

P40 SPS THRUSTING

Prethrust Program Complete
 Verify SIM BASIC and PRE SPS
 BURN SIM PREP (CUE CARD)
 CMC & ISS - on
 SCS - OPERATING
 TEST C/W LAMPS
 Perform EMS ΔV TEST & NULL
 BIAS CHECK, pg G/2-5
 Set ΔVC
 EMS FUNC - ΔV
 SPS GAUGING - AC1
 PUG MODE - ~~NORMAL~~ PRIM
 OXID FLOW vlv - ~~PR~~ SEC
 BMAG MODE (3) - RATE 2
 CMC MODE - FREE
 AUTO RCS SELECT(16)-as req'd
 LOAD DAP (check roll jets)
 ROT CONTR PWR NORM (2) - AC/DC
 Set DET
 V37E 00E
 SC CONT - CMC/AUTO

THRUSTING (P40's)

3/29/72
 DATE 12/8/71

- 1 MNVR TO PAD BURN ATT
V49E
- 2 PERFORM BORESIGHT & SXT STAR CHECK
V41 N91E
- 3 V37E 40E
(TFI available via N40, N45 or N35)
- 4 F 50 18 REQUEST MNVR TO FDAI RPY ANGLES (.01°)
(AUTO) BMAG MODE (3) - RATE 2
SC CONT - CMC/AUTO
PRO
- 5 06 18 AUTO MNVR TO FDAI RPY ANGLES (.01°)

6 F 50 18 REQUEST TRIM MNVR TO FDAI RPY ANGLES
ALIGN S/C ROLL (.01°)
GDC ALIGN

TVC CHECK & PREP

cb STAB CONT SYS (all) - close (Pnl 8)
cb SPS (12) - close
SET ΔVC (verify)
EMS FUNC - ΔV (verify)
MAN ATT (3) - RATE CMD
ATT DB - MIN
RATE - LOW
SCS TVC (2) - RATE CMD
ΔVCG - LM/CSM or CSM
TVC GMBL DRIVE P&Y - AUTO

+54:00m
(-06:00)

MN BUS TIE (2) - ON
TAPE RCDR - HBR/RCD/FWD/CMD RESET
SPS He vlvs (2) - AUTO (verify)
Check N2 A and N2 B
TVC SERVO PWR #1 - AC1/MNA
TVC SERVO PWR #2 - AC2/MNB
ROT CONTR PWR NORMAL (2) - AC
ROT CONT PWR DIRECT (2) - OFF
BMAG MODE (3) - ATT1/RATE 2
SC CONT - SCS
RHC #2 - ARMED

55:00m
(-05:00)

PRIMARY TVC CHECK

GMBL MOT P1-Y1-START/ON (LMP Confirm)
Verify TRIM CONTROL & SET
Verify MTVC
IF SCS: SCS TVC (2) - AUTO
SC CONT - CMC (SCS)
THC - CW
Verify NO MTVC

SEC TVC CHECK

GMBL MOT P2-Y2-START/ON (LMP Confirm)
SET GPI TRIM
Verify MTVC
THC NEUTRAL
Verify NO MTVC

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Verify GPI returns to 0,0(CMC)or trim
(SCS)

(TRIM) ROT CONT PWR NORM (2) - AC/DC
ROT CONT PWR DIRECT (2) - MNA/MNB
BMAG MODE (3) - RATE 2
PRO
BMAG MODE (3) - ATT1/RATE 2
ENTR

7 F 50 25 00204 GMBL TEST OPTION
(ACCEPT) SC CONT - CMC (verify)
PRO

Monitor GPI Response:
00,20,-20,00,02,-02,00, Trim

*TEST FAIL: *
*SC CONT - SCS *
SCS TVC(2) - AUTO

(REJECT) ENTR

8 06 40 TFI, VG, ΔVM (min-sec,.1fps)
PROG ALARM - TIG Slipped
*V5N9E 01703 *
*KEY RLSE TO 8 *

FDAI SCALE - 5/1
RATE - HIGH
UPDATE DET

59:00
(-01:00)

EMS MODE - NORMAL
TRANS CONT PWR - ON
ΔV THRUST A(B) - NORMAL
THC - ARMED
RHC (2) - ARMED

59:25
(-00:35)

DSKY BLANKS

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59:30 (AVE G ON)
(-00:30)

06 40 TFI, VG, ΔVM (min-sec, .1fps)
CHECK PIPA BIAS <2fps for 5 sec

59:XX ULLAGE
(-00:XX)

