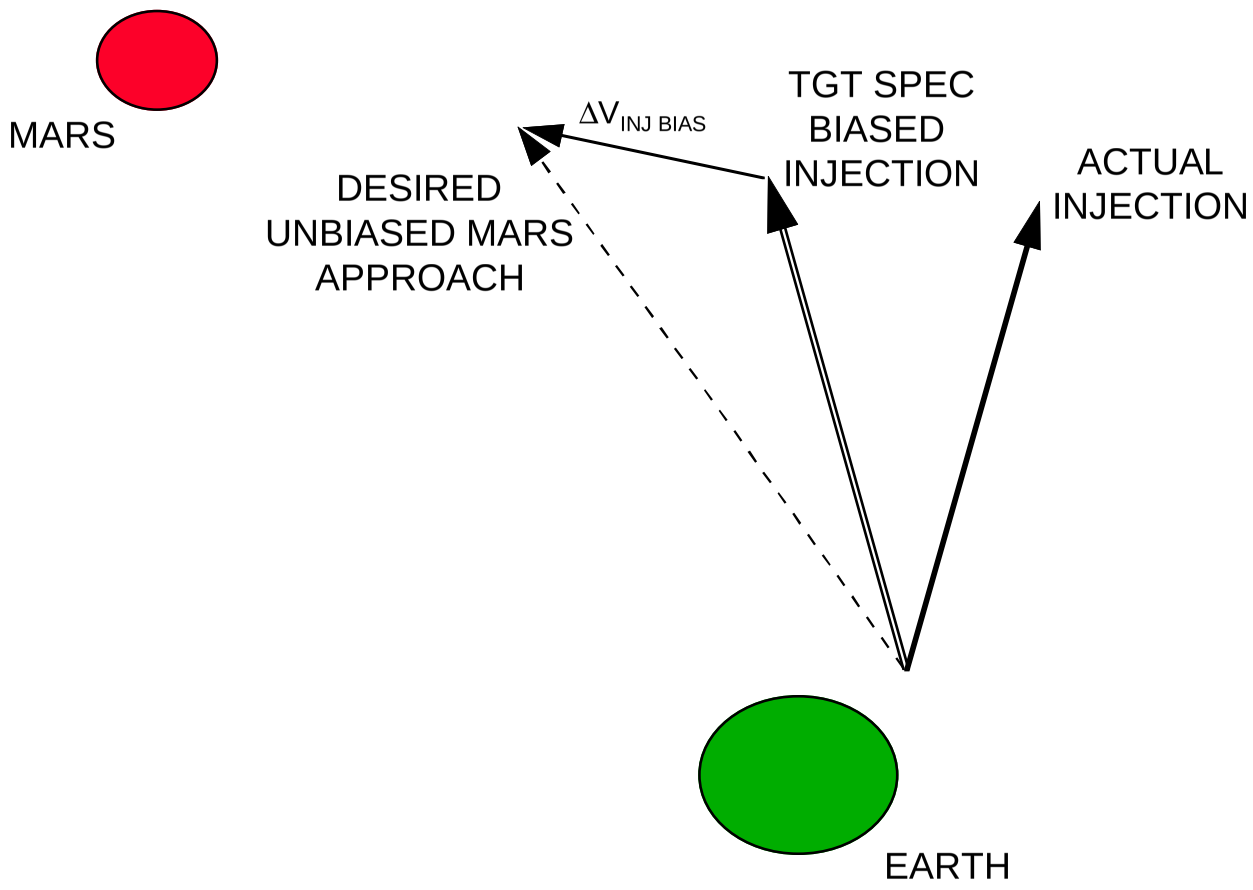
- MDA INJECTION PERFORMANCE AWARD FEE WILL BE BASED ON A SINGLE TRAJECTORY CORRECTION MANEUVER (TCM) PERFORMED AT LAUNCH + 15 DAYS. THIS TCM WILL CORRECT THE INJECTION STATE TO THE PQ BIASED TARGET PARAMETERS (B•T, B•R, TF) USED IN GENERATING THE MGS FINAL TARGET SPECIFICATION DOCUMENT.
  - FUNCTION OF LAUNCH DATE

NOTES:

(1) THIS TCM IS NOT THE OPTIMIZED TCM-1 AND TCM-2 ΔV SOLUTION THAT WILL BE DETERMINED BY THE FLIGHT TEAM.

