NAS8-37143
DR-2

Shuttle

N-16-CR
121592
P.161

November 1987

Orientation

Definition of a Space Transportation Systems Cargo Element (Shuttle-C)

(NASA-CR-179404) DEFINITION OF A SPACE TRANSPORTATION SYSTEMS CARGO ELEMENT (SHUTTLE-C). ORIENTATION (Martin Marietta Aerospace) 161 p CSCL 22B

N89-12579

Unclas
G3/16 0121592

MARTIN MARIETTA
MANNED SPACE SYSTEMS

Agenda

• Organization	J. McCown
• Staffing	J. McCown
• System Definition Technical Activities	
- Systems Engineering and Integration (& Past Studies Applications)	J. R. Tewell
- Design and Analysis	B. VanBeek
LUNCH	
- Operations	B. King
- Production and Test	J. Kubnick
- Safety, Reliability, and Quality Assurance	J. Mangino
• Program Issues and Summary	J. McCown

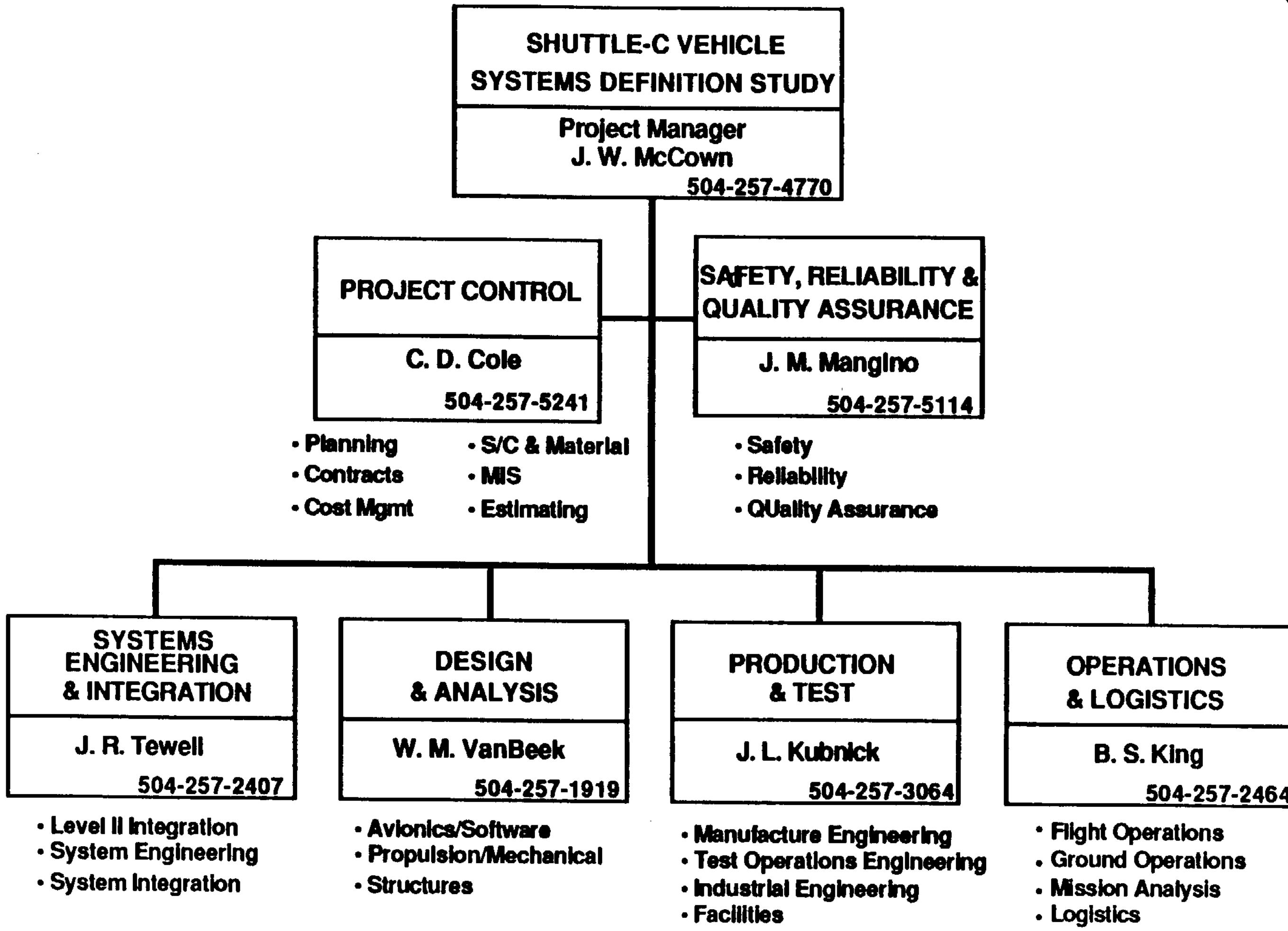
MARTIN MARIETTA
MANNED SPACE SYSTEMS

MARTIN MARIETTA SHUTTLE-C PROJECT

The Shuttle-C project organization has been tailored to fit the tasks required for the Phase B study. Lead responsibilities have been assigned for Program Control; Safety, Reliability, and Quality Assurance (SR&QA); Systems Engineering and Integration (SE&I); Design and Analysis; Production and Test; and Operations.

The functional leads and their phone numbers are shown on this organization chart.

Martin Marietta Shuttle-C Project



MARTIN MARIETTA
MANNED SPACE SYSTEMS

MARTIN MARIETTA SUBCONTRACTORS

The Shuttle-C project organization has been tailored to fit the tasks required for the Phase B study. Lead responsibilities have been assigned for Program Control; Safety, Reliability, and Quality Assurance (SR&QA); Systems Engineering and Integration (SE&I); Design and Analysis; Production and Test; and Operations.

The functional leads and their phone numbers are shown on this organization chart.

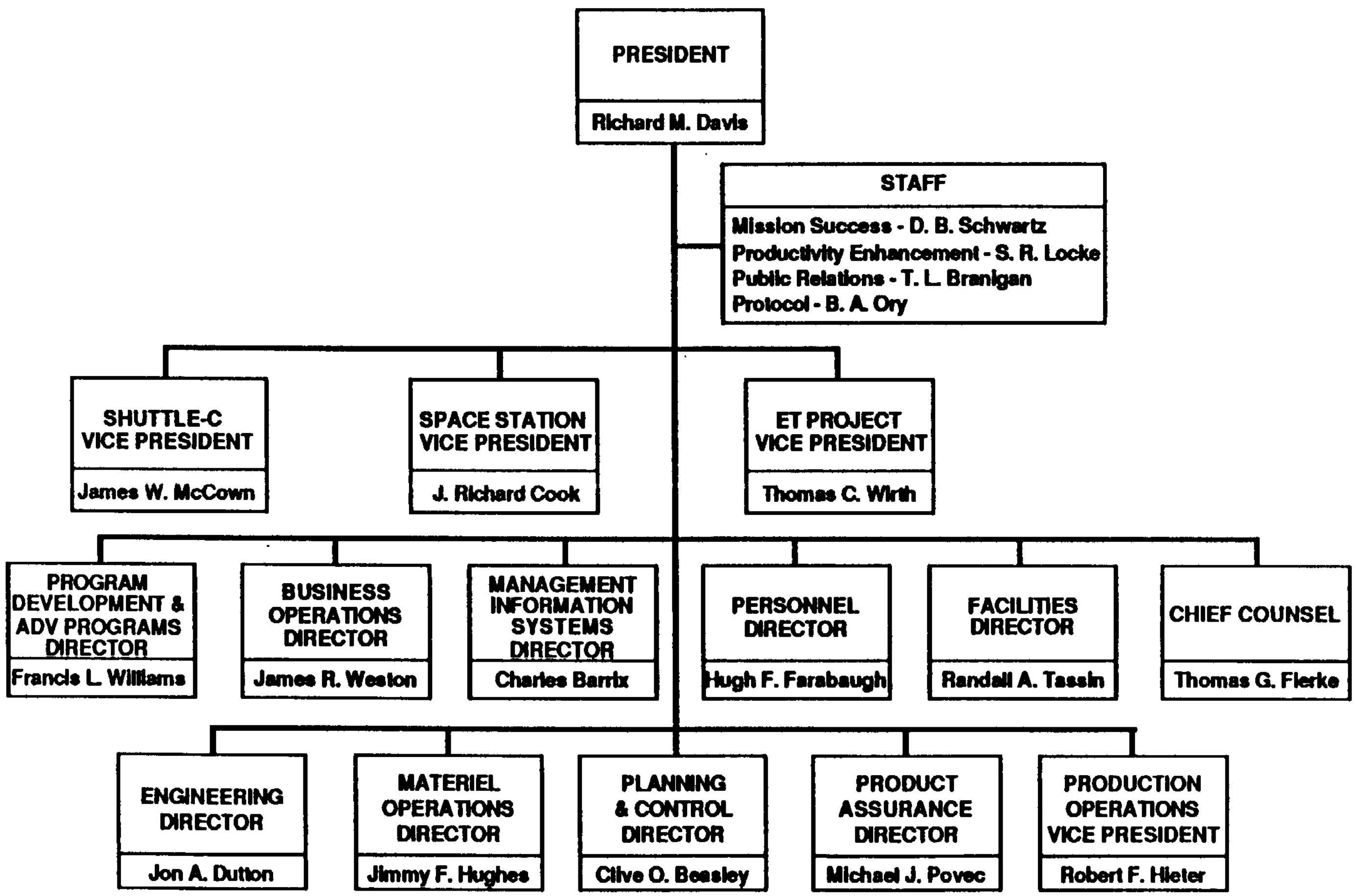
Martin Marietta Subcontractors

Teammembers	Responsibility
• IBM Federal Systems	Flight Software and Computer Requirements
• Honeywell International	Flight Control / Stability Requirements, SSME Control, GN&C Arch Definition, Avionics Trade Study Report
• General Dynamics	Payload Accommodations and Integration
• Eagle Engineering, Inc.	Overall Vehicle (Ground and Flight Systems) Level II and SE&I Planning Inputs
• Barrios Technology, Inc.	Vehicle and Upperstage Rendezvous & Proximity Operations Requirements and 6-DOF Analyses
• Hernandez Engineering	Flight and Mission Operations Requirements, Operational, Payload and Ground Safety Requirements, and European Columbus Interfaces

MARTIN MARIETTA MANNED SPACE SYSTEMS

The Shuttle-C organization is part of the Martin Marietta Manned Space Systems company which is located at the Michoud Assembly Facility. Mr. Richard Davis is president of Manned Space Systems. This organization chart shows the lines of responsibility.

Martin Marietta Manned Space Systems

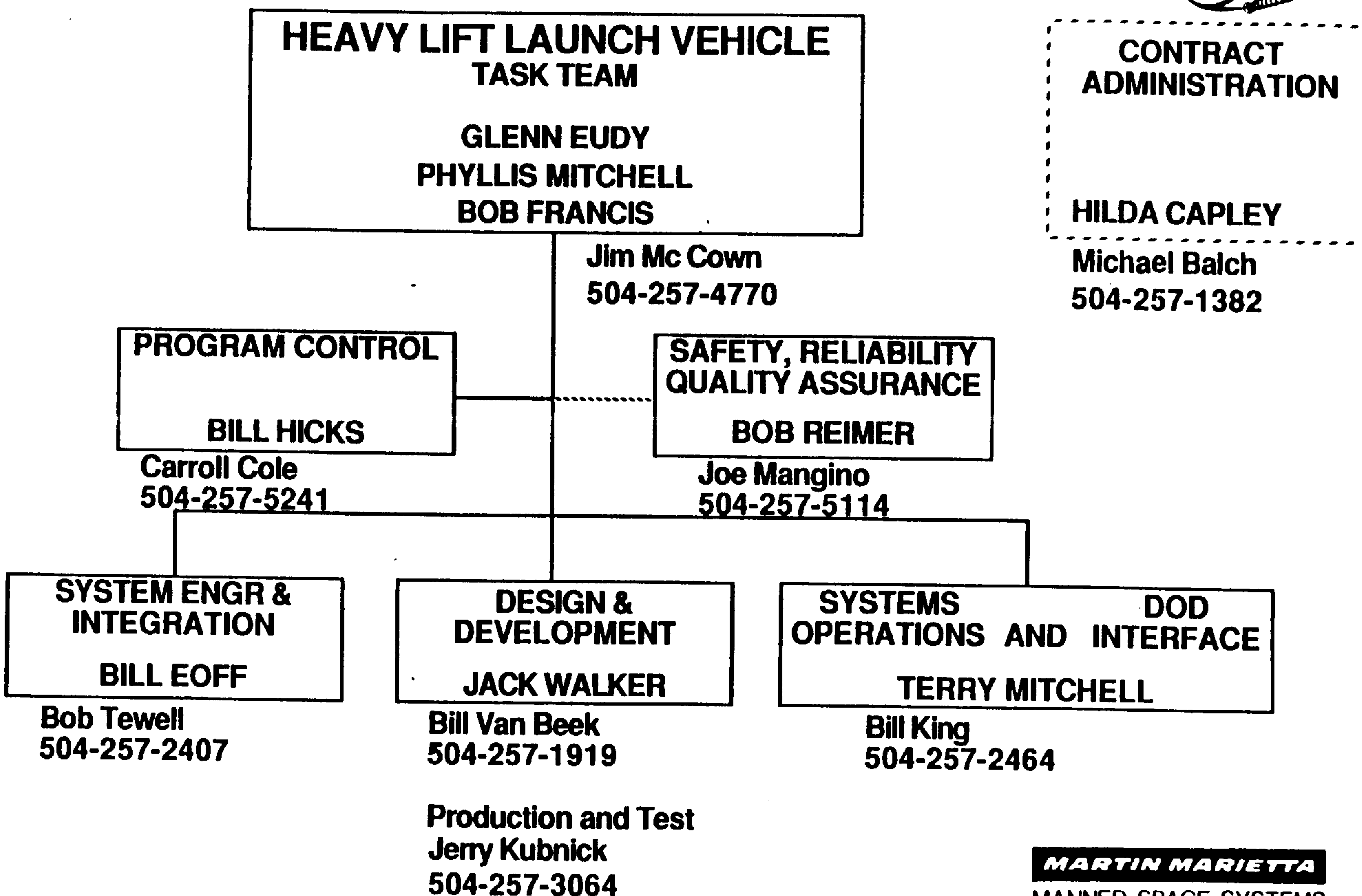


MARTIN MARIETTA
MANNED SPACE SYSTEMS

MSFC/MARTIN MARIETTA INTERFACES

This viewgraph shows the MSFC Shuttle-C project organization chart which identifies the Martin Marietta leads and their MSFC counterparts.

MSFC/MARTIN MARIETTA INTERFACES

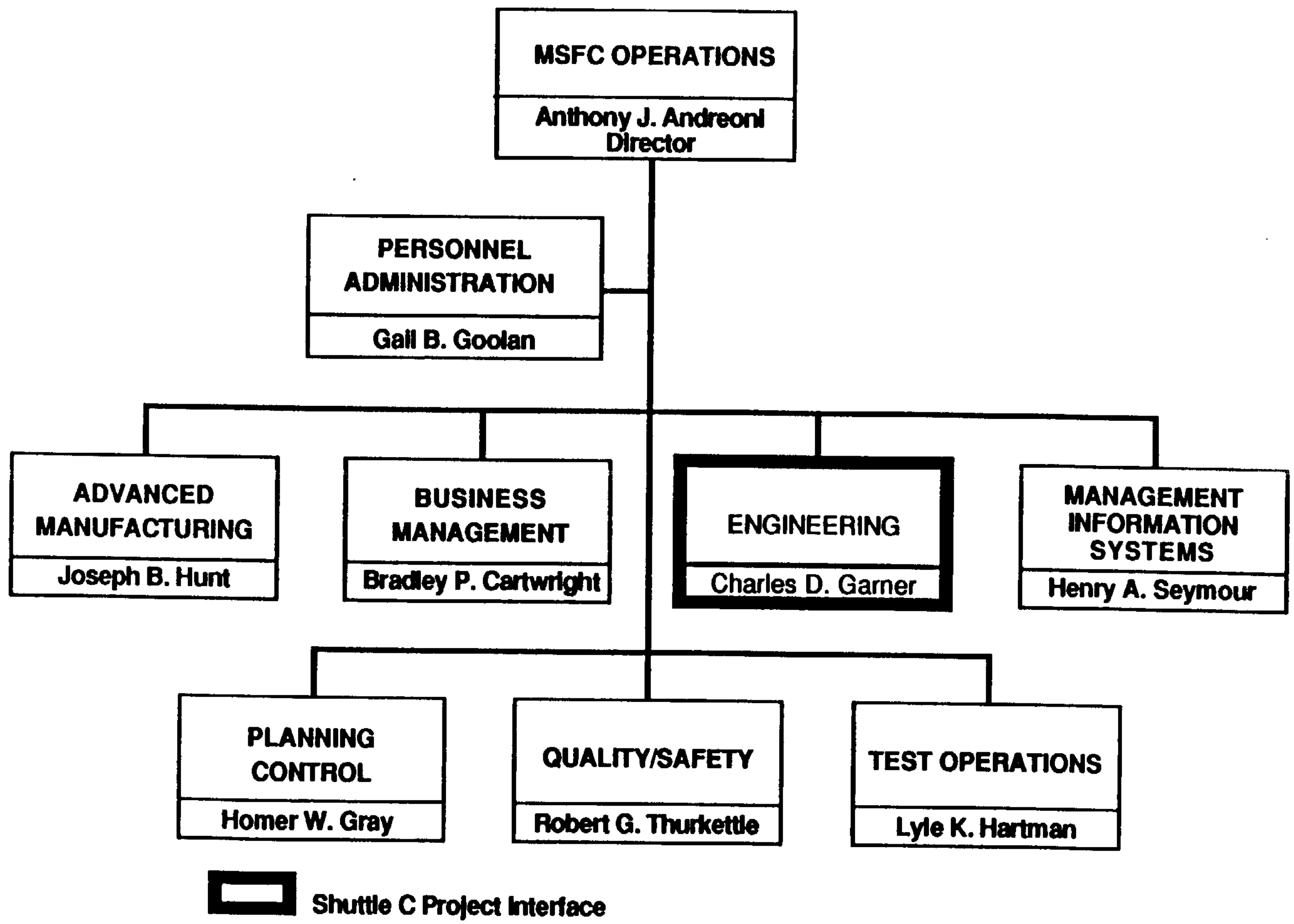


MARTIN MARIETTA
MANNED SPACE SYSTEMS

MARTIN MARIETTA'S MSFC OPERATION

Tony Androni directs Manned Space Systems activities at Huntsville for the Shuttle-C study. Charlie Garner will provide the initial interface. As the work proceeds, another engineer will be added as a full-time interface.

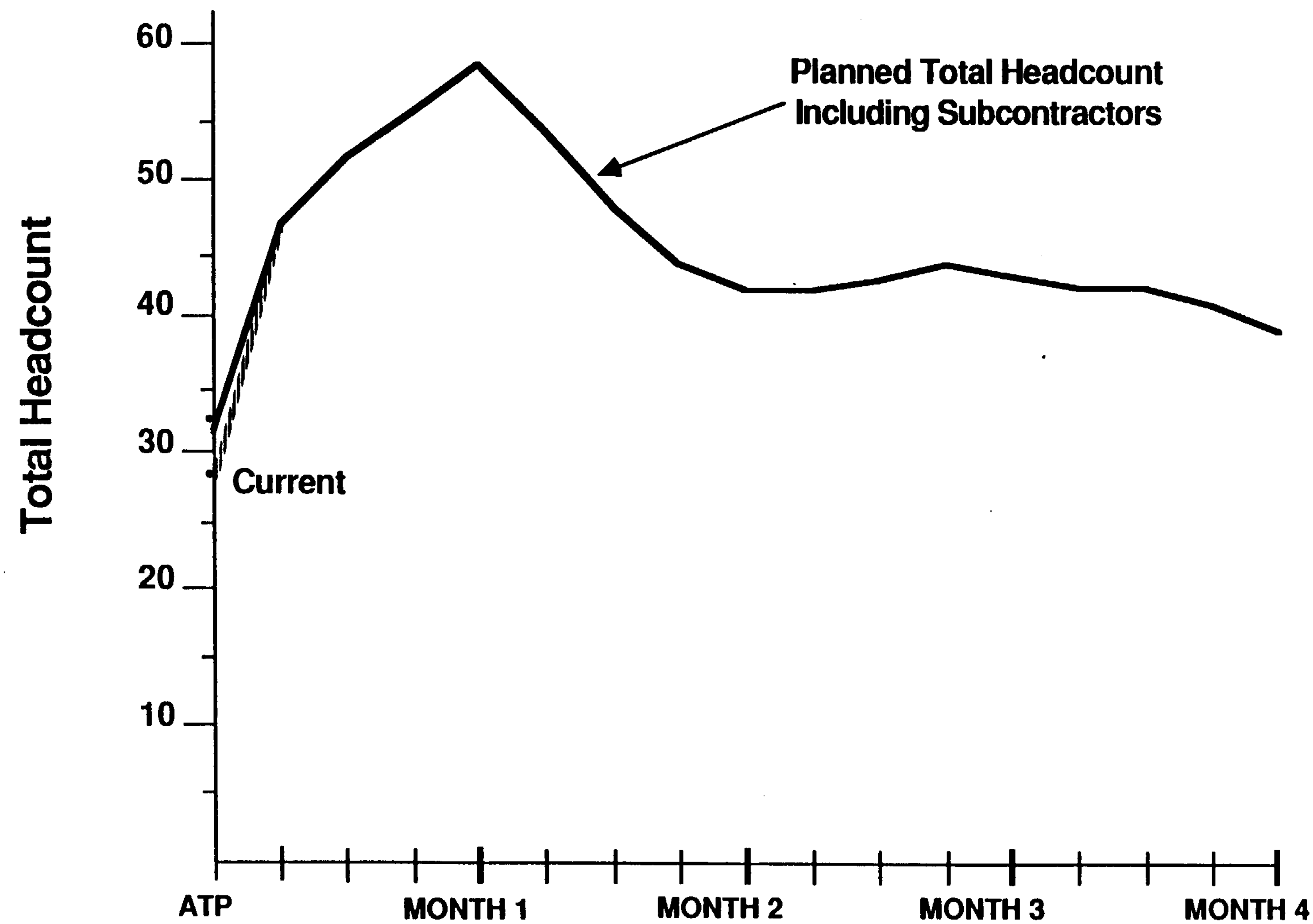
Martin Marietta MSFC Operations



SHUTTLE-C STAFFING PLAN

This chart shows our Phase I Shuttle-C staffing and the total head count (including subcontractors) assigned to this phase of the program.

