#13 PRELAUNCH FINAL

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IN REPLY REFER TO: 70-FM73-56

MAR 1 2 1970

MEMORANDUM TO: FS/Chief, Flight Support Division

FROM : FM/Chief, Mission Planning and Analysis Division

SUBJECT : Final prelaunch erasable load parameters for Apollo 13 flight programs using April 11, 1970 launch date

The enclosure to this memorandum defines the final Apollo 13 prelaunch erasable load parameters for COLOSSUS IID and LUMINARY IC that have been assigned to the Mission Planning and Analysis Division (MPAD). As requested by the Flight Support Division (FSD), MPAD is to supply to the Apollo Guidance Program Section (AGPS) the preliminary and final values for the specified erasable quantities. The Guidance and Performance Branch (GPB) of the MPAD has coordinated with the appropriate MPAD branches for the definition of those parameters, and they are listed in the table (enclosure). It should be noted that certain of the parameters are a function of the launch date. The enclosed table contains values which are valid for a April 11, 1970 launch date. Any questions or comments concerning the erasable load should be directed to Aldo Bordano, extension 4491 or to Wayne Steifle, extension 4581.

John P. Mayer

Enclosure

cc:
(See attached page)

COLOSSUS IID (MANCHE 72 REV 3)

CMC Name	Description	Final Value	
EMDOT	SPS mass flow rate	67.6 lb/sec	0.30663 kg/cs
RTED1	First coefficient defining high speed V-γ target line polynomial	1.6602637	
DVTHRESH	Threshold value of ΔV which must be sensed in two second period or SPS thrust failure is indicated	2.0 ft/sec	0.6096E-2 m/cs
HORIZALT	Horizon altitude	78740.1576 ft	24000.0 m
ALTVAR	COAS angular error variance		0.152168E-4 $(rad)^2$
AZO[1]	Angle between reference and Greenwich meridian at emphemeris origin	278.876597731 deg	.77465721592 rev
UN1TW[1]	Polar axis unit vector in reference coordinates		.36440789700E-4 .43138861656E-4 .99999999627
EK1VAL	SPS impulse acquired from a one second burn	18848. lb-sec	838.400810 kg.m./cs
EK2VAL	SPS minimum impulse constant used to estimate burn time when burn time is less than 1.0 sec.	6606.5 lb-sec	293.871761 kg.m./cs
EK3VAL	SPS minimum impulse constant equal to the slope of the minimum impulse curve. Used to estimate burn time when burn time is less than 1.0 sec.	25454.5 lb	11.32272571 $kg.m./(cs)^2$

CMC Name	Description	Final Value	
FANG	SPS thrust used to estimate burn time when burn time is less than 6 sec.	20385. lb	9.06769976 kg.m./(cs)^2
E3J22R2M	Product of J22 lunar potential coeff., μ moon, radius of the moon squared, and 3.0		92.0479047931E+15 $m^5/(cs)^2$
E32C31RM	Product of C(3,1) lunar potential coeff., μ moon, radius of the moon cubed, and 1.5		13.1289255968E+22 $m^6/(cs)^2$
WRENDPOS	W matrix initialization for rendezvous navigation	10000.0 ft.	3048.0 m
WRENDVEL	W matrix initialization for rendezvous navigation	10.0 fps	0.03048 m/cs
RMAX	Rendezvous navigation position update threshold limit	2000.0 ft.	609.60 m
VMAX	Rendezvous navigation velocity update threshold limit	2.0 fps	0.6096E-2 m/cs
WORBPOS	W matrix initialization for orbital navigation	0.0	
WORBVEL	W matrix initialization for orbit navigation	0.0	
S22WSUBL	W matrix initialization for orbital navigation	32808.4 ft.	10000.0 m
RPVAR	Primary body radius error variance		4000000.0 m^2

CMC Name	Description	Final Value	
504LM[1]	Lunar libration correction vector in moon-fixed coordinates		-.35294517875E-3 rad -.27538836002E-3 rad .37855282426E-3 rad
EMSALT	EMS initialization altitude	290001.0 ft	88392.305 m
RLS[4]	Lunar landing site radius vector		1.653055500E+06 m -5.20704000E+05 m -1.11122500E+05 m
TIMEMO[1]	Time at center of range over which lunar position polynomial is valid		.25207159620E+10 cs
VECOEM[1]	Lunar position polynomial coefficients		$\underline{C}_0$ - $\underline{C}_9$ (meters, centiseconds)