*If no ULLAGE: *
* DIR ULLAGE PB - PUSH*
* Control Att with RHC*

MONITOR ΔVM (R3) COUNTING UP

59:55
(-00:05)

F 99 40 ENG ON ENABLE REQUEST
(AUTO IGN) PRO AT TFI >0 Sec
(BYPASS IGN) ENTR to 11 (Perform switching in 10)
EXIT - V37E 00E

9 00:00 IGN *IF SCS: +X & THRUST PB - PUSH*

06 40 TFC, VG, ΔVM (min-sec, .1fps, .1fps)

*F 97 40 SPS Thrust fail *
*ΔV THRUST B(A)-NORMAL *
*(CONT GUID) PRO to 06 40 *
(RECYCLE) ENTR to TIG-05sec

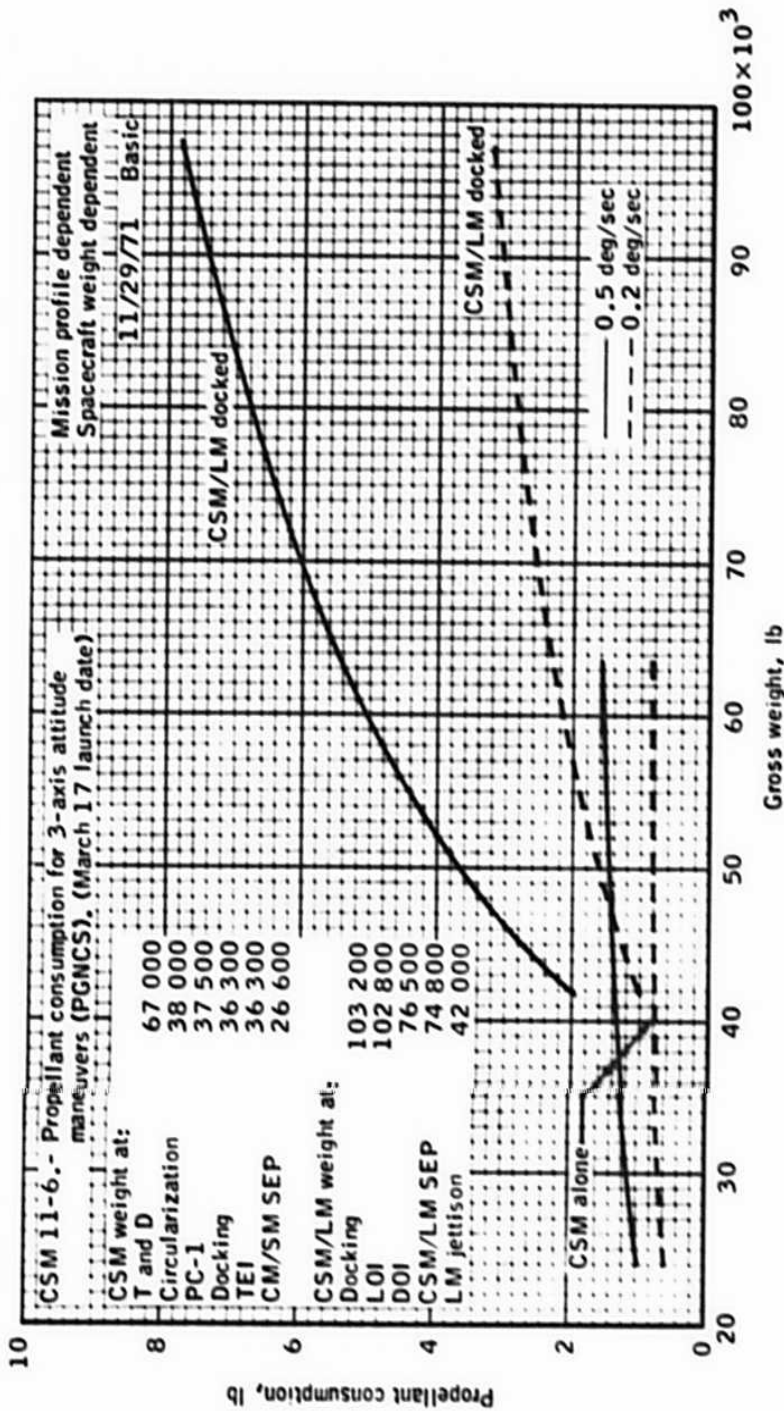
00:03

SPS THRUST Lt - ON
ΔV THRUST B(A) - NORMAL
IF SCS: +X & THRUST PB - PUSH
MONITOR THRUSTING
Pc 95-105 psia
EMS COUNTING DOWN
SPS INJ VLVS (4) - OPEN
SPS He vlvs tb-gray
SPS FUEL/OXID PRESS - 170-195 psia
PUGS - BALANCED

