EMP ASTP-76 CSM-ALONE TRANSLATIONAL IMPULSE MODE

PURPOSE:

This EMP provides impulse translation in response to Translational Hand Controller (THC) deflections in the AUTO or HOLD mode. EMP ASTP-76 responds to each discrete deflection of the THC by firing a pair of translational jets for a period of n milliseconds, where n is a quantity stored in erasable memory. The astronaut can apply a multiplication factor of 1, 2, or 4 to the n millisecond firing time by setting his panel switch for CMC Control Mode to one of the positions, FREE, HOLD, or AUTO. By appropriate DSKY operations, the astronaut can modify the basic firing time of n milliseconds and/or he can apply an additional multiplication factor in response to the position (IU or CMC) of the IU GUIDANCE switch.

FUNCTIONAL DESCRIPTION:

EMP ASTP-76 is designed for use in the CSM ALONE or CSM/DM configuration, but uses the Docked DAP with modified erasable loads for attitude control. When EMP ASTP-76 is active, execution of its coding is triggered by the DOWNLINK interrupt (every 20 ms. high bit rate). Because the CMC Control Mode switch (AUTO, HOLD, FREE; bits 13, 14 of channel 31) is used by EMP ASTP-76 the Digital Autopilot (DAP) uses C31FLWRD instead of bits 13, 14 of channel 31. The EMP does copy bit 15 of channel 31 into C31FLWRD, so that the DAP will have correct, up-to-date information on the SC Control Mode switch, (a two-position switch, CMC or SCS).

The initial EMP pass activates code to re-store VAC area protection for the EMP code, re-directing

N 26 for the next VERB 31 ENTR. The EMP phase following the second VERB 31 ENTR (1) re-directs N26 so that the next V 31 E will execute the EMP termination, (2) sets bits 13 - 14 of C31FLWRD so that the DAP will use CMC MODE AUTO from C31FLWRD, ignoring the true switch position, and (3) initializes ECP and ECYW. On each cycle of EMP ASTP 76, the translation bits of channel 31 are compared to a stored image of channel 31 from the previous iteration. A new THC command causes a pair of translation jets to be fired. The switch for CMC Control Mode applies a multiplication factor of 1, 2, or 4 (corresponding to a switch positions FREE, HOLD, and AUTO) to the nominal firing time. The same multiplication factor is used to calculate the DAP inhibition counter value, which specifies the number of passes during which the DAP jet firings are inhibited to prevent interference with the impulse firing. Initial values provided by the uplink are shown in Table I.

Since Y and Z axis translation firings introduce significant pitch or yaw rotations, EMP ASTP-76 supplies rotational firings to correct the induced attitude error (the DAP jet firings being inhibited), and it informs the DAP rate estimator of the translational and the corrective firings. Translation impulse firings are max-limited to 10.24 sec and corrective firings are minimum-limited to 14 milliseconds.

The value of variable OMICRON (R3 of Noun 78) is copied into downlist location MARKDOWN + 6 in

each pass. The termination zeros bits 13 - 14 of C31FLWRD, so that the DAP will respond to the CMC Control Mode switch.

ASSUMPTIONS:

1) The vehicles are not actually docked.
2) Zeros have been loaded for the ACXTRANS and BDXTRANS digits of N87 R1 (i.e., the normal Docked DAP X translation response is disconnected).
3) Torque couple control has been selected for both Pitch and Yaw.
4) No jets are (hardware) disabled.
5) The EMP has been uplinked, and the initial phase is activated before the code in VACs 3, 4 can be overlaid.
6) Downlink high bit rate has been selected. Note: Low bit rate could synchronize with DAP and inhibit operation of EMP ASTP-76.

RESTRICTIONS and LIMITATIONS:

1) The EMP has been designed and tested for use in P20 Option 5, and in P00 only.
2) EMP must be terminated before activating CSM-alone DAP (V 46 E).
3) Enter one THC command at a time; return to detent between commands.
4) When EMP ASTP-76 is active, changes to the CMC Autopilot Control mode must be implemented by DSKY changes to C31FLWRD (in location 373 octal) because the EMP pre-empts the use of the corresponding panel switch.
5) Software jet inhibitions will be ignored.
6) P21, P29, and P3x overlay the EMP coding, and therefore must not be executed after the EMP has been uplinked.

7) If any VERB 37 major mode change or restart has occurred after EMP ASTP-76 coding is up-linked, ensure that the program code in VAC areas 3 and 4 is intact.

PROCEDURES:

1) VERB 44 ENTR
Load NOUN 87:
R1 X0000
R2 00000
R3 00000
where X can be either 0 or 1.
Load NOUN 89 with desired rate and deadband.

2) VERB 45 ENTR

3) VERB 5 NOUN 26 to verify NOUN 26 contains
R1 00001
R2 01555
R3 12007

4) VERB 31 ENTR to activate initial (protective) phase of EMP.