$\underline{C}_0$ m	$\underline{C}_1$ m/cs	$\underline{C}_2$ m/(cs)^2	$\underline{C}_3$ m/(cs)^3
-.395695208+009	-.620883107+000	.125782575-006	.182029392-015
.410797200+008	-.868792701+001	-.140668561-007	.915304306-015
.901138400+007	-.470093012+001	-.326380345-008	.499900872-015
$\underline{C}_4$ m/(cs)^4	$\underline{C}_5$ m/(cs)^5	$\underline{C}_6$ m/(cs)^6	$\underline{C}_7$ m/(cs)^7
-.588310059-023	-.219687434-031	.126732557-040	.136177101-047
.205552145-023	-.182990969-031	-.162962428-039	-.528784573-048
.898642733-024	-.106537698-031	-.871441241-040	-.237136090-048
$\underline{C}_8$ m/(cs)^8	$\underline{C}_9$ m/(cs)^9		
.414341970-056	-.380419660-064		
.603338833-056	.296226476-064		
.339366304-056	.146391935-064		

CMC Name	Description	Final	Value
RESO[1]	Position vector of sun at TIMEMO		.13231044198E+12 m .65299567616E+11 m .28315797504E+11 m
VESO[1]	Velocity vector of sun at TIMEMO		-.14043304825E+3 m/cs .23951376152E+3 m/cs .10385063934E+3 m/cs
OMEGAES[1]	Angular velocity of solar position vector at TIMEMO		.31402530576E-9 rev/cs
INTVAR	Coasting integration error variance		196.0 m^2
LAUNCHAZ[1]	Desired azimuth of the stable member X-axis east of true north	72.042916 deg	0.20011921 rev
WMIDPOS	W matrix initialization for cislunar midcourse navigation	30000.0 ft	9144.0 m
WMIDVEL	W matrix initialization for cislunar midcourse navigation	30 ft/sec	0.09144 m/cs
RVAR	VHF range error variance	0.0	
RVARMIN	VHF minimum range error variance	-40000.0 ft^2	-3716.1216 m^2
LADPAD	Reference L/D ratio	0.30	
LODPAD	Final phase reference L/D ratio	0.18	
ALFAPAD	Hypersonic value of angle of attack (α) for CM in trimmed flight	-21.49 deg	-.0596944 rev
ETDECAY	Value subtracted from time-to-go which compensates for SPS thrust tailoff	.612 sec	61.2 cs

CMC Name	Description		Final Value
PACTOFF	Pitch angle to CSM c.g. at insertion	-1.517 deg.	-63.94099 cdu puls.
YACTOFF	Yaw angle to CSM c.g. at insertion	1.3158 deg.	55.46048 cdu puls.
LEMMASS	LM mass (at transposition and docking)	33420.9 lb	15159.4654 kg.
CSMMASS	CSM mass (at transposition and docking)	63678.1 lb	28883.9006 kg.
POLYNUM	Boost monitor pitch polynomial degree information	5	
	Boost monitor pitch polynomial coefficients, A_0 - A_6		-0.7646894E-01 deg 0.1799880E+00 deg/sec 0.9298907E-02 deg/(sec)^2 -0.1492420E-03 deg/(sec)^3 0.2078269E-05 deg/(sec)^4 -0.1601873E-07 deg/(sec)^5 0.4401981E-10 deg/(sec)^6
SATRLRT	Boost roll rate	1.0 deg/sec	0.27777777E-4 rev/cs
RPSTART	Time from liftoff to start boost polynomial and booster roll	11.85 sec	1185.0 cs
POLYSTOP	Time increment after RPSTART to stop boost polynomial and hold display of attitude error constant	-149.5 sec	-14950.0 cs
P37 RANGE	Nominal inertial range from 300,000 ft altitude to target	1185.64 n.mi.	

