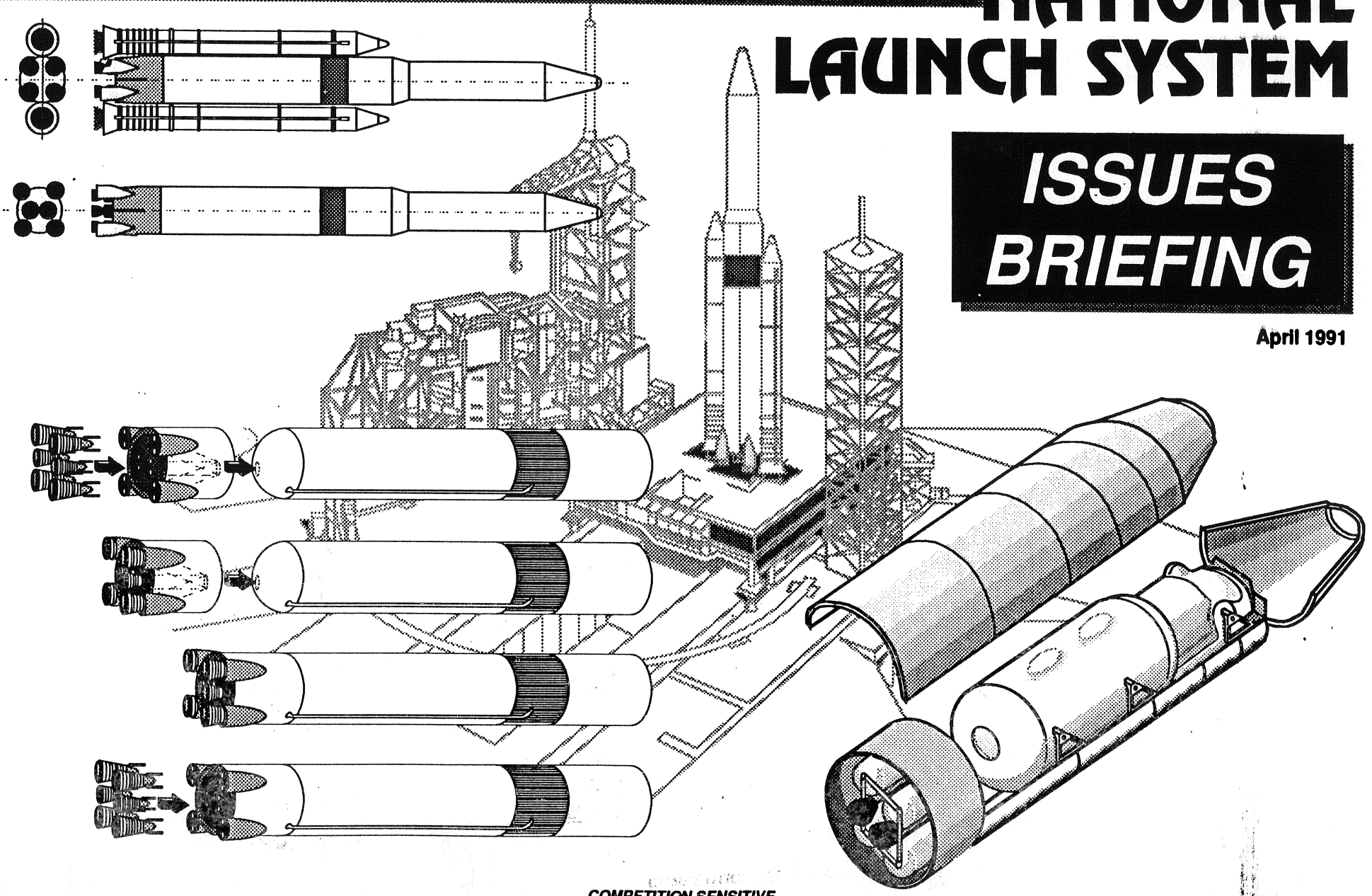
Lockheed

NATIONAL LAUNCH SYSTEM

ISSUES BRIEFING

April 1991



COMPETITION SENSITIVE

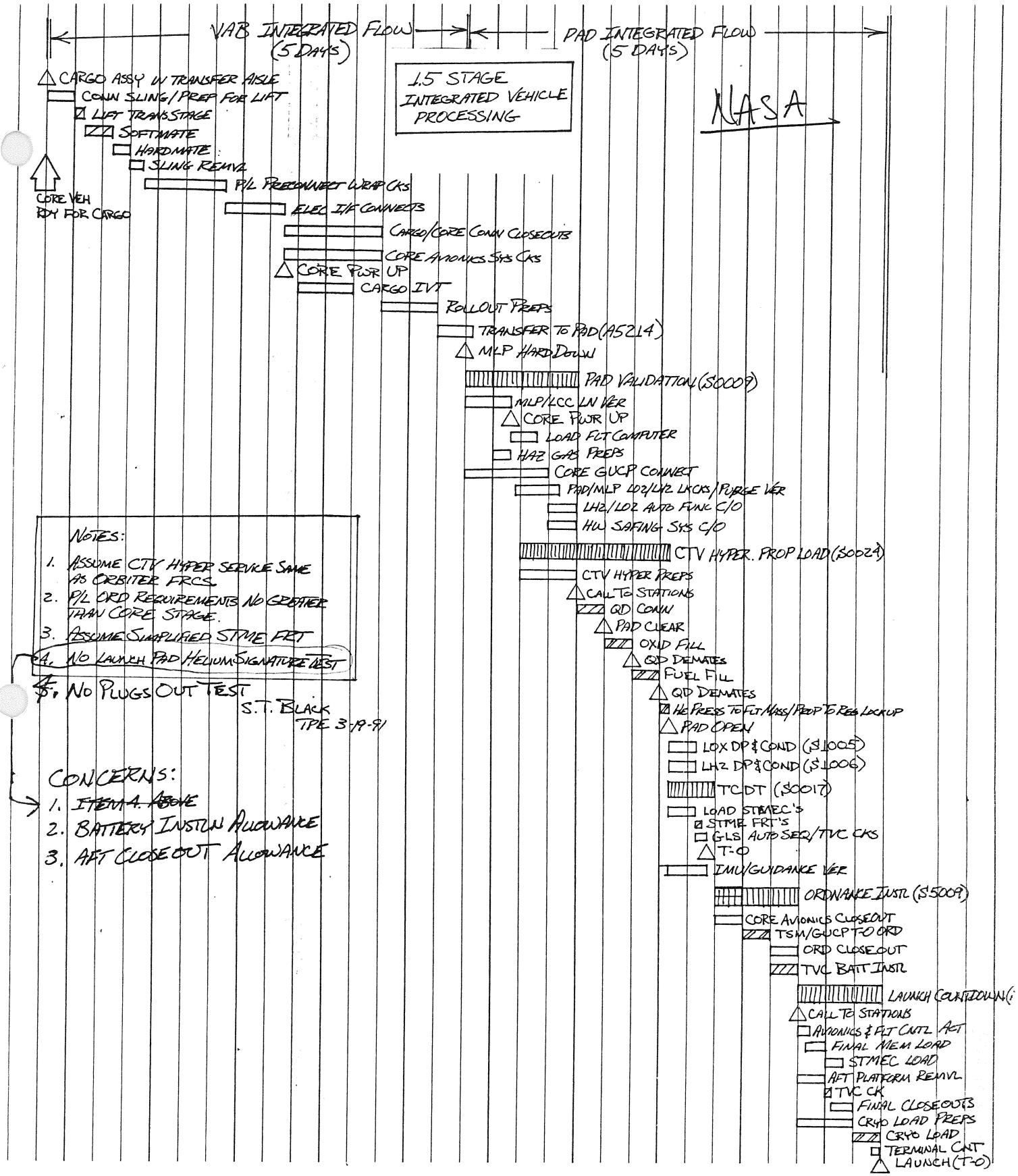
HLLV PROCESSING ENHANCEMENTS ~~OVERVIEW~~

- STREAM LINE PAPER SYSTEM
  - LESS COMPLEX TECHNICAL OPERATION PROCEDURES (TOP's) PROCESSING
  - LESS ~~SIGNATURE~~ AUTHORIZATION SIGNATURES
  - BAR CODE ACCOUNTING SYSTEM

- OPTIMIZE QUALITY VERIFICATION SYSTEM
  - ~~2~~ TWO TECH SYSTEM FOR 'FLOOR' WORK/BUY OPERATIONS
  - QCV INSPECTOR AUDITS COMPLETED PROCEDURES OFFLINE
  - TASK LEADER RESPONSIBLE ~~FOR~~ TO UPHOLD QPRD VERIFICATION REQUIREMENT ON TOP's.
  - BAR CODE OMRS ACCOUNTING SYSTEM
  - QUALITY ENGINEERING MAINTAINS LIFE/CYCLE ACCOUNTABILITY, ~~FAILURE~~ HARDWARE FAILURE/INCIDENT RECURRANCE STUDIES AND MONITORS OVERALL QUALITY CONTROL SYSTEM
  - GOVERNMENT QUALITY ONLY INVOLVED ~~ON~~ WITH MAJOR INTEGRATED HARDWARE CRITICALITY 1 VERIFICATIONS.

- TEST/WORK OPERATIONS
  - SYSTEM ORIENTED TECHNICIAN TEAMS ~~LEAD~~ CERTIFIED BY SYSTEM
  - TASK LEADER (SYSTEM ENGINEER/~~LEAD~~ SENIOR TECHNICIAN) RESPONSIBLE FOR ACCOMPLISHING TEST/OPERATION, WITH AUTHORITY OVER TEAM ~~WITH SPECIALIZED TECHNICIAN TEAM ANSWERING TO H~~
  - PERFORM AS MUCH ELEMENT CHECKOUT AS POSSIBLE TO MINIMIZE INTEGRATED TESTING/ENHANCE 'LAUNCH ON DEMAND' CAPABILITY.

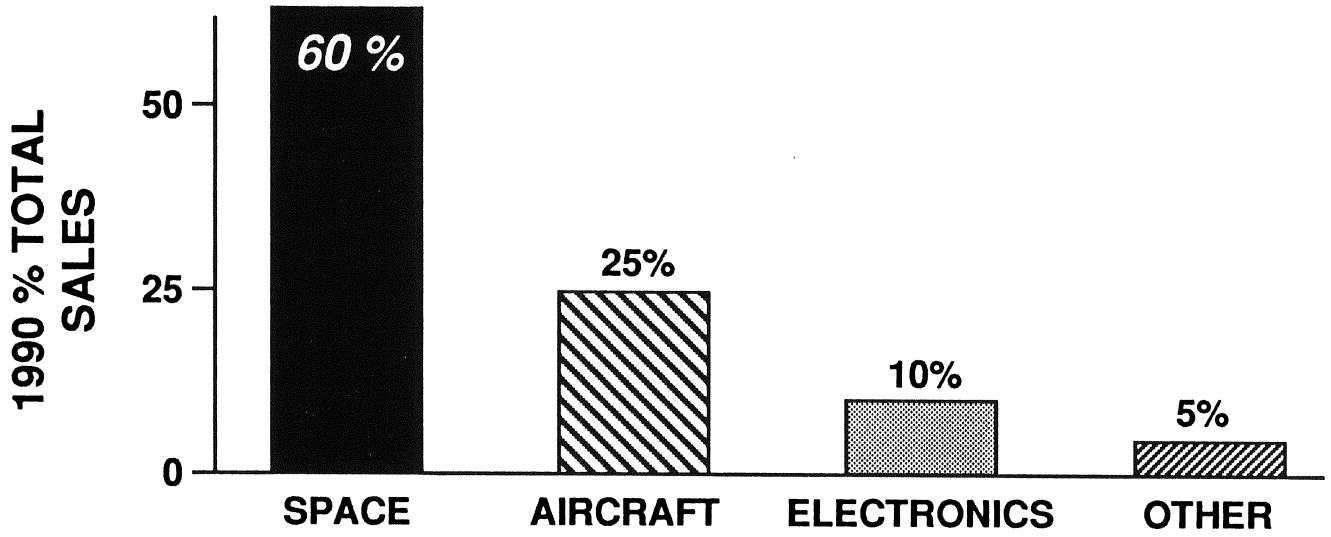
- VEHICLE/GSE DESIGN TO ENHANCE GROUND CHECKOUT
  - AUTOMATED CHECKOUT/SERVICING IN AVIONICS SYSTEMS
  - UTILIZE BITE CIRCUITS ~~AS MUCH AS POSSIBLE~~
  - WELD JOINTS IN FLUID SYSTEMS TO ELIMINATE FITTINGS WHERE POSSIBLE.
  - E/M TVC AND ENGINE VALVE CONTROL FOR CORE VEHICLE.


VAB INTEGRATED FLOW (5 DAYS)
PAD INTEGRATED FLOW (5 DAYS)
1.5 STAGE INTEGRATED VEHICLE PROCESSING
NASA
CARGO ASSY IN TRANSFER AISLE
CONN SLING/PREP FOR LIFT
LIFT TRANSTAGE
SOFTMATE
HARDMATE
SLING REMVL
P/L PRECONNECT WRAP CKS
CORE VEH RDY FOR CARGO
ELEC I/F CONNECTS
CARGO/CORE CONN CLOSEOUTS
CORE AVIONICS SYS CKS
CORE PWR UP
CARGO IVT
ROLLOUT PREPS
TRANSFER TO PAD (A5214)
MLP HARDDOWN
PAD VALIDATION ($0009)
MLP/LCC LN VER
CORE PWR UP
LOAD FLT COMPUTER
HAZ GAS PREPS
CORE GUCP CONNECT
PAD/MLP LO2/LH2 LNCHS/PURGE VER
LH2/LO2 AUTO FUNC C/O
HW SAFING SYS C/O
CTV HYPER. PROP LOAD ($0024)
CTV HYPER PREPS
CALL TO STATIONS
QD CONN
PAD CLEAR
OXID FILL
QD DEMATES
FUEL FILL
QD DEMATES
HE PRESS TO FLT MASS/PROP TO REG LOCKUP
PAD OPEN
LOX DP & COND ($1005)
LH2 DP & COND ($1006)
TCDT ($0017)
LOAD STMEC's
STME FRT's
GLS AUTO SEQ/TVC CKS
T-0
IMU/GUIDANCE VER
ORDNANCE INSTL ($5009)
CORE AVIONICS CLOSEOUT
TSM/GUCP T-0 ORD
ORD CLOSEOUT
TVC BATT INSTL
LAUNCH COUNTDOWN (
CALL TO STATIONS
AVIONICS & FLT CNTL AFT
FINAL MEM LOAD
STMEC LOAD
AFT PLATFORM REMVL
TVC CK
FINAL CLOSEOUTS
CRYO LOAD PREPS
CRYO LOAD
TERMINAL CNT
LAUNCH (T-0)
NOTES:
1. ASSUME CTV HYPER SERVICE SAME AS ORBITER FRCS.
2. P/L ORD REQUIREMENTS NO GREATER THAN CORE STAGE.
3. ASSUME SIMPLIFIED STME FRT
4. NO LAUNCH PAD HELIUM SIGNATURE TEST
5. NO PLUGS OUT TEST
S.T. BLACK TPE 3-19-91
CONCERNS:
1. ITEM 4. ABOVE
2. BATTERY INSTLN ALLOWANCE
3. AFT CLOSEOUT ALLOWANCE

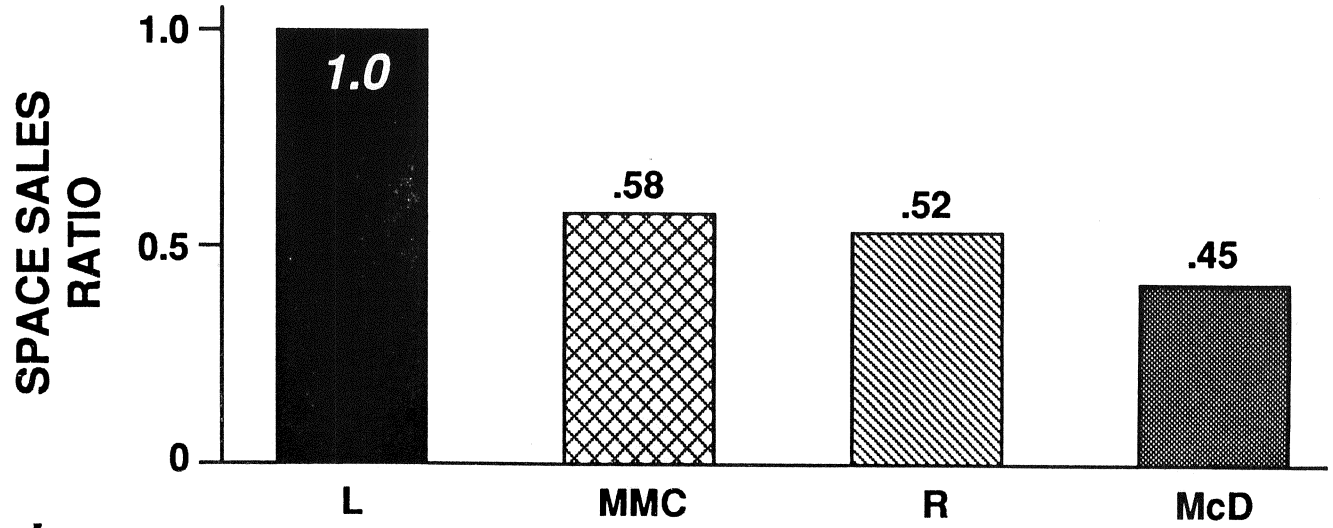
AGENDA

OVERVIEW	Jim Madewell
CORE VEHICLE ANALYSIS	Jim McCurry
CARGO TRANSFER VEHICLE	Dick Collart
LAUNCH SITE PROCESSING	Gary Letchworth
SUMMARY	Jim Madewell

LOCKHEED IS A SPACE COMPANY



THE NATION'S LARGEST SPACE COMPANY



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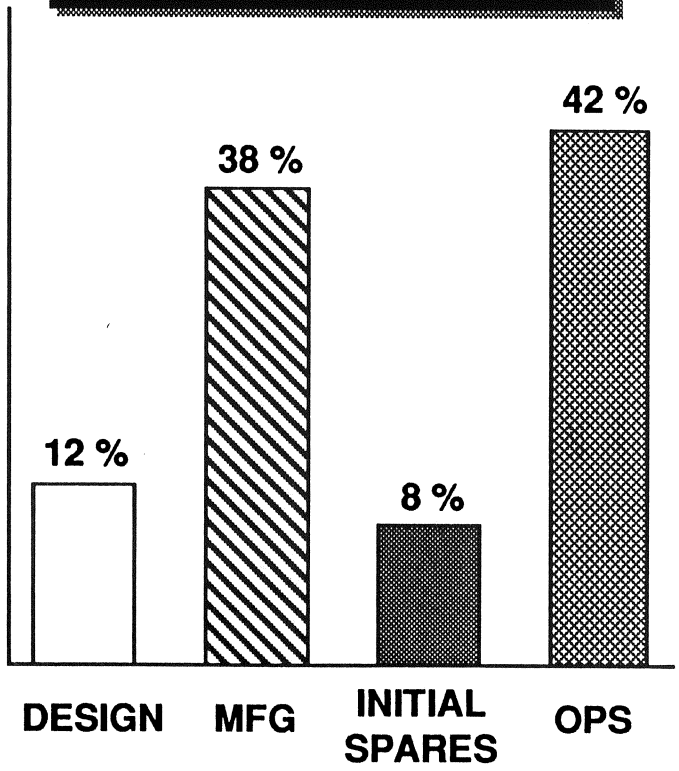
COMPETITION SENSITIVE