(2) THIS TCM WILL BE BASED ON THE FINAL ORBIT DETERMINATION USED FOR THE DESIGN OF (1) ABOVE.


MARS
$\Delta V_{INJ\ BIAS}$
TGT SPEC
BIASED
INJECTION
ACTUAL
INJECTION
DESIRED
UNBIASED MARS
APPROACH
EARTH

- MITIGATING INJECTION PERFORMANCE ISSUES TO CONSIDER
  - INJECTION COVARIANCE ASSUMPTIONS (SPIN RATE, SPACECRAFT MASS AND MASS PROPERTIES, NUTATION TIME CONSTANT, ETC.)
  - LAUNCH AT TIME OTHER THAN DESIRED (I.E. COLA)
  - PROBABILITY OF COMMAND SHUTDOWN (PCS)
    - NOMINAL DELTA MISSION = 99.7%

<u>PROPOSED SOLUTION:</u> AUGMENT THE AVAILABLE TCM ΔV WITH AN APPROPRIATE LEVEL OF BIPROPELLANT ΔV RESERVE CAPABILITY

TCM ΔV ALLOCATION:

+LAUNCH DAY TCM-1 ΔV BIPROPELLANT ALLOCATION

- NOMINAL TCM-2 ΔV = 6 M/S (BLOWDOWN)

+PRE-LAUNCH ΔV BIPROPELLANT RESERVES AUGMENTED BY:

1) RELAY ORBIT ΔV
   - ADDITIONAL ΔV = (1.0 / 0.0 / 10.0)
2) PERCENTAGE OF THE MAPPING ORBIT ΔV {(1-X)*MAPPING ORBIT ΔV}
   - A) 100% AWARD FEE: ADDITIONAL ΔV = (0.0 / 0.0 / 0.0) -> X=1.00
   - B) 75% AWARD FEE: ADDITIONAL ΔV = (0.9 / 0.0 / 10.0) -> X=0.75
   - C) 50% AWARD FEE: ADDITIONAL ΔV = (1.9 / 0.0 / 20.0) -> X=0.50

-ΔV COST TO REMOVE INJECTION BIASING ASSOCIATED WITH TCM-1

AWARD FEE (%):	100%	75%	50%
11/6: IF TCM ΔV,	$\Delta V \leq 52.5$	$52.5 < \Delta V \leq 62.9$	$62.9 \leq \Delta V$
	52.5=(30+25.3-2.8)	57.7=(30+30.5-2.8)	62.9=(30+35.7-2.8)
11/25: IF TCM ΔV,	$\Delta V \leq 47.7$	$47.7 < \Delta V \leq 58.1$	$58.1 \leq \Delta V$
	47.7=(43+12.4-7.7)	52.9=(43+17.6-7.7)	58.1=(43+22.8-7.7)

