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Common Lunar Lander

Engineering Study Results

Presentation to Aaron Cohen

September 17, 1991

by

Jonette Stecklein

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CLL Engineering Study: Results

- CLL Engineering Study
- CLL Mission
- Options
- CLL Team & Supporters

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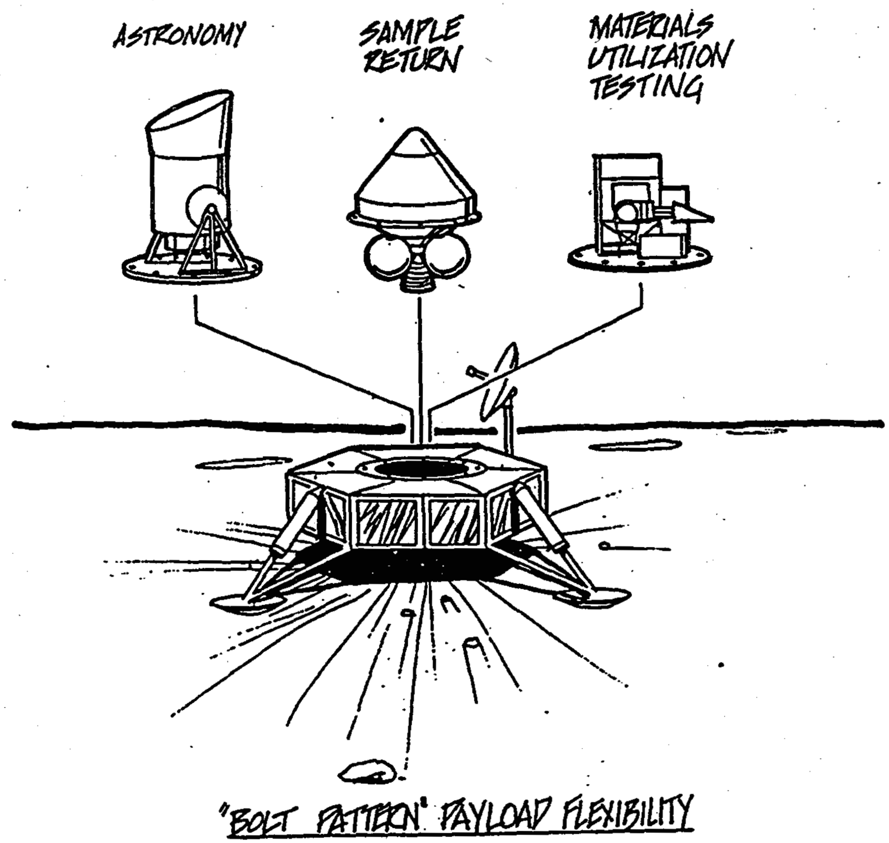
Mission

Provide a delivery system to soft-land a 200 kg payload set at any given Lunar latitude and longitude.



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CLL Engineering Study

Objective : Perform a feasibility study of the CLL concept

Approach : Point design of lunar lander + Overall system trades

Products : Requirements for delivery system
(launch vehicle, lander, payload i/f, mission op.)
Completion and documentation of major system trades
Lunar lander conceptual design and drawings
Subsystem design and characterization (lunar lander)
Cost estimates at the subsystem level (lunar lander)

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J. Stecklein
9/16/91

Common Lunar Lander Engineering Study Schedule

Month	Mon.	Tues.	Wed.	Thurs.	Fri.
July 1991			KICKOFF MTG 17	18	19
	22	23	24	25	1ST TEAM INPUT 26
	29	30	31	1	2
August 1991	5	Team Mtg 6	7	8	Power rqmts to Betsy 9
	12	Team Mtg 13	LAUNCH VEHICLE CHOSEN 14	PAYLOAD INTEGRATION COMPLETED → 15	Subsystem Chosen 16
	LANDER ARCHITECTURE COMPLETED 19 ← SUBSYSTEM INTEGRATION →	Team Mtg 20	21	Dry Run 22	SENIOR BOARD REVIEW 23
	26	Team Mtg 27	28	29	Trip to D.C. 30
September 1991	Holiday	3	Team Mtg 4	5	Subsystem Charac to Jonette 6
	← 9	Team Mtg 10 SUBSYSTEM INTEGRATION →	11	12	Dry Run 13
	16	COHEN 2 - 4 pm B.1; Rm 945 17	9 weeks from Study Kickoff		