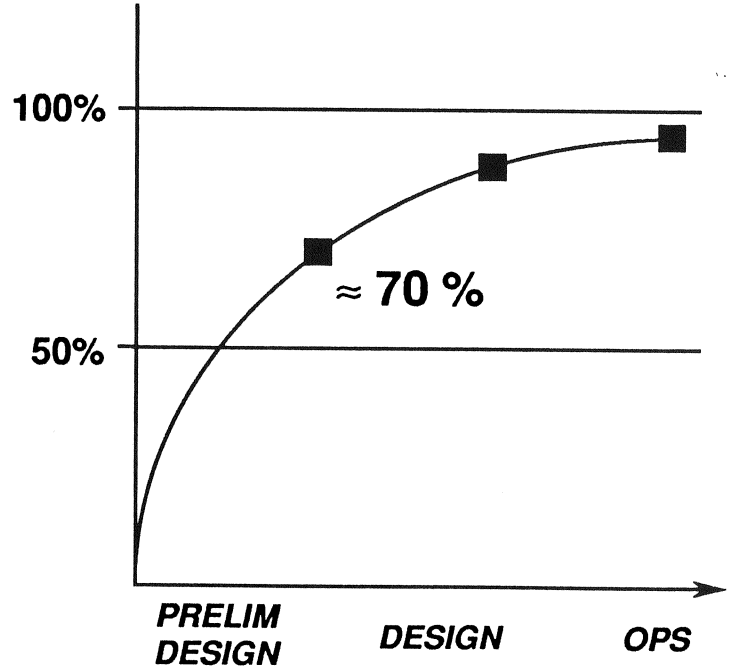
JFM/NLS(1) 040891 A

EFFECTIVE CONCURRENT ENGINEERING

TACTICAL AIRCRAFT LIFE CYCLE COST



OPS IMPACT



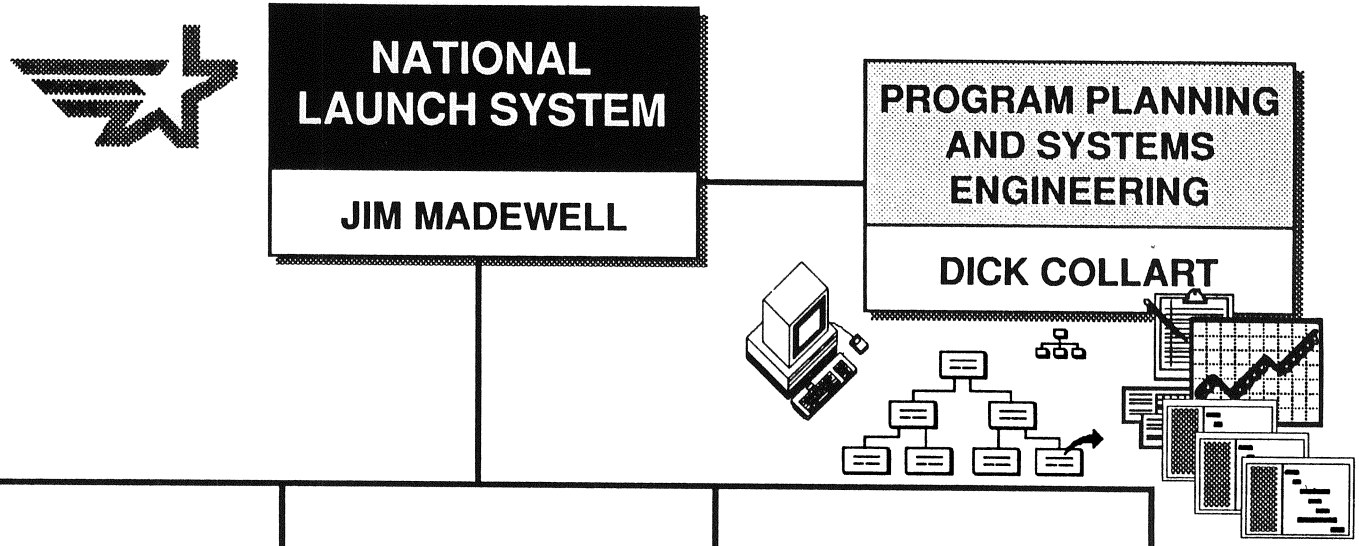
SOURCE: AIR FORCE LOGISTICS COMMAND

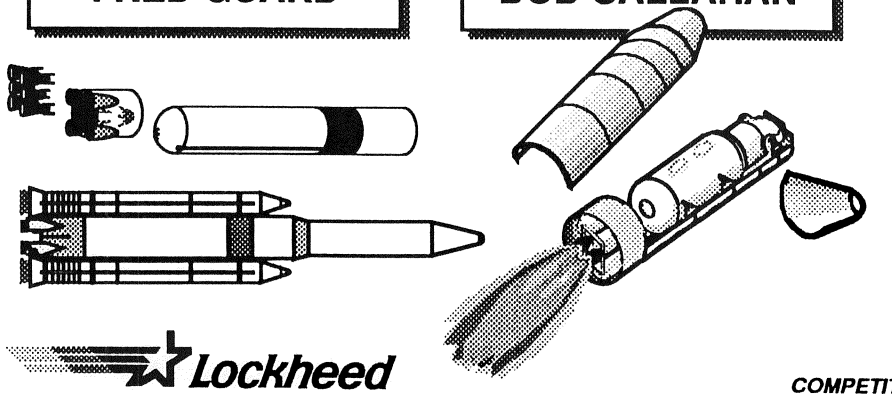
LOCKHEED CORPORATION ORGANIZATION

LOCKHEED CORPORATION
DAN TELLEP

AERONAUTICAL SYSTEMS GROUP	MISSILES AND SPACE SYSTEMS GROUP	ELECTRONICS GROUP	TECHNOLOGY SERVICES GROUP
KEN CANNASTRA	JOHN McMAHON	VAL PELINE	DON JONES
• ADVANCED TACTICAL FIGHTER (ATF)	• ADVANCED SOLID ROCKET MOTOR • BUS 1 • PAYLOAD REQUIREMENTS • PAYLOAD SHROUD • Al-Li • SYSTEMS ENGINEERING / INTEGRATION	• ATF TEST SYSTEMS	• SHUTTLE PROCESSING • TITAN / CENTAUR LAUNCH COMPLEX • SHUTTLE SYSTEMS INTEGRATION AND TRAJECTORY ANALYSIS

LOCKHEED NLS PROJECT OFFICE ORGANIZATION





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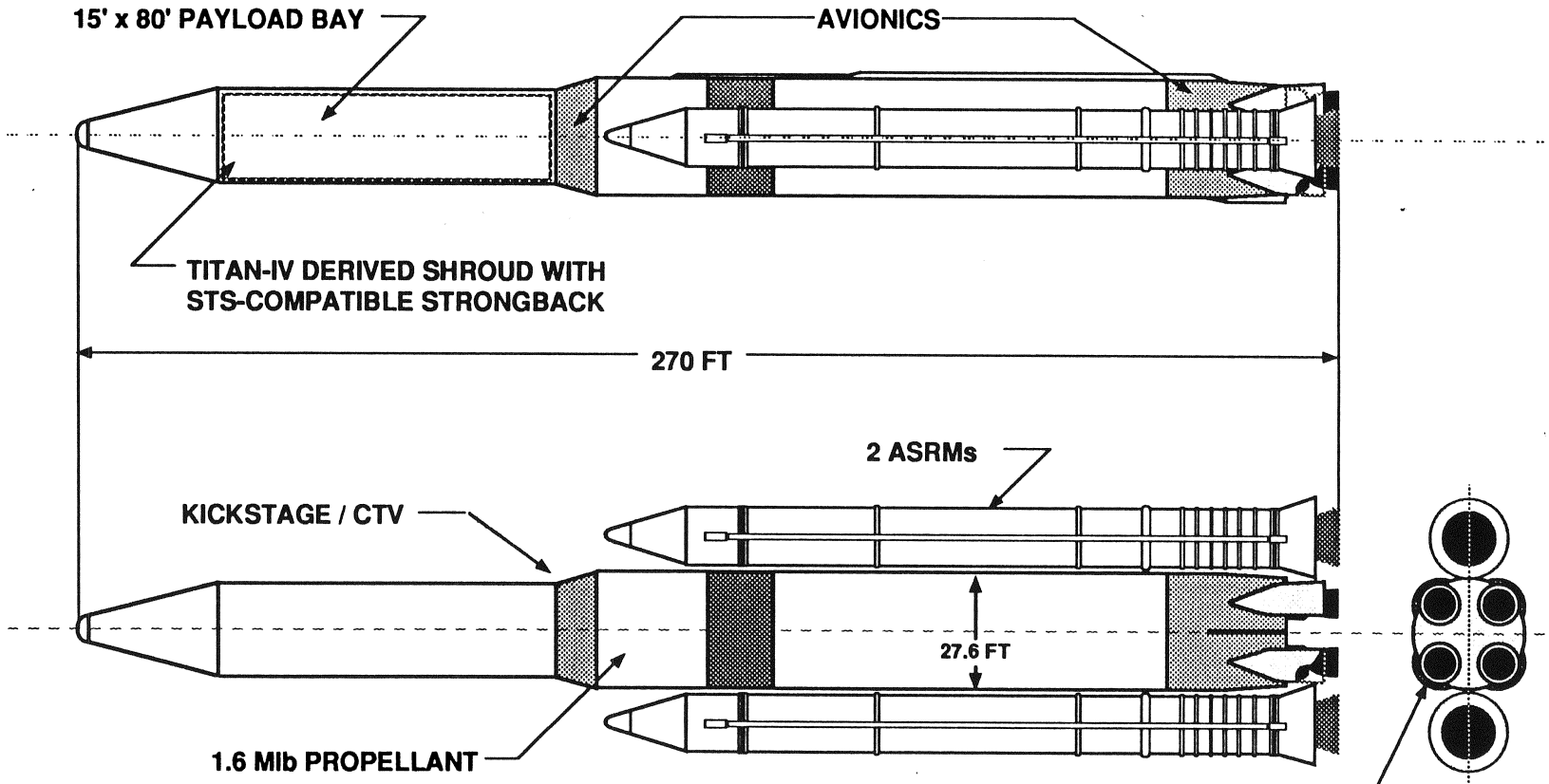
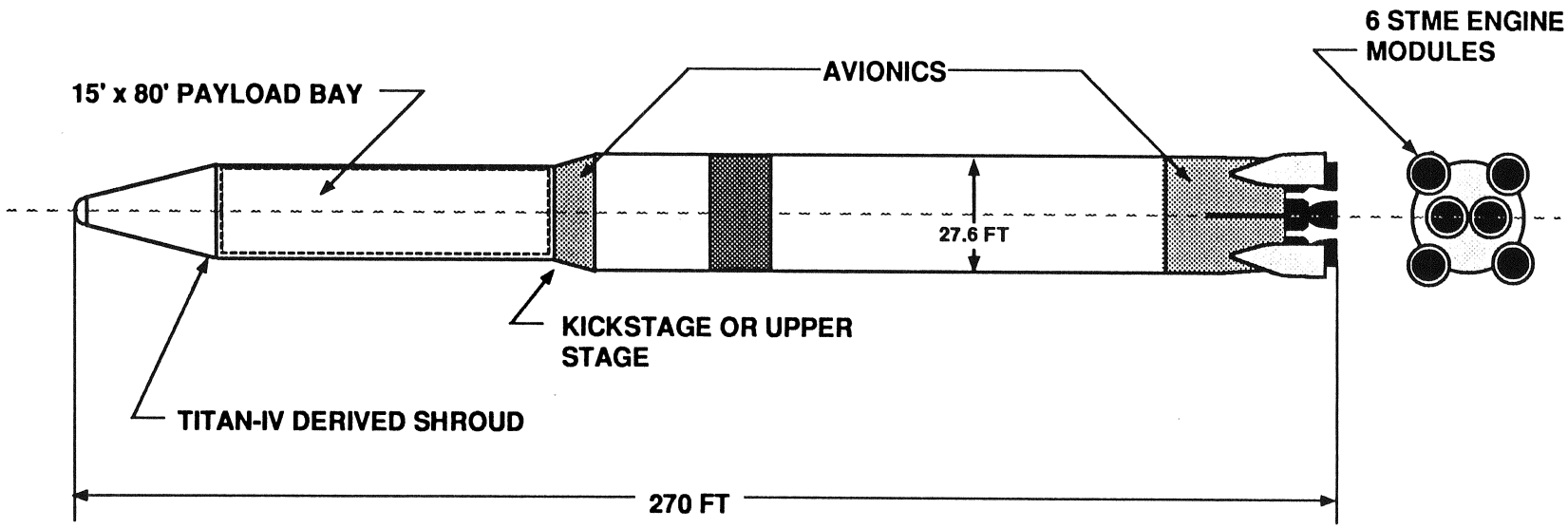
BASELINE NASA HLLV



- 150Klb - 160 Klb PAYLOAD
- PROPULSION MODULE: 4 SUSTAINER STMEs
- 1999 LAUNCH FROM LC-39 (KSC)

BASELINE 50Klb 1.5 STAGE VEHICLE



- 50 - 80 Klb PAYLOAD
- PROPULSION MODULE: 4 STAGED STMEs
  2 SUSTAINER STMEs
- 2002 FIRST LAUNCH FROM LC-34 / 37 (CCAFS)

CORE VEHICLE ANALYSIS

NLS ANALYSIS ACTIVITIES

OCTOBER 1990

- DEFINED 11 HLLV CONFIGURATIONS AND ASSESSED PERFORMANCE
- DEVELOPED HLLV SUBSYSTEM TRADE TREES
- IDENTIFIED ASRM GROWTH OPTIONS

NOVEMBER — DECEMBER 1990

- ASSESSED SIX HLLV CONFIGURATIONS FOR NEW CORE VEHICLE ENGINE DESIGN
- ASSESSED SMALL SOLID BOOSTERS (CASTORS) WITH CORE VEHICLE PER MSFC REQUEST
- MODELED CORE VEHICLE ENGINE PLUME FOR ASRM PLUME HEATING ISSUES

JANUARY — MARCH 1991

- ASSESSED ASRM NOZZLE EXTENSION PERFORMANCE
- ASSESSED EIGHT NEW HLLV BASELINE CONFIGURATIONS (7 NASA, 1 DoD) PER MSFC REQUEST
- QUALITATIVELY ASSESSED CORE VEHICLE ENGINE CONFIGURATIONS FOR RADIATIVE AND CONVECTIVE HEATING ISSUES WITH ASRMs
- OPTIMIZED MECO TARGETS

CONFIGURATIONS DEFINITION PROCESS

PERFORMANCE / COMPATIBILITY

- ASRM COMPATIBILITY
- PAYLOAD COMPATIBILITY
- ASCENT CONSTRAINTS ADHERENCE
- MINIMUM CORE MODIFICATIONS
- DoD / NASA CORE COMMONALITY

GEOMETRY

- ASRM GROWTH OPTIONS
- THRUST STRUCTURE DEFINITION
- PLUME HEATING IMPACTS
- PROPELLANT FEED LINE DEFINITION
- STME NOZZLE / THROTTLE DEFINITION
- ET STRETCH

SUBSYSTEM INTEGRATION

- SYSTEMS ENGINEERING AND INTEGRATION PLAN
- INTEGRATED LAUNCH VEHICLE ANALYSIS
- COMMON CORE UNIQUE CONSIDERATIONS
- PROPULSION SYSTEM TEST ENGINEERING
- MAN-RATING PLAN
- LOGISTICS / OPERATIONAL SUPPORT

INITIAL ASSESSMENT → *CURRENT ASSESSMENT* → *PLANNED ASSESSMENT*

PERFORMANCE GROUNDRULES AND CONSTRAINTS

AERODYNAMICS

- CONFIGURATION SPECIFIC FOREBODY (AXIAL AND NORMAL) AND POWER-ON BASE EFFECTS AERO

CONSTRAINTS

- 4G ACCELERATION LIMITING VIA STME THROTTLING OR ENGINE SHUTDOWN
- 900 psf DYNAMIC PRESSURE CONSTRAINT
- SRB APOGEE CONSTRAINT

ENVIRONMENT

- FEBRUARY PMBT FOR ASRMs
- NO WINDS
- 1963 PATRICK ATMOSPHERE

TRAJECTORY SIMULATION

- PITCH RATE OPTIMIZATION
- NASA MISSION
  - — MECO ORBIT: 31 x 220 nm, 28.5° INCLINATION
  - — MECO ALTITUDE: 70 nm
  - — SHROUD JETTISON: 13,180 lbm OF TOTAL 24,486 lbm SHROUD JETTISONED AT MECO

PERFORMANCE GROUNDRULES AND CONSTRAINTS (cont'd)

TRAJECTORY SIMULATION (cont'd)

- DoD MISSION
  - — MECO ORBIT: 80 x 150 nm, 28.5° INCLINATION
  - — MECO ALTITUDE: 80 nm
  - — SHROUD JETTISON: 11,979 lbm OF TOTAL 19,572 lbm SHROUD JETTISONED AT 400,000 FT

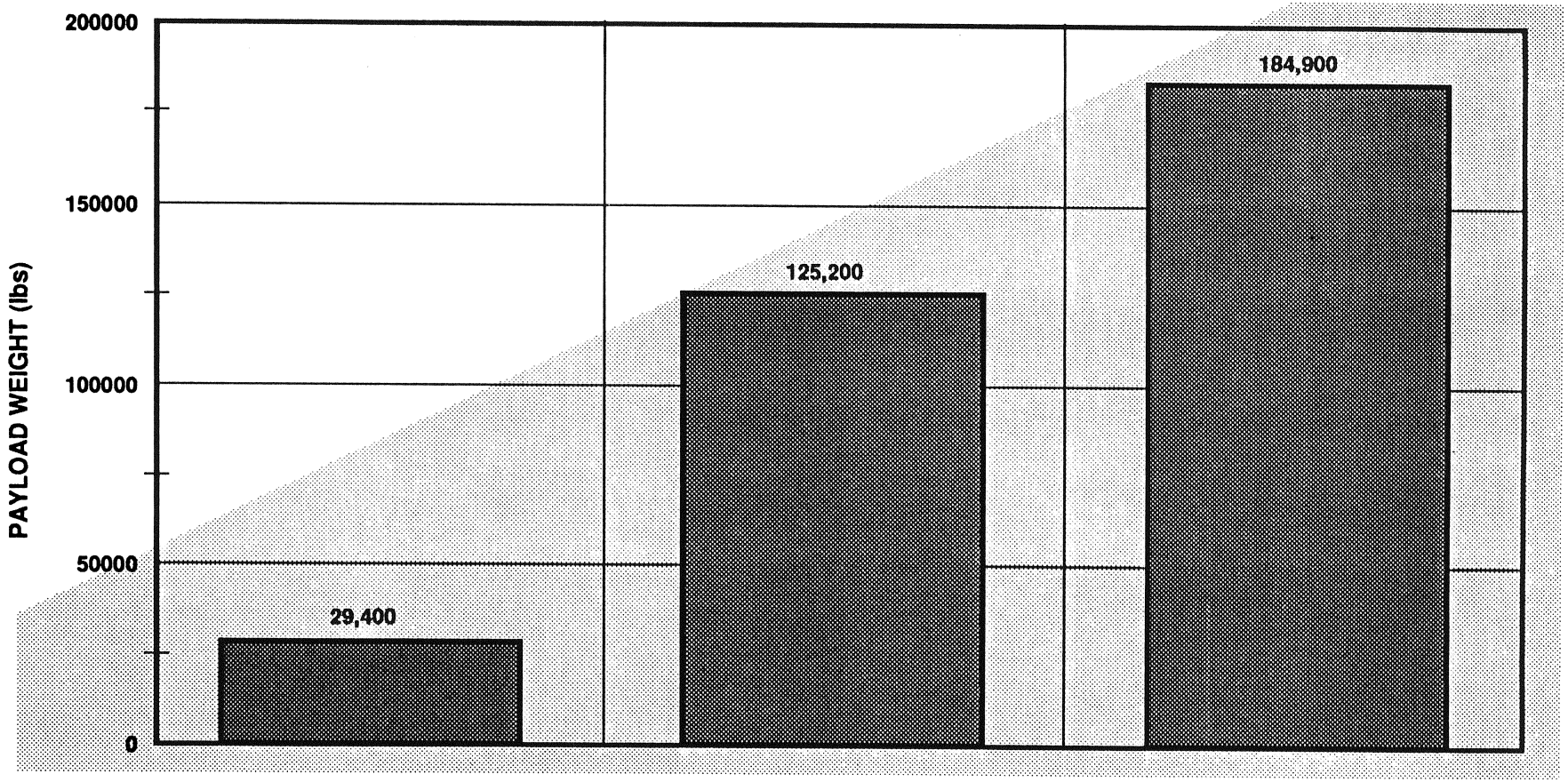
MASS PROPERTIES

- ET CORE PROPELLANT LOAD: 1,600,000 lbm
- ET CORE MASS PROPERTIES FROM MSFC / PD DOCUMENTS
- FLIGHT PERFORMANCE RESERVES: 2% CORE VEHICLE BURNOUT WEIGHT (APPROXIMATELY 1% OF MISSION TOTAL ΔV)
- PAYLOAD MASS IS MAXIMIZED FOR FLIGHT PERFORMANCE RESERVES REMAINING AT MECO