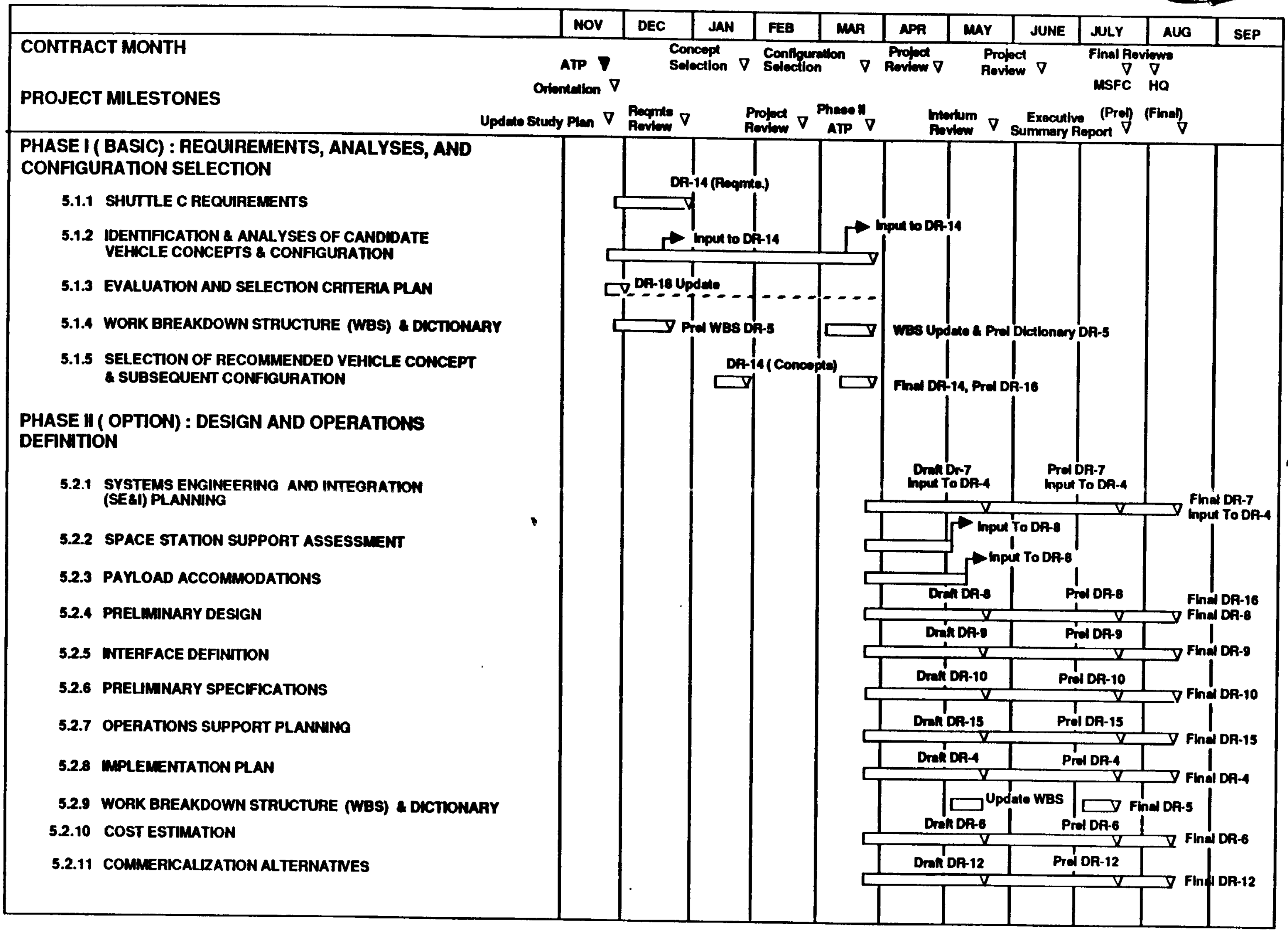
Shuttle-C Staffing Plan



SHUTTLE-C PROJECT TASK SCHEDULE

This chart shows the Shuttle-C Project Summary Schedule for Phases I and II, and the respective study outputs in the form of DR's.

Shuttle -C Project Summary Schedule



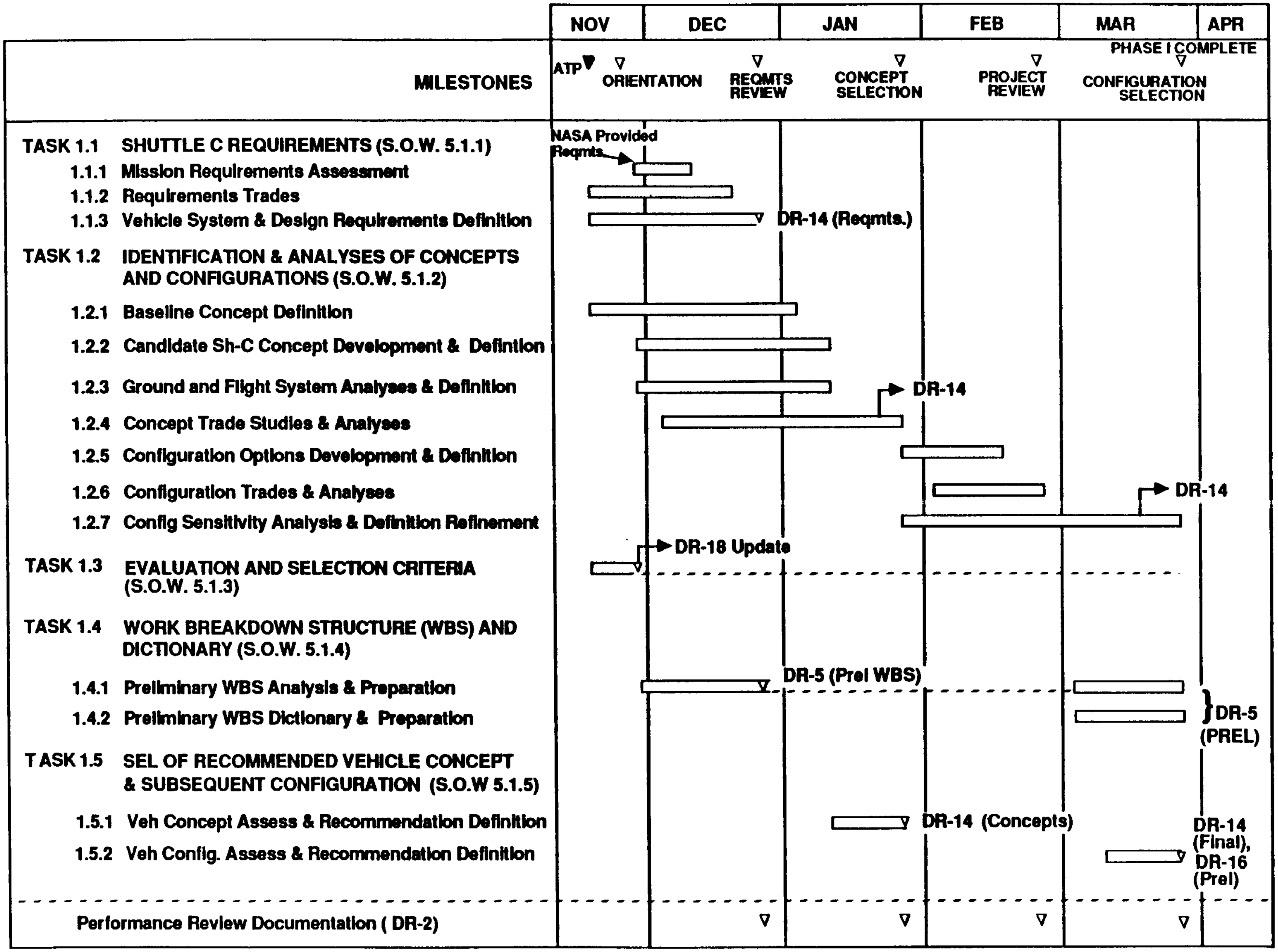
ORIGINAL PAGE IS
OF POOR QUALITY

PHASE I SCHEDULE

This chart shows a more detailed subtask schedule for the Phase I and II study products (DR's). Today we have brought with us an updated Study Plan (DR-1) and an updated Evaluation and Selection Criteria Plan (DR-18).

Since the DR-14 (Requirements markup) and DR-5 (WBS Dictionary) are required within 30 days, we believe that these should be worked conjointly rather than leaving NASA to integrate the products for into a single document.

Shuttle-C Phase I (Basic) Schedule



11/19/87

Agenda

Shuttle

• Organization	J. McCown
• Staffing	J. McCown
• System Definition Technical Activities	
- Systems Engineering and Integration (and Past Studies Applications)	J. R. Tewell
- Design and Analysis	B. VanBeek
LUNCH	
- Operations and Logistics	B. King
- Production and Test	J. Kubnick
- Safety, Reliability, and Quality Assurance	J. Mangino
• Program Issues and Summary	J. McCown

MARTIN MARIETTA
MANNED SPACE SYSTEMS

Agenda

- Past Studies
- Organization
- Requirements
- Trades
- Concept Evaluation

CONTRACTS

Martin Marietta Manned Space Systems has been studying SDVs for 7 years under contract to the National Aeronautics and Space Administration (NASA) and the Air Force. The experience gained in these contracts, and in associated Independent Research and Development (IR&D) studies is directly applicable to the Shuttle-C contract.

Contracts

- Shuttle Derived Vehicles

- SDCV Technology Requirements Study	NASA
- SDCV Trade Analysis Study	NASA
- Guaranteed Access to Space Study	DOD
- ACC and SDV Definition Study	NASA/DOD
- Advanced STS Ground Operations Study	NASA
- SBL Launch & Servicing Segment Definition Study	DOD
- SDCV Wind Tunnel Data Evaluation	NASA
- SDCV Accelerated Schedule Study	NASA/DOD
- ULV Cost Refinement Study	DOD
- Advanced STS Ground Operations Study Follow-On	NASA

Contracts con't

- Propulsion Systems

- Liquid Boost Module	NASA
- Hybrid Rocket Booster Study	NASA
- Stretched External Tank Technical Directive	NASA
- Expendable Cryo-Booster Tank Study	DOD
- Low Cost Expendable Propulsion Study	DOD
- P/A Module Definition Study	NASA
- Propellant Scavenging System Study	NASA
- STS Liquid Rocket Booster (LRB) Systems Study	NASA

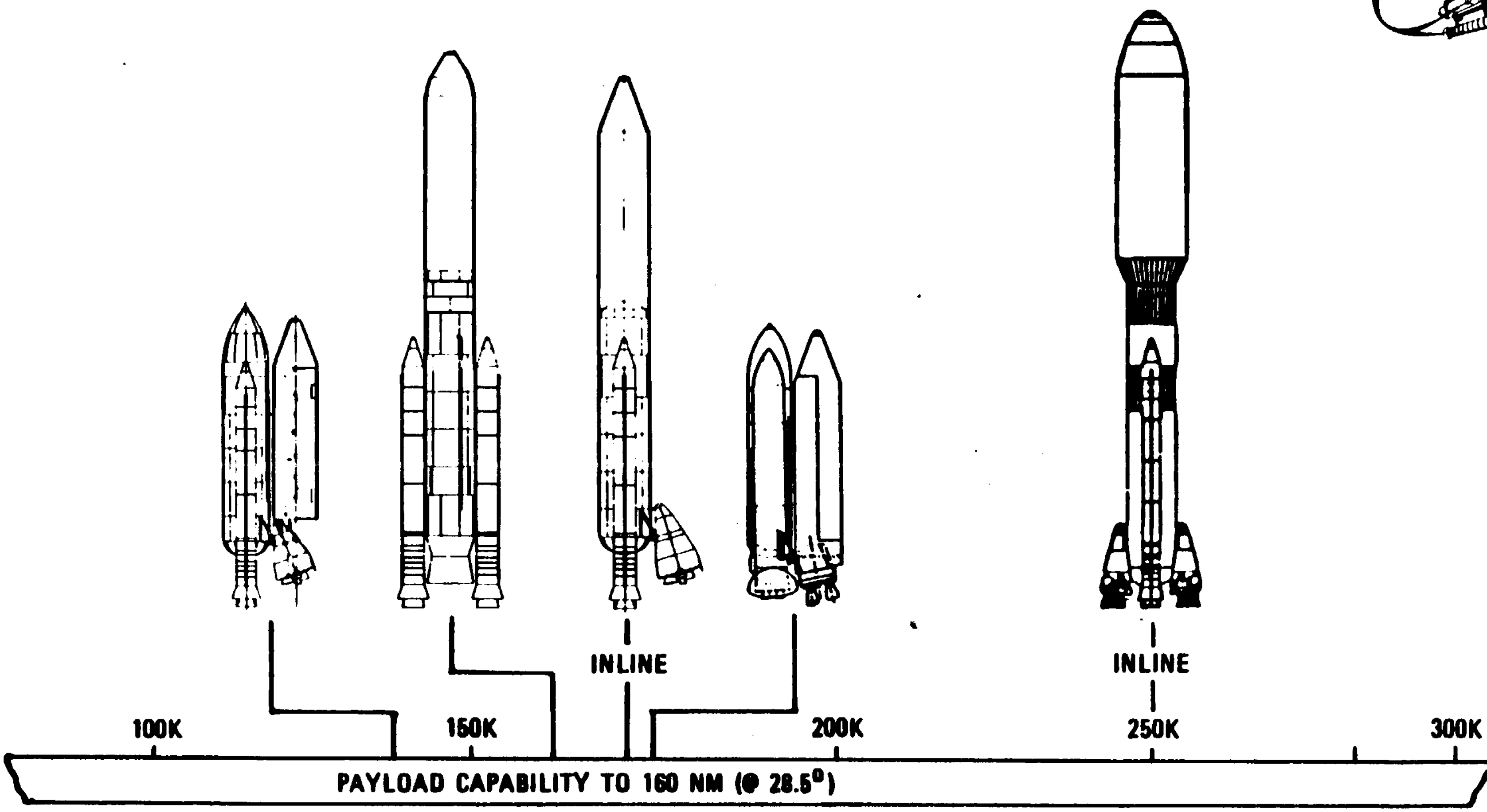
- Other

- Space Transportation Architecture Study	NASA
- Advanced Launch System Design Study	DOD
- Modified ET Facility Impacts	NASA
- General Purpose Aft Cargo Carrier Study	NASA

RECOVERABLE SDV CONFIGURATIONS

The configurations depicted are the SDVs that include provisions for recovering and reusing the Propulsion and Avionics (P/A) system--two of the major cost items in current launch vehicles. These concepts incorporate one or more modules which are separated from the vehicle and returned ballistically to Earth. Both water and land landings have been studied. Both the two and three engine (P/A) modules have been conceptually designed.

Recoverable SDV Configurations



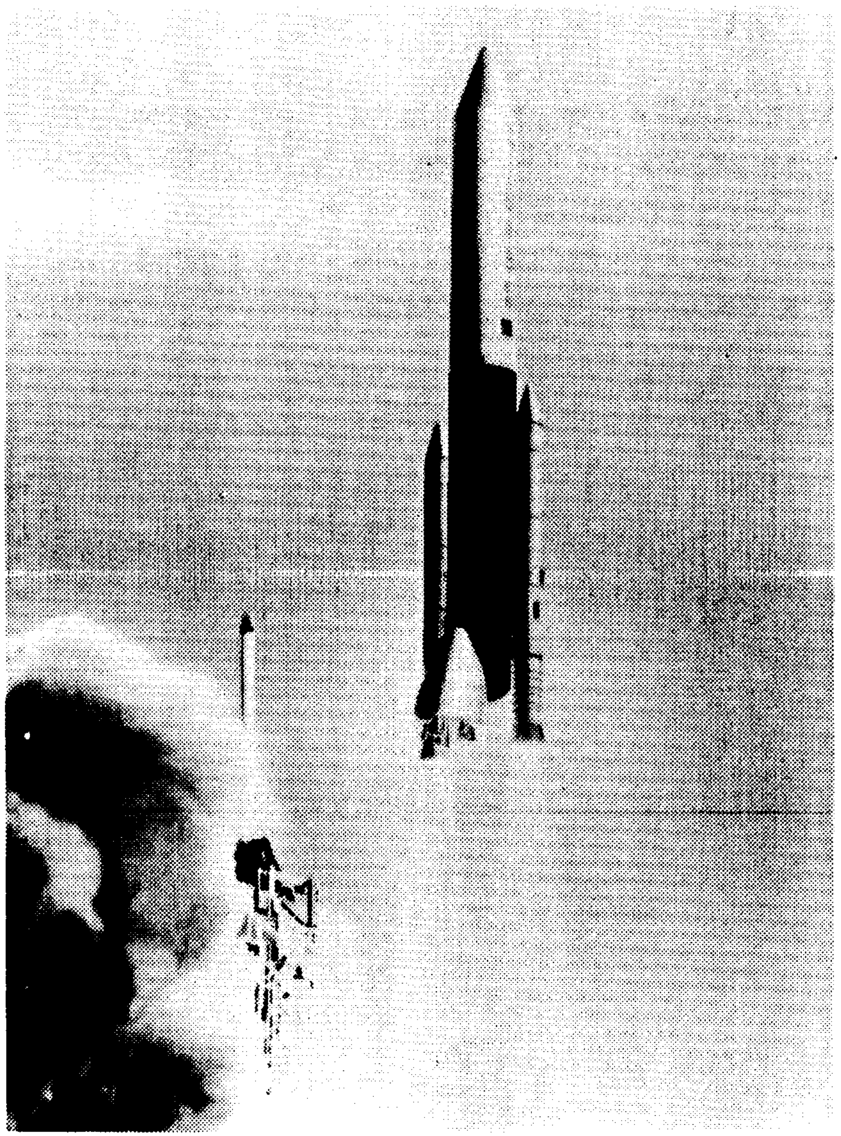
MARTIN MARIETTA
MANNED SPACE SYSTEMS

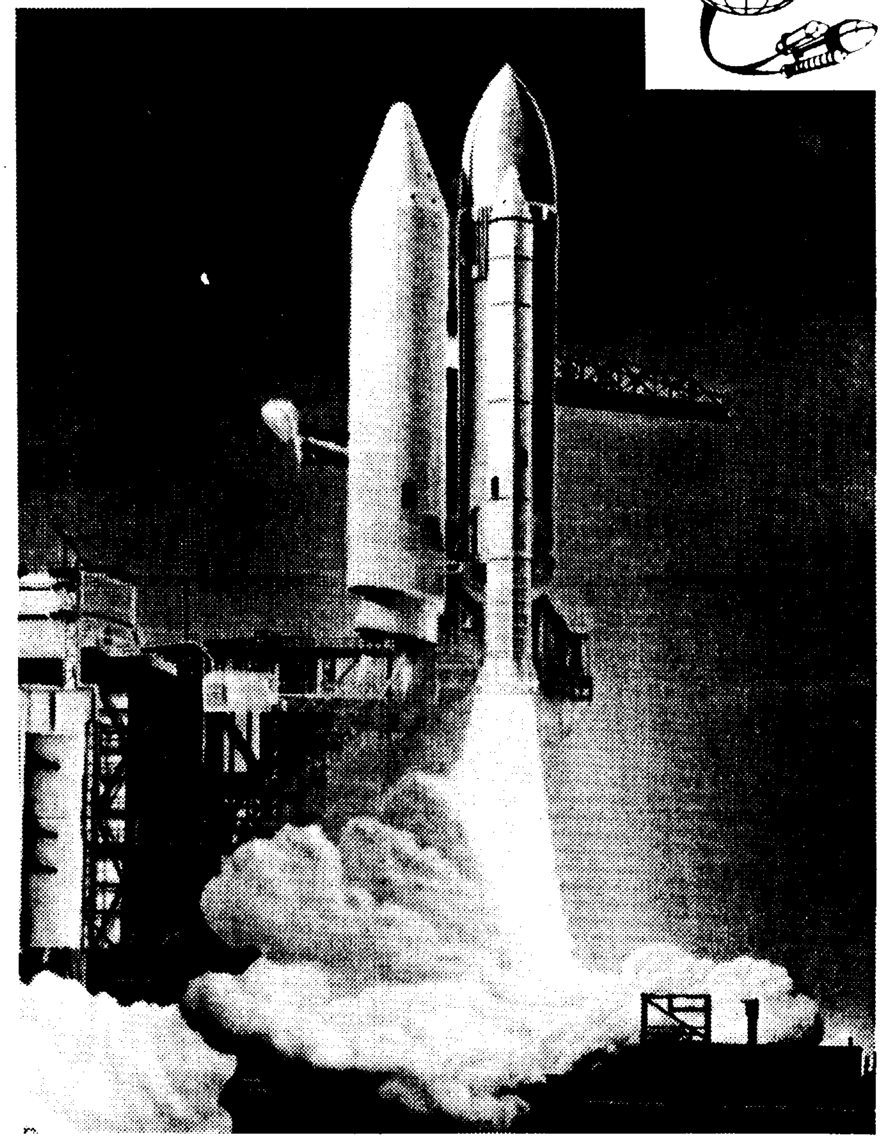
SDV CONCEPTS

Among the Shuttle Derived Vehicle (SDV) concepts were two that fit closely with the launch facility. The concept on the right has the propulsion system sidemounted where the Orbiter engines would be located so that the flame bucket and associated interfaces are the same. The umbilical connections can be conveniently located at or near their Orbiter location.

Although the concept on the left also locates these features as on the Orbiter, the payload is forward of the ET. This concept is a hybrid between the Inline and Sidemount configurations.

SDV Concepts



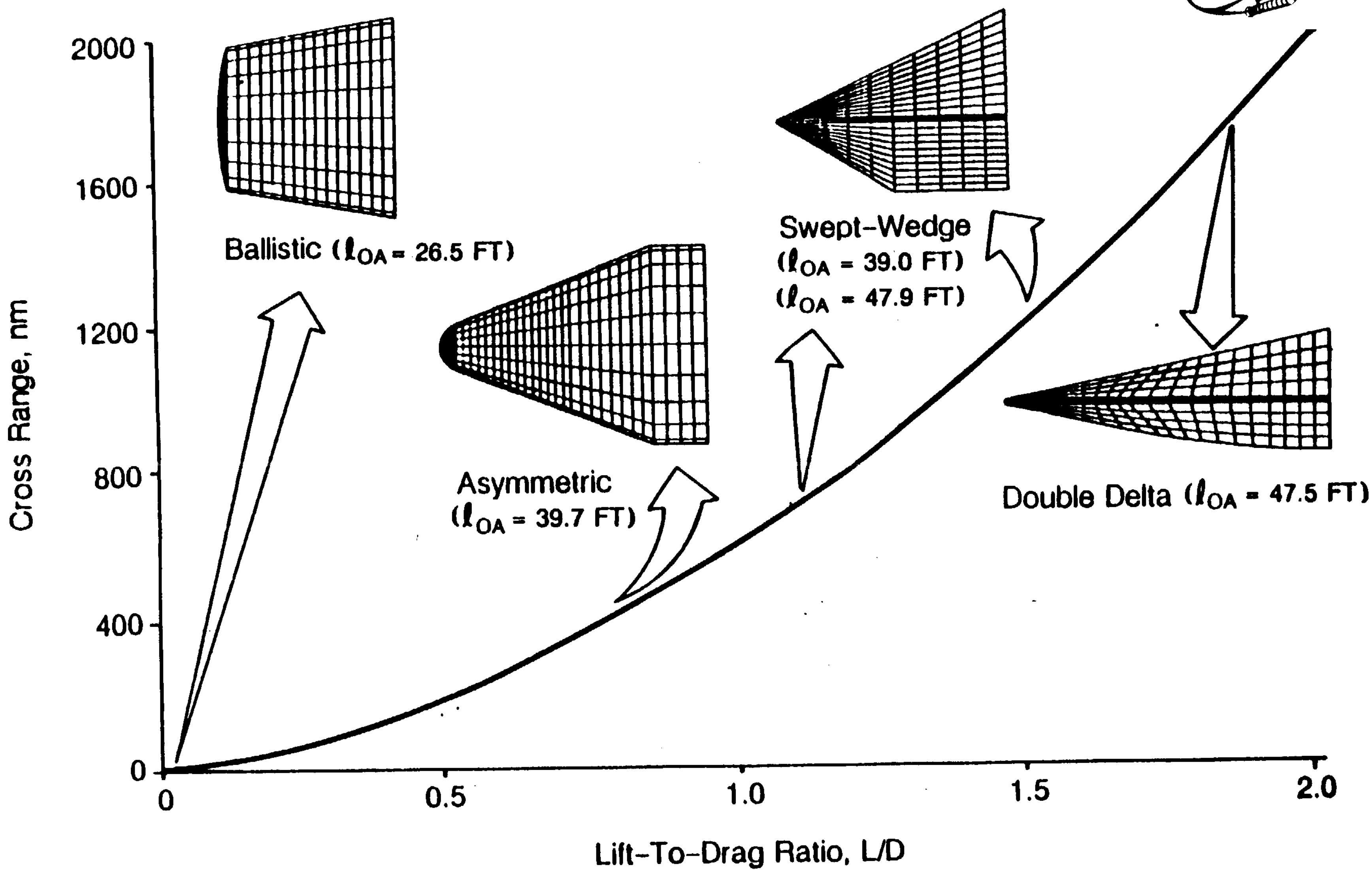


ORIGINAL PAGE IS
OF POOR QUALITY

P/A MODULE STUDY CONFIGURATIONS

Martin Marietta has investigated a number of concepts for propulsion modules which allow recovery of six major cost items. Aerodynamic configuration and thermal analysis have been performed to trade-off the advantages of each. High lift configurations offer advantages in flexibility of return path. The P/A Module is currently in work by Martin Marietta under a Marshall Space Flight Center (MSFC) contract.

