	1.42	1.42
124	FLT. SUPT. SFTWRE	3	1.99	.00	.00	1.99	.00	.00	.00	.00	1.09	.00	1.09	3.09
	TOTAL FLIGHT OPNS		4.20	.00	.00	4.20	.00	.00	.00	.00	10.03	.00	10.03	14.23
	TOTAL		4.20	.00	.00	4.20	.00	.00	.00	.00	10.03	.00	10.03	14.23

OPTION 31 5 VEHICLES TUG 300IR 9/11/73 12:30 PM

WBS	COST ELEMENT C	ED&D (MIL)	6TH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
130	REFURB &INTEG #TR3												
131	SCH MAINT & REF 3	.00	.00	.00	.00	.00	.00	.00	.00	.38	.00	.38	.38
132	UNSCH MAINT & REF3	.00	.00	.00	.00	.00	.00	.00	.00	.09	.00	.09	.09
133	POST MAINT C/O 3	.00	.00	.00	.00	.00	.00	.00	.00	.05	.00	.05	.05
134	TUG/PL MAING &/CO3	.00	.00	.00	.00	.00	.00	.00	.00	.21	.00	.21	.21
135	REFURB RQMTS PLG 3	.11	.00	.00	.11	.00	.00	.00	.00	.10	.00	.10	.21
136	DEPOT MAINT 3	.00	.00	.00	.00	.00	.00	.00	.00	1.94	.00	1.94	1.94
	TOTAL REFURB &INTE	.11	.00	.00	.11	.00	.00	.00	.00	2.77	.00	2.77	2.88
	TOTAL	.11	.00	.00	.11	.00	.00	.00	.00	2.77	.00	2.77	2.88

OPTION 3I 5 VEHICLES TUG 300IR 9/11/73 12:20 PM

WBS	COST ELEMENT	C	ED&D (MIL)	6TH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
140	REFURB &INTEG ETR	3												
141	SCH MAINT & REF	3	.00	.00	.00	.00	.00	.00	.00	.00	2.56	.00	2.56	2.56
142	UNSCH MAINT & REF	3	.00	.00	.00	.00	.00	.00	.00	.00	.63	.00	.63	.63
143	POST MAINT C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.13	.00	.13	.13
144	TUG/PL MATING,C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	1.60	.00	1.60	1.60
145	REFURB RQMTS PLG	3	.11	.00	.00	.11	.00	.00	.00	.00	.72	.00	.72	.83
146	DEPOT MAINT	3	.00	.00	.00	.00	.00	.00	.00	.00	18.15	.00	18.15	18.15
	TOTAL REFURB &INTE		.11	.00	.00	.11	.00	.00	.00	.00	23.79	.00	23.79	23.90
	TOTAL		.11	.00	.00	.11	.00	.00	.00	.00	23.79	.00	23.79	23.90

OPTION 3F 11 VEHICLES TUG300FR 9/11/73 8:30 PM

WBS	COST ELEMENT C	EDDD (MIL)	OTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
10	TOTAL PROJECT MGMT	3.00	.00	.00	3.00	.00	5.25	.00	5.25	5.92	.00	5.92	14.17
20	TOTAL SYS. ENGR. &	7.05	.00	.00	7.05	.00	44.06	.00	44.06	7.13	.00	7.13	58.25
30	TOTAL VEH MAIN STA	43.67	5.81	.00	49.48	17.40	115.88	4.61	120.50	2.87	9.86	12.73	182.71
40	TOTAL VEH AUX. STA	.00	.00	.00	.00	.00	4.97	.00	4.97	.00	.00	.00	4.97
50	TOTAL LOGISTICS	2.34	.00	.00	2.34	.00	.35	.00	.35	5.53	.00	5.53	8.22
60	TOTAL FACILITIES	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
70	TOTAL GRND. SUPT.	4.77	.00	.00	4.77	.00	1.68	.00	1.68	3.91	.00	3.91	10.36
80	TOTAL VEHICLE TEST	.00	13.70	.46	14.15	.00	.00	.00	.00	.00	.00	.00	14.15
90	TOTAL LAUNCH OPNS.	.00	.00	.00	.00	.00	.00	.00	.00	14.62	.00	14.62	14.62
100	TOTAL LAUNCH OPNS	.00	.00	.00	.00	.00	.00	.00	.00	35.87	.00	35.87	35.87
110	TOTAL FLIGHT OPNS	4.62	.00	.00	4.62	.00	.00	.00	.00	31.94	.00	31.94	36.56
120	TOTAL FLIGHT OPNS	3.18	.00	.00	3.18	.00	.00	.00	.00	24.31	.00	24.31	27.50
130	TOTAL REFURB &INTE	.11	.00	.00	.11	.00	.00	.00	.00	13.77	.00	13.77	13.88
140	TOTAL REFURB &INTE	.11	.00	.00	.11	.00	.00	.00	.00	48.70	.00	48.70	48.81
	TOTAL	68.85	19.51	.46	88.82	17.40	172.19	4.61	176.81	194.59	9.86	204.46	470.08

OPTION 3F 11 VEHICLES TU0300FR 9/11/73 0130 PM

WBS	COST ELEMENT	C	ED&D (MIL)	6TH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
10	PROJECT MGMT.	3												
11	COST/PERF. MGMT.	3	2.06	.00	.00	2.06	.00	3.57	.00	3.57	3.89	.00	3.89	9.52
12	PROJ. DIRECTION	3	.88	.00	.00	.88	.00	1.56	.00	1.56	1.86	.00	1.86	4.31
13	INFORM. MGMT.	3	.06	.00	.00	.06	.00	.11	.00	.11	.17	.00	.17	.34
	TOTAL PROJECT MGMT		3.00	.00	.00	3.00	.00	5.25	.00	5.25	5.92	.00	5.92	14.17
	TOTAL		3.00	.00	.00	3.00	.00	5.25	.00	5.25	5.92	.00	5.92	14.17

OPTION 3F 11 VEHICLES TUG300FR 9/11/73 8:30 PM

WBS	COST ELEMENT	C	ED&D (MIL)	8TH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
20	SYS. ENGR. & INT.	3												
21	TUG SYS. ENGR.	3	5.64	.00	.00	5.64	.00	6.42	.00	6.42	.00	.00	.00	12.06
22	SHUTTLE I/F	3	.35	.00	.00	.35	.00	1.61	.00	1.61	.00	.00	.00	1.96
23	PAYLOAD I/F	3	1.06	.00	.00	1.06	.00	3.21	.00	3.21	.00	.00	.00	4.27
24	SUST. ENGR.	3	.00	.00	.00	.00	.00	32.82	.00	32.82	7.13	.00	7.13	39.95
	TOTAL SYS. ENGR.	8	7.05	.00	.00	7.05	.00	44.06	.00	44.06	7.13	.00	7.13	58.25
	TOTAL		7.05	.00	.00	7.05	.00	44.06	.00	44.06	7.13	.00	7.13	58.25

6-2/9

OPTION 3F 11 VEHICLES TU03U8FR 9/11/73 8:30 PM

WBS	COST ELEMENT	C	EO&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
30	VEH MAIN STAGE	3												
31	STRUCTURES	3	3.22	.00	.00	3.22	1.99	15.02	.00	15.02	.00	.07	.07	18.31
32	THERMAL CONTROL	3	.00	.08	.00	.08	.49	3.67	.00	3.67	.00	.10	.10	3.85
33	AVIONICS	3	20.43	3.31	.00	24.14	5.77	45.82	3.20	48.72	2.87	6.70	9.57	82.42
34	PROPULSION	3	16.38	1.99	.00	18.38	4.20	31.81	1.14	32.95	.00	2.37	2.37	53.70
35	ORBITER I/F	3	.00	.00	.00	.00	2.30	1.93	.27	2.20	.00	.62	.62	2.83
36	DROP TANKS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
37	FINAL ASSY & C/O	3	3.23	.43	.00	3.67	2.65	17.94	.00	17.94	.00	.00	.00	21.61
	TOTAL VEH MAIN STA		43.67	5.81	.00	49.48	17.40	115.88	4.61	120.50	2.87	9.86	12.73	182.71
	TOTAL		43.67	5.81	.00	49.48	17.40	115.88	4.61	120.50	2.87	9.86	12.73	182.71

A1E-9

LEVEL 6

WBS	COST ELEMENT	C	EDSD (MIL)	OTH (MIL)	PTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
3101	FUEL TK & SUPT	3	.00	.00	.00	.00	.47	3.63	.00	3.63	.00	.00	.00	3.63
3102	OXID. TK & SUPT	3	.00	.00	.00	.00	.19	1.49	.00	1.49	.00	.00	.00	1.49
3103	BODY STRUCTURE	3	.00	.00	.00	.00	.10	.77	.00	.77	.00	.00	.00	.77
3104	THRUST STRUCTURE	3	.00	.00	.00	.00	.06	.49	.00	.49	.00	.00	.00	.49
3105	METEOROID SHIELD	3	.00	.00	.00	.00	.43	3.32	.00	3.32	.00	.00	.00	3.32
3106	PAYLOAD I/F	3	2.98	.00	.00	2.98	.57	4.39	.00	4.39	.00	.00	.00	7.37
3107	INSTL, ASSY & C/O	3	.24	.00	.00	.24	.15	.94	.00	.94	.00	.00	.00	1.18
31	STRUCTURE		3.22	.00	.00	3.22	1.99	15.02	.00	15.02	.00	.00	.00	18.24
3201	FUEL TANK INSL	3	.00	.05	.00	.05	.11	.81	.00	.81	.00	.01	.01	.87
3202	OXID. TANK INSL.	3	.00	.03	.00	.03	.05	.40	.00	.40	.00	.00	.00	.43
3203	INSL. PURGE SYS.	3	.00	.00	.00	.00	.30	2.31	.00	2.31	.00	.09	.09	2.39
3204	THERM CONT. SYS.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
3205	INSTL ASSY & C/O	3	.00	.00	.00	.00	.02	.15	.00	.15	.00	.00	.00	.15
32	THERMAL CONTROL		.00	.08	.00	.08	.48	3.67	.00	3.67	.00	.10	.10	3.85
3301	DATA MGMT.	3	8.20	.54	.00	8.74	1.50	11.43	.31	11.74	2.87	.36	3.23	23.71
3302	G N & C	3	3.10	.64	.00	3.74	.87	6.66	.51	7.17	.00	.36	.36	11.27
3303	COMMUNICATIONS	3	.00	.00	.00	.00	1.83	14.02	.14	14.16	.00	3.02	3.02	17.17
3304	INSTRUMENTATION	3	.00	.00	.00	.00	.18	1.36	.00	1.36	.00	.03	.03	1.39
3305	ELECT. POWER	3	4.72	1.85	.00	6.57	.93	8.83	2.24	11.07	.00	2.92	2.92	20.57
3306	PWR. DIST. & CONT	3	.00	.03	.00	.03	.03	.32	.00	.32	.00	.00	.00	.36
3307	INSTL, ASSY & C/O	3	4.81	.24	.00	5.05	.43	2.90	.00	2.90	.00	.00	.00	7.95
33	AVIONICS		20.83	3.31	.00	24.14	5.77	45.52	3.20	48.72	2.87	6.70	9.57	82.42
3401	MAIN ENGINE	3	.00	.00	.00	.00	.70	5.35	1.14	6.49	.00	1.06	1.06	7.55
3402	MAIN ENG. SUPT	3	5.23	.60	.00	5.83	2.00	15.26	.00	15.26	.00	.62	.62	21.71
3403	ACPS ENGINE	3	.76	.18	.00	.94	.18	1.36	.00	1.36	.00	.10	.10	2.39
3404	ACPS ENG. SUPT	3	9.62	1.12	.00	10.74	1.12	8.56	.00	8.56	.00	.60	.60	19.90
3405	INSTL, ASSY & C/O	3	.78	.09	.00	.87	.20	1.28	.00	1.28	.00	.00	.00	2.15
34	PROPULSION		16.38	1.99	.00	18.38	4.20	31.81	1.14	32.95	.00	2.37	2.37	53.70
3501	STRUCTURES	3	.00	.00	.00	.00	.36	.31	.01	.32	.00	.03	.03	.35
3502	I/F PANELS	3	.00	.00	.00	.00	1.49	1.26	.24	1.50	.00	.57	.57	2.07
3503	PURGE PROV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
3504	ABORT PROV.	3	.00	.00	.00	.00	.28	.24	.01	.25	.00	.02	.02	.27
3505	INSTL, ASSY & C/O	3	.00	.00	.00	.00	.17	.13	.00	.13	.00	.00	.00	.13
35	ORBITER I/F		.00	.00	.00	.00	2.30	1.93	.27	2.20	.00	.62	.62	2.83

LEVEL 6

WBS	COST ELEMENT	C	EDAD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
3701	FINAL ASSY	3	2.02	.27	.00	2.29	2.21	14.95	.00	14.95	.00	.00	.00	17.24
3702	C/O	3	1.21	.16	.00	1.37	.44	2.99	.00	2.99	.00	.00	.00	4.36
37	FINAL ASSY & C/O		3.23	.43	.00	3.67	2.65	17.94	.00	17.94	.00	.00	.00	21.61

LEVEL 7

WBS	COST ELEMENT	C	EO&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
310102	LH2 CYLINDER	3	.00	.00	.00	.00	.08	.00	.00	.00	.00	.00	.00	.00
310103	LH2 SUPPORTS	3	.00	.00	.00	.00	.31	.00	.00	.00	.00	.00	.00	.00
3101	FUEL TK & SUPT		.00	.00	.00	.00	.47	.00	.00	.00	.00	.00	.00	.00
310201	LO2 DOMES	3	.00	.00	.00	.00	.08	.00	.00	.00	.00	.00	.00	.00
310202	LO2 SUPPORTS	3	.00	.00	.00	.00	.12	.00	.00	.00	.00	.00	.00	.00
3102	OXID. TK & SUPT		.00	.00	.00	.00	.19	.00	.00	.00	.00	.00	.00	.00
310301	FWD AFT SKIRT	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
310302	INTERTANK	3	.00	.00	.00	.00	.05	.00	.00	.00	.00	.00	.00	.00
310303	SDWL SHELL	3	.00	.00	.00	.00	.05	.00	.00	.00	.00	.00	.00	.00
3103	BODY STRUCTURE		.00	.00	.00	.00	.10	.00	.00	.00	.00	.00	.00	.00
330101	SCU		4.00	.50	.00	4.50	1.25	.00	.00	.00	.00	.00	.00	4.50
330102	DATA DISTR.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330103	EQ. THERM CONT.	3	.00	.00	.00	.00	.11	.00	.00	.00	.00	.00	.00	.00
330104	CIRCUITRY	3	.00	.00	.00	.00	.03	.00	.00	.00	.00	.00	.00	.00
330105	SOFTWARE	3	3.60	.00	.00	3.60	.00	.00	.00	.00	2.87	.00	2.87	6.47
330106	SOFTWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330107	SOFTWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330108	INSTL. ASSY & C/O3		.61	.04	.00	.65	.11	.00	.00	.00	.00	.00	.00	.65
3301	DATA MGMT.		8.20	.54	.00	8.74	1.50	.00	.00	.00	2.87	.00	2.87	11.61
330201	I M U	3	2.44	.38	.00	2.81	.38	.00	.00	.00	.00	.00	.00	2.81
330202	TRACKING/ELECT	3	.00	.00	.00	.00	.32	.00	.00	.00	.00	.00	.00	.00
330203	REN DEZ&DOCKING	3	.43	.22	.00	.65	.11	.00	.00	.00	.00	.00	.00	.65
330204	INSTL. ASSY & C/O3		.23	.05	.00	.28	.06	.00	.00	.00	.00	.00	.00	.28
3302	G N & C		3.10	.64	.00	3.74	.87	.00	.00	.00	.00	.00	.00	3.74
330301	M/W CIRC +RF MUX	3	.00	.00	.00	.00	.40	.00	.00	.00	.00	.00	.00	.00
330302	TRANSPONDERS	3	.00	.00	.00	.00	.43	.00	.00	.00	.00	.00	.00	.00
330303	POWER AMP.	3	.00	.00	.00	.00	.18	.00	.00	.00	.00	.00	.00	.00
330304	ANTENNA	3	.00	.00	.00	.00	.09	.00	.00	.00	.00	.00	.00	.00
330305	DEC/ENC+MOD/DEM	3	.00	.00	.00	.00	.37	.00	.00	.00	.00	.00	.00	.00
330306	TAPE RECORDER	3	.00	.00	.00	.00	.15	.00	.00	.00	.00	.00	.00	.00
330307	P/L INTER EQUIP	3	.00	.00	.00	.00	.08	.00	.00	.00	.00	.00	.00	.00
330308	INSTL. ASSY & C/O3		.00	.00	.00	.00	.14	.00	.00	.00	.00	.00	.00	.00
3303	COMMUNICATIONS		.00	.00	.00	.00	1.83	.00	.00	.00	.00	.00	.00	.00

LEVEL 7

WBS	COST ELEMENT	C	EDSD (MIL)	OTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
330401	DATA SENSORS	3	.00	.00	.00	.00	.04	.00	.00	.00	.00	.00	.00	.00
330402	SIGNAL COND.	3	.00	.00	.00	.00	.04	.00	.00	.00	.00	.00	.00	.00
330403	CIRCUITRY	3	.00	.00	.00	.00	.09	.00	.00	.00	.00	.00	.00	.00
330404	INSTL. ASSY & C/O	3	.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00
3304	INSTRUMENTATION		.00	.00	.00	.00	.18	.00	.00	.00	.00	.00	.00	.00
330501	BATTERY	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330502	FUEL CELL	3	4.37	1.71	.00	6.08	.86	.00	.00	.00	.00	.00	.00	6.08
330503	INSTL. ASSY & C/O	3	.35	.14	.00	.49	.07	.00	.00	.00	.00	.00	.00	.49
3305	ELECT. POWER		4.72	1.85	.00	6.57	.93	.00	.00	.00	.00	.00	.00	6.57
330601	DISTR.	3	.00	.03	.00	.03	.03	.00	.00	.00	.00	.00	.00	.03
330602	TANKS SYSTEM	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330603	INSTL. ASSY & C/O		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
3306	PWR. DIST. & CONT		.00	.03	.00	.03	.03	.00	.00	.00	.00	.00	.00	.03

OPTION 3F 11 VEHICLES TUG300FN 9/11/73 0130 PM

WBS	COST ELEMENT	C	ED&D (MIL)	OTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
40	VEH AUX. STAGE	3												
41	VEH AUX. STAGE	3	.00	.00	.00	.00	.00	4.97	.00	4.97	.00	.00	.00	4.97
	TOTAL VEH AUX. STA		.00	.00	.00	.00	.00	4.97	.00	4.97	.00	.00	.00	4.97
	TOTAL		.00	.00	.00	.00	.00	4.97	.00	4.97	.00	.00	.00	4.97

6-319

OPTION 3F 11 VEHICLES TUG300FR 9/1[illegible]/3 8130 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
50	LOGISTICS	3												
51	TRANSP. & HDLG.	3	.00	.00	.00	.00	.00	.35	.00	.35	.23	.00	.23	.58
52	TRAINING	3	1.18	.00	.00	1.18	.00	.00	.00	.00	1.18	.00	1.18	2.37
53	INV CONT. & WHSNGS		1.16	.00	.00	1.16	.00	.00	.00	.00	4.11	.00	4.11	5.27
	TOTAL LOGISTICS		2.34	.00	.00	2.34	.00	.35	.00	.35	5.53	.00	5.53	8.22
	TOTAL		2.34	.00	.00	2.34	.00	.35	.00	.35	5.53	.00	5.53	8.22

LEVEL 6

WBS	COST ELEMENT	C	EO&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
5201	SIM. & EQUIP.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
5202	GROUND CREW	3	1.18	.00	.00	1.18	.00	.00	.00	.00	1.18	.00	1.18	2.37
52	TRAINING		1.18	.00	.00	1.18	.00	.00	.00	.00	1.18	.00	1.18	2.37

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
60	FACILITIES	3												
61	MANUFACTURING	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
62	TEST	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
63	ETR MAINT. & REF.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
64	ETR LAUNCH	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
65	WTR MAINT. & REF.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
66	WTR LAUNCH	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	TOTAL FACILITIES		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

LEVEL 6

WBS	COST ELEMENT	C	ED&D (MIL)	OTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
6101	DES./CONST.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6102	ACTIV./MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
61	MANUFACTURING		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6201	DES./CONST.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6202	ACTIV./MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
62	TEST		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6301	DES./CONST.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6302	ACTIV./MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
63	ETR MAINT. & REF.		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6401	DES./CONST.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6402	ACTIV./MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
64	ETR LAUNCH		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6501	DES./CONST.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6502	ACTIV./MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
65	WTR MAINT. & REF.		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6601	DES./CONST.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6602	ACTIV./MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
66	WTR LAUNCH		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

OPTION 3F 11 VEHICLES TUG300FR 9/11/73 8:30 PM

#85	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
70	GRND. SUPT. EQUIPS													
71	MFG. GSE	3	1.94	.00	.00	1.94	.00	1.68	.00	1.68	.00	.00	.00	3.61
72	ETR GSE	3	.94	.00	.00	.94	.00	.00	.00	.00	1.34	.00	1.34	2.28
73	WTR GSE	3	.95	.00	.00	.95	.00	.00	.00	.00	.40	.00	.40	1.35
74	FLT OPS GSE(NASA)		.47	.00	.00	.47	.00	.00	.00	.00	1.09	.00	1.09	1.56
75	FLT OPS GSE(DOD)		.47	.00	.00	.47	.00	.00	.00	.00	1.09	.00	1.09	1.56
	TOTAL GRND. SUPT.		4.77	.00	.00	4.77	.00	1.68	.00	1.68	3.91	.00	3.91	10.36
	TOTAL		4.77	.00	.00	4.77	.00	1.68	.00	1.68	3.91	.00	3.91	10.36

Page 7

LEVEL 6

WBS	COST ELEMENT	C	EDSD (MIL)	OTH (MIL)	PTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
7101	HARDWARE	3	1.69	.00	.00	1.69	.00	.00	.00	.00	.00	.00	.00	1.69
7102	SITE ACTIV.	3	.03	.00	.00	.03	.00	.00	.00	.00	.00	.00	.00	.03
7103	MAINT.	3	.00	.00	.00	.00	.00	1.68	.00	1.68	.00	.00	.00	1.68
7104	SOFTWARE	3	.21	.00	.00	.21	.00	.00	.00	.00	.00	.00	.00	.21
71	MFG. GSE		1.94	.00	.00	1.94	.00	1.68	.00	1.68	.00	.00	.00	3.61
7201	HARDWARE	3	.60	.00	.00	.60	.00	.00	.00	.00	.00	.00	.00	.60
7202	SITE ACTIV.	3	.20	.00	.00	.20	.00	.00	.00	.00	.00	.00	.00	.20
7203	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.15	.00	.15	.15
7204	SOFTWARE	3	.14	.00	.00	.14	.00	.00	.00	.00	1.18	.00	1.18	1.33
72	ETR GSE		.94	.00	.00	.94	.00	.00	.00	.00	1.34	.00	1.34	2.28
7301	HARDWARE	3	.61	.00	.00	.61	.00	.00	.00	.00	.00	.00	.00	.61
7302	SITE ACTIV.	3	.20	.00	.00	.20	.00	.00	.00	.00	.00	.00	.00	.20
7303	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.15	.00	.15	.15
7304	SOFTWARE	3	.14	.00	.00	.14	.00	.00	.00	.00	.25	.00	.25	.39
73	WTR GSE		.95	.00	.00	.95	.00	.00	.00	.00	.40	.00	.40	1.35
7401	HARDWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7402	SITE ACTIV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7403	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7404	SOFTWARE	3	.47	.00	.00	.47	.00	.00	.00	.00	1.09	.00	1.09	1.56
74	HARDWA(5) SUBTOTAL		.47	.00	.00	.47	.00	.00	.00	.00	1.09	.00	1.09	1.56
7501	HARDWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7502	SITE ACTIV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7503	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7504	SOFTWARE	3	.47	.00	.00	.47	.00	.00	.00	.00	1.09	.00	1.09	1.56
75	HARDWA(5) SUBTOTAL		.47	.00	.00	.47	.00	.00	.00	.00	1.09	.00	1.09	1.56

OPTION 3F 11 VEHICLES TUG300FR 9/11/73 8:30 PM

WBS	COST ELEMENT	C	EDAD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPHS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
80	VEHICLE TEST	3												
81	GND TEST HDWE.	3	.00	8.70	.00	8.70	.00	.00	.00	.00	.00	.00	.00	8.70
82	GND TEST OPNS.	3	.00	5.00	.00	5.00	.00	.00	.00	.00	.00	.00	.00	5.00
83	FLT. TEST HDWE.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
84	FLT. TEST OPNS	3	.00	.00	.46	.46	.00	.00	.00	.00	.00	.00	.00	.46
	TOTAL VEHICLE TEST		.00	13.70	.46	14.15	.00	.00	.00	.00	.00	.00	.00	14.15
	TOTAL		.00	13.70	.46	14.15	.00	.00	.00	.00	.00	.00	.00	14.15

LEVEL 6

WBS	COST ELEMENT	C	EDAD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
8101	PTV TEST	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8102	MAJOR TEST ART.	3	.00	8.31	.00	8.31	.00	.00	.00	.00	.00	.00	.00	8.31
8103	MOCKUPS	3	.00	.38	.00	.38	.00	.00	.00	.00	.00	.00	.00	.38
81	GND TEST HDWE.		.00	8.70	.00	8.70	.00	.00	.00	.00	.00	.00	.00	8.70
8301	STRUCTURES	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8302	THERMAL CONTROL	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8303	AVIONICS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8304	PROPULSION	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8305	ORBITER I/F	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8306	DROP TANKS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8307	FINAL ASSY & C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
83	FLT. TEST HDWE.		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

LEVEL 7

WBS	COST ELEMENT	C	ED&D (MIL)	OTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
830102	OXID. TK & SUPT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830103	BODY STRUCTURE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830104	THRUST STRUCTURE		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830105	METEOROID SHIELD	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830106	PAYLOAD I/F	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830107	INSTL, ASSY & C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8301	STRUCTURES		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830201	FUEL TANK INSL	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830202	OXID TANK INSL	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830203	INSL PURGE SYS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830204	THERM CONT SYS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830205	INSTL, ASSY & C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8302	THERMAL CONTROL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830301	DATA MGMT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830302	G N & C	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830303	COMMUNICATIONS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830304	INSTRUMENTATION	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830305	ELECT. POWER	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830306	PWR DIST. & CONT	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830307	INSTL, ASSY & C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8303	AVIONICS		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830401	MAIN ENGINE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830402	MAIN ENG SUPT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830403	ACPS ENGINE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830404	ACPS ENG SUPT	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830405	INSTL, ASSY & C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8304	PROPULSION		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830501	STRUCTURES	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830502	I/F PANELS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830503	PURGE PROV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830504	ABORT PROV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830505	INSTL, ASSY & C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8305	ORBITER I/F		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

LEVEL 7

WBS	COST ELEMENT	C	ED&O (MIL)	OTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
830701	FINAL ASSY	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830702	C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8307	FINAL ASSY & C/O		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

SEE-7

OPTION 3F 11 VEHICLES TUG300FR 9/11/73 8:30 PM

WBS	COST ELEMENT	C	EDSD (MIL)	BTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
90	LAUNCH OPNS. WTR	3												
91	LNCH SITE SVCES	3	.00	.00	.00	.00	.00	.00	.00	.00	5.43	.00	5.43	5.43
92	TUG/SHTL MATING	3	.00	.00	.00	.00	.00	.00	.00	.00	1.70	.00	1.70	1.70
93	PRELAUNCH C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	1.95	.00	1.95	1.95
94	COUNTDOWN	3	.00	.00	.00	.00	.00	.00	.00	.00	3.06	.00	3.06	3.06
95	PRLNTS. & GASES	3	.00	.00	.00	.00	.00	.00	.00	.00	.32	.00	.32	.32
96	POST FLT. SAFING	3	.00	.00	.00	.00	.00	.00	.00	.00	2.15	.00	2.15	2.15
	TOTAL LAUNCH OPNS.		.00	.00	.00	.00	.00	.00	.00	.00	14.62	.00	14.62	14.62
	TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	14.62	.00	14.62	14.62

OPTION 3F 11 VEHICLES TUG300FR 9/11/73 8:30 PM

WBS	COST ELEMENT	C	EO&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
100	LAUNCH OPNS ETR	3												
101	LNCH SITE SVCES	3	.00	.00	.00	.00	.00	.00	.00	.00	13.01	.00	13.01	13.01
102	TUG/SHTL MATING	3	.00	.00	.00	.00	.00	.00	.00	.00	3.74	.00	3.74	3.74
103	PRELAUNCH C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	4.55	.00	4.55	4.55
104	COUNTDOWN	3	.00	.00	.00	.00	.00	.00	.00	.00	7.54	.00	7.54	7.54
105	PRLNTS & GASES	3	.00	.00	.00	.00	.00	.00	.00	.00	1.51	.00	1.51	1.51
106	POST FLT. SAFING	3	.00	.00	.00	.00	.00	.00	.00	.00	5.52	.00	5.52	5.52
	TOTAL LAUNCH OPNS		.00	.00	.00	.00	.00	.00	.00	.00	35.87	.00	35.87	35.87
	TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	35.87	.00	35.87	35.87

OPTION 3F 11 VEHICLES TUG306FR 9/11/73 8:30 PM

WBS	COST ELEMENT	C	ED&D (MIL)	OTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
110	FLIGHT OPNS NASA	3												
111	MISSION PLG.	3	4.10	.00	.00	4.10	.00	.00	.00	.00	6.86	.00	6.86	10.95
112	FLT. CONTROL	3	.28	.00	.00	.28	.00	.00	.00	.00	13.94	.00	13.94	14.22
113	FLT. EVAL.	3	.00	.00	.00	.00	.00	.00	.00	.00	7.68	.00	7.68	7.68
114	FLT. SUPT. SFTWRE	3	.24	.00	.00	.24	.00	.00	.00	.00	3.47	.00	3.47	3.71
	TOTAL FLIGHT OPNS		4.62	.00	.00	4.62	.00	.00	.00	.00	31.94	.00	31.94	36.56
	TOTAL		4.62	.00	.00	4.62	.00	.00	.00	.00	31.94	.00	31.94	36.56

OPTION 3F 11 VEHICLES TUG500FR 9/11/73 8:30 PM

WBS	COST ELEMENT	C	EO&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
120	FLIGHT OPNS DOD	3												
121	MISSION PLG	3	2.62	.00	.00	2.62	.00	.00	.00	.00	5.73	.00	5.73	8.55
122	FLT. CONTROL	3	.19	.00	.00	.19	.00	.00	.00	.00	9.51	.00	9.51	9.71
123	FLT. EVAL.	3	.00	.00	.00	.00	.00	.00	.00	.00	6.43	.00	6.43	6.43
124	FLT. SUPT. SFTWRE	3	.16	.00	.00	.16	.00	.00	.00	.00	2.64	.00	2.64	2.81
	TOTAL FLIGHT OPNS		3.18	.00	.00	3.18	.00	.00	.00	.00	24.31	.00	24.31	27.50
	TOTAL		3.18	.00	.00	3.18	.00	.00	.00	.00	24.31	.00	24.31	27.50

OPTION 3F 11 VEHICLES TUG300FR 9/11/73 8:30 PM

WBS	COST ELEMENT C	ED&D (MIL)	OTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
130	REFURB &INTEG WTR3												
131	SCH MAINT & REF 3	.00	.00	.00	.00	.00	.00	.00	.00	3.19	.00	3.19	3.19
132	UNSCH MAINT & REF3	.00	.00	.00	.00	.00	.00	.00	.00	.63	.00	.63	.63
133	POST MAINT C/O 3	.00	.00	.00	.00	.00	.00	.00	.00	.16	.00	.16	.16
134	TUG/PL MAING &/CO3	.00	.00	.00	.00	.00	.00	.00	.00	2.24	.00	2.24	2.24
135	REFURB RQMTS PLG 3	.11	.00	.00	.11	.00	.00	.00	.00	.77	.00	.77	.88
136	DEPOT MAINT 3	.00	.00	.00	.00	.00	.00	.00	.00	6.77	.00	6.77	6.77
	TOTAL REFURB &INTE	.11	.00	.00	.11	.00	.00	.00	.00	13.77	.00	13.77	13.88
	TOTAL	.11	.00	.00	.11	.00	.00	.00	.00	13.77	.00	13.77	13.88

OPTION 3F 11 VEHICLES TH6300FR 9/11/73 8:30 PM

WBS	COST ELEMENT C	EDØD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
140	REFURB &INTEG ETR3												
141	SCH MAINT & REF 3	.00	.00	.00	.00	.00	.00	.00	.00	7.58	.00	7.58	7.58
142	UNSCH MAINT & REF3	.00	.00	.00	.00	.00	.00	.00	.00	1.47	.00	1.47	1.47
143	POST MAINT C/O 3	.00	.00	.00	.00	.00	.00	.00	.00	.38	.00	.38	.38
144	TUG/PL MATING,C/O3	.00	.00	.00	.00	.00	.00	.00	.00	5.36	.00	5.36	5.36
145	REFURB RQMTS PLG 3	.11	.00	.00	.11	.00	.00	.00	.00	1.80	.00	1.80	1.91
146	DEPOT MAINT 3	.00	.00	.00	.00	.00	.00	.00	.00	32.11	.00	32.11	32.11
	TOTAL REFURB &INTE	.11	.00	.00	.11	.00	.00	.00	.00	48.70	.00	48.70	48.81
	TOTAL	.11	.00	.00	.11	.00	.00	.00	.00	48.70	.00	48.70	48.81

5F2.7

OPTION 3 TOTAL 16 VEHICLES TUG300R 9/12/73 8:20 AM

#86	COST ELEMENT C	ED&D (MIL)	GTH + (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
10	TOTAL PROJECT MGMT	9.86	.00	.00	9.86	.00	7.72	.00	7.72	8.18	.00	8.18	25.77
20	TOTAL SYS. ENGR. &	21.55	.00	.00	21.55	.00	67.75	.00	67.75	10.45	.00	10.45	99.75
30	TOTAL VEH MAIN STA	133.46	17.12	.00	150.57	32.08	171.86	7.21	179.07	3.70	17.48	21.18	350.83
40	TOTAL VEH AUX. STA	1.62	.00	.00	1.62	.00	17.16	.00	17.16	.00	.00	.00	18.79
50	TOTAL LOGISTICS	4.01	.00	.00	4.01	.00	.50	.00	.50	8.04	.00	8.04	12.55
60	TOTAL FACILITIES	5.17	.00	.00	5.17	.00	.44	.00	.44	1.21	.00	1.21	6.81
70	TOTAL GRND. SUPT.	32.42	.00	.00	32.42	.00	2.87	.00	2.87	10.22	.00	10.22	45.51
80	TOTAL VEHICLE TEST	.00	34.04	1.31	35.35	.00	.00	.00	.00	.00	.00	.00	35.35
90	TOTAL LAUNCH OPNS.	.00	.00	.00	.00	.00	.00	.00	.00	16.47	.00	16.47	16.47
100	TOTAL LAUNCH OPNS	.00	.00	.00	.00	.00	.00	.00	.00	48.12	.00	48.12	48.12
110	TOTAL FLIGHT OPNS	10.54	.00	.00	10.54	.00	.00	.00	.00	45.79	.00	45.79	56.32
120	TOTAL FLIGHT OPNS	7.38	.00	.00	7.38	.00	.00	.00	.00	34.34	.00	34.34	41.72
130	TOTAL REFURB &INTE	.22	.00	.00	.22	.00	.00	.00	.00	16.54	.00	16.54	16.76
140	TOTAL REFURB &INTE	.22	.00	.00	.22	.00	.00	.00	.00	72.49	.00	72.49	72.71
	TOTAL	226.45	51.16	1.31	278.92	32.08	268.32	7.21	275.53	275.54	17.48	293.02	847.47

7FC-7

OPTION 3 TOTAL 16 VEHICLES TUG300H 9/12/73 8:20 AM

WBS	COST ELEMENT	C	EDSD (MIL)	BTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
10	PROJECT MGMT.	3												
11	COST/PERF. MGMT.	3	6.77	.00	.00	6.77	.00	5.26	.00	5.26	5.38	.00	5.38	17.40
12	PROJ. DIRECTION	3	2.90	.00	.00	2.90	.00	2.30	.00	2.30	2.57	.00	2.57	7.77
13	INFORM. MGMT.	3	.19	.00	.00	.19	.00	.16	.00	.16	.23	.00	.23	.59
	TOTAL PROJECT MGMT		9.86	.00	.00	9.86	.00	7.72	.00	7.72	8.18	.00	8.18	25.77
	TOTAL		9.86	.00	.00	9.86	.00	7.72	.00	7.72	8.18	.00	8.18	25.77

OPTION 3 TOTAL 16 VEHICLES TUG500H 9/12/73 9:20 AM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
20	SYS. ENGR. & INT.	3												
21	TUG SYS. ENGR.	3	17.24	.00	.00	17.24	.00	9.41	.00	9.41	.00	.00	.00	26.65
22	SHUTTLE I/F	3	1.08	.00	.00	1.08	.00	2.36	.00	2.36	.00	.00	.00	3.44
23	PAYLOAD I/F	3	3.23	.00	.00	3.23	.00	4.70	.00	4.70	.00	.00	.00	7.93
24	SUST. ENGR.	3	.00	.00	.00	.00	.00	51.28	.00	51.28	10.45	.00	10.45	61.72
	TOTAL SYS. ENGR. &		21.55	.00	.00	21.55	.00	67.75	.00	67.75	10.45	.00	10.45	99.75
	TOTAL		21.55	.00	.00	21.55	.00	67.75	.00	67.75	10.45	.00	10.45	99.75

8 EC-7

OPTION 3 TOTAL 16 VEHICLES TUG300R 9/12/73 8:20 AM

WBS	COST ELEMENT	C	EDØD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
30	VEH MAIN STAGE	3												
31	STRUCTURES	3	20.93	.00	.00	20.93	3.72	21.74	.00	21.74	.00	.28	.28	42.94
32	THERMAL CONTROL	3	.93	.59	.00	1.52	.97	5.55	.00	5.55	.00	.16	.16	7.23
33	AVIONICS	3	43.00	6.64	.00	49.72	10.35	63.49	3.75	67.24	3.70	10.79	14.49	131.45
34	PROPULSION	3	44.73	6.31	.00	51.04	7.54	44.92	2.96	47.88	.00	5.09	5.09	104.02
35	ORBITER I/F	3	10.29	2.30	.00	12.59	4.60	10.66	.50	11.16	.00	1.16	1.16	24.91
36	DROP TANKS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
37	FINAL ASSY & C/O	3	13.50	1.27	.00	14.77	4.89	25.51	.00	25.51	.00	.00	.00	40.28
	TOTAL VEH MAIN STA		133.46	17.12	.00	150.57	32.08	171.86	7.21	179.07	3.70	17.48	21.18	350.83
	TOTAL		133.46	17.12	.00	150.57	32.08	171.86	7.21	179.07	3.70	17.48	21.18	350.83

5E.7

LEVEL 6

WBS	COST ELEMENT	C	EDAD (MIL)	8TH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
3101	FUEL TK & SUPT	3	4.85	.00	.00	4.85	.95	5.48	.00	5.48	.00	.00	.00	10.34
3102	OXID. TK & SUPT	3	2.62	.00	.00	2.62	.39	2.25	.00	2.25	.00	.00	.00	4.87
3103	BODY STRUCTURE	3	4.09	.00	.00	4.09	.20	1.16	.00	1.16	.00	.00	.00	5.25
3104	THRUST STRUCTURE	3	1.38	.00	.00	1.38	.13	.74	.00	.74	.00	.00	.00	2.12
3105	METEOROID SHIELD	3	.98	.00	.00	.98	.87	5.03	.00	5.03	.00	.00	.00	6.01
3106	PAYLOAD I/F	3	5.45	.00	.00	5.45	.90	5.70	.00	5.70	.00	.00	.00	11.15
3107	INSTL, ASSY & C/03		1.55	.00	.00	1.55	.28	1.38	.00	1.38	.00	.00	.00	2.93
31	STRUCTURE		20.93	.00	.00	20.93	3.72	21.74	.00	21.74	.00	.00	.00	42.66
3201	FUEL TANK INSL	3	.16	.05	.00	.22	.21	1.23	.00	1.23	.00	.02	.02	1.47
3202	OXID. TANK INSL.	3	.08	.03	.00	.11	.10	.60	.00	.60	.00	.02	.02	.73
3203	INSL. PURGE SYS.	3	.64	.49	.00	1.13	.60	3.49	.00	3.49	.00	.12	.12	4.74
3204	THERM CONT. SYS.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
3205	INSTL ASSY & C/O	3	.04	.03	.00	.07	.05	.22	.00	.22	.00	.00	.00	.30
32	THERMAL CONTROL		.93	.59	.00	1.52	.97	5.55	.00	5.55	.00	.16	.16	7.23
3301	DATA MGMT.	3	16.61	1.88	.00	18.49	2.52	15.49	.50	15.99	3.70	.72	4.42	38.89
3302	G N & C	3	4.57	.64	.00	5.21	1.99	11.03	.52	11.56	.00	.41	.41	17.17
3303	COMMUNICATIONS	3	4.26	1.62	.00	5.89	3.67	21.20	.40	21.60	.00	3.63	3.63	31.12
3304	INSTRUMENTATION	3	2.04	.04	.00	2.08	.36	2.06	.00	2.06	.00	.24	.24	4.38
3305	ELECT. POWER	3	4.81	1.90	.00	6.71	.98	9.17	2.33	11.50	.00	5.79	5.79	23.99
3306	PWR. DIST. & CONTS		.85	.07	.00	.91	.07	.48	.00	.48	.00	.01	.01	1.40
3307	INSTL, ASSY & C/03		9.94	.49	.00	10.43	.77	4.06	.00	4.06	.00	.00	.00	14.49
33	AVIONICS		43.08	6.64	.00	49.72	10.35	63.49	3.75	67.24	3.70	10.79	14.49	131.45
3401	MAIN ENGINE	3	13.00	.00	.00	13.00	1.40	8.09	2.38	10.47	.00	2.63	2.63	26.09
3402	MAIN ENG. SUPT	3	14.06	3.85	.00	17.91	3.62	21.67	.00	21.67	.00	1.07	1.07	40.66
3403	ACPS ENGINE	3	1.04	.30	.00	1.34	.30	1.84	.59	2.43	.00	.69	.69	4.47
3404	ACPS ENG. SUPT	3	14.50	1.86	.00	16.36	1.86	11.49	.00	11.49	.00	.70	.70	28.55
3405	INSTL, ASSY & C/03		2.13	.30	.00	2.43	.36	1.82	.00	1.82	.00	.00	.00	4.25
34	PROPULSION		44.73	6.31	.00	51.04	7.54	44.92	2.96	47.88	.00	5.09	5.09	104.02
3501	STRUCTURES	3	3.65	.36	.00	4.01	.72	1.69	.03	1.72	.00	.08	.08	5.79
3502	I/F PANELS	3	4.99	1.49	.00	6.47	2.97	6.96	.45	7.41	.00	1.06	1.06	14.95
3503	PURGE PROV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
3504	ABORT PROV.	3	.89	.28	.00	1.17	.56	1.32	.02	1.34	.00	.04	.04	2.54
3505	INSTL, ASSY & C/03		.76	.17	.00	.93	.34	.69	.00	.69	.00	.00	.00	1.63
35	ORBITER I/F		10.29	2.30	.00	12.59	4.60	10.66	.80	11.16	.00	1.18	1.18	24.91

LEVEL 6

WBS	COST ELEMENT	C	EDOD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPKS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPKS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
3701	FINAL ASSY	3	9.90	.79	.00	10.70	4.08	21.26	.00	21.26	.00	.00	.00	31.96
3702	C/O	3	3.60	.48	.00	4.07	.82	4.25	.00	4.25	.00	.00	.00	8.33
37	FINAL ASSY & C/O		13.50	1.27	.00	14.77	4.89	25.51	.00	25.51	.00	.00	.00	40.28

1457

LEVEL 7

WBS	COST ELEMENT	C	EO&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
310101	LH2 DOMES	3	1.70	.00	.00	1.70	.16	.00	.00	.00	.00	.00	.00	1.70
310102	LH2 CYLINDER	3	2.24	.00	.00	2.24	.17	.00	.00	.00	.00	.00	.00	2.24
310103	LH2 SUPPORTS	3	.91	.00	.00	.91	.62	.00	.00	.00	.00	.00	.00	.91
3101	FUEL TK & SUPT		4.85	.00	.00	4.85	.95	.00	.00	.00	.00	.00	.00	4.85
310201	LO2 DOMES	3	1.99	.00	.00	1.99	.15	.00	.00	.00	.00	.00	.00	1.99
310202	LO2 SUPPORTS	3	.63	.00	.00	.63	.24	.00	.00	.00	.00	.00	.00	.63
3102	OXID. TK & SUPT		2.62	.00	.00	2.62	.39	.00	.00	.00	.00	.00	.00	2.62
310301	FWD AFT SKIRT	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
310302	INTERTANK	3	1.98	.00	.00	1.98	.10	.00	.00	.00	.00	.00	.00	1.98
310303	SOWL SHELL	3	2.11	.00	.00	2.11	.11	.00	.00	.00	.00	.00	.00	2.11
3103	BODY STRUCTURE		4.09	.00	.00	4.09	.20	.00	.00	.00	.00	.00	.00	4.09
330101	COMPUTER	3	8.59	1.32	.00	9.90	2.07	.00	.00	.00	.00	.00	.00	9.90
330102	DATA DISTR.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330103	EQ. THERM CONT.	3	.33	.42	.00	.75	.21	.00	.00	.00	.00	.00	.00	.75
330104	CIRCUITRY	3	.53	.00	.00	.54	.05	.00	.00	.00	.00	.00	.00	.54
330105	SOFTWARE	3	5.93	.00	.00	5.93	.00	.00	.00	.00	3.70	.00	3.70	9.63
330106	SOFTWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330107	SOFTWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330108	INSTL, ASSY & C/O3		1.23	.14	.00	1.37	.19	.00	.00	.00	.00	.00	.00	1.37
3301	DATA MGMT.		16.61	1.88	.00	18.49	2.52	.00	.00	.00	3.70	.00	3.70	22.19
330201	I M U	3	3.15	.38	.00	3.53	1.09	.00	.00	.00	.00	.00	.00	3.53
330202	TRACKING/ELECT	3	.65	.00	.00	.65	.65	.00	.00	.00	.00	.00	.00	.65
330203	REN DEZ&DOCKING	3	.43	.22	.00	.65	.11	.00	.00	.00	.00	.00	.00	.65
330204	INSTL, ASSY & C/O3		.34	.05	.00	.39	.15	.00	.00	.00	.00	.00	.00	.39
3302	G N & C		4.57	.64	.00	5.21	1.99	.00	.00	.00	.00	.00	.00	5.21
330301	M/W CIRC +RF MUX	3	1.40	.80	.00	2.20	.80	.00	.00	.00	.00	.00	.00	2.20
330302	TRANSPONDERS	3	.87	.00	.00	.87	.85	.00	.00	.00	.00	.00	.00	.87
330303	POWER AMP.	3	.38	.00	.00	.39	.36	.00	.00	.00	.00	.00	.00	.39
330304	ANTENNA	3	.18	.18	.00	.36	.18	.00	.00	.00	.00	.00	.00	.36
330305	DEC/ENC+MOD/DEM	3	.75	.38	.00	1.13	.75	.00	.00	.00	.00	.00	.00	1.13
330306	TAPE RECORDER	3	.12	.15	.00	.27	.30	.00	.00	.00	.00	.00	.00	.27
330307	P/L INTER EQUIP	3	.24	.00	.00	.24	.16	.00	.00	.00	.00	.00	.00	.24
330308	INSTL, ASSY & C/O3		.32	.12	.00	.44	.27	.00	.00	.00	.00	.00	.00	.44
3303	COMMUNICATIONS		4.26	1.62	.00	5.89	3.67	.00	.00	.00	.00	.00	.00	5.89

LEVEL 7

WBS	COST ELEMENT	C	EDSD (MIL)	OTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
330401	DATA SENSORS	3	.06	.00	.00	.06	.08	.00	.00	.00	.00	.00	.00	.06
330402	SIGNAL COND.	3	.10	.04	.00	.14	.08	.00	.00	.00	.00	.00	.00	.14
330403	CIRCUITRY	3	1.73	.00	.00	1.73	.17	.00	.00	.00	.00	.00	.00	1.73
330404	INSTL, ASSY & C/O	3	.15	.00	.00	.15	.03	.00	.00	.00	.00	.00	.00	.15
3304	INSTRUMENTATION		2.04	.04	.00	2.08	.36	.00	.00	.00	.00	.00	.00	2.08
330501	BATTERY	3	.08	.05	.00	.13	.05	.00	.00	.00	.00	.00	.00	.13
330502	FUEL CELL	3	4.37	1.71	.00	6.08	.86	.00	.00	.00	.00	.00	.00	6.08
330503	INSTL, ASSY & C/O	3	.36	.14	.00	.50	.07	.00	.00	.00	.00	.00	.00	.50
3305	ELECT. POWER		4.81	1.90	.00	6.71	.98	.00	.00	.00	.00	.00	.00	6.71
330601	DISTR.	3	.78	.06	.00	.85	.06	.00	.00	.00	.00	.00	.00	.85
330602	TANKS SYSTEM	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330603	INSTL, ASSY & C/O		.06	.00	.00	.07	.00	.00	.00	.00	.00	.00	.00	.07
3306	PWR. DIST. & CONT		.85	.07	.00	.91	.07	.00	.00	.00	.00	.00	.00	.91

OPTION 3 TOTAL 16 VEHICLES TUG300R 9/12/73 8:20 AM

WBS	COST ELEMENT	C	ED&D (MIL)	BTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
40	VEH AUX. STAGE	3												
41	VEH AUX. STAGE	3	1.62	.00	.00	1.62	.00	17.16	.00	17.16	.00	.00	.00	18.79
	TOTAL VEH AUX. STA		1.62	.00	.00	1.62	.00	17.16	.00	17.16	.00	.00	.00	18.79
	TOTAL		1.62	.00	.00	1.62	.00	17.16	.00	17.16	.00	.00	.00	18.79

OPTION 3 TOTAL 16 VEHICLES TUG300R 9/12/73 8:20 AM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
50	LOGISTICS	3												
51	TRANSP. & HDLG.	3	.00	.00	.00	.00	.00	.50	.00	.50	.33	.00	.33	.84
52	TRAINING	3	2.55	.00	.00	2.55	.00	.00	.00	.00	2.55	.00	2.55	5.11
53	INV CONT. & WHSNG	3	1.45	.00	.00	1.45	.00	.00	.00	.00	5.15	.00	5.15	6.60
	TOTAL LOGISTICS		4.01	.00	.00	4.01	.00	.50	.00	.50	8.04	.00	8.04	12.55
	TOTAL		4.01	.00	.00	4.01	.00	.50	.00	.50	8.04	.00	8.04	12.55

LEVEL 6

WBS	COST ELEMENT	C	ED&D (MIL)	6TH (MIL)	FTH (MIL)	TOTAL DUT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
5201	SIM. & EQUIP.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
5202	GROUND CREW	3	2.55	.00	.00	2.55	.00	.00	.00	.00	2.55	.00	2.55	5.10
52	TRAINING		2.55	.00	.00	2.55	.00	.00	.00	.00	2.55	.00	2.55	5.11

OPTION 3 TOTAL 16 VEHICLES TUG300R 9/13/73 8:20 AM

WBS	COST ELEMENT	C	EDSD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
60	FACILITIES	3												
61	MANUFACTURING	3	1.12	.00	.00	1.12	.00	.44	.00	.44	.00	.00	.00	1.56
62	TEST	3	1.50	.00	.00	1.50	.00	.00	.00	.00	.00	.00	.00	1.50
63	ETR MAINT. & REF.	3	1.02	.00	.00	1.02	.00	.00	.00	.00	.55	.00	.55	1.57
64	ETR LAUNCH	3	.39	.00	.00	.39	.00	.00	.00	.00	.21	.00	.21	.60
65	WTR MAINT. & REF.	3	.76	.00	.00	.76	.00	.00	.00	.00	.30	.00	.30	1.06
66	WTR LAUNCH	3	.38	.00	.00	.38	.00	.00	.00	.00	.15	.00	.15	.53
	TOTAL FACILITIES		5.17	.00	.00	5.17	.00	.44	.00	.44	1.21	.00	1.21	6.81
	TOTAL		5.17	.00	.00	5.17	.00	.44	.00	.44	1.21	.00	1.21	6.81

(1E-7)

LEVEL 6

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
6101	DES./CONST.	3	1.09	.00	.00	1.09	.00	.00	.00	.00	.00	.00	.00	1.09
6102	ACTIV./MAINT.	3	.02	.00	.00	.02	.00	.44	.00	.44	.00	.00	.00	.46
61	MANUFACTURING		1.12	.00	.00	1.12	.00	.44	.00	.44	.00	.00	.00	1.56
6201	DES./CONST.	3	1.50	.00	.00	1.50	.00	.00	.00	.00	.00	.00	.00	1.50
6202	ACTIV./MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
62	TEST		1.50	.00	.00	1.50	.00	.00	.00	.00	.00	.00	.00	1.50
6301	DES./CONST.	3	1.00	.00	.00	1.00	.00	.00	.00	.00	.00	.00	.00	1.00
6302	ACTIV./MAINT.	3	.02	.00	.00	.02	.00	.00	.00	.00	.55	.00	.55	.57
63	ETR MAINT. & REF.		1.02	.00	.00	1.02	.00	.00	.00	.00	.55	.00	.55	1.57
6401	DES./CONST.	3	.38	.00	.00	.38	.00	.00	.00	.00	.00	.00	.00	.38
6402	ACTIV./MAINT.	3	.01	.00	.00	.01	.00	.00	.00	.00	.21	.00	.21	.22
64	ETR LAUNCH		.39	.00	.00	.39	.00	.00	.00	.00	.21	.00	.21	.60
6501	DES./CONST.	3	.75	.00	.00	.75	.00	.00	.00	.00	.00	.00	.00	.75
6502	ACTIV./MAINT.	3	.01	.00	.00	.01	.00	.00	.00	.00	.30	.00	.30	.31
65	WTR MAINT. & REF.		.76	.00	.00	.76	.00	.00	.00	.00	.30	.00	.30	1.06
6601	DES./CONST.	3	.37	.00	.00	.37	.00	.00	.00	.00	.00	.00	.00	.37
6602	ACTIV./MAINT.	3	.01	.00	.00	.01	.00	.00	.00	.00	.15	.00	.15	.16
66	WTR LAUNCH		.38	.00	.00	.38	.00	.00	.00	.00	.15	.00	.15	.53

OPTION 3 TOTAL 16 VEHICLES TU6300R 9/12/73 8:20 AM

WBS	COST ELEMENT	C	EO&D (MIL)	OTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
70	GRND. SUPT. EQUIPS													
71	MFG. GSE	3	8.83	.00	.00	8.83	.00	2.87	.00	2.87	.00	.00	.00	11.70
72	ETH GSE	3	11.18	.00	.00	11.18	.00	.00	.00	.00	3.79	.00	3.79	14.98
73	WTR GSE	3	10.51	.00	.00	10.51	.00	.00	.00	.00	2.08	.00	2.08	12.59
74	FLT OPS GSE(NASA)		.95	.00	.00	.95	.00	.00	.00	.00	2.17	.00	2.17	3.12
75	FLT OPS GSE(DOD)		.95	.00	.00	.95	.00	.00	.00	.00	2.17	.00	2.17	3.12
	TOTAL GRND. SUPT.		32.42	.00	.00	32.42	.00	2.87	.00	2.87	10.22	.00	10.22	45.51
	TOTAL		32.42	.00	.00	32.42	.00	2.87	.00	2.87	10.22	.00	10.22	45.51

SPE-7

LEVEL 6

WBS	COST ELEMENT	C	EU&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TO OPER (MIL)	TOTAL (MIL)
7101	HARDWARE	3	6.11	.00	.00	6.11	.00	.00	.00	.00	.00	.00	.00	6.11
7102	SITE ACTIV.	3	.12	.00	.00	.12	.00	.00	.00	.00	.00	.00	.00	.12
7103	MAINT.	3	.00	.00	.00	.00	.00	2.87	.00	2.87	.00	.00	.00	2.87
7104	SOFTWARE	3	2.59	.00	.00	2.59	.00	.00	.00	.00	.00	.00	.00	2.59
71	MFG. GSE		8.83	.00	.00	8.83	.00	2.87	.00	2.87	.00	.00	.00	11.70
7201	HARDWARE	3	7.09	.00	.00	7.09	.00	.00	.00	.00	.00	.00	.00	7.09
7202	SITE ACTIV.	3	2.34	.00	.00	2.34	.00	.00	.00	.00	.00	.00	.00	2.34
7203	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	2.23	.00	2.23	2.23
7204	SOFTWARE	3	1.75	.00	.00	1.75	.00	.00	.00	.00	1.56	.00	1.56	3.31
72	ETR GSE		11.18	.00	.00	11.18	.00	.00	.00	.00	3.79	.00	3.79	14.98
7301	HARDWARE	3	6.63	.00	.00	6.63	.00	.00	.00	.00	.00	.00	.00	6.63
7302	SITE ACTIV.	3	2.19	.00	.00	2.19	.00	.00	.00	.00	.00	.00	.00	2.19
7303	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	1.79	.00	1.79	1.79
7304	SOFTWARE	3	1.69	.00	.00	1.69	.00	.00	.00	.00	.29	.00	.29	1.98
73	WTR GSE		10.51	.00	.00	10.51	.00	.00	.00	.00	2.08	.00	2.08	12.59
7401	HARDWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7402	SITE ACTIV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7403	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7404	SOFTWARE	3	.95	.00	.00	.95	.00	.00	.00	.00	2.17	.00	2.17	3.12
74	HARDWA(5) SUBTOTAL		.95	.00	.00	.95	.00	.00	.00	.00	2.17	.00	2.17	3.12
7501	HARDWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7502	SITE ACTIV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7503	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7504	SOFTWARE	3	.95	.00	.00	.95	.00	.00	.00	.00	2.17	.00	2.17	3.12
75	HARDWA(5) SUBTOTAL		.95	.00	.00	.95	.00	.00	.00	.00	2.17	.00	2.17	3.12

OPTION 3 TOTAL 16 VEHICLES TU6300R 9/12/73 8:20 AM

WBS	COST ELEMENT	C	EDSD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPHS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
80	VEHICLE TEST	3												
81	GND TEST HDWE.	3	.00	22.66	.00	22.66	.00	.00	.00	.00	.00	.00	.00	22.66
82	GND TEST OPNS.	3	.00	11.39	.00	11.39	.00	.00	.00	.00	.00	.00	.00	11.39
83	FLT. TEST HDWE.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
84	FLT. TEST OPNS	3	.00	.00	1.31	1.31	.00	.00	.00	.00	.00	.00	.00	1.31
	TOTAL VEHICLE TEST		.00	34.04	1.31	35.35	.00	.00	.00	.00	.00	.00	.00	35.35
	TOTAL		.00	34.04	1.31	35.35	.00	.00	.00	.00	.00	.00	.00	35.35

LEVEL 6

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
8101	PTV TEST	3	.00	3.22	.00	3.22	.00	.00	.00	.00	.00	.00	.00	3.22
8102	MAJOR TEST ART.	3	.00	18.57	.00	18.57	.00	.00	.00	.00	.00	.00	.00	18.57
8103	MOCKUPS	3	.00	.87	.00	.87	.00	.00	.00	.00	.00	.00	.00	.87
81	GND TEST HDWE.		.00	22.66	.00	22.66	.00	.00	.00	.00	.00	.00	.00	22.66
8301	STRUCTURES	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8302	THERMAL CONTROL	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8303	AVIONICS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8304	PROPULSION	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8305	ORBITER I/F	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8306	DROP TANKS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8307	FINAL ASSY & C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
83	FLT. TEST HDWE.		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

LEVEL 7

WBS	COST ELEMENT	C	EDSD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
830102	OXID. TK & SUPT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830103	BODY STRUCTURE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830104	THRUST STRUCTURE		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830105	METEOROID SHIELD	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830106	PAYLOAD I/F	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830107	INSTL, ASSY & C/O3		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8301	STRUCTURES		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830201	FUEL TANK INSL	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830202	OXID TANK INSL	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830203	INSL PURGE SYS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830204	THERM CONT SYS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830205	INSTL, ASSY & C/O3		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8302	THERMAL CONTROL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830301	DATA MGMT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830302	G N & C	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830303	COMMUNICATIONS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830304	INSTRUMENTATION	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830305	ELECT. POWER	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830306	PWR DIST. & CONT	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830307	INSTL, ASSY & C/O3		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8303	AVIONICS		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830401	MAIN ENGINE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830402	MAIN ENG SUPT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830403	ACPS ENGINE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830404	ACPS ENG SUPT	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830405	INSTL, ASSY & C/O3		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8304	PROPULSION		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830501	STRUCTURES	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830502	I/F PANELS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830503	PURGE PROV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830504	ABORT PROV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830505	INSTL, ASSY & C/O3		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8305	ORBITER I/F		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

LEVEL 7

WBS	COST ELEMENT	C	ED&D (MIL)	OTH (MIL)	PTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
830701	FINAL ASSY	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830702	C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8307	FINAL ASSY & C/O		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

OPTION 3 TOTAL 16 VEHICLES TUG300R 9/12/73 8:20 AM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
90	LAUNCH OPNS. WTR	3												
91	LNCH SITE SVCES	3	.00	.00	.00	.00	.00	.00	.00	.00	6.11	.00	6.11	6.11
92	TUG/SHTL MATING	3	.00	.00	.00	.00	.00	.00	.00	.00	1.92	.00	1.92	1.92
93	PRELAUNCH C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	2.22	.00	2.22	2.22
94	COUNTDOWN	3	.00	.00	.00	.00	.00	.00	.00	.00	3.42	.00	3.42	3.42
95	PRLNTS. & GASES	3	.00	.00	.00	.00	.00	.00	.00	.00	.37	.00	.37	.37
96	POST FLT. SAPING	3	.00	.00	.00	.00	.00	.00	.00	.00	2.43	.00	2.43	2.43
	TOTAL LAUNCH OPNS.		.00	.00	.00	.00	.00	.00	.00	.00	16.47	.00	16.47	16.47
	TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	16.47	.00	16.47	16.47

OPTION 3 TOTAL 16 VEHICLES TUG300R 9/12/73 0120 AM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
100	LAUNCH OPNS ETR	3												
101	LNCH SITE SVCES	3	.00	.00	.00	.00	.00	.00	.00	.00	17.57	.00	17.57	17.57
102	TUG/SHTL MATING	3	.00	.00	.00	.00	.00	.00	.00	.00	5.13	.00	5.13	5.13
103	PRELAUNCH C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	6.28	.00	6.28	6.28
104	COUNTDOWN	3	.00	.00	.00	.00	.00	.00	.00	.00	9.78	.00	9.78	9.78
105	PRLNTS & GASES	3	.00	.00	.00	.00	.00	.00	.00	.00	1.99	.00	1.99	1.99
106	POST FLT, SAFING	3	.00	.00	.00	.00	.00	.00	.00	.00	7.37	.00	7.37	7.37
	TOTAL LAUNCH OPNS		.00	.00	.00	.00	.00	.00	.00	.00	48.12	.00	48.12	48.12
	TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	48.12	.00	48.12	48.12

OPTION 3 TOTAL 16 VEHICLES TUG300R 9/12/73 8:20 AM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
110	FLIGHT OPNS NASA	3												
111	MISSION PLG.	3	6.80	.00	.00	6.80	.00	.00	.00	.00	9.22	.00	9.22	16.02
112	FLT. CONTROL	3	.69	.00	.00	.69	.00	.00	.00	.00	21.77	.00	21.77	22.46
113	FLT. EVAL.	3	.00	.00	.00	.00	.00	.00	.00	.00	9.81	.00	9.81	9.81
114	FLT. SUPT. SFTWRE	3	3.05	.00	.00	3.05	.00	.00	.00	.00	4.98	.00	4.98	8.03
	TOTAL FLIGHT OPNS		10.54	.00	.00	10.54	.00	.00	.00	.00	45.79	.00	45.79	56.32
	TOTAL		10.54	.00	.00	10.54	.00	.00	.00	.00	45.79	.00	45.79	56.32

OPTION 3 TOTAL 16 VEHICLES TUG300R 9/12/73 8:20 AM

WBS	COST ELEMENT	C	ED&D (MIL)	STH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
120	FLIGHT OPNS DOD	3												
121	MISSION PLG	3	4.74	.00	.00	4.74	.00	.00	.00	.00	7.40	.00	7.40	12.14
122	FLT. CONTROL	3	.48	.00	.00	.48	.00	.00	.00	.00	15.35	.00	15.35	15.84
123	FLT. EVAL.	3	.00	.00	.00	.00	.00	.00	.00	.00	7.85	.00	7.85	7.85
124	FLT. SUPT. SFTWRE	3	2.16	.00	.00	2.16	.00	.00	.00	.00	3.74	.00	3.74	5.90
	TOTAL FLIGHT OPNS		7.38	.00	.00	7.38	.00	.00	.00	.00	34.34	.00	34.34	41.72
	TOTAL		7.38	.00	.00	7.38	.00	.00	.00	.00	34.34	.00	34.34	41.72

OPTION 3 TOTAL 16 VEHICLES TUG300H 9/12/73 8:20 AM

WBS	COST ELEMENT C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
130	REFURB &INTEG WTR3												
131	SCH MAINT & REF 3	.00	.00	.00	.00	.00	.00	.00	.00	3.57	.00	3.57	3.57
132	UNSCH MAINT & REF3	.00	.00	.00	.00	.00	.00	.00	.00	.73	.00	.73	.73
133	POST MAINT C/O 3	.00	.00	.00	.00	.00	.00	.00	.00	.21	.00	.21	.21
134	TUG/PL MAING &/CO3	.00	.00	.00	.00	.00	.00	.00	.00	2.45	.00	2.45	2.45
135	REFURB RQMTS PLG 3	.22	.00	.00	.22	.00	.00	.00	.00	.87	.00	.87	1.09
136	DEPOT MAINT 3	.00	.00	.00	.00	.00	.00	.00	.00	8.71	.00	8.71	8.71
	TOTAL REFURB &INTE	.22	.00	.00	.22	.00	.00	.00	.00	16.54	.00	16.54	16.76
	TOTAL	.22	.00	.00	.22	.00	.00	.00	.00	16.54	.00	16.54	16.76

OPTION 3 TOTAL 16 VEHICLES TUG300H 9/12/73 8:20 AM

WBS	COST ELEMENT C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
140	REFURB &INTEG ETR3												
141	SCH MAINT & REF 3	.00	.00	.00	.00	.00	.00	.00	.00	10.14	.00	10.14	10.14
142	UNSCH MAINT & REF3	.00	.00	.00	.00	.00	.00	.00	.00	2.10	.00	2.10	2.10
143	POST MAINT C/O 3	.00	.00	.00	.00	.00	.00	.00	.00	.51	.00	.51	.51
144	TUG/PL MATING,C/O3	.00	.00	.00	.00	.00	.00	.00	.00	6.95	.00	6.95	6.95
145	REFURB RQMTS PLG 3	.22	.00	.00	.22	.00	.00	.00	.00	2.52	.00	2.52	2.74
146	DEPOT MAINT 3	.00	.00	.00	.00	.00	.00	.00	.00	50.26	.00	50.26	50.26
	TOTAL REFURB &INTE	.22	.00	.00	.22	.00	.00	.00	.00	72.49	.00	72.49	72.71
	TOTAL	.22	.00	.00	.22	.00	.00	.00	.00	72.49	.00	72.49	72.71

6.9 Cost Per Flight

Cost per flight values have been calculated and are reported in accordance with letter No. PD-TUG-P(015-74), dated 3 August 1973, from the Chairman, Programmatics/Cost Panel to the COR's. The costs per flight are presented by Agency (NASA/DOD) and by Flight Mode. Since no DOD flights require either an expended Tug or an expended auxiliary stage, no DOD cost per flight sheets have been included for Mode-2 and Mod-3.