XX:XX	ECO	
10 F 16 40	TFC (STATIC), VG, Δ VM (min-sec,.1fps) Δ V THRUST A&B - OFF VERIFY THRUST OFF SPS INJ VLVS (4) - CLOSED SPS He vlvs tb (2) - bp GMBL MTRS (4) - OFF (LMP Confirm) TVC SERVO PWR 1&2 - OFF PRO	
11 F 16 85	VG XYZ (CM) (.1fps) NULL RESIDUALS RHC & THC - LOCKED TRANS CONT PWR - OFF ROT CONTR PWR DIRECT (2) - OFF cb DIRECT ULLAGE (2) - open cb SPS P1 & Y1 - open RECORD Δ V COUNTER & RESIDUALS Δ VC EMS FUNC - OFF VGX EMS MODE - STBY VGY PRO (If MINKEY, to Sequencer VGZ 3X.2) ATT DB - MAX BMAG MODE (3) - RATE 2 MN BUS TIE (2) - OFF PCM BIT RATE - LOW	PROP CONS
12 F 37	V82E	
13 F 16 44	HA,HP,TFF (.1nm,min-sec) PRO	
14 F 37	OOE	

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PROP CONS



Propellant consumption 3-axis attitude maneuvers (PGNCS).

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CSM 11-17.- SM RCS propellant translation cost.
(March 17 launch date)

SM RCS PROPELLANT TRANSLATION COST

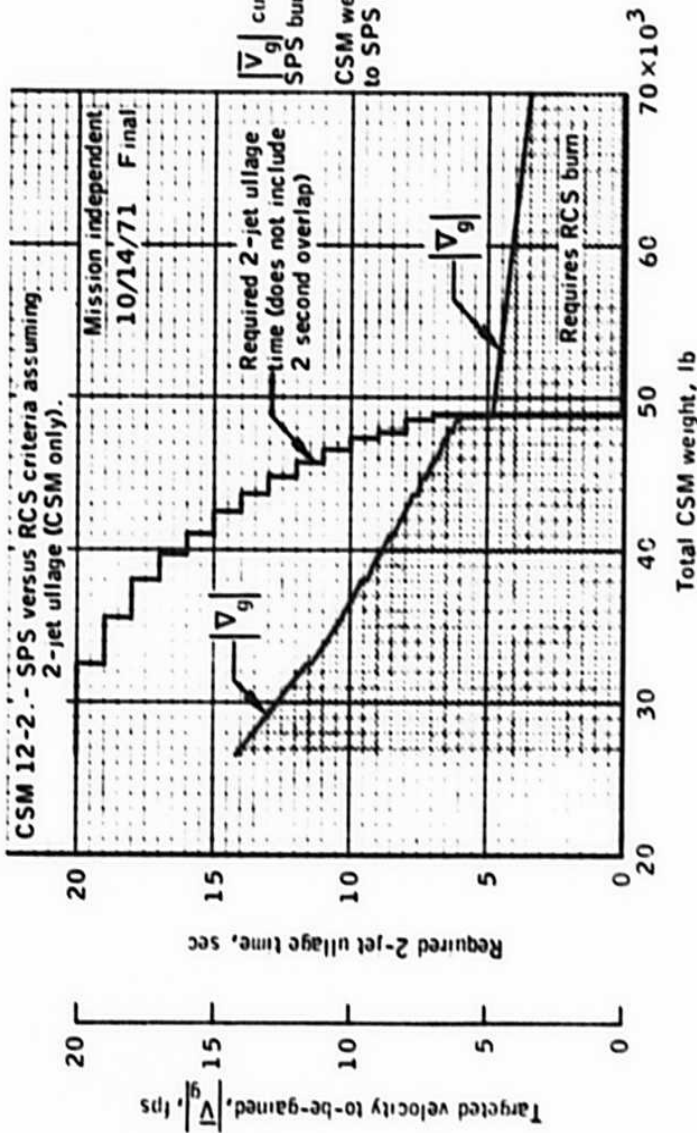
APOLLO 16

(CSM 113/LM-11)

