Artemis

Common Lunar Lander (CLL)

Conceptual Design
&
Mass Properties

Shelby Lawson, ET2, x36611 September 17, 1991

CLL Preliminary Conceptual Design

Artemis

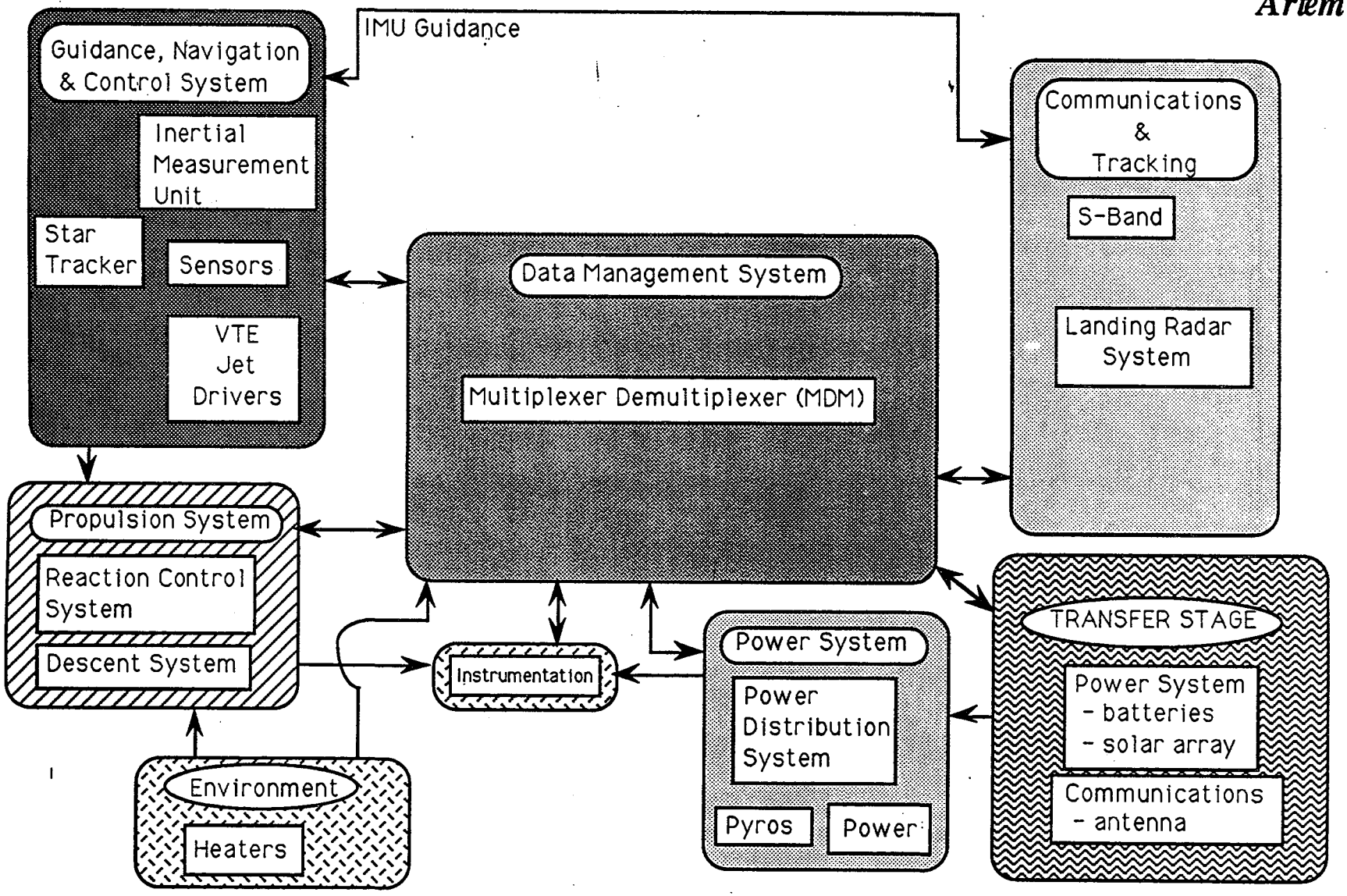
- Lander sized to fit within Delta payload shroud
  - 3-lander legs stowed during flight
  - 5 S-band omni antennas
  - Landing radar underneath lander structure
  - 6 VTE bi-propellant engines for lunar descent and landing
  - 12 RCS engines for attitude control
- Crushable honeycomb legs deploy during lunar descent