P/A Module Study Configurations



MARTIN MARIETTA
MANNED SPACE SYSTEMS

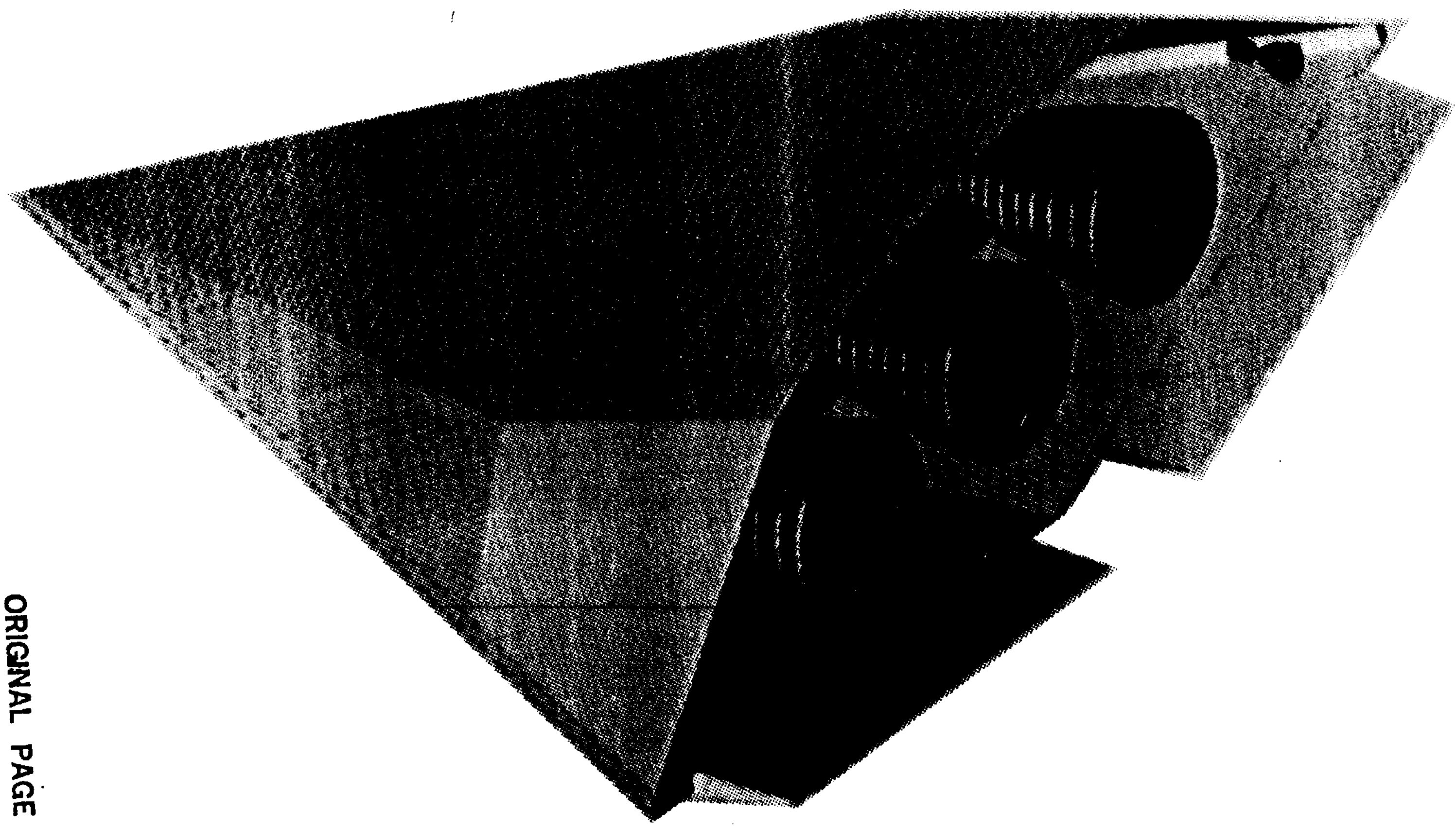
PROPULSION/AVIONICS MODULE

This configuration has a high lift-to-drag (L/D) ratio that allows a descent slow enough to minimize heating.

The Module is made of aluminum, and the nose tip and leading edges are of graphite-graphite. This concept has a considerable cross range because of its high lift.

Propulsion/Avionics Module

Shuttle C



ORIGINAL PAGE IS
OF POOR QUALITY

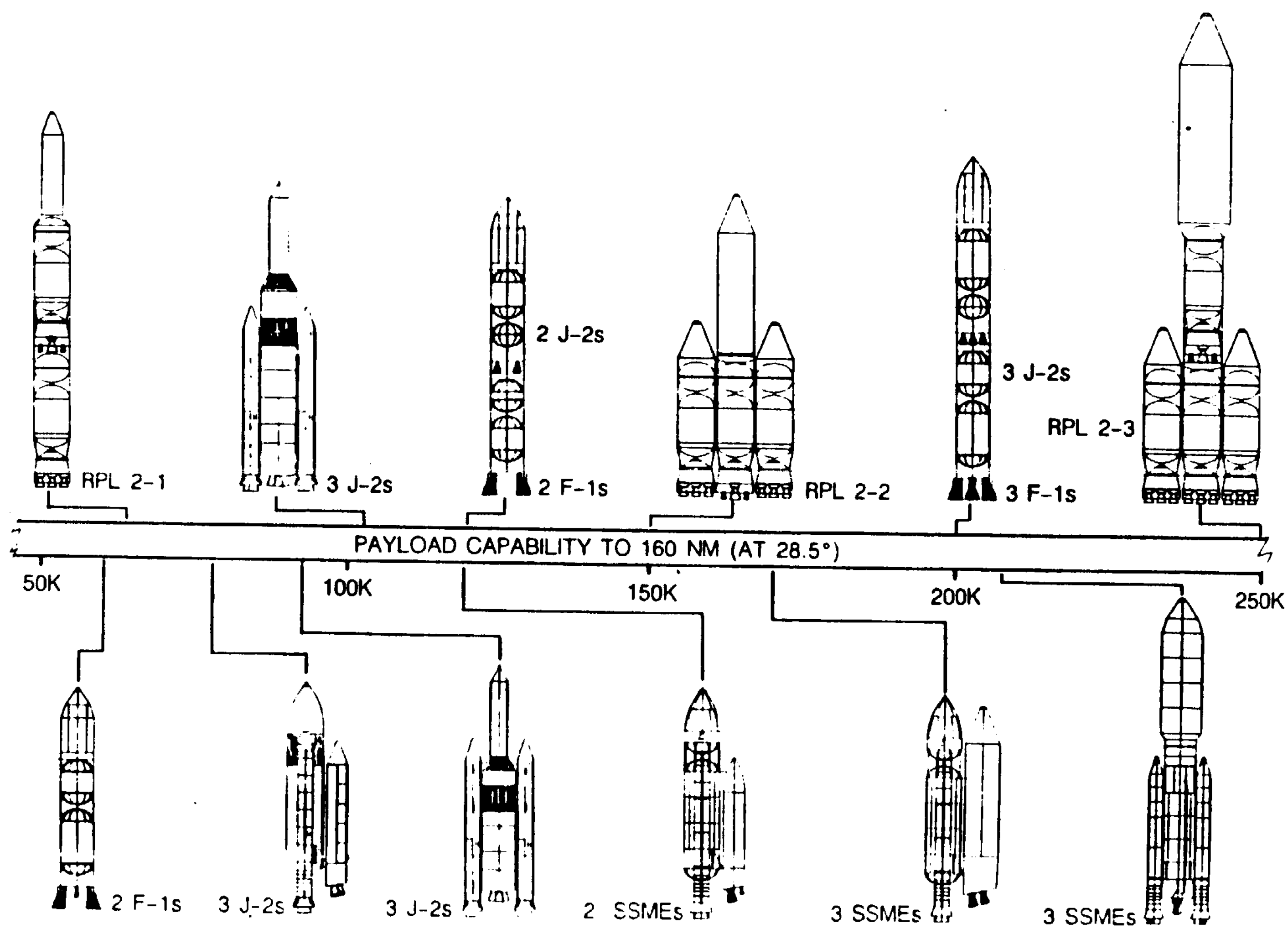
MARTIN MARIETTA
MANNED SPACE SYSTEMS

EXPENDABLE SDV CONFIGURATIONS

Martin Marietta has conducted studies for a wide variety of launch vehicles derived from Shuttle elements. Payloads range from 50 klb to 250 klb; the payload bay sizes range from Orbiter-size up to 45 ft diameter x 120 ft long.

The engines considered included the Space Shuttle main engine (SSME), F-1, J-2, and other engine concepts identified while working with the Air Force Rocket Propulsion Laboratory (AFRPL).

Expendable SDV Configurations



EXPENDABLE SDV COST SUMMARY (1986 $M)

This chart is an example of the large LCC database of expendable SDV launch vehicles developed by Martin Marietta over the past 7 years. The SDV vehicles encompass 1-, 2-, and 3-engine configurations as well as a wide variety of payload bay shapes and sizes.

Expendable SDV Cost Summary (1986 $M)

Shuttle

Nonrecurring

Hardware Element	Cost
P/A Module	$343
P/L Module	140
Vehicle GSE	26
External Tank	4
SRB	- -
Level II SE&I	107
ULV Vehicle DDT&E	620
Facilities	87
Total Nonrecurring	$707M

Cost Per Flight*

Operations Element	Cost
P/A Module	$102.0
P/L Module	11.6
External Tank	25.0
SRB	27.5
Launch Operations	10.6
Flight Operations	2.1
Propellant	1.3
GSE Spares	1.0
Total CPF	$181.1

*Average For 1992 - 1995

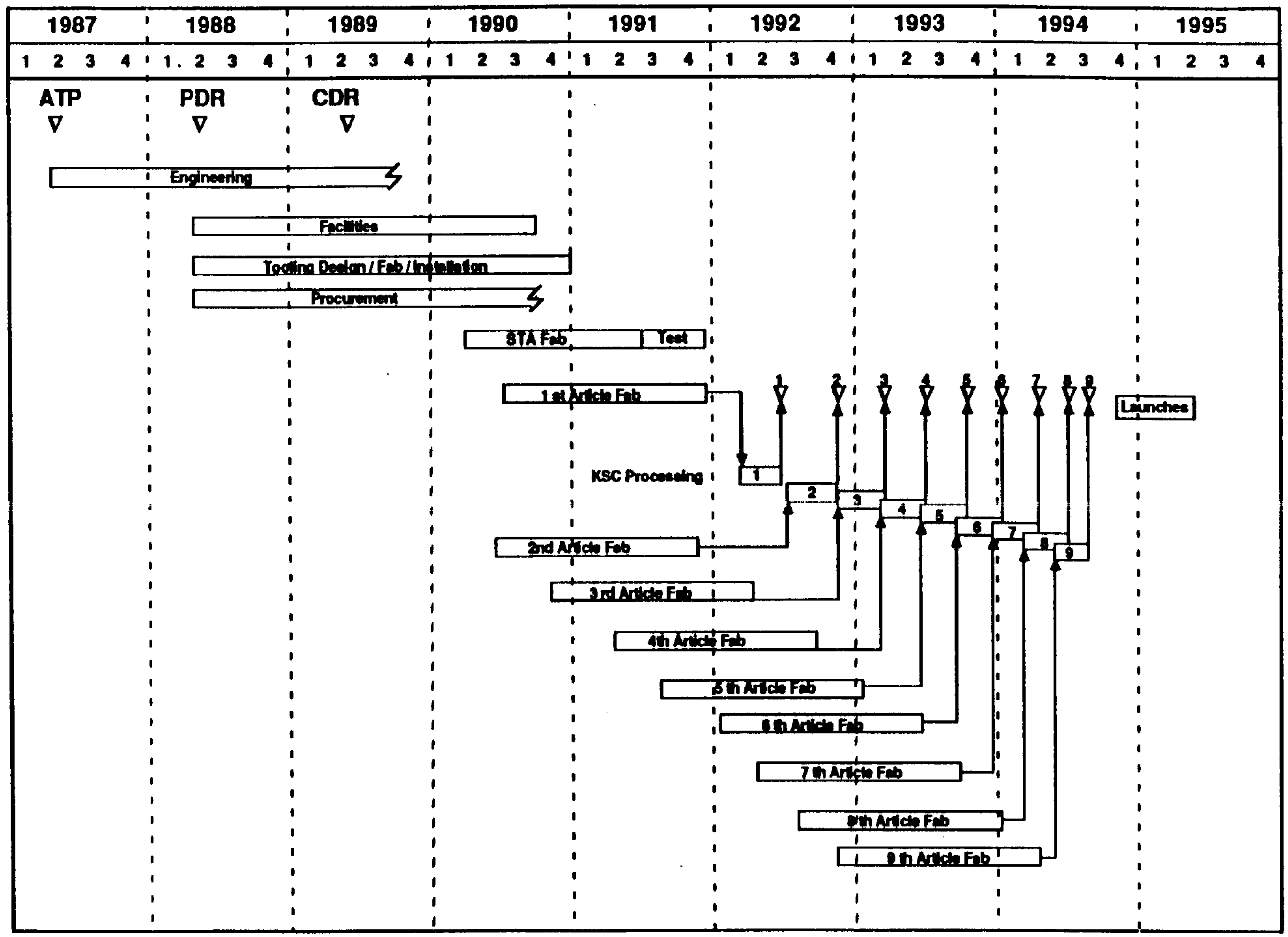
EXPENDABLE SDV SCHEDULE

A development schedule for an expendable configuration shows that the first flight in 1992 could have been achieved with a mid-1987 start date. This earlier study by Martin Marietta supports a five year development timeframe for the Shuttle-C.

For this study, and utilizing other guidelines, two vehicles are flown in the first year, three the next year, and a higher rate thereafter.

The Structural Test Article (STA) was a major milestone in this schedule but not a driver.

Expendable SDV Schedule



ORIGINAL PAGE IS
OF POOR QUALITY

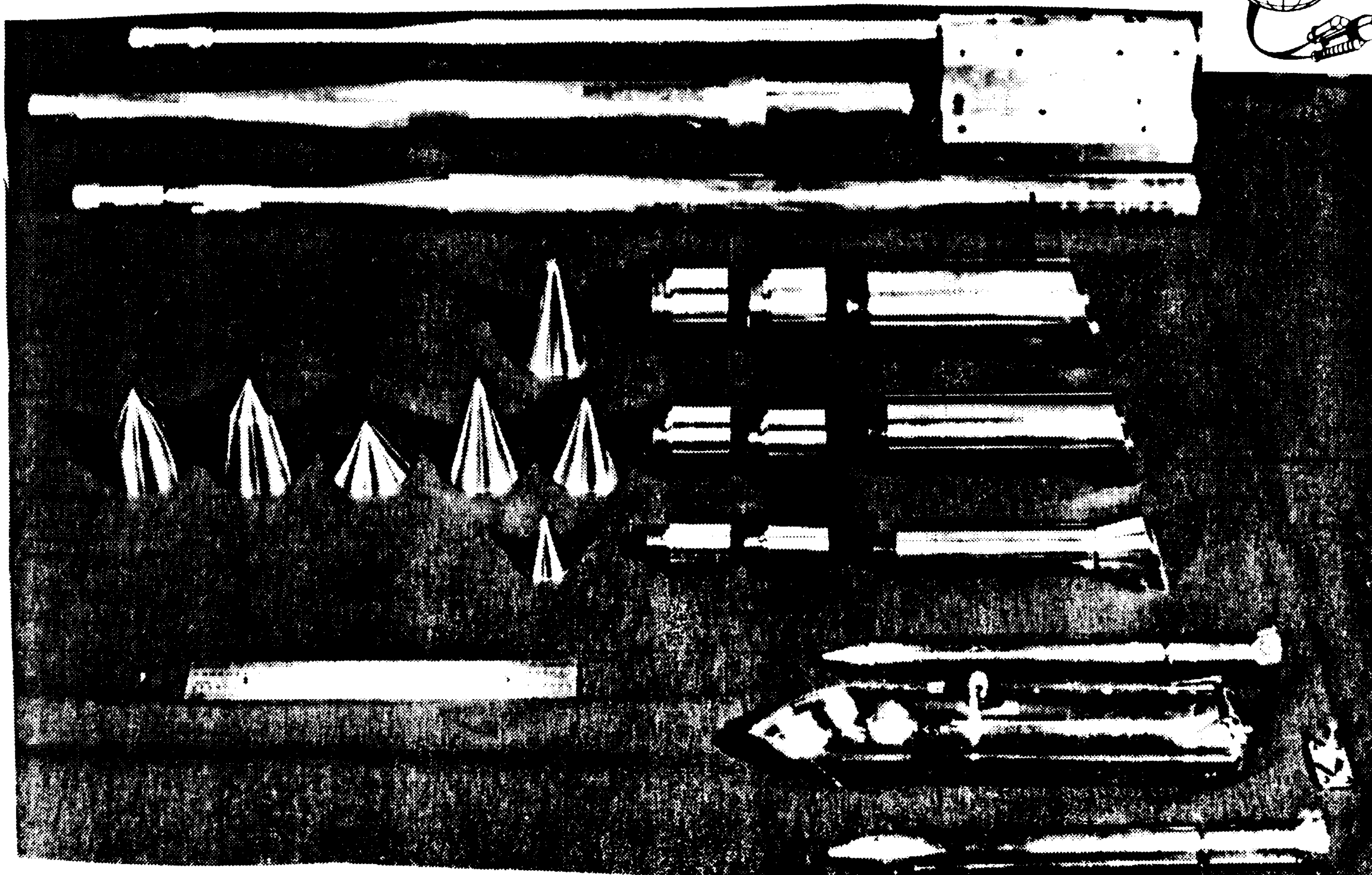
MARTIN MARIETTA
MANNED SPACE SYSTEMS

WIND TUNNEL TEST HARDWARE

The wind tunnel model parts shown were used to establish a basis for SDV aerodynamics for a sidemount configuration cargo vehicle. Three different diameters of Cargo Element (CE), three different lengths of CE body, and five nose shapes were tested.

The test program was run in the MSFC 14-inch trisonic Wind Tunnel Facility as a joint activity between Martin Marietta and MSFC.

Wind Tunnel Test Hardware



MARTIN MARIETTA
MANNED SPACE SYSTEMS

ORIGINAL PAGE IS
OF POOR QUALITY

WIND TUNNEL TEST

Wind tunnel tests on as SDV sidemount model were performed up to Mach 6. This schlieren photograph shows the shock waves around the model being tested. These test results were used to analyze the interface loads between the ET and a large CC (25 ft x 90 ft).

Base pressures were measured in addition to the force and moment data.

Wind Tunnel Test

673
9070

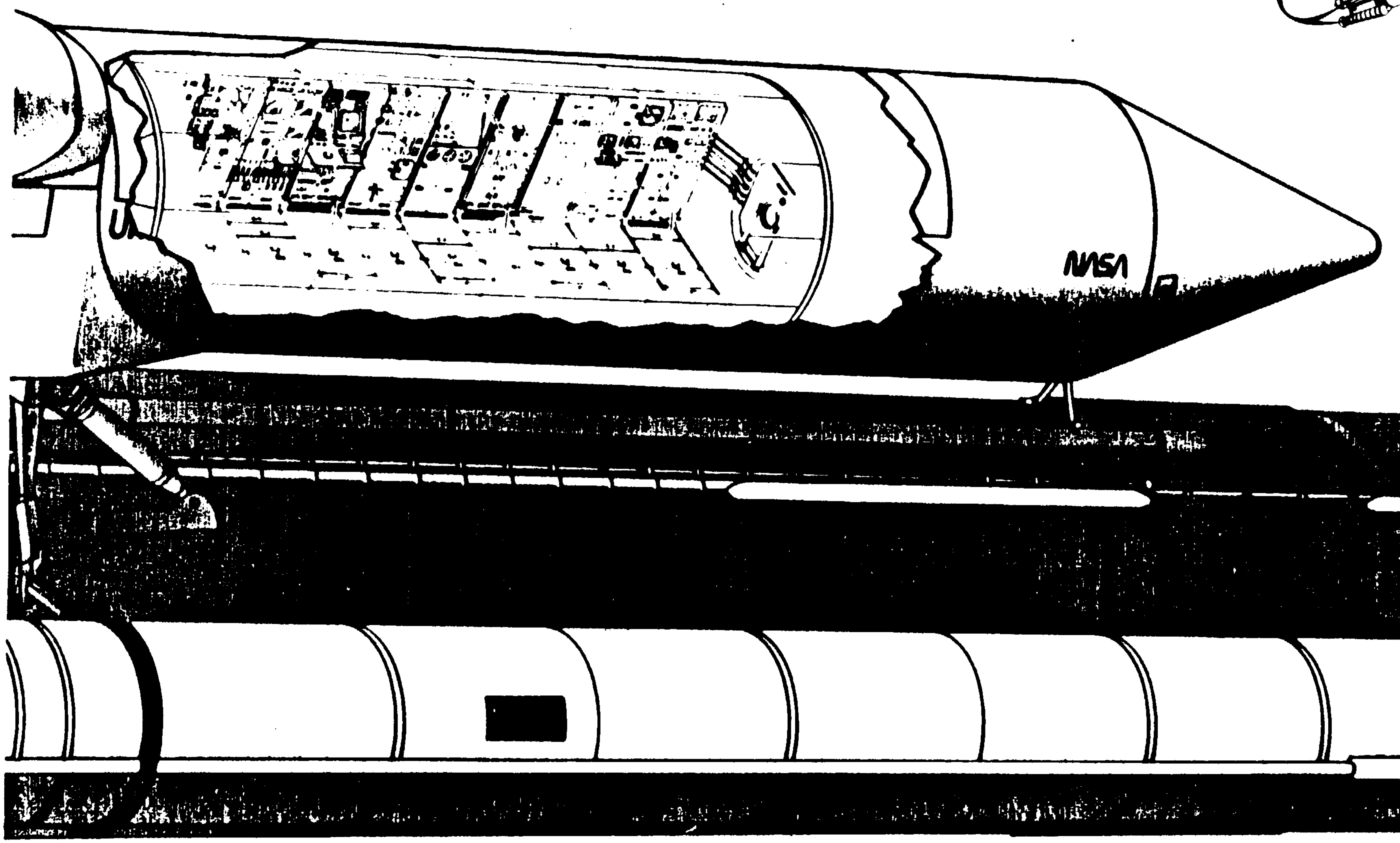
ORIGINAL PAGE IS
OF POOR QUALITY

MARTIN MARIETTA
MANNED SPACE SYSTEMS

SPACE STATION LABORATORY MODULE PAYLOAD

Requirements definition and concept selection will include consideration of delivering a completely outfitted space station module to orbit using the 100,000 pound capability (minimum) of Shuttle-C.