AVERAGE COST PER FLIGHT

AGENCY NASA

MODE 1 Expendable Basic Stage

PROGRAM OPTION SE

LAUNCH OPERATIONS		$ 190,861
Tug/Shuttle mating and checkout	$ 19,242	
Tug/Payload mating and checkout	21,742	
Prelaunch checkout	23,917	
Countdown	31,150	
Propellant and gases	6,510	
Post flight safing	25,558	
Site services and support	62,742	
MAINTENANCE AND REFURBISHMENT		$ 394,877
Scheduled maintenance and refurbishment	$ 35,200	
Unscheduled maintenance and refurbishment	8,667	
Tug engine maintenance and refurbishment	21,515	
Tug vehicle spares	74,365	
Tug engine spares	19,298	
Post maintenance checkout	2,175	
Refurbishment requirements planning	9,825	
Depot maintenance	223,832	
TOTAL GROUND OPERATIONS (Launch and Maintenance and Refurbishment)		$ 585,738
FLIGHT OPERATIONS		$ 252,500
Mission planning	$ 48,200	
Flight control	159,900	
Flight evaluation	43,600	
Flight software	30,800	
OPERATIONS SUPPORT		$ 184,958
Airborne software update	$ 10,202	
GSE maintenance	45,602	
Sustaining engineering	40,685	
Program management	27,779	
Transportation and handling	1,229	
Inventory control and warehousing	12,783	
Facilities maintenance	14,873	
GSE software update	31,835	
EXPENDABLE VEHICLE MAIN STAGE		$ 0
EXPENDABLE VEHICLE AUXILIARY STAGE		$ 0
TOTAL AVERAGE PER FLIGHT COST		$ 1,053,226

AVERAGE COST PER FLIGHT

AGENCY NASA

MODE 1 REUSABLE BASIC STAGE

PROGRAM OPTION SF

LAUNCH OPERATIONS		$ 206,084
Tug/Shuttle mating and checkout	$ 19,375	
Tug/Payload mating and checkout	26,961	
Prelaunch checkout	23,089	
Countdown	37,575	
Propellant and gases	6,427	
Post flight safing	27,189	
Site services and support	65,468	
MAINTENANCE AND REFURBISHMENT		$ 225,716
Scheduled maintenance and refurbishment	$ 38,266	
Unscheduled maintenance and refurbishment	7,477	
Tug engine maintenance and refurbishment	9,143	
Tug vehicle spares	30,905	
Tug engine spares	3,723	
Post maintenance checkout	1,914	
Refurbishment requirements planning	9,132	
Depot maintenance	125,156	
TOTAL GROUND OPERATIONS (Launch and Maintenance and Refurbishment)		$ 431,800
FLIGHT OPERATIONS		$ 186,800
Mission planning	$ 40,100	
Flight control	81,500	
Flight evaluation	44,900	
Flight software	20,300	
OPERATIONS SUPPORT		$ 84,882
Airborne software update	$ 10,079	
GSE maintenance	1,054	
Sustaining engineering	25,040	
Program management	20,790	
Transportation and handling	807	
Inventory control and warehousing	14,434	
Facilities maintenance	0	
GSE software update	12,678	
EXPENDABLE VEHICLE MAIN STAGE		$ 0
EXPENDABLE VEHICLE AUXILIARY STAGE		$ 0
TOTAL AVERAGE PER FLIGHT COST		$ 703,482

AVERAGE COST PER FLIGHT

MODE: 2 EXPENDABLE TUG

AGENCY NASA

PROGRAM OPTION [illegible]

LAUNCH OPERATIONS		$ 206,080
Tug/Shuttle mating and checkout	$ 19,375	
Tug/Payload mating and checkout	26,961	
Prelaunch checkout	23,089	
Countdown	37,575	
Propellant and gases	6,427	
Post flight safing	27,189	
Site services and support	65,468	
MAINTENANCE AND REFURBISHMENT		$ 0
Scheduled maintenance and refurbishment	$	
Unscheduled maintenance and refurbishment		
Tug engine maintenance and refurbishment		
Tug vehicle spares		
Tug engine spares		
Post maintenance checkout		
Refurbishment requirements planning		
Depot maintenance		
TOTAL GROUND OPERATIONS (Launch and Maintenance and Refurbishment)		$ 206,080
FLIGHT OPERATIONS		$ 186,800
Mission planning	$ 40,100	
Flight control	81,500	
Flight evaluation	44,900	
Flight software	20,300	
OPERATIONS SUPPORT		$ 84,882
Airborne software update	$ 10,079	
GSE maintenance	1,054	
Sustaining engineering	25,040	
Program management	20,790	
Transportation and handling	807	
Inventory control and warehousing	14,434	
Facilities maintenance	0	
GSE software update	12,678	
EXPENDABLE VEHICLE MAIN STAGE		$ 15,500,000
EXPENDABLE VEHICLE AUXILIARY STAGE		$ 0
TOTAL AVERAGE PER FLIGHT COST		$ 15,977,766

AVERAGE COST PER FLIGHT

AGENCY NASA

MODE 3 Expended Kickstage

PROGRAM OPTION 3E

LAUNCH OPERATIONS		$ 190,861
Tug/Shuttle mating and checkout	$ 19,242	
Tug/Payload mating and checkout	21,742	
Prelaunch checkout	23,917	
Countdown	31,150	
Propellant and gases	6,510	
Post flight safing	25,558	
Site services and support	62,742	
MAINTENANCE AND REFURBISHMENT		$ 394,877
Scheduled maintenance and refurbishment	$ 35,200	
Unscheduled maintenance and refurbishment	8,667	
Tug engine maintenance and refurbishment	21,515	
Tug vehicle spares	24,365	
Tug engine spares	19,298	
Post maintenance checkout	2,175	
Refurbishment requirements planning	9,825	
Depot maintenance	223,832	
TOTAL GROUND OPERATIONS (Launch and Maintenance and Refurbishment)		$ 585,738
FLIGHT OPERATIONS		$ 282,500
Mission planning	$ 48,200	
Flight control	159,900	
Flight evaluation	43,600	
Flight software	30,800	
OPERATIONS SUPPORT		$ 184,988
Airborne software update	$ 10,202	
GSE maintenance	45,602	
Sustaining engineering	40,685	
Program management	27,779	
Transportation and handling	1,229	
Inventory control and warehousing	12,783	
Facilities maintenance	14,873	
GSE software update	31,835	
EXPENDABLE VEHICLE MAIN STAGE		$ -0-
EXPENDABLE VEHICLE AUXILIARY STAGE		$ 5,150,000
TOTAL AVERAGE PER FLIGHT COST ~~(1973 $ IN MILLIONS)~~		$ 6,203,226

AVERAGE COST PER FLIGHT

AGENCY NASA

MODE 3 EXPENDABLE, [illegible]

PROGRAM OPTION [illegible]

LAUNCH OPERATIONS		$ 206,084
Tug/Shuttle mating and checkout	$ 19,345	
Tug/Payload mating and checkout	26,961	
Prelaunch checkout	23,089	
Countdown	37,575	
Propellant and gases	6,427	
Post flight safing	27,189	
Site services and support	65,468	
MAINTENANCE AND REFURBISHMENT		$ 225,716
Scheduled maintenance and refurbishment	$ 38,266	
Unscheduled maintenance and refurbishment	7,477	
Tug engine maintenance and refurbishment	9,143	
Tug vehicle spares	30,905	
Tug engine spares	3,723	
Post maintenance checkout	1,910	
Refurbishment requirements planning	9,132	
Depot maintenance	125,156	
TOTAL GROUND OPERATIONS (Launch and Maintenance and Refurbishment)		$ 431,800
FLIGHT OPERATIONS		$ 186,800
Mission planning	$ 40,100	
Flight control	81,500	
Flight evaluation	44,900	
Flight software	20,300	
OPERATIONS SUPPORT		$ 84,852
Airborne software update	$ 10,079	
GSE maintenance	1,054	
Sustaining engineering	25,040	
Program management	20,790	
Transportation and handling	807	
Inventory control and warehousing	14,434	
Facilities maintenance	0	
GSE software update	12,678	
EXPENDABLE VEHICLE MAIN STAGE		$ 0
EXPENDABLE VEHICLE AUXILIARY STAGE		$ 910,000
TOTAL AVERAGE PER FLIGHT COST		$ 1,613,482

AVERAGE COST PER FLIGHT

AGENCY DoD

MODE: 1 Reusable Basic Stage

PROGRAM OPTION 3I

LAUNCH OPERATIONS		$ 193,273
Tug/Shuttle mating and checkout	$ 19,547	
Tug/Payload mating and checkout	21,923	
Prelaunch checkout	24,294	
Countdown	31,665	
Propellant and gases	6,391	
Post flight safing	25,912	
Site services and support	63,541	
MAINTENANCE AND REFURBISHMENT		$ 393,072
Scheduled maintenance and refurbishment	$ 35,653	
Unscheduled maintenance and refurbishment	8,776	
Tug engine maintenance and refurbishment	21,107	
Tug vehicle spares	72,956	
Tug engine spares	18,932	
Post maintenance checkout	2,329	
Refurbishment requirements planning	9,918	
Depot maintenance	223,401	
TOTAL GROUND OPERATIONS (Launch and Maintenance and Refurbishment)		$ 586,345
FLIGHT OPERATIONS		$ 294,900
Mission planning	$ 49,100	
Flight control	171,800	
Flight evaluation	41,800	
Flight software	32,200	
OPERATIONS SUPPORT		$ 181,085
Airborne software update	$ 10,009	
GSE maintenance	44,738	
Sustaining engineering	39,915	
Program management	27,253	
Transportation and handling	1,206	
Inventory control and warehousing	12,541	
Facilities maintenance	14,591	
GSE software update	31,232	
EXPENDABLE VEHICLE MAIN STAGE		$ 0
EXPENDABLE VEHICLE AUXILIARY STAGE		$ 0
TOTAL AVERAGE PER FLIGHT COST		$ 1,062,730

AVERAGE COST PER FLIGHT

MODE: 1 REUSABLE BASIC STAGE

AGENCY: DoD

PROGRAM OPTION: 3A

LAUNCH OPERATIONS		$ 197,985
Tug/Shuttle mating and checkout	$ 18,067	
Tug/Payload mating and checkout	25,853	
Prelaunch checkout	22,102	
Countdown	36,109	
Propellant and gases	6,468	
Post flight safing	26,202	
Site services and support	62,784	
MAINTENANCE AND REFURBISHMENT		$ 229,925
Scheduled maintenance and refurbishment	$ 36,675	
Unscheduled maintenance and refurbishment	7,153	
Tug engine maintenance and refurbishment	9,202	
Tug vehicle spares	31,103	
Tug engine spares	3,747	
Post maintenance checkout	1,834	
Refurbishment requirements planning	8,743	
Depot maintenance	131,468	
TOTAL GROUND OPERATIONS (Launch and Maintenance and Refurbishment)		$ 427,910
FLIGHT OPERATIONS		$ 209,600
Mission planning	$ 49,400	
Flight control	82,000	
Flight evaluation	55,400	
Flight software	22,800	
OPERATIONS SUPPORT		$ 85,427
Airborne software update	$ 10,140	
GSE maintenance	1,060	
Sustaining engineering	25,200	
Program management	20,924	
Transportation and handling	813	
Inventory control and warehousing	14,527	
Facilities maintenance	0	
GSE software update	12,759	
EXPENDABLE VEHICLE MAIN STAGE		$ 0
EXPENDABLE VEHICLE AUXILIARY STAGE		$ 0
TOTAL AVERAGE PER FLIGHT COST		$ 722,937

AVERAGE COST PER FLIGHT

AGENCY [illegible]

MODE 3 [illegible]

PROGRAM OPTION [illegible]

LAUNCH OPERATIONS		$ 193,273
Tug/Shuttle mating and checkout	$ 19,547	
Tug/Payload mating and checkout	21,923	
Prelaunch checkout	24,294	
Countdown	31,665	
Propellant and gases	6,391	
Post flight safing	25,912	
Site services and support	63,541	
MAINTENANCE AND REFURBISHMENT		$ 393,072
Scheduled maintenance and refurbishment	$ 35,653	
Unscheduled maintenance and refurbishment	8,776	
Tug engine maintenance and refurbishment	21,107	
Tug vehicle spares	72,956	
Tug engine spares	18,932	
Post maintenance checkout	2,329	
Refurbishment requirements planning	9,918	
Depot maintenance	223,401	
TOTAL GROUND OPERATIONS (Launch and Maintenance and Refurbishment)		$ 586,345
FLIGHT OPERATIONS		$ 294,900
Mission planning	$ 49,100	
Flight control	171,800	
Flight evaluation	41,800	
Flight software	32,200	
OPERATIONS SUPPORT		$ 181,085
Airborne software update	$ 10,009	
GSE maintenance	44,738	
Sustaining engineering	39,915	
Program management	27,253	
Transportation and handling	1,206	
Inventory control and warehousing	12,541	
Facilities maintenance	14,591	
GSE software update	31,232	
EXPENDABLE VEHICLE MAIN STAGE		$ 0
EXPENDABLE VEHICLE AUXILIARY STAGE		$ 5,150 000
TOTAL AVERAGE PER FLIGHT COST		$ 6,212,730

6.10 Subdivisions of Work (Form T)

Provided in this subsection on Data Form T are the subdivisions of work as defined in the following Government-furnished documents:

Data Package - Space Tug System Studies, dated April 1973.

Space Tug Systems Studies - Work Breakdown Structure and Dictionary, prepared by PD-TUG-P and dated 7 May 1973.

Estimated costs and hours are reported on Data Form-T for WBS elements through Level 6, although the calculations are performed through Level 7. The estimated costs and hours on Data Form-T are consistent with the definitions in the Work Breakdown Structure and Dictionary, as follows:

1. Engineering is the design, development, analysis, evaluation, and redesign of TUG hardware, GSE, and associated planning and analysis activities. It includes such activities as configuration management, the preparation of specifications, drawings, parts lists, wiring diagrams, technical coordination between engineering and other activities, facilities engineering, vendor coordination, test planning and scheduling, analysis of test results, safety analysis, data reduction and engineering report preparation. It also includes the engineering activities required to support Production and the Operational phases. Materials and subcontracts associated with the above activities are included.

2. Manufacturing includes product and materials receiving, ware-

OPTION 3

INITIAL

COST DATA FORMS T

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 16 OF

X NON RECURRING(DDT&E) | RECURRING(PRODUCTION) | RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32001	PROJECT MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	234	6.86	234	6.86
32002	SYS. ENGR. & INT.	481	13.63	0	.00	0	.00	0	.00	28	.65	0	.22	509	14.50
32003	VEH MAIN STAGE	1479	42.95	332	8.44	572	14.07	98	2.19	1189	33.43	0	.00	3670	101.09
32004	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.62	0	1.62
32005	LOGISTICS	6	.15	0	.00	0	.00	0	.00	0	.00	83	1.51	89	1.66
32006	FACILITIES	0	.00	0	.00	0	.00	0	.00	0	.00	0	5.17	0	5.17
32007	GRND. SUPT. EQUIP	307	8.71	484	13.74	56	1.24	89	1.99	83	1.96	0	.00	1020	27.65
32008	VEHICLE TEST	172	4.01	519	13.03	0	.00	158	3.37	33	.78	0	.00	882	21.20
32009	LAUNCH OPNS. WTR	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32010	LAUNCH OPNS ETR	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32011	FLIGHT OPNS NASA	122	2.85	113	2.03	0	.00	44	.83	0	.00	12	.21	291	5.92
32012	FLIGHT OPNS DOD	87	2.02	80	1.44	0	.00	31	.59	0	.00	8	.15	207	4.20
32013	REFURB &INTEG WTR	0	.00	3	.08	0	.00	1	.02	0	.01	0	.00	4	.11
32014	REFURB &INTEG ETR	0	.00	3	.08	0	.00	1	.02	0	.01	0	.00	4	.11
	TOTAL	2654	74.33	1534	38.86	628	15.32	422	9.01	1333	36.84	337	15.74	6910	190.10

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 1 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32001	PROJECT MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	234	6.86	234	6.86
3200101	COST/PERF. MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	161	4.71	161	4.71
3200102	PROJ. DIRECTION	0	.00	0	.00	0	.00	0	.00	0	.00	69	2.02	69	2.02
3200103	INFORM. MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	5	.13	5	.13

E4E-7

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 2 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32002	SYS. ENGR. & INT.	481	13.63	0	.00	0	.00	0	.00	28	.65	0	.22	509	14.50
3200201	TUG SYS. ENGR.	385	10.90	0	.00	0	.00	0	.00	22	.52	0	.17	407	11.60
3200202	SHUTTLE I/F	24	.68	0	.00	0	.00	0	.00	1	.03	0	.01	26	.73
3200203	PAYLOAD I/F	72	2.04	0	.00	0	.00	0	.00	4	.10	0	.03	76	2.17

A-E-7

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 3 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32003	VEH MAIN STAGE	1479	42.95	332	8.44	572	14.07	98	2.19	1189	33.43	0	.00	3670	101.09
3200301	STRUCTURES	194	5.56	0	.00	239	5.91	0	.00	232	6.23	0	.00	665	17.71
3200302	THERMAL CONTROL	10	.29	17	.36	13	.31	5	.11	14	.36	0	.00	59	1.44
3200303	AVIONICS	432	12.62	92	2.54	20	.49	27	.61	360	9.33	0	.00	931	25.59
3200304	PROPULSION	469	13.86	119	3.29	45	1.05	35	.79	440	13.68	0	.00	1108	32.67
3200305	ORBITER I/F	113	3.23	79	1.62	139	3.44	23	.52	141	3.78	0	.00	495	12.59
3200306	DROP TANKS	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200307	FINAL ASSY & C/O	261	7.39	24	.63	116	2.88	7	.16	2	.05	0	.00	411	11.11
320030101	FUEL TK & SUPT	53	1.52	0	.00	66	1.62	0	.00	63	1.71	0	.00	182	4.85
320030102	OXID. TK & SUPT	29	.82	0	.00	35	.87	0	.00	34	.92	0	.00	98	2.62
320030103	BODY STRUCTURE	45	1.28	0	.00	55	1.37	0	.00	54	1.44	0	.00	154	4.09
320030104	THRUST STRUCTURE	15	.43	0	.00	19	.46	0	.00	18	.49	0	.00	52	1.38
320030105	METEOROID SHIELD	11	.31	0	.00	13	.33	0	.00	13	.35	0	.00	37	.98
320030106	PAYLOAD I/F	27	.77	0	.00	33	.82	0	.00	32	.87	0	.00	93	2.47
320030107	INSTL. ASSY & C/O	14	.41	0	.00	18	.44	0	.00	17	.46	0	.00	49	1.31
320030201	FUEL TANK INSL	2	.05	0	.00	2	.08	0	.00	2	.05	0	.00	6	.16
320030202	OXID. TANK INSL.	1	.03	0	.00	1	.03	0	.00	1	.03	0	.00	3	.08
320030203	INSL. PURGE SYS.	7	.20	17	.34	9	.22	5	.11	10	.26	0	.00	47	1.13
320030204	THERM CONT. SYS.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030205	INSTL ASSY & C/O	0	.01	1	.02	1	.01	0	.01	1	.02	0	.00	3	.07
320030301	DATA MGMT. 3	163	4.77	37	1.02	8	.18	11	.24	136	3.53	0	.00	355	9.75
320030302	G N & C	29	.83	0	.00	1	.03	0	.00	23	.61	0	.00	53	1.47
320030303	COMMUNICATIONS	83	2.42	45	1.24	4	.09	13	.30	71	1.84	0	.00	216	5.89
320030304	INSTRUMENTATION	40	1.16	1	.03	2	.04	0	.01	32	.84	0	.00	75	2.08
320030305	ELECT. POWER	2	.05	1	.04	0	.00	0	.01	1	.04	0	.00	5	.14
320030306	PWR. DIST. & CONT	16	.48	1	.03	1	.02	0	.01	13	.35	0	.00	32	.88
320030307	INSTL. ASSY & C/O	100	2.91	7	.19	5	.11	2	.04	82	2.12	0	.00	195	5.38
320030401	MAIN ENGINE 3	215	6.36	0	.00	21	.48	0	.00	197	6.16	0	.00	433	13.00
320030402	MAIN ENG. SUPT	146	4.32	90	2.48	14	.33	27	.59	142	4.37	0	.00	418	12.08
320030403	ACPS ENGINE	5	.14	3	.09	0	.01	1	.02	5	.14	0	.00	14	.41
320030404	ACPS ENG. SUPT	81	2.39	20	.86	8	.18	6	.13	76	2.36	0	.00	191	5.62
320030405	INSTL. ASSY & C/O	22	.66	6	.16	2	.05	2	.04	21	.65	0	.00	53	1.56
320030501	STRUCTURES	40	1.15	12	.25	49	1.22	4	.08	49	1.31	0	.00	154	4.01
320030502	I/F PANELS	55	1.57	51	1.05	67	1.67	15	.34	78	1.86	0	.00	258	6.47
320030503	PURGE PROV.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030504	ABORT PROV.	10	.28	10	.20	12	.30	3	.06	12	.33	0	.00	47	1.17
320030505	INSTL. ASSY & C/O	8	.24	6	.12	10	.25	2	.04	10	.28	0	.00	37	.93
320030701	FINAL ASSY	200	5.68	15	.39	89	2.21	5	.10	1	.03	0	.00	310	8.41
320030702	C/O	61	1.72	9	.24	27	.67	3	.06	1	.02	0	.00	100	2.70
32003010101	LH2 DOMES	19	.53	0	.00	23	.57	0	.00	22	.60	0	.00	64	1.73
32003010102	LH2 CYLINDER	25	.70	0	.00	30	.75	0	.00	29	.79	0	.00	84	2.24
32003010103	LH2 SUPPORTS	10	.29	0	.00	12	.31	0	.00	12	.32	0	.00	34	.91
32003010201	LO2 DOMES	22	.62	0	.00	27	.66	0	.00	26	.70	0	.00	75	1.99
32003010202	LO2 SUPPORTS	7	.20	0	.00	9	.21	0	.00	8	.22	0	.00	24	.63
32003010301	FWD AFT SKIRT	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003010302	INTERTANK	22	.62	0	.00	27	.66	0	.00	26	.70	0	.00	74	1.98

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 4 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32003010303	SDWL SHELL	23	.66	0	.00	29	.71	0	.00	28	.74	0	.00	79	2.11
32003030101	COMPUTER	89	2.60	22	.62	4	.10	7	.15	75	1.93	0	.00	197	5.41
32003030102	DATA DISTR.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030103	EQ. THERM CONT.	6	.19	12	.32	0	.01	3	.08	6	.16	0	.00	28	.75
32003030104	CIRCUITRY 3	10	.30	0	.00	0	.01	0	.00	8	.22	0	.00	19	.54
32003030105	SOFTWARE	45	1.32	0	.00	2	.05	0	.00	37	.96	0	.00	84	2.33
32003030106	SOFTWARE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030107	SOFTWARE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030108	INSTL. ASSY & C/O	12	.35	3	.08	1	.01	1	.02	10	.26	0	.00	26	.72
32003030201	I M U	14	.41	0	.00	1	.02	0	.00	11	.29	0	.00	26	.72
32003030202	TRACKING/ELECT 3	13	.37	0	.00	1	.01	0	.00	10	.27	0	.00	23	.65
32003030203	REN DEZ&DOCKING 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030204	INSTL. ASSY & C/O	2	.06	0	.00	0	.00	0	.00	2	.04	0	.00	4	.11
32003030301	M/W CIRC +RF MUX	27	.79	22	.61	1	.03	7	.15	24	.62	0	.00	81	2.20
32003030302	TRANSPONDERS 3	17	.49	0	.00	1	.02	0	.00	14	.36	0	.00	32	.87
32003030303	POWER AMP.	7	.22	0	.00	0	.01	0	.00	6	.16	0	.00	14	.39
32003030304	ANTENNA	3	.10	5	.14	0	.00	1	.03	3	.08	0	.00	13	.36
32003030305	DEC/ENC+MOD/DEM	15	.43	10	.29	1	.02	3	.07	13	.33	0	.00	41	1.12
32003030306	TAPE RECORDER	2	.07	4	.11	0	.00	1	.03	2	.06	0	.00	10	.27
32003030307	P/L INTER EQUIP	5	.14	0	.00	0	.01	0	.00	4	.10	0	.00	9	.24
32003030308	INSTL. ASSY & C/O	6	.18	3	.09	0	.01	1	.02	5	.14	0	.00	16	.44
32003030401	DATA SENSORS	1	.03	0	.00	0	.00	0	.00	1	.02	0	.00	2	.05
32003030402	SIGNAL COND.	2	.06	1	.03	0	.00	0	.01	2	.04	0	.00	5	.14
32003030403	CIRCUITRY	34	.98	0	.00	2	.04	0	.00	27	.71	0	.00	62	1.73
32003030404	INSTL. ASSY & C/O	3	.09	0	.00	0	.00	0	.00	2	.06	0	.00	6	.15
32003030501	BATTERY	2	.05	1	.04	0	.00	0	.01	1	.04	0	.00	5	.13
32003030502	FUEL CELL 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030503	INSTL. ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.01
32003030601	DISTR.	15	.44	1	.02	1	.02	0	.01	12	.32	0	.00	30	.81
32003030602	TANKS SYSTEM 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030603	INSTL. ASSY & C/O	1	.04	0	.00	0	.00	0	.00	1	.03	0	.00	2	.07

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 5 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32004	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.62	0	1.62
3200401	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.62	0	1.62

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 6 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32005	LOGISTICS	6	.15	0	.00	0	.00	0	.00	0	.00	83	1.51	89	1.66
3200501	TRANSP. & HDLG.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200502	TRAINING	5	.12	0	.00	0	.00	0	.00	0	.00	68	1.25	73	1.37
3200503	INV CONT. & WHSNG	1	.03	0	.00	0	.00	0	.00	0	.00	15	.27	16	.29
320050201	SIM. & EQUIP.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320050202	GROUND CREW	5	.12	0	.00	0	.00	0	.00	0	.00	68	1.25	73	1.37

STUDY TITLE: SPACE TUG SYS.STY (CRY) COST ESTIMATE DATE: SEPTEMBER 11, 1973
CONTRACT NO: NAS 8-29677 DATA FORM T PAGE: 7 OF

X NON RECURRING(DDTAE) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
3200	FACILITIES	0	.00	0	.00	0	.00	0	.00	0	.00	0	5.17	0	5.17
3200601	MANUFACTURING	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.12	0	1.12
3200602	TEST	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.50	0	1.50
3200603	ETR MAINT. & REF.	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.02	0	1.02
3200604	ETR LAUNCH	0	.00	0	.00	0	.00	0	.00	0	.00	0	.39	0	.39
3200605	WTR MAINT. & REF.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.76	0	.76
3200606	WTR LAUNCH	0	.00	0	.00	0	.00	0	.00	0	.00	0	.38	0	.38
320060101	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.09	0	1.09
320060102	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.02	0	.02
320060201	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.50	0	1.50
320060202	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060301	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.00	0	1.00
320060302	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.02	0	.02
320060401	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.38	0	.38
320060402	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.01	0	.01
320060501	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.75	0	.75
320060502	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.01	0	.01
320060601	DES./CONST. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.37	0	.37
320060602	ACTIV./MAINT. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.01	0	.01

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 8 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32007	GRND. SUPT. EQUIP	307	8.71	484	13.74	56	1.24	89	1.99	83	1.96	0	.00	1020	27.65
3200701	MFG. GSE	77	2.17	121	3.42	14	.31	22	.50	21	.49	0	.00	254	6.89
3200702	ETR GSE	114	3.23	179	5.09	21	.46	33	.74	31	.73	0	.00	378	10.24
3200703	WTR GSE	106	3.01	167	4.75	19	.43	31	.69	29	.68	0	.00	353	9.57
3200704	FLT OPS GSE(NASA)	5	.15	8	.24	1	.02	2	.03	1	.03	0	.00	18	.47
3200705	FLT OPS GSE(DOD)	5	.15	8	.24	1	.02	2	.03	1	.03	0	.00	18	.47
320070101	HARDWARE	49	1.39	77	2.20	9	.20	14	.32	13	.31	0	.00	163	4.42
320070102	SITE ACTIV.	1	.03	2	.04	0	.00	0	.01	0	.01	0	.00	3	.09
320070103	MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070104	SOFTWARE	26	.75	42	1.18	5	.11	8	.17	7	.17	0	.00	88	2.38
320070201	HARDWARE	72	2.05	114	3.23	13	.29	21	.47	20	.46	0	.00	240	6.49
320070202	SITE ACTIV.	24	.67	37	1.06	4	.10	7	.15	6	.15	0	.00	79	2.14
320070203	MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070204	SOFTWARE	18	.51	28	.80	3	.07	5	.12	5	.11	0	.00	59	1.61
320070301	HARDWARE	67	1.90	105	2.99	12	.27	19	.43	18	.43	0	.00	222	6.03
320070302	SITE ACTIV.	22	.63	35	.99	4	.09	6	.14	6	.14	0	.00	73	1.99
320070303	MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070304	SOFTWARE	17	.49	27	.77	3	.07	5	.11	5	.11	0	.00	57	1.55
320070401	HARDWARE 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070402	SITE ACTIV. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070404	SOFTWARE 3	5	.15	8	.24	1	.02	2	.03	1	.03	0	.00	18	.47
320070501	HARDWARE 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070502	SITE ACTIV. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070504	SOFTWARE 3	5	.15	8	.24	1	.02	2	.03	1	.03	0	.00	18	.47

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 9 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32008	VEHICLE TEST	172	4.01	519	13.03	0	.00	158	3.37	33	.78	0	.00	882	21.20
3200801	GND TEST HDWE.	0	.00	385	10.63	0	.00	114	2.54	33	.78	0	.00	532	13.96
3200802	GND TEST OPNS.	140	3.26	129	2.30	0	.00	44	.83	0	.00	0	.00	312	6.39
3200804	FLT. TEST OPNS	32	.76	5	.10	0	.00	0	.00	0	.00	0	.00	38	.85
320080101	PTV TEST	0	.00	89	2.45	0	.00	26	.59	8	.18	0	.00	123	3.22
320080102	MAJOR TEST ART.	0	.00	283	7.82	0	.00	84	1.87	24	.57	0	.00	391	10.26
320080103	MOCKUPS	0	.00	13	.37	0	.00	4	.09	1	.03	0	.00	18	.48

18C-9

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM I

DATE: SEPTEMBER 11, 1974
PAGE: 10 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS; HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32009	LAUNCH OPNS. WTR	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200901	LNCH SITE SVCES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200902	TUG/SHTL MATING	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200903	PRELAUNCH C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200904	COUNTDOWN	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200905	PRLNTS. & GASES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200906	POST FLT. SAFING	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

C-2-9

STUDY TITLE: SPACE TUG SYS.STY (FY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 11 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32010	LAUNCH OPNS ETR	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201001	LNCH SITE SVCES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201002	TUG/SHTL MATING	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201003	PRELAUNCH C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201004	COUNTDOWN	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201005	PRLNTS & GASES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201006	POST FLT. SAFING	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

STUDY TITLE: SPACE TUG SYS.STY (CR/)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 12 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32011	FLIGHT OPNS NASA	122	2.85	113	3.03	0	.00	44	.83	0	.00	12	.21	291	5.92
3201101	MISSION PLG.	56	1.30	52	.93	0	.00	20	.38	0	.00	5	.09	133	2.70
3201102	FLT. CONTROL	8	.20	8	.14	0	.00	3	.06	0	.00	1	.01	20	.41
3201103	FLT. EVAL.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201104	FLT. SUPT. SFTWRE	58	1.35	54	.96	0	.00	21	.39	0	.00	6	.10	138	2.81

PAGE 7

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 13 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32012	FLIGHT OPNS DOO	87	2.02	80	1.44	0	.00	31	.59	0	.00	8	.15	207	4.20
3201201	MISSION PLG	40	.92	37	.66	0	.00	14	.27	0	.00	4	.07	94	1.92
3201202	FLT. CONTROL	6	.14	6	.10	0	.00	2	.04	0	.00	1	.01	14	.29
3201203	FLT. EVAL.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201204	FLT. SUPT. SFTWRE	41	.96	38	.68	0	.00	15	.28	0	.00	4	.07	98	1.99

C.7

STUDY TITLE: SPACE TUG SYS.STY (CRY) | COST ESTIMATE | DATE: SEPTEMBER 11, 1973
CONTRACT NO: NAS 8-29677 | DATA FORM T | PAGE: 14 OF

X NON RECURRING(DDT&E) | RECURRING(PRODUCTION) | RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32013	REFURB &INTEG WTR	0	.00	3	.08	0	.00	1	.02	0	.01	0	.00	4	.11
3201301	SCH MAINT & REF	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201302	UNSCH MAINT & REF	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201303	POST MAINT C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201304	TUG/PL MAING &/CO	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201305	REFURB RQMTS PLG	0	.00	3	.08	0	.00	1	.02	0	.01	0	.00	4	.11
3201306	DEPOT MAINT	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

STUDY TITLE: SPACE TUG SYS.STY (CHY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 15 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32014	REFURB &INTEG ETR	0	.00	3	.08	0	.00	1	.02	0	.01	0	.00	4	.11
3201401	SCH MAINT & REF	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201402	UNSCH MAINT & REF	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201403	POST MAINT C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201404	TUG/PL MATING,C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201405	REFURB RQMTS PLB	0	.00	3	.08	0	.00	1	.02	0	.01	0	.00	4	.11
3201406	DEPOT MAINT	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 25 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32001	PROJECT MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	84	2.48	84	2.48
32002	SYS. ENGR. & INT.	542	15.38	118	2.25	0	.00	125	2.79	135	3.19	0	.08	921	23.68
32003	VEH MAIN STAGE	0	.00	1741	43.43	0	.00	516	11.49	150	3.53	0	.00	2406	58.45
32004	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	12.19	0	12.19
32005	LOGISTICS	1	.01	0	.00	0	.00	0	.00	0	.00	8	.14	8	.15
32006	FACILITIES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.44	0	.44
32007	GRND. SUPT. EQUIP	0	.00	33	.91	0	.00	10	.22	3	.07	0	.00	46	1.20
32008	VEHICLE TEST	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
	TOTAL	543	15.39	1892	46.59	0	.00	651	14.50	288	6.78	92	15.33	3465	98.59

88C-7

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 17 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32001	PROJECT MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	84	2.48	84	2.48
3200101	COST/PERF. MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	57	1.69	57	1.69
3200102	PROJ. DIRECTION	0	.00	0	.00	0	.00	0	.00	0	.00	25	.74	25	.74
3200103	INFORM. MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	2	.05	2	.05

585.7

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 18 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32002	SYS. ENGR. & INT.	542	15.38	118	2.25	0	.00	125	2.79	135	3.19	0	.08	921	23.68
3200201	TUG SYS. ENGR.	99	2.81	0	.00	0	.00	0	.00	6	.13	0	.04	105	2.98
3200202	SHUTTLE I/F	25	.70	0	.00	0	.00	0	.00	1	.03	0	.01	26	.75
3200203	PAYLOAD I/F	49	1.40	0	.00	0	.00	0	.00	3	.07	0	.02	52	1.49
3200204	SUST. ENGR.	369	10.47	118	2.25	0	.00	125	2.79	125	2.95	0	.00	738	18.46

C-190

STUDY : (TLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 19 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
3200	VEH MAIN STAGE	0	.00	1741	43.43	0	.00	516	11.49	150	3.53	0	.00	2406	58.45
3200301	STRUCTURES	0	.00	229	4.71	0	.00	68	1.51	20	.46	0	.00	316	6.69
3200302	THERMAL CONTROL	0	.00	64	1.33	0	.00	19	.42	6	.13	0	.00	89	1.88
3200303	AVIONICS	0	.00	507	14.00	0	.00	150	3.34	44	1.03	0	.00	701	18.37
3200304	PROPULSION	0	.00	409	11.30	0	.00	121	2.70	35	.83	0	.00	566	14.84
3200305	ORBITER I/F	0	.00	313	6.45	0	.00	93	2.07	27	.63	0	.00	432	9.14
3200306	DROP TANKS	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200307	FINAL ASSY & C/O	0	.00	219	5.64	0	.00	65	1.45	19	.44	0	.00	302	7.53
320030101	FUEL TK & SUPT	0	.00	64	1.31	0	.00	19	.42	5	.13	0	.00	88	1.86
320030102	OXID. TK & SUPT	0	.00	26	.54	0	.00	8	.17	2	.05	0	.00	36	.76
320030103	BODY STRUCTURE	0	.00	13	.28	0	.00	4	.09	1	.03	0	.00	19	.39
320030104	THRUST STRUC	0	.00	9	.18	0	.00	3	.06	1	.02	0	.00	12	.25
320030105	METEOROID SH	0	.00	58	1.20	0	.00	17	.38	5	.12	0	.00	81	1.70
320030106	PAYLOAD I/F	0	.00	44	.91	0	.00	13	.29	4	.09	0	.00	61	1.29
320030107	INSTL. ASSY & C/O	0	.00	15	.30	0	.00	4	.10	1	.03	0	.00	20	.43
320030201	FUEL TANK IN	0	.00	14	.29	0	.00	4	.09	1	.03	0	.00	20	.42
320030202	OXID. TANK I	0	.00	7	.14	0	.00	2	.05	1	.01	0	.00	10	.20
320030203	INSL. PURGE SYS.	0	.00	40	.83	0	.00	12	.27	3	.08	0	.00	56	1.18
320030204	THERM CONT. SYS.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030205	INSTL ASSY & C/O	0	.00	3	.05	0	.00	1	.02	0	.01	0	.00	4	.08
320030301	DATA MGMT. 3	0	.00	116	3.20	0	.00	34	.76	10	.24	0	.00	160	4.20
320030302	G N & C	0	.00	123	3.36	0	.00	36	.80	10	.25	0	.00	169	4.41
320030303	COMMUNICATIONS	0	.00	205	5.67	0	.00	61	1.35	18	.42	0	.00	284	7.44
320030304	INSTRUMENTATION	0	.00	19	.53	0	.00	6	.13	2	.04	0	.00	27	.70
320030305	ELECT. POWER	0	.00	9	.24	0	.00	3	.06	1	.02	0	.00	13	.32
320030306	PWR. DIST. & CONT	0	.00	4	.12	0	.00	1	.03	0	.01	0	.00	6	.16
320030307	INSTL. ASSY & C/O	0	.00	32	.88	0	.00	9	.21	3	.06	0	.00	44	1.15
320030401	MAIN ENGINE	0	.00	110	3.03	0	.00	32	.73	9	.22	0	.00	151	3.97
320030402	MAIN ENG. SUPT	0	.00	176	4.85	0	.00	52	1.16	15	.36	0	.00	243	6.37
320030403	ACPS ENGINE	0	.00	29	.81	0	.00	9	.19	3	.06	0	.00	41	1.06
320030404	ACPS ENG. SUPT	0	.00	80	2.20	0	.00	24	.53	7	.16	0	.00	110	2.89
320030405	INSTL. ASSY & C/O	0	.00	15	.41	0	.00	4	.10	1	.03	0	.00	20	.54
320030501	STRUCTURES	0	.00	49	1.01	0	.00	14	.32	4	.10	0	.00	67	1.43
320030502	I/F PANELS	0	.00	206	4.25	0	.00	61	1.36	18	.42	0	.00	285	6.93
320030503	PURGE PROV.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030504	ABORT PROV.	0	.00	38	.78	0	.00	11	.25	3	.08	0	.00	53	1.11
320030505	INSTL. ASSY & C/O	0	.00	20	.40	0	.00	6	.13	2	.04	0	.00	27	.57
320030701	FINAL ASSY	0	.00	182	4.70	0	.00	54	1.20	16	.37	0	.00	252	6.27
320030702	C/O	0	.00	36	.94	0	.00	11	.24	3	.07	0	.00	50	1.25

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 20 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32004	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	12.19	0	12.19
3200401	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	12.19	0	12.19

E5E-7

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 21 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32005	LOGISTICS	1	.01	0	.00	0	.00	0	.00	0	.00	8	.14	8	.15
3200501	TRANSP. & HDLG.	1	.01	0	.00	0	.00	0	.00	0	.00	8	.14	8	.15
3200502	TRAINING	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200503	INV CONT. & WHSNG	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320050201	SIM. & EQUIP.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

66F-7

STUDY TITLE: SPACE TUG SYS.STY (CRY) COST ESTIMATE DATE: SEPTEMBER 11, 1973
CONTRACT NO: NAS 8-29677 DATA FORM T PAGE: 22 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32006	FACILITIES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.44	0	.44
3200601	MANUFACTURING	0	.00	0	.00	0	.00	0	.00	0	.00	0	.44	0	.44
3200602	TEST	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060101	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060102	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.44	0	.44
320060201	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060202	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

A5F-7

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 23 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32007	GRND. SUPT. EQUIP	0	.00	33	.91	0	.00	10	.22	3	.07	0	.00	46	1.20
3200701	MFG. GSE	0	.00	33	.91	0	.00	10	.22	3	.07	0	.00	46	1.20
320070101	HARDWARE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070102	SITE ACTIV.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070103	MAINT.	0	.00	33	.91	0	.00	10	.22	3	.07	0	.00	46	1.20

SSE-7

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 24 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32008	VEHICLE TEST	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

76F-9

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 39 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32001	PROJECT MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	77	2.26	77	2.26
32002	SYS. ENGR. & INT.	66	1.88	21	.40	0	.00	22	.50	23	.53	0	.00	132	3.31
32003	VEH MAIN STAGE 3	0	.00	238	6.39	0	.00	71	1.57	21	.48	0	.00	330	8.45
32004	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32005	LOGISTICS	10	.22	0	.00	0	.00	0	.00	0	.00	124	2.29	134	2.51
32006	FACILITIES	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.21	0	1.21
32007	GROUND SUPT. EQUIP	0	.00	174	4.80	0	.00	51	1.15	15	.35	0	.00	240	6.30
32009	LAUNCH OPNS. WTR	22	.52	38	.68	0	.00	7	.14	4	.09	24	.42	95	1.85
32010	LAUNCH OPNS ETR	147	3.44	250	4.47	0	.00	49	.93	27	.62	156	2.78	630	12.25
32011	FLIGHT OPNS NASA	286	6.67	265	4.75	0	.00	102	1.94	0	.00	27	.48	681	13.84
32012	FLIGHT OPNS DOD	207	4.83	192	3.44	0	.00	74	1.40	0	.00	20	.35	493	10.03
32013	REFURB &INTEG WTR	0	.00	76	2.11	0	.00	23	.50	7	.16	0	.00	106	2.77
32014	REFURB &INTEG ETR	0	.00	656	18.13	0	.00	194	4.33	57	1.33	0	.00	907	23.79
	TOTAL	738	17.57	1910	45.17	0	.00	593	12.47	154	3.57	428	9.78	3825	88.56

STOP

COMPUTE TIME 27.154
READY

BBYE

6-47

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 26 OF

NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32001	PROJECT MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	77	2.26	77	2.26
3200101	COST/PERF. MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	51	1.48	51	1.48
3200102	PROJ. DIRECTION	0	.00	0	.00	0	.00	0	.00	0	.00	24	.71	24	.71
3200103	INFORM. MGMT. 3	0	.00	0	.00	0	.00	0	.00	0	.00	2	.06	2	.06

STUDY TITLE: SPACE TUG SYS.STY (CHY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 27 OF

NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32002	SYS. ENGR. & INT.	66	1.88	21	.40	0	.00	22	.50	23	.53	0	.00	132	3.31
3200204	SUST. ENGR.	3	66	1.88	21	.40	0	.00	22	.50	23	.53	0	.00	132	3.31

SSF-7

STUDY TITLE: SPACE TUG SYS.STY (CHY)
CONTRACT NO: NAS 8-29577

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 28 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WUS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32003	VEH MAIN STAGE 3	0	.00	238	6.39	0	.00	71	1.57	21	.48	0	.00	330	8.45
3200301	STRUCTURES	0	.00	7	.15	0	.00	2	.05	1	.01	0	.00	10	.21
3200302	THERMAL CONTROL	0	.00	2	.04	0	.00	1	.01	0	.00	0	.00	3	.06
3200303	AVIONICS 3	0	.00	136	3.75	0	.00	40	.89	12	.28	0	.00	187	4.92
3200304	PROPULSION	0	.00	75	2.07	0	.00	22	.50	6	.15	0	.00	104	2.72
3200305	ORBITER I/F	0	.00	18	.58	0	.00	5	.12	2	.04	0	.00	25	.54
3200306	DROP TANKS	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200307	FINAL ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030101	FUEL TK & SUPT	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030102	OXID. TK & SUPT	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030103	BODY STRUCTURE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030104	THRUST STRUC	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030105	METEOROID SH	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030106	PAYLOAD I/F	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030107	INSTL. ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030201	FUEL TANK INSL	0	.00	1	.01	0	.00	0	.00	0	.00	0	.00	1	.02
320030202	OXID. TANK INSL.	0	.00	1	.01	0	.00	0	.00	0	.00	0	.00	1	.01
320030203	INSL. PURGE SYS.	0	.00	1	.02	0	.00	0	.01	0	.00	0	.00	1	.03
320030204	THERM CONT. SYS.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030205	INSTL. ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030301	DATA MGMT. 3	0	.00	33	.90	0	.00	10	.22	3	.07	0	.00	45	1.19
320030302	G N & C	0	.00	1	.03	0	.00	0	.01	0	.00	0	.00	2	.05
320030303	COMMUNICATIONS	0	.00	17	.46	0	.00	5	.11	1	.03	0	.00	23	.61
320030304	INSTRUMENTATION	0	.00	6	.16	0	.00	2	.04	0	.01	0	.00	8	.21
320030305	ELECT. POWER	0	.00	79	2.18	0	.00	23	.52	7	.16	0	.00	109	2.86
320030306	PWR. DIST. & CONT	0	.00	0	.01	0	.00	0	.00	0	.00	0	.00	0	.01
320030307	INSTL. ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030401	MAIN ENGINE	0	.00	43	1.20	0	.00	13	.29	4	.09	0	.00	60	1.57
320030402	MAIN ENG. SUPT	0	.00	13	.35	0	.00	4	.08	1	.03	0	.00	17	.45
320030403	ACPS ENGINE	0	.00	16	.45	0	.00	5	.11	1	.03	0	.00	23	.60
320030404	ACPS ENG. SUPT	0	.00	3	.08	0	.00	1	.02	0	.01	0	.00	4	.10
320030405	INSTL. ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030501	STRUCTURES	0	.00	1	.02	0	.00	0	.01	0	.00	0	.00	1	.03
320030502	I/F PANELS	0	.00	17	.35	0	.00	5	.11	1	.03	0	.00	23	.49
320030503	PURGE PROV.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030504	ABORT PROV.	0	.00	1	.01	0	.00	0	.00	0	.00	0	.00	1	.02
320030505	INSTL. ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030701	FINAL ASSY	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030702	C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030105	SOFTWARE 3	0	.00	23	.63	0	.00	7	.15	2	.08	0	.00	32	.83

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 29 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32004	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

1 of 9

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 30 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32005	LOGISTICS	10	.22	0	.00	0	.00	0	.00	0	.00	124	2.28	134	2.51
3200501	TRANSP. & HDLG.	0	.01	0	.00	0	.00	0	.00	0	.00	5	.09	5	.10
3200502	TRAINING	5	.12	0	.00	0	.00	0	.00	0	.00	68	1.25	73	1.37
3200503	INV CONT. & WHSNG	4	.09	0	.00	0	.00	0	.00	0	.00	52	.95	55	1.04
320050201	SIM. & EQUIP.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320050202	GROUND CREW	5	.12	0	.00	0	.00	0	.00	0	.00	68	1.25	73	1.37

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 31 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32006	FACILITIES	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.21	0	1.21
3200603	ETR MAINT. & REF.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.55	0	.55
3200604	ETR LAUNCH	0	.00	0	.00	0	.00	0	.00	0	.00	0	.21	0	.21
3200605	WTR MAINT. & REF.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.30	0	.30
3200606	WTR LAUNCH	0	.00	0	.00	0	.00	0	.00	0	.00	0	.15	0	.15
320060301	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060302	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.55	0	.55
320060401	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060402	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.21	0	.21
320060501	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060502	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.30	0	.30
320060601	DES./CONST. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060602	ACTIV./MAINT. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.15	0	.15

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 32 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32007	GRND. SUPT. EQUIP	0	.00	174	4.80	0	.00	51	1.15	15	.35	0	.00	240	6.30
3200701	MFG. GSE 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200702	ETH GSE	0	.00	68	1.87	0	.00	20	.45	6	.14	0	.00	94	2.46
3200703	WTR GSE	0	.00	46	1.27	0	.00	14	.30	4	.09	0	.00	64	1.67
3200704	FLT OPS GSE(NASA)	0	.00	30	.83	0	.00	9	.20	3	.06	0	.00	41	1.09
3200705	FLT OPS GSE(DOD)	0	.00	30	.83	0	.00	9	.20	3	.06	0	.00	41	1.09
320070104	SOFTWARE 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070201	HARDWARE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070202	SITE ACTIV.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070203	MAINT.	0	.00	57	1.59	0	.00	17	.38	5	.12	0	.00	79	2.08
320070204	SOFTWARE	0	.00	10	.29	0	.00	3	.07	1	.02	0	.00	14	.37
320070301	HARDWARE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070302	SITE ACTIV.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070303	MAINT.	0	.00	45	1.24	0	.00	13	.30	4	.09	0	.00	62	1.63
320070304	SOFTWARE 3	0	.00	1	.03	0	.00	0	.01	0	.00	0	.00	2	.04
320070403	MAINT. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070404	SOFTWARE 3	0	.00	30	.83	0	.00	9	.20	3	.06	0	.00	41	1.09
320070503	MAINT. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070504	SOFTWARE 3	0	.00	30	.83	0	.00	9	.20	3	.06	0	.00	41	1.09

6-7

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 33 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32009	LAUNCH OPNS. WTR	22	.52	38	.68	0	.00	7	.14	4	.09	24	.42	95	1.85
3200901	LNCH SITE SVCES	8	.19	14	.25	0	.00	3	.05	2	.03	9	.15	35	.67
3200902	TUG/SHTL MATING	3	.06	4	.08	0	.00	1	.02	0	.01	3	.05	11	.22
3200903	PRELAUNCH C/O	3	.08	6	.10	0	.00	1	.02	1	.01	3	.06	14	.27
3200904	COUNTDOWN	4	.10	7	.13	0	.00	1	.03	1	.02	5	.08	18	.36
3200905	PRLNTS. & BASES	1	.01	1	.02	0	.00	0	.00	0	.00	1	.01	3	.05
3200906	POST FLT. SAFING	3	.08	6	.10	0	.00	1	.02	1	.01	4	.06	14	.28

STUDY TITLE: SPACE TUG SYS.STY (CRY) | COST ESTIMATE | DATE: SEPTEMBER 11, 1973
CONTRACT NO: NAS 8-29677 | DATA FORM T | PAGE: 34 OF

NON RECURRING(DDT&E) | RECURRING(PRODUCTION) | X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32010	LAUNCH OPNS ETR	147	3.44	250	4.47	0	.00	49	.93	27	.62	156	2.78	630	12.25
3201001	LNCH SITE SVCES	55	1.28	93	1.66	0	.00	18	.35	10	.23	58	1.04	234	4.56
3201002	TUG/SHTL MATING	17	.39	28	.51	0	.00	6	.11	3	.07	18	.31	71	1.39
3201003	PRELAUNCH C/O	21	.48	35	.63	0	.00	7	.13	4	.09	22	.39	89	1.72
3201004	COUNTDOWN	27	.63	46	.82	0	.00	9	.17	5	.11	29	.51	115	2.24
3201005	PRLNTS & GASES	6	.13	10	.17	0	.00	2	.04	1	.02	6	.11	25	.48
3201006	POST FLT. SAFING	22	.52	38	.68	0	.00	7	.14	4	.09	24	.42	95	1.85

STUDY TITLE: SPACE TUG SYS.STY (CHY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 35 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32011	FLIGHT OPNS NASA	286	6.67	265	4.75	0	.00	102	1.94	0	.00	27	.48	681	13.84
3201101	MISSION PLG.	49	1.14	45	.81	0	.00	17	.33	0	.00	5	.08	116	2.36
3201102	FLT. CONTROL	162	3.78	150	2.69	0	.00	58	1.10	0	.00	15	.27	385	7.84
3201103	FLT. EVAL.	44	1.03	41	.73	0	.00	16	.30	0	.00	4	.07	105	2.14
3201104	FLT. SUPT. SFTWRE	31	.73	29	.52	0	.00	11	.21	0	.00	3	.05	74	1.51

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 36 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32012	FLIGHT OPNS DOD	207	4.83	132	3.44	0	.00	74	1.40	0	.00	20	.35	493	10.04
3201201	MISSION PLG 3	34	.80	32	.57	0	.00	12	.23	0	.00	3	.06	82	1.67
3201202	FLT. CONTROL	121	2.82	112	2.00	0	.00	43	.82	0	.00	11	.20	287	5.84
3201203	FLT. EVAL.	29	.69	27	.49	0	.00	11	.20	0	.00	3	.06	70	1.42
3201204	FLT. SUPT. SFTWRE	23	.53	21	.38	0	.00	8	.15	0	.00	2	.04	54	1.09

C-30

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 37 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32013	REFURB &INTEG WTR	0	.00	76	2.11	0	.00	23	.50	7	.16	0	.00	106	2.77
3201301	SCH MAINT & REF	0	.00	10	.29	0	.00	3	.07	1	.02	0	.00	14	.38
3201302	UNSCH MAINT & REF	0	.00	3	.07	0	.00	1	.02	0	.01	0	.00	4	.09
3201303	POST MAINT C/O	0	.00	1	.04	0	.00	0	.01	0	.00	0	.00	2	.05
3201304	TUG/PL MAING &/CO	0	.00	6	.16	0	.00	2	.04	1	.01	0	.00	8	.21
3201305	REFURB RQMTS PLG	0	.00	3	.07	0	.00	1	.02	0	.01	0	.00	4	.10
3201306	DEPOT MAINT	0	.00	53	1.48	0	.00	16	.35	5	.11	0	.00	74	1.94

5 of 7

STUDY TITLE: SPACE TUG SYS.STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 38 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32014	REFURB &INTEG ETR	0	.00	656	14.13	0	.00	194	4.33	57	1.33	0	.00	907	23.79
3201401	SCH MAINT & REF	0	.00	71	1.95	0	.00	21	.47	6	.14	0	.00	98	2.56
3201402	UNSCH MAINT & REF	0	.00	17	.48	0	.00	5	.11	1	.04	0	.00	24	.63
3201403	POST MAINT C/O	0	.00	4	.10	0	.00	1	.02	0	.01	0	.00	5	.13
3201404	TUG/PL MATING,C/O	0	.00	44	1.22	0	.00	13	.29	4	.09	0	.00	61	1.60
3201405	REFURB RQMTS PLG	0	.00	20	.55	0	.00	6	.13	2	.04	0	.00	27	.72
3201406	DEPOT MAINT	0	.00	501	13.83	0	.00	148	3.30	43	1.02	0	.00	692	18.15

C-3/0

OPTION 3

FINAL

COST DATA FORMS 'T

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM 1

DATE: SEPTEMBER 11, 1973
PAGE: 16 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32001	PROJECT MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	102	3.00	102	3.00
32002	SYS. ENGR. & INT.	234	6.63	0	.00	0	.00	0	.00	13	.32	0	.11	247	7.05
32003	VEH MAIN STAGE	793	23.16	162	4.42	125	3.05	48	1.07	634	17.79	0	.00	1761	49.48
32004	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32005	LOGISTICS	9	.21	0	.00	0	.00	0	.00	0	.00	116	2.14	125	2.34
32006	FACILITIES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32007	GRND. SUPT. EQUIP	53	1.50	84	2.37	10	.21	15	.34	14	.34	0	.00	176	4.77
32008	VEHICLE TEST	126	2.95	343	8.48	0	.00	105	2.23	21	.49	0	.00	596	14.15
32009	LAUNCH OPNS. WTR	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32010	LAUNCH OPNS ETR	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32011	FLIGHT OPNS NASA	95	2.23	88	1.58	0	.00	34	.65	0	.00	9	.16	227	4.62
32012	FLIGHT OPNS DOD	66	1.53	61	1.09	0	.00	24	.45	0	.00	6	.11	156	3.18
32013	REFURB &INTEG WTR	0	.00	3	.08	0	.00	1	.02	0	.01	0	.00	4	.11
32014	REFURB &INTEG ETR	0	.00	3	.08	0	.00	1	.02	0	.01	0	.00	4	.11
	TOTAL	1378	38.21	744	18.11	135	3.26	228	4.77	682	18.94	233	5.51	3398	88.52

E-8-7

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-24677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 1 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS; HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32001	PROJECT MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	102	3.00	102	3.00
3200101	COST/PERF. MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	70	2.06	70	2.06
3200102	PROJ. DIRECTION	0	.00	0	.00	0	.00	0	.00	0	.00	30	.88	30	.88
3200103	INFORM. MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	2	.06	2	.06

E-7

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 2 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32002	SYS. ENGR. & INT.	234	6.83	0	.00	0	.00	0	.00	13	.32	0	.11	247	7.05
3200201	TUG SYS. ENGR.	187	5.30	0	.00	0	.00	0	.00	11	.25	0	.08	198	5.64
3200202	SHUTTLE I/F	12	.33	0	.00	0	.00	0	.00	1	.02	0	.01	12	.35
3200203	PAYLOAD I/F	35	.99	0	.00	0	.00	0	.00	2	.05	0	.02	37	1.06

A1 E-7

STUDY TITLE: SPACE TUG SYS. STY (CRY) COST ESTIMATE DATE: SEPTEMBER 11, 1973
CONTRACT NO: NAS 8-29677 DATA FORM T PAGE: 3 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS; HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32003	VEH MAIN STAGE	793	23.16	162	4.42	125	3.05	48	1.07	634	17.79	0	.00	1761	49.48
3200301	STRUCTURES	35	1.01	0	.00	44	1.08	0	.00	42	1.13	0	.00	121	3.22
3200302	THERMAL CONTROL	0	.00	3	.06	0	.00	1	.02	0	.01	0	.00	4	.08
3200303	AVIONICS	404	11.81	91	2.52	19	.46	27	.60	338	8.75	0	.00	879	24.14
3200304	PROPULSION	271	8.01	55	1.52	26	.61	16	.36	253	7.88	0	.00	621	18.38
3200305	ORBITER I/F	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200306	DROP TANKS	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200307	FINAL ASSY & C/O	82	2.33	13	.32	37	.91	4	.08	1	.03	0	.00	136	3.67
320030101	FUEL TK & SUPT	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030102	OXID. TK & SUPT	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030103	BODY STRUCTURE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030104	THRUST STRUCTURE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030105	METEOROID SHIELD	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030106	PAYLOAD I/F	33	.94	0	.00	40	1.00	0	.00	39	1.05	0	.00	112	2.98
320030107	INSTL. ASSY & C/O	3	.07	0	.00	3	.08	0	.00	3	.08	0	.00	9	.24
320030201	FUEL TANK INSL	0	.00	2	.04	0	.00	1	.01	0	.00	0	.00	3	.05
320030202	OXID. TANK INSL.	0	.00	1	.02	0	.00	0	.01	0	.00	0	.00	1	.03
320030203	INSL. PURGE SYS.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030204	THERM CONT. SYS.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030205	INSTL ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030301	DATA MGMT. 3	159	4.65	15	.41	7	.18	4	.10	131	3.40	0	.00	317	8.74
320030302	G N & C	60	1.76	18	.49	3	.07	5	.12	51	1.31	0	.00	136	3.74
320030303	COMMUNICATIONS	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030304	INSTRUMENTATION	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030305	ELECT. POWER	92	2.68	51	1.41	4	.10	15	.34	79	2.04	0	.00	241	6.57
320030306	PWR. DIST. & CONT	0	.00	1	.03	0	.00	0	.01	0	.00	0	.00	1	.03
320030307	INSTL. ASSY & C/O	93	2.73	7	.19	4	.11	2	.04	77	1.99	0	.00	183	5.05
320030401	MAIN ENGINE 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030402	MAIN ENG. SUPT	86	2.56	17	.46	8	.19	5	.11	81	2.51	0	.00	197	5.83
320030403	ACPS ENGINE	13	.37	5	.14	1	.03	1	.03	12	.37	0	.00	32	.94
320030404	ACPS ENG. SUPT	159	4.70	31	.85	15	.36	9	.20	148	4.62	0	.00	363	10.74
320030405	INSTL. ASSY & C/O	13	.38	3	.07	1	.03	1	.02	12	.35	0	.00	30	.87
320030501	STRUCTURES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030502	I/F PANELS	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030503	PURGE PROV.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030504	ABORT PROV.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030505	INSTL. ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030701	FINAL ASSY	51	1.46	8	.20	23	.57	2	.05	1	.02	0	.00	85	2.29
320030702	C/O	31	.87	5	.12	14	.34	1	.03	0	.01	0	.00	51	1.37
32003010101	LH2 DOMES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003010102	LH2 CYLINDER	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003010103	LH2 SUPPORTS	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003010201	LO2 DOMES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003010202	LO2 SUPPORTS	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003010301	FWD AFT SKIRT	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003010302	INTERTANK	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

5-27

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 4 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32003010303	SDWL SHELL	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030101	SCU	78	2.27	14	.38	4	.09	4	.09	64	1.67	0	.00	164	4.50
32003030102	DATA DISTR.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030103	EQ. THERM CONT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030104	CIRCUITRY 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030105	SOFTWARE	70	2.04	0	.00	3	.08	0	.00	57	1.48	0	.00	130	3.60
32003030106	SOFTWARE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030107	SOFTWARE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030108	INSTL, ASSY & C/O	12	.34	1	.03	1	.01	0	.01	10	.25	0	.00	23	.65
32003030201	I M U	47	1.38	10	.29	2	.05	3	.07	39	1.02	0	.00	102	2.81
32003030202	TRACKING/ELECT 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030203	REN DEZ&DOCKING 3	8	.24	6	.16	0	.01	2	.04	7	.19	0	.00	24	.65
32003030204	INSTL, ASSY & C/O	4	.13	1	.04	0	.01	0	.01	4	.10	0	.00	10	.28
32003030301	M/W CIRC +HF MUX	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030302	TRANSPONDERS 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030303	POWER AMP.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030304	ANTENNA	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030305	DEC/ENC+MOD/DEM	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030306	TAPE RECORDER	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030307	P/L INTER EQUIP	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030308	INSTL, ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030401	DATA SENSORS	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030402	SIGNAL COND.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030403	CIRCUITRY	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030404	INSTL, ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030501	BATTERY	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030502	FUEL CELL 3	85	2.48	47	1.30	4	.10	14	.31	73	1.89	0	.00	223	6.08
32003030503	INSTL, ASSY & C/O	7	.20	4	.10	0	.01	1	.02	6	.15	0	.00	18	.49
32003030601	DISTR.	0	.00	1	.02	0	.00	0	.01	0	.00	0	.00	1	.03
32003030602	TANKS SYSTEM 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030603	INSTL, ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 5 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32004	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200401	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

STUDY TITLE: SPACE TUG SYS. STY (CRY) COST ESTIMATE DATE: SEPTEMBER 11, 1973
CONTRACT NO: NAS 8-29677 DATA FORM T PAGE: 6 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32005	LOGISTICS	9	.21	0	.00	0	.00	0	.00	0	.00	116	2.14	125	2.34
3200501	TRANSP. & HDLG.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200502	TRAINING	5	.11	0	.00	0	.00	0	.00	0	.00	59	1.08	63	1.18
3200503	INV CONT. & WHSNG	4	.10	0	.00	0	.00	0	.00	0	.00	58	1.06	62	1.15
320050201	SIM. & EQUIP.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320050202	GROUND CREW	5	.11	0	.00	0	.00	0	.00	0	.00	59	1.08	63	1.18

8/67

STUDY TITLE: SPACE TUG SYS. STY (CRY) COST ESTIMATE DATE: SEPTEMBER 11, 1973
CONTRACT NO: NAS 8-29677 DATA FORM T PAGE: 7 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS; HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32006	FACILITIES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200601	MANUFACTURING	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200602	TEST	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200603	ETR MAINT. & REF.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200604	ETR LAUNCH	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200605	WTR MAINT. & REF.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200606	WTR LAUNCH	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060101	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060102	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060201	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060202	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060301	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060302	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060401	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060402	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060501	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060502	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060601	DES./CONST. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060602	ACTIV./MAINT. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

S/C-7

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 8 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32007	GRND. SUPT. EQUIP	53	1.50	84	2.37	10	.21	15	.34	14	.34	0	.00	176	4.77
3200701	MFG. GSE	22	.61	34	.96	4	.09	6	.14	6	.14	0	.00	71	1.94
3200702	ETR GSE	10	.30	16	.47	2	.04	3	.07	3	.07	0	.00	35	.94
3200703	WTR GSE	11	.30	17	.47	2	.04	3	.07	3	.07	0	.00	35	.95
3200704	FLT OPS GSE(NASA)	5	.15	8	.24	1	.02	2	.03	1	.03	0	.00	18	.47
3200705	FLT OPS GSE(DOD)	5	.15	8	.24	1	.02	2	.03	1	.03	0	.00	18	.47
320070101	HARDWARE	19	.53	30	.84	3	.08	5	.12	5	.12	0	.00	62	1.69
320070102	SITE ACTIV.	0	.01	1	.02	0	.00	0	.00	0	.00	0	.00	1	.03
320070103	MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070104	SOFTWARE	2	.07	4	.10	0	.01	1	.02	1	.01	0	.00	8	.21
320070201	HARDWARE	7	.19	11	.30	1	.03	2	.04	2	.04	0	.00	22	.60
320070202	SITE ACTIV.	2	.06	3	.10	0	.01	1	.01	1	.01	0	.00	7	.20
320070203	MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070204	SOFTWARE	2	.04	2	.07	0	.01	0	.01	0	.01	0	.00	5	.14
320070301	HARDWARE	7	.19	11	.30	1	.03	2	.04	2	.04	0	.00	22	.61
320070302	SITE ACTIV.	2	.06	4	.10	0	.01	1	.01	1	.01	0	.00	7	.20
320070303	MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070304	SOFTWARE	2	.04	2	.07	0	.01	0	.01	0	.01	0	.00	5	.14
320070401	HARDWARE 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070402	SITE ACTIV. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070404	SOFTWARE 3	5	.15	8	.24	1	.02	2	.03	1	.03	0	.00	18	.47
320070501	HARDWARE 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070502	SITE ACTIV. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070504	SOFTWARE 3	5	.15	8	.24	1	.02	2	.03	1	.03	0	.00	18	.47

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 9 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32008	VEHICLE TEST	126	2.95	343	8.48	0	.00	105	2.23	21	.49	0	.00	596	14.15
3200801	GND TEST HDWE.	0	.00	240	6.63	0	.00	71	1.58	21	.49	0	.00	332	8.70
3200802	GND TEST OPNS.	109	2.55	100	1.80	0	.00	34	.65	0	.00	0	.00	244	5.00
3200804	FLT. TEST OPNS	17	.40	3	.05	0	.00	0	.00	0	.00	0	.00	20	.46
320080101	PTV TEST	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320080102	MAJOR TEST ART.	0	.00	229	6.33	0	.00	68	1.51	20	.47	0	.00	317	8.31
320080103	MOCKUPS	0	.00	11	.29	0	.00	3	.07	1	.02	0	.00	15	.38

