Ascent Targeting Workbook
ASC TGT-S 2102

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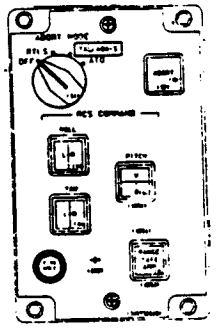
Practice cases in OMS 1 and OMS 2 targeting for nominal, ATO and AOA situations.



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ASCENT OMS TARGETING WORKBOOK

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Introduction

This lesson is designed to provide practice in the application of the OMS 1 and OMS 2 targeting cards in a variety of nominal and abort situations. This lesson is intended to be a interim replacement for the OMS targeting lesson on the Regency Trainer which is currently out-of-date. Prior to taking this lesson you should be familiar with ascent abort procedures and should have read the ATO/AOA/TAL Training Manual (ATO/AOA/TAL 2102).

This lesson will present a brief review of the targeting cards and procedures and then provide a series of practice cases in which you will be given initial conditions at MECO and be asked to select the appropriate OMS 1 target. After checking to see that the OMS 1 target selection is correct you will be given post-OMS 1 conditions and be asked to select the appropriate target for OMS 2.

The targeting options vary for different types of Shuttle missions and so there will be three different sets of cases presented. The unique aspects of targeting will be explained for each set before starting the practice cases.

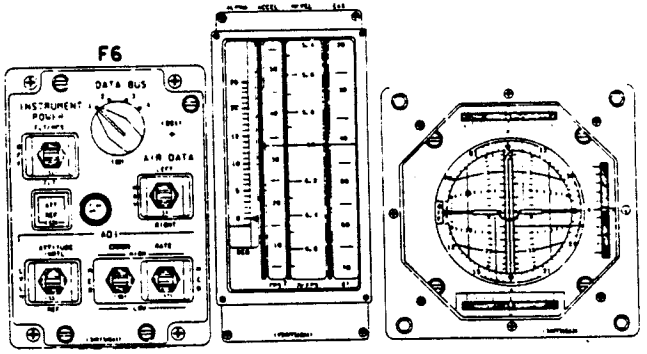
Type A Mission: No Pre-MECO ATO

The first type of Shuttle flight to be dealt with is one in which it is not considered necessary for performance reasons to include procedures for pre-MECO ATO selection. This means that unless an RTLS or TAL is required there are no special actions before MECO even if a main engine failure occurs. The principle consequence of this is that no pre-MECO OMS propellant dump is done for ATO situations.

The situation at MECO is evaluated and if an abort is required the appropriate target for OMS 1 is selected based on a recommendation from Mission Control. In case the crew can not talk to the MCC, targeting cards are included in the Ascent Checklist which can be used to determine the correct target.

There are three basic reasons for an ascent abort: 1) a main engine failure which causes an underspeed at MECO, 2) a failure in the OMS which causes a loss of post-MECO delta-V capability, or 3) a failure of a support system which makes it necessary to land early.

At MECO the crew should determine if any of the three abort situations exist. You should suspect an underspeed if there was a main engine failure and in any case you should take a look at the velocity indicator to see that MECO occurred at the correct velocity.



The Mach/Velocity Meter on panel F6 (and F8) indicates inertial velocity during Ascent.

Type A Mission: No Pre-MECO ATO

The first type of Shuttle flight to be dealt with is one in which it is not considered necessary for performance reasons to include procedures for pre-MECO ATO selection. This means that unless an RTLS or TAL is required there are no special actions before MECO even if a main engine failure occurs. The principle consequence of this is that no pre-MECO OMS propellant dump is done for ATO situations.

The situation at MECO is evaluated and if an abort is required the appropriate target for OMS 1 is selected based on a recommendation from Mission Control. In case the crew can not talk to the MCC, targeting cards are included in the Ascent Checklist which can be used to determine the correct target.

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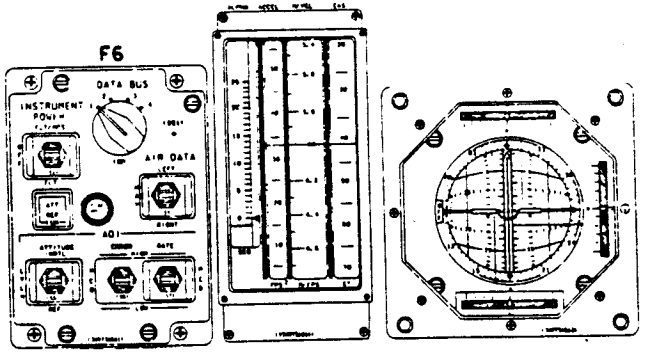


The Mach/Velocity Meter on panel F6 (and F8) indicates inertial velocity during Ascent.

The most reliable check for proper MECO conditions is on the Maneuver display which appears in MM 104 after ET separation. The display indicates the current height of apogee and perigee (CUR HA and HP) which are a good indication of the MECO state.

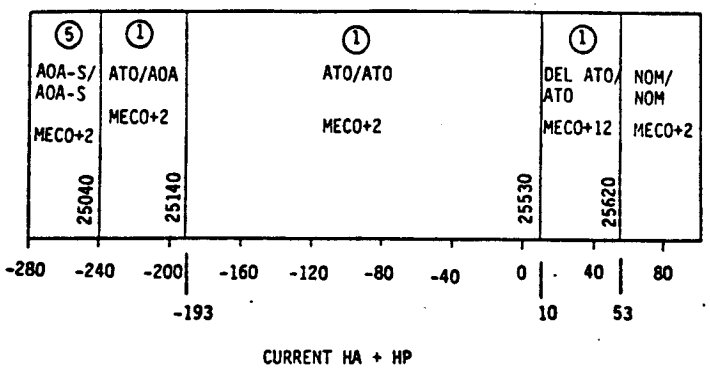
```
1041/   /      OMS 1 MNVR EXEC        1 000/00:09:28
OMS BOTH 1*                             000/00:01:00
        L 2
        R 3     BURN ATT
RCS SEL  4       24 R 335              ΔVTOT    156.5
5 TV ROLL 180    25 P 179              TGO        1:33
TRIM LOAD        26 Y 347
 6 P [+]0.4      MNVR 27               VGO X + 145.70
 7 LY[+]5.7                                 Y +   0.21
 8 RY[+]5.7      REI                        Z +  47.33
 9 WT 244025     TTA 15:02
10 TIG                GMBL                    HA     HP
    0/00:10:28.0        L      R      TGT 130    + 34
TGT PEG 4        P +0.3   +0.5        CUR  88    -  7
 14 C1                   0            Y -5.4   +5.8
 15 C2  [ ]0.0000
 16 HT    134.000       PRI 28*  29*   35 ABORT TGT __
 17 θT    140.000       SEC 30   31
 18 PRPLT [ ]____0      OFF 32   33      FWD RCS
TGT PEG 7                               ARM  36
 19 ΔVX [ ]____t_       GMBL CK  34      DUMP 37
 20 ΔVY [ ]____t_                        OFF  38*
 21 ΔVZ [ ]____t_                      SURF DRIVE
LOAD 22/TIMER 23                         ON   39
                                         OFF  40*
```

3209.ART,3

OMS 1 Maneuver display as it would appear one minute before OMS 1 ignition.

The OMS targeting cue card uses the algebraic sum of current HA and HP to indicate on a chart which OMS 1 and OMS 2 targets should be used. The smaller the value of HA+HP, the larger the underspeed. If HA+HP is in the normal range, nominal OMS targets are used. If HA+HP falls below normal then ATO or AOA targets must be used. Take a look at the example targeting card below.

OMS 1/2 TGTING



The card indicates the types of targets to use in each case. For example, ATO/AOA-S means to use an ATO target for OMS 1 and an AOA-shallow target for OMS 2. DEL ATO means a delayed ATO target. Above the target names there are circled numbers which indicate the target ID number which can be used to enter the target with item entry 35 on the Maneuver display.

Below the target names there is an indication of what the time of ignition (TIG) should be for OMS 1. MECO+2 means that TIG should be two minutes after MECO and MECO+12 means that TIG should be twelve minutes after MECO which is the TIG for delayed OMS 1 burns. Notice that as you move to the left across the chart the HA+HP value gets smaller and the abort modes get more severe (nominal to ATO to AOA-shallow).

For problems other than main engine failures you should consult the table of systems failures for OMS 1 which is shown below. Generally failures in the OMS system require that a delayed ATO OMS 1 target be used. No OMS 2 burn is required. More severe OMS failures require a delayed AOA-shallow OMS 1 followed by a deorbit burn for OMS 2. If there is an ET feedline disconnect valve failure, a delayed nominal OMS 1 burn is done, followed by a nominal OMS 2. When there are system failures that require an early return but do not affect vehicle performance, a nominal OMS 1 is done followed by an AOA deorbit for OMS 2.

OMS 1 TARGETING

DELAY DO NOT DELAY BURN IF CUR HA < 70 **		
FAILURE	OMS 1 TARGET	OMS 2
OMS - 1 He TK 1 PRPLT TK 2 OMS ENG 2 N2 TKS (I'cnect to RCS) EPS - MNA & B MNA & C ET SEP	DELAYED ATO	N/R
FEEDLINE DISC VLV	DELAYED NOM	NOM
OMS - 2 He TKS - 1 OX & 1 FU TK diff PODS - 2 OX & 2 FU TK	DELAYED AOA-S	AOA-S
ON TIME 2 APU/HYD 2 FREON LOOPS 2 H2O LOOPS 3 AV BAY FANS (BAYS 1,2) CABIN LEAK (BKUP dP/dT > .12)	NOMINAL	AOA/ AOA-S

OMS 1 burns cannot be delayed if there is a significant underspeed at MECO and so the chart with current HA+HP should always be consulted before doing a delayed OMS 1 burn. Aborts required for MECO underspeeds take precedence over those required for systems problems. If current HA is less than 70 NM then OMS 1 should not be delayed.

Once the correct target is determined it must be entered on the Maneuver display. At the transition to MM 104 the display will appear with the nominal OMS 1 target selected and loaded. If a different target is needed it can be entered in several ways. The abort rotary switch can be turned to ATO or AOA-S to enter an ATO or AOA target, ITEM 35 on the display can be used to enter a target ID number or the target parameters can be entered individually using ITEM's 10 through 17 on the display. For OMS 1, targets selected with the rotary switch or ITEM 35 are loaded automatically and a burn solution will appear which includes delta-VTOT, TGO, VGO, TGT HA and HP, and BURN ATT. If target paramenters are entered individually then the target is loaded by executing ITEM 22. ITEM 23 starts the CRT timer which counts down to TIG.

For the practice cases in this book, you can indicate target selection by using the target ID numbers when possible and in some cases you will be asked to fill in target parameters as well. Some targets cannot be selected with ITEM 35 and so the target parameters must be entered individually.

The OMS 2 Targeting cue card is used when system failures occur after OMS 1. For the less severe OMS failures a nominal or ATO OMS 2 target is used. (If OMS 1 was nominal, use the nominal target for OMS 2. If OMS 1 was ATO, use the ATO target for OMS 2.) However the burn is cut off at a lower than normal perigee altitude; either at 100 NM or for more severe cases at 80 NM. If the problem requires an immediate return then an AOA deorbit burn is done. An AOA-shallow is only done if there is not sufficient propellant available to do a normal AOA.

OMS 2 TARGETING

FAILURE	OMS 2 TARGET
OMS - 1 PRPLT TK 1 OX & 1 FU TK diff PODS	Nominal/ATO CUT OFF Hp = 100
2 OMS ENG 2 He TKS EPS - MNA & B MNA & C	Nominal/ATO CUT OFF Hp = 80
OMS - 2 OX or 2 FU TKS diff PODS 2 APU/HYD 2 FREON LOOPS 2 H2O LOOPS 3 AV BAY FANS (BAYS 1,2) CABIN LEAK (BKUP dP/dT > .12)	AOA/AOA-S

When there has been a major leak of OMS propellant the crew can determine the remaining performance capability by referring to the table below. This table is found on the OMS 2 Targeting cue card.

POST OMS 1 HP	OMS REQD (Single Pod) ATO ΔV	ATO %	AOA after ATO ΔV	AOA after ATO %
80	47	41	207	39
75	55	42	199	38
70	64	44	190	36
65	73	45	180	35
60	82	47	173	33
55	92	49	172	33
50	101	50	222	42
45	111	52	153	30

To use the table, determine the current perigee altitude following OMS 1. Perigee altitudes are listed in the first column. The next column indicates the delta-V required to do an ATO OMS 2 burn. The third column indicates the quantity of OMS propellant that would be needed to do the OMS 2 burn and a subsequent deorbit burn. The last two columns indicate the delta-V and quantity needed to complete an AOA deorbit. If the table indicates that you do not have enough OMS quantity to do an ATO then you would need to do an AOA. If there was not enough for an AOA then you should attempt an AOA-shallow and use RCS propellant, if necessary, to complete the burn. This table is described in more detail in the ATO/AOA/TAL manual.