  (dimensions are to be updated by George Sanger & Fred Abolfathi)
  - 4.0 meter footprint
  - 2.25 meter diameter lander base
- Transfer stage performs TLI, midcourse, LOI and lunar deorbit burns
  - 2 solar arrays and rechargeable batteries
  - 1 Transtar bi-propellant engine

Shelby Lawson, ET2, x36611 September 17, 1991

CLL Schematic

Artemis



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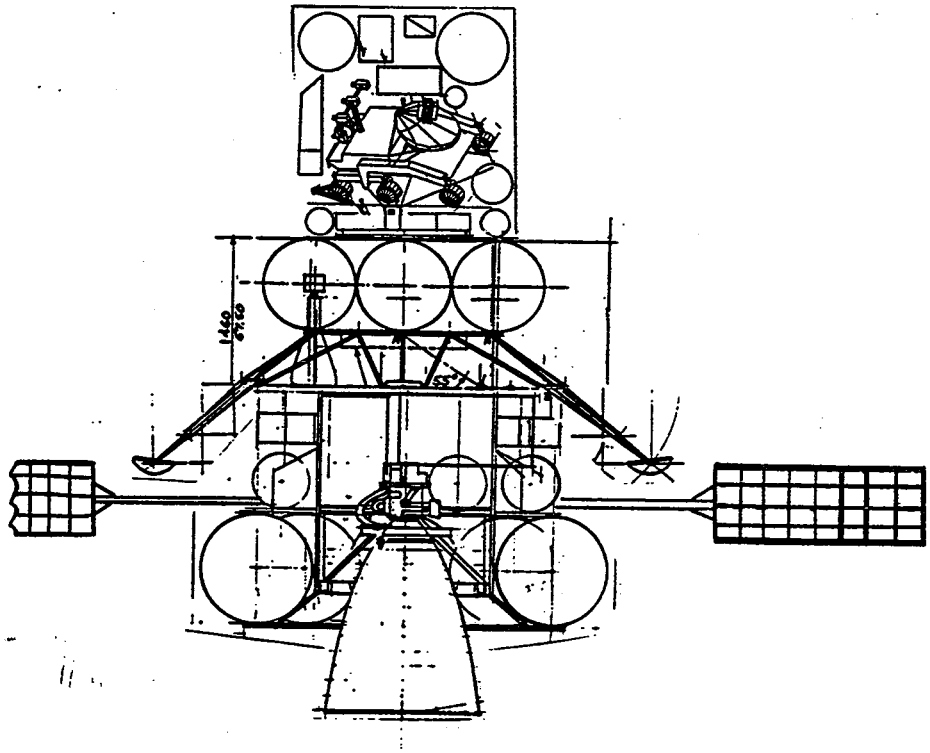
NOTE: ALL MASS IS IN KILOGRAMS.

DESIGN MASS SUMMARY

Common Lunar Lander (CLL)

FUNCTIONAL SUBSYSTEM CODE	Lander	Transfer Stage		CLL Launch Adapter	
1.0 STRUCTURE	27	300		255	
2.0 PROTECTION	3				
3.0 PROPULSION	94	282			
4.0 POWER	39	93			
5.0 CONTROL	0	0			
6.0 AVIONICS	91	1			
7.0 ENVIRONMENT	2				
8.0 OTHER	24	4			
9.0 GROWTH	0				
DRY MASS	280	679		255	
10.0 NON-CARGO	11	104			
11.0 CARGO	200	0			
INERT MASS	491	784		255	
12.0 NON-PROPELLANT	0	0			
13.0 PROPELLANT	426	4,410			
GROSS MASS	917	5,193		255	



NOTE: ALL DIMENSIONS ARE IN METERS.

NOTE: Single string systems. Selective redundancy.
Lander: 5.8 m dia legs deployed, 2.75 m dia lander structure
Payload: 1.5 x 1.5 x 1.5 meter cube represented, 200 kg.