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Mission Goals and Requirements

GUIDELINES		SYSTEM DRIVERS
- Small, simple, cheap, & quick	→	① Cost ② Schedule ③ Performance

Earth Launch

- Use existing launch vehicle (medium class)
- First flight: Nov. 1996
- 2 to 5 flights/year for 20 years

Lander

- Lander provides no services to the payload (other than landing)
- Lander is active until touchdown + time to telemeter landing information
- Design loads and limits are constrained by launch vehicle, not by lander system
- Budget: $30 million/each for Lander hardware (recurring cost)

Payload Imposed Requirements

- Provide unobstructed hemispherical view of the sky
- Do not preclude payload access to lunar surface OR payload dismount
- Do not preclude payload return to Earth (Sample Return Mission)

Lander Subsystems

- Emphasis on choosing existing system, rather than new design
- Subsystem hardware delivery by Oct. 1993 (now Oct. 1994)
- Strive for light weight solutions
- Avoid block redundancy when a single string system can provide adequate reliability

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CLL Reference Mission

- Payload set mated to pallet. CLL spacecraft built in parallel. Payload pallet and CLL spacecraft integrated (structural i/f only).
- CLL 2 stage spacecraft is launched by ELV using an east coast launch pad.
- LV places CLL in circular Earth orbit..
- CLL remains in Earth orbit for up to 1 rev.
- CLL Transfer Stage performs TLI.
- 5 day trip to moon.
- Transfer Stage performs LOI, into circular orbit about Moon.
- Up to 14 day wait in lunar orbit.
- Transfer Stage performs deorbit burn.
- Transfer Stage separates from Lander Stage.
- Lander performs descent and landing burns, targeting for a given lunar lat/long, and landing at lunar dawn.
- Lander transmits final system performance and landing location information to Earth. Sized for 1 hour lifetime on lunar surface.

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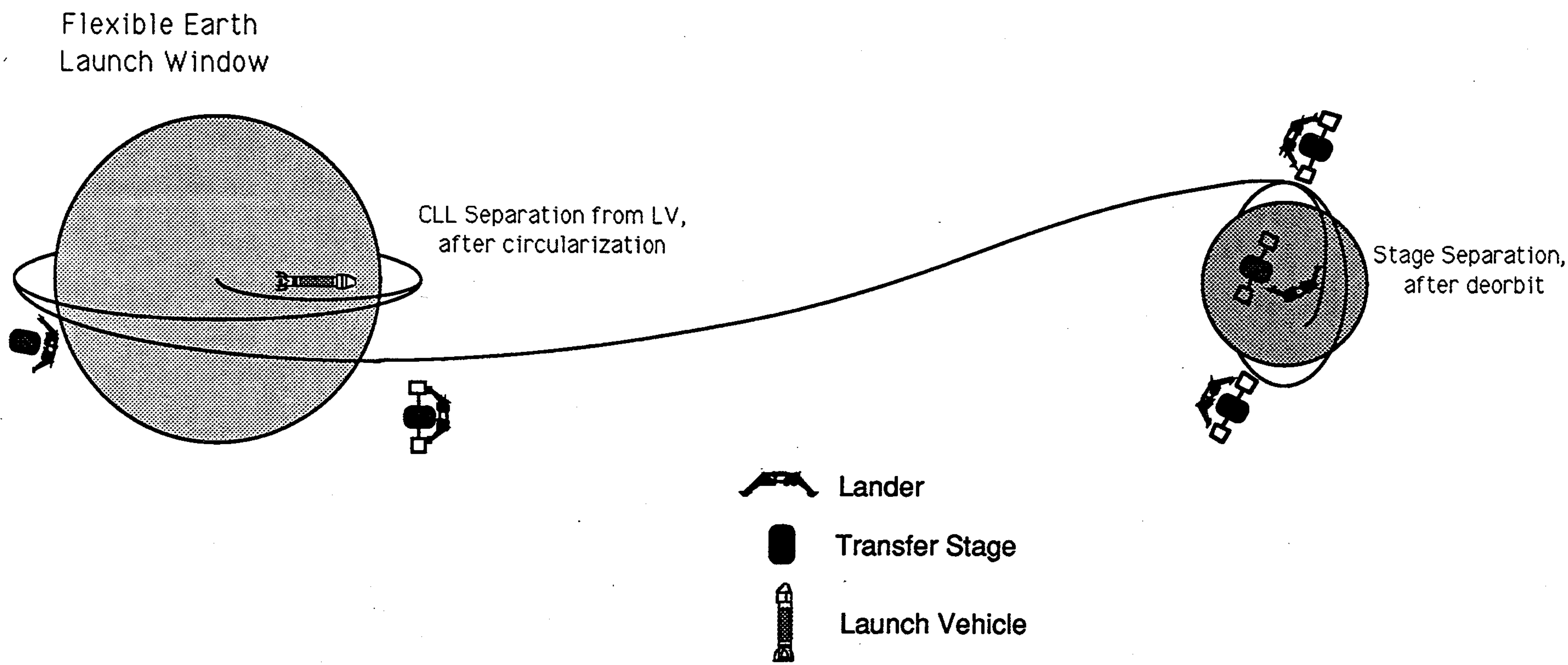
CLL Mission