Mars Global Surveyor

Mission ΔV Budget - ORR Baseline (August 1996)
Launch Date - 11/6/96

MISSION PHASE	MANEUVER	MPROP TRANS ΔV Reqd (m/s)	BIPROP TRANS ΔV Reqd (m/s)	MPROP ROTAT ΔV Reqd (m/s)	Resultant Orbit Rp X Ra (km) (km)	Orbit Period (hr)	Notes / Assumptions
CRUISE *ΔV95*	TCM-1/2	0.0	36.0	0.3	Heliocentric Transfer		Interplanetary trajectory aimpoints biased for planetary protection.
	TCM-3/4	2.0	0.0	0.0	Mars Hyperbolic Approach:		Cruise TCM ΔV statistics based on 95th percentile.
	pre-Lnch ΔV Reserves	0.0	20.1	0.0	Rp=3775.0 km Inc=93.0 deg		Minimum Delta Stage II PCS --- 11/6/96: 97.9% 11/25/96: 97.3%
CAPTURE	MOI - Pitchover Mode	0.0	968.2	5.9	3700.0 x 60055.4	48.0000	Capture Orbit: Rp = 3700 km, Per = 48 Hr, Inc = 93.0 deg
Aerobraking Walk-in	AB-1	0.0	7.5	0.1	3547.2 x 60096.5	47.8475	AB-1 includes 1.3 m/s for Δi post-MOI.
	AB-i (i=2,4)	2.5	0.0	0.0	3497.8 x 53867.1	40.9672	Aerobraking main phase established.
Aerobraking Main Phase	ABM Translation	5.0	0.0	0.0			ABM = aerobraking trim maneuvers
	ACS Rotation	0.0	0.0	5.0	Aerobraking Corridor Control		ABM's as necessary to maintain aerobraking "glide slope."
							Aerobraking walk-out begins (Hp=106). ~Daily ABM's to protect 3-day orbit lifetime.
Aerobraking Walk-out	ABM Translation	20.0	0.0	0.0			ABM's continually raise Hp (Hp=>144 km).
	ACS Rotation	0.0	0.0	30.0			Aerobraking Termination: Per=1.9 Hrs, Hp=144 km, Ha=451 km
					3544.1 x 3844.7	1.8938	Arg Per=358 deg, FMS=2:00 PM
Aerobraking Contingency	Aerobraking Pop-Up	2.5	14.5	0.0			Aerobraking Pop-Up ΔV: 8.5 m/s Rp raise + 8.5 m/s Rp lower => effective Δh=35 km
	post-Lnch ΔV Reserves	0.0	0.0	0.0			from an orbit with a 2-hour orbit period. Pre-Launch ΔV reserves roll over to increase aerobraking ΔV margins.
Transition To Mapping	ABX	0.0	60.2	0.4	3797.0 x 3844.7	1.9918	ABX includes 1.0 m/s for Δi post-aerobraking.
					3747.0 x 3857.0	1.9771	As Arg Per drifts to 270 deg, Rp decreases and Ra increases.
	TMO	0.0	16.1	0.1	3747.0 x 3786.2	1.9496	TMO - Final maneuver establishing mapping orbit (351 ≤ Altmap ≤ 455).
MAPPING *Drag Dens 95%*	OTM-1 (Frzn)	0.0	7.5	0.0			OTM-1 - Orbit trim maneuver. Corrects TMO and establishes frozen orbit condition based on gravity field calibration results. Biprop maneuvers (TCM-1/2+OTM-1) with
	OTM (Drag/GTE)	3.9	0.0	0.0	Orbit Trim Maneuvers		statistical components combined at 95th percentile. (Summed means and RSS'd
	ACS Rotation	0.0	0.0	40.0			sigmas) Mapping orbit drag make-up based on atmospheric density confidence level of 95th percentile. (2.0 m/s reserved for GTE => 1.9 m/s drag make-up)
ADDITIONAL ΔV REQ'D	QUARANTINE ORBIT (PQ) - 2-BURN	22.8	0.0	0.0			Planetary quarantine orbit raise maneuver performed at end of mapping mission raises Rp to 427 km. (2-burn maneuver sequence).
RELAY *Drag Dens 95%*	OTM (Drag)	1.0	0.0	0.0	Orbit Trim Maneuvers		Relay orbit drag make-up (6 months) based on atmospheric density confidence
	ACS Rotation	0.0	0.0	10.0			level of 95th percentile.
	SUB-TOTALS	59.7	1130.1	91.8			
	MISSION TOTAL ΔV	**1281.6**					

Mars Global Surveyor

MARS GLOBAL SURVEYOR MISSION ΔV BUDGET

Mission ΔV Budget - ORR Baseline (August 1996)