Adapter, Support Equipment:

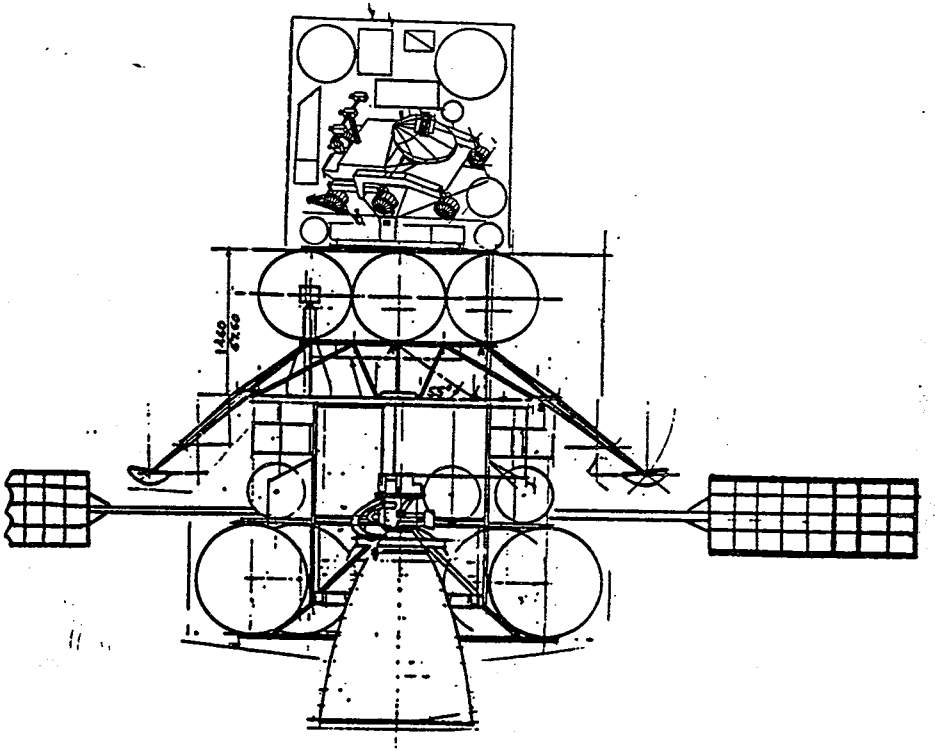
Launch mass = 6,365 kg

NOTE: ALL MASS IS IN KILOGRAMS.

DESIGN MASS SUMMARY

Common Lunar Lander (CLL)

FUNCTIONAL SUBSYSTEM CODE	Lander	Transfer Stage		CLL Launch Adapter	
1.0 STRUCTURE	27	300		270	
2.0 PROTECTION	3				
3.0 PROPULSION	96	291			
4.0 POWER	39	93			
5.0 CONTROL	0	0			
6.0 AVIONICS	91	1			
7.0 ENVIRONMENT	2				
8.0 OTHER	24	4			
9.0 GROWTH (15%)	42				
DRY MASS	325	689		270	
10.0 NON-CARGO	12	111			
11.0 CARGO	200	0			
INERT MASS	537	799		270	
12.0 NON-PROPELLANT	0	0			
13.0 PROPELLANT	465	4,671			
GROSS MASS	1,002	5,470		270	



NOTE: ALL DIMENSIONS ARE IN METERS.

NOTE: Single string systems. Selective redundancy.
Lander: 4.0 m dia legs deployed, 2.25 m dia lander structure
Payload: 1.5 x 1.5 x 0.6 meter Rover & instruments, 200 kg.
Transfer Stage: 87% Mass Fraction
Adapter, Support Equipment: 4% of CLL & Transfer Stage.