Mission phase	Typical S/C weight (1b)	$\frac{+X}{4}$ jet G&C (1b/fps)	$\frac{+X}{4}$ jet SCS (1b/fps)	$\frac{+X}{2}$ jet A/C G&C (1b/fps)	$\frac{+X}{2}$ jet A/C SCS (1b/fps)	$\frac{+X}{2}$ jet B/D G&C (1b/fps)	$\frac{+X}{2}$ jet B/D SCS (1b/fps)	$\frac{+Y \text{ or } +Z}{G&C}$ (1b/fps)
Translunar	103 000	11.7	13.3	12.0	13.3	12.4	13.3	--
Lunar orbit docked	75 000	8.6	9.3	8.7	9.3	8.8	9.3	--
Lunar orbit undocked	36 500	4.0	4.7	4.1	4.7	4.3	4.7	5.0
Transearth	26 900	3.1	3.8	3.2	3.8	3.4	3.8	3.5

57

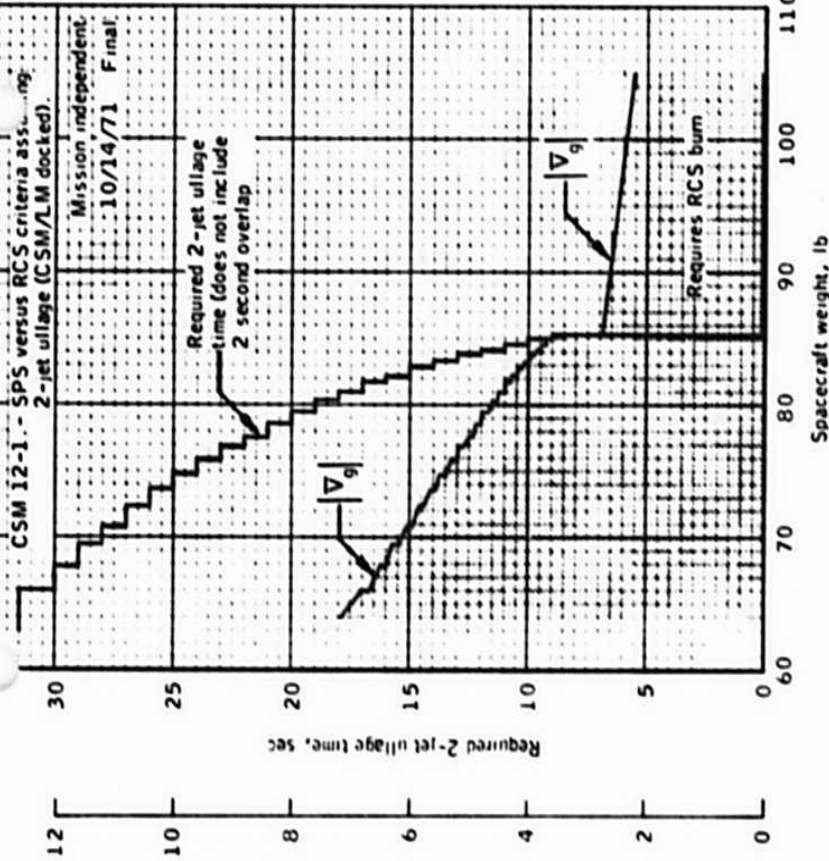
SPS vs RCS CRITERIA



SPS versus RCS criteria assuming 2-jet ullage (CSM only).