STUDY TITLE: SPACE TUG SYS. STY (CRY) COST ESTIMATE DATE: SEPTEMBER 11, 1973
CONTRACT NO: NAS 8-29677 DATA FORM T PAGE: 10 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32009	LAUNCH OPNS. WTR	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200901	LNCH SITE SVCES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200902	TUG/SHTL MATING	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200903	PRELAUNCH C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200904	COUNTDOWN	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200905	PRLNTS. & GASES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200906	POST FLT. SAFING	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

STUDY TITLE: SPACE TUG SYS. STY (CRY) | COST ESTIMATE | DATE: SEPTEMBER 11, 1973
CONTRACT NO: NAS 8-29677 | DATA FORM T | PAGE: 11 OF

X NON RECURRING(DDT&E) | RECURRING(PRODUCTION) | RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32010	LAUNCH OPNS ETR	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201001	LNCH SITE SVCES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201002	TUG/SHTL MATING	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201003	PRELAUNCH C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201004	COUNTDOWN	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201005	PRLNTS & GASES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201006	POST FLT. SAFING	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

E-23

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM 1

DATE: SEPTEMBER 11, 1973
PAGE: 12 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32011	FLIGHT OPNS NASA	95	2.23	88	1.58	0	.00	34	.65	0	.00	9	.16	227	4.62
3201101	MISSION PLG.	85	1.97	79	1.41	0	.00	30	.57	0	.00	8	.14	201	4.10
3201102	FLT. CONTROL	6	.14	5	.10	0	.00	2	.04	0	.00	1	.01	14	.23
3201103	FLT. EVAL.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201104	FLT. SUPT. SFTWRE	5	.12	5	.08	0	.00	2	.03	0	.00	0	.01	12	.24

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 13 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32012	FLIGHT OPNS DOD	66	1.53	61	1.09	0	.00	24	.45	0	.00	6	.11	156	3.18
3201201	MISSION PLG	58	1.36	54	.97	0	.00	21	.40	0	.00	6	.10	139	2.82
3201202	FLT. CONTROL	4	.09	4	.07	0	.00	1	.03	0	.00	0	.01	10	.19
3201203	FLT. EVAL.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201204	FLT. SUPT. SFTWRE	3	.08	3	.06	0	.00	1	.02	0	.00	0	.01	8	.16

STUDY TITLE: SPACE TUG SYS. STY (CRY) | COST ESTIMATE | DATE: SEPTEMBER 11, 1973
CONTRACT NO: NAS 8-29677 | DATA FORM T | PAGE: 14 OF

X NON RECURRING(DDT&E) | RECURRING(PRODUCTION) | RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32013	REFURB &INTEG WTR	0	.00	3	.08	0	.00	1	.02	0	.01	0	.00	4	.11
3201301	SCH MAINT & REF	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201302	UNSCH MAINT & REF	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201303	POST MAINT C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201304	TUG/PL MAING &/CO	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201305	REFURB RQMTS PLG	0	.00	3	.08	0	.00	1	.02	0	.01	0	.00	4	.11
3201306	DEPOT MAINT	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

STUDY TITLE: SPACE TUG SYS. STY (CONT)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 15 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32014	REFURB MAINTEG ETR	0	.00	3	.08	0	.00	1	.02	0	.01	0	.00	4	.11
3201401	SCH MAINT & REF	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201402	UNSCH MAINT & REF	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201403	POST MAINT C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201404	TUG/PL MATING, C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201405	REFURB RQMTS PLO	0	.00	3	.08	0	.00	1	.02	0	.01	0	.00	4	.11
3201406	DEPOT MAINT	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

C-27

STUDY TITLE: SPACE TUG SYS. STY (CRY) | COST ESTIMATE | DATE: SEPTEMBER 11, 1973
CONTRACT NO: NAS 8-29677 | DATA FORM T | PAGE: 25 OF

NON RECURRING(DDT&E) | X RECURRING(PRODUCTION) | RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS; HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32001	PROJECT MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	179	5.25	179	5.25
32002	SYS. ENGR. & INT.	1029	29.18	210	4.00	0	.00	222	4.96	244	5.76	0	.17	1706	44.06
32003	VEH MAIN STAGE	0	.00	3489	90.39	0	.00	1034	23.03	300	7.07	0	.00	4823	120.50
32004	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	4.97	0	4.97
32005	LOGISTICS	1	.03	0	.00	0	.00	0	.00	0	.00	17	.32	19	.35
32006	FACILITIES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32007	GRND. SUPT. EQUIP	0	.00	46	1.28	0	.00	14	.31	4	.09	0	.00	64	1.68
32008	VEHICLE TEST	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
	TOTAL	1030	29.21	3745	95.68	0	.00	1270	28.29	548	12.92	196	10.71	6791	176.81

ACE-7

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 17 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32001	PROJECT MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	179	5.25	179	5.25
3200101	COST/PERF. MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	122	3.57	122	3.57
3200102	PROJ. DIRECTION	0	.00	0	.00	0	.00	0	.00	0	.00	53	1.56	53	1.56
3200103	INFORM. MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	4	.11	4	.11

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 18 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32002	SYS. ENGR. & INT.	1029	29.18	210	4.00	0	.00	222	4.96	244	5.76	0	.17	1706	44.06
3200201	TUG SYS. ENGR.	213	6.04	0	.00	0	.00	0	.00	12	.29	0	.10	225	6.42
3200202	SHUTTLE I/F	53	1.51	0	.00	0	.00	0	.00	3	.07	0	.02	56	1.61
3200203	PAYLOAD I/F	106	3.02	0	.00	0	.00	0	.00	6	.14	0	.05	113	3.21
3200204	SUST. ENGR.	656	18.61	210	4.00	0	.00	222	4.96	223	5.25	0	.00	1312	32.82

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-24677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1975
PAGE: 19 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32003	VEH MAIN STAGE	0	.00	3489	90.39	0	.00	1034	23.03	300	7.07	0	.00	4823	120.50
3200301	STRUCTURES	0	.00	514	10.59	0	.00	152	3.39	44	1.04	0	.00	710	15.02
3200302	THERMAL CONTROL	0	.00	125	2.58	0	.00	37	.83	11	.25	0	.00	173	3.67
3200303	AVIONICS	0	.00	1344	37.12	0	.00	398	8.87	116	2.73	0	.00	1858	48.72
3200304	PROPULSION	0	.00	909	25.11	0	.00	269	6.00	78	1.85	0	.00	1257	32.95
3200305	ORBITER I/F	0	.00	75	1.55	0	.00	22	.50	6	.15	0	.00	104	2.20
3200306	DROP TANKS	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200307	FINAL ASSY & C/O	0	.00	521	13.44	0	.00	155	3.44	45	1.06	0	.00	721	17.94
320030101	FUEL TK & SUPT	0	.00	124	2.56	0	.00	37	.82	11	.25	0	.00	171	3.63
320030102	OXID. TK & SUPT	0	.00	51	1.05	0	.00	15	.34	4	.10	0	.00	70	1.49
320030103	BODY STRUCTURE	0	.00	26	.54	0	.00	8	.17	2	.05	0	.00	36	.77
320030104	THRUST STRUC	0	.00	17	.34	0	.00	5	.11	1	.03	0	.00	23	.49
320030105	METEOROID SH	0	.00	114	2.34	0	.00	34	.75	10	.23	0	.00	157	3.32
320030106	PAYLOAD I/F	0	.00	150	3.09	0	.00	45	.99	13	.30	0	.00	207	4.39
320030107	INSTL. ASSY & C/O	0	.00	32	.67	0	.00	10	.21	3	.07	0	.00	45	.94
320030201	FUEL TANK IN	0	.00	28	.57	0	.00	8	.18	2	.06	0	.00	38	.81
320030202	OXID. TANK I	0	.00	14	.28	0	.00	4	.09	1	.03	0	.00	19	.40
320030203	INSL. PURGE SYS.	0	.00	79	1.63	0	.00	23	.52	7	.16	0	.00	109	2.31
320030204	THERM CONT. SYS.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030205	INSTL ASSY & C/O	0	.00	5	.10	0	.00	1	.03	0	.01	0	.00	7	.15
320030301	DATA MGMT. 3	0	.00	324	8.95	0	.00	96	2.14	28	.66	0	.00	448	11.74
320030302	G N & C	0	.00	198	5.46	0	.00	59	1.30	17	.40	0	.00	273	7.17
320030303	COMMUNICATIONS	0	.00	391	10.79	0	.00	116	2.58	34	.79	0	.00	540	14.16
320030304	INSTRUMENTATION	0	.00	38	1.04	0	.00	11	.25	3	.08	0	.00	52	1.36
320030305	ELECT. POWER	0	.00	305	8.44	0	.00	90	2.02	26	.62	0	.00	422	11.07
320030306	PWR. DIST. & CONT	0	.00	9	.24	0	.00	3	.06	1	.02	0	.00	12	.32
320030307	INSTL. ASSY & C/O	0	.00	80	2.21	0	.00	24	.53	7	.16	0	.00	111	2.90
320030401	MAIN ENGINE	0	.00	179	4.95	0	.00	53	1.18	15	.36	0	.00	248	6.49
320030402	MAIN ENG. SUPT	0	.00	421	11.63	0	.00	125	2.78	36	.85	0	.00	582	15.26
320030403	ACPS ENGINE	0	.00	38	1.04	0	.00	11	.25	3	.08	0	.00	52	1.36
320030404	ACPS ENG. SUPT	0	.00	236	6.52	0	.00	70	1.56	20	.48	0	.00	326	8.56
320030405	INSTL. ASSY & C/O	0	.00	35	.97	0	.00	10	.23	3	.07	0	.00	49	1.23
320030501	STRUCTURES	0	.00	11	.23	0	.00	3	.07	1	.02	0	.00	15	.32
320030502	I/F PANELS	0	.00	51	1.06	0	.00	15	.34	4	.10	0	.00	71	1.50
320030503	PURGE PROV.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030504	ABORT PROV.	0	.00	8	.17	0	.00	3	.06	1	.02	0	.00	12	.25
320030505	INSTL. ASSY & C/O	0	.00	5	.09	0	.00	1	.03	0	.01	0	.00	6	.13
320030701	FINAL ASSY	0	.00	434	11.20	0	.00	129	2.87	37	.88	0	.00	601	14.95
320030702	C/O	0	.00	87	2.24	0	.00	26	.57	7	.18	0	.00	120	2.49

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 20 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32004	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	4.97	0	4.97
3200401	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	4.97	0	4.97

STUDY TITLE: SPACE TUG SYS. STY (CNT)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 21 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32005	LOGISTICS	1	.03	0	.00	0	.00	0	.00	0	.00	17	.32	19	.35
3200501	TRANSP. & HDLG.	1	.03	0	.00	0	.00	0	.00	0	.00	17	.32	19	.35
3200502	TRAINING	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200503	INV CONT. & WHSNG	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320050201	SIM. & EQUIP.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 22 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32006	FACILITIES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200601	MANUFACTURING	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200602	TEST	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060101	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060102	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060201	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060202	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

C-334

STUDY TITLE: SPACE TUG SYS. STY (CRY) | COST ESTIMATE | DATE: SEPTEMBER 11, 1973
CONTRACT NO: NAS 8-29677 | DATA FORM T | PAGE: 23 OF

NON RECURRING(DDT&E) | X RECURRING(PRODUCTION) | RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS) HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32007	GRND. SUPT. EQUIP	0	.00	46	1.28	0	.00	14	.31	4	.09	0	.00	64	1.68
3200701	MFG. GSE	0	.00	46	1.28	0	.00	14	.31	4	.09	0	.00	64	1.68
320070101	HARDWARE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070102	SITE ACTIV.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070103	MAINT.	0	.00	46	1.28	0	.00	14	.31	4	.09	0	.00	64	1.68

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 24 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32008	VEHICLE TEST	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

7EE-7

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 39 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) x RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32001	PROJECT MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	202	5.92	202	5.92
32002	SYS. ENGR. & INT.	143	4.05	46	.87	0	.00	48	1.08	48	1.14	0	.00	285	7.13
32003	VEH MAIN STAGE 3	0	.00	356	9.66	0	.00	106	2.35	31	.72	0	.00	493	12.73
32004	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32005	LOGISTICS	21	.49	0	.00	0	.00	0	.00	0	.00	275	5.04	296	5.53
32006	FACILITIES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32007	GRND. SUPT. EQUIP	0	.00	108	2.98	0	.00	32	.71	9	.22	0	.00	149	3.91
32009	LAUNCH OPNS. WTR	176	4.11	298	5.34	0	.00	59	1.11	33	.75	186	3.32	752	14.62
32010	LAUNCH OPNS ETR	432	10.08	732	13.09	0	.00	144	2.73	80	1.83	457	8.14	1843	35.87
32011	FLIGHT OPNS NASA	660	15.40	612	10.96	0	.00	236	4.47	0	.00	63	1.12	1571	31.94
32012	FLIGHT OPNS DOD	502	11.72	466	8.34	0	.00	180	3.40	0	.00	48	.85	1196	24.31
32013	REFURB &INTEG WTR	0	.00	380	10.50	0	.00	113	2.51	33	.77	0	.00	525	13.77
32014	REFURB &INTEG ETR	0	.00	1344	37.11	0	.00	398	8.88	116	2.73	0	.00	1857	48.70
	TOTAL	1934	45.84	4342	98.84	0	.00	1316	27.23	350	8.16	1231	24.39	9171	204.46

VSTRIP

STUDY TITLE: SPACE TUG SYS. STY (CRYT
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 26 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32001	PROJECT MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	202	5.92	202	5.92
3200101	COST/PERF. MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	133	3.89	133	3.89
3200102	PROJ. DIRECTION	0	.00	0	.00	0	.00	0	.00	0	.00	63	1.86	63	1.86
3200103	INFORM. MGMT. 3	0	.00	0	.00	0	.00	0	.00	0	.00	6	.17	6	.17

STUDY TITLE: SPACE TUG SYS. STY (CONT)
CONTRACT NO: NAS 8-24677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 27 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
~~32002~~	~~SYS. ENGR. & INT.~~	~~143~~	~~4.05~~	~~46~~	~~.87~~	~~0~~	~~.00~~	~~48~~	~~1.08~~	~~48~~	~~1.14~~	~~0~~	~~.00~~	~~285~~	~~7.13~~
3200204	SUST. ENGR. 3	143	4.05	46	.87	0	.00	48	1.08	48	1.14	0	.00	285	7.13

SFE-7

STUDY TITLE: SPACE TUG SYS. STY (CRY) | COST ESTIMATE | DATE: SEPTEMBER 11, 1973
CONTRACT NO: NAS 8-29677 | DATA FORM 1 | PAGE: 28 OF

NON RECURRING(DDT&E) | RECURRING(PRODUCTION) | X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32003	VEH MAIN STAGE 3	0	.00	356	9.66	0	.00	106	2.35	31	.72	0	.00	493	12.73
3200301	STRUCTURES	0	.00	2	.05	0	.00	1	.02	0	.00	0	.00	3	.07
3200302	THERMAL CONTROL	0	.00	3	.07	0	.00	1	.02	0	.01	0	.00	5	.10
3200303	AVIONICS 3	0	.00	264	7.29	0	.00	78	1.74	23	.54	0	.00	365	9.57
3200304	PROPULSION	0	.00	65	1.81	0	.00	19	.43	6	.13	0	.00	91	2.37
3200305	ORBITER I/F	0	.00	21	.44	0	.00	6	.14	2	.04	0	.00	30	.62
3200306	DROP TANKS	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200307	FINAL ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030101	FUEL TK & SUPT	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030102	OXID. TK & SUPT	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030103	BODY STRUCTURE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030104	THRUST STRUC	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030105	METEOROID SH	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030106	PAYLOAD I/F	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030107	INSTL, ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030201	FUEL TANK INSL	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.01
320030202	OXID. TANK INSL.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030203	INSL. PURGE SYS.	0	.00	3	.06	0	.00	1	.02	0	.01	0	.00	4	.09
320030204	THERM CONT. SYS.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030205	INSTL, ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030301	DATA MGMT. 3	0	.00	89	2.46	0	.00	26	.59	8	.18	0	.00	123	3.23
320030302	G N & C	0	.00	10	.28	0	.00	3	.07	1	.02	0	.00	14	.36
320030303	COMMUNICATIONS	0	.00	83	2.30	0	.00	25	.55	7	.17	0	.00	115	3.02
320030304	INSTRUMENTATION	0	.00	1	.02	0	.00	0	.01	0	.00	0	.00	1	.03
320030305	ELECT. POWER	0	.00	81	2.23	0	.00	24	.53	7	.16	0	.00	112	2.92
320030306	PWR. DIST. & CONT	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030307	INSTL, ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030401	MAIN ENGINE	0	.00	29	.81	0	.00	9	.19	3	.06	0	.00	40	1.06
320030402	MAIN ENG. SUPT	0	.00	17	.47	0	.00	5	.11	1	.03	0	.00	24	.62
320030403	ACPS ENGINE	0	.00	3	.07	0	.00	1	.02	0	.01	0	.00	4	.10
320030404	ACPS ENG. SUPT	0	.00	17	.46	0	.00	5	.11	1	.03	0	.00	23	.60
320030405	INSTL, ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030501	STRUCTURES	0	.00	1	.02	0	.00	0	.01	0	.00	0	.00	2	.03
320030502	I/F PANELS	0	.00	20	.40	0	.00	6	.13	2	.04	0	.00	27	.57
320030503	PURGE PROV.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030504	ABORT PROV.	0	.00	1	.01	0	.00	0	.00	0	.00	0	.00	1	.02
320030505	INSTL, ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030701	FINAL ASSY	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030702	C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030105	SOFTWARE 3	0	.00	79	2.19	0	.00	23	.52	7	.16	0	.00	109	2.87

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 29 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32004	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

14F-7

STUDY TITLE: SPACE TUG SYS. STY (CONT)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 30 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32005	LOGISTICS	21	.49	0	.00	0	.00	0	.00	0	.00	275	5.04	296	5.53
3200501	TRANSP. & HDLG.	1	.02	0	.00	0	.00	0	.00	0	.00	12	.21	13	.23
3200502	TRAINING	5	.11	0	.00	0	.00	0	.00	0	.00	59	1.08	63	1.18
3200503	INV CONT. & WRSHG	16	.37	0	.00	0	.00	0	.00	0	.00	204	3.75	220	4.11
320050201	SIM. & EQUIP.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320050202	GROUND CREW	5	.11	0	.00	0	.00	0	.00	0	.00	59	1.08	63	1.18

C-4E-7

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 31 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32006	FACILITIES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200603	ETR MAINT. & REF.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200604	ETR LAUNCH	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200605	WTR MAINT. & REF.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200606	WTR LAUNCH	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060301	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060302	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060401	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060402	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060501	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060502	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060601	DES./CONST. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060602	ACTIV./MAINT. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

E-44-7

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 32 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32007	GRND. SUPT. EQUIP	0	.00	108	2.98	0	.00	32	.71	9	.22	0	.00	149	3.91
3200701	MFG. GSE 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200702	ETR GSE	0	.00	37	1.02	0	.00	11	.24	3	.07	0	.00	51	1.34
3200703	WTR GSE	0	.00	11	.31	0	.00	3	.07	1	.02	0	.00	15	.40
3200704	FLT OPS GSE(NASA)	0	.00	30	.83	0	.00	9	.20	3	.06	0	.00	41	1.09
3200705	FLT OPS GSE(DOD)	0	.00	30	.83	0	.00	9	.20	3	.06	0	.00	41	1.09
320070104	SOFTWARE 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070201	HARDWARE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070202	SITE ACTIV.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070203	MAINT.	0	.00	4	.12	0	.00	1	.03	0	.01	0	.00	6	.15
320070204	SOFTWARE	0	.00	33	.90	0	.00	10	.22	3	.07	0	.00	45	1.18
320070301	HARDWARE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070302	SITE ACTIV.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070303	MAINT.	0	.00	4	.12	0	.00	1	.03	0	.01	0	.00	6	.15
320070304	SOFTWARE 3	0	.00	7	.19	0	.00	2	.05	1	.01	0	.00	10	.25
320070403	MAINT. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070404	SOFTWARE 3	0	.00	30	.83	0	.00	9	.20	3	.06	0	.00	41	1.09
320070503	MAINT. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070504	SOFTWARE 3	0	.00	30	.83	0	.00	9	.20	3	.06	0	.00	41	1.09

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 33 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32009	LAUNCH OPNS. WTR	176	4.11	298	5.34	0	.00	59	1.11	33	.75	186	3.32	752	14.62
3200901	LNCH SITE SVCES	65	1.53	111	1.98	0	.00	22	.41	12	.28	69	1.23	279	5.43
3200902	TUG/SHTL MATING	20	.48	35	.62	0	.00	7	.13	4	.09	22	.39	87	1.70
3200903	PRELAUNCH C/O	23	.55	40	.71	0	.00	8	.15	4	.10	25	.44	100	1.95
3200904	COUNTDOWN	37	.86	62	1.12	0	.00	12	.23	7	.16	39	.69	157	3.06
3200905	PRLNTS. & GASES	4	.09	6	.12	0	.00	1	.02	1	.02	4	.07	16	.32
3200906	POST FLT. SAFING	26	.61	44	.79	0	.00	9	.16	5	.11	27	.49	111	2.15

SME-7

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 34 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32010	LAUNCH OPNS ETR	432	10.08	732	13.09	0	.00	144	2.73	80	1.83	457	8.14	1845	35.87
3201001	LNCH SITE SVCES	157	3.66	265	4.75	0	.00	52	.99	29	.65	166	2.95	669	13.01
3201002	TUG/SHTL MATING	45	1.05	76	1.37	0	.00	15	.28	8	.19	48	.85	193	3.74
3201003	PRELAUNCH C/O	55	1.28	93	1.66	0	.00	18	.35	10	.23	58	1.03	234	4.55
3201004	COUNTDOWN	91	2.12	154	2.75	0	.00	30	.57	17	.38	96	1.71	388	7.54
3201005	PRLNTS & BASES	18	.42	31	.55	0	.00	6	.11	3	.08	19	.34	78	1.51
3201006	POST FLT. SAFING	67	1.55	113	2.02	0	.00	22	.42	12	.28	70	1.25	284	5.52

74847

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 35 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32011	FLIGHT OPNS NASA	660	15.40	612	10.96	0	.00	236	4.47	0	.00	63	1.12	1571	31.94
3201101	MISSION PLG.	142	3.31	131	2.35	0	.00	51	.96	0	.00	13	.24	337	6.86
3201102	FLT. CONTROL	288	6.72	267	4.78	0	.00	103	1.95	0	.00	27	.49	685	13.94
3201103	FLT. EVAL.	139	3.70	147	2.63	0	.00	57	1.07	0	.00	15	.27	378	7.68
3201104	FLT. SUPT. SFTWRE	72	1.67	67	1.19	0	.00	26	.49	0	.00	7	.12	171	3.47

L-3-47

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 36 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32012	FLIGHT OPNS DOD	502	11.72	466	8.34	0	.00	180	3.40	0	.00	48	.85	1196	24.31
3201201	MISSION PLG 3	118	2.76	110	1.97	0	.00	42	.80	0	.00	11	.20	282	5.73
3201202	FLT. CONTROL	197	4.58	182	3.26	0	.00	70	1.33	0	.00	19	.33	468	9.51
3201203	FLT. EVAL.	133	3.10	123	2.20	0	.00	48	.90	0	.00	13	.22	316	6.43
3201204	FLT. SUPT. SFTWRE	55	1.27	51	.91	0	.00	20	.37	0	.00	5	.09	130	2.64

8467

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 37 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32013	REFURB &INTEG WTR	0	.00	380	10.50	0	.00	113	2.51	33	.77	0	.00	525	13.77
3201301	SCH MAINT & REF	0	.00	88	2.43	0	.00	26	.58	8	.18	0	.00	122	3.19
3201302	UNSCH MAINT & REF	0	.00	18	.48	0	.00	5	.12	2	.04	0	.00	24	.63
3201303	POST MAINT C/O	0	.00	4	.12	0	.00	1	.03	0	.01	0	.00	6	.16
3201304	TUG/PL MAING &/CO	0	.00	62	1.71	0	.00	18	.41	5	.13	0	.00	85	2.24
3201305	REFURB RQMTS PLG	0	.00	21	.59	0	.00	6	.14	2	.04	0	.00	29	.77
3201306	DEPOT MAINT	0	.00	187	5.16	0	.00	55	1.23	16	.38	0	.00	258	6.77

SHEET 7

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 11, 1973
PAGE: 38 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32014	REFURB &INTEG ETR	0	.00	1344	37.11	0	.00	398	8.86	115	2.73	0	.00	1857	48.70
3201401	SCH MAINT & REF	0	.00	209	5.78	0	.00	62	1.38	18	.42	0	.00	289	7.58
3201402	UNSCH MAINT & REF	0	.00	41	1.12	0	.00	12	.27	3	.08	0	.00	56	1.47
3201403	POST MAINT C/O	0	.00	10	.29	0	.00	3	.07	1	.02	0	.00	14	.38
3201404	TUG/PL MATING,C/O	0	.00	148	4.08	0	.00	44	.97	13	.30	0	.00	204	5.36
3201405	REFURB RQMTS PLB	0	.00	50	1.37	0	.00	15	.33	4	.10	0	.00	69	1.80
3201406	DEPOT MAINT	0	.00	886	24.47	0	.00	262	5.84	76	1.80	0	.00	1224	32.11

OPTION 3

TOTAL

COST DATA FORMS T

STUDY TITLE: SPACE TUG SYS. STY (CRY) | COST ESTIMATE | DATE: SEPTEMBER 12, 1973
CONTRACT NO: NAS 8-29677 | DATA FORM T | PAGE: 16 OF

X NON RECURRING(DDT&E) | RECURRING(PRODUCTION) | RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32001	PROJECT MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	336	9.86	336	9.86
32002	SYS. ENGR. & INT.	715	20.26	0	.00	0	.00	0	.00	41	.97	0	.32	756	21.55
32003	VEH MAIN STAGE	2271	66.11	493	12.86	697	17.12	146	3.25	1823	51.22	0	.00	5431	150.57
32004	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.62	0	1.62
32005	LOGISTICS	15	.36	0	.00	0	.00	0	.00	0	.00	199	3.65	214	4.01
32006	FACILITIES	0	.00	0	.00	0	.00	0	.00	0	.00	0	5.17	0	5.17
32007	GRND. SUPT. EQUIP	360	10.21	567	16.11	66	1.46	105	2.33	98	2.30	0	.00	1196	32.42
32008	VEHICLE TEST	299	6.97	862	21.51	0	.00	263	5.60	54	1.27	0	.00	1478	35.35
32009	LAUNCH OPNS. WTR	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32010	LAUNCH OPNS ETR	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32011	FLIGHT OPNS NASA	218	5.08	202	3.61	0	.00	78	1.48	0	.00	21	.37	518	10.54
32012	FLIGHT OPNS DOD	153	3.56	141	2.53	0	.00	55	1.03	0	.00	14	.26	363	7.38
32013	REFURB &INTEG WTR	0	.00	6	.17	0	.00	2	.04	1	.01	0	.00	8	.22
32014	REFURB &INTEG ETR	0	.00	6	.17	0	.00	2	.04	1	.01	0	.00	8	.22
	TOTAL	4031	112.55	2277	56.97	763	18.58	651	15.78	2018	55.79	570	21.26	10308	278.92

7-35

STUDY TITLE: SPACE TUG SYS. STY (CRY) COST ESTIMATE DATE: SEPTEMBER 12, 1973
CONTRACT NO: NAS 8-29677 DATA FORM T PAGE: 1 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

WBS SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32001	PROJECT MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	336	9.86	336	9.86
3200101	COST/PERF. MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	231	6.77	231	6.77
3200102	PROJ. DIRECTION	0	.00	0	.00	0	.00	0	.00	0	.00	99	2.90	99	2.90
3200103	INFORM. MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	7	.19	7	.19

E58-7

STUDY TITLE: SPACE TUG SYS. STY (CRV) COST ESTIMATE DATE: SEPTEMBER 12, 1973
CONTRACT NO: NAS 8-29677 DATA FORM T PAGE: 2 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32002	SYS. ENGR. & INT.	715	20.26	0	.00	0	.00	0	.00	41	.97	0	.32	756	21.55
3200201	TUG SYS. ENGR.	572	16.21	0	.00	0	.00	0	.00	33	.78	0	.26	605	17.24
3200202	SHUTTLE I/F	36	1.02	0	.00	0	.00	0	.00	2	.05	0	.02	38	1.08
3200203	PAYLOAD I/F	107	3.04	0	.00	0	.00	0	.00	6	.15	0	.05	113	3.23

4SE-7

STUDY TITLE: SPACE TUG SYS. STY (CRY) — COST ESTIMATE — DATE: SEPTEMBER 12, 1973

CONTRACT NO: NAS 8-29677 — DATA FORM T — PAGE: 3 OF

X NON RECURRING(DDT&E) — RECURRING(PRODUCTION) — RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32003	VEH MAIN STAGE	2271	66.11	493	12.86	697	17.12	146	3.25	1823	51.22	0	.00	5431	150.57
3200301	STRUCTURES	230	6.57	0	.00	283	6.99	0	.00	274	7.37	0	.00	786	20.93
3200302	THERMAL CONTROL	10	.29	20	.42	13	.31	6	.13	14	.37	0	.00	63	1.52
3200303	AVIONICS	836	24.42	183	5.06	39	.95	54	1.21	698	18.08	0	.00	1810	49.72
3200304	PROPULSION	740	21.87	174	4.81	71	1.65	52	1.15	693	21.56	0	.00	1730	51.04
3200305	ORBITER I/F	113	3.23	79	1.62	139	3.44	23	.52	141	3.78	0	.00	495	12.59
3200306	DROP TANKS	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200307	FINAL ASSY & C/O	343	9.72	37	.95	153	3.78	11	.24	3	.07	0	.00	547	14.77
320030101	FUEL TK & SUPT	53	1.52	0	.00	66	1.62	0	.00	63	1.71	0	.00	182	4.85
320030102	OXID. TK & SUPT	29	.82	0	.00	35	.87	0	.00	34	.92	0	.00	98	2.62
320030103	BODY STRUCTURE	45	1.28	0	.00	55	1.37	0	.00	54	1.44	0	.00	154	4.09
320030104	THRUST STRUCTURE	15	.43	0	.00	19	.46	0	.00	18	.49	0	.00	52	1.38
320030105	METEOROID SHIELD	11	.31	0	.00	13	.33	0	.00	13	.35	0	.00	37	.98
320030106	PAYLOAD I/F	60	1.71	0	.00	74	1.82	0	.00	71	1.92	0	.00	205	5.45
320030107	INSTL. ASSY & C/O	17	.49	0	.00	21	.52	0	.00	20	.55	0	.00	58	1.55
320030201	FUEL TANK INSL	2	.05	2	.04	2	.05	1	.01	2	.06	0	.00	9	.22
320030202	OXID. TANK INSL.	1	.03	1	.02	1	.03	0	.01	1	.03	0	.00	4	.11
320030203	INSL. PURGE SYS.	7	.20	17	.34	9	.22	5	.11	10	.26	0	.00	47	1.13
320030204	THERM CONT. SYS.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030205	INSTL ASSY & C/O	0	.01	1	.02	1	.01	0	.01	1	.02	0	.00	3	.07
320030301	DATA MGMT. 3	322	9.42	52	1.43	15	.37	15	.34	268	6.93	0	.00	672	18.49
320030302	G N & C	89	2.59	18	.49	4	.10	5	.12	74	1.91	0	.00	190	5.21
320030303	COMMUNICATIONS	83	2.42	45	1.24	4	.09	13	.30	71	1.84	0	.00	216	5.89
320030304	INSTRUMENTATION	40	1.16	1	.03	2	.04	0	.01	32	.84	0	.00	75	2.08
320030305	ELECT. POWER	93	2.73	52	1.45	4	.11	16	.35	81	2.08	0	.00	246	6.71
320030306	PWR. DIST. & CONT	16	.48	2	.05	1	.02	1	.01	14	.35	0	.00	33	.91
320030307	INSTL. ASSY & C/O	193	5.64	14	.37	9	.22	4	.09	159	4.11	0	.00	378	10.43
320030401	MAIN ENGINE 3	215	6.36	0	.00	21	.48	0	.00	197	6.16	0	.00	433	13.00
320030402	MAIN ENG. SUPT	233	6.87	106	2.94	22	.52	31	.70	222	6.88	0	.00	615	17.91
320030403	ACPS ENGINE	17	.51	8	.23	2	.04	2	.05	17	.51	0	.00	46	1.34
320030404	ACPS ENG. SUPT	240	7.09	51	1.42	23	.54	15	.34	224	6.98	0	.00	554	16.36
320030405	INSTL. ASSY & C/O	35	1.04	8	.23	3	.08	2	.05	33	1.03	0	.00	82	2.43
320030501	STRUCTURES	40	1.15	12	.25	49	1.22	4	.08	49	1.31	0	.00	154	4.01
320030502	I/F PANELS	55	1.57	51	1.05	67	1.67	15	.34	70	1.86	0	.00	258	6.47
320030503	PURGE PROV.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030504	ABORT PROV.	10	.28	10	.20	12	.30	3	.06	12	.33	0	.00	47	1.17
320030505	INSTL. ASSY & C/O	8	.24	6	.12	10	.26	2	.04	10	.28	0	.00	37	.93
320030701	FINAL ASSY	252	7.13	23	.59	112	2.77	7	.15	2	.05	0	.00	395	10.79
320030702	C/O	91	2.59	14	.36	41	1.01	4	.09	1	.03	0	.00	151	4.07
32003010101	LH2 DOMES	19	.53	0	.00	23	.57	0	.00	22	.60	0	.00	64	1.70
32003010102	LH2 CYLINDER	25	.70	0	.00	30	.75	0	.00	29	.79	0	.00	84	2.24
32003010103	LH2 SUPPORTS	10	.29	0	.00	12	.31	0	.00	12	.32	0	.00	34	.91
32003010201	LO2 DOMES	22	.62	0	.00	27	.66	0	.00	26	.70	0	.00	75	1.99
32003010202	LO2 SUPPORTS	7	.20	0	.00	9	.21	0	.00	8	.22	0	.00	24	.63
32003010301	FWD AFT SKIRT	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003010302	INTERTANK	22	.62	0	.00	27	.66	0	.00	26	.70	0	.00	74	1.98

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 12, 1973
PAGE: 4 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32003010303	SDWL SHELL	23	.66	0	.00	29	.71	0	.00	28	.74	0	.00	79	2.11
32003030101	COMPUTER	167	4.87	36	1.00	8	.19	11	.24	139	3.60	0	.00	361	9.30
32003030102	DATA DISTR.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030103	EQ. THERM CONT.	6	.19	12	.32	0	.01	3	.08	6	.16	0	.00	28	.75
32003030104	CIRCUITRY 3	10	.30	0	.00	0	.01	0	.00	8	.22	0	.00	19	.54
32003030105	SOFTWARE	115	3.36	0	.00	5	.13	0	.00	94	2.44	0	.00	214	5.93
32003030106	SOFTWARE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030107	SOFTWARE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030108	INSTL. ASSY & C/O	24	.70	4	.11	1	.03	1	.03	20	.51	0	.00	50	1.37
32003030201	I M U	61	1.79	10	.29	3	.07	3	.07	51	1.32	0	.00	128	3.53
32003030202	TRACKING/ELECT 3	13	.37	0	.00	1	.01	0	.00	10	.27	0	.00	23	.65
32003030203	REN DEZ&DOCKING 3	8	.24	6	.16	0	.01	2	.04	7	.19	0	.00	24	.65
32003030204	INSTL. ASSY & C/O	7	.19	1	.04	0	.01	0	.01	5	.14	0	.00	14	.39
32003030301	M/W CIRC +RF MUX	27	.79	22	.61	1	.03	7	.15	24	.62	0	.00	81	2.20
32003030302	TRANSPONDERS 3	17	.49	0	.00	1	.02	0	.00	14	.36	0	.00	32	.87
32003030303	POWER AMP.	7	.22	0	.00	0	.01	0	.00	6	.16	0	.00	14	.39
32003030304	ANTENNA	3	.10	5	.14	0	.00	1	.03	3	.08	0	.00	13	.35
32003030305	DEC/ENC+MOD/DEM	15	.43	10	.29	1	.02	3	.07	13	.33	0	.00	41	1.13
32003030306	TAPE RECORDER	2	.07	4	.11	0	.00	1	.03	2	.06	0	.00	10	.27
32003030307	P/L INTER EQUIP	5	.14	0	.00	0	.01	0	.00	4	.10	0	.00	9	.24
32003030308	INSTL. ASSY & C/O	6	.18	3	.09	0	.01	1	.02	5	.14	0	.00	16	.44
32003030401	DATA SENSORS	1	.03	0	.00	0	.00	0	.00	1	.02	0	.00	2	.06
32003030402	SIGNAL COND.	2	.06	1	.03	0	.00	0	.01	2	.04	0	.00	5	.14
32003030403	CIRCUITRY	34	.98	0	.00	2	.04	0	.00	27	.71	0	.00	62	1.73
32003030404	INSTL. ASSY & C/O	3	.09	0	.00	0	.00	0	.00	2	.06	0	.00	6	.15
32003030501	BATTERY	2	.05	1	.04	0	.00	0	.01	1	.04	0	.00	5	.13
32003030502	FUEL CELL 3	85	2.48	47	1.30	4	.10	14	.31	73	1.89	0	.00	223	6.08
32003030503	INSTL. ASSY & C/O	7	.20	4	.11	0	.01	1	.03	6	.15	0	.00	18	.50
32003030601	DISTR.	15	.44	2	.05	1	.02	1	.01	13	.33	0	.00	31	.85
32003030602	TANKS SYSTEM 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030603	INSTL. ASSY & C/O	1	.04	0	.00	0	.00	0	.00	1	.03	0	.00	2	.07

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 12, 1973
PAGE: 5 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32004	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.62	0	1.62
3200401	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.62	0	1.62

STUDY TITLE: SPACE TUG SYS. STY (CRY) | COST ESTIMATE | DATE: SEPTEMBER 12, 1973
CONTRACT NO: NAS 8-29677 | DATA FORM 7 | PAGE: 6 OF

X NON RECURRING(DDT&E) | RECURRING(PRODUCTION) | RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32005	LOGISTICS	15	.36	0	.00	0	.00	0	.00	0	.00	199	3.65	214	4.01
3200501	TRANSP. & HDLG.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200502	TRAINING	10	.23	0	.00	0	.00	0	.00	0	.00	127	2.33	137	2.55
3200503	INV CONT. & MNSNG	6	.13	0	.00	0	.00	0	.00	0	.00	72	1.32	78	1.45
320050201	SIM. & EQUIP.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320050202	GROUND CREW	10	.23	0	.00	0	.00	0	.00	0	.00	127	2.32	136	2.55

8-SE-7

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 12, 1973
PAGE: 7 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32006	FACILITIES	0	.00	0	.00	0	.00	0	.00	0	.00	0	5.17	0	5.17
3200601	MANUFACTURING	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.12	0	1.12
3200602	TEST	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.50	0	1.50
3200603	ETR MAINT. & REF.	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.02	0	1.02
3200604	ETR LAUNCH	0	.00	0	.00	0	.00	0	.00	0	.00	0	.39	0	.39
3200605	WTR MAINT. & REF.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.76	0	.76
3200606	WTR LAUNCH	0	.00	0	.00	0	.00	0	.00	0	.00	0	.38	0	.38
320060101	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.09	0	1.09
320060102	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.02	0	.02
320060201	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.50	0	1.50
320060202	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060301	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.00	0	1.00
320060302	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.02	0	.02
320060401	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.38	0	.38
320060402	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.01	0	.01
320060501	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.75	0	.75
320060502	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.01	0	.01
320060601	DES./CONST. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.37	0	.37
320060602	ACTIV./MAINT. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.01	0	.01

C-35

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 12, 1973
PAGE: 8 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32007	GRND. SUPT. EQUIP	360	10.21	567	16.11	66	1.46	105	2.33	98	2.30	0	.00	1196	32.42
3200701	MFG. GSE	98	2.78	154	4.39	18	.40	29	.64	27	.63	0	.00	326	8.83
3200702	ETR GSE	124	3.52	196	5.56	23	.50	36	.81	34	.79	0	.00	413	11.18
3200703	WTR GSE	117	3.31	184	5.22	21	.47	34	.76	32	.75	0	.00	388	10.51
3200704	FLT OPS GSE(NASA)	11	.30	17	.47	2	.04	3	.07	3	.07	0	.00	35	.95
3200705	FLT OPS GSE(DOD)	11	.30	17	.47	2	.04	3	.07	3	.07	0	.00	35	.95
320070101	HARDWARE	68	1.93	107	3.04	12	.28	20	.44	18	.43	0	.00	225	6.11
320070102	SITE ACTIV.	1	.04	2	.06	0	.01	0	.01	0	.01	0	.00	5	.12
320070103	MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070104	SOFTWARE	29	.82	45	1.29	5	.12	8	.19	8	.18	0	.00	96	2.59
320070201	HARDWARE	79	2.23	124	3.53	14	.32	23	.51	21	.50	0	.00	262	7.09
320070202	SITE ACTIV.	26	.74	41	1.16	5	.11	8	.17	7	.17	0	.00	86	2.34
320070203	MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070204	SOFTWARE	19	.55	31	.87	4	.08	6	.13	5	.12	0	.00	65	1.75
320070301	HARDWARE	74	2.09	116	3.30	13	.30	21	.48	20	.47	0	.00	245	6.63
320070302	SITE ACTIV.	24	.69	38	1.09	4	.10	7	.16	7	.16	0	.00	81	2.19
320070303	MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070304	SOFTWARE	19	.53	30	.84	3	.08	5	.12	5	.12	0	.00	62	1.69
320070401	HARDWARE 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070402	SITE ACTIV. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070404	SOFTWARE 3	11	.30	17	.47	2	.04	3	.07	3	.07	0	.00	35	.95
320070501	HARDWARE 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070502	SITE ACTIV. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070504	SOFTWARE 3	11	.30	17	.47	2	.04	3	.07	3	.07	0	.00	35	.95

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 12, 1973
PAGE: 9 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32008	VEHICLE TEST	299	6.97	862	21.51	0	.00	263	5.60	54	1.27	0	.00	1478	35.35
3200801	GND TEST HDWE.	0	.00	625	17.26	0	.00	185	4.12	54	1.27	0	.00	864	22.66
3200802	GND TEST OPNS.	249	5.81	229	4.10	0	.00	78	1.48	0	.00	0	.00	556	11.39
3200804	FLT. TEST OPNS	50	1.16	8	.15	0	.00	0	.00	0	.00	0	.00	58	1.31
320080101	PTV TEST	0	.00	89	2.45	0	.00	26	.59	8	.18	0	.00	123	3.22
320080102	MAJOR TEST ART.	0	.00	512	14.15	0	.00	152	3.38	44	1.04	0	.00	708	18.57
320080103	MOCKUPS	0	.00	24	.66	0	.00	7	.16	2	.05	0	.00	33	.87

17817

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM 7

DATE: SEPTEMBER 12, 1973
PAGE: 10 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32009	LAUNCH OPNS. WTR	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200901	LNCH SITE SVCES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200902	TUG/SHTL MATING	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200903	PRELAUNCH C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200904	COUNTDOWN	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200905	PRLNTS. & BASES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200906	POST FLT. SAFING	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

STUDY TITLE: SPACE TUG SYS. STY (CRY) COST ESTIMATE DATE: SEPTEMBER 12, 1973
CONTRACT NO: NAS 8-29677 DATA FORM T PAGE: 11 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32010	LAUNCH OPNS ETR	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201001	LNCH SITE SVCES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201002	TUG/SHTL MATING	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201003	PRELAUNCH C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201004	COUNTDOWN	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201005	PRLNTS & BASES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201006	POST FLT. SAFING	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

E7E-7

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 12, 1973
PAGE: 12 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32011	FLIGHT OPNS NASA	218	5.08	202	3.61	0	.00	78	1.48	0	.00	21	.37	518	10.54
3201101	MISSION PLG.	141	3.28	130	2.33	0	.00	50	.95	0	.00	13	.24	334	6.80
3201102	FLT. CONTROL	14	.33	13	.24	0	.00	5	.10	0	.00	1	.02	34	.69
3201103	FLT. EVAL.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201104	FLT. SUPT. SFTWRE	63	1.47	58	1.04	0	.00	23	.43	0	.00	6	.11	150	3.05

STUDY TITLE: SPACE TUG SYS. STY (CRY) COST ESTIMATE DATE: SEPTEMBER 12, 1973
CONTRACT NO: NAS-8-29677 DATA FORM T PAGE: 13 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32012	FLIGHT OPNS DOD	153	3.56	141	2.53	0	.00	55	1.03	0	.00	14	.26	363	7.38
3201201	MISSION PLB	98	2.29	91	1.63	0	.00	35	.66	0	.00	9	.17	233	4.74
3201202	FLT. CONTROL	10	.23	9	.17	0	.00	4	.07	0	.00	1	.02	24	.48
3201203	FLT. EVAL.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201204	FLT. SUPT. SFTWRE	45	1.04	41	.74	0	.00	16	.30	0	.00	4	.08	106	2.16

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 12, 1973
PAGE: 14 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32013	REFURB &INTEG WTR	0	.00	6	.17	0	.00	2	.04	1	.01	0	.00	8	.22
3201301	SCH MAINT & REF	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201302	UNSCH MAINT & REF	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201303	POST MAINT C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201304	TUG/PL MAING &/CO	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201305	REFURB RQMTS PLG	0	.00	6	.17	0	.00	2	.04	1	.01	0	.00	8	.22
3201306	DEPOT MAINT	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 12, 1973
PAGE: 15 OF

X NON RECURRING(DDTAE)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32014	REFURB &INTEG ETR	0	.00	6	.17	0	.00	2	.04	1	.01	0	.00	8	.22
3201401	SCH MAINT & REF	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201402	UNSCH MAINT & REF	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201403	POST MAINT C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201404	TUG/PL MATING,C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3201405	REFURB RQMTS PLB	0	.00	6	.17	0	.00	2	.04	1	.01	0	.00	8	.22
3201406	DEPOT MAINT	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 12, 1973
PAGE: 25 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32001	PROJECT MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	263	7.72	263	7.72
32002	SYS. ENGR. & INT.	1572	44.56	329	6.26	0	.00	348	7.74	380	8.95	0	.25	2628	67.75
32003	VEH MAIN STAGE	0	.00	5232	133.93	0	.00	1550	34.54	450	10.60	0	.00	7233	179.07
32004	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	17.16	0	17.16
32005	LOGISTICS	2	.04	0	.00	0	.00	0	.00	0	.00	25	.46	27	.50
32006	FACILITIES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.44	0	.44
32007	GRND. SUPT. EQUIP	0	.00	79	2.19	0	.00	23	.52	7	.16	0	.00	110	2.87
32008	VEHICLE TEST	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
	TOTAL	1574	44.60	5640	142.38	0	.00	1921	42.80	837	19.71	288	26.03	10261	275.53

87E-7

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM 1

DATE: SEPTEMBER 12, 1973
PAGE: 17 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32001	PROJECT MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	263	7.72	263	7.72
3200101	COST/PERF. MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	179	5.26	179	5.26
3200102	PROJ. DIRECTION	0	.00	0	.00	0	.00	0	.00	0	.00	78	2.30	78	2.30
3200103	INFORM. MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	6	.16	6	.16

57E-1

STUDY TITLE: SPACE TUG SYS. STY (CHY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 12, 1973
PAGE: 18 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32002	SYS. ENGR. & INT.	1572	44.56	329	6.26	0	.00	348	7.74	380	8.95	0	.25	2628	67.75
3200201	TUG SYS. ENGR.	312	8.84	0	.00	0	.00	0	.00	18	.42	0	.14	330	9.41
3200202	SHUTTLE I/F	78	2.22	0	.00	0	.00	0	.00	5	.11	0	.04	83	2.36
3200203	PAYLOAD I/F	156	4.42	0	.00	0	.00	0	.00	9	.21	0	.07	165	4.70
3200204	SUST. ENGR.	1026	29.07	329	6.26	0	.00	348	7.74	348	8.20	0	.00	2050	51.28

STUDY TITLE: SPACE TUG SYS. STY (CRY) | COST ESTIMATE | DATE: SEPTEMBER 12, 1973
CONTRACT NO: NAS 8-29677 | DATA FORM T | PAGE: 19 OF

NON RECURRING(DDT&E) | X RECURRING(PRODUCTION) | RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL. A HOURS	QUAL & REL. A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32003	VEH MAIN STAGE	0	.00	5232	133.93	0	.00	1550	34.54	450	10.60	0	.00	7233	179.07
3200301	STRUCTURES	0	.00	744	15.32	0	.00	220	4.91	64	1.50	0	.00	1028	21.74
3200302	THERMAL CONTROL	0	.00	190	3.91	0	.00	56	1.25	16	.38	0	.00	262	5.55
3200303	AVIONICS	0	.00	1855	51.24	0	.00	549	12.24	160	3.77	0	.00	2564	67.24
3200304	PROPULSION	0	.00	1321	36.48	0	.00	391	8.71	114	2.68	0	.00	1826	47.88
3200305	ORBITER I/F	0	.00	382	7.87	0	.00	113	2.52	33	.77	0	.00	528	11.16
3200306	DROP TANKS	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200307	FINAL ASSY & C/O	0	.00	741	19.11	0	.00	220	4.90	64	1.51	0	.00	1025	25.51
320030101	FUEL TK & SUPT	0	.00	188	3.87	0	.00	56	1.24	16	.38	0	.00	259	5.48
320030102	OXID. TK & SUPT	0	.00	77	1.58	0	.00	23	.51	7	.16	0	.00	106	2.25
320030103	BODY STRUCTURE	0	.00	40	.82	0	.00	12	.26	3	.08	0	.00	55	1.16
320030104	THRUST STRUC	0	.00	25	.52	0	.00	7	.17	2	.05	0	.00	35	.74
320030105	METEOROID SH	0	.00	172	3.54	0	.00	51	1.14	15	.35	0	.00	238	5.03
320030106	PAYLOAD I/F	0	.00	195	4.02	0	.00	58	1.29	17	.39	0	.00	270	5.70
320030107	INSTL. ASSY & C/O	0	.00	47	.97	0	.00	14	.31	4	.09	0	.00	65	1.38
320030201	FUEL TANK IN	0	.00	42	.87	0	.00	12	.29	4	.08	0	.00	58	1.23
320030202	OXID. TANK I	0	.00	21	.43	0	.00	6	.14	2	.04	0	.00	29	.60
320030203	INSL. PURGE SYS.	0	.00	119	2.46	0	.00	35	.79	10	.24	0	.00	165	3.49
320030204	THERM CONT. SYS.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030205	INSTL ASSY & C/O	0	.00	8	.16	0	.00	2	.05	1	.02	0	.00	11	.22
320030301	DATA MGMT. 3	0	.00	441	12.18	0	.00	131	2.91	38	.90	0	.00	610	15.99
320030302	G N & C	0	.00	319	8.81	0	.00	94	2.10	27	.65	0	.00	441	11.56
320030303	COMMUNICATIONS	0	.00	596	16.46	0	.00	176	3.93	51	1.21	0	.00	824	21.67
320030304	INSTRUMENTATION	0	.00	57	1.57	0	.00	17	.37	5	.12	0	.00	79	2.06
320030305	ELECT. POWER	0	.00	317	8.76	0	.00	94	2.09	27	.64	0	.00	438	11.50
320030306	PWR. DIST. & CONT	0	.00	13	.36	0	.00	4	.09	1	.03	0	.00	18	.48
320030307	INSTL. ASSY & C/O	0	.00	112	3.09	0	.00	33	.74	10	.23	0	.00	155	4.06
320030401	MAIN ENGINE	0	.00	289	7.98	0	.00	85	1.90	25	.59	0	.00	399	10.47
320030402	MAIN ENG. SUPT	0	.00	598	16.52	0	.00	177	3.94	52	1.21	0	.00	827	21.67
320030403	ACPS ENGINE	0	.00	67	1.85	0	.00	20	.44	6	.14	0	.00	93	2.43
320030404	ACPS ENG. SUPT	0	.00	317	8.75	0	.00	94	2.09	27	.64	0	.00	438	11.49
320030405	INSTL. ASSY & C/O	0	.00	50	1.39	0	.00	15	.33	4	.10	0	.00	69	1.82
320030501	STRUCTURES	0	.00	59	1.21	0	.00	17	.39	5	.12	0	.00	81	1.72
320030502	I/F PANELS	0	.00	254	5.22	0	.00	75	1.67	22	.51	0	.00	350	7.41
320030503	PURGE PROV.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030504	ABORT PROV.	0	.00	46	.94	0	.00	14	.30	4	.09	0	.00	63	1.34
320030505	INSTL. ASSY & C/O	0	.00	24	.49	0	.00	7	.16	2	.05	0	.00	33	.69
320030701	FINAL ASSY	0	.00	618	15.92	0	.00	183	4.08	53	1.25	0	.00	854	21.26
320030702	C/O	0	.00	124	3.18	0	.00	37	.82	11	.25	0	.00	171	4.25

16E-9

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 12, 1973
PAGE: 20 OF

NON RECURRING(DDT&E)

X RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32004	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	17.16	0	17.16
3200401	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	17.16	0	17.16

STUDY TITLE: SPACE TUG SYS. STY (CRY) COST ESTIMATE DATE: SEPTEMBER 12, 1973
CONTRACT NO: NAS 8-29677 DATA FORM T PAGE: 21 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32005	LOGISTICS	2	.04	0	.00	0	.00	0	.00	0	.00	25	.46	27	.50
3200501	TRANSP. & HDLG.	2	.04	0	.00	0	.00	0	.00	0	.00	25	.46	27	.50
3200502	TRAINING	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200503	INV CONT. & WHSNG	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320050201	SIM. & EQUIP.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

STUDY TITLE: SPACE TUB SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 12, 1973
PAGE: 22 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32006	FACILITIES	0	.00	0	.00	0	.00	0	.00	0	.00	0	.44	0	.44
3200601	MANUFACTURING	0	.00	0	.00	0	.00	0	.00	0	.00	0	.44	0	.44
3200602	TEST	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060101	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060102	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.44	0	.44
320060201	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060202	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

STUDY TITLE: SPACE TUG SYS. STY (CRY) COST ESTIMATE DATE: SEPTEMBER 12, 1973
CONTRACT NO: NAS 8-29677 DATA FORM T PAGE: 23 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32007	GRND. SUPT. EQUIP	0	.00	79	2.19	0	.00	23	.52	7	.16	0	.00	110	2.87
320701	MFG. GSE	0	.00	79	2.19	0	.00	23	.52	7	.16	0	.00	110	2.87
320070101	HARDWARE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070102	SITE ACTIV.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070103	MAINT.	0	.00	79	2.19	0	.00	23	.52	7	.16	0	.00	110	2.87

SYE-7

STUDY TITLE: SPACE TUG SYS. STY (CRY) COST ESTIMATE DATE: SEPTEMBER 12, 1973
CONTRACT NO: NAS 8-29677 DATA FORM T PAGE: 24 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32008	VEHICLE TEST	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

STUDY TITLE: SPACE TUG SYS. STY (CRY) COST ESTIMATE DATE: SEPTEMBER 12, 1973
CONTRACT NO: NAS 8-29677 DATA FORM T PAGE: 39 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32001	PROJECT MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	279	8.18	279	8.18
32002	SYS. ENGR. & INT.	209	5.92	67	1.27	0	.00	71	1.58	71	1.67	0	.00	418	10.45
32003	VEH MAIN STAGE 3	0	.00	595	16.05	0	.00	176	3.93	51	1.21	0	.00	822	21.18
32004	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32005	LOGISTICS	31	.72	0	.00	0	.00	0	.00	0	.00	399	7.32	430	8.04
32006	FACILITIES	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.21	0	1.21
32007	GRND. SUPT. EQUIP	0	.00	282	7.79	0	.00	83	1.86	24	.57	0	.00	390	10.22
32009	LAUNCH OPNS. WTR	198	4.63	336	6.01	0	.00	66	1.25	37	.84	210	3.74	847	16.47
32010	LAUNCH OPNS ETR	580	13.52	981	17.56	0	.00	193	3.66	108	2.45	613	10.92	2474	48.12
32011	FLIGHT OPNS NASA	946	22.07	877	15.70	0	.00	338	6.41	0	.00	90	1.60	2252	45.79
32012	FLIGHT OPNS DOD	709	16.55	658	11.78	0	.00	254	4.81	0	.00	67	1.20	1689	34.34
32013	REFURB &INTEG WTR	0	.00	456	12.61	0	.00	135	3.01	39	.93	0	.00	631	16.54
32014	REFURB &INTEG ETR	0	.00	2000	55.24	0	.00	592	13.19	172	4.06	0	.00	2764	72.49
	TOTAL	2673	63.41	6252	144.01	0	.00	1908	39.69	502	11.73	1658	34.17	12996	293.02

STOP

COMPUTE TIME 27.110
READY

*

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 12, 1973
PAGE: 26 OF

NON RECURRING(UDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32001	PROJECT MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	279	8.18	279	8.18
3200101	COST/PERF. MGMT.	0	.00	0	.00	0	.00	0	.00	0	.00	183	5.38	183	5.38
3200102	PROJ. DIRECTION	0	.00	0	.00	0	.00	0	.00	0	.00	88	2.57	88	2.57
3200103	INFORM. MGMT. 3	0	.00	0	.00	0	.00	0	.00	0	.00	8	.23	8	.23

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 12, 1973
PAGE: 27 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32002	SYS. ENGR. & INT.	209	5.92	67	1.27	0	.00	71	1.58	71	1.67	0	.00	418	10.45
3200204	SUST. ENGR. 3	209	5.92	67	1.27	0	.00	71	1.58	71	1.67	0	.00	418	10.45

STUDY TITLE: SPACE TUG SYS. STY (CRY) — COST ESTIMATE — DATE: SEPTEMBER 12, 1973

CONTRACT NO: NAS 8-29677 — DATA FORM 1 — PAGE: 28 OF

NON RECURRING(DDT&E) — RECURRING(PRODUCTION) — X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32003	VEH MAIN STAGE 3	0	.00	595	16.05	0	.00	176	3.93	51	1.21	0	.00	822	21.13
3200301	STRUCTURES	0	.00	10	.20	0	.00	3	.06	1	.02	0	.00	15	.28
3200302	THERMAL CONTROL	0	.00	5	.11	0	.00	2	.04	0	.01	0	.00	8	.15
3200303	AVIONICS 3	0	.00	400	11.04	0	.00	118	2.64	34	.81	0	.00	552	14.49
3200304	PROPULSION	0	.00	141	3.88	0	.00	42	.93	12	.29	0	.00	194	5.09
3200305	ORBITER I/F	0	.00	40	.82	0	.00	12	.26	3	.08	0	.00	55	1.16
3200306	DROP TANKS	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200307	FINAL ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030101	FUEL TK & SUPT	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030102	OXID. TK & SUPT	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030103	BODY STRUCTURE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030104	THRUST STRUC	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030105	METEOROID SH	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030106	PAYLOAD I/F	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030107	INSTL. ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030201	FUEL TANK INSL	0	.00	1	.02	0	.00	0	.01	0	.00	0	.00	1	.02
320030202	OXID. TANK INSL.	0	.00	1	.01	0	.00	0	.00	0	.00	0	.00	1	.02
320030203	INSL. PURGE SYS.	0	.00	4	.08	0	.00	1	.03	0	.01	0	.00	6	.12
320030204	THERM CONT. SYS.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030205	INSTL. ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030301	DATA MGMT. 3	0	.00	122	3.37	0	.00	36	.80	11	.25	0	.00	168	4.42
320030302	G N & C	0	.00	11	.31	0	.00	3	.07	1	.02	0	.00	15	.41
320030303	COMMUNICATIONS	0	.00	100	2.76	0	.00	30	.66	9	.20	0	.00	138	3.63
320030304	INSTRUMENTATION	0	.00	7	.18	0	.00	2	.04	1	.01	0	.00	9	.24
320030305	ELECT. POWER	0	.00	160	4.41	0	.00	47	1.05	14	.32	0	.00	221	5.79
320030306	PWR. DIST. & CONT	0	.00	0	.01	0	.00	0	.00	0	.00	0	.00	0	.01
320030307	INSTL. ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030401	MAIN ENGINE	0	.00	72	2.00	0	.00	21	.48	6	.15	0	.00	100	2.63
320030402	MAIN ENG. SUPT	0	.00	30	.82	0	.00	9	.20	3	.06	0	.00	41	1.07
320030403	ACPS ENGINE	0	.00	19	.53	0	.00	6	.13	2	.04	0	.00	26	.69
320030404	ACPS ENG. SUPT	0	.00	19	.53	0	.00	6	.13	2	.04	0	.00	27	.70
320030405	INSTL. ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030501	STRUCTURES	0	.00	2	.04	0	.00	1	.01	0	.00	0	.00	5	.06
320030502	I/F PANELS	0	.00	36	.75	0	.00	11	.24	3	.07	0	.00	50	1.05
320030503	PURGE PROV.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030504	ABORT PROV.	0	.00	1	.03	0	.00	0	.01	0	.00	0	.00	2	.04
320030505	INSTL. ASSY & C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030701	FINAL ASSY	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320030702	C/O	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
32003030105	SOFTWARE 3	0	.00	102	2.82	0	.00	30	.67	9	.21	0	.00	141	3.70

STUDY TITLE: SPACE TUG SYS. STY (CHY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 12, 1973
PAGE: 29 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32004	VEH AUX. STAGE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00

C-381

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 12, 1973
PAGE: 30 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32005	LOGISTICS	31	.72	0	.00	0	.00	0	.00	0	.00	399	7.32	430	8.04
3200501	TRANSP. & HDLG.	1	.03	0	.00	0	.00	0	.00	0	.00	17	.31	18	.33
3200502	TRAINING	10	.23	0	.00	0	.00	0	.00	0	.00	127	2.32	136	2.55
3200503	INV CONT. & WHSNG	20	.46	0	.00	0	.00	0	.00	0	.00	256	4.69	275	5.15
320050201	SIM. & EQUIP.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320050202	GROUND CREW	10	.23	0	.00	0	.00	0	.00	0	.00	127	2.32	136	2.55

STUDY TITLE: SPACE TUG SYS. STY (CRY) | COST ESTIMATE | DATE: SEPTEMBER 12, 1973
CONTRACT NO: NAS 8-29677 | DATA FORM T | PAGE: 31 OF

NON RECURRING(DDT&E) | RECURRING(PRODUCTION) | X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32006	FACILITIES	0	.00	0	.00	0	.00	0	.00	0	.00	0	1.21	0	1.21
3200603	ETR MAINT. & REF.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.55	0	.55
3200604	ETR LAUNCH	0	.00	0	.00	0	.00	0	.00	0	.00	0	.21	0	.21
3200605	WTR MAINT. & REF.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.30	0	.30
3200606	WTR LAUNCH	0	.00	0	.00	0	.00	0	.00	0	.00	0	.15	0	.15
320060301	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060302	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.55	0	.55
320060401	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060402	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.21	0	.21
320060501	DES./CONST.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060502	ACTIV./MAINT.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.30	0	.30
320060601	DES./CONST. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320060602	ACTIV./MAINT. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.15	0	.15

STUDY TITLE: SPACE TUG SYS. STY (CRY) COST ESTIMATE DATE: SEPTEMBER 12, 1973
CONTRACT NO: NAS 8-29677 DATA FORM T PAGE: 32 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32007	GRND. SUPT. EQUIP	0	.00	282	7.79	0	.00	83	1.86	24	.57	0	.00	390	10.22
3200701	MFG. GSE 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
3200702	ETR GSE	0	.00	105	2.89	0	.00	31	.69	9	.21	0	.00	145	3.79
3200703	WTR GSE	0	.00	57	1.58	0	.00	17	.38	5	.12	0	.00	79	2.08
3200704	FLT OPS GSE(NASA)	0	.00	60	1.66	0	.00	18	.40	5	.12	0	.00	83	2.17
3200705	FLT OPS GSE(DOD)	0	.00	60	1.66	0	.00	18	.40	5	.12	0	.00	83	2.17
320070104	SOFTWARE 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070201	HARDWARE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070202	SITE ACTIV.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070203	MAINT.	0	.00	62	1.70	0	.00	18	.41	5	.13	0	.00	85	2.23
320070204	SOFTWARE	0	.00	43	1.19	0	.00	13	.28	4	.09	0	.00	59	1.55
320070301	HARDWARE	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070302	SITE ACTIV.	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070303	MAINT.	0	.00	49	1.36	0	.00	15	.33	4	.10	0	.00	68	1.79
320070304	SOFTWARE 3	0	.00	8	.22	0	.00	2	.05	1	.02	0	.00	11	.29
320070403	MAINT. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070404	SOFTWARE 3	0	.00	60	1.66	0	.00	18	.40	5	.12	0	.00	83	2.17
320070503	MAINT. 3	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00	0	.00
320070504	SOFTWARE 3	0	.00	60	1.66	0	.00	18	.40	5	.12	0	.00	83	2.17

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 12, 1973
PAGE: 33 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32009	LAUNCH OPNS. WTR	198	4.63	336	6.01	0	.00	66	1.25	37	.84	210	3.74	847	16.47
3200901	LNCH SITE SVCES	74	1.72	125	2.23	0	.00	25	.46	14	.31	78	1.39	314	6.11
3200902	TUG/SHTL MATING	23	.54	39	.70	0	.00	8	.15	4	.10	24	.44	99	1.92
3200903	PRELAUNCH C/O	27	.62	45	.81	0	.00	9	.17	5	.11	28	.50	114	2.22
3200904	COUNTDOWN	41	.96	70	1.25	0	.00	14	.26	8	.17	44	.78	176	3.42
3200905	PRLNTS. & BASES	4	.10	8	.13	0	.00	1	.03	1	.02	5	.08	19	.37
3200906	POST FLT. SAFING	29	.68	50	.89	0	.00	10	.19	5	.12	31	.55	125	2.43

SPE-2

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 12, 1973
PAGE: 34 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32010	LAUNCH OPNS ETR	580	13.52	981	17.56	0	.00	193	3.66	108	2.45	613	10.92	2474	48.12
3201001	LNCH SITE SVCES	212	4.94	358	6.41	0	.00	71	1.34	39	.90	224	3.99	904	17.57
3201002	TUG/SHTL MATING	62	1.44	105	1.87	0	.00	21	.39	11	.26	65	1.16	264	5.13
3201003	PRELAUNCH C/O	76	1.76	128	2.29	0	.00	25	.48	14	.32	80	1.42	323	6.28
3201004	COUNTDOWN	118	2.75	199	3.57	0	.00	39	.74	22	.50	125	2.22	503	9.78
3201005	PRLNTS & BASES	24	.56	41	.73	0	.00	8	.15	4	.10	25	.45	102	1.99
3201006	POST FLT. SAFING	89	2.07	150	2.69	0	.00	30	.56	16	.38	94	1.67	379	7.37

STUDY TITLE: SPACE TUG SYS. STY (CHY)
CONTRACT NO: NAS 3-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 12, 1973
PAGE: 35 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL. A HOURS	QUAL & REL. A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32011	FLIGHT OPNS NASA	946	22.07	877	15.70	0	.00	338	6.41	0	.00	90	1.50	2252	45.74
3201101	MISSION PLG.	190	4.44	177	3.16	0	.00	68	1.29	0	.00	18	.32	453	9.22
3201102	FLT. CONTROL	450	10.49	417	7.47	0	.00	161	3.05	0	.00	43	.76	1071	21.77
3201103	FLT. EVAL.	203	4.73	188	3.37	0	.00	73	1.37	0	.00	19	.34	483	9.91
3201104	FLT. SUPT. SFTWRE	103	2.40	95	1.71	0	.00	37	.70	0	.00	10	.17	245	4.98

(-287)

STUDY TITLE: SPACE TUG SYS. STY (CRY)
CONTRACT NO: NAS 8-29677

COST ESTIMATE
DATA FORM T

DATE: SEPTEMBER 12, 1973
PAGE: 36 OF

NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32012	FLIGHT OPNS DOD 3	709	16.55	658	11.78	0	.00	254	4.81	0	.00	67	1.20	1689	34.34
3201201	MISSION PLB	153	3.57	142	2.54	0	.00	55	1.04	0	.00	15	.26	364	7.40
3201202	FLT. CONTROL	317	7.40	294	5.27	0	.00	113	2.15	0	.00	30	.54	755	15.35
3201203	FLT. EVAL.	162	3.78	150	2.69	0	.00	58	1.10	0	.00	15	.27	386	7.85
3201204	FLT. SUPT. SFTWRE	77	1.80	72	1.28	0	.00	28	.52	0	.00	7	.13	184	3.74

C-388

STUDY TITLE: SPACE TUG SYS. STY (CRY) | COST ESTIMATE | DATE: SEPTEMBER 12, 1973
CONTRACT NO: NAS 8-29677 | DATA FORM T | PAGE: 37 OF

NON RECURRING(DDT&E) | RECURRING(PRODUCTION) | X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32013	REFURB &INTEG WTR	0	.00	456	12.61	0	.00	135	3.01	39	.93	0	.00	631	16.54
3201301	SCH MAINT & REF	0	.00	99	2.72	0	.00	29	.65	8	.20	0	.00	136	3.57
3201302	UNSCH MAINT & REF	0	.00	20	.55	0	.00	6	.13	2	.04	0	.00	28	.73
3201303	POST MAINT C/O	0	.00	6	.16	0	.00	2	.04	1	.01	0	.00	8	.21
3201304	TUG/PL MAING &/CO	0	.00	68	1.87	0	.00	20	.45	6	.14	0	.00	94	2.45
3201305	REFURB RQMTS PLG	0	.00	24	.66	0	.00	7	.16	2	.05	0	.00	33	.87
3201306	DEPOT MAINT	0	.00	240	6.64	0	.00	71	1.59	21	.49	0	.00	332	8.71

STUDY TITLE: SPACE TUG SYS. STY (CRY) | COST ESTIMATE | DATE: SEPTEMBER 12, 1973
CONTRACT NO: NAS 8-29677 | DATA FORM T | PAGE: 38 OF

NON RECURRING(DDT&E) | RECURRING(PRODUCTION) | X RECURRING(OPERATIONS)

SUBDIVISIONS OF WORK (DOLLARS IN MILLIONS, HOURS IN THOUSANDS)

WBS IDENTIFIER NUMBER	WBS NAME	ENGINEERING HOURS	ENGINEERING DOLLARS	MANUFACTURING HOURS	MANUFACTURING DOLLARS	TOOLING & STE HOURS	TOOLING & STE DOLLARS	QUAL & REL A HOURS	QUAL & REL A DOLLARS	TESTING HOURS	TESTING DOLLARS	MGMT & OTHER HOURS	MGMT & OTHER DOLLARS	TOTAL HOURS	TOTAL DOLLARS
32014	REFURB &INTEG ETR	0	.00	2000	55.24	0	.00	592	13.19	172	4.06	0	.00	2764	72.49
3201401	SCH MAINT & REF	0	.00	280	7.73	0	.00	83	1.85	24	.57	0	.00	387	10.14
3201402	UNSCH MAINT & REF	0	.00	58	1.60	0	.00	17	.38	5	.12	0	.00	80	2.10
3201403	POST MAINT C/O	0	.00	14	.39	0	.00	4	.09	1	.03	0	.00	20	.51
3201404	TUG/PL MATING,C/O	0	.00	192	5.30	0	.00	57	1.27	17	.39	0	.00	265	6.95
3201405	REFURB RQMTS PLB	0	.00	70	1.92	0	.00	21	.46	6	.14	0	.00	96	2.52
3201406	DEPOT MAINT	0	.00	1387	38.30	0	.00	411	9.15	120	2.81	0	.00	1917	50.26

housing, fabrication, processing, assembly installation, reworking, modifications, experimental production, shop support to engineering checkout, preparation of hardware for shipping and preparation of necessary manufacturing associated paper work. Includes quality control and inspection activities. This Subdivision of Work (SOW) also includes technicians who support various test operations as as launch operations and refurbishment activities. Materials and subcontracts associated with the above activities are included.