Launch mass = 6,742 kg

Common Lunar Lander Mass Properties

9/17/91

CLL Lander	Tl. Mass KG		Tl. Mass KG
1.0 Structure	**27**	**8.0 Other**	**24**
- Space Frame Assembly	19	- Landing System	22
- CLL / Transfer Stage Adapter	8	- Pyrotechnics	2
- Mounting Structure (info)	21	- Miscellaneous Mechanisms	0
2.0 Protection	**3**	**9.0 Growth**	**42**
- Insulation	3		
		CLL Lander Dry Mass	**325**
3.0 Propulsion	**96**		
- Integrated Propulsion System	96	**10.0 Non-Cargo**	**12**
		- Reserve and Residual Fluids	12
4.0 Power	**39**		
- Generation	13	**11.0 Cargo**	**200**
- Electrical Pwr Dist. & Control (EPDC)	16		
- Wiring	11		
		CLL Lander Inert Mass	**537**
6.0 Avionics	**91**		
- Guidance, Navigation & Control (GNC)	9	**12.0 Non-Propellant (Consummables)**	**0**
- Data Management System (DMS)	23		
- Instrumentation	6	**13.0 Propellant**	**465**
- Communications & Tracking (C&T)	53		
		CLL Lander Gross Mass	**1,002**
7.0 Environment	**2**		
- Environment Control System (ECS)	2		

CLL Transfer Stage	Tl. Mass KG
1.0 Structure	300
- Primary Body Structure	300
2.0 Protection	
- Insulation	
3.0 Propulsion	291
- Integrated Propulsion System	291
4.0 Power	93
- Generation	47
- Electrical Pwr Dist. & Control (EPDC)	27
- Wiring	18
6.0 Avionics	1
- Instrumentation	1
7.0 Environment	
- Environment Control System (ECS)	

	Tl. Mass KG
8.0 Other	4
- Miscellaneous Mechanisms	4
9.0 Growth	0
CLL Transfer Stage Dry Mass	689
10.0 Non-Cargo	111
- Reserve and Residual Fluids	111
11.0 Cargo	0
CLL Transfer Stage Inert Mass	799
12.0 Non-Propellant (Consummables)	0
13.0 Propellant	4,671
CLL Transfer Stage Gross Mass	5,470

Launch Adapter & Support	270	Used on launch from ELV. Estimate.

Total Launch Mass	6,742

CLL: LANDER SUBSYSTEM:	Tl. Mass (KG)	No	Comments
1.0 Structure:	**27.2**		Contact George Sanger or Fred Abolfathi, LESC, 333-7254.
Space Frame Assembly	19.2		
CLL / Transfer Stage Adapter	8.0		
Subsystem Mounting (info only)	20.8		
CLL: LANDER SUBSYSTEM:	**Tl. Mass (KG)**	**No**	**Comments**
2.0 Protection:	**3.0**		Contact Steve Bailey, 283-5411. Estimated.
Insulation	3.0		

CLL: LANDER SUBSYSTEM:	Tl. Mass (KG)	No	Comments
3.0 Propulsion:	96.0		Contact Don Hyatt, x39019. Performs descent & landing burns.
Integrated Propulsion System	96.0		Bipropellant RCS and Primary Engine System, Delta V=1820 m/s.
Fuel Tanks	7.2	2	Spherical, 59 cm dia.
Oxidizer Tanks	7.2	2	Spherical, 59 cm dia.
Pressurant Tanks	12.3	4	Spherical, 30 cm dia.
RCS Engines	12.6	12	Marquardt R-6C
Descent Lander Engines	46.3	6	TRW VTE engines, Isp=300 sec.
Lines, Valves & Insulation	8.7		Historical estimate.
Mounting Structure	1.7		Historical estimate.

CLL: LANDER SUBSYSTEM:	Tl. Mass (KG)	No	Comments
4.0 Power:	39.3		Contact Betsy Kluksdahl, x36484.
Generation	13.1		
Primary Batteries	11.3		
Mounting Structure	1.8		Structure factor of 15.6% supplied by George Sanger, 333-7254.
Electrical Pwr Dist. & Control (EPDC)	15.7		Contact Betsy Kluksdahl, x36484. Preliminary estimate.
Bus Controller	13.6	1	38.1x38.1x15.2 cm
Mounting Structure	2.1		Structure factor of 15.6% supplied by George Sanger, 333-7254.
Wiring	10.5		Contact Betsy Kluksdahl, x36484. Estimate based on ACRV
Cable	9.1		Includes connectors, 25.9K cm3
Mounting Structure	1.4		Structure factor of 15.6% supplied by George Sanger, 333-7254.