Once the proper target for OMS 2 has been determined it should be selected on the Maneuver display. The display will first appear in MM 105 with some target selected. This target will correspond to the target used for OMS 1 and it may be the correct one. But a change may be necessary and a new target can be entered with the rotary switch, ITEM 35, or by typing-in the individual parameters. For all burns after OMS 1, the targets do not get automatically loaded; ITEM 22 must always be executed to load the target and get a solution. If an AOA target is being used, it can be selected in MM 105 (and probably should be since ITEM 35 only works in OPS 1) but not loaded until after the transition to OPS 3 is complete.

You should now be prepared to handle some practice cases using the targeting cards and checklist.

For each case you will be given initial conditions at MECO. This will include an excerpt from the Maneuver display showing current HA and HP. Choose the correct target for OMS 1 using the Ascent Checklist for reference. The targeting cards in the checklist will help you to determine which target to use. The actual target parameter data will be found on pages 8-2 and 8-3 in the back of the checklist.

To show your target selection write in the target ID number, if there is one, next to item 35 and write in the target parameters next to items 10 through 17 and answer any additional questions. In some cases the correct answer is to leave some or all of the items blank. Additional comments can be added such as "no burn required" or "burn should be terminated at HP=80 NM". When you are satisfied with your solution for OMS 1 turn to the next page to check your target selection. Post-OMS 1 conditions will then be listed and you should once again write in the proper target information where required and check your answer on the next page.

Copies of the required pages of the Ascent Checklist are included at the end of this book. You might want to remove them and keep them out for reference while working on the cases. There are three sets of checklist pages. Make sure that you are using the checklist with targeting cards that correspond to the correct type of mission.

Practice Cases

Type A Mission: No Pre-MECO ATO Selection.

Case A-1

MECO Conditions

The right main engine failed during ascent. There are no other system problems. As with all cases in this section, ATO was not selected before MECO and no OMS dump was done.

	HA	HP	
CUR	60	-140	MET at MECO = 9:58

Fill in the items as appropriate for OMS 1.

35 ABORT TGT __

10 TIG
___/__:__:__.__

TGT	PEG 4	
14	C1	_____
15	C2	[]_.____
16	HT	___.___
17	ΘT	___.___

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP=60+(-140) = -80. -80 falls in the ATO/ATO region of the targeting chart and so an ATO target with a target ID number of 1 should be used for OMS 1. TIG is at MECO+2 minutes which is 9:58+2:00 = 11:58. HT and OT were found on page 8-2 of the checklist.

```
35 ABORT TGT _1          10 TIG
                              0/00:11:58.0
                         TGT PEG 4
                          14 C1
                          15 C2  [] _____
                          16 HT   112.000
                          17 ΘT   235.000
```

You should anticipate using an ATO target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __          10 TIG
                            ___/__:__:__._
                         TGT PEG 4
                          14 C1
                          15 C2  [] _____
                          16 HT    ___.___
                          17 ΘT    ___.___
```

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

The targeting chart used for OMS 1 indicated that an ATO target should be used for OMS 2 and that is what should be done since no new problems have developed.

```
35 ABORT TGT _1          10 TIG
                              0/01:02:54.0
                         TGT PEG 4
                          14 C1
                          15 C2  [] _____
                          16 HT   113.000
                          17 ΘT   415.000
```

The approximate delta-VTOT will be 88 ft/sec which is shown with the target data on page 8-2 of the checklist.

Case A-2

MECO Conditions

The left main engine failed during ascent. There are no other system problems.

```
      HA    HP
CUR   50   -270        MET at MECO = 10:56
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __          10 TIG
                            ___/__:__:__._
                         TGT PEG 4
                          14 C1
                          15 C2  [] _____
                          16 HT    ___.___
                          17 ΘT    ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 50+(-270)= -220. -220 falls in the ATO/AOA region of the targeting chart and so the ATO target with the ID number of 1 should be used for OMS 1. TIG is at MECO+2 minutes which is 10:56+2:00 = 12:56. This is the same OMS 1 target as was used in the previous case.

```
35 ABORT TGT _1        10 TIG
                          __0/00:12:56.0
                       TGT PEG 4
                        14 C1    _____
                        15 C2  []_.____
                        16 HT    112.000
                        17 ΘT    235.000
```

You should anticipate using an AOA target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1    _____
                        15 C2  []_.____
                        16 HT    ___.___
                        17 ΘT    ___.___
```

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

The targeting chart used for OMS 1 indicated that an AOA target should be used for OMS 2 and that is what should be done since no new problems have developed.

```
35 ABORT TGT _6        10 TIG
                          __0/00:52:35.0
                       TGT PEG 4
                        14 C1      16430
                        15 C2 [-]0.6582
                        16 HT    _65.800
                        17 ΘT    _84.000
```

The approximate delta-VTOT will be 180 ft/sec which is shown with the target data on page 8-2 of the checklist.

Case A-3

MECO Conditions

There was a main engine failure during powered flight. APU 1 has also failed.

```
      HA    HP
CUR   50   -303              MET at MECO = 11:21
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1    _____
                        15 C2  []_.____
                        16 HT    ___.___
                        17 ΘT    ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 50+(-303)= -253. Using -253 on the targeting chart places you in the AOA-S/AOA-S section and the target ID is 5 for AOA-shallow OMS 1. The APU failure has no bearing on the targeting decision.

```
35 ABORT TGT _5        10 TIG
                         __0/00:13:21.0
                       TGT PEG 4
                        14 C1
                        15 C2  []_._____
                        16 HT    _95.000
                        17 ΘT    225.000
```

You should anticipate using an AOA-shallow target for OMS 2.

6 Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __        10 TIG
                         ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_._____
                        16 HT    ___.___
                        17 ΘT    ___.___
```

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

The targeting card indicated that the target for OMS 2 should be AOA-shallow and that is what should be used. You were committed to an AOA when the AOA burn was done for OMS 1.

```
35 ABORT TGT _5        10 TIG
                         __0/00:44:45.0
                       TGT PEG 4
                        14 C1      20455
                        15 C2 [-]0.8057
                        16 HT    _65.800
                        17 ΘT    _99.000
```

The approximate delta-VTOT will be 119 ft/sec which is shown with the target data on page 8-2 of the checklist.

Case A-4

MECO Conditions

The center main engine failed during ascent.

```
      HA    HP
CUR   80   - 51          MET at MECO = 8:57
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                         ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_._____
                        16 HT    ___.___
                        17 ΘT    ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 80+(-51)= 29. On the targeting chart a 29 means that there was a small underspeed and a Delayed-ATO OMS 1 target should be used. Target ID 1 enters the correct target data except that the TIG must be changed to be ten minutes later. The burn can be delayed because HP is greater than 70 NM.

```
35 ABORT TGT _1        10 TIG
                          __0/00:20:57.0
                       TGT PEG 4
                        14 C1
                        15 C2  []_._____
                        16 HT   112.000
                        17 ΘT   235.000
```

You should anticipate using an ATO target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_.____
                        16 HT   ___.___
                        17 ΘT   ___.___
```

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

The targeting chart for OMS 1 indicated that an ATO target should be used for OMS 2. A target ID number of 1 enters the target data which is also listed on page 8-3 of the checklist.

```
35 ABORT TGT _1        10 TIG
                          __0/01:01:52.0
                       TGT PEG 4
                        14 C1
                        15 C2  []_._____
                        16 HT   113.000
                        17 ΘT   415.000
```

The approximate delta-VTOT will be 43 ft/sec which is shown with the target data on page 8-3 of the checklist.

Case A-5

MECO Conditions

There was a very late main engine failure and also one H2O loop has failed.

```
     HA    HP
CUR  60  - 1          MET at MECO = 9:01
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_.____
                        16 HT   ___.___
                        17 ΘT   ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 60+(-1)= 59. 59 falls in the nominal region of the targeting chart. The failure of one H2O loop does not require any targeting changes. The target that appears automatically is the correct one to use.

```
35 ABORT TGT __        10 TIG
                          __0/00:11:01.0
                       TGT PEG 4
                        14 C1
                        15 C2  []_.____
                        16 HT   171.000
                        17 ΘT   167.000
```

You should anticipate using a nominal target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_.____
                        16 HT   ___.___
                        17 ΘT   ___.___
```

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

The nominal target would be used for OMS 2.

```
35 ABORT TGT __        10 TIG
                          __0/00:45:17.0
                       TGT PEG 4
                        14 C1
                        15 C2  []_.____
                        16 HT   171.000
                        17 ΘT   348.000
```

The approximate delta-VTOT will be 204 ft/sec which is shown with the target data on page 8-2 of the checklist.

Case A-6

MECO Conditions

There were no engine failures however there was an ET SEP Inhibit message which is assumed to be due to an ET feedline disconnect valve failure.

```
      HA    HP
CUR   80    + 25          MET at MECO = 8:36
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_.____
                        16 HT   ___.___
                        17 ΘT   ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 80+25= 105. 105 is well within the nominal region. A delayed-nominal OMS 1 is done because of the feedline disconnect valve failure. That target must be typed in.

```
35 ABORT TGT __          10 TIG
                            0/00:20:36.0
                         TGT PEG 4
                          14 C1
                          15 C2  []_.____
                          16 HT   174.000
                          17 ΘT   240.000
```

You should anticipate using a Nominal target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __          10 TIG
                            ___/__:__:__._
                         TGT PEG 4
                          14 C1
                          15 C2  []_.____
                          16 HT    ___.___
                          17 ΘT    ___.___
```

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

The nominal target listed on page 8-3 of the checklist is the correct one to use. It differs from the nominal target that follows an on-time nominal OMS 1.

```
35 ABORT TGT __          10 TIG
                            0/01:03:42.0
                         TGT PEG 4
                          14 C1
                          15 C2  []_.____
                          16 HT   173.000
                          17 ΘT   410.000
```

The approximate delta-VTOT will be 149 ft/sec which is shown with the target data on page 8-3 of the checklist.

Case A-7

MECO Conditions

There were no engine failures but a leak developed in the left OMS oxidizer tank. The tank has now failed.

```
      HA    HP
CUR   80   + 25          MET at MECO = 8:36
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __          10 TIG
                            ___/__:__:__._
                         TGT PEG 4
                          14 C1
                          15 C2  []_.____
                          16 HT    ___.___
                          17 ΘT    ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 80+25 = 105. The MECO state is nominal but because of the OMS tank failure a delayed-ATO target should be used as indicated on page 2-4 of the checklist. The OMS 1 burn can be delayed because HA>70 NM.

```
35 ABORT TGT _1        10 TIG
                          0/00:20:36.0
                     TGT PEG 4
                      14 C1
                      15 C2  [].
                      16 HT   112.000
                      17 ΘT   235.000
```

Unless some new problem developes no burn will be required for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. During OMS 1, control bus BC2 failed.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                     TGT PEG 4
                      14 C1
                      15 C2  []_.____
                      16 HT    ___.___
                      17 ΘT    ___.___
```

Comments:

OMS 2 Solution

No burn is required for OMS 2. The orbit resulting from the delayed-ATO OMS 1 burn will be stable for about one day. A decision will be made in concurrence with Mission Control to either raise the orbit with special OMS burns or perform an early deorbit. Note that this situation is different from case 4 in which the delayed-ATO burn had to be followed by an OMS 2 burn because there had been an underspeed at MECO.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                     TGT PEG 4
                      14 C1
                      15 C2  []_.____
                      16 HT    ___.___
                      17 ΘT    ___.___
```

Case A-8

MECO Conditions

The only problem at MECO is an electrical short on main bus A.

```
      HA    HP
CUR   80    + 25          MET at MECO = 8:36
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                     TGT PEG 4
                      14 C1
                      15 C2  []_.____
                      16 HT    ___.___
                      17 ΘT    ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 80+25= 105. The short on main bus A does not cause any targeting changes. The nominal target is used.

```
35 ABORT TGT __          10 TIG
                            __0/00:10:36.0
                         TGT PEG 4
                          14 C1
                          15 C2   [] _.____
                          16 HT    171.000
                          17 ΘT    235.000
```

You should anticipate using the nominal target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. A cabin leak is detected. The dP/dT is determined to be 0.13.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __          10 TIG
                            ___/__:__:__._
                         TGT PEG 4
                          14 C1
                          15 C2   [] _.____
                          16 HT    ___.___
                          17 ΘT    ___.___
```

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

The target for OMS 2 would have been nominal except that the dP/dT due to the cabin leak exceeded 0.12 which makes an AOA necessary according to page 2-8 of the checklist.

```
35 ABORT TGT 12          10 TIG
                            __0/00:50:09.0
                         TGT PEG 4
                          14 C1      14800
                          15 C2  [-]0.5955
                          16 HT     65.800
                          17 ΘT     95.000
```

The approximate delta-VTOT will be 84 ft/sec which is shown with the target data on page 8-2 of the checklist.

