

RTCC MFD Input Reference Guide

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PRELAUNCH

LAUNCH DELAY - UTI, IU, LAU: Record new launch azimuth *After insertion, subtract delay from PTC GET*

TLI

TLI PAD

- Press TLI (M68) on MPT display, Use DMT (MSK 54) for TIG, RPY(TLI), BT, DVC
- Use Checkout Monitor (MSK 1619) REF: MVE for VI and TLI cut-off GET
- RPY(SEP): Add 0 DV maneuver to MPT: Press INP (M66), CSM, TIG: TLI cutoff+15, THR: CSM RCS+X(2 quads), ATT: Inertial, BPA: P1, COO: LVLH=X Y Z (see mission-specific data)
- Use DMT (MSK 54) to view RPY(SEP)
- RPY(EXT): R(SEP)-56, P(SEP)+180, Y(SEP)+/-

TLI+90 MPT: TLI+undocking(CSM only)

- TAR, ENT, RTE: TIG: TLI TIG+90min, LNG: Atlantic (Apollo 16: MPL), TYP: Abort, CLC

TLC

P37/Direct Abort PAD

- TAR, ENT, RTE: TIG: Block Data, LNG: MPL, TYP: Abort, CLC

TLMCC transfer: ITE: iterate

- TAR, MCC, TIG: flight plan

MCC 1&2: - Free-Return Profile (Apollo 8,10,11): Option 3 - Hybrid/Non-FR Profile no LOI ellipse rotation (Apollo 12): Option 5 - Hybrid/Non-FR Profile with LOI ellipse rotation (Apollo 13+): Option 4

MCC 3&4: Option 1 (on Apollo 13+, Option 4 may be used to ensure proper post-LOI ellipse)

Option 1: TAR, MCC, MAN: Option 1, SFP: 1 (no updated SFP) 2 (updated SFP)

Option 3: TAR, MCC, MAN: Option 3, SFP: 1

Option 4: TAR, MCC, MAN: Option 4, SFP: 1, Apollo 13-16: Tweak REVS1 until DOI DVZ = 0. *REVS1 & ETA1 parameter in LOI processor must match TLMCC processor*, Apollo 13-17: Adjust LOI ignition time (below)

Option 5: TAR, MCC, MAN: Option 5, SFP: 1, Adjust LOI ignition time (below)

- TAR, MCC, MID (Midcourse Tradeoff Display), CLC

After final option 2-5 calculation, move column to SFP block 2 (TAR, MCC, MID, F30)

To adjust LOI ignition time:

Constant trans-lunar flight time (Apollo 13 & prior): If TLI is on-time, TAR, MCC, CON, F23: Adjust TLMIN/TLMAX (10-minute range) until LOI ignition time (TAR, MCC, MID: GET LOI) matches flight plan. If TLI is late, do not specify a TLMIN/TLMAX constraint.

Constant lunar arrival GMT (Apollo 14+): Find REV 2 Delta T (Common Functions), Note initial GET LOI (TAR, MCC, MID), then TAR, MCC, CON, F23: Adjust TLMIN/TLMAX (10-minute range) until new GET LOI = old GET LOI + REV 2 Delta T

FLY BY & PC+2 (fly-by targets a slow return ~90 hours, PC+2 targets a fast return ~48 hours)

- TAR, ENT, RTM, OPT: ATP Discrete, TIG: LOI-5/PC+2 hours, LNG: MPL, INC: Optimize DV, if very high INC, tweak EIT then if still >40, set INC: 40, EIT: block data (tweak to find lowest safe fly-by altitude)

For PC+2, TAR, ENT, CON, set VRMAX to 37500 fps, then revert to previous (36323 fps) afterwards

LIFTOFF TIME UPDATE (Apollo 14+)

- RTCC MFD: CFG, UPD, update liftoff time, then subtract nominal liftoff GMT (mission-specific data) from updated liftoff GMT, then DSKY: V55, add result (delay) to CMC clock

- Find nominal liftoff TEPHEM (mission-specific data)

- DSKY: V25N01E, 1706E, load nominal liftoff TEPHEM, V05N01E, 1706E, verify TEPHEM

- RTCC MFD: CFG, UPD, update liftoff time

- CSM SV update, V66

Add delay to PTC GET

LUNAR ORBIT

LOI transfer: ITE: iterate

- TAR, LOI, INI: R1=REVS1(TLMCC), ETA=ETA1(TLMCC)

- TAR, LOI, DIS, CLC: Planned LOI-2 (Apollo 12 and before): Use plane solution. No LOI-2 (Apollo 13+): Use intersection solution.

Each mode has 2 solutions, if they are different, use the solution with the correct HPC, if both HPC are the same but different DV, use the lowest DV solution. If LOI DV is high, note LOI solution AZMN/AZMX range, if range is high, then tweak approach azimuth (TAR, LOI, ADS) until LOI DV is nominal. Do not go outside of azimuth limits (AMN, AMX).