CLL: LANDER SUBSYSTEM:	Tl. Mass (KG)	No	Comments
6.0 Avionics:	**91.2**		
Guidance, Navigation and Control (GNC)	9.2		Contact Nancy Smith, x38275. Features integrated DMS system.
Inertial Measurement Unit (IMU)	7.3	1	Honeywell-764. 17.7x17.7x22.9 cm, 7200 cm3, 40W.
Star Tracker	1.0	1	Lawrence Livermore. 18x18x25 cm, 8100 cm3, 8W.
Mounting Structure	0.9		Structure factor of 10.8% supplied by George Sanger, 333-7254.
Data Management System (DMS)	22.9		Contact Nancy Smith, x38275.
Multiplexer/DeMultiplexer (MDM)	20.0	1	Honeywell, similar to SSF, contains RJD functions. 37xc23x34 cm, 29K cm3, 100W.
Mounting Structure	2.9		Structure factor of 14.5% supplied by George Sanger, 333-7254.
Instrumentation	5.8		Contact S. Lawson, x36611. Based on historical data. Dist. among subsystems.
Sensors	3.5		
Signal Conditioners	1.5		
Mounting Structure	0.8		Structure factor of 16.6% supplied by George Sanger, 333-7254.
Communications & Tracking (C&T)	53.3		Contact Henry Chen, x30128, Zafar Taqvi, 333-6544. 8/16/91.
• S-Band System	23.9		Uses DSN 34 subnet, for telemetry, ranging and command.
Transponder	3.3	1	Motorola, inc. Cmd detector. 16x20x11 cm, 3500 cm3, 8W avg, 17.5W peak.
RF Assembly	7.4	1	New, 16x20x3224 cm, 7800 cm3, 18.8W avg., 71W peak.
Processing Module	3.0	1	New; process, signal condition, control and monitors. 16x20x15 cm, 4800 cm3, 27W.
Antenna	4.6	5	TRW, Log conical spiral. 12.5 cm dia x 30 cm h, 3300 cm3, 0W.
Coaxial Cable	2.4	1	Gore, 900 cm3, dependent on communication equipment placement.
Mounting Structure	3.2		Structure factor of 15.6% supplied by George Sanger, 333-7254.
• Tracking	29.4		Contact Bill Culpepper, x31479. Viking Heritage, Teledyne Ryan Co.
Landing Radar	22.1	1	Antenna on surface, 76.2x76.2x8.26 cm, 68W
Altimeter	5.1	1	23.4x14.7x20.1 cm, 28.5W
Altimeter Antenna	0.7	1	Cone shaped, 1721 cm3
Coax cable	0.1		Connection between altimeter and antenna. Estimate.
Mounting Structure	1.4		Structure factor of 5.0% supplied by George Sanger, 333-7254.

CLL: LANDER SUBSYSTEM:	Tl. Mass (KG)	No	Comments
7.0 Environment:	**2.1**		
Environment Control System (ECS)	2.1		Contact Steve Bailey, 283-5411. Estimated.
Heaters	2.0		Estimate. Used to keep engines, tanks and subsystems warm.
Mounting Structure	0.1		Structure factor of 5.6% supplied by George Sanger, 333-7254.

CLL: LANDER SUBSYSTEM:	Tl. Mass (KG)	No	Comments
8.0 Other:	**23.7**		
Landing System	21.9		Contact George Sanger, LESC, 333-7254.
Lander Legs	18.0	3	Alum. honeycomb.
Mounting Structure	3.9		Structure factor of 21.6% supplied by George Sanger, 333-7254.
Pyrotechnics System	1.8		Contact Betsy Kluksdahl, x36484.
N/C Pyrovalve	0.6	4	RCS Isolate, Unidynamics (P/N 51-1630) 8x5x5 cm, 200 cm3, 5A @ 30 mSec peak pwr.
Uplock Cutter	0.8	3	Lander Leg deploy,Apollo,16x12x5 cm,960 cm3,5A @ 30 mSec peak pwr.
Mounting Structure	0.5		Structure factor of 38.5% supplied by George Sanger, 333-7254.

CLL: LANDER SUBSYSTEM:	Tl. Mass (KG)	No	Comments
9.0 Growth:	42.4		15% of all subsystems.