CMC Name	Description	Final Value	
LAT (SPL)	Entry target data for boost aborts, latitude	+26.48 deg. (north, geodetic)	.0735555555 rev.
LNG (SPL)	Entry target data for boost aborts, longitude	-17.05 deg. (west)	-0.0473611111 rev.
ECSTEER	Steering parameter (c) for Lambert burn	1.0	

LUMINARY IC (LUMINARY 131)

LGC Name	Description		Final Value
MASS	Total vehicle mass (CSM/LM separation)	33872.3 lb	15364.217 kg
LEMMASS	LM mass (at CSM/LM separation)	33872.3 lb	15364.217 kg
CSMMASS	CSM mass (at CSM/LM separation)	37580.3 lb	17046.138 kg
E3J22R2M	Product of J22 lunar potential coefficient, μ moon, radius of the moon squared, and 3.0		92.0479047931E+15 $m^5/(cs)^2$
E32C31RM	Product of C(3,1) lunar potential coefficient, μ moon, radius of the moon cubed, and 1.5		13.1289255968E+22 $m^6/(cs)^2$
RADSKAL	Quantity representing the LR scale information for high scale radar output		0.0
SKALSKAL	Factor by which the correction to the LR data is reduced if the LR is on low range scale		0.0
X789	Vector containing the best estimate of bias necessary to offset the rendezvous radar position error	0.0 0.0 0.0	
AZØ[1]	Angle between reference and Greenwich meridian at ephemeris origin	278.876597731 deg	0.77465721592 rev
-AYO[1]	True to mean pole rotation about the -Y axis		.36440789700E-4 rad

LGC Name	Description	Final Value	
AXO[1]	True to mean pole rotation about the +X axis		.43138861656E-4 rad
RANGEVAR	Variance expected in measured range	0.1111111111E-4	
RATEVAR	Variance expected in measured range rate	1.877777E-5	
RVARMIN	Minimum rendezvous radar range error variance		66.0 $(\text{meters})^2$
VVARMIN	Minimum rendezvous radar range rate error variance		0.17445E-5 $(\text{meters/cs})^2$
WRENDPOS	1st - 3rd diagonal components of W-matrix	10000 ft	3048.0 m
WRENDVEL	4th - 6th diagonal components of W-matrix	10 ft/sec	.03048 m/cs
WSHAFT	7th diagonal component of W-matrix		0.015 rad.
WTRUN	8th diagonal componet of W-matrix		0.015 rad.
RMAX	Maximum value of rendezvous position update allowed without astronaut approval	2000.0 ft.	609.6 m
VMAX	Maximum value of rendezvous velocity update allowed without astronaut approval	2.0 ft/sec	0.006096 m/cs

LGC Name	Description	Final Value	
WSURFPOS	Variance in spacecraft position on the surface	0.0 ft	0.0 meters
WSURFVEL	Variance in spacecraft velocity on the surface	0.0 ft/sec	0.0 meters/cs
SHAFTVAR	Variance associated with the measured value of the rendezvous radar shaft angle		0.000001 $(rad)^2$
TRUNVAR	Variance associated with the measured value of the rendezvous radar trunion angle		0.000001 $(rad)^2$
504LM[1]	Lunar libration correction vector in moon-fixed coordinates		-.35294517875E-3 rad -.27538836002E-3 rad .37855282426E-3 rad
RLS[4]	Lunar landing site radius vector		1.653055500E+06 m -5.20704000E+05 m -1.11122500E+05 m
TLAND	Nominal time of lunar landing	103.743381 hr GET	37347617.2 cs GET
RBRFG	Hi-gate position aimpoint vector in the descent guidance coordinate system	-3562.05 ft 0.0 -13705.710 ft	-1085.713 m 0.0 -4.17750E+03 m
VBRFG	Hi-gate velocity aimpoint vector expressed in the descent guidance coordinate system	-186.90305 ft/sec 0.0 -98.738190 ft/sec	-5.6968049E-01 m/cs 0.0 -3.0095400E-01 m/cs
ABRFG	Hi-gate acceleration aimpoint vector expressed in the descent guidance coordinate system	-.45024950 $ft/(sec)^2$ 0.0 -9.5150975 $ft/(sec)^2$	-.13723605E-04 $m/(cs)^2$ 0.0 -.29002017E-03 $m/(cs)^2$
VBRFG*[2]	Z component of VBRFG multiplied by 18	-1777.2875 ft/sec	-.54171723E+01 m/cs