5) VERB 5 NOUN 26 to verify NOUN 26 contains
R1 00001
R2 01523
R3 12007

6) VERB 31 ENTR to activate EMP ASTP-76.

7) VERB 5 NOUN 26 ENTR to verify NOUN 26 contains
R1 00001
R2 01536
R3 12007

8) VERB 31 ENTR to terminate the EMP.

9) VERB 46 ENTR to change from Docked DAP operation to undocked.

RECOVERY/
TERMINATION:

1) Activation of EMP ASTP-76 via VERB 31 ENTR alters NOUN 26 so that the next VERB 31 ENTR terminates the EMP. Therefore termination procedure is: VERB 31 ENTR.

2) A software restart (including VERB 37 ENTR XXENTR) will not affect the operation of the EMP. (See RESTRICTIONS and LIMITATIONS, #6 and 7) V74 WILL TERMINATE

3) EMP ASTP-76 is not restart protected. Should a hardware restart occur, VERB 25 NOUN 26 ENTR 00001 ENTR 01523 ENTR 12007 ENTR will re-direct NOUN 26 to the EMP initialization entry, so that the next VERB 31 ENTR will re-start the EMP at section 5) of "PROCEDURES". VERB 25 NOUN 26 ENTR 00001 ENTR 01555 ENTR 12007 ENTR will restart the EMP at section 3) of "PROCEDURES"

4) After termination of EMP ASTP-76, execute VERB 46 ENTR. Further execution of the Docked DAP depends on re-loading erasables ECP, ECYW, KMJDCKD, KMJ1DCKD, KMJ2DCKD, J/MDCKD, J/M1DCKD, J/M2DCKD with values appropriate to docked operations.

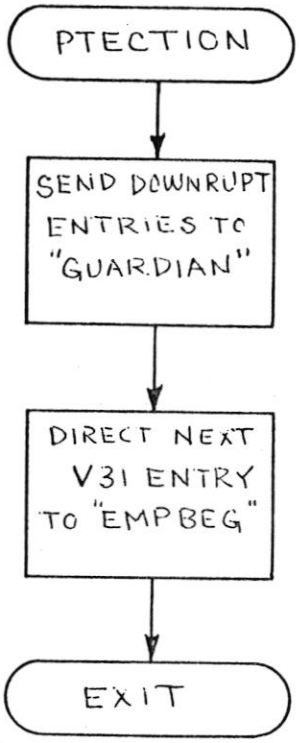
TABLE 1

Initial Values Provided by Uplink

ECADR			
2462	INMS	310	.125 sec. impulse firing interval corresponds to Delta-V of .025 fps for a 32000 lb. vehicle.
1377	NHIBIT	2	Number of inhibited DAP passes
530	VAC3USE	0	Pre-empts VAC 3.
604	VAC4USE	0	Pre-empts VAC 4.
3043	KMJDCKD	1711	
3044	KMJ1DCKD	261	
3045	KMJ2DCKD	261	
3046	J/MDCKD	21	
3047	J/M1DCKD	137	
3050	J/M2DCKD	137	

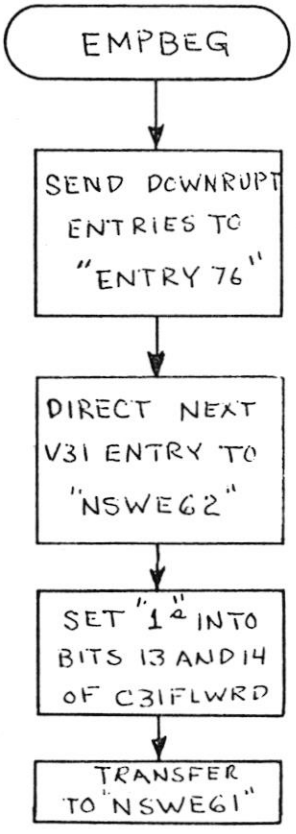
A .1 FPS (X4)
H .05 FPS (X2)
F .025 FPS (X1)

EMP ASTP-76 FLOWCHART (PAGE 1 OF 6)



FIRST V31 ENTRY (NORMALLY EXECUTED FROM GROUND).

GUARDIAN ZEROS THE VAC3USE AND VAC4USE CELLS.



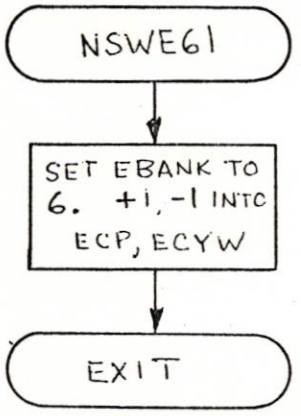
SECOND V31 ENTRY

START EXECUTING EMP AT NEXT DOWNRUPT.