Space Station Laboratory Module Payload

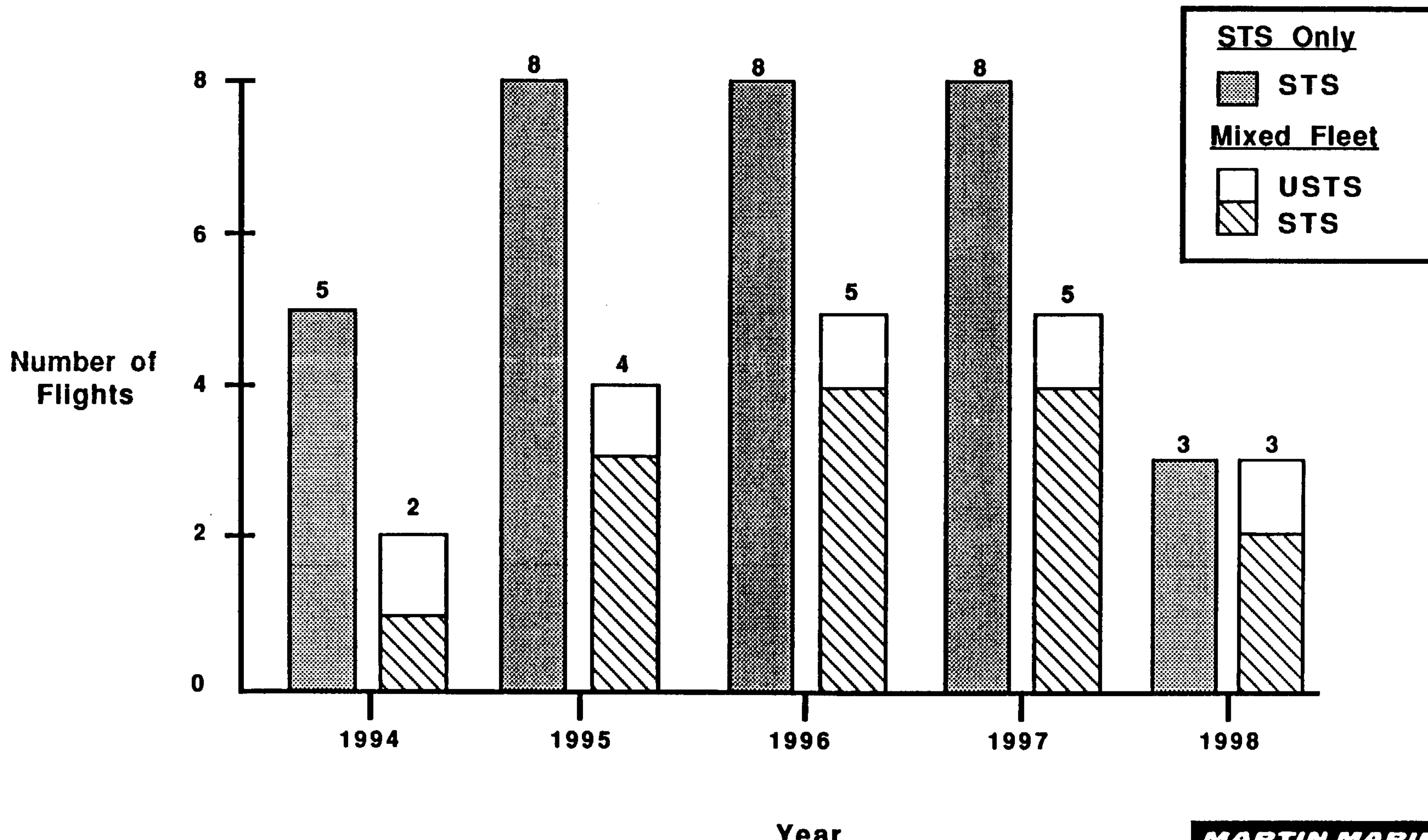


SPACE STATION FLIGHTS PER YEAR

Utilization of Shuttle-C in a mixed fleet will significantly reduce shuttle commitments and total cost. Martin Marietta has analysed the impact of a mixed fleet on the delivery flight schedule and has the data base to apply using the Shuttle-C groundrules and requirements.

The number of orbiter flights are reduced in every year, but savings in the early years are most affected.

Space Station Flights Per Year



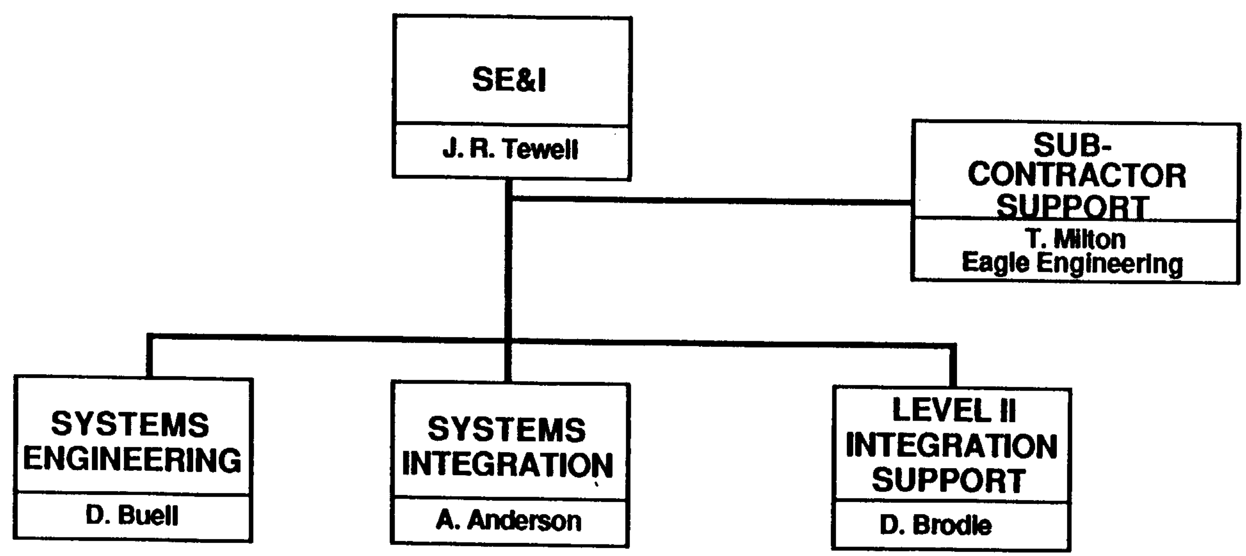
MARTIN MARIETTA
MANNED SPACE SYSTEMS

SDV5.87

SHUTTLE-C SE&I

The Shuttle-C SE&I Organization is managed by J. R. Tewell. His organization is divided into three branches, Systems Engineering, Systems Integration and Level II Integration Support. Subcontractor support in special SE&I areas will be provided by Eagle Engineering, Inc.

Shuttle-C SE&I Organization



- Requirements Definition and Allocation
- Trade Studies
- Vehicle Configuration
- Resource Management

- Interface Definition
- Economic Analysis
- SE&I PLan
- Preliminary Specifications
- Configuration Management

- 07700 Documentation
- Interfaces
  - NSTS
  - Space Station
  - OMV
  - CERV
  - Centaur G'

MISSION REQUIREMENTS

The Mission requirements identified by NASA have guided early work on Shuttle-C Data and techniques developed during earlier Shuttle Derived Vehicle work will apply to these proposed Shuttle-C missions.

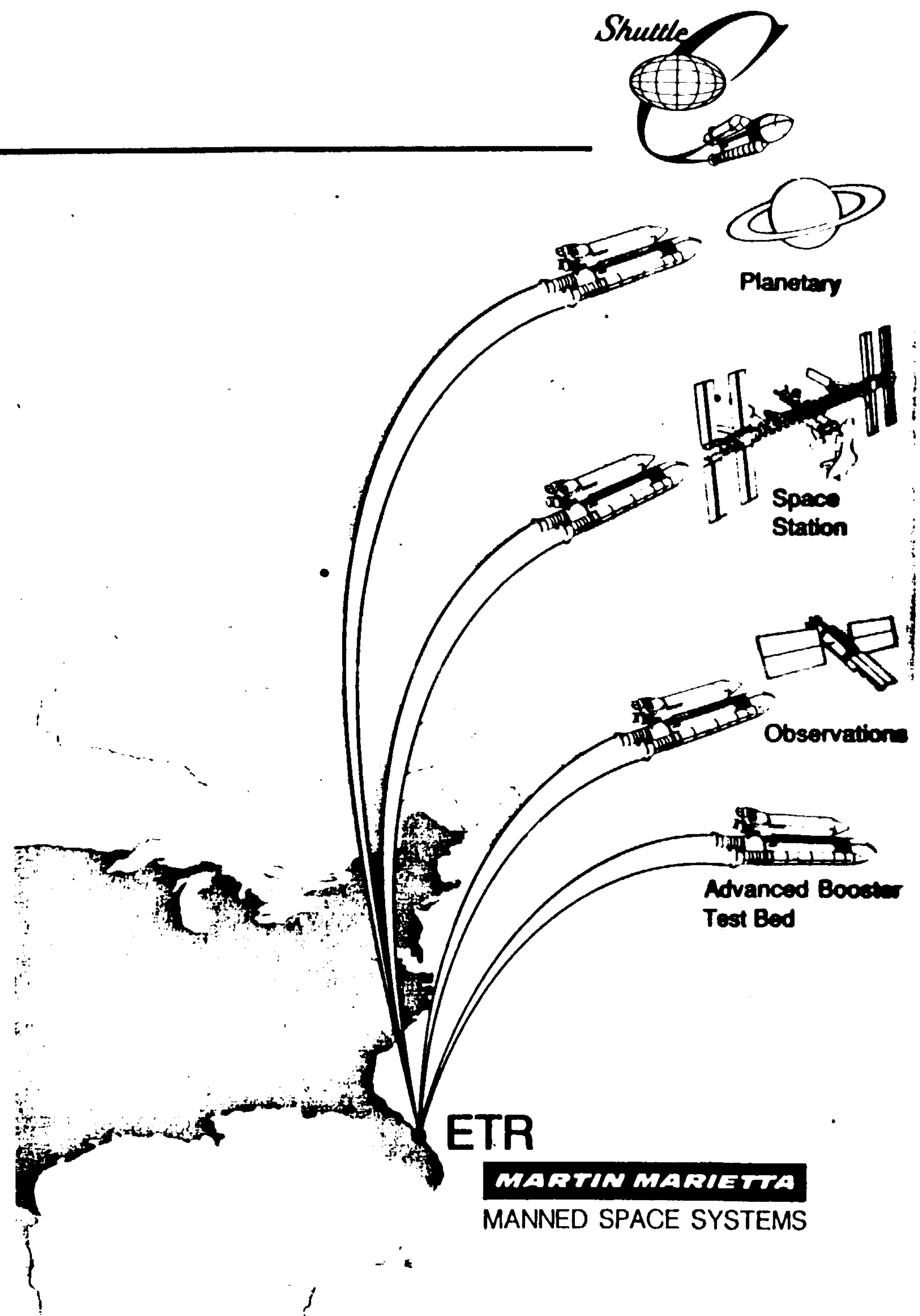
Mission Requirements

- Space Station/OMV
  - Assembly
  - Logistics

- Crew Emergency Rescue Vehicle
  - Definition Studies Planned

- Planetary/Centaur G'
  - Comet Rendezvous/Asteroid Flyby
  - Mars Rover Sample Return
  - Cassini

- Test Bed
  - Boosters: ASRM and LRB
  - Engines: STBE and STME
  - Recoverable P/A Module



MARTIN MARIETTA
MANNED SPACE SYSTEMS

KEY GUIDELINES

The guidelines which have been used so far to drive the Shuttle-C concept analyses are taken directly from the Request for Proposal. These provide a basis for a much enhanced mission capability for the national space transportation system.

Key Guidelines

Shuttle C

- 100 klb Payload Capability to 220 nm, 28.5° circular orbit from ETR
- Minimum Payload Envelope = 15 ft Diameter x 60 ft Long
- Initial Launch Date Mid-1993 or Earlier
- NSTS to Shuttle-C Payload Transferability
- Design to Man-Rated Criteria
- Maximum Use of Developed/Proven Shuttle or Other Hardware/Software

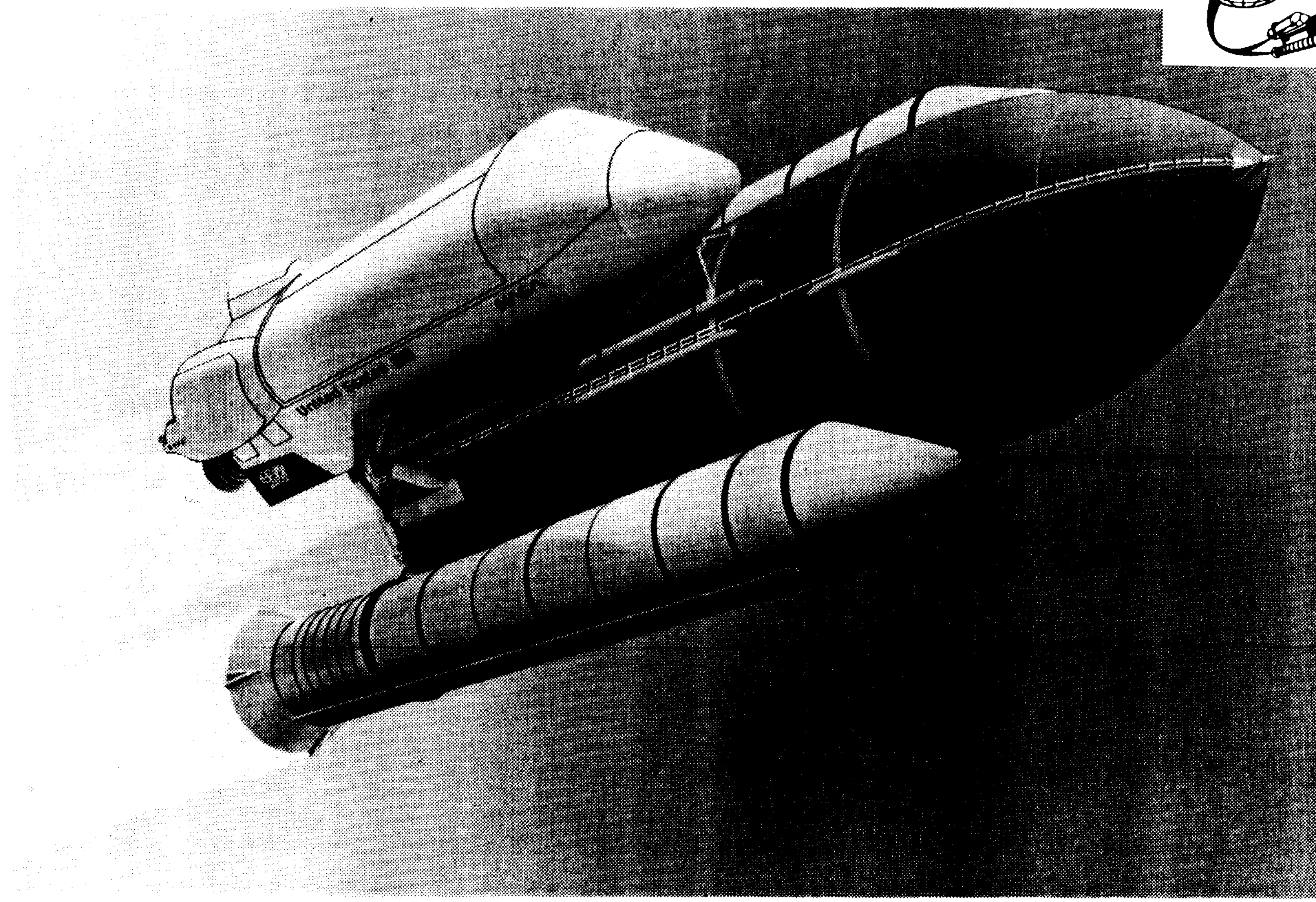
SHUTTLE-C SIDEMOUNT REFERENCE CONCEPT

The sidemount reference concept includes an ET common with the STS, common SRB, and a cargo element which utilizes the Boattail of the Orbiter as the propulsion system for the Cargo Element modified for two SSMEs.

The Payload Carrier houses 15 by 70 foot payloads within an Orbiter type bay. This concept mates with the weather seal used during payload installation and changeout at the launch pad.

This concept maximizes commonality with existing NSTS systems and will be used as a basis of trades for determination of the recommended configuration.

Shuttle-C Sidemount Reference Concept



ORIGINAL PAGE IS
OF POOR QUALITY

REQUIREMENTS APPROACH

The requirements flowdown process will start with the government supplied mission requirements set. Requirements will be allocated and traceable from mission requirements through NSTS 07700 type documentation. A data base approach will be used to document requirements and supporting trades and analyses.

Requirements Approach

Shuttle

- Maximize Use of Existing NSTS Program Definition and Requirements Documentation
- Define the Shuttle-C Requirements that can be Imposed to Provide High Reliability at Low Cost
- Assure All Requirements Are Accounted For Through Systematic Analyses
- Provide Traceability of Imposed and Derived Requirements to Source Documentation
    - Systems Requirements Database
    - Trades & Analyses Database

REQUIREMENTS EMPHASIS

Special emphasis will be given to the development of design requirements. These have been adjudged as provided major inputs to the success of the Shuttle-C program.

Requirements Emphasis

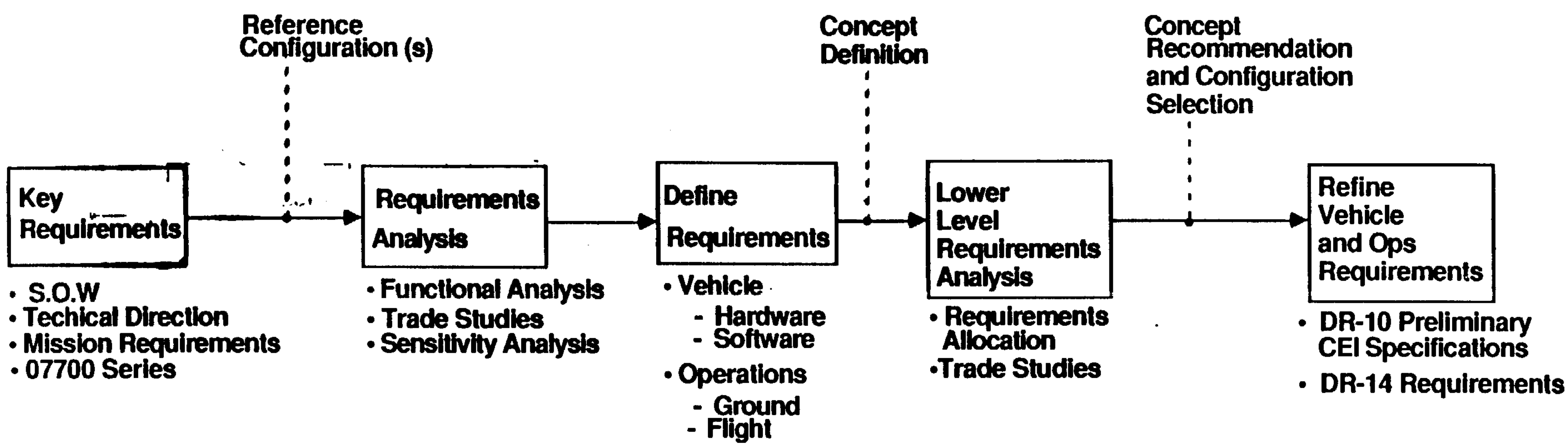
- Redundancy
- Factors of Safety
- Verification
- Lifetime
- Reliability

REQUIREMENTS ANALYSIS

This activity defines a set of engineering requirements for the system and subsystems. The analysis applies to both hardware and software--which are usually developed in parallel--and operations.

As the program phases evolve, the requirements are defined/refined in increasing depth. Then the requirements are documented in the DR-10 format as a precursor to the Preliminary Contract End Item (CEI) Specifications and the prelimiinary edition of the DR-14, "Requirements, Concepts, and Configuration Trades/Analyses."