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Launch Vehicle

- Purchase
  - medium class ELV
- Options
  - Delta II
  - Titan II Series
  - Atlas II Series

Transfer Stage

- Preliminary Sizing
- 86.5% Mass Fraction
  - 7.6% prop. sys. (dry)
  - 5.9% structure, etc.
- Subsystems off-loaded from Lander Stage

Lander Stage

- Designed through subsystem level
- Subsystems designed
  - Structure
  - Propulsion
  - Power
  - GN&C
  - Communication
  - Tracking
- Subsystems estimated
  - Thermal
  - Insulation

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Cost

	Recurring Costs	Non-recurring Costs
• Launch Vehicle	$ 50 - 100 million	
• CLL System		
• Transfer Stage	$ 10 million	$ 40 million
• Lander Stage	$ 30 million	$120 million

- Payloads
  - Separate program.
  - Specific costs are payload specific.

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CLL Options

- Architectural Options
  - 1 stage CLL Vehicle (LOI, DD&L)
  - 2 stage CLL Vehicle
    - considered staging opportunities within (0 - 100% TLI, LOI, DD&L) burns
- Lower Cost Options
  - Lower Performance Launch Vehicle
  - Use of Refurbished ICBM Missiles (Titan II)
- Lower Weight Options
  - Use of SDIO Developed Hardware
  - Full Sun Trajectory during Lunar Orbit Wait
    - leads to smaller Solar Arrays