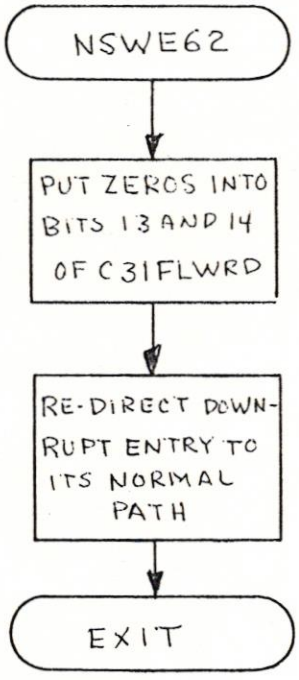
DAP WILL READ THESE BITS INSTEAD OF CMC MODE SWITCH BITS IN CHANNEL 31.

GO TO UNSWITCHED ERASABLE IN ORDER TO ACCESS EBANK 6

EMP ASTP-76 FLOWCHART (PAGE 2 OF 6)



ECP, ECYW MAX. MAGNITUDES ARE = 1.



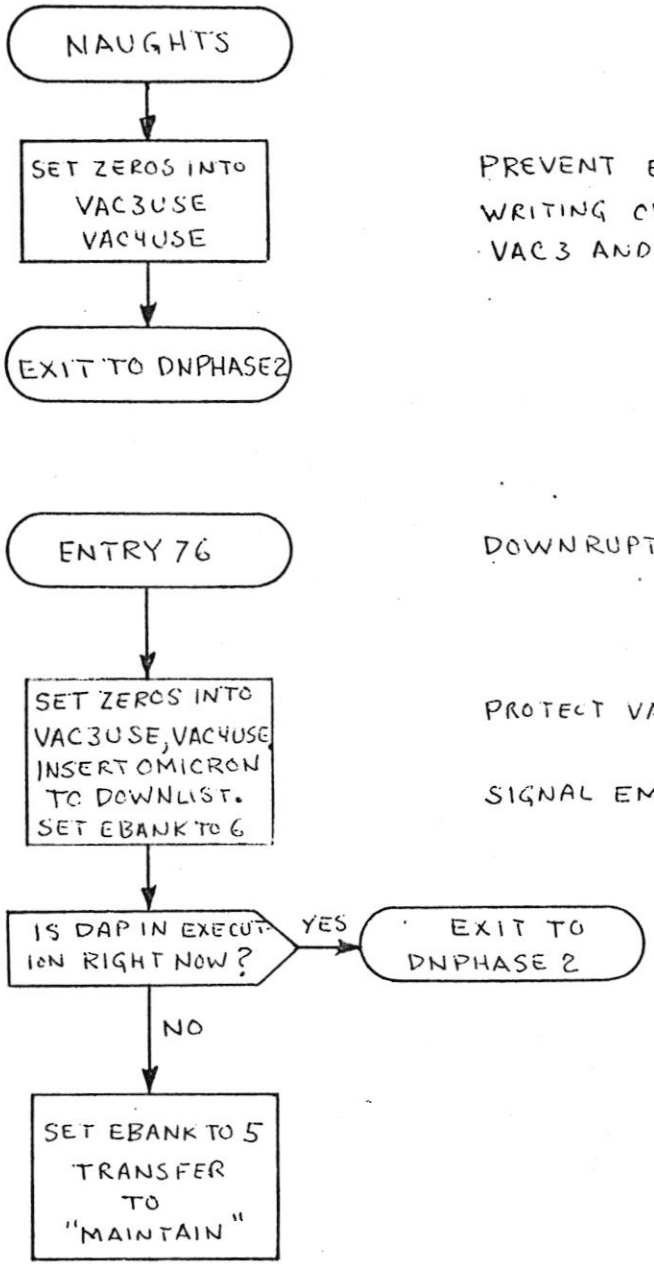
THIRD V31 ENTRY.

DAP WILL NOW HONOR CMC MODE SWITCH BITS IN CHANNEL 31.