CLL Lander DRY MASS	325

CLL: LANDER SUBSYSTEM:	Tl. Mass (KG)	No	Comments
10.0 Non-Cargo	12.0		
Reserve and Residual Fluids	12.0		
IPS Fuel Reserves	0.0		0% reserves, D. Hyatt.
IPS Fuel Residuals	3.6	2	2% residuals, Monomethylhydrazine (MMH), Contact D. Hyatt.
IPS Oxidizer Reserves	0.0		0% reserves, D. Hyatt.
IPS Oxidizer Residuals	5.9	2	2% residuals, Nitrogen Tetroxide (NTO), Contact D. Hyatt.
IPS Pressurant	2.5	4	Helium, D. Hyatt.

CLL: LANDER SUBSYSTEM:	Tl. Mass (KG)	No	Comments
11.0 Cargo	200.0		Contact Alan Binder, 283-5849.
Scientic Paylbads	200.0		
Rover + Instruments	200.0	1	150 kg rover + 50 kg instruments; 1.5x1.5x1.5 m box dimensions assume

CLL Lander INERT MASS	537

CLL: LANDER SUBSYSTEM:	Tl. Mass (KG)	No	Comments
12.0 Non-Propellant (Consummables)	0.0		

CLL: LANDER SUBSYSTEM:	Tl. Mass (KG)	No	Comments
13.0 Propellant	465.1		Delta V = 1820 m/s
Fuel	176.2	2	Monomethylhydrazine (MMH)
Oxidizer	288.9	2	Nitrogen Tetroxide (NTO)

CLL Lander GROSS MASS	1,002

CLL: TRANSFER STAGE SUBSYSTEM:	Tl. Mass (KG)	No	Comments
1.0 Structure:	**300.0**		Contact Steve Bailey, 283-5411. Assume 5% of t.s. gross mass.
Primary Body Structure	300.0		Includes all subsystem mass except power & mechanisms.

CLL: TRANSFER STAGE SUBSYSTEM:	Tl. Mass (KG)	No	Comments
2.0 Protection:	**0.0**		Contact Steve Bailey, 283-5411.
Insulation	0.0		Included in structure mass.

CLL: TRANSFER STAGE SUBSYSTEM:	Tl. Mass (KG)	No	Comments
3.0 Propulsion:	**291.4**		Contact Don Hyatt, x39019. Performs RCS, TLI, LOI & deorbit burns
Integrated Propulsion System	291.4		Bipropellant RCS and Primary Engine System, Delta V=4100 m/s.
Fuel Tanks	40.1	4	Spherical, 99 cm dia.
Oxidizer Tanks	42.8	4	Spherical, 102 cm dia.
Pressurant Tanks	77.0	4	Spherical, 55 cm dia.
RCS Engines	26.8	12	Marquardt R-IE, 25 lbs thrust
Transfer Stage Engine	66.7	1	Transtar engine, Isp=328 sec.
Lines, Valves & Insulation	31.6		Historical estimate.
Mounting Structure	6.3		Historical estimate.

CLL: TRANSFER STAGE SUBSYSTEM:	Tl. Mass (KG)	No	Comments
4.0 Power:	**92.6**		Contact Betsy Kluksdahl, x36484.
Generation	47.3		
Rechargeable Batteries	11.3		Silver-Zinc chemistry (Zn-AgO), 3 modules,0.01 M3, jettison prior to deorbit
Solar Arrays	36.0	2	Silicon cells, accordian-style, 1.33 w x 4.0 h m ea.
Mounting Structure	0.0		Included in structure mass.
Electrical Pwr Dist. & Control (EPDC)	27.2		Contact Betsy Kluksdahl, x36484. Preliminary estimate.
Solar Array Controller	9.1	1	25.4x38.1x15.2 cm
Battery Charger	9.1	1	25.4x30.5x12.7 cm
Bus Controller	9.1	1	38.1x38.1x15.2 cm
Mounting Structure	0.0		Included in structure mass.
Wiring	18.1		Contact Betsy Kluksdahl, x36484. Estimate based on ACRV
Cable	18.1		Includes connectors, 25.9K cm3
Mounting Structure	0.0		Included in structure mass.