3. Tooling and STE includes planning, design, fabrication, quality control and inspection, modification, maintenance, and rework of all tools, dies, jigs, fixtures, gauges, handling equipment, work platforms, and test equipment and Special Test Equipment (STE) in support of the manufacturing process. It also includes writing and planning tool orders, certification of welding operations, maintaining tool and STE records, preparation of templates, scheduling and controlling all tool and STE orders, programming and preparation of tapes for all numerically controlled machine parts, and calibration and periodic maintenance of production and test tooling. It also includes the necessary tooling maintenance for the Production and Operational phases. Materials and subcontracts associated with the above activities are included.

4. Quality and Reliability Assurance (Q&RA) includes the establishment of Q&RA policies, procedures and requirements; Q&RA review of procurement requests and plans; test plans from a Q&RA standpoint and Q&RA report preparation. Develops Q&RA training plans and certification of quality control personnel. Also includes failure review, analysis and reporting. Materials and subcontracts associ-

ated with the above activities are included.

5. Testing involves the investigations on all components, assemblies, subsystems, and systems to determine operational characteristics, verify the suitability in meeting the required criteria, and assure compatiability with the overall system and its intended operational/nonoperational environment. Such tests include design feasibility test, qualification test, design verification tests, reliability tests, and bench functional and environmental tests. Monitoring tests, data reduction, and report preparation are also included. Materials and subcontracts associated with the above activities are included.

6. Management/Other includes all management and administrative effort for planning, organizing, coordinating, directing, controlling, and approving that is required to accomplish the program objectives. Other items not included in the preceding subdivisions should be included in this item where possible. Materials and subcontracts associated with the above activities are included.

The "total costs" shown on Data Form-T are the same as the "expected costs" presented on Cost Data Form-A, which in turn are time-phased on Cost Data Form-C.

6.11 Technical Characteristics Data (Form-B)

This subsection presents on Data Form-B the technical, physical and mission characteristics which have a significant effect on the cost of an item. As required, Data Form-B contains parameters that have been utilized in generating the cost-estimates.

The data in Form-B complies with the following stipulation in Data Requirement Document MF-003M dated 7 May 1971: "Since the TCD is used for cost parameter purposes, it is not necessary that the sums of the lower level individual characteristics, such as weight or volume, equal the total weight or volume of the higher level WBS item."

In addition to, and/or in conjunction with, the parameters stated on Data Form-B, the following factors are reflected in the estimated costs:

Technology

Size/Shape/Materials/Weight

Fabrication/Assembly Methods

Tooling Requirements

Quantities - Subsystems/Flight Articles

Commonality

Maintainability

Test Philosophy

Complexity/Workability

TECHNICAL CHARACTERISTICS DATA FORM B

STUDY TITLE SPACE TUG SYSTEMS STUDY (CRYOGENIC)

CONTRACT NO. NAS 8-29677

OPTION NO. 3I

DATE 3 September 1973

WBS IDENTIFICATION NUMBER	WBS IDENTIFICATION	QUANTITY OR VALUE	UNITS OF MEASURE	CHARACTERISTICS	NOTES
320	Total Tug Project	-	-	Summation	
320-01	Project Management	5	Percent	320-(320-01 + 320-02)	
320-02	Systems Engrg. & Integr.	Note	-	DDT&E-%; Prod.-Factor; Ops - Level of Effort	
320-03	Vehicle Main Stage	-	-	Subsystems	
320-03-01	Structures Subsystem	-	-	Assembly Costs	
320-03-01-01	Fuel Tank and Support	951	Pounds	Components	
320-03-01-02	Oxidizer Tank and Support	313	Pounds	Components	
320-03-01-03	Body Structure	943	Pounds	Components	
320-03-01-04	Thrust Structure	106	Pounds		
320-03-01-05	Meteoroid Shield	-	-	Direct Estimate	
320-03-01-06	Payload Interface	128	Pounds		
320-03-01-07	Installation, Assembly & C/O	8	Percent		
320-03-02	Thermal Control Subsystem	-	-	Assembly Costs	
320-03-02-01	Fuel Tank Insulation	-	-	Direct Estimate	
320-03-02-02	Oxidizer Tank Insulation	-	-	" "	
320-03-02-03	Insulation Purge System	-	-	" "	
320-03-02-04	Control System	-	-	" "	
320-03-02-05	Installation, Assembly & C/O	8	Percent		
320-03-03	Avionics Subsystem	-	-	Assembly Costs	
320-03-03-01	Data Management	-	-	Component Costs	
320-03-01-01-01	Computer	-	-	Direct Estimate	
320-03-03-01-02	Data Distribution	-	-	-	
320-03-03-01-03	Bus Controller	-	-	-	

4.6.9

TECHNICAL CHARACTERISTICS DATA FORM B

STUDY TITLE SPACE TUG SYSTEMS STUDY (CRYOGENIC)

CONTRACT NO. NAS 8-29677

OPTION NO. 3I

DATE 3 September 1973

WBS IDENTIFICATION NUMBER	WBS IDENTIFICATION	QUANTITY OR VALUE	UNITS OF MEASURE	CHARACTERISTICS	NOTES
320-03-03-01-04	Circuitry	79.5	Pounds		
320-03-03-01-05	Software - A	-	-	Direct Estimate	
320-03-03-01-06	Software - B	-	-	-	
320-03-03-01-07	Software - C	-	-	-	
320-03-03-01-08	Installation, Assembly & C/O	8	Percent		
320-03-03-02	GN&C	-	-	Assembly Costs	
320-03-03-02-01	IMU	-	-	Direct Estimate	
320-03-03-02-02	Star Tracker	-	-	" "	
320-03-03-02-03	Laser Radar	-	-	-	
320-03-03-02-04	Installation, Assembly & C/O	8	Percent		
320-03-03-03	Communications	-	-	Assembly Costs	
320-03-03-03-01	Microwave Circuitry/RF-Mplxr.	24	Pounds	Direct Estimate for RF Mtplxr.	
320-03-03-03-02	Transponders	32/36	Watts		
320-03-03-03-03	Power Amplifier			Direct Estimate	
320-03-03-03-04	Antenna			" "	
320-03-03-03-05	Decoder/Encoder - Mod./Demod.			" "	
320-03-03-03-06	Tape Recorder			" "	
320-03-03-03-07	P/L Interface Equip. - Com Sec.	14	Watts		
320-03-03-03-08	Installation, Assembly & C/O	8	Percent		
320-03-03-04	Instrumentation	-	-	Assembly Costs	
320-03-03-04-01	Data Sensors	-	-	Direct Estimate	
320-03-03-04-02	Signal Conditioning	7	Pounds		
320-03-03-04-03	Circuitry	79.5	Pounds		

TECHNICAL CHARACTERISTICS DATA FORM B

STUDY TITLE SPACE TUG SYSTEMS STUDY (CRYOGENIC)

DATE 3 September 1973

CONTRACT NO. NAS 8-29677

OPTION NO. 3I

WBS IDENTIFICATION NUMBER	WBS IDENTIFICATION	QUANTITY OR VALUE	UNITS OF MEASURE	CHARACTERISTICS	NOTES
320-03-03-04-04	Installation, Assembly & C/O	8	Percent		
320-03-03-05	Electrical Power	-	-	Assembly Costs	
320-03-03-05-01	Battery	-	-	Direct Estimate	
320-03-03-05-02	Fuel Cell	-	-	-	
320-03-03-05-03	Installation, Assembly & C/O	8	Percent		
320-03-03-06	Power Distribution & Control	-	-	Assembly Costs	
320-03-03-06-01	Distribution	90	Pounds		
320-03-03-06-02	Tanks - Fuel/Cell	-	-	-	
320-03-03-06-03	Installation, Assembly & C/O	8	Percent		
320-03-04	Propulsion	-	-	Assembly Costs	
320-03-04-01	Main Engine (GFE)	D&D=$13.0M T_1 =$0.7M	Per Unit	Government Furnished	
320-03-04-02	Main Engine Support	-	-	Component Level Estimates	
320-03-04-03	ACPS Engine	25	LBf		
320-03-04-04	ACPS Engine Support	264	Pounds	Less Thrustors	
320-03-04-05	Installation, Assembly & C/O	8	Percent		
320-03-05	Orbiter Interface			Assembly Costs	
320-03-05-01	Structures	498/614	Tilt Table/ Trunnion		
320-03-05-02	Interface Panels			Individual Panel Costs	
320-03-05-03	Purge Provisions	-	-	-	
320-03-05-04	Abort Provisions	95	Pounds		
320-03-05-05	Installation, Assembly & C/O	8	Percent		
320-03-06	Drop Tanks	-	-	-	
320-03-07	Final Assembly & C/O	-	Percent	Individual Factors DDT&E/Prod./Ops	

TECHNICAL CHARACTERISTICS DATA FORM B

STUDY TITLE SPACE TUG SYSTEMS STUDY (CRYOGENIC)

DATE 3 September 1973

CONTRACT NO. NAS 8-29677

OPTION NO. 3I

PAGE 4 OF 6

WBS IDENTIFICATION NUMBER	WBS IDENTIFICATION	QUANTITY OR VALUE	UNITS OF MEASURE	CHARACTERISTICS	NOTES
320-04	Space Tug Auxiliary Stage	-	-	Direct Estimate-Stage Costs provided by Governme	
320-05	Logistics	-	-	Summation	
320-05-01	Transportation & Handling			Direct Estimate - Operations	
320-05-02	Training	-	-	Direct Estimate	
320-05-03	Inventory Control & Warehsng.	-	-	" "	
320-06	Facilities	-	-	Summation	
320-06-01	Manufacturing	-	-	Direct Estimate	
320-06-02	Test			" "	
320-06-03	Maint. & Refurb. - ETR			" "	
320-06-04	ETR Launch			" "	
320-06-05	Maint. & Refurb. - WTR			" "	
320-06-06	WTR Launch			" "	
320-07	Ground Support Equipment	-	-	Direct Estimate	
320-07-01	Manufacturing GSE	-	-	" "	
320-07-02	ETR GSE	-	-	" "	
320-07-03	WTR GSE	-	-	" "	
320-07-04	Flight Ops. GSE - NASA	-	-	" "	
320-07-05	Flight Ops. GSE - DOD	-	-	" "	
320-08	Vehicle Test	-	-	Summation	
320-08-01	Ground Test Hardware	-	-	No. Equivalent Units by Subsystem and Assembly	
320-08-02	Ground Test Operations	-	-	Direct Estimate	
320-08-03	Flight Test Hardware	-	-	-	
320-08-04	Flight Test Operations	-	-	Direct Estimate	

TECHNICAL CHARACTERISTICS DATA FORM B

STUDY TITLE SPACE TUG SYSTEMS STUDY (CRYOGENIC)

CONTRACT NO. NAS 8-29677

OPTION NO. 3I

DATE 3 September 1973

WBS IDENTIFICATION NUMBER	WBS IDENTIFICATION	QUANTITY OR VALUE	UNITS OF MEASURE	CHARACTERISTICS	NOTES
320-09	Launch Operations - WTR	-	-	Direct Estimate	
320-09-01	Launch Site Services & Support	-	-	" "	
320-09-02	Tug/Shuttle Mating & C/O	-	-	" "	
320-09-03	Prelaunch Checkout	-	-	" "	
320-09-04	Countdown			" "	
320-09-05	Propellants & Gases			" "	
320-09-06	Post Flight Safing			" "	
320-10	Launch Operations - ETR			" "	
320-10-01	Launch Site Services & Support			" "	
320-10-02	Tug/Shuttle Mating & C/O			" "	
320-10-03	Prelaunch Checkout			" "	
320-10-04	Countdown			" "	
320-10-05	Propellants & Gases			" "	
320-10-06	Post Flight Safing			" "	
320-11	Flight Operations - NASA			Summation	
320-11-01	Mission Planning			Direct Estimate	
320-11-02	Flight Control			" "	
320-11-03	Flight Evaluation			" "	
320-11-04	Flight Support Software			" "	
320-12	Flight Operations - DOD			Summation	
320-12-01	Mission Planning			Direct Estimate	
320-12-02	Flight Control			" "	
320-12-03	Flight Evaluation			" "	

TECHNICAL CHARACTERISTICS DATA FORM B

STUDY TITLE SPACE TUG SYSTEMS STUDY (CRYOGENIC)

DATE 3 September 1973

CONTRACT NO. NAS 8-29677

OPTION NO. 3I

WBS IDENTIFICATION NUMBER	WBS IDENTIFICATION	QUANTITY OR VALUE	UNITS OF MEASURE	CHARACTERISTICS	NOTES
320-12-04	Flight Support Software			Direct Estimate	
320-13	Refurbishment & Integr. - WTR			Summation	
320-13-01	Scheduled Maint. & Refurb.			Direct Estimate	
320-13-02	Unsched. Maint. & Refurb.			" "	
320-13-03	Post Maintenance Checkout			" "	
320-13-04	Tug/Payload Mating & C/O	-	-	" "	
320-13-05	Refurb. Requirements Planning	-	-	" "	
320-13-06	Depot Maintenance	-	-	" "	
320-14	Refurbishment & Integr. - FTR	-	-	Summation	
320-14-01	Scheduled Maint. & Refurb.	-	-	Direct Estimate	
320-14-02	Unsched. Maint. & Refurb.	-	-	" "	
320-14-03	Post Maintenance Checkout	-	-	" "	
320-14-04	Tug/Payload Mating & C/O	-	-	" "	
320-14-05	Refurb. Requirements Planning	-	-	" "	
320-14-06	Depot Maintenance	-	-	" "	

TECHNICAL CHARACTERISTICS DATA FORM B

STUDY TITLE SPACE TUG SYSTEMS STUDY (CRYOGENIC)

DATE 3 September 1973

CONTRACT NO. NAS 8-29677

OPTION NO. 3F

WBS IDENTIFICATION NUMBER	WBS IDENTIFICATION	QUANTITY OR VALUE	UNITS OF MEASURE	CHARACTERISTICS	NOTES
320	Total Tug Project	-	-	Summation	
320-01	Project Management	5	Percent	320-(320-01 + 320-02)	
320-02	Systems Engrg. & Integr.	Note	-	DDT&E-%; Prod.-Factor; Ops. - Level of Effort	
320-03	Vehicle Main Stage	-	-	Subsystems	
320-03-01	Structures Subsystem	-	-	Assembly Costs	
320-03-01-01	Fuel Tank and Support	951	Pounds	Components	
320-03-01-02	Oxidizer Tank and Support	313	Pounds	Components	
320-03-01-03	Body Structure	943	Pounds	Components	
320-03-01-04	Thrust Structure	106	Pounds		
320-03-01-05	Meteoroid Shield	-	-	Direct Estimate	
320-03-01-06	Payload Interface	128	Pounds		
320-03-01-07	Installation, Assembly & C/O	9	Percent		
320-03-02	Thermal Control Subsystem	-	-	Assembly Costs	
320-03-02-01	Fuel Tank Insulation	-	-	Direct Estimate	
320-03-02-02	Oxidizer Tank Insulation	-	-	" "	
320-03-02-03	Insulation Purge System	-	-	" "	
320-03-02-04	Control System	-	-	" "	
320-03-02-05	Installation, Assembly & C/O	8	Percent		
320-03-03	Avionics Subsystem	-	-	Assembly Costs	
320-03-03-01	Data Management	-	-	Component Costs	
320-03-01-01-01	Computer	-	-	Direct Estimate	
320-03-03-01-02	Data Distribution	-	-	-	
320-03-03-01-03	Bus Controller	-	-	-	

TECHNICAL CHARACTERISTICS DATA FORM B

STUDY TITLE SPACE TUG SYSTEMS STUDY (CRYOGENIC)

DATE 3 September 1973

CONTRACT NO. NAS 8-29677

OPTION NO. 3F

WBS IDENTIFICATION NUMBER	WBS IDENTIFICATION	QUANTITY OR VALUE	UNITS OF MEASURE	CHARACTERISTICS	NOTES
320-03-03-01-04	Circuitry	79.5	Pounds		
320-03-03-01-05	Software - A	-	-	Direct Estimate	
320-03-03-01-06	Software - B	-	-	-	
320-03-03-01-07	Software - C	-	-	-	
320-03-03-01-08	Installation, Assembly & C/O	8	Percent		
320-03-03-02	GN&C	-	-	Assembly Costs	
320-03-03-02-01	IMU	-	-	Direct Estimate	
320-03-03-02-02	Star Tracker	-	-	" "	
320-03-03-02-03	Laser Radar	-	-	-	
320-03-03-02-04	Installation, Assembly & C/O	8	Percent		
320-03-03-03	Communications	-	-	Assembly Costs	
320-03-03-03-01	Microwave Circuitry/RF-Mplxr.	24	Pounds	Direct Estimate for RF Mplxr.	
320-03-03-03-02	Transponders	32/36	Watts		
320-03-03-03-03	Power Amplifier			Direct Estimate	
320-03-03-03-04	Antenna			" "	
320-03-03-03-05	Decoder/Encoder - Mod./Demod.			" "	
320-03-03-03-06	Tape Recorder			" "	
320-03-03-03-07	P/L Interface Equip. - Com Sec.	14	Watts		
320-03-03-03-08	Installation, Assembly & C/O	8	Percent		
320-03-03-04	Instrumentation	-	-	Assembly Costs	
320-03-03-04-01	Data Sensors	-	-	Direct Estimate	
320-03-03-04-02	Signal Conditioning	7	Pounds		
320-03-03-04-03	Circuitry	79.5	Pounds		

TECHNICAL CHARACTERISTICS DATA FORM B

STUDY TITLE SPACE TUG SYSTEMS STUDY (CRYOGENIC)

DATE 3 September 1973

CONTRACT NO. NAS 8-29677

OPTION 3F

WBS IDENTIFICATION NUMBER	WBS IDENTIFICATION	QUANTITY OR VALUE	UNITS OF MEASURE	CHARACTERISTICS	NOTES
320-03-03-04-04	Installation, Assembly & C/O	8	Percent		
320-03-03-05	Electrical Power	-	-	Assembly Costs	
320-03-03-05-01	Battery	-	-	Direct Estimate	
320-03-03-05-02	Fuel Cell	-	-	-	
320-03-03-05-03	Installation, Assembly & C/O	8	Percent		
320-03-03-06	Power Distribution & Control	-	-	Assembly Costs	
320-03-03-06-01	Distribution	99	Pounds		
320-03-03-06-02	Tanks - Fuel/Cell	-	-	-	
320-03-03-06-03	Installation, Assembly & C/O	8	Percent		
320-03-04	Propulsion	-	-	Assembly Costs	
320-03-04-01	Main Engine (GFE)	D&D=$13.0M T_1=$0.7M	Per Unit	Government Furnished	
320-03-04-02	Main Engine Support	-	-	Component Level Estimates	
320-03-04-03	ACPS Engine	25	LBf		
320-03-04-04	ACPS Engine Support	200	Pounds	Less Thrustors	
320-03-04-05	Installation, Assembly & C/O	8	Percent		
320-03-05	Orbiter Interface			Assembly Costs	
320-03-05-01	Structures	498/614	Tilt Table/ Trunnion		
320-03-05-02	Interface Panels			Individual Panel Costs	
320-03-05-03	Purge Provisions	-	-	-	
320-03-05-04	Abort Provisions	95	Pounds		
320-03-05-05	Installation, Assembly & C/O	8	Percent		
320-03-06	Drop Tanks	-	-	-	
320-03-07	Final Assembly & C/O	-	Percent	Individual Factors DDT&E/PROD./OPS.	

TECHNICAL CHARACTERISTICS DATA FORM B

STUDY TITLE SPACE TUG SYSTEMS STUDY (CRYOGENIC) DATE 3 September 1973

CONTRACT NO. NAS 8-29677 OPTION NO. 3F PAGE 4 OF 6

WBS IDENTIFICATION NUMBER	WBS IDENTIFICATION	QUANTITY OR VALUE	UNITS OF MEASURE	CHARACTERISTICS	NOTES
320-04	Space Tug Auxiliary Stage	-	-	Direct Estimate - Stage	Costs Provided by Governm
320-05	Logistics	-	-	Summation	
320-05-01	Transportation & Handling			Direct Estimate - Operations	
320-05-02	Training	-	-	Direct Estimate	
320-05-03	Inventory Control & Warehsng.	-	-	" "	
320-06	Facilities	-	-	Summation	
320-06-01	Manufacturing	-	-	Direct Estimate	
320-06-02	Test	-	-	" "	
320-06-03	Maint. & Refurb. - ETR	-	-	" "	
320-06-04	ETR Launch	-	-	" "	
320-06-05	Maint. & Refurb. - WTR	-	-	" "	
320-06-06	WTR Launch	-	-	" "	
320-07	Ground Support Equipment	-	-	Summation	
320-07-01	Manufacturing GSE	-	-	Direct Estimate	
320-07-02	ETR GSE	-	-	" "	
320-07-03	WTR GSE	-	-	" "	
320-07-04	Flight Ops. GSE - NASA	-	-	" "	
320-07-05	Flight Ops. GSE - DOD	-	-	" "	
320-08	Vehicle Test	-	-	Summation	
320-08-01	Ground Test Hardware	-	-	No. Equivalent Units by Subsystem and Assembly	
320-08-02	Ground Test Operations	-	-	Direct Estimate	
320-08-03	Flight Test Hardware	-	-	-	
320-08-04	Flight Test Operations	-	-	Direct Estimate	

TECHNICAL CHARACTERISTICS DATA FORM B

STUDY TITLE SPACE TUG SYSTEMS STUDY (CRYOGENIC) DATE 3 September 1973

CONTRACT NO. NAS 8-29677 OPTION NO. 3F PAGE 5 OF 6

WBS IDENTIFICATION NUMBER	WBS IDENTIFICATION	QUANTITY OR VALUE	UNITS OF MEASURE	CHARACTERISTICS	NOTES
320-09	Launch Operations - WTR	-	-	Direct Estimate	
320-09-01	Launch Site Services & Support	-	-	" "	
320-09-02	Tug/Shuttle Mating & C/O	-	-	" "	
320-09-03	Prelaunch Checkout	-	-	" "	
320-09-04	Countdown	-	-	" "	
320-09-05	Propellants & Gases				
320-09-06	Post Flight Safing			" "	
320-10	Launch Operations - ETR			" "	
320-10-01	Launch Site Services & Support			" "	
320-10-02	Tug/Shuttle Mating & C/O			" "	
320-10-03	Prelaunch Checkout			" "	
320-10-04	Countdown			" "	
320-10-05	Propellants & Gases			" "	
320-10-06	Post Flight Safing			"	
320-11	Flight Operations - NASA			Summation	
320-11-01	Mission Planning			Direct Estimate	
320-11-02	Flight Control			" "	
320-11-03	Flight Evaluation			" "	
320-11-04	Flight Support Software			" "	
320-12	Flight Operations - DOD			Summation	
320-12-01	Mission Planning			Direct Estimate	
320-12-02	Flight Control			" "	
320-12-03	Flight Evaluation			" "	

TECHNICAL CHARACTERISTICS DATA FORM B

STUDY TITLE SPACE TUG SYSTEMS STUDY (CRYOGENIC) DATE 3 September 1973

CONTRACT NO. NAS 8-29677 OPTION NO. 3F PAGE 6 OF 6

WBS IDENTIFICATION NUMBER	WBS IDENTIFICATION	QUANTITY OR VALUE	UNITS OF MEASURE	CHARACTERISTICS	NOTES
320-12-04	Flight Support Software			Direct Estimate	
320-13	Refurbishment & Integr. - WTR			Summation	
320-13-01	Scheduled Maint. & Refurb.			Direct Estimate	
320-13-02	Unsched. Maint. & Refurb.			" "	
320-13-03	Post Maintenance Checkout			" "	
320-13-04	Tug/Payload Mating & C/O	-	-	" "	
320-13-05	Refurb. Requirements Planning	-	-	" "	
320-13-06	Depot Maintenance	-	-	" "	
320-14	Refurbishment & Integr. - FTR	-	-	Summation	
320-14-01	Scheduled Maint. & Refurb.	-	-	Direct Estimate	
320-14-02	Unsched. Maint. & Refurb.	-	-	" "	
320-14-03	Post Maintenance Checkout	-	-	" "	
320-14-04	Tug/Payload Mating & C/O	-	-	" "	
320-14-05	Refurb. Requirements Planning	-	-	" "	
320-14-06	Depot Maintenance	-	-	" "	

Section 7
FLIGHT SCHEDULES

This section presents programmatics input data in the form of flight schedules for Option 1 (Tables 7-1 through 7-5), a flight requirement summary (Table 7-6) depicting the annual flight composition, and a Tug fleet utilization schedule (Table 7-7). The flight schedules are provided in accordance with the formatting instructions contained in NASA letter PD-TUG-P (028-74).

These data were generated by mission accomplishment analysis in conjunction with ground launch/refurbishment and mission operations timeline and turnaround analyses. Supporting details of these analyses are reported in Volume 4, Mission Accomplishment.

The major influence on fleet sizing is the number of expendable Tug missions required. A contributing factor is the number of vehicles to be provided for contingency (expected reliability losses based on one loss per 100 vehicle flights). For Option 3 these considerations result in a total fleet buy of 5 Increment I vehicles and 11 Increment II vehicles.

Table 7-1

F L I G H T S C H E D U L E

TUG CONCEPT OPTION 3

LAUNCH SITE ETR/WTR AGENCY NASA/DOD

COMPANY MDAC

	79	80	81	82	83	84	85	86	87	88	89	90	TOTAL
TUG (BASIC) **		3	21	23	36	44	40	41	40	38	41	41	370
AUXILIARY STAGE				(2)	(1)	(2)		(3)	(2)				(10)
DROP TANKS													
(OTHER)	1*												
SHUTTLE	1*	3	21	23	36	44	40	41	40	38	41	41	370

() DENOTES NUMBER EXPENDED.

REMARKS: 33 payloads not accommodated due to Shuttle limits of 3 Tug flights in 1980 and 21 in 1981

* IVU test flight

** Includes reflights due to Tug reliability losses

Table 7-2

F L I G H T S C H E D U L E

TUG CONCEPT OPTION 3

LAUNCH SITE ETR AGENCY NASA

COMPANY MDAC

	79	80	81	82	83	84	85	86	87	88	89	90	TOTAL
TUG (BASIC)		3	14	12	15	22	22	20	18	15	20	18	179
AUXILIARY STAGE				(2)		(2)		(3)	(2)				9
DROP TANKS													0
(OTHER)	1*												1
SHUTTLE	1*	3	14	12	15	22	22	20	18	15	20	18	179

() DENOTES NUMBER EXPENDED.

REMARKS: 13 NASA payloads not accomplished due to Shuttle limit on Tug flights

* IVU test flight

Table 7-3

F L I G H T S C H E D U L E

TUG CONCEPT OPTION 3

LAUNCH SITE ETR AGENCY DOD

COMPANY MDAC

	79	80	81	82	83	84	85	86	87	88	89	90	TOTAL
TUG (BASIC)			7	10	13	17	11	12	14	16	12	17	129
AUXILIARY STAGE					(1)								(1)
DROP TANKS													0
(OTHER)													0
SHUTTLE			7	10	13	17	11	12	14	16	12	17	129

() DENOTES NUMBER EXPENDED.

REMARKS: 20 DOD payloads not accomplished due to Shuttle limit on Tug flights

Table 7-4

F L I G H T S C H E D U L E

TUG CONCEPT OPTION 3

LAUNCH SITE WTR AGENCY NASA

COMPANY MDAC

	79	80	81	82	83	84	85	86	87	88	89	90	TOTAL
TUG (BASIC)					4	4	6	4	6	4	5	4	37
AUXILIARY STAGE													0
DROP TANKS													0
(OTHER)													0
SHUTTLE					4	4	6	4	6	4	5	4	37

() DENOTES NUMBER EXPENDED.

REMARKS:

Table 7-5

F L I G H T S C H E D U L E

TUG CONCEPT OPTION 3

LAUNCH SITE WTR AGENCY DOD

COMPANY MDAC

	79	80	81	82	83	84	85	86	87	88	89	90	TOTAL
TUG (BASIC)					4	1	2	5	2	2	4	1	21
AUXILIARY STAGE													0
DROP TANKS													0
(OTHER)													0
SHUTTLE					4	1	2	5	2	2	4	1	21

() DENOTES NUMBER EXPENDED.

REMARKS:

Table 7-6

FLIGHT REQUIREMENTS

OPTION 3

	80	81	82	83	84	85	86	87	88	89	90	TOTAL
ETR												
NASA	3	14	10	15	18	22	16	15	15	17	17	162
DOD	-	7	10	12	17	11	12	14	16	12	17	128
NASA EXPENDABLE	-	-	-	-	2	-	1	1	-	3	1	8
NASA KICK STAGE	-	-	2	-	2	-	3	2	-	-	-	9
DOD KICK STAGE	-	-	-	1	-	-	-	-	-	-	-	1
TOTAL	3	21	22	28	39	33	32	32	31	32	35	308
WTR												
NASA	-	-	-	4	4	6	4	6	4	5	4	37
DOD	-	-	-	4	1	2	5	2	2	4	1	21
TOTAL	0	0	0	8	5	8	9	8	6	9	5	58
REFLIGHTS / LOSSES			1		1				1		1	

Table 7-7

EQUAL USAGE SCHEDULE

OPTION 3

	80	81	82	83	84	85	86	87	88	89	90	TOTAL
NUMBER OF FLIGHTS	3	21	22	36	44	41	41	40	37	41	40	366
NUMBER OF EXPENDED TUGS					2		1			3	1	8
TUG ID 1	2	9	7	10	4							32
2	1	8	9	10	4							32
3		4	2	10	5	7	5					33
4			4	6	4	6	8	5				33
5					9	8	6	4	4	2		33
6					9	8	6	4	4	2		33
7					9	8	6	4	4	2		33
8						4	6	10	2	5	6	33
9							4	10	3	10	6	33
10								3	10	10	10	33
11									10	5	9	24
12										5	9	14
REFLIGHTS / LOSSES												

Section 8

COST SENSITIVITIES FOR THE PROGRAM OPTION

This section presents the results of cost sensitivities analyses for the following primary program options defined for the Tug Program Option No. 3:

- Two year IOC delay
- 3500 pound retrieval capability.

- Two Year IOC Delay

The objectives of this analysis involved an examination of techniques to lower peak annual funding while maintaining reasonably low DDT&E costs and an attempt to optimize the required program ATP date. Reference is made to Subsection 11.6 which presents the methodology and cost and funding impacts which result from varying the IOC dates. The data in the following paragraphs have been extracted from Subsection 11.6.

8.1 IMPACT ON DDT&E

A two year delay in IOC for the Initial phase would result in a 17.5 percent increase in DDT&E costs, from $190.0 million to $218.6 million -- an increase of $28.6 million. This assumes that the October 1975 ATP date is retained while the IOC date is delayed two years. The analysis has determined that DDT&E cost is increased by 3.5 percent, or $6 million, to $196 million if the ATP date is delayed to October 1976. Since the latter case also involved the lowest maximum cost risked to meet schedules, it would be recommended from a DDT&E cost standpoint. No significant difference was identified from the Final phase schedule comparison.

8.2 IMPACT ON PRODUCTION

A two year delay in IOC (actually 20 months) would result in a 33 percent increase in the project level value for total production costs -- a $19.5 million increase from $58.5 million to $78.5 million. For the Final configuration, the increase amounted to $4.8 or 4 percent -- $120.5 million versus $125.3 million.

8.3 IMPACT ON OPERATIONS

Schedule impacts on operations costs were quantified on the basis of the variations in numbers of flights at the average cost per flight value. The two year

IOC delay would increase the number of flights for the Initial phase by 102 -- 83 versus 18.5 and would reduce the number of flights by 126 for the Final phase -- 287 versus 161. The net result was an increase of $19.3 million for the total project.

8.4 IMPACT ON FUNDING

DDT&E

Figure 8.4-1 presents the comparative DDT&E funding impacts of the two year IOC delay for both program phases. For the total project, the peak funding year would move from GFY 1978 to GFY 1980, and peak year funding would be reduced from $66.6 million to $63.2 million -- a 5 percent reduction.

Production

Figure 8.4-2 illustrates the comparative production funding impacts of the two year IOC delay for both program phases. The peak funding year would move from GFY 1983 for the total project to GFY 1985, but the peak funding would be increased by 13 percent, from $48.7 million to $55.1 million.

Operations

Figure 8.4-3 compares the total project relative funding for the two year IOC delay and the baseline. These differences are reflected in the funding curves.

Total Project

Figure 8.4-4 and Table 8.4-1 present the total project comparison of the two year IOC delay with the baseline. This case would move the funding peak year from GFY 1981 to GFY 1985 and would increase peak year funding by 26 percent or $23.2 million, from $90.2 million to $113.4 million. The only real advantages observed are decreased funding requirements in the early years of the program.

3500 Pound Retrieval Capability

As assessment was made (reference Volume 5) of the impact of incorporating the changes to enable the Option 3 vehicle to retrieve 3500 pounds of payload identified as Option 3S.

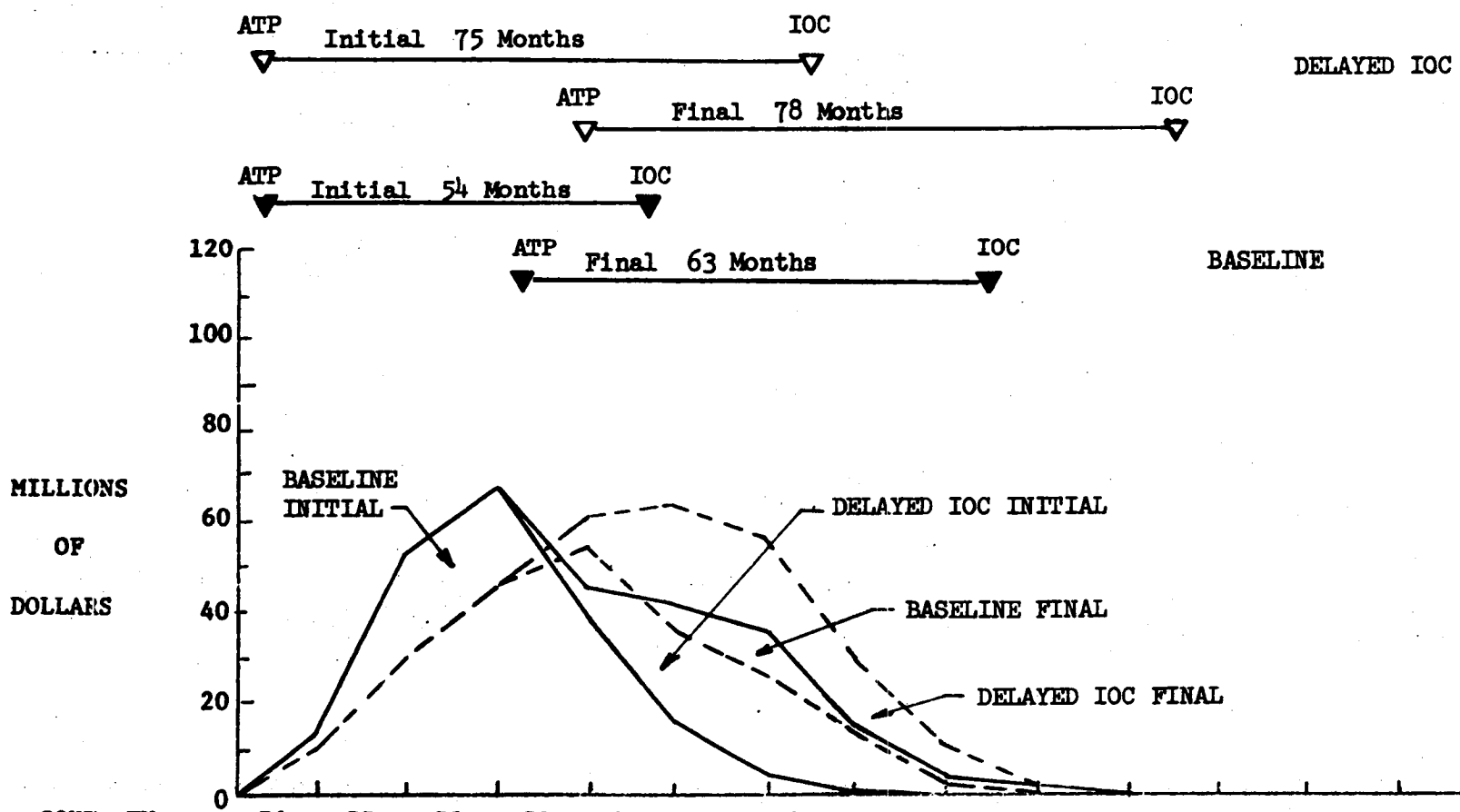
8.1 IMPACT ON DDT&E

The significant cost differences between the Option 3 and Option 3S programs. are shown in the tabulation below. The most significant difference is the DDT&E

Figure 8.4-1 Program Option No. 3

2 Year Delayed IOC -- DDT&E Funding Impact

Annual Funding, Millions 1973 Dollars

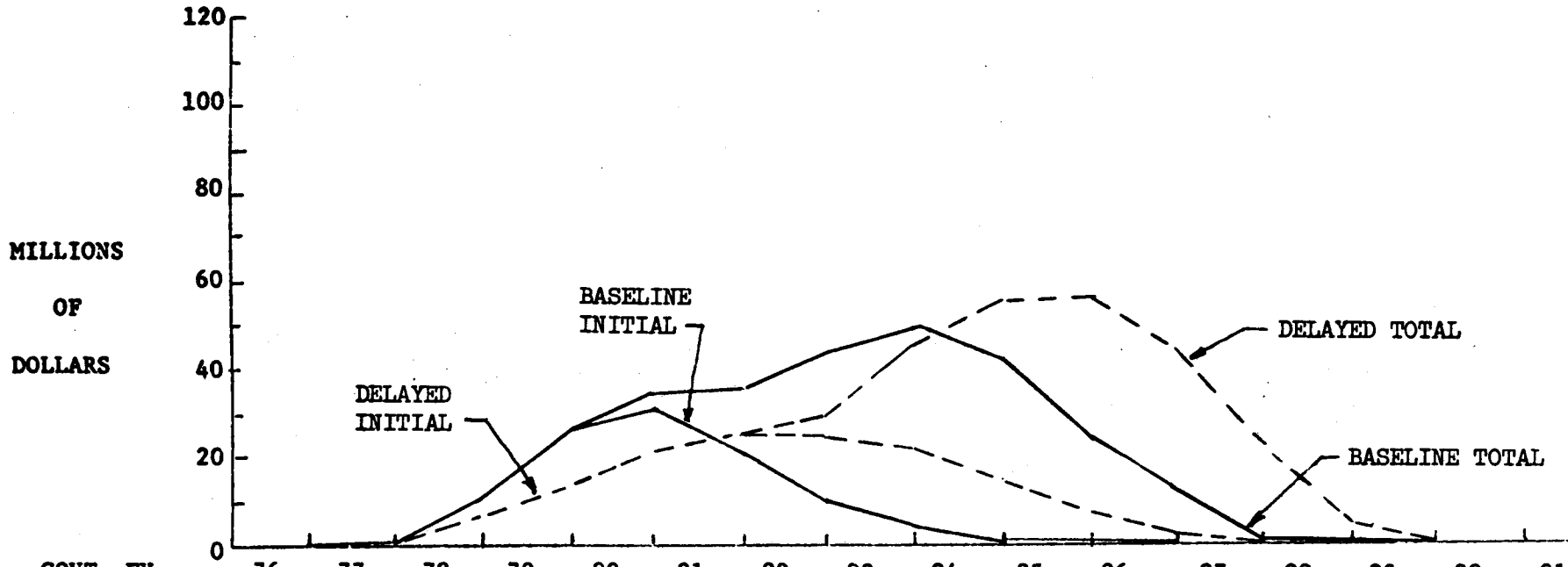


GOVT. FY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	TOTAL
BASELINE	13	52	67	44	41	36	17	7	2								270
DELAYED IOC	10	30	45	60	63	57	30	10	2								307
DIFFERENCE	-3	-22	-22	16	22	21	13	3	0								28

Figure 8.4-2 Program Option No. 3

2 Year Delayed IOC -- Production Funding Impact

Annual Funding, Millions 1973 Dollars

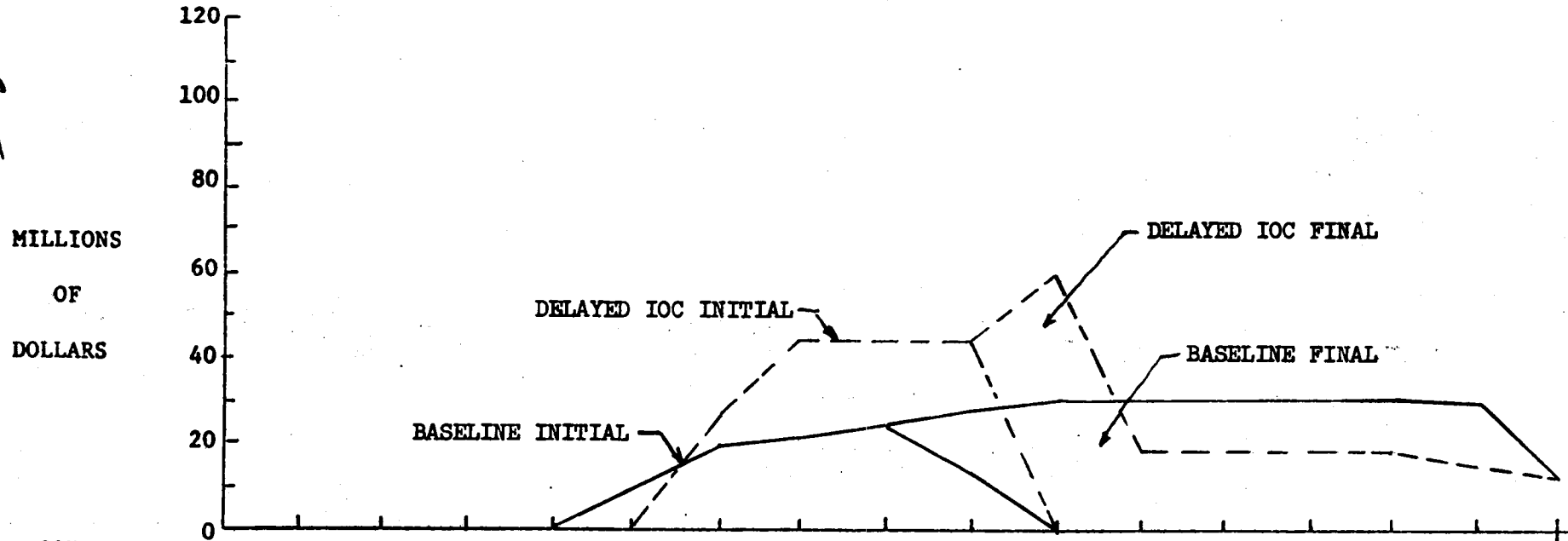


GOVT. FY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	TOTAL
BASELINE		1.4	10.1	26.0	33.4	35.1	43.5	48.7	40.9	23.1	12.9	0.8	0.4				275.4
DELAYED IOC		1.4	6.5	13.8	20.2	24.0	28.3	44.6	54.8	55.1	42.1	22.4	4.2				315.4
DIFFERENCE																	40.0

Figure 8.4-3 Program Option No. 3

2 Year Delayed IOC -- Operations Funding Impact

Annual Funding, Millions 1973 Dollars



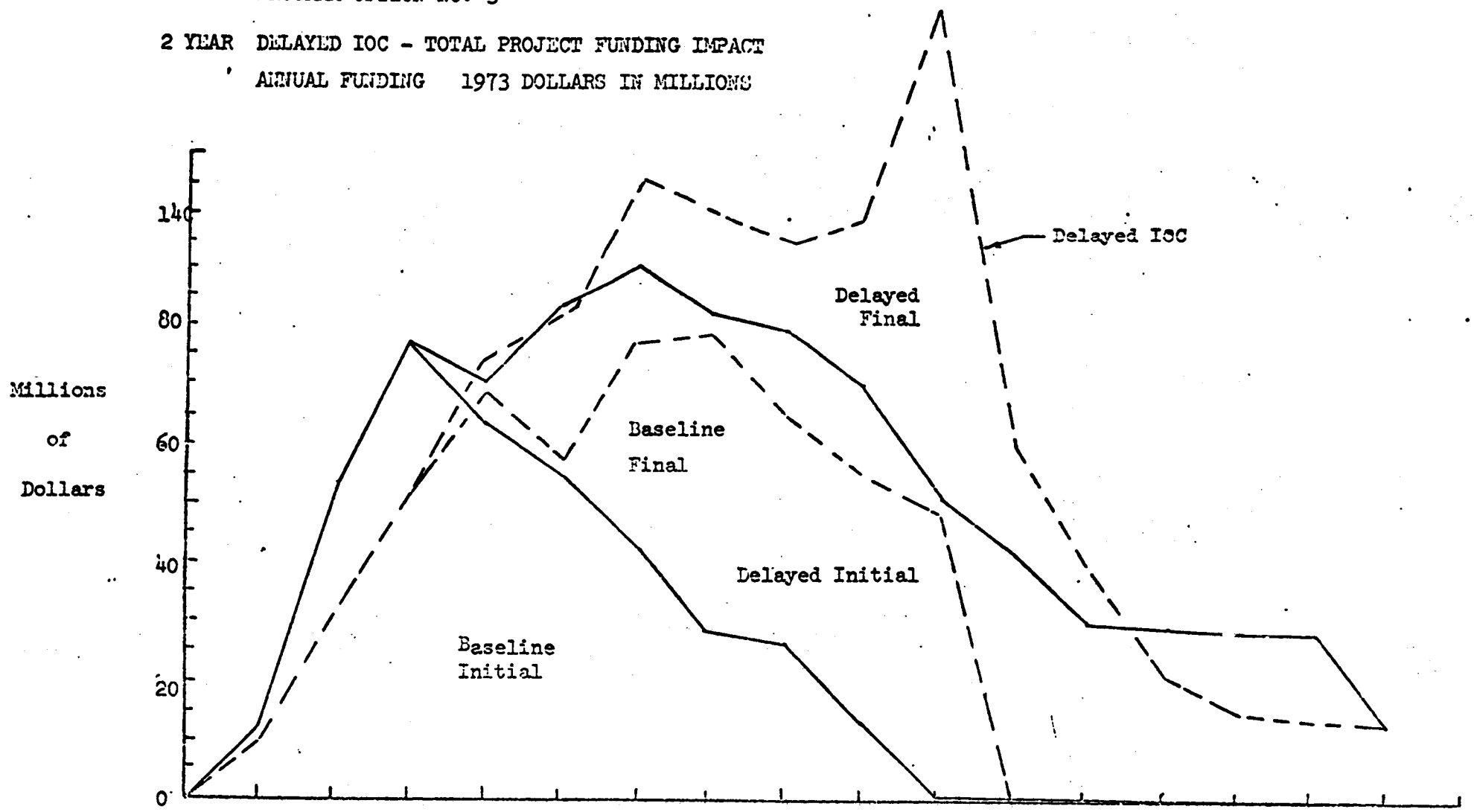
GOVT. FY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	TOTAL
BASELINE					9.8	19.4	20.6	23.8	26.8	29.9	29.9	29.9	29.9	29.9	29.1	14.1	293.1
DELAYED IOC						26.5	42.3	42.3	42.3	58.3	17.5	17.5	17.5	17.5	16.7	14.1	312.4
DIFFERENCE																	19.3

Figure 8.4-4

PROGRAM OPTION NO. 3

2 YEAR DELAYED IOC - TOTAL PROJECT FUNDING IMPACT

ANNUAL FUNDING 1973 DOLLARS IN MILLIONS



Govt. FY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	Total
Baseline	13.0	53.7	76.7	70.5	83.7	90.2	80.9	79.2	69.9	52.0	42.8	30.7	30.3	29.9	29.1	14.1	847
Delayed IOC	10.0	31.4	51.7	74.1	83.4	107.2	100.2	95.5	99.3	113.4	59.6	39.9	21.7	17.5	16.7	14.1	935

Table 8.4-1 Program Option No. 3

2 Year Delayed IOC -- Total Project Funding Impact

Annual Funding Summary

1973 Dollars in Millions

GFY	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	TOTAL
BASELINE (Reference Section 6.12)																	
Total Initial	13.0	53.7	76.7	64.6	54.6	42.9	28.8	27.4	12.7	.6	.6	.4	.4	.4	.4	.2	377
Total Final				6.1	29.1	47.3	52.1	51.8	57.2	52.4	42.2	30.3	29.9	29.5	28.7	13.9	470
Grand Total	13.0	53.7	76.7	70.5	83.7	90.2	80.9	79.2	69.9	53.0	42.8	30.7	30.3	29.9	29.1	14.1	847
2-YEAR DELAY IOC																	
Initial																	
DDT&E	10.1	30.0	45.2	54.2	37.6	25.0	13.0	3.6									
Prod.		1.4	6.5	13.8	20.2	24.0	24.0	20.2	13.8	6.5	1.1						
Ops.						26.5	42.3	42.3	42.3	42.1	.4	.4	.4	.4	.4	.2	
Total	10.0	31.4	51.7	68.0	57.8	75.5	79.3	66.1	56.1	48.6	1.5	.4	.4	.4	.4	.2	547.8
Final																	
DDT&E				6.1	25.6	31.7	16.6	6.7	2.2								
Prod							4.3	22.4	41.0	48.6	41.0	22.4	4.2				
Ops										16.2	17.1	17.1	17.1	17.1	16.3	13.9	
Total				6.1	25.6	31.7	20.9	29.1	43.2	64.8	58.1	39.5	21.3	17.1	16.3	13.9	387.6
GRAND TOTAL	10.0	31.4	51.7	74.1	83.4	107.2	100.2	95.5	99.3	113.4	59.6	39.9	21.7	17.5	16.7	14.1	935.4

increase for the development effort on the Category IIA RL10 main engine. Engine cost data provided by the Government show Category IIA RL10 DDT&E cost of $50 millions as compared to $13 millions for the Category I RL10. The main engine static firing test program cost bases were the data developed for the Option 2 program related to the main engine testing modified to reflect the Option 3 hardware costs. The static firing test program costs are shown in Table 8.1-1. The total DDT&E cost increase is $40 million with the majority of this expenditure in the early part of the development program.

Option 3S Cost Differences

DDT&E	Δ Cost ($M)
Engine	37.00
Feed System	0.80
Static Firing Test (PTV)	5.33
Pressurization	-3.20
TOTAL	39.93

8.2 IMPACT ON PRODUCTION

The production costs of the Option 3S program are about $15 millions lower than the Option 3 program due primarily to the need for a fleet of 10 final configuration Tugs as compared to 11 final configuration Tugs for Option 3. A small additional decrease in production cost is gained over the Option 3 program due to the elimination of the pressurization system in Option 3S.

DDT&E	Δ Cost ($M)
1 Less Tug	-15.0
10 Less Pressurization System	- 0.3
TOTAL	-15.3

8.3 IMPACT ON OPERATIONS

The operations costs change results from the reduction in the number of flights. The number of flights and also the active fleet size are both reduced about 10 percent, thus a reduction of the total operations cost by proportional to the number of flights reduced appeared to be a valid difference between Option 3 and 3S.

Operations			Δ Cost ($M)
34 less flights	34 x .98 =		-33.2
		TOTAL	-33.2

8.4 IMPACT ON FUNDING

No funding impact was determined because of minimal impact to total program cost. The total program cost difference of -$8.57 million is negligible (about 1 percent) when considering only the direct Tug program costs. However, the inclusion of Shuttle launch costs related to the decrease in the number of Tug flights required (34 x $10.5 millions = $357 millions) would show the increased capability Option 3S to be the more cost effective on a total program basis.

Table 8.1-1

STATIC FIRING TEST COST ESTIMATE

($ MILLIONS)

1.2 X MAIN ENGINE SUPP ASSY		1.2 X 1.65	= 1.98
2 X MAIN ENGINE (REFURBISHMENT)		2 X .167	= 0.34
GOUND EQUIPMENT (INCLUDING SOFTWARE)			= 0.16
FACILITY			= 1.00
MANPOWER	425 MAN MONTHS X $3400/MAN MO		= 1.45
PROPELLANTS			0.40
		TOTAL	$5.33

SECTION 9

RISK ASSESSMENT

The following paragraph is quoted directly from the Statement of Work:

5.4.1.1 Project Assessment

"The contractor shall conduct a study to identify all development risk (technical and cost) uncertainties involved with each concept and option studied. An assessment of the operations and capabilities risks of developing various Tug configurations for various levels of development costs will be made. Technical and programmatic uncertainties that could significantly affect the schedules, costs, or that could result in failure to achieve any vital capability requirements will be identified and discussed. Special consideration should be given critical technology areas, critical design factors (e.g., mass fraction), off-the-shelf vs. new hardware development, design sensitivities, etc. This activity will be conducted throughout the study and will be coordinated closely with all other tasks at appropriate times."

To quantify the technical, cost, and schedule uncertainties, requested above, MDAC-W used a Risk Assessment Scoring Guide (see the accompanying Tables). This guide provides a range of values from 0 to 10, i.e., "no risk" to "high risk" for different defined levels of the following four criteria: estimating conditions; nature of the item; item description; and method of analysis and data. Using the Risk Assessment Scoring Guide, multi-discipline teams (representing the engineering technologies, manufacturing, test, logistics, safety, reliability, ground and flight operations, cost, schedule, and program management experts, as appropriate) assigned risk values to each of the WBS elements at the lowest level considered meaningful. Separate data sheets were developed for each program option for the DDT&E, the production, and the operational phases.

The risk values assigned at the lower WBS levels were summarized to the subsystems level, the systems level, and then the project level. Any WBS element receiving a risk value of 5 or higher is discussed, and the reasons for the moderate to high risk value documented. NOTE: The highest risk value assigned at the lower WBS level is the risk value carried forward at the summary WBS level.

TABLE 9-1

RISK ASSESSMENT SCORING GUIDE

RANGE	ESTIMATING CONDITIONS
8, 9, 10	**Estimating Time and Information Access** Completely inadequate amount of time provided to make the estimate or there is a complete lack of access to useful data sources. **Ground Rules and Assumptions** No guidance was provided on ground rules and all assumptions made by the analyst were arbitrary.
5, 6, 7	**Estimating Time and Information Access** A very short due date or major problems of access to available data tend to make this estimate highly uncertain. **Ground Rules and Assumptions** Very little guidance was provided relative to ground rules. Most of the assumptions made by the analyst were considered quite arbitrary.
2, 3, 4	**Estimating Time and Information Access** A more accurate estimate could have been made if freer access or more time had been available to research known data sources. **Ground Rules and Assumptions** Ground rules were generally inadequate. Many of the assumptions were authenticated but a substantial number are considered questionable.
0, 1	**Estimating Time and Information Access** There were minor problems of access to available data and there was generally sufficient time to define the item. **Ground Rules and Assumptions** Major ground rules were provided and most of the assumptions were authenticated.

MCDONNELL DOUGLAS CORPORATION

TABLE 9-2

RISK ASSESSMENT SCORING GUIDE

RANGE	NATURE OF THE ITEM
8, 9, 10	**State-of-the-Art** The item is substantially beyond the current state-of-the-art. Major development work is required. **Production Experience** No production of any kind has been started.
5, 6, 7	**State-of-the-Art** The item is slightly beyond the state-of-the-art and some development work will be required. **Production Experience** Experimental laboratory fabrication of a similar item is in process.
2, 3, 4	**State-of-the-Art** The item is within the state-of-the-art but no commercial counterpart exists. **Production Experience** A prototype of the item has been produced.
0, 1	**State-of-the-Art** The item will involve a minor modification of commercial or standard aerospace issue items. **Production Experience** The item has been produced in limited quantity.

MCDONNELL DOUGLAS CORPORATION

TABLE 9-3

RISK ASSESSMENT SCORING GUIDE

RANGE	ITEM DESCRIPTION
8, 9, 10	Specification Status No work on a specification has started. Operating Program Characteristics None of the OPC for using the item have been formulated.
5, 6, 7	Specification Status Work on a specification is in an early stage and only general requirements are identified. Operating Program Characteristics The general outline of the OPC under which the item will be used has been only tentatively defined and many specific details are lacking.
2, 3, 4	Specification Status A specification for the item has not been completed but a specification on a similar item is available. Operating Program Characteristics The general outline of the OPC has been formulated, but many specific details are lacking.
0, 1	Specification Status A specification for the item has been prepared but is under review or revision. Operating Program Characteristics The OPC have been substantially defined, but are under review or revision.

MCDONNELL DOUGLAS CORPORATION

TABLE 9-4

RISK ASSESSMENT SCORING GUIDE

RANGE	METHODS OF ANALYSIS AND DATA
8, 9, 10	**Methods** The estimate is almost a poor guess and little or no confidence can be placed in it. **Data** An almost total lack of current and reliable relevant data make the estimate completely uncertain.
5, 6, 7	**Methods** A highly arbitrary rule-of-thumb has been used. **Data** The data used to make the estimate are highly suspect, very sparse in quantity, and characterized by major inconsistencies.
2, 3, 4	**Methods** A commonly used rule-of-thumb, but with no supporting backup, has been used. **Data** The data have been obtained from official or standard sources. Notable inconsistencies, lack of currency, or gaps in data reduce the confidence in the estimate.
0, 1	**Methods** The basic method used to derive the data is well documented, but no double-check or authentication has been possible. **Data** The data used are generally relevant and from a reputable source. They are incomplete, preliminary, or not completely current, however.

RISK ASSESSMENT SUMMARY
PHASED PROGRAM OPTION 3

The Space Tug project is in the early stages of program definition (Phase A). We are confident that as definition of the hardware, software, and programmatics evolve, that the risk values identified will diminish significantly. Therefore, we assess Program Option 3 as a moderately low risk program.

On a scale of 0 to 10 (i.e., low risk to high risk, respectively) the average life-cycle risk values for Options 3 Initial/3 Final are: 2.4/2.5 for Cost; 2.0/2.4 for Schedule; and 2.7/3.1 for Technical performance. (Refer to RISK ASSESSMENT SUMMARY, Table 9-5 and 9-15). These relatively low risk values mean that the multi-discipline team of experts, who have assessed the uncertainties in accomplishing the cost, schedule, and technical objectives and assigned the risk values, have a moderately high degree of confidence that all objectives will be met for every WBS element in every phase of the project. Their collective judgments are based on the following:

1) Specifications on similar hardware and software items are available;

2) The hardware and software subsystems/components are well within the state-of-the-art and (as a minimum) prototype items have been produced (in many cases off-the-shelf hardware is selected);

3) The estimating ground rules and assumptions were generally adequate although subject to some question; and

4) The data have generally been obtained from reliable sources.

In the risk Assessment Data Sheets (Table 9-6 and 9-16) a narrative risk assessment is provided for all cost, schedule, and technical risk values of 5 or greater. It is significant that most of the moderate to high risk values shown are due to the preliminary or incomplete nature of the information available and are not due to technical or capability uncertainties. Therefore, as further definition of the program evolves, we can expect a corresponding decrease in all risk values.