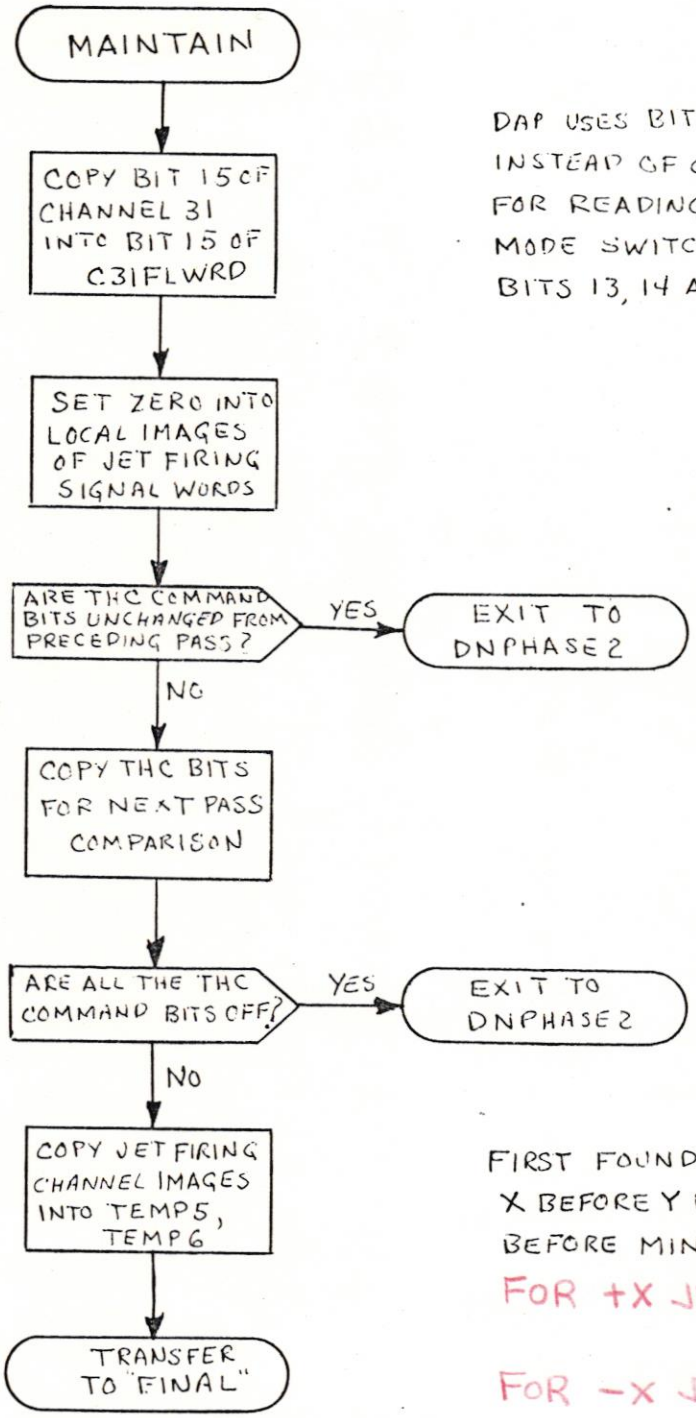
DOWNRUPT ENTRY

"GUARDIAN" IS IN UNSWITCHED ERASABLE. "NAUGHTS" IS IN EBANK 7.

EMP ASTP-76 FLOWCHART (PAGE 3 OF 6)



EMP ASTP-76 FLOWCHART (PAGE 4 OF 6)



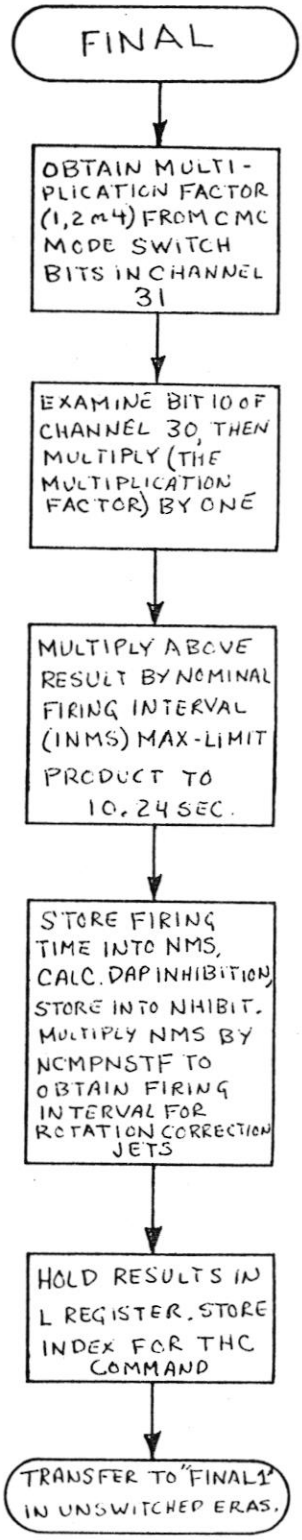
DAP USES BIT 15 OF C31FLWRD INSTEAD OF CHANNEL 31 BIT 15 FOR READING THE SC CONTROL MODE SWITCH WHILE C31FLWRD BITS 13, 14 ARE NOT BOTH ZERO.

FIRST FOUND WILL BE IMPLEMENTED
X BEFORE Y BEFORE Z, PLUS BEFORE MINUS.

FOR +X JETS 5 & 6 ARE FIRED (D B)

FOR −X JETS 8 & 7 ARE FIRED (D B)

EMP ASTP-76 FLOWCHART (PAGE 5 OF 6)



THIS CODE CAN APPLY AN ADDITIONAL FACTOR, DEPENDENT ON POSITION OF IU GUIDANCE SWITCH, IF ONE WORD IS CHANGED.