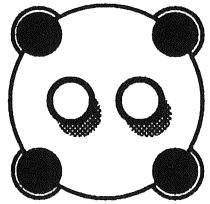
PROPULSION

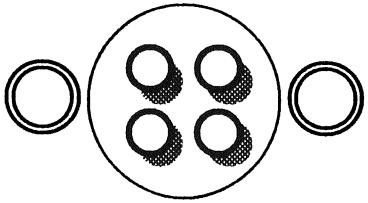
- A3A ASRM PERFORMANCE PROFILE WITH THRUST-RISE AND TAIL-OFF
- STME SPECIFICATIONS
  - — THRUST: 580,000 lbf VACUUM
  - — Isp: 432 sec VACUUM
  - — MIXTURE RATIO (OXIDIZER:FUEL): 6:1

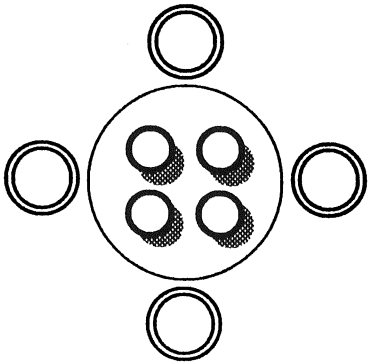
CURRENT NLS PERFORMANCE



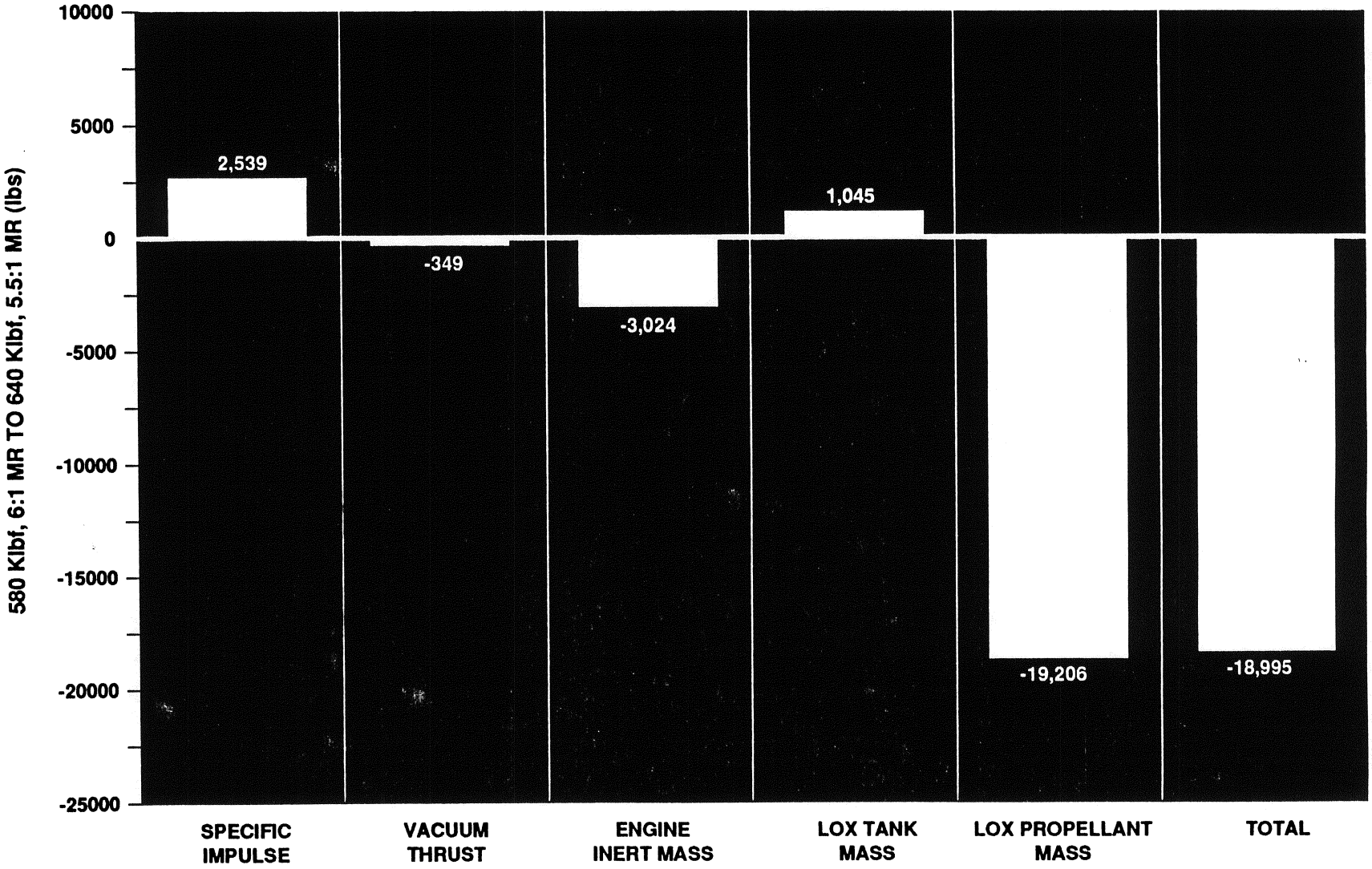
INDICATES STAGED ENGINES



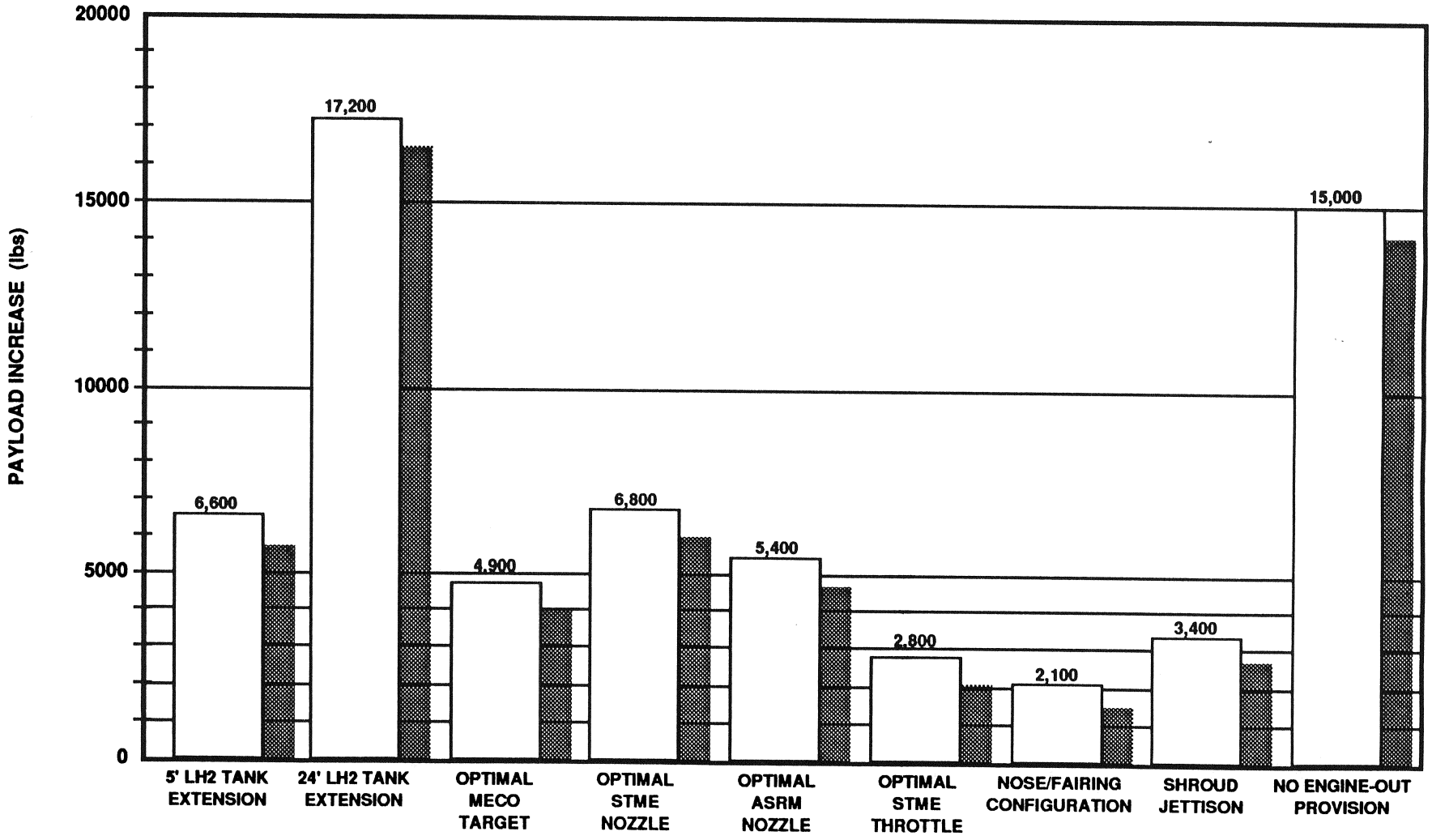




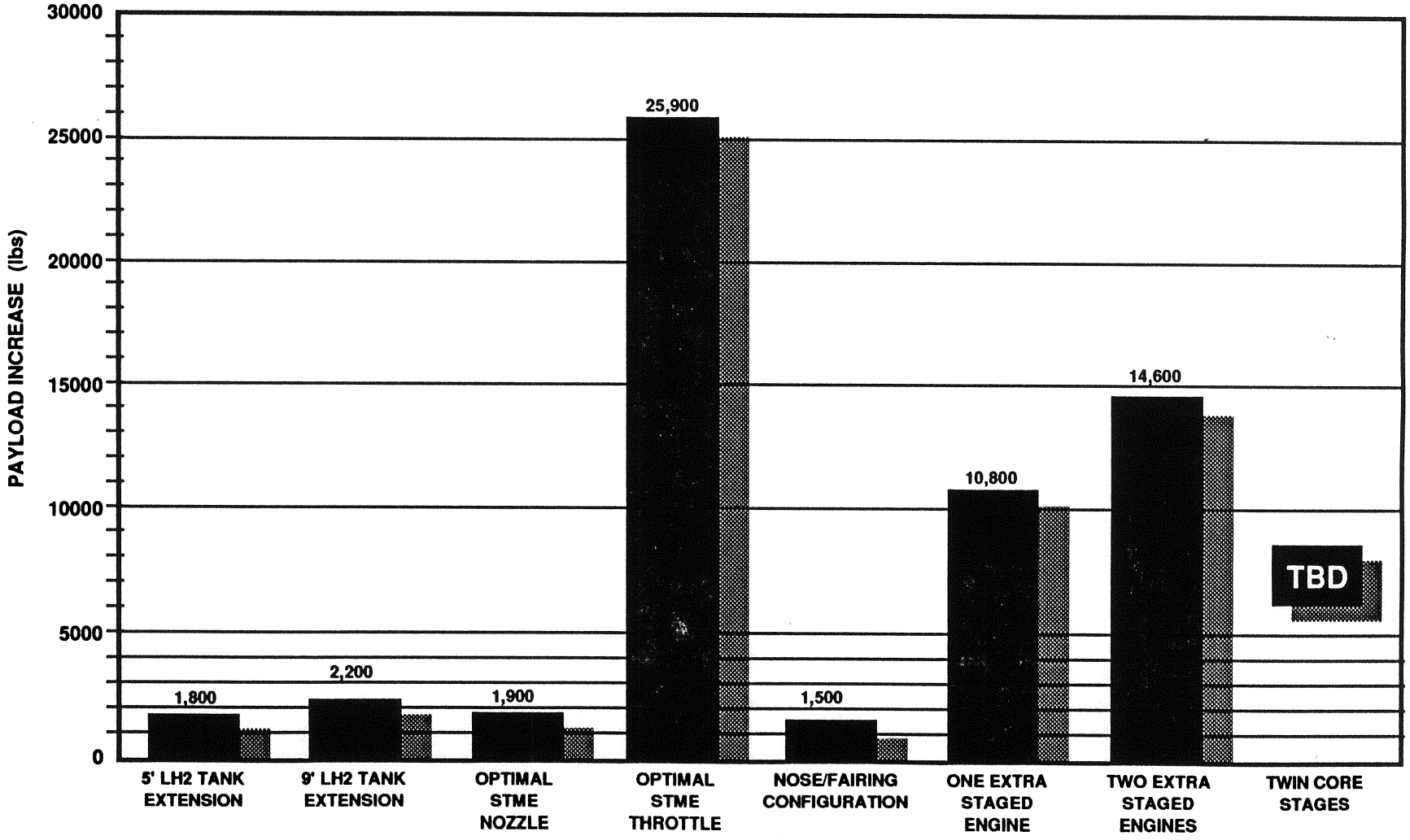
PERFORMANCE SENSITIVITIES DUE TO STME RE-SIZING



METHODS OF HLLV PERFORMANCE AUGMENTATION — NASA CONFIGURATION



METHODS OF NLS PERFORMANCE AUGMENTATION — DoD CONFIGURATION



ADDITIONAL DESIGN ISSUES

PERFORMANCE

- PERFORMANCE TRENDS INDICATE THAT BOTH THE NASA AND DoD CONFIGURATIONS NEED A HIGHER THRUST STME (650—700 Klbf VACUUM THRUST CLASS) TO BALANCE PAYLOAD MAXIMIZATION, NUMBERS OF CORE ENGINES, AND CORE PROPELLANT QUANTITY
- STAGING OF STMEs PRE-MECO PROVIDES 10—40 Klbm PAYLOAD INCREASE
- MECO TARGET OPTIMIZATION FOR NASA AND DoD MISSIONS COULD ENHANCE BOTH VEHICLE PERFORMANCE AND RANGE SAFETY
- ALL CONFIGURATIONS MEET ASCENT CONSTRAINTS WITH EXCEPTION OF 4-ASRM VEHICLE
  - *ASRM APOGEE ALTITUDE CONSTRAINT VIOLATED (RECOVERY AND REUSE ISSUE)*

ADDITIONAL DESIGN ISSUES (cont'd)

PLUME HEATING

- PLUME HEATING ANALYSIS IS A LONG-LEAD ITEM
  - *— RADIATIVE HEATING PREDICTION IS ANALYTICALLY ACCURATE (BASED ON PLUME CONSTITUENTS)*
  - *— CONVECTIVE HEATING PREDICTION IS EMPIRICAL (BASED ON PLUME INTERACTIONS)*
- ASRM RADIATIVE HEATING WILL BE HIGHER THAN RSRM
  - *— STME HEAT SHIELDING MAY BE REQUIRED*
- ANALYSIS WILL BE REQUIRED TO DETERMINE DOMINANCE OF CONVECTIVE AND RADIATIVE BASE HEATING FOR BOTH CORE AND ASRM
- CORE VEHICLE CONVECTIVE HEATING "HOT SPOTS" WILL LOCALIZE BETWEEN ADJACENT STME PAIRS
- CONVECTIVE HEATING FLIGHT DATA FOR CLUSTER OF FOUR LIQUID ENGINES IS LIMITED OR NON-EXISTENT

ADDITIONAL DESIGN ISSUES (cont'd)

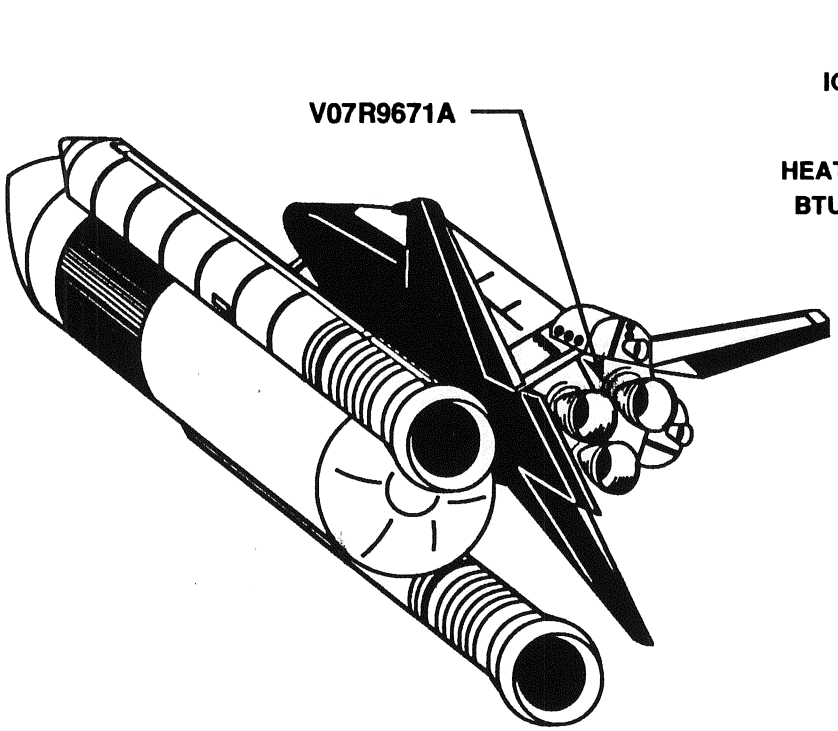
PLUME HEATING BASICS

PLUME RADIATION

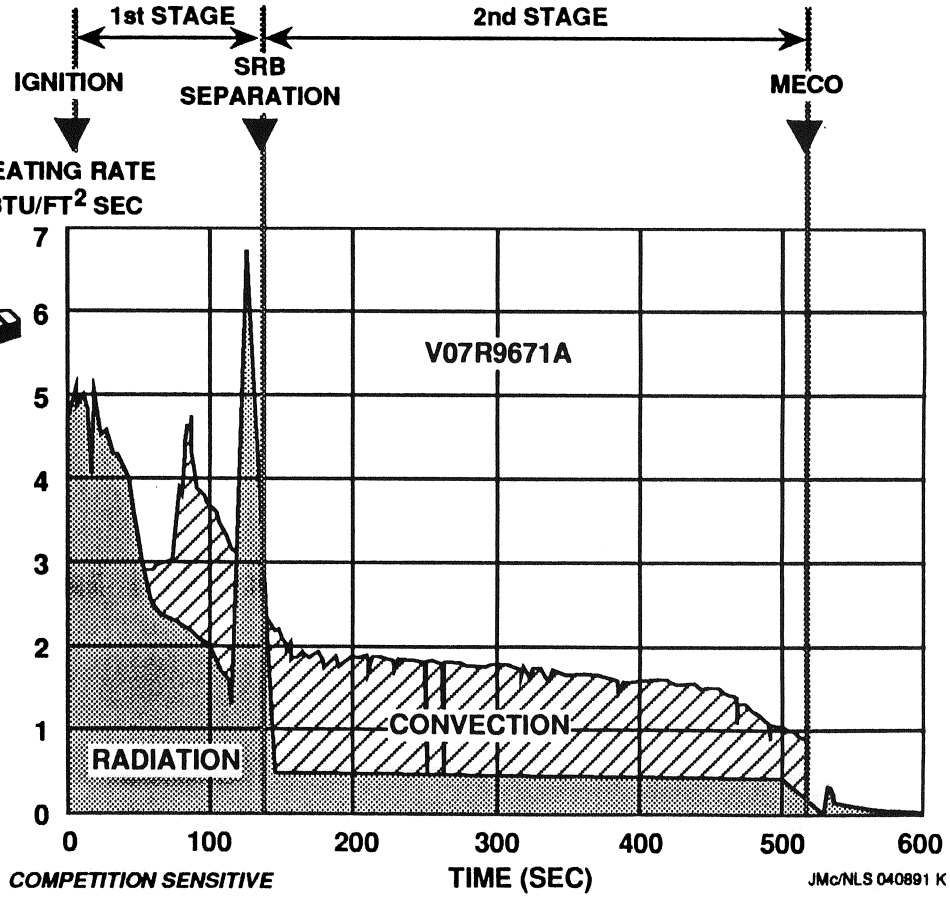
- RADIATION FROM HOT PLUME GAS
- RADIATION FROM HOT PLUME PARTICLES
- HIGHER RADIATION HEATING FROM SOLID ROCKET MOTORS BECAUSE PARTICLES RADIATE MORE EFFICIENTLY

PLUME CONVECTION

- PLUME CONVECTION HEATING DUE TO INTERSECTING PLUMES THAT CAUSE HOT PLUME GAS TO RECIRCULATE INTO BASE REGION
- PLUME SIZE INCREASES WITH ALTITUDE WHICH INCREASES PLUME INTERACTION