Table 9-5

RISK ASSESSMENT SUMMARY PROGRAM OPTION 3I

Risk Values (0 = Low; 10 = High Risk)

Project Phase	Risk Area		
	Cost	Schedule	Technical
DDT&E	2.9	1.9	3.2
PROD	2.2	1.7	2.4
OPNS	2.1	2.3	2.6
Average Life Cycle Risk Values	2.4	2.0	2.7

Table 9-6 (Page 1 of 9)

RISK ASSESSMENT DATA SHEET

Program Option 3I, DDT&E Phase
Page 1 of 5

WBS Element	Risk Values 0 = Low; 10 = High			Risk Assessment (Values of 5 or Greater)
	Cost	Sched	Tech	
320-01 Project Management	3	1	1	
320-02 Systems Engr & Integration	3	1	1	
320-03 Vehicle Main Stage				
-01 Structures	2	2	4	
-02 Thermal Control	2	2	4	
-03 Avionics	2	2	3	
-04 Propulsion	2	1	4	
-05 Orbiter Interface	5	1	6	Prelim. Spec. Definition (Cost); Prelim Abort Data & Analysis (Tech)
-06 Drop Tanks	N/A	N/A	N/A	
-07 Final Ass'y & c/o	2	2	5	Pressure/Chemical/Heat Hazards (Tech)
320-04 Vehicle Auxiliary Stage	5	GFE	1	Mfg. Start-up on Poseidon Questionable (Cost)

9-8

Table 9-7 (Page 2 of 9)

RISK ASSESSMENT DATA SHEET

Program Option 3I, DDT&E Phase

WBS Element	RISK VALUES 0 = Low; 10 = High Cost	Sched	Tech	Risk Assessment (Risk Values of 5 or Greater)
320-05 Logistics	3	3	1	
320-06 Facilities	5	3	1	Prelim. Info Only (Cost)
320-07 Ground Support Equipment	3	2	5	Prelim. Definition of Interfaces (Tech)
320-08 Vehicle Test	3	2	4	
320-09 Launch Opns - WTR	-	-	-	
320-10 Launch Opns - ETR	-	-	-	
320-11 Flight Opns - WTR	2	3	2	
320-12 Flight Opns - ETR	2	3	2	
320-13 Refurb & Integration - WTR	-	-	-	
320-14 Refurb & Integration - ETR	-	-	-	
TOTAL SCORE	44	28	48	
MAXIMUM SCORE POSSIBLE	150	150	150	
RISK VALUE (0-10 SCALE)	2.9	1.9	3.2	

RISK ASSESSMENT DATA SHEET

WBS ELEMENT	RISK VALUES 0 = Low; 10 = High COST	SCHED	TECH	RISK ASSESSMENT (Risk Value of 5 or Greater)
320-03 Space Tug Vehicle Main Stage				
-01 Structures	2	2	4	
Fuel Tank/Support			2/4	
Oxidizer Tank/Support			2/4	
Body Structure			2	
Thrust Structure			4	
Meteoroid Shield			2	
Payload Interface			1	
Installation, Assembly and Check			2	
-02 Thermal Control	2	2	5	
Fuel Tank Insulation			4	
Oxidizer Tank Insulation			3	
Insulation Purge System			4	
Control System			3	
Installation, Assembly and Check			5	Bonding definition required (tech)

9-10

RISK ASSESSMENT DATA SHEET

WBS ELEMENT	RISK VALUES 0 = Low; 10 = High			RISK ASSESSMENT (Risk Value of 5 or Greater)
	COST	SCHED	TECH	
320-03 Space Tug Vehicle Main Stage				
-03 Avionics	2	2	3	
Data Management	1		3	
GN&C	1		3	
Communications	2		2	
Instrumentation	1		1	
Electrical Power	1		1	
Power Distribution and Control	1		2	
Installation, Assembly and Check	1		3	
-04 Propulsion	2	1	4	
Main Engine (GFE)			1	
Main Engine Support			4	
ACPS Engine			0	
ACPS Engine Support			2	
Installation, Assembly and Check			2	

RISK ASSESSMENT DATA SHEET

WBS ELEMENT		RISK VALUES 0 = Low; 10 = High COST	SCHED	TECH	RISK ASSESSMENT (Risk Value of 5 or Greater)
320-03	Space Tug Vehicle Main Stage				
-05	Orbiter Interface	5	1	6	
	Structures			2	
	Interface Panels			3	
	Purge Provisions			4	
	Abort Provisions			6	Abort techniques and operations derived by analysis (tech)
	Installation, Assembly and Check			4	
-06	Drop Tanks	N/A	N/A	N/A	
	Structures				
	Thermal Insulation				
	Propellant Support System				
	Installation, Assembly and Check				
-07	Final Assembly and Checkout	2	2	5	Pressure/chemical/heat hazards (tech)
	Final Assembly				
	Checkout				
320-04	Space Tug Vehicle, Auxiliary Stage	5	GFE	1	Mfg startup on Poseidon questionable (cost)

Table 9-11 (Page 6 of 9)

RISK ASSESSMENT DATA SHEET

Program Option 3I, PROD Phase

WBS Element	Risk Values 0 = Low; 10 = High			Risk Assessment (Values of 5 or Greater)
	Cost	Sched	Tech	
320-01 Project Management	2	1	1	
320-02 Systems Engr & Integration	2	1	1	
320-03 Vehicle Main Stage				
-01 Structures	2	2	4	
-02 Thermal Control	2	2	1	
-03 Avionics	2	2	3	
-04 Propulsion	2	1	3	
-05 Orbiter Interface	3	1	5	Prelim. Spec. Definition (Tech)
-06 Drop Tanks	N/A	N/A	N/A	
-07 Final Ass'y & c/o	2	2	5	Pressure/Chemical/Heat Hazards (Tech)
320-04 Vehicle Auxiliary Stage	5	GFE	1	Mfg. Start-up on Poseidon Questionable (Cost)

Table 9-12 (Page 7 of 9)

RISK ASSESSMENT DATA SHEET

Program Option 3I, PROD Phase
Page 2 of 2

WBS Element	RISK VALUES 0 = Low; 10 = High Cost	Sched	Tech	Risk Assessment (Risk Values of 5 or Greater)
320-05 Logistics	2	3	1	
320-06 Facilities	1	3	1	
320-07 Ground Support Equipment	1	2	3	
320-08 Vehicle Test	-	-	-	
320-09 Launch Opns - WTR	-	-	-	
320-10 Launch Opns - ETR	-	-	-	
320-11 Flight Opns - WTR	-	-	-	
320-12 Flight Opns - ETR	-	-	-	
320-13 Refurb & Integration - WTR	-	-	-	
320-14 Refurb & Integration - ETR	-	-	-	
TOTAL SCORE	20	20	29	
MAXIMUM SCORE POSSIBLE	120	120	120	
RISK VALUE (0-10 SCALE)	2.2	1.7	2.4	

Table 9-13 (Page 8 of 9)

RISK ASSESSMENT DATA SHEET

Program Option 3I, OPNS Phase
Page 1 of 2

WBS Element	Risk Values 0 = Low; 10 = High			Risk Assessment (Values of 5 or Greater)
	Cost	Sched	Tech	
320-01 Project Management	-	-	-	
320-02 Systems Engr & Integration	-	-	-	
320-03 Vehicle Main Stage				
-01 Structures	1	2	1	
-02 Thermal Control	1	2	4	
-03 Avionics	1	2	3	
-04 Propulsion	1	1	3	
-05 Orbiter Interface	1	1	1	
-06 Drop Tanks	N/A	N/A	N/A	
-07 Final Ass'y & c/o	N/A	N/A	N/A	
320-04 Vehicle Auxiliary Stage	1	GFE	2	

Table 9-14 (Page 9 of 9)

RISK ASSESSMENT DATA SHEET

Program Option 3I, OPNS Phase

WBS Element	RISK VALUES 0 = Low; 10 = High Cost	Sched	Tech	Risk Assessment (Risk Values of 5 or Greater)
320-05 Logistics	2	3	1	
320-06 Facilities	3	3	1	
320-07 Ground Support Equipment	2	2	1	
320-08 Vehicle Test	-	-	-	
320-09 Launch Opns - WTR	3	3	4	
320-10 Launch Opns - ETR	3	3	4	
320-11 Flight Opns - WTR	3	3	4	
320-12 Flight Opns - ETR	3	3	4	
320-13 Refurb & Integration - WTR	3	3	4	
320-14 Refurb & Integration - ETR	3	3	3	
TOTAL SCORE	31	34	39	
MAXIMUM SCORE POSSIBLE	150	150	150	
RISK VALUE (0-10 SCALE)	2.1	2.3	2.6	

9-16

Table 9-15

RISK ASSESSMENT SUMMARY PROGRAM OPTION 3F

Risk Values (0 = Low; 10 = High Risk)

Project Phase	Risk Area		
	Cost	Schedule	Technical
DDT&E	3.0	2.3	3.3
PROD	2.3	2.2	3.0
OPNS	2.1	2.6	2.9
Average Life Cycle Risk Values	2.5	2.4	3.1

Table 9-16 (Page 1 of 6)

RISK ASSESSMENT DATA SHEET

WBS Element	Risk Values 0 = Low; 10 = High			Risk Assessment (Values of 5 or Greater)
	Cost	Sched	Tech	
320-01 Project Management	3	1	1	
320-02 Systems Engr & Integration	3	1	1	
320-03 Vehicle Main Stage				
-01 Structures	2	3	4	
-02 Thermal Control	2	3	4	
-03 Avionics	3	3	7	Laser Docking/Advance Fuel Cell/Solid State Power Distribution (Tech)
-04 Propulsion	2	2	4	
-05 Orbiter Interface	5	1	6	Prelim. Spec. Definition (Cost); Prelim Abort Data & Analysis (Tech)
-06 Drop Tanks	N/A	N/A	N/A	
-07 Final Ass'y & c/o	2	3	6	Pressure/Chemical/Heat Hazards (Tech)
320-04 Vehicle Auxiliary Stage	5	GFE	1	Mfg. Start-up on Poseidon Questionable (Cost)

Table 9-17 (Page 2 of 6)

RISK ASSESSMENT DATA SHEET

Program Option 3F, DDT&E Phase

WBS Element	RISK VALUES 0 = Low; 10 = High Cost	Sched	Tech	Risk Assessment (Risk Values of 5 or Greater)
320-05 Logistics	3	3	1	
320-06 Facilities	5	3	1	Prelim. Info Only (Cost)
320-07 Ground Support Equipment	3	3	5	Prelim. Definition of Interfaces (Tech)
320-08 Vehicle Test	3	3	2	
320-09 Launch Opns - WTR	-	-	-	
320-10 Launch Opns - ETR	-	-	-	
320-11 Flight Opns - WTR	2	3	3	
320-12 Flight Opns - ETR	2	3	3	
320-13 Refurb & Integration - WTR	-	-	-	
320-14 Refurb & Integration - ETR	-	-	-	
TOTAL SCORE	45	35	49	
MAXIMUM SCORE POSSIBLE	150	150	150	
RISK VALUE (0-10 SCALE)	3.0	2.3	3.3	

Table 9-18 (Page 3 of 6)

RISK ASSESSMENT DATA SHEET

Program Option 3F, PROD Phase
Page 1 of 2

WBS Element	Risk Values 0 = Low; 10 = High			Risk Assessment (Values of 5 or Greater)
	Cost	Sched	Tech	
320-01 Project Management	2	1	1	
320-02 Systems Engr & Integration	2	1	1	
320-03 Vehicle Main Stage				
-01 Structures	2	3	3	
-02 Thermal Control	2	3	3	
-03 Avionics	3	3	6	Prelim. Fuel Cell Spec. (Tech)
-04 Propulsion	2	2	4	
-05 Orbiter Interface	3	1	5	Prelim. Spec. Definition (Tech)
-06 Drop Tanks	N/A	N/A	N/A	
-07 Final Ass'y & c/o	2	3	6	Pressure/Chemical/Heat Hazards (Tech)
320-04 Vehicle Auxiliary Stage	5	GFE	1	Mfg. Start-up on Poseidon Questionable (Cost

Table 9-19 (Page 4 of 6)

RISK ASSESSMENT DATA SHEET

Program Option 3F, PROD Phase

WBS Element	RISK VALUES 0 = Low; 10 = High			Risk Assessment (Risk Values of 5 or Greater)
	Cost	Sched	Tech	
320-05 Logistics	2	3	1	
320-06 Facilities	1	3	1	
320-07 Ground Support Equipment	1	3	4	
320-08 Vehicle Test	-	-	-	
320-09 Launch Opns - WTR	-	-	-	
320-10 Launch Opns - ETR	-	-	-	
320-11 Flight Opns - WTR	-	-	-	
320-12 Flight Opns - ETR	-	-	-	
320-13 Refurb & Integration - WTR	-	-	-	
320-14 Refurb & Integration - ETR	-	-	-	
TOTAL SCORE	27	26	36	
MAXIMUM SCORE POSSIBLE	120	120	120	
RISK VALUE (0-10 SCALE)	2.3	2.2	3.0	

Table 9-20 (Page 5 of 6)

RISK ASSESSMENT DATA SHEET

Program Option 3F, OPNS Phase
Page 1 of 2

WBS Element	Risk Values 0 = Low; 10 = High			Risk Assessment (Values of 5 or Greater)
	Cost	Sched	Tech	
320-01 Project Management	-	-	-	
320-02 Systems Engr & Integration	-	-	-	
320-03 Vehicle Main Stage				
-01 Structures	1	3	1	
-02 Thermal Control	1	3	4	
-03 Avionics	1	3	4	
-04 Propulsion	1	2	3	
-05 Orbiter Interface	1	1	1	
-06 Drop Tanks	N/A	N/A	N/A	
-07 Final Ass'y & c/o	N/A	N/A	N/A	
320-04 Vehicle Auxiliary Stage	1	GFE	2	

Table 9-21 (Page 6 of 6)

RISK ASSESSMENT DATA SHEET

Program Option 3F, OPNS Phase

WBS Element	RISK VALUES 0 = Low; 10 = High Cost	Sched	Tech	Risk Assessment (Risk Values of 5 or Greater)
320-05 Logistics	2	3	1	
320-06 Facilities	3	3	1	
320-07 Ground Support Equipment	2	3	4	
320-08 Vehicle Test	-	-	-	
320-09 Launch Opns - WTR	3	3	4	
320-10 Launch Opns - ETR	3	3	4	
320-11 Flight Opns - WTR	3	3	4	
320-12 Flight Opns - ETR	3	3	4	
320-13 Refurb & Integration - WTR	3	3	3	
320-14 Refurb & Integration - ETR	3	3	3	
TOTAL SCORE	31	39	43	
MAXIMUM SCORE POSSIBLE	150	150	150	
RISK VALUE (0-10 SCALE)	2.1	2.6	2.9	

Section 10
SUPPORTING RESEARCH AND TECHNOLOGY (SR&T)

The SR&T requirements for Option 3 are shown in Table 10-1.

The first item, development of potential hazard/failure detection techniques, relates to safety and is applicable to any Tug program, regardless of funding constraints or phasing. The second item relates to establishing basic data required to develop an effective thermal control system. The dollars shown are a summation of the thermal control requirements for both the initial and final configurations. The remaining items in the avionics area are required for the final configuration. In the G&C area, star tracker self-check and IMU self-calibration are needed to reduce maintenance costs. Laser radar rendezvous/docking techniques need substantial advancement before final definition for the Tug. Performance is the primary offshoot of improving fuel cell specifics.

The SR&T for the option represents just over 5% of total program DDT&E.

The following paragraphs give a more detailed explanation of the SR&T item identified in the table.

10.1 STRUCTURES

10.1.1 Develop Potential Hazard/Failure Detection Techniques

Technology Deficiencies

Shuttle and Shuttle payloads present new challenges in reliability and safety requirements because of the necessity of reusable space

Table 10-1

S R & T S U M M A R Y - - O P T I O N 3

WBS ELEMENT/OPTION	TECHNOLOGY REQUIREMENT	COST ($M)	TIME(YEARS)	REQUIRED START TIME
320-03-01				
STRUCTURE	DEVELOP POTENTIAL HAZARD/FAILURE DETECTION TECHNIQUES	0.75	1.5	CY 1/75
320-03-02				
THERMAL CONTROL RADIATION BARRIER MULTI-LAYER INSULATION AND PURGE BAG	ESTABLISH THERMAL PERFORMANCE, MATERIAL PROPERTIES AND PURGE BAG MATERIAL, FABRICATION, AND OPERATION TECHNIQUES	0.24	1.5	7/75
320-03-03				
AVIONICS - GN&C	INCREASE STAR TRACKER/HORIZON SENSOR SELF-CHECK CAPABILITY	3.00	1.5	4/78
	ADD IMU SELF-CALIBRATION CAPABILITY	2.00	1.5	4/78
RENDEZVOUS/DOCKING	DEVELOP LASER RADAR RENDEZVOUS/DOCKING TECHNIQUES	5.00	2.0	10/77
POWER	REDUCE FUEL CELL WEIGHT, INCREASE EFFICIENCY, LIFE	3.00	1.0	10/78
	TOTAL	13.99		

transportation elements. In current space missions such as Skylab, for example, only limited attention was given to failure detection techniques for overboard or on-board leaks which might present a toxic, fire, or explosion hazard. A comprehensive study program on a damage control system for leaks was carried out by MDAC in 1970-72 for the 10 year Space Station. (NAS1-10184 and NAS1-10840) The results of this program provides the basis for identifying failure detection techniques for future space systems.

The Space Tug in terms of hazards and failure modes presents a major safety threat as regards tank explosions and leaks leading to toxic/fire effects and gas explosions damaging the Orbiter. In addition to the major LOX/LH_2 tankage, similar considerations apply to ancillary propellants, fuel cells, and general plumbing. For the Tug system, conventional ground based NDE techniques are inadequate. What is required is a permanently installed monitoring system which will give early warning of leaks or precursor damage notes so as to allow effective remedial action to be taken.

A continuous monitoring system should perform a dual function: (1) Monitor potential modes in space and (2) Function as part of the ground checkout system prior to launch.

Recommended Solution(s)

A primary failure detection technique which shows great promise as applied to Space Tug is the acoustic method. In-house MDAC research has demonstrated the power of this method in detecting leaks and precursor damage modes from a variety of fluids (gas and liquid) including cryogens. Piezoelectric acoustic transducers permanently mounted on tanks and related plumbing can perform in both a passive and active mode. In the passive monitoring mode, a transducer array

can detect and locate by triangulation techniques: (1) dynamic flaws that can lead to leaks or catastrophic failures. Acoustic emission bursts are emitted by dynamic flaws which can be detected. (2) Physical leaks. The fluid leaking through the container will generate a unique ultrasonic signal which propagates in the container wall and is detected by transducers bonded to the wall. Active mode operation is envisioned as being employed during ground checkout as part of NDE operations. In this mode, lamb waves would be propagated in the tank wall to detect flaws.

To complement the acoustic detection technique, a tape detection technique is judged promising for plumbing, valves, etc., where acoustic signals may not be present. An example would be a leak from a flange or heavily insulated pipe. For tape methods, electrical resistance, color change, or blistering phenomena are all potentially useful.

Schedule

The proposed schedule for this effort is shown on Table 10.1.1-1.

Level of Effort

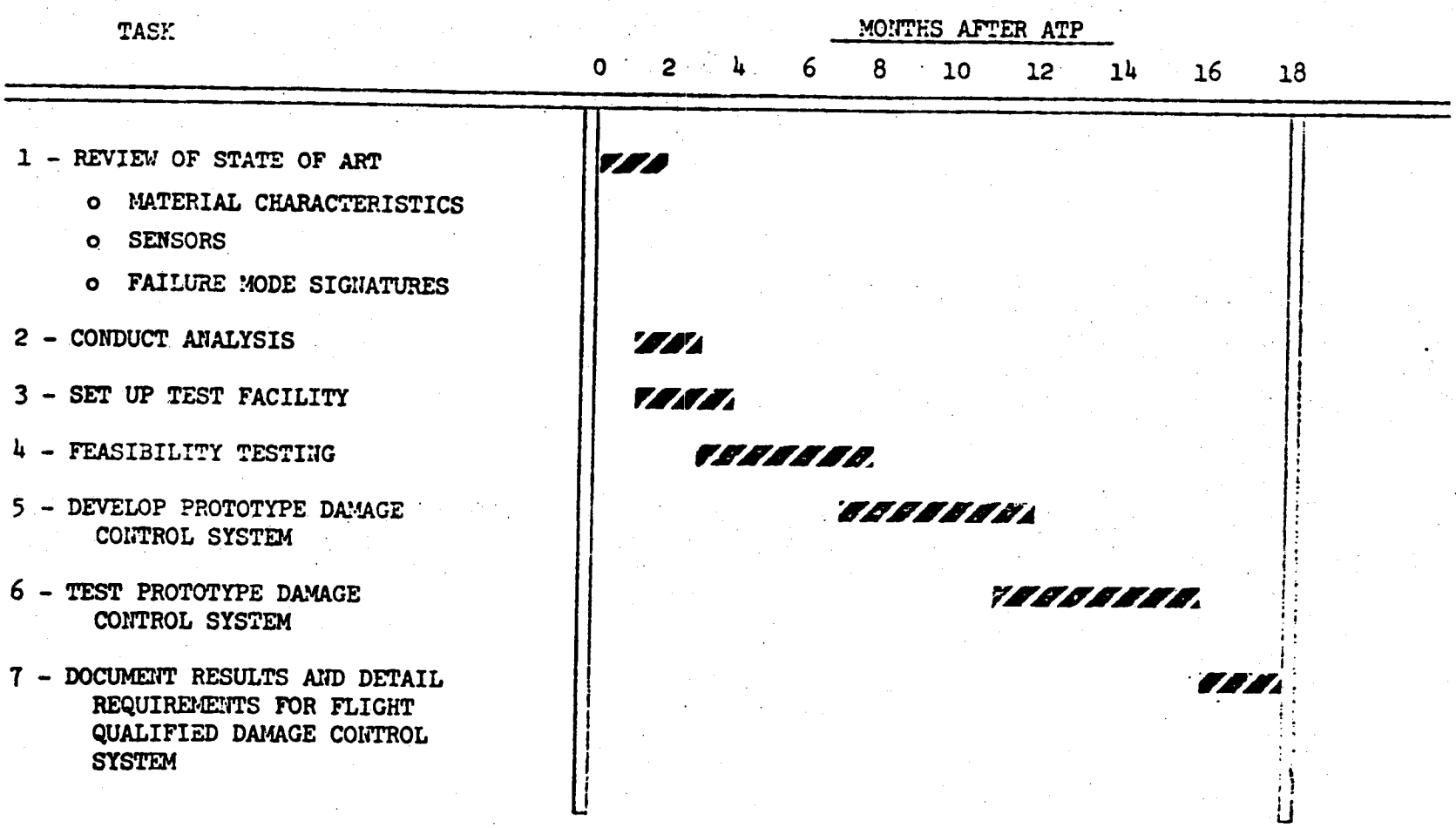
The projected level of effort is based upon past experience on damage control systems. For an 18 month program resulting in the development and test of a prototype damage control system, funding requirements are estimated at $750,000.

	18 Month Time Period
Manpower (6 man years/year)	9 man years
Funding	
Engrg + Technician	$500,000
Equipment + Materials	200,000
Miscellaneous (Travel Reports, etc.)	50,000
	$750,000

Table 10.1.1-1

SR&T SCHEDULE

DAMAGE CONTROL SYSTEM



10.2 THERMAL CONTROL

A survey of the supporting research and technology (SR&T) requirements related to the insulation systems on the fuel and oxidizer tank was accomplished. The areas identified in which further information is required are shown in Table 10.2-1 for both the 3I and 3F options. An estimate of one year is needed for the SR&T effort associated with the 3I option and 1.5 years is estimated for the 3F option.

The effects of configuration variables on the thermal performance could be accomplished with small samples on a calorimeter. The MDAC heat flux gage calorimeter or 15" diameter cylindrical tank are examples of calorimeters which could be used. These calorimeters are discussed in References 1, 2, and 4. Several data points for each configuration variable would be obtained to allow a more optimum design in future MLI systems. The insulation referred to in the 3I option requirements in Table 10.2.1 is that between the LH_2 tank and the radiation barrier on this tank. The effect of the standoff configuration, particularly the height, needs to be considered in both the 3I and 3F options since these are completely different types of standoffs. The effect of tank leakage on thermal performance could also be determined in one of the previously mentioned calorimeters. This data would provide a determination of the maximum allowable leakage from a tank.

The material property at LH_2 temperature of primary interest is brittleness. Testing of the candidate materials to ensure selecting materials which will maintain their structural integrity at LH_2 temperatures is needed. Subjecting the candidate materials to the thermal cycling anticipated in a reusable system is also needed to ensure proper material selection for MLI applications of this type. Additional LH_2 temperature and thermal cycling tests will be required for the 3F option since different materials are involved. Outgassing data on the candidate materials will aid in material selection for MLI systems since

Table 10.2.1

SR&T REQUIREMENTS

	$ (THOUSAND)
3I OPTION REQUIREMENTS	
THERMAL PERFORMANCE - EFFECT OF CONFIGURATION VARIABLES	50
(A) INSULATION THICKNESS (GROUND HOLD PERIOD HEATING)	
(B) INSULATION MATERIAL	
(C) STANDOFFS	
MATERIAL PROPERTIES	10
(A) AT LH_2 TEMPERATURES	
(B) EFFECT OF THERMAL CYCLING	
PURGE BAG	30
(A) MATERIAL	
(B) FABRICATION TECHNIQUES	
3F OPTION REQUIREMENTS (IN ADDITION TO ABOVE)	
THERMAL PERFORMANCE - EFFECT OF CONFIGURATION VARIABLES	75
(A) MLI THICKNESS	
(B) MLI AT PENETRATION	
(C) MLI JOINTS	
(D) PANEL ATTACHMENT HARDWARE	
(E) STANDOFFS	
TANK LEAKAGE - EFFECT ON THERMAL PERFORMANCE	15
MATERIAL PROPERTIES	25
(A) AT LH_2 TEMPERATURES	
(B) EFFECT OF THERMAL CYCLING	
(C) OUTGASSING	
(D) FASTENER MATERIAL	
PURGE AND EVACUATION SYSTEM	30
(A) EFFECT OF STANDOFF DIMENSIONS	
(B) EFFECT OF MLI THICKNESS	
(C) EFFECT OF EVACUATION VALVE LOCATION AND SIZE	
TOTAL	235

MLI requires a low outgassing rate for optimum in-space performance. A study of potential fastener materials is needed to facilitate MLI panel fabrication.

The effort needed for the purge bag includes both the evaluation of candidate bag materials and the bag fabrication techniques. The testing involved would include environmental testing of the bag material and strength and leakage testing of the potential techniques for joining the gore segments of the bag. The selection and attachment of closures would also be considered.

The effects of several variables on the performance of the purge and evacuation system when MLI is used need to be studied. This includes the effect of the standoff dimensions (primarily the height) on both the purge time required and the evacuation rate, the effect of MLI thickness on both the purge time required and the evacuation rate, and the effect of evacuation valve size and location on the evacuation rate. This effort would involve analyses and subscale testing in a flat panel configuration.

10.3 AVIONICS

10.3.1 Star Tracker Self Check and Calibration

Technology Deficiencies

A limited number of star trackers have been designed and flown on space qualified programs. In most cases, the design was tailored to specific user requirements. Consequently, prelaunch check out of the sensor was performed using non deliverable Ground Support Equipment (GSE). This was only used as a go/no-go indicator. All calibration is done in the laboratory. While no particular time constraint has been established

for recalibration, manufacturers have suggested that the unit be recalibrated at six month intervals. This, however, is based upon shelf life only. Exposure to contamination, shock, and vibration environments for each flight is expected to establish the need for more frequent calibrations. In the initial flights, the optics should be checked for effects of contamination and Shuttle launch environments. Considering the turn around and reuse capabilities defined for the Space Tug, a desirable feature is the ability to perform in place or onboard ground calibration without removing the equipment from the vehicle.

Recommended Solution

A method for onboard checkout of a strapdown star tracker is being developed which includes the capability to check the optics. Previous built in test equipment only verified operation of the electronics. The optical checkout is accomplished by using a light emitting diode (LED) which is fiber optic coupled to the tracker. When the LED is energized by an external command signal, a simulated star signal with known position coordinates is presented on the image dissector. This measured simulated star signal is compared to the preset position data and a No-Go output is generated if these data differ.

Extension of this technology to permit onboard calibration is recommended. It is estimated this effort invloves an equivalent of $3 million over an 18 month period.

10.3.2 IMU Self Calibration

Technology Deficiencies

Strapdown IMUs presently utilized on spacecraft have no provision for onboard calibration since present vehicles are not reusable. The IMU is normally calibrated in a laboratory prior to launch. Most conventional inertial instruments must be recalibrated every 90 to 120 days to assure proper performance. However, exposure to the Shuttle shock, acoustic, and vibration environments are expected to reduce this interval. In the initial flights, the IMU should be recalibrated subsequent to a full mission environment exposure to verify structural integrity and performance tolerances of the sensor. It is also desirable to utilize the data obtained in periodic calibrations for hardware trend. Considering the turnaround and reuse capabilities defined for the Space Tug, a desirable feature is the ability to perform inplace or onboard ground calibration without removing the equipment from the vehicle.

Recommended Solution

By providing the capability to rotate the strapdown IMU to selected orientations, full onboard calibration of the IMU is possible.

Recent developments in strapdown systems include configurations which can accomplish these functions with less complexity and cost than a fully gimballed IMU. One such configuration includes a single calibration gimbal about the system roll axis and an additional step-index mechanism around a selected set of instruments. These calibration mechanisms are then locked in a known reference position prior to flight.

By extending this concept to three gimbals, full onboard calibration can be achieved. Extension of the technology from a single to a three gimballed system is expected to require 1.5 years of SR&T, at an expense of $2 million.

10.3.3 Lasar Radar Rendezvous and Docking Techniques

The present state of development of the ITT scanning laser radar is such that the actual minimum radar is such that the actual minimum and maximum range capabilities of the system do not satisfy the requirements of a

Tug rendezvous and docking sequence. The sequence requires that acquisition, track and ranging shall occur up to a range of at least 100 miles and that, in addition, target attitude data shall be available from approximately 1000 feet to 5 feet.

In addition to this sensor problem, the capability for automatic port recognition and relative orientation measurement has not been demonstrated.

Recommended Solution

Rendezvous and Docking--The original ITT laser system is based upon a GaAs laser diode. This diode is a low power device which limits the range capability to less than 100 miles. To increase the power level and hence the range of the system, a Neodymium YAG diode should be considered. Much greater power is available from NdYAG devices and their use is limited by thermal considerations and by reliability of the pumping light source. Methods of cooling the higher power device and the use of diodes as laser pumps to improve reliability should be evaluated.

In order to accomplish terminal rendezvous and docking, the docking port must be identified and three axis attitude of the target and change vehicles relative to the port must be determined. The use of multiple optical rendezvous on the target with known location and geometry is a candidate technique. Separate range and angle readings to each reflector are made and target attitude and range are determined by triangulation. At short ranges, the transmitter beam can be spread out larger than the receiver instantaneous field-of-view and only the receiver need scan at a faster rate. A 6.1 degree instantaneous FOV would see a projected area with a diameter of 1.75 feet at a target range of 1000 feet, and the reflector geometry would have to be laid out with this order of magnitude spacing.

In order to evaluate these problems and proposed solutions, both analysis and simulation is required. An appropriate methodology for extracting the required orientation data from the sensor information must be developed and guidance and control laws using these data for all phases of rendezvous and docking sequence are needed. A simulation which incorporates sensors, realistic targets, and controlled target-chaser relative motion including the effect of propellant dynamics will be used to demonstrate overall system performance.

SR&T Schedule

Sensor development should be scheduled so that prototype equipment capable of meeting system requirements is available in one year and final version equipment in 18 months. Guidance and control low analysis and development and simulation facility development should be completed in one year to allow acceptance of developing sensor hardware. System evaluation and development using this facility would then accupy the second program year. This is an ambitious program and could run as high as $5 million total.

10.3.4 Fuel Cell Improvements

Deficiencies

Fuel cells that are developed from Shuttle technology can be used on the Tug, but limit the available payload that can be carried. Payload performance improvements can be gained through additional SR&T by reducing the fixed weight of fuel cell batteries. It is also possible to reduce the specific reactant consumption rate by increasing the operating efficiency of the fuel cells. Projected lifetime of Shuttle technology fuel cells can be improved upon.

Recommended Solutions

Fuel cell battery structure can be lightened by making end plates out of nonmetallic material instead of metal.

Fuel cell life can be improved by finding materials that are more stable in caustic and oxidizing environments internal to the fuel cell batteries. This will also bring about lowered and uniform cell temperatures which will result in reduced polarization losses within the cells.

The current density within the cells should be decreased by increasing active surface area at the electrodes. This will decrease polarization losses further. Concurrent with this, the cell thickness can be reduced to conserve weight.

Parasitic power can be reduced by replacing motor-driven hydrogen-water separators with suitable passive water removal mechanisms.

Additional work needs to be done to perfect an evaporative cooling concept that is compatible with the new fuel cell battery design. This will allow the use of product water from the cells to help cool the cells before this water is vented overboard.

This effort has been scoped at $3 million over one year.

Section 11

SPECIAL COST SENSITIVITIES OPTION 3

This section discusses a series of special cost sensitivity analyses conducted for Option 3 as called for by the Government-furnished outline and as required by action item 54 from the First Review Meeting. The majority of these trades can be examined in the light of their effects upon production and operations costs since most of the variables in question affect the number of flights and the increase or decrease in flight hardware (Tug vehicles or kick stages) required to support the change in traffic. The sensitivity of program cost to changes in schedule is a different and more complex analysis. Section 11.6 describes this analysis for Option 3.

11.1 COST VS PAYLOAD WEIGHT

Variations in payload weight of ± 20% were examined for impact on number of flights and for changes in flight hardware required. The resulting program cost sensitivity is shown in the following table.

OPTION 3 PAYLOAD WEIGHT CHANGE	SENSITIVITIES				
	NUMBER OF FLIGHTS		HARDWARE CHANGE		DOLLARS
	ΔFLIGHTS	Δ$	ΔHARDWARE	Δ$	TOTAL IN M
+20%	+8	+7.2	+8 Ks	+4.9	+12.1
-20%	-10	-9.0	0	0	-9.0

11.2 COST VS TRAFFIC RATE

Variations in traffic rate of ± 10% were examined for impact on number of flights and for changes in flight hardware required. The resulting program cost sensitivity is shown in the following table:

OPTION 3 TRAFFIC RATE CHANGE	SENSITIVITIES				
	NUMBER OF FLIGHTS		HARDWARE CHANGE		DOLLARS
	ΔFLIGHTS	Δ$	ΔHARDWARE	Δ$	TOTAL IN M
+10%	+33	+29.7	0	0	+29.7
-10%	-33	-29.7	-1	-12.2	-41.9

11.3 COST VS DRY WEIGHT

Variations in vehicle dry weight of ± 10% were examined for impact on number of flights and for changes in flight hardware required. The resulting program cost sensitivity is shown in the following table:

OPTION 3 DRY WEIGHT CHANGE	SENSITIVITIES				
	NUMBER OF FLIGHTS		HARDWARE CHANGE		DOLLARS
	ΔFLIGHTS	Δ$	ΔHARDWARE	Δ$	TOTAL IN M
+10%	+102	+91.8	+ 7 TUG + 50 Ks	+85.5 +30.5	+207.8
-10%	-40	-36.0	-1 TUG	-12.2	-48.2

11.4 COST VS DELETION OF EXPENDABLES

Deletion of expendables was examined for impact on number of flights and for changes in flight hardware required. The resulting program cost sensitivity is shown in the following table:

OPTION 3	SENSITIVITIES				
	NUMBER OF FLIGHTS		HARDWARE CHANGE		DOLLARS
	ΔFLIGHTS	Δ$	ΔHARDWARE	Δ$	TOTAL IN M
DELETE EXPENDABLES	-8	-7.2	-4 TUGS	-48.9	-56.1

11.5 COST VS. CHANGE IN ISP (10 SEC.)

OPTION 3 CHANGE IN ISP	SENSITIVITIES				
	NUMBER OF FLIGHTS		HARDWARE CHANGE		DOLLARS
	ΔFLIGHTS	Δ$	ΔHARDWARE	Δ$	TOTAL IN M
+10 SEC	-23	-20.7	0	0	-20.7
-10 SEC	+97	+87.3	+2 TUGS +41 Ks	+24.4 +25.0	+136.7

11.6 COST VERSUS SCHEDULE

The objective of this analysis was to determine the programmatic sensitivity of Option 3 to a two year IOC delay from December 31, 1979 to December 31, 1981, for the Initial phase of the project and from December 31, 1983 to December 31, 1985, for the Final phase. Primary goals were to evaluate techniques for reducing the peak year funding without excessive total program and early year DDT&E cost impact.

Cost and funding variations were quantified for variations from the baseline schedules. Costs were estimated for variations of ± one and two years for DDT&E and Production. Funding impacts for DDT&E and Production were identified for the two IOC schedules. Schedule impacts on Operations costs and funding were quantified based on the variation in the number of flights at an average cost per flight.

For the analysis, similar to Case 1 examined for Option 1 and reported in detail in Volume 8, Book 1, Section 8, it was assumed that the ATP for the Initial phase DDT&E was held at October 1975, as in the baseline option. Thus, an attempt was made to trade schedule years against related cost impacts. The Initial phase DDT&E is extended by 21 months with resulting impacts on cost. By delaying the IOC two years, the Initial phase of the program loses 24 flights which decreases operations costs; however, delay of the Final phase causes the initial vehicle to fly significantly more missions in years 1984 and 1985, including 2 expendable missions. The net result of the operations difference amounts to an increase in operations phase costs for the total project.

DDT&E Impact

Methodology -- The methodology used to quantify the DDT&E cost impacts was the same as that detailed in Subsection 11.6 of Book 1, Volume 8. For the Initial phase, the 31 December 1983 IOC schedule was assumed to be a reasonable schedule for a reasonable cost. Its CDR point, 38 months after ATP was considered to be the minimum schedule point at which dollars could not buy time. For the Final phase, the ATP equivalent date was 1 June 1979 and the CDR date was 40 months after ATP at 1 October 1982.

FIGURE 11.6-1
PROGRAM OPTION 3 - INITIAL

DEVELOPMENT SCHEDULE/RISK COST ESTIMATES

$C_n = F_n + V_n$

n	F	V	C
4	.275	1.000	1.375
2	.375	.650	1.025
1(Base)	.500	.500	1.000
3	.610	.425	1.035
5	.725	.450	1.175

R_n

n	R
4	.30
2	.27
1	.80
3	.90
5	.94

$C^*_n = C_n \div R_n$

n	C	R	C*
4	1.375	.30	4.583
2	1.025	.27	3.796
1	1.000	.80	1.250
3	1.035	.90	1.150
5	1.175	.94	1.250

APPLYING FACTORS TO OPTION NO. 3 - INITIAL

DDT&E COST AT $190.10 MILLION

n	SCHEDULE ADJUSTMENT IN YEARS	EXPECTED COST		MAXIMUM COST RISKED TO MEET SCHEDULE	
		C	1973 $ MIL	C*	1973 $ MIL
4	-2	1.375	260.44	4.583	1,193.60
2	-1	1.025	194.85	3.796	739.65
1	0	1.000	190.10	1.250	237.63
3	+1	1.035	195.80	1.150	225.17
5	+2	1.150	218.62	1.250	273.28

Comparison of the two Initial schedules in terms of DDT&E cost impact is summarized in Figure 11.6-1. No significance could be identified between the two Final Schedules. The terms used in Figure 11.6-1 are defined as follows:

$C_n = F_n + V_n$

C_n = Total DDT&E Cost, comprised of both fixed and variable elements. At Baseline - IOC, $C_n = C_1 = 100\%$.

F_n = Costs that are Fixed with time. At Baseline - IOC, $F_n = F_1 =$ 50% of C_1.

V_n = Costs that are variable with time. At Baseline - IOC, $V_n = V_1 =$ 50% of C_1.

n = Number of years variations from the baseline identified as a subscript, as follows:

n - Subscript	Years from Baseline
4	-2
2	-1
1	Baseline = 0
3	+1
5	+2

$C_n^* = C_n + R_n$

C_n^* = Index of Maximum Cost Risked to meet development objectives.

C_n = Total expected DDT&E cost as defined above.

R_n = Diminishing Risk Probability. Values represent the probability of not meeting program objectives in terms of cost and schedule R_1 at IOC considered = .8.

Applying factors to the baseline DDT&E cost for Program Option No. 2 resulted in two tabular sets of cost impacts shown in Figure 11.6-1. One table lists the variation in Expected DDT&E Cost, while the other table shows the variation in Maximum Cost Risked to Meet Schedule.

Cost Sensitivities

The expected cost table in Figure 11.6-1 indicates that for the Initial Phase the following conclusions might be drawn:

- The development schedule could be varied by ± one year with only minimal impact on DDT&E cost (2.5 - 3.5%).
- A two year extension of the development schedule would increase DDT&E cost by 17.5%.
- A two year compression of the DDT&E schedule would increase DDT&E costs by 37.5%.

The table of maximum cost risked to meet schedule provides the basis for another significant conclusion:

- That by extending the baseline schedule by one year, the C* value can be reduced from the baseline index of 1.25 to an index of 1.15. The corresponding cost could be reduced from $238 million to $225 million.

Combining these conclusions lead to further conclusions:

- That from a DDT&E cost/risk standpoint for the Initial Phase alone, it would be preferable to:
  - Extend by one year the months between ATP and IOC, thus achieving a two year delay of IOC from the baseline.
  - Delay ATP one year, from October 1975 to October 1976.
- That the results of these actions would be:
  - Only a 3.5% increase in DDT&E cost (from $190 to $196 million).
  - A <u>reduction</u> in the maximum cost risked to meet schedule from $238 to $225 million, or -5%.

However, these benefits would be achieved only if the relationship in time were maintained between the two IOC dates.

<u>Production Impact</u>

<u>Methodology</u> -- The methodology followed in determining production rate cost sensitivity due to schedule adjustment was similar to that followed for DDT&E. The impacts were quantified for variations of ± one year and ± two years from the baseline schedule. Figures 11.6-2 and 11.6-3 summarize the cost methdology and the resultant cost sensitivities for the Initial and Final phases, respectively.

FIGURE 11.6-2

PROGRAM OPTION NO. 3 INITIAL

PRODUCTION RATE COST SENSITIVITY

1973 DOLLARS IN MILLIONS

	SCHEDULE ADJUSTMENT IN YEARS	PRODUCTION RATE PER YEAR	PRODUCTION RATE FACTOR (1)	VEHICLE MAIN STAGE COSTS TOTAL	VEHICLE MAIN STAGE COSTS AVG. UNIT (5)	TOTAL PROJECT PRODUCTION COSTS $ (3) Δ	TOTAL PROJECT PRODUCTION COSTS TOTAL $
	- 1	4.174	2.352	166.70	20.84	+182.59	281.18
BASELINE	0	1.714	1.000	58.45	11.63	-	98.59
	+ 1	2.043	1.366	79.84	9.98	+ 36.08	134.67
(20 MONTHS)	+ 1.67	1.745	1.334	77.97	9.75	+ 32.93	131.52
	+24	1.627	1.348	78.79	9.85	+ 34.31	132.90

Note: (1) Factor derived from following equation:

$$\text{New Expected Cost Factor (NECF)} = \left\{ \underbrace{\left[\frac{\text{New No. Months}}{\left[-66.52 + (3.2 * \text{New No. Mos.}) \right]} \right]}_{\text{Variable Elements Cost Impact}} \times .5 \underbrace{\left(\text{Baseline Expected Cost Factor (BECF)} \right)}_{\text{Assume Baseline Includes .5 Variable Elements}} \right] + \underbrace{\left[\left(\frac{\text{New No. Mos.}}{\text{Base No. Mos}} \right) \times .5 \left(\text{Baseline Expected Cost Factor (BECF)} \right) \right]}_{\text{Fixed Element Cost Impact}} \right\} + \underbrace{F'}_{\text{Assume Baseline Includes .5 Fixed Elements}} \quad \text{(4)}$$

(Assume Plan Prior to Pr Start has Effect)

(2) Parabolic equation derived from least squares regression analysis

(3) Project level costs; include system level and + S.E. and I at .382 and Project Management at .045

(4) F' = Normalized index derived from equation: $F' = \frac{42.99\ (\text{New No. Months})^{-1.06}}{F \text{ of Case No. Months}}$

(5) Baseline = 5 vehicles; Other schedules = 8 vehicles.

FIGURE 11.6-3

PROGRAM OPTION NO. 3 FINAL

PRODUCTION RATE COST SENSITIVITY

1973 DOLLARS IN MILLIONS

SCHEDULE ADJUSTMENT IN YEARS	PRODUCTION RATE PER YEAR	PRODUCTION RATE FACTOR (1)	VEHICLE MAIN STAGE COSTS TOTAL	VEHICLE MAIN STAGE COSTS AVG. UNIT (5)	TOTAL PROJECT PRODUCTION COSTS $ (3) Δ	TOTAL PROJECT PRODUCTION COSTS TOTAL $
- 2	2.157	1.126	135.68	16.96	+ 22.28	199.09
(-10 MONTHS)- .83	1.761	1.040	125.32	15.67	+ 7.07	183.88
BASELINE 0	1.674	1.000	120.50	13.39	-	176.81
+ 1	1.255	1.009	121.58	15.20	+ 1.59	178.40
+ 2	1.085	1.009	121.58	15.20	+ 1.59	178.40

Note: (1) Factor derived from following equation:

$$\text{New Expected Cost Factor (NECF)} = \left\{ \left[\underbrace{\frac{\text{New No. Months}}{\left[-66.52 + (3.2 * \text{New No. Mos.})\right]}}_{\text{Variable Elements Cost Impact}} \right. \underbrace{\text{X}.5 \left(\text{Baseline Expected Cost Factor (BECF)}\right)}_{\text{Assume Baseline Includes .5 Variable Elements}} \right] + \left[\underbrace{\left(\frac{\text{New No. Mos.}}{\text{Base No. Mos}}\right)}_{\text{Fixed Element Cost Impact}} \underbrace{\text{X}.5 \left(\text{Baseline Expected Cost Factor (BECF)}\right)}_{\text{Assume Baseline Includes .5 Fixed Elements}} \right] \left. \right\} \underbrace{+ F'}_{\text{Assume Planni Prior to Prod Start has F' Effect}}$$

(NNM) (2) (4)

(2) Parabolic equation derived from least squares regression analysis

(3) Project level costs; include system level and + S.E. and I at .382 and Project Management at .045

(4) F' = Normalized index derived from equation: $F' = \frac{42.99\ (\text{New No. Months})^{-1.06}}{F \text{ of Case No. Months}}$

(5) Baseline = 9 vehicles; Other schedules = 8 vehicles.

The equation shown assumes that the baseline cost for the baseline schedule has an index of 1.0 and that the index is composed of two equal factors (.5 each). One factor is that which results from elements variable with time, while the second factor represents the elements that are fixed with time. Measurement of the schedule variation impact on the variable factor was accomplished using the equation element by which the new number of production months was divided by a parabolic equation form. The fixed element cost impact was determined by the simple equation form which divided the new number of months by the base number of months. In addition to the values produced by substituting the appropriate variables, it was felt that the index should be adjusted to reflect the influence of planning the production approach for a given rate. This planning would start prior to production initiation, of course. The F' equation was derived to fulfill this function.

Cost Sensitivities

Figures 11.6-2 and 11.6-3 presents the tabulated results of applying the production rate factor to schedule and companionate production rate variations from the baseline for the Initial and Final phases, respectively. The baseline rate was established for the Initial phase as that needed to have two vehicles available at IOC. The production rate factor for the baseline case was computed at 1.00 and was based on a single shift operation for both the Initial and Final configurations. The tables also present the average unit costs for the noted fleet size required number of production units of the Vehicle Main Stage. For the Initial configuration, extending the Production Schedule by 20 months would increase Vehicle Main Stage costs from $58.5 million to $78.0 million. For the Final configurations the schedule would be compressed by 10 months from the Baseline and this would increase Production costs of the vehicle main stage from $120.5 million to $125.3 million. Thus, the impact of the adjusted IOC dates would be the sum of the two deltas -- $19.5 million ($78.0 - $58.5) plus $4.8 million ($125.3 - $120.5), or $24.3 million.

Operations Impact

Methodology -- Schedule impacts on operations costs were quantified based on variation in the number of flights at an average cost per flight. (Reference Section 6.9 of this book and volume.) The relative numbers of flights used for the two year IOC program were as follows:

3-Initial

	Number of Flights						
GFY	80	81	82	83	84	85	TOTAL
Baseline	10	18	20	23	12	--	83
2-Year IOC Delay	--	25	40	40	40	40	185
Δ	-10	7	20	17	28	40	102

Cost per flight = $1.053 million; Δ for 102 flights = $109.1 million ($197.7-$88.6)

3-Final

GFY	84	85	86	87	88	89	90	91	TOTAL
Baseline	22	41	41	41	41	41	40	20	287
2-Year IOC Delay	--	23	24	24	24	24	22	20	161
Δ	-22	-18	-17	-17	-17	-17	-18	0	-126

Cost per flight = $0.704; Δ for 126 flights = $-89.8

Cost Sensitivity

From the calculations above, the two year IOC delay would have the effect of increasing the Operations cost by $19.3 million, due to the respective costs per flight of the limited flights versus the Final flights.

3-Total

		Cost
Baseline =	370 flights =	$293.1 million
2-Year IOC Delay =	346 flights =	$312.4 million
Δ	-24 flights	$ 19.3 million

SECTION 12

DOD ACQUISITION APPROACH (AFSCP 800-3)

12.3 Costs for Each Phase

12.3.1 Assumptions, Ground Rules, and Rationale

1. The Tug Vehicle Definition (Program Option 3) is the same as that for the NASA program.

2. The cost estimates and funding projections are predicated on the AFSCP 800-3 System Acquisition Cycle, with project ATP occurring at the start of the Validation Phase.

3. The Validation Phase costs include those for: Supporting Research and Technology (SR&T); Concept Validation - Refined Definition - Risk Reduction; Part I (Performance) Specifications; Contract End Item Identification; Critical Prototype Testing; Program Plans for the Full Scale Development (FSD) Phase; DSARC Review - one month.

4. The Full Scale Development (FSD) Phase costs include those for: System Design; Test Article Fabrication; Development Testing; Production Phase Planning; Part II Design Specifications; Category I (Subsystem) and Category II (System) Tests; PDR - Preliminary Design Review; CDR - Concept Design Review; PCA (FACI) - First Article Configuration Inspections refined Operations Planning; Flight Software; Facilities; AGE/GSE; Auxiliary Stage Activation; DSARC Review - one month.

5. The Production Phase costs assume that DOD procures the national fleet. Production costs reflect the following reductions based on anticipated reductions in change traffic due to full scale development phase accomplishments:

Structure = -5%; Avionics = -10%; Propulsion = -10%

6. The Deployment/Operations Phase costs assume the DOD top level operational concept, and the following numbers of flights:

	INITIAL	FINAL	TOTAL
DOD			
ETR	28	99	127
WTR	2	17	19
Total	30	116	146
NASA			
ETR	34	138	172
WTR	0	33	33
Total	34	171	205
ETR Total	62	237	299
WTR Total	2	50	52
Grand Total	64	287	351

7. The Operations Phase costs reflect an approximate 10 percent reduction in maintenance and refurbishment cost due to assumed/lowered requirements for both scheduled and unscheduled maintenance and refurbishment. The lower requirements, in turn, are assumed to result from FSD phase accomplishments, including use of high reliability/long life components. The FSD Phase costs include: one flight article - and two flight tests, both for the Initial Tug and for the Final Tug. The vehicles are assumed to be refurbished and added to the operational fleet.

8. The Production Phase costs include the following operational fleet sizes:

	INITIAL	FINAL	TOTAL
Total Required	5	11	16
Less: Flight Test Hardware (Refurbished)	-1	- 1	- 2
Net Procured	4	10	14

9. Funding of Production Phase costs assumes the DOD full funding policy.

10. The FSD Phase costs include initial Operational Test and Evaluation (IOT&E) flights (all at ETR) as follows:

	INITIAL	FINAL	TOTAL
DOD	2	5	7
NASA	6	5	11
Total	8	10	18

Since all these flights are with payloads, their FSD costs have been accumulated in the following WBS accounts:

320-1 Launch Operations - ETR

320-11 Flight Operations - NASA

320-14 Refurbishment and Maintenance - ETR

12.3.2 Costs

12.3.2.1 Methodology

Using the above assumptions, ground rules and rationale, the LEADER II Cost Model has been used to develop DOD cost estimates for the FSD, Production and Deployment/Operations phases. Since resource limitations precluded reprogramming of the cost model at this time, the following costs have been calculated separately: DOD - Validation Phase; NASA - DDT&E Production and Operations Phases.

12.3.2.2 Cost Summary

The followint Table 12.3.2.2 summarizes the cost estimates by phase and by agency.

12.3.2.3 Cost Details

The following pages present the LEADER II Cost Model printouts of detail cost estimates for the DOD Full Scale Development Phase, Production Phase, and Deployment/Operations Phase. Also included are the calculations for the DOD Validation Phase costs and for NASA's IOT&E and Operations. Figures 12.3.2.3.1, 12.3.2.3.2, 12.3.2.3.3, and 12.3.2.3.4.

12.4 Funding Distribution for Each Phase

Figures 12.4.1.1 and 12.4.1.2 present tabular and graphic projections of the funding requirements for the DOD system acquisition cycle. Validation phase funding approximates a Beta distribution (of the funding in 50 percent of the scheduled time). FSD phase funding approximates a Beta distribution, while operations phase funding has been level loaded commensurate with the flight

Table 12.3.2.2

Program Option 3 -- DOD

Space Tug

Cost Summary Tabulation

1973 Dollars in Millions

	PROGRAM PHASE				
	VALIDATION	FULL SCALE DEVELOPMENT	PRODUCTION	OPERATIONS	TOTAL
DOD					
INITIAL	16.08	199.30	68.70	42.17	326.25
FINAL	23.52	107.14	141.05	95.32	367.03
TOTAL	39.60	306.44	209.75	137.49	693.28
NASA					
INITIAL	---	17.39	12.19	26.79	56.37
FINAL	---	12.36	4.97	99.91	117.24
TOTAL	---	29.75	17.16	126.70	173.61
TOTAL PROGRAM	39.60	336.19	226.91	264.19	866.89

schedule. In accordance with DOD full funding policy, the final phase of the program is split into two equal buys of five (5) Tugs each.

Peak year funding occurs in GFY 1980 and totals $111.9 million, of which $100.6 million is DOD funding and the remaining $11.3 million is for NASA.

12.5 Comparison of DOD and NASA Rationale for Differences

Figure 12.5.1 is a summary comparison of the estimated costs by agency by phase. This chart shows that costs for DOD's validation + FSD phases are $375.79 million, or $96.87 million more than those for NASA's DDT&E phase; while DOD's production phase costs are $226.91 million, or $48.62 million less than NASA's production costs; and DOD's operations costs are $264.19 million, or $28.82 million less than NASA's operations costs. On a total program basis, it is estimated that the DOD System Acquisition Cycle would result in a $19.42 million cost increase. Although DOD objectives of lower production and operational costs were achieved, the net increase in total program cost is attributable to an allocation of additional funding during the FSD phase to maintain the engineering and production capability between flight test article completion and FSD phase DSARC review.

OPTION 3I DOD 5 VEHICLES 9/12/73 6100 PM

WBS	COST ELEMENT C	EDBD (MIL)	GTR (MIL)	FTR (MIL)	TOTAL DDT&E (MIL)	MEMO TI (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
10	TOTAL PROJECT MGMT	6.54	.00	.00	6.54	.00	2.04	.00	2.04	.77	.00	.77	9.35
20	TOTAL SYS. ENGR. &	14.50	.00	.00	14.50	.00	20.87	.00	20.87	3.31	.00	3.31	38.68
30	TOTAL VEH MAIN STA	89.79	10.75	.00	100.54	13.48	38.24	2.40	40.64	.30	7.00	7.30	148.48
40	TOTAL VEH AUX. STA	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
50	TOTAL LOGISTICS	1.66	.00	.00	1.66	.00	.15	.00	.15	2.51	.00	2.51	4.32
60	TOTAL FACILITIES	5.17	.00	.00	5.17	.00	.44	.00	.44	1.21	.00	1.21	6.81
70	TOTAL GRND. SUPT.	27.17	.00	.00	27.17	.00	1.20	.00	1.20	4.95	.00	4.95	33.32
80	TOTAL VEHICLE TEST	.00	19.64	16.53	36.17	.00	3.37	.00	3.37	.00	.00	.00	39.54
90	TOTAL LAUNCH OPNS.	.00	.00	.00	.00	.00	.00	.00	.00	.46	.00	.46	.46
100	TOTAL LAUNCH OPNS	.00	.00	1.01	1.01	.00	.00	.00	.00	4.57	.00	4.57	5.58
110	TOTAL FLIGHT OPNS	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
120	TOTAL FLIGHT OPNS	4.20	.00	1.18	5.38	.00	.00	.00	.00	8.85	.00	8.85	14.23
130	TOTAL REFURB &INTE	.11	.00	.00	.11	.00	.00	.00	.00	.60	.00	.60	.71
140	TOTAL REFURB &INTE	.11	.00	.93	1.04	.00	.00	.00	.00	7.64	.00	7.64	8.68
	TOTAL	149.25	30.40	19.65	199.30	13.48	66.31	2.40	68.70	35.17	7.00	42.17	310.17

OPTION 31 DOD 3 VEHICLES 9/12/73 6100 PM

WBS	COST ELEMENT	C	ED&D (MIL)	6TH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
10	PROJECT MGMT.	3												
11	COST/PERF. MGMT.	3	4.49	.00	.00	4.49	.00	1.39	.00	1.39	.51	.00	.51	6.38
12	PROJ. DIRECTION	3	1.92	.00	.00	1.92	.00	.61	.00	.61	.24	.00	.24	2.77
13	INFORM. MGMT.	3	.13	.00	.00	.13	.00	.04	.00	.04	.02	.00	.02	.19
	TOTAL PROJECT MGMT		6.54	.00	.00	6.54	.00	2.04	.00	2.04	.77	.00	.77	9.35
	TOTAL		6.54	.00	.00	6.54	.00	2.04	.00	2.04	.77	.00	.77	9.35

127

OPTION 3I DOD 5 VEHICLES 9/12/73 6:00 PM

WBS	COST ELEMENT	C	EDGD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
20	SYS. ENGR. & INT.	3												
21	TUG SYS. ENGR.	3	11.60	.00	.00	11.60	.00	2.24	.00	2.24	.00	.00	.00	13.84
22	SHUTTLE I/F	3	.73	.00	.00	.73	.00	.56	.00	.56	.00	.00	.00	1.29
23	PAYLOAD I/F	3	2.17	.00	.00	2.17	.00	1.12	.00	1.12	.00	.00	.00	3.29
24	SUST. ENGR.	3	.00	.00	.00	.00	.00	16.94	.00	16.94	3.31	.00	3.31	20.26
	TOTAL SYS. ENGR. &		14.50	.00	.00	14.50	.00	20.87	.00	20.87	3.31	.00	3.31	38.68
	TOTAL		14.50	.00	.00	14.50	.00	20.87	.00	20.87	3.31	.00	3.31	38.68

OPTION 31 DOD 3 VEHICLES 9/12/73 6:00 PM

WBS	COST ELEMENT	C	EDDD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
30	VEH MAIN STAGE	3												
31	STRUCTURES	3	17.71	.64	.00	18.35	1.64	4.73	.00	4.73	.00	.20	.20	23.28
32	THERMAL CONTROL	3	.93	.24	.00	1.17	.46	1.33	.00	1.33	.00	.06	.06	2.57
33	AVIONICS	3	22.25	3.00	.00	25.25	4.12	11.95	.50	12.45	.30	3.71	4.01	41.71
34	PROPULSION	3	28.35	3.89	.00	32.23	3.01	8.73	1.67	10.40	.00	2.50	2.50	45.13
35	ORBITER I/F	3	10.29	2.19	.00	12.47	2.19	6.31	.22	6.53	.00	.53	.53	19.53
36	DROP TANKS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
37	FINAL ASSY & C/O	3	10.27	.80	.00	11.06	2.06	5.19	.00	5.19	.00	.00	.00	16.26
	TOTAL VEH MAIN STA		89.79	10.75	.00	100.54	13.48	38.24	2.40	40.64	.30	7.00	7.30	148.48
	TOTAL		89.79	10.75	.00	100.54	13.48	38.24	2.40	40.64	.30	7.00	7.30	148.48

LEVEL 6

WBS	COST ELEMENT	C	EDSD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO TI (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
3101	FUEL TK & SUPT	3	4.85	.00	.00	4.85	.45	1.31	.00	1.31	.00	.00	.00	6.17
3102	OXID. TK & SUPT	3	2.62	.00	.00	2.62	.18	.54	.00	.54	.00	.00	.00	3.16
3103	BODY STRUCTURE	3	4.09	.00	.00	4.09	.10	.28	.00	.28	.00	.00	.00	4.37
3104	THRUST STRUCTURE	3	1.38	.00	.00	1.38	.06	.18	.00	.18	.00	.00	.00	1.56
3105	METEOROID SHIELD	3	.98	.00	.00	.98	.41	1.20	.00	1.20	.00	.00	.00	2.19
3106	PAYLOAD I/F	3	2.47	.59	.00	3.06	.31	.91	.00	.91	.00	.00	.00	3.97
3107	INSTL. ASSY & C/O	3	1.31	.05	.00	1.36	.12	.31	.00	.31	.00	.00	.00	1.67
31	STRUCTURE		17.71	.64	.00	18.35	1.64	4.73	.00	4.73	.00	.00	.00	23.08
3201	FUEL TANK INSL	3	.16	.00	.00	.16	.10	.29	.00	.29	.00	.02	.02	.47
3202	OXID. TANK INSL.	3	.08	.00	.00	.08	.05	.14	.00	.14	.00	.01	.01	.24
3203	INSL. PURGE SYS.	3	.64	.23	.00	.87	.29	.84	.00	.84	.00	.03	.03	1.74
3204	THERM CONT. SYS.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
3205	INSTL ASSY & C/O	3	.04	.01	.00	.06	.02	.06	.00	.06	.00	.00	.00	.11
32	THERMAL CONTROL		.93	.24	.00	1.17	.46	1.33	.00	1.33	.00	.06	.06	2.57
3301	DATA MGMT.	3	8.41	1.20	.00	9.61	.92	2.69	.17	2.86	.30	.33	.63	13.10
3302	G N & C	3	1.47	.00	.00	1.47	1.01	2.94	.01	2.96	.00	.04	.04	4.47
3303	COMMUNICATIONS	3	4.26	1.46	.00	5.72	1.65	4.81	.24	5.05	.00	.56	.56	11.34
3304	INSTRUMENTATION	3	2.04	.04	.00	2.08	.16	.47	.00	.47	.00	.19	.19	2.73
3305	ELECT. POWER	3	.09	.05	.00	.13	.05	.16	.07	.23	.00	2.58	2.58	2.95
3306	PWR. DIST. & CONTS	3	.85	.03	.00	.88	.03	.10	.00	.10	.00	.01	.01	.99
3307	INSTL. ASSY & C/O	3	5.13	.22	.00	5.36	.31	.78	.00	.78	.00	.00	.00	6.13
33	AVIONICS		22.25	3.00	.00	25.25	4.12	11.95	.50	12.45	.30	3.71	4.01	41.71
3401	MAIN ENGINE	3	13.00	.00	.00	13.00	.63	1.84	1.13	2.97	.00	1.44	1.44	17.41
3402	MAIN ENG. SUPT	3	8.83	2.93	.00	11.76	1.46	4.27	.00	4.27	.00	.42	.42	16.45
3403	ACPS ENGINE	3	.28	.11	.00	.39	.11	.32	.54	.86	.00	.55	.55	1.80
3404	ACPS ENG. SUPT	3	4.88	.67	.00	5.55	.67	1.94	.00	1.94	.00	.09	.09	7.58
3405	INSTL. ASSY & C/O	3	1.35	.19	.00	1.53	.14	.36	.00	.36	.00	.00	.00	1.90
34	PROPULSION		28.35	3.89	.00	32.23	3.01	8.73	1.67	10.40	.00	2.50	2.50	45.13
3501	STRUCTURES	3	3.65	.34	.00	3.99	.34	1.00	.01	1.01	.00	.03	.03	5.03
3502	I/F PANELS	3	4.99	1.41	.00	6.40	1.41	4.12	.21	4.32	.00	.48	.48	11.20
3503	PURGE PROV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
3504	ABORT PROV.	3	.89	.27	.00	1.15	.27	.78	.01	.79	.00	.02	.02	1.96
3505	INSTL. ASSY & C/O	3	.76	.16	.00	.92	.16	.41	.00	.41	.00	.00	.00	1.33
35	ORBITER I/F		10.29	2.19	.00	12.47	2.19	6.31	.22	6.53	.00	.53	.53	19.53

LEVEL 6

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO TI (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
3701	FINAL ASSY	3	7.88	.50	.00	8.38	1.71	4.33	.00	4.33	.00	.00	.00	12.71
3702	C/O	3	2.39	.30	.00	2.68	.34	.87	.00	.87	.00	.00	.00	3.55
37	FINAL ASSY & C/O		10.27	.80	.00	11.06	2.06	5.19	.00	5.19	.00	.00	.00	16.26

LEVEL 7

WBS	COST ELEMENT	C	EO&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DUT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
310101	LH2 DOMES	3	1.70	.00	.00	1.70	.08	.00	.00	.00	.00	.00	.00	1.70
310102	LH2 CYLINDER	3	2.24	.00	.00	2.24	.08	.00	.00	.00	.00	.00	.00	2.24
310103	LH2 SUPPORTS	3	.91	.00	.00	.91	.30	.00	.00	.00	.00	.00	.00	.91
3101	FUEL TK & SUPT		4.85	.00	.00	4.85	.45	.00	.00	.00	.00	.00	.00	4.85
310201	LO2 DOMES	3	1.99	.00	.00	1.99	.07	.00	.00	.00	.00	.00	.00	1.99
310202	LO2 SUPPORTS	3	.63	.00	.00	.63	.11	.00	.00	.00	.00	.00	.00	.63
3102	OXID. TK & SUPT		2.62	.00	.00	2.62	.18	.00	.00	.00	.00	.00	.00	2.62
310301	FWD AFT SKIRT	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
310302	INTERTANK	3	1.98	.00	.00	1.98	.05	.00	.00	.00	.00	.00	.00	1.98
310303	SOWL SHELL	3	2.11	.00	.00	2.11	.05	.00	.00	.00	.00	.00	.00	2.11
3103	BODY STRUCTURE		4.09	.00	.00	4.09	.10	.00	.00	.00	.00	.00	.00	4.09
330101	COMPUTER	3	4.59	.73	.00	5.32	.73	.00	.00	.00	.00	.00	.00	5.32
330102	DATA DISTR.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330103	EQ. THERM CONT.	3	.33	.38	.00	.71	.10	.00	.00	.00	.00	.00	.00	.71
330104	CIRCUITRY	3	.53	.00	.00	.54	.02	.00	.00	.00	.00	.00	.00	.54
330105	SOFTWARE	3	2.33	.00	.00	2.33	.00	.00	.00	.00	.30	.00	.30	2.63
330106	SOFTWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330107	SOFTWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330108	INSTL. ASSY & C/O3		.62	.09	.00	.71	.07	.00	.00	.00	.00	.00	.00	.71
3301	DATA MGMT.		8.41	1.20	.00	9.61	.92	.00	.00	.00	.30	.00	.30	9.91
330201	I M U	3	.71	.00	.00	.72	.64	.00	.00	.00	.00	.00	.00	.72
330202	TRACKING/ELECT	3	.65	.00	.00	.65	.29	.00	.00	.00	.00	.00	.00	.65
330203	REN DEZ&DOCKING	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330204	INSTL. ASSY & C/O3		.11	.00	.00	.11	.07	.00	.00	.00	.00	.00	.00	.11
3302	G N & C		1.47	.00	.00	1.47	1.01	.00	.00	.00	.00	.00	.00	1.47
330301	M/W CIRC +RF MUX	3	1.40	.72	.00	2.12	.36	.00	.00	.00	.00	.00	.00	2.12
330302	TRANSPONDERS	3	.87	.00	.00	.87	.38	.00	.00	.00	.00	.00	.00	.87
330303	POWER AMP.	3	.38	.00	.00	.39	.16	.00	.00	.00	.00	.00	.00	.39
330304	ANTENNA	3	.18	.16	.00	.34	.08	.00	.00	.00	.00	.00	.00	.34
330305	DEC/ENC+MOD/DEM	3	.75	.34	.00	1.09	.34	.00	.00	.00	.00	.00	.00	1.09
330306	TAPE RECORDER	3	.12	.13	.00	.25	.13	.00	.00	.00	.00	.00	.00	.25
330307	P/L INTER EQUIP	3	.24	.00	.00	.24	.07	.00	.00	.00	.00	.00	.00	.24
330308	INSTL. ASSY & C/O3		.32	.11	.00	.42	.12	.00	.00	.00	.00	.00	.00	.42
3303	COMMUNICATIONS		4.26	1.46	.00	5.72	1.65	.00	.00	.00	.00	.00	.00	5.72

LEVEL 7

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO TI (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
330401	DATA SENSORS	3	.06	.00	.00	.06	.04	.00	.00	.00	.00	.00	.00	.06
330402	SIGNAL COND.	3	.10	.04	.00	.14	.04	.00	.00	.00	.00	.00	.00	.14
330403	CIRCUITRY	3	1.73	.00	.00	1.73	.08	.00	.00	.00	.00	.00	.00	1.73
330404	INSTL, ASSY & C/O	3	.15	.00	.00	.15	.01	.00	.00	.00	.00	.00	.00	.15
3304	INSTRUMENTATION		2.04	.04	.00	2.08	.16	.00	.00	.00	.00	.00	.00	2.08
330501	BATTERY	3	.08	.04	.00	.12	.04	.00	.00	.00	.00	.00	.00	.12
330502	FUEL CELL	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330503	INSTL, ASSY & C/O	3	.01	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.01
3305	ELECT. POWER		.09	.05	.00	.13	.05	.00	.00	.00	.00	.00	.00	.13
330601	DISTR.	3	.78	.03	.00	.81	.03	.00	.00	.00	.00	.00	.00	.81
330602	TANKS SYSTEM	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330603	INSTL, ASSY & C/O		.06	.00	.00	.06	.00	.00	.00	.00	.00	.00	.00	.06
3306	PWR. DIST. & CONT		.85	.03	.00	.88	.03	.00	.00	.00	.00	.00	.00	.88

OPTION 3I DOD 5 VEHICLES 9/12/73 6:00 PM

WBS	COST ELEMENT	C	ED&D (MIL)	STM & FTM (MIL)	TOTAL DDT&E (MIL)	MEMO TI (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
40	VEH AUX. STAGE	3											
41	VEH AUX. STAGE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	TOTAL VEH AUX. STA		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