CLL: TRANSFER STAGE SUBSYSTEM:	Tl. Mass (KG)	No	Comments
6.0 Avionics:	**1.0**		
Communications	1.0		
Antenna	1.0	1	TRW, Log conical spiral. 12.5 cm dia x 30 cm h, 3300 cm3, 0W.
Mounting Structure	0.0		Included in structure estimate

CLL: TRANSFER STAGE SUBSYSTEM:	Tl. Mass (KG)	No	Comments
7.0 Environment:	**0.0**		Contact Steve Bailey, 283-5411. Included in structure estimate.

CLL: TRANSFER STAGE SUBSYSTEM:	Tl. Mass (KG)	No	Comments
8.0 Other:	**3.6**		
Mechanisms	3.6		Contact George Sanger, 333-7254.
Solar Array Deployment & Tracking	3.6	2	
Mounting Structure	0.0		Included in structure mass.

CLL: TRANSFER STAGE SUBSYSTEM:	Tl. Mass (KG)	No	Comments
9.0 Growth:	**0.0**		No growth or contingency mass calculated. Using mass fraction.

CLL Transfer Stage DRY MASS	**689**

CLL: TRANSFER STAGE SUBSYSTEM:	Tl. Mass (KG)	No	Comments
10.0 Non-Cargo	110.7		
Reserve and Residual Fluids	110.7		
IPS Fuel Reserves	0.0		0% reserves, D. Hyatt.
IPS Fuel Residuals	34.1	4	2% residuals, Monomethylhydrazine (MMH), Contact D. Hyatt.
IPS Oxidizer Reserves	0.0		0% reserves, D. Hyatt.
IPS Oxidizer Residuals	61.3	4	2% residuals, Nitrogen Tetroxide (NTO), Contact D. Hyatt.
IPS Pressurant	15.4	4	Helium, D. Hyatt.

CLL: TRANSFER STAGE SUBSYSTEM:	Tl. Mass (KG)	No	Comments
11.0 Cargo	0.0		

CLL Transfer Stage INERT MASS	**799**

CLL: TRANSFER STAGE SUBSYSTEM:	Tl. Mass (KG)	No	Comments
12.0 Non-Propellant (Consummables)	0.0		

CLL: TRANSFER STAGE SUBSYSTEM:	Tl. Mass (KG)	No	Comments
13.0 Propellant	4,671.1		3200 m/s TLI, 30 m/s midcourse, 840 m/s LOI, 30 m/s deorbit
Fuel	1,668.3	4	Monomethylhydrazine (MMH)
Oxidizer	3,002.9	4	Nitrogen Tetroxide (NTO)

CLL Transfer Stage GROSS MASS	**5,470**

CLL: Launch Adapter & Support Equipment

SUBSYSTEM:	Tl. Mass (KG)	No	Comments
			Contact Steve Bailey, 283-5411.
1.0 Structure	269.7		Includes ground support equipment, cables, pyros.
8.0 Other	0.0		
9.0 Growth	0.0		Included in structure.

Launch Adapter & Support	270	1	Used on launch from ELV.

CLL Mission Mass Summary	Tl. Mass (KG)		Comments
Launch Mass	6742		CLL Gross Mass + Transfer Stage Gross Mass + Launch Adapter Gross Mas
Prior to leaving Earth Orbit	6472		Launch Mass - Launch Adapter
5 day Moon trip	?		Prior to leaving Earth Orbit - TLI burn propellant
14 day Lunar orbit wait	?		5 day moon trip - LOI burn propellant
Lunar deorbit	?		14 day lunar orbit wait - Deorbit burn propellant
Prior to descent burn	1002		Lunar deorbit - Transfer Stage Inert Mass
Landed Vehicle	537		Prior to descent burn - Descent burn propellant
Scientific Payload	200		Landed Vehicle - CLL Inert Mass + Payload

Other Design Information	Tl Mass-kg		
CLL Payload	200		
CLL Structure	27		Primary
CLL Subsystems	202		Without dry propulsion system.
Transfer Stage Structure	300		Primary, Secondary and Mounting Structure
Transfer Stage Subsystems	97		Without dry propulsion system.
Transfer Stage "Payload"	1002		CLL Gross Mass