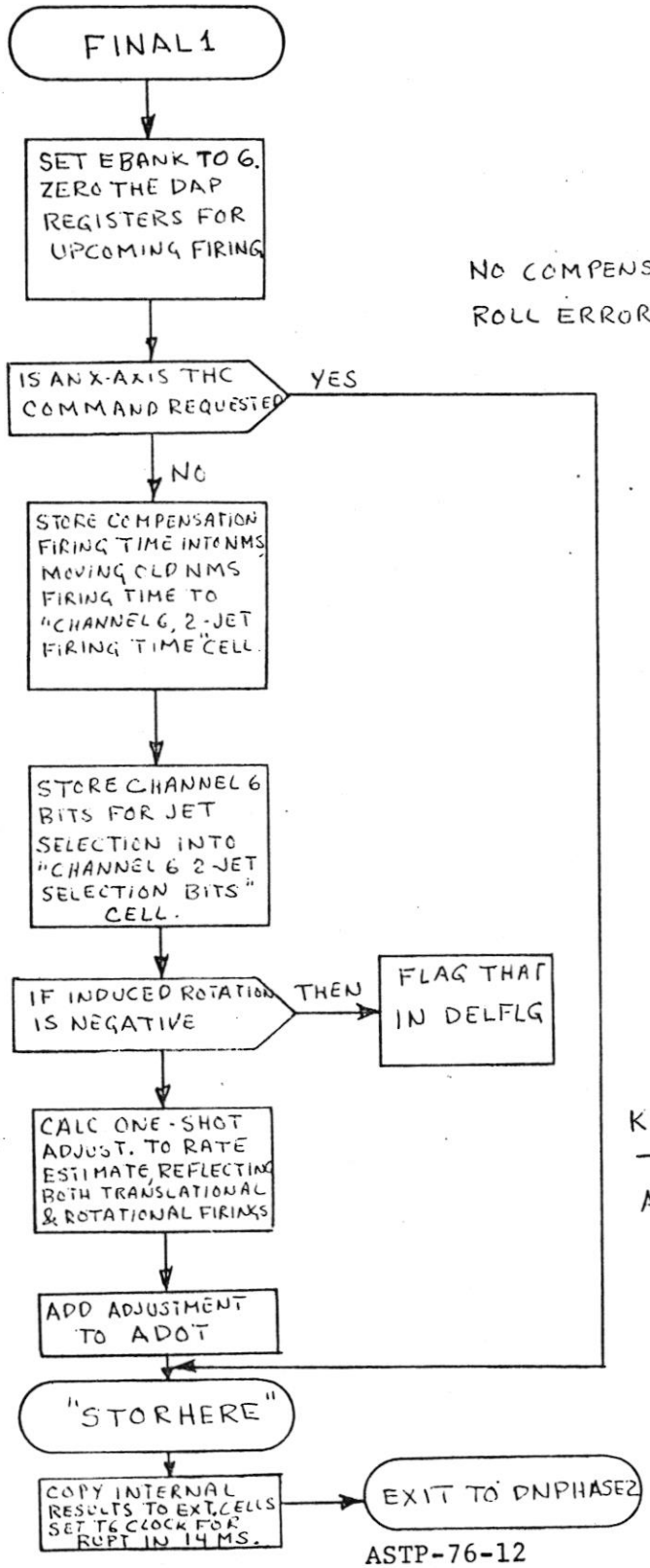
A IS ROTATION DUE TO TRANSLATION FIRINGS, B IS ROTATION DUE TO CORRECTION FIRINGS. CORRECTION FIRING TIME IS

$$NMS * \left(1 - SQRT\left((A+B)/B\right)\right)$$

FOR ZERO ATTITUDE ERROR AFTER COMPLETED FIRING.

GO TO UNSWITCHED FOR E6 CALCULATIONS.

EMP ASTP-76 FLOWCHART (PAGE 6 OF 6)



NO COMPENSATION FOR INDUCED ROLL ERRORS.

KMJ*(1/ECP + NCMPNSTF −1)*2 IS THE DV ADJUSTMENT TO ADOT.