Requirements Analysis

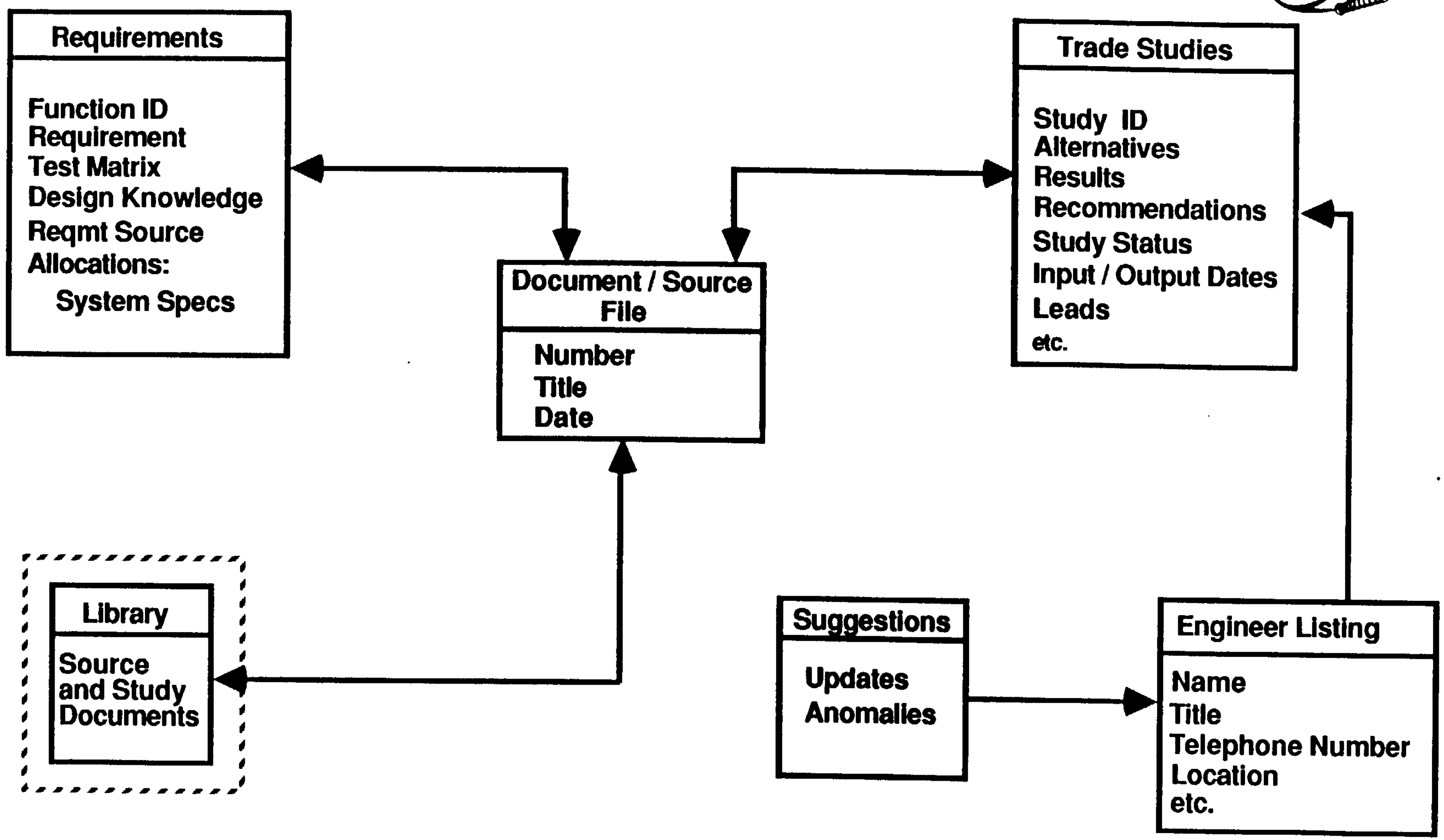


MARTIN MARIETTA
MANNED SPACE SYSTEMS

SYSTEM ENGINEERING DATA BASE

The System Engineering Data Base will be organized to provide dissemination and access of the requirements, trade studies, and configuration definition as they are developed. This system will provide a means of maintaining up to date and valid documentation of study results and assuring that all groups have available the correct and approved data to work with. Appropriate portions of this data will be computerized.

System Engineering Data Base



MARTIN MARIETTA
MANNED SPACE SYSTEMS

KEY TRADES

The trade studies identified here are major factors in the early phase of the Shuttle-C program. The Inline/Sidemount selection, which precedes most of the subsystem analysis, trades, and design, will influence provisions for payload delivery from main engine cutoff (MECO) to the orbital destination.

The number of engines largely depend on the man-rating requirements which also precede the preponderance of subsystem work.

Cargo bay size has a fundamental influence on the launch facility impacts which are a major driver. Also, this parameter derives from the manifesting and mission operations trades which will supply the fundamental data required for ensuing trades.

Key Trades

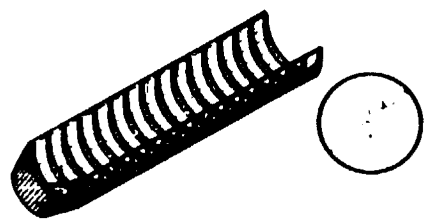
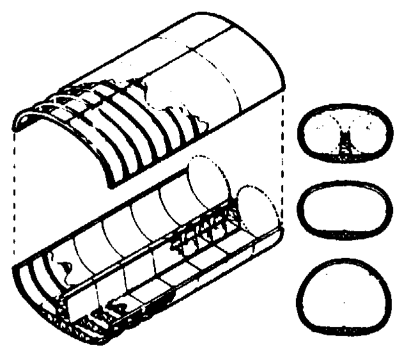
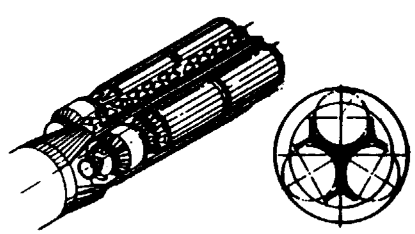
- Inline vs Sidemount Concepts
- Two vs Three Engines
- Cargo Bay Size

PAYLOAD CARRIER ALTERNATIVES

The Payload Carrier (PC) body shape trade study will address optimization of the structural and aerodynamic body shape, capitalizing on the results of past studies. This viewgraph shows representative configurations previously investigated.

An assessment of aerodynamic data, design concepts, payload bay size, and shroud/door concepts for access, facilities, and production operations will be made to define a preferred PC body shape.

Payload Carrier Alternatives

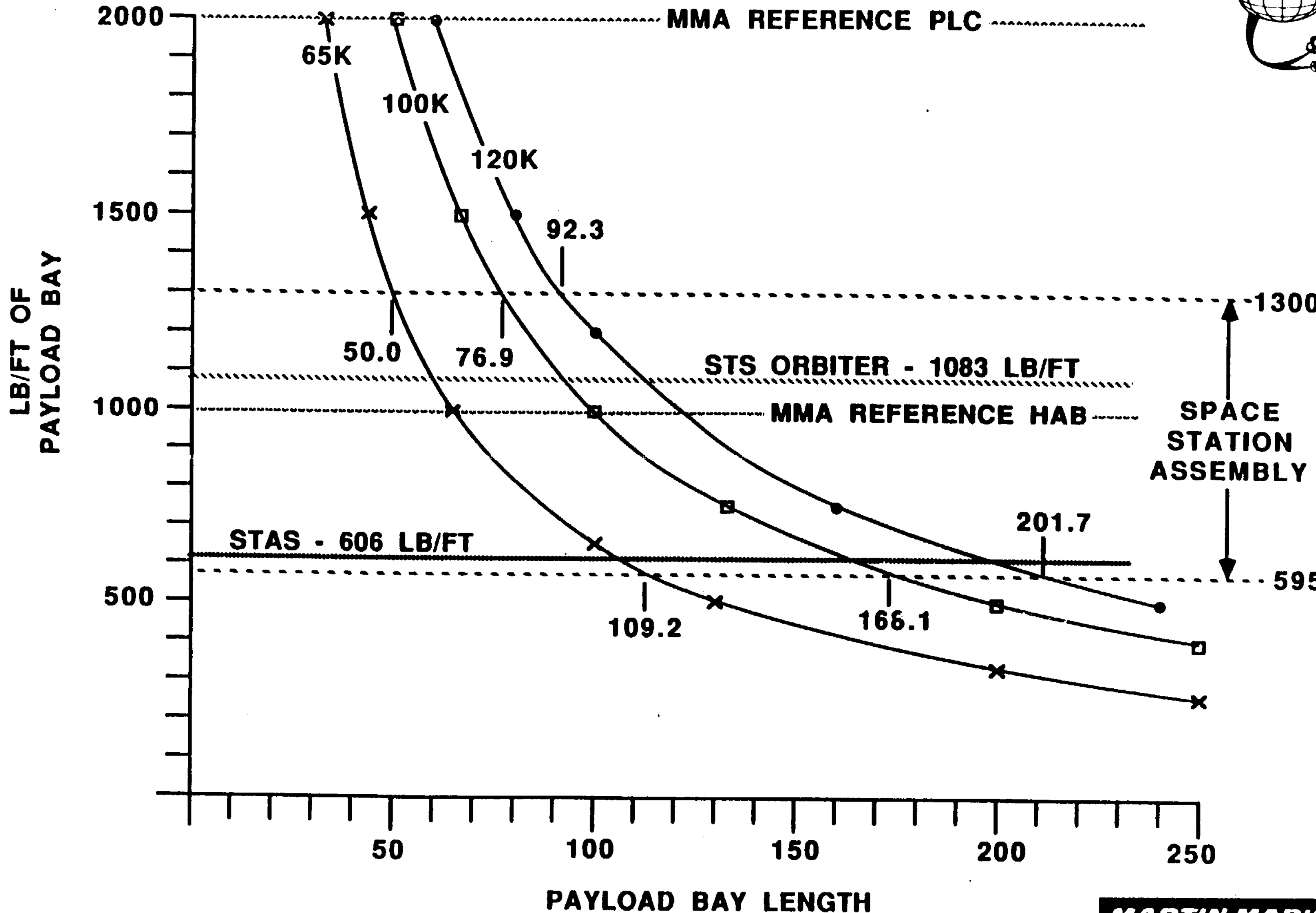
	Type	Characteristics
	Single	17-45 foot diameter 60-120 feet Long
	Dual Tandem	33 foot diameter 60-90 feet long
	Three Tandem	33 foot diameter 60-90 feet long

CARGO BAY SENSITIVITIES

Manifesting studies have been conducted by Martin Marietta which bound the problem and provide a starting point for applying the techniques to the mission model identified by NASA for Shuttle-C.

Manifesting studies will consider total anticipated payload population from mission requirements, size, mass properties, interface requirements and delivery schedule.

Cargo Bay Sensitivities



SELECTION CRITERIA DEVELOPMENT

Trade studies will be made using established criteria and traceable to requirements. The course screening is worked to apply those requirements which are essentially go-no go to eliminate those configurations which simply do not meet requirements.

The fine screen is an assessment made against criteria which will be weighted and summed to provide an overall assessment.

Selection Criteria Development

CRITERIA SOURCES

SOW - Phase 1 Objectives
SOW - Guidelines & Assumptions
SOW - Phase 1 Tasks
DR - 14 Requirements
DR - 18 Requirements

COARSE SCREEN CRITERIA

100 KLB TO 220NMI.
IOC BY 1993
P/L 15'X 60' (MINIMUM)
MANRATED CARGO ELEMENT

FINE SCREEN CRITERIA

Minimum DDT&E
Maximum Operational Flexibility
Minimum Risk
Maximum Reliability
Maximum NSTS Synergism
Maximum Safety

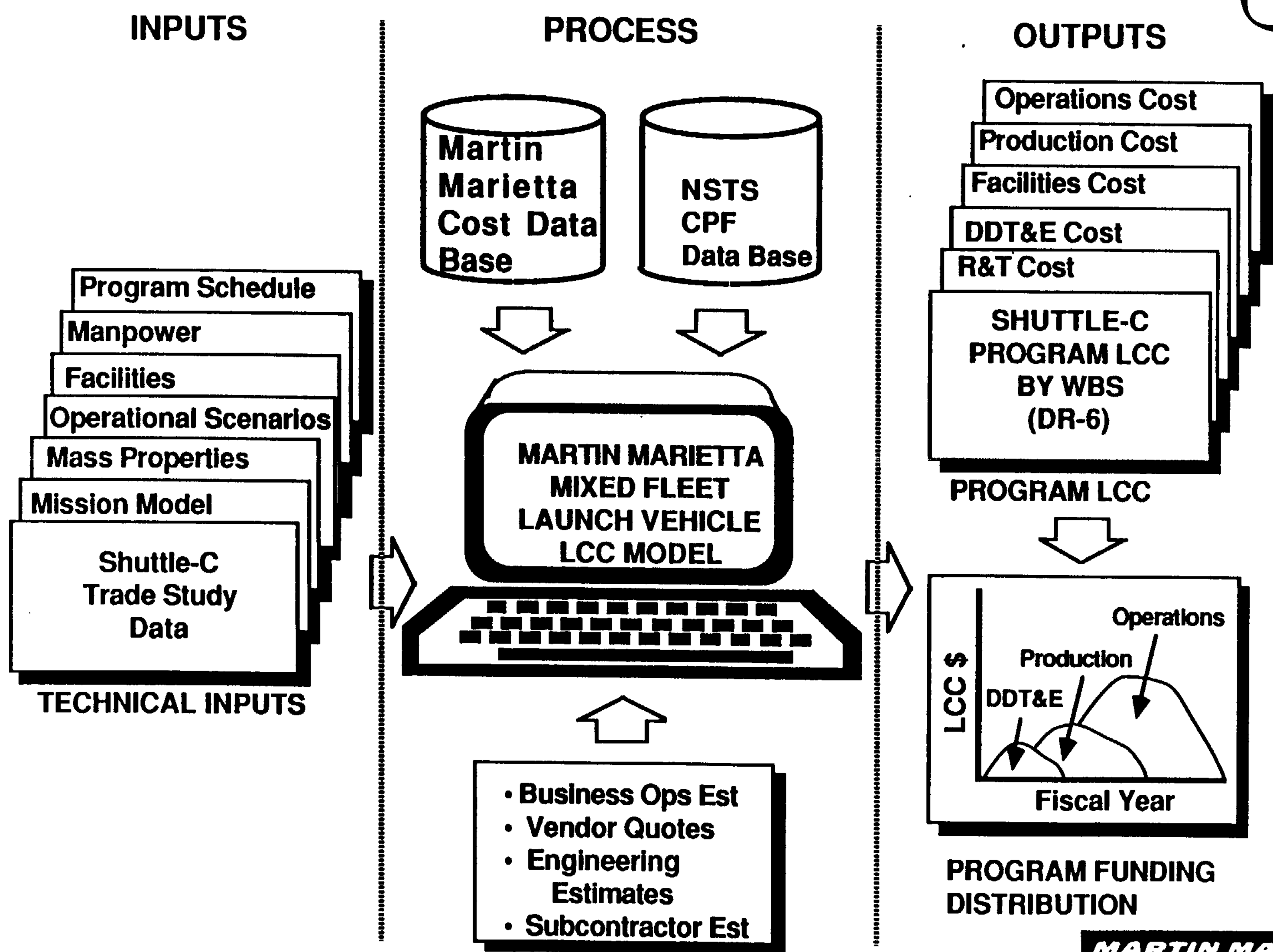
LIFE CYCLE COST METHODOLOGY

Our developed and proven Life Cycle Cost (LCC) methodology is based on a parametric cost estimating technique. The Shuttle-C trade study data (e.g., schedule, manpower, facilities, mission model) are input to the LCC model. This model is continuously updated with NSTS, Martin Marietta, subcontractor, and vendor data.

The mixed fleet launch vehicle LCC model outputs the Shuttle-C Program LCC which is reported by WBS phase (e.g., R&T, DDT&E, Production, Operations, Facilities) for the DR-6. Program funding distributions are also generated.

Use of this model assures consistent cost assessment of the Shuttle-C trade studies and LCC.

Life Cycle Cost Methodology



MARTIN MARIETTA
MANNED SPACE SYSTEMS

STUDY PLAN-SYSTEMS ENGINEERING AND INTEGRATION

The near term goals and critical milestones have been established. Included in this plan are the results of the supporting document.

Study Plan - Systems Engineering & Integration

Contract Task	NOV 20	NOV 25	DECEMBER 4	DECEMBER 11	DECEMBER 18	DECEMBER 24	JANUARY 8	JANUARY 15	JANUARY 22	JANUARY 29
		23/24 ▽ ORIENTATION				REQMTS REVIEW ▽				CONCEPT SELECTION ▽
DR-18 Evaluation and Selection Criteria Plan		Updated ▼								
Man-Rated Criteria Established			▽							
Mission Requirements Assessed				▽						
Technical Requirement Developed					▽					
Two vs Three Engines Resolved					▽					
DR-10 Preliminary CEI Specifications Submitted						▽				
Cargo Bay Size Established							▽			
Launch Operations Impacts Defined							▽			
Inline/Sidemount Concept Selected								▽		
DR-14 Requirements, Configuration, Trades, and Analysis Submitted						▽			▽	

Agenda

• Organization	J. McCown
• Staffing	J. McCown
• System Definition Technical Activities	
- Systems Engineering and Integration (and Past Studies Applications)	J. R. Tewell
- Design and Analysis	B. VanBeek
LUNCH	
- Operations and Logistics	B. King
- Production and Test	J. Kubnick
- Safety, Reliability, and Quality Assurance	J. Mangino
• Program Issues and Summary	J. McCown

AGENDA - DESIGN AND ANALYSIS

The agenda for the Design and Analysis group provides an overview of the organization, past accomplishments, and plans for the immediate future.

Agenda - Design and Analysis

Shuttle C

- Design and Analysis Organization
- Database
- Structures
  - Plan
  - Trade Studies
- Avionics
  - Plan
  - Trade Studies
- Propulsion and Mechanical
  - Plan
  - Trade Studies

ORGANIZATION - DESIGN AND ANALYSIS

The Design and Analysis group will provide the subsystem configurations and data needed for the trade studies. They will also be the central technical contact point for tasks assigned to IBM, Honeywell, and General Dynamics.

Organization - Design and Analysis

Shuttle

DESIGN & ANALYSIS
Wm. VanBeek

AVIONICS/ SOFTWARE
Charles Levy

- Software
- GN&C
- Electrical Power
- Communications
- Data Management
- Electronic Syst. Integr
- Manage IBM S/C (S/W)
- Manage Honeywell S/C (GN&C)

PROPULSION/ MECHANICAL
Bruce Emerick

- System Design & Analysis
- Thermal Analysis & Design
- Hydraulic Design
- Mechanisms
- Manage General Dynamics S/C (Centaur Integr)

STRUCTURES
Larry Hansen

- Internal Load Evaluation
- Structure Design & Stress Analysis
- Design Integration
- Vehicle Design & Subsystem Installation
- Materials

DATABASE FOR STUDY

Prior studies, IR&Ds, and ET evaluations provide a database which will allow trade studies and performance evaluations to be performed much quicker with new people and, in some cases, with refinement only.

Database for Study

- Advanced Programs Studies, IR&Ds, and ET Evaluations Provide the Database
  - Requirements
  - Preliminary System Architecture
  - Hardware Size, Weights, and Power
  - Operational Parameters for Trade Studies
  - Softrware Requirements for Various Configurations
  - Interfaces
  - Deorbit System Concepts
  - Alternate System Concepts
  - Rotating Service Structure (RSS) Concepts
  - System Commonality with NSTS
  - Redundancy Management Techniques
  - 2 vs 3-Engine Trade Studies
  - Reaction Control System (RCS)
  - OMS Deorbit Studies

STUDY PLAN - STRUCTURES

The Structures Study Plan supports the design requirements definition of the inline vs sidemount trade study required for concept selection.

Definition of the baseline concept and inputs to NSTS elements will be identified after project review. Structural updates and environmental assessments will also be completed in time to support concept selection.

Study Plan - Structures

Contract Task	NOV		DECEMBER				JANUARY			
	20	25	4	11	18	24	8	15	22	29
		23/24 ▽ ORIENTATION			REQMTS REVIEW	▽		CONCEPT SELECTION		▽
Structural Design Requirements Provided To SE & I			▽							
In Line Trade Study Concept Layout Published			▽							
Baseline Trade Study Concept Layout Published						▽				
Memo Issued On Impact To Existing NSTS Elements						▽				
Memo Issued On CE Payload Environments For In Line / Sidemount								▽		

COMPUTER-AIDED DESIGN (CAD) - SIDEMOUNT

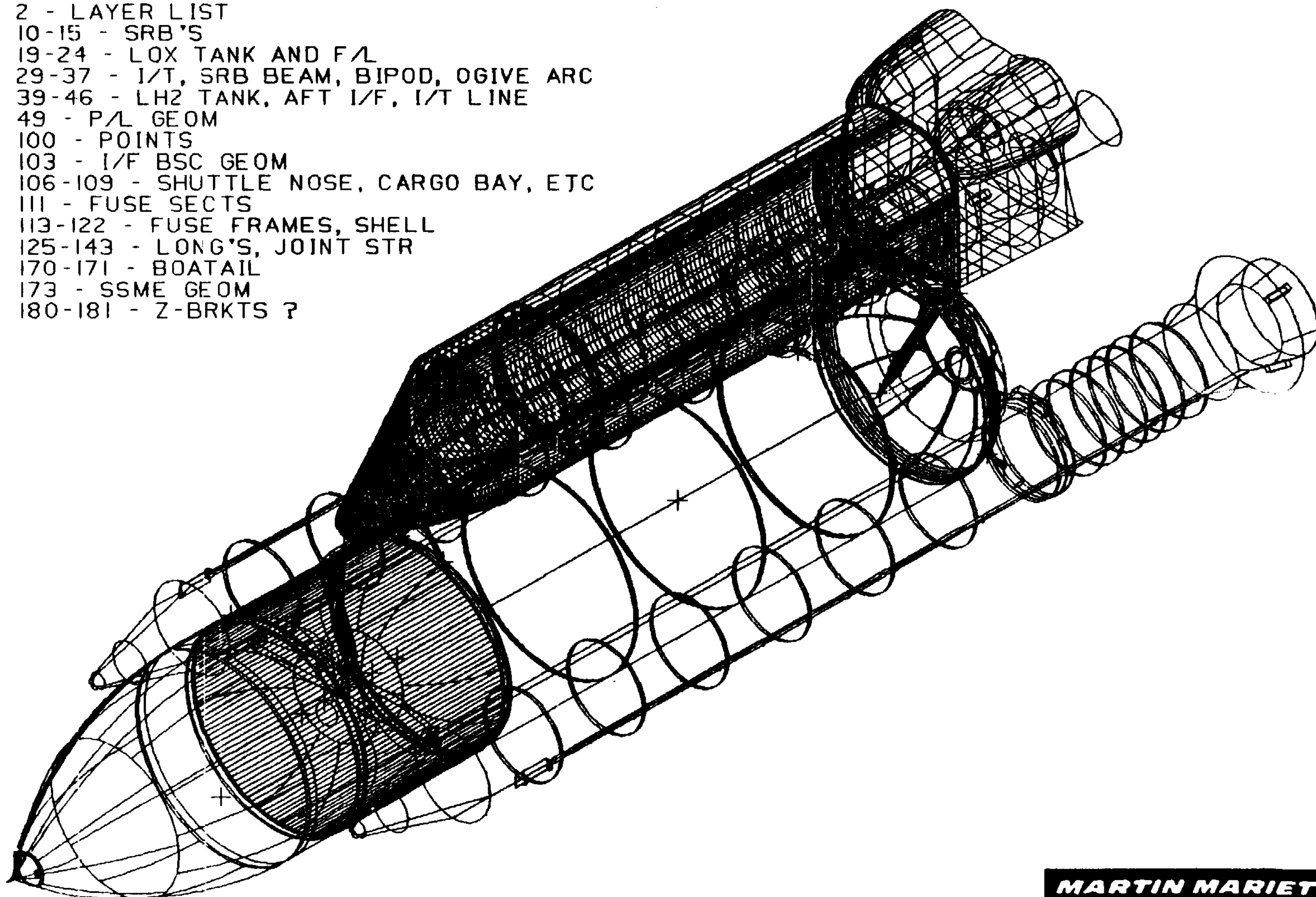
The baseline concept consists of a sidemount CE with a modified Orbiter boattail 2-engine propulsion module, a standard NSTS External Tank (ET), and standard SRBs. Structural detail will be added where required to support the trade studies.