12+14

OPTION 31 DDO 5 VEHICLES 9/12/73 6100 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
50	LOGISTICS	3												
51	TRANSP. & HDLG.	3	.00	.00	.00	.00	.00	.15	.00	.15	.10	.00	.10	.25
52	TRAINING	3	1.37	.00	.00	1.37	.00	.00	.00	.00	1.37	.00	1.37	2.74
53	INV CONT. & WHSNG	3	.29	.00	.00	.29	.00	.00	.00	.00	1.04	.00	1.04	1.33
	TOTAL LOGISTICS		1.66	.00	.00	1.66	.00	.15	.00	.15	2.51	.00	2.51	4.32
	TOTAL		1.66	.00	.00	1.66	.00	.15	.00	.15	2.51	.00	2.51	4.32

LEVEL 6

WBS	COST ELEMENT	C	EDRD (MIL)	OTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
5201	SIM. & EQUIP.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
5202	GROUND CREW	3	1.37	.00	.00	1.37	.00	.00	.00	.00	1.37	.00	1.37	2.74
52	TRAINING		1.37	.00	.00	1.37	.00	.00	.00	.00	1.37	.00	1.37	2.74

OPTION 31 DOD 5 VEHICLES 9/12/73 6:00 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
60	FACILITIES	3												
61	MANUFACTURING	3	1.12	.00	.00	1.12	.00	.44	.00	.44	.00	.00	.00	1.56
62	TEST	3	1.50	.00	.00	1.50	.00	.00	.00	.00	.00	.00	.00	1.50
63	ETR MAINT. & REF.	3	1.02	.00	.00	1.02	.00	.00	.00	.00	.55	.00	.55	1.57
64	ETR LAUNCH	3	.39	.00	.00	.39	.00	.00	.00	.00	.21	.00	.21	.60
65	WTR MAINT. & REF.	3	.76	.00	.00	.76	.00	.00	.00	.00	.30	.00	.30	1.06
66	WTR LAUNCH	3	.38	.00	.00	.38	.00	.00	.00	.00	.15	.00	.15	.53
	TOTAL FACILITIES		5.17	.00	.00	5.17	.00	.44	.00	.44	1.21	.00	1.21	6.81
	TOTAL		5.17	.00	.00	5.17	.00	.44	.00	.44	1.21	.00	1.21	6.81

LEVEL 6

WBS	COST ELEMENT	C	EOHD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO TI (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
6101	DES./CONST.	3	1.09	.00	.00	1.09	.00	.00	.00	.00	.00	.00	.00	1.09
6102	ACTIV./MAINT.	3	.02	.00	.00	.02	.00	.44	.00	.44	.00	.00	.00	.46
61	MANUFACTURING		1.12	.00	.00	1.12	.00	.44	.00	.44	.00	.00	.00	1.56
6201	DES./CONST.	3	1.50	.00	.00	1.50	.00	.00	.00	.00	.00	.00	.00	1.50
6202	ACTIV./MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
62	TEST		1.50	.00	.00	1.50	.00	.00	.00	.00	.00	.00	.00	1.50
6301	DES./CONST.	3	1.00	.00	.00	1.00	.00	.00	.00	.00	.00	.00	.00	1.00
6302	ACTIV./MAINT.	3	.02	.00	.00	.02	.00	.00	.00	.00	.55	.00	.55	.57
63	ETR MAINT. & REF.		1.02	.00	.00	1.02	.00	.00	.00	.00	.55	.00	.55	1.57
6401	DES./CONST.	3	.38	.00	.00	.38	.00	.00	.00	.00	.00	.00	.00	.38
6402	ACTIV./MAINT.	3	.01	.00	.00	.01	.00	.00	.00	.00	.21	.00	.21	.22
64	ETR LAUNCH		.39	.00	.00	.39	.00	.00	.00	.00	.21	.00	.21	.60
6501	DES./CONST.	3	.75	.00	.00	.75	.00	.00	.00	.00	.00	.00	.00	.75
6502	ACTIV./MAINT.	3	.01	.00	.00	.01	.00	.00	.00	.00	.30	.00	.30	.31
65	WTR MAINT. & REF.		.76	.00	.00	.76	.00	.00	.00	.00	.30	.00	.30	1.06
6601	DES./CONST.	3	.37	.00	.00	.37	.00	.00	.00	.00	.00	.00	.00	.37
6602	ACTIV./MAINT.	3	.01	.00	.00	.01	.00	.00	.00	.00	.15	.00	.15	.16
66	WTR LAUNCH		.38	.00	.00	.38	.00	.00	.00	.00	.15	.00	.15	.53

OPTION 3I DOD 5 VEHICLES 9/12/73 6:00 PM

WBS	COST ELEMENT	C	EO&D (MIL)	6TH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO TI (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
70	GRND. SUPT. EQUIPS													
71	MFG. GSE	3	6.89	.00	.00	6.89	.00	1.20	.00	1.20	.00	.00	.00	8.09
72	ETR GSE	3	10.24	.00	.00	10.24	.00	.00	.00	.00	2.22	.00	2.22	12.47
73	WTR GSE	3	9.57	.00	.00	9.57	.00	.00	.00	.00	1.64	.00	1.64	11.21
74	FLT OPS GSE(NASA)		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
75	FLT OPS GSE(DOD)		.47	.00	.00	.47	.00	.00	.00	.00	1.09	.00	1.09	1.56
	TOTAL GRND. SUPT.		27.17	.00	.00	27.17	.00	1.20	.00	1.20	4.95	.00	4.95	33.32
	TOTAL		27.17	.00	.00	27.17	.00	1.20	.00	1.20	4.95	.00	4.95	33.32

B-21

LEVEL 6

WBS	COST ELEMENT	C	EO&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO TI (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
7101	HARDWARE	3	4.42	.00	.00	4.42	.00	.00	.00	.00	.00	.00	.00	4.42
7102	SITE ACTIV.	3	.09	.00	.00	.09	.00	.00	.00	.00	.00	.00	.00	.09
7103	MAINT.	3	.00	.00	.00	.00	.00	1.20	.00	1.20	.00	.00	.00	1.20
7104	SOFTWARE	3	2.38	.00	.00	2.38	.00	.00	.00	.00	.00	.00	.00	2.38
71	MFG. GSE		6.89	.00	.00	6.89	.00	1.20	.00	1.20	.00	.00	.00	8.09
7201	HARDWARE	3	6.49	.00	.00	6.49	.00	.00	.00	.00	.00	.00	.00	6.49
7202	SITE ACTIV.	3	2.14	.00	.00	2.14	.00	.00	.00	.00	.00	.00	.00	2.14
7203	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	2.08	.00	2.08	2.08
7204	SOFTWARE	3	1.61	.00	.00	1.61	.00	.00	.00	.00	.14	.00	.14	1.75
72	ETR GSE		10.24	.00	.00	10.24	.00	.00	.00	.00	2.22	.00	2.22	12.47
7301	HARDWARE	3	6.03	.00	.00	6.03	.00	.00	.00	.00	.00	.00	.00	6.03
7302	SITE ACTIV.	3	1.99	.00	.00	1.99	.00	.00	.00	.00	.00	.00	.00	1.99
7303	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	1.63	.00	1.63	1.63
7304	SOFTWARE	3	1.55	.00	.00	1.55	.00	.00	.00	.00	.01	.00	.01	1.56
73	WTR GSE		9.57	.00	.00	9.57	.00	.00	.00	.00	1.64	.00	1.64	11.21
7401	HARDWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7402	SITE ACTIV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7403	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7404	SOFTWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
74	HARDWA(S) SUBTOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7501	HARDWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7502	SITE ACTIV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7503	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7504	SOFTWARE	3	.47	.00	.00	.47	.00	.00	.00	.00	1.09	.00	1.09	1.56
75	HARDWA(S) SUBTOTAL		.47	.00	.00	.47	.00	.00	.00	.00	1.09	.00	1.09	1.56

OPTION 3I DOD 5 VEHICLES 9/12/73 6:00 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTM (MIL)	FTM (MIL)	TOTAL DDT&E (MIL)	MEMO TI (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
80	VEHICLE TEST	3												
81	GND TEST HDWE.	3	.00	13.39	.00	13.39	.00	.00	.00	.00	.00	.00	.00	13.39
82	GND TEST OPNS.	3	.00	6.26	.00	6.26	.00	.00	.00	.00	.00	.00	.00	6.26
83	FLT. TEST HDWE.	3	.00	.00	13.48	13.48	.00	3.37	.00	3.37	.00	.00	.00	16.84
84	FLT. TEST OPNS	3	.00	.00	3.05	3.05	.00	.00	.00	.00	.00	.00	.00	3.05
	TOTAL VEHICLE TEST		.00	19.64	16.53	36.17	.00	3.37	.00	3.37	.00	.00	.00	39.54
	TOTAL		.00	19.64	16.53	36.17	.00	3.37	.00	3.37	.00	.00	.00	39.54

LEVEL 6

WBS	COST ELEMENT	C	EDAD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
8101	PTV TEST	3	.00	4.70	.00	4.70	.00	.00	.00	.00	.00	.00	.00	4.70
8102	MAJOR TEST ART.	3	.00	8.25	.00	8.25	.00	.00	.00	.00	.00	.00	.00	8.25
8103	MOCKUPS	3	.00	.44	.00	.44	.00	.00	.00	.00	.00	.00	.00	.44
81	GND TEST HDWE.		.00	13.39	.00	13.39	.00	.00	.00	.00	.00	.00	.00	13.39
8301	STRUCTURES	3	.00	.00	1.64	1.64	.00	.00	.00	.00	.00	.00	.00	1.64
8302	THERMAL CONTROL	3	.00	.00	.46	.46	.00	.00	.00	.00	.00	.00	.00	.46
8303	AVIONICS	3	.00	.00	4.12	4.12	.00	.00	.00	.00	.00	.00	.00	4.12
8304	PROPULSION	3	.00	.00	3.01	3.01	.00	.00	.00	.00	.00	.00	.00	3.01
8305	ORBITER I/F	3	.00	.00	2.19	2.19	.00	.00	.00	.00	.00	.00	.00	2.19
8306	DROP TANKS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8307	FINAL ASSY & C/O	3	.00	.00	2.06	2.06	.00	.00	.00	.00	.00	.00	.00	2.06
83	FLT. TEST HDWE.		.00	.00	13.48	13.48	.00	.00	.00	.00	.00	.00	.00	13.48

LEVEL 7

WBS	COST ELEMENT	C	EDMD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
830102	OXID. TK & SUPT.	3	.00	.00	.18	.18	.00	.00	.00	.00	.00	.00	.00	.18
830103	BODY STRUCTURE	3	.00	.00	.10	.10	.00	.00	.00	.00	.00	.00	.00	.10
830104	THRUST STRUCTURE		.00	.00	.06	.06	.00	.00	.00	.00	.00	.00	.00	.06
830105	METEOROID SHIELD	3	.00	.00	.41	.41	.00	.00	.00	.00	.00	.00	.00	.41
830106	PAYLOAD I/F	3	.00	.00	.31	.31	.00	.00	.00	.00	.00	.00	.00	.31
830107	INSTL. ASSY & C/O3		.00	.00	.12	.12	.00	.00	.00	.00	.00	.00	.00	.12
8301	STRUCTURES		.00	.00	1.64	1.64	.00	.00	.00	.00	.00	.00	.00	1.64
830201	FUEL TANK INSL	3	.00	.00	.10	.10	.00	.00	.00	.00	.00	.00	.00	.10
830202	OXID TANK INSL	3	.00	.00	.05	.05	.00	.00	.00	.00	.00	.00	.00	.05
830203	INSL PURGE SYS	3	.00	.00	.29	.29	.00	.00	.00	.00	.00	.00	.00	.29
830204	THERM CONT SYS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830205	INSTL. ASSY & C/O3		.00	.00	.02	.02	.00	.00	.00	.00	.00	.00	.00	.02
8302	THERMAL CONTROL		.00	.00	.46	.46	.00	.00	.00	.00	.00	.00	.00	.46
830301	DATA MGMT.	3	.00	.00	.92	.92	.00	.00	.00	.00	.00	.00	.00	.92
830302	G N & C	3	.00	.00	1.01	1.01	.00	.00	.00	.00	.00	.00	.00	1.01
830303	COMMUNICATIONS	3	.00	.00	1.65	1.65	.00	.00	.00	.00	.00	.00	.00	1.65
830304	INSTRUMENTATION	3	.00	.00	.16	.16	.00	.00	.00	.00	.00	.00	.00	.16
830305	ELECT. POWER	3	.00	.00	.05	.05	.00	.00	.00	.00	.00	.00	.00	.05
830306	PWR DIST. & CONT	3	.00	.00	.03	.03	.00	.00	.00	.00	.00	.00	.00	.03
830307	INSTL. ASSY & C/O3		.00	.00	.31	.31	.00	.00	.00	.00	.00	.00	.00	.31
8303	AVIONICS		.00	.00	4.12	4.12	.00	.00	.00	.00	.00	.00	.00	4.12
830401	MAIN ENGINE	3	.00	.00	.63	.63	.00	.00	.00	.00	.00	.00	.00	.63
830402	MAIN ENG SUPT.	3	.00	.00	1.46	1.46	.00	.00	.00	.00	.00	.00	.00	1.46
830403	ACPS ENGINE	3	.00	.00	.11	.11	.00	.00	.00	.00	.00	.00	.00	.11
830404	ACPS ENG SUPT	3	.00	.00	.67	.67	.00	.00	.00	.00	.00	.00	.00	.67
830405	INSTL. ASSY & C/O3		.00	.00	.14	.14	.00	.00	.00	.00	.00	.00	.00	.14
8304	PROPULSION		.00	.00	3.01	3.01	.00	.00	.00	.00	.00	.00	.00	3.01
830501	STRUCTURES	3	.00	.00	.34	.34	.00	.00	.00	.00	.00	.00	.00	.34
830502	I/F PANELS	3	.00	.00	1.41	1.41	.00	.00	.00	.00	.00	.00	.00	1.41
830503	PURGE PROV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830504	ABORT PROV.	3	.00	.00	.27	.27	.00	.00	.00	.00	.00	.00	.00	.27
830505	INSTL. ASSY & C/O3		.00	.00	.16	.16	.00	.00	.00	.00	.00	.00	.00	.16
8305	ORBITER I/F		.00	.00	2.19	2.19	.00	.00	.00	.00	.00	.00	.00	2.19

12+23

LEVEL 7

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO TI (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
830701	FINAL ASSY	3	.00	.00	1.71	1.71	.00	.00	.00	.00	.00	.00	.00	1.71
830702	C/O	3	.00	.00	.34	.34	.00	.00	.00	.00	.00	.00	.00	.34
8307	FINAL ASSY & C/O		.00	.00	2.06	2.06	.00	.00	.00	.00	.00	.00	.00	2.06

OPTION 31 DOD 3 VEHICLES 9/12/73 6100 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
90	LAUNCH OPNS. WTR	3												
91	LNCH SITE SVCES	3	.00	.00	.00	.00	.00	.00	.00	.00	.17	.00	.17	.17
92	TUG/SHTL MATING	3	.00	.00	.00	.00	.00	.00	.00	.00	.05	.00	.05	.05
93	PRELAUNCH C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.07	.00	.07	.07
94	COUNTDOWN	3	.00	.00	.00	.00	.00	.00	.00	.00	.09	.00	.09	.09
95	PRLNTS. & GASES	3	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.01	.01
96	POST FLT. SAFING	3	.00	.00	.00	.00	.00	.00	.00	.00	.07	.00	.07	.07
	TOTAL LAUNCH OPNS.		.00	.00	.00	.00	.00	.00	.00	.00	.46	.00	.46	.46
	TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.46	.00	.46	.46

12-85

OPTION 31 DOD 5 VEHICLES 9/12/73 6100 PM

WBS	COST ELEMENT	C	EDAD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
100	LAUNCH OPNS ETR	3												
101	LNCH SITE SVCES	3	.00	.00	.38	.38	.00	.00	.00	.00	1.70	.00	1.70	2.08
102	TUG/SHTL MATING	3	.00	.00	.11	.11	.00	.00	.00	.00	.52	.00	.52	.63
103	PRELAUNCH C/O	3	.00	.00	.13	.13	.00	.00	.00	.00	.64	.00	.64	.77
104	COUNTDOWN	3	.00	.00	.21	.21	.00	.00	.00	.00	.84	.00	.84	1.04
105	PRLNTS & GASES	3	.00	.00	.01	.01	.00	.00	.00	.00	.18	.00	.18	.19
106	POST FLT. SAFING	3	.00	.00	.17	.17	.00	.00	.00	.00	.69	.00	.69	.87
	TOTAL LAUNCH OPNS		.00	.00	1.01	1.01	.00	.00	.00	.00	4.57	.00	4.57	5.58
	TOTAL		.00	.00	1.01	1.01	.00	.00	.00	.00	4.57	.00	4.57	5.58

OPTION 31 DOD 5 VEHICLES 9/12/73 8100 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
110	FLIGHT OPNS NASA	3												
111	MISSION PLG.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
112	FLT. CONTROL	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
113	FLT. EVAL.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
114	FLT. SUPT. SFTWRE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	TOTAL FLIGHT OPNS		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

12-27

OPTION 31 DOD 3 VEHICLES 9/12/73 6100 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
120	FLIGHT OPNS DOD	3												
121	MISSION PLG	3	1.92	.00	.30	2.22	.00	.00	.00	.00	1.47	.00	1.47	3.69
122	FLT. CONTROL	3	.29	.00	.66	.95	.00	.00	.00	.00	5.15	.00	5.15	6.11
123	FLT. EVAL.	3	.00	.00	.22	.22	.00	.00	.00	.00	1.25	.00	1.25	1.47
124	FLT. SUPT. SFTWRE	3	1.99	.00	.00	1.99	.00	.00	.00	.00	.97	.00	.97	2.96
	TOTAL FLIGHT OPNS		4.20	.00	1.18	5.38	.00	.00	.00	.00	8.85	.00	8.85	14.23
	TOTAL		4.20	.00	1.18	5.38	.00	.00	.00	.00	8.85	.00	8.85	14.23

OPTION 31 000 5 VEHICLES 9/12/73 6100 PM

WBS	COST ELEMENT C	ED&D (MIL)	6TH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
130	REFURB &INTEG WTR3												
131	SCH MAINT & REF 3	.00	.00	.00	.00	.00	.00	.00	.00	.09	.00	.09	.09
132	UNSCH MAINT & REF3	.00	.00	.00	.00	.00	.00	.00	.00	.02	.00	.02	.02
133	POST MAINT C/O 3	.00	.00	.00	.00	.00	.00	.00	.00	.01	.00	.01	.01
134	TUG/PL MAING &/C03	.00	.00	.00	.00	.00	.00	.00	.00	.05	.00	.05	.05
135	REFURB RDMTS PLG 3	.11	.00	.00	.11	.00	.00	.00	.00	.02	.00	.02	.13
136	DEPOT MAINT 3	.00	.00	.00	.00	.00	.00	.00	.00	.41	.00	.41	.41
	TOTAL REFURB &INTE	.11	.00	.00	.11	.00	.00	.00	.00	.60	.00	.60	.71
	TOTAL	.11	.00	.00	.11	.00	.00	.00	.00	.60	.00	.60	.71

OPTION 31 DOD 5 VEHICLES 9/12/73 6100 PM

WBS	COST ELEMENT	C	EDBD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
140	REFURB &INTEG ETR3													
141	SCH MAINT & REF	3	.00	.00	.21	.21	.00	.00	.00	.00	.86	.00	.86	1.07
142	UNSCH MAINT & REF	3	.00	.00	.06	.06	.00	.00	.00	.00	.21	.00	.21	.27
143	POST MAINT C/O	3	.00	.00	.02	.02	.00	.00	.00	.00	.05	.00	.05	.06
144	TUG/PL MATING,C/O	3	.00	.00	.16	.16	.00	.00	.00	.00	.54	.00	.54	.69
145	REFURB RQMTS PLG	3	.11	.00	.05	.16	.00	.00	.00	.00	.24	.00	.24	.40
146	DEPOT MAINT	3	.00	.00	.44	.44	.00	.00	.00	.00	5.74	.00	5.74	6.18
	TOTAL REFURB &INTE		.11	.00	.93	1.04	.00	.00	.00	.00	7.64	.00	7.64	8.68
	TOTAL		.11	.00	.93	1.04	.00	.00	.00	.00	7.64	.00	7.64	8.68

12+30

OPTION 3FDOD 11 VEHICLES 9/13/73 5:15 PM

WBS	COST ELEMENT C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
10	TOTAL PROJECT MGMT	2.74	.00	.00	2.74	.00	4.60	.00	4.60	2.38	.00	2.38	9.72
20	TOTAL SYS. ENGR. &	7.05	.00	.00	7.05	.00	34.48	.00	34.48	7.13	.00	7.13	48.67
30	TOTAL VEH MAIN STA	43.67	5.37	.00	49.04	15.94	91.91	4.20	96.11	1.16	9.00	10.16	155.31
40	TOTAL VEH AUX. STA	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
50	TOTAL LOGISTICS	2.34	.00	.00	2.34	.00	.35	.00	.35	5.53	.00	5.53	8.22
60	TOTAL FACILITIES	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
70	TOTAL GRND. SUPT.	4.30	.00	.00	4.30	.00	1.52	.00	1.52	1.97	.00	1.97	7.80
80	TOTAL VEHICLE TEST	.00	12.95	18.04	31.00	.00	3.98	.00	3.98	.00	.00	.00	34.98
90	TOTAL LAUNCH OPNS.	.00	.00	.00	.00	.00	.00	.00	.00	4.97	.00	4.97	4.97
100	TOTAL LAUNCH OPNS	.00	.00	2.53	2.53	.00	.00	.00	.00	14.99	.00	14.99	17.51
110	TOTAL FLIGHT OPNS	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
120	TOTAL FLIGHT OPNS	3.18	.00	2.95	6.13	.00	.00	.00	.00	24.31	.00	24.31	30.45
130	TOTAL REFURB &INTE	.11	.00	.00	.11	.00	.00	.00	.00	4.51	.00	4.51	4.62
140	TOTAL REFURB &INTE	.11	.00	1.80	1.91	.00	.00	.00	.00	19.35	.00	19.35	21.26
	TOTAL	63.50	18.32	25.32	107.14	15.94	136.85	4.20	141.05	86.32	9.00	95.32	343.51

12+32

OPTION 3FDOD 11 VEHICLES 9/13/73 5:15 PM

WBS	COST ELEMENT	C	EDSD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
10	PROJECT MGMT.	3												
11	COST/PERF. MGMT.	3	1.88	.00	.00	1.88	.00	3.13	.00	3.13	1.57	.00	1.57	6.58
12	PROJ. DIRECTION	3	.81	.00	.00	.81	.00	1.37	.00	1.37	.75	.00	.75	2.92
13	INFORM. MGMT.	3	.05	.00	.00	.05	.00	.10	.00	.10	.07	.00	.07	.22
	TOTAL PROJECT MGMT		2.74	.00	.00	2.74	.00	4.60	.00	4.60	2.38	.00	2.38	9.72
	TOTAL		2.74	.00	.00	2.74	.00	4.60	.00	4.60	2.38	.00	2.38	9.72

12432

OPTION 3FDOD 11 VEHICLES 9/13/73 5:15 PM

WBS	COST ELEMENT	C	EDAD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
20	SYS. ENGR. & INT.3													
21	TUG SYS. ENGR.	3	5.64	.00	.00	5.64	.00	5.39	.00	5.39	.00	.00	.00	11.03
22	SHUTTLE I/F	3	.35	.00	.00	.35	.00	1.35	.00	1.35	.00	.00	.00	1.70
23	PAYLOAD I/F	3	1.06	.00	.00	1.06	.00	2.69	.00	2.69	.00	.00	.00	3.75
24	SUST. ENGR.	3	.00	.00	.00	.00	.00	25.05	.00	25.05	7.13	.00	7.13	32.19
	TOTAL SYS. ENGR. &		7.05	.00	.00	7.05	.00	34.48	.00	34.48	7.13	.00	7.13	48.67
	TOTAL		7.05	.00	.00	7.05	.00	34.48	.00	34.48	7.13	.00	7.13	48.67

OPTION 3FDOD 11 VEHICLES 9/13/73 5:15 PM

WBS	COST ELEMENT	C	EDSD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
30	VEH MAIN STAGE	3												
31	STRUCTURES	3	3.22	.59	.00	3.81	1.89	12.40	.00	12.40	.00	.07	.07	16.28
32	THERMAL CONTROL	3	.00	.05	.00	.05	.46	3.03	.00	3.03	.00	.09	.09	3.17
33	AVIONICS	3	20.83	2.54	.00	23.37	5.19	35.57	2.90	38.47	1.16	6.08	7.24	69.08
34	PROPULSION	3	16.38	1.79	.00	18.18	3.78	24.88	1.04	25.93	.00	2.16	2.16	46.26
35	ORBITER I/F	3	.00	.00	.00	.00	2.19	1.74	.25	1.99	.00	.59	.59	2.59
36	DROP TANKS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
37	FINAL ASSY & C/O	3	3.23	.40	.00	3.63	2.43	14.29	.00	14.29	.00	.00	.00	17.93
	TOTAL VEH MAIN STA		43.67	5.37	.00	49.04	15.94	91.91	4.20	96.11	1.16	9.00	10.16	155.31
	TOTAL		43.67	5.37	.00	49.04	15.94	91.91	4.20	96.11	1.16	9.00	10.16	155.31

LEVEL 6

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
3101	FUEL TK & SUPT	3	.00	.00	.00	.00	.45	2.99	.00	2.99	.00	.00	.00	2.99
3102	OXID. TK & SUPT	3	.00	.00	.00	.00	.18	1.23	.00	1.23	.00	.00	.00	1.23
3103	BODY STRUCTURE	3	.00	.00	.00	.00	.10	.63	.00	.63	.00	.00	.00	.63
3104	THRUST STRUCTURE	3	.00	.00	.00	.00	.06	.40	.00	.40	.00	.00	.00	.40
3105	METEOROID SHIELD	3	.00	.00	.00	.00	.41	2.74	.00	2.74	.00	.00	.00	2.74
3106	PAYLOAD I/F	3	2.98	.54	.00	3.53	.55	3.62	.00	3.62	.00	.00	.00	7.15
3107	INSTL. ASSY & C/O	3	.24	.04	.00	.28	.14	.78	.00	.78	.00	.00	.00	1.06
31	STRUCTURE		3.22	.59	.00	3.81	1.89	12.40	.00	12.40	.00	.00	.00	16.21
3201	FUEL TANK INSL	3	.00	.03	.00	.03	.10	.67	.00	.67	.00	.01	.01	.71
3202	OXID. TANK INSL.	3	.00	.01	.00	.01	.05	.33	.00	.33	.00	.00	.00	.35
3203	INSL. PURGE SYS.	3	.00	.00	.00	.00	.29	1.91	.00	1.91	.00	.08	.08	1.99
3204	THERM CONT. SYS.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
3205	INSTL ASSY & C/O	3	.00	.00	.00	.00	.02	.12	.00	.12	.00	.00	.00	.12
32	THERMAL CONTROL		.00	.05	.00	.05	.46	3.03	.00	3.03	.00	.09	.09	3.17
3301	DATA MGMT.	3	8.20	.37	.00	8.56	1.35	8.94	.28	9.22	1.16	.33	1.49	19.28
3302	G N & C	3	3.10	.54	.00	3.64	.78	5.21	.46	5.67	.00	.33	.33	9.65
3303	COMMUNICATIONS	3	.00	.00	.00	.00	1.65	10.96	.13	11.09	.00	2.75	2.75	13.84
3304	INSTRUMENTATION	3	.00	.00	.00	.00	.16	1.06	.00	1.07	.00	.03	.03	1.09
3305	ELECT. POWER	3	4.72	1.41	.00	6.14	.84	6.87	2.03	8.90	.00	2.65	2.65	17.68
3306	PWR. DIST. & CONT	3	.00	.03	.00	.03	.03	.25	.00	.25	.00	.00	.00	.28
3307	INSTL. ASSY & C/O	3	4.81	.19	.00	4.99	.38	2.27	.00	2.27	.00	.00	.00	7.27
33	AVIONICS		20.83	2.54	.00	23.37	5.19	35.57	2.90	38.47	1.16	6.08	7.24	69.08
3401	MAIN ENGINE	3	.00	.00	.00	.00	.63	4.18	1.04	5.22	.00	.96	.96	6.19
3402	MAIN ENG. SUPT	3	5.23	.54	.00	5.77	1.80	11.94	.00	11.94	.00	.56	.56	18.27
3403	ACPS ENGINE	3	.76	.16	.00	.92	.16	1.06	.00	1.06	.00	.09	.09	2.07
3404	ACPS ENG. SUPT	3	9.62	1.01	.00	10.63	1.01	6.69	.00	6.69	.00	.55	.55	17.87
3405	INSTL. ASSY & C/O	3	.78	.09	.00	.87	.18	1.00	.00	1.00	.00	.00	.00	1.87
34	PROPULSION		16.38	1.79	.00	18.18	3.78	24.88	1.04	25.93	.00	2.16	2.16	46.26
3501	STRUCTURES	3	.00	.00	.00	.00	.34	.27	.01	.29	.00	.03	.03	.32
3502	I/F PANELS	3	.00	.00	.00	.00	1.41	1.13	.23	1.36	.00	.54	.54	1.90
3503	PURGE PROV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
3504	ABORT PROV.	3	.00	.00	.00	.00	.27	.21	.01	.22	.00	.02	.02	.24
3505	INSTL. ASSY & C/O	3	.00	.00	.00	.00	.16	.12	.00	.12	.00	.00	.00	.12
35	ORBITER I/F		.00	.00	.00	.00	2.19	1.74	.25	1.99	.00	.59	.59	2.59

12+35

LEVEL 6

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
3701	FINAL ASSY	3	2.02	.25	.00	2.27	2.03	11.91	.00	11.91	.00	.00	.00	14.18
3702	C/O	3	1.21	.15	.00	1.36	.41	2.38	.00	2.38	.00	.00	.00	3.74
37	FINAL ASSY & C/O		3.23	.40	.00	3.63	2.43	14.29	.00	14.29	.00	.00	.00	17.93

LEVEL 7

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
310102	LH2 CYLINDER	3	.00	.00	.00	.00	.08	.00	.00	.00	.00	.00	.00	.00
310103	LH2 SUPPORTS	3	.00	.00	.00	.00	.30	.00	.00	.00	.00	.00	.00	.00
3101	FUEL TK & SUPT		.00	.00	.00	.00	.45	.00	.00	.00	.00	.00	.00	.00
310201	LO2 DOMES	3	.00	.00	.00	.00	.07	.00	.00	.00	.00	.00	.00	.00
310202	LO2 SUPPORTS	3	.00	.00	.00	.00	.11	.00	.00	.00	.00	.00	.00	.00
3102	OXID. TK & SUPT		.00	.00	.00	.00	.18	.00	.00	.00	.00	.00	.00	.00
310301	F&D AFT SKIRT	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
310302	INTERTANK	3	.00	.00	.00	.00	.05	.00	.00	.00	.00	.00	.00	.00
310303	SDWL SHELL	3	.00	.00	.00	.00	.05	.00	.00	.00	.00	.00	.00	.00
3103	BODY STRUCTURE		.00	.00	.00	.00	.10	.00	.00	.00	.00	.00	.00	.00
330101	SCU		4.00	.34	.00	4.33	1.13	.00	.00	.00	.00	.00	.00	4.33
330102	DATA DISTR.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330103	EQ. THERM CONT.	3	.00	.00	.00	.00	.10	.00	.00	.00	.00	.00	.00	.00
330104	CIRCUITRY	3	.00	.00	.00	.00	.02	.00	.00	.00	.00	.00	.00	.00
330105	SOFTWARE	3	3.60	.00	.00	3.60	.00	.00	.00	.00	1.16	.00	1.16	4.76
330106	SOFTWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330107	SOFTWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330108	INSTL, ASSY & C/O3		.61	.03	.00	.63	.10	.00	.00	.00	.00	.00	.00	.63
3301	DATA MGMT.		8.20	.37	.00	8.56	1.35	.00	.00	.00	1.16	.00	1.16	9.72
330201	I M U	3	2.44	.34	.00	2.78	.34	.00	.00	.00	.00	.00	.00	2.78
330202	TRACKING/ELECT	3	.00	.00	.00	.00	.29	.00	.00	.00	.00	.00	.00	.00
330203	REN DEZ&DOCKING	3	.43	.17	.00	.60	.10	.00	.00	.00	.00	.00	.00	.60
330204	INSTL, ASSY & C/O3		.23	.04	.00	.27	.06	.00	.00	.00	.00	.00	.00	.27
3302	G N & C		3.10	.54	.00	3.64	.78	.00	.00	.00	.00	.00	.00	3.64
330301	M/W CIRC +RF MUX	3	.00	.00	.00	.00	.56	.00	.00	.00	.00	.00	.00	.00
330302	TRANSPONDERS	3	.00	.00	.00	.00	.38	.00	.00	.00	.00	.00	.00	.00
330303	POWER AMP.	3	.00	.00	.00	.00	.16	.00	.00	.00	.00	.00	.00	.00
330304	ANTENNA	3	.00	.00	.00	.00	.08	.00	.00	.00	.00	.00	.00	.00
330305	DEC/ENC+MOD/DEM	3	.00	.00	.00	.00	.34	.00	.00	.00	.00	.00	.00	.00
330306	TAPE RECORDER	3	.00	.00	.00	.00	.13	.00	.00	.00	.00	.00	.00	.00
330307	P/L INTER EQUIP	3	.00	.00	.00	.00	.07	.00	.00	.00	.00	.00	.00	.00
330308	INSTL, ASSY & C/O3		.00	.00	.00	.00	.12	.00	.00	.00	.00	.00	.00	.00
3303	COMMUNICATIONS		.00	.00	.00	.00	1.65	.00	.00	.00	.00	.00	.00	.00

LEVEL 7

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
330401	DATA SENSORS	3	.00	.00	.00	.00	.04	.00	.00	.00	.00	.00	.00	.00
330402	SIGNAL CONU.	3	.00	.00	.00	.00	.04	.00	.00	.00	.00	.00	.00	.00
330403	CIRCUITRY	3	.00	.00	.00	.00	.08	.00	.00	.00	.00	.00	.00	.00
330404	INSTL. ASSY & C/03		.00	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00
3304	INSTRUMENTATION		.00	.00	.00	.00	.16	.00	.00	.00	.00	.00	.00	.00
330501	BATTERY	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330502	FUEL CELL	3	4.37	1.31	.00	5.68	.77	.00	.00	.00	.00	.00	.00	5.68
330503	INSTL. ASSY & C/03		.35	.10	.00	.45	.06	.00	.00	.00	.00	.00	.00	.45
3305	ELECT. POWER		4.72	1.41	.00	6.14	.84	.00	.00	.00	.00	.00	.00	6.14
330601	DISTR.	3	.00	.03	.00	.03	.03	.00	.00	.00	.00	.00	.00	.03
330602	TANKS SYSTEM	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330603	INSTL. ASSY & C/O		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
3306	PWR. DIST. & CONT		.00	.03	.00	.03	.03	.00	.00	.00	.00	.00	.00	.03

OPTION 3FDOD 11 VEHICLES 9/13/73 5:15 PM

WBS	COST ELEMENT	C	ED&D (MIL)	BTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
40	VEH AUX. STAGE	3												
41	VEH AUX. STAGE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	TOTAL VEH AUX. STA		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

OPTION 3FDOU 11 VEHICLES 9/13/73 5:15 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
50	LOGISTICS	3												
51	TRANSP. & HDLG.	3	.00	.00	.00	.00	.00	.35	.00	.35	.23	.00	.23	.58
52	TRAINING	3	1.18	.00	.00	1.18	.00	.00	.00	.00	1.18	.00	1.18	2.37
53	INV CONT. & WHSNG	3	1.16	.00	.00	1.16	.00	.00	.00	.00	4.11	.00	4.11	5.27
	TOTAL LOGISTICS		2.34	.00	.00	2.34	.00	.35	.00	.35	5.53	.00	5.53	8.22
	TOTAL		2.34	.00	.00	2.34	.00	.35	.00	.35	5.53	.00	5.53	8.22

LEVEL 6

WBS	COST ELEMENT	C	ED&D (MIL)	6TH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
5201	SIM. & EQUIP.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
5202	GROUND CREW	3	1.18	.00	.00	1.18	.00	.00	.00	.00	1.18	.00	1.18	2.37
52	TRAINING		1.18	.00	.00	1.18	.00	.00	.00	.00	1.18	.00	1.18	2.37

OPTION 3FD00 11 VEHICLES 9/13/73 5:15 PM

#85	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
60	FACILITIES	3												
61	MANUFACTURING	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
62	TEST	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
63	ETR MAINT. & REF.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
64	ETR LAUNCH	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
65	WTR MAINT. & REF.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
66	WTR LAUNCH	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	TOTAL FACILITIES		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

12+42

LEVEL 6

WBS	COST ELEMENT	C	EDBD (MIL)	BTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
6101	DES./CONST.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6102	ACTIV./MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
61	MANUFACTURING		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6201	DES./CONST.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6202	ACTIV./MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
62	TEST		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6301	DES./CONST.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6302	ACTIV./MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
63	ETR MAINT. & REF.		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6401	DES./CONST.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6402	ACTIV./MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
64	ETR LAUNCH		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6501	DES./CONST.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6502	ACTIV./MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
65	WTR MAINT. & REF.		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6601	DES./CONST.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
6602	ACTIV./MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
66	WTR LAUNCH		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

OPTION 3FDOO II VEHICLES 9/13/73 5:15 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
70	GRND. SUPT. EQUIPS													
71	MFG. GSE	3	1.94	.00	.00	1.94	.00	1.52	.00	1.52	.00	.00	.00	3.46
72	ETH GSE	3	.94	.00	.00	.94	.00	.00	.00	.00	.65	.00	.65	1.59
73	WTH GSE	3	.95	.00	.00	.95	.00	.00	.00	.00	.24	.00	.24	1.18
74	FLT OPS GSE(NASA)		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
75	FLT OPS GSE(DOO)		.47	.00	.00	.47	.00	.00	.00	.00	1.09	.00	1.09	1.56
	TOTAL GRND. SUPT.		4.30	.00	.00	4.30	.00	1.52	.00	1.52	1.97	.00	1.97	7.80
	TOTAL		4.30	.00	.00	4.30	.00	1.52	.00	1.52	1.97	.00	1.97	7.80

LEVEL 6

WBS	COST ELEMENT	C	EUSD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
7101	HARDWARE	3	1.69	.00	.00	1.69	.00	.00	.00	.00	.00	.00	.00	1.69
7102	SITE ACTIV.	3	.03	.00	.00	.03	.00	.00	.00	.00	.00	.00	.00	.03
7103	MAINT.	3	.00	.00	.00	.00	.00	1.52	.00	1.52	.00	.00	.00	1.52
7104	SOFTWARE	3	.21	.00	.00	.21	.00	.00	.00	.00	.00	.00	.00	.21
71	MFG. GSE		1.94	.00	.00	1.94	.00	1.52	.00	1.52	.00	.00	.00	3.46
7201	HARDWARE	3	.60	.00	.00	.60	.00	.00	.00	.00	.00	.00	.00	.60
7202	SITE ACTIV.	3	.20	.00	.00	.20	.00	.00	.00	.00	.00	.00	.00	.20
7203	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.15	.00	.15	.15
7204	SOFTWARE	3	.14	.00	.00	.14	.00	.00	.00	.00	.49	.00	.49	.64
72	ETR GSE		.94	.00	.00	.94	.00	.00	.00	.00	.65	.00	.65	1.59
7301	HARDWARE	3	.61	.00	.00	.61	.00	.00	.00	.00	.00	.00	.00	.61
7302	SITE ACTIV.	3	.20	.00	.00	.20	.00	.00	.00	.00	.00	.00	.00	.20
7303	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.15	.00	.15	.15
7304	SOFTWARE	3	.14	.00	.00	.14	.00	.00	.00	.00	.08	.00	.08	.22
73	WTR GSE		.95	.00	.00	.95	.00	.00	.00	.00	.24	.00	.24	1.18
7401	HARDWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7402	SITE ACTIV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7403	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7404	SOFTWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
74	HARDWA(S) SUBTOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7501	HARDWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7502	SITE ACTIV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7503	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7504	SOFTWARE	3	.47	.00	.00	.47	.00	.00	.00	.00	1.09	.00	1.09	1.56
75	HARDWA(S) SUBTOTAL		.47	.00	.00	.47	.00	.00	.00	.00	1.09	.00	1.09	1.56

OPTION 3FDOD 11 VEHICLES 9/13/73 5:15 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
80	VEHICLE TEST	3												
81	GND TEST HDWE.	3	.00	7.97	.00	7.97	.00	.00	.00	.00	.00	.00	.00	7.97
82	GND TEST OPNS.	3	.00	4.98	.00	4.98	.00	.00	.00	.00	.00	.00	.00	4.98
83	FLT. TEST HDWE.	3	.00	.00	15.94	15.94	.00	3.98	.00	3.98	.00	.00	.00	19.92
84	FLT. TEST OPNS	3	.00	.00	2.11	2.11	.00	.00	.00	.00	.00	.00	.00	2.11
	TOTAL VEHICLE TEST		.00	12.95	18.04	31.00	.00	3.98	.00	3.98	.00	.00	.00	34.98
	TOTAL		.00	12.95	18.04	31.00	.00	3.98	.00	3.98	.00	.00	.00	34.98

LEVEL 6

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
8101	PTV TEST	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8102	MAJOR TEST ART.	3	.00	7.62	.00	7.62	.00	.00	.00	.00	.00	.00	.00	7.62
8103	MOCKUPS	3	.00	.35	.00	.35	.00	.00	.00	.00	.00	.00	.00	.35
81	GND TEST HDWE.		.00	7.97	.00	7.97	.00	.00	.00	.00	.00	.00	.00	7.97
8301	STRUCTURES	3	.00	.00	1.89	1.89	.00	.00	.00	.00	.00	.00	.00	1.89
8302	THERMAL CONTROL	3	.00	.00	.46	.46	.00	.00	.00	.00	.00	.00	.00	.46
8303	AVIONICS	3	.00	.00	5.19	5.19	.00	.00	.00	.00	.00	.00	.00	5.19
8304	PROPULSION	3	.00	.00	3.78	3.78	.00	.00	.00	.00	.00	.00	.00	3.78
8305	ORBITER I/F	3	.00	.00	2.19	2.19	.00	.00	.00	.00	.00	.00	.00	2.19
8306	DROP TANKS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8307	FINAL ASSY & C/O	3	.00	.00	2.43	2.43	.00	.00	.00	.00	.00	.00	.00	2.43
83	FLT. TEST HDWE.		.00	.00	15.94	15.94	.00	.00	.00	.00	.00	.00	.00	15.94

LEVEL 7

WBS	COST ELEMENT	C	EDAD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
830102	OXID. TK & SUPT.	3	.00	.00	.18	.18	.00	.00	.00	.00	.00	.00	.00	.18
830103	BODY STRUCTURE	3	.00	.00	.10	.10	.00	.00	.00	.00	.00	.00	.00	.10
830104	THRUST STRUCTURE		.00	.00	.06	.06	.00	.00	.00	.00	.00	.00	.00	.06
830105	METEOROID SHIELD	3	.00	.00	.41	.41	.00	.00	.00	.00	.00	.00	.00	.41
830106	PAYLOAD I/F	3	.00	.00	.55	.55	.00	.00	.00	.00	.00	.00	.00	.55
830107	INSTL, ASSY & C/O3		.00	.00	.14	.14	.00	.00	.00	.00	.00	.00	.00	.14
8301	STRUCTURES		.00	.00	1.89	1.89	.00	.00	.00	.00	.00	.00	.00	1.89
830201	FUEL TANK INSL	3	.00	.00	.10	.10	.00	.00	.00	.00	.00	.00	.00	.10
830202	OXID TANK INSL	3	.00	.00	.05	.05	.00	.00	.00	.00	.00	.00	.00	.05
830203	INSL PURGE SYS	3	.00	.00	.29	.29	.00	.00	.00	.00	.00	.00	.00	.29
830204	THERM CONT SYS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830205	INSTL, ASSY & C/O3		.00	.00	.02	.02	.00	.00	.00	.00	.00	.00	.00	.02
8302	THERMAL CONTROL		.00	.00	.46	.46	.00	.00	.00	.00	.00	.00	.00	.46
830301	DATA MGMT.	3	.00	.00	1.35	1.35	.00	.00	.00	.00	.00	.00	.00	1.35
830302	G N & C	3	.00	.00	.78	.78	.00	.00	.00	.00	.00	.00	.00	.78
830303	COMMUNICATIONS	3	.00	.00	1.65	1.65	.00	.00	.00	.00	.00	.00	.00	1.65
830304	INSTRUMENTATION	3	.00	.00	.16	.16	.00	.00	.00	.00	.00	.00	.00	.16
830305	ELECT. POWER	3	.00	.00	.84	.84	.00	.00	.00	.00	.00	.00	.00	.84
830306	PWR DIST. & CONT	3	.00	.00	.03	.03	.00	.00	.00	.00	.00	.00	.00	.03
830307	INSTL, ASSY & C/O3		.00	.00	.38	.38	.00	.00	.00	.00	.00	.00	.00	.38
8303	AVIONICS		.00	.00	5.19	5.19	.00	.00	.00	.00	.00	.00	.00	5.19
830401	MAIN ENGINE	3	.00	.00	.63	.63	.00	.00	.00	.00	.00	.00	.00	.63
830402	MAIN ENG SUPT.	3	.00	.00	1.80	1.80	.00	.00	.00	.00	.00	.00	.00	1.80
830403	ACPS ENGINE	3	.00	.00	.16	.16	.00	.00	.00	.00	.00	.00	.00	.16
830404	ACPS ENG SUPT	3	.00	.00	1.01	1.01	.00	.00	.00	.00	.00	.00	.00	1.01
830405	INSTL, ASSY & C/O3		.00	.00	.18	.18	.00	.00	.00	.00	.00	.00	.00	.18
8304	PROPULSION		.00	.00	3.78	3.78	.00	.00	.00	.00	.00	.00	.00	3.78
830501	STRUCTURES	3	.00	.00	.34	.34	.00	.00	.00	.00	.00	.00	.00	.34
830502	I/F PANELS	3	.00	.00	1.41	1.41	.00	.00	.00	.00	.00	.00	.00	1.41
830503	PURGE PROV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830504	ABORT PROV.	3	.00	.00	.27	.27	.00	.00	.00	.00	.00	.00	.00	.27
830505	INSTL, ASSY & C/O3		.00	.00	.16	.16	.00	.00	.00	.00	.00	.00	.00	.16
8305	ORBITER I/F		.00	.00	2.19	2.19	.00	.00	.00	.00	.00	.00	.00	2.19

LEVEL 7

WBS	COST ELEMENT	C	EDBD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
830701	FINAL ASSY	3	.00	.00	2.03	2.03	.00	.00	.00	.00	.00	.00	.00	2.03
830702	C/O	3	.00	.00	.41	.41	.00	.00	.00	.00	.00	.00	.00	.41
8307	FINAL ASSY & C/O		.00	.00	2.43	2.43	.00	.00	.00	.00	.00	.00	.00	2.43

OPTION 3FDOD II VEHICLES 9/13/73 5:15 PM

WBS	COST ELEMENT	C	EDBD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
90	LAUNCH OPNS. #TR	3												
91	LNCH SITE SVCES	3	.00	.00	.00	.00	.00	.00	.00	.00	1.85	.00	1.85	1.85
92	TUG/SHTL MATING	3	.00	.00	.00	.00	.00	.00	.00	.00	.58	.00	.58	.58
93	PRELAUNCH C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.66	.00	.66	.66
94	COUNTDOWN	3	.00	.00	.00	.00	.00	.00	.00	.00	1.04	.00	1.04	1.04
95	PRLNTS. & GASES	3	.00	.00	.00	.00	.00	.00	.00	.00	.11	.00	.11	.11
96	POST FLT. SAFING	3	.00	.00	.00	.00	.00	.00	.00	.00	.73	.00	.73	.73
	TOTAL LAUNCH OPNS.		.00	.00	.00	.00	.00	.00	.00	.00	4.97	.00	4.97	4.97
	TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	4.97	.00	4.97	4.97

OPTION 3FDOD 11 VEHICLES 9/13/73 5:15 PM

WBS	COST ELEMENT	C	EDAO (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
100	LAUNCH OPNS ETR	3												
101	LNCH SITE SVCES	3	.00	.00	.95	.95	.00	.00	.00	.00	5.44	.00	5.44	6.38
102	TUG/SHTL MATING	3	.00	.00	.28	.28	.00	.00	.00	.00	1.56	.00	1.56	1.84
103	PRELAUNCH C/O	3	.00	.00	.32	.32	.00	.00	.00	.00	1.90	.00	1.90	2.22
104	COUNTDOWN	3	.00	.00	.52	.52	.00	.00	.00	.00	3.15	.00	3.15	3.66
105	PRLNTS & GASES	3	.00	.00	.03	.03	.00	.00	.00	.00	.63	.00	.63	.66
106	POST FLT. SAFING	3	.00	.00	.44	.44	.00	.00	.00	.00	2.31	.00	2.31	2.74
	TOTAL LAUNCH OPNS		.00	.00	2.53	2.53	.00	.00	.00	.00	14.99	.00	14.99	17.51
	TOTAL		.00	.00	2.53	2.53	.00	.00	.00	.00	14.99	.00	14.99	17.51

12.5/

OPTION 3FDOD 11 VEHICLES 9/13/73 5:15 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
110	FLIGHT OPNS NASA	3												
111	MISSION PLG.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
112	FLT. CONTROL	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
113	FLT. EVAL.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
114	FLT. SUPT. SFTWRE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	TOTAL FLIGHT OPNS		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

12-52

OPTION 3FDOD 11 VEHICLES 9/13/73 5:15 PM

WBS	COST ELEMENT	C	EDRD (MIL)	BTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
1.20	FLIGHT OPNS OOD	3												
1.21	MISSION PLG	3	2.82	.00	.75	3.57	.00	.00	.00	.00	5.73	.00	5.73	9.30
1.22	FLT. CONTROL	3	.19	.00	1.65	1.85	.00	.00	.00	.00	9.51	.00	9.51	11.36
1.23	FLT. EVAL.	3	.00	.00	.54	.54	.00	.00	.00	.00	6.43	.00	6.43	6.97
1.24	FLT. SUPT. SFTWRE	3	.16	.00	.00	.16	.00	.00	.00	.00	2.64	.00	2.64	2.81
	TOTAL FLIGHT OPNS		3.18	.00	2.95	6.13	.00	.00	.00	.00	24.31	.00	24.31	30.45
	TOTAL		3.18	.00	2.95	6.13	.00	.00	.00	.00	24.31	.00	24.31	30.45

12-53

OPTION 3FDOO 11 VEHICLES 9/13/73 5:15 PM

WBS	COST ELEMENT	C	EDGO (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
130	REFURB &INTEG WTR	3												
131	SCH MAINT & REF	3	.00	.00	.00	.00	.00	.00	.00	.00	1.09	.00	1.09	1.09
132	UNSCH MAINT & REF	3	.00	.00	.00	.00	.00	.00	.00	.00	.22	.00	.22	.22
133	POST MAINT C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.05	.00	.05	.05
134	TUG/PL MAING &/CO	3	.00	.00	.00	.00	.00	.00	.00	.00	.76	.00	.76	.76
135	REFURB RQMTS PLG	3	.11	.00	.00	.11	.00	.00	.00	.00	.26	.00	.26	.37
136	DEPOT MAINT	3	.00	.00	.00	.00	.00	.00	.00	.00	2.13	.00	2.13	2.13
	TOTAL REFURB &INTE		.11	.00	.00	.11	.00	.00	.00	.00	4.51	.00	4.51	4.62
	TOTAL		.11	.00	.00	.11	.00	.00	.00	.00	4.51	.00	4.51	4.62

12-54

OPTION 3FDOD 11 VEHICLES 9/13/73 5:15 PM

WBS	COST ELEMENT C	EDGD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
140	REFURB &INTEG ETR3												
141	SCH MAINT & REF 3	.00	.00	.52	.52	.00	.00	.00	.00	3.17	.00	3.17	3.68
142	UNSCH MAINT & REF3	.00	.00	.16	.16	.00	.00	.00	.00	.61	.00	.61	.77
143	POST MAINT C/O 3	.00	.00	.04	.04	.00	.00	.00	.00	.16	.00	.16	.20
144	TUG/PL MATING,C/O3	.00	.00	.39	.39	.00	.00	.00	.00	2.24	.00	2.24	2.63
145	REFURB RQMTS PLG 3	.11	.00	.12	.23	.00	.00	.00	.00	.75	.00	.75	.98
146	DEPOT MAINT 3	.00	.00	.57	.57	.00	.00	.00	.00	12.42	.00	12.42	12.99
	TOTAL REFURB &INTE	.11	.00	1.80	1.91	.00	.00	.00	.00	19.35	.00	19.35	21.26
	TOTAL	.11	.00	1.80	1.91	.00	.00	.00	.00	19.35	.00	19.35	21.26

12-55

OPTION 3 TOTAL PROGRAM DOD 16 VEHICLES 9/13/73 7:00 PM

WBS	COST ELEMENT C	EO&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
10	TOTAL PROJECT MGMT	9.28	.00	.00	9.28	.00	6.63	.00	6.53	3.16	.00	3.16	19.07
20	TOTAL SYS. ENGR. &	21.55	.00	.00	21.55	.00	55.35	.00	55.35	10.45	.00	10.45	87.35
30	TOTAL VEH MAIN STA	133.46	16.12	.00	149.58	29.41	130.15	6.60	136.75	1.46	16.00	17.46	303.79
40	TOTAL VEH AUX. STA	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
50	TOTAL LOGISTICS	4.01	.00	.00	4.01	.00	.50	.00	.50	8.04	.00	8.04	12.55
60	TOTAL FACILITIES	5.17	.00	.00	5.17	.00	.44	.00	.44	1.21	.00	1.21	6.81
70	TOTAL GRND. SUPT.	31.47	.00	.00	31.47	.00	2.72	.00	2.72	6.92	.00	6.92	41.12
80	TOTAL VEHICLE TEST	.00	32.60	34.57	67.17	.00	7.35	.00	7.35	.00	.00	.00	74.52
90	TOTAL LAUNCH OPNS.	.00	.00	.00	.00	.00	.00	.00	.00	5.43	.00	5.43	5.43
100	TOTAL LAUNCH OPNS	.00	.00	3.54	3.54	.00	.00	.00	.00	19.56	.00	19.56	23.09
110	TOTAL FLIGHT OPNS	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
120	TOTAL FLIGHT OPNS	7.38	.00	4.13	11.51	.00	.00	.00	.00	33.16	.00	33.16	44.67
130	TOTAL REFURB &INTE	.22	.00	.00	.22	.00	.00	.00	.00	5.11	.00	5.11	5.33
140	TOTAL REFURB &INTE	.22	.00	2.73	2.95	.00	.00	.00	.00	26.99	.00	26.99	29.94
	TOTAL	212.76	48.72	44.97	306.44	29.41	203.15	6.60	209.75	121.49	16.00	137.49	653.68

12.56

OPTION 3 TOTAL PROGRAM DOD 16 VEHICLES 9/13/73 7:00 PM

WBS	COST ELEMENT	C	ED&D (MIL)	6TH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
10	PROJECT MGMT.	3												
11	COST/PERF. MGMT.	3	6.37	.00	.00	6.37	.00	4.52	.00	4.52	2.08	.00	2.08	12.96
12	PROJ. DIRECTION	3	2.73	.00	.00	2.73	.00	1.98	.00	1.98	.99	.00	.99	5.70
13	INFORM. MGMT.	3	.18	.00	.00	.18	.00	.14	.00	.14	.09	.00	.09	.41
	TOTAL PROJECT MGMT		9.28	.00	.00	9.28	.00	6.63	.00	6.63	3.16	.00	3.16	19.07
	TOTAL		9.28	.00	.00	9.28	.00	6.63	.00	6.63	3.16	.00	3.16	19.07

12-57

OPTION 3 TOTAL PROGRAM DOD 16 VEHICLES 9/13/73 7100 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
20	SYS. ENGR. & INT.	3												
21	TUG SYS. ENGR.	3	17.24	.00	.00	17.24	.00	7.63	.00	7.63	.00	.00	.00	24.87
22	SHUTTLE I/F	3	1.08	.00	.00	1.08	.00	1.91	.00	1.91	.00	.00	.00	2.99
23	PAYLOAD I/F	3	3.23	.00	.00	3.23	.00	3.81	.00	3.81	.00	.00	.00	7.04
24	SUST. ENGR.	3	.00	.00	.00	.00	.00	41.99	.00	41.99	10.45	.00	10.45	52.44
	TOTAL SYS. ENGR. &		21.55	.00	.00	21.55	.00	55.35	.00	55.35	10.45	.00	10.45	87.35
	TOTAL		21.55	.00	.00	21.55	.00	55.35	.00	55.35	10.45	.00	10.45	87.35

OPTION 3 TOTAL PROGRAM DOD 16 VEHICLES 9/13/73 7:00 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
30	VEH MAIN STAGE	3												
31	STRUCTURES	3	20.93	1.23	.00	22.15	3.53	17.14	.00	17.14	.00	.27	.27	39.56
32	THERMAL CONTROL	3	.93	.29	.00	1.22	.92	4.36	.00	4.36	.00	.15	.15	5.73
33	AVIONICS	3	43.06	5.54	.00	48.62	9.32	47.52	3.41	50.92	1.45	9.79	11.25	110.40
34	PROPULSION	3	44.73	5.68	.00	50.41	6.79	33.61	2.71	36.32	.00	4.66	4.66	91.40
35	ORBITER I/F	3	10.29	2.19	.00	12.47	4.37	8.05	.48	8.52	.00	1.12	1.12	22.12
36	DROP TANKS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
37	FINAL ASSY & C/O	3	13.50	1.19	.00	14.70	4.49	19.49	.00	19.49	.00	.00	.00	34.18
	TOTAL VEH MAIN STA		133.46	16.12	.00	149.58	29.41	130.15	6.60	136.75	1.46	16.00	17.46	303.79
	TOTAL		133.46	16.12	.00	149.58	29.41	130.15	6.60	136.75	1.46	16.00	17.46	303.79

12-58

LEVEL 6

WBS	COST ELEMENT	C	EDRD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DUT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPHS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPHS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
3101	FUEL TK & SUPT	3	4.85	.00	.00	4.85	.90	4.31	.00	4.31	.00	.00	.00	9.16
3102	OXID. TK & SUPT	3	2.62	.00	.00	2.62	.37	1.76	.00	1.76	.00	.00	.00	4.35
3103	BODY STRUCTURE	3	4.09	.00	.00	4.09	.19	.91	.00	.91	.00	.00	.00	5.00
3104	THRUST STRUCTURE	3	1.38	.00	.00	1.38	.12	.58	.00	.58	.00	.00	.00	1.96
3105	METEOROID SHIELD	3	.98	.00	.00	.98	.83	3.95	.00	3.95	.00	.00	.00	4.93
3106	PAYLOAD I/F	3	5.45	1.14	.00	6.58	.86	4.54	.00	4.54	.00	.00	.00	11.12
3107	INSTL. ASSY & C/O	3	1.55	.09	.00	1.64	.26	1.09	.00	1.09	.00	.00	.00	2.73
31	STRUCTURE		20.93	1.23	.00	22.15	3.53	17.14	.00	17.14	.00	.00	.00	39.29
3201	FUEL TANK INSL	3	.16	.03	.00	.19	.20	.96	.00	.96	.00	.02	.02	1.18
3202	OXID. TANK INSL.	3	.08	.01	.00	.10	.10	.47	.00	.47	.00	.02	.02	.59
3203	INSL. PURGE SYS.	3	.64	.23	.00	.87	.57	2.74	.00	2.74	.00	.11	.11	3.73
3204	THERM CONT. SYS.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
3205	INSTL ASSY & C/O	3	.04	.01	.00	.06	.04	.18	.00	.18	.00	.00	.00	.24
32	THERMAL CONTROL		.93	.29	.00	1.22	.92	4.36	.00	4.36	.00	.15	.15	5.73
3301	DATA MGMT.	3	16.61	1.57	.00	18.18	2.27	11.63	.46	12.09	1.46	.66	2.12	32.38
3302	G N & C	3	4.57	.54	.00	5.11	1.79	8.15	.48	8.63	.00	.37	.37	14.12
3303	COMMUNICATIONS	3	4.26	1.46	.00	5.72	3.30	15.78	.37	16.14	.00	3.31	3.31	25.18
3304	INSTRUMENTATION	3	2.04	.04	.00	2.08	.32	1.53	.00	1.53	.00	.22	.22	3.83
3305	ELECT. POWER	3	4.81	1.46	.00	6.27	.88	7.02	2.11	9.13	.00	5.23	5.23	20.63
3306	PWR. DIST. & CONTS		.85	.06	.00	.91	.06	.35	.00	.35	.00	.01	.01	1.27
3307	INSTL. ASSY & C/O	3	9.94	.41	.00	10.35	.69	3.05	.00	3.05	.00	.00	.00	13.40
33	AVIONICS		43.08	5.54	.00	48.62	9.32	47.52	3.41	50.92	1.46	9.79	11.25	110.80
3401	MAIN ENGINE	3	13.00	.00	.00	13.00	1.26	6.02	2.17	8.19	.00	2.41	2.41	23.60
3402	MAIN ENG. SUPT	3	14.06	3.47	.00	17.52	3.26	16.21	.00	16.21	.00	.98	.98	34.72
3403	ACPS ENGINE	3	1.04	.27	.00	1.31	.27	1.38	.54	1.92	.00	.64	.64	3.87
3404	ACPS ENG. SUPT	3	14.50	1.67	.00	16.17	1.67	8.63	.00	8.63	.00	.64	.64	25.45
3405	INSTL. ASSY & C/O	3	2.13	.27	.00	2.40	.38	1.37	.00	1.37	.00	.00	.00	3.77
34	PROPULSION		44.73	5.68	.00	50.41	6.79	33.61	2.71	36.32	.00	4.66	4.66	91.40
3501	STRUCTURES	3	3.65	.34	.00	3.99	.69	1.27	.03	1.30	.00	.06	.06	5.35
3502	I/F PANELS	3	4.99	1.41	.00	6.40	2.83	5.25	.44	5.68	.00	1.02	1.02	13.11
3503	PURGE PROV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
3504	ABORT PROV.	3	.89	.27	.00	1.15	.54	1.00	.02	1.01	.00	.04	.04	2.20
3505	INSTL. ASSY & C/O	3	.76	.16	.00	.92	.32	.53	.00	.53	.00	.00	.00	1.45
35	ORBITER I/F		10.29	2.19	.00	12.47	4.37	8.05	.48	8.52	.00	1.12	1.12	22.12

LEVEL 6

WBS	COST ELEMENT	C	EDAD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL ODT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
3701	FINAL ASSY	3	9.90	.75	.00	10.65	3.74	16.24	.00	16.24	.00	.00	.00	26.89
3702	C/O	3	3.60	.45	.00	4.05	.75	3.25	.00	3.25	.00	.00	.00	7.29
37	FINAL ASSY & C/O		13.50	1.19	.00	14.70	4.49	19.49	.00	19.49	.00	.00	.00	34.18

12-61

LEVEL 7

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
310101	LH2 DOMES	3	1.70	.00	.00	1.70	.15	.00	.00	.00	.00	.00	.00	1.70
310102	LH2 CYLINDER	3	2.24	.00	.00	2.24	.16	.00	.00	.00	.00	.00	.00	2.24
310103	LH2 SUPPORTS	3	.91	.00	.00	.91	.59	.00	.00	.00	.00	.00	.00	.91
3101	FUEL TK & SUPT		4.85	.00	.00	4.85	.90	.00	.00	.00	.00	.00	.00	4.85
310201	LO2 DOMES	3	1.99	.00	.00	1.99	.14	.00	.00	.00	.00	.00	.00	1.99
310202	LO2 SUPPORTS	3	.63	.00	.00	.63	.23	.00	.00	.00	.00	.00	.00	.63
3102	OXID. TK & SUPT		2.62	.00	.00	2.62	.37	.00	.00	.00	.00	.00	.00	2.62
310301	FWD AFT SKIRT	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
310302	INTERTANK	3	1.98	.00	.00	1.98	.09	.00	.00	.00	.00	.00	.00	1.99
310303	SW'L SHELL	3	2.11	.00	.00	2.11	.10	.00	.00	.00	.00	.00	.00	2.11
3103	BODY STRUCTURE		4.09	.00	.00	4.09	.19	.00	.00	.00	.00	.00	.00	4.09
330101	COMPUTER	3	8.59	1.07	.00	9.66	1.86	.00	.00	.00	.00	.00	.00	9.66
330102	DATA DISTR.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330103	EQ. THERM CONT.	3	.33	.38	.00	.71	.19	.00	.00	.00	.00	.00	.00	.71
330104	CIRCUITRY	3	.53	.00	.00	.54	.05	.00	.00	.00	.00	.00	.00	.54
330105	SOFTWARE	3	5.93	.00	.00	5.93	.00	.00	.00	.00	1.46	.00	1.46	7.39
330106	SOFTWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330107	SOFTWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330108	INSTL. ASSY & C/OS		1.23	.12	.00	1.35	.17	.00	.00	.00	.00	.00	.00	1.35
3301	DATA MGMT.		16.61	1.57	.00	18.18	2.27	.00	.00	.00	1.46	.00	1.46	19.64
330201	I M U	3	3.15	.34	.00	3.49	.98	.00	.00	.00	.00	.00	.00	3.49
330202	TRACKING/ELECT	3	.65	.00	.00	.65	.58	.00	.00	.00	.00	.00	.00	.65
330203	REN DEZ&DOCKING	3	.43	.17	.00	.60	.10	.00	.00	.00	.00	.00	.00	.60
330204	INSTL. ASSY & C/OS		.34	.04	.00	.38	.13	.00	.00	.00	.00	.00	.00	.38
3302	G N & C		4.57	.54	.00	5.11	1.79	.00	.00	.00	.00	.00	.00	5.11
330301	M/W CIRC +RF MUX	3	1.40	.72	.00	2.12	.72	.00	.00	.00	.00	.00	.00	2.12
330302	TRANSPONDERS	3	.87	.00	.00	.87	.77	.00	.00	.00	.00	.00	.00	.87
330303	POWER AMP.	3	.38	.00	.00	.39	.32	.00	.00	.00	.00	.00	.00	.39
330304	ANTENNA	3	.18	.16	.00	.34	.16	.00	.00	.00	.00	.00	.00	.34
330305	DEC/ENC+MOD/DEM	3	.75	.34	.00	1.09	.67	.00	.00	.00	.00	.00	.00	1.09
330306	TAPE RECORDER	3	.12	.13	.00	.25	.27	.00	.00	.00	.00	.00	.00	.25
330307	P/L INTER EQUIP	3	.24	.00	.00	.24	.14	.00	.00	.00	.00	.00	.00	.24
330308	INSTL. ASSY & C/OS		.32	.11	.00	.42	.24	.00	.00	.00	.00	.00	.00	.42
3303	COMMUNICATIONS		4.26	1.46	.00	5.72	3.30	.00	.00	.00	.00	.00	.00	5.72