ECADR	Tag	Code		Comments	Octal
000530	VAC3USE	OCT	0	PREEMPT VAC3	00000
000531	NSWE61	TC	E6SETTER		04611
000532		CS	L		40001
000533		DXCH	ECP		53440
000534	NSWE61X	TC	TASKOVER		05327
000535	ENTRY76	CA	ZERO	PROTECT VACS	35003
000536		TS	VAC3USE		54530
000537		TS	VAC4USE		54604
000540		TC	E7SETTER	INSERT OMICRON	04606
000541		CA	AZIMANGL	TO DOWNLIST	31344
000542		XCH	MARKDOWN +6		57662
000543		TC	E6SETTER		04611
000544		CCS	DAPZRUPT	IS DAP EXECUT-	11463
000545		TC	DNPHASE2	ING RIGHT NOW?	03452
000546		TC	DNPHASE2		03452
000547		TC	+2		00551
000550		TC	DNPHASE2		03452
000551		CA	EBANK5		35055
000552		TS	EBANK		54003
000553		TC	MAINTAIN		01400
000554	FINAL1	TC	E6SETTER		04611
000555		CA	FIVE	ZEROING SEVEN	35004
000556	LOOP2STP	TS	DELFLG	QUANTITIES	55553
000557		CA	ZERO		35003
000560		INDEX	DELFLG		51553
000561		TS	5PT		55477
000562		CCS	DELFLG		11553
000563		TC	LOOP2STP		00556
000564		CCS	HOLDDIFF	X AXIS THC?	11367
000565		TC	STORHERE	X AXIS. GO ON	00637
000566		TC	DNPHASE2	AVAILABLE	03452
000567		TC	+1		00570
000570		LXCH	NMS	Y OR Z THC	23370
000571		CCS	A		10000