LOI-2 transfer: ITE: iterate

- TAR, DES, MOD: Single CSM Maneuver, SEQ: CIR, DOI, TH1: threshold time before LOI-2 (nearest hour), TH2: threshold time before DOI (nearest hour)

-TAR, DES, DPT, CLC

DOI transfer: ITE: iterate (if LM: 10P: -15s, DPS: 0.4) *for Apollo 17 DOI-1, see common functions*

If DOI-2/Trim: TAR, DES, INI, N: revs before PDI (0), Apollo 17 DOI-2: HDP: 40000 ft

- TAR, DES, MOD: LM Maneuver Sequence, SEQ: DOI, TH1: threshold time before DOI (nearest hour)

- TAR, DES, DPT, CLC

TEI *For Apollo 13+ EOM/INC, see mission-specific data*

- TAR, ENT, RTM, OPT: ATP Search, TIG: flight plan (block data) LNG: MPL (or EOM), EIT: flight plan (TEI usually targets a normal return ~60-80 hours, tweak EIT until TIG matches block data), INC: Optimize DV

- For Apollo 13+ nominal & 1 REV late TEI's: LNG: EOM, INC: Specified INC

- TAR, ENT, RTM, CLC

CIRC transfer: ITE: iterate

- TAR, ORB, TYP: Circularization, PNT: Apoapsis or Time, GET: flight plan, CLC

PDI-0 transfer: ITE: iterate, 10P: -15s, DPS: 0.4

- Find Peri GET: FDO Orbit Digitals LM (MSK 45), GET P = Peri GET

- TAR, REN, DKI, INI, DH = 15, E: 26.6

- TAR, REN, DKI, OPT, MAN: Maneuver Line, RAD: Horizontal

- TAR, REN, DKI, PRO: CSI/CDH Seq, TIG: Peri GET, TPI: Sunrise-16min

NO PDI+12 (Apollo 12 and before) MPT: CSM SEP+DOI

- TAR, REN, LAM, OPT: NCC/NSR, T1: PDI TIG+12min, N:0, SPH: Perturbed, AXI: Multi

OFF: P52,,15,-4.475,, T2: Iterate until Actual TPI Time = Sunrise-23min

To find CSI TIG: calculate CSI, iterate CSI TIG until CSI DV = 0

NO PDI+12 (Apollo 13 and later) transfer: ITE: iterate, 10P: -15s, DPS: 0.4

- TAR, REN, DKI, INI, DH: 15, E: 26.6

- TAR, REN, DKI, TIG: PDI TIG+12min, TPI: Sunrise-16min

- TAR, REN, DKI, PRO: HAM-CSI/CDH Seq (Apollo 13 to 15 both PDIs & 16-17 PDI-2) or CSI/CDH Seq (Apollo 16-17 PDI-1)

- TAR, REN, DKI, OPT, MAN: Spec DTs, RAD: -50 ft/s, DT1: Apollo 16 PDI-1: 50min/Apollo 13-14-15-17 PDI-1, Apollo 16 PDI-2: 55min/Apollo 13-14-15-17 PDI-2: 60min

For Apollo 17: Calculate DVX of No PDI+12 for DOI-2 case

PDI PAD, T1 & T2

- TPI Times: Apollo 12 & earlier: Sunrise-23min, Apollo 13 & later: Sunrise-16min

- Apollo 11 PDI Abort > 10 min phasing TIG: PDI TIG + 67 min

- Apollo 11 T2: MPT: DOI+PDI+Ascent, use Ascent Processor with inputs +5515.2, +19.6, TIG: PDI TIG + 21:24, Checkout Monitor (MVE) for insertion GET, Phasing TIG = insertion GET + 50 min, CSI TIG = Phasing TIG + 2h48m

T3, ASCENT (Concentric)

- TPI Times: Apollo 14 & earlier: Sunrise-23min, Apollo 15+: Sunrise-16min

- TAR, LIF, OPT: Concentric, TPI: TPI, TLO: Desired TPI Time, VOP: Input Ins. Vel., VLH: +5535.6, VLV: +32.0, CLC

-TAR, ASC, CLC, - TAR, LIF, CLC, - TAR, ASC, CLC *For nominal liftoff, note CSI TIG & calculate CSI PAD*

CSI/CDH transfer: ITE: do not iterate, TIM: impulsive TIG

- TAR, REN, CDH, INI, DH: 15 (for CDH: use DH from CSI solution, if different), E: 26.6, TPI: Desired TPI Time

CSI: TAR, REN, CDH, MOD: CSI, TIM: Fixed TPI, TIG: Liftoff/DKI estimate, CLC

CDH: TAR, REN, CDH, MOD: CDH, TIM: Find GETI, TIG: 1st guess, CLC

TPI transfer: ITE: do not iterate, TIM: impulsive TIG

- TAR, REN, LAM, OPT: TPI/TPF, N:0, SPH: Perturbed, AXI: Multi, OFF: P51,0,0,26.6,130.0;, T1: -1:0:0, T2: -1:0:0, CLC

DIRECT ASCENT & TWEAK (Apollo 14+)