TYPICAL SHUTTLE BASE HEATING ENVIRONMENTS

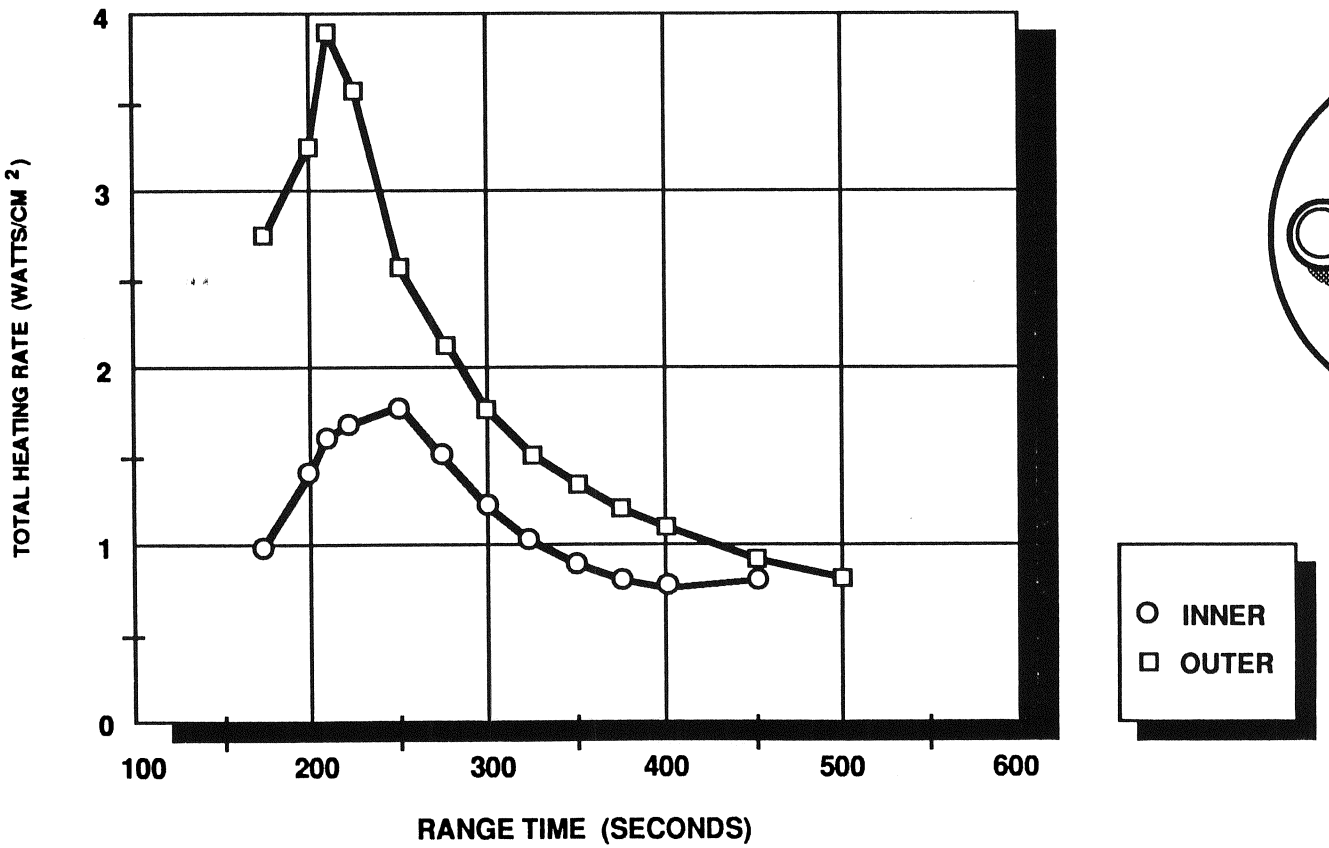


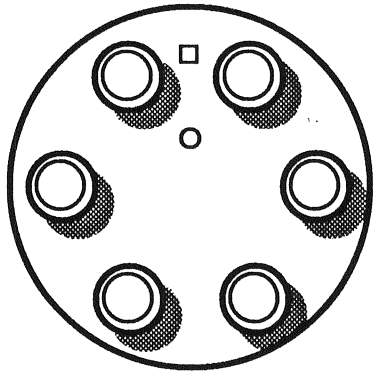
ADDITIONAL DESIGN ISSUES (cont'd)

EXPERIMENTAL FLIGHT DATA

- SATURN 1 S-IV STAGE
- LO_2/LH_2 @ CHAMBER PRESSURE OF 300 PSIA
- 160,000 TO 250,000 FEET ALTITUDE

FLIGHT DATA RESULTS

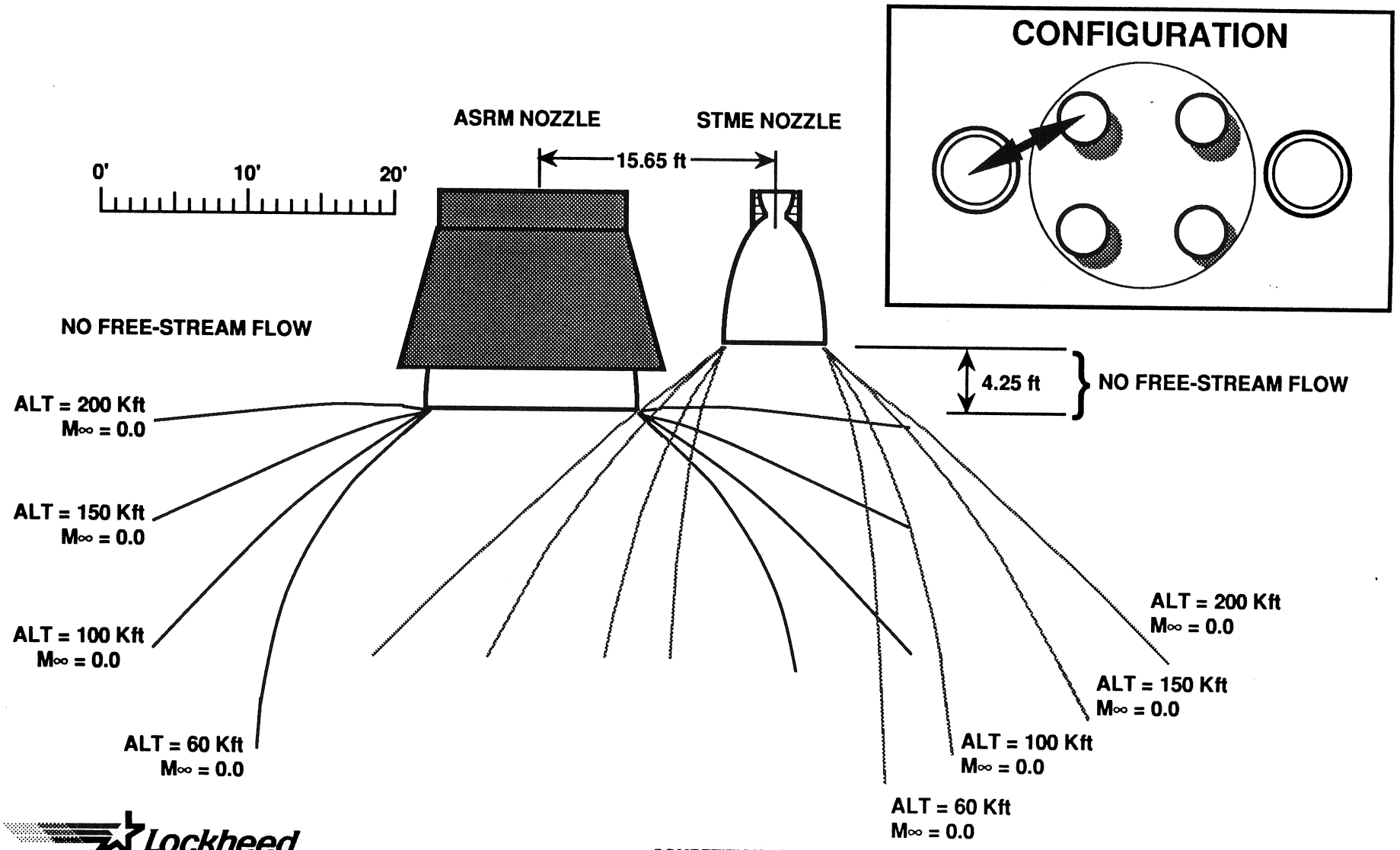




O INNER
□ OUTER

ADDITIONAL DESIGN ISSUES (cont'd)

ASRM (AFT POSITION) / STME PLUME BOUNDARIES



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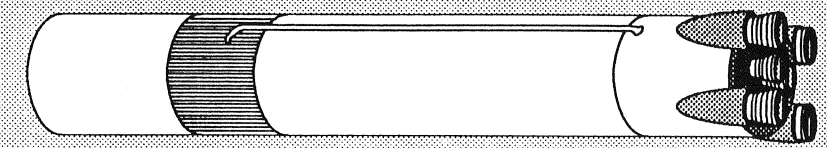
FUTURE WORK

- CORE VEHICLE SIZING AND PERFORMANCE ASSESSMENTS
- CORE ENGINE-OUT CONTROLLABILITY REQUIREMENTS
- USE OF UPPER STAGE PERFORMANCE FOR ASCENT ABORT PROTECTION
- SUBSYSTEM FUNCTIONAL DEFINITION AND COMPONENT SELECTION TRADE STUDIES
- ASRM PERFORMANCE GROWTH OPTIONS
- MAN-RATING AND VEHICLE HEALTH MANAGEMENT SCARRING



CARGO TRANSFER VEHICLE (CTV)

SYSTEMS ENGINEERING APPROACH

REFINE MISSION REQUIREMENTS

- *SSF SUPPORT*
- *PAYLOAD SUPPORT*
- *LAUNCH FREQUENCY*
- *FLOW REQUIREMENTS DOWN TO APPROPRIATE LEVEL*
- *NON-SSF MISSIONS*
- *MISSION LIFE*
- *PERFORMANCE CAPABILITY*

IDENTIFY CANDIDATE CONFIGURATIONS AND ISSUES

- *SEPARATE vs COMBINED CTV / KICKSTAGE*
- *EXPENDABLE vs REUSABLE VEHICLE*
- *NEW VEHICLE vs EXISTING*

DEVELOP CANDIDATES TO LEVEL NECESSARY FOR TRADE STUDIES

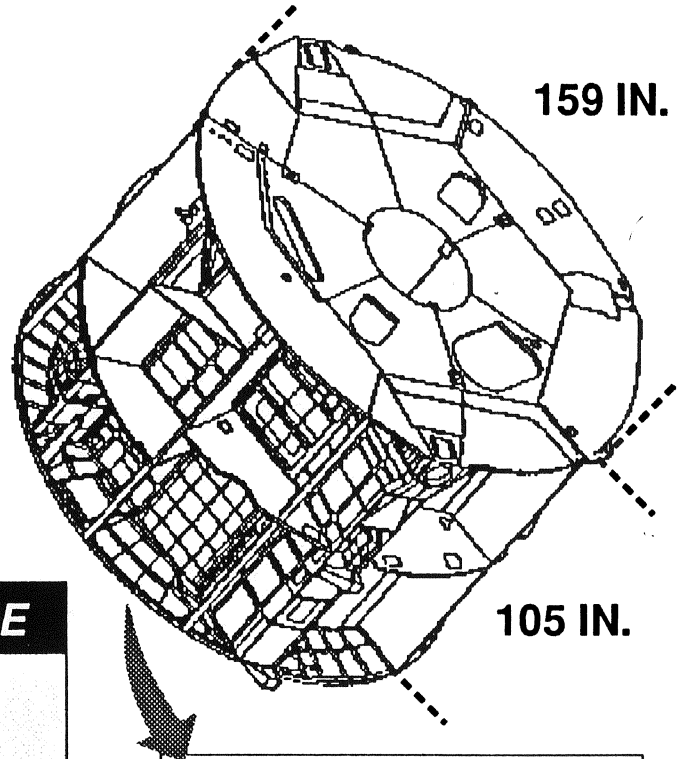
PERFORM TRADES TO SELECT CANDIDATES; CRITERIA INCLUDES:

- *LIFE CYCLE COST*
- *SUPPORTABILITY*
- *PERFORMANCE vs REQUIREMENTS*
- *COST / SCHEDULE / TECHNICAL RISK*
- *SAFETY / RELIABILITY / MAINTAINABILITY*
- *GROWTH CAPABILITY*

BUS 1 OVERVIEW

GENERAL CHARACTERISTICS

- ONGOING LOCKHEED PROGRAM
- CLASSIFIED MISSION WITH P/L UNIQUE AVIONICS
- MULTI-YEAR OPERATION IN LEO
- 3-AXIS CONTROL PLUS ORBIT TRANSFER



- MMH/N204 (BIPROP)
- 7700 OR 11500 lbm
- 200 lbf (2) AND 14 lbf (12) THRUSTERS
- 5900—6600 lbm (DRY) WITH NO AVIONICS

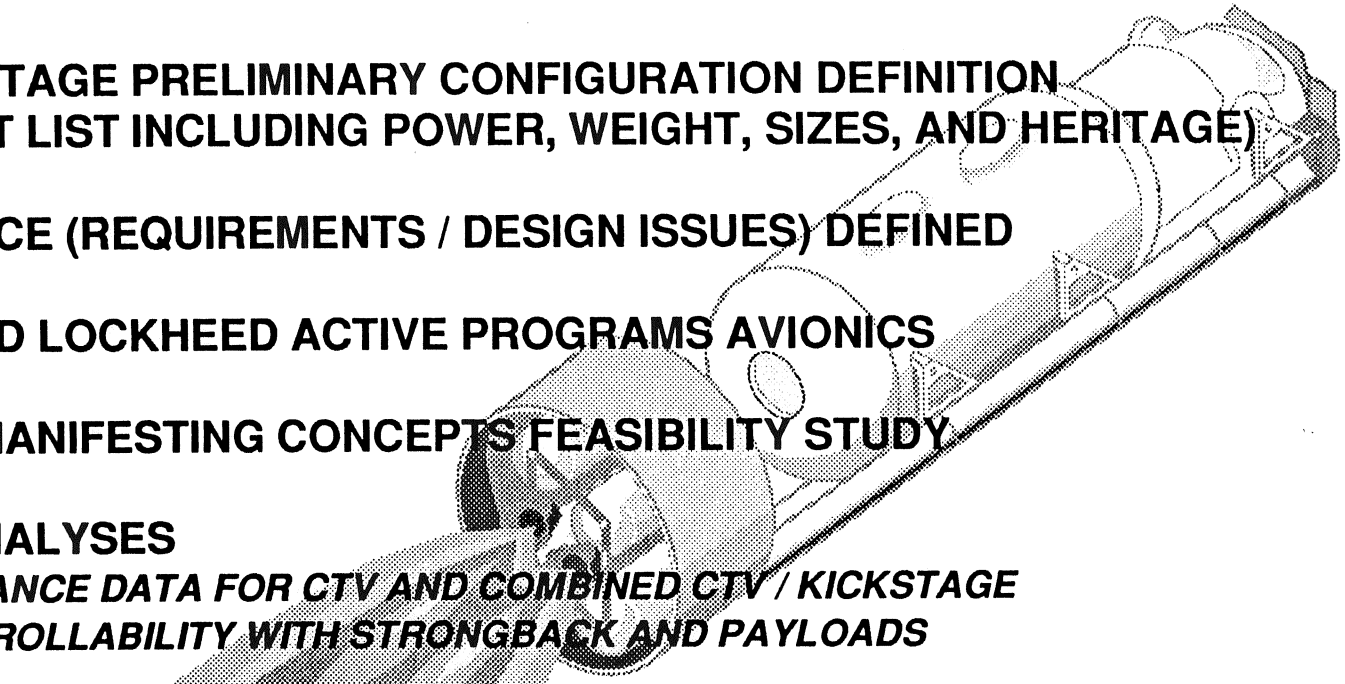
FEATURES APPLICABLE TO CTV / KICKSTAGE

- PROPELLANT CAPACITY EXCEEDS REQUIREMENTS
- MULTIPLE BURNS AND REUSABILITY POTENTIAL
- THRUST LEVELS WELL-MATCHED
- EXTENSIVE REDUNDANCY
- QUALIFIED FOR STS AND TITAN-IV
- LARGE VOLUME FOR SUBSYSTEMS
- EASY ACCESS FOR MAINTENANCE
- AVOIDS DEVELOPMENT OF TWO SEPARATE VEHICLES

EXISTING LOCKHEED PROGRAMS SUPPORT

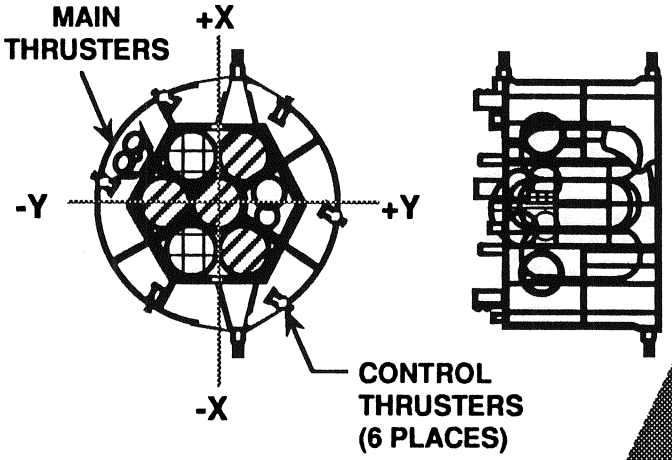
ALL AVIONICS EXCEPT PROXIMITY OPERATIONS

ACCOMPLISHMENTS

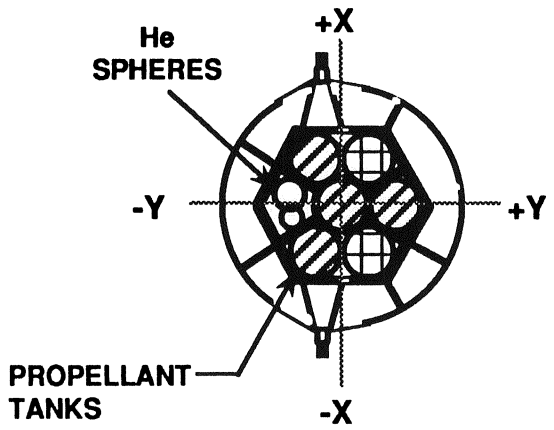


- CTV / KICKSTAGE PRELIMINARY REQUIREMENTS ANALYSIS
- CTV / KICKSTAGE PRELIMINARY CONFIGURATION DEFINITION (EQUIPMENT LIST INCLUDING POWER, WEIGHT, SIZES, AND HERITAGE)
- TRADE SPACE (REQUIREMENTS / DESIGN ISSUES) DEFINED
- INTEGRATED LOCKHEED ACTIVE PROGRAMS AVIONICS
- PAYLOAD MANIFESTING CONCEPTS FEASIBILITY STUDY
- MISSION ANALYSES
  - *— PERFORMANCE DATA FOR CTV AND COMBINED CTV / KICKSTAGE*
  - *— CTV CONTROLLABILITY WITH STRONGBACK AND PAYLOADS*
- BUS 1 REUSABILITY ASSESSMENT (STRUCTURAL FRACTURE MECHANICS AND PROPULSION ELEMENT LIFE ASPECTS)
- SPACE STATION FREEDOM INTERFACE ISSUES
- PRELIMINARY SCHEDULE
- COST COMPARISON OF EXISTING DESIGNS vs NEW DESIGN

BUS 1 CONFIGURATION OPTIONS



BUS 1 PRODUCTION FLOW



KICKSTAGE / CTV

- REUSABLE VERSION
- FULL AVIONICS (INCLUDING HLLV)
- PROXIMITY OPERATIONS SENSORS
- MAXIMUM BATTERY COMPLEMENT
- SOLAR ARRAY
- 6-DOF RCS
- SSF, STS COMPATIBLE
- LEO THERMAL CONTROL
- STS RETRIEVABLE
- DOCKING, GRAPPLE FIXTURES

KICKSTAGE

- EXPENDABLE VERSION
- SIMPLE AVIONICS
- MINIMUM BATTERY COMPLEMENT
- MINIMUM RCS
- SOME STRUCTURAL ELEMENTS DELETED
- 4- OR 6-TANK CONFIGURATION
- MINIMUM THERMAL CONTROL
- SOME PROPULSION VALVES, INSTRUMENTATION DELETED