Case A-9

MECO Conditions

There was a main engine failure during ascent.

```
      HA     HP
CUR   59    - 59          MET at MECO = 9:56
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __          10 TIG
                            ___/__:__:__._
                         TGT PEG 4
                          14 C1
                          15 C2   [] _.____
                          16 HT    ___.___
                          17 ΘT    ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 59+(-59)= 0. The targeting chart indicates that an ATO target is required for OMS 1 with an ID number of 1.

```
35 ABORT TGT _1        10 TIG
                          __0/00:11:56.0
                       TGT PEG 4
                        14 C1
                        15 C2  []_._____
                        16 HT   112.000
                        17 ΘT   167.000
```

You should anticipate using an ATO target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. A leak developed during OMS 1 in the right OMS fuel tank. That tank is now failed. The OMS quantity gage reads 40% for the left OMS tanks. The current HP is 50 NM.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_._____
                        16 HT    ___.___
                        17 ΘT    ___.___
```

Comments:

OMS 2 Solution

Because of the OMS tank failure an ATO target for OMS 2 may no longer be appropriate. Looking at the table on page 2-9 of the checklist with an HP of 50 NM, the quantity needed to do an ATO OMS 2 and later deorbit is 50%. Only 40% is available. To do a normal AOA, 42% is needed but an AOA-Shallow will require a little less and so that is the correct target to pick.

```
35 ABORT TGT _7        10 TIG
                          __0/00:39:19.0
                       TGT PEG 4
                        14 C1     19502
                        15 C2 [-]0.7688
                        16 HT    65.800
                        17 ΘT   129.000
```

Case A-10

MECO Conditions

During ascent main bus A and C failed.

```
    HA    HP
CUR 80   + 25          MET at MECO = 8:36
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_._____
                        16 HT    ___.___
                        17 ΘT    ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 80+25 = 105. There is no underspeed and since HA>70, OMS 1 can be delayed which is what should be done with main bus A and C failed. A delayed-ATO burn is done because these two bus failures cause the loss of an OMS engine and a variety of other problems.

```
35 ABORT TGT _1        10 TIG
                          __0/00:20:36.0
                       TGT PEG 4
                        14 C1
                        15 C2  []_._____
                        16 HT   112.000
                        17 ΘT   235.000
```

An OMS 2 burn should not be required if no additional problems occur.

Post-OMS 1 Conditions

OMS 1 was completed successfully but during the burn the right OMS fuel line began leaking. Your PLT thought that it was a propellant failure and so completed the whole burn using only the left pod tanks. Now the left contains 22% and the right side, in which the leak is now isolated, contains 20%. The current HP is 80 NM. Assume that you can use the remaining propellant in both pods.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_._____
                        16 HT    ___.___
                        17 ΘT    ___.___
```

Comments:

OMS 2 Solution

When there has been a significant loss of propellant it is a good idea to check the table on page 2-9 of the checklist to see if an AOA might be required. In this case the remaining propellant adds up to 42% (20+22) but since the table is designed for using only one pod it only accounts for the unusable propellant (3%) on one side. When adding together the quantities for two pods you must subtract 3% for unusable propellant before using the table. The usable quantity is therefore 39% (20+22-3). At an HP = 80 NM it would require 41% for an ATO and 39% for an AOA so AOA is the correct choice.

```
35 ABORT TGT _6        10 TIG
                          __0/00:51:36.0
                       TGT PEG 4
                        14 C1     16430
                        15 C2 [-]0.6582
                        16 HT    _65.800
                        17 ΘT    _85.000
```

Case A-11

MECO Conditions

There was a main engine failure during ascent.

```
     HA     HP
CUR  57    -247              MET at MECO = 10:01
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_._____
                        16 HT    ___.___
                        17 ΘT    ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 57+(-247)= -190. The targeting chart indicates that an ATO OMS 1 is required.

```
35 ABORT TGT _1        10 TIG
                          0/00:12:01.0
                       TGT PEG 4
                        14 C1     _____
                        15 C2 []_.____
                        16 HT  112.000
                        17 ΘT  235.000
```

You should anticipate using an ATO target for OMS 2.

17

Post-OMS 1 Conditions

OMS 1 was completed successfully, however during the burn both OMS engines failed and the burn was completed using RCS jets.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1     _____
                        15 C2  []_.____
                        16 HT    ___.___
                        17 ΘT    ___.___
```

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

Since both OMS engines failed you need to go to the OMS 2 TARGETING card and choose the target on the basis of this failure. The card says "Nominal/ATO" which means that the ATO target will be used because OMS 1 was ATO. Your comments should include the fact that the burn should be terminated when HP reaches 80 NM.

```
35 ABORT TGT _1        10 TIG
                          0/01:02:54.0
                       TGT PEG 4
                        14 C1     _____
                        15 C2  []_.____
                        16 HT   113.000
                        17 ΘT   415.000
```

The approximate delta-VTOT will be 88 ft/sec which is shown with the target data on page 8-2 of the checklist. The delta-V for the actual burn will be less because the burn will be terminated when HP = 80 NM.

Case A-12

MECO Conditions

All three main engines shut down at VI = 24500 ft/sec.

```
     HA    HP
CUR  52   -957              MET at MECO = 8:27
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1     _____
                        15 C2  []_.____
                        16 HT    ___.___
                        17 ΘT    ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= -905. You probably realize from the low MECO velocity and early MECO time that something is seriously wrong. The underspeed is so large that an ATO or AOA is not possible. A downrange abort is the only option.

```
35 ABORT TGT __        10 TIG
                        ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_.____
                        16 HT   ___.___
                        17 ΘT   ___.___
```

There will be no OMS 1 or OMS 2 burn.

Case A-13

MECO Conditions

The MECO state was nominal but GPC 4 failed at 6 minutes after liftoff.

```
      HA    HP
CUR   80   + 25          MET at MECO = 8:36
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                        ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_.____
                        16 HT   ___.___
                        17 ΘT   ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 80+25= 105. There is no underspeed. The GPC failure does not affect the targeting decision. The nominal target should be used.

```
35 ABORT TGT __        10 TIG
                          0/00:10:36.0
                       TGT PEG 4
                        14 C1
                        15 C2  []_.____
                        16 HT   171.000
                        17 ΘT   167.000
```

You should anticipate using a nominal target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully but leaks developed in both the left OMS oxidizer tank and the right OMS fuel tank and the tanks are now considered failed.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __        10 TIG
                        ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_.____
                        16 HT   ___.___
                        17 ΘT   ___.___
```

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

According to page 2-8 of the checklist, when one OMS oxidizer and one OMS fuel tank in different pods have failed the correct target for OMS 2 is nominal if OMS 1 was nominal and ATO if OMS 1 was ATO. In this case OMS 1 was nominal and so OMS 2 should use a nominal target but, in order to conserve propellant and not raise the orbit any higher than necessary the burn should be manually stopped when the perigee altitude reaches 100 NM.

```
35 ABORT TGT __        10 TIG
                          __0/00:45:17.0
                       TGT PEG 4
                        14 C1
                        15 C2  []_.____
                        16 HT   171.000
                        17 ΘT   348.000
```

The approximate delta-VTOT will be 204 ft/sec which is shown with the target data on page 8-2 of the checklist. However, the total delta-V used will be much less since the burn will be cut off early.

Case A-14

MECO Conditions

There was a main engine failure during ascent and there was an ET SEP inhibit due to a feedline disconnect valve failure.

```
      HA    HP
CUR   56    -257          MET at MECO = 10:56
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_.____
                        16 HT   ___.___
                        17 ΘT   ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 56+(-257)= -201. This indicates that an ATO target should be used due to an underspeed. Since there was an ET feedline disconnect valve failure the normal procedure would be to do a delayed nominal OMS 1 but in this case the burn cannot be delayed because of the underspeed (HP<70 NM).

```
35 ABORT TGT _1        10 TIG
                          __0/00:12:56.0
                       TGT PEG 4
                        14 C1
                        15 C2  []_.____
                        16 HT   112.000
                        17 ΘT   235.000
```

You should anticipate using an AOA target for OMS 2. This is indicated on the chart on page 2-5 of the checklist.

Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_.____
                        16 HT   ___.___
                        17 ΘT   ___.___
```

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

The targeting chart referred to previously indicated that the OMS 2 target should be AOA and there is no reason to alter that choice.

```
35 ABORT TGT _6        10 TIG
                          __0/00:52:35.0
                       TGT PEG 4
                        14 C1      16430
                        15 C2 [-]0.6582
                        16 HT    _65.800
                        17 ΘT    _84.000
```

The approximate delta-VTOT will be 180 ft/sec which is shown with the target data on page 8-2 of the checklist.

Case A-15

MECO Conditions

Vehicle performance was nominal at MECO however you have discovered that both the left and right OMS helium tanks have been leaking and are now failed.

```
      HA    HP
CUR   80    + 25              MET at MECO = 8:36
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1      _____
                        15 C2   [ ]_.____
                        16 HT     ___.___
                        17 ΘT     ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 80+25= 105. Because of the failure of both OMS helium tanks the correct target for OMS 1 is delayed AOA-shallow. The burn can be delayed because HP>70 NM.

```
35 ABORT TGT _4        10 TIG
                          __0/00:20:36.0
                       TGT PEG 4
                        14 C1      _____
                        15 C2   [ ]_.____
                        16 HT    100.000
                        17 ΘT    175.000
```

You should anticipate using an AOA-S target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1      _____
                        15 C2   [ ]_.____
                        16 HT     ___.___
                        17 ΘT     ___.___
```

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

According to page 2-4 of the checklist an AOA-Shallow target should be used for OMS 2.

```
35 ABORT TGT _4        10 TIG
                         __0/00:49:53.0
                       TGT PEG 4
                        14 C1     19379
                        15 C2 [-]0.7641
                        16 HT    _65.800
                        17 ΘT    _78.000
```

The approximate delta-VTOT will be 88 ft/sec which is shown with the target data on page 8-2 of the checklist.

Case A-16

MECO Conditions

The only problem so far has been the failure of two Freon loops.

```
      HA    HP
CUR   80   + 25              MET at MECO = 8:36
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                         ___/__:__:__._
                       TGT PEG 4
                        14 C1     _____
                        15 C2  []_.____
                        16 HT     ___.___
                        17 ΘT     ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 80+25= 105. This is a nominal MECO state. According to page 2-4 of the checklist, the correct target for OMS 1 when two Freon loops have failed is the nominal target.

```
35 ABORT TGT __        10 TIG
                         __0/00:10:36.0
                       TGT PEG 4
                        14 C1     _____
                        15 C2  []_.____
                        16 HT    171.000
                        17 ΘT    167.000
```

You should anticipate using an AOA target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __        10 TIG
                         ___/__:__:__._
                       TGT PEG 4
                        14 C1     _____
                        15 C2  []_.____
                        16 HT     ___.___
                        17 ΘT     ___.___
```

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

As indicated on page 2-4 of the checklist, when two Freon loops have failed, the nominal OMS 1 burn is followed with an AOA OMS 2 burn. There is no benefit to committing to an AOA before OMS 2 when there is no performance problem.

```
35 ABORT TGT 12        10 TIG
                          __0/00:50:09.0
                       TGT PEG 4
                        14 C1     14800
                        15 C2 [-]0.5955
                        16 HT    _65.800
                        17 ΘT    _95.000
```

The approximate delta-VTOT will be 84 ft/sec which is shown with the target data on page 8-2 of the checklist.

Case A-17

MECO Conditions

During ascent APU 2 failed. There was also an ET SEP inhibit due to a feedline disconnect valve failure.

```
      HA    HP
CUR   80   + 25              MET at MECO = 8:36
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1      _____
                        15 C2  []_.____
                        16 HT    ___.___
                        17 ΘT    ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 80+25= 105. There is no performance problem and the APU failure does not make any target changes necessary. The OMS 1 target should be delayed nominal due to the feedline disconnect valve failure.

```
35 ABORT TGT __        10 TIG
                          __0/00:20:36.0
                       TGT PEG 4
                        14 C1      _____
                        15 C2  []_.____
                        16 HT    174.000
                        17 ΘT    240.000
```

You should anticipate using a nominal target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. A massive leak developed in hydraulic system 3.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1      _____
                        15 C2  []_.____
                        16 HT    ___.___
                        17 ΘT    ___.___
```

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

APU 2 and hydraulic system 3 are now failed. According to page 2-8 of the checklist, the failure of two APU's or hydraulic systems is cause for an AOA.

