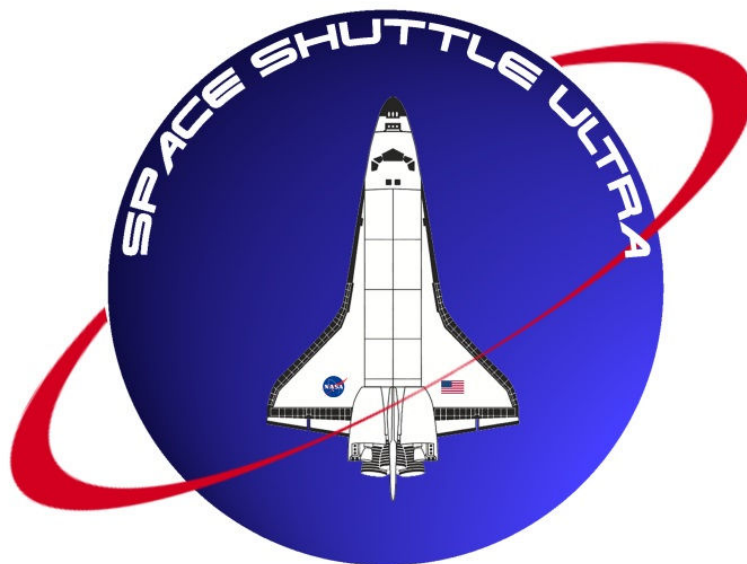


# Entry Checklist

**Generic**  
**Rev 1.0**  
**Sep 2017**



**Space Shuttle Ultra 4.2**  
**Orbiter 2010-2016**

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### OMS/RCS ΔV

OMS% GAGE	OMS He Press *	OMS V	RCS V	RCS BURN MIN:SEC
50	3300	244	202	7:19
40	2900	190	158	5:42
38	2820	180	150	5:23
36	2740	169	141	5:04
34	2660	158	132	4:45
32	2580	147	123	4:26
30	2500	137	114	4:06
28	2420	126	105	3:47
26	2340	115	96	3:28
24	2260	104	87	3:09
22	2180	93	79	2:49
20	2100	83	70	2:30
18	2020	72	61	2:11
16	1940	61	51	1:51
14	1860	50	42	1:31
12	1780	39	33	1:12
10	1700	28	24	0:52
8	1620	17	15	0:32
6	1540	6	5	0:12
<b>5</b>	<b>1500</b>	<b>1</b>	<b>1</b>	<b>0:03</b>

\* He pressure not valid until 1 hr after last burn

<b>V CAPABILITY</b>	
ARCS V fps = 0.8 x [ L% + R% - AFT QTY 1 ]	
FRCS V fps =	0.8 x FRCS %
OMS V fps =	5.4 x OMS %

NOTE: Uses assumed vehicle weight of 245,158 lb

# DEORBIT MNVR PAD

OMS BOTH 1		BURN ATT	I	VTOT	
L 2		R 24		TGO	
R 3		P 25		VGO X	( )
RCS SEL 4		Y 26		VGO Y	( )
TV ROLL 5		REI		VGO Z	( )
TRIM LOAD		TXX		HA	
P 6	( )			TGT	
LY 7	( )			HP	
RY 8	( )				
WT 9					
TIG 10					
TGT PEG 4					
C1 14					
C2 15	( )				
HT 16					
θT 17					
PRPLT18	( )				

**NOTES**

RCS I'CNCT:

☐ L OMS → RCS  
☐ R OMS → RCS  
☐ NONE

## DEL PAD

<u>PRE-DEORBIT</u>																																		
APU START: SINGLE APU START, ATTEMPT					APU(s)																													
APU START SEQUENCE					THEN																													
<u>DEORBIT</u>																																		
BURN CUE CARD:																																		
OMS TIG SLIP – NO EXEC > TIG +					<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td>:</td><td></td><td></td></tr> <tr><td></td><td>:</td><td></td><td></td></tr> </table>						:				:																			
	:																																	
	:																																	
RCS DOWNMODING					<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>																													
STOP/CONTINUE CUES: L OMS FAIL HP					<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>																													
R OMS FAIL HP					<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>																													
OMS ENG FAIL XFEED QTY CUE					%L		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td></tr> </table>				%R																							
ENG FAIL HP					<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>																													
SAFE HP					<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>																													
TOT AFT QTY 1 (%)					<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>																													
TOT AFT QTY 2 (%)					<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>																													
CAPTURE HP		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td></tr> </table>				PB/FLIP HP		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td></tr> </table>				AFT HP		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td></tr> </table>				B/U SITE		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>														
FRCS: DUMP TO % (USE TIME AS CUE)					OX		FU		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td></tr> </table>																									
<u>ENTRY/LANDING</u>																																		
EI - 5 MM303 INRTL ATT					R		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td></tr> </table>					P		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td></tr> </table>					Y		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>													
MM304 PREBANK (ENT MNVR Cue Card)					L		R		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>						<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>						<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>													
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EXPECTED AIL TRIM					L		R		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>						<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>						<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>													
VREL 1ST REVERSAL					<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>						<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>						<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>						<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>						<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>					
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LAND SITE		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td></tr> </table>				RWY		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>						50K		/		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>																
L		OVHD		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>						deg		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td></tr> </table>				MLS		38K		/														
R		STRT		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>						TAC		28K		/		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>																		
T MACH < 1 TO HAC					MAX Nz		Nz LIMIT		20K		/		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>																					
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T HAC INIT to H = 20K					<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>						<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>						7K		/		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>													
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AIMPOINT					SPEEDBRAKE		% @ 3K		1K		/		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>																					
NOM					NOM		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td></tr> </table>				SURFACE		/		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td><td></td><td></td></tr> </table>																			
CLOSE-IN					S.F.		<table border="1" style="width: 100%; text-align: center;"> <tr><td></td><td></td></tr> </table>																											
<u>REMARKS:</u>																																		