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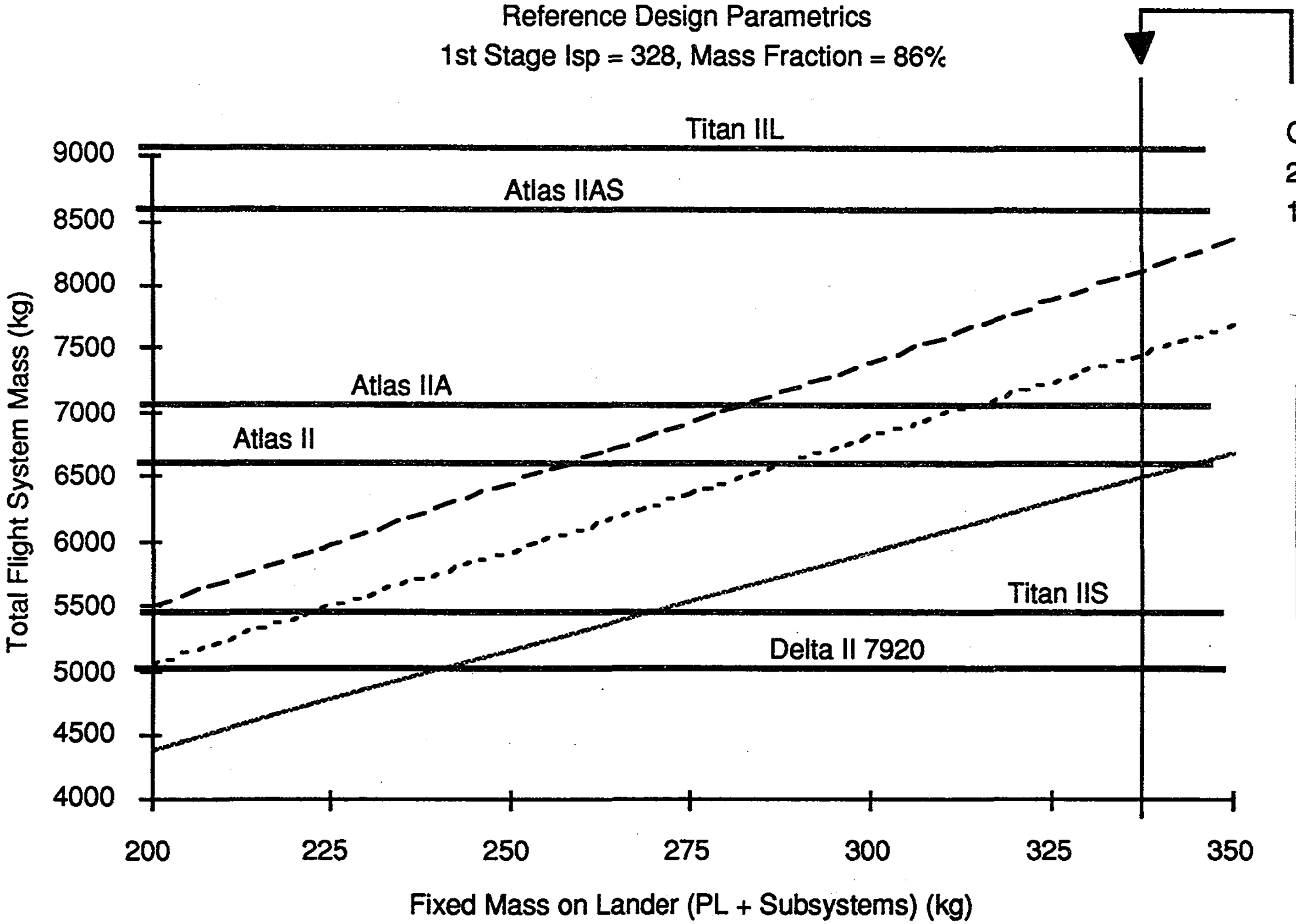
Two Stage Performance Analysis
1st Stage Mass Fraction = 0.86



