



HST SM4 Payload Operations Working Group #2
March 9, 2007



Contingency EVA 6 and Deploy Scenarios

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Systems Management

HST CHAMP Project (Code 441)

Goddard Space Flight Center



HST SM4 Payload Operations Working Group #2
March 9, 2007



Agenda

- ⌘ Background
- ⌘ Options to Minimize Time for Nominal Deploy
 - Eliminate of Pre-release Battery Charge Task
 - Back-away Deploy of HST
 - Deploy HGA post-EVA 5
- ⌘ Selected EVA 6+Deploy Scenarios
 - RMS Deploy with Aperture Door Open
 - Back-away Deploy with Aperture Door Closed
 - Back-away Deploy with Aperture Door Open
- ⌘ Conclusions
- ⌘ Summary of Open Work



Background

- α New SM4 EVA scenario dictated by Shuttle Requirement for TPS surveys and late inspections
 - HST must deploy on Flight Day 9 (FD9)
 - HST will only be allotted 5 scheduled EVA days
 - » Contingency EVA 6 time *may* be available on FD9 depending on deploy scenario
- α Eight-hour “EVA6+Deploy”
 - Crew Egress
 - Daily Set-up
 - Contingency EVA 6 tasks
 - HST deploy with possible EVA assist
 - » HST Mission Success tasks include
 - Manual HGA deploy
 - Manual aperture door open
 - » Shuttle Safety tasks include
 - EVA override (retraction) of either the FSS Main Umbilical, or FSS Back-up umbilical
 - EVA override (opening) of a FSS Berthing Latch
 - EVA override of either the BAPS pivoter or rotator
 - Final close-out
 - Crew Ingress
- α **Implication for SM4 planning: Optimize nominal SM4 deploy day (FD9) timeline to maximize time for contingency EVA 6 activities and protect for EVA-assisted deploy**



Background

- SMIT was analyzed to determine activities that have the largest impact on Flight Day 9 timeline
 - Move pre-release battery charge
 - » Reduces overhead associated with SA slew and Orbiter maneuver for battery charge attitude
 - » Need to assess if battery charging is required with mission SOC profile
 - Perform Back-away Deploy
 - » Provides options for removing prep activities associated with RMS deploy
 - RMS Grapple, SADE power cycle, RMS maneuver, Aperture door open
 - » Assumes deploy in +V3 Sunpoint attitude
 - Move final close-out to deploy day and delay HGA deployment to post-EVA5
 - » Opens up additional EVA time at end of EVA 5
 - Protect for HST deploy anomalies
 - » Limits amount contingency EVA 6 time
 - » EVA-assist for aperture door anomaly is most prohibitive
 - » Times estimates are not currently well understood



Options to Minimize Time for Nominal Deploy

Eliminate Pre-release Battery Charge Task

- ⌘ Without pre-release battery charge, HST meets SM3B minimum release SOC during nominal deploy with 19 Ah of margin
 - SM3B minimum release SOC = 235 Ah
 - » Limit may be adjusted following assessment of required safing margin
 - Estimated SOC at release = 254 Ah, based on:
 - » Post-battery FT SOC
 - » SOC loss due to self-discharge
 - » SOC loss due to Battery Load-share Test
 - » System SOC loss during 2-hour discharge between transfer to HST internal power and release
 - Assumes no battery charging during FD9
 - » Some battery charging may occur once HST is in release attitude
- ⌘ Additional discharge at 43A load for 26 min results in loss of 19 Ah margin
- ⌘ Pre-FD9 battery charge may be used to acquire additional SOC margin
 - May be implemented after battery FT during post-EVA, Crew Sleep, Pre- or Post-Sleep



Options to Minimize Time for Nominal Deploy

Deploy HST via back-away instead of RMS release

- Assumes deploy in +V3 sunpoint and Low Z thruster firings and VRCS
- HST Project preference has historically been to perform back-away with aperture closed
 - Mitigates issues associated with potential high tip-off rates ($>0.1^\circ/\text{sec}$) and high attitude uncertainty ($>5^\circ$)
 - » Refer to STS-109 Flight Rule for “Aperture Door Open Requirements”
 - » Prevents violation of bright earth avoidance (BEA) constraints and passing sunlight into HST optics
 - Contamination risk with aperture door open is considered acceptable as long as thruster firings are constrained to Low Z (away from HST)
 - » Prevents trigger of Bright Object Detection (BOD)
 - SM3B back-away attitude is not compatible with BEA
 - Does not protect for any anomalies during nominal opening of aperture door with MCU
 - Planning for back-away with aperture open requires additional analysis into acceptable levels of bright earth exposure due to tip-off rates
- SCM Impacts
 - “Guide plate” added to protect sill-plate hardware and FSS harnessing from possible contact with SCM during nominal RMS deploy and contingency re-berth reduces clearances for back-away
 - Impact loads are still under analysis as guide plate design evolves



Options to Minimize Time for Nominal Deploy

- ⌘ Delay EVA Final Close-out until FD9 and deploy HGAs post-EVA5
 - Substitutes 30-min Daily Close-out for 60-min Final Close-out on EVA5
 - We now have ~45 min EVA time following nominal EVA 5 activities
 - Avoids allotting time for HGA deploy on FD9
 - Introduces clearance issues during contingency EVA 6
 - » Clearance between crew and HGA masts under assessment by EVA team
 - » JSC would likely perform pre-EVA RMS clearance checks
 - Refer to clearance checks performed during SM2 pre-EVA5
 - » I&C can maneuver dishes to assist in EVA, RMS, and vertical stabilizer clearance



Selected EVA6 + Deploy Scenarios

Overview

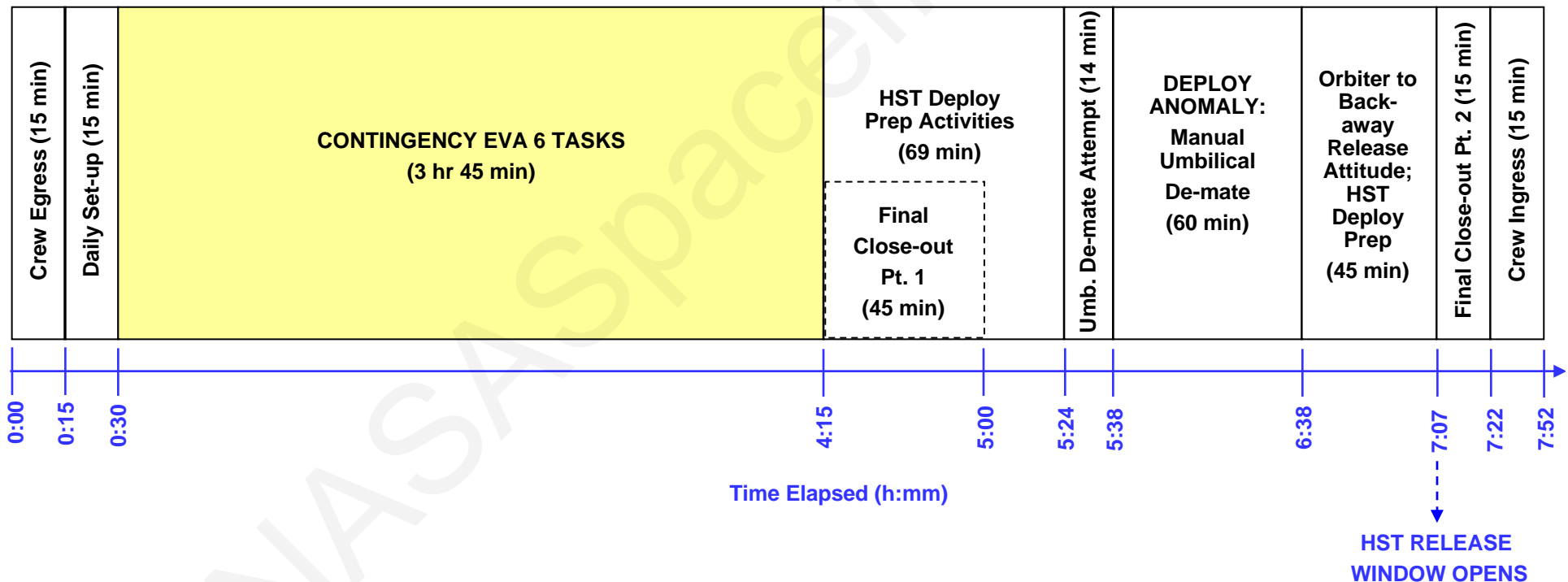
- ⌘ RMS Deploy with AD Open
 - No EVA6 task time available, accounting for ~3 hr 45 min EVA-assisted aperture door opening
- ⌘ Back-away deploy with Aperture Door Closed
 - ~ 3 hrs, 45 min EVA 6 task time, accounting for ~1 hr EVA-assisted umbilical de-mate
- ⌘ Back-away deploy with Aperture Door Open
 - ~ 1 hr, 35 min EVA 6 task time, accounting for ~2 hrs 34 min EVA-assisted aperture door opening



Selected EVA6 + Deploy Scenarios

Back-away Deploy with Aperture Door Closed

- Provides ~ 3 hrs, 45 min EVA 6 task time
- Accounts for ~1 hr EVA assist for a manual de-mate of the umbilical
- Does not account for restoring inhibits prior to EVA activity for assistance with deploy (e.g. Zero-ing SMACS)





SERVICING MISSION INTEGRATED TIMELINE: EVA-6 BACKAWAY DEPLOY [AD CLOSED]

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OF 74

442 / 441
DATE Mar 1, 2007

TIME	GMT: 262 MET: 07	2300 1500	2330 1530	0000 1600	0030 1630	0100 1700	0130 1730	0200 1800
ORBIT#	seconds mode		116		117			
DAY / NIGHT		[Black bar]			[Black bar]			
SAA								
HST ATTITUDE					HST TO BERTHING POSITION (+3 AXIS/FWD)			
ORBITER ATT					DELTA			
CREW SCHED				POST SLEEP			AL DEPR	EVA-6
JSC					PHOTO/TV DOCUMENT ENTIRE HST RELEASE OPS		EVA CREW EGRESS [15 min]	P/TV 17
ORBITER, CREW, SSE								
FREE DRIFT								
HST								
ACTIVITIES AND COMMANDS								
▲ REAL-TIME COMMAND								
● COMMENT/ EVENT								
⊙ SPC								
⊙ HAZARDOUS								
			SAC DELIVER TABLES TO CORE					
					118 ● LOAD EPHEMERIS TABLES			
					116 ▲ D032a-DMS: LOAD EPHEMERIS DATA [1min]			
					118 ▲ D753-CLEAR EPHEMERIS DELTA TIME LIMIT EXCEED FLAG [1min]			
COMM	ENG EAST WEST							
MAJOR EVENTS:								BEGIN EVA-6 [TBD] ● STOCC GO FOR EVA-6 [TBD] CHANGEOUT ● FOLLOWING PREP FOR CHANGEOUT



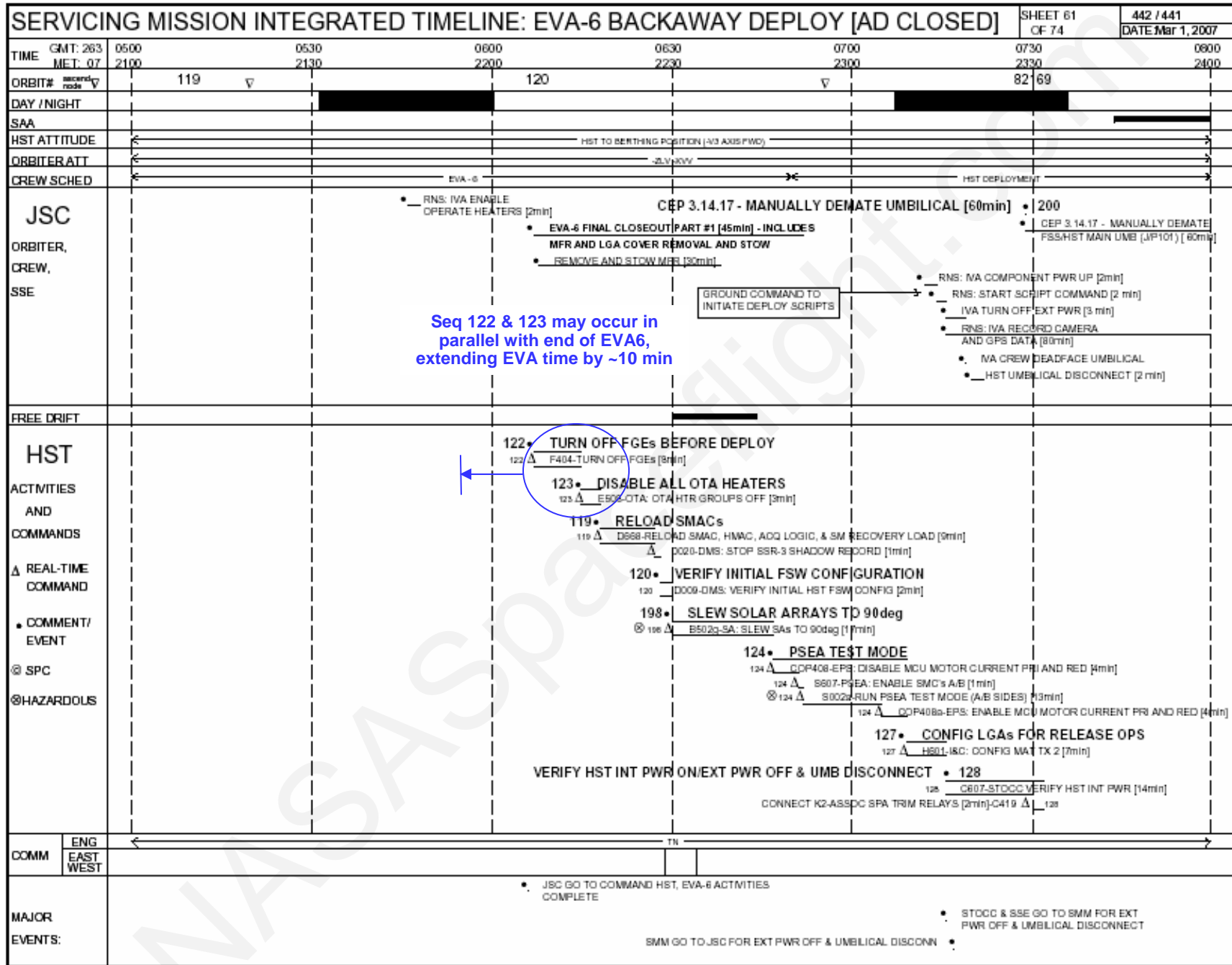
SERVICING MISSION INTEGRATED TIMELINE: EVA-6 BACKAWAY DEPLOY [AD CLOSED]

SHEET 60
OF 74

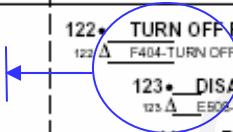
442 / 441
DATE Mar 1, 2007

TIME	GMT: 263	0200	0230	0300	0330	0400	0430	0500
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ORBIT#	ascend node ▽	117 ▽		118		▽		119
DAY / NIGHT		[REDACTED]				[REDACTED]		
SAA								
HST ATTITUDE	←				HST TO BERTHING POSITION (-W3 AXIS FWD)			→
ORBITER ATT	←				-2.5°/30V			→
CREW SCHED	←				EVA-6			→
JSC		<ul style="list-style-type: none"> EVA CREW EGRESS [15 min] (CONT.) <ul style="list-style-type: none"> EVA CREW PREP FOR EVA-6 [15 min] (INCLUDES BSP CENTER PP-PINS INSERT) BSP SETUP [5 min] MFR SETUP [15 min] 						
ORBITER, CREW, SSE								
FREE DRIFT								
HST								
ACTIVITIES AND COMMANDS								
▲ REAL-TIME COMMAND								
● COMMENT/ EVENT								
◎ SPC								
⊗ HAZARDOUS								
COMM	ENG EAST WEST				TK			
MAJOR EVENTS:								

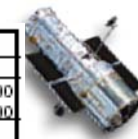




Seq 122 & 123 may occur in parallel with end of EVA6, extending EVA time by ~10 min

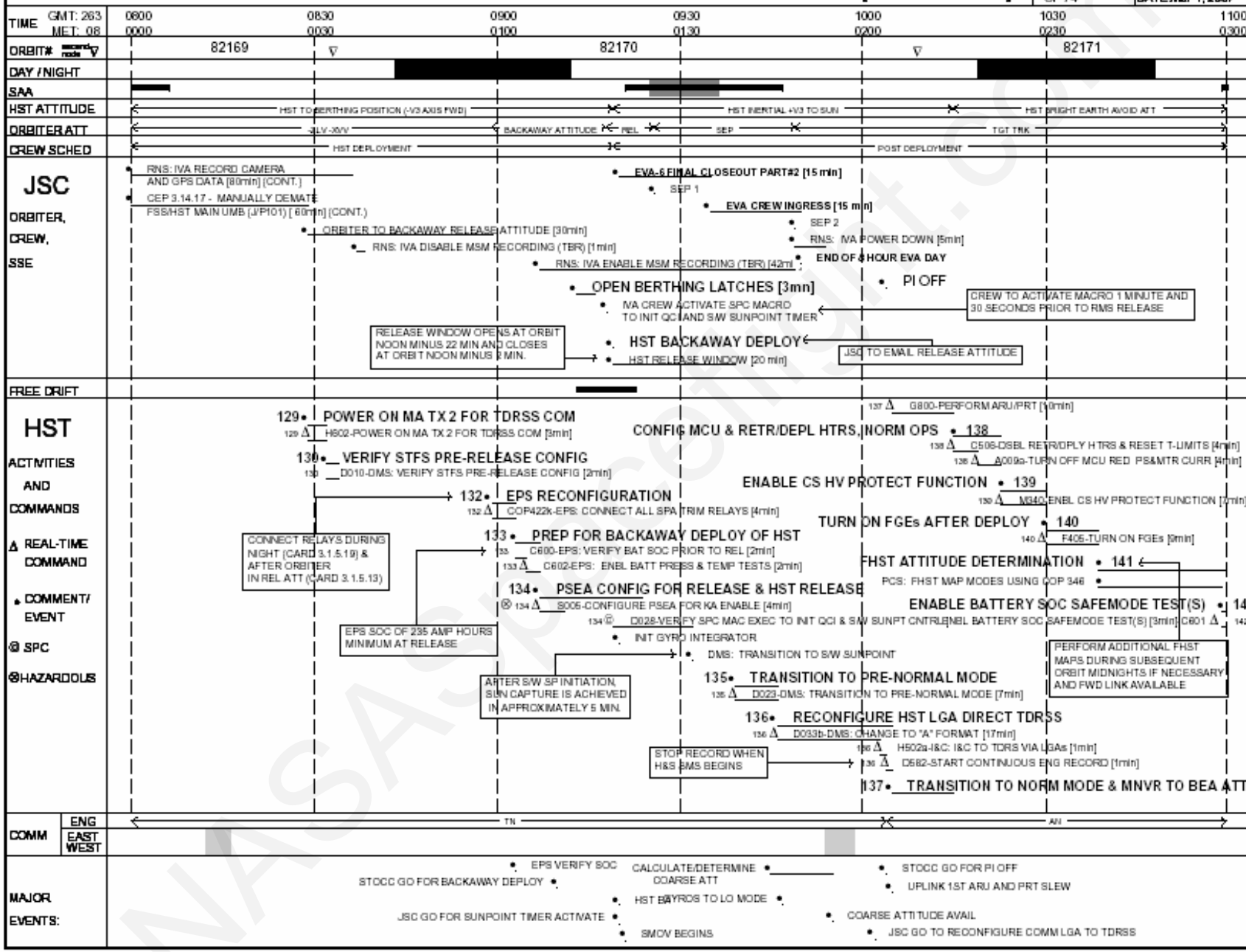


115 EXPORT CONTROL LED INFORMATION



SERVICING MISSION INTEGRATED TIMELINE: EVA-6 BACKAWAY DEPLOY [AD CLOSED]

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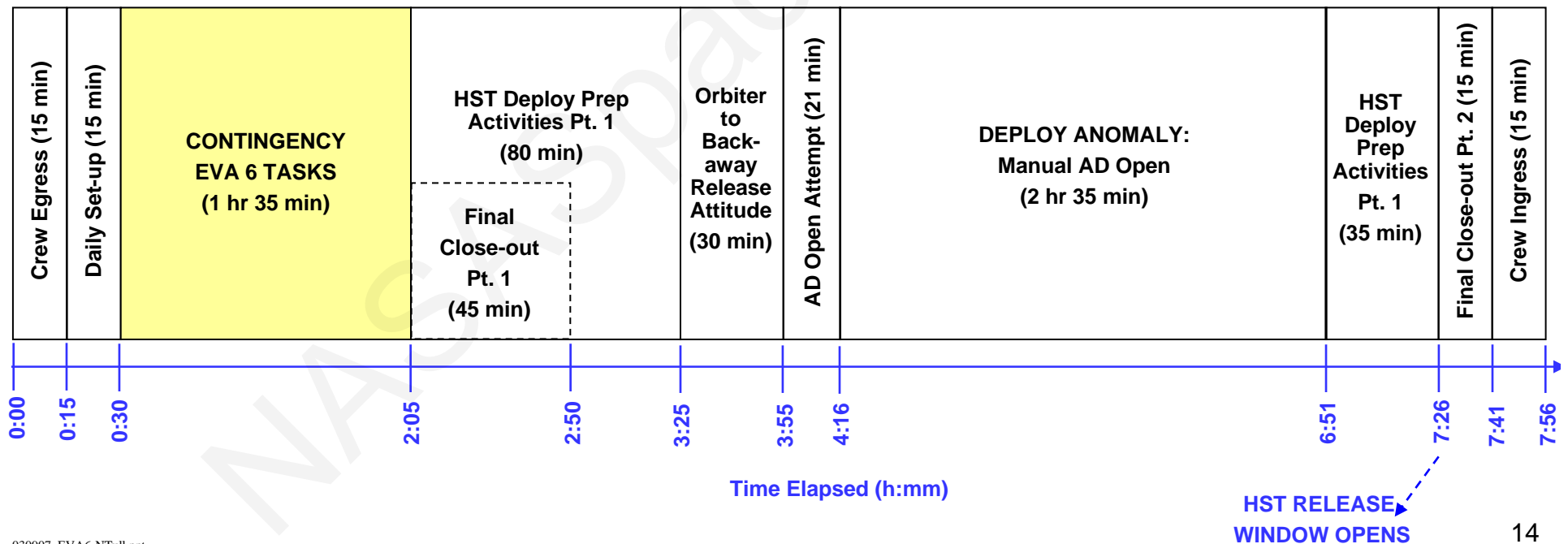




Selected EVA6 + Deploy Scenarios

Back-away Deploy with Aperture Door Open

- **Provides ~1 hr 35min EVA 6 task time**
- Accounts for ~2 hr 34 min EVA assist to open aperture door
 - » Contamination risk with aperture door open is acceptable since thruster firing is constrained to Low Z (away from HST)
- Assumes HST is deployed in a sun-pointing attitude
- Does not account for:
 - » Restoring inhibits prior to EVA activity for assistance with deploy (Zero-ing SMACS, etc)
 - » Return to Orbiter external power during manual AD open task to prevent excessive SOC rundown
 - May be mitigated by nominally delaying umbilical de-mate until after AD open





Conclusions

- ⌘ Back-away deploy is required to guarantee any significant contingency EVA 6 task time if protecting for longest duration EVA-assisted deploy scenario on FD9
- ⌘ Loss of one full unscheduled EVA day for SM4 requires extensive pre-mission planning to characterize protection for deploy anomalies requiring EVA assistance
 - Recommend development of HST contingency products to document EVA-HST choreography for different deploy scenarios
- ⌘ Additional detailed analysis must be undertaken in order to develop hierarchy of feasible FD9 scenarios



Summary of Open Work

- ⌘ HST Project needs to determine how much risk it is willing to accept with respect to deploy day anomalies
- ⌘ Determine durations for deploy anomalies that require EVA assistance
- ⌘ Resolve issues with EVA and RMS clearance if HGAs are deployed prior to contingency EVA 6
- ⌘ Define impact loads with SCM+guide plate
- ⌘ Assess tip-off rates, BEA and BOD requirements to determine feasibility for back-away deploy with aperture door open
 - Determine if BEA-compatible back-away attitude may be developed
 - Investigate possibility of refining back-away procedure such that tip-off rates are sufficiently reduced
 - Quantify acceptable levels of BEA violation with respect to contamination
- ⌘ Safing to investigate legacy of minimum SOC requirement for HST Release and assess margin
- ⌘ Determine expected SOC post-battery FT for hybrid battery case (one original module + one replacement module)
- ⌘ Identify impacts of nominal back-away deploy to planned RNS data collection



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Back-up Charts

NASA Spaceflight.com



HST Estimated 6-battery SOC at SM4 Release

- α Estimated SOC at release = 254 Ah
 - 6-battery SOC post-battery change-out = 372 Ah (per MSFC 1042/FSB SM4 simulation test)
 - System SOC loss due to self-discharge in 90 hrs = -18 Ah (per MSFC 1042/FSB SM4 simulation test)
 - System SOC loss due to Battery Load-share Test = -14 Ah
 - » Based on 15 min discharge on HST internal power with 56 A load (SM4 load with safed SIs)
 - System SOC loss during 2-hour discharge between transfer to HST internal power and release = -86 Ah
 - » Based on 43 A load (SM4 load with safed SIs, FGEs and OTA heaters off)



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DRAFT SMIT 2:
EVA-5 Daily Close-out and Delayed HGA Deploy

NASA Spaceflight.com



HST SERVICING MISSION INTEGRATED TIMELINE:				HGA Deploy				442 / 441	
								DATE: Mar 1, 2007	
TIME	GMT: 262 MET: 06	0500 2100	0530 2130	0600 2200	0630 2230	0700 2300	0730 2330	0800 2400	
ORBIT#	ascend node	104	105	106					
DAY / NIGHT									
SAA									
HST ATTITUDE			HST +V2 AXIS FWD			HST 135deg FWD		HST TO BERTHING POSITI	
ORBITER ATT		SUN PROTECT			ZLV -XW				
CREW SCHED					EVA-5				
JSC		<ul style="list-style-type: none"> FGS-3 CHANGEOUT [3 hrs] (CONT.) FGS-3R INSTALLATION [30 min] (CONT.) 	<ul style="list-style-type: none"> MATE FGS-3R GROUND STRAP MATE FGS-3R CONNECTORS [10min] CLOSE +V2 FGS-3 DOORS [20 min] FGS3 DOORS CLOSED FGS-3 STOW [30 min] REMOVE FGS-3 FROM AFT FIXTURE [10 min] FSIPE OPEN INSERT FGS-3 INTO FSIPE [5 min] FSIPE CLOSED 	<ul style="list-style-type: none"> OVER VOLTAGE PROTECTION [30 min] ATTACH JUMPER PLUG TO CSH AT DBA2 ATTACH OVP ELECTRONICS UNIT ATTACH JUMPER PLUG TO CSH AT HST J601 TENT COVER OFF TENT COVER ON FSS ROTATE TO 135° [10 min] CONFIGURE OCE-EK [35 min] OCE-EK MATE [25 min] BAY C DOOR OPEN CONNECTORS DEMATED CONNECTORS MATED 	<ul style="list-style-type: none"> CLOSE BAY C DOOR [10 min] BAY C DOOR CLOSED FSS ROTATE TO TBD POSITION [11 min] 				
ORBITER, CREW, SSE									
FREE DRIFT									
HST		<ul style="list-style-type: none"> 100 • FGS-3R ALIVENESS TEST 100 Δ F612-FGE-3 INITIALIZATION [1min] 100 Δ E602-POWER UP OTA BUS #2 [1min] 100 Δ E603-POWER ON EPTCE [2min] 100 Δ E606-ENABLE FGS-3R HEATERS [1min] 100 Δ F601a-POWER UP FGE-3 [3min] 	<ul style="list-style-type: none"> 101 • RE-ENABLE OTA HTR GROUPS (PART 1 OF 3) 101 Δ E504d-ENABLE STAGE 1 OTA HEATER GROUPS [4min] 	<ul style="list-style-type: none"> 102 • RE-ENBL OTA HTR GROUPS (PART 2 OF 3) 102 Δ E504e-ENABLE REMAINING STAGE 2 OTA HEATER GROUPS [2min] 	<ul style="list-style-type: none"> 103 • PREP FOR OVP (TBD) 	<ul style="list-style-type: none"> 105 • RE-ENABLE OTA HTR GRPS (PART 3 OF 3) 105 Δ E504f-ENABLE STAGE 3 OTA HEATER GROUPS [2min] 	<ul style="list-style-type: none"> 106 • OVP ALIVENESS TEST (TBD) 	<ul style="list-style-type: none"> 107 • OCE CABLE RECONFIGURATION (PREP) 107 Δ E618-OCE INITIALIZATION [1min] 107 Δ F307a-POWER DOWN FGE-3 [2min] 107 Δ E604-POWER DOWN OTA BUS 4 [1min] 	<ul style="list-style-type: none"> 108 • OCE CABLE/AMS ALIVENESS TEST 108 Δ F613-FGE-3 INITIALIZATION [1min] 108 Δ E619-OCE INITIALIZATION [1min] 108 Δ E605-POWER UP OTA BUS 4 [1min]
ACTIVITIES AND COMMANDS									
Δ REAL-TIME COMMAND									
• COMMENT/ EVENT									
© SPC									
⊗ HAZARDOUS									
COMM	ENG EAST WEST				IN				
MAJOR EVENTS:		<ul style="list-style-type: none"> JSC GO FOR FGS-3R A/T AFTER MATE CONNECTORS STOCC VERIFY FGS-3R A/T SUCCESSFUL 	<ul style="list-style-type: none"> STOCC GO FOR OVP INSTALL AFTER OVP PREP 	<ul style="list-style-type: none"> STOCC VERIFY OVP A/T SUCCESSFUL 	<ul style="list-style-type: none"> STOCC GO FOR OCE-EK INSTALL AFTER OTA BUS 4 PWR DOWN JSC GO FOR OCE CABLE/AMS A/T AFTER MATE CONNECTORS 	<ul style="list-style-type: none"> STOCC VERIFY OCE CABLE/AMS A/T SUCCESSFUL 			

HST SERVICING MISSION INTEGRATED TIMELINE:

HGA Deploy

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DATE: Mar 1, 2007

TIME	GMT: 262 MET: 07	0800	0830	0900	0130	0200	0230	1100	0300
ORBIT#	ascend node ▽	106	▽	107	▽	108			
DAY / NIGHT									
SAA									
HST ATTITUDE			HST TO BERTHING POSITION (TBD)				HST -V2 AXIS FWD		
ORBITER ATT		ZLV -XV		BIAS +ZLV +XV			ZLV -XV		
CREW SCHED		EVA-5		AL REPR			POST EVA		
JSC			<ul style="list-style-type: none"> EVA-5 DAILY CLOSEOUT [30 min] (INCLUDES INSPECT INGRESS AIDS) ORBITER MANEUVER TO REBOOST ATTITUDE [35min] <ul style="list-style-type: none"> EVA CREW INSPECT J101 CONNECTOR FOR DEBRIS [5] REMOVE BSP CENTER PIP-PINS [5 min] <ul style="list-style-type: none"> END OF 6 HOUR EVA DAY EVA CREW INGRESS [10 min] <ul style="list-style-type: none"> HST REBOOST [TBD min] P/TM 16 						
ORBITER, CREW, SSE									
FREE DRIFT									
HST									
ACTIVITIES AND COMMANDS									
Δ REAL-TIME COMMAND									
● COMMENT/ EVENT									
⊙ SPC									
⊙ HAZARDOUS									
109 ● PARALLEL HGA DEPLOYMENT (PART 1)									
⊙ 109 Δ D550n-DMS: ENBL/ACT SPC SUPPORT MACRO [2min]									
⊙ 109 ⊙ A005-S&M: DEPLOY HGA MASTS [14min]									
⊙ 109 Δ D550s-DMS: ENBL/ACT SPC SUPPORT MACRO [2min]									
109 ⊙ H515b-I8C: SLEW ±HGAs TO (0,0) [6min]									
109 ⊙ 915a-DMS: RESTORE HGA DB LIMITS [1min]									
111 ● PARALLEL HGA DEPLOYMENT (PART 2)									
111 Δ COP509-DMS: SLEW ±HGAs FOR STRUCTURAL CLEARANCE [16min]									
⊙ 111 Δ A008-S&M: RELAX HGA LATCHES [8min]									
113 ● FGS-3R FUNCTIONAL TEST									
113 Δ E608-FILTER WHEEL VERIFICATION [5min]									
PMT DARK COUNT VERIFICATION [8min]-E609 Δ 113									
113 Δ E610-SLEW FGS-3 TO ITS [1min]									
HST TLM CHANGE TO HN [1min]-E611 Δ 113									
113 Δ E624-FGS-3 FL ON ITS [13min]									
FGS PERFORMS LOS SCAN ON ITS [8min]-E625 Δ 113									
FGS TO DEFAULT MODE [2min]-E612 Δ 113									
DO NOT EXECUTE ANY FGS COMMANDING DURING SAA LEVEL 1 PASSAGE									
COMM	ENG EAST WEST				TH			HN	
MAJOR EVENTS:			<ul style="list-style-type: none"> JSC GO FOR SOLAR ARRAY SLEW TO 90 DEG JSC GO FOR HGA DEPLOYMENT END EVA-5 STOCC GO FOR REBOOST 				<ul style="list-style-type: none"> STOCC VERIFY FGS-3R F/T SUCCESSFUL 		
								<ul style="list-style-type: none"> REPLAN CONFERENCE #1 	



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DRAFT SMIT 3:
EVA-6 Back-away Deploy with AD Open

NASA Spaceflight.com



HST SERVICING MISSION INTEGRATED TIMELINE: EVA-6 BACKAWAY DEPLOY [AD OPEN]							SHEET 59 OF 74		442 / 441	
									DATE: Mar 1, 2007	
TIME	GMT: 262	2300	2330	0000	0030	0100	0130	0200		
	MET: 07	1500	1530	1600	1630	1700	1730	1800		
ORBIT#	second node		116				117			
DAY / NIGHT		[Solid black bar]					[Solid black bar]			
SAA										
HST ATTITUDE		HST TO BERTHING POSITION (43 AXIS FWD)								
ORBITER ATT		-2.1V 30V								
CREW SCHED		POST SLEEP								
JSC		PHOTO/TV DOCUMENT ENTIRE HST RELEASE OPS								
ORBITER, CREW, SSE		EVA CREW EGRESS [15 min] • PRTV 17								
FREE DRIFT										
HST		118 • LOAD EPHEMERIS TABLES								
ACTIVITIES AND COMMANDS		118 Δ D032-DMS: LOAD EPHEMERIS DATA [1min]								
Δ REAL-TIME COMMAND		118 Δ D753-CLEAR EPHEMERIS DELTA TIME LIMIT EXCEED FLAG [1min]								
• COMMENT/ EVENT		SAC DELIVER TABLES TO CORE								
⊙ SPC										
⊙ HAZARDOUS										
COMM	ENG EAST WEST	TN								
MAJOR EVENTS:		BEGIN EVA-6 [TBD] • STOC GO FOR EVA-6 [TBD] CHANGEOUT • FOLLOWING PREP FOR CHANGEOUT								



HST SERVICING MISSION INTEGRATED TIMELINE: EVA-6 BACKAWAY DEPLOY [AD OPEN]

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OF 74

442 / 441
DATE: Mar 1, 2007

TIME	GMT: 263	0200	0230	0300	0330	0400	0430	0500
MET: 07		1800	1830	1900	1930	2000	2030	2100
ORBIT#	second mode	117		118			119	
DAY / NIGHT		[Night]				[Night]		
SAA								
HST ATTITUDE		HST TO BERTHING POSITION (A/3 AXIS PWD)						
ORBITER ATT		-2.0 V X/Y/Z						
CREW SCHED		EVA-6						HST DEPLOYMENT
JSC		<ul style="list-style-type: none"> EVA CREW EGRESS [15 min] (CONT.) <ul style="list-style-type: none"> EVA CREW PREP FOR EVA-6 [15 min] (INCLUDES BSP CENTER PP-PINS INSERT) BSP SETUP [5 min] MFR SETUP [15 min] EVA-6 FINAL CLOSEOUT PART #1 [45 min] - INCLUDES MFR AND LGA REMOVAL AND STOW REMOVE AND STOW MFR [30 min] 						
ORBITER, CREW, SSE								
FREE DRIFT		[Night]						
HST								
ACTIVITIES AND COMMANDS		122 • TURN OFF FGEs BEFORE DEPLOY 122 Δ F104-TURN OFF FGEs [8min] 123 • DISABLE ALL OTA HEATERS 123 Δ E508-OTA: OTA HTR GROUP OFF [8min] 119 • RELOAD SMACs 119 Δ D020-DMS: STDP SSR-3 SHADOW RECORD [1min] 120 • VERIFY INITIAL FSW CONFIGURATION 120 Δ D009-DMS: VERIFY INITIAL HST FSW CONFIG [2min] 198 • SLEW SOLAR ARRAYS TO 90deg 198 Δ B502g-SA: SLEW SAs TO 90deg [17min] 124 • PSEA TEST MODE EPS: DISABLE MCU MOTOR CURRENT PRI AND RED [4min]-COP408 Δ 124 PSEA: ENABLE SMC's A/B [1min]-S607 Δ 124 RUN PSEA TEST MODE (A/B SIDES) [13min]-S002g Δ 124 EPS: ENABLE MCU MOTOR CURRENT PRI AND RED [4min]-COP408g Δ 124 CONFIG LGAs FOR RELEASE OPS • 127 127 Δ CONFIG MAT TX 2 [7min]-H601 Δ 127						
REAL-TIME COMMAND								
COMMENT/ EVENT								
SPC								
HAZARDOUS								
COMM	ENG EAST WEST							
MAJOR EVENTS:		<ul style="list-style-type: none"> JSC GO TO COMMAND HST, EVA-6 ACTIVITIES COMPLETE 						



HST SERVICING MISSION INTEGRATED TIMELINE: EVA-6 BACKAWAY DEPLOY [AD OPEN]

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OF 74

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DATE Mar 1, 2007

TIME	GMT: 263 MET: 07	0500 2100	0530 2130	0600 2200	0630 2230	0700 2300	0730 2330	0800 2400
ORBIT#		119		120			82	69
DAY / NIGHT								
SAA								
HST ATTITUDE								
ORBITER ATT								
CREW SCHED								
JSC								
ORBITER, CREW, SSE								
FREE DRIFT								
HST								
ACTIVITIES AND COMMANDS								
REAL-TIME COMMAND								
COMMENT/ EVENT								
SPC								
HAZARDOUS								
COMM								
MAJOR EVENTS:								

- RNS: MA COMPONENT PWR UP [2min]
- RNS: START SCRIPT COMMAND [2 min]
- IVA TURN OFF EXT PWR [3 min]
- RNS: IVA RECORD
- CAMERA & GPS DATA [8min]
- MA CREW DEADFACE UMBILICAL
- HST UMBILICAL DISCONNECT [2 min]
- RNS: MA ENABLE OPERATE HEATERS [2min]
- ORBITER TO BACKAWAY RELEASE ATTITUDE [30min]
- MFR SETUP [15min]
- HST TO BERTHING POSITION (AV3 AXIS PWD)
- FSS ROTATE TO +V3 [14min]
- FSS PIVOT TO 43.8deg [15min]
- RMS TO APERTURE DOOR [5min]
- RELEASE SUN SHADE J-HOOK BOLTS (3) [10min]
- OPEN SUN SHADE [5min]
- OPEN APERTURE DOOR [5min]
- CLOSE SUN SHADE [5min]
- RENGAGE SUN SHADE J-HOOK BOLTS [10min]
- RMS TO MFR STOW POSITION [5min]
- MFR STOW [15min]
- FSS PIVOT TO 90deg [15min]
- CEP 3.15.2 - MANUALLY OPEN APERTURE DOOR [154min]
- CEP 3.15.2 - MANUALLY OPEN APERTURE DOOR [154min]

GROUND COMMAND TO INITIATE DEPLOY SCRIPTS

201. SLEW SOLAR ARRAYS TO 0deg
SLEW SA TO 0deg [17min]

FIG 4.40 - AD FAILS TO OPEN

131. OPEN APERTURE DOOR

130. DMS: VERIFY STFS PRE-RELEASE CONFIG

129. POWER ON MA TX 2 FOR TDRSS COM

128. VERIFY HST INT PWR ON/EXT PWR OFF & UMB DISCONNECT

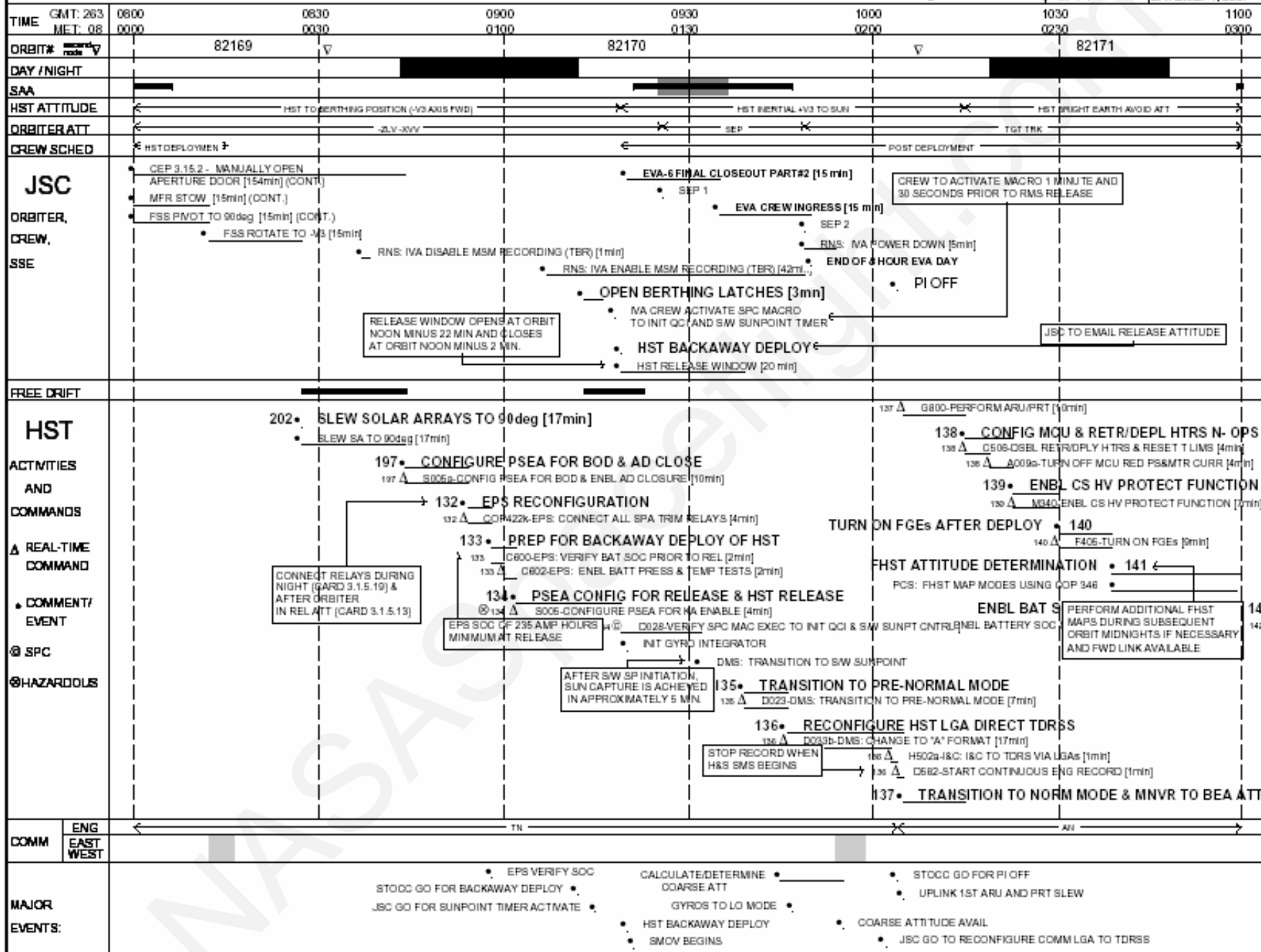
CONFIG LGA's FOR RELEASE OPS (CONT.)

H801 (CONT.)

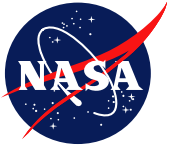
- STOCC & SSE GO TO SMM FOR EXT PWR OFF & UMBILICAL DISCONNECT
- SMM GO TO JSC FOR EXT PWR OFF & UMBILICAL DISCONN

HST SERVICING MISSION INTEGRATED TIMELINE: EVA-6 BACKAWAY DEPLOY [AD OPEN]

SHEET 62 OF 74
442 / 441
DATE: Mar 1, 2007



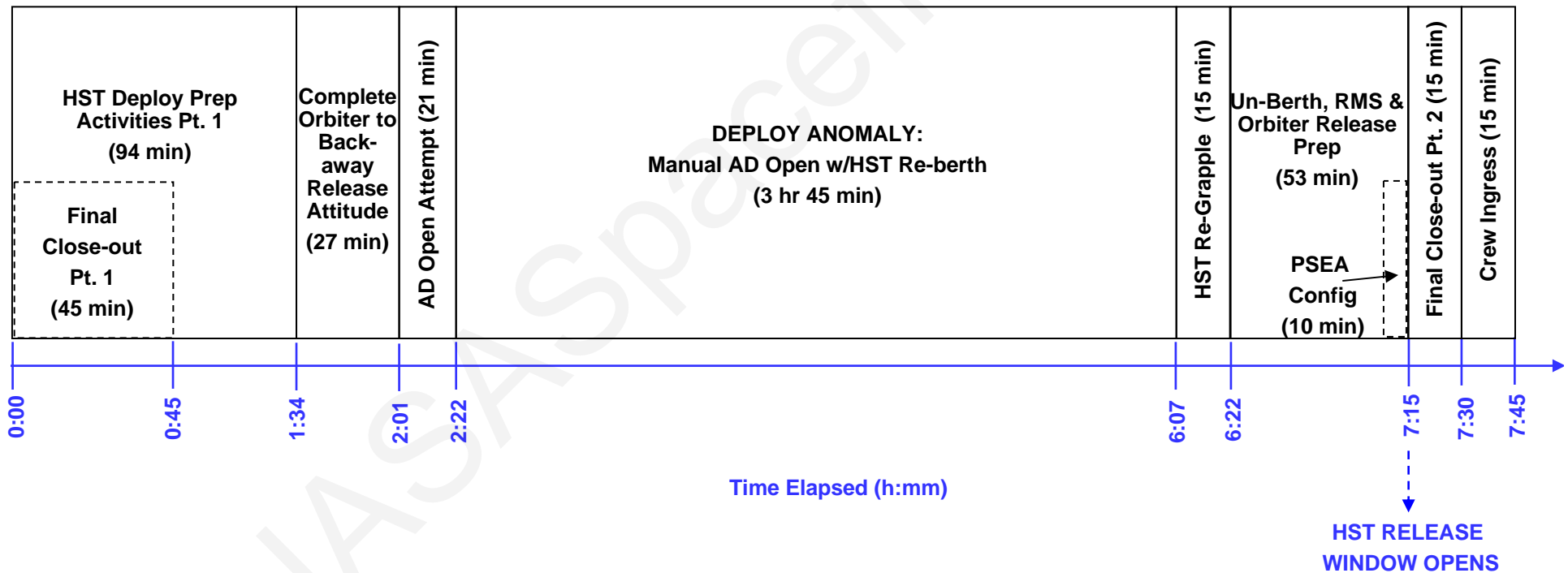
U.S. EXPORT CONTROLLED INFORMATION



RMS Deploy with Aperture Door Open

⌘ No contingency EVA 6 task time available

- Accounts for ~3 hr 45 min EVA assist to open aperture door
 - » Anomaly duration longer (in comparison to back-away) due to HST re-grapple and re-berth, etc, for EVA-assisted AD opening





HST SM4 Payload Operations Working Group #2
March 9, 2007



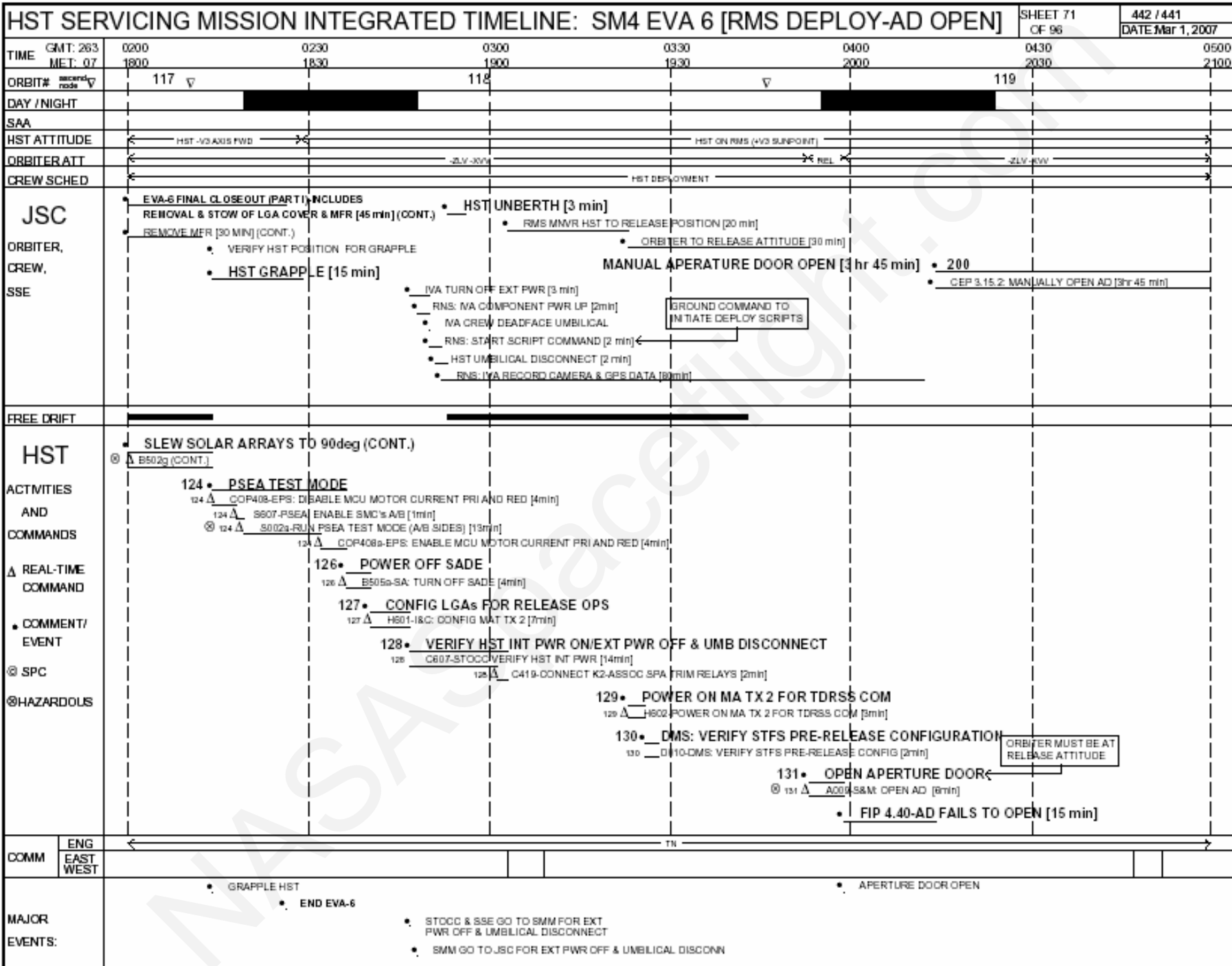
DRAFT SMIT 4:
RMS Deploy with AD Open (No EVA6)

NASA Spaceflight.com



HST SERVICING MISSION INTEGRATED TIMELINE: SM4 EVA 6 [RMS DEPLOY-AD OPEN]							SHEET 70 OF 96	442 / 441 DATE Mar 1, 2007
TIME	GMT: 262 MET: 07	2300 1500	2330 1530	0000 1600	0030 1630	0100 1700	0130 1730	0200 1800
ORBIT#			116			117		
DAY / NIGHT								
SAA								
HST ATTITUDE					HST-AD AXIS FWD			
ORBITER ATT								
CREW SCHED				POST SLEEP			AL REPR	HST DEPLO
JSC ORBITER, CREW, SSE								
FREE DRIFT								
HST ACTIVITIES AND COMMANDS								
▲ REAL-TIME COMMAND								
● COMMENT/ EVENT								
⊙ SPC								
⊙ HAZARDOUS								
COMM	ENG EAST WEST							
MAJOR EVENTS:								JSC GO TO COMMAND HST, EVA-6 ACTIVITIES COMPLETE

U.S. EXPORT CONTROL LED INFORMATION



HST SERVICING MISSION INTEGRATED TIMELINE: SM4 EVA 6 [RMS DEPLOY-AD OPEN]

SHEET 72 OF 96
442 / 441
DATE Mar 1, 2007

TIME	GMT: 263 MET: 07	0500 2100	0530 2130	0600 2200	0630 2230	0700 2300	0730 2330	0800 2400
ORBIT#		119		120			82	69
DAY / NIGHT								
SAA								
HST ATTITUDE					HST ON RMS (W/SUNPOINT)			
ORBITER ATT					UNKNOWN			
CREW SCHED					HST DEPLOYMENT			
JSC		<ul style="list-style-type: none"> MANUAL OPERATION DOOR OPEN [3 hr 45 min] (CONT.) CEP 3.15.2: MANUALLY OPEN AD [3hr 45 min] (CONT.) 						
ORBITER, CREW, SSE							<ul style="list-style-type: none"> VERIFY HST POSITION FOR GRAPPLE HST RE-GRAPPLE [15 min] 	
FREE DRIFT								
HST ACTIVITIES AND COMMANDS								
<ul style="list-style-type: none"> ▲ REAL-TIME COMMAND ● COMMENT/ EVENT Ⓢ SPC Ⓢ HAZARDOUS 								
COMM	ENG EAST WEST	←-----→						
MAJOR EVENTS:								



HST SERVICING MISSION INTEGRATED TIMELINE: SM4 EVA 6 [RMS DEPLOY-AD OPEN]

SHEET 73 OF 96 442 / 441 DATE: Mar 1, 2007

TIME	GMT: 263 MET: 08	0800 0000	0830 0030	0900 0100	0930 0130	1000 0200	1030 0230	1100 0300
ORBIT#		82169		82170			82171	
DAY / NIGHT								
SAA								
HST ATTITUDE		HST ON RMS (+V3 SUNPOINT)		HST BERTIAL +V3 TO SUN		HST BRIGHT EARTH AVOID ATT		
ORBITER ATT		ZLV-ZVV		RELEASE ATT		REL		TGT TRK
CREW SCHED		HST DEPLOYMENT				POST DEPLOYMENT		

JSC

- HST RE-GRAPPLE [15 min] (CONT.)
- HST UNBERTH [3 min]
- RMS MNVR HST TO RELEASE POSITION [20 min]
- RNS: IVA DISABLE MSM RECORDING (TBR) [1min]
- ORBITER TO RELEASE ATTITUDE [30 min]
- RNS: IVA ENABLE MSM RECORDING (TBR) [42min]
- MA CREW ACTIVATE SPC MACRO TO INIT QC AND SW SUNPOINT TIMER
- HST RELEASE
- HST RELEASE WINDOW [20 min]
- EVA-6 FINAL CLOSEOUT (PART II)-INCLUDES REMOVAL & STOW OF INGRESS AIDS [15 min]
- SEP 1
- EVA CREW INGRESS [15 min]
- SEP 2
- RNS: IVA POWER DOWN [5min]
- PI OFF
- CREW TO ACTIVATE MACRO 1 MINUTE AND 30 SECONDS PRIOR TO RMS RELEASE
- RELEASE WINDOW OPENS AT ORBIT NOON MINUS 22 MIN AND CLOSES AT ORBIT NOON MINUS 2 MIN.

JSC TO EMAIL RELEASE ATTITUDE

HST

ACTIVITIES AND COMMANDS

REAL-TIME COMMAND

COMMENT/ EVENT

SPC

HAZARDOUS

197 • CONF PSEA 4 BOD/AD CLD

132 • EPS RECONFIG

133 • PREP FOR RMS RELEASE OF HST

134 • PSEA CONFIG 4 REL & HST REL

135 • TRANSITION TO PRE-NORMAL MODE

136 • RECONFIGURE HST LGA DIRECT TDRSS

137 • PERFORM ARU/PRT

138 • CONF MCU & RET/DEP HTRS NORM OPS

139 • ENBL CS HV PROTECT FUNC

140 • F405-TURN ON FGEs

141 • F405-TURN ON FGEs

CONNECT RELAYS DURING NIGHT (CARD 3.1.5.19) & AFTER ORBITER IN REL ATT (CARD 3.1.5.13)

EPS SOC OF 255 AMP HOURS MINIMUM AT RELEASE

AFTER SW SP INITIATION, SUN CAPTURE IS ACHIEVED IN APPROXIMATELY 5 MIN.

STOP RECORD WHEN H&S SMS BEGINS

PERFORM ADDITIONAL FHST MAPS DURING SUBSEQUENT ORBIT MIDNIGHTS IF NECESSARY AND FWD LINK AVAILABLE

COMM	ENG EAST WEST							
------	---------------	--	--	--	--	--	--	--

MAJOR EVENTS:

- EPS VERIFY SOC
- STOCC GO FOR ACTV SUNPT TIMER FOR RMS RELEASE
- STOCC GO FOR RMS RELEASE
- HST RELEASE
- SMOV BEGINS
- CALC DETERMINE COARSE ATT
- GYRO TO LO MODE
- JSC GO TO RECONFIGURE COMM LGA TO TDRSS
- STOCC GO FOR PI OFF
- UPLINK 1ST ARU AND PRT SLEW
- COARSE ATTITUDE AVAIL



HST SM4 Payload Operations Working Group #2
March 9, 2007



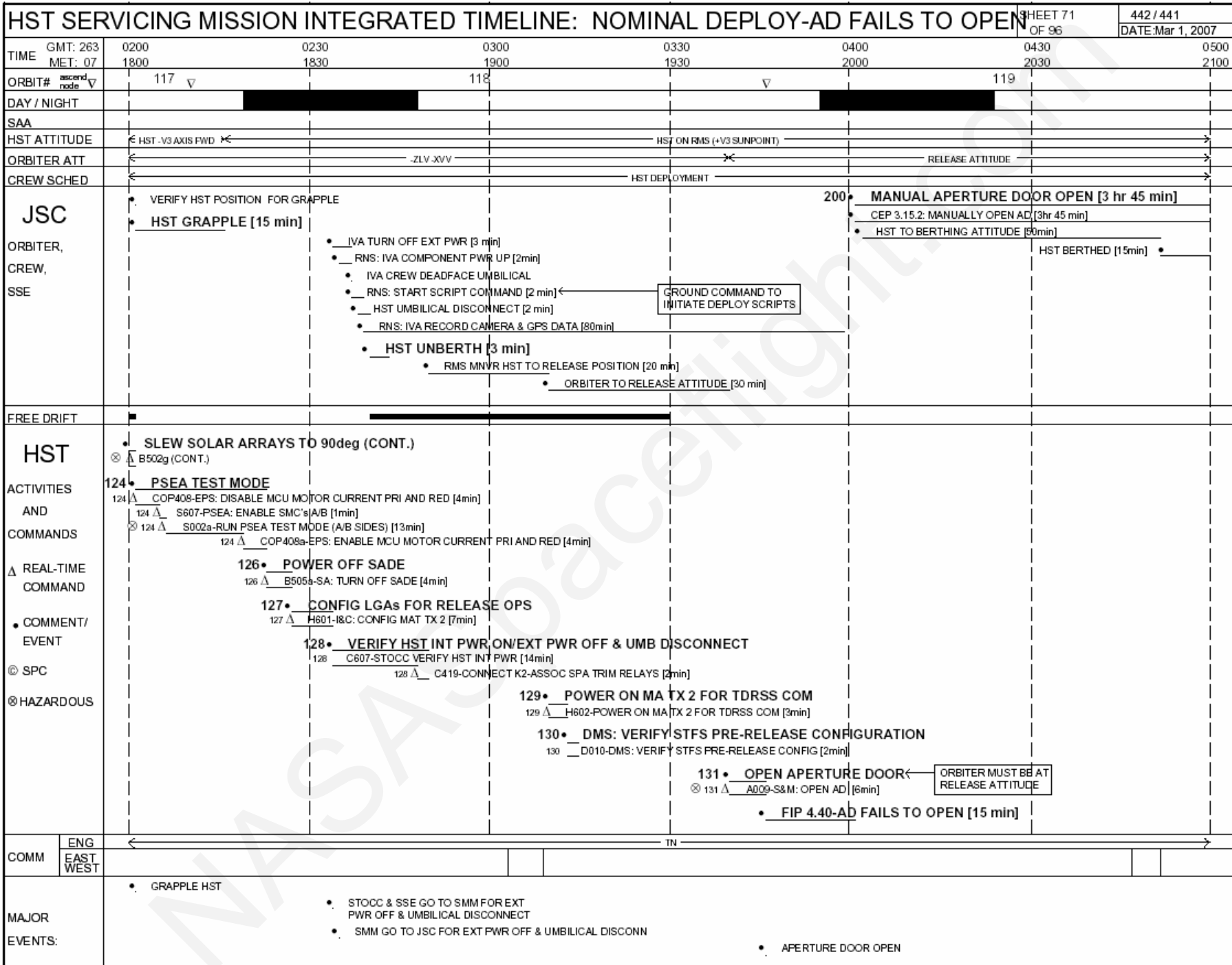
DRAFT SMIT 5:
Nominal Deploy with AD Open (No EVA6)

NASA Spaceflight.com



HST SERVICING MISSION INTEGRATED TIMELINE: NOMINAL DEPLOY-AD FAILS TO OPEN							SHEET 70 OF 96	442 / 441 DATE: Mar 1, 2007
TIME	GMT: 262 MET: 07	2300 1500	2330 1530	0000 1600	0030 1630	0100 1700	0130 1730	0200 1800
ORBIT#	ascend node ▽		116		▽		117	
DAY / NIGHT		[Black Bar]			[Black Bar]			
SAA								
HST ATTITUDE	←				HST -V3 AXIS FWD			→
ORBITER ATT	←				ZLV -XV			→
CREW SCHED	←			POST SLEEP			AVL REPR	HST DEPLO
JSC							• RNS IVA ENABLE OPERATE HEATERS [2min]	• P/TV 17
ORBITER, CREW, SSE							PHOTO/TV DOCUMENT ENTIRE HST RELEASE OPS	
FREE DRIFT								[Black Bar]
HST								
ACTIVITIES AND COMMANDS								
Δ REAL-TIME COMMAND								
• COMMENT/ EVENT								
⊙ SPC								
⊗ HAZARDOUS								
			SAC DELIVER TABLES TO CORE					
					118• LOAD EPHEMERIS TABLES			
					118 Δ D032a-DMS: LOAD EPHEMERIS DATA [1min]			
					118 Δ D753-CLEAR EPHEMERIS DELTA TIME LIMIT EXCEED FLAG [1min]			
						122• TURN OFF FGEs BEFORE DEPLOY		
						122 Δ F404-TURN OFF FGEs [8min]		
						123• DISABLE ALL OTA HEATERS		
						123 Δ E508-OTA: OTA HTR GROUPS OFF [3min]		
						119• RELOAD SMACs		
						RELOAD SMAC, HMAC, ACQ LOGIC & SM RECOVERY LOAD [9min]-D668 Δ 119		
						DMS: STOP SSR-3 SHADOW RECORD [1min]-D020 Δ 119		
						VERIFY INITIAL FSW CONFIG • 120		
						DMS: VERIFY INITIAL HST FSW CONFIG [2min]-D009 Δ 120		
						SLEW SOLAR ARRAYS TO 90deg • 198		
						SA: SLEW SAs TO 90deg [17min]-B502g Δ 198 ⊗		
COMM	ENG EAST WEST				IN			
MAJOR EVENTS:								





HST SERVICING MISSION INTEGRATED TIMELINE: NOMINAL DEPLOY-AD FAILS TO OPEN

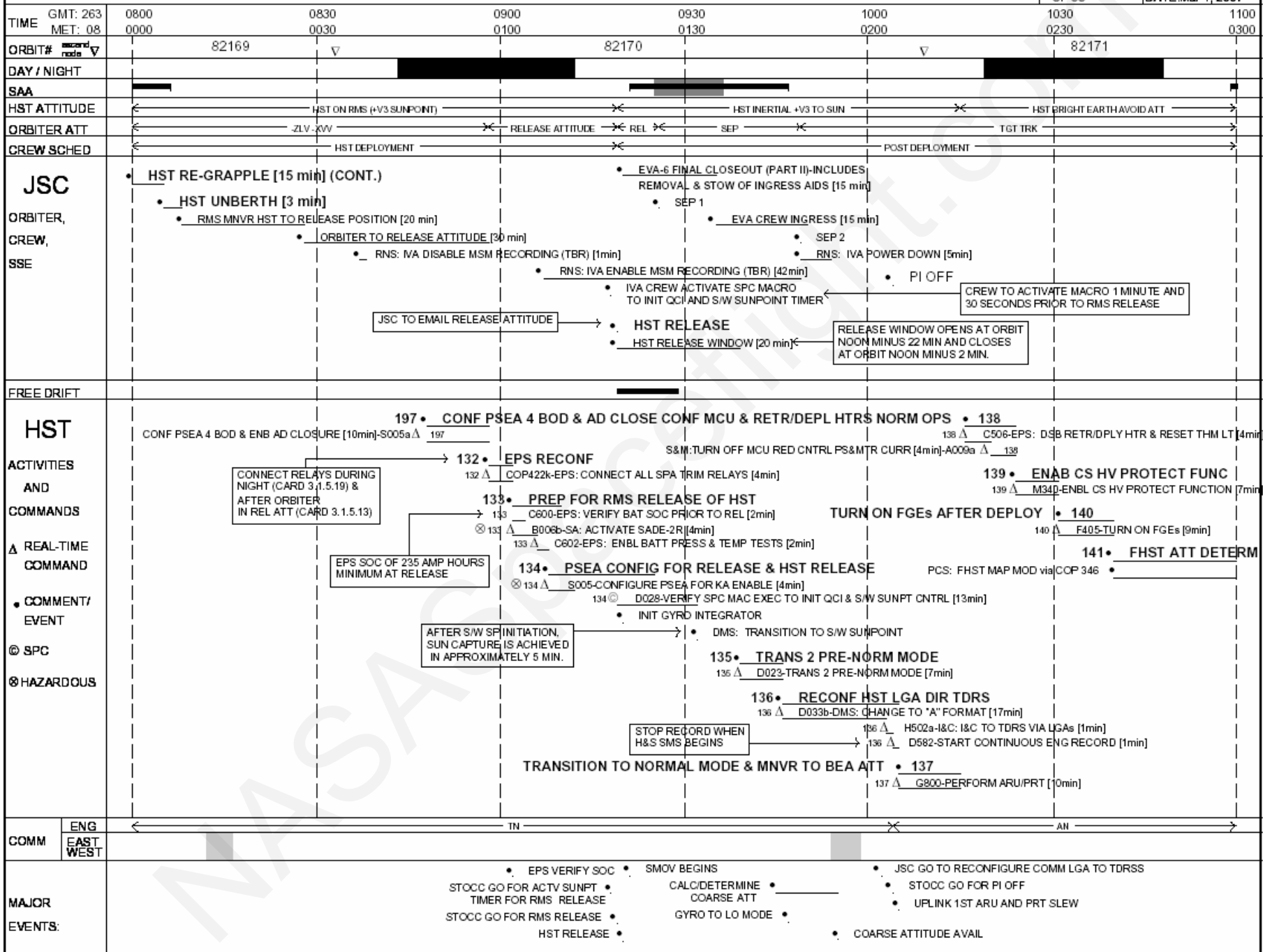
SHEET 72 OF 96 442 / 441
DATE: Mar 1, 2007

TIME	GMT: 263 MET: 07	0500 2100	0530 2130	0600 2200	0630 2230	0700 2300	0730 2330	0800 2400
ORBIT#	ascend node ▽	119 ▽		120		▽	82169	
DAY / NIGHT								
SAA								
HST ATTITUDE					HST ON RMS (+V3 SUNPOINT)			
ORBITER ATT		RELEASE ATTITUDE ✕				.LV.XVV		
CREW SCHED					HST DEPLOYMENT			
JSC								
ORBITER, CREW, SSE		<ul style="list-style-type: none"> MANUAL APERTURE DOOR OPEN [3 hr 45 min] (CONT.) CEP 3.15.2: MANUALLY OPEN AD [3hr 45 min] (CONT.) HST BERTHED [15min] (CONT.) <ul style="list-style-type: none"> RMS RELEASE [5 min] MFR SETUP [15 min] 		<ul style="list-style-type: none"> FSS ROTATE TO +V3 [15 min] FSS PIVOT TO 43.8deg [15min] RMS TO APERTURE DOOR [5 min] RELEASE SUN SHADE J-HOOK BOLTS(3) [10 min] OPEN SUN SHADE [5 min] OPEN APERTURE DOOR [5 min] 		<ul style="list-style-type: none"> CLOSE SUN SHADE [5min] RE-ENGAGE SUN SHADE J-HOOK BOLTS [10 min] RMS TO MFR STOW POSITION [5 min] MFR STOW [15min] FSS PIVOT 90deg [15 min] FSS ROTATE TO -V3 [15 min] VERIFY HST POSITION FOR GRAPPLE HST RE-GRAPPLE [15 min] 		
FREE DRIFT								
HST								
ACTIVITIES AND COMMANDS		<ul style="list-style-type: none"> 201 • POWER SADE ON <ul style="list-style-type: none"> 201 Δ B505b-SA: TURN ON SADE [4min] 202 • SLEW SOLAR ARRAYS TO 0deg <ul style="list-style-type: none"> 202 Δ B502c-SA: SLEW SAs TO 0deg [17min] 					<ul style="list-style-type: none"> SLEW SOLAR ARRAYS TO 90deg • 203 <ul style="list-style-type: none"> 203 Δ B502a-SA: SLEW SAs TO 90deg [17min] POWER OFF SADE • 204 <ul style="list-style-type: none"> SA: TURN OFF SADE [4min]-B505c Δ 204 	
Δ REAL-TIME COMMAND								
• COMMENT/ EVENT								
⊙ SPC								
⊙ HAZARDOUS								
COMM	ENG EAST WEST				TN			
MAJOR EVENTS:								



HST SERVICING MISSION INTEGRATED TIMELINE: NOMINAL DEPLOY-AD FAILS TO OPEN

SHEET 73 OF 96
442/441
DATE: Mar 1, 2007





HST SERVICING MISSION INTEGRATED TIMELINE: NOMINAL DEPLOY-AD FAILS TO OPEN

SHEET 74
CF 96
442 / 441
DATE Mar 1, 2007

TIME	GMT: 263	1100	1130	1200	1230	1300	1330	1400
MET: 08	0300	0330	0400	0430	0500	0530	0600	0600
ORBIT#		82171			82172			82173
DAY / NIGHT								
SAA								
HST ATTITUDE								
ORBITER ATT								
CREW SCHED								
JSC								
ORBITER, CREW, SSE								
FREE DRIFT								
HST								
ACTIVITIES AND COMMANDS								
REAL-TIME COMMAND								
COMMENT/ EVENT								
SPC								
HAZARDOUS								
COMM								
ENG EAST WEST								
MAJOR EVENTS:								

142 • ENABLE BATTERY SOC SAFEMODE TEST(S)
 142 Δ C801-ENBL BATTERY SOC SAFEMODE TEST(S) [3min]

143 • ENABLE OTA STAGE 1 HEATERS
 143 Δ E507a-OTA: ENBL STAGE 1 OTA HTR GRPS [3min]

144 • ENABLE OTA STAGE 2 HEATERS
 144 Δ E507b-OTA: ENBL STAGE 2 OTA HEATER GROUPS [2min]
 141 Δ COP346r-PCS: FHST 1,2 MAP [10min]

145 • ATTITUDE DETERMINATION FOR FIRST HLGBU
 ATTITUDE DETERMINATION FOR FIRST HLGBU [5HRS]
 145 Δ COP346r-PCS: FHST 1,2 MAP [10min]
 141 Δ COP346l-PCS: FHST 2,3 MAP [10min]

146 • ENABLE OTA STAGE 3 HEATERS
 146 Δ E507c-OTA: ENBL STAGE 3 OTA HEATER GROUPS [2min]
 • CALCULATE GYRO BIASES [4HRS]

147 • RE-CENTER HGA GIMBALS
 147 Δ H515r-IBC: SLEW ±HGAs TO (0,0) [9min]

PCS: FHST 1,2 MAP [10min]-COP346r Δ 145

PERFORM ADDITIONAL FHST MAPS DURING SUBSEQUENT ORBIT MIDNIGHTS IF NECESSARY AND FWD LINK AVAILABLE

PERFORM ADDITIONAL FHST MAPS DURING SUBSEQUENT ORBIT MIDNIGHTS TO COMPUTE GYRO DRIFT RATE BIASES FOR LGBU

FDF DELIVERS ALL EPHEMERIS PRODUCTS TO STSd