LGC Name	Description	Final Value	
ABRFG*	Z component of ABRFG multiplied by 6	-57.090585 ft/(sec)^2	-1.740121E-03 m/(cs)^2
JBRFG*^{3}	Hi-gate jerk aimpoint, Z component only	-.014742736 ft/(sec)^3	-0.449358E-8 m/(cs)^3
GAINBRAK	Gain constant used in the orientation of the descent guidance system in P63	1.0	
TCGFBRAK	Latest time guidance frame is erected in braking phase	30 sec	3000.0 cs
TCGIBRAK	Earliest time guidance frame is erected in braking phase	900 sec	90000.0 cs
RAPFG	Low gate position aimpoint vector in the descent guidance coordinate system	82.9275 ft 0.0 -20.1605 ft	25.276302 m 0.0 -6.1449203 m
VAPFG	Low gate velocity aimpoint vector expressed in the descent guidance coordinate system	-.319 ft/sec 0.0 .31233 ft/sec	-9.7231199E-04 m/cs 0.0 9.5198183E-04m/cs
AAPFG	Low gate acceleration aimpoint vector expressed in the descent guidance coordinate system	0.29982 ft/(sec)^2 0.0 -.40165 ft/(sec)^2	9.1385135E-06m/(cs)^2 0.0 -1.2242292E-05 m/(cs)^2
VAPFG*^{2}	Z component of VAPFG multiplied by 18	5.62194 ft/sec	1.713567E-02 m/cs
AAPFG*	Z component of AAPFG multiplied by 6	-2.40990 ft/(sec)^2	-7.3453752E-05 m/(cs)^2
JAPFG*^{3}	Low gate jerk aimpoint, Z component only	0.03769542 ft/(sec)^3	1.1489564E-08 m/(cs)^3
GAINAPPR	Gain constant used in the orientation of the descent guidance coordinate system in P64	0.0	

LGC Name	Description	Final Value	
TCGFAPPR	Latest time guidance frame is erected in approach phase	6.0 sec	600.0 cs
TCGIAPPR	Earliest time guidance frame is erected in approach phase	200 sec	20000.0 cs
VIGN	Speed desired at ignition, relative to the rotating moon	5545.3644 ft/sec	16.90227069 m/cs
RIGNX	X component of desired position relative to the landing site. Expressed in the descent guidance coordinate system	-133371.54 ft	-40651.64539 m
RIGNZ	Z component of desired position relative to the landing site (desired cross range component is zero)	-1445069.5 ft	-440457.1836 m
KIGNX/B4	Landing site vertical error scale factor used in the ignition-time test quantity	-.331	
KIGNY/B8	Cross range error scale factor used in the ignition-time test quantity	$-5.86940E-07\ (ft)^{-1}$	
KIGNV/B4	Speed error scale factor used in the ignition-time test quantity	-438.0 sec	-43800. cs
LOWCRIT	Upper limit on the variable throttle region in a situation of decreasing thrust commands	5985 lb	2124.4 DPS throttle pulses
HIGHCRIT	Upper limit on the variable throttle region in a situation of increasing thrust commands	6615.0 lb	2348.0 DPS throttle pulses

LGC Name	Description		Final Value
TAUHZ	Time constant for nulling horizontal velocity in P-66 auto		5.0000000E+02 m/cs
QHZ	Feedback constant for previous acceleration level		4.0000000E-01
AHZLIM	Maximum horizontal acceleration in auto P-66		5.9100000E-05
TOOFEW	Minimum no. of consecutive ROD calculations required before issuing program alarm in P-66		3.0000000
HLROOF	Altitude of which the landing radar updating is inhibited	50.0 ft	1.5240000E+01 m
2LATE466	Maximum time after start of servicer cycle for which 2nd ROD calculations will be started	1.50 sec	1.5000000E+02 cs
DELQFIX	LR data reasonableness test parameter	200.0 ft	60.960 m
LRVMAX	Maximum limit for velocity calculations that are allowed to be updated by the LR	2000.0 ft/sec	6.0960 m/cs
LRVF	Value at which velocity update coefficients are changed	200.0 ft/sec	0.6096 m/cs
LRWVZ	Weighting factor for LR Z-axis velocity update	0.3	
LRWVY	Weighting factor for LR Y-axis velocity update	0.3	
LRWVX	Weighting factor for LR X-axis velocity update	0.3	
LRWVFZ	LR velocity weighting function	0.2	
LRWVFY	LR velocity weighting function	0.2	
LRWVFX	LR velocity weighting function	0.2	
LRWVFF	Weighting factor used for P65, P66, and P67	0.1	