## DEORBIT BURN

**LANDING SITE TABLE**  
**(50° to 63,5° INCLINATION)**

S I T E	LOCATION	RWY	TACANS		MLS CH	LG	+ OVR RUN
				ITEM 5			
1	KSC	KSC 15 KSC 33	TTS 59Y	COF 97	8 6	15000 15000	1000 1000
2	BEN GUERIR	BEN 36 BEN 18	MAK 80 ■	CBA 116 ■	- -	13720 13220	0 1000
3	MORON AB	MRN 20 MRN 02	MRN 100	AOG 23	◆6 -	11730 11730	1000 1000
4	ZARAGOZA	ZZA 30L ZZA 12R	ZZA 64	ZAR 77 ■	◆6 -	12200 12200	1000 1010
5	MYRTLE BEACH	MYR 36 MYR 18	ILM 117	FLO 99	- -	9500 9500	1000 1000
6	WILMINGTON	ILM 06 ILM 24	ILM 117	DIW 107 ■	- -	7500 7500	0 0
7	CHERRY POINT	NKT 32L NKT 23R	EWN 83 ■	NCA 101	- -	7110 7100	800 880
8	OCEANA NAS	NTU 32R NTU 23L	NGU 86Y	ORF 116	- -	7500 11500	0 0
9	WALLOPS	WAL 28 WAL 04	SBY 49	SWL 71	- -	7510 8750	0 0
10	DOVER AFB	DOV 32 DOV 19	SIE 95	CYN 81	- -	12400 9100	0 0
11	ATLANTIC CITY	ACY 31 ACY 13	CYN 81	SIE 95	- -	9500 9500	0 0
12	BEN GUERIR	BEN 36 BEN 18	MAK 80 ■	CBA 116 ■	- -	13720 13220	0 1000
13	*MORON AB	MRN 20 MRN 02	MRN 100	AOG 23	◆6 -	11730 11730	1000 1000
14	*ZARAGOZA	ZZA 30L ZZA 12R	ZZA 64	ZAR 77 ■	◆6 -	12200 12200	1000 1010
15	GABRESKI	FOK 06 FOK 24	HTO 83	GON 45Y■	- -	8500 8500	1000 1000

◆ Available for TAL Only

\* LO XRNG TAL Site

■ DME

Length after displaced threshold

**LANDING SITE TABLE**  
**(50° to 63,5° INCLINATION)**

S I T E	LOCATION	RWY	TACANS		MLS CH	LG	+ OVR RUN
				ITEM 5			
16	CAPE COD CGAS	FMH 32 FMH 23	PVD 103	ACK 109 ■	- -	9000 7500	0 0
17	PEASE INT'L	PSM 34 PSM 16	ENE 118	BOS 74 ■	- -	10020 10020	0 0
18	HALIFAX INT'L	YHZ 23 YHZ 32	UAW 38	YHZ 98 ■	- -	8800 7700	0 0
19	STEPHENVILLE	YJT 09 YJT 27	YJT 78	YDF 80 ■	- -	9500 9500	0 0
20	ST JOHNS INT'L	YYT 29 YYT 11	UYT 23	YYT 82 ■	- -	8500 8500	0 0
21	GANDER INT'L	YQX 21 YQX 31	YQX 74	IQX 32 ■	- -	9700 8900	0 0
22	GOOSE BAY	YYR 20 YYR 34	UYR 40	YYR 120 ■	- -	10550 9080	0 0
23	LAJES AB	LAJ 15 LAJ 33	TRM 109	LAJ 45	- -	10870 10870	970 990
24	BEJA AB	BEJ 01L BEJ 19R	MOJ 37	BEJ 105	- -	10820 10820	0 900
25	KEFLAVIK INT'L	IKF 20 IKF 29	KEF 57	HL 44 ■	- -	9520 9560	0 0
26	SHANNON	INN 06 INN 24	SHA 80 ■	CRK 93 ■	- -	9540 9540	0 0
27	FAIRFORD	FFA 27 FFA 09	FFA 81	BZN 56	- -	9490 9490	990 970
28	KOLN-BONN	KBO 14L KBO 32R	GIX 18	DOR 23Y ■	- -	12020 12020	0 0
29	ISTRES AB	FMI 33 FMI 15	◆FMI 16	NIM 53	◆6 -	11300 12300	3960 0
30	ESENROGA	ESN 03R ESN 21L	BAG 76 ■	BUK 90 ■	- -	11800 11800	0 0

◆ Available for TAL Only

■ DME

Length after displaced threshold



**LANDING SITE TABLE**  
(50° to 63,5° INCLINATION)

S I T E	LOCATION	RWY	TACANS		MLS CH	LG	+ OVR RUN
				ITEM 5			
31	KING KHALED	KKI 15R KKI 33L	RIY 92	KIA 80	- -	13300 13300	0 0
32	DIEGO GARCIA	JDG 31 JDG 13	NKW 57	NKW 57	- -	12000 12000	950 950
33	AMBERLEY TINDAL RAAF	AMB 15 PTN 14	AMB 94 -	- TDL 70	- -	9500 8500	0 0
34	YOKOTA AB	JTY 36 JIY 18	SHT 19	NJA 98	- -	11000 11000	1000 1000
35	ANDERSEN AFB	GUA 06L GUA 24R	UAM 54	UNZ 105	- -	10560 10560	1050 1000
36	WAKE ISLAND	WAK 28 WAK 10	AWK 82	AWK 82	- -	9340 9340	0 0
37	HONOLULU	HNL 08R HNL 26L	HNL 95	NGF 93	- -	11500 11500	0 0
38	ELMENDORF	EDF 24 EDF 06	EDF 81	BGQ 72	- -	9500 9500	0 0
39	HAO ATOLL	HAO 12 HAO 30	HAO 85 ■	HAO 85 ■	- -	10690 10690	0 0
40	EDW TEMP	EDT 22R EDT 04L	EDW 111	LHS 21	8 6	12000 12000	1000 1000
41	ASCENSION	HAW 13 HAW 31	ASI 59	ASI 59	- -	9520 9520	0 0
42	NORTHROP	NOR 17 NOR 23	SNG 121Y	HMN 92	6 6	15000 15000	Lkbd Lkbd
43	NORTHROP	NOR 05 NOR 35	SNG 121Y	HMN 92	- -	15000 15000	Lkbd Lkbd
44	EDWARDS AFB	EDW 15 EDW 18L	EDW 111	LHS 21	- -	16300 15000	Lkbd Lkbd
45	EDWARDS AFB	EDW 22 EDW 04	EDW 111	LHS 21	8/† 6	15020 14020	0 1800

† MSBLS Jr. Ch 8 - Requires Uplink

■ DME

Length after displaced threshold

TIG-45	CRT1	GNC OPS 301 PRO (DEORB MNVR COAST)
	CRT3	GNC BFS SPEC 50 PRO (HORIZ SIT) √LAND SITE per DEL PAD
	CRT1	LOAD – ITEM 22 EXEC TIMER – ITEM 23 EXEC
	CRT1,3	√PASS & BFS TGTs per MNVR PAD: BURN ATT VTOT TGO HA HP

APU PRE START (GLS √ @ T-5:25)

R2	√BLR N2 SPLY (three)	– ON
	√BL RPWR (three)	– ON
	√BLR CNTLR/HTR (three)	– B
	√APU FU TK VLV (three)	– CL
	√APU OPER (three)	– OFF
	√HYD MN PUMP PRESS (three)	– LO
	APU CNTLR PWR (three)	– ON
	APU FU TK VLV (three)	– OP
	√APU/HYD RDY tb (three)	– gray
	APU FU TK VLV (three)	– CL

## HORIZ SIT CONFIG

		<u>PASS ITEM</u>	<u>BFS ITEM</u>
PTI	INH	1	
LAND SITE (DEL PAD)		41	41
RWY (DEL PAD)		3	3
		4	4
TAEM TGT			
G&N	OVHD	6	blank
HSI	blank		blank
XEP	NEP	7	NEP 7
AIM (DEL PAD)	NOM	8	NOM 8
	(or CLSE)		(or CLSE)
SPDBK	NOM	39	
TAC	INH	20	INH 20
GPS	INH	43	INH 43
DRAG H	AUT	22	AUT 22
ADTA H	INH	26	INH 26
ADTA TO G&C	INH	29	AUT 28
DES any failed TACANs			
TAC	DELTA	35	
AIF_G	INH	48	