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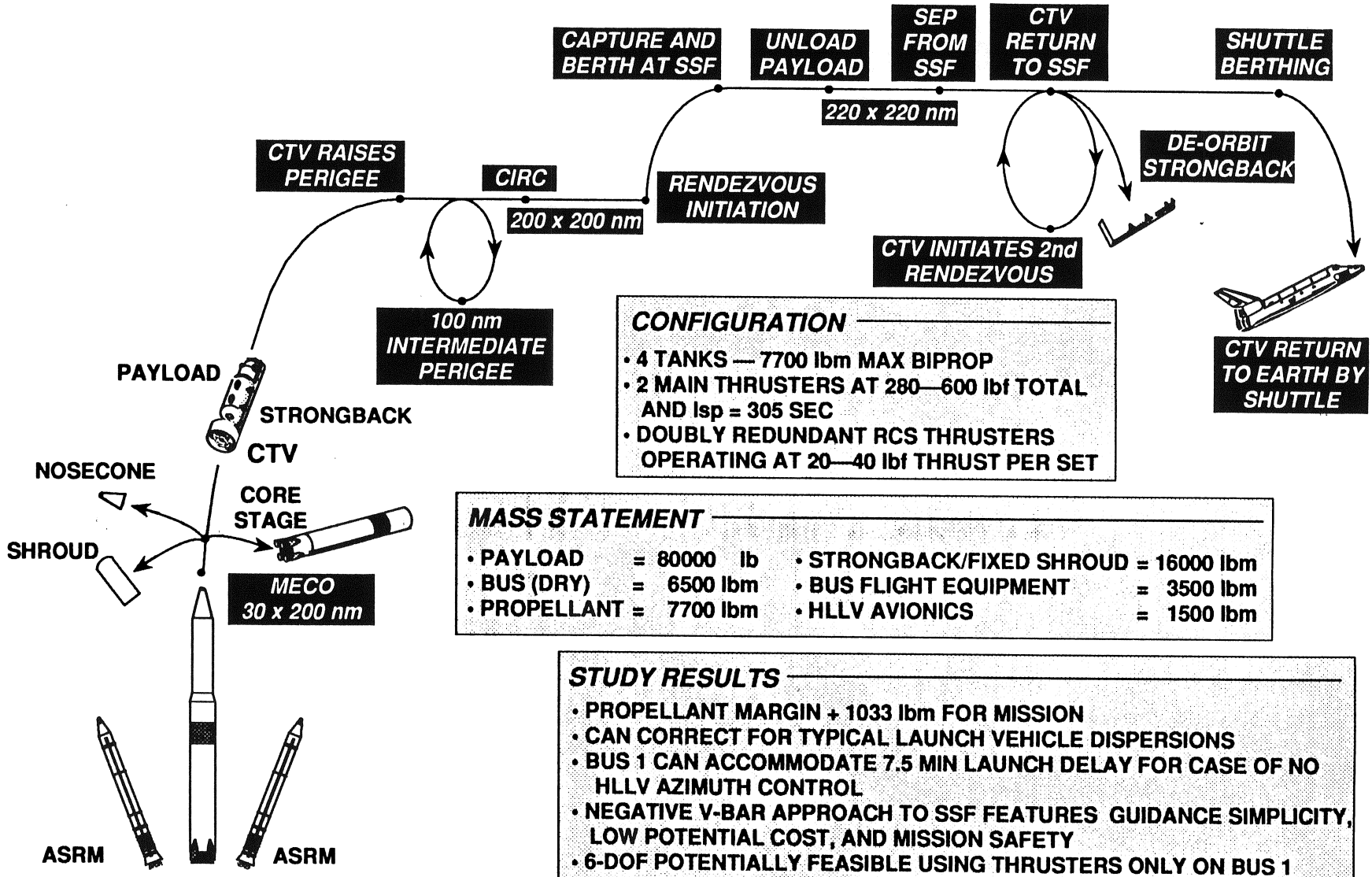
VEHICLE CONFIGURATION OPTIONS

EQUIPMENT	EXPENDABLE KICKSTAGE	REUSABLE KICKSTAGE	EXPENDABLE KICKSTAGE/ CTV	REUSABLE KICKSTAGE/ CTV	EXPENDABLE CTV	REUSABLE CTV
AVIONICS						
• KICKSTAGE + HLLV	●	●				
• KICKSTAGE/CTV + HLLV			●	●		
• CTV ONLY					●	●
PROPULSION						
• HIGH ΔV + SIMPLE RCS	●	●				
• HIGH ΔV + 6-DOF RCS			●	●		
• LOW ΔV + 6-DOF RCS					●	●
• RETRIEVABLE / REUSABLE		●		●		●
POWER						
• MIN BATTERY COMPLEMENT	●				●	
• MAX BATTERY COMPLEMENT		●	●	●		●
• SOLAR ARRAYS				●		●
PROX OPS EQUIPMENT						
• SENSORS / AVIONICS			●	●	●	●
• DOCKING MECHANISM				●		●
• GRAPPLE FIXTURES		●		●		●
THERMAL CONTROL						
• TRANSIENT	●					
• LONG-LIFE LEO		●	●	●	●	●

COMBINED MISSION SCENARIO



CONFIGURATION

- 4 TANKS — 7700 lbm MAX BIPROP
- 2 MAIN THRUSTERS AT 280—600 lbf TOTAL AND Isp = 305 SEC
- DOUBLY REDUNDANT RCS THRUSTERS OPERATING AT 20—40 lbf THRUST PER SET

MASS STATEMENT

• PAYLOAD	= 80000 lb	• STRONGBACK/FIXED SHROUD	= 16000 lbm
• BUS (DRY)	= 6500 lbm	• BUS FLIGHT EQUIPMENT	= 3500 lbm
• PROPELLANT	= 7700 lbm	• HLLV AVIONICS	= 1500 lbm

STUDY RESULTS

- PROPELLANT MARGIN + 1033 lbm FOR MISSION
- CAN CORRECT FOR TYPICAL LAUNCH VEHICLE DISPERSIONS
- BUS 1 CAN ACCOMMODATE 7.5 MIN LAUNCH DELAY FOR CASE OF NO HLLV AZIMUTH CONTROL
- NEGATIVE V-BAR APPROACH TO SSF FEATURES GUIDANCE SIMPLICITY, LOW POTENTIAL COST, AND MISSION SAFETY
- 6-DOF POTENTIALLY FEASIBLE USING THRUSTERS ONLY ON BUS 1

ORBIT ESTABLISHMENT, RENDEZVOUS, AND STRONGBACK DE-ORBIT PERFORMED BY SINGLE VEHICLE

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PAYLOAD MANIFESTING CONCEPT

REQUIREMENTS: SIZE 15 FT x 80 FT; PAYLOAD 80,000 LBS

DESIGN CONCEPT: STS BAY DUPLICATION

BENEFITS

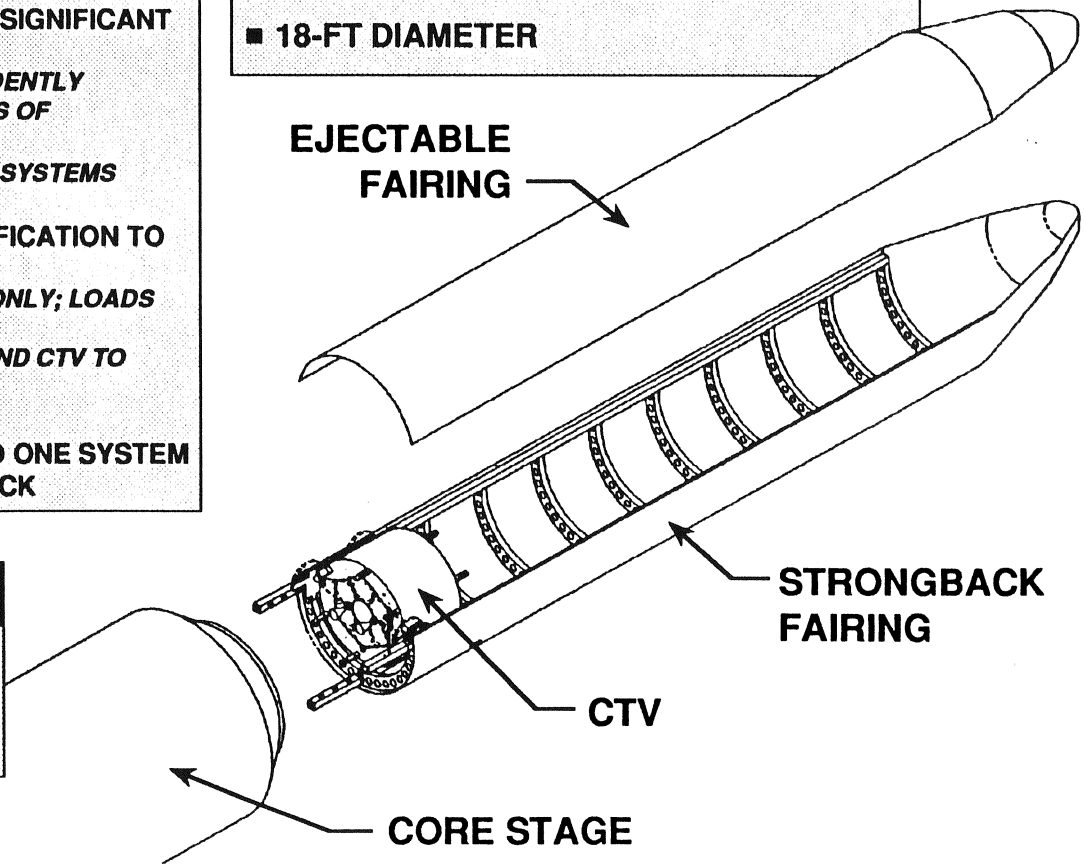
- STS INTERFACE COMPATIBILITY OFFERS SIGNIFICANT MANIFESTING BENEFITS
  - *PAYLOADS MAY BE DEVELOPED INDEPENDENTLY AS LOWER UNITS NEED NOT CARRY LOADS OF UPPER UNITS*
  - *MAXIMIZES COMMONALITY WITH EXISTING SYSTEMS*
- CONCEPT MINIMIZES STRUCTURAL MODIFICATION TO BUS 1
  - *TRUNNIONS CARRY CTV LAUNCH LOADS ONLY; LOADS DURING CTV BURNS ARE MUCH SMALLER*
  - *PAYLOAD LAUNCH LOADS CARRIED AROUND CTV TO HLLV*
- CONCENTRATE "NEW DEVELOPMENT" TO ONE SYSTEM ELEMENT; i.e., THE SHROUD / STRONGBACK

DESIGN

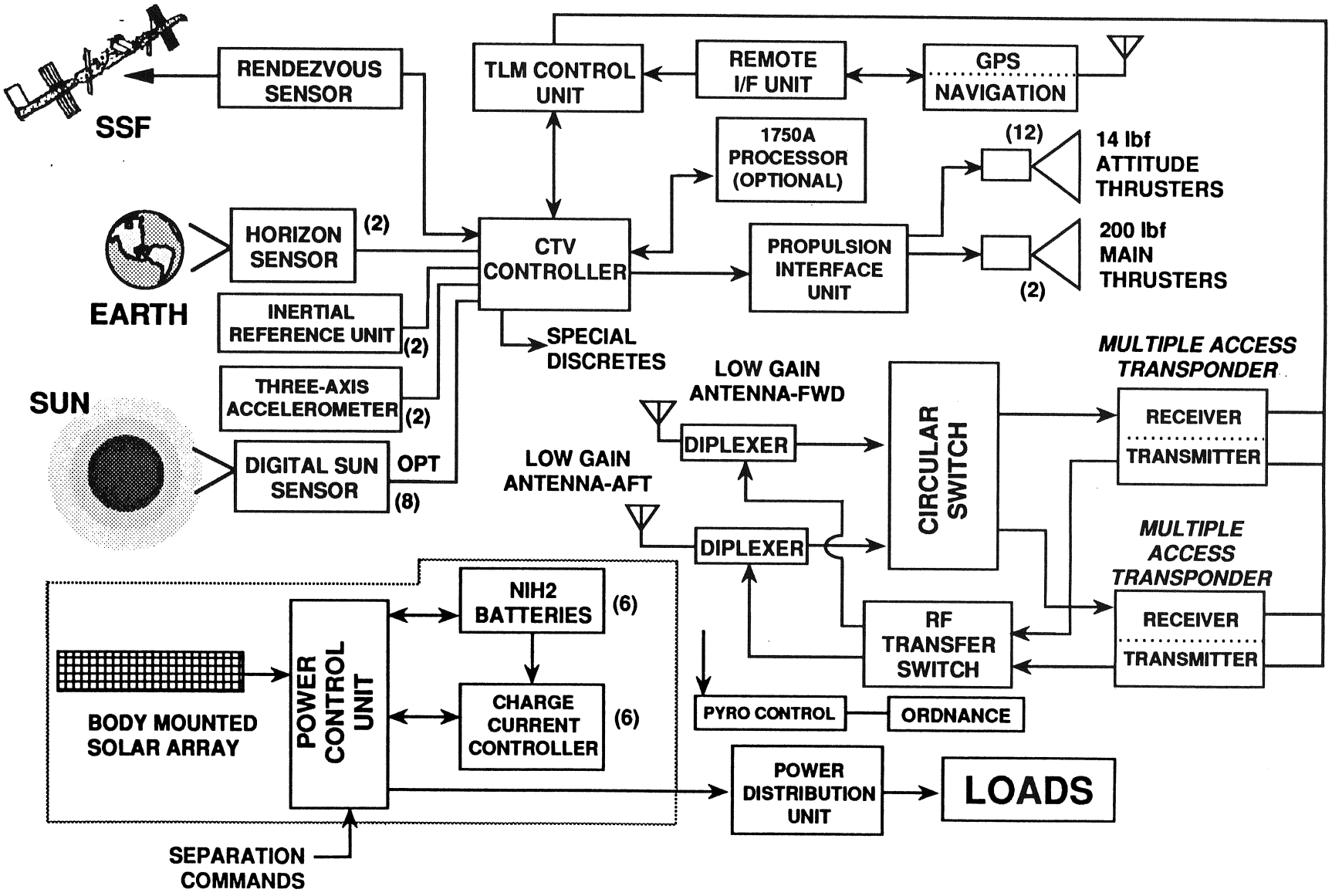
- C-STRUCTURAL SECTION ON STRONGBACK HALF
- STANDARD SHROUD ON OTHER HALF
- 18-FT DIAMETER

WEIGHT

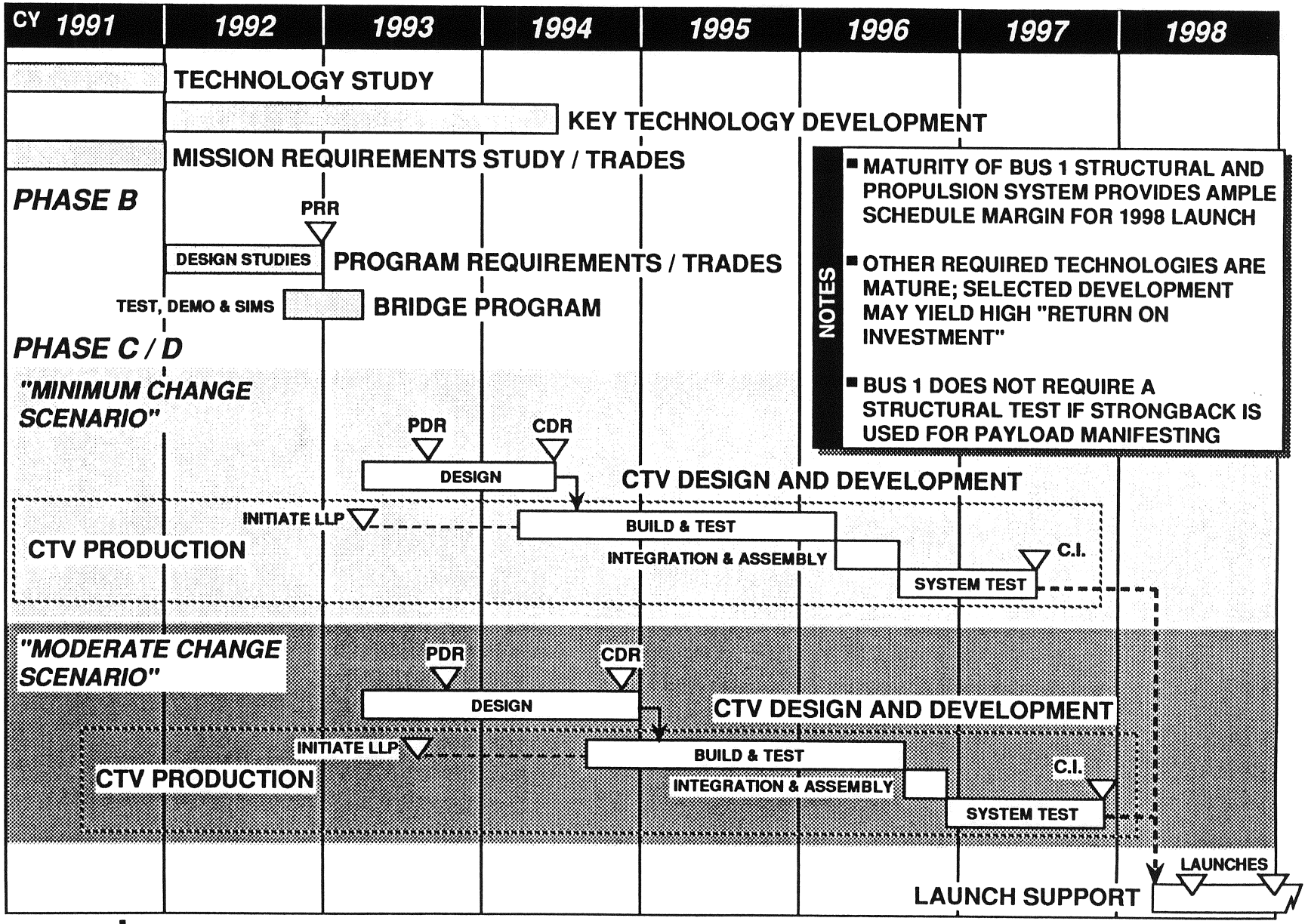
STRONGBACK	16,000 lbs
DEPLOYABLE SHROUD	7,000 lbs