- TPI Times: Apollo 14: Sunrise-18.5min, Apollo 15+: Sunrise-16min

- TAR, LIF, OPT: Direct, DT: Apollo 14: 38min, Apollo 15: 45min, Apollo 16/17: 47min, TPI: TLO, TLO: Liftoff TIG 1st guess, CLC

- TAR, ASC, CLC, - TAR, LIF, CLC, DT: Adjust so T TPI = Desired TPI Time, CLC

- TAR, ASC, CLC, - TAR, LIF, CLC *Note insertion GET*

For Tweak: *Pre-fill values before LM liftoff*

- TAR, REN, LAM, OPT: NCC/NSR, T1: Insertion+3min, T2: Desired TPI Time, N:0, Perturbed, AXI: Multi, OFF: P52,,15,-1.7; *Push CLC after insertion & read DV*

PLANE CHANGE transfer: ITE: iterate (update stored RLS to current LM position or set desired coordinates)

- TAR, DES, INI, AZI: Optimum or Desired,

- TAR, DES, MOD: CSM Prelaunch Plane Change, TH1: TIG-1hour, TH2: Align Time-1hour, CLC

SHAPE transfer: ITE: iterate

- TAR, ORB, TYP: Apogee & Perigee change, PNT: Time, GET/ApA/PeA: flight plan, CLC

TEC

TEMCC

- TAR, ENT, RTE, TIG: flight plan, TYP: Corridor Control, CLC

COMMON FUNCTIONS

Find VIO, GET 0.05 G

- Checkout monitor (MSK 1619): U02,CSM,ALT,48.4,GET of EI-10 hours rounded to nearest 10 hours;

GET = GET 0.05 G, V = VIO

Find RTGO (after RTE solution calculated)

- TAR, ENT, SPL: Actual Range = RTGO

Find REV 2 Delta T MPT: MCC+LOI

REV 2 GMT = planned launch GMT + flight plan REV 2 GET

- Checkout monitor (MSK 1619): U02,CSM,GMT,REV 2 GMT,,MCT;

- LONG C: REV 2 longitude, Delta T = 1 minute per 3-degree difference from 180. If LONG C is West (-) of 180, Delta T is negative. If LONG C is East (+) of 180, Delta T is positive. For example, LONG C: +177, Delta T = 1 minute.

Find Sunrise Time For TPI Lighting

- From target vehicle: Sunrise/Sunset times (MSK 1502)

Find Orbit Period, P+Delta T (Apollo 11 T3 PAD)

From CSM, Orbit Digital (MSK 46), TO=Period (P), L: U13,CSM,liftoff REV,LDG SITE LONG,, Liftoff GET - GET L = Delta T

Apollo 17 DOI-1 transfer: ITE: iterate

- TAR, ORB, TYP: Apo & Peri Change, PNT: Time, GET: flight plan, REF: Pad/LS, ApA: 60.0, PeA: 13.17, Tweak GET until LONG P = 31.36

MISSION-SPECIFIC DATA

TLI PAD RPY(SEP) LVLH INPUTS

CSM LVLH P: +120 Y: +/-40 R: 0 = LVDC LVLH P: +41.6 Y: +/-120.8 R: +/-131.9

CSM LVLH P: +120 Y: +/-30 R: 0 = LVDC LVLH P: +48.6 Y: +/-130.9 R: +/-139.1

- Apollo 10: P: +41.6 Y: +120.8 R: +131.9

- Apollo 11 July 16: P: +41.6 Y: +120.8 R: +131.9 July 18/21: P: +41.6 Y: -120.8 R: -131.9

- Apollo 12: P: +48.6 Y: -130.9 R: -139.1 - Apollo 13/14/15/16: P: +41.6 Y: -120.8 R: -131.9

- Apollo 17: P: +41.6 Y: +120.8 R: +131.9

EOM (End Of Mission Target) / Return Inclination

- Apollo 13: -157.497 / 40A - Apollo 14 -171.53 / 40A - Apollo 15: -158.0 / 40A - Apollo 16: -158.7 / 61.8A

- Apollo 17: -166.0 / 66.5D

LM Impact Burn Targets

- Apollo 12: 149:28:17, DVX: -181.2 DVY: +60.3 DVZ: -1.5 - Apollo 13: 144:32:20, DVX: -180.0 DVY: 45.0 DVZ: 0

- Apollo 14: 147:52:59, DVX: -180.0 DVY: +36.5 DVZ: 0 - Apollo 15: 179:06:23, DVX: -161.1 DVY: +57.3 DVZ:

+94.6 - Apollo 16: 179:16:29, DVX: -134.5 DVY: -80.0 DVZ: +168.0 - Apollo 17: 195:39:13, DVX: -219.2 DVY: +56.0 DVZ: +168.0

Nominal Liftoff GMT / TEPHEM

- Apollo 14: 20:23:00 / 00006 35223 16024 - Apollo 15: 13:34:00 / 00000 32251 26157 - Apollo 16: 17:54:00 / 00011 13352 37740 - Apollo 17: 02:53:00 / 00020 34666 32261