```
35 ABORT TGT  10       10 TIG
                           0/00:38:49.0
                        TGT PEG 4
                         14 C1      15360
                         15 C2 [-]0.6172
                         16 HT     65.800
                         17 ΘT     142.000
```

The approximate delta-VTOT will be 207 ft/sec which is shown with the target data on page 8-3 of the checklist.

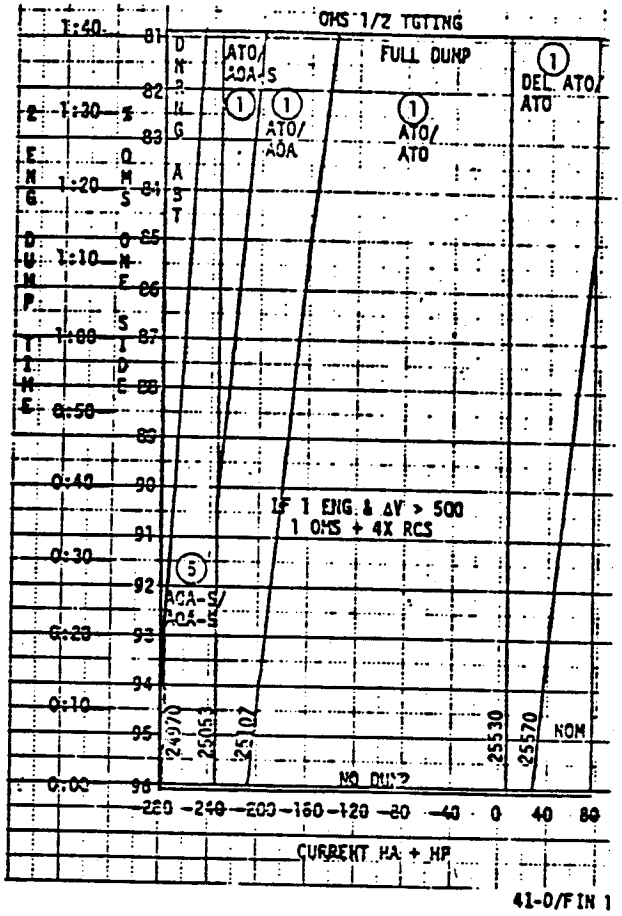
Type B Mission: Pre-MECO ATO

For many flights the ascent abort options will include pre-MECO selection of ATO. The purpose of this is to initiate a dump of OMS propellant during powered flight. The OMS dump reduces the vehicle weight and thereby improves performance. This means that if a main engine fails within a certain timeframe the magnitude of the underspeed at MECO can be reduced by dumping OMS propellant. The exact timeframe in which a dump is beneficial and the duration of the dump is determined by pre-flight analysis. ATO is selected and the dump is done when a main engine failure occurs between the Press to ATO and Press to MECO abort boundaries.

Although the ATO OMS dump improves vehicle performance and lessens the MECO underspeed it also reduces the amount of OMS propellant available for OMS 1 and 2. Following an ATO dump you are committed to doing an ATO or AOA.

The targeting cards used for OMS 1 and 2 for missions with the pre-MECO ATO option are similar to those described earlier. The only difference is that the underspeed targeting chart must account for the amount of OMS propellant that was dumped. For this purpose the chart has a vertical axis which represents OMS quantity remaining. The vertical axis is labelled with both quantity and dump time. Dump time is generally a better method of measuring the quantity than the OMS gages but to use it the crew must take note of the duration of the dump when it occurs in powered flight. A typical targeting chart is shown on the next page.

To use the chart you find the intersection of the value of current HA+HP and OMS dump time (or OMS quantity). Use the target indicated for the region of the chart where the intersection point lies. If ATO was not selected before MECO and therefore no dump was done, the bottom scale (NO DUMP, 0:00) would be used. If a full dump was done the top scale would be used. ATO dumps can be of a fixed duration or they can be of variable duration depending on how the I-loads were set up for a particular mission. If the dump is variable then its duration depends on the velocity at which the main engine failure occurred. If the dump has a fixed duration it will always last the same amount of time unless it is stopped for some reason such as a leak or OMS engine failure. In any case it is always a good idea to check the duration of the dump when it occurs.



The targeting cards for systems failures are just like the ones used for flights with no pre-MECO ATO. The procedures for loading targets are also the same except that if ATO is selected before MECO the target that will appear automatically in MM 104 will be an ATO target instead of the nominal target.

You should now be ready to handle some practice cases in OMS targeting for missions with pre-MECO ATO selection. Make sure that you use the checklist pages for the Type B Mission.

Practice Cases

Type B Mission: Pre-MECO ATO

Case B-1

MECO Conditions

A main engine failed after the Press to MECO call (no ATO dump was done).

	HA	HP	
CUR	60	- 40	MET at MECO = 9:30

Fill in the items as appropriate for OMS 1.

35 ABORT TGT __ 10 TIG ___/___:__:__.__

TGT	PEG 4	
14	C1	_____
15	C2	[]_.____
16	HT	___.___
17	ΘT	___.___

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 60+(-40)= 20. The bottom line of the targeting card on page 2-5 of the checklist is used since there was no dump. An HA+HP value of 20 falls in the "DEL ATO/ATO" region. The correct target is found on page 8-3 of the checklist.

```
35 ABORT TGT _1        10 TIG
                         __0/00:21:30.0
                       TGT PEG 4
                        14 C1
                        15 C2  []_._____
                        16 HT   112.000
                        17 ΘT   235.000
```

You should anticipate using an ATO target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __        10 TIG
                         ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_._____
                        16 HT   ___.___
                        17 ΘT   ___.___
```

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

The targeting card indicated that an ATO target should be used for OMS 2.

```
35 ABORT TGT _1        10 TIG
                         __0/01:01:43.0
                       TGT PEG 4
                        14 C1
                        15 C2  []_._____
                        16 HT   113.000
                        17 ΘT   415.000
```

The approximate delta-VTOT will be 44 ft/sec which is shown with the target data on page 8-3 of the checklist.

Case B-2

MECO Conditions

A main engine failed after the Press to ATO call but before the Press to MECO call (so an ATO dump was done).

```
      HA    HP
CUR   54   -215          MET at MECO = 10:16
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                         ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_._____
                        16 HT   ___.___
                        17 ΘT   ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 54+(-215)= -161. Since a full ATO dump was done, the top of the targeting chart is used and a value of -161 falls in the "ATO/AOA" region.

```
35 ABORT TGT _1        10 TIG
                          0/00:12:16.0
                       TGT PEG 4
                        14 C1
                        15 C2  [] .
                        16 HT   112.000
                        17 ΘT   235.000
```

You should anticipate using an AOA target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  [] .
                        16 HT    ___.___
                        17 ΘT    ___.___
```

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

The AOA target was specified for OMS 2 on the targeting card.

```
35 ABORT TGT _6        10 TIG
                          0/00:52:28.0
                       TGT PEG 4
                        14 C1     16430
                        15 C2 [-]0.6582
                        16 HT    65.800
                        17 ΘT    84.000
```

The approximate delta-VTOT will be 170 ft/sec which is shown with the target data on page 8-2 of the checklist.

Case B-3

MECO Conditions

There was a main engine failure after the Press to MECO call.

```
      HA    HP
CUR   85   + 20            MET at MECO = 8:36
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  [] .
                        16 HT    ___.___
                        17 ΘT    ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 85+20= 105. This is in the nominal range on the targeting card and since no ATO dump was done, the nominal target can be used for OMS 1.

```
35 ABORT TGT __          10 TIG
                           __0/00:10:36.0
                         TGT PEG 4
                          14 C1   _____
                          15 C2  []_.____
                          16 HT   179.000
                          17 ΘT   170.000
```

You should anticipate using a nominal target for OMS 2.

27 Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __          10 TIG
                           ___/__:__:__._
                         TGT PEG 4
                          14 C1   _____
                          15 C2  []_.____
                          16 HT   ___.___
                          17 ΘT   ___.___
```

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

The nominal target should be used for OMS 2.

```
35 ABORT TGT __          10 TIG
                           __0/00:46:01.0
                         TGT PEG 4
                          14 C1   _____
                          15 C2  []_.____
                          16 HT   179.000
                          17 ΘT   350.000
```

The approximate delta-VTOT will be 216 ft/sec which is shown with the target data on page 8-2 of the checklist.

Case B-4

MECO Conditions

A main engine failure occurred right after the Press to ATO call. ATO was selected with the rotary switch at that time.

```
      HA    HP
CUR   80   - 20          MET at MECO = 9:49
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __          10 TIG
                           ___/__:__:__._
                         TGT PEG 4
                          14 C1   _____
                          15 C2  []_.____
                          16 HT   ___.___
                          17 ΘT   ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 60. Since ATO was selected and you can assume that a full dump occurred, the top line on the targeting chart should be used which means that 60 falls in the Delayed ATO/ATO region.

```
35 ABORT TGT _1        10 TIG
                          __0/00:21:49.0
                       TGT PEG 4
                        14 C1      _____
                        15 C2   []_.____
                        16 HT    112.000
                        17 ΘT    235.000
```

You should anticipate using an ATO target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1      _____
                        15 C2   []_.____
                        16 HT     ___.___
                        17 ΘT     ___.___
```

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

The Delayed-ATO OMS 1 should be followed by an ATO OMS 2 because there was an underspeed at MECO. If MECO had been nominal and the delayed ATO burn was done because of a system problem then an OMS 2 burn might not be necessary.

```
35 ABORT TGT _1        10 TIG
                          __0/01:01:43.0
                       TGT PEG 4
                        14 C1      _____
                        15 C2 [-]_.____
                        16 HT    113.000
                        17 ΘT    415.000
```

The approximate delta-VTOT will be 44 ft/sec which is shown with the target data on page 8-3 of the checklist.

Case B-5

MECO Conditions

There was a main engine failure after the Press to MECO call.

```
     HA    HP
CUR  65   - 65          MET at MECO = 10:02
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1      _____
                        15 C2   []_.____
                        16 HT     ___.___
                        17 ΘT     ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 0. Since the failure occurred after the Press to MECO call, no dump would be done. The bottom line on the chart would be used and 0 falls in the ATO/ATO region.

```
35 ABORT TGT _1        10 TIG
                          0/00:12:02.0
                       TGT PEG 4
                        14 C1
                        15 C2  []_.____
                        16 HT   112.000
                        17 ΘT   235.000
```

You should anticipate using an ATO target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_.____
                        16 HT   ___.___
                        17 ΘT   ___.___
```

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

Since there are no new problems the ATO OMS 2 target should be used as expected.

```
35 ABORT TGT _1        10 TIG
                          0/01:03:34.0
                       TGT PEG 4
                        14 C1
                        15 C2  []_.____
                        16 HT   113.000
                        17 ΘT   415.000
```

The approximate delta-VTOT will be 78 ft/sec which is shown with the target data on page 8-2 of the checklist.

Case B-6

MECO Conditions

A main engine failed right after the Press to ATO call. During the ATO dump an OMS engine failed and the alert crew shut off both OMS engines and noted that 45 seconds of the dump had occurred.

```
      HA    HP
CUR   61   - 22          MET at MECO = 9:29
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_.____
                        16 HT   ___.___
                        17 ΘT   ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 39. With 39 NM and a two-engine dump time of 0:45, the intersection falls in the Delayed ATO/ATO region. The single OMS engine failure has no effect on the targeting decisions for OMS 1 or OMS 2.

```
35 ABORT TGT _1        10 TIG
                          __0/00:21:29.0
                       TGT PEG 4
                        14 C1
                        15 C2  []_._____
                        16 HT   112.000
                        17 ΘT   235.000
```

You should anticipate using an ATO target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

The OMS 2 target will be ATO as expected. You can skip setting up this target since it is similar to those done earlier.

Case B-7

MECO Conditions

A main engine failed before the Press to MECO call.

```
      HA    HP
CUR   50   -130          MET at MECO = 9:37
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_._____
                        16 HT    ___.___
                        17 ΘT    ___.___
```

What target do you anticipate using for OMS 2?

OMS 1 Solution:

HA+HP= -80. Since the engine failure occurred before the Press to MECO call you should assume that an ATO dump was done and use the top line of the targeting chart. On this line a value of -80 falls in the ATO/ATO region.

```
35 ABORT TGT _1        10 TIG
                          __0/00:11:37.0
                       TGT PEG 4
                        14 C1
                        15 C2  []_._____
                        16 HT   112.000
                        17 ΘT   235.000
```

You should anticipate using an ATO target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

The OMS 2 target will be ATO as expected and you can move on to the next case.

Case B-8

MECO Conditions

After MECO there was an ET SEP inhibit due to a feedline disconnect valve failure.

```
      HA    HP
CUR   85   + 20          MET at MECO = 8:30
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  []_._____
                        16 HT    ___.___
                        17 ΘT    ___.___
```

What target do you anticipate using for OMS 2?

OMS 1 Solution

MECO was nominal and so a delayed-nominal OMS 1 target is used because of the ET feedline disconnect valve failure.

```
35 ABORT TGT __          10 TIG
                            __0/00:20:30.0
                         TGT PEG 4
                          14 C1
                          15 C2  []_._____
                          16 HT   182.000
                          17 ΘT   231.000
```

You should anticipate using a nominal target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed but there was a propellant failure in the right OMS during the burn.

```
        HA    HP                  OMS QTY: LEFT  KIT  RIGHT
CUR    182   + 55                            45    0     67
```

Use this information to select a target for OMS 2.