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Assumptions

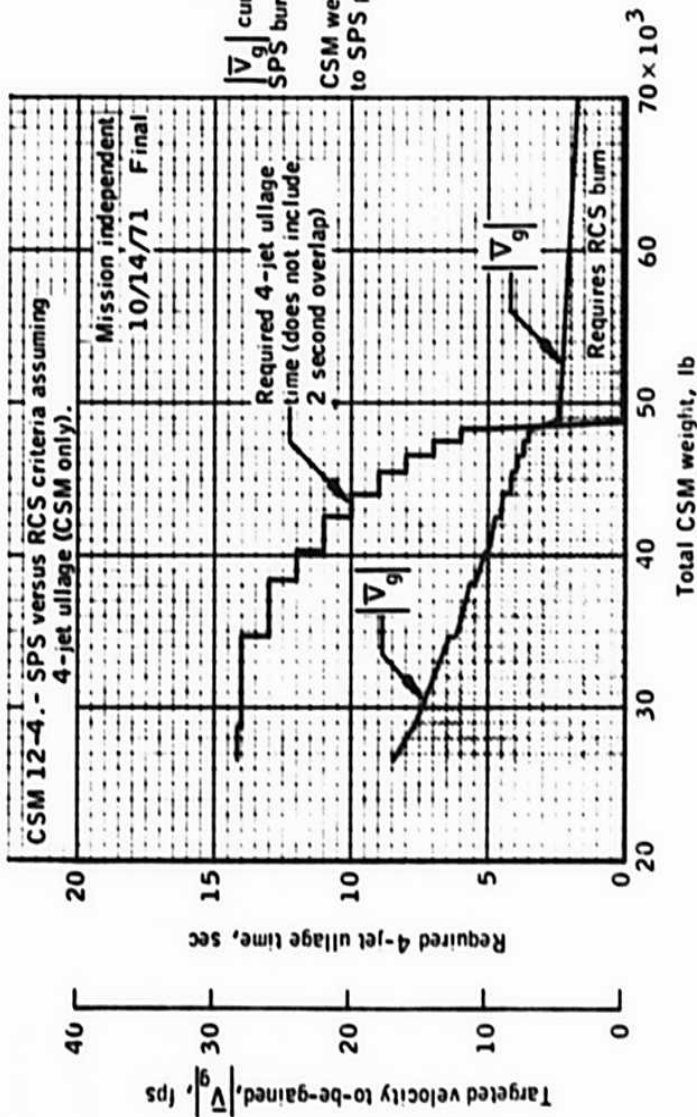
Spacecraft weight assumed to consist of CSM and fully loaded LM

\bar{V}_g curve represents minimum SPS burn of 0.5 seconds

CSM weight variations are due to SPS propellant loss only

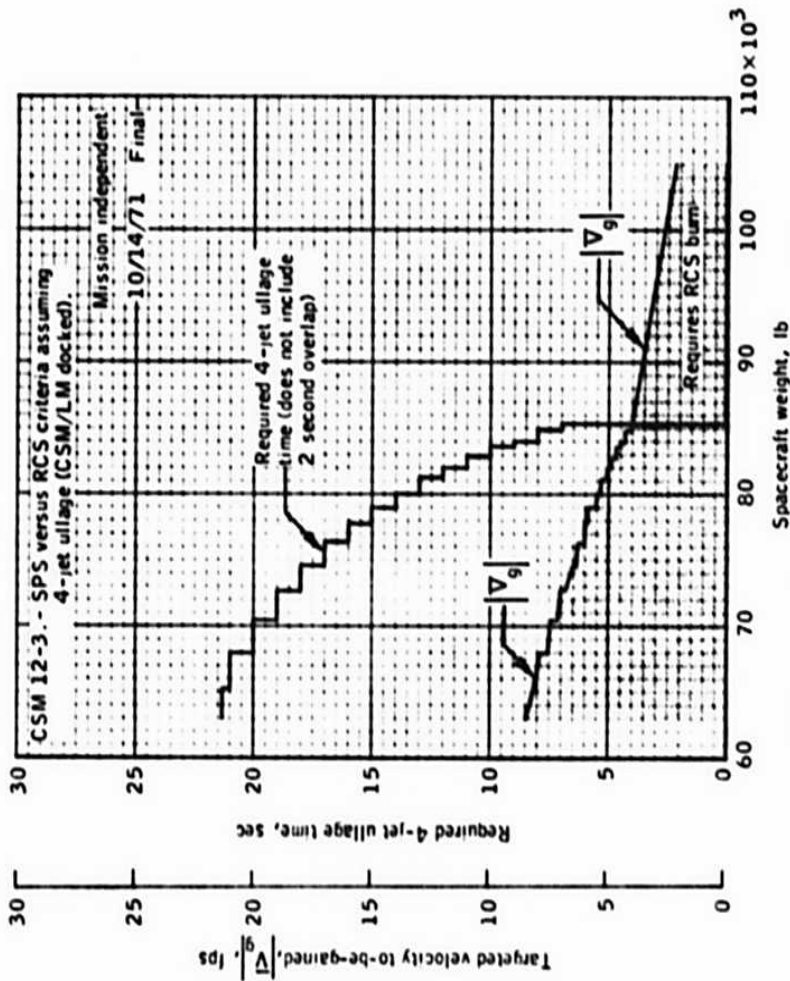
5-6

SPS versus RCS criteria assuming 2-jet ullage (CSM/LM docked).