Current Reference Design
200 kg Payload
138 kg Subsystems

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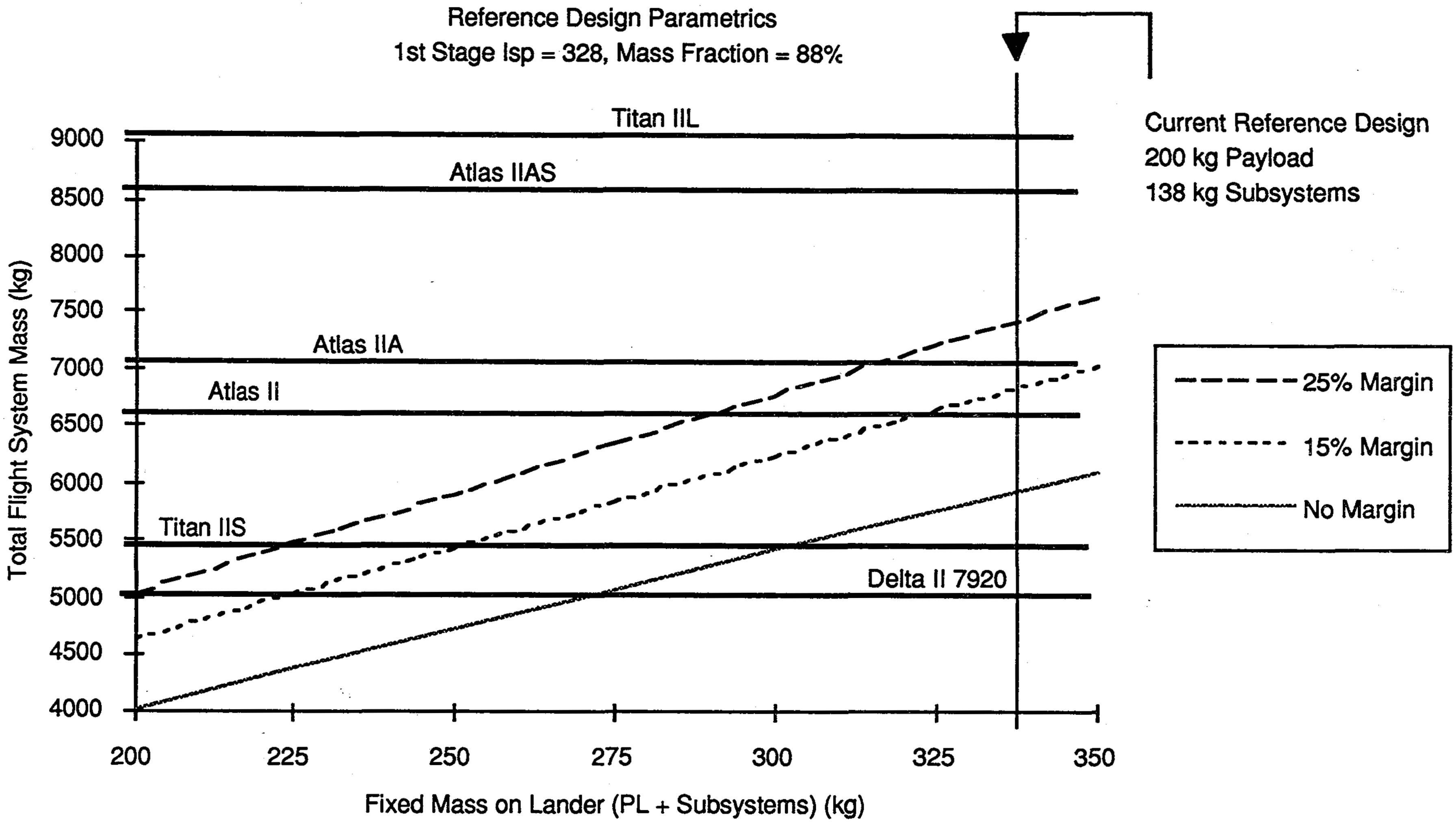
Two Stage Performance Analysis (Cont)
1st Stage Mass Fraction = 0.88