Computer-Aided Design (CAD) - Sidemount

LAYER LIST

- - - - - - - - - -

LAYER 1 - FORMAT AND TEXT
LAYER 2 - LAYER LIST
LAYER 10-15 - SRB'S
LAYER 19-24 - LOX TANK AND F/L
LAYER 29-37 - I/T, SRB BEAM, BIPOD, OGIVE ARC
LAYER 39-46 - LH2 TANK, AFT I/F, I/T LINE
LAYER 49 - P/L GEOM
LAYER 100 - POINTS
LAYER 103 - I/F BSC GEOM
LAYER 106-109 - SHUTTLE NOSE, CARGO BAY, ETC
LAYER 111 - FUSE SECTS
LAYER 113-122 - FUSE FRAMES, SHELL
LAYER 125-143 - LONG'S, JOINT STR
LAYER 170-171 - BOATAIL
LAYER 173 - SSME GEOM
LAYER 180-181 - Z-BRKTS ?

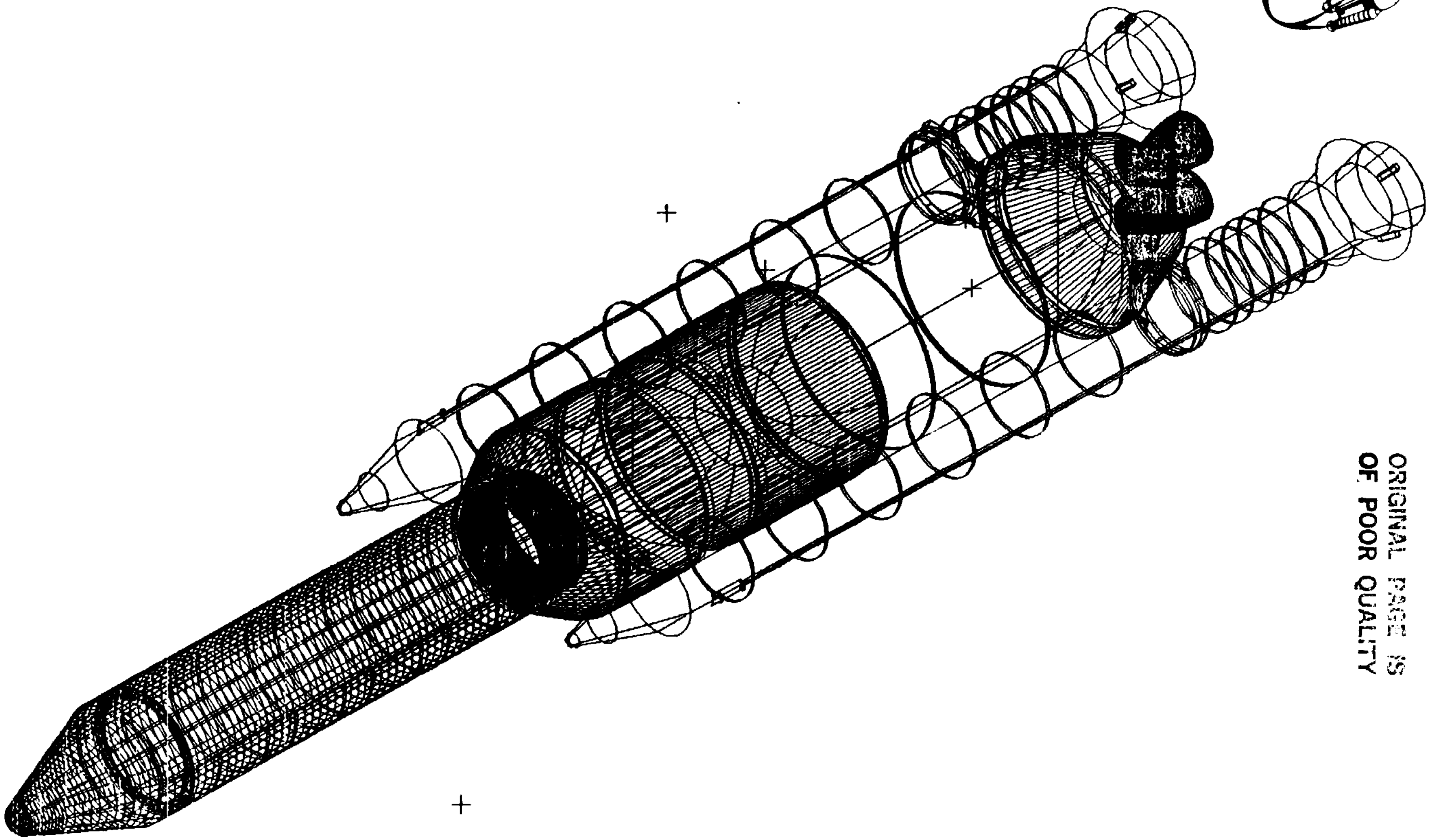


MARTIN MARIETTA
MANNED SPACE SYSTEMS

CAD - INLINE

The inline concept presented in the proposal will be updated to provide the detail required to support the concept trade studies. Key components of this configuration are standard NSTS SRBs, a shortened ET with a modified Intertank (I/T), an inline CE mounted on a payload adapter, and an inline propulsion 2-engine module mounted to an aft adapter.

CAD - Inline



ORIGINAL PAGE IS
OF POOR QUALITY

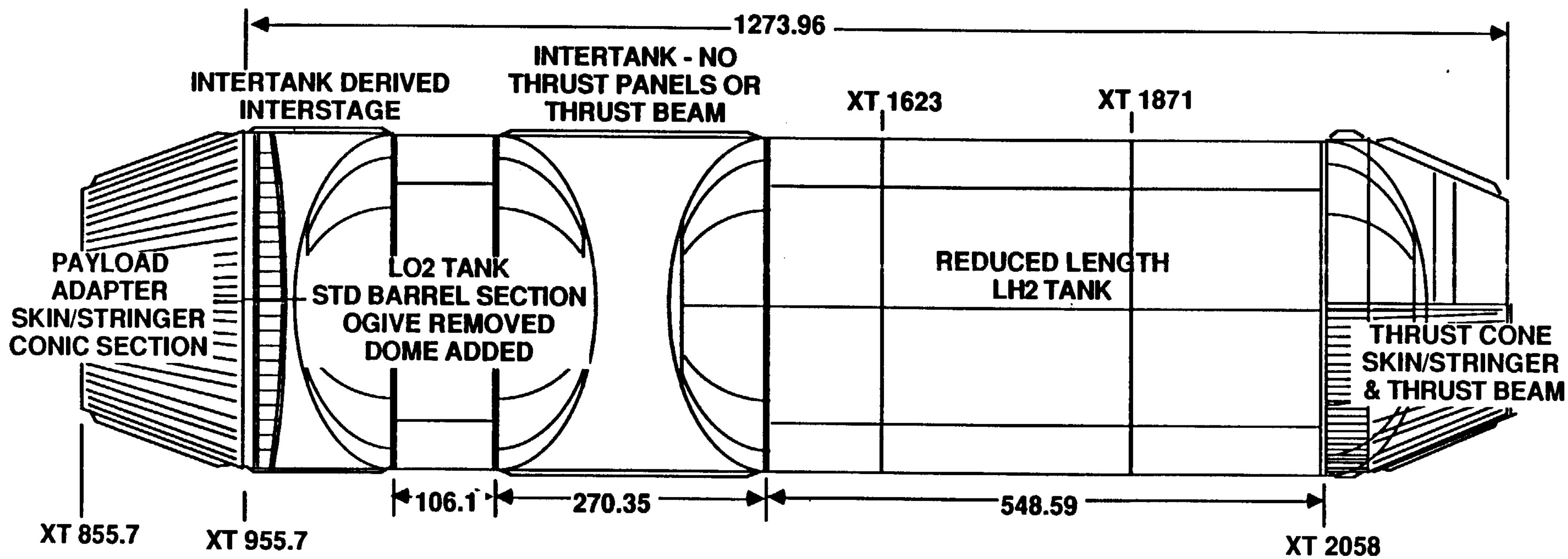
MARTIN MARIETTA
MANNED SPACE SYSTEMS

INLINE CONFIGURATION - ET IMPACTS

The inline concept requires major modifications to the NSTS ET. Although structural impacts could be reduced by using an offloaded full-length LH2 tank, this approach would present facility difficulties.

The effects of the inline configuration on payload bay environments will be evaluated to assure that payloads may be transferable from the NSTS to the Shuttle-C.

Inline Configuration - ET Impacts



MARTIN MARIETTA
MANNED SPACE SYSTEMS

STUDY PLAN - AVIONICS AND SOFTWARE

The avionics and software plan supports the initial two-month activity of defining requirements and providing the data required for concept selection.

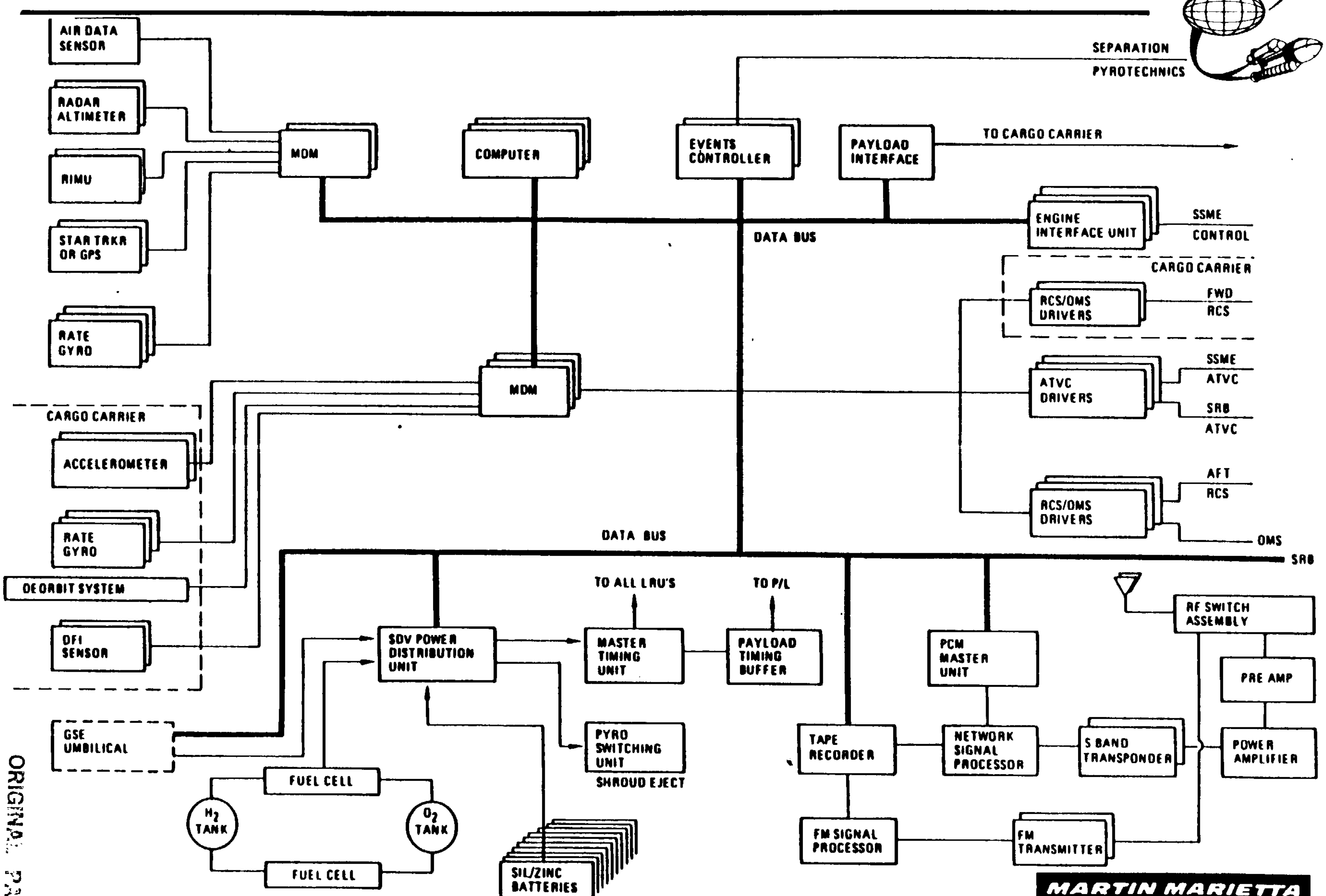
Study Plan - Avionics & Software

Contract Task	NOV 20	NOV 25	DECEMBER 4	DECEMBER 11	DECEMBER 18	DECEMBER 24	JANUARY 8	JANUARY 15	JANUARY 22	JANUARY 29
		23/24 ▽ ORIENTATION				REQMTS REVIEW ▽				CONCEPT SELECTION ▽
Library Of Prior Studies Established	......	......	▽							
Ascent Performance & Stability Analysis For GN & C Assessed For Inline & Sidemount Provided To SE & I	......	......	......	▽						
Requirements For Mission / Systems / Payload Accomodation Provided To SE & I	......	......	......	▽						
Hardware Alternatives & System Impacts For Comm, Data, Power & Control Assessments Preliminary List Issued	......	......	......	......	▽					
S/W Mods & New S/W Development Impact Determined & Assessed List For In Line / Sidemount Provided To SE & I	......	......	......	......	▽					

SDV AVIONICS SYSTEM BLOCK DIAGRAM

This viewgraph shows an SDV avionics concept. The sidemount baseline will be derived by using this concept and similar data from other studies along with the inputs provided by NASA.

SDV Avionics System Block Diagram



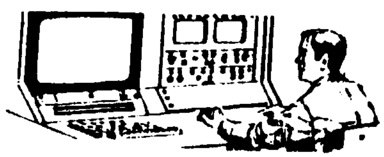
MARTIN MARIETTA
MANNED SPACE SYSTEMS

ORIGINAL PAGE IS
OF POOR QUALITY

AVIONICS TRADES FOR HARDWARE CHANGES

Since the Shuttle-C is expendable, the avionics hardware trades will be performed to utilize proven hardware that is low cost. The goal will be to make no modifications to either the launch facilities or Mission Control systems, including as a minimum the Checkout, Control, and Monitoring Subsystem (CCMS); Cargo Integration Test Equipment (CITE); and Shuttle Avionics Integration Laboratory (SAIL). If modifications are required for Shuttle avionics system enhancement, they will be traded against the ground system impacts.

Avionics Trades for Hardware Changes



Control Centers

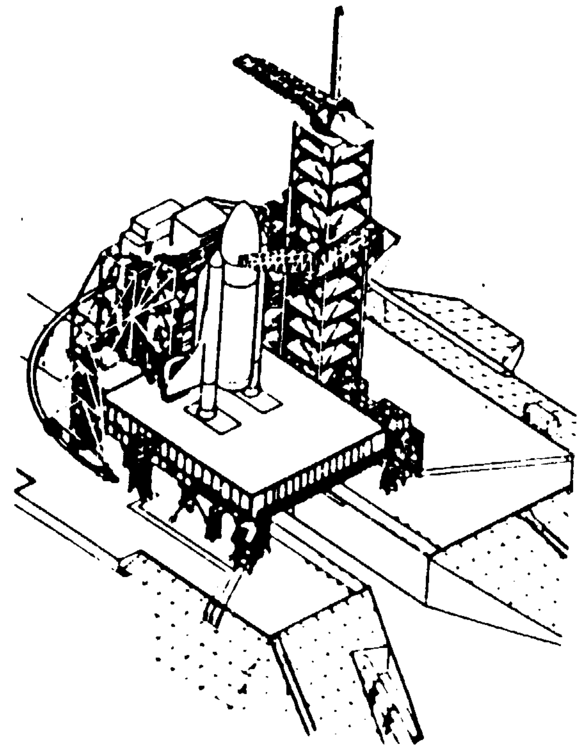
Interfaces

Telemetry

Command

Mission Specific Software

Payload Test



MARTIN MARIETTA

MANNED SPACE SYSTEMS

STUDY PLAN - PROPULSION AND MECHANICAL

During the first two months, emphasis is on those tasks that contribute to the selection of an inline or sidemount configuration.

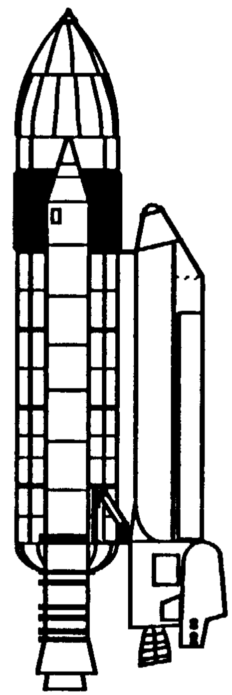
Study Plan - Propulsion & Mechanical

Contract Task	NOV 20	NOV 25	DECEMBER 4	DECEMBER 11	DECEMBER 18	DECEMBER 24	JANUARY 8	JANUARY 15	JANUARY 22	JANUARY 29
		23/24 ▽ ORIENTATION				REQMTS REVIEW ▽				CONCEPT SELECTION ▽
Library Of Prior Studies Established			▽							
ET / MPS Deltas For Baseline Concept Issued			▽							
ET / MPS Deltas Provided to SE & I				▽						
- 2 Engine In - Line										
- 3 Engine In - Line										
Separation And On - Orbit Propulsion Requirements Trades Inputs Provided To SE & I					▽					
Facility I/F Requirements For Centaur In - Line CE Provided To SE & I						▽				
Facility I/F Requirements For B/L And Side - Mount Defined							▽			

PROPULSION AND MECHANICAL TRADE STUDY

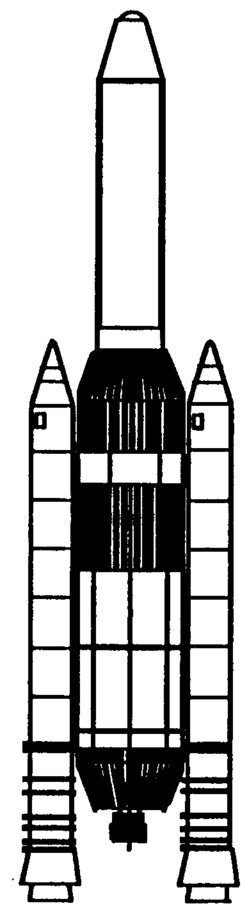
This study will identify some issues inherent in the baseline and inline concepts as well as tasks common to both configurations.

Propulsion & Mechanical Trade Study



- Lower Propellant Levels Require Minimum For Ullage Pressure (Vent Restriction)
- Larger Initial Ullage Volumes Require Press System Orificing
- STS-Compatible Propellant Gauging

- Shroud Separation & Development
- Payload Separation & Development
- On-Orbit Propulsion Requirements



- Feedline & Press Line Length Changes
- "Air Start" Feasibility
- Facility I/F Requirements

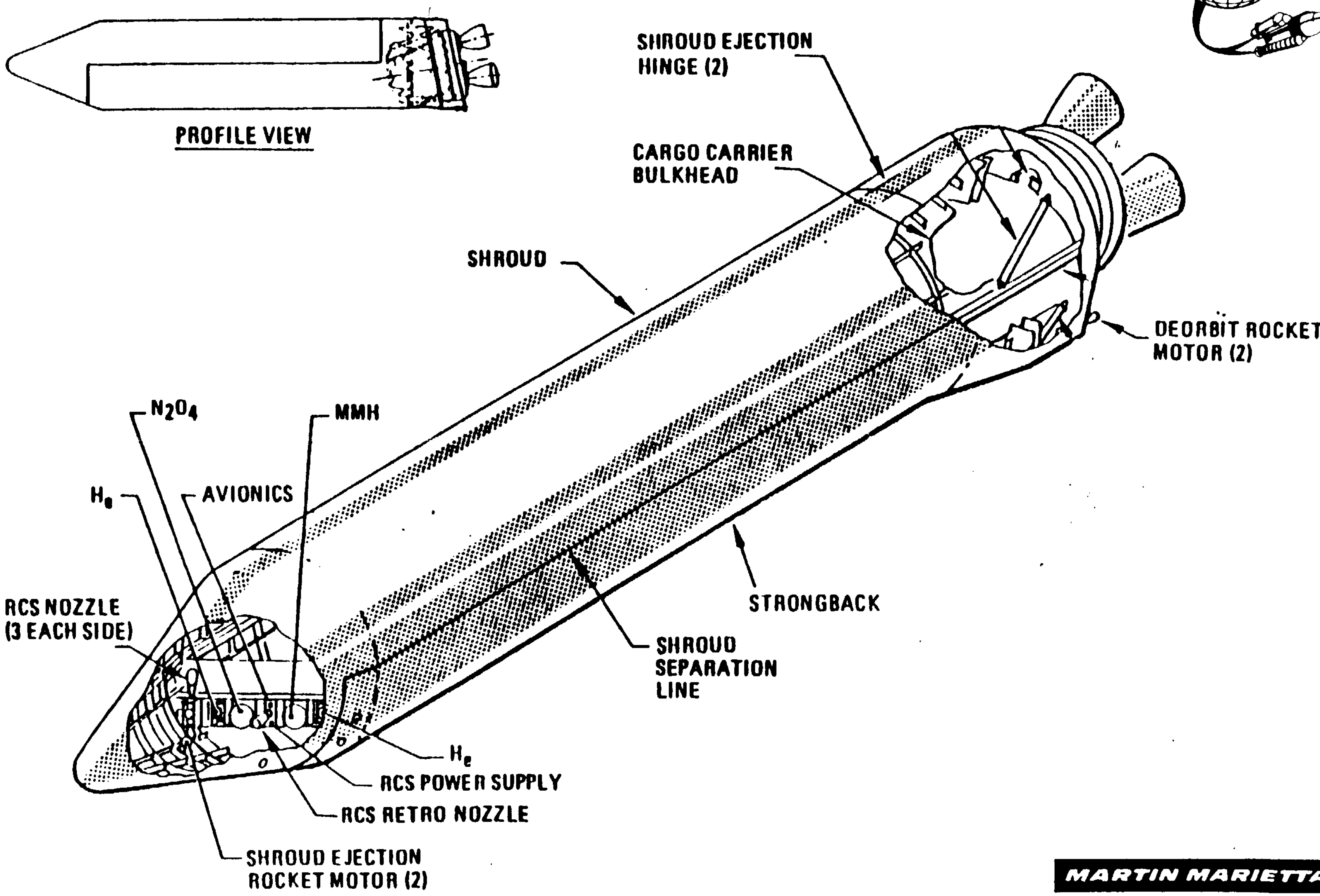
- Centaur Servicing In FWD Cargo Carrier

MARTIN MARIETTA
MANNED SPACE SYSTEMS

SDV CARGO CARRIER

Previous studies show that an orbital Cargo Element (CE) will require a reactive control system and associated avionics located in the CE nose.