CTV AVIONICS FUNCTIONAL FLOW DIAGRAM

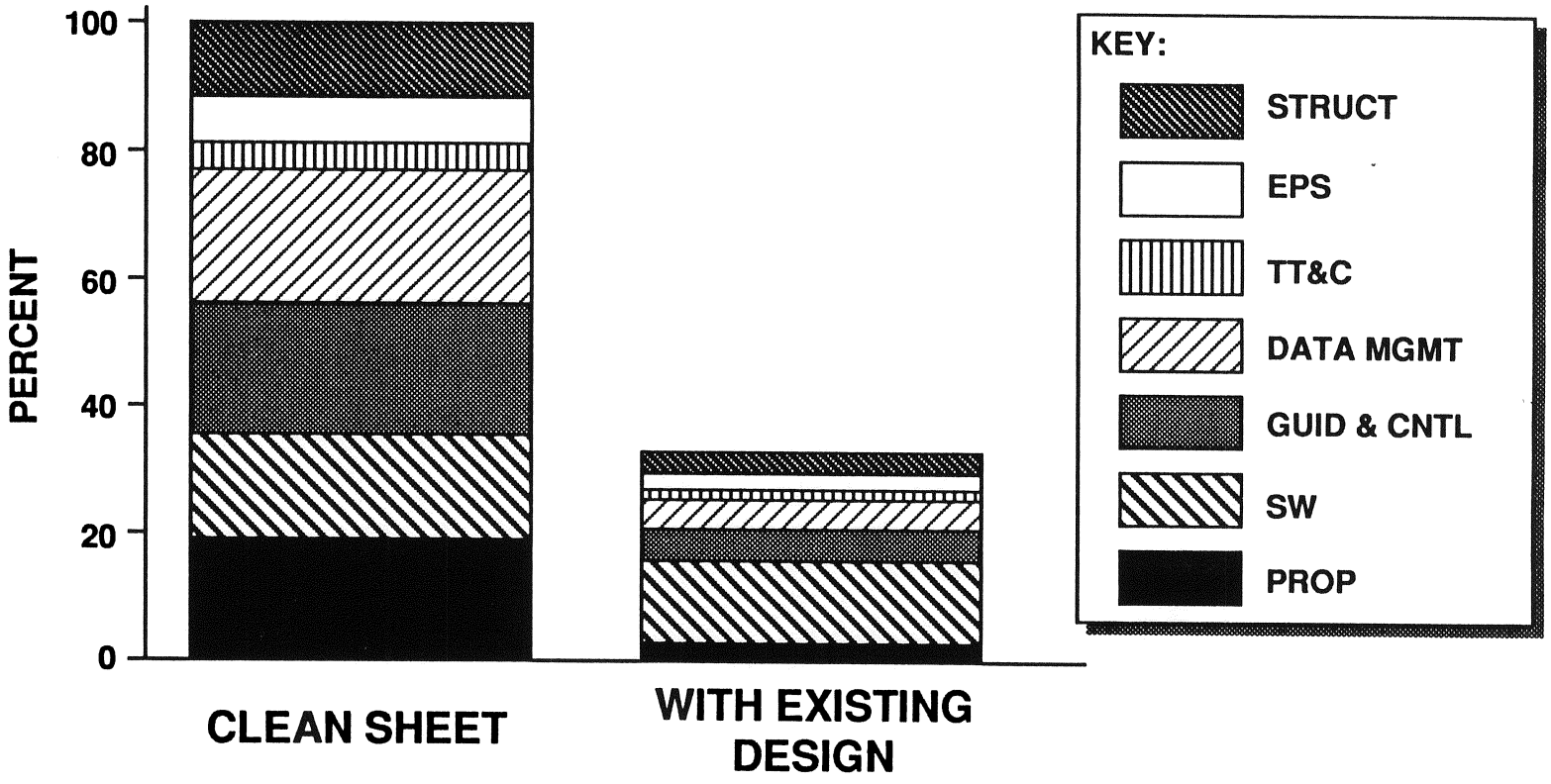


SCHEDULE


CY 1991
1992
1993
1994
1995
1996
1997
1998
TECHNOLOGY STUDY
KEY TECHNOLOGY DEVELOPMENT
MISSION REQUIREMENTS STUDY / TRADES
PHASE B
PRR
DESIGN STUDIES
PROGRAM REQUIREMENTS / TRADES
TEST, DEMO & SIMS
BRIDGE PROGRAM
PHASE C / D
"MINIMUM CHANGE SCENARIO"
PDR
CDR
DESIGN
CTV DESIGN AND DEVELOPMENT
INITIATE LLP
BUILD & TEST
CTV PRODUCTION
INTEGRATION & ASSEMBLY
C.I.
SYSTEM TEST
"MODERATE CHANGE SCENARIO"
PDR
CDR
DESIGN
CTV DESIGN AND DEVELOPMENT
INITIATE LLP
BUILD & TEST
CTV PRODUCTION
INTEGRATION & ASSEMBLY
C.I.
SYSTEM TEST
LAUNCHES
LAUNCH SUPPORT
NOTES
■ MATURITY OF BUS 1 STRUCTURAL AND PROPULSION SYSTEM PROVIDES AMPLE SCHEDULE MARGIN FOR 1998 LAUNCH
■ OTHER REQUIRED TECHNOLOGIES ARE MATURE; SELECTED DEVELOPMENT MAY YIELD HIGH "RETURN ON INVESTMENT"
■ BUS 1 DOES NOT REQUIRE A STRUCTURAL TEST IF STRONGBACK IS USED FOR PAYLOAD MANIFESTING

TOTAL DEVELOPMENT SAVING

DDT&E ALLOCATION



USING EXISTING DESIGNS WILL RESULT IN UP TO 27 PERCENT REDUCTION IN TOTAL VEHICLE COST AND UP TO 72 PERCENT REDUCTION IN DDT&E COMPARED TO A CLEAN SHEET APPROACH IN CTV DEVELOPMENT

SUMMARY

BUS 1 PERFORMS THE KICKSTAGE AND CTV FUNCTIONS USING THE SAME VEHICLE

- AMPLE PROPULSIVE CAPABILITY FOR CTV + KICKSTAGE
- MINIMUM TECHNICAL, SCHEDULE, AND COST RISK
- AMPLE VOLUME FOR CTV AND HLLV EQUIPMENT
- EFFICIENT INTERFACE TO 15-FT DIAMETER PAYLOAD
- ESTABLISHED STS INTERFACES

LOCKHEED CONTINUES TO SUPPORT MSFC IN-HOUSE FEASIBILITY AND COST STUDIES

- REQUIREMENTS DEFINITION: CTV, KICKSTAGE, SSF INTERFACE
- KEY CONCEPT DEVELOPMENT / COST MODELING OF ALTERNATIVES
  - — CTV + KICKSTAGE COMBINATION
  - — REUSABLE vs EXPENDABLE
  - — PROXIMITY OPERATIONS / RENDEZVOUS CONCEPTS
  - — SSF INTERFACES
  - — PAYLOAD ACCOMMODATIONS / MANIFESTING
  - — NLS AVIONICS INTEGRATION

LAUNCH SITE PROCESSING

OUTLINE

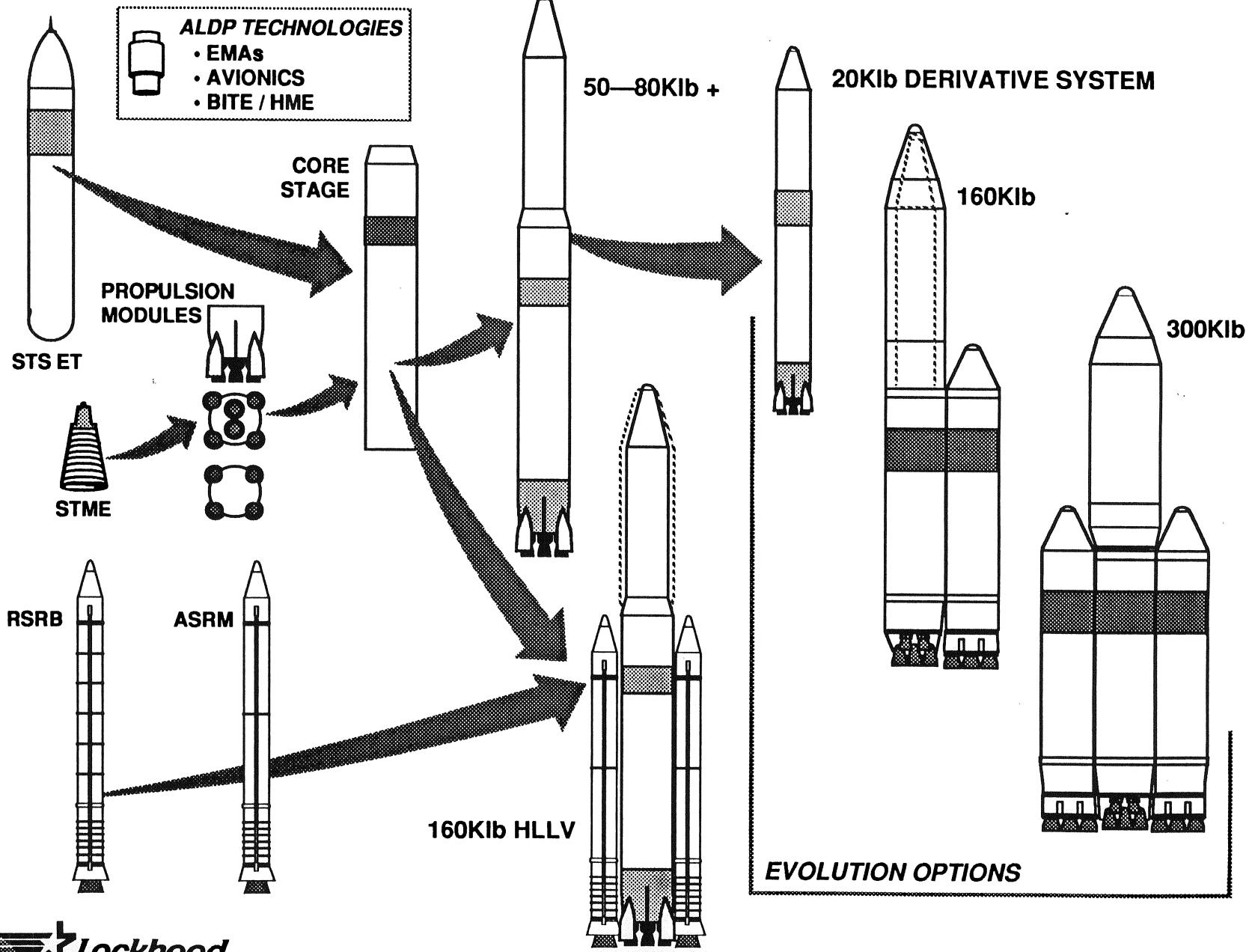
- NLS VEHICLE EVOLUTION
- TITAN-IV DERIVED SHROUD / BUS-1 KICKSTAGE / CTV

- CORE STAGE INTEGRATION — PROCESSING OPTIONS
- SCHEDULING METHODOLOGIES
- CORE VEHICLE INTEGRATION TIMELINES
- NLS INTEGRATED PROCESSING SCENARIO
- STS 1993+ INTEGRATED PROCESSING TIMELINE (GOAL)
- NLS INTEGRATED PROCESSING TIMELINES

- NLS FLIGHT ELEMENT PROCESSING — ACTIVITIES AND TECH MANHOURS
- NLS / STS FLIGHT ELEMENT PROCESSING — TOTAL MANHOUR COMPARISON

- LOCKHEED LAUNCH SITE OBSERVATIONS

VEHICLE EVOLUTION



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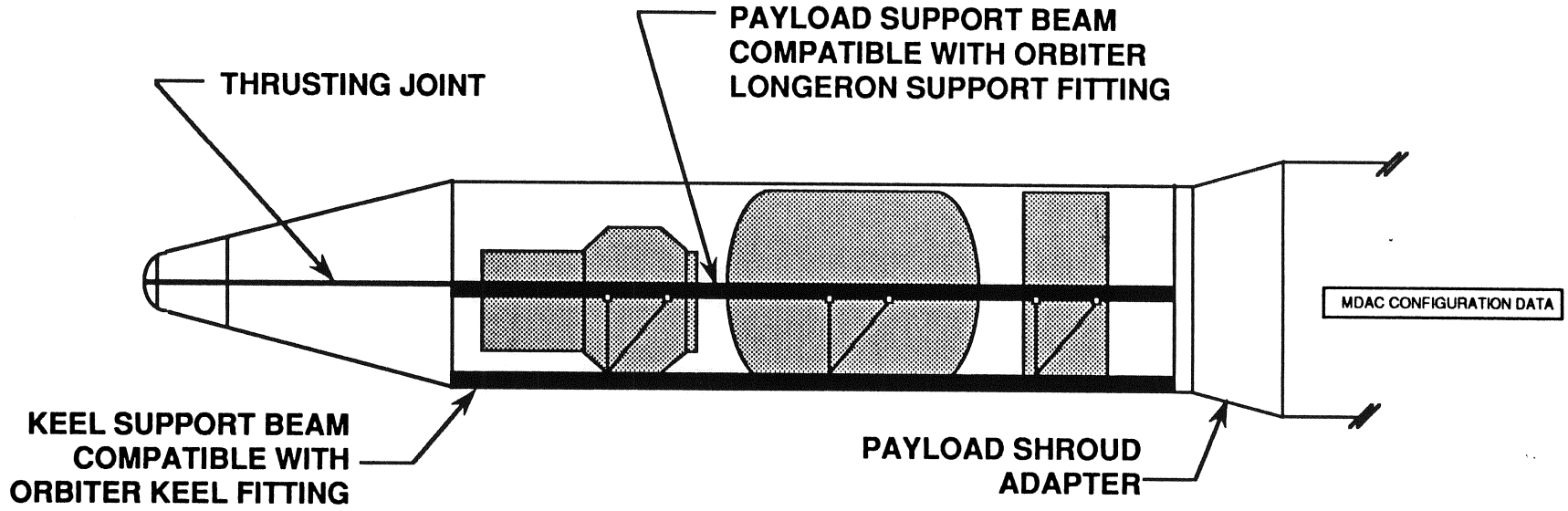
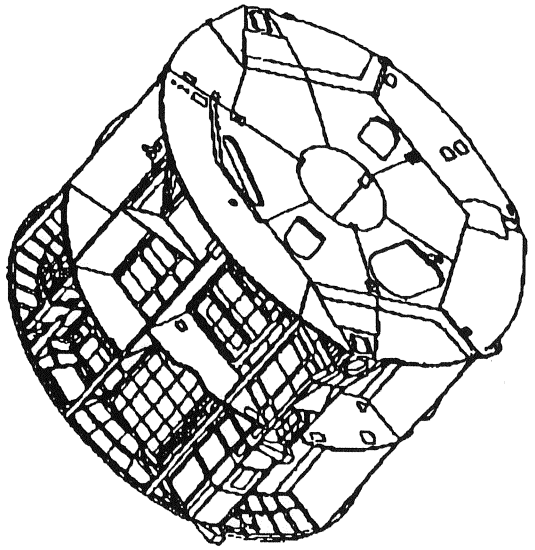
COMPETITION SENSITIVE

TITAN-IV DERIVED PAYLOAD SHROUD (HLLV)



BUS 1 KICKSTAGE / CTV

- BUS-1 SERVES AS CTV *AND* KICKSTAGE
- SAVES **$100M** COST OF SEPARATE CTV PROCESSING FACILITY
- SAVES APPROXIMATELY **$30M** COST OF 2 SEPARATE STAGES



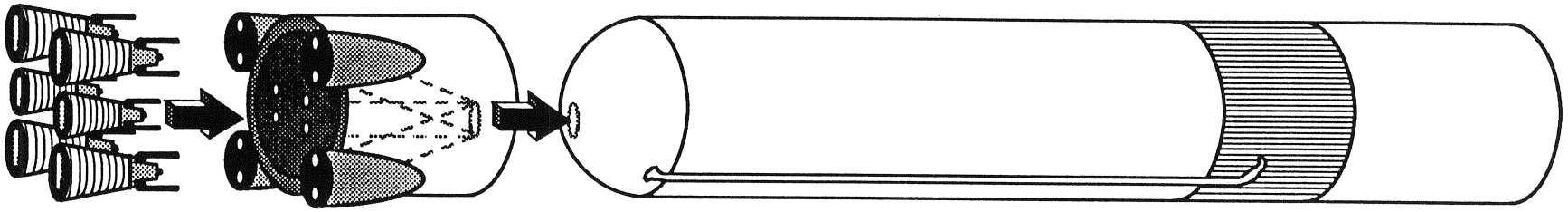
NLS LAUNCH SITE FACILITY OPTIONS

FLIGHT ELEMENT	PROCESSING FACILITY OPTION
PROPULSION MODULE	• NEW PROPULSION MODULE PROCESSING FACILITY • NEW CORE ASSEMBLY / PROCESSING FACILITY • EXISTING VAB HIGHBAY OR LOWBAY
CORE STAGE	• NEW CORE ASSEMBLY / PROCESSING FACILITY • EXISTING VAB HIGHBAY
ADAPTER	• NEW CARGO INTEGRATION FACILITY • NEW CORE ASSEMBLY / PROCESSING FACILITY • VAB LOWBAY • SMAB* • VIF*
SHROUD	• NEW CARGO INTEGRATION FACILITY • VPF (< 60 FT, < 60 Klb)
STRONGBACK	• NEW CARGO INTEGRATION FACILITY (VERTICAL) • SSPF (HORIZONTAL)
KICKSTAGE, CTV	• NEW SHARED vs SEPARATE HAZARDOUS PROCESSING FACILITIES • SAEF-2 • ESA-60 • RSRB RPSF • HMF
PAYLOADS	• EXISTING KSC, CCAFS vs NEW FACILITIES (e.g., SSPF)
INTEGRATED VEHICLE LAUNCH	• LC-39A/B • LC-34 / 37 • LC-40 / 41*

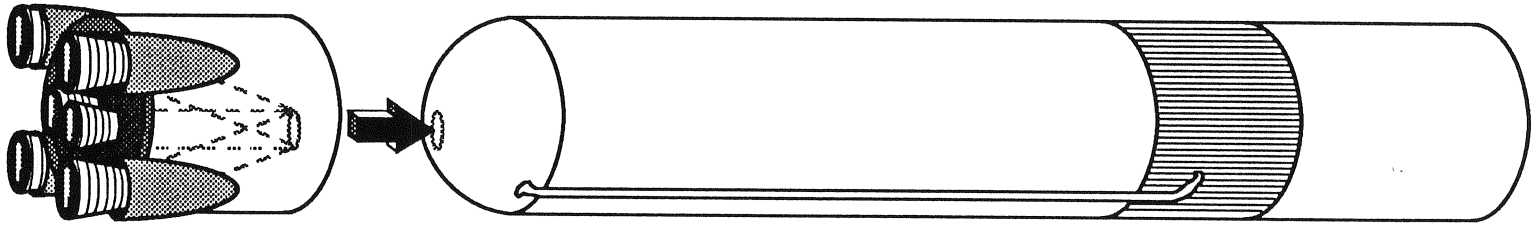
* ASSUMES 1.5 STAGE VEHICLE REPLACES TITAN-IV

CORE STAGE INTEGRATION — LAUNCH PROCESSING OPTIONS

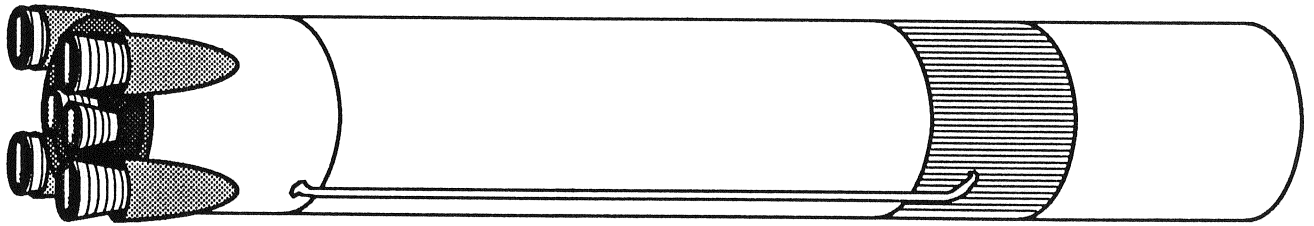
OPTION 1



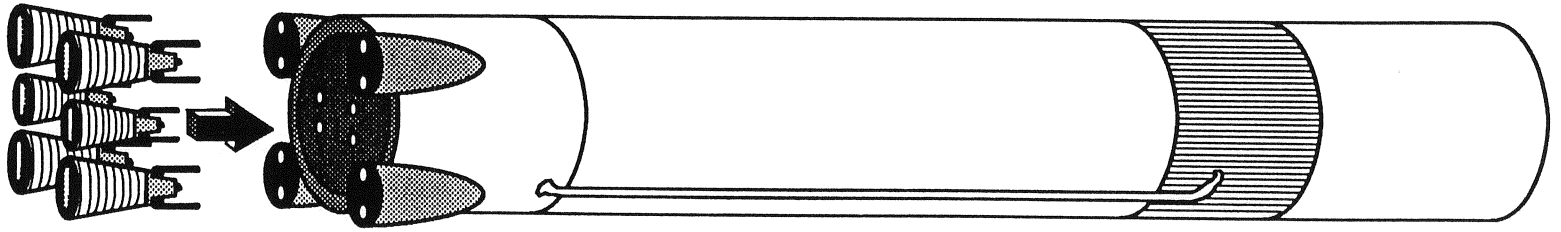
OPTION 2



OPTION 3



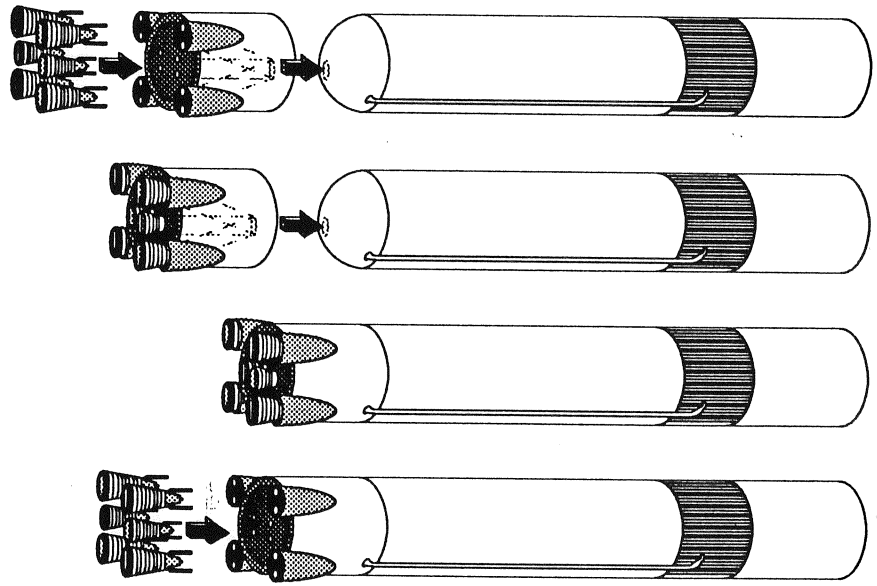
OPTION 4



CORE STAGE INTEGRATION — LAUNCH PROCESSING OPTIONS (cont'd)