LEVEL 7

WBS	COST ELEMENT	C	EDAD (MIL)	GTH (MIL)	ETH (MIL)	TOTAL UDTAE (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
330401	DATA SENSORS	3	.06	.00	.00	.06	.07	.00	.00	.00	.00	.00	.00	.06
330402	SIGNAL COND.	3	.10	.04	.00	.14	.07	.00	.00	.00	.00	.00	.00	.14
330403	CIRCUITRY	3	1.73	.00	.00	1.73	.16	.00	.00	.00	.00	.00	.00	1.73
330404	INSTL, ASSY & C/O3		.15	.00	.00	.15	.02	.00	.00	.00	.00	.00	.00	.15
3304	INSTRUMENTATION		2.04	.04	.00	2.08	.32	.00	.00	.00	.00	.00	.00	2.08
330501	BATTERY	3	.08	.04	.00	.12	.05	.00	.00	.00	.00	.00	.00	.12
330502	FUEL CELL	3	4.37	1.31	.00	5.68	.77	.00	.00	.00	.00	.00	.00	5.68
330503	INSTL, ASSY & C/O3		.36	.11	.00	.46	.07	.00	.00	.00	.00	.00	.00	.46
3305	ELECT. POWER		4.81	1.46	.00	6.27	.88	.00	.00	.00	.00	.00	.00	6.27
330601	DISTR.	3	.78	.06	.00	.84	.06	.00	.00	.00	.00	.00	.00	.84
330602	TANKS SYSTEM	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
330603	INSTL, ASSY & C/O		.06	.00	.00	.07	.00	.00	.00	.00	.00	.00	.00	.07
3306	PWR. DIST. & CONT		.85	.06	.00	.91	.06	.00	.00	.00	.00	.00	.00	.91

12+63

OPTION 3 TOTAL PROGRAM DOD 16 VEHICLES 9/13/73 7:00 PM

WBS	COST ELEMENT	C	EO&D (MIL)	GTH (MIL)	FTM (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
60	VEH AUX. STAGE	3												
61	VEH AUX. STAGE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	TOTAL VEH AUX. STA		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

12-64

OPTION 3 TOTAL PROGRAM DOD 16 VEHICLES 9/13/73 7:00 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
50	LOGISTICS	3												
51	TRANSP. & HDLG.	3	.00	.00	.00	.00	.00	.50	.00	.50	.33	.00	.33	.84
52	TRAINING	3	2.55	.00	.00	2.55	.00	.00	.00	.00	2.55	.00	2.55	5.11
53	INV CONT. & WHSNG	3	1.45	.00	.00	1.45	.00	.00	.00	.00	5.15	.00	5.15	6.60
	TOTAL LOGISTICS		4.01	.00	.00	4.01	.00	.50	.00	.50	8.04	.00	8.04	12.55
	TOTAL		4.01	.00	.00	4.01	.00	.50	.00	.50	8.04	.00	8.04	12.55

LEVEL 6

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DUT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
5201	SIM. & EQUIP.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
5202	GROUND CREW	3	2.55	.00	.00	2.55	.00	.00	.00	.00	2.55	.00	2.55	5.10
52	TRAINING		2.55	.00	.00	2.55	.00	.00	.00	.00	2.55	.00	2.55	5.11

OPTION 3 TOTAL PROGRAM DOD 16 VEHICLES 9/13/73 7:00 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
60	FACILITIES	3												
61	MANUFACTURING	3	1.12	.00	.00	1.12	.00	.44	.00	.44	.00	.00	.00	1.56
62	TEST	3	1.50	.00	.00	1.50	.00	.00	.00	.00	.00	.00	.00	1.50
63	ETR MAINT. & REF.	3	1.02	.00	.00	1.02	.00	.00	.00	.00	.55	.00	.55	1.57
64	ETR LAUNCH	3	.39	.00	.00	.39	.00	.00	.00	.00	.21	.00	.21	.60
65	WTR MAINT. & REF.	3	.76	.00	.00	.76	.00	.00	.00	.00	.30	.00	.30	1.06
66	WTR LAUNCH	3	.38	.00	.00	.38	.00	.00	.00	.00	.15	.00	.15	.53
	TOTAL FACILITIES		5.17	.00	.00	5.17	.00	.44	.00	.44	1.21	.00	1.21	6.81
	TOTAL		5.17	.00	.00	5.17	.00	.44	.00	.44	1.21	.00	1.21	6.81

12+67

LEVEL 6

WBS	COST ELEMENT	C	EDAU (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
6101	DES./CONST.	3	1.09	.00	.00	1.09	.00	.00	.00	.00	.00	.00	.00	1.09
6102	ACTIV./MAINT.	3	.02	.00	.00	.02	.00	.44	.00	.44	.00	.00	.00	.46
61	MANUFACTURING		1.12	.00	.00	1.12	.00	.44	.00	.44	.00	.00	.00	1.56
6201	DES./CONST.	3	1.50	.00	.00	1.50	.00	.00	.00	.00	.00	.00	.00	1.50
6202	ACTIV./MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
62	TEST		1.50	.00	.00	1.50	.00	.00	.00	.00	.00	.00	.00	1.50
6301	DES./CONST.	3	1.00	.00	.00	1.00	.00	.00	.00	.00	.00	.00	.00	1.00
6302	ACTIV./MAINT.	3	.02	.00	.00	.02	.00	.00	.00	.00	.55	.00	.55	.57
63	ETR MAINT. & REF.		1.02	.00	.00	1.02	.00	.00	.00	.00	.55	.00	.55	1.57
6401	DES./CONST.	3	.38	.00	.00	.38	.00	.00	.00	.00	.00	.00	.00	.38
6402	ACTIV./MAINT.	3	.01	.00	.00	.01	.00	.00	.00	.00	.21	.00	.21	.22
64	ETR LAUNCH		.39	.00	.00	.39	.00	.00	.00	.00	.21	.00	.21	.60
6501	DES./CONST.	3	.75	.00	.00	.75	.00	.00	.00	.00	.00	.00	.00	.75
6502	ACTIV./MAINT.	3	.01	.00	.00	.01	.00	.00	.00	.00	.30	.00	.30	.31
65	WTR MAINT. & REF.		.76	.00	.00	.76	.00	.00	.00	.00	.30	.00	.30	1.06
6601	DES./CONST.	3	.37	.00	.00	.37	.00	.00	.00	.00	.00	.00	.00	.37
6602	ACTIV./MAINT.	3	.01	.00	.00	.01	.00	.00	.00	.00	.15	.00	.15	.16
66	WTR LAUNCH		.38	.00	.00	.38	.00	.00	.00	.00	.15	.00	.15	.53

OPTION 3 TOTAL PROGRAM DOD 16 VEHICLES 9/13/73 7:00 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
70	GRND. SUPT. EQUIPS													
71	MFG. GSE	3	8.83	.00	.00	8.83	.00	2.72	.00	2.72	.00	.00	.00	11.55
72	FTH GSE	3	11.18	.00	.00	11.18	.00	.00	.00	.00	2.87	.00	2.87	14.05
73	WTH GSE	3	10.51	.00	.00	10.51	.00	.00	.00	.00	1.88	.00	1.88	12.39
74	FLT OPS GSE(NASA)		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
75	FLT OPS GSE(DOD)		.95	.00	.00	.95	.00	.00	.00	.00	2.17	.00	2.17	3.12
	TOTAL GRND. SUPT.		31.47	.00	.00	31.47	.00	2.72	.00	2.72	6.92	.00	6.92	41.12
	TOTAL		31.47	.00	.00	31.47	.00	2.72	.00	2.72	6.92	.00	6.92	41.12

LEVEL 6

WBS	COST ELEMENT	C	EDBU (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
7101	HARDWARE	3	6.11	.00	.00	6.11	.00	.00	.00	.00	.00	.00	.00	6.11
7102	SITE ACTIV.	3	.12	.00	.00	.12	.00	.00	.00	.00	.00	.00	.00	.12
7103	MAINT.	3	.00	.00	.00	.00	.00	2.72	.00	2.72	.00	.00	.00	2.72
7104	SOFTWARE	3	2.59	.00	.00	2.59	.00	.00	.00	.00	.00	.00	.00	2.59
71	MFG. GSE		8.83	.00	.00	8.83	.00	2.72	.00	2.72	.00	.00	.00	11.55
7201	HARDWARE	3	7.09	.00	.00	7.09	.00	.00	.00	.00	.00	.00	.00	7.09
7202	SITE ACTIV.	3	2.34	.00	.00	2.34	.00	.00	.00	.00	.00	.00	.00	2.34
7203	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	2.23	.00	2.23	2.23
7204	SOFTWARE	3	1.75	.00	.00	1.75	.00	.00	.00	.00	.63	.00	.63	2.38
72	ETR GSE		11.18	.00	.00	11.18	.00	.00	.00	.00	2.87	.00	2.87	14.05
7301	HARDWARE	3	6.63	.00	.00	6.63	.00	.00	.00	.00	.00	.00	.00	6.63
7302	SITE ACTIV.	3	2.19	.00	.00	2.19	.00	.00	.00	.00	.00	.00	.00	2.19
7303	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	1.79	.00	1.79	1.79
7304	SOFTWARE	3	1.69	.00	.00	1.69	.00	.00	.00	.00	.09	.00	.09	1.78
73	WTR GSE		10.51	.00	.00	10.51	.00	.00	.00	.00	1.88	.00	1.88	12.39
7401	HARDWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7402	SITE ACTIV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7403	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7404	SOFTWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
74	HARDWA(5) SUBTOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7501	HARDWARE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7502	SITE ACTIV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7503	MAINT.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
7504	SOFTWARE	3	.95	.00	.00	.95	.00	.00	.00	.00	2.17	.00	2.17	3.12
75	HARDWA(5) SUBTOTAL		.95	.00	.00	.95	.00	.00	.00	.00	2.17	.00	2.17	3.12

12-70

OPTION 3 TOTAL PROGRAM DOD 16 VEHICLES 9/13/73 7:00 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
80	VEHICLE TEST	3												
81	GND TEST HDWE.	3	.00	21.35	.00	21.35	.00	.00	.00	.00	.00	.00	.00	21.35
82	GND TEST OPNS.	3	.00	11.24	.00	11.24	.00	.00	.00	.00	.00	.00	.00	11.24
83	FLT. TEST HDWE.	3	.00	.00	29.41	29.41	.00	7.35	.00	7.35	.00	.00	.00	36.77
84	FLT. TEST OPNS	3	.00	.00	5.16	5.16	.00	.00	.00	.00	.00	.00	.00	5.16
	TOTAL VEHICLE TEST		.00	32.60	34.57	67.17	.00	7.35	.00	7.35	.00	.00	.00	74.52
	TOTAL		.00	32.60	34.57	67.17	.00	7.35	.00	7.35	.00	.00	.00	74.52

LEVEL 6

WBS	COST ELEMENT	C	EDAD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
8101	PTV TEST	3	.00	4.70	.00	4.70	.00	.00	.00	.00	.00	.00	.00	4.70
8102	MAJOR TEST ART.	3	.00	15.86	.00	15.86	.00	.00	.00	.00	.00	.00	.00	15.86
8103	MOCKUPS	3	.00	.79	.00	.79	.00	.00	.00	.00	.00	.00	.00	.79
81	GND TEST HDWE.		.00	21.35	.00	21.35	.00	.00	.00	.00	.00	.00	.00	21.35
8301	STRUCTURES	3	.00	.00	3.53	3.53	.00	.00	.00	.00	.00	.00	.00	3.53
8302	THERMAL CONTROL	3	.00	.00	.92	.92	.00	.00	.00	.00	.00	.00	.00	.92
8303	AVIONICS	3	.00	.00	9.32	9.32	.00	.00	.00	.00	.00	.00	.00	9.32
8304	PROPULSION	3	.00	.00	6.79	6.79	.00	.00	.00	.00	.00	.00	.00	6.79
8305	ORBITER I/F	3	.00	.00	4.37	4.37	.00	.00	.00	.00	.00	.00	.00	4.37
8306	DROP TANKS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
8307	FINAL ASSY & C/O	3	.00	.00	4.49	4.49	.00	.00	.00	.00	.00	.00	.00	4.49
83	FLT. TEST HDWE.		.00	.00	29.41	29.41	.00	.00	.00	.00	.00	.00	.00	29.41

LEVEL 7

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
830102	OXID. TK & SUPT.	3	.00	.00	.37	.37	.00	.00	.00	.00	.00	.00	.00	.37
830103	BODY STRUCTURE	3	.00	.00	.19	.19	.00	.00	.00	.00	.00	.00	.00	.19
830104	THRUST STRUCTURE		.00	.00	.12	.12	.00	.00	.00	.00	.00	.00	.00	.12
830105	METEOROID SHIELD	3	.00	.00	.83	.83	.00	.00	.00	.00	.00	.00	.00	.83
830106	PAYLOAD I/F	3	.00	.00	.86	.86	.00	.00	.00	.00	.00	.00	.00	.86
830107	INSTL. ASSY & C/O3		.00	.00	.26	.26	.00	.00	.00	.00	.00	.00	.00	.26
8301	STRUCTURES		.00	.00	3.53	3.53	.00	.00	.00	.00	.00	.00	.00	3.53
830201	FUEL TANK INSL	3	.00	.00	.20	.20	.00	.00	.00	.00	.00	.00	.00	.20
830202	OXID TANK INSL	3	.00	.00	.10	.10	.00	.00	.00	.00	.00	.00	.00	.10
830203	INSL PURGE SYS	3	.00	.00	.57	.57	.00	.00	.00	.00	.00	.00	.00	.57
830204	THERM CONT SYS	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830205	INSTL. ASSY & C/O3		.00	.00	.04	.04	.00	.00	.00	.00	.00	.00	.00	.04
8302	THERMAL CONTROL		.00	.00	.92	.92	.00	.00	.00	.00	.00	.00	.00	.92
830301	DATA MGMT.	3	.00	.00	2.27	2.27	.00	.00	.00	.00	.00	.00	.00	2.27
830302	G N & C	3	.00	.00	1.79	1.79	.00	.00	.00	.00	.00	.00	.00	1.79
830303	COMMUNICATIONS	3	.00	.00	3.30	3.30	.00	.00	.00	.00	.00	.00	.00	3.30
830304	INSTRUMENTATION	3	.00	.00	.32	.32	.00	.00	.00	.00	.00	.00	.00	.32
830305	ELECT. POWER	3	.00	.00	.88	.88	.00	.00	.00	.00	.00	.00	.00	.88
830306	P&R DIST. & CONT	3	.00	.00	.06	.06	.00	.00	.00	.00	.00	.00	.00	.06
830307	INSTL. ASSY & C/O3		.00	.00	.69	.69	.00	.00	.00	.00	.00	.00	.00	.69
8303	AVIONICS		.00	.00	9.32	9.32	.00	.00	.00	.00	.00	.00	.00	9.32
830401	MAIN ENGINE	3	.00	.00	1.26	1.26	.00	.00	.00	.00	.00	.00	.00	1.26
830402	MAIN ENG SUPT.	3	.00	.00	3.26	3.26	.00	.00	.00	.00	.00	.00	.00	3.26
830403	ACPS ENGINE	3	.00	.00	.27	.27	.00	.00	.00	.00	.00	.00	.00	.27
830404	ACPS ENG SUPT	3	.00	.00	1.67	1.67	.00	.00	.00	.00	.00	.00	.00	1.67
830405	INSTL. ASSY & C/O3		.00	.00	.32	.32	.00	.00	.00	.00	.00	.00	.00	.32
8304	PROPULSION		.00	.00	6.79	6.79	.00	.00	.00	.00	.00	.00	.00	6.79
830501	STRUCTURES	3	.00	.00	.69	.69	.00	.00	.00	.00	.00	.00	.00	.69
830502	I/F PANELS	3	.00	.00	2.83	2.83	.00	.00	.00	.00	.00	.00	.00	2.83
830503	PURGE PROV.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
830504	ABORT PROV.	3	.00	.00	.54	.54	.00	.00	.00	.00	.00	.00	.00	.54
830505	INSTL. ASSY & C/O3		.00	.00	.32	.32	.00	.00	.00	.00	.00	.00	.00	.32
8305	ORBITER I/F		.00	.00	4.37	4.37	.00	.00	.00	.00	.00	.00	.00	4.37

LEVEL 7

WBS	COST ELEMENT	C	EDAD (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
830701	FINAL ASSY	3	.00	.00	3.74	3.74	.00	.00	.00	.00	.00	.00	.00	3.74
830702	C/O	3	.00	.00	.75	.75	.00	.00	.00	.00	.00	.00	.00	.75
8307	FINAL ASSY & C/O		.00	.00	4.49	4.49	.00	.00	.00	.00	.00	.00	.00	4.49

OPTION 3 TOTAL PROGRAM DOD 16 VEHICLES 9/13/73 7100 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
90	LAUNCH OPNS. WTR	3												
91	LNCH SITE SVCES	3	.00	.00	.00	.00	.00	.00	.00	.00	2.02	.00	2.02	2.02
92	TUG/SHTL MATING	3	.00	.00	.00	.00	.00	.00	.00	.00	.63	.00	.63	.63
93	PRELAUNCH C/O	3	.00	.00	.00	.00	.00	.00	.00	.00	.73	.00	.73	.73
94	COUNTDOWN	3	.00	.00	.00	.00	.00	.00	.00	.00	1.13	.00	1.13	1.13
95	PRLNTS. & GASES	3	.00	.00	.00	.00	.00	.00	.00	.00	.12	.00	.12	.12
96	POST FLT. SAFING	3	.00	.00	.00	.00	.00	.00	.00	.00	.80	.00	.80	.80
	TOTAL LAUNCH OPNS.		.00	.00	.00	.00	.00	.00	.00	.00	5.43	.00	5.43	5.43
	TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	5.43	.00	5.43	5.43

OPTION 3 TOTAL PROGRAM DOD 16 VEHICLES 9/13/73 7:00 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
100	LAUNCH OPNS ETR	3												
101	LNCH SITE SVCES	3	.00	.00	1.33	1.33	.00	.00	.00	.00	7.14	.00	7.14	8.46
102	TUG/SHTL MATING	3	.00	.00	.39	.39	.00	.00	.00	.00	2.08	.00	2.08	2.47
103	PRELAUNCH C/O	3	.00	.00	.44	.44	.00	.00	.00	.00	2.54	.00	2.54	2.99
104	COUNTDOWN	3	.00	.00	.72	.72	.00	.00	.00	.00	3.99	.00	3.99	4.71
105	PRLNTS & GASES	3	.00	.00	.04	.04	.00	.00	.00	.00	.81	.00	.81	.85
106	POST FLT. SAFING	3	.00	.00	.61	.61	.00	.00	.00	.00	3.00	.00	3.00	3.61
	TOTAL LAUNCH OPNS		.00	.00	3.54	3.54	.00	.00	.00	.00	19.56	.00	19.56	23.09
	TOTAL		.00	.00	3.54	3.54	.00	.00	.00	.00	19.56	.00	19.56	23.09

OPTION 3 TOTAL PROGRAM DOD 16 VEHICLES 9/13/73 7:00 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
110	FLIGHT OPNS NASA	3												
111	MISSION PLG.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
112	FLT. CONTROL	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
113	FLT. EVAL.	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
114	FLT. SUPT. SFTWRE	3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	TOTAL FLIGHT OPNS		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
	TOTAL		.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

OPTION 3 TOTAL PROGRAM DOD 16 VEHICLES 9/13/73 7:00 PM

WBS	COST ELEMENT	C	ED&D (MIL)	GTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
120	FLIGHT OPNS DOD	3												
121	MISSION PLG	3	4.74	.00	1.05	5.79	.00	.00	.00	.00	7.20	.00	7.20	13.00
122	FLT. CONTROL	3	.48	.00	2.32	2.80	.00	.00	.00	.00	14.67	.00	14.67	17.47
123	FLT. EVAL.	3	.00	.00	.76	.76	.00	.00	.00	.00	7.68	.00	7.68	8.44
124	FLT. SUPT. SFTWRE	3	2.16	.00	.00	2.16	.00	.00	.00	.00	3.61	.00	3.61	5.77
	TOTAL FLIGHT OPNS		7.38	.00	4.13	11.51	.00	.00	.00	.00	33.16	.00	33.16	44.67
	TOTAL		7.38	.00	4.13	11.51	.00	.00	.00	.00	33.16	.00	33.16	44.67

12178

OPTION 3 TOTAL PROGRAM DOD 16 VEHICLES 9/13/73 7100 PM

#85	COST ELEMENT C	EDBD (MIL)	BTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
130	REFURB &INTEG #TR3												
131	SCH MAINT & REF 3	.00	.00	.00	.00	.00	.00	.00	.00	1.17	.00	1.17	1.17
132	UNSCH MAINT & REF3	.00	.00	.00	.00	.00	.00	.00	.00	.24	.00	.24	.24
133	POST MAINT C/O 3	.00	.00	.00	.00	.00	.00	.00	.00	.07	.00	.07	.07
134	TUG/PL MAING &/CO3	.00	.00	.00	.00	.00	.00	.00	.00	.81	.00	.81	.81
135	REFURB RQMTS PLG 3	.22	.00	.00	.22	.00	.00	.00	.00	.28	.00	.28	.50
136	DEPOT MAINT 3	.00	.00	.00	.00	.00	.00	.00	.00	2.54	.00	2.54	2.54
	TOTAL REFURB &INTE	.22	.00	.00	.22	.00	.00	.00	.00	5.11	.00	5.11	5.33
	TOTAL	.22	.00	.00	.22	.00	.00	.00	.00	5.11	.00	5.11	5.33

12479

OPTION 3 TOTAL PROGRAM DOD 16 VEHICLES 9/13/73 7:00 PM

WBS	COST ELEMENT	C	EDBD (MIL)	BTH (MIL)	FTH (MIL)	TOTAL DDT&E (MIL)	MEMO T1 (MIL)	VEH PROD (MIL)	IN SPRS (MIL)	TOT PROD (MIL)	OPER ACTIV (MIL)	OPS SPRS (MIL)	TOT OPER (MIL)	TOTAL (MIL)
140	REFURB &INTEG ETR3													
141	SCH MAINT & REF	3	.00	.00	.72	.72	.00	.00	.00	.00	4.03	.00	4.03	4.75
142	UNSCH MAINT & REF3		.00	.00	.22	.22	.00	.00	.00	.00	.83	.00	.83	1.04
143	POST MAINT C/O	3	.00	.00	.06	.06	.00	.00	.00	.00	.20	.00	.20	.26
144	TUG/PL MATING,C/O	3	.00	.00	.55	.55	.00	.00	.00	.00	2.77	.00	2.77	3.33
145	REFURB RQMTS PLG	3	.22	.00	.17	.39	.00	.00	.00	.00	.99	.00	.99	1.38
146	DEPOT MAINT	3	.00	.00	1.01	1.01	.00	.00	.00	.00	18.17	.00	18.17	19.18
	TOTAL REFURB &INTE		.22	.00	2.73	2.95	.00	.00	.00	.00	26.99	.00	26.99	29.94
	TOTAL		.22	.00	2.73	2.95	.00	.00	.00	.00	26.99	.00	26.99	29.94

OPTION 3 -- DOD

INITIAL

DATA FORM C

12-81

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: 9/12/73
PAGE: 5 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
32001	PROJECT MGMT.	1.0	1.3	1.3	1.3	1.3	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.3	2.3	4.5	4.7	2.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	11.4	39.6	37.1	12.1	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.5	.5	.5	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.1	.6	1.2	1.5	1.2	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.1	2.4	6.3	8.4	7.2	2.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.1	5.2	17.1	10.5	3.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32010	LAUNCH OPNS ETR	.0	.2	.2	.2	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32011	FLIGHT OPNS NASA	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	1.1	2.2	1.6	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32014	REFURB &INTEG ETR	.0	.2	.2	.2	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320	TOTAL PROJ PHASE	12.9	52.4	69.5	41.7	18.1	4.7	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0

12-82

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: 9/12/73
PAGE: 1 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
320	TOTAL PROJ PHASE	12.9	52.4	69.5	41.7	18.1	4.7	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
32001	PROJECT MGMT.	1.0	1.3	1.3	1.3	1.3	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200101	COST/PERF. MGMT.	.7	.9	.9	.9	.9	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200102	PROJ. DIRECTION	.3	.4	.4	.4	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200103	INFORM. MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.3	2.3	4.5	4.7	2.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200201	TUG SYS. ENGR.	.2	1.8	3.6	3.8	2.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200202	SHUTTLE I/F	.0	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200203	PAYLOAD I/F	.0	.3	.7	.7	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	11.4	39.6	37.1	12.1	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200301	STRUCTURES	2.2	7.7	6.8	1.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200302	THERMAL CONTROL	.2	.6	.5	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200303	AVIONICS	2.6	9.6	9.5	3.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200304	PROPULSION	3.8	13.4	12.1	3.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200305	ORBITER I/F	1.6	4.5	4.1	2.0	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200307	FINAL ASSY & C/O	1.0	3.8	4.2	2.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200401	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.5	.5	.5	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200501	TRANSP. & HDLG.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200502	TRAINING	.0	.4	.4	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200503	INV CONT. & WHSNG	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.1	.6	1.2	1.5	1.2	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200601	MANUFACTURING	.0	.1	.3	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200602	TEST	.0	.2	.4	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200603	ETR MAINT. & REF.	.0	.1	.2	.3	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200604	ETR LAUNCH	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200605	WTR MAINT. & REF.	.0	.1	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200606	WTR LAUNCH	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.1	2.4	6.3	8.4	7.2	2.8	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200701	MFG. GSE	.0	.6	1.6	2.1	1.8	.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200702	ETR GSE	.0	.9	2.4	3.1	2.7	1.0	.0	.0	.SSSSSSS							
? 2.5	1.0 .0 .0 .0 .0 .0 .0 .0 .0 .0 .0											3200703	WTR GSE			.0	.9
3200704	FLT OPS GSE(NASA)	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200705	FLT OPS GSE(DOD)	.0	.0	.1	.2	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.1	5.2	17.1	10.5	3.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200801	GND TEST HDWE.	.1	4.3	7.6	1.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200802	GND TEST OPNS.	.0	.3	3.0	2.9	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200803	FLT. TEST HDWE.	.0	.7	6.4	6.1	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200804	FLT. TEST OPNS	.0	.0	.0	.1	3.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200901	LNCH SITE SVCES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200902	TUG/SHTL MATING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200903	PRELAUNCH C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200904	COUNTDOWN	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200905	PRLNTS. & GASES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

12-83

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: 9/12/73
PAGE: 2 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
3200906	POST FLT. SAFING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32010	LAUNCH OPNS ETR	.0	.2	.2	.2	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201001	LNCH SITE SVCES	.0	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201002	TUG/SHTL MATING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201003	PRELAUNCH C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201004	COUNTDOWN	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201005	PRLNTS & GASES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201006	POST FLT. SAFING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32011	FLIGHT OPNS NASA	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201101	MISSION PLG.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201102	FLT. CONTROL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201103	FLT. EVAL.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201104	FLT. SUPT. SFTWRE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	1.1	2.2	1.6	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201201	MISSION PLG	.0	.0	.4	.9	.8	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201202	FLT. CONTROL	.0	.0	.1	.3	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201203	FLT. EVAL.	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201204	FLT. SUPT. SFTWRE	.0	.0	.6	.9	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201301	SCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201302	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201303	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201304	TUG/PL MAING &/CO	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201305	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201306	DEPOT MAINT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32014	REFURB &INTEG ETR	.0	.2	.2	.2	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201401	SCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201402	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201403	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201404	TUG/PL MATING,C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201405	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201406	DEPOT MAINT	.0	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: 9/12/73
PAGE: 5 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.7	1.0	.2	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.0	.0	5.2	6.9	6.9	1.7	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	.0	.0	.0	.0	40.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.0	.0	.0	.0	.0	3.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320	TOTAL PROJ PHASE	.0	.0	.0	5.5	47.9	11.3	3.1	.4	.2	.2	.2	.0	.0	.0	.0	.0

12-85

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: 9/12/73
PAGE: 4 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
320	TOTAL PROJ PHASE	.0	.0	.0	5.5	47.9	11.3	5.1	.4	.2	.2	.2	.0	.0	.0	.0	.0
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.7	1.0	.2	.0	.0	.0	.0	.0	.0	.0	.0
3200101	COST/PERF. MGMT.	.0	.0	.0	.0	.0	.5	.7	.2	.0	.0	.0	.0	.0	.0	.0	.0
3200102	PROJ. DIRECTION	.0	.0	.0	.0	.0	.2	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200103	INFORM. MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.0	.0	5.2	6.9	6.9	1.7	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200201	TUG SYS. ENGR.	.0	.0	.0	.5	.7	.7	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200202	SHUTTLE I/F	.0	.0	.0	.1	.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200203	PAYLOAD I/F	.0	.0	.0	.3	.4	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	.0	.0	.0	.0	40.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200301	STRUCTURES	.0	.0	.0	.0	4.7	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200302	THERMAL CONTROL	.0	.0	.0	.0	1.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200303	AVIONICS	.0	.0	.0	.0	12.6	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200304	PROPULSION	.0	.0	.0	.0	10.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200305	ORBITER I/F	.0	.0	.0	.0	6.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200307	FINAL ASSY & C/O	.0	.0	.0	.0	5.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200401	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200501	TRANSP. & HDLG.	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200502	TRAINING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200503	INV CONT. & WHSNG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200601	MANUFACTURING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200602	TEST	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0
3200701	MFG. GSE	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.0	.0	.0	.0	.0	3.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200803	FLT. TEST HDWE.	.0	.0	.0	.0	.0	3.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200204	SUST. ENGR.	.0	.0	.0	4.2	5.6	5.6	1.4	.0	.0	.0	.0	.0	.0	.0	.0	.0

12-86

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: 9/12/73
PAGE: 8 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.0	.0	.0	.0	.8	1.0	1.0	.5	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	.0	.0	.0	.0	.5	1.9	1.9	1.9	.9	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.2	.7	.7	.7	.3	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
32007	GRND. SUPT. EQUIP	.0	.0	.0	.0	.2	.7	.7	.7	.5	.3	.3	.3	.3	.3	.3	.2
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.0	.4	.2	.0	.0	.0	.0	.0	.0	.0
32010	LAUNCH OPNS ETR	.0	.0	.0	.0	.0	.7	1.5	1.5	.7	.0	.0	.0	.0	.0	.0	.0
32011	FLIGHT OPNS NASA	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	.0	.0	.0	1.5	3.0	3.0	1.5	.0	.0	.0	.0	.0	.0	.0
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	.0	.0	.3	.2	.0	.0	.0	.0	.0	.0	.0
32014	REFURB &INTEG ETR	.0	.0	.0	.0	.0	1.2	2.5	2.5	1.2	.0	.0	.0	.0	.0	.0	.0
320	TOTAL PROJ PHASE	.0	.0	.0	.0	.8	7.7	11.6	12.3	6.4	.4	.4	.4	.4	.4	.4	.2

STOP

COMPUTE TIME 49.512
READY

*

12-87

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: 9/12/73
PAGE: 6 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
320	TOTAL PROJ PHASE	.0	.0	.0	.0	.8	7.7	11.6	12.3	6.4	.4	.4	.4	.4	.4	.4	.2
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0
3200101	COST/PERF. MGMT.	.0	.0	.0	.0	.0	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0
3200102	PROJ. DIRECTION	.0	.0	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200103	INFORM. MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.0	.0	.0	.0	.8	1.0	1.0	.5	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	.0	.0	.0	.0	.5	1.9	1.9	1.9	.9	.0	.0	.0	.0	.0	.0	.0
3200301	STRUCTURES	.0	.0	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200302	THERMAL CONTROL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200303	AVIONICS	.0	.0	.0	.0	.3	1.1	1.1	1.1	.5	.0	.0	.0	.0	.0	.0	.0
3200304	PROPULSION	.0	.0	.0	.0	.2	.6	.6	.6	.3	.0	.0	.0	.0	.0	.0	.0
3200305	ORBITER I/F	.0	.0	.0	.0	.0	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0
3200306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200307	FINAL ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.2	.7	.7	.7	.3	.0	.0	.0	.0	.0	.0	.0
3200501	TRANSP. & HDLG.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200502	TRAINING	.0	.0	.0	.0	.1	.4	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0
3200503	INV CONT. & WHSNG	.0	.0	.0	.0	.1	.3	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
3200603	ETR MAINT. & REF.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200604	ETR LAUNCH	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200605	WTR MAINT. & REF.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200606	WTR LAUNCH	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.0	.0	.0	.2	.7	.7	.7	.5	.3	.3	.3	.3	.3	.3	.2
3200701	MFG. GSE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200702	ETR GSE	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.1
3200703	WTR GSE	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
3200704	FLT OPS GSE(NASA)	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200705	FLT OPS GSE(DOD)	.0	.0	.0	.0	.1	.3	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.0	.4	.2	.0	.0	.0	.0	.0	.0	.0
3200901	LNCH SITE SVCES	.0	.0	.0	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0
3200902	TUG/SHTL MATING	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200903	PRELAUNCH C/O	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200904	COUNTDOWN	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200905	PRLNTS. & GASES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200906	POST FLT. SAFING	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0
32010	LAUNCH OPNS ETR	.0	.0	.0	.0	.0	.7	1.5	1.5	.7	.0	.0	.0	.0	.0	.0	.0
3201001	LNCH SITE SVCES	.0	.0	.0	.0	.0	.3	.6	.6	.3	.0	.0	.0	.0	.0	.0	.0
3201002	TUG/SHTL MATING	.0	.0	.0	.0	.0	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0
3201003	PRELAUNCH C/O	.0	.0	.0	.0	.0	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0
3201004	COUNTDOWN	.0	.0	.0	.0	.0	.1	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0
3201005	PRLNTS & GASES	.0	.0	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
3201006	POST FLT. SAFING	.0	.0	.0	.0	.0	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0
32011	FLIGHT OPNS NASA	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201101	MISSION PLG.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201102	FLT. CONTROL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

12-88

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: 9/12/73
PAGE: 7 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
3201103	FLT. EVAL.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201104	FLT. SUPT. SFTWRE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	.0	.0	.0	1.5	3.0	3.0	1.5	.0	.0	.0	.0	.0	.0	.0
3201201	MISSION PLG	.0	.0	.0	.0	.0	.2	.5	.5	.2	.0	.0	.0	.0	.0	.0	.0
3201202	FLT. CONTROL	.0	.0	.0	.0	.0	.9	1.7	1.7	.9	.0	.0	.0	.0	.0	.0	.0
3201203	FLT. EVAL.	.0	.0	.0	.0	.0	.2	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0
3201204	FLT. SUPT. SFTWRE	.0	.0	.0	.0	.0	.2	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0
32013	REFURB &INTEG #TR	.0	.0	.0	.0	.0	.0	.0	.3	.2	.0	.0	.0	.0	.0	.0	.0
3201301	SCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.1	.0	.0	.0	.0	.0	.0	.0	.0
3201302	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201303	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201304	TUG/PL MAT'G &/CO	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201305	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201306	DEPOT MAINT	.0	.0	.0	.0	.0	.0	.0	.3	.1	.0	.0	.0	.0	.0	.0	.0
32014	REFURB &INTEG ETR	.0	.0	.0	.0	.0	1.2	2.5	2.5	1.2	.0	.0	.0	.0	.0	.0	.0
3201401	SCH MAINT & REF	.0	.0	.0	.0	.0	.1	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0
3201402	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
3201403	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201404	TUG/PL MATING,C/O	.0	.0	.0	.0	.0	.1	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0
3201405	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
3201406	DEPOT MAINT	.0	.0	.0	.0	.0	.9	1.9	1.9	.9	.0	.0	.0	.0	.0	.0	.0
3200204	SUST. ENGR.	.0	.0	.0	.0	.0	.8	1.0	1.0	.5	.0	.0	.0	.0	.0	.0	.0

12-89

OPTION 3 -- DOD

FINAL

DATA FORM C

12-90

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 14, 1973
PAGE: 2 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93
32001	PROJECT MGMT.	.3	.4	.4	.4	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.4	1.1	1.7	2.0	1.6	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	5.1	18.6	18.6	6.7	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.0	.0	.0	.1	.4	.4	.4	.3	.0	.0	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.0	.0	.0	.0	.0	4.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
320	TOTAL PROJ PHASE	5.7	24.3	33.8	22.4	13.1	5.8	2.1	.0	.0	.0	.0	.0	.0	.0	.0	.0

12-91

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 14, 1973
PAGE: 1 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93
320	TOTAL PROJ PHASE	5.7	24.3	33.8	22.4	13.1	5.8	2.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
32001	PROJECT MGMT.	.3	.4	.4	.4	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200101	COST/PERF. MGMT.	.2	.3	.3	.3	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200102	PROJ. DIRECTION	.1	.1	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200103	INFORM. MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.4	1.1	1.7	2.0	1.6	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200201	TUG SYS. ENGR.	.0	.3	.9	1.4	1.6	1.2	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200202	SHUTTLE I/F	.0	.0	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200203	PAYLOAD I/F	.0	.1	.2	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	5.1	18.6	18.6	6.7	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200301	STRUCTURES	.4	1.4	1.4	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200302	THERMAL CONTROL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200303	AVIONICS	2.4	8.9	8.9	3.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200304	PROPULSION	1.9	6.9	6.9	2.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200305	ORBITER I/F	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200307	FINAL ASSY & C/O	.4	1.4	1.4	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200401	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0
3200501	TRANSP. & HDLG.	.0	.0	.0	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0
3200502	TRAINING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200503	INV CONT. & WHSNG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200601	MANUFACTURING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200602	TEST	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.0	.0	.0	.1	.4	.4	.4	.3	.0	.0	.0	.0	.0	.0	.0
3200701	MFG. GSE	.0	.0	.0	.0	.1	.4	.4	.4	.3	.0	.0	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.0	.0	.0	.0	.0	4.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200803	FLT. TEST HDWE.	.0	.0	.0	.0	.0	4.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200204	SUST. ENGR.	.0	.0	.0	.0	1.6	6.3	6.3	6.3	4.7	.0	.0	.0	.0	.0	.0	.0

12-92

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 14, 1973
PAGE: 5 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.0	1.6	1.6	1.4	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGN. & INT.	.0	.0	.0	.0	2.2	8.6	8.6	8.6	6.5	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	.0	.0	.0	.1	51.6	.0	44.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.0	.0	.4	.8	.8	.8	.8	.8	.8	.4	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.0	.0	.0	.0	.0	.1	.3	.3	.3	.3	.3	.3	.1	.0	.0
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.3	.7	.7	.7	.7	.7	.7	.3	.0	.0
32010	LAUNCH OPNS ETR	.0	.0	.0	.0	.0	.0	1.1	2.1	2.1	2.1	2.1	2.1	2.1	1.1	.0	.0
32011	FLIGHT OPNS NASA	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	.0	.0	.0	.0	1.7	3.5	3.5	3.5	3.5	3.5	3.5	1.7	.0	.0
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	.0	.3	.7	.7	.7	.7	.7	.7	.3	.0	.0
32014	REFURB &INTEG ETR	.0	.0	.0	.0	.0	.0	1.4	2.8	2.8	2.8	2.8	2.8	2.8	1.4	.0	.0
320	TOTAL PROJ PHASE	.0	.0	.0	.1	53.8	13.0	55.1	10.8	8.2	.0	.0	.0	.0	.0	.0	.0

12-93

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 14, 1973
PAGE: 3 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93
320	TOTAL PROJ PHASE	.0	.0	.0	.1	53.8	13.0	55.1	10.8	8.2	.0	.0	.0	.0	.0	.0	.0
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.0	1.6	1.6	1.4	.0	.0	.0	.0	.0	.0	.0
3200101	COST/PERF. MGMT.	.0	.0	.0	.0	.0	.0	1.1	1.1	.9	.0	.0	.0	.0	.0	.0	.0
3200102	PROJ. DIRECTION	.0	.0	.0	.0	.0	.0	.5	.5	.4	.0	.0	.0	.0	.0	.0	.0
3200103	INFORM. MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.0	.0	.0	2.2	8.6	8.6	8.6	6.5	.0	.0	.0	.0	.0	.0	.0
3200201	TUG SYS. ENGR.	.0	.0	.0	.0	.3	1.3	1.3	1.3	1.0	.0	.0	.0	.0	.0	.0	.0
3200202	SHUTTLE I/F	.0	.0	.0	.0	.1	.3	.3	.3	.3	.0	.0	.0	.0	.0	.0	.0
3200203	PAYLOAD I/F	.0	.0	.0	.0	.2	.7	.7	.7	.5	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	.0	.0	.0	.1	51.6	.0	44.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200301	STRUCTURES	.0	.0	.0	.0	6.5	.0	5.7	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200302	THERMAL CONTROL	.0	.0	.0	.0	1.6	.0	1.4	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200303	AVIONICS	.0	.0	.0	.0	20.8	.0	17.8	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200304	PROPULSION	.0	.0	.0	.0	13.9	.0	11.9	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200305	ORBITER I/F	.0	.0	.0	.0	1.0	.0	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200307	FINAL ASSY & C/O	.0	.0	.0	.0	7.7	.0	6.6	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.0	.0	.4	.8	.8	.8	.8	.8	.8	.4	.0	.0
3200501	TRANSP. & HDLG.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200502	TRAINING	.0	.0	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.2	.1	.0	.0
3200503	INV CONT. & WHSNG	.0	.0	.0	.0	.0	.0	.3	.6	.6	.6	.6	.6	.6	.3	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200603	ETR MAINT. & REF.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200604	ETR LAUNCH	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200605	WTR MAINT. & REF.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200606	WTR LAUNCH	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.0	.0	.0	.0	.0	.1	.3	.3	.3	.3	.3	.3	.1	.0	.0
3200701	MFG. GSE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200702	ETR GSE	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.0	.0	.0
3200703	WTR GSE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200704	FLT OPS GSE(NASA)	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200705	FLT OPS GSE(DOD)	.0	.0	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.2	.1	.0	.0
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.3	.7	.7	.7	.7	.7	.7	.3	.0	.0
3200901	LNCH SITE SVCES	.0	.0	.0	.0	.0	.0	.1	.3	.3	.3	.3	.3	.3	.1	.0	.0
3200902	TUG/SHTL MATING	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.0	.0	.0
3200903	PRELAUNCH C/O	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.0	.0	.0
3200904	COUNTDOWN	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.0	.0
3200905	PRLNTS. & GASES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200906	POST FLT. SAFING	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.0	.0	.0
32010	LAUNCH OPNS ETR	.0	.0	.0	.0	.0	.0	1.1	2.1	2.1	2.1	2.1	2.1	2.1	1.1	.0	.0
3201001	LNCH SITE SVCES	.0	.0	.0	.0	.0	.0	.4	.8	.8	.8	.8	.8	.8	.4	.0	.0
3201002	TUG/SHTL MATING	.0	.0	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.2	.1	.0	.0
3201003	PRELAUNCH C/O	.0	.0	.0	.0	.0	.0	.1	.3	.3	.3	.3	.3	.3	.1	.0	.0
3201004	COUNTDOWN	.0	.0	.0	.0	.0	.0	.2	.4	.4	.4	.4	.4	.4	.2	.0	.0
3201005	PRLNTS & GASES	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.0	.0	.0
3201006	POST FLT. SAFING	.0	.0	.0	.0	.0	.0	.2	.3	.3	.3	.3	.3	.3	.2	.0	.0

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 14, 1973
PAGE: 4 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93
32011	FLIGHT OPNS NASA	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201101	MISSION PLG.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201102	FLT. CONTROL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201103	FLT. EVAL.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201104	FLT. SUPT. SFTWRE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	.0	.0	.0	.0	1.7	3.5	3.5	3.5	3.5	3.5	3.5	1.7	.0	.0
3201201	MISSION PLG	.0	.0	.0	.0	.0	.0	.4	.8	.8	.8	.8	.8	.8	.4	.0	.0
3201202	FLT. CONTROL	.0	.0	.0	.0	.0	.0	.7	1.4	1.4	1.4	1.4	1.4	1.4	.7	.0	.0
3201203	FLT. EVAL.	.0	.0	.0	.0	.0	.0	.5	.9	.9	.9	.9	.9	.9	.5	.0	.0
3201204	FLT. SUPT. SFTWRE	.0	.0	.0	.0	.0	.0	.2	.4	.4	.4	.4	.4	.4	.2	.0	.0
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	.0	.3	.7	.7	.7	.7	.7	.7	.3	.0	.0
3201301	SCH MAINT & REF	.0	.0	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.2	.1	.0	.0
3201302	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201303	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201304	TUG/PL MAING &/CO	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.0	.0
3201305	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201306	DEPOT MAINT	.0	.0	.0	.0	.0	.0	.1	.3	.3	.3	.3	.3	.3	.1	.0	.0
32014	REFURB &INTEG ETR	.0	.0	.0	.0	.0	.0	1.4	2.8	2.8	2.8	2.8	2.8	2.8	1.4	.0	.0
3201401	SCH MAINT & REF	.0	.0	.0	.0	.0	.0	.2	.5	.5	.5	.5	.5	.5	.2	.0	.0
3201402	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.0	.0	.0
3201403	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201404	TUG/PL MATING.C/O	.0	.0	.0	.0	.0	.0	.2	.3	.3	.3	.3	.3	.3	.2	.0	.0
3201405	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.0	.0
3201406	DEPOT MAINT	.0	.0	.0	.0	.0	.0	.9	1.8	1.8	1.8	1.8	1.8	1.8	.9	.0	.0
3200204	SUST. ENGR.	.0	.0	.0	.0	.0	.0	.5	1.0	1.0	1.0	1.0	1.0	1.0	.5	.0	.0

12-95

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 14, 1973
PAGE: 8 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.0	.2	.3	.3	.3	.3	.3	.3	.2	.0	.0
32002	SYS. ENGR. & INT.	.0	.0	.0	.0	.0	.0	.5	1.0	1.0	1.0	1.0	1.0	1.0	.5	.0	.0
32003	VEH MAIN STAGE	.0	.0	.0	.0	.0	.0	.8	1.6	1.6	1.6	1.6	1.6	.9	.1	.0	.0
32005	LOGISTICS	.1	.6	.6	.6	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.5	1.2	1.4	1.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.0	3.7	11.3	9.9	5.9	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32010	LAUNCH OPNS ETR	.0	.0	.3	.6	.6	.6	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
32011	FLIGHT OPNS NASA	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	.0	.5	2.1	2.5	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32014	REFURB &INTEG ETR	.0	.0	.2	.5	.5	.5	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
320	TOTAL PROJ PHASE	.0	.0	.0	.0	.0	.0	6.9	13.8	13.8	13.8	13.8	13.8	13.1	6.2	.0	.0

STOP

COMPUTE TIME 49.662
READY

*BYE

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 14, 1973
PAGE: 6 OF

NON RECURRING(DDT&E) | RECURRING(PRODUCTION) | X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93
320	TOTAL PROJ PHASE	.0	.0	.0	.0	.0	.0	6.9	13.8	13.8	13.8	13.8	13.8	13.1	6.2	.0	.0
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.0	.2	.3	.3	.3	.3	.3	.3	.2	.0	.0
3200101	COST/PERF. MGMT.	.0	.0	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.2	.1	.0	.0
3200102	PROJ. DIRECTION	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.0	.0	.0
3200103	INFORM. MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.0	.0	.0	.0	.0	.5	1.0	1.0	1.0	1.0	1.0	1.0	.5	.0	.0
32003	VEH MAIN STAGE	.0	.0	.0	.0	.0	.0	.8	1.6	1.6	1.6	1.6	1.6	.9	.1	.0	.0
3200301	STRUCTURES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200302	THERMAL CONTROL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200303	AVIONICS	.0	.0	.0	.0	.0	.0	.6	1.1	1.1	1.1	1.1	1.1	.7	.1	.0	.0
3200304	PROPULSION	.0	.0	.0	.0	.0	.0	.2	.4	.4	.4	.4	.4	.2	.0	.0	.0
3200305	ORBITER I/F	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.0	.0	.0	.0
3200306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200307	FINAL ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200401	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.1	.6	.6	.6	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200501	TRANSP. & HDLG.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200502	TRAINING	.1	.3	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200503	INV CONT. & WHSNG	.1	.3	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200601	MANUFACTURING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200602	TEST	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200603	ETR MAINT. & REF.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200604	ETR LAUNCH	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200605	WTR MAINT. & REF.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200606	WTR LAUNCH	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.5	1.2	1.4	1.0	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200701	MFG. GSE	.0	.2	.5	.6	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200702	ETR GSE	.0	.1	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200703	WTR GSE	.0	.1	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200704	FLT OPS GSE(NASA)	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200705	FLT OPS GSE(DOD)	.0	.1	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.0	3.7	11.3	9.9	5.9	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200801	GND TEST HDWE.	.0	2.1	4.4	1.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200802	GND TEST OPNS.	.0	1.3	2.7	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200803	FLT. TEST HDWE.	.0	.3	4.2	7.4	3.8	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200804	FLT. TEST OPNS	.0	.0	.0	.0	2.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200901	LNCH SITE SVCES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200902	TUG/SHTL MATING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200903	PRELAUNCH C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200904	COUNTDOWN	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200905	PRLNTS. & GASES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200906	POST FLT. SAFING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32010	LAUNCH OPNS ETR	.0	.0	.3	.6	.6	.6	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201001	LNCH SITE SVCES	.0	.0	.1	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201002	TUG/SHTL MATING	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

12-97

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: SEPTEMBER 14, 1973
PAGE: 7 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93
3201003	PRELAUNCH C/O	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201004	COUNTDOWN	.0	.0	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201005	PRLNTS & GASES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201006	POST FLT. SAFING	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32011	FLIGHT OPNS NASA	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201101	MISSION PLG.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201102	FLT. CONTROL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201103	FLT. EVAL.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201104	FLT. SUPT. SFTWRE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32012	FLIGHT OPNS DOO	.0	.0	.0	.5	2.1	2.5	1.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201201	MISSION PLG	.0	.0	.0	.4	1.4	1.4	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201202	FLT. CONTROL	.0	.0	.0	.1	.5	.8	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201203	FLT. EVAL.	.0	.0	.0	.0	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201204	FLT. SUPT. SFTWRE	.0	.0	.0	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201301	SCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201302	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201303	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201304	TUG/PL MAING &/CO	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201305	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201306	DEPOT MAINT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32014	REFURB &INTEG ETR	.0	.0	.2	.5	.5	.5	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201401	SCH MAINT & REF	.0	.0	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201402	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201403	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201404	TUG/PL MATING,C/O	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201405	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201406	DEPOT MAINT	.0	.0	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0

12+98

OPTION 3 -- DOD

TOTAL

DATA FORM C

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: 9/14/73
PAGE: 3 OF

X NON RECURRING(DDT&E) RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
32001	PROJECT MGMT.	1.0	1.3	1.6	1.7	1.7	.7	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.3	2.3	4.5	5.1	3.7	1.8	2.0	1.6	.3	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	11.4	39.6	42.2	30.7	19.0	6.7	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.5	.6	1.1	.7	.6	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.1	.6	1.2	1.5	1.2	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.1	2.4	6.3	8.9	8.4	4.2	1.0	.1	.0	.0	.0	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.1	5.2	17.1	14.2	14.5	9.9	5.9	.1	.0	.0	.0	.0	.0	.0	.0	.0
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32010	LAUNCH OPNS ETR	.0	.2	.2	.2	.5	.8	.6	.6	.3	.0	.0	.0	.0	.0	.0	.0
32011	FLIGHT OPNS NASA	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	1.1	2.2	1.6	1.0	2.1	2.5	1.0	.0	.0	.0	.0	.0	.0	.0
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32014	REFURB &INTEG ETR	.0	.2	.2	.2	.4	.7	.5	.5	.2	.0	.0	.0	.0	.0	.0	.0
320	TOTAL PROJ PHASE	12.9	52.4	75.2	66.0	51.9	27.1	13.2	5.8	2.1	.0	.0	.0	.0	.0	.0	.0

12-100

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: 9/14/73
PAGE: 1 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
320	TOTAL PROJ PHASE	12.9	52.4	75.2	66.0	51.9	27.1	13.2	5.8	2.1	.0	.0	.0	.0	.0	.0	.0
32001	PROJECT MGMT.	1.0	1.3	1.6	1.7	1.7	.7	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0
3200101	COST/PERF. MGMT.	.7	.9	1.1	1.2	1.2	.5	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0
3200102	PROJ. DIRECTION	.3	.4	.5	.5	.5	.2	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0
3200103	INFORM. MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.3	2.3	4.5	5.1	3.7	1.8	2.0	1.6	.3	.0	.0	.0	.0	.0	.0	.0
3200201	TUG SYS. ENGR.	.2	1.8	3.6	4.1	3.0	1.5	1.6	1.2	.2	.0	.0	.0	.0	.0	.0	.0
3200202	SHUTTLE I/F	.0	.1	.2	.2	.2	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200203	PAYLOAD I/F	.0	.3	.7	.8	.6	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	11.4	39.6	42.2	30.7	19.0	6.7	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200301	STRUCTURES	2.2	7.7	7.2	3.1	1.4	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200302	THERMAL CONTROL	.2	.6	.5	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200303	AVIONICS	2.6	9.6	11.9	12.3	8.9	3.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200304	PROPULSION	3.8	13.4	14.0	9.9	6.9	2.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200305	ORBITER I/F	1.6	4.5	4.1	2.0	.3	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200307	FINAL ASSY & C/O	1.0	3.8	4.6	3.4	1.5	.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200401	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.5	.6	1.1	.7	.6	.4	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200501	TRANSP. & HDLG.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200502	TRAINING	.0	.4	.5	.7	.4	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200503	INV CONT. & WHSNG	.0	.1	.2	.4	.3	.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.1	.6	1.2	1.5	1.2	.6	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200601	MANUFACTURING	.0	.1	.3	.3	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200602	TEST	.0	.2	.4	.4	.4	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200603	ETR MAINT. & REF.	.0	.1	.2	.3	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200604	ETR LAUNCH	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200605	WTR MAINT. & REF.	.0	.1	.2	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200606	WTR LAUNCH	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.1	2.4	6.3	8.9	8.4	4.2	1.0	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200701	MFG. GSE	.0	.6	1.6	2.3	2.3	1.3	.4	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200702	ETR GSE	.0	.9	2.4	3.2	3.0	1.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200703	WTR GSE	.0	.9	2.2	3.1	2.8	1.3	.2	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200704	FLT OPS GSE(NASA)	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200705	FLT OPS GSE(DOD)	.0	.0	.1	.3	.2	.3	.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.1	5.2	17.1	14.2	14.5	9.9	5.9	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200801	GND TEST HDWE.	.1	4.3	7.6	3.5	4.4	1.5	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200802	GND TEST OPNS.	.0	.3	3.0	4.2	2.8	.9	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200803	FLT. TEST HDWE.	.0	.7	6.4	6.4	4.4	7.4	3.8	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200804	FLT. TEST OPNS	.0	.0	.0	.1	3.0	.0	2.1	.0	.0	.0	.0	.0	.0	.0	.0	.0
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200901	LNCH SITE SVCES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200902	TUG/SHTL MATING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200903	PRELAUNCH C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200904	COUNTDOWN	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200905	PRLNTS. & GASES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: 9/14/73
PAGE: 2 OF

X NON RECURRING(DDT&E)

RECURRING(PRODUCTION)

RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
3200906	POST FLT. SAFING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32010	LAUNCH OPNS ETR	.0	.2	.2	.2	.5	.8	.6	.6	.3	.0	.0	.0	.0	.0	.0	.0
3201001	LNCH SITE SVCES	.0	.1	.1	.1	.2	.3	.2	.2	.1	.0	.0	.0	.0	.0	.0	.0
3201002	TUG/SHTL MATING	.0	.0	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
3201003	PRELAUNCH C/O	.0	.0	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
3201004	COUNTDOWN	.0	.0	.0	.0	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0
3201005	PRLNTS & GASES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201006	POST FLT. SAFING	.0	.0	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
32011	FLIGHT OPNS NASA	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201101	MISSION PLG.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201102	FLT. CONTROL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201103	FLT. EVAL.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201104	FLT. SUPT. SFTWRE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	1.1	2.2	1.6	1.0	2.1	2.5	1.0	.0	.0	.0	.0	.0	.0	.0
3201201	MISSION PLG	.0	.0	.4	.9	.8	.6	1.4	1.4	.4	.0	.0	.0	.0	.0	.0	.0
3201202	FLT. CONTROL	.0	.0	.1	.3	.4	.3	.5	.8	.5	.0	.0	.0	.0	.0	.0	.0
3201203	FLT. EVAL.	.0	.0	.0	.1	.1	.1	.1	.2	.1	.0	.0	.0	.0	.0	.0	.0
3201204	FLT. SUPT. SFTWRE	.0	.0	.6	.9	.4	.0	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201301	SCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201302	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201303	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201304	TUG/PL MAING &/CO	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201305	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201306	DEPOT MAINT	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32014	REFURB &INTEG ETR	.0	.2	.2	.2	.4	.7	.5	.5	.2	.0	.0	.0	.0	.0	.0	.0
3201401	SCH MAINT & REF	.0	.0	.0	.0	.1	.1	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0
3201402	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201403	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201404	TUG/PL MATING,C/O	.0	.0	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
3201405	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201406	DEPOT MAINT	.0	.1	.1	.1	.2	.2	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0

12-102

STUDY TITLE: SPACE TUG SYS STY (CHYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: 9/14/73
PAGE: 5 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.7	1.0	.2	1.6	1.6	1.4	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.0	.0	5.2	6.9	6.9	3.9	8.6	8.6	8.6	6.5	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	.0	.0	.0	.0	40.7	.1	51.6	.0	44.3	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.1	.1	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.0	.0	.1	.1	.1	.2	.5	.5	.5	.4	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.0	.0	.0	.0	.0	3.4	.0	4.0	.0	.0	.0	.0	.0	.0	.0	.0
320	TOTAL PROJ PHASE	.0	.0	.0	5.5	47.9	11.4	56.9	13.4	55.3	11.0	8.4	.0	.0	.0	.0	.0

12-103

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: 9/14/73
PAGE: 4 OF

NON RECURRING(DDT&E) X RECURRING(PRODUCTION) RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
320	TOTAL PROJ PHASE	.0	.0	.0	8.5	47.9	11.4	56.9	13.4	55.3	11.0	8.4	.0	.0	.0	.0	.0
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.7	1.0	.2	1.6	1.6	1.4	.0	.0	.0	.0	.0
3200101	COST/PERF. MGMT.	.0	.0	.0	.0	.0	.5	.7	.2	1.1	1.1	.9	.0	.0	.0	.0	.0
3200102	PROJ. DIRECTION	.0	.0	.0	.0	.0	.2	.3	.1	.5	.5	.4	.0	.0	.0	.0	.0
3200103	INFORM. MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.0	.0	5.2	6.9	6.9	3.9	8.6	8.6	8.6	6.5	.0	.0	.0	.0	.0
3200201	TUG SYS. ENGR.	.0	.0	.0	.5	.7	.7	.5	1.3	1.3	1.3	1.0	.0	.0	.0	.0	.0
3200202	SHUTTLE I/F	.0	.0	.0	.1	.2	.2	.1	.3	.3	.3	.3	.0	.0	.0	.0	.0
3200203	PAYLOAD I/F	.0	.0	.0	.3	.4	.4	.3	.7	.7	.7	.5	.0	.0	.0	.0	.0
32003	VEH MAIN STAGE	.0	.0	.0	.0	40.7	.1	51.6	.0	44.3	.0	.0	.0	.0	.0	.0	.0
3200301	STRUCTURES	.0	.0	.0	.0	4.7	.0	6.5	.0	5.7	.0	.0	.0	.0	.0	.0	.0
3200302	THERMAL CONTROL	.0	.0	.0	.0	1.3	.0	1.6	.0	1.4	.0	.0	.0	.0	.0	.0	.0
3200303	AVIONICS	.0	.0	.0	.0	12.6	.0	20.8	.0	17.8	.0	.0	.0	.0	.0	.0	.0
3200304	PROPULSION	.0	.0	.0	.0	10.5	.0	13.9	.0	11.9	.0	.0	.0	.0	.0	.0	.0
3200305	ORBITER I/F	.0	.0	.0	.0	6.4	.0	1.0	.0	.9	.0	.0	.0	.0	.0	.0	.0
3200306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200307	FINAL ASSY & C/O	.0	.0	.0	.0	5.2	.0	7.7	.0	6.6	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200401	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.1	.1	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0
3200501	TRANSP. & HDLG.	.0	.0	.0	.0	.1	.1	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0
3200502	TRAINING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200503	INV CONT. & WHSNG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32006	FACILITIES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200601	MANUFACTURING	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200602	TEST	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.0	.0	.1	.1	.1	.2	.5	.5	.5	.4	.0	.0	.0	.0	.0
3200701	MFG. GSE	.0	.0	.0	.1	.1	.1	.2	.5	.5	.5	.4	.0	.0	.0	.0	.0
32008	VEHICLE TEST	.0	.0	.0	.0	.0	3.4	.0	4.0	.0	.0	.0	.0	.0	.0	.0	.0
3200803	FLT. TEST HDWE.	.0	.0	.0	.0	.0	3.4	.0	4.0	.0	.0	.0	.0	.0	.0	.0	.0
3200204	SUST. ENGR.	.0	.0	.0	4.2	5.6	5.6	3.0	6.3	6.3	6.3	4.7	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: 9/14/73
PAGE: 8 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.2
32002	SYS. ENGR. & INT.	.0	.0	.0	.0	.0	.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	.5
32003	VEH MAIN STAGE	.0	.0	.0	.0	.5	1.9	1.9	1.9	1.7	1.6	1.6	1.6	1.6	1.6	.9	.1
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.2	.7	.7	.7	.7	.8	.8	.8	.8	.8	.8	.4
32006	FACILITIES	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
32007	GRND. SUPT. EQUIP	.0	.0	.0	.0	.2	.7	.7	.7	.6	.6	.6	.6	.6	.6	.6	.3
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.0	.4	.5	.7	.7	.7	.7	.7	.7	.3
32010	LAUNCH OPNS ETR	.0	.0	.0	.0	.0	.7	1.5	1.5	1.8	2.1	2.1	2.1	2.1	2.1	2.1	1.1
32011	FLIGHT OPNS NASA	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	.0	.0	.0	1.5	3.0	3.0	3.2	3.5	3.5	3.5	3.5	3.5	3.5	1.7
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	.0	.0	.3	.5	.7	.7	.7	.7	.7	.7	.3
32014	REFURB &INTEG ETR	.0	.0	.0	.0	.0	1.2	2.5	2.5	2.6	2.8	2.8	2.8	2.8	2.8	2.8	1.4
320	TOTAL PROJ PHASE	.0	.0	.0	.0	.8	7.7	11.6	12.3	13.3	14.2	14.2	14.2	14.2	14.2	13.5	6.4

STOP

COMPUTE TIME 50.856
READY

12-105

STUDY TITLE: SPACE TUG SYS STY (CRYO) | FUNDING SCHEDULE | DATE: 9/14/73
CONTRACT NO: NAS 8-29677 | DATA FORM C | PAGE: 6 OF

NON RECURRING(DDT&E) | RECURRING(PRODUCTION) | X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
320	TOTAL PROJ PHASE	.0	.0	.0	.0	.8	7.7	11.6	12.3	13.3	14.2	14.2	14.2	14.2	14.2	13.5	6.4
32001	PROJECT MGMT.	.0	.0	.0	.0	.0	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.2
3200101	COST/PERF. MGMT.	.0	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.1
3200102	PROJ. DIRECTION	.0	.0	.0	.0	.0	.0	.1	.1	.0	.1	.1	.1	.1	.1	.1	.0
3200103	INFORM. MGMT.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32002	SYS. ENGR. & INT.	.0	.0	.0	.0	.0	.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	.5
32003	VEH MAIN STAGE	.0	.0	.0	.0	.5	1.9	1.9	1.9	1.7	1.6	1.6	1.6	1.6	1.6	.9	.1
3200301	STRUCTURES	.0	.0	.0	.0	.0	.1	.1	.1	.0	.0	.0	.0	.0	.0	.0	.0
3200302	THERMAL CONTROL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200303	AVIONICS	.0	.0	.0	.0	.3	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	.7	.1
3200304	PROPULSION	.0	.0	.0	.0	.2	.6	.6	.6	.5	.4	.4	.4	.4	.4	.2	.0
3200305	ORBITER I/F	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.0	.0
3200306	DROP TANKS	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200307	FINAL ASSY & C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32004	VEH AUX. STAGE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32005	LOGISTICS	.0	.0	.0	.0	.2	.7	.7	.7	.7	.8	.8	.8	.8	.8	.8	.4
3200501	TRANSP. & HDLG.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200502	TRAINING	.0	.0	.0	.0	.1	.4	.4	.4	.3	.2	.2	.2	.2	.2	.2	.1
3200503	INV CONT. & WHSNG	.0	.0	.0	.0	.1	.3	.3	.3	.4	.6	.6	.6	.6	.6	.6	.3
32006	FACILITIES	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
3200603	ETR MAINT. & REF.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200604	ETR LAUNCH	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200605	WTR MAINT. & REF.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200606	WTR LAUNCH	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32007	GRND. SUPT. EQUIP	.0	.0	.0	.0	.2	.7	.7	.7	.6	.6	.6	.6	.6	.6	.6	.3
3200701	MFG. GSE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200702	ETR GSE	.0	.0	.0	.0	.1	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.1
3200703	WTR GSE	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
3200704	FLT OPS GSE(NASA)	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200705	FLT OPS GSE(DOD)	.0	.0	.0	.0	.1	.3	.3	.3	.2	.2	.2	.2	.2	.2	.2	.1
32009	LAUNCH OPNS. WTR	.0	.0	.0	.0	.0	.0	.0	.4	.5	.7	.7	.7	.7	.7	.7	.3
3200901	LNCH SITE SVCES	.0	.0	.0	.0	.0	.0	.0	.1	.2	.3	.3	.3	.3	.3	.3	.1
3200902	TUG/SHTL MATING	.0	.0	.0	.0	.0	.0	.0	.1	.0	.1	.1	.1	.1	.1	.1	.0
3200903	PRELAUNCH C/O	.0	.0	.0	.0	.0	.0	.0	.1	.0	.1	.1	.1	.1	.1	.1	.0
3200904	COUNTDOWN	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1
3200905	PRLNTS. & GASES	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3200906	POST FLT. SAFING	.0	.0	.0	.0	.0	.0	.0	.1	.0	.1	.1	.1	.1	.1	.1	.0
32010	LAUNCH OPNS ETR	.0	.0	.0	.0	.0	.7	1.5	1.5	1.8	2.1	2.1	2.1	2.1	2.1	2.1	1.1
3201001	LNCH SITE SVCES	.0	.0	.0	.0	.0	.3	.6	.6	.7	.8	.8	.8	.8	.8	.8	.4
3201002	TUG/SHTL MATING	.0	.0	.0	.0	.0	.1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.1
3201003	PRELAUNCH C/O	.0	.0	.0	.0	.0	.1	.2	.2	.2	.3	.3	.3	.3	.3	.3	.1
3201004	COUNTDOWN	.0	.0	.0	.0	.0	.1	.3	.3	.3	.4	.4	.4	.4	.4	.4	.2
3201005	PRLNTS & GASES	.0	.0	.0	.0	.0	.0	.1	.1	.0	.1	.1	.1	.1	.1	.1	.0
3201006	POST FLT. SAFING	.0	.0	.0	.0	.0	.1	.2	.2	.3	.3	.3	.3	.3	.3	.3	.2
32011	FLIGHT OPNS NASA	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201101	MISSION PLG.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201102	FLT. CONTROL	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0

STUDY TITLE: SPACE TUG SYS STY (CRYO)
CONTRACT NO: NAS 8-29677

FUNDING SCHEDULE
DATA FORM C

DATE: 9/14/73
PAGE: 7 OF

NON RECURRING(DDT&E) RECURRING(PRODUCTION) X RECURRING(OPERATIONS)

DOLLARS IN MILLIONS

WBS NUMBER	WBS NAME	FY 76	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89	FY 90	FY 91
3201103	FLT. EVAL.	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201104	FLT. SUPT. SFTWRE	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
32012	FLIGHT OPNS DOD	.0	.0	.0	.0	.0	1.5	3.0	3.0	3.2	3.5	3.5	3.5	3.5	3.5	3.5	1.7
3201201	MISSION PLG	.0	.0	.0	.0	.0	.2	.5	.5	.6	.8	.8	.8	.8	.8	.8	.4
3201202	FLT. CONTROL	.0	.0	.0	.0	.0	.9	1.7	1.7	1.6	1.4	1.4	1.4	1.4	1.4	1.4	.7
3201203	FLT. EVAL.	.0	.0	.0	.0	.0	.2	.4	.4	.7	.9	.9	.9	.9	.9	.9	.5
3201204	FLT. SUPT. SFTWRE	.0	.0	.0	.0	.0	.2	.3	.3	.4	.4	.4	.4	.4	.4	.4	.2
32013	REFURB &INTEG WTR	.0	.0	.0	.0	.0	.0	.0	.3	.5	.7	.7	.7	.7	.7	.7	.3
3201301	SCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.1	.1	.2	.2	.2	.2	.2	.2	.1
3201302	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201303	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201304	TUG/PL MAING &/CO	.0	.0	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1
3201305	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201306	DEPOT MAINT	.0	.0	.0	.0	.0	.0	.0	.3	.2	.3	.3	.3	.3	.3	.3	.1
32014	REFURB &INTEG ETR	.0	.0	.0	.0	.0	1.2	2.5	2.5	2.6	2.8	2.8	2.8	2.8	2.8	2.8	1.4
3201401	SCH MAINT & REF	.0	.0	.0	.0	.0	.1	.3	.3	.3	.5	.5	.5	.5	.5	.5	.2
3201402	UNSCH MAINT & REF	.0	.0	.0	.0	.0	.0	.1	.1	.0	.1	.1	.1	.1	.1	.1	.0
3201403	POST MAINT C/O	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
3201404	TUG/PL MATING,C/O	.0	.0	.0	.0	.0	.1	.2	.2	.3	.3	.3	.3	.3	.3	.3	.2
3201405	REFURB RQMTS PLG	.0	.0	.0	.0	.0	.0	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
3201406	DEPOT MAINT	.0	.0	.0	.0	.0	.9	1.9	1.9	1.8	1.8	1.8	1.8	1.8	1.8	1.8	.9
3200204	SUST. ENGR.	.0	.0	.0	.0	.0	.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	.5

Figure 12.3.2.3.1

DOD PROGRAM OPTION 3 SPACE TUG
VALIDATION PHASE ESTIMATED COSTS
(1973 Dollars in Millions)

WBS No.	Description	Cost Estimate		
		Initial	Final	Total
320-01	Project Management	.61	.90	1.51
320-02	Systems Engineering and Integration	1.94	2.84	4.78
320-03	Vehicle Main Stage (Including SR&T)	11.98	17.61	29.59
320-08-01	Vehicle Test- Ground Test Hardware	.66	.59	1.25
320-08-02	Vehible Test - Ground Test Operations	.16	.51	.67
	Sub-Total	15.35	22.45	37.80
	DSARC Review - One Month	.73	1.07	1.80
	TOTAL	16.08	23.52	39.60

Figure 12.3.2.3.2

DOD PROGRAM OPTION 3 SPACE TUG
NASA FULL SCALE DEVELOPMENT PHASE ESTIMATED COSTS
(1973 Dollars in Millions)

WBS No.	Description	Cost Estimate		
		Initial	Final	Total
320-04	Vehicle Auxiliary Stage	1.63	0	1.63
320-07-04	Flight Operations Control GSE (NASA)	.48	.48	.96
320-10	Launch Operations - ETR	3.03	2.52	5.55
320-11	Flight Operations - NASA	9.46	7.56	17.02
320-14	Refurbishment and Integration - ETR	2.79	1.80	4.59
	TOTAL	17.39(1)	12.36(2)	29.75

(1) Includes the cost of six IOT&E flights at $1.561 M per flight.