SDV Cargo Carrier



MARTIN MARIETTA
MANNED SPACE SYSTEMS

Agenda

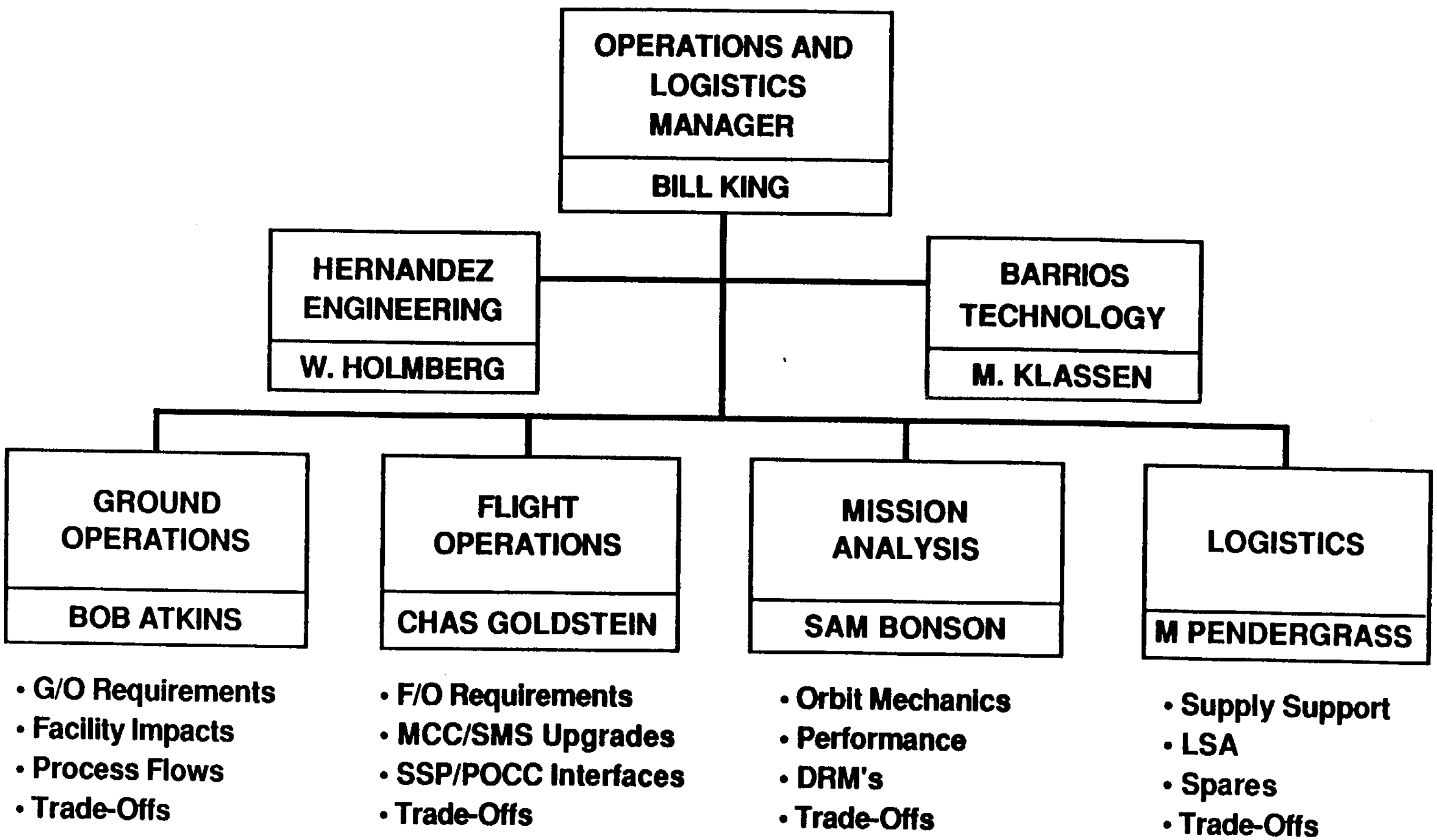
• Organization	J. McCown
• Staffing	J. McCown
• System Definition Technical Activities	
- Systems Engineering and Integration (and Past Studies Applications)	J. R. Tewell
- Design and Analysis	B. VanBeek
LUNCH	
- Operations and Logistics	B. King
- Production and Test	J. Kubnick
- Safety, Reliability, and Quality Assurance	J. Mangino
• Program Issues and Summary	J. McCown

OPERATIONS AND LOGISTICS ORGANIZATION

Support for this function is divided into standardized categories of flight and ground operations, mission analysis, and logistics support. Most of the ground operations effort will be performed at KSC.

Barrios Technology will assist in the analysis of proximity operations, and Hernandez Engineering will support the Operations planning tasks.

Operations and Logistics Organization



SHUTTLE-C OPERATIONS AND LOGISTICS AGENDA

The operations and logistics topics on this viewgraph identify areas requiring early attention. Many of these issues impact both the operational requirements and the vehicle design.

Shuttle-C Operations and Logistics Agenda

- Operation and Logistics Organization
- Ground Operations Processing Analyses
- Payload Integration Streamlining
- Design Reference Mission (DRM) Envelope
- Functional Analysis / Allocation
- Proximity Operations / Rendezvous and Docking Analyses
- MCC / LCC Operations Assessments
- Study Plan / Near-Term Activities
- Operations Trade Studies
- Operations Issues Needing Early Resolution
- Suggested "Mixed Fleet" Guidelines

PRELAUNCH OPERATIONS PAST ACTIVITIES

Under previous contracts, the Manned Space Systems Advanced Programs group at KSC conducted launch processing analyses for the following studies: SDVs, Advanced STS Ground Operations (ASTS/GO); Orbital Transfer Vehicle (OTV), Orbital Maneuvering Vehicle (OMV), Space Transportation Architecture Study (STAS), and Advanced Launch Systems (ALS).

Resulting data show the facilities impacts and OMV control capability required for payload modularization in the range of 45 to 50 klb. During the STAS and ALS studies, work began on a model (GAMMA) for processing analyses. This model may warrant further consideration.

Prelaunch Operations Past Activities

Shuttle C

- Past SDV / ASTS-GO / OTV / OMV / STAS / ALS Study Participation
- Assessments of Heavier / Larger Payload Handling Impacts on Equipment and Facilities
- Consider Modularization of Payloads for Both Ease of Processing and OMV Accommodation On-orbit
- Consider Use of GAMMA Model Developed for STAS / ALS Studies

PAYLOAD INTEGRATION STREAMLINING

Martin Marietta has integrated numerous payloads for the Titan and Shuttle. We assisted the USAF/Space Division (SD) in preparing a briefing for DOD headquarters which compared Titan and NSTS integration costs as a percentage of delivery costs. The results indicated a close comparison (i.e., 8% - 15%) for integration, with payload/mission complexity providing the highest sensitivity.

For the integration process, we developed a computerized functional task flow that facilitates tailoring of a detailed integration plan for each payload and delineates the roles/responsibilities and task interrelationships. Also, we participated in a USAF/SD study for streamling payload integration. We will use the study results as a starting point for the integration task.

Some past comparisons of integration cost and complexity were performed using various definitions of integration. Our integration effort will start significantly ahead of the Request for Flight Assignment (Form 100). Early "cost of integration" comparisons were made without taking into account previous requirements work and feasibility mission planning that occured prior to entering the PIP annexes and Shuttle Interface Control Document (ICD) cycles.

Payload Integration Streamlining

- Cost of Integration Analyses Results (USAF/SD)
  - Comparable Percentage to Titan Integration
  - Complexity of Payload and Interfaces Is Largest Cost Driver

- Payload Integration and Operations System-Planning Guide
  - Developed Computerized Functional Flow for Integration Process (Project 2 Software)
  - Sortable for Class of P/L (Upper Stage; Free-flyer or Attached; and KSC or VAFB Launch)

- Martin Marietta Involved in USAF/SD Study to Streamline Integration Process

- Current Integration Process Validates Need for Early Requirements Definition (Pre-Form 100)

DESIGN REFERENCE MISSION OPTIONS

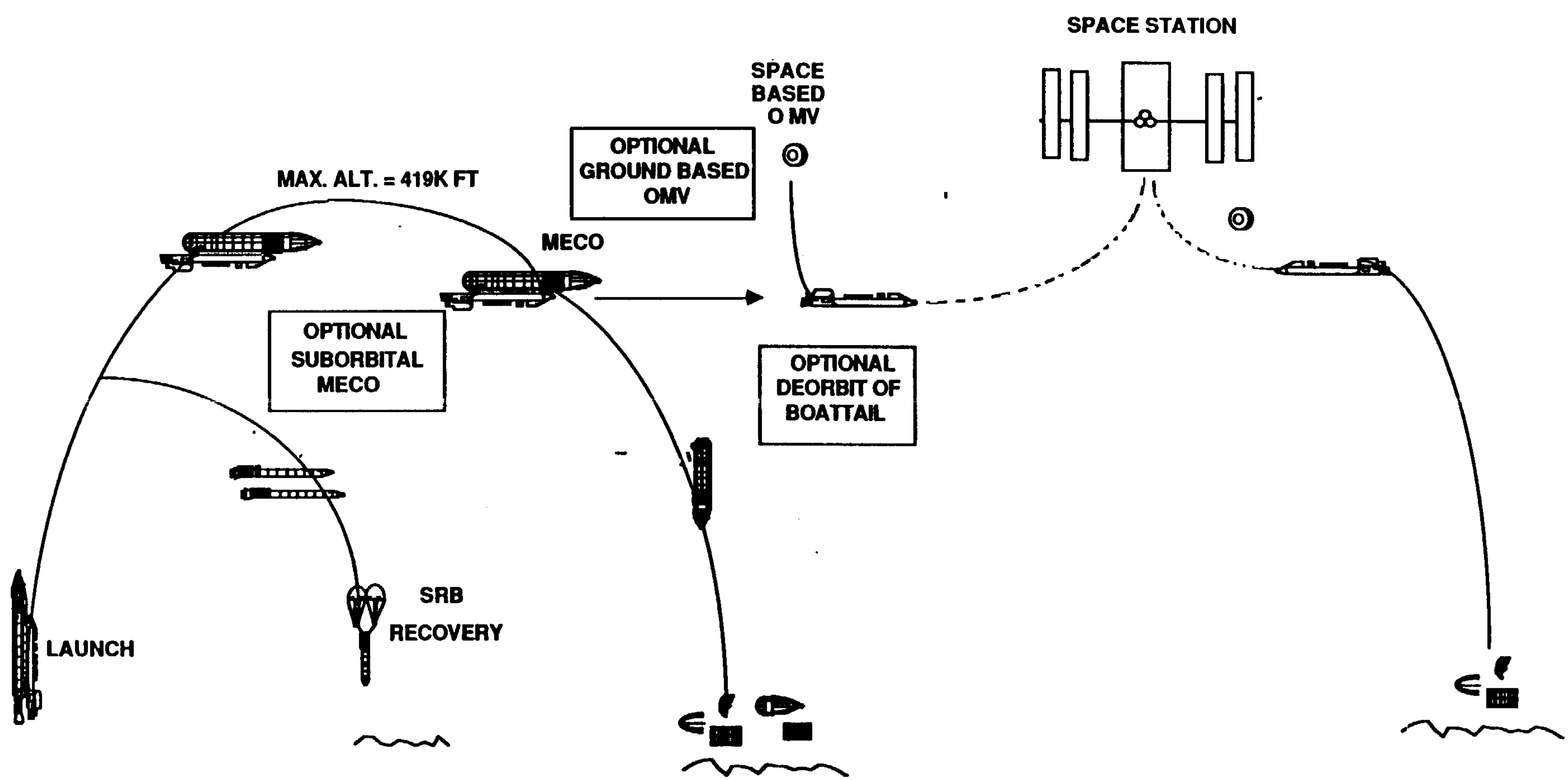
A key operations issue is the degree to which Shuttle-C missions are flown identical to Shuttle Orbiter missions.

One alternative would be to fly the Shuttle-C in a suborbital trajectory--similar to expendable launch vehicles (ELV)--where a planetary payload separates after MECO, using self-propulsion (i.e., RCS, OMV, or Centaur) to achieve circularization and extended on-orbit stay time.

Another alternative is the mission scenario where the Shuttle-C is responsible for circularizing and stationkeeping to rendezvous and dock with the Space Station (SS).

These operational issues are design drivers which require early resolution to reduce cost and schedule risks.

Design Reference Mission Options



MARTIN MARIETTA
MANNED SPACE SYSTEMS

FUNCTIONAL ANALYSIS/ALLOCATIONS

Certain functions currently performed by the NSTS crew in prime or backup roles will be allocated to onboard automation or ground command uplink. Criteria have been established to evaluate the allocation trade-offs. Some factors which will be considered are time criticality and degree of difficulty in the decision logic.

For payload attachment and deployment, we will apply our expertise with varying types of payloads that use different scenarios. We have "hands on" experience in maintaining dual compatibility while integrating numerous DOD payloads on NSTS and Titan vehicles.

Functional Analysis / Allocations

- Replacement of Crew Functions
  - Prelaunch and Ascent Functions Via GPC S/W Based on Self-Test
  - Payload Predeployment Checkout and Deploy Via Automated Methods

- Payload Attachment/Deployment Analyses
  - Draw on Misc Experience with Dually Compatible NSTS and Titan Payloads (e.g., IUS and Centaur)
  - Trade-off Options for RMS Deployment (e.g., Shroud Jettison)
  - Assumes Retrieval by NSTS Orbiter, If Required

PROXIMITY OPERATIONS - RENDEZVOUS AND DOCKING

Our Phase I approach will maintain compatibility with OMV/NSTS rendezvous and proximity operations tools. During the OMV Phase B studies, we utilized LINCOM as a subcontractor for Orbital Operations Simulation (OOS) development. For our NSTS payload integration contract, we used the Flight Design System (FDS) and Barrios Technology to provide training to our flight designers and other USAF/SD and Air Force Satellite Control Facility (AFSCF) contractors.

Johnson Space Center/Mission Planning and Analysis Division (JSC/MPAD) personnel believe that the Simulation, Monitoring, Analysis, Reduction, and Test System (SMARTS) program might be a useful tool for this feasibility level activity.

Proximity Operations - Rendezvous and Docking

- Feasibility Level Analyses Only for Phase I
- Use Tools Easily Interfaces with OMV Simulations, Including OOS, SMARTS, and FDS
- OOS Undergoing Modification, but Feasibility Level Modules Now Available
- SMARTS Also Available and May Be Useful
- FDS Rendezvous and Payload Retrieval Analysis Capability Available at Denver and Barrios Engineering

MCC/LCC OPERATIONS ASSESSMENTS

Shuttle-C operations must maintain compatible Mission Control Center/Launch Control Center (MCC/LCC) interfaces to void costly dual operations. Shuttle-C operations must also be as transparent as possible to dually compatible payloads.

We propose to track NSTS MCC/LCC upgrades and simulator changes to maintain this compatibility requirement. To avoid divergence into separate programs, tracking should encompass payload interface compatibility with SAIL, CITE, and other facility interfaces.

MCC / LCC Operations Assessments

- Maintain Awareness/Compatibility with NSTS Control Center and Simulator Upgrades
- Maintain Compatibility with LCC for Subsets of NSTS Subsystems
- Maintain Awareness of SSSC Development, MSFC POCC, and Interfaces with WP-01 Distributed Subsystems
- Booster Portion of Flight Primarily Automated
  - Full Automation Impact Is Small

STUDY PLAN AND TRADE STUDIES

Time-phased task plans on the next two charts show the planned availability of documented task and trade study outputs. Such outputs are scheduled to meet the program milestones or fulfill an internal requirement to support another activity.

Study Plan - Operations

Contract Task	NOV 20	NOV 25	DECEMBER 4	DECEMBER 11	DECEMBER 18	DECEMBER 24	JANUARY 8	JANUARY 15	JANUARY 22	JANUARY 29
		23/24 ▽ ORIENTATION			REQMTS REVIEW	▽		CONCEPT SELECTION		▽
Operations Requirements Defined			▽							
Operations RequirementsAnalysis					▽					
Operations Requirements Trades										
M01 On Orbit Propulsion			▽							
M02 Performance Studies				▽						
M03 Payload Orbital Operations				▽						
M04 Mission Profiles					▽					
M05 Guidance & Control						▽				
Concept Definition Baseline Assessment						▽				
Shuttle - C Concepts Candidates Assessment								▽		

Study Plan - Operations (Continued)

Contract Task	NOV 20	NOV 25	DECEMBER 4	DECEMBER 11	DECEMBER 18	DECEMBER 24	JANUARY 8	JANUARY 15	JANUARY 22	JANUARY 29
		23/24 ∇ ORIENTATION		REQMTS REVIEW		∇	CONCEPT SELECTION			∇
WBS Inputs				∇						
Concept Trade Studies / Analyses										
FS01 Space Transportation			∇							
FS02 Launch Facilities				∇						
FS03 Ground Processing					∇					
FS04 GSE Comparison							∇			
FS05 S/W Ground Processing								∇		
NSTS Impact Studies (Inputs)										
NI02 ET Structural Mods Study					∇					
NI04 GN & C Study							∇			
NI05 InterfaceReqmts Change								∇		
Ground / Flight Systems Analyzed / Defined								∇		

OPERATIONS ISSUES REQUIRING EARLY RESOLUTION

A major program driver is the handover of Shuttle-C missions to either a Space Station or planetary payload control.

Duplicating too many NSTS functions would complicate the Shuttle-C program and introduce unnecessary cost and schedule risks. Handover of the mission to the payload community too early would result in excessive cost and complexity to that discipline.

Operations Issues Requiring Early Resolution

Shuttle

- Degree Of Commonality with NSTS
  - Operational Scenarios Duplicating NSTS Ascent/Circulariztion
  - Handoff to Payload tor Planetary Missions Like ELV Flights
  - Handoff to OMV/SSP for Rendezvous/Docking
  - Compatibility with RMS Deployed Payloads

- Complexity Drives Shuttle-C Design
  - Early Handover to OMV/SSP or Planetary Payload Simplifies Shuttle-C Software and Subsystems
  - Flying Like Saturn/Titan Decreases Vehicle Complexity, but Levies More Requirements on Payloads

SUGGESTED MIXED FLEET GROUND RULES/GUIDELINES

The most logical Shuttle-C use is for "delivery only" missions which reduce Orbiter/crew risk. The NSTS could be used for missons requiring a space platform, for retrieval of space hardware/data upon mission completion, or for repair.

Suggested Mixed Fleet Ground Rules / Guidelines

Shuttle

- Use NSTS Orbiter for Payloads Requiring
  - Space Platform for Pointing/Attitude Control
  - Deployment/Retrieval Needing RMS

- Use Shuttle-c For Payloads Requiring:
  - Delivery Only (e.g., Centaur) Missions
  - Deliver SSP Payloads to Retrieval Zone for OMV or NSTS Proximity Operations

- Provide Safing/Inerting/Propellant Dumps for Payloads for Subsequent Retrieval if Anomalies Occur

Agenda

• Organization	J. McCown
• Staffing	J. McCown
• System Definition Technical Activities	
- Systems Engineering and Integration (and Past Studies Applications)	J. R. Tewell
- Design and Analysis	B. VanBeek
LUNCH	
- Operations and Logistics	B. King
- Production and Test	J. Kubnick
- Safety, Reliability, and Quality Assurance	J. Mangino
• Program Issues and Summary	J. McCown

Production and Test - Agenda

- Study Objective
- Organization
- Prior Studies
- Performance Status

PRODUCTION AND TEST - OBJECTIVES

The objectives of the Production and Test group for the Shuttle-C study are shown on the opposite page. These objectives are fully responsive to all study elements and documentation requirements.

Production and Test - Objectives

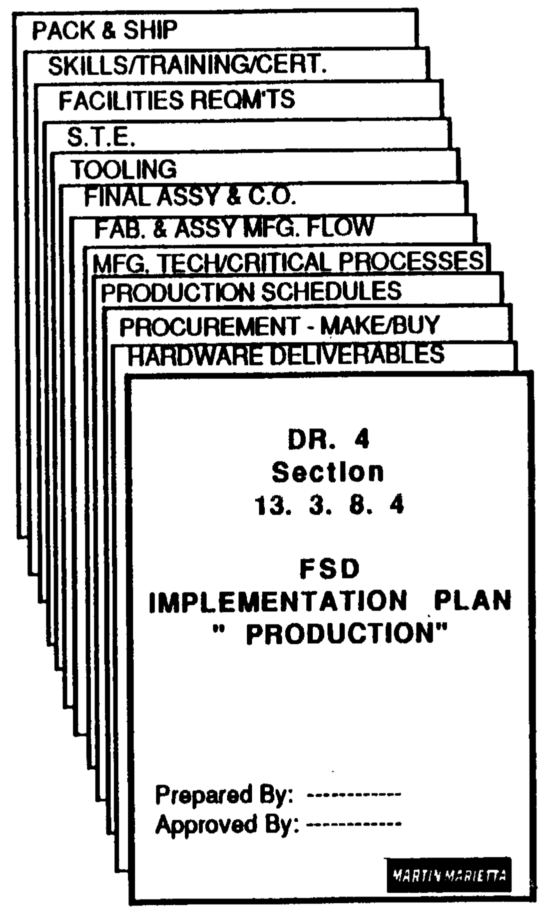
Develop Manufacturing, Test, and Facilities Plans for Implementing the Shuttle-C Project

- Manufacturing and Test Feasibility - Concepts
- Producibility Analysis - Alternative Configurations
- Manufacturing, Test, and Facility Trade Studies
  - Manufacturing Facilities Availability
  - Manufacturing Location
- FSD Implementation Plan (DR-4)
  - Production Plan
- Program Cost Estimate (DR-6)
  - Manufacturing, Test, Tooling, STE, and Facilities Cost Estimates

PRODUCTION PLAN - DR-4

This chart illustrates the content of the Full-Scale Development (FSD) Production Implementation Plan (PIP) which will be developed during Phase II of the study.

Production Plan - DR-4

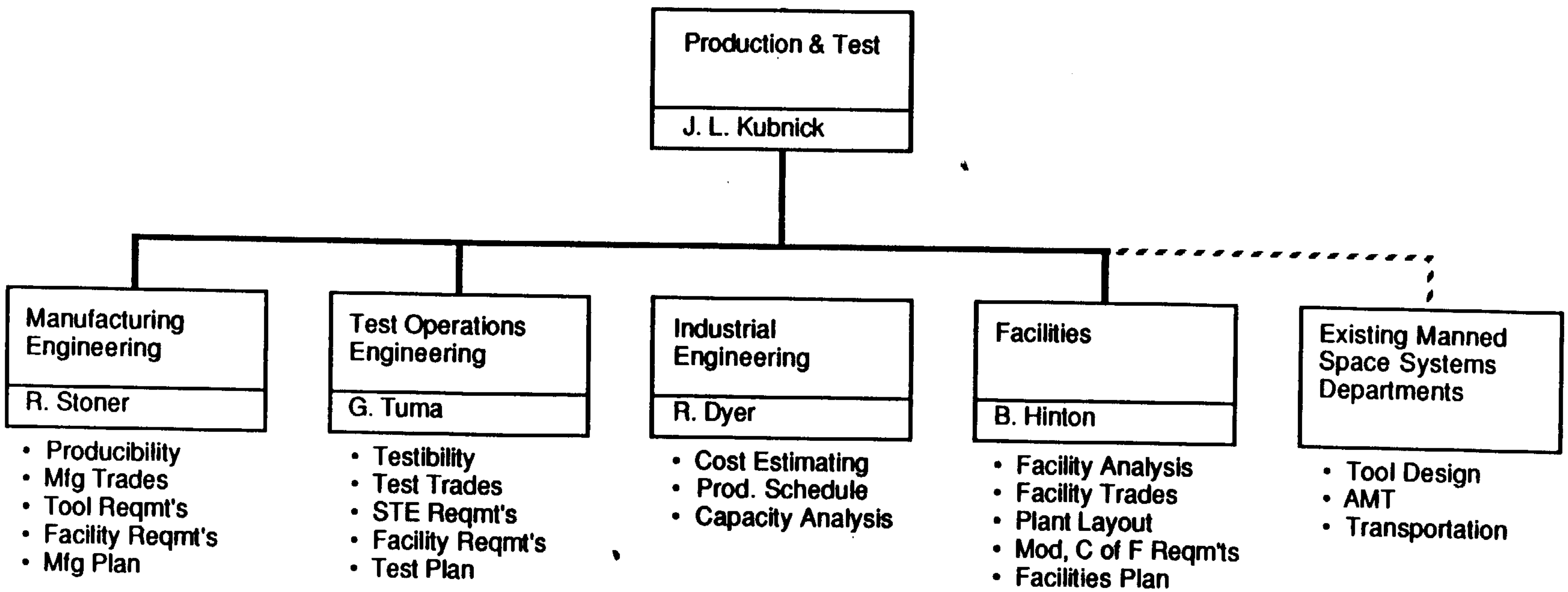


Production Plan is Fully Responsive to DR-4

PRODUCTION AND TEST - ORGANIZATION

The Production and Test group comprises four major functional areas: manufacturing, test operations, industrial development, and facilities engineering. The lead personnel identified for each area have been identified and are in place. These functions will be supported by existing Manned Space Systems departments on an "as needed" basis.