- **CORE INTEGRATION SCHEDULES FOR OPTIONS 1, 2, AND 3 HAVE BEEN EVALUATED ON A PRELIMINARY BASIS; OPTION 4 EVALUATION IN PROGRESS**

- **CORE STAGE CONFIGURATION SELECTION CRITERIA:**
  - **— INTERFACE COMPLEXITY / CONTROL**
  - **— CHECKOUT REQUIREMENTS AT LAUNCH SITE**
  - **— CHECKOUT REQUIREMENTS AT MANUFACTURER(S)**
  - **— DUPLICATION OF CHECKOUT ("SHIP-AND-SHOOT" SUCCESS LIMITED TO DATE)**
  - **— MISSION FLEXIBILITY**
  - **— EVOLUTION OF PROPULSION MODULE TO RECOVERABLE P/A MODULE**
  - **— AVIONICS ARCHITECTURE**

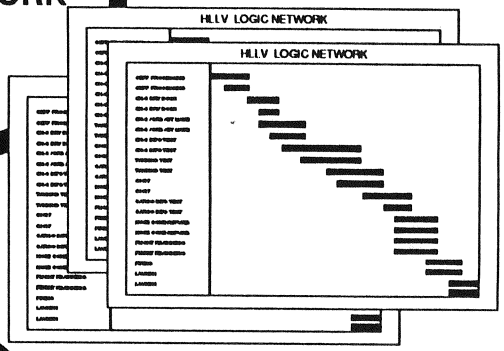


SCHEDULING METHODOLOGY

STS PROCESSING DATA

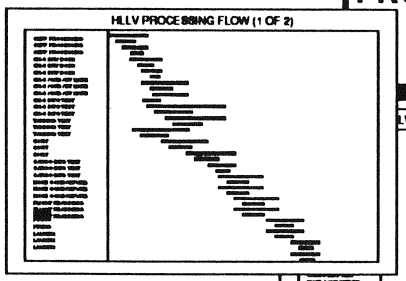
PROCESS ENGINEERING / CAPSS* ANALYSIS

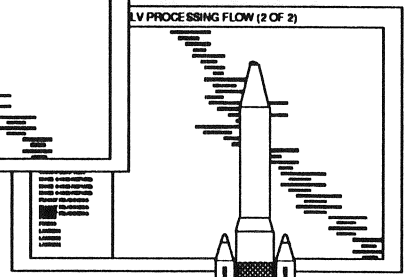
STS-DERIVED LOGIC NETWORK ACTIVITY RESOURCES



DATA ANALYSIS

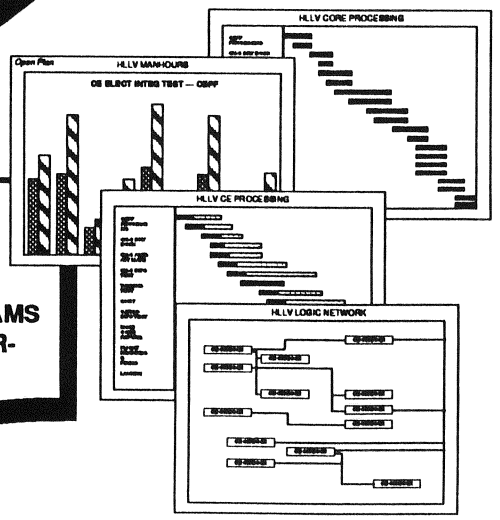
HLLV FLIGHT ELEMENT PROCESSING FLOW ITERATION





HLLV FLIGHT ELEMENTS

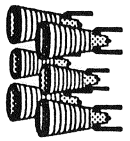
- LOGIC NETWORKS
- WATERFALL DIAGRAMS
- ACTIVITY FLOAT BAR-CHART
- MANHOURS



* COMPUTER AIDED PLANNING AND SCHEDULING SYSTEM

OPTION 1 CORE VEHICLE INTEGRATION TIMELINE

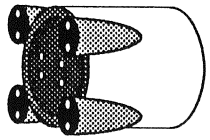
STME CHECKOUT — 22 DAYS



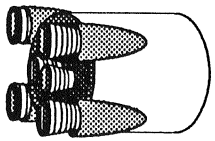
6 ENGINES = 55 DAYS

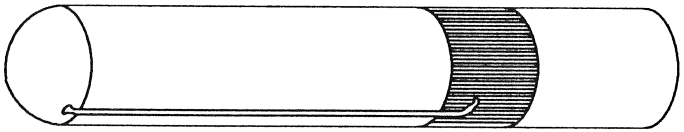
4 ENGINES = 50 DAYS

PM CHECKOUT — 22 DAYS



INTEGRATED PM OPS — 17 DAYS

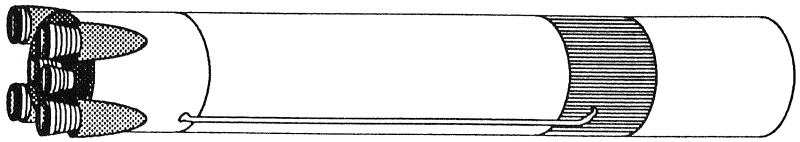




17 DAYS

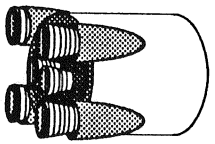
CORE CHECKOUT

INTEGRATED CORE VEHICLE OPS — 16 DAYS

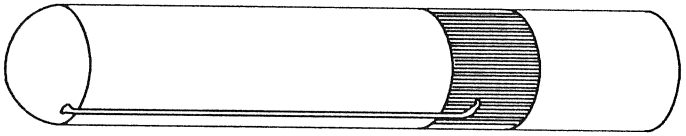


OPTION 2 CORE VEHICLE INTEGRATION TIMELINE

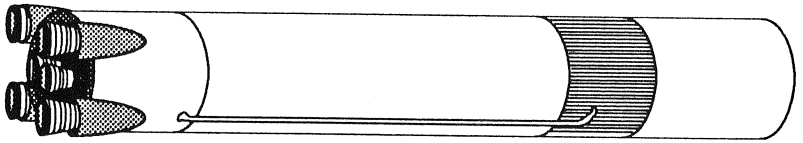
INTEGRATED PM OPS — 21 DAYS



CORE CHECKOUT — 17 DAYS



INTEGRATED CORE VEHICLE OPS — 16 DAYS

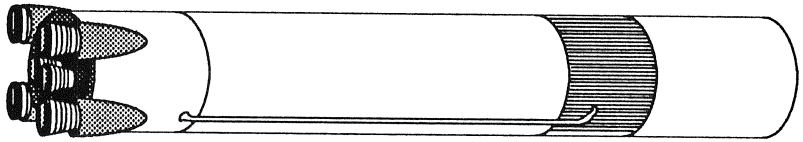


6 ENGINES = 37 DAYS

4 ENGINES = 34 DAYS

OPTION 3 CORE VEHICLE INTEGRATION TIMELINE

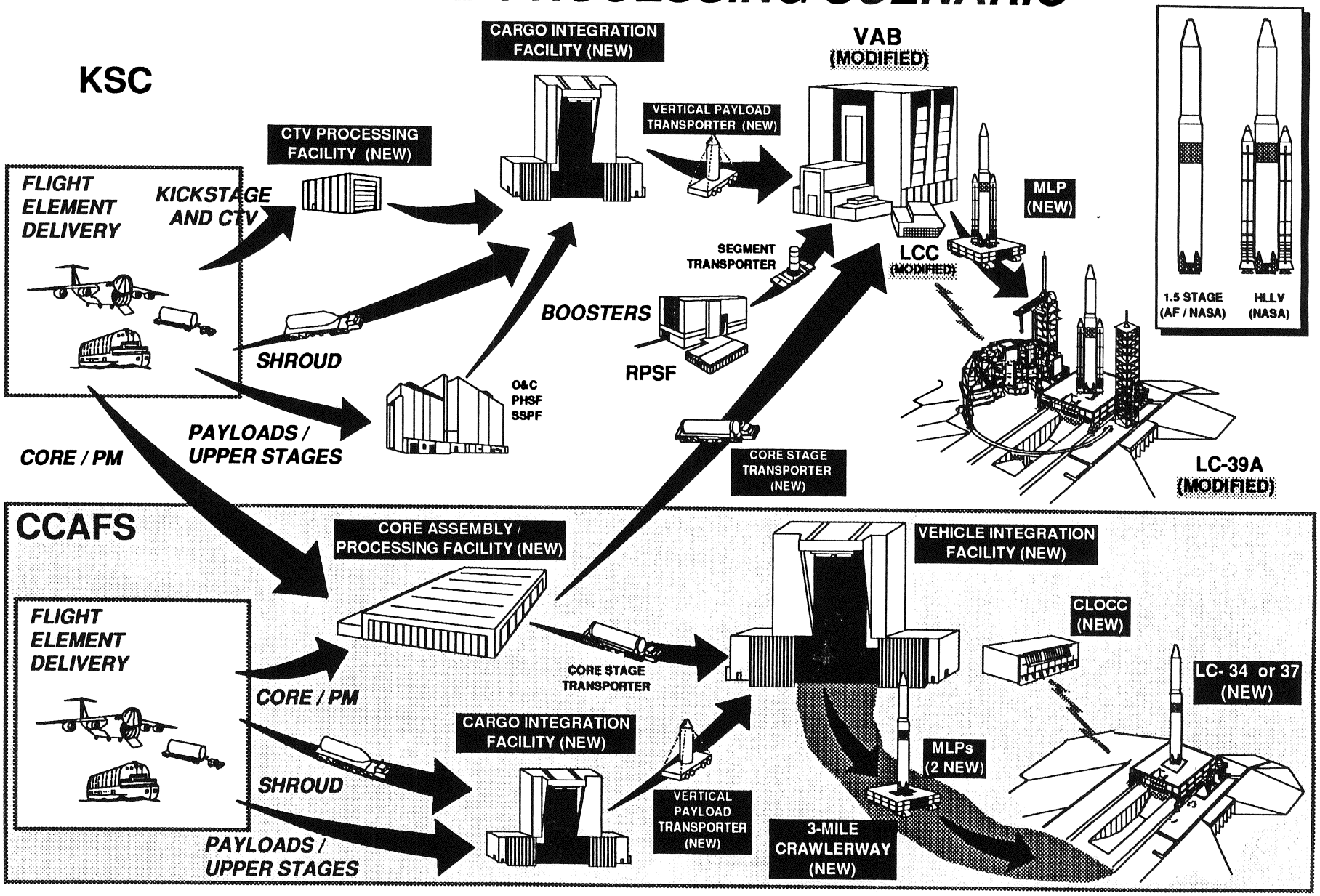
INTEGRATED CORE VEHICLE OPS — 24 DAYS



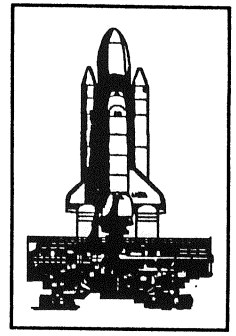
6 ENGINES = 24 DAYS

4 ENGINES = 21 DAYS

NLS INTEGRATED PROCESSING SCENARIO



STS 1993+ INTEGRATED PROCESSING TIMELINE (GOAL)



OPF OPS

60 — ORBITER PROCESSING

ORBITER MOVE TO VAB

VAB OPS

ET CHECKOUT — 26

ET MATE

13 — ET/SRB MATE AND CLOSEOUT

ASRM STACKING AND CLOSEOUT — 3 — 24

BEGIN MLP OPS

5 — VEHICLE INTEGRATED OPS

23 — RPSF OPS

MOVE TO PAD

LAUNCH

PAD OPS — 20

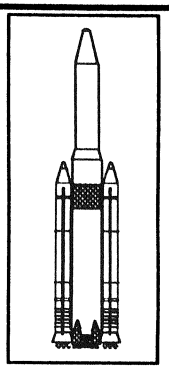
85 DAYS

PROCESSING DAYS (3 SHIFTS/DAY)

PROCESSING DAYS (2 SHIFTS/DAY)

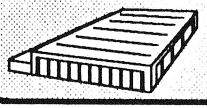
HLLV BASELINE PROCESSING TIMELINE

PRELIMINARY

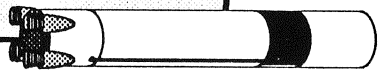


CORE ASSEMBLY / PROCESSING FACLITY OPS

21 — CORE PROCESSING / CHECKOUT



4-ENGINE CORE

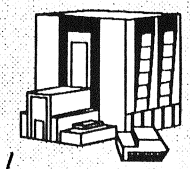


MOVE CORE TO VAB

VAB OPS

BEGIN MLP OPS

13 — CORE /BOOSTER MATE / CLOSEOUT

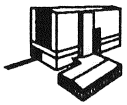


ASRM STACKING AND CLOSEOUT — 3 — 24

5 — MATE PAYLOAD / INTEGRATED CHECKOUT

RPSF OPS

ASRM PROCESSING — 23



MOVE PAYLOAD TO VAB

MOVE TO PAD

PAYLOAD OPS

KICKSTAGE / CTV PROCESSING FACILITIES

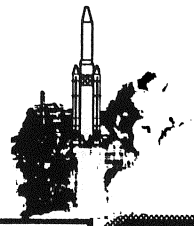
KICKSTAGE / CTV PROCESSING — XXX

PAYLOAD ENCAPSULATION FACILITY

PAYLOAD ENCAPSULATION — XXX

PAYLOAD PROCESSING FACILITY

PAYLOAD PROCESSING* — XXX



PAD OPS

14

79 DAYS

PROCESSING DAYS (7/3 SHIFTING)

* POTENTIAL CRITICAL PATH ITEM

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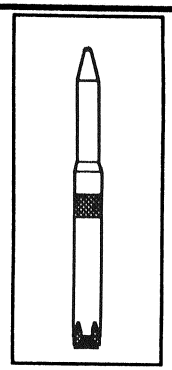
COMPETITION SENSITIVE

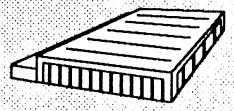
1.5 STAGE INTEGRATED PROCESSING TIMELINE

PRELIMINARY

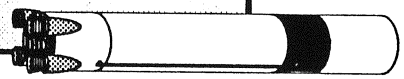


CORE ASSEMBLY / PROCESSING FACILITY OPS

24 — CORE PROCESSING / CHECKOUT



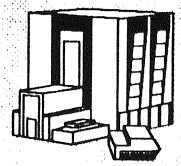
6-ENGINE CORE



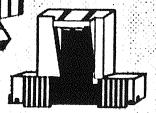
MOVE CORE TO VAB

VAB (OR VIF) OPS

4 — CORE MATE TO MLP / CLOSEOUTS



5 — MATE PAYLOAD / INTEGRATED CHECKOUT



PAYLOAD OPS

MOVE PAYLOAD TO VAB

MOVE TO PAD

KICKSTAGE / CTV OR UPPER STAGE PROCESSING FACILITIES

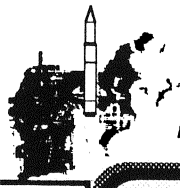
KICKSTAGE / CTV / UPPER STAGE PROCESSING — XXX

PAYLOAD ENCAPSULATION FACILITY

PAYLOAD ENCAPSULATION — XXX

PAYLOAD PROCESSING FACILITY

PAYLOAD PROCESSING* — XXX



LAUNCH

PAD OPS

14

47 DAYS

PROCESSING DAYS (7/3 SHIFTING)

* POTENTIAL CRITICAL PATH ITEM

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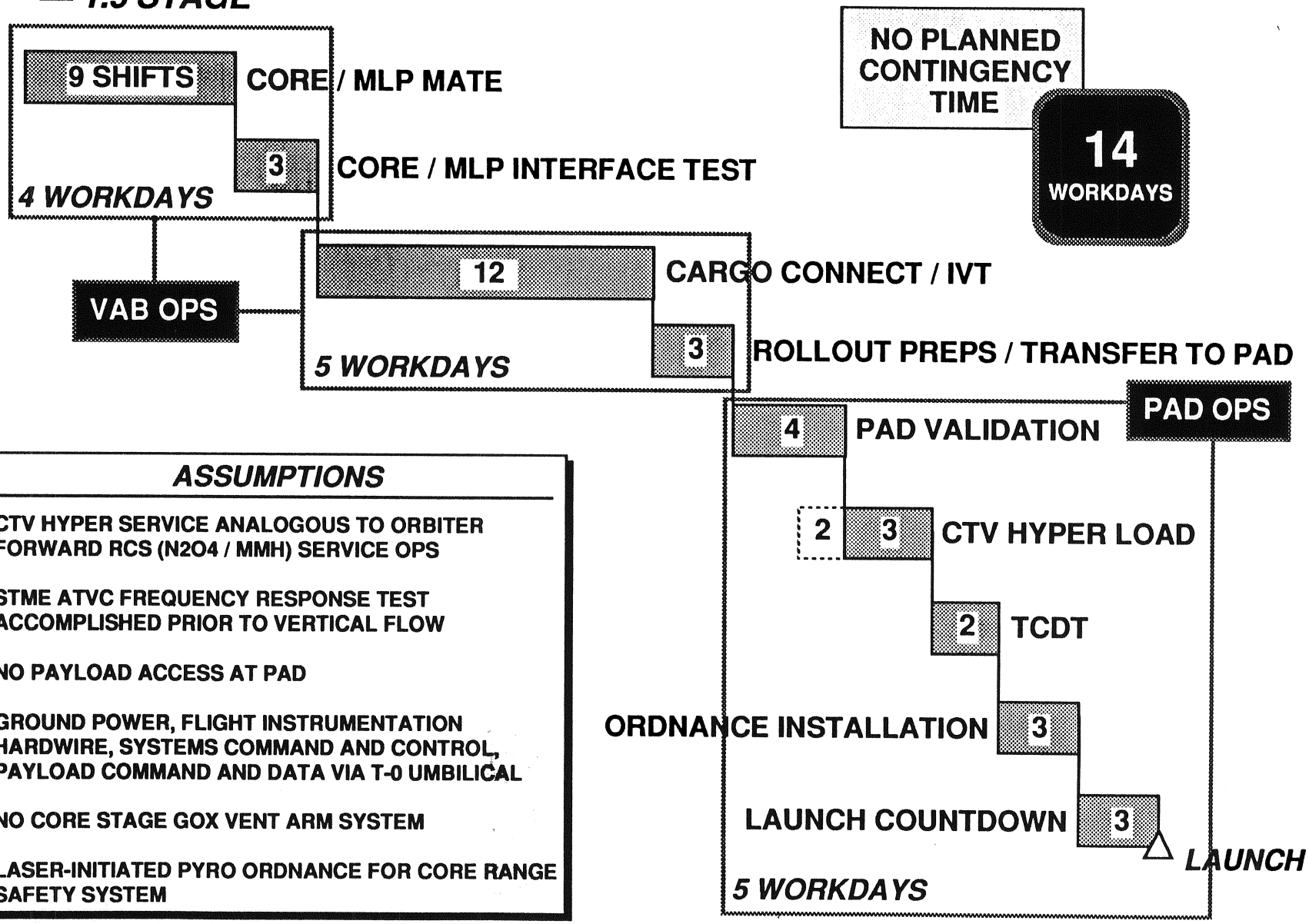
ACCELERATED INTEGRATED LAUNCH OPERATIONS FLOW ASSESSMENT — 1.5 STAGE