```
35 ABORT TGT __          10 TIG
                            ___/__:__:__._
                         TGT PEG 4
                          14 C1
                          15 C2  []_.____
                          16 HT   ___.___
                          17 ΘT   ___.___
```

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

The propellant failure means that you cannot use any of the propellant in the right pod. With this kind of propellant loss you should consult the table on page 2-9 of the checklist. HP is equal to 55 NM after OMS 1 and the there is 45% usable propellant. According to the table you would need 47% to do an ATO which more than is available. Only 34% is needed for an AOA and there is definitely enough propellant for that option.

```
35 ABORT TGT 10          10 TIG
                            __0/00:38:43.0
                         TGT PEG 4
                          14 C1      15360
                          15 C2 [-]0.6172
                          16 HT    65.800
                          17 ΘT   142.000
```

The approximate delta-VTOT will be 199 ft/sec which is shown with the target data on page 8-3 of the checklist.

Case B-9

MECO Conditions

There was a main engine failure after the Press to MECO call.

```
      HA    HP
CUR   60   -280          MET at MECO = 10:13
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __          10 TIG
                            ___/__:__:__._
                         TGT PEG 4
                          14 C1
                          15 C2  []_.____
                          16 HT   ___.___
                          17 ΘT   ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

Since the failure occurred after Press to MECO, no dump was done. The bottom line of the targeting chart is used with HA+HP equal to -220 which falls in the ATO/AOA region.

```
35 ABORT TGT _1        10 TIG
                          __0/00:12:13.0
                       TGT PEG 4
                        14 C1
                        15 C2  [] _._____
                        16 HT   112.000
                        17 ΘT   235.000
```

You should anticipate using an AOA target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

What target ID number would you use for OMS 2?

At what MET should TIG occur?

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

OMS 2 Solution

AOA target with ID number 6. TIG will be at 52:28. The approximate delta-VTOT should be 170 ft/sec.

Case B-10

MECO Conditions

A main engine failed before the Press to MECO call. The ATO dump was terminated early because the right OMS engine failed. The actual duration of the dump is not known precisely.

```
      HA    HP
CUR   59   -218                MET at MECO = 10:04

OMS QTY:   LEFT  KIT  RIGHT
            83    0     82
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  [] _._____
                        16 HT    ___.___
                        17 ΘT    ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= -159. Using 82.5% as the OMS quantity remaining on the targeting chart yields a target choice of ATO/AOA.

```
35 ABORT TGT _1        10 TIG
                          __0/00:12:04.0
                       TGT PEG 4
                        14 C1
                        15 C2  [] .
                        16 HT   112.000
                        17 ΘT   235.000
```

You should anticipate using an AOA target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

What target ID number would you use for OMS 2?

OMS 2 Solution

AOA target number 6 is the correct target for OMS 2.

Case B-11

MECO Conditions

There was a main engine failure right after the Press to MECO call.

```
      HA    HP
CUR   55    -295          MET at MECO = 10:46
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1
                        15 C2  [] .
                        16 HT   ___.___
                        17 ΘT   ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= -240 and no ATO dump was done which should put you in the AOA-S/AOA-S region of the targeting chart.

```
35 ABORT TGT _5        10 TIG
                          __0/00:12:46.0
                       TGT PEG 4
                        14 C1    _____
                        15 C2  []_.____
                        16 HT    _95.000
                        17 ΘT    225.000
```

You should anticipate using an AOA-S target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__.__
                       TGT PEG 4
                        14 C1    _____
                        15 C2  []_.____
                        16 HT    ___.___
                        17 ΘT    ___.___
```

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

AOA-shallow is the correct target based on the OMS 1/2 target chart.

```
35 ABORT TGT _5        10 TIG
                          __0/00:45:10.0
                       TGT PEG 4
                        14 C1      20455
                        15 C2 [-]0.8057
                        16 HT    _65.800
                        17 ΘT    _99.000
```

The approximate delta-VTOT will be 86 ft/sec which is shown with the target data on page 8-2 of the checklist.

Case B-12

MECO Conditions

A main engine failed before the Press to MECO call.

```
     HA    HP
CUR  58   -278          MET at MECO = 10:15
```

What target ID would you use for OMS 1?

What time would TIG be for OMS 1?

What would HA be after OMS 1?

35

OMS 1 Solution

HA+HP= -220 and since an ATO dump would have been done, the top line of the targeting chart would be used which puts you in the ATO/AOA-S region. Notice how the dump changes the target selection in comparison to Case B-9 which had no dump.

The correct target for OMS 1 is ATO with TIG at 12:15. HA after OMS 1 would be approximately 112 NM which is the HT for that target.

Post-OMS 1 Conditions

OMS 1 was completed successfully.

What target ID number would you use for OMS 2?

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

In what major mode should you enter the target ID number?

In what major mode should you load the target?

OMS 2 Solution

Use target ID number 7 for AOA-shallow. The approximate delta-VTOT would be 98 ft/sec.

The target ID should be entered in MM 105. Item 35 will only function in OPS 1. The target should be loaded in MM 301 or MM 302. If an AOA target is loaded in OPS 1 the solution will be invalid.

Case B-13

MECO Conditions

A main engine failure occurred before the Press to MECO call. The dump had to be stopped before it was complete because the right OMS helium tank began leaking. At this time the helium tank is still usable.

	HA	HP	
CUR	61	-286	MET at MECO = 9:58

OMS QTY:	LEFT	KIT	RIGHT
	81	0	86

What target ID number would you use for OMS 1 and at what time would TIG be?

OMS 1 Solution

HA+HP= -225. The low apogee altitude precludes any consideration of a delayed OMS 1 burn even though there is an OMS helium tank problem. Actually since the tank is leaking but still usable it is a good idea to burn on-time. The remaining propellant amount is approximately the average of the left and right quantities or 83.5%. On the targeting chart that puts you in the ATO/AOA-S region. You would use the ATO target with an ID number of 1 and TIG would be at 11:58.

Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

What target ID number would you use for OMS 2?

In what major mode would the burn be done?

How much time would you have between OMS 1 TIG and OMS 2 TIG?

OMS 2 Solution

An AOA-Shallow target with an ID number of 7 would be used for OMS 2. The burn would be done in MM 302. There would be 27 minutes between OMS 1 TIG and OMS 2 TIG.

Case B-14

MECO Conditions

The left main engine failed right after the Press to ATO call and a full ATO dump was done. Later, near MECO, the other two main engines failed.

	HA	HP	
CUR	45	-305	MET at MECO = 9:38

Fill in the items as appropriate for OMS 1.

35 ABORT TGT __

10 TIG
___/__:__:__.__

TGT PEG 4
14 C1 _____
15 C2 []_.____
16 HT ___.___
17 ΘT ___.___

Comments:

OMS 1 Solution

HA+HP= -260. With a full dump the targeting card indicates that you are in a downrange abort situation and no OMS 1 or OMS 2 burn should be done.

Case B-15

MECO Conditions

A main engine failed before the Press to MECO call. Due to the failure of an MDM unit and an electrical control bus the right OMS engine will not ignite.

	HA	HP	
CUR	69	-109	MET at MECO = 9:31

What target ID number would you use for OMS 1?

What time would TIG be?

What would HA be when OMS 1 is complete?

What target would you anticipate using for OMS 2?

38

OMS 1 Solution

The loss of one OMS engine does not affect the targeting decision nor does the failure of the MDM or control bus.

HA+HP= -40 and with a full dump the targeting card indicates that an ATO target is required for OMS 1 followed by ATO for OMS 2. The target ID for OMS 1 is 1, TIG would be at 11:31 and HA should be 112 NM when OMS 1 is complete.

OMS 2 Conditions

OMS 1 was completed successfully but had to be finished using RCS jets when the left engine failed. The MDM and control bus are still failed.

What target would you use for OMS 2 and are there any special procedures for this burn?

OMS 2 Solution

According to the targeting card on page 2-8 of the checklist, with two OMS engines failed the correct OMS 2 target is Nominal or ATO with a cutoff when HP reaches 80 NM. Since an ATO burn was done for OMS 1, an ATO target should be used for OMS 2. The only special procedure is to do the burn with the aft RCS jets and terminate the burn when the HP is equal to 80 NM.

Case B-16

MECO Conditions

The center main engine failed before the Press to MECO call. After dumping for 1:02, the dump was terminated because the left OMS engine failed. There was an ET SEP inhibit due to a feedline disconnect valve failure.

	HA	HP	
CUR	61	-271	MET at MECO = 10:09

What target ID number would you use for OMS 1?

What time would TIG be?

What OMS quantity would you expect to have in the left and right pods?

39

OMS 1 Solution

In spite of the ET SEP inhibit, the burn cannot be delayed because of the underspeed. Using the targeting card with HA+HP= -210 and a dump time of 1:02, the correct target would appear to be ATO. TIG should be at 12:09. For the given dump time, the corresponding quantity would be 86.5% per side.

OMS 2 Conditions

OMS 2 was completed successfully. There are no new problems.

What target ID would you use for OMS 2?

What value would be entered for C2?

What value would you expect to see for REI?

OMS 2 Solution

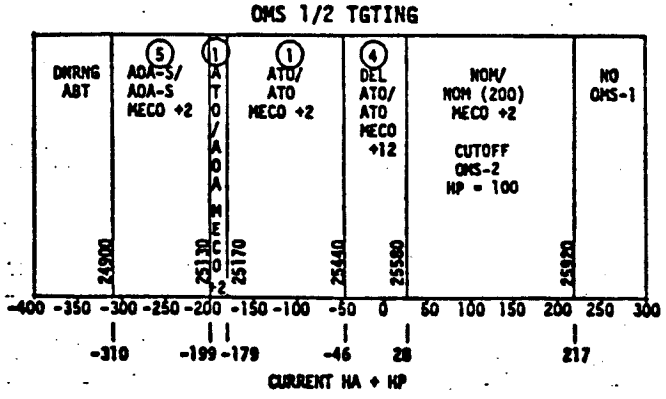
An AOA target should be used with an ID number of 6. C2 should equal -0.6582. REI should equal 4240 NM.

Type C Mission: Direct Insertion

Direct insertion launches make use of the main engines to achieve a higher trajectory than normal and thereby eliminate the need for an OMS 1 burn. An OMS 2 burn is done at apogee to circularize the orbit. A much higher orbit can be reached or a higher payload weight can be carried in this way.

There are still OMS 1 and 2 targeting cards for direct insertion missions and they look surprisingly similar to the standard cards. That is because if there is an underspeed or a system failure the consequences are still the same.

The OMS 1 and 2 targeting card for a direct insertion mission with no pre-MECO ATO dump is shown below. Notice that if current HA+HP is in the nominal range no OMS 1 is required but if there was an underspeed then an OMS 1 burn will be required. For small underspeeds a special nominal target is used for OMS 1 and the OMS 2 burn is cut off at a lower altitude in order to conserve propellant for deorbit. In other words it will be similar to an ATO. For larger underspeeds, a delayed-ATO, ATO, or AOA-shallow target may be required.



For systems problems no OMS 1 is done if performance was nominal but if an early return is required an AOA deorbit burn is done for OMS 2. For some problems which affect OMS performance capability, OMS 2 is cut off at a perigee altitude of 80 NM.

A direct insertion mission could have a pre-MECO ATO dump and the targeting card would then have a vertical scale for OMS quantity. For the purpose of the practice cases in this book the direct insertion mission will not have the pre-MECO ATO option.

You should now be ready to handle some practice cases for a direct insertion mission. Make sure that you use the checklist pages for the Type C Mission.

Practice Cases

Type C Mission: Direct Insertion (No Pre-MECO ATO Selection)

Case C-1

MECO Conditions

The right main engine failed during ascent.

	HA	HP	
CUR	92	+ 9	MET at MECO = 8:34

Fill in the items as appropriate for OMS 1.

35 ABORT TGT __ 10 TIG

___/__:__:__.-

TGT PEG 4

14 C1

15 C2 []_.____

16 HT ___.___

17 ΘT ___.___

Comments:

OMS 1 Solution

HA+HP= 101. This places you in the NOM/NOM(200) region which means that there was enough of an underspeed to make an OMS 1 burn necessary and to make the original high orbit unreachable. A "nominal" burn is done to reach a perigee altitude of 200 NM. This target is the one that will appear automatically in MM 104. Under normal conditions it would not be used.

35 ABORT TGT __ 10 TIG

__0/00:10:34.0

14 C1

15 C2 []_.____

16 HT 206.000

17 ΘT 165.000

Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

	HA	HP
CUR	206	+ 92

Fill in the items as appropriate for OMS 1.

35 ABORT TGT __ 10 TIG

___/__:__:__.-

TGT PEG 4

14 C1

15 C2 []_.____

16 HT ___.___

17 ΘT ___.___

Comments:

OMS 2 Solution

The nominal(200) target is used. It has an ID number of 2 and is different from the nominal OMS 2 target that is used if everything is normal. The burn would be terminated as soon as HP reaches 100 NM and that will not take very long since HP is already 92 NM.