Launch Date - 11/25/96

MISSION PHASE	MANEUVER	MPROP TRANS ΔV Reqd (m/s)	BIPROP TRANS ΔV Reqd (m/s)	MPROP ROTAT ΔV Reqd (m/s)	Resultant Orbit Rp X Ra (km) (km)	Orbit Period (hr)	Notes / Assumptions
CRUISE ΔV95	TCM-1/2	0.0	49.0	0.3	Heliocentric Transfer		Interplanetary trajectory aimpoints biased for planetary protection.
	TCM-3/4	2.0	0.0	0.0	Mars Hyperbolic Approach:		Cruise TCM ΔV statistics based on 95th percentile.
	pre-Lnch ΔV Reserves	0.0	7.0	0.0	Rp=3775.0 km Inc=93.0 deg		Minimum Delta Stage II PCS --- 11/6/96: 97.9% 11/25/96: 97.3%
CAPTURE	MOI - Pitchover Mode	0.0	975.1	5.9	3700.0 x 60055.4	48.0000	Capture Orbit: Rp = 3700 km, Per = 48 Hr, Inc = 93.0 deg
Aerobraking Walk-in	AB-1	0.0	7.5	0.1	3547.2 x 60096.5	47.8475	AB-1 includes 1.3 m/s for Δi post-MOI.
	AB-i (i=2,4)	2.5	0.0	0.0	3497.8 x 53867.1	40.9672	Aerobraking main phase established.
Aerobraking Main Phase	ABM Translation	5.0	0.0	0.0			ABM = aerobraking trim maneuvers
	ACS Rotation	0.0	0.0	5.0	Aerobraking Corridor Control		ABM's as necessary to maintain aerobraking "glide slope." Aerobraking walk-out begins (Hp=106). ~Daily ABM's to protect 3-day orbit lifetime.
Aerobraking Walk-out	ABM Translation	11.0	0.0	0.0			ABM's continually raise Hp (Hp=>144 km).
	ACS Rotation	0.0	0.0	26.5			Aerobraking Termination: Per=1.9 Hrs, Hp=144 km, Ha=451 km
					3544.1 x 3844.7	1.8938	Arg Per=358 deg, FMS=2:00 PM
Aerobraking Contingency	Aerobraking Pop-Up	15.8	0.0	0.0			Aerobraking Pop-Up ΔV: 8.5 m/s Rp raise + 8.5 m/s Rp lower => effective Δh=35 km
	post-Lnch ΔV Reserves	0.0	0.0	0.0			from an orbit with a 2-hour orbit period. Pre-Launch ΔV reserves roll over to increase aerobraking ΔV margins.
Transition To Mapping	ABX	0.0	65.8	0.4	3797.0 x 3844.7	1.9918	ABX includes 1.0 m/s for Δi post-aerobraking.
					3747.0 x 3857.0	1.9771	As Arg Per drifts to 270 deg, Rp decreases and Ra increases.
	TMO	0.0	17.9	0.1	3747.0 x 3786.2	1.9496	TMO - Final maneuver establishing mapping orbit (351 ≤ Altmap ≤ 455).
MAPPING Drag Dens 95%	OTM-1 (Frzn)	0.0	7.5	0.0			OTM-1 - Orbit trim maneuver. Corrects TMO and establishes frozen orbit condition based on gravity field calibration results. Biprop maneuvers (TCM-1/2+OTM-1) with
	OTM (Drag/GTE)	3.9	0.0	0.0	Orbit Trim Maneuvers		statistical components combined at 95th percentile. (Summed means and RSS'd
	ACS Rotation	0.0	0.0	40.0			sigmas) Mapping orbit drag make-up based on atmospheric density confidence level of 95th percentile. (2.0 m/s reserved for GTE => 1.9 m/s drag make-up)
ADDITIONAL ΔV REQ'D	QUARANTINE ORBIT (PQ) - 2-BURN	22.8	0.0	0.0			Planetary quarantine orbit raise maneuver performed at end of mapping mission raises Rp to 427 km. (2-burn maneuver sequence).
RELAY Drag Dens 95%	OTM (Drag)	1.0	0.0	0.0	Orbit Trim Maneuvers		Relay orbit drag make-up (6 months) based on atmospheric density confidence
	ACS Rotation	0.0	0.0	10.0			level of 95th percentile.
	SUB-TOTALS	64.0	1129.8	88.3			
	MISSION TOTAL ΔV	1282.1					