Production and Test - Organization



PRODUCTION AND TEST - PRIOR STUDIES

Numerous prior studies have been performed for NASA and the Air Force on various configurations of SDVs, Shuttle Derived Cargo Vehicles (SDCV), and Unmanned Launch Vehicles (ULV).

The data compiled during these studies provide a sound point of departure for evaluating alternate configurations during the Shuttle-C study.

Production and Test - Prior Studies

- NASA - SDV and SDCV Studies
  - Developed Manufacturing and Facilities Plans For Various Side-Mounted Configurations

- USAF - ULV System Costs Study
  - Assessed ET and MAF Impact for In-Line Configuration

Provides Sound Point of Departure For Evaluating Alternate Configurations

EXAMPLE: MANUFACTURING PLANS

This chart illustrates the approach and content of the manufacturing plan developed for the assembly of the Payload (P/L) Module and Propulsion Avionics (P/A) Module studies.

These and similar data from prior studies are available to the Shuttle-C study team.

Manufacturing Plans

DEVELOP MANUFACTURING APPROACH FOR P/L MODULE AND P/A MODULE USING CURRENT MANUFACTURING STATE-OF-THE-ART WHILE TAKING ADVANTAGE OF TECHNOLOGIES AND TOOLING CONCEPTS DEVELOPED FOR THE ET PROGRAM

INCLUDES:

- MAKE OR BUY PLAN
- MANUFACTURING FLOW
- TOOLING/TEST EQUIPMENT REQUIREMENTS
- MANUFACTURING FACILITY REQUIREMENTS
- TOOLING ESTIMATES
- TOOLING SCHEDULES

EXAMPLE

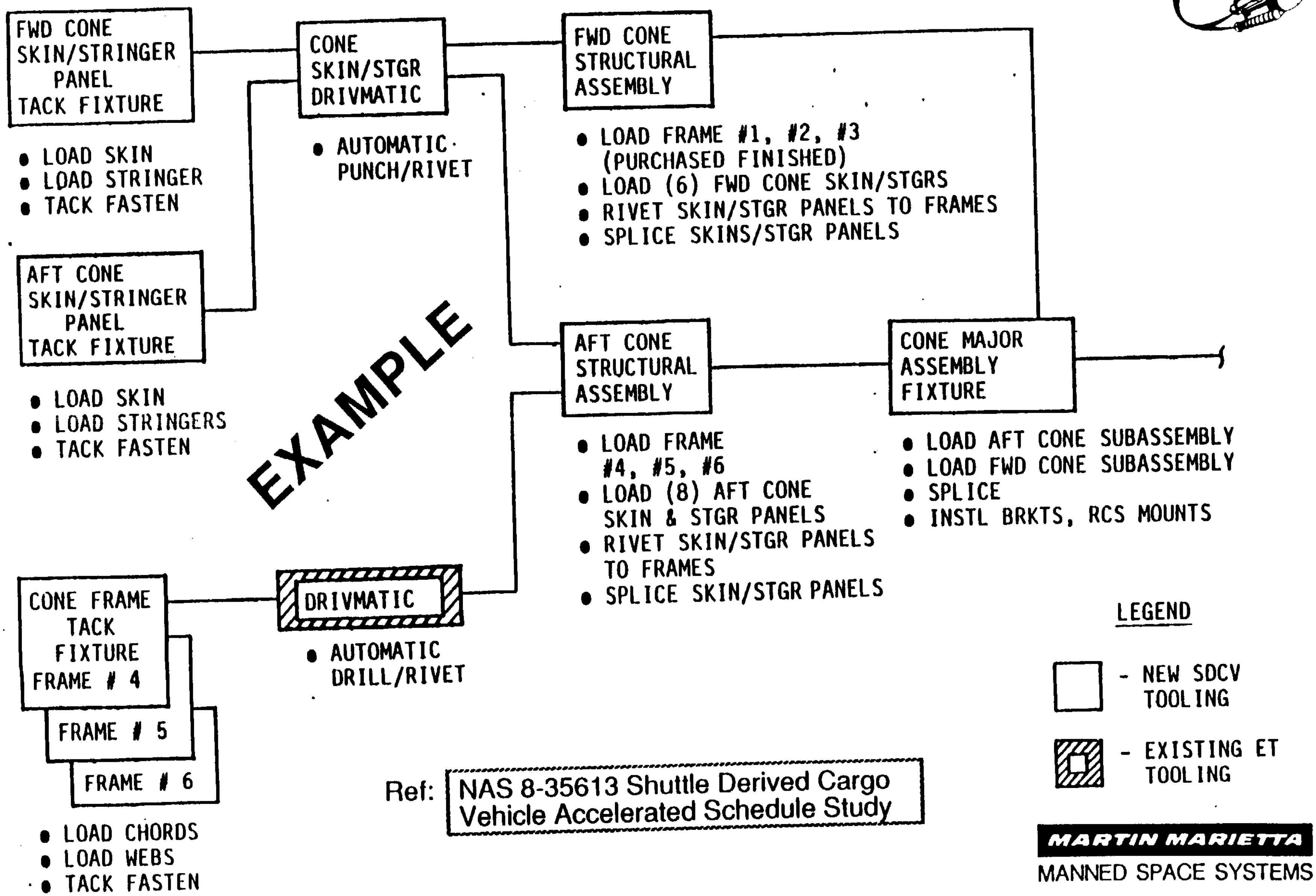
Ref: NAS 8-35613 Shuttle Derived Cargo Vehicle Accelerated Schedule Study

MARTIN MARIETTA
MANNED SPACE SYSTEMS

EXAMPLE: MANUFACTURING SEQUENCE FLOW PAYLOAD MODULE NOSE CONE STRUCTURE

This example shows a summary level manufacturing sequence flow chart from the SDCV study Martin Marietta performed for NASA. Similar flows will be developed during Phase I of the Shuttle-C study to define the various manufacturing sequences and tooling requirements.

Payload Module Nose Cone Structure



Ref: NAS 8-35613 Shuttle Derived Cargo Vehicle Accelerated Schedule Study

MARTIN MARIETTA
MANNED SPACE SYSTEMS

EXAMPLE: IMPACT ON MICHOUD ASSEMBLY FACILITY OPERATIONS

This chart shows the requirements that identified the production operations and cost impacts for operating the Michoud Assembly Facility (MAF) for a mix of standard and reduced length ETs during Martin Marietta's USAF-ULV study.

Task 6–
Impact on Michoud Assembly Facility

- Identify the production operations and cost impacts for operating the MAF for mix of standard and reduced length ETs.

  - Production Requirements
    - STS - 18 Lwt/Year
    - ULV - 10 Reduced length core stage ET tanks
  - ULV Configuration
    - Boeing SDCLV-2 - 4 Segment SRB
  - ET Elements
    - LO2 Tank - Two Dome Configuration
    - Intertank - Without SRB Thrust Beam
    - LH2 Tank - Reduced Length
    - TPS - SOFI LH2 only
    - Stack - LO2, I/T, and LH2
    - F/A, Test & Checkout

EXAMPLE

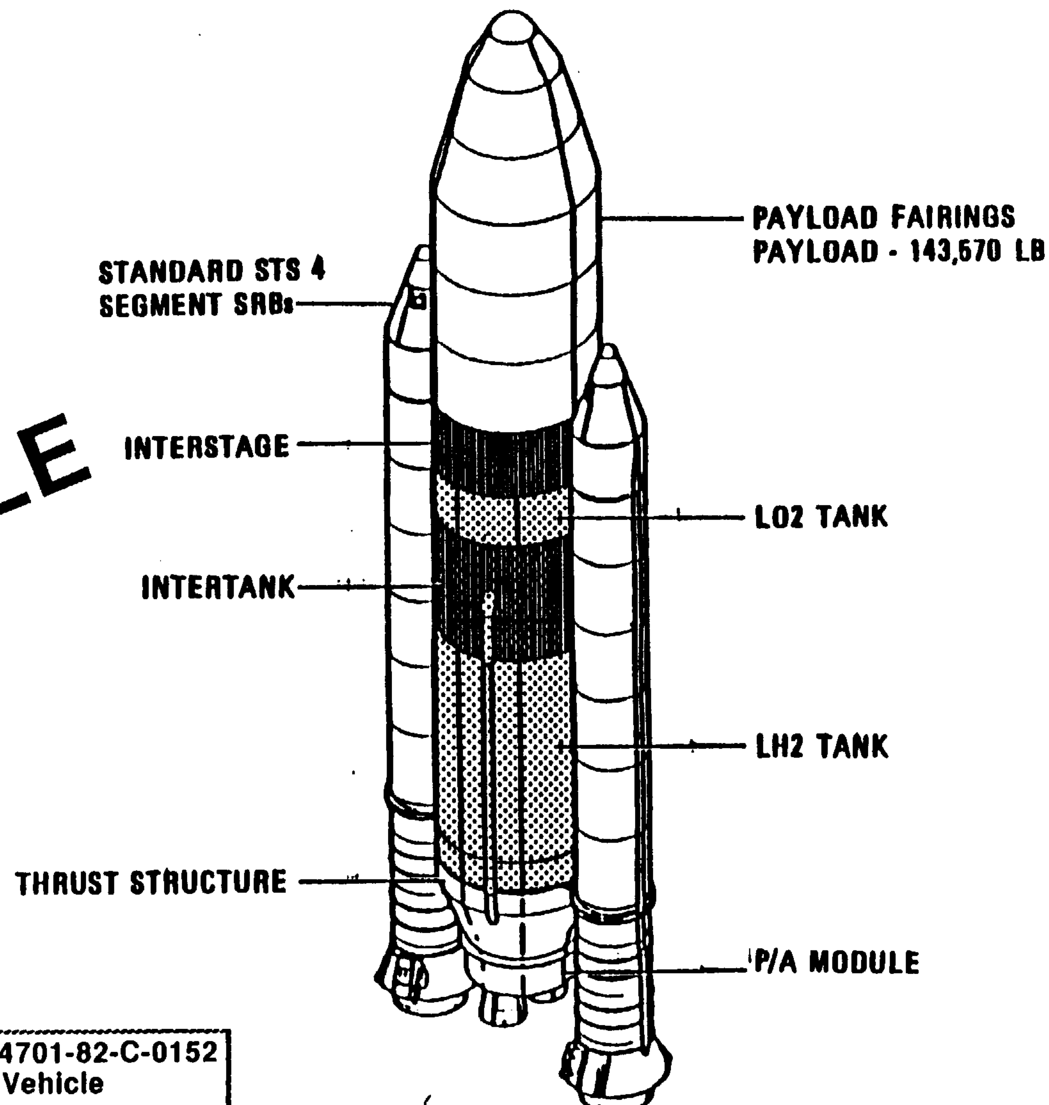
Ref: USAF Contract F04701-82-C-0152
Unmanned Launch Vehicle System Cost Study

MARTIN MARIETTA
MANNED SPACE SYSTEMS

EXAMPLE: ULV CONFIGURATION SDCLV-2 (4 SEGMENT SRB)

This chart illustrates the ET elements that were addressed during the USAF-ULV study.

ULV Configuration SDCLV-2 (4 Segment SRB)



EXAMPLE

Ref: USAF Contract F04701-82-C-0152
Unmanned Launch Vehicle
System Cost Study

MARTIN MARIETTA
MANNED SPACE SYSTEMS

EXAMPLE: FACILITY ASSESSMENT - REDUCED LENGTH TANK

This sample chart summarizes the facilities modifications required to accommodate the mixed production of standard and reduced length ETs. Similar assessments will be made to identify facility impacts during the Shuttle-C study.

Facility Assessment–Reduced Length Tank (18 STS/10 ULV)

● REQUIREMENTS

MANUFACTURING REQUIREMENTS	REASON	FACILITY REQUIREMENTS
• PROVIDE DOME MECHANICAL INSTALLATION POSITION (7054)	RATE	• EXTEND UTILITIES TO EXISTING DOME QUEUING POSITION
• PROVIDE (2) DOME WELD POSITIONS – GORE/GORE PANEL WELD (5001) – 1/4 PANEL TO CHORD WELD (5002)	CONFIG	• SITE PREPARATION OF (2) EXISTING FOUNDATIONS INCLUDING UTILITY EXTENSIONS • PURCHASE (2) PLASMA ARC WELD PACKAGES
• PROVIDE 2ND INTERTANK MECHANICAL INSTALLATION POSITION (7046)	RATE	• RELOCATE TOOL STORES FROM COL Q-R/4-5 TO COL F/18 • EXTEND UTILITIES TO NEW POSITION
• PROVIDE NEW 42" BARREL WELD POSITION (5901)	CONFIG	• SITE PREPARATION TO EXISTING FOUNDATION TO INCLUDE UTILITY EXTENSIONS • PURCHASE (1) PLASMA ARC WELD PACKAGE
• PROVIDE A FINAL ASSY POSITION FOR REDUCED LENGTH TANK	RATE	• MODIFY FA POSITION #4 TO INCLUDE: - PURCHASE (2) PURGE CARTS & FORMULATORS - INSTALLATION OF A SOFI STORAGE AREA
• PROVIDE A TEST AND CHECKOUT POSITION	RATE	• MODIFY CELL 3 BLDG 420 TO SAME CONFIGURATION AS CELLS 1 & 2 PURCHASE GENERAL EQUIPMENT TEST EQUIPMENT AND PURGE CART

*TO OFFLOAD PROPULSION/ELECTRICAL INSTALLATIONS CURRENTLY IN CELL 'E' THEREBY ENHANCING E CAPABILITY FROM 24 TO 28/YEAR

● C OF F SCHEDULE

TOOLING FOOTPRINTS

0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32

CRIT | DESIGN | BID | MODIFICATIONS

ORIGINAL PAGE IS OF POOR QUALITY

Ref: USAF Contract F04701-82-C-0152
Unmanned Launch Vehicle System Cost Study

MARTIN MARIETTA
MANNED SPACE SYSTEMS

PERFORMANCE STATUS - PRODUCTION AND TEST

A contract task completion schedule was constructed for a two-month period: the current and following month. Each production and task completion date was coordinated to support the overall study outputs.

Study Plan - Production & Test

Contract Task	NOV 20	25	DECEMBER 4	11	18	24	JANUARY 8	15	22	29
		23/24 ∇ ORIENTATION		REQMTS REVIEW		∇	CONCEPT SELECTION			∇
SHUTTLE - C REQUIREMENTS										
Manufacturing Feasibility Assessment Provided				∇						
VEHICLE CONCEPTS & CONFIGURATION										
Producibility Analysis To Support Baseline Concept Definition Issued						∇				
Manufacturing / Facility Trades Provided							∇			
Manufacturing Approach For Alternate Concepts Defined								∇		
Manufacturing Facility Requirements Identified								∇		
Preliminary Production and Test Cost Assessed									∇	
WORK BREAKDOWN STRUCTURE (WBS)										
Inputs For WBS Prepared / Issued					∇					

Agenda

Shuttle

• Organization	J. McCown
• Staffing	J. McCown
• System Definition Technical Activities	
- Systems Engineering and Integration (and Past Studies Applications)	J. R. Tewell
- Design and Analysis	B. VanBeek
LUNCH	
- Operations and Logistics	B. King
- Production and Test	J. Kubnick
- Safety, Reliability, and Quality Assurance	J. Mangino
• Program Issues and Summary	J. McCown

SR & QA - Agenda

Shuttle C

- SAFETY
- RELIABILITY
- QUALITY ASSURANCE
- MAINTAINABILITY

SAFETY

The System Safety group will provide engineering safety criteria for the Shuttle-C design to allow the vehicle to meet safety and man-rated requirements. Two-fault tolerance will be stressed in all critical paths. An ongoing working group will meet regularly with the Quality, Reliability, and Maintainability people to assure that safety requirements will be reviewed for application to those disciplines.

Safety

- Objective
  - Assure System Safety and Provide for Manned Rating
- Data Source
  - NHB 5300.4 (1D-2) Sept 1978, Safety, Reliability, Maintainability, and Quality Provisions for Space Shuttle Program
  - NHB 1700.1
  - NHB 1700.1B
  - NHB 1700.7
  - Martin Marietta
  - Safety Plan for Shuttle "C" Program
  - Safety Checklist
  - Trade Study Results
- Application of Criteria
  - Provide Engineering with Safety Criteria for the Design of Shuttle "C" Which Will Allow the Vehicle to Meet Requirements.
  - Working Group Meetings with Quality, Reliability, and Maintainability and Design Organizations.

RELIABILITY

The Reliability Engineering group will directly interface with all disciplines to assure dissemination and application of the latest Critical Items List (CIL), lessons learned, check lists, and state-of-the-art tools. Martin Marietta's in-place policies, procedures and practices will control the reliability program.

Reliability

- Objective
  - Utilize Flight Proven Components
  - Incorporate Hardware Improvments Through FMEA Results and Other Studies
- Data Source
  - NHB 5300.4 (1D-2) Sept 1978 Safety Reliability, Maintainability, and Quality Provision for Space Shuttle Program
  - Reliability Plan for Support of the Design, Manufacturer, Assembly, Test Audit and Launch of Shuttle "C" No. TBD
  - Reliability Checklists TBD
  - Trade Study Results
- Application of Criteria
  - Interface with All Disciplines To Assure the Dissemination and and Application of the Latest Critical Items List (CIL), Lessons Learned, Checklists, and Developed Tools

QUALITY ASSURANCE

We will apply existing Martin Marietta procedures and practices that have been effective on previous missile and spacecraft programs. Our company-wide standard procedures describe the management techniques and systems to be used in conducting Martin Marietta's business. Quality aprocedures outline the basic policies, systems, and responsibilities utilized by the Quality Assurance group to assure that all contract and management requirements are satisfied.

Program Directives are generally issued by Quality Assurance to define specific program/project tasks and requirements. In the Shuttle-C project, these directives will be approved by the SRM&QA manager.

Quality Assurance

- Objective
  - Assure Proper Management, Planning, Controls, Methods, Tests, Inspection, Documentation, and Assessments are Enforced Throughout the Program

- Data Source
  - NHB 5300.4 (1D-2) Sept 1978 - Safety, Reliability, Maintainability, and Quality Provision for Space Shuttle Program (Replaces JSC 07700 Vol XIII)
  - Quality Assurance Plan for the System Support, Assembly, and Test of the Shuttle "C" Program NO. TBD

- Application of Criteria
  - Procedures and Practices That Have Been Effective on Previous Programs
  - Participation of Quality Engineering During the Design Process
  - Development and Review of Quality Plans

MAINTAINABILITY

During the early design phase, our Maintainability group will assure that those items identified in the CIL which greatly impact safety and reliability will provide redundancy, fail safe, or quick fix capabilities through easy access.

Maintainability

- Objective
  - Make It Easy To Isolate Problems and Fix In the Shortest Time.
- Data Source
  - NHB 5300.4 (ID - 2) Sept 1978 Safety, Reliability, Maintainability and Quality Provision for Space Shuttle Program.
  - Maintainability Plan for Support of the Design, Assembly, Test and Launch of Shuttle "C" No. TBD
  - Maintainability Checklist No. TBD
  - Trade Study Results
  - Lessons Learned From NSTS Program (SPC Contractor)
- Application of Criteria
  - Maximum Interface of Our Maintainability Engineer During the Early Design Phases to Assure Maintainability Critical Items are Properly Worked During the Design Process

Study Plan - SR & QA

Contract Task	NOV 20	NOV 25	DECEMBER 4	DECEMBER 11	DECEMBER 18	DECEMBER 24	JANUARY 8	JANUARY 15	JANUARY 22	JANUARY 29
		23/24 ▽ ORIENTATION			REQMTS REVIEW	▽		CONCEPT SELECTION		▽
Interfaces Established		▽								
Provide Requirements										
JSC & MSFC Documents For STS"C" Impacts Reviewed & Revised			▽	▽	▽		▽		▽	
Lessons Learned For STS "C" Application Reviewed			▽	▽	▽					
Concepts										
Safety, Reliability, Maintenance And Quality Assurance Evaluated			▽ ▽	▽						
Preliminary Hazard Identification and Critical Items List (CIL) Drafted									▽	
Preliminary Hazards Analysis Drafted										▽

MARTIN MARIETTA
MANNED SPACE SYSTEMS

Agenda

Shuttle

• Organization	J. McCown
• Staffing	J. McCown
• System Definition Technical Activities	
- Systems Engineering and Integration (and Past Studies Applications)	J. R. Tewell
- Design and Analysis	B. VanBeek
LUNCH	
- Operations and Logistics	B. King
- Production and Test	J. Kubnick
- Safety, Reliability, and Quality Assurance	J. Mangino
• Program Issues and Summary	J. McCown

MARTIN MARIETTA
MANNED SPACE SYSTEMS

SHUTTLE-C PROGRAM ISSUES

A number of key issues are summarized on the next two charts, which must be resolved early in Phase I. Most of these issues must be resolved conjointly with the contractors and NASA.

Shuttle-C Program Issues

- Define Level of Integration Between Shuttle-C and NSTS Program
- Establish Shuttle-C Baseline; i.e., Inline versus Sidemount, and 2 versus 3 Engine Configuration
- Establish a Program Wide Systems Level Trade to Resolve The Extent of Shuttle-C Orbital Operations versus Only Direct Payload Delivery to Orbit
- Define Man Rating Guidelines for Shuttle-C Early
- Obtain JSC 00700 Documents Through Text / Graphics Electronics Data Processing Media
- Define Interfaces of Shuttle-C with Other NASA On-Going Studies; e.g., LRB, Adv SRM, STBE, STME, CERV and Recoverable P/A Module

Shuttle-C Program Issues (Continued)

- Conduct a Program Wide Shuttle-C Payload Requirements Study
- Define Requirements for Transferability of Payloads from STS to Shuttle-C and from Shuttle-C to STS
- Establish Study Conduct Performance Review Guidelines