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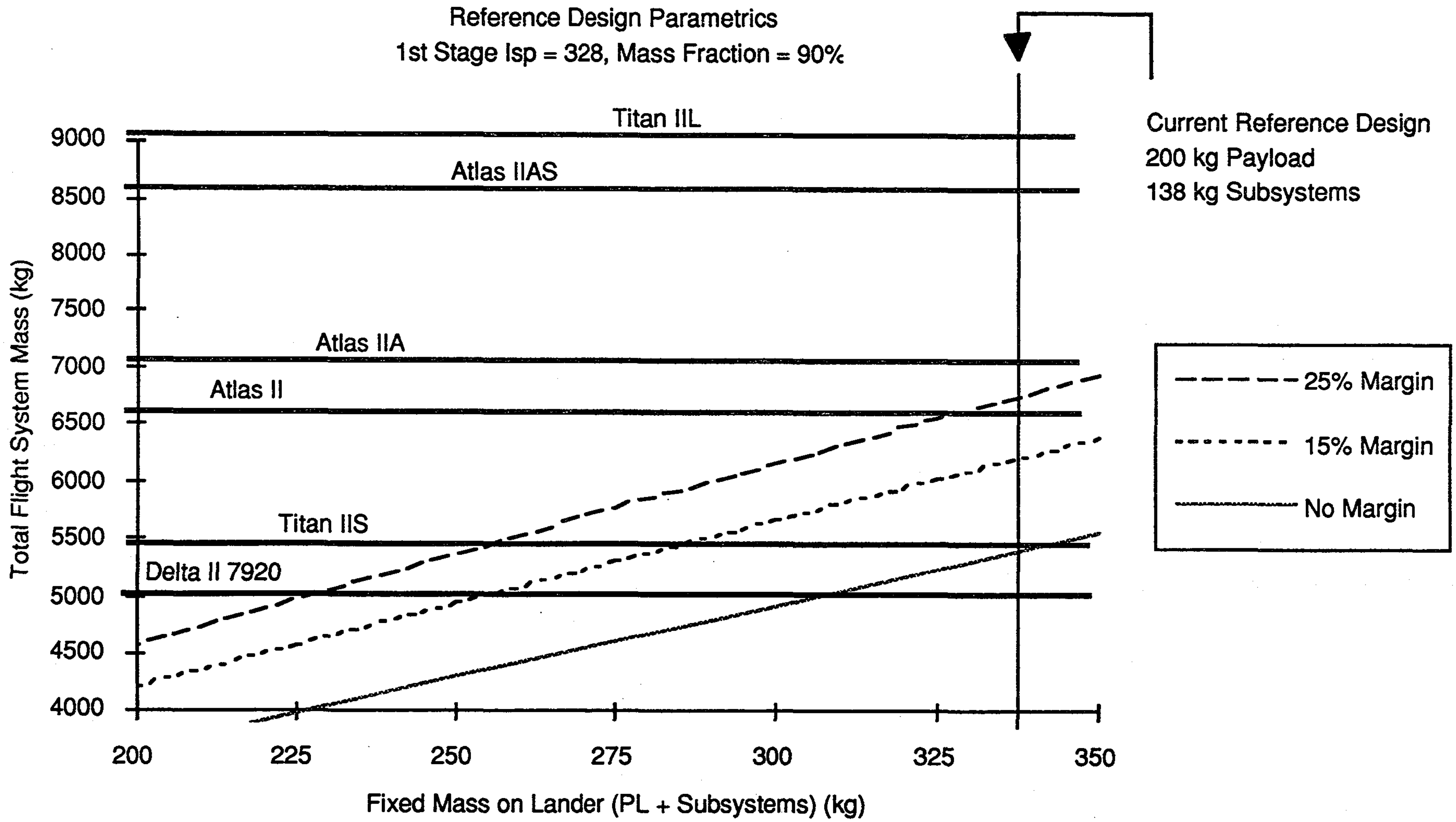
Two Stage Performance Analysis (Cont)
1st Stage Mass Fraction = 0.90



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CLL Engineering Team

Jonette Stecklein	ET2	Lead Engineer
Shelby Lawson		Configuration Design
Ed Robertson		Launch Vehicle Assessment
Lynn Wagner	ET3	Trajectory Design
Bill Culpepper	EE6	Tracking
Henry Chen	EE7	Communications
Nancy Smith	EG2	GN&C
Don Hyatt	EP4	Propulsion
Betsy Kluksdahl	EP5	Power
George Sanger	LESC	Structures
Ken Baker	ER2	Landing:Hazard Avoidance

CLL Team Supporters

John Kowal	Thermal Control	Rich Schoenberg	Propulsion	Paul Phillips	Programmatics
Nancy Wilks	Mission Analysis	Bob Hendrix	Power (EPDC)	Steve Hoffman	Cost Estimation
Gerry Condon	Mission Analysis	Darin McKinnis	Power (Pyrotechnics)	Gail Boyes	Procurement
Max Kilbourn	Mission Analysis	Shannan Fisher	Power (Solar Arrays)	Alan Binder	Payloads/Science
Rocky Duncan	Mission Analysis	Don Allison	Power (Solar Arrays)	W. Holdenbach	Payloads Assessment
D. Mclain	Communication	Bob Bragg	Power (Batteries)	Jim Engler	GN&C
T. Early	Communications	Fred Abolfathi	Structures	D. McSweeny	Operations
Zafar Taqvi	Communications	Rick Deppisch	GN&C	D.McLaughlin	SR&QA
				Edmund Hack	Landing