```
35 ABORT TGT _2        10 TIG
                           0/00:45:24.0
                       TGT PEG 4
                        14 C1
                        15 C2  [] .
                        16 HT   206.000
                        17 θT   345.000
```

Case C-2

MECO Conditions

A main engine failure occurred during ascent.

```
          HA    HP
   CUR    95   -279       MET at MECO = 9:17
```

What target ID number, if any, would you select for OMS 1?

At what MET should the first OMS burn occur?

OMS 1 Solution

HA+HP= -184 which places you in the ATO/AOA region. The ATO target with ID number 1 would be used and TIG should be at 11:17.

Post-OMS 1 Conditions

OMS 1 was completed successfully. What target ID number would you enter for OMS 2?

What will HT be for this target?

OMS 2 Solution

The AOA target with ID number 6 should be used for OMS 2. HT should be 65.8 NM.

Case C-3

MECO Conditions

The center main engine failed during ascent.

	HA	HP	
CUR	250	- 50	MET at MECO = 8:49

Fill in the items as appropriate for OMS 1.

35 ABORT TGT __ 10 TIG ___/__:__:__._

TGT	PEG 4	
14	C1	_____
15	C2	[]_.____
16	HT	___.___
17	ΘT	___.___

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 200 which falls in the NOM/NOM(200) region. The correct target for OMS 1 is nominal.

35 ABORT TGT 10 TIG 0/00:10:49.0

TGT	PEG 4	
14	C1	
15	C2	[]_.____
16	HT	206.000
17	ΘT	165.000

You should anticipate using a nominal target for OMS 2 and cut off the burn when HP is equal to 100 NM.

Post-OMS 1 Conditions

OMS 1 was completed successfully. Both the left and right OMS oxidizer tanks are now leaking and are expected to fail before OMS 2.

Fill in the items as appropriate for OMS 2.

35 ABORT TGT __ 10 TIG ___/__:__:__._

TGT	PEG 4	
14	C1	_____
15	C2	[]_.____
16	HT	___.___
17	ΘT	___.___

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

According to page 2-8 of the checklist, the failure of two OMS oxidizer tanks makes an AOA-shallow necessary.

```
35 ABORT TGT _9        10 TIG
                          __0/00:26:42.0
                       TGT PEG 4
                        14 C1     15860
                        15 C2 [-]0.6286
                        16 HT    _65.800
                        17 ΘT    189.000
```

The approximate delta-VTOT will be between 119 and 130 ft/sec which is shown with the target data on page 8-2 of the checklist.

Case C-4

MECO Conditions

The left main engine failed right after Press to MECO and the center engine failed near MECO.

```
      HA    HP
CUR  135   -340            MET at MECO = 10:19
```

What target ID would you use for OMS 1?

In what major mode will the burn be done?

OMS 1 Solution

HA+HP= -205 which falls in the AOA-S/AOA-S region. The AOA-shallow target with ID number 5 would be used for OMS 1 and the burn would be done in MM 104.

OMS 2 Conditions

OMS 1 was completed sucessfully. There are no new problems.

What target ID would you use for OMS 2?

If REI appears with a value of 5320 what should the adjusted TIG be?

OMS 2 Solution

The AOA-shallow target with ID number 3 should be used for OMS 2.

If REI differs from the checklist value, TIG should be adjusted by the amount shown at the bottom of page 8-2. REI should be 5220 for this target and if the burn solution provided a value of 5320 then the delta-REI is +100 which corresponds to a TIG adjustment of approximately +25 seconds. TIG was originally 44:35 and so the new TIG should be 45:00.

Case C-5

MECO Conditions

MECO is nominal except there is an ET feedline disconnect valve failure.

	HA	HP	
CUR	270	+ 30	MET at MECO = 8:30

Fill in the items as appropriate for OMS 1.

35 ABORT TGT __ 10 TIG ___/__:__:__._

TGT	PEG 4	
14	C1	_____
15	C2	[]_.____
16	HT	___.___
17	ΘT	___.___

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 300 which is nominal and so you should not have filled in the target information and your comments should indicate that no OMS 1 is required. Since no OMS 1 is done, no special target is required for the ET feedline disconnect valve failure.

The expected OMS 2 target is nominal.

Post-OMS 1 Conditions

OMS 1 was completed sucessfully. There are no new problems.

Fill in the items as appropriate for OMS 2.

35 ABORT TGT __ 10 TIG ___/__:__:__._

TGT	PEG 4	
14	C1	_____
15	C2	[]_.____
16	HT	___.___
17	ΘT	___.___

What approximate delta-VTOT would you expect to see on the Maneuver display after loading the OMS 2 target?

Comments:

OMS 2 Solution

The nominal OMS 2 target is loaded.

```
35 ABORT TGT __          10 TIG
                            __0/00:42:43.0
                         TGT PEG 4
                          14 C1     _____
                          15 C2   [] _.____
                          16 HT     134.000
                          17 ΘT     335.000
```

The approximate delta-VTOT could range between 157 and 385 ft/sec depending on the precise conditions at MECO.

Case C-6

MECO Conditions

The right main engine failed during ascent.

```
     HA    HP
CUR 141   -242        MET at MECO = 10:14
```

What target ID should you use for OMS 1?

What target do you expect to use for OMS 2?

OMS 1 Solution

HA+HP= -101 and this falls in the ATO/ATO region. The OMS 1 target should be ATO with an ID number of 1 and OMS 2 should use an ATO target as well.

OMS 2 Conditions

During OMS 1 there was a propellant failure in the left OMS. The post-OMS 1 HP is 70 NM and the right OMS quantity is 34%.

What target ID number would you use for OMS 2?

OMS 2 Solution

The decision to use an ATO target for OMS 2 must be reconsidered in light of the propellant failure. No propellant from the left OMS can be used and only 34% remains in the right OMS. Using the chart on page 2-9 of the checklist with an HP of 70 NM it can be seen that an ATO requires 42% for OMS 2 plus the deorbit burn and an AOA requires 36%. Since the AOA refers to a normal AOA, an AOA-shallow ought to be possible with 34%. The target ID in this case would be number 7.

Case C-7

MECO Conditions

47

The right main engine failed during ascent. After MECO there was an ET SEP inhibit due to a feedline disconnect valve failure.

```
      HA    HP
CUR  136   + 53            MET at MECO = 8:59
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1     _____
                        15 C2   []_.____
                        16 HT    ___.___
                        17 ΘT    ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 189 which falls in the NOM/NOM(200) region. Since HA is greater than 79 NM it is permissible to delay OMS 1 due to the feedline disconnect valve failure. Two delayed nominal OMS 1 targets are provided on page 8-3 of the checklist. One target is used if HA+HP is less than 135 NM and the other if it is greater than 135 NM. In this case HA+HP is greater than 135.

```
35 ABORT TGT __        10 TIG
                          __0/00:20:59.0
                       TGT PEG 4
                        14 C1     _____
                        15 C2   []_.____
                        16 HT    206.000
                        17 ΘT    165.000
```

You should anticipate using a nominal target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed sucessfully. There are no new problems.

Fill in the items as appropriate for OMS 2.

```
35 ABORT TGT __        10 TIG
                          ___/__:__:__._
                       TGT PEG 4
                        14 C1     _____
                        15 C2   []_.____
                        16 HT    ___.___
                        17 ΘT    ___.___
```

Comments:

OMS 2 Solution

The appropriate nominal target from page 8-3 should be selected. It can be entered with ID number 2. Your comments should mention that the burn will be terminated when HP reaches 100 NM since that was indicated on the targeting card as the procedure required due to the underspeed at MECO.

```
35 ABORT TGT _2        10 TIG
                          __0/00:45:24
                       TGT PEG 4
                        14 C1
                        15 C2  [] _.____
                        16 HT   206.000
                        17 ΘT   345.000
```

Case C-8

MECO Conditions

There was a failure of the center main engine during ascent.

```
            HA    HP
      CUR   97   - 95      MET at MECO = 10:03
```

What target ID number would you use for OMS 1 and at what MET would TIG occur?

Which value below is most likely to be the inertial velocity at MECO?

a) 25527 ft/sec
b) 24945 ft/sec
c) 25550 mi/hr

48

OMS 1 Solution

HA+HP= 2 which falls in the DEL ATO/ATO region. A target ID number of 4 should be used and the TIG would would be 22:03 since it is a delayed burn. In this case the TIG would appear with the right value automatically since the delayed ATO target is stored with its own ID number.

The inertial velocity at MECO was likely to be between the values listed on the targeting card which are 25440 and 25580 and so (a) 25527 ft/sec is the most reasonable answer. Answer (b) is too small and (c) is far too large since it is in units of miles/hour.

Post OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

Which target ID would you use for OMS 2?

What value would C1 have with this target?

OMS 2 Solution

The ATO target with ID number 1 would be selected. It is interesting to note that this target is identical to the ATO target that follows the on-time ATO OMS 1 burn. C1 would have a value of zero for this and all targets other than those for deorbit burns.

Case C-9

MECO Conditions

There was a very late failure of the left main engine.

	HA	HP	
CUR	204	+ 15	MET at MECO = 8:45

What target ID number would you use for OMS 1?

OMS 1 Solution

HA+HP= 219 which is just enough to make OMS 1 unnecessary. There would be no OMS 1 burn.

OMS 2 Conditions

There are no new problems. What target would you use for OMS 2?

Fill in the following: TIG ___/__:__:__._
HT ___.___
ΘT ___.___

OMS 2 Solution

The nominal target for OMS 2 is used. This is the normal OMS burn sequence for direct insertion missions.

TIG	0/00:42:43.0
HT	134.000
ΘT	335.000

Case C-10

MECO Conditions

The right main engine failed during ascent.

	HA	HP	
CUR	61	-211	MET at MECO = 9:47

What target ID number would you use for OMS 1?

At what time would TIG occur?

What target do you anticipate using for OMS 2?

What is HT for that OMS 2 target?

OMS 1 Solution

HA+HP= -150 which falls in the ATO/ATO region. The ATO target with ID number 1 should be used for OMS 1 and TIG should occur at 11:47.

For OMS 2 the expected target would be ATO with ID number 1 and HT equal to 113 NM.

Post OMS 1 Conditions

OMS 1 was completed sucessfully. However, since the burn, two Freon loops have failed. Do you need to change the target decision for OMS 2 and if so, what is the correct target ID number and what time will TIG occur?

OMS 2 Solution

Since two Freon loops failed, the checklist indicates that an AOA or AOA-shallow needs to be done. The AOA target with ID number 6 is the correct target and TIG will occur at 51:52

Case C-11

MECO Conditions

A main engine failed during ascent. After MECO there was an ET SEP inhibit due to a feedline disconnect valve failure.

	HA	HP	
CUR	105	- 54	MET at MECO = 9:06

Fill in the items as appropriate for OMS 1.

35 ABORT TGT __ 10 TIG ___/__:__:__._

TGT	PEG 4	
14	C1	_____
15	C2	[]_.____
16	HT	___.___
17	ΘT	___.___

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= 51 which falls in the NOM/NOM(200) region. Since HA is greater than 79 NM it is safe to delay the OMS 1 burn which is what should be done because of the feedline disconnect valve failure. There are two delayed nominal OMS 1 targets and the one that should be used is the one listed under HA+HP<135.

35 ABORT TGT __ 10 TIG __0/00:21:06.0

14	C1	_____
15	C2	[]_.____
16	HT	209.000
17	ΘT	230.000

You should anticipate using a nominal target for OMS 2.

Post-OMS 1 Conditions

OMS 1 was completed successfully. There are no new problems.

Fill in the items as appropriate for OMS 2.

35 ABORT TGT __ 10 TIG ___/__:__:__._

TGT	PEG 4	
14	C1	_____
15	C2	[]_.____
16	HT	___.___
17	ΘT	___.___

What should HP be equal to when OMS 2 is complete?

Comments:

OMS 2 Solution

The appropriate nominal OMS 2 target should be used.

```
35 ABORT TGT __          10 TIG
                            __0/01:01:00.0
                         TGT PEG 4
                          14 C1
                          15 C2   []_.____
                          16 HT    207.000
                          17 ΘT    400.000
```

HP should be equal to 100 NM after the burn is complete because the burn should be stopped at that point according to the instructions on the targeting chart.

Case C-12

MECO Conditions

All three main engine failed near MECO.

```
      HA    HP
CUR   52   -401          MET at MECO = 8:20
```

Fill in the items as appropriate for OMS 1.

```
35 ABORT TGT __          10 TIG
                            ___/__:__:__._
                         TGT PEG 4
                          14 C1
                          15 C2   []_.____
                          16 HT    ___.___
                          17 ΘT    ___.___
```

What target do you anticipate using for OMS 2?

Comments:

OMS 1 Solution

HA+HP= -349 which falls in the downrange abort region. The underspeed is too large to even attempt an AOA-Shallow and so there will be no OMS 1 or OMS 2 burn.

Case C-13

MECO Conditions

The center main engine failed during ascent.

```
      HA    HP
CUR   105   -116          MET at MECO = 9:04
```

What target ID would you use for OMS 1?