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000572          CS      ONE                             45001
000573          INDEX   A                               50000
000574          LXCH    62YWT                           23504
000575          TS      TEX1        SAVE Y/Z INDEX      54072
000576          ADS     A                               26000
000577          TS      TEX2        SAVE FOR ADOT       54073
000600          CA      TEMP6                           31373
000601          INDEX   TEX1                            50072
000602          TS      62YWW                           55512
000603  603     TC      VAC4                            00605
000604  VAC4USE OCTAL   0                               00000
000605  VAC4    CA      HOLDDIFF    POS OR NEG ROTN?    31367
000606          EXTEND                                  00006
000607          MP      HALF                            74764
000610          MASK    BIT1                            75001
000611          TS      L                               54001
000612          CA      HOLDDIFF                        31367
000613          MASK    BIT1                            75001
000614          EXTEND                                  00006
000615          RXOR    LCHAN                           06001
000616          CCS     A                               10000
000617          TC      NOTIFY      POS ROTN. SKIP      00625
000620          INDEX   TEX1                            50072
000621          CA      BIT11                           34767
000622          ADS     DELFLG                          27553
000623          CS      CRECTION                        40655
000624          TC      +2                              00626
000625  NOTIFY  CA      CRECTION                        30655
000626          EXTEND                                  00006
000627          INDEX   TEX1                            50072
000630          MP      KMJ2        KMJ*(1/ECP +        71653
000631          DAS     A           NCMPNSTF-1)*2       20001
000632          EXTEND              IS DV ADJUSTMENT    00006
000633          INDEX   TEX1        TO ADOT.            50072
000634          MP      62YWT                           71504
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000635                  INDEX   TEX2                            50073
000636                  ADS     ADOT2                           27566
000637  STORHERE        CA      TEMP6                           31373
000640                  TS      6WORD                           55662
000641                  CA      TEMP5                           31372
000642                  TS      5WORD                           55661
000643                  CA      NMS                             31370
000644                  TS      NEXT6INT                        55660
000645                  CA      NHIBIT                          31377
000646                  TS      INHIBIT                         55465
000647                  CA      DEC23                           34626
000650                  TS      TIME6                           54031
000651                  CAF     BIT15                           34763
000652                  EXTEND                                  00006
000653                  WOR     CHAN13                          05013
000654                  TC      DNPHASE2                        03452
000655  CRECTION        OCTAL   46200           FOR ADOT UPDATE 46200
000656  DEC103          DEC     103                             00147
001016  N26/PRI         OCT     00001                           00001
001017                  ADRES   PTECTION                        01555
001020                  OCT     12007                           12007
001366  TEMP31          OCT     37777                           37777
001372  TEMP5           OCT     0                               00000
001373  TEMP6           OCT     0                               00000
001374  GUARDIAN        TC      E7SETTER        SET EBANK       04606
001375                  TC      NAUGHTS         PROTECT VACS    01550
001377  NHIBIT          OCT     2                               00002
003523  EMPBEG          CA      EMPAD           POINT INTERRUPT 31545
003524                  XCH     DNTMGOTO        TO EMP ASTP76   56334
003525                  CA      EXITLOC         POINT VERB 31   31546
003526                  XCH     N26/PRI +1      TO EMP EXIT     57017
003527                  CS      BIT13-14        ESTABLISH C31FL 44346
003530                  MASK    C31FLWRD                        70373
003531                  AD      BIT 13-14                       64346
003532                  XCH     C31FLWRD                        56373
003533                  CA      NEGMAX                          34763
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003534                  XCH     L                               56001
003535  GONSWE61        TC      NSWE61          USE EBANK6      00531
003536  NSWE62          CS      BIT13-14                        44346
003537                  MASK    C31FLWRD                        70373
003540                  TC      +1                              01541
003541                  XCH     C31FLWRD                        56373
003542                  CA      OCT03452        RE-CONNECT THE  31547
003543                  XCH     DNTMGOTO        DOWNLINK        56334
003544  NSWE62X         TC      TASKOVER                        05327
003545  EMPAD           ADRES   ENTRY76                         00535
003546  EXITLOC         ADRES   NSWE62                          01536
003547  OCT03452        OCTAL   03452           DOWNLINK POINTER 03452
003550  NAUGHTS         CA      ZERO            PROTECT VAC     35003
003551                  TS      VAC3USE         AREAS 3, 4      54530
003552                  TS      VAC4USE                         54604
003553                  TC      DNPHASE2                        03452
003554  GUARDLOC        ADRES   GUARDIAN                        01374
003555  PTECTION        CA      GUARDLOC        VAC 3, 4 PRO    31554
003556                  XCH     DNTMGOTO        TECTION UNTIL   56334
003557                  CA      ADREMP          NEXT VERB 31    31562
003560                  XCH     N26/PRI +1                      57017
003561                  TC      TASKOVER                        05327
003562  ADREMP          ADRES   EMPBEG                          01523
002400  MAINTAIN        CA      NEGMAX          MAINTAIN BIT15  34763
002401                  EXTEND                  OF C31FLWRD     00006
002402                  RAND    CHAN31                          02031
002403                  XCH     C31FLWRD                        56373
002404                  MASK    POSMAX                          74761
002405                  ADS     C31FLWRD                        26373
002406                  CAF     ZERO                            35003
002407                  TS      TEMP5                           55372
002410                  TS      TEMP6                           55373
002411  THCSCAN         EXTEND                  NORMAL PATH     00006
002412                  READ    CHAN31                          00031
002413                  TS      L               NEW THC CMD?    54001
002414                  CA      TEMP31                          31366
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002415                  EXTEND                                  00006
002416                  RXOR    LCHAN                           06001
002417                  MASK    OCT07700                        71463
002420                  CCS     A                               10000
002421                  TC      +2                              01423
002422                  TC      DNPHASE2                        03452
002423                  LXCH    TEMP31                          23366