LGC Name	Description	Final Value	
RODSCALE	Click scale factor for rate of descent	1.0 ft/sec	0.30480E-2 m/cs
TAUROD	Time constant for rate of descent	1.5 sec	150.0 cs
LAG/TAU	Lag time divided by TAUROD (P66)	0.413333	
MINFORCE	Minimum thrust P66 will command	980.0 lb	0.43592571 kg.m./(cs)^2
MAXFORCE	Maximum thrust P66 will command	6300.0 lb	2.8023796 kg.m./(cs)^2
J1PARAM	Parameter used in the computation of insertion velocity for aborts if the LM to CSM phase angle existing at the time of abort is less than THETCRIT	6042735.9 ft	1841825.90 m
K1PARAM	Same definition as J1PARAM	-317438.91 ft/rad	
J2PARAM	Parameter used in the computation of insertion velocity for aborts if the LM to CSM phase angle existing at the time of abort is greater or equal to THETCRIT	6046910.4 ft	1843098.29 m
K2PARAM	Same definition as J2PARAM	-624599.85 ft/rad	
THETCRIT	Central angle switching criteria	-.29990476 rad	
RAMIN	The minimum apolune radius allowed for aborts from powered descent	5880484.94 ft	1792371.81 m
YLIM	Maximum cross range distance in aborts	8.2 n. mi.	15186.4 m
ABTRDOT	Desired radial velocity for aborts	19.5 ft/sec	0.594360E-1 m/cs

LGC Name	Description	Final Value		
COSTHET1	Cosine 90°. Cosine of cone 1 angle for aborts. Used to determine direction of attitude rotation to preferred abort attitude.	0.0		
COSTHET2	Cosine 30°. Cosine of cone 2 angle for aborts. Used to determine direction of attitude rotation to preferred abort attitude.	0.8660254037		
HIASCENT	Upper bound on the mass of the ascent stage	10900.0 lb		
ROLLTIME	Time to drive the DPS gimbal around the R-axis, starting at the hard stop, to position it prior to DOI	28.60 sec	2860 cs	
PITTIME	Time to drive the DPS gimbal around the Q-axis, starting at the hard stop, to position it prior to DOI	23.79 sec	2379 cs	
IGNAOSQ	Initial DAP estimate of offset acceleration about the Q axis	7.63 deg/(sec)^2	2.119444E-02	rev/(sec)^2
IGNAOSR	Initial DAP estimate of offset acceleration about the R axis	0.57 deg/(sec)^2	1.583333E-03	rev/(sec)^2
LRHMAX	Maximum limit for altitude calculations that are allowed to be updated by the LR	50000.0 ft	15240.0 m	
LRWH	Weighting factor for incorporation of LR altitude measurements into the LM state vector	0.35		

LGC Name	Description	Final Value	
ZOOMTIME	Time after ignition to raise the DPS to full throttle position	26.0 sec	2600 cs
TENDBRAK	Time from the end of the present phase when the transition is made from the quadratic braking phase into the linear braking phase or into the approach phase	62.0 sec	6200 cs
TENDAPPR	Time from the end of the present phase when the transition is made from the quadratic approach phase into the linear approach phase or into the final phase	12.0 sec	1200 cs
DELTTFAP	Time increment added to t_{go} when switching from P63 to P64	-90.0 sec	-9000.0 cs
LEADTIME	Time increment specifying how far guidance is projected forward in P63 and P64	-2.2 sec	-220.0 cs
RPCRTIME	Time from the end of the present descent guidance phase at which the LR may be repositioned to position 2	62.0 sec	6200 cs
RPCRTQSW	Required X component of the X-body axis in platform coordinates at the time of LR reposition to position 2	-1.0	
TNEWA	Cycle period at which Lambert solution updates A-steer target parameters	15.53 days	134217728.0 cs ($20000\ 00000_8$)

[1] These values are valid for a launch date of April 11, 1970.

[2] To achieve the proper octal value in the LGC, this number should be scaled B13.

[3] To achieve the proper octal value in the LGC, this number should be scaled B-21.

[4] FRA MAURO landing site used for April 11, 1970 launch date.