At what time will TIG occur?

What will be the HA after OMS 1 is complete?

OMS 1 Solution

HA+HP= -11 which puts you in the DEL ATO/ATO region. The OMS 1 target will be delayed-ATO with an ID number of 4. TIG will occur at 21:04. HA after the burn should be approximately equal to HT which is 112 NM.

Post-OMS 1 Conditions

OMS 1 was completed sucessfully. During the burn there was a propellant failure in the left pod. The quantity in the right pod is 38% and HP is equal to 67 NM.

What target will you use for OMS 2?

At what time will TIG occur?

What is the angular distance between the target point and the point of OMS 2 ignition?

In what major mode will the burn occur?

53

OMS 2 Solution

Because of the propellant failure, the propellant in the left pod is not usable and you need to refer to the table on page 2-9 of the checklist. With HP=67 and 38% propellant available an ATO is not possible because at least 42% is needed. An AOA is possible however since it only requires about 36%. The correct target is number 4 with a TIG time of 51:52. The angular distance between the target point and the point of ignition is the definition of θT in OPS 3 and in this case it is 84 degrees. The burn will occur in MM 302.

Case C-14

MECO Conditions

There were no main engine failures but the right OMS helium tank developed a rapid leak and is now failed.

	HA	HP	
CUR	270	+ 30	MET at MECO = 8:30

What target would you use for OMS 1?

In what major mode will the first OMS burn occur?

OMS 1 Solution

Since there was no underspeed, no OMS 1 burn is required. According to page 2-4 of the checklist, for the failure of one OMS helium tank no OMS 1 burn is required but OMS 2 should be cut off when HP reaches 80 NM. The first OMS burn will occur in MM 105.

Post-OMS 1 Conditions

There are no new problems.

What target would you use for OMS 2?

Would you follow any special procedures due to the OMS helium tank failure?

At what time will TIG occur?

54

OMS 2 Solution

The OMS 2 target will be nominal but it should be cut off when HP reaches 80 NM. TIG will occur at 42:43.

Case C-15

MECO Conditions

There were no main engine failures however there is a cabin leak and the backup dP/dT is equal to 0.14.

	HA	HP	
CUR	269	+ 32	MET at MECO = 8:31

What target would you use for OMS 1?

OMS 1 Solution

According to page 2-4 of the checklist a cabin leak of this magnitude means that an AOA is required but no OMS 1 is necessary.

Post-OMS 1 Conditions

There are no new problems.

What target would you use for OMS 2?

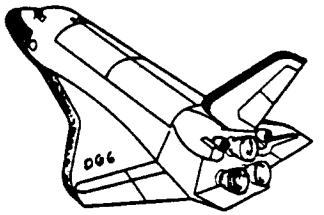
What REI would you expect to see after the target is loaded?

55

OMS 2 Solution

The AOA target with ID number 12 would be used because of the cabin leak. REI should be equal to 4160 NM.

This concludes the cases in this book. If you have any questions or comments on this book please direct them to the Ascent/Entry Section, DG6.



OMS 1 TARGETING

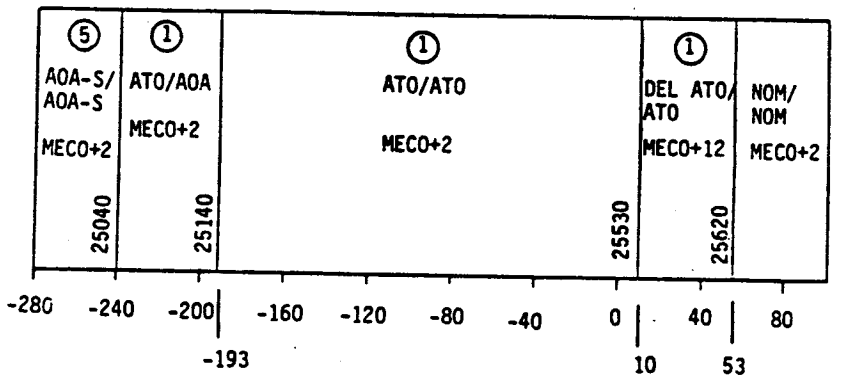
DELAY DO NOT DELAY BURN IF CUR HA < 70 **		
FAILURE	OMS 1 TARGET	OMS 2
OMS - 1 He TK 1 PRPLT TK 2 OMS ENG 2 N2 TKS (I'cnect to RCS) EPS - MNA & B MNA & C ET SEP	DELAYED ATO	N/R
FEEDLINE DISC VLV	DELAYED NOM	NOM
OMS - 2 He TKS - 1 OX & 1 FU TK diff PODS - 2 OX & 2 FU TK	DELAYED AOA-S	AOA-S

ON TIME		
2 APU/HYD 2 FREON LOOPS 2 H2O LOOPS 3 AV BAY FANS (BAYS 1,2) CABIN LEAK (BKUP dP/dT > .12)	NOMINAL	AOA/ AOA-S

FB 2-4

Type A Mission: No Pre-MECO ATO

OMS 1/2 TGTING



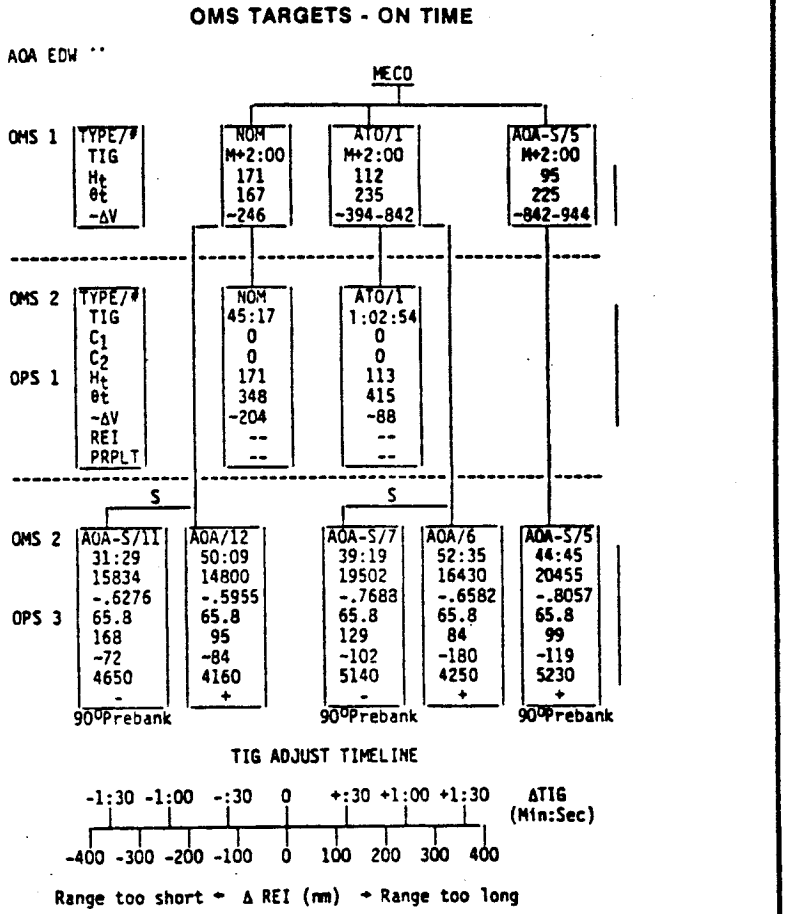
FB 2-5

OMS 2 TARGETING

FAILURE	OMS 2 TARGET
OMS - 1 PRPLT TK 1 OX & 1 FU TK diff PODS	Nominal/ATO CUT OFF Hp = 100
2 OMS ENG 2 He TKS EPS - MNA & B MNA & C	Nominal/ATO CUT OFF Hp = 80
OMS - 2 OX or 2 FU TKS diff PODS 2 APU/HYD 2 FREON LOOPS 2 H2O LOOPS 3 AV BAY FANS (BAYS 1,2) CABIN LEAK (BKUP dP/dT > .12)	AOA/AOA-S

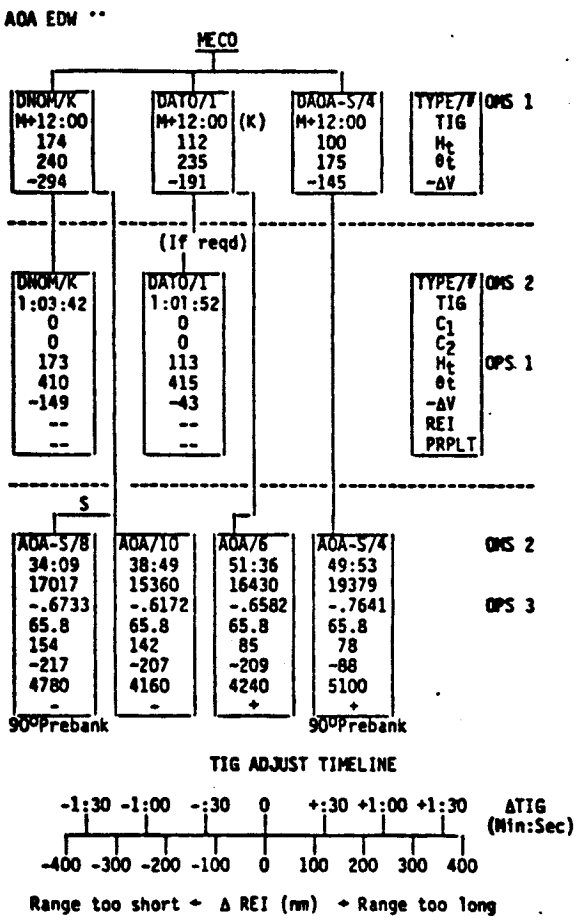
OMS He	%
4430 -	90
4120 -	80
3820 -	70
3520 -	60
3230 -	50
2940 -	40
2660 -	30
2380 -	20
2100 -	10

POST OMS 1 HP	OMS REQD ATO ΔV	ATO %	(Single Pod) AOA after ATO ΔV	AOA after ATO %
80	47	41	207	39
75	55	42	199	38
70	64	44	190	36
65	73	45	180	35
60	82	47	173	33
55	92	49	172	33
50	101	50	222	42
45	111	52	153	30



FS 8-2

Type A Mission: No Pre-MECO ATO



FS 8-3

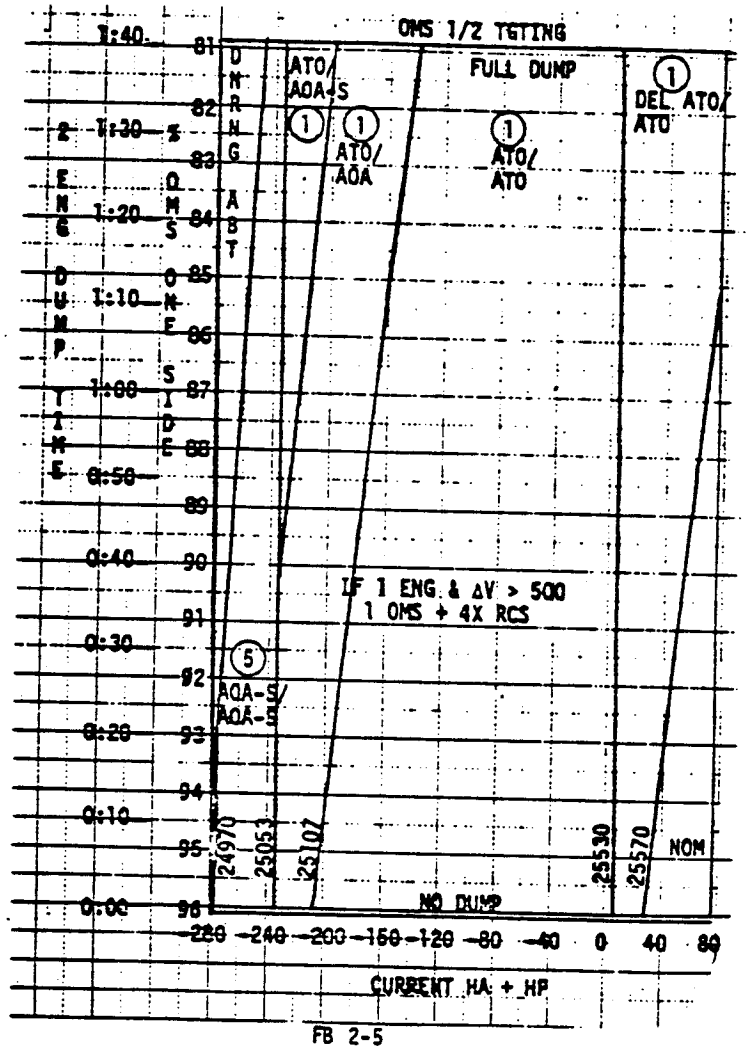
OMS 1 TARGETING

FAILURE	OMS 1 TARGET	OMS 2
DELAY DO NOT DELAY BURN IF CUR HA < 70 **		
OMS - 1 He TK 1 PRPLT TK 2 OMS ENG 2 N2 TKS (I'cnect to RCS) EPS - MNA & B MNA & C ET SEP	DELAYED ATO	N/R
FEEDLINE DISC VLV	DELAYED NOM	NOM
OMS - 2 He TKS - 1 OX & 1 FU TK diff PODS - 2 OX & 2 FU TK	DELAYED AOA-S	AOA-S
ON TIME 2 FREON LOOPS 2 H2O LOOPS 3 AV BAY FANS (BAYS 1,2) CAB IN LEAK (BKUP dP/dT > .12)	NOMINAL	AOA/ AOA-S

OMS

He	%	He	%
4360	90	2750	40
4030	80	2450	30
3700	70	2150	20
3380	60	1860	10
3060	50		

FB 2-4



FB 2-5

OMS 2 TARGETING

FAILURE	OMS 2 TARGET
OMS - 1 PRPLT TK 1 OX & 1 FU TK diff PODS	Nominal/ATO CUTOFF Hp = 100
2 OMS ENG 2 He TKS EPS - MNA & B MNA & C	Nominal/ATO CUTOFF Hp = 80
OMS - 2 OX or 2 FU TKS 2 FREON LOOPS 2 H2O LOOPS 3 AV BAY FANS (BAYS 1,2) CABIN LEAK (BKUP dP/dT > .12)	AOA/AOA-S

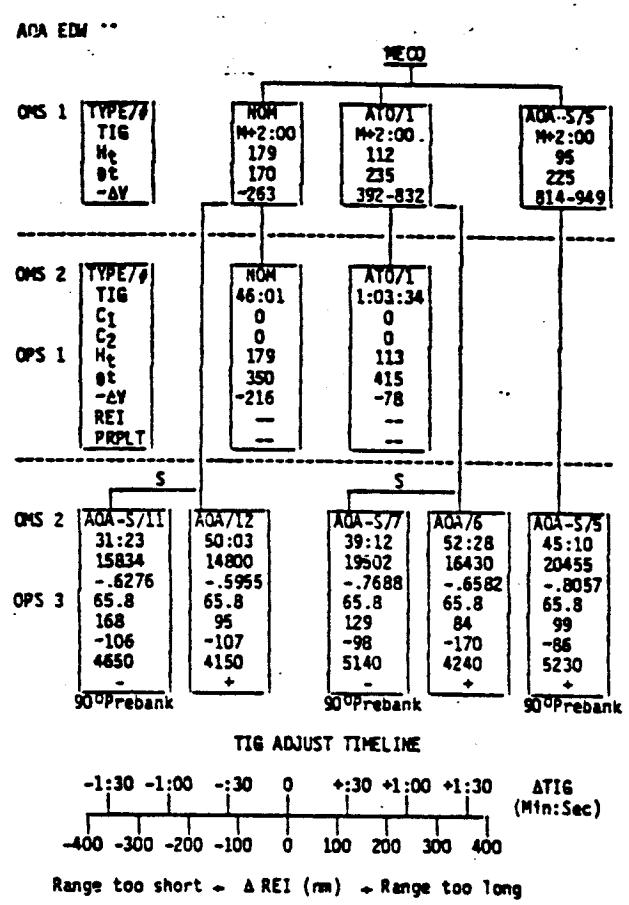
FB 2-8

POST OMS 1 HP	OMS REQD (Single Pod) ATO ΔV	ATO %	AOA after ATO ΔV	AOA after ATO %
80	47	39	207	41
75	55	40	199	39
70	64	42	190	38
65	73	44	180	36
60	82	45	172	34
55	92	47	171	34
50	102	49	204	40
45	112	51	152	31

FB 2-9

Type B Mission: Pre-MECO ATO

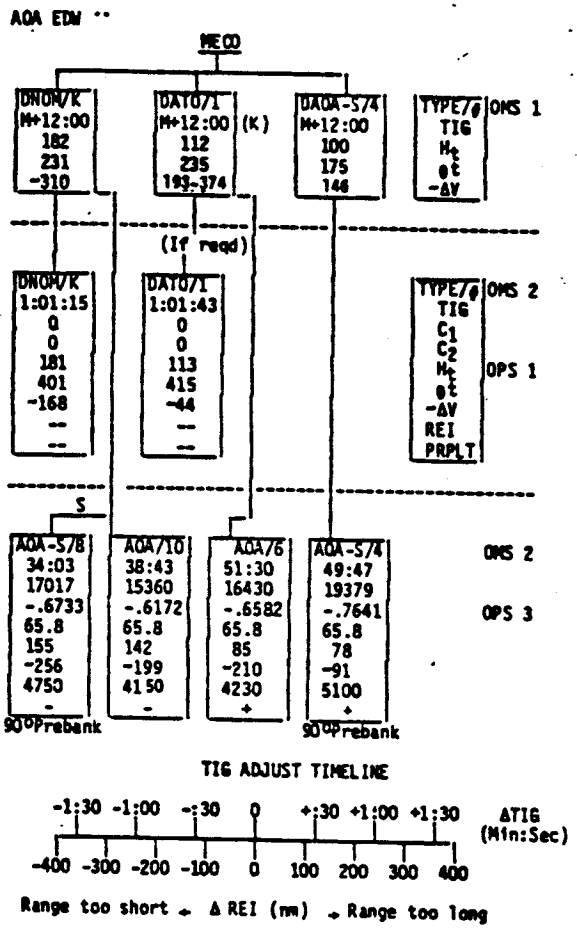
OMS TARGETS - ON TIME



FS 8-2

Type B Mission: Pre-MECO ATO

OMS TARGETS - DELAYED



FS 8-3

OMS 1 TARGETING

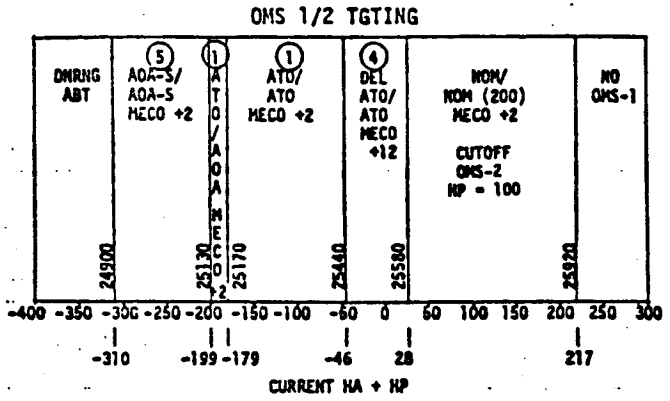
DELAY DO NOT DELAY BURN IF CUR HA < 79 ·· FAILURE	OMS 1 TARGET	OMS 2
OMS - 1 He TK 1 PRPLT TK 2 OMS ENG 2 N2 TKS (I'cnect to RCS) EPS - MNA & B MNA & C ET SEP	NO OMS 1	CUTOFF HP=80
FEEDLINE DISC VLV	NO OMS 1	NOM
OMS - 2 He TKS - 1 OX & 1 FU TK diff PODS - 2 OX & 2 FU TK	NO OMS 1	AOA
ON TIME 2 FREON LOOPS 2 H2O LOOPS 3 AV BAY FANS (BAYS 1,2) CABIN LEAK (BKUP dP/dT > .12)	NO OMS 1	AOA

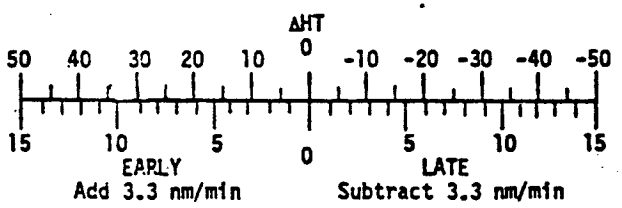
OMS

He	%	He	%
4360	90	2750	40
4030	80	2450	30
3700	70	2150	20
3380	60	1860	10
3060	50		

FB 2-4

Type C Mission: Direct Insertion





FB 2-5

OMS 2 TARGETING

FAILURE	OMS 2 TARGET
OMS - 1 PRPLT TK 1 OX & 1 FU TK diff PODS	Nominal/ATO CUTOFF Hp = 100
2 OMS ENG 2 He TKS EPS - MNA & B MNA & C	Nominal/ATO CUTOFF Hp = 80
OMS - 2 OX or 2 FU TKS diff PODS 2 FREON LOOPS 2 H2O LOOPS 3 AV BAY FANS (BAYS 1,2) CABIN LEAK (BKUP dP/dT > .12)	AOA/AOA-S

FB 2-8

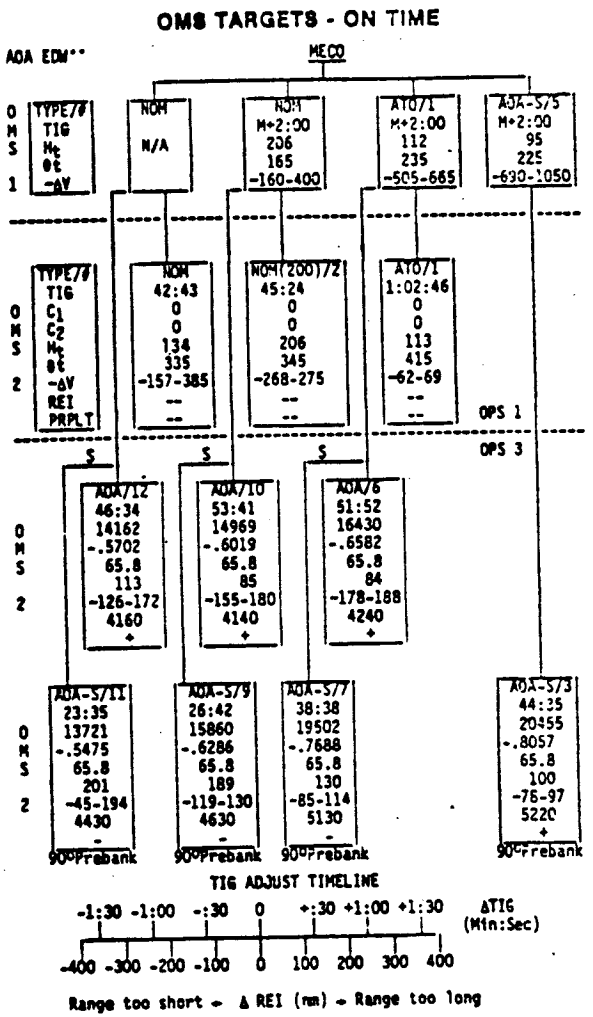
Type C Mission: Direct Insertion

ATO TO 105 NM

POST OMS 1 HP	OMS REQD (Single Pod) ATO ΔV	ATO %	AOA after ATO ΔV	AOA after ATO %
100	9	32	245	47
95	19	34	236	45
90	28	36	227	43
85	37	37	218	42
80	46	39	209	40
75	56	41	200	39
70	65	42	185	36
65	74	44	178	35
60	83	46	171	33

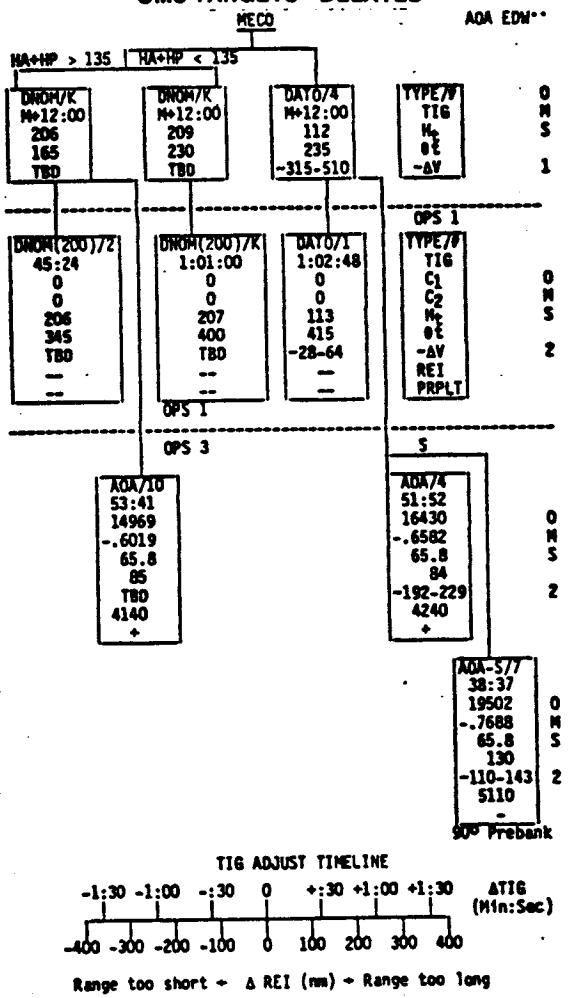
FB 2-9

Type C Mission: Direct Insertion



FS 8-2

Type C Mission: Direct Insertion



FS 8-3

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END