002424                  CA      FIVE                            35004
002425  LOOPPASS        TS      AVAIL1                          55475
002426                  CA      TEMP31                          31366
002427                  INDEX   AVAIL1                          51475
002430                  MASK    BIT12                           74766
002431                  CCS     A                               10000
002432                  TC      LOOPSTEP                        01442
002433                  INDEX   AVAIL1                          51475
002434                  CA      -ZFORC                          31446
002435                  TS      TEMP6                           55373
002436                  INDEX   AVAIL1                          51475
002437                  CA      -ZCMPNST                        31454
002440                  TS      TEMP5                           55372
002441                  TC      FINAL                           01464
002442  LOOPSTEP        CCS     AVAIL1                          11475
002443                  TC      LOOPPASS                        01425
002444                  TC      DNPHASE2                        03452
002445  NCMPNSTF        OCT     67663           SQRT(5/9)-1     67663
002446  -ZFORC          OCT     00006                           00006
002447  +ZFORC          OCT     00011                           00011
002450  -YFORC          OCT     00140                           00140
002451  +YFORC          OCT     00220                           00220
002452  -XCMPNST        OCT     0                               00000
002453  +XCMPNST        OCT     0                               00000
002454  -ZCMPNST        OCT     5                               00005
002455  +ZCMPNST        OCT     12                              00012
002456  -YCMPNST        OCT     240                             00240
002457  +YCMPNST        OCT     120                             00120
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002460   -EXBD      OCT      140                          00140
002461   +EXBD      OCT      220                          00220
002462   INMS       OCT      310          .125 SEC        00310
002463   OCT07700   OCT      07700                        07700
002464   FINAL      EXTEND                                00006
002465              READ     CHAN31                       00031
002466              MASK     BIT13-14                     74346
002467              EXTEND                                00006
002470              MP       BIT3                         74777
002471              TS       L                            54001
002472              AD       NEG3                         67700
002473              CCS      A                            10000
002474              TC       +5                           01501
002475   AVAIL1     TC       +4                           01501
002476              TC       +3                           01501
002477              CA       BIT3                         34777
002500              TS       L                            54001
002501              EXTEND                                00006
002502              READ     CHAN30                       00030
002503              MASK     BIT10                        74770
002504              CCS      A                            10000
002505              CA       ZERO                         35003
002506              AD       ONE                          65001
002507              EXTEND                                00006
002510              MP       L                            70001
002511              CA       L                            30001
002512              EXTEND                                00006
002513              MP       INMS                         71462
002514              CCS      A                            10000
002515              TC       +3                           01520
002516              CA       L                            30001
002517              TC       +2                           01521
002520              CA       POSMAX                       34761
002521              TS       NMS                          55370
002522              EXTEND                                00006
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002523          MP      DEC103          70656
002524          XCH     NHIBIT          57377
002525          CA      NMS             31370
002526          EXTEND                  00006
002527          MP      NCMPNSTF        71445
002530          AD      DEC23           64626
002531          CCS     A               10000
002532          CA      ZERO            35003
002533          TC      +2              01535
002534          AD      ONE             65001
002535          AD      DEC23           64626
002536          TS      L               54001
002537          CS      THREE           46214
002540          AD      AVAIL1          61475
002541          TS      HOLDDIFF        55367
002542          TC      FINAL1          00554
003043  3043    OCT     01711           01711
003044          OCT     00261           00261
003045          OCT     00261           00261
003046          OCT     00021           00021
003047          OCT     00137           00137
003050          OCT     00137           00137
```

UPLINK:

Load 1	Load 2	Load 3	Load 4	Load 5
V 72 E	V 71 E	V 71 E	V 71 E	V 71 E
17 E	24 E	24 E	24 E	24 E
1016 E	530 E	552 E	574 E	616 E
1 E	0 E	54003 E	23504 E	10000 E
1017 E	4611 E	1400 E	54072 E	625 E
1555 E	40001 E	4611 E	26000 E	50072 E
1020 E	53440 E	35004 E	54073 E	34767 E
12007 E	5327 E	55553 E	31373 E	27553 E
1366 E	35003 E	35003 E	50072 E	40655 E
37777 E	54530 E	51553 E	55512 E	626 E
1374 E	54604 E	55477 E	605 E	30655 E
4606 E	4606 E	11553 E	0 E	6 E
1375 E	31344 E	556 E	31367 E	50072 E
1550 E	57662 E	11367 E	6 E	71653 E
1377 E	4611 E	637 E	74764 E	20001 E
2 E	11463 E	3452 E	75001 E	6 E
V 33 E	3452 E	570 E	54001 E	50072 E
	3452 E	23370 E	31367 E	71504 E
	551 E	10000 E	75001 E	50073 E
	3452 E	45001 E	6 E	27566 E
	35055 E	50000 E	6001 E	31373 E
	V 33 E	V 33 E	V 33 E	V 33 E

UPLINK:

Load 6	Load 7	Load 8	Load 9	Load 10
V 71 E	V71 E	V 71 E	V 71 E	V 71 E
21 E	24 E	20 E	24 E	24 E
640 E	3523 E	3545 E	2400 E	2422 E
55662 E	31545 E	535 E	34763 E	3452 E
31372 E	56334 E	1536 E	6 E	23366 E
55661 E	31546 E	3452 E	2031 E	35004 E
31370 E	57017 E	35003 E	56373 E	55475 E
55660 E	44346 E	54530 E	74761 E	31366 E
31377 E	70373 E	54604 E	26373 E	51475 E
55465 E	64346 E	3452 E	35003 E	74766 E
34626 E	56373 E	1374 E	55372 E	10000 E
54031 E	34763 E	31554 E	55373 E	1442 E
34763 E	56001 E	56334 E	6 E	51475 E
6 E	531 E	31562 E	31 E	31446 E
5013 E	44346 E	57017 E	54001 E	55373 E
03452 E	70373 E	5327 E	31366 E	51475 E
46200 E	1541 E	1523 E	6 E	31454 E
147 E	56373 E	V 33 E	6001 E	55372 E
V 33 E	31547 E		71463 E	1464 E
	56334 E		10000 E	11475 E
	5327 E		1423 E	1425 E
	V 33 E		V 33 E	V 33 E

DO NOT UPLINK WITH 1ST 14 LOADS.

Load 11	Load 12	Load 13	Load 14	Load 15
V 71 E	V 71 E	V 71 E	V 71 E	V 71 E
24 E	24 E	24 E	13 E	10 E
2444 E	2466 E	2510 E	2532 E	3043 E
3452 E	74346 E	70001 E	35003 E	1711 E
67663 E	6 E	30001 E	1535 E	261 E
6 E	74777 E	6 E	65001 E	261 E
11 E	54001 E	71462 E	64626 E	21 E
140 E	67700 E	10000 E	54001 E	137 E
220 E	10000 E	1520 E	46214 E	137 E
0 E	1501 E	30001 E	61475 E.	V 33 E
0 E	1501 E	1521 E	55367 E	
5 E	1501 E	34761 E	554 E	
12 E	34777 E	55370 E	V 33 E	
240 E	54001 E	6 E		
120 E	6 E	70656 E		
140 E	30 E	57377 E		
220 E	74770 E	31370 E		
310 E	10000 E	6 E		
7700 E	35003 E	71445 E		
6 E	65001 E	64626 E		
31 E	6 E	10000 E		
V 33 E	V 33 E	V 33 E		

*Locations 3043 through 3050 are Docked DAP pad loads. The values are a function of the mass properties of the specific vehicle being controlled. These values are for a CSM/DM at separation from Soyuz (based on the O.D.B. Volume II Amendment 5). (See Table 1 for values.)