(2) Includes the cost of five IOT&E flights at $1.455 M per flight.

Figure 12.3.2.3.3

DOD PROGRAM OPTION 3 SPACE TUG
NASA PRODUCTION PHASE ESTIMATED COSTS
(1973 Dollars in Millions)

WBS No.	Description	Cost Estimate		
		Initial	Final	Total
320-04	Vehicle Auxiliary Stage	12.10(1)	4.97(2)	17.16

(1) Includes $10.0 M start up cost and three units at $.73 M per unit.

(2) Includes the cost of seven units at $.71 M per unit

Figure 12.3.2.3.4

DOD PROGRAM OPTION 3 SPACE TUG
NASA OPERATIONS PHASE ESTIMATED COSTS
(1973 Dollars in Millions)

WBS No.	Description	Cost Estimate		
		Initial	Final	Total
320-03-03	Vehicle Main Stage Avionics (Software)	.34	1.71	2.05
320-07-02	ETR GSE (Software)	.17	.69	.86
320-07-03	WTR GSE (Software)	-0-	.17	.17
320-07-04	Flight Operations Control GSE (NASA)	1.09	1.09	2.18
320-09	Launch Operations - WTR	-0-	9.65	9.65
320-10	Launch Operations - ETR	5.55	20.89	26.44
320-11	Flight Operations - NASA	9.60	31.94	41.54
320-13	Refurbishment and Integration - WTR	-0-	8.38	8.38
320-14	Refurbishment and Integration - ETR	10.04	25.39	35.43
	TOTAL	26.79(1)	99.91(2)	126.70

(1) Provides for 34 operational flights (ETR only).

(2) Provides for 171 operational flifhts (138 at ETR and 33 at WTR).

Figure 12.4.1.1

Program Option No. 3 - DOD

WBS 320 Level - 3 Total Space Tug Project

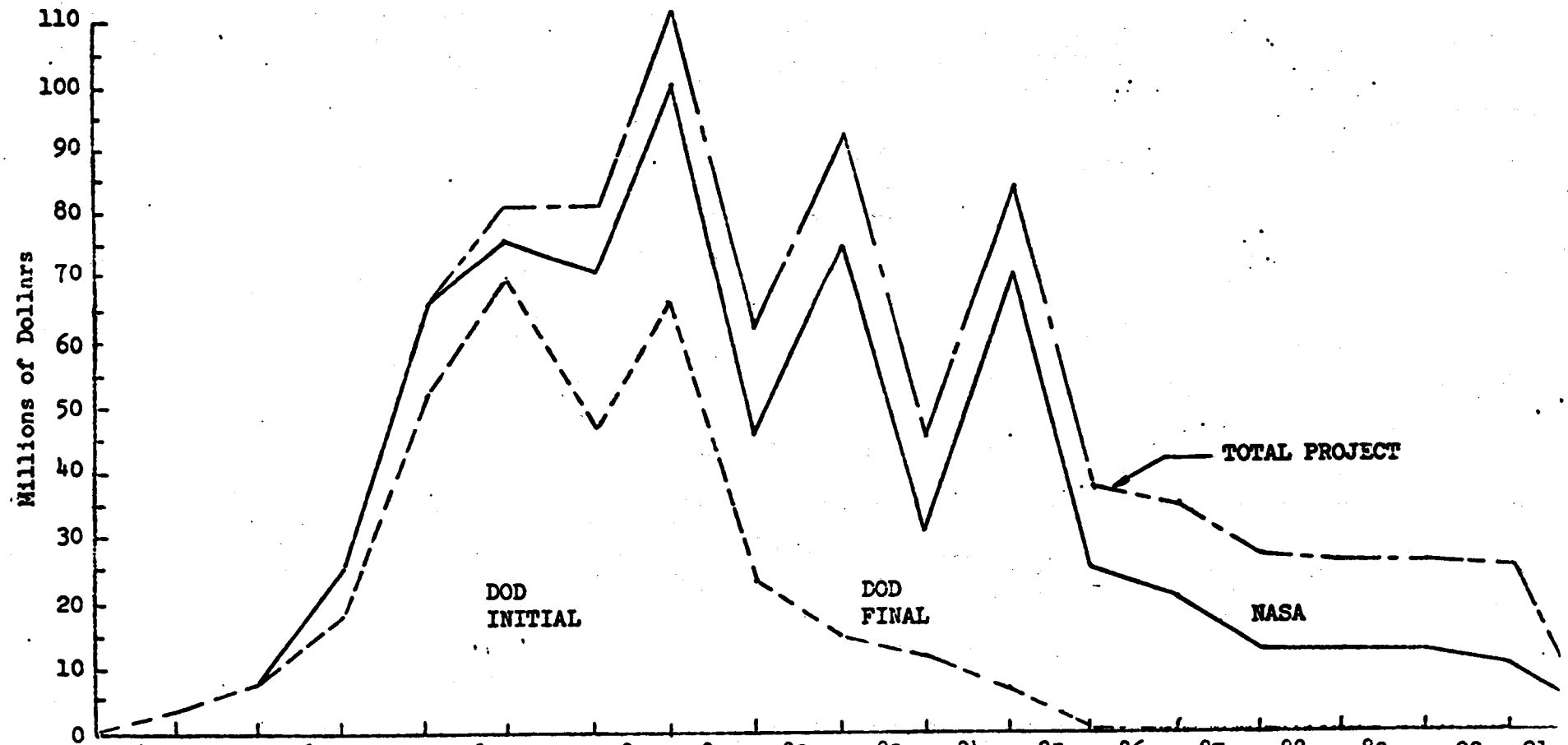
Annual Funding - Tabular

1973 Dollars in Millions

GFY	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	TOTAL
DOD INITIAL																			
VALID.	3.0	8.0	5.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16.1
FSD	0	0	12.9	52.4	69.5	41.7	18.1	4.7	.1	0	0	0	0	0	0	0	0	0	199.3
PROD.	0	0	0	0	0	5.5	47.9	11.3	3.1	.4	.2	.2	.2	0	0	0	0	0	68.7
OPS	0	0	0	0	0	0	.8	7.7	11.6	12.3	6.4	.4	.4	.4	.4	.4	.4	.2	42.2
SUBTOTAL	3.0	8.0	18.0	52.4	69.5	47.2	66.8	23.7	14.8	12.7	6.6	.6	.6	.4	.4	.4	.4	.2	326.3
DOD FINAL																			
VALID.	0	0	6.0	15.0	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	23.5
FSD	0	0	0	0	5.7	24.3	33.8	22.4	13.1	5.8	2.1	0	0	0	0	0	0	0	107.1
PROD.	0	0	0	0	0	0	0	.1	53.8	13.0	55.1	10.8	8.2	0	0	0	0	0	141.1
OPS	0	0	0	0	0	0	0	0	0	0	6.9	13.8	13.8	13.8	13.8	13.8	13.1	6.2	95.3
DOD TOTAL	3.0	8.0	24.0	67.4	77.7	71.5	100.6	46.2	81.7	31.5	70.7	25.2	22.6	14.2	14.2	14.2	13.5	6.4	693.3
NASA INITIAL	0	0	0	0	3.0	9.1	9.2	12.6	9.0	9.0	4.5	0	0	0	0	0	0	0	56.4
NASA FINAL	0	0	0	0	0	0	2.1	2.5	2.5	4.8	9.6	15.3	15.3	15.3	14.3	14.3	14.3	7.0	117.2
NASA TOTAL	0	0	0	0	3.0	9.1	11.3	15.1	11.5	13.8	14.1	15.3	15.3	15.3	14.3	14.3	14.3	7.0	173.6
PROJECT TOTAL	3.0	8.0	24.0	67.4	80.7	80.6	111.9	61.3	93.2	45.3	84.8	40.5	37.9	29.5	28.5	28.5	27.8	13.4	866.9

Figure 12.4.1.2

OPTION 3 DOD PROGRAM
ANNUAL FUNDING
(1973 Dollars in Millions)



GFY	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
DOD Initial	3.0	8.0	18.0	52.4	69.5	47.2	66.8	23.7	14.8	12.7	6.6	.6	.6	.4	.4	.4	.4	.2
DOD Final			6.0	15.0	8.2	24.3	33.3	22.5	66.9	18.8	64.1	24.6	22.0	13.8	13.8	13.8	13.1	6.2
DOD Total	3.0	8.0	24.0	67.4	77.7	71.5	100.6	46.2	31.7	31.5	70.7	25.2	22.6	14.2	14.2	14.2	13.5	6.1
NASA Total					3.0	9.1	11.3	15.1	11.5	13.8	14.1	15.3	15.3	15.3	14.3	14.3	14.3	7.0
Project Total	3.0	8.0	24.0	67.4	80.7	80.6	111.9	61.3	93.2	45.3	84.8	40.5	37.9	29.5	28.5	28.5	27.8	13.1

Figure 12.5.1

PROGRAM OPTION 3 SPACE TUG

COST COMPARISON - DOD VS. NASA SYSTEM ACQUISITION CYCLE

TOTAL PROGRAM COSTS

1973 DOLLARS IN MILLIONS

AGENCY	PROGRAM PHASES					
	VALIDATION	FULL SCALE DEVELOPMENT	DDT&E (VAL.+ FSD)	PRODUCTION	OPERATIONS	TOTAL PROGRAM
DOD	39.60	336.19	375.79	226.91	264.19	866.89
NASA	-	-	278.92	275.53	293.02	847.47
Δ DOD VS. NASA			+96.87 (Δ+33%)	-48.62 (Δ-18%)	-28.83 (Δ-10%)	+19.42 (Δ+2%)

SECTION 13

13 COST ESTIMATING METHODOLOGY

13.1 Overall Cost Methodology

13.1.1 Summary

Existing, proven analytical tools in the hands of experienced analysts have been utilized to achieve the study objective of reliable, consistent, well-defined and documented "should cost" estimates and funding projections within the constraints of budget and schedule. The ability to effectively and realistically estimate costs and funding is dependent upon three major factors: (1) completeness and comprehensiveness of definitions; (2) the validity of an applicable data base; and (3) the ability to relate these two factors utilizing highly qualified estimators.

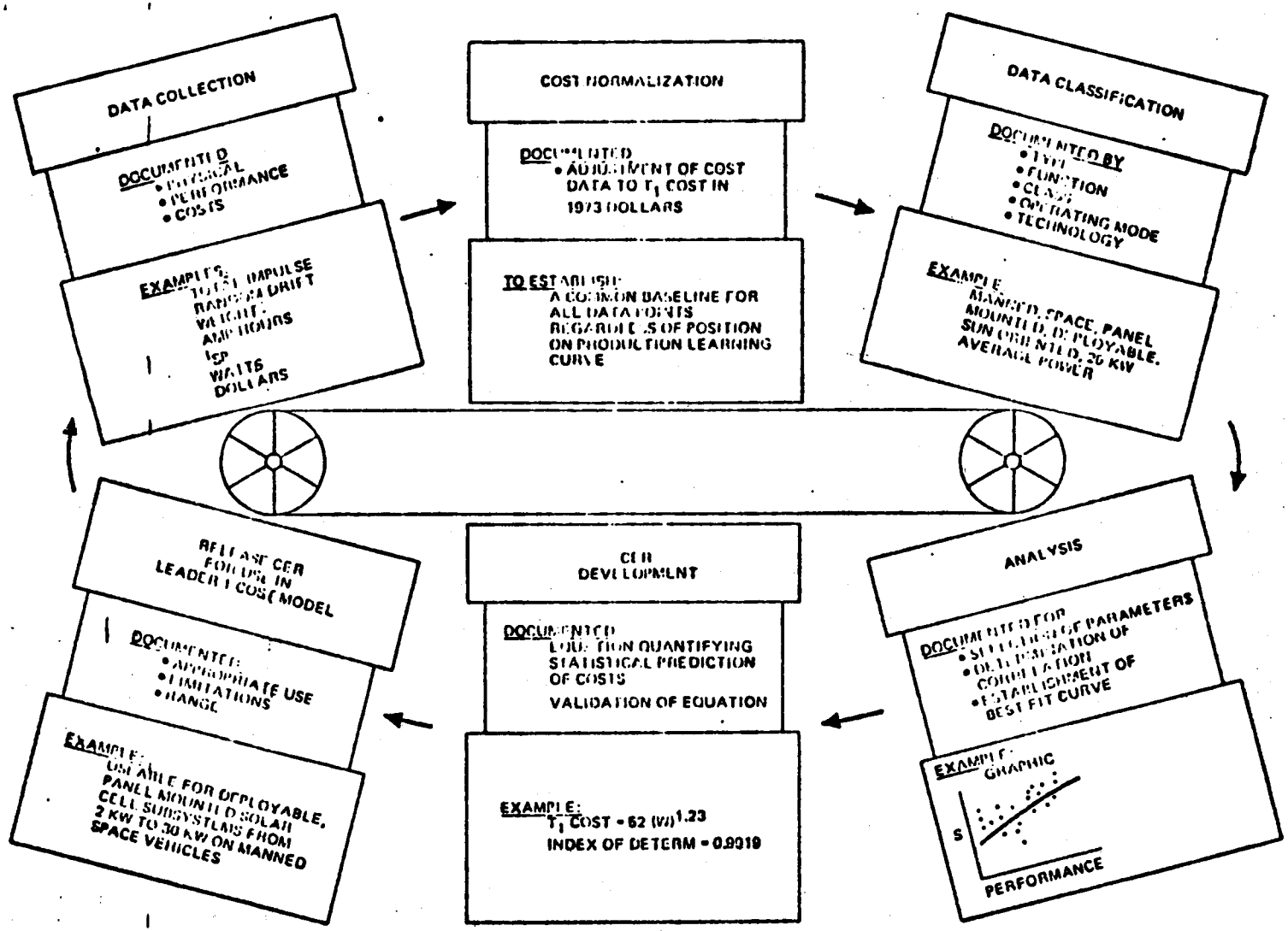
The LEADER II cost model has been used to relate the technical and programmatic definitions, provided by other members of the study team, to the Cost Data Base stored in the cost model and to generate cost estimates and funding analyses in accordance with the NASA-approved WBS. The estimates effectively correlate technical performance, schedules and costs. As a rapid, multi-faceted, techno-economic tool for estimating costs, funding and manpower, LEADER II has been used to measure higher-level cost and funding impacts of lower level alternatives. Its use contributes to the credibility, consistency and traceability of the cost estimates. It has been used to generate the cost and funding of Space Tug Project's total life cycle and elements thereof based on CER's (Cost Estimating Relationships), cost factors, or direct inputs values.

The CER's and cost factors, which constitute the LEADER II data base, have been developed over a seven-year period from data quotes, and study values of function, physical, performance, schedule and cost on a number of major programs. The basic data used in the LEADER II data base were derived principally from Thor/Delta, SIV/SIVB, Sky Lab, SOAR II, Gemini, MOL, Sortie/Lab, Saturn/Apollo, and Titan. In addition, data specifically for the Space Tug has been received from prospective suppliers in response to formal Requests for Information. The cost model, as modified to conform to the Space Tug WBS, encompasses 865 lines of data (each for the basic equations and the variable file) and a cross reference matrix of 276 lines.

As depicted in Figure 13.1.1-1, development of the CER's began with collecting and validating applicable physical, performance and cost data and then normalizing the data to a common baseline. The data were then classified within homogeneous groupings. Multivariable regression analysis and other statistical techniques were used to identify these parameters which best predicted costs, and to derive the equations, or CER's, which expressed the costs as a function of technical/performance values. The CER's were tested and validated before being incorporated into the cost model. Each of the steps in CER development was documented to provide a traceable record from raw source data and rationale and methodology used in the analyses, through CER development and validation.

Having adequate and valid cost data is a primary requisite for the development of reliable CER's. As an organizational element of

CER DEVELOPMENT CYCLE



MCDONNELL DOUGLAS

Figure 13.1.1-1

the Fiscal Management Subdivision, the Advance Systems Cost Analysis team uniquely has access to historical and proprietary data contained in its departmental data bank. The Data Bank for many years has actively collected, catalogued and stored pertinent techno-economic and cost information obtained from industry, government agencies and non-profit organizations. The Data Bank serves as a repository for departmental and technical or performance data.

A description of the cost estimating technique for each WBS element, as appropriate, is contained in Table 13.1.1-1

13.1.2 Assumptions, Ground Rules and Rationale

13.1.2.1 Cost estimates are in constant 1973 dollars.

13.1.2.2 Cost estimates have been developed in consonance with the Government provided Space Tug Systems Studies Work Breakdown Structure and Dictionary, PD-Tug-P, dated 7 May 1973, and with clarifications/amendments thereto appearing in the following documents: (1) Data Package, Spage Tug Systems Studies, April 1973; (2) Memorandum PD-Tug-P (020-74), dated 10 August 1973, from PD-Tug-P/Mr. Stucker to PD-Tug-C/Mr. Orillion, subject: Changes to the Work Breakdown Structure and Dictionary. Figure 13.1.2.2-1 displays the WBS as amended.

13.1.2.3 Candidate concept costs have been estimated and are reported at or below the WBS level shown in the Government provided WBS Diagram and Dictionary. The costs have been estimated at the same level of detail as the technical data, which generally has been

OVERALL COST METHODOLOGY

STUDY TITLE: SPACE TUG SYSTEMS STUDY (CRYOGENIC)

CONTRACT NO.: NAS 8-29677

DATE: 5 September 1973

WBS ELEMENT		ESTIMATING TECHNIQUE APPLIED
WBS NUMBER	WBS INDENTIFICATION	
320	Total Tug Project	Summation of lower level values
320-01	Project Management	Percentages of costs excluding Project Management and Systems Engineering and Integration
320-02	Systems Engrg. & Integration	DDT&E - Percentage of WBS 320-03 Vehicle Main Stage DDT&E cost Production - Level of effort computed as a function of vehicle complexity, production schedule, production rate, and Total Production Cost for WBS 320-03, Vehicle Main Stage. Operations - Time-related level of effort.
320-03	Vehicle Main Stage	Summation of lower level values.
320-03-01	Structures Subsystem	Summation of lower level CER's and direct estimates expressing costs as a function of designs, types of material, power, performance, methods of fabrication, quantities, and other considerations as summarized on Data Form-B. Main Engine costs were provided by the Government. CER's were cross-checked against vendor quotes for certain assemblies and components. Initial Spares and Operational Spares calculated as decimal portions of First Unit Cost of Assembly Hardware (Level 6) following the Production Quantity x Quantity of Spares at Level 6 on the appropriate Learning Curve.
320-03-02	Thermal Control Subsystem	
320-03-03	Avionics Subsystem	
320-03-04	Propulsion Subsystem	
320-03-05	Orbiter Interface Subsystem	
320-03-06	Drop Tanks Subsystem	None required
320-03-07	Final Assembly & Checkout	Percentage of subsystems costs excluding Final Assembly and Checkout.

Table 13.I.1-1

STUDY TITLE: SPACE TUG SYSTEMS STUDY (CRYOGENIC)

CONTRACT NO.: NAS 8-29677

DATE: 5 September 1973

WBS ELEMENT		ESTIMATING TECHNIQUE APPLIED
WBS NUMBER	WBS INDENTIFICATION	
320-04	Vehicle Auxiliary Stage	Stage costs supplied by the Government. Adaptation/Integration costs estimated using CER's at Subsystem/Assembly levels.
320-05	Logistics	Summation of lower level values
320-05-01	Transportation & Handling	Cost/Trip x Number of Trips
320-05-02	Training	Summation of Lower Level Values
320-05-02-01	Simulation and Equipment	Vehicle equivalent Units x Unit Cost
320-05-02-02	Training	Ground Crew / Flight Operations } Labor Man-Months x Cost/Man-Month
320-05-03	Inventory Control & Warehousing	Labor Man-Months x Cost/Man-Month
320-06	Facilities	Summation of lower level values Design and Construction - Quantities by Site x Current Unit Values Activation - Percentage of Design/Construction Cost Maintenance - Factor/Year x Number of Years
320-07	Ground Support	Summation of lower level values Hardware - Unit Cost x Number of Units at each Location - Factory, ETR and WTR Activation - Percentage of Hardware Cost Software - Number of Words x Average Cost/Word Maintenance: Hardware - Percentage/Year x Number of Years Software - Update Cost/Flight x Number of Flights

Table 13.1.1

13-6

WBS ELEMENT		ESTIMATING TECHNIQUE APPLIED
WBS NUMBER	WBS INDENTIFICATION	
320-08	Vehicle Test	Summation of Lower Level Values
320-08-01	Ground Test Hardware	Number of equivalent units by Subsystem and Assembly
320-08-02	Ground Test Operations	Number of Man-Months by Skill x Rates Per Man-Month by Skill
320-08-03	Flight Test Hardware	Number of equivalent complete units of Vehicle Main Stage x First Unit Cost of Vehicle Main Stage
320-08-04	Flight Test Operations	Number of Man-Months by Skill x Rates Per Man-Month by Skill
320-09	Launch Operations - WTR	Summation of Lower Level Values
320-09-01	Launch Site Services/Support	Summation of number of Man-Months by Skill, by Shift, by Task, by specific year x Rates Per Man-Month by Skill
320-09-02	Tug/Shuttle Mating and Checkout	
320-09-03	Prelaunch Checkout	
320-09-04	Countdown	
320-09-06	Post-Flight Safing	
320-09-05	Propellant and Gases	Number of pounds Per Flight x Costs Per Pound (Provided by the Government) x Number of Flights
320-10	Launch Operations - ETR	Same as 320-09
320-11	Flight Operations - NASA	Summation of Lower Level Values
320-11-01	Mission Planning	Summation of: [Number of Man-Months by Skill, by Task, by Specific Year, by Agency x Rates Per Man-Month by Skill] + [Number of Computer Hours Per Year x Cost Per Computer Hour]
320-11-02	Flight Control	
320-11-03	Flight Evaluation	
320-11-04	Flight Support Software	

Table 13.1.1-1

OVERALL COST METHODOLOGY

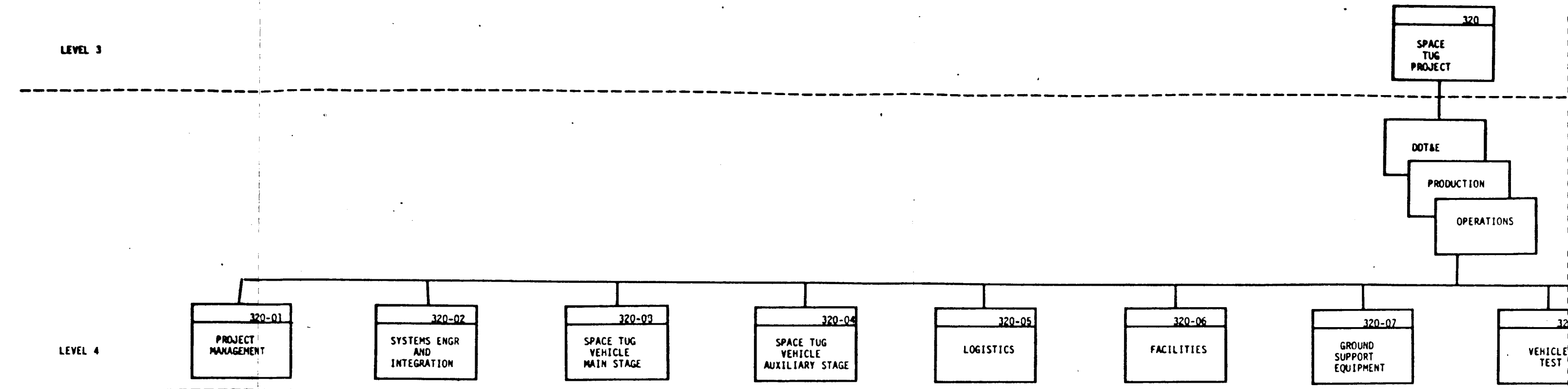
STUDY TITLE: SPACE TUG SYSTEMS STUDY (CRYOGENIC)

CONTRACT NO.: NAS 8-29677

DATE: 5 September 1973

WBS ELEMENT		ESTIMATING TECHNIQUE APPLIED
WBS NUMBER	WBS INDENTIFICATION	
320-12	Flight Operations - DOD	Same as 320-11
320-13	Refurbishment and Integration - WTR	Summation of Lower Level Values
320-13-01	Scheduled Maintenance and Refurbishment	Summation of the Number of Man-Months by Skill, by Shift, by Task, by Specific Year x Rates Per Man-Month by Skill
320-13-02	Unscheduled Maintenance and Refurbishment	
320-13-03	Post Maintenance Checkout	
320-13-04	Tug/Payload Mating and Checkout	
320-13-05	Refurbishment Requirements Plannint	
320-13-06	Depot Maintenance	Summation of Per Flight Values per Subsystem x Number of Flights. Per Flight Values Per Subsystem derived from analyses at Assembly and Component Levels - Levels 5 and 6
320-14	Refurbishment and Integration - ETR	Same as 320-13.

Table 13.1.1-1



LEVEL 5 & 6

320-01-01 COST/PERFORM MGMT
320-01-02 PROJECT DIRECTION
320-01-03 INFORMATION MGMT

320-02-01 TUG SYSTEMS ENGRG
320-02-02 SHUTTLE INTERFACE
320-02-03 PAYLOAD INTERFACE
320-02-04 SUSTAINING ENGRG

320-03-01 STRUCTURES
- 320-03-01-01 FUEL TK & SPT
- 320-03-01-02 OXID TK & SPT
- 320-03-01-03 BODY STRUCTURE
- 320-03-01-04 THRUST STRUC
- 320-03-01-05 METEOROID SH
- 320-03-01-06 PAYLOAD INTFAC
- 320-03-01-07 INST ASM & C/O

320-03-02 THERMAL CONTROL
- 320-03-02-01 FUEL TK INSUL
- 320-03-02-02 OXID TK INSUL
- 320-03-02-03 INSUL PURG SYS
- 320-03-02-04 CONTROL SYSTEM
- 320-03-02-05 INST ASM & C/O

320-03-03 AVIONICS
- 320-03-03-01 DATA MGMT
- 320-03-03-02 GN&C
- 320-03-03-03 COMMUNICATIONS
- 320-03-03-04 INSTRUMENTATION
- 320-03-03-05 ELEC POWER
- 320-03-03-06 PWR DIST & CNTL
- 320-03-03-07 INST ASM & C/O

320-03-04 PROPULSION
- 320-03-04-01 MAIN ENG (GFE)
- 320-03-04-02 MAIN ENG SUPT
- 320-03-04-03 ACPS ENGINE
- 320-03-04-04 ACPS ENG SUPT
- 320-03-04-05 INST ASM & C/O

320-03-05 ORBITER INTERFACE
- 320-03-05-01 STRUCTURES
- 320-03-05-02 INTRFAC PANELS
- 320-03-05-03 PURGE PROVISION
- 320-03-05-04 ABORT PROVISION
- 320-03-05-05 INST ASM & C/O

320-03-06 DROP TANKS
- 320-03-06-01 STRUCTURES
- 320-03-06-02 THERMAL INSUL
- 320-03-06-03 PROP SUPT SYS
- 320-03-06-04 INST ASM & C/O

320-03-07 FINAL ASSEMBLY & C/O
- 320-03-07-01 FINAL ASSEMBLY
- 320-03-07-02 CHECKOUT

320-05-01 TRANSPORT & HANDLING
320-05-02 TRAINING
- 320-05-02-01 SIM. & EQUIP.
- 320-05-02-02 GROUND CREW
- 320-05-02-03 FLT OPER CREW

320-05-03 INV CONTL & WAREH

320-06-01 MANUFACTURING
- 320-06-01-01 DESIGN/CONSTR
- 320-06-01-02 ACTIVA/MAINTE

320-06-02 TEST
- 320-06-02-01 DESIGN/CONSTR
- 320-06-02-02 ACTIVA/MAINTE

320-06-03 MAINT & REFURB. ETR
- 320-06-03-01 DESIGN/CONSTR
- 320-06-03-02 ACTIVA/MAINTE

320-06-04 ETR LAUNCH
- 320-06-04-01 DESIGN/CONSTR
- 320-06-04-02 ACTIVA/MAINTE

320-06-05 MAINT & REFURB. WTR
- 320-06-05-01 DESIGN/CONSTR
- 320-06-05-02 ACTIVA/MAINTE

320-06-06 WTR LAUNCH
- 320-06-06-01 DESIGN/CONSTR
- 320-06-06-02 ACTIVA/MAINTE

320-07-01 MFG GSE
- 320-07-01-01 HARDWARE
- 320-07-01-02 SITE ACT
- 320-07-01-03 MAINTENANCE
- 320-07-01-04 SOFTWARE

320-07-02 EAST TEST RNG GSE
- 320-07-02-01 HARDWARE
- 320-07-02-02 SITE ACT
- 320-07-02-03 MAINTENANCE
- 320-07-02-04 SOFTWARE

320-07-03 WEST TEST RNG GSE
- 320-07-03-01 HARDWARE
- 320-07-03-02 SITE ACT
- 320-07-03-03 MAINTENANCE
- 320-07-03-04 SOFTWARE

320-07-04 FLT OPER CONTROL GSE (NASA)
- 320-07-04-01 HARDWARE
- 320-07-04-02 SITE ACT
- 320-07-04-03 MAINTENANCE
- 320-07-04-04 SOFTWARE

320-07-05 FLT OPER CONTROL GSE (DOD)
- 320-07-05-01 HARDWARE
- 320-07-05-02 SITE ACT
- 320-07-05-03 MAINTENANCE
- 320-07-05-04 SOFTWARE

320-08-01 GR
- 320-08-01-01
- 320-08-01-02
- 320-08-01-0
- 320-08-02 GR
- 320-08-03 FL
- 320-08-04 FL

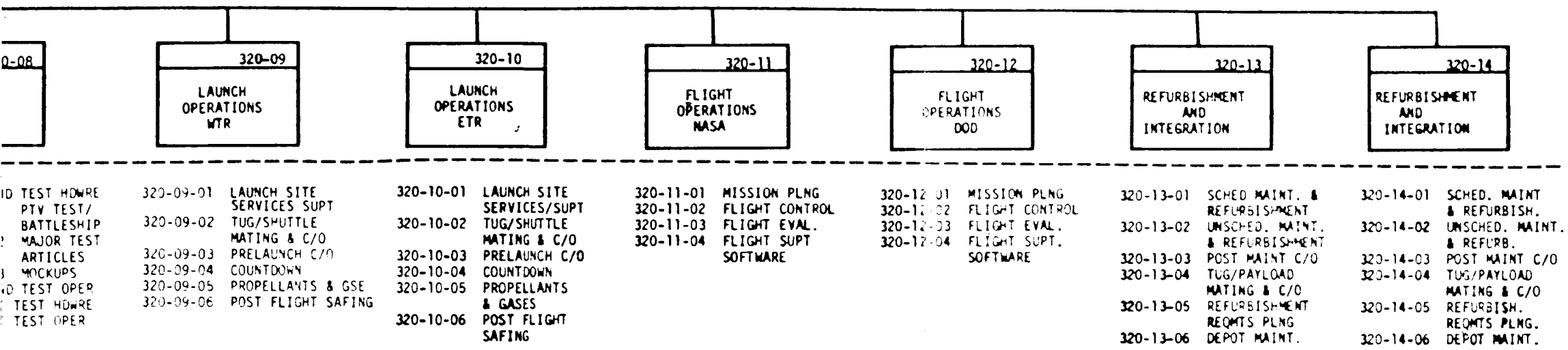


Figure 13.1.2.2-1. Space Tug Work Breakdown Structure

one or more levels below that reported.

13.1.2.4 The cost estimates are commensurate with the program definitions available at this time, the relative level of study effort, and with the understanding that the estimates are only for preliminary planning and tradeoff study purposes.

13.1.2.5 Funding estimates are reported by Government Fiscal Year - 1 July through 30 June.

13.1.2.6 The cost estimates reflect recent employment levels (calendar 1968-1972) and a 6 percent (compounded annually) inflation factor to derive values in terms of 1973 dollars. The estimates also reflect reduced Project Management, Systems Engineering and Integration, and Manufacturing costs. (Reference: Results of MDAC Special Cost Reduction Task.) Thus, the cost estimates effectively assume that timely award of a Phase C/D Contract; (1) would cause contractor employment to approach the 1968-1972 levels; and (2) that the Phase C/D effort would achieve effective management at reduced cost.

13.1.2.7 The cost estimates assume that all required Supporting Research and Technology (SRT), identified separately in Sections 2.6 and 10, will be available when needed.

The cost estimates and reporting are consistent with the following Government Action Items:

Reference: PD-Tug-P, 4 April 1973

4. ACTION ITEM:

WHAT IS THE LOWEST LEVEL OF COST REPORTING REQUIRED?

RESPONSE:

COST AND TECHNICAL DATA FOR DATA FORMS A(1), A(2), A(3) AND B SHOULD BE REPORTED TO THE LOWEST LEVEL SHOWN ON THE APPROVED COMMON WBS.

COST AND MANPOWER DATA FOR DATA FORM C SHOULD BE REPORTED AT WBS LEVEL 4 EXCEPT FOR THE FOLLOWING CATEGORIES: VEHICLE MAIN STAGE, AUXILIARY STAGE, FACILITIES, GSE, VEHICLE TEST, LAUNCH OPERATIONS AND REFURBISHMENT AND INTEGRATION SHOULD BE REPORTED AT WBS LEVEL 5.

5. ACTION ITEM:

WHAT IS THE SHUTTLE COST PER FLIGHT?

RESPONSE:

THE SHUTTLE COST PER FLIGHT IS $10.5M FOR THE PURPOSES OF THESE STUDIES.

8. ACTION ITEM:

COST OF EXISTING KICK STAGES?

RESPONSE:

REQUESTS FOR THE COST OF EXISTING KICK STAGES SHOULD BE MADE TO DICK KLAN, MSFC, 205-453-0462. ANY MODIFICATIONS NECESSARY FOR TUG APPLICATION OR DEVELOPMENT OF NEW KICK STAGES SHOULD BE ESTIMATED AND REPORTED BY THE CONTRACTORS.

9. ACTION ITEM:

WHAT YEAR DOLLARS SHOULD COSTS BE REPORTED?

RESPONSE:

ALL COSTS SHOULD BE REPORTED IN CONSTANT 1973 DOLLARS.

10. ACTION ITEM:

HOW WILL COST BE HANDLED FOR LOSS OF MISSION/PAYLOAD RESULTING FROM TUG RELIABILITY?

RESPONSE:

THE COST OF A "LOST" TUG SHOULD BE CONSIDERED IN SIZING THE TUG FLEET. IN THE EVENT A MISSION IS ABORTED AND MUST BE REFLOWN, THE COST OF A SECOND FLIGHT SHOULD BE INCLUDED. COST OF THE PAYLOADS THEMSELVES SHOULD NOT BE CONSIDERED.

11. ACTION ITEM:

USE OF COST DATA FORMATS - NASA AND USAF PHASING.

RESPONSE:

THE DATA FORMS A(1), A(2), A(3), B AND T SHOULD BE COMMON TO BOTH NASA AND USAF. BECAUSE OF THE DIFFERENT PHASING, IT MAY BE NECESSARY TO COMPLETE TWO SETS OF DATA FORM C; ONE TO REFLECT NASA PHASING AND ONE FOR THE USAF PHASING.

12. ACTION ITEM:

WHAT LEARNING CURVE SHOULD BE USED?

RESPONSE:

A LEARNING CURVE MAY BE USED TO ESTIMATE HARDWARE QUANTITY COSTS. THE TYPE LEARNING CURVE USED (STRAIGHT-LINE PROJECTION OF CUMULATIVE AVERAGE COSTS OR STRAIGHT-LINE PROJECTED UNIT COSTS) SHOULD BE NOTED AND THE PERCENT OF LEARNING SPECIFIED.

13.1.2.8 As directed by the Government, Operations cost estimates for ground tracking, i.e., MSFN/STADAN, include the cost of personnel required for tracking the Tug, even though these same people may track other space vehicles at other times. For example, if the Tug requires these people for only four hours, the Tug project is charged for a full eight hour day.

13.1.2.9 The cost estimates assume that DDT&E and Production essentially would be accomplished at MDAC's Huntington Beach, California, facilities.

13.1.2.10 As directed by the Government, the cost estimates assume that existing STE/GSE/PTE, etc., from previous programs (e.g., SIVB) will be available for Space Tug at no cost except for modification/upgrading costs which would be Tug peculiar and would then be chargeable. The storage and maintenance costs of existing facilities and GSE up to the time of Space Tug use are not chargeable to the Tug Program.

13.1.2.11 The following main engine costs have been provided by the Government and incorporated in the cost estimates:

Table 13.1.2.11-1

SPACE TUG MAIN ENGINE CANDIDATES

COSTS AND DEVELOPMENT TIMES

1973 DOLLARS IN MILLIONS

Main Engine	Total DDT&E Cost	First Unit Cost	Development Time to PFC (Mos.)	Development Time to FFC (Mos.)
Category I RL10(1)	$ 13.00	$0.70	-	24
Category IIA RL10(2)				
With Pumped Idle	57.00	0.80	36	48
Without Pumped Idle	50.00	0.80	36	48
Category IIB RL10(1)	52.00	0.80	27	35
Category IV RL10(1)	119.00	0.90	48	60
Aerospike (1)	140.00	1.10	43	60
Advanced Space (1)	154.00	1.20	54	66

Note: (1) Values provided by S. Saucier - NASA/MSFC to C. Bonner - MDAC-W, 5 June 1973 - Documented in Record of Discussion.

(2) Values provided by S. Saucier to C. Bonner, 25 August 1973 - Documented in Record of Discussion.

13.1.2.12 The following vehicle auxiliary stage costs have been provided by the Government and incorporated in the cost estimates:

Vehicle Auxiliary Stage	Start-Up	1973 Dollars in Millions Recurring Production Unit Cost	Recurring Operations Cost/Flight
Burner II	-	$ .530	$ .140
Polaris A3, Second Stage -	$ 8.00	.270	
Basic with Guidance	+2.00	+ .300	
Poseidon, Second Stage -	$10.0	$ .355	
Basic with Guidance	+2.70	+4.95	

13.1.2.13 The costs per pound of candidate propellants have been provided by the Government to assure consistency in the Tug contractor trade studies. These costs have been incorporated in the MDAC estimates.

PROPELLANT		COST $/POUND
Liquid Oxygen	LOX	.013
Liquid Hydrogen	LH2	.50
Nitrogen Tetroxide	N2O4	.12
High Density Acid	HDA	.30
Monomethyl Hydrazine	MMH	2.75
Unsymetrical Dimethyl Hydrazine	UDMH	.55
50% N2H4 and 50% UDMH	AEROZINE-50	1.00
Hydrazine	N2H4	1.85

13.1.2.14 Based on its own sources, MDAC has estimated the cost of gaseous helium at $7.86 per pound. The Government has concurred in this value.

13.1.2.15 Launch operations cost estimates have been calculated using the following general ground rules and assumptions:

1. That manloading per year, per shift, per site by skill level are for direct and indirect personnel.

2. That launch site support services are equivalent to 24% of personnel and are included in No. 1 above.

3. That launch site direct and indirect personnel will perform GSE maintenance within their regular shift activities.

4. That home plant support is equivalent to 15% of field location manhours (excluding Project Management and System Engineering).

5. That the cost of field site personnel is based on mid 1973 hourly rates.

6. That the weighted average cost of inplant support (for No. 4 above) is based on mid-1973 hourly rates.

7. That Government Program/Project Management of launch operations is part of the Government's institutional base and thus is excluded from Tug project costs.

13.1.2.16 Flight Operations cost estimates have been calculated using the following general ground rules and assumptions:

1. That the attached manhours per flight include field site direct and indirect personnel.

2. That home plant support is equivalent to 10% of field site manhours. (Excluding Project Management and System Engineering.)

3. That the field site manhours reflect a 97% learning curve.

4. That the weighted average cost of field site personnel is based on mid-1973 hourly rates.

5. That the weighted average cost of inplant support is based on mid-1973 hourly rates.

6. That "computer hours/flight" reflect sharing existing computers with others, i.e., Shuttle Orbiter, Payloads.

7. That the average cost of a computer hour/flight including both machine and labor costs has been based on recent quotations.

8. That flight support and software (WBS 32A-114, 124) is a one time activity and its cost thus is part of DDT&E.

13.1.2.17 The cost estimates have been calculated to be total cost to the Government excluding NASA Program Management and Systems Support and Prime Contractor Fee on costs at System Level 4 and above, in accordance with NASA direction.

13.2 Description of Estimating Philosophy

The general equation form for CER's expressing recurring costs is shown in Figure 13.2-1. In this equation form, Y=A*X**B(F) the "A" value is the driver which generates the specific first unit cost by moving from the Y-intercept along a line (straight-line on a log-log plot) whose slope is expressed by the exponent "B". If the cost so calculated fairly represents an item whose design, method of fabrication, technology and other attendant variables are virtually the same as the data base from which the equation was derived, then the cost could be accepted as calculated. However, this seldom is the case and some means must be provided to adjust the calculated cost to indeed reflect the characteristics of the item being estimated. The "F" factor is included in the equation to perform the adjustment function. Quantification of the "F" factor is performed by the systems cost analyst and is predicated upon: (1) his knowledge of the data base; (2) his understanding of the item being estimated, achieved through continuous communication with other members of the study team; and (3) his professional expertise. Fortuitously, the systems cost analysts on the Space Tug Study Team are among those

SPACE TUG COST METHODOLOGY

EXAMPLE -- STRUCTURE ASSEMBLY COMPLETE

LEADER II COST MODEL CER'S -- RECURRING COSTS

- GENERAL EQUATION FORM

  $$COST = A(X)^B \cdot F$$

  WHERE: A = A CONSTANT
  X = A VARIABLE (I.E., AREA, WEIGHT)
  B = AN EXPONENT
  F = A COMPLEXITY FACTOR, WHOSE FUNCTION IS TO MODIFY THE BASIC EQUATION TO REFLECT DEVIATION FROM THE BASE FOR VARIOUS MATERIALS AND TYPES OF CONSTRUCTION

  EACH EQUATION DERIVED BY ANALYSIS (I.E., REGRESSION ANALYSIS) FROM A KNOWN DATA BASE

- DATA BASE INCLUDES COST AND ENGINEERING DATA FROM:

SIVB	SPACE STATION (MODULAR)
SKYLAB	SORTIE LAB
SHUTTLE EXTERNAL TANK	SOAR II
NUCLEAR STAGE	ADVANCED COMPOSITES STUDIES

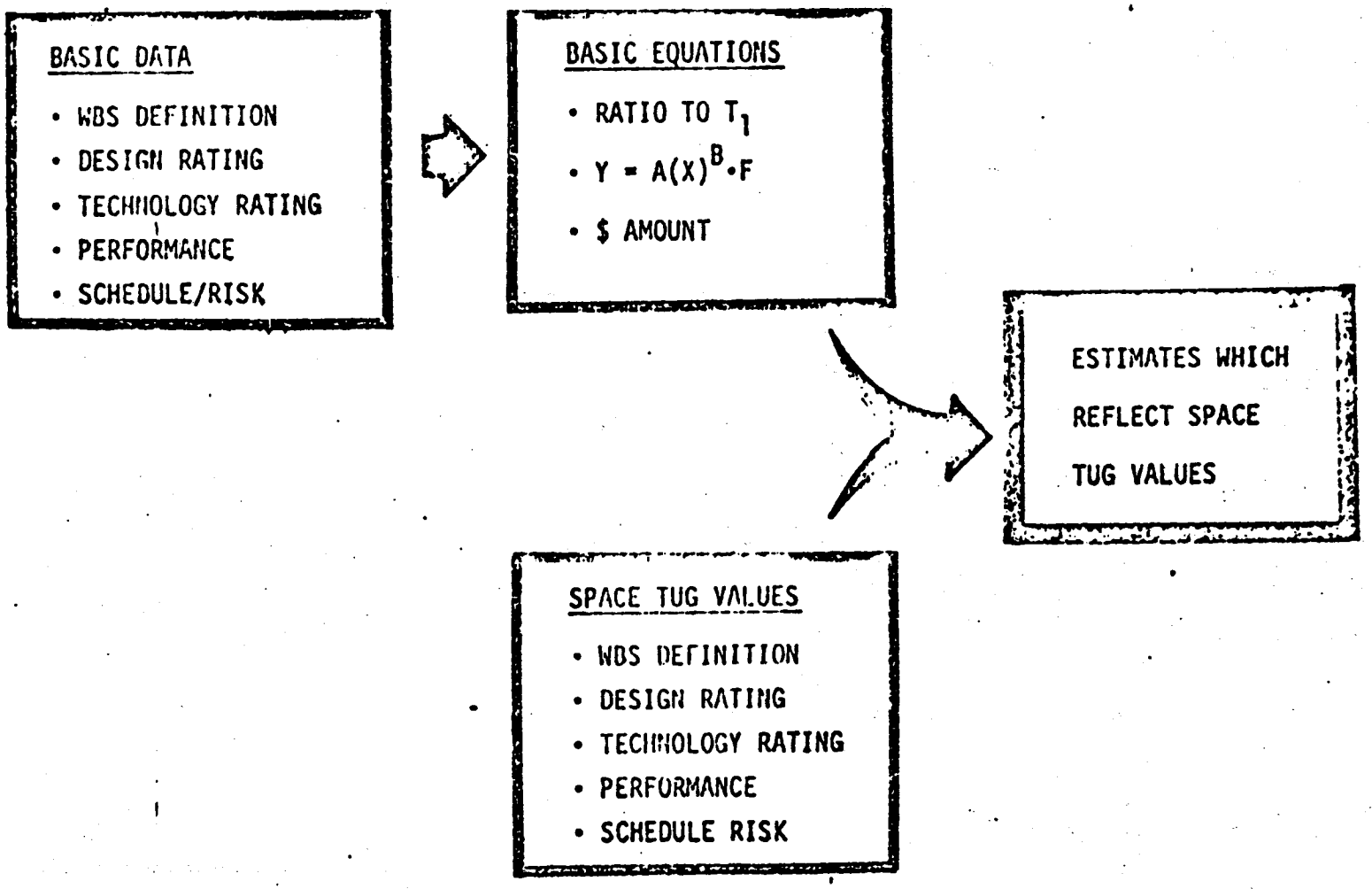
MCDONNELL DOUGLAS

Figure 13.2-1

who build the CER building blocks for the LEADER cost model. Thus, they have all three requisites for quantification of the "F" values.

The methodology used for calculating DDT&E costs is summarized in Figure 13.2-2. Three basic equation forms are used to relate basic data to Space Tug values and generate DDT&E cost estimates which realistically reflect the Space Tug values. The first equation form is a "ratio to T1". As used for the Space Tug WBS elements, this equation has meant that Engineering Design and Development cost is "N" times the first unit production cost. The second equation form, Y=A*X**B(F), is the same as that used for first unit production cost and discussed in the preceeding paragraph. The third equation form is a specific dollar value which usually has been derived from quotations submitted by prospective suppliers of assemblies and components. Similar to the practice for first unit production cost estimating, the "F" factor is quantified by the systems cost analyst to reflect Space Tug values for specific WBS elements in terms of design rating, technology rating and schedule risk, which are defined in Figure 13.2-3. Ground test hardware quantities and flight test hardware quantitites have been established at the component, assembly, subsystem and system levels as discussed in Section 2 of this book. The estimated costs for ground test hardware and flight test hardware are the result of applying equivalent quantity values to first unit production cost at the appropriate WBS levels.

SPACE TUG COST METHODOLOGY
DDT&E COST ESTIMATES



MCDONNELL DOUGLAS

Figure 13.2-2

SPACE TUG COST METHODOLOGY
DDT&E COST ESTIMATE FACTORS

- **DESIGN RATING**

5	COMPLETELY "OFF THE SHELF" OR PREVIOUSLY DESIGNED AND MANUFACTURED ON OTHER MONEY -- NO DDT&E
4	APPROXIMATELY 75 PERCENT OF SUBSYSTEM PREVIOUSLY DESIGNED AND MANUFACTURED ON OTHER MONEY. NEW OR REDESIGN EFFORT REQUIRED ON REMAINDER.
3	APPROXIMATELY 50 PERCENT OF SUBSYSTEM PREVIOUSLY DESIGNED AND MANUFACTURED ON OTHER MONEY. NEW OR REDESIGN EFFORT REQUIRED ON REMAINDER.
2	APPROXIMATELY 25 PERCENT OF SUBSYSTEM PREVIOUSLY DESIGNED AND MANUFACTURED ON OTHER MONEY. NEW OR REDESIGN EFFORT REQUIRED ON REMAINDER.
1	COMPLETELY NEW OR REDESIGN EFFORT ON ALL ITEMS IN THE SUBSYSTEM.

- **TECHNOLOGY RATING**

100	COMPLETELY NEW TECHNOLOGY, ASSUMING THE SRT WHICH WE HAVE PROGRAMMED IS COMPLETED BY PHASE C ATP.
1	COMPLETELY EXISTING TECHNOLOGY WITH SAME SRT ASSUMPTION.

- **SCHEDULE RISK**

  EXPRESSED AS A PERCENT OF A BASELINE (100 PERCENT), WHICH IS THE EXPECTED COST FOR THE EXPECTED SCHEDULE; LEADS TO DERIVATION OF MAXIMUM COST RISKED TO MEET DEVELOPMENT OBJECTIVES FOR GIVEN PERFORMANCE GOALS.

Figure 13.2-3

MCDONNELL DOUGLAS

Whether the estimate is for DDT&E cost or recurring production cost, quantification of the "F" value is the product of the cost analyst's judgement of a number of influencing elements in addition to those identified above. These additional elements include: reliability, maintainability, safety, commonality, workability/fabrication methods, DDT&E approach versus change traffic, and knowldge of prospective suppliers' pricing policies and cost performance - actuals versus estimates.

This latter knowledge has been paricularly useful in evaluating the ROM quotations from propective suppliers in response to Requests for Information on this study. Thus, the factors applied to the suppliers quotes have varied to reflect individual company performance, as well as the cost of sub-contract management.

In accordance with NASA direction, the cost estimates represent cost to the Government, except for NASA Program Management and and System Support and Prime Contractor Fee on costs at System Level 4 and above. Thus, the costs include those for the main engine, which has been identified as GFE. Reference also is made to Subsection 13.1.2, Assumptions, Ground Rules and Rationale.

13.3 Related Historical Programs

As noted above, the related historical programs, which constitute the data base for the LEADER II cost model, include: Saturn SIV/SIVB, Skylab, Space Station (modular), SOAR II, Sortie Lab, Thor/Delta, Gemini, MOL, Saturn/Apollo, and Titan.

The data base also incorporates the results of a number of Government-funded and industry-funded studies, and the quotations submitted by prospective suppliers of assemblies/ components.

Table 13.3-1 lists the WBS elements whose costs have been estimated using CER's, Cost Factors, and Direct Estimates/ Other, through Component Level 7.

TABLE 13.3-1

COST METHODOLOGY
APPLICATION OF CER'S, COST
FACTORS AND DIRECT ESTIMATES

STUDY TITLE: SPACE TUG SYSTEMS STUDY (CRYOGENIC)

CONTRACT NO.: NAS 8-29677

DATE: 3 September 1973

WBS IDENTIFICATION NUMBER	WBS INDENTIFICATION	DDT&E			PRODUCTION			OPERATIONS	
		CER'S	COST FACTORS	DIRECT EST/OTHER	CER'S	COST FACTORS	DIRECT EST/OTHER	COST FACTORS	DIRECT EST/OTHER
320	Total Tug Project			x			x		x
320-01	Project Management		x			x		x	
320-02	Systems Eng'g. & Integration		x			x			x
320-03	Vehicle Main Stage			x			x	x	
320-03-01	Structures Subsystem			x			x		x
320-03-01-01	Fuel Tank and Support	x			x			x	
320-03-01-02	Oxidizer Tank and Support	x			x			x	
320-03-01-03	Body Structure	x			x			x	
320-03-01-04	Thrust Structure	x			x			x	
320-03-01-05	Meteoroid Shield	x			x			x	
320-03-01-06	Payload Interface	x			x			x	
320-03-01-07	Installation, Assembly & C/O		x			x		x	
320-03-02	Thermal Control Subsystem			x			x		x
320-03-02-01	Fuel Tank Insulation			x			x	x	
320-03-02-02	Oxidizer Tank Insulation			x			x	x	
320-03-02-04	Insulation Purge System			x			x	x	
320-03-02-04	Control System			x			x	x	
320-03-02-05	Installation, Assembly & C/O		x			x		x	
320-03-03	Avionics Subsystem								
320-03-03-01	Data Management			x			x		x
320-03-03-01-01	Computer			x			x		x
320-03-03-01-02	Data Distribution	x			x			x	
320-03-01-03	Bus Controller	x			x			x	
320-03-03-01-04	Other	x			x			x	

TABLE 13.3-1

COST METHODOLOGY
APPLICATION OF CER'S, COST
FACTORS AND DIRECT ESTIMATES

STUDY TITLE: SPACE TUG SYSTEMS STUDY (CRYOGENIC)

CONTRACT NO.: NAS 8-29677

DATE: 3 September 1973

WBS IDENTIFICATION NUMBER	WBS INDENTIFICATION	DDT&E			PRODUCTION			OPERATIONS	
		CER'S	COST FACTORS	DIRECT EST/OTHER	CER'S	COST FACTORS	DIRECT EST/OTHER	COST FACTORS	DIRECT EST/OTHER
320-03-03-01-05	Software - A			x			--	x	
320-03-03-01-06	Software - B	--	--	--	--	--	--	--	--
320-03-03-01-07	Software - C	--	--	--	--	--	--	--	--
320-03-03-01-08	Installation, Assembly & C/O		x			x		x	
320-03-03-02	GN&C			x			x		x
320-03-03-02-01	IMU			x			x	x	
320-03-03-02-02	Star Tracker			x			x	x	
320-03-03-02-03	Laser Radar	--	--	--	--	--	--	--	--
320-03-03-02-04	Installation, Assembly & C/O		x			x		x	
320-03-03-03	Communications			x			x		x
320-03-03-03-01	Microwave Circuitry/RF-MPLXR	x			x			x	
320-03-03-03-02	Transponders	x			x			x	
320-03-03-03-03	Power Amplifier			x			x	x	
320-02-02-02-04	Antenna			x			x	x	
320-03-03-03-05	Decoder/Encoder-Mod./ Demod.			x			x	x	
320-03-03-03-06	Tape Recorder			x			x	x	
320-03-03-03-07	P/L Interface Equip.-Com Sec.	x			x			x	
320-03-03-03-08	Installation, Assembly & C/O		x			x		x	
320-03-03-04	Instrumentation			x			x		x
320-03-03-04-01	Data Sensors		x				x	x	
320-03-03-04-02	Signal Conditioning	x			x			x	
320-03-03-04-03	Circuitry	x			x			x	
320-03-03-04-04	Installation, Assembly & C/O		x			x		x	
320-03-03-05	Electrical Power			x			x		x

TABLE 13.3-1

COST METHODOLOGY
APPLICATION OF CER'S, COST
FACTORS AND DIRECT ESTIMATES

STUDY TITLE: SPACE TUG SYSTEMS STUDY (CRYOGENIC)

CONTRACT NO.: NAS 8-29677

DATE: 3 September 1973

PAGE 3 OF 6

WBS IDENTIFICATION NUMBER	WBS INDENTIFICATION	DDT&E			PRODUCTION			OPERATIONS	
		CER'S	COST FACTORS	DIRECT EST/OTHER	CER'S	COST FACTORS	DIRECT EST/OTHER	COST FACTORS	DIRECT EST/OTHER
320-03-03-05-01	Battery			x			x	x	
320-03-03-05-02	Fuel Cell	--	--	--	--	--	--	--	--
320-03-03-05-03	Installation, Assembly & C/O		x			x		x	
320-03-03-06	Power Distribution & Control			x			x		x
320-03-03-06-01	Distribution	x			x			x	
320-03-03-06-02	Tanks - Fuel Cell	--	--	--	--	--	--	--	--
320-03-03-06-03	Installation, Assembly & C/O		x			x		x	
320-03-04	Propulsion			x			x		x
320-03-04-01	Main Engine (GFE)			x			x	x	
320-03-04-02	Main Engine Support	x			x			x	
320-03-04-03	ACPS Engine			x			x	x	
320-03-04-04	ACPS Engine Support	x			x			x	
320-03-04-05	Installation, Assembly & C/O		x			x		x	
320-03-05	Orbiter Interface			x			x		x
320-03-05-01	Structures	x			x			x	
320-03-05-02	Interface Panels	x			x			x	
320-03-05-03	Purge Provisions	--	--	--	--	--	--	--	--
320-03-05-04	Abort Provisions	x			x			x	
320-03-05-05	Installation, Assembly & C/O		x			x		x	
320-03-06	Drop Tanks	--	--	--	--	--	--	--	--
320-03-07	Final Assembly & Checkout		x			x		x	
320-04	Space Tug Auxiliary Stage			x			x	--	--
320-05	Logistics			x	--	--	--		x
320-05-01	Transportation & Handling	--	--	--	--	--	--		x

TABLE 13.3-1

COST METHODOLOGY
APPLICATION OF CER'S, COST
FACTORS AND DIRECT ESTIMATES

STUDY TITLE: SPACE TUG SYSTEMS STUDY (CRYOGENIC)

CONTRACT NO.: NAS 8-29677

DATE: 3 September 1973

WBS IDENTIFICATION NUMBER	WBS INDENTIFICATION	DDT&E			PRODUCTION			OPERATIONS	
		CER'S	COST FACTORS	DIRECT EST/OTHER	CER'S	COST FACTORS	DIRECT EST/OTHER	COST FACTORS	DIRECT EST/OTHER
320-05-02	Training			x	--	--	--		x
320-05-03	Inventory Control & Warehsng.			x	--	--	--		x
320-06	Facilities			x			x		x
320-06-01	Manufacturing			x		x		--	--
320-06-02	Test			x	--	--	--	--	--
320-06-03	Maint. & Refurb. - ETR			x	--	--	--	x	
320-06-04	ETR Launch			x	--	--	--	x	
320-06-05	Maint. & Refurb. - WTR			x	--	--	--	x	
320-06-06	WTR Launch			x	--	--	--	x	
320-07	Ground Support Equipment			x		x		x	
320-07-01	Manufacturing GSE			x		x		--	--
320-07-02	ETR GSE			x	--	--	--	x	
320-07-03	WTR GSE			x	--	--	--	x	
320-07-04	Flight Ops. GSE-NASA			x	--	--	--	x	
320-07-05	Flight Ops. Gse-DOD			x	--	--	--	x	
320-08	Vehicle Test			x	--	--	--	--	--
320-08-01	Ground Test Hardware		x		--	--	--	--	--
320-08-02	Ground Test Operations			x	--	--	--	--	--
320-08-03	Flight Test Hardware	--	--	--	--	--	--	--	--
320-08-04	Flight Test Operations			x	--	--	--	--	--
320-09	Launch Operations - WTR	--	--	--	--	--	--		x
320-09-01	Launch Site Services & Support	--	--	--	--	--	--		x
320-09-02	Tug/Shuttle Mating & C/O	--	--	--	--	--	--		x
320-09-03	Prelaunch Checkout	--	--	--	--	--	--		x

TABLE 13.3-1

COST METHODOLOGY
APPLICATION OF CER'S, COST
FACTORS AND DIRECT ESTIMATES

STUDY TITLE: SPACE TUG SYSTEMS STUDY (CRYOGENIC)

CONTRACT NO.: NAS 8-29677

DATE: 3 September 1973

PAGE 5 OF 6

WBS IDENTIFICATION NUMBER	WBS INDENTIFICATION	DDT&E			PRODUCTION			OPERATIONS	
		CER'S	COST FACTORS	DIRECT EST/OTHER	CER'S	COST FACTORS	DIRECT EST/OTHER	COST FACTORS	DIRECT EST/OTHER
320-09-04	Countdown	--	--	--	--	--	--		x
320-09-05	Propellants & Gases	--	--	--	--	--	--		x
320-09-06	Post Flight Safing	--	--	--	--	--	--		x
320-10	Launch Operations - ETR	--	--	--	--	--	--		x
320-10-01	Launch Site Services & Support	--	--	--	--	--	--		x
320-10-02	Tug/Shuttle Mating & C/O	--	--	--	--	--	--		x
320-10-03	Prelaunch Checkout	--	--	--	--	--	--		x
320-10-04	Countdown	--	--	--	--	--	--		x
320-10-05	Propellant & Gases	--	--	--	--	--	--		x
320-10-06	Post Flight Safing	--	--	--	--	--	--		x
320-11	Flight Operations - NASA			x	--	--	--		x
320-11-01	Mission Planning			x	--	--	--		x
320-11-02	Flight Control			x	--	--	--		x
320-11-03	Flight Evaluation			x	--	--	--		x
320-11-04	Flight Support Software			x	--	--	--		x
320-12	Flight Operations - DOD			x	--	--	--		x
320-12-01	Mission Planning			x	--	--	--		x
320-12-02	Flight Control			x	--	--	--		x
320-12-03	Flight Evaluation			x	--	--	--		x
320-12-04	Flight Support Software			x	--	--	--		x
320-13	Refurbishment & Integr.-WTR			x	--	--	--		x
320-13-01	Scheduled Maint. & Refurb.	--	--	--	--	--	--		x
320-13-02	Unsched. Maint. & Refurb.	--	--	--	--	--	--		x
320-13-03	Post Maintenance Checkout	--	--	--	--	--	--		x

TABLE 13.3-1

COST METHODOLOGY
APPLICATION OF CER'S, COST
FACTORS AND DIRECT ESTIMATES

STUDY TITLE: SPACE TUG SYSTEMS STUDY (CRYOGENIC)

CONTRACT NO.: NAS 8-29677

DATE: 3 September 1973

PAGE 6 OF 6

WBS IDENTIFICATION NUMBER	WBS INDENTIFICATION	DDT&E			PRODUCTION			OPERATIONS	
		CER'S	COST FACTORS	DIRECT EST/OTHER	CER'S	COST FACTORS	DIRECT EST/OTHER	COST FACTORS	DIRECT EST/OTHER
320-13-04	Tug/Payload Mating & C/O	--	--	--	--	--	--		x
320-13-05	Refurb. Requirements Planning			x	--	--	--		x
320-13-06	Depot Maintenance	--	--	--	--	--	--		x
320-14	Refurbishment & Integr.-ETR			x	--	--	--		x
320-14-01	Scheduled Maint. & Refurb.	--	--	--	--	--	--		x
320-14-02	Unsched. Maint. & Refurb.	--	--	--	--	--	--		x
320-14-03	Post Maintenance Checkout	--	--	--	--	--	--		x
320-14-04	Tug/Payload Mating & C/O	--	--	--	--	--	--		x
320-14-05	Refurb. Requirements Planning			x	--	--	--		x
320-14-06	Depot Maintenance	--	--	--	--	--	--		x

Section 14

OTHER SENSITIVITIES AS DEFINED

Table 14-1 presents a summary of the results of defined sensitivity analyses performed on Program Option No. 3. Cost impacts shown on the summary were determined for each analysis from subsystem/assembly cost data and the LEADER II Cost Model printout (contained in Section 6) as appropriate to specific trades to be made. Detail discussions of the rationale and results of these sensitivity analyses are presented in Volume 5, Book 3, Section 9.2.

Table 14-1

SENSITIVITY RESULTS SUMMARY - OPTION 3

SENSITIVITY AREA	REFERENCE	IMPACT DELTA (REFERENCE)							
		COST ($ MILLIONS)				VEH. DESIGN		DEV. RISK	CRITICAL TECH AREAS
		TECH	DDT&E	FIRST UNIT	TOTAL OPN	INERT WT (LB)	P/L WT (LB)		
AUTONOMY	LEVEL III								
LEVEL IV		0	-9.76	0	4.26			None	None
LEVEL II		0	18.88	0.79	2.41			Medium	Auto Nav and Mission Plan
LEVEL I		0	14.58	0.79	1.13			Low to Med	Auto Nav
.97 RELIABILITY	.97/36 hr (I) .97/144 hr(F)								
.97/36 hour		0	-3.4	-.66	---	-36	+100	None	None
.97/72 hour		0	0	-.20	---	-10	+ 27	None	None
DESIGN LIFE <100	20 flights	0	0	0	0	0	0	None	None