SPS versus RCS criteria assuming 4-jet ullage (CSM only).

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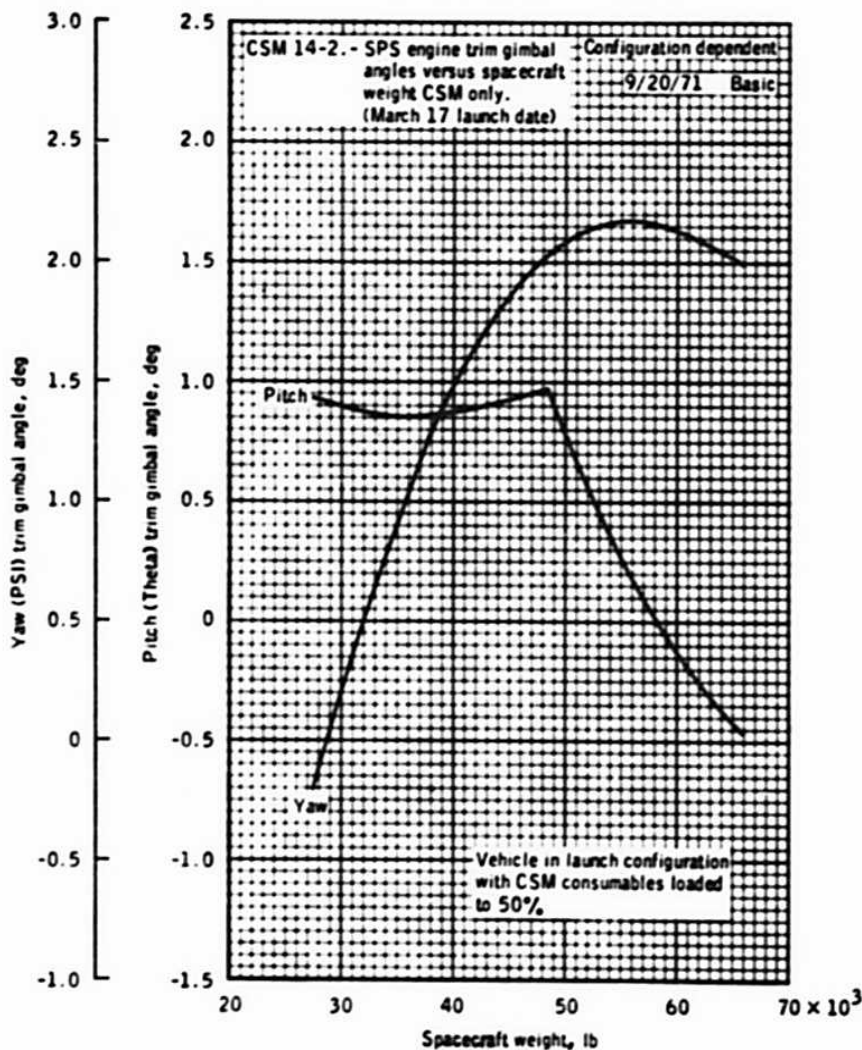
SPS versus RCS criteria assuming 4-jet ullage (CSM/LM docked).

