

# STS – 133

## Level A Groundrules And Constraints

### One Cycle To Flight Profile

Launch Date: September 16, 2010

Note: This product supports STS-133 Ascent, Entry and Navigation I-Load design.

Flight Design And Dynamics Department

March 15, 2010



***United Space Alliance***

Flight Design and Dynamics Department  
 United Space Alliance  
 Houston, Texas

## STS-133 Level A Groundrules and Constraints

This document contains the approved groundrules and constraints and associated trajectory to be used in generating the One Cycle to Flight Ascent/Entry Profile. Hardware development, software verification, and crew training should be consistent with the data presented.

These groundrules and constraints are approved and controlled by the office of the USA Flight Design and Dynamics Department, Flight Design Management Unit. Configuration Management Requirements of the Flight Operations Panel (FOP) function are specified in the Flight Design Management Plan.

Prepared By: USA Flight Design Management Office  
 USA Flight Design and Dynamics Department

Submitted by:

<u>Original signed by</u>	<u>3/18/2010</u>
Jared Renshaw	Date
STS-133 Flight Design Manager	

Approved by:

<u>Original signed by</u>	<u>3/23/2010</u>	<u>Original signed by</u>	<u>3/23/2010</u>
Dawn M. Gabriel	Date	Greg E. Schrage	Date
Group Lead, Flight Design Managers		FOP Chairman	

STS-133  
Level A Groundrules and Constraints  
Description of Changes to  
One Cycle to Flight Profile

<u>Change Notice</u>	<u>Description/Authority</u>	<u>Date</u>	<u>Pages Affected</u>
Baseline	Baseline One Cycle to Flight Ascent/Entry Profile Groundrules and Constraints	03-15-10	All

## INTRODUCTION

This document defines the Level A Groundrules and Constraints and associated profile baselined by the Flight Operations Panel which will be used in generating the One Cycle to Flight Ascent/Entry (OCF-AE) profile for STS-133.

## STS-133 MISSION DESCRIPTION

The primary objective of the STS-133 mission is to deliver the ULF-5 launch package consisting of the ExPRESS Logistics Carrier 4 (ELC4) and the Permanent Logistics Module (PLM). STS-133 will also deliver and retrieve ISS equipment and supplies.

# STS-133

## MISSION OBJECTIVES

JARED RENSHAW/DM2  
DAWN GABRIEL/DM2

### PRIMARY OBJECTIVES

- Launch and install the ISS-ULF5 Launch Package (LP)
  - Expedite the Processing of Equipment to Space Station (ExPRESS) Logistics Carrier 4 (ELC4)
  - Permanent Multi-Purpose Module (PMM) on Node 1 nadir
- Transfer ISS equipment and supplies

### PAYLOADS OF OPPORTUNITY

- MAUI Analysis of Upper-atmospheric Injections (MAUI)
- Shuttle Exhaust Ion Turbulence Experiment (SEITE)
- Shuttle Ionospheric Modifications with Pulsed Local Exhaust (SIMPLEX)
- Ram Burn Observation -2 (RAMBO-2)

### DEVELOPMENT TEST OBJECTIVES (DTOs)

- DTO 701A TriDAR Automated Rendezvous and Docking (AR & D) Sensor
- DTO 805 Crosswind Landing Performance (DTO of opportunity)
- DTO 900 Shuttle RSRB Chamber Pressure, Strain Gauge, and Acceleration Rates Data Collection

# STS-133 FLIGHT OVERVIEW

JARED RENSCHAW/DM2  
DAWN GABRIEL/DM2

## OCF ORBIT CYCLE

## OCF-A/E CYCLE

### LAUNCH DATA:

DATE: JULY 29, 2010 GMT  
TIME: 12:04:02 GMT (8:04:02 EDT)  
WINDOW DURATION  
LAUNCH PAD

September 16, 2010 GMT  
15:40:20 GMT (11:40:20 EDT)  
10 MINUTES  
39A

### FLIGHT DURATION:

10 + 1 + 2 DAYS

8 + 1 + 2 DAYS

### CREW:

5 UP / 5 DOWN (NO ROTATION)

6 UP / 6 DOWN (NO ROTATION)

### ORBIT DATA:

INSERTION ALTITUDE  
MAX RENDEZVOUS ALTITUDE 205 N. MI.  
INCLINATION  
BETA ANGLE @ LAUNCH, MAX,  
EOM + 2 DAYS -31.42°, -31.42°, 13.77°

122 N. MI.  
200 N. MI.  
51.6°  
-33.13°, -51.97°, -46.31°

### EVAs (ISS BASED)

1 SCHEDULED / 0 UNSCHEDULED

0 SCHEDULED / 1 UNSCHEDULED

### VEHICLE DATA:

ORBITER  
NUMBER OF CRYO TANK SETS  
GN2 TANKS  
OMS LOAD  
FORWARD RCS LOAD  
ORBITER SOFTWARE  
ET

OV-103  
4 (200 LBM OFFLOAD)  
5 (NO OFFLOAD)  
22,761 LBM  
1,912 LBM (MIN)  
OI-34  
SLWT

**STS-133  
FLIGHT OVERVIEW  
ASCENT SUMMARY**

Richard Arias / USH-482L

<u>ITEM</u>	<u>133 OCF – ORBIT FOP</u>	<u>133 OCF – A/E FOP</u>
TDDP	SPLAF133(001)	OCFAF133(002)
OMS ASSIST (sec)	53	66
MECO ALTITUDE (nmi)	52	52
Q CONSTRAINT / PE ALPHA TARGET	PE OPS HIGH Q SUM / PE MAX ALPHA	PE OPS HIGH Q SUM / PE MAX ALPHA
SSME THROTTLE SCHEDULE 1 <sup>st</sup> STAGE (%)	104 / 104 / 72 / 104	104 / 104 / 72 / 104
ASCENT MEAN WINDS / SRB BULK TEMP.	July / 80	September / 81

**STS-133  
FLIGHT OVERVIEW – Continued  
ASCENT SUMMARY**

Richard Arias / USH-482L

<u>ITEM</u>	<u>133 OCF – ORBIT FOP</u>	<u>133 OCF – A/E FOP</u>
<b>TDDP ASCENT PERFORMANCE MARGIN (lb)</b>	<b>1578</b>	<b>2101</b>
OMS Propellant difference between PROP-01 and TDDP		-1
 <b>DESIGN ASSESSMENT PERFORMANCE MARGIN (lb)</b>	 <b>1577</b>	 <b>2100</b>
Protection for DOL Dispersions		-700
Projection to 5-minute window from inplane		-600
SRB Burn Rate / 0.55 MIL Lower than 0.3705 Average		-198
Rendezvous Altitude Update to 190 nmi**		1160
Payload Difference Between Greenbook and Ascent Simulation		176
Crew Compartment Difference Between Greenbook and Ascent Simulation		-176
STS Operator Difference Between Greenbook and Ascent Simulation		-22
 <b>PROJECTED ASSESSMENT PERFORMANCE MARGIN (lb)</b>	 <b>78</b>	 <b>1740*</b>
*CONTAINS 03/09/2010 GREEN BOOK PROJECTIONS		

\*\* Note: APM projection is not consistent with 200 nmi rendezvous altitude



# STS-133

## DESCENT SUMMARY

JARED RENSHAW/DM2  
DAWN GABRIEL/DM2

### MAXIMUM CROSSRANGE (NMI.)

<u>APPROACH / DIRECTION</u>	<u>UNDISPERSED</u>	<u>DISPERSED</u>	<u>NOMINAL</u>
A / L	843	787	743
A / R	897	838	N/A
D / L	856	797	N/A
D / R	890	832	N/A

NOTE: A/L IS THE MISSION SPECIFIC CASE.

### LANDING SITES:

EOM	- PRIME	KSC 15
	- ALTERNATE	EDW 22
	- ALTERNATE	NOR 17
RTLS	- PRIME	KSC33
TAL	- PRIME	ZZA 30
	- ALTERNATE	MRN 20
	-ALTERNATE	FMI 33
AOA	- PRIME	KSC 15
	- ALTERNATE	NOR 17

**CONTINGENCY ABORT BLACK ZONE STATUS**

- Contingency Abort Black Zone (CABZ) assessment is not required
  - Mass properties do not exceed the CABZ assessment criteria of liftoff weight greater than 259,000 LBM and X-CG aft of 1115.0 IN
  - Liftoff mass properties: 265,372 LBM and X-CG = 1110.5 IN

**STS-133 LANDING SITE TABLE  
(50° to 63.5° INCLINATION)**

Version 001

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

**STS-133 LANDING SITE TABLE  
(50° to 63.5° INCLINATION)**

Version 001

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 26 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	ESENBOGA	ESN 03R ESN 21L	BAG 78 ■	BUK 90 ■	- -	11800 11800	0 0

◆ Available for TAL Only

■ DME  
Length after displaced threshold

**STS-133 LANDING SITE TABLE  
(50° to 63.5° INCLINATION)**

Version 001

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 JTY 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

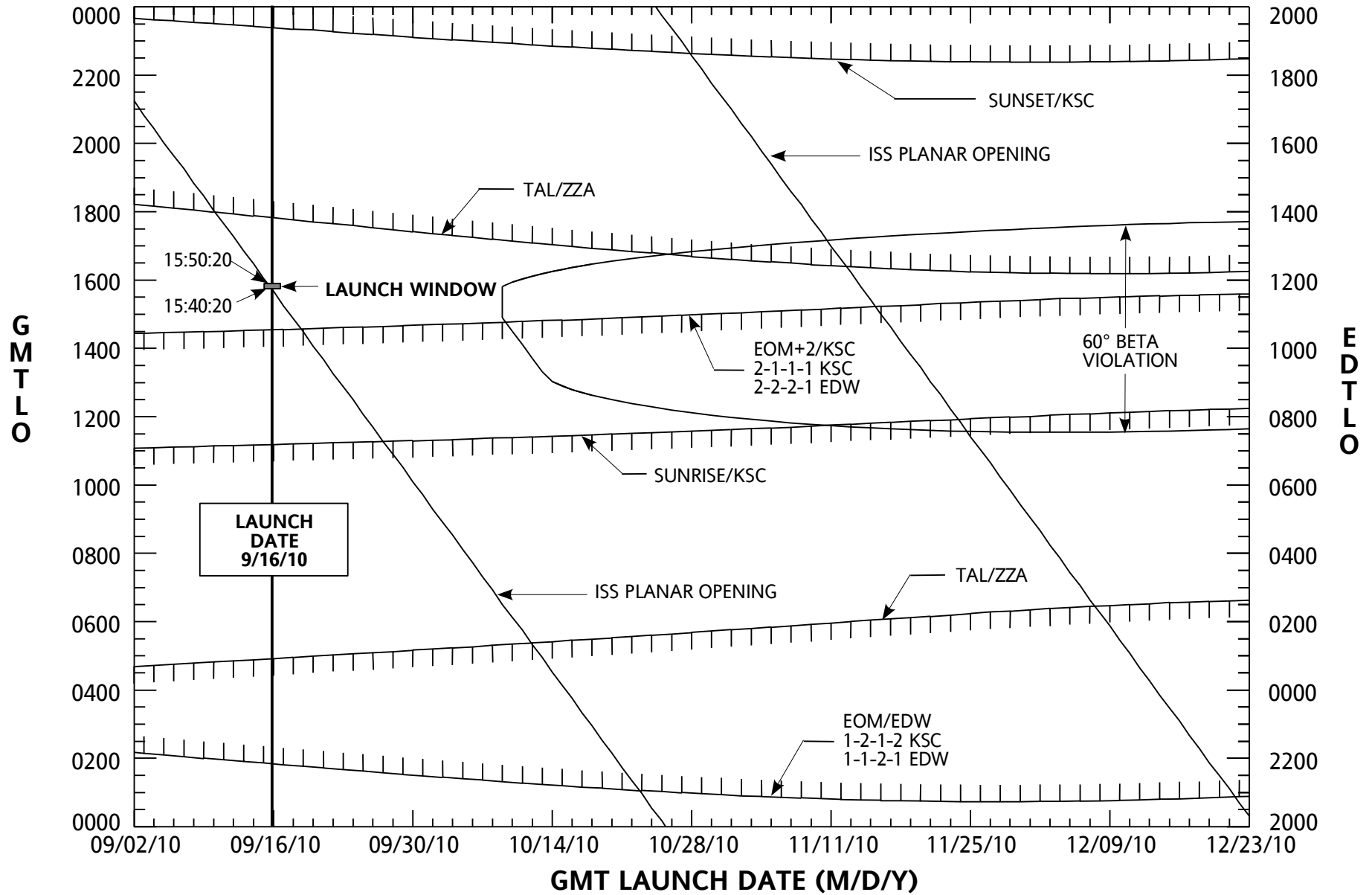
■ DME  
Length after displaced threshold

Mission Duration = 8+1+2  
 Inclination = 51.6°  
 OMS2 ha/hp = 124 x 85 nmi.  
 Target ha/hp = 206 x 194 nmi.

# STS-133

P. Gentry/USH-483L  
 M. Jamroz/USH-483L

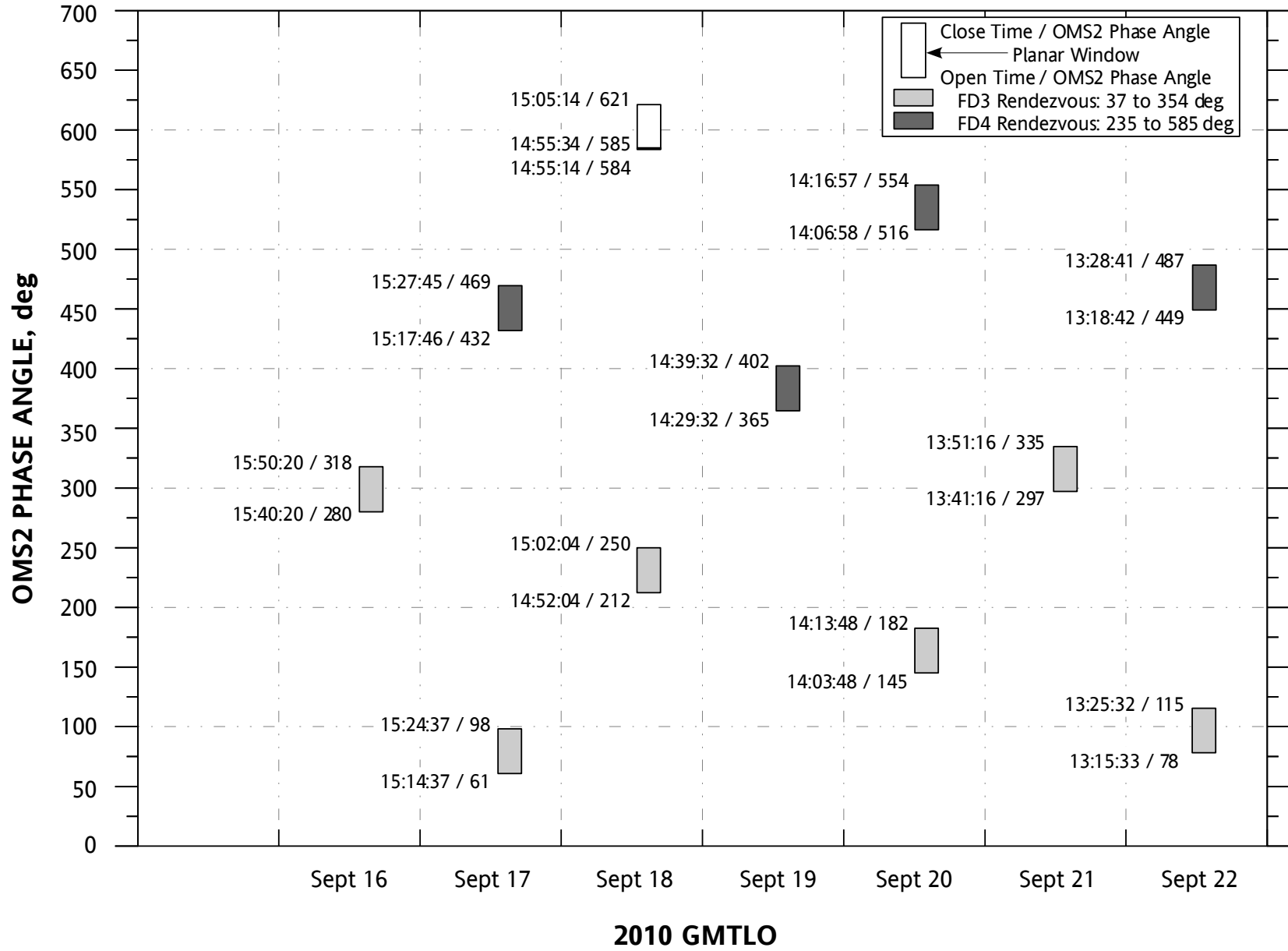
## LAUNCH WINDOW



Note: EOM lighting lines, based on an OMS2 phase angle of 280 deg, are representative only.  
 The ISS beta angle ( $|\beta| < 60^\circ$ ) for mated operation begins ~ 1/20:19:22 MET (FD3 Rendezvous) and ends ~ 6/16:39 MET.

# STS-133

## DAILY PLANAR/PHASE WINDOWS



## LAUNCH WINDOW SUMMARY

### LAUNCH WINDOW

- Consists of the planar and phase windows
- Follows ISS planar opening time throughout the year
- Based on an STS-133 ISS vector obtained from the ISS December 2009 reference trajectory which was modified to provide a FD3 rendezvous

### PLANAR WINDOW

- Maximum duration is 10 minutes based on thermal limits
- ISS planar opening occurs approximately 24 minutes earlier each day  
(Repeating approximately every 59 days)

### PHASE WINDOW

- Phase angle range based on 200 nmi target average altitude and 85 nmi Orbiter minimum perigee
- Phase angle range at OMS2: 37° to 354° for a flight day 3 rendezvous
- Phase angle range at OMS2: 235° to 585° for a flight day 4 rendezvous
- There is a 75% chance of a full planar window with flight day 3 rendezvous capability
  - 20% chance that flight day 3 capability will be a partial window
  - 5% chance that no flight day 3 planar window exists



## LAUNCH WINDOW SUMMARY

### SSP LIGHTING

- For September 16, 2010 GMT launch date, launch, RTLS, TAL, and EOM landings are in daylight
- Daily shift of planar window and/or ISS planar uncertainties may result in lighting changes for launch, aborts, and EOM landing opportunities
- Daylight EOM protection will vary with OMS2 phase angle

### BETA ANGLE OF $|\beta| < 60^\circ$ FOR MATED OPERATIONS

- Solar beta angle constraint of  $|\beta| < 60^\circ$  for mated operations is satisfied for a September 16, 2010 GMT launch
- The  $60^\circ$  solar beta angle will be violated from November 11, 2010 through November 24, 2010

**STS-133**  
**SEQUENCE OF EVENTS**  
 LAUNCH DATE: SEP 16, 2010  
 LIFTOFF: 15:40:20 GMT

P. Gentry/USH-483L  
 J. Bacher/USH-483L  
 D. Brownfield/USH-483L

EVENT	ORBIT	DAILY ORBIT	MET (DD:HH:MM)	REFERENCE DELTA V (FPS)	HP/HA (N. MI.)	HOUSTON DATE	HOUSTON TIME (CDT)
LAUNCH	***	***	0:00:00	****	*** **	09/16/2010	10:40
OMS2	1	6	0:00:39	97.1	85 124	09/16/2010	11:19
NC1	3	8	0:03:35	88.6	124 135	09/16/2010	14:15
NC2	12	1	0:16:59	8.0	124 139	09/17/2010	03:39
NPC	12	1	0:17:08	1.8	124 139	09/17/2010	03:48
NC3	18	7	1:02:40	3.0	125 139	09/17/2010	13:20
NH	27	16	1:15:22	110.0	126 201	09/18/2010	02:02
NC4	28	1	1:16:09	119.5	190 203	09/18/2010	02:49
Ti	29	2	1:17:41	8.9	193 205	09/18/2010	04:21
DOCK	30	3	1:20:19	****	194 206	09/18/2010	06:59
UNDOCK	90	2	5:16:06	****	194 205	09/22/2010	02:46
SEP1	91	3	5:17:21	3.0	194 206	09/22/2010	04:01
SEP2	91	3	5:17:49	1.5	195 206	09/22/2010	04:29
NC5	97	9	6:02:00	0.0	195 206	09/22/2010	12:40
DEORBIT	124	5	7:19:53	321.0	*** **	09/24/2010	06:33
LANDING	125	6	7:20:59	****	*** **	09/24/2010	07:39

- Notes: (1) HP and HA altitudes prior to deorbit are 195 X 206 NM.  
 (2) Sequence of events is based on OMS2 phase angle of 280 degrees. Event times, burn delta-Vs, HA and HP will vary with actual OMS2 phase angle.  
 (3) Ti occurs at Sunset - 36 minutes. Undocking occurs at Midnight - 2 minutes.  
 (4) SEP1 burned DV is 1.5 fps. Effective DV is 3.0 fps due to a resultant flyaround.  
 (5) SEP1 and SEP2 burn times assume a 1 lap flyaround.

# RENDEZVOUS DESIGN ASSUMPTIONS AND CONSTRAINTS

- 206 X 194 nmi predicted ISS orbit
- 280 degrees predicted OMS2 phase angle
- 1 orbit transfer from NC4 to Ti
- Docking with ISS on flight day 3
- 124 nmi effective insertion altitude
- 85 nmi minimum perigee
- Propellant budget does not protect for FD4 rendezvous
- The Ti lighting constraint is sunset - 36 minutes because the solar beta angle is not within +/- 15 degrees during the manual phase

# STS-133

## ISS-ULF5 APPROACH DESIGN

D. Brownfield/USH-483L

G. Bartz/USH-483L

### ISS CONFIGURATION FOR FINAL APPROACH

- ISS in LVLH hold (+XVV +ZLV) with PMA2 docking port pointed along +Vbar and arrays feathered for plume loads
- Solar array feathering, radiator feathering, SSRMS position, and visiting vehicle configuration may be different from figures

### APPROACH PROFILE

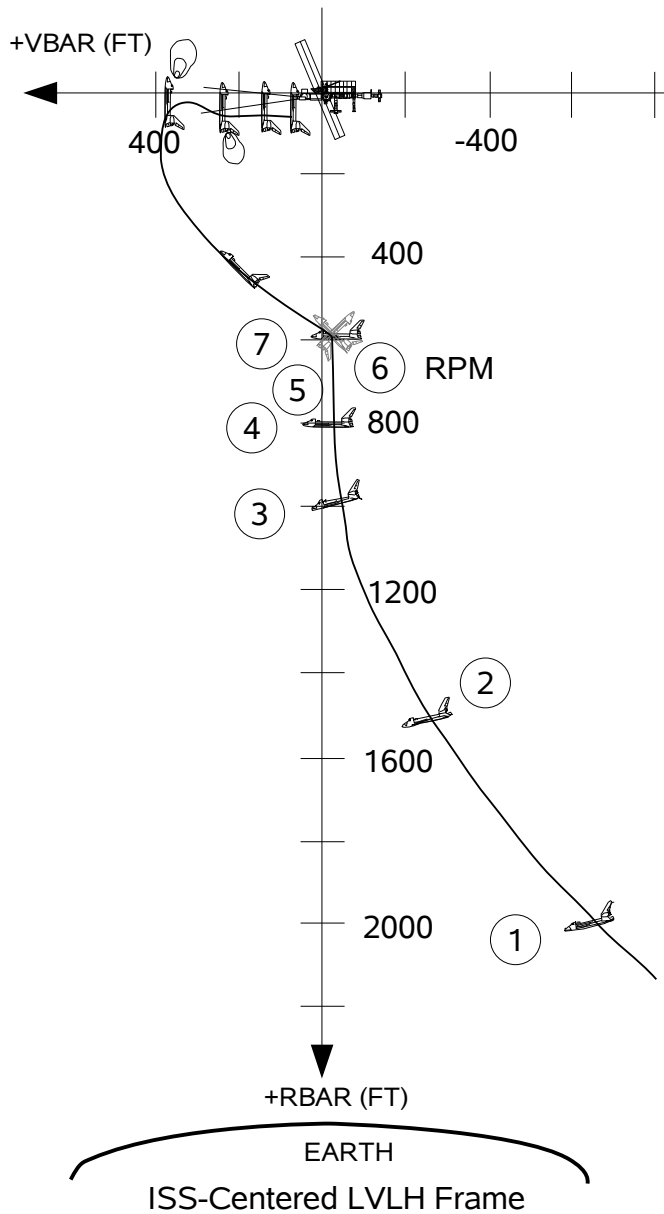
- LOWZ required from 1000 ft. to 75 ft.
- **Rbar Pitch Maneuver (RPM)** at 600 ft.
  - 360 degree pitch rotation at 0.75 deg./sec.
  - Terminal phase range rate gates lowered to set up for RPM
  - May require up to 14 minutes of Rbar stationkeeping to avoid Orbiter shadowing by ISS for beta angles less than 20 deg.
- Initiate **Twice Orbital rate Rbar to Vbar Approach (TORVA)** at 600 ft. after RPM
- **Post-Vbar arrival**
  - 8 deg. corridor from 250 ft. to 35 ft. and then 5 deg. corridor until 3 ft.
  - Inside 170 ft.,  $\pm Y$  pulses restricted to DAP B
  - Transition to NORMZ at 75 ft., +Z pulses restricted to DAP B, single -X jet configuration continues to be used to avoid requiring a new Loads jet-firing database
  - Stationkeep at 30 ft. if required to provide for possible angular alignment maneuver

# STS-133

D. Brownfield/USH-483L

G. Bartz/USH-483L

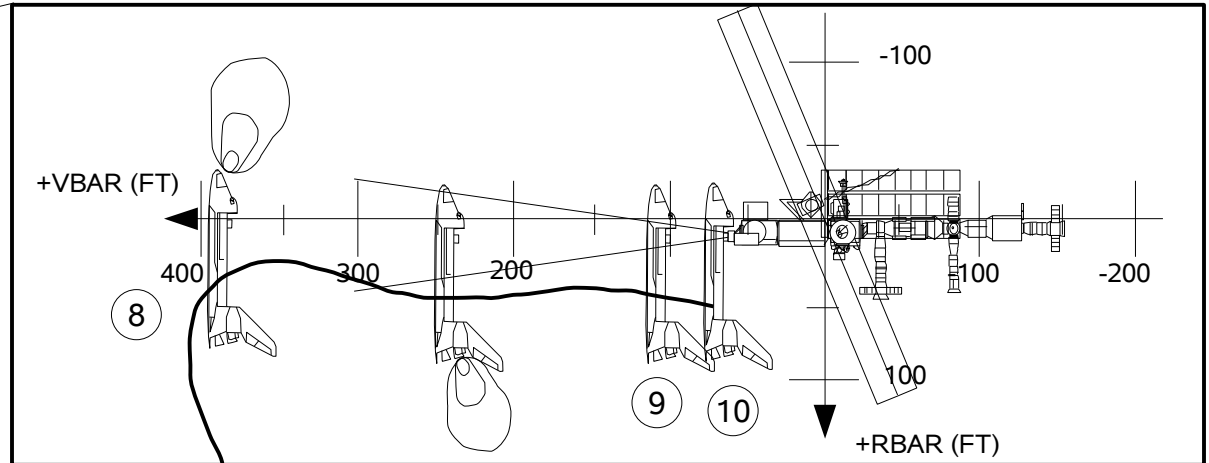
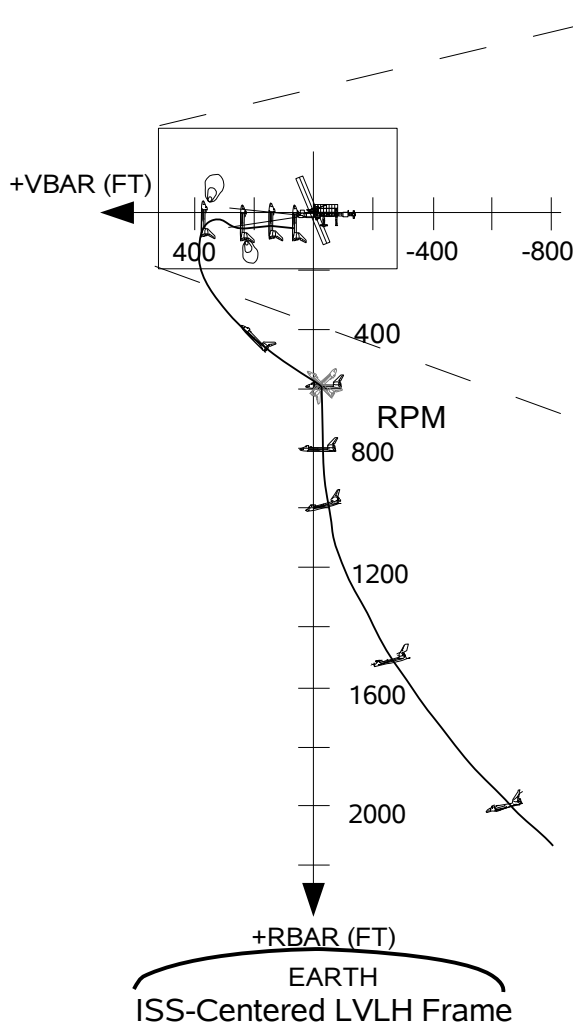
## TERMINAL PHASE, RPM, AND TORVA



	MC2 ET (h:mm)	Range (ft) CG - CG	Rdot (fps)	EVENT
1	0:27	2000	-3.0	MANUAL PHASE TAKEOVER (POST-MC4)
	0:29	1700	-2.4	
2	0:31	1500	-2.1	
3	0:36	1000	-1.3	TRANSITION TO LOWZ
	0:37	900	-1.1	
4				WHEN IN RBAR ATTITUDE:LOAD DAP A9/B9 MOD DAP A PRI/VERN ROT RATE TO 0.75 DEG/SEC AND YAW JET OPTION TO BOTH NOSE & TAIL (ALL) LOAD UNIV PTG P=145 DEG
		800	-0.9	
		700	-0.6	
		650	-0.4	
5	0:46	620	0.0	STATIONKEEP TO AVOID SHADOWING IF REQUIRED
6	1:00	OPT 620 TION 600 N 580	-0.35 -0.25 -0.15	<b>INITIATE RPM:</b> DAP A/PRI, ITEM 19 WHEN -Z ADI PITCH > 100 DEG; DAP A/VERN WHEN -Z ADI PITCH > 170 DEG; DAP FREE, RESET UNIV PTG P=270 DEG, ITEM 19 DIGITAL IMAGERY TAKEN FROM ISS SM WHEN -Z ADI PITCH > 10 DEG; DAP PRI/AUTO WHEN RPM COMPLETE: DAP VERN
7	1:11	OPT 600 TION 550 N 500	-0.7 -0.6 -0.4	RELOAD DAP A9, LOAD UNIV PTG P=179 DEG, REESTABLISH RDOT PER TORVA ICS <b>INITIATE TORVA:</b> DAP A, ITEM 19 (+X PULSES AS REQ'D TO NULL TARGET MOTION IN CAMERA)

# STS-133 VBAR APPROACH

D. Brownfield/USH-483L  
G. Bartz/USH-483L



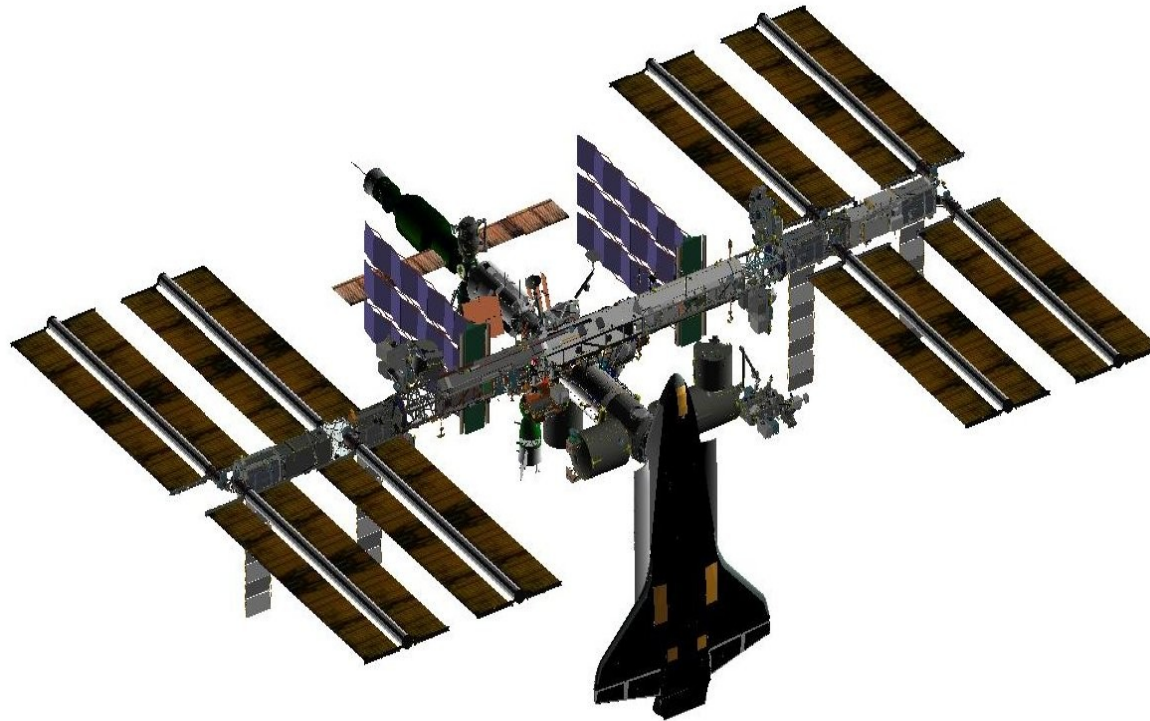
	MC2 ET (h:mm)	Range (ft) DP - DP	Rdot (fps)	EVENT
8	1:25	320	-0.20	VBAR ARRIVAL (-X PULSES AS REQ'D TO NULL TARGET MOTION IN CAMERA)
	1:42	110	-0.15	
	1:46	75	-0.10	TRANSITION TO NORMZ, LOAD DAP A10/B10, CONFIGURE FOR SINGLE -X JET
9	1:54	30	-0.07	STATIONKEEP FOR 5 MINUTES IF ANGULAR ALIGNMENT MANEUVER REQUIRED
10	2:05	0	-0.10	DOCKING

# STS-133 ISS-ULF5 SEPARATION DESIGN

D. Brownfield/USH-483L  
G. Bartz/USH-483L

## ISS CONFIGURATION FOR UNDOCKING

- ISS undocking attitude the same as approach
  - ISS LVLH PYR (0, 0, 0)
  - Orbiter LVLH PYR (90, 0, 0)
- Arrays feathered for plume loads, ISS self-impingement loads, and power balance



Solar array feathering, radiator feathering, SSRMS position, and visiting vehicle configuration may be different from the figure

## ISS-ULF5 SEPARATION DESIGN (CONTINUED)

### SEPARATION PROFILE

- Undocking time of midnight - 2 minutes chosen to ensure sunlight for flyaround (if performed)
- Separation profile designed to minimize plume impingement and propellant usage
  - Initial separation sequence combines attitude control firings and +Z burns to achieve opening rate
    - ALT DAP mode with 0.08 sec. on time limit and variable 10 sec. delay required for attitude control
    - DAP B and 10 sec. intervals required for +Z translations inside 75 ft.
    - Timing and burn size constraints imposed to protect solar arrays of the Russian docked vehicles
  - Prior to 50 ft., single -X jet configuration continues to be used to avoid requiring a new Loads jet-firing database
  - 8 degree corridor separation along the +Vbar
  - Inside 150 ft.,  $\pm Y$  pulses restricted to DAP B
  - LOWZ between the ranges of 75 ft. and 1000 ft.
  - If no flyaround, Vbar separation sequence performed outside 400 ft.
- If prop available, a 1 lap **Twice Orbital Rate Separation/Flyaround (TORS/TORF)** performed for photographic survey of ISS
  - Flyaround required to be outside 600 ft. range for plume loads
  - After TORF, perform Vbar separation sequence

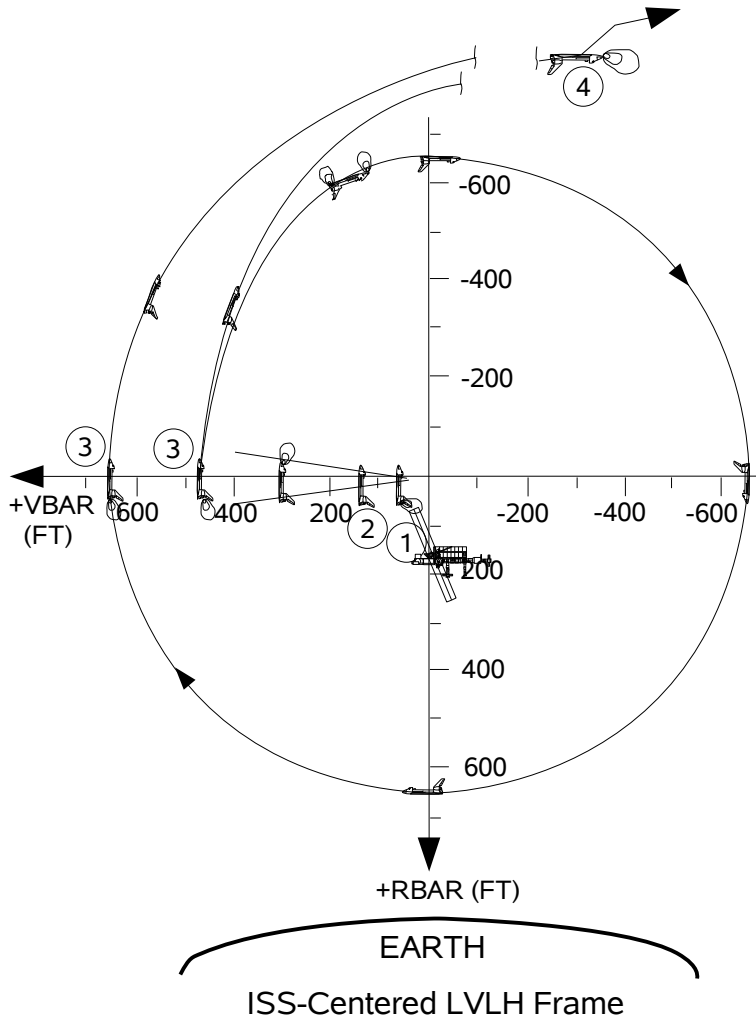


# STS-133

D. Brownfield/USH-483L

G. Bartz/USH-483L

## UNDOCKING, TORS/TORF, AND FINAL SEPARATION



	UNDOCK ET (h:mm)	Range (ft) DP - DP	EVENT
	-0:03	0	ORBITER AND ISS IN FREE DRIFT TO BEGIN UNHOOKING (ISS LVLH PYR 0, 0, 0, ATTITUDE)
1	0:00	0 2	<b>UNDOCKING</b> AT MIDNIGHT-2 MIN; DAP B/ALT MODE TO LVLH; MAINTAIN CORRIDOR
	0:01		SELECT VERN; PERFORM DAP B +Z NORMZ BURNS AT 10 SEC INTERVALS TO BUILD OPENING RATE TO 0.15 FPS
	>0:03	>30	DAP B +Z NORMZ BURNS AT 10 SEC INTERVALS TO BUILD OPENING RATE TO 0.20 FPS
		50	RESELECT -X JETS
2	0:07	75	TRANSITION TO LOWZ
3	0:29 [1:15]*	>400 (CG-CG)	<b>SEP1:</b> 1.5 FPS +X RADIAL BURN [IF PROP AVAILABLE, PERFORM 1/4 LAP TORS BETWEEN 400 AND 600 FT (CG-CG); NULL OPENING RATE OUTSIDE 600 FT; PERFORM 3/4 LAP TORF BETWEEN 600 AND 700 FT; THEN PERFORM SEP1]
4	0:57 [1:43]*	>2000 (CG-CG)	<b>SEP2:</b> 1.5 FPS -X, NORMZ POSIGRADE BURN

\* Alternate Times are for Flyaround Case

# STS-133

## ABORT LANDING OPPORTUNITIES

P. Gentry/USH-483L

M. Jamroz/USH-483L

LAUNCH DATE: 09/16/2010

LIFTOFF: 15:40:20 GMT

ABORT	SITE	ORBIT	XRANGE (NM)	DIR	LANDING MET (D:H:M)	TIME AFTER SUNRISE (H:M)	TIME BEFORE SUNSET (H:M)
RTLS	KSC	1			00:00:20	04:52	07:26
TAL	ZZA	1			00:00:38	10:33	01:53
	MRN	1			00:00:38	10:13	02:10
	FMI	1			00:00:38	10:57	01:30
AOA	KSC	2			00:01:54	06:26	05:52
	NOR	2			00:01:45	04:35	07:45
PLBD FAIL PRIME	EDW	4	616	A/R	00:04:47	06:52	05:28
PLBD FAIL B/U	KSC	6	413	D/R	00:08:04	-11:23	-00:18
PLBD FAIL B/U	NOR	7	314	D/R	00:09:32	-11:37	-00:02

NOTE: (-) = DARKNESS

# STS-133 LANDING OPPORTUNITIES

P. Gentry/USH-483L  
M. Jamroz/USH-483L

## EOM-1

LAUNCH DATE= 09/16/2010 LAUNCH TIME= 15:40:20.000 GMT H:M:S															
ORBIT NO.	KSC --- LANDING TIMES ---				EDW --- LANDING TIMES ---				NOR --- LANDING TIMES ---						
	CROSSRANGE		MET/ DLST	BEFORE SS/ AFTER SR	CROSSRANGE		MET/ DLST	BEFORE SS/ AFTER SR	CROSSRANGE		MET/ DLST	BEFORE SS/ AFTER SR			
	NM	A/D L/R	(D:H:M)	(H:M)	NM	A/D L/R	(D:H:M)	(H:M)	NM	A/D L/R	(D:H:M)	(H:M)			
109	*	682	A/L	6:20:27 8:07	11:10 0:55										
110	*	259	A/R	6:22:02 9:43	9:35 2:31										
111						*	514	A/L	6:23:33 8:13	10:32 1:33	*	11	A/L	6:23:34 9:15	9:45 2:20
112						*	291	A/R	7:01:09 9:49	8:57 3:09	*	702	A/R	7:01:11 10:51	8:09 3:57
113						*	838	A/R	7:02:45 11:26	7:20 4:45					
114		763	D/R	7:04:31 16:12	3:05 9:00										
115		53	D/L	7:06:08 17:48	1:29 10:36		768	D/R	7:06:00 14:40	4:06 8:00		611	D/R	7:06:02 15:43	3:17 8:48
116							168	D/R	7:07:36 16:16	2:29 9:36		139	D/L	7:07:38 17:19	1:41 10:24
117							670	D/L	7:09:12 17:52	0:54 11:12					

NOTE: (\*) DENOTES ACCEPTABLE LANDING OPPORTUNITY  
FOR A GROUND-UP RENDEZVOUS, LANDING OPPORTUNITIES WILL VARY WITH OMS 2 PHASE ANGLE.

# STS-133 LANDING OPPORTUNITIES

P. Gentry/USH-483L  
M. Jamroz/USH-483L

## EOM

LAUNCH DATE= 09/16/2010 LAUNCH TIME= 15:40:20.000 GMT H:M:S												
ORBIT NO.	KSC --- LANDING TIMES ---				EDW --- LANDING TIMES ---				NOR --- LANDING TIMES ---			
	CROSSRANGE		MET/ DLST	BEFORE SS/ AFTER SR	CROSSRANGE		MET/ DLST	BEFORE SS/ AFTER SR	CROSSRANGE		MET/ DLST	BEFORE SS/ AFTER SR
	NM	A/D L/R	(D:H:M)	(H:M)	NM	A/D L/R	(D:H:M)	(H:M)	NM	A/D L/R	(D:H:M)	(H:M)
125	104	A/L	7:20:59	10:36								
			8:40	1:27								
126	* 725	A/R	7:22:36	9:00	892	A/L	7:22:31	11:33	* 365	A/L	7:22:32	10:47
			10:16	3:04			7:11	0:30			8:12	1:17
127					* 11	A/L	8:00:06	9:58	* 443	A/R	8:00:08	9:11
							8:46	2:05			9:48	2:53
128					* 655	A/R	8:01:42	8:22				
							10:22	3:41				
130	306	D/R	8:05:05	2:31					837	D/R	8:04:59	4:19
			16:45	9:33							14:39	7:44
131	626	D/L	8:06:40	0:55	448	D/R	8:06:33	3:31	195	D/R	8:06:36	2:43
			18:21	11:09			15:14	8:33			16:16	9:21
132					307	D/L	8:08:09	1:55	679	D/L	8:08:11	1:07
							16:49	10:08			17:51	10:56

NOTE: (\*) DENOTES ACCEPTABLE LANDING OPPORTUNITY  
 PRIMARY END OF MISSION LANDING SITE  
 FOR A GROUND-UP RENDEZVOUS, LANDING OPPORTUNITIES WILL VARY WITH OMS 2 PHASE ANGLE.

# STS-133 LANDING OPPORTUNITIES

P. Gentry/USH-483L  
M. Jamroz/USH-483L

## EOM+1

LAUNCH DATE= 09/16/2010 LAUNCH TIME= 15:40:20.000 GMT H:M:S														
ORBIT NO.	KSC			--- LANDING TIMES ---		EDW			--- LANDING TIMES ---		NOR		--- LANDING TIMES ---	
	CROSSRANGE		MET/	BEFORE SS/	CROSSRANGE		MET/	BEFORE SS/	CROSSRANGE		MET/	BEFORE SS/		
	NM	DLST	AFTER SR	NM	DLST	AFTER SR	NM	DLST	AFTER SR	NM	DLST	AFTER SR		
	A/D	L/R	(D:H:M)	(H:M)	A/D	L/R	(D:H:M)	(H:M)	A/D	L/R	(D:H:M)	(H:M)		
140	*	495	A/L	8:19:57	11:38									
				7:37	0:24									
141	*	415	A/R	8:21:32	10:02				*	746	A/L	11:48		
				9:13	2:00						8:21:29	0:14		
									7:09					
142						*	350	A/L	8:23:03	10:59	*	140	A/R	10:12
									7:44	1:02			8:23:05	1:49
									8:45				8:45	
143						*	416	A/R	9:00:39	9:23	*	803	A/R	8:36
									9:19	2:38			9:00:41	3:26
									10:21				10:21	
145		629	D/R	9:04:02	3:33									
				15:42	8:29									
146		228	D/L	9:05:38	1:57	680	D/R	9:05:30	4:32	491	D/R	9:05:33	3:44	
				17:18	10:05			14:10	7:29			15:13	8:17	
												16:49	9:05	
147						27	D/R	9:07:06	2:56	302	D/L	9:07:09	2:08	
								15:47	9:05			16:49	9:53	
148						845	D/L	9:08:42	1:21					
								17:22	10:40					

NOTE: (\*) DENOTES ACCEPTABLE LANDING OPPORTUNITY  
FOR A GROUND-UP RENDEZVOUS, LANDING OPPORTUNITIES WILL VARY WITH OMS 2 PHASE ANGLE.

# STS-133 LANDING OPPORTUNITIES

P. Gentry/USH-483L  
M. Jamroz/USH-483L

## EOM+2

LAUNCH DATE= 09/16/2010 LAUNCH TIME= 15:40:20.000 GMT H:M:S												
ORBIT NO.	KSC --- LANDING TIMES ---				EDW --- LANDING TIMES ---				NOR --- LANDING TIMES ---			
	CROSSRANGE		MET/ DLST	BEFORE SS/ AFTER SR	CROSSRANGE		MET/ DLST	BEFORE SS/ AFTER SR	CROSSRANGE		MET/ DLST	BEFORE SS/ AFTER SR
	NM	A/D L/R	(D:H:M)	(H:M)	NM	A/D L/R	(D:H:M)	(H:M)	NM	A/D L/R	(D:H:M)	(H:M)
156	*	66 A/R	9:20:30	11:04								
			8:10	0:57								
157		852 A/R	9:22:06	9:27	*	716 A/L	9:22:01	-11:57	*	199 A/L	9:22:02	11:14
			9:46	2:33			6:41	-0:01			7:42	0:46
158					*	132 A/R	9:23:36	10:25	*	568 A/R	9:23:38	9:38
							8:16	1:34			9:18	2:22
159					*	746 A/R	10:01:12	8:49				
							9:53	3:10				
161		145 D/R	10:04:35	2:58		856 D/R	10:04:27	5:34		740 D/R	10:04:30	4:46
			16:15	9:02			13:07	6:25			14:10	7:13
162		815 D/L	10:06:11	1:23		325 D/R	10:06:03	3:58		46 D/R	10:06:06	3:10
			17:51	10:38			14:44	8:01			15:46	8:50
163						470 D/L	10:07:39	2:22		859 D/L	10:07:41	1:34
							16:20	9:37			17:22	10:25

NOTE: (\*) DENOTES ACCEPTABLE LANDING OPPORTUNITY  
FOR A GROUND-UP RENDEZVOUS, LANDING OPPORTUNITIES WILL VARY WITH OMS 2 PHASE ANGLE.

# STS-133 LANDING OPPORTUNITIES

P. Gentry/USH-483L  
M. Jamroz/USH-483L

## EOM+3

LAUNCH DATE= 09/16/2010 LAUNCH TIME= 15:40:20.000 GMT H:M:S																		
ORBIT NO.	KSC			--- LANDING TIMES ---			EDW			--- LANDING TIMES ---			NOR		--- LANDING TIMES ---			
	CROSSRANGE		MET/	BEFORE SS/		CROSSRANGE		MET/	BEFORE SS/		CROSSRANGE		MET/	BEFORE SS/				
	NM	DLST	AFTER SR		NM	DLST	AFTER SR		NM	DLST	AFTER SR		NM	DLST	AFTER SR			
	A/D	L/R	(D:H:M)	(H:M)		A/D	L/R	(D:H:M)	(H:M)		A/D	L/R	(D:H:M)	(H:M)				
171	*	313	A/L	10:19:27	-11:52													
				7:07	-0:06													
172	*	562	A/R	10:21:03	10:29						*	569	A/L	10:20:59	-11:43			
				8:43	1:29								6:40	-0:17				
173							*	191	A/L	10:22:33	11:26		*	284	A/R	10:22:35	10:39	
										7:14	0:30				8:15	1:18		
174							*	532	A/R	11:00:09	9:50			892	A/R	11:00:11	9:03	
										8:50	2:06				9:52	2:55		
176		486	D/R	11:03:32	4:00													
				15:12	7:59													
177		407	D/L	11:05:08	2:24		580	D/R	11:05:00	4:59		360	D/R	11:05:03	4:11			
				16:48	9:35				13:41	6:58				14:43	7:46			
178							122	D/L	11:06:36	3:23		472	D/L	11:06:39	2:36			
									15:17	8:34				16:19	9:22			

NOTE: (\*) DENOTES ACCEPTABLE LANDING OPPORTUNITY  
FOR A GROUND-UP RENDEZVOUS, LANDING OPPORTUNITIES WILL VARY WITH OMS 2 PHASE ANGLE.

**PROPULSION SYSTEMS ANALYSIS**

- 1) Propellant has been allocated for:
  - TPS Inspection
  - ET-photo opportunity +X translation and modified pitch maneuver
  - 48-Hour Extension
  - Any Attitude Sep/Wcbkout for No-Dock PLS
  - Emergency Sep for Nominal & EOM Contingency Payload Cases
  - 3 mated water/waste dumps with 6 maneuvers
  - Early and Late Inspection Surveys
- 2) Propellant has not been allocated for: fly-around, RCS hotfire, DTOs, or any other mated ops than those stated above.
- 3) OMS Assist is set to 66 sec (2582 lbm).
- 4) Aft fuselage ballast is 104 lbm.
- 5) The following cases require ballast:
  - NO DOCK PLS requires 185 lbm ARCS
  - AOA requires 97 lbm ARCS
- 6) Relative to the 0.5" XCG margin protection, the abort & critical XCG margins at 'PRIOR TO WHEELS DOWN' event (with consideration to ballasting) are:
  - RTLS XCG margin is 3.40"
  - TAL XCG margin is 2.92"
  - AOA and NO DOCK PLS both have an XCG margin of 0.00".
- 7) The NO DOCK PLS case exceeds the EOM downweight limit by 1199 lbm.



**OMS/RCS PROPELLANT REQUIREMENTS SUMMARY**

<b>ITEM</b>	<b>FWD RCS (LBM)</b>	<b>AFT RCS (LBM)</b>	<b>OMS (LBM)</b>
TOTAL LOADED	1912	4970	22761
MISSION USAGE	952	2664	20037
TOTAL DISPERSIONS & CONTINGENCIES	432	1928	1893
UNUSABLE	282	378	797
BUDGETED BALLAST	0	0	0
TOTAL REQUIRED	1665	4970	22726
MARGINS	247	0	35

DATA REFERENCE: OCFAF133

FLT SOFTWARE: OI-34

ANALYSIS DATE: Tue Mar 02 15:10:51 2010

MISSION USAGE BREAKDOWN

ITEM	Delta-V (FPS)	FWD RCS (LBM)	AFT RCS (LBM)	OMS (LBM)
ASCENT USAGE		195	478	2582 **
OMS-2 INSERTION BURN	97.0			2460
NC1	88.6			2224
NC2	8.0			200
NPC	3.3	4	101	
NC3	3.0	4	92	
NH	110.2			2728
NC4	119.5			2925
NCC		23	26	
TI	8.9			216
MC1-MC4 BURNS		35	101	
PROXIMITY OPERATIONS		143	229	
UNDOCK TO 400 FT		21	12	
SEP1	1.5	2	39	
SEP2	1.5	39	4	
ON-ORBIT USAGE		486	1232	
OMS DEORBIT BURN	323.0			6702
ENTRY USAGE			350	
MISSION USAGE		952	2664	20037

\*\* ASCENT OMS ASSIST ENABLED

DATA REFERENCE: OCFAF133

FLT SOFTWARE: OI-34

ANALYSIS DATE: Tue Mar 02 15:10:51 2010

**TOTAL DISPERSIONS AND CONTINGENCIES**

ITEM	FWD RCS (LBM)	AFT RCS (LBM)	OMS (LBM)
INFLIGHT GAUGE ERROR	84	168	
ENTRY REDLINE		825	
LTP BIAS	2	87	0
MPS DUMP BIAS	2	93	0
MINIMUM PERIGEE BIAS	0	0	151
TARGET ALT UNCERTAINTY BIAS	0	0	27
3-SIGMA NOMINAL DISPERSIONS	93	282	108
48 HOUR EXTENSION	244	451	207
CONTINGENCY PAYLOAD RETURN	5	5	896
OMS DISPERSIONS	0	0	503
MIXTURE RATIO BIAS	2	17	1
TOTAL DISPERSIONS & CONTINGENCIES	432	1928	1893

DATA REFERENCE: OCFAF133

FLT SOFTWARE: OI-34

ANALYSIS DATE: Tue Mar 02 15:10:51 2010

**PROPELLANT DUMP CONFIGURATION**

CASE	MPS	OMS	ARCS	FRCS
RTLS	# 5143 LBM	* MIDPOINT 18565 LBM	0 SEC 0 LBM	25 SEC 305 LBM
TAL	5143 LBM	** 11% GAUGE 18855 LBM	0 SEC 0 LBM	60 SEC 732 LBM
AOA	5143 LBM	*** 848.4 FPS 21357 LBM	**** 96.8 FPS 2810 LBM	0% GAUGE 1236 LBM
NOMINAL	5143 LBM	5% GAUGE 1195 LBM	NO DUMP 0 LBM	0% GAUGE 585 LBM
NO DOCK PLS	5143 LBM	5% GAUGE 249 LBM	NO DUMP 0 LBM	0% GAUGE 855 LBM
NO DEPLOY/RETRIEVE ALL	5143 LBM	5% GAUGE 315 LBM	NO DUMP 0 LBM	0% GAUGE 580 LBM
DEPLOY ELC4 ONLY	5143 LBM	5% GAUGE 560 LBM	NO DUMP 0 LBM	0% GAUGE 582 LBM

- # MPS LO2 DUMP DELAY OF 53.0 SEC IMPLEMENTED FOR THIS FLIGHT  
MPS LO2 8" FILL AND DRAIN DELAY OF 30.0 SEC IMPLEMENTED FOR THIS FLIGHT
- \* RTLS PRE-MECO OMS DUMP TO MIDPOINT WITH INTERCONNECT ENABLED
- \*\* TAL OMS DUMP INCLUDES PRE-MECO OMS DUMP (16430 LBM) WITH INTERCONNECT ENABLED AND 100.0 FPS POST-MECO OMS DUMP (2425 LBM) WITH INTERCONNECT INHIBITED FOR ET RUPTURE DEBRIS AVOIDANCE
- \*\*\* INCLUDES A 785.1 FPS OMS-1 BURN (19860 LBM) AND A 63.2 FPS DEORBIT BURN (1498 LBM)
- \*\*\*\* AOA PROTECTS 97 LBM ARCS PROP FOR ENTRY X-CG CONTROL

NOTE: RTLS AND TAL OMS DUMP QUANTITIES MAY REQUIRE UPDATES DUE TO ASCENT I-LOAD DESIGN

# STS-133 MASS PROPERTIES

MATHEW LEE/USH-485L

## Mass Properties Post ET Separation

REPORT POINT	WEIGHT (LBM)	X cg(IN)	Y cg(IN)	Z cg(IN)
RTLS	244967	1085.7	-0.1	376.4
TAL	247155	1089.7	-0.1	377.2

## Mass Properties at Entry Interface

REPORT POINT	WEIGHT (LBM)	X cg(IN)	Y cg(IN)	Z cg(IN)
NOMINAL	203673	1080.9	-0.3	371.1
TAL	239596	1083.0	-0.3	376.4
AOA	233429	1077.5	-0.3	374.5
NO DOCK PLS	234747	1078.9	-0.2	375.3
NO DEPLOY/RETRIEVE ALL	233061	1079.2	-0.2	375.4
DEPLOY ELC4 ONLY	225238	1086.5	-0.2	373.7

## Mass Properties Post Full MPS Dump

REPORT POINT	WEIGHT (LBM)	X cg(IN)	Y cg(IN)	Z cg(IN)
TAL	239050	1081.3	-0.3	376.4

## Mass Properties at Mach 3.5

REPORT POINT	WEIGHT (LBM)	X cg(IN)	Y cg(IN)	Z cg(IN)
NOMINAL	203201	1079.9	-0.3	370.9
RTLS	240219	1080.8	-0.3	376.7
TAL	238088	1080.3	-0.3	376.1
AOA	232860	1076.4	-0.3	374.3
NO DOCK PLS	234278	1078.1	-0.2	375.1
NO DEPLOY/RETRIEVE ALL	232590	1078.3	-0.2	375.3
DEPLOY ELC4 ONLY	224766	1085.6	-0.2	373.6

NOTE: RTLS X-CG AT ALPHA EQUAL TO 30 DEGREES IS 1083.2 INCHES.

**MASS PROPERTIES - Concluded**

**Touchdown Weights at Landing**

REPORT POINT	WEIGHT (LBM)	X cg(IN)	PITCHDOWN MOMENTS (FT-LB)
NOMINAL	203121	1081.8	1.53E06
RTLS	240060	1082.3	1.80E06
TAL	237942	1081.8	1.79E06
AOA	232748	1078.0	1.83E06
NO DOCK PLS	234199*	1079.7	1.81E06
NO DEPLOY/RETRIEVE ALL	232510	1080.0	1.79E06
DEPLOY ELC4 ONLY	224686	1087.3	1.59E06

\* NOTE: NEOM DOWNWEIGHT LIMIT EXCEEDED FOR CONTINGENCY P/L RETURN

AOA REQUIRES 97 LBM AFT RCS BALLAST

NO DOCK PLS REQUIRES 185 LBM AFT RCS BALLAST

DATA REFERENCE: OCFAF133

FLT SOFTWARE: OI-34

ANALYSIS DATE: Tue Mar 02 15:10:51 2010

## STS-133 EPS CONSUMABLES SUMMARY

MISSION DURATION (TD): = 211.95 HOURS

MISSION DURATION (EOM): = 214.95 HOURS

CONSUMABLES	NUMBER OF TANKS	LIFTOFF QUANTITY (LBM)	MIN/LO REQMT (LBM)	MARGIN (LBM)	LAUNCH HOLD CAPABILITY (HOURS)	EVALUATION
CRYOGENIC HYDROGEN	4	364.4	260.6	103.8	321.7	ADEQUATE
CRYOGENIC OXYGEN	4	2908.5	2349.4	559.0	582.5	ADEQUATE

Offload: 200 lbm O2 offloaded evenly from tanks 1, 2, 3, and 4

(a) Cryogenic Loading and Stabilization Times:

TANK #	<u>HYDROGEN</u>		<u>OXYGEN</u>	
	LOADED	STABILIZATION	LOADED	STABILIZATION
	(%)	(L – HRS)	(%)	(L – HRS)
1-4	102.1	45.0	94.2	42.0

(b) This analysis assumes SN109 for FC1, SN104 for FC2, and SN115 for FC3. Degradation of each fuel cell was estimated based on previous flight performance, resulting in a total degradation of 46.64%. Changes to fuel cell complement will impact this analysis.

(c) Group B Powerdowns scheduled per the Flight Plan.

- RJD Logics and Drivers remain powered until docking

(d) 2-2-2 deorbit opportunities protected

(e) 35.0 lbm O2 protected for PMA/ODS repress, PMM Vestibule repress, 1 EVA, and 25 lbm ISS transfer.

**EPS CONSUMABLES SUMMARY – Concluded**

(f) ULF-3 Payload/DTO Energy Summary

ELC 4	0.0 kWh	(No Power Required)
PMM	0.1 kWh	(Pressure and environment checks)
TriDAR	8.8 kWh	28/36.1 W On-Orbit incl ext days, 120 W Sensors
NLP/CGBA	18.5 kWh	70 W from L/O to EOM, including extension days
GLACIER	42.3 kWh	160 W from L/O to EOM, including extension days
MICE AEMs	19.0 kWh	72 W from FD9 to EOM, including extension days

(g) Analysis protects for 3 hrs extended postlanding power for middeck payloads

(h) Analysis includes an Additional Day with an unscheduled EVA and 4 SSPTS converters activated except 6.5 hrs of only 2 SSPTS converters during the EVA. Average power for the 24.0 hr day is 7.5 kW, which equates to 15.2 lbm H2 and 136.8 lbm O2.

	<u>with SSPTS</u>	<u>without SSPTS</u>
(i) Mission Average power	10.42 kW	14.04 kW
Docked Average power	7.18 kW	13.91 kW

(j) SSPTS output energy provided is 778.4 kWh based on:

- 4 OPCU converters for 97.3 hrs (including 24 hrs on the add'l Day)
- 2 OPCU converters for 12.5 hrs (powerdown for water dump and EVA 1)

(k) SSPTS 120 Vdc input required from ISS at the APAS: 9.49 kW (4 converters)

(l) For the 8+1+2 day mission the offload can be increased to a total of 640 lbm O2 while still maintaining 96 hours of launch hold.



**STS-133****ECS CONSUMABLES SUMMARY**

MISSION DURATION (TD): = 211.95 HOURS

MISSION DURATION (TD): = 08/19:57 DHM

CONSUMABLES	NUMBER OF OV TANKS	LIFTOFF QUANTITY (LBM, CANS)	MIN/LO REQMT (LBM, CANS)	MARGIN (LBM, CANS)	EVALUATION
ATMOSPHERIC N <sub>2</sub>	5	321.8	263.1	58.7	ADEQUATE
LiOH	N/A	31	29	2	ADEQUATE

## Regenerative consumables

- Supply and waste water budgets are adequate.
  - Non-standard supply water loading reflects a 180 lbm offload to support CG and ascent performance margins.
    - Supply water 306 lbm (std 486 lbm)
    - Waste water 20 lbm
- On orbit and end-of-mission water requirements can be satisfied through water management.

## Non-Regenerative consumables

- N2 Redline protects largest single contingency: the N2 amount required for an 8 psi, 165 minute contingency return. N2 Redline does not protect for both a cabin leak and extension days.

## LiOH

- Min L/O rqmt protects FRD requirements (6 man 8+1+3 day mission) 31 LiOH cans stowed/installed in Shuttle Middeck
  - Equivalent of 8 cans provided by ISS CDRA and Vozdukh operation
- Liftoff quantity reflects planned stowage for this flight. 31 cans stowed in the middeck
- Margin reflects planned LiOH use, updated based on ISS CO2 removal during docked phase

**DEVIATIONS AND VIOLATIONS**

- None

# STS-133 REFERENCES

JARED RENSHAW/DM2  
DAWN GABRIEL/DM2

- A. Mission specific Flight Implementation Data Package (FIDP) 133-BASE-L, March 5, 2010
- B. Generic FIDP Generic-LY, March 3, 2010