## OMS BURN PREP

CRT1,2,3 GNC OPS 301 PRO (DEORB MNVR COAST)

CRT2 OMS ENG TRIMS  
 2 ENG BURN:  
 $\sqrt{\text{TRIM LOAD per MNVR PAD or:}}$   
 L,R – ITEM 6 +0.0 -5.7 +5.7 EXEC

1 ENG BURN:  
 $\sqrt{\text{TRIM LOAD per MNVR PAD or:}}$   
 P – ITEM 6 +0.0 EXEC  
 Good eng Y:  
 LY – ITEM 7 +5.2 EXEC  
 RY – ITEM 8 -5.2 EXEC

CRT1,2,3 GNC OPS 302 PRO (DEORB MNVR EXEC)

If NO-GO for DEORBIT BURN:

R2 HYD MN PUMP PRESS (three) – NORM

CRT1 GNC OPS 301 PRO (DEORB MNVR COAST)

TIG-20

MANVR TO DEORBIT BURN ATT

C3	√DAP: AUTO
F6/F8	√ADI ATT (two) – INRTL √ERR (two) – MED √RATE (two) – MED
CRT1	MNVR – ITEM 27 EXEC (*) (√ADI ATT with CRT BURN ATT)
CRT3	GNC SYS SUMM2

TIG-5

SINGLE APU START

R2	APU FU TK VLV – OP OPER – START/RUN
MDU	√HYD PRESS ind – LO green  √BURN ATT ± 5°  Go to <b>DEORBIT BURN</b> (Cue Card)

## DEORBIT BURN CUECARDS

## DEORBIT BURN (2 ENG)

CRT                   √MM302  
                          √OMS BOTH (ITEM 1)  
  
                          Enter TGO + 5 sec  
                          TRIM per MNVR PAD or P +0.0, LY -5.7, RY +5.7t

C3                   DAP – AUTO(PASS)/DISC

F6/F8               ADI – LVLH(REF)/HI/MED  
                          FLT CNTLR PWR (two) – ON

TIG -02:00

C3                   OMS ENG (two) – ARM/PRESS

TIG -00:15               EXEC (NO EXEC > TIG + \_\_\_\_ / \_\_\_\_ : \_\_\_\_)

                          If OMS AFT QTY < 11%, THC +X to OMS IGN + 1 sec

TIG  
00:00

                          Start watch ( Pc, VTOT, ENG VLVs)

                          If no OMS ignition: APUs – SHUT DN

### RCS COMPLETION (If reqrd)

                          THC +X to TGT HP or TOT AFT QTY 1 %

### FRCS COMPLETION (if applicable):

                          MNVR to -X Att (pitch up at 3°/sec to VGOz = +1/4)  
                          THC -X to TGT HP or FRCS depletion (JETS FAIL OFF)

CUTOFF  
+00 :02

C3                   OMS ENG(s) – OFF

                          Trim X,Z residuals < 2 fps (< 0.5 fps if shallow)

F6/F8               FLT CNTLR PWR (two) – OFF

C3                   √DAP: AUTO

## DEORBIT BURN (1 ENG)

CRT                   √MM302  
                      √OMS L or R (ITEM 2/3)  
                      Enter TGO + 10 sec  
                      √TRIM per MNVR PAD or P +0.0, LY +5.2, RY -5.2

C3                   √DAP – AUTO(PASS)/DISC

F6/F8               ADI – LVLH(REF)/HI/MED  
                      FLT CNTLR PWR (two) – ON

TIG-00:02           Good OMS ENG – ARM/PRESS               :                       )

- 00:15               EXEC (NO EXEC > TIG + \_\_\_\_ / \_\_\_\_ : \_\_\_\_)

If OMS AFT QTY < 11%, THC +X to OMS IGN + 1 sec

TIG  
00:00               Start watch (√Pc, VTOT, ENG VLVs)

\* If no OMS ignition: APUs – SHUT DN \*

### RCS COMPLETION (If reqrd)

THC +X to TGT HP or TOT AFT QTY 1 %

### FRCS COMPLETION (if applicable):

MNVR to -X Att (pitch up at 3°/sec to VGOz = +1/4  
THC -X to TGT HP or FRCS depletion (JETS FAIL OFF)

CUTOFF  
+00 :02

C3                   OMS ENG – OFF

Trim X,Z residuals < 2 fps (< 0.5 fps if shallow)

F6/F8               FLT CNTLR PWR (two) – OFF

C3                   √DAP: AUTO

## DEORBIT BURN (RCS)

√MM302  
√RCS SEL (ITEM 4)

C3 L,R OMS He PRESS/VAP ISOL A (two) – OP

Wait 2 sec

L,R OMS He PRESS/VAP ISOL B (two) – OP

√DAP – INRTL/DISC

F6/F8 ADI – LVLH(REF)/MED/MED  
FLT CNTLR PWR (two) – ON

TIG THC +X to TGT HP  
Maintain PITCH ATT ERR  $\pm 3$

CUTOFF: VGOx = 0, release THC

If no OMS IGNITION at TIG:

C3 OMS ENG (two) – OFF

R2 √APU – SHUT DN

CRT GNC OPS 301 PRO (DEORB MNVR COAST)

F6/F8 FLT CNTLR PWR (two) – OFF

C3 √DAP: AUTO

If burn terminated with HP > SAFE HP:

C3 √OMS ENG (two) – OFF

R2 √APU – SHUT DN

CRT GNC OPS 301 PRO (DEORB MNVR COAST)



## UNDERBURN

Determine HP (CUR HP – TGT HP)

Record prebank on ENTRY MANEUVERS Cue Card

### **PREBANK TABLE EDW (HA = 201 NM)**

EDW									
ΔHP	0	3	6	9	12	REDES.	13	(14)	REDES.
PREBANK	0	70	100	115	135	NOR ELS	150	170	YR
NOR							IF NOR NOGO		
G50 ITEM 41 +4 2. √RWY 17 SET TACAN tw (three) 121Y									
ΔHP		10	11	12	13	15	17	(18)	REDES.
PREBANK		105	105	110	120	135	165	180	YR
YR									
G50 ITEM 41 +2 2. √RWY 26 SET TACAN tw (three) 040X									
ΔHP						15	19	22	24 (26) 28
PREBANK						65	90	105	125 145 180

### **PREBANK TABLE KSC (HA = 201 NM)**

<b>KSC</b>									
$\Delta$ HP	0	2	5	7	9	12	14	(15)	REDES.
PREBANK	0	50	90	105	110	130	155	175	YQX
<b>YQX</b>									
<b>G50</b> ITEM 41 +2 1. $\sqrt$ RWY 21 SET TACAN tw (three) 074X									
$\Delta$ HP							16	22	(25) RED.
PREBANK							95	135	170 INN
<b>INN</b>									
<b>G50</b> ITEM 41 +2 6. $\sqrt$ RWY 06 SET TACAN tw (three) 080X									
$\Delta$ HP								26	28
PREBANK								135	180

CRT1,2      GNC   OPS 303 PRO (DEORB MNVR EXEC)

CRT3        GNC   SYS SUMM 2

CRT1                Enter INRTL EI-5 MM303 ATT from DEL PAD

Mnvr to EI-5 ATT – ITEM 27 EXEC (\*)

R – ITEM 24 + \_\_\_\_\_

P – ITEM 25 + \_\_\_\_\_

Y – ITEM 26 + \_\_\_\_\_

If UNDERBURN or no DEL PAD, manually mnvr to

LVLH R = 001  
Y = 358  
P = per table →

TIME to EI (min)	LVLH PITCH (deg)
20	339
	343
	347
	351
	355
15	359
	3
	7
	11
	15
10	19
	23
	27
	31
	35
5	39

## ENTRY SW CHECK

CRTX        GNC   SPEC 51 PRO (OVERRIDE)

C3                SRB SEP – AUTO  
                  ET SEP – AUTO

F6/F8            ADI ERR – MED  
                  RATE – MED

O8                RADAR ALTM (two) – ON

EI-13

## REMAINING APUs START

### **WARNING**

If APU failed to start at TIG-5  
start remaining good APU only

R2                APU FU TK VLV (two) – OP  
                  √APU/HYD RDY tb (two) – gray  
                  APU OPER (two) – START/RUN

MDU            √HYD PRESS ind (two) – LO green

R2                √APU/HYD RDY tb (two) – bp

If two APUs operating: CONDITIONING  
Delay following until EI-6:

R2                HYD MN PUMP PRESS (two) – NORM  
                  √PRESS ind (two) – HI green

If only one APU operating:

R2                APU AUTO SHTDN (one) – INH

Delay MM304 trans until EI-2  
Immediately prior to MM304 trans:

R2                HYD MN PUMP PRESS (one) – NORM

MDU            √PRESS ind (one) – HI green

MDU            HYD MN PUMP PRESS (three) – NORM  
                  √PRESS ind (three) – HI green

F6,F8            FLT CNTLR PWR (two) – ON

EI-6                Go to ENTRY MANEUVERS (Cue Card)

## ENTRY MANEUVERS

### **WARNING**

DO NOT transition to MM304 before EI – 4 min as to do so may trigger uncommanded RCS firing leading to orbiter LOC

FLIGHT CONDITIONS	MANEUVER
	EI-5 <span style="float: right;">√LVLH ATT</span> GNC, OPS 304 PRO <div style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;">             If PREBANK, R/Y – CSS              Roll at 1°/sec to  <u>1 8 0</u> → if HP ≥ 46 (not AOA), else              — — — → (from <u>Prebank Table</u>)              Maintain PREBANK ±5°           </div> (AOA) SPI When SB position – 0%: √HYD MN PUMP PRESS (three) – LO
qbar= 1	(AOA) HYD MN PUMP PRESS (three) – NORM
‘Guidance Box’ @ qbar~ 8 or D ~ 3	CLOSED LOOP GUIDANCE ____:____:____ If PREBANK: P,R/Y – AUTO  Begin AIL trim monitoring
D = 11	√DRAG H
Az = 10.5°	FIRST ROLL REVERSAL
V = 19K	√HYD MPS/TVC ISOL VLV SYS (three) – CL
V = 15K	√NAVAIDS (I/O RESET if reqd)
V = 12K	RAD BYP VLV MODE (two) – AUTO CNTLR LOOP (two) – AUTO B(A)
V = 10K	√SPDBK to 81%

FLIGHT CONDITIONS	MANEUVER
V = 5K	ADTA PROBES – DEPLOY ( HEAT)
M = 2.7	√APUs HUD PWR (two) – ON
M = 2.0	Ensure ADTA to G&C else √Theta limits
M < 1.0	√R FLT CNTLR – ON P,R/Y – CSS as reqd √SPDBK CMD vs POS
M = 0.7	√LND GEAR EXTD ISO VLV – OP
h = 15K	√MLS
h = 10K	√A/L (Tabs)
h = 2K	LDG GEAR ARM pb – push (ARM lt on)
h = 300	LDG GEAR DN pb – push (DN lt on)
MAIN GEAR TD	√SPDBK – 100%
V = 195 KEAS	DRAG CHUTE ARM, DPY pb (two) – push (simo) (All lts on)
V = 185 KEAS	DEROTATE
NOSE GEAR TD	SRB SEP – MAN/AUTO and depress pb √HYD BK ISOL VLV (three) – OP
V < 120 KGS or 5K' remaining	BRAKE as required (8-10 fps <sup>2</sup> , -0.25 to -0.3G)
If 5K' remaining and V > 140 KGS – MAX BRAKING	
V = 60 KGS	DRAG CHUTE JETT pb – push (JETT1,JETT2 lt on)
V = 40 KGS	BRAKE < 6 fps <sup>2</sup> (-0.2G) (Antiskid cutout)
WHEEL STOP	Go to ENT C/L, <u>POST LANDING PROCEDURES</u>

### DRAG CHUTE DEPLOY

MCC Call	Flight Condition
Early	Main Gear TD
NOMINAL	195 KEAS
Late	Post-Nose Gear TD Xwind DTO
Emergency Only	No Deploy Except CDR call
NO DEPLOY prior to MGTD >230 KEAS < 80 KGS Xwind > 15 kts	

## ENTRY ALPHA

VR	$\alpha$	ref	R	H	Href	Rref
25	HI	40 LO	4404	400		
24	HI	40 LO	2596	248	-47	L79
23	43	40 37	2134	240	-64	69
22	43	40 37	1782	233	-84	63
21	43	40 37	1509	227	-106	60
20	43	40 37	1288	222	-124	R59
19	43	40 37	1114	214	-146	60
18	43	40 37	976	207	-169	62
17	43	40 37	862	200	-188	63
16	43	40 37	764	193	-201	65

## KSC 15

MAX L/D	
M	$\alpha$
3	17
2	15
1	12

(133 OCF CV)

ASC-14b/133/A,E/A

HOOK VELCRO	HOOK VELCRO
----------------	----------------

15	43	40	37	686	187	-118	64
14	43	40	37	613	183	-127	63
13	43	40	37	546	180	-136	60
12	43	40	37	484	175	-152	59
11	42	39	36	429	171	-192	L56
10	41	38	35	376	166	-174	47
9	39	36	33	327	160	-206	43
8	37	34	31	278	153	-238	39
7	33	30	27	230	143	-267	38
6	30	27	24	185	132	-272	40
5	26	23	20	142	119	-273	41
4	23	20	18	107	106	-262	R38
3	19	16	15	74	91	-248	35
2.5		14		61	83	-251	
2		13		50	78	-257	
1.5		10		39	69	-311	
1		8		28	54	-261	

r

## POST LANDING

### WARNING

APUs OFF ASAP for APU  
Hydrazine, OMS, RCS (FWD or  
AFT) or MPS propellant leak

00:00

After orbiter stops:  
Report, "WHEELS STOP"

If RTLS or TAL abort:  
Perform ET UMBILICAL DOOR OPENING

### **ET UMBILICAL DOOR OPENING**

R2	ET UMB DR
	MODE – GPC/MAN
	R LAT – REL (tb-bp, REL ~6 sec)
	R LAT – OFF
	R DR – OP (tb-bp)
Wait 12 sec,	
	R DR – OFF (tb-bp)
	L LAT – REL (tb-bp, REL ~6 sec)
	L LAT – OFF
	L DR – OP (tb-bp)
Wait 12 sec,	
	L DR – OFF (tb-bp)
	MODE – GPC

R1                   √AC BUS SNSR (three) – AUTO

F6,F8               FLT CNTLR PWR – OFF

F3                   HUD PWR (two) – OFF

CRT1           GNC OPS 305 PRO (VERT SIT 2)

CRT2           GNC SYS SUMM 1

CRT3 BFS GNC OPS 305 PRO (VERT SIT 2)

### RCS, OMS SAFING

C3                   √OMS ENG (two) – OFF

### DEACT AIR DATA PROBE HTRS

C3                   √AIR DATA PROBE (two) – DPY



### APU/HYD SHUTDN

R2                    BLR PWR (three)                    – OFF  
                      BLR N2 SPLY (three)           – OFF  
                      APU OPER  
                          (1,2,3; 5 sec interval)           – OFF (MA)  
                      APU FU TK VLV (three)           – CL  
                      √Shutdn (HYD PRESS < 200)  
                      APU CNTLR PWR (three) – OFF

### POST LANDING MPS RECONFIG

(After APU/HYD shutdn + 1 min)

R2                    MPS He ISOL (six)                    – CL  
                      MPS He I'CNCT L                    – OUT OP  
                      MPS PNEU L ENG He XOVR           – CL

### GPC DEACT

O6                    GPC MODE 1,2,3,4,5 (five) – STBY (tb-bp)  
                      GPC MODE 1,2,3,4,5 (five) – HALT

### MDU's PWRDN

F6                    CDR1, 2                    – OFF  
  
F7                    CRT1, 2, 3                    – OFF  
                      MFD1, 2                    – OFF  
  
F8                    PLT1, 2                    – OFF

### VEHICLE PWRDN

R1                    MN BUS TIE (three)                    – OFF  
                      FC/MN BUS (three)                    – OFF  
                      ESS BUS SOURCE FC (three)           – OFF

### GPC PWRDN

O6                    GPC PWR 2,3,4 (three)           – OFF  
  
C2                    IDP/CRT 1,2,3 PWR                    – OFF  
  
R12                   IDP/CRT 4 PWR                    – OFF  
  
O8                    RADAR ALTM (two)                    – OFF

## ENTRY PROCEDURES SUMMARY (SCOM)

## 5.4 ENTRY

### CONTENTS

Deorbit Preparation .....	5.4-1
Deorbit Burn .....	5.4-3
Entry Interface .....	5.4-5
Terminal Area Energy Management (TAEM) .....	5.4-6
Approach and Landing .....	5.4-7

### Deorbit Preparation

#### TIG

Hr:Min (approx)

- 4:00 The crew transitions to the Deorbit Prep Checklist for nominal procedures. PLT sets CRT timer for deorbit TIG using the GNC 2 TIME display and SM timer.
- 3:56 CDR initiates radiator coldsoak by placing *RAD CNTLR OUT TEMP* switch to the *HI* position and activating topping FES to minimize propulsive venting. Vehicle is maneuvered to "tail sun" attitude (-X SI) for the coldsoak. The H2O Loop Bypass controllers are checked out and the H2O loops are configured for entry.
- 3:50 MSs continue entry stowage along with entry airlock configuration.
- 3:48 Ku-band antenna is stowed (if not already accomplished in last presleep period).
- 3:45 Radiators are stowed (if deployed).
- 3:42 Compute N2 quantity (for entry cabin leaks) and identify depleted H2 tanks (for burn cards).
- 3:35 Specialists install seats and FDP containers.

- 3:30 MS performs payload deactivation/entry preparation in this timeframe, as required.
- 2:30
- 3:27 DPS is configured for deorbit preparation. The BFS is woken up to ensure it has interface to the forward IDPs.
- 3:25 PLT activates APU water boiler steam vent heaters (at least 2 hr before APU start) and terminates hyd thermal conditioning. PLT prepares for hydraulic repressurization of the main engine thrust vector controls (engine bells must be properly stowed to prevent thermal damage).
- 3:15 CDR, PLT power up FCS, DDU's and navigation aids for entry (RGAs and ASAs must be on prior to OPS 3 transition).
- 3:10 Crew begins Entry Switch List verification by comparing crew compartment switch positions with diagrams in the Deorbit Prep book.
- 2:55 CDR initiates radiator bypass to retain Freon coldsoak. Alternate FES controllers are checked out to save ground test time. PLBDs will not be closed until this checkout and until Freon temperatures are down to 39° F. Primary RCS jets are used because FES Hi Load vent forces are too strong for vernier jets. H2O crossover valve is *verified open* to allow all water tanks to feed the FES equally.
- 2:51 MS prepares for PLBD closing: PLB lights activated (as required), cameras/video recorder readied, RMS TV camera positioned and RMS heaters secured (if RMS flown).
- 2:40 *Crew* closes PLBDs using SM PL BAY DOORS display on IDP 4 (SM OPS 2).

TIG

Hr:Min (approx)

-2:25 MS performs post-PLBD closing procedures, which include securing PLB lights, deactivating/stowing cameras, and taping down foot restraints (to prevent tripping during egress).

-2:23 CDR monitors auto maneuver to attitude suitable for S-band communications if required. Crew may go to deorbit attitude, depending on flight profile and TDRS position.

-2:16 CDR, PLT configure DPS (three phases) to place GPCs 1, 2, 3, and 4 in PASS OPS 3 and GPC 5 in BFS OPS 3. Prior to OPS 3 transition, entry TFLs are loaded and SM Checkpoint Initiate is performed to update the FDA in case a wave-off is required. Once in OPS 3, the crew refers to the Entry Pocket Checklist for malfunction procedures.

-1:58 MS deactivates star tracker and closes doors.

-1:55 CDR, PLT, MSs perform entry switch list configuration and verification at this time. The following items will be performed or verified:

#### Forward Flight Deck

- Electrical power to brakes, brake heaters, anti-skid, and nose wheel steering (NWS) is applied.
- Verniers are secured.
- FES control is given to the BFS. Freon loop RADIATOR ISOLATION MODE switch is taken to OFF. Cb's for HUM SEP and IMU FAN signal conditioners are opened.
- One O2/N2 valve is opened in case of a cabin leak.

- Communications panels are configured to provide maximum redundancy.

#### Aft Flight Deck

- Secure hydraulic heaters.
- Set up DTV for entry.
- Connect an LES communications cable (dC Utility Power MN C).
- Open Ku-band circuit breakers.

#### Middeck

- Configure communications panel for entry.
- Pressure control system (PCS) is configured for N2 water tank ullage pressure.
- Close 14.7 cabin regulators (protects N2 if leak occurs)
- Close O2 regulators (so O2 flow goes only to LES).
- Remove and stow bleed orifice.

-1:42 CDR receives MCC readup of PADs (OMS propellant PAD, deorbit/entry/land PAD, and deorbit maneuver PAD). The current state vector, and deorbit targets are also uplinked. Crew can use PGSC (SPOC) to determine targets and c.g. if required.

-1:40 MS enables MPS helium system pressure C/W (assists crew in isolating failed open regulator). Hydraulic system C/W parameters for low pressure are activated (alarm will sound immediately since APUs are OFF).

-1:39 Crew conducts entry review as required (15 min allotted).

-1:24 CDR, PLT don LESs.

TIG	CDR, PLT conduct horizontal situation configuration using GNC 50 HORIZ SIT; BFS GNC 50 HORIZ SIT; and GNC 51 OVERRIDE for both PASS and BFS.
Hr:Min (approx)	
-1:10 Specialists don LESs.	
-1:06 Final IMU alignment is performed by CDR to reset RM threshold prior to deorbit burn. This maximizes IMU RM, two-level attitude failure detection.	PLT initiates OMS burn preparation, which includes checking engine trims and placing OMS and RCS valve switches in the pre-burn configuration.
-1:04 Crew begins fluid loading (containers filled in post-sleep). This helps prevent orthostatic intolerance upon exposure to gravity.	MS3 removes and stows side hatch UV filter, locking device, and Pyro Box Safing pin.
-0:59 CDR, PLT ingress seats.	-0:25 PLT performs vent door closure with the GNC 51 OVERRIDE display.
-0:57 CDR, PLT remove HUD covers.	CDR, PLT receive final deorbit update/uplink if required. MS1 and MS2 ingress their seats.
-0:53 Crew performs LES pressure integrity check.	CDR proceeds to OPS 302 and GO/NO-GO is given for deorbit burn.
-0:50 Crew doffs and stows on-orbit communications headsets.	-0:15 CDR initiates maneuver to deorbit burn attitude on OMS MNVR EXEC display. CDR, PLT verify ADI switches in proper positions. MS places OMS/RCS heater switches in proper configuration for entry.
-0:33 MS deactivates WCS and galley.	
<b>Deorbit Burn</b>	
-1:03 All begin fluid loading per individual prescription.	-0:05 PLT performs single APU start. One APU must be operating in low pressure prior to the burn. First APU start procedures vary, depending on weather. CDR verifies orbiter is in the deorbit burn attitude $\pm 5^\circ$ . The crew transitions to the Deorbit Burn cue card for nominal procedures, and the Burn Monitor cue card for malfunction procedures. The Deorbit Burn Flight Rules cue card should be consulted prior to executing the burn.
-0:55 CDR, PLT perform LES pressure integrity check.	
-0:47 CDR, PLT stow all unnecessary FDF items and transition to the Entry Checklist for the nominal procedures.	
-0:46 CDR, PLT receive final deorbit update/uplink. Deorbit flight rules are verified with MCC. Exact time may vary.	
-0:40 CDR performs OMS TVC gimbal check (during AOS), using OMS MNVR EXEC display.	Deorbit Burn TIG Min:Sec (approx)
PLT initiates APU pre-start procedures (during AOS). BFS, SM SYS SUMM 2 is used to check APU status.	-5:00 Once on the Deorbit Burn cue cards, CDR and PLT ensure OMS He switches, ADI switches, and FLT CNTRL PWR are in the proper burn configuration.



-2:00	CDR takes OMS ENG switches to ARM/PRESS in preparation for the burn.	EI	
		Min:Sec (approx)	
-0:15	CDR hits EXEC key to trigger OMS ignition.	-20:00	CDR starts a secondary actuator check, if not already done during FCS checkout and time allows, using GNC 53 CONTROLS, BFS SM SYS SUMM 2, and GNC DEORB MNVR COAST displays.
0:00	Deorbit burn TIG. CDR, PLT monitor the burn using delta VTOT, VGO, TGO, and Hp from GNC OMS MNVR EXEC. BFS GNC SYS SUMM 2 display is used for OMS systems data. Section 7 discusses deorbit burn monitoring and downmoding.	-18:00	PLT performs forward RCS dump with GNC 23 RCS, GNC DEORB MNVR COAST, and GNC SYS SUMM 2 displays. Dump times for various forward RCS quantities are listed in the Entry Checklist. It takes 90 seconds to dump 50 percent forward RCS with 4 jets (twice as long using a 2 jet dump).
	As burn termination nears (TGO going to 0), crew monitors current perigee (HP) approaching targeted HP and delta VTOT approaching 0. Deorbit OMS burn time varies with orbital altitude. Typical burn times are 2-3 minutes. During the burn, the Deorbit Burn Monitor cue card is used for malfunction procedures.		The forward RCS is always dumped unless needed for c.g. control. This reduces the hazard to the crew if a hard landing is made.
	OMS Cutoff		CDR, PLT perform entry switch checks (using GNC 51 OVERRIDE) and exercise brake pedals.
+2 sec	If nominal burn, CDR secures OMS engines following the automatic purge and trims residual X and Z velocities (<2 fps for steep targets and -0.5 fps for shallow ones). The crew returns to the Entry Checklist Post Deorbit Burn section for nominal procedures and to the Entry Pocket Checklist for malfunction procedures.	-13:00	PLT starts remaining two APUs, verifies nominal performance, then switches all three APUs to normal pressure in preparation for the SSME hydraulic repress.
	PLT performs OMS/RCS reconfiguration by verifying the proper position of RCS switches and closing OMS HE and crossfeed valves; MS stows PGSC (SPOC).		PLT performs main engine hydraulic system repressurization to ensure the nozzles are properly stowed.
	CDR proceeds to OPS 303, verifies the proper attitude, and initiates maneuver to the EI -5 min attitude. CDR also conducts OMS gimbal powerdown verifying after gimbals have driven to the proper entry position.	-11:00	If required, PLT initiates hydraulic fluid conditioning on MCC's call and monitors surface position indicators for aerosurface cycling.
			Crew makes burn report to MCC and updates new state vector if required. All crew members inflate anti-g suits if desired.
		-6:00	The crew transitions to the Entry Maneuver cue card for nominal entry procedures.

-5:00	CDR transitions GPCs to OPS 304 when verified at EI-5 attitude. Crew switches to AESP for malfunction procedures.	+6:10	Maximum surface temperature region begins (Mach 24 to 19). Actual drag should be within .5 fps <sup>2</sup> of orbiter bug drag.
	Program test inputs (PTIs) are enabled on SPEC 50 when applicable.	+8:04	Pitch RCS jets deactivated at q-bar = 40.
-3:00	PLT verifies <i>FWD RCS MANIFOLD ISOLATION</i> valve switches (4) are closed (unless forward RCS PTIs are scheduled).	+11:49	At drag = 11 fps <sup>2</sup> , drag H updates begin in NAV filter. Crew monitors data on GNC 50 HORIZ SIT display.
		-20:25	
		+13:40	First roll reversal is issued by guidance when azimuth error (delta AZ) = $\pm 10.5^\circ$ . Occurs at a flight-specific velocity between 23,000 and 6,200 fps, depending on crossrange.
		-18:34	
<b>Entry Interface</b>			
+ = Time from EI			
- = Time to touchdown			
Min:Sec (approx)			
+0:00	Orbiter reaches EI (400,000 ft) at an		
-32:14	Earth relative velocity (V) of ~24,600 fps and descent rate (H-dot) of ~500 fps. The crew compares ADI, AMI, and AVVI data to Entry cue card data. ENTRY TRAJ (1 - 5), HORIZ SIT, and GNC SYS SUMM 1 displays are monitored. The BFS ENTRY TRAJ display is available to compare PASS and BFS guidance. The PLT can call up BFS SYS SUMM displays as desired to check system operation.		
		<u>Note:</u>	1 k fps = Mach 1.0
		+14:42	The PLT checks that the MPS TVC isolation valves are closed. Pitch and roll RCS activity lights are reconfigured when q-bar = 50 psf to indicate RCS saturation.
		-17:32	
		V <sub>m</sub> = 19 k fps	
		(Mach = 19)	
		Alt = 215 k ft	
		+15:51	PASS and BFS TRAJ displays mode to ENTRY TRAJ 2.
		-16:23	
		V <sub>m</sub> = 17 k fps	
		(Mach = 17)	
		Alt = 200 k ft	
+2:39	Automatic elevon trim begins at a	+17:00	NAVAID power is verified and I/O RESET performed. This ensures NAVAIDs will warm up before they are required (in case they were off due to a powerdown).
-29:35	q-bar = 0.5 psf.	-15:14	
+3:32	Aerosurface control begins at q-bar = 2.0 psf. CDR, PLT monitor elevon and aileron deflection angles on surface position indicator.	V <sub>REL</sub> = 15 k fps	
-28:42		(Mach = 15)	
		Alt = 185 k ft	
+4:45	Closed loop guidance initiated (CLG Init) at q-bar = ~8 psf or drag = ~3 fps <sup>2</sup> . Guidance box appears on ENTRY TRAJ to indicate closed loop guidance.	+17:57	PASS and BFS ENTRY TRAJ mode to ENTRY TRAJ 3. Drag is up to 33 fps <sup>2</sup> and Gs up to 1.5.
-27:29		-14:17	
		V <sub>m</sub> = 14 k fps	
		(Mach = 14)	
		Alt = 182 k ft	
+5:00	Roll RCS jets deactivated at q-bar = 10		
27:14	psf.		
+5:18	First non-zero bank command issued by guidance at H-dot -240 ft/sec (CLG Init plus 15 to 30 sec).		
-26:56			

+18:57 -13:17 $V_{REL}=12$ k fps (Mach = 12) Alt = 176 k ft	Radiator coldsoak usage is initiated in preparation for the FES becoming inactive: Radiator bypass valves (2) are placed in automatic and radiator controller loops (2) are put in AUTO B(A).  CDR and PLT begin monitoring for aileron saturation.	+23:30 -08:44 $V_{\infty}=5$ k fps (Mach = 5) Alt = 120 k ft	Air data probes are deployed. CDR, PLT begin aileron and rudder trim monitoring. The crew can check for good probe deploy discretes by noting the absence of OFF flags on the AMI and AVVI tapes when the AIR DATA select switch is taken from NAV to LEFT then RIGHT. This does not apply if the BFS is engaged. The BFS does not support OFF flags. Air data information will not be valid until Mach is <3.5.
+19:20 -12:54 $V_{REL}=10.5$ k fps (Mach = 10.5) Alt = 167 k ft	PASS and BFS ENTRY TRAJ mode to ENTRY TRAJ 4. Alpha and drag start to ramp down, but Gs stay up over 1.3.	+25:00 -07:14 (Mach = 3.4) Alt = 95 k ft	Using GNC 51 OVRD, GNC 50 HORIZ SIT, and instrument tapes the crew checks air data is close to NAV. MCC will give a GO to take air data to NAV and/or G&C using Items 25 and 28 on GNC 50 HORIZ SIT.
+20:03 -12:11 $V_{REL}=10$ k fps (Mach = 10) Alt = 150 k ft	Speedbrake opens to 81 percent.	+25:30 -06:44 (Mach = 2.6) Alt = 83 k ft	PLT ensures APU's operating in the best possible configuration for landing based on any previous failures. CDR, PLT activate HUDs.
+21:00 -11:14 $V_{RC}=8.0$ k fps (Mach = 8)	SSME repositioning for drag chute deploy. If GPC annunciates SSME REPOS FAIL, drag chute is emergency deploy only.		
+21:34 -10:40 $V_{\infty}=7.5$ k fps (Mach = 7.5) Alt = 144 k ft	MCC has sufficient tracking for state vector update. This time can vary depending on ground track and tracking station performance.		
+22:00 -10:14 $V_{\infty}=7$ k fps (Mach = 7) Alt = 138 k ft	MCC and the crew compare TACAN data to NAV. If acceptable, MCC tells the crew to take TACAN. GNC 50 HORIZ SIT display is used to check TACAN errors and accept TACAN data for use by the NAV filter.		
+22:41 -09:33 $V_{\infty}=6$ k fps (Mach = 6) Alt = 131 k ft	PASS and BFS ENTRY TRAJ displays mode to GNC ENTRY TRAJ 5.		
			<b>Terminal Area Energy Management (TAEM)</b>
		+25:40 -06:34 (Mach = 2.5)  Alt = 81 k ft	PLT verifies air data incorporated into guidance. If not, the CDR must take CSS control to avoid a transient when air data is incorporated. Software transitions automatically to OPS 305. Guidance enters TAEM phase. VERT SIT 1 displays replace PASS and BFS ENTRY TRAJ displays.
		+25:55 -06:19 (Mach = 2.4) Alt = 80 k ft	Forward, aft, and midbody compartment vents open.



+26:50 Air data must be  
-05:24 incorporated to Guidance and  
(Mach = 2.0) Control or the crew must stay  
Alt = 75 k ft within theta limits as shown  
on the ADI or on the VERT  
SIT display.

#### WARNING

If low energy, or flying a big heading alignment cone (HAC) ( $> \sim 325^\circ$ ) and air data is not incorporated, TAEM guidance will command an uncontrollable pitch up between Mach 1.0 and 1.5. The CDR will fly pitch CSS at  $M < 2.0$  and monitor theta limits.

+27:53 RCS yaw jets are deactivated.  
-04:21  
(Mach = 1.0)  
Alt = 54 k ft

+28:17 CDR selects pitch, roll, and  
-03:57 yaw (R/Y) CSS. Speedbrake  
(Mach = 0.9) "commanded" versus "actual"  
Alt = 46 k ft position is verified. Speed  
brake is now controlling  
energy. PLT flight controller  
is verified ON. This switch  
must be on for NWS to work.  
NWS is verified in system 1.

+29:00 PLT verifies landing gear  
-03:14 extend isolation valve is open  
(Mach = 0.7) (occurs at  $M=0.8$ ). PASS and  
Alt = 32 k ft BPS VERT SIT displays  
transition to VERT SIT 2. PLT  
and CDR monitor PASS and  
BPS GNC 50 HORIZ SIT for  
HAC acquisition. The glide  
slope indicator (GSI) is now  
accurate enough to use.

+30:00 MS2 monitors MLS acquisition.  
-02:14 All residuals and ratios  
280 KEAS disappear from PASS GNC 50  
Alt = 15 k ft HORIZ SIT upon MLS acquisition  
and an overbright MLS  
will appear in the middle right  
of the display. CDR and PLT  
check PAPIs and HUD  
overlays on runway to evaluate  
NAV state. De-clutter  
HUDs as required. Crew  
starts landing comm protocol.

#### Approach and Landing

+31:00  
-1:14  
300 KEAS ( $18^\circ$  and  $20^\circ$  OGS)  
Alt = 12 k ft CDR and PLT monitor outer  
glide slope (OGS) and verify  
with the PAPIs. At 10,000 ft  
crew verifies Approach and  
Landing guidance (flashing  
A/L on VERT SIT display),  
body flap to TRAIL, and LES  
visors down (KSC).

+31:24 PLT compares radar ALT 1  
-0:50 vs. 2.  
300 KEAS

Alt = 5 k ft

+31:35 MS2 checks speed brake  
-0:39 command percent (actual will  
300 KEAS lag).  
Alt = 3 k ft

31:41 CDR initiates preflare and  
-0:33 begins transition onto ball  
300 KEAS bar. PLT arms landing gear  
Alt = 2 k ft on call from CDR.

+31:51 Shuttle will be lined up on  
-00:23 ball bar. MS2 checks speed  
297 KEAS brake command percent  
Alt = 500 ft (second smart speed brake  
reset).

+31:54 PLT deploys the landing gear  
-0:20 on call from CDR. PLT/MS2  
288 KEAS check gear indications down.  
Alt = 300 ft

+32:04 -0:10 261 KEAS Alt = 30-80 ft	Final flare begins.	+32:34 +00:20	CDR checks ground speed and decel on HUD. Post midfield, CDR applies brakes at 140 knots ground speed (KGS) or 5000 feet runway remaining, whichever occurs first. If 140 KGS is reached first, nominal braking profile is used. This deceleration profile is typically 8 to 10 ft/sec <sup>2</sup> . At 5000 feet of runway remaining, if ground-speed is greater than 140 knots, CDR applies maximum braking.
+32:14 -00:00 195 or 205 KEAS	Main gear touchdown (195 KEAS GW <220,000 lb). CDR controls drift with rudder, maintains wings level with RHC. PLT and MS check speed brake opening. PLT checks HUD display for WOW lock on (WOWLON) (HUD reconfigures and air-speed moves to upper left corner of the display). Also, the velocity vector disappears.	+32:46 +00:32 60 KGS (±20 kts)	PLT jettisons drag chute on CDR call.
+32:15 +00:01 195 KEAS	PLT deploys drag chute on call from CDR. 195 KEAS.	+32:50 00:36 40 KGS	CDR reduces braking to less than 6 ft/sec <sup>2</sup> until wheelstop.
+32:16 +00:02 185 KEAS	CDR initiates beep trim derotation, which targets 1.5 deg/sec.	+32:56 +00:42	Orbiter stops; CDR reports "wheels stop" to MCC. Crew transitions to Post Landing Procedures in the Entry Checklist. At wheel stop, speed brake is closed.
+32:24 +00:10 145 to 155 KEAS	Nose gear touchdown (HUD reconfigures with a "G" showing up by the groundspeed). MS2 selects SRB SEP to AUTO/MAN or ET SEP to MAN and depresses the corresponding pushbutton to backup automatic discretes for elevon load relief, NWS, and anti-skid circuitry. CDR maintains or slowly and judiciously corrects to centerline with NWS. MS checks elevons down (makes sure they have load relief) and NWS FAIL and anti-skid fail lights off. MS calls "NWS FAIL" as necessary. (If no load relief, RHC full forward. If NWS FAIL light comes on, steer with rudder, RHC, and brakes. NWS2 may be available.)		

## 5.5 POSTLANDING

- CDR takes NWS, flight controller power, and HUD power off. PLT checks that APU auto shutdown is enabled and speed select is in norm. PLT takes HUD power off.
- CDR and PLT safe RCS/OMS, and deactivate air data probe heaters.
- CDR, PLT, and MS safe the *drag chute and landing gear*.
- PLT, after notifying MCC, opens the ET umbilical doors. PLT initiates hydraulic load test on MCC call.
- CDR performs DPS transition to GNC OPS 901 on MCC call.
- CDR performs the radiator reconfig and activates the NH3 boiler, as required (MCC call or C/W). *Typically, this is done out of order from the rest of the postlanding procedures based on cooling requirements and frequently is done very early in the post-landing time frame.*
- PLT sets body flap to trail and performs main engine reposition with PASS OPS 9 display GNC 105 TCS CONTROL. PLT also performs APU/HYD shutdown after main engine repositioning is complete.
- CDR performs PCS deactivation. With a GO for extended powerup from MCC, CDR/PLT begin system deactivation. CDR secures GPCs 2-4 reassigning strings to GPC 1 and informs MS to proceed with MS System Deactivation Procedures (LRU and APU heater deactivation, RCS/OMS heaters turned OFF).
- PLT performs vent door purge positioning and RCS/OMS valve test.
- Convoy personnel open hatch.
- Flight Surgeon enters cabin for health check. ASP, suit tech, and Shuttle Processing Contract Spacecraft Operator (SPC SCO) enter the cabin to assist with egress and removal of experiments and early return items.
- CDR, MS, (PS) egress seats. MS, PS retrieve "return to Houston bags."
- CDR, PLT, MS, (PS) egress orbiter to begin postlanding activities. After medical evaluations, showers, visits with family and postlanding medical data collection, the crew returns to Houston. Normal return to Houston occurs 6 to 9 hours after landing.
- ASP removes special FDF but retains some entry related FDF until handover to KSC.
- ASP hands vehicle over to SPC SCO when MCC (Houston flight) hands off to Orbiter Test Conductor (OTC).



**ENTRY  
CHECKLIST**

**STS  
ALL**

BACK COVER