Assumptions

Spacecraft weight assumed to consist of CSM and fully loaded LM

V_g curve represents minimum SPS burn of 0.5 seconds

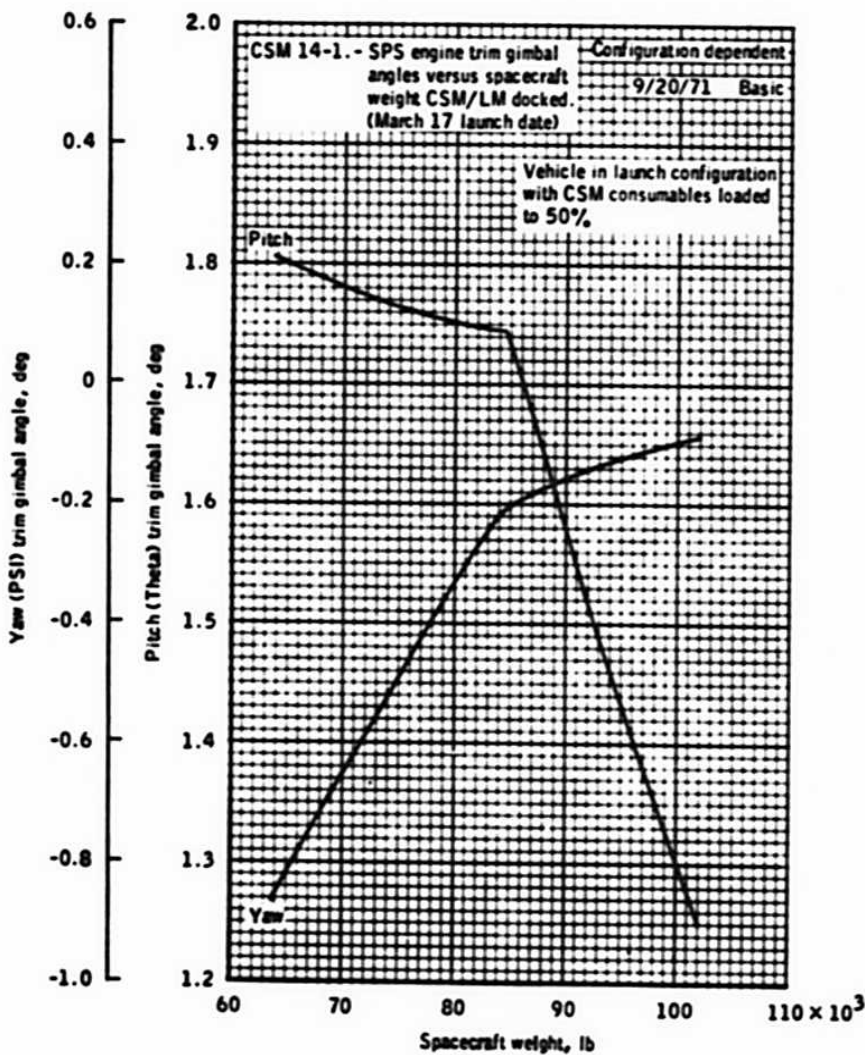
CSM weight variations are due to SPS propellant loss only



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SPS engine trim gimbal angles versus spacecraft weight CSM only.

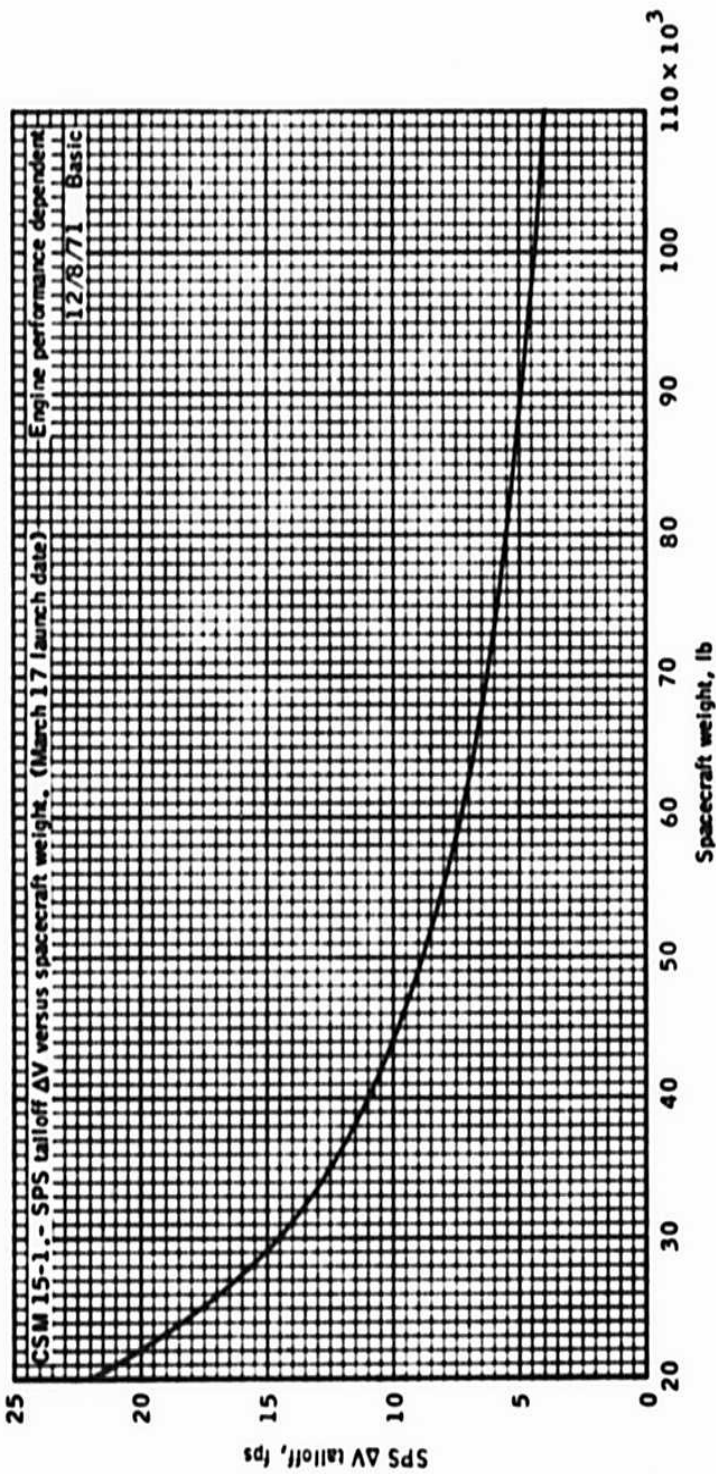
Does not include SPS Propellant



SPS engine trim gimbal angles versus spacecraft weight CSM/LM docked.

Does not include SPS Propellant

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SPS tailoff ΔV versus spacecraft weight.

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P41 - RCS THRUSTING

Prethrust Program Complete
Verify SIM BASIC CONFIGURATION
(CUE CARD)
CMC - on
ISS - on
SCS - OPERATING
TEST C/W LAMPS
Perform EMS ΔV TEST & NULL
BIAS CHECK, pg G/2-5
Set $\Delta V C$
EMS FUNC - ΔV
BMAG MODE (3) - RATE 2
CMC MODE - FREE
AUTO RCS SELECT (16) - as Req'd
LOAD DAP (check roll jets)
ROT CONTR PWR NORMAL (2) - AC/DC
ROT CONTR PWR DIRECT (2) - MNA/B
Set DET
V37E 00E
SC CONT - CMC/AUTO

1 MNVR TO PAD BURN ATTITUDE
V49E

2 PERFORM BORESIGHT & SXT STAR CHECK
V41 N91E

3 V37E 41E
(TFI available via N40, N45 or N35)

4 F 50 18 REQUEST MNVR TO FDAI RPY ANGLES (.01°)
(AUTO) BMAG MODE (3) - RATE 2
SC CONT - CMC/AUTO
PRO

5 06 18 AUTO MNVR TO FDAI RPY ANGLES (.01°)

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G
5-16

6 F 50 18 REQUEST MNVR TO FDAI RPY ANGLES (.01°)
(AUTO TRIM) BMAG MODE (3) - RATE 2
ALIGN SC ROLL
SC CONT - CMC/AUTO

PRO

MAN ATT (3) - RATE CMD
ATT DB - MIN
RATE - LOW
BMAG MODE (3) - ATT1/RATE 2
GDC ALIGN

ENTR

7 06 85 VG X,Y,Z (.1fps)

* PROG Alarm 1t *
* V5N9E - 01703 - TIG SLIPPED *
* KEY RLSE To 7 *

55:00
(-05:00)

TRANS CONT PWR - on (up)
HAND CONTROLLERS - ARMED

59:25
(-00:35)

DSKY BLANKS

59:30
(-00:30)

8 16 85 VG X,Y,Z (AVE G ON)
TAPE RCDR - HBR/RCD/FWD/CMD RESET
LIMIT CYCLE - OFF
EMS MODE - NORMAL

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00:00
9 F 16 85 VG X,Y,Z
NULL COMPONENTS
RHC & THC - LOCKED
TRANS CONT PWR - OFF
ROT CONTR PWR DIRECT - OFF
RECORD Δ V COUNTER & RESIDUALS Δ VC _____
EMS FUNC - OFF VGX _____
EMS MODE - STBY VGY _____
PRO (If MINKEY, to sequencer 3X.2) VGZ _____
BMAG MODE (3) - RATE 2
TAPE RCDR - off (ctr)
PCM BIT RATE - LOW

10 F 37 V82E

11 F 16 44 HA,HP,TFF (.1nm,min-sec)

PRO

12 F 37 00E

P47 Thrust Monitor Program

CMC - on
ISS - on & aligned

1 F 16 83 V37E 47E
 Δ V XYZ(CSM) (.1fps)

VI,HDOT,H available by N62E
*KEY RLSE to return to N83 *

(RECYCLE) V32E
(TERM) PRO

2 F 37 00E

DATE 12/8/71