ASSUMPTIONS

- CTV HYPER SERVICE ANALOGOUS TO ORBITER FORWARD RCS (N_2O_4 / MMH) SERVICE OPS
- STME ATVC FREQUENCY RESPONSE TEST ACCOMPLISHED PRIOR TO VERTICAL FLOW
- NO PAYLOAD ACCESS AT PAD
- GROUND POWER, FLIGHT INSTRUMENTATION HARDWIRE, SYSTEMS COMMAND AND CONTROL, PAYLOAD COMMAND AND DATA VIA T-0 UMBILICAL
- NO CORE STAGE GOX VENT ARM SYSTEM
- LASER-INITIATED PYRO ORDNANCE FOR CORE RANGE SAFETY SYSTEM

ACCELERATED 1.5 STAGE CARGO CHANGEOUT ASSESSMENT (17 DAYS SCRUB TO LAUNCH)

4 WORKDAYS VEHICLE SAFING / ROLLBACK TO VAB

△ LAUNCH READY

3 REMOVE CARGO / SHROUD

△ REPLACEMENT CARGO READY

4 INSTALL NEW CARGO / IVT

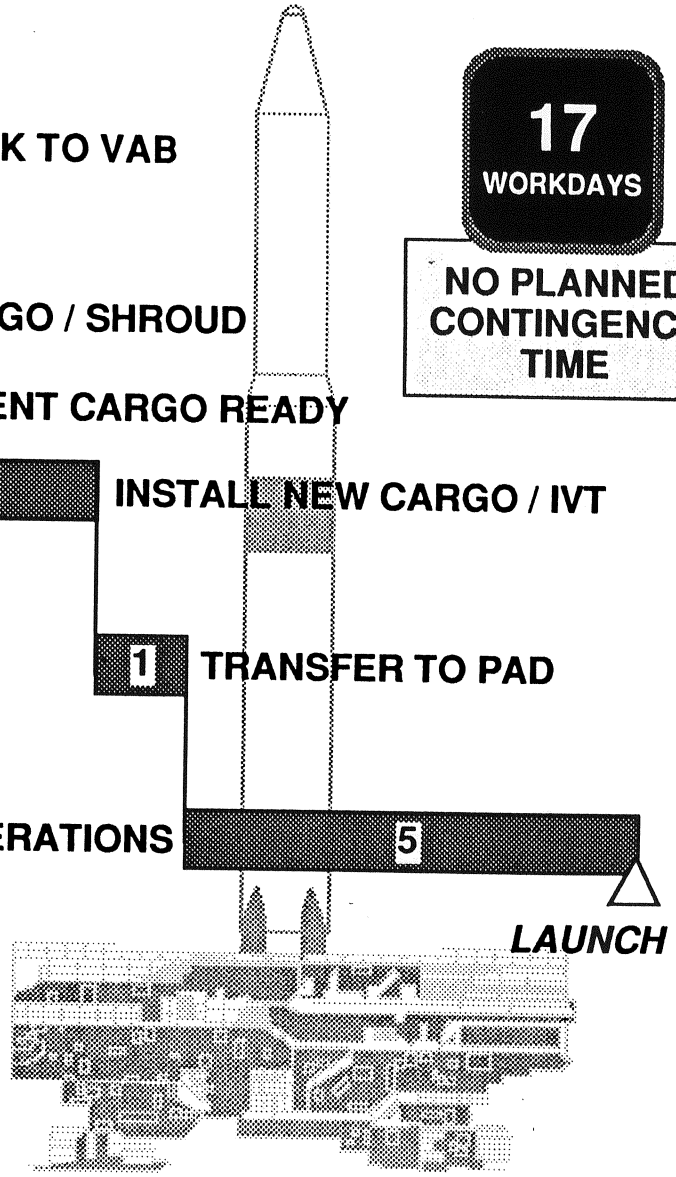
1 TRANSFER TO PAD

PAD OPERATIONS **5**

△ LAUNCH

17 WORKDAYS

NO PLANNED CONTINGENCY TIME

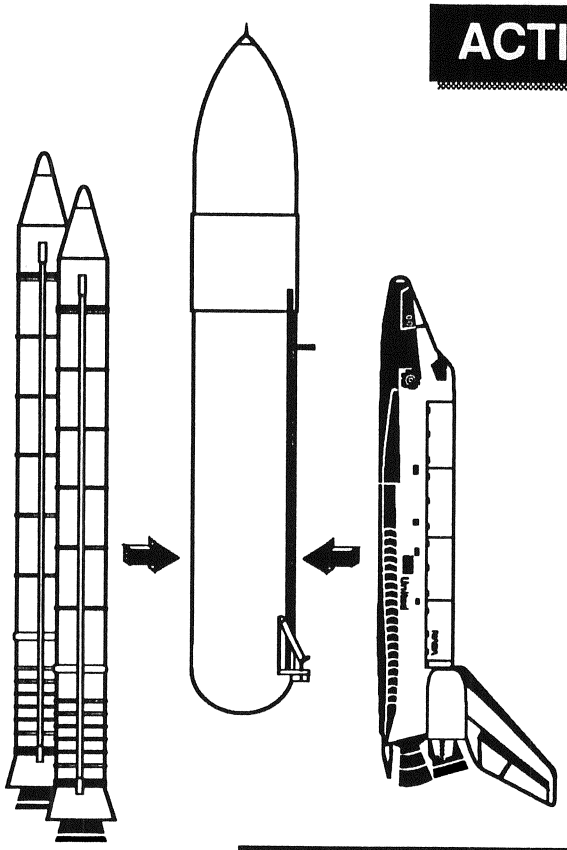


NOTES

- MISSION-UNIQUE ENGINEERING FOR PATCH RACKS AVAILABLE 6 DAYS FROM DECISION
- CORE (NEW MISSION) FLIGHT MEMORY LOAD AVAILABLE 9 DAYS FROM DECISION
- REPLACEMENT ENCAPSULATED CARGO AVAILABLE AND AT VAB WITHIN 7 DAYS FROM DECISION
- LCC TCID FOR NEW MISSION IS AVAILABLE 7 DAYS FROM DECISION
- NO CORE VEHICLE CARGO SUPPORT SYSTEM RECONFIG REQUIRED (STANDARD CARGO SERVICES AND INTERFACES)

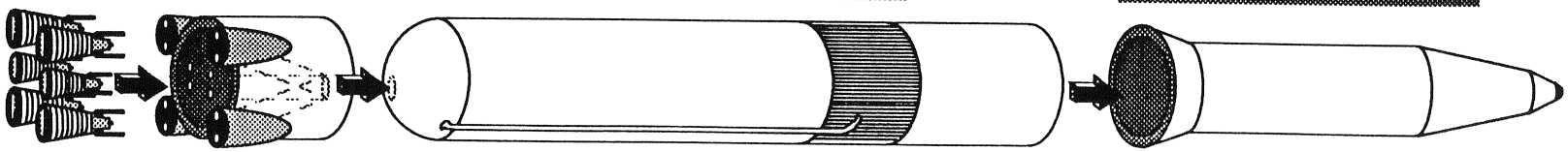
NLS FLIGHT ELEMENT PROCESSING

ACTIVITIES AND TECHNICIAN MANHOURS



SRB ACTIVITIES ARE EQUIVALENT FOR STS AND HLLV

	STS	NLS
ORBITER (OPF)	361 ACTIVITIES 35,483 TECH MHrs	CARGO ELEMENT 26 ACTIVITIES 2,679 TECH MHrs
ET (VAB)	50 ACTIVITIES 6,440 TECH MHrs	KICKSTAGE * 25 ACTIVITIES 1,287 TECH MHrs
CORE / PM		176 ACTIVITIES 16,062 TECH MHrs
TOTAL ACTIVITIES	411	227
TOTAL TECHNICIAN MHrs	41,923	20,028



*HMF PROCESSING MANHOURS EXCLUDED

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NLS FLIGHT ELEMENT PROCESSING (cont'd)

PRELIMINARY

■ QUESTION: *HOW WOULD AN HLLV OR 1.5 STAGE VEHICLE COMPARE TO STS IF IT WERE PROCESSED TODAY?*

TOTAL MANHOUR COMPARISONS

ELEMENT	STS-36 (MHrs)	HLLV (MHrs)		1.5 STAGE (MHrs)	
SRB BUILDUP	20,000 ①	20,000 ①		—	
SRB STACKING	33,488 ①	33,488 ①		—	
ET STAND-ALONE	15,092 ①	—		—	
ORBITER ③	212,583 ①	—		—	
ET (OR CORE) / SRB (OR ASRM) MATE & CLOSEOUT	37,292 ①	37,292 ①		—	
VAB INTEGRATED OPS	10,655 ①	10,655 ①		10,655	
PAD INTEGRATED OPS	77,652 ①	31,061		31,061	
KICKSTAGE	—	6,911 ②		6,911 ②	
CARGO ELEMENT	—	14,386 ②		14,386 ②	
CORE / PM	—	OPTION 1 86,253	OPTION 3 37,638	OPTION 1 86,253	OPTION 3 37,638
TOTAL MANHOURS	406,762	240,046	191,431	149,266	100,651

① LSOC PROGRAM CONTROLS STS-36 ACTUAL MHrs

② APPLIED SPC SUPPORT RATIO TO TECH MHrs

③ EXCLUDES LANDING AND RECOVERY OPS FOR COMPARISON PURPOSES

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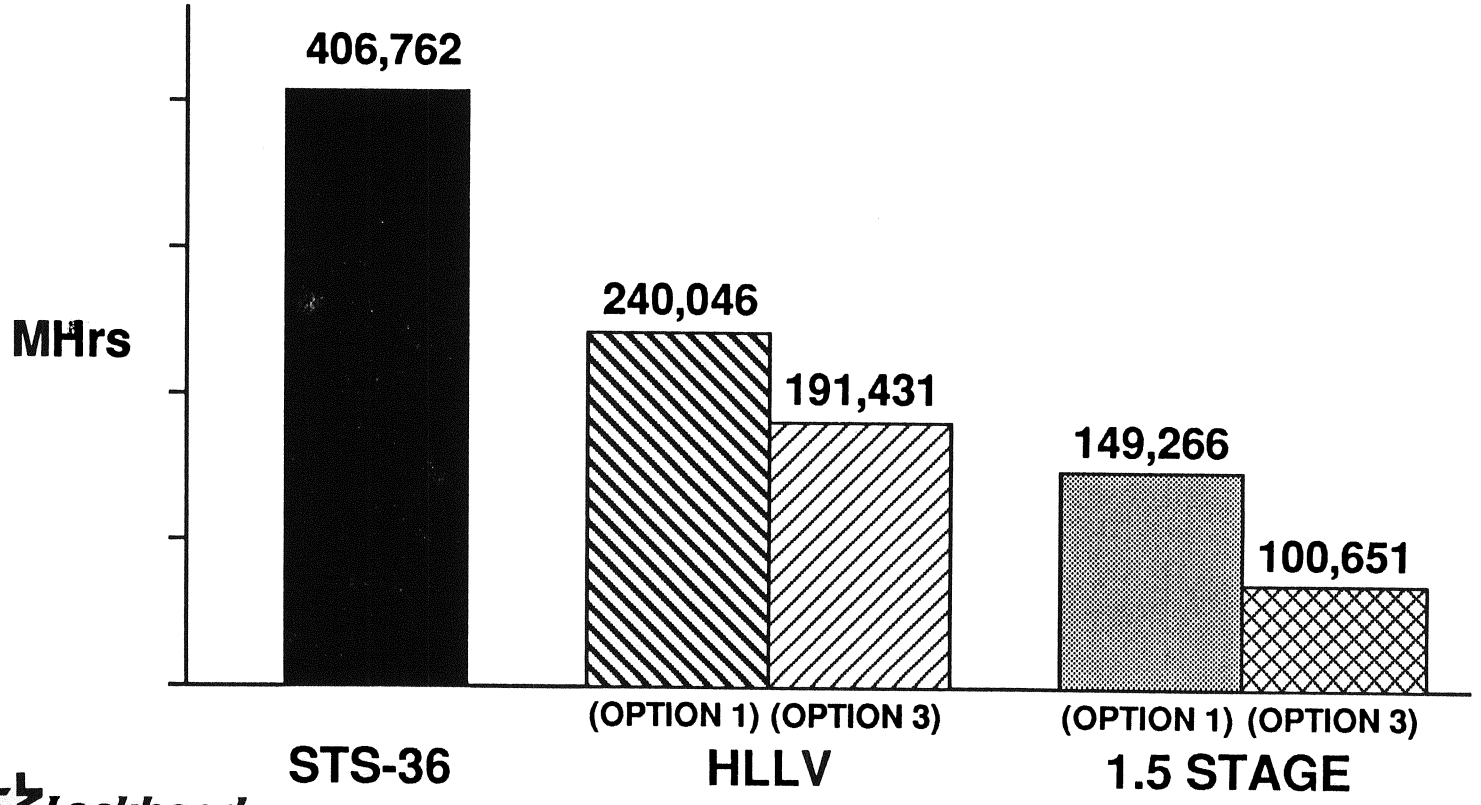
COMPETITION SENSITIVE

NLS FLIGHT ELEMENT PROCESSING (cont'd)

TOTAL MANHOUR COMPARISONS (cont'd)

PRELIMINARY

- **ANSWER:**
  - *1.5 STAGE REQUIRES AS FEW AS 25% OF TOTAL STS MANHOURS*
  - *HLLV REQUIRES AS FEW AS 47% OF TOTAL STS MANHOURS*



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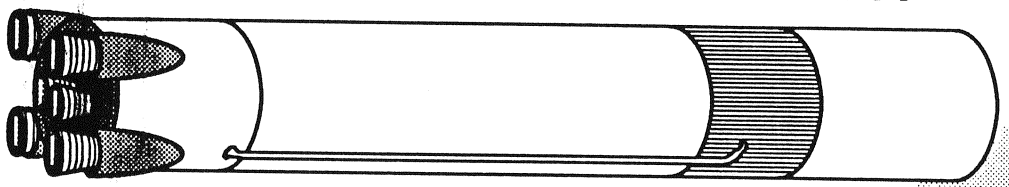
COMPETITION SENSITIVE

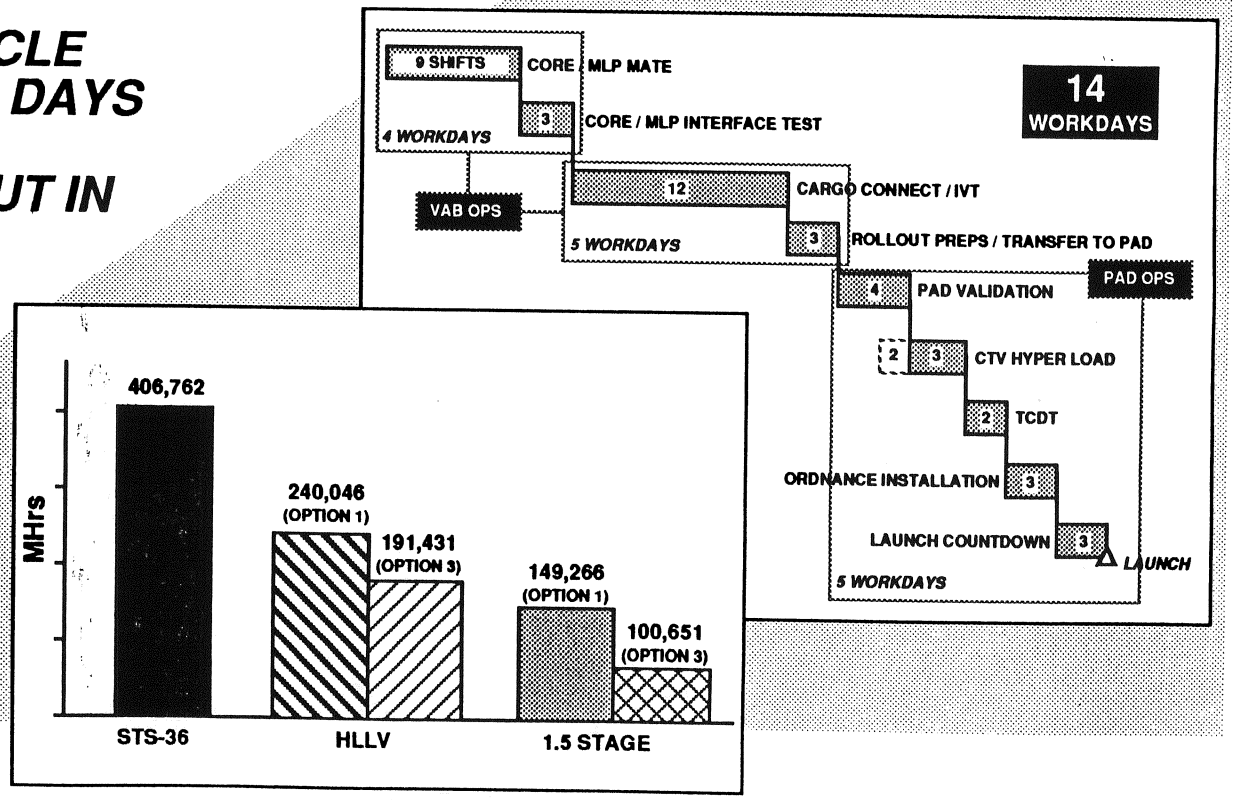
LOCKHEED LAUNCH SITE OBSERVATIONS

- **FOR MINIMUM LAUNCH SITE FLOW TIME, AN INTEGRATED CORE / PROPULSION MODULE IS PREFERRED . . .**



. . . BUT AN INTEGRATED PROGRAM ASSESSMENT IS ESSENTIAL TO AVOID SUB-OPTIMIZATION

- **INTEGRATED VEHICLE OPERATIONS IN 14 DAYS**
- **CARGO CHANGEOUT IN 17 DAYS**
- **HLLV AND 1.5 STAGE PROCESSING MANHOURS SIGNIFICANTLY LESS COMPARED TO STS**



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COMPETITION SENSITIVE

SUMMARY

BASELINE CORE SENSITIVITY

BASELINE CORE CONFIGURATIONS ARE EXTREMELY SENSITIVE TO T_{STME} , MR_{STME} , AND MF_{CORE}

BUS 1 ADVANTAGES

BUS 1 PERFORMS KICKSTAGE AND CTV FUNCTIONS USING THE SAME STAGE WITH 13.4 % PROPELLANT MARGIN

INTEGRATED CORE / PROPULSION MODULE EFFICIENCIES

A FACTORY-INTEGRATED CORE / PROPULSION MODULE REDUCES LAUNCH SITE FLOW BY 40% (31 DAYS) AND LABOR HOURS BY 32%

CORE STAGE LAUNCH PROCESSING

CORE STAGE TURNAROUND (LAUNCH-READY TO LAUNCH-READY) WITH NEW PAYLOAD REQUIRES 17 WORKDAYS; HANGAR-READY TO LAUNCH-READY REQUIRES 14 WORKDAYS

PLUME HEATING

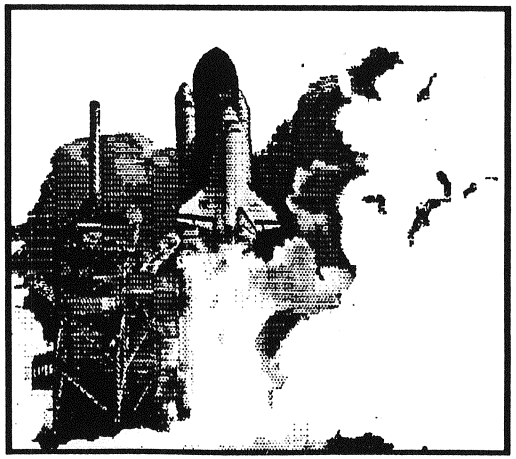
PLUME HEATING ANALYSIS IS A KEY FACTOR IN THE DESIGN OF ENGINE SPACING, EXIT PLANE / GIMBAL PLANE POSITION, FEEDLINE LAYOUT, TANK BOTTOM LOCATION, AND HEAT SHIELDING WEIGHT

Al-Li MAY HAVE A ROLE IN NLS

LOCKHEED IS THE FREE WORLD'S LARGEST USER OF ALUMINUM LITHIUM (APPROXIMATELY 500,000 LB / YEAR) AND HAS FABRICATED AND FLOWN MAJOR Al-Li SPACE STRUCTURES FOR 5 YEARS

LASER-INITIATED ORDNANCE SUPPORTS LAUNCH-ON-NEED AND REDUCES LAUNCH SITE LABOR HOURS

LOCKHEED HAS A $4 M / 4 YEAR TECHNOLOGY DEMO PROGRAM WITH USAF PHILLIPS LABORATORY



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