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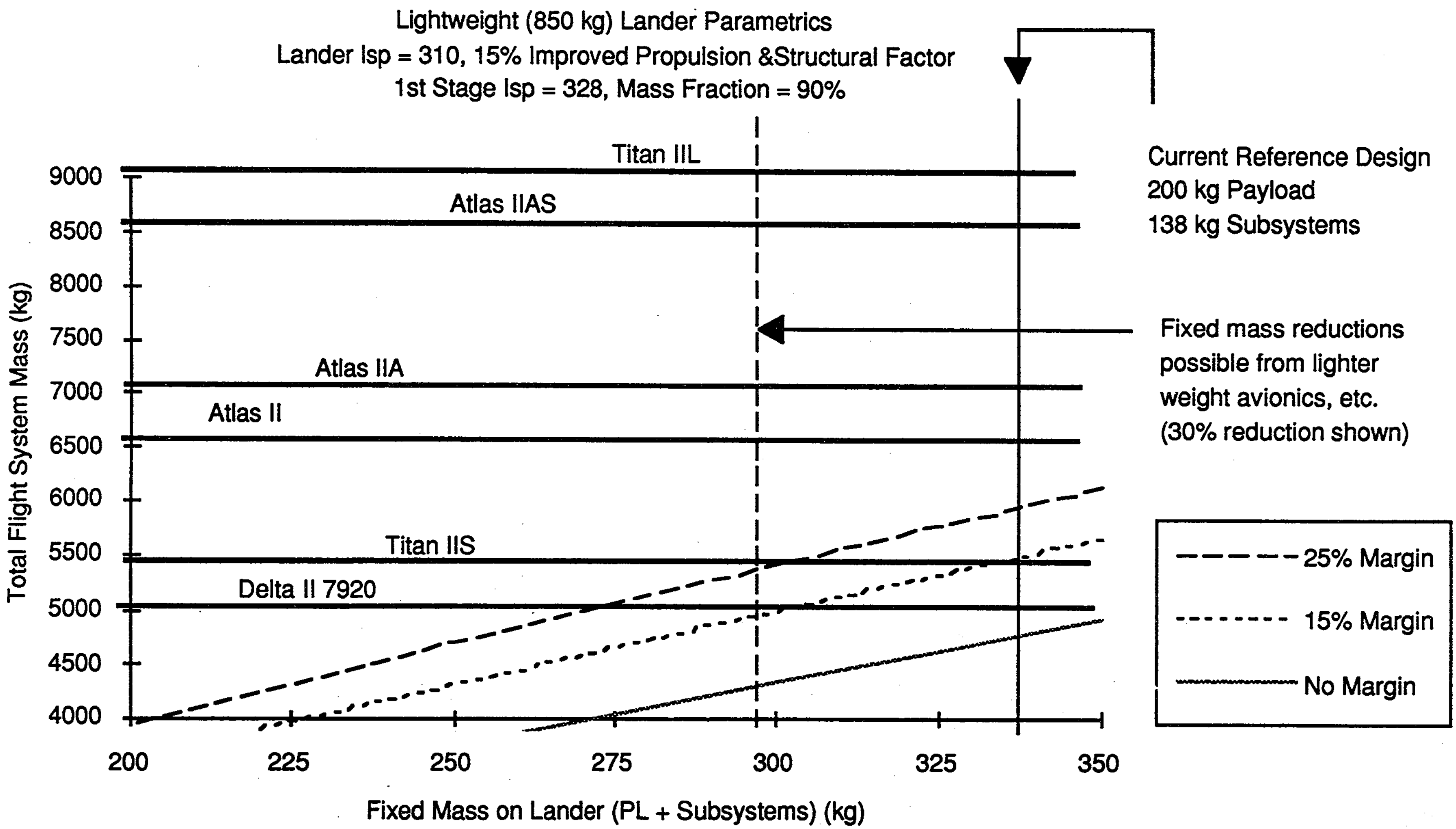
Two Stage Performance Analysis (Cont)
1st Stage Mass Fraction = 0.9, 850 kg Reference Lander



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