

HST/SM4 Mission Timeline and EVA Support



**JSC Mission Operations Directorate
Flight Director Office**

**DA8/A. Ceccacci
March, 2007**



**Mission Operations Directorate
Flight Director Office**

DA8/Ceccacci 281-483-0699

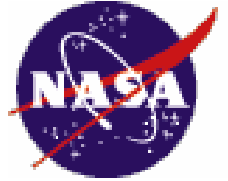
Agenda



- **Why are we here?**
- **SM4 Mission Timeline Development**
- **Unscheduled EVA Plan**
- **Options assessed for 6th “Scheduled” EVA**
 - **FD9 EVA #6/HST Deploy post EVA (6+0)**
 - **Delete EOM +2 (6+1)**
 - **Delete Late Inspection Day (6+1)**
 - **Partial Late Inspection**
 - **FD2 Rendezvous**
- **EVA Priorities**
- **Summary**



Why We are Here

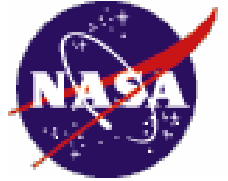


- **STS-125/HST SM4 Mission is limited to a duration of 11+2 (a)**
 - Duration limited by SSP mandatory mission requirements (crew and vehicle safety), SM4 power requirements, and 5 tank Cryo capabilities
- **SSP Mandatory mission requirements impact EVA planning (a)**
 - SM4 EVA capability is limited to 5 “scheduled” and 1 “unscheduled” EVA
 - » 5 Scheduled
 - EVA 1 (RSU, Battery/Bay 3) – 6:45
 - EVA 2 (COS, Battery/Bay 2) – 6:50
 - EVA 3 (WFC III, NOBL 5, 7, and 8) – 6:10
 - EVA 4 (STIS, STIKER) – 6:25
 - EVA 5 (FGS 3 (possibly #2), OVP, OCE-EK (not reqd if FGS 2)- 6:30
 - » 1 Unscheduled
 - EVA (Rapid response EVA on HST Release Day)
 - Previous Servicing missions were able to support 2 “unscheduled’ EVAs
- **With the failure of the ACS, consideration is being given to adding additional EVA activities in support of ACS repair**

(a) Backup charts contain presentation given to HST Management at Crew Fam (2/12/07) defining mission and EVA capabilities/limitations based on new programmatic requirements since STS-109/SM3B mission



Why We are Here (cont.)



- **Options being assessed/evaluated to provide additional EVA capability**
 - Rearranging mission timeline activities
 - Replace SSP mission requirements with EVA
 - Re-evaluate EVA task priorities/EVA timelines
- **All options being assessed will have impact to mission risks, mission safety and mission success**

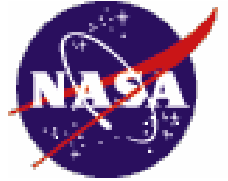




SM4 Mission Timeline Development



SM4 Mission Timeline Development

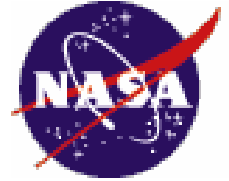


- **Pre-Mission Timeline developed/developed/planned to protect (in priority order):**
 - Shuttle Operational Flight Rules
 - » FD2 Surveys – TPS Health Post Ascent
 - » Focused Inspection (if required) for detailed assessment on AOI to “clear” TPS for Entry (Ascent debris environment)
 - » Late Inspection - WLE Health
 - MMOD #2 concern on SSP PRA list
 - HST Mission “manifested” based on ability to accommodate Late Inspection
 - » EOM+1 and EOM+2 Extension Day Requirements (2 extension days Weather/Systems required)
 - » EVA length (planned 6:30 hrs)
 - » Optimize MMOD protect attitude
 - » D/O Opportunity Planning
 - SCSC (Shuttle Crew Scheduling Constraints)
 - » Example – Crew day length, Pre/Post Sleep, sleep shifting for D/O, Off Duty, etc.
 - Nominal Shuttle house keeping
 - Flight Requirements/Mission Objectives/Mission Priorities (SM4)

**** Underline indicates new programmatic requirements since last Servicing mission ****



SM4 Mission Draft Timeline (11+2)



FD1	FD2	FD3	FD4	FD5	FD6	FD7
<ul style="list-style-type: none"> •Ascent •PI •RMS C/O 	<ul style="list-style-type: none"> •TPS Surveys (RCC & Tile Acreage) •EMU C/O •RNDZ Prep 	<ul style="list-style-type: none"> •RNDZ •HST Grapple •HST Berth •Battery Charge •RMS Survey •EVA #1 RVW 	<ul style="list-style-type: none"> •HST EVA #1 •Battery Charge •EVA #2 RVW 	<ul style="list-style-type: none"> •HST EVA #2 •Battery Charge •EVA #3 RVW 	<ul style="list-style-type: none"> •HST EVA #3 •EVA #4 RVW 	<ul style="list-style-type: none"> •HST EVA #4 •EVA #5 RVW

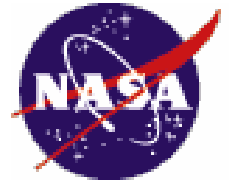
FD8	FD9	FD10	FD11	FD12	FD13	FD14
<ul style="list-style-type: none"> •HST EVA #5 	<ul style="list-style-type: none"> •HST Release •OBSS Unberth •Late Inspection Part I (STBD WLE & Nose Cap) 	<ul style="list-style-type: none"> •Late Inspection Part II (Port WLE) •OBSS Berth •Crew Off Duty 	<ul style="list-style-type: none"> •EOM-1 •(Cabin Stow, FCS C/O, RCS Hot Fire, etc.) •Crew Off Duty 	<ul style="list-style-type: none"> •Entry 	<ul style="list-style-type: none"> •EOM +1 	<ul style="list-style-type: none"> •EOM +2

• Red Font Indicates Shuttle Program Requirements/days that cannot be traded for Mission Success (EVA's)

•FD1, FD2, FD3, FD9 (Late Inspection), FD10 (Late Inspection), FD11, FD12, FD13, FD14



SM3B Mission Timeline (11+2)



- SM3B Mission Timeline provided for comparison:

FD1	FD2	FD3	FD4	FD5	FD6	FD7
<ul style="list-style-type: none"> •Ascent •PI •RMS C/O 	<ul style="list-style-type: none"> •EMU C/O •RNDZ Prep 	<ul style="list-style-type: none"> •RNDZ •HST Grapple •HST Berth •Battery Charge •RMS Survey •SA Retract •EVA #1 RVW 	<ul style="list-style-type: none"> •HST EVA #1 •Battery Charge •EVA #2 RVW 	<ul style="list-style-type: none"> •HST EVA #2 •Battery Charge •EVA #3 RVW 	<ul style="list-style-type: none"> •HST EVA #3 •Battery Charge •EVA #4 RVW 	<ul style="list-style-type: none"> •HST EVA #4 •EVA #5 RVW
FD8	FD9	FD10	FD11	FD12	FD13	FD14
<ul style="list-style-type: none"> •HST EVA #5 	<ul style="list-style-type: none"> •HST Release 	<ul style="list-style-type: none"> •Crew Off Duty 	<ul style="list-style-type: none"> •EOM-1 •(Cabin Stow, FCS C/O, RCS Hot Fire, etc.) 	<ul style="list-style-type: none"> •Entry 	<ul style="list-style-type: none"> •EOM +1 	<ul style="list-style-type: none"> •EOM +2

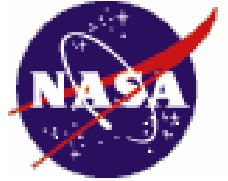




Unscheduled EVA Plan



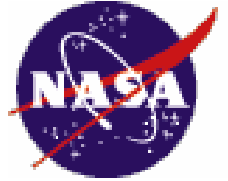
Unscheduled EVA Plan



- **Plan is to prepare for a “Rapid Response” EVA in parallel with HST Release activities on FD9 since only 1 “unscheduled” EVA available**
 - **Schedule crew HST release activities/release as early as possible on FD9**
 - » **Requires HST to streamline/minimize telescope prep configuration (long pole in the tent)**
 - **EV crew prepped and ready to respond to “HST Deploy Contingencies” as required**
 - » **Hi Gain Ant Deploy Cont EVA will be know the evening before**
 - » **Umb Disconnect, Unberth, APT Door Open will occur during EVA Prep, providing heads up if any of these activities cannot be successfully completed**
 - » **If the above activities go well, complete EVA prep up to HUT Donning. If EE release is unsuccessful, Complete EVA Prep and begin EMU purge and pre-breath while telescope is being re-berthed**
 - **“Rapid Response” EVA plan provides:**
 - » **Earlier planned release provides more “runway” (crew day) to support HST Deploy/Release Contingencies**
 - » **Quick response**
 - » **Maximum EVA capability/proficiency (time available ~ 6 hrs total)**
 - **To meet crew day length and Pre-sleep requirements**
 - » **Possible EVA support for 2nd HST Deploy attempt**
 - **Dependent on Contingency task duration and 2nd attempt HST deploy method (RMS release or Backaway)**



Unscheduled EVA Plan (cont)

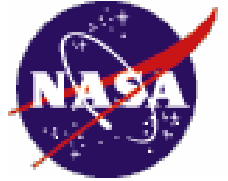


- **Impacts:**
 - SCSC violation on FD10 to accomplish/complete Late Inspection
 - » Loss of required Crew “Off Duty” time on FD10
- **Open Work/Issues:**
 - Ensure adequate crew resources to support parallel operations
 - Minimizing HST telescope deploy/release prep activities (HST Action)
 - » Key to making this work

FD8	<u>FD9</u>	<u>FD10</u>	FD11	FD12	FD13	FD14
<ul style="list-style-type: none"> •HST EVA #5 •Rapid Response EVA #6 Review 	<ul style="list-style-type: none"> •HST Unsch EVA •HST Release 	<ul style="list-style-type: none"> •OBSS Unberth •Late Inspection Part I (STBD WLE & Nose Cap) •Late Inspection Part II (Port WLE) •OBSS Berth 	<ul style="list-style-type: none"> •EOM-1 •(Cabin Stow, FCS C/O, RCS Hot Fire, etc.) •Crew Off Duty 	<ul style="list-style-type: none"> •Entry 	<ul style="list-style-type: none"> •EOM +1 	<ul style="list-style-type: none"> •EOM +2



Unscheduled EVA Plan (cont)



- Rapid Response “Unscheduled” EVA Plan provides requirement to support deployment day problems
 - Important since only 1 “Unscheduled” EVA opportunity exists
- Low probability of having to actually execute the “unscheduled” EVA due to HST and Orbiter redundancy as well as hardware flight history
 - Preparing for EVA has very minor effect to timelined activities and does not result in any SCSC violations



Unscheduled EVA Plan (cont)



Wakeup at
7/16:30

EVA Start at
7/21:52

02/21/07 13:31:25

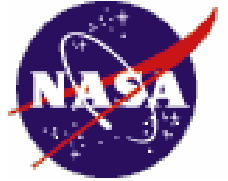
EVA Stop at
8/04:00

Presleep at
8/05:30

BETA - 9.2 CT 03/07/02 (066) FD09 MET		03/08		01		02		03		04		05		06		07		08		09		10		11		06				
Day 007		18		19		20		21		22		23		00B/00		01		02		03		04		05		06				
CDR ALTMAN	POST SLEEP	GRPB PMJP	UMBC L	HST UMBTH MNVRE	RA ET LT SE	HST RELEASE PREP	REL HST	SEP1A RELEASE OPS	SEP2A		-X LV VV	GR PR BD N	MEAL	PO AP OP TY	EXERCISE												14.7 RPRSS	PMC OCA	PS R L E E P	
PLT CAREY	POST SLEEP	GRPB PMJP		PTV17 SETUP & OPS							PS TE VT IU 1P	PTV11 OPS	GR PR BD N	MEAL	PS TE VT OU 2P	PO AP OP TY	EXERCISE											14.7 RPRSS	W C S	PRE S L E E P
MS2/R1 CURRIE	POST SLEEP	MC IB UC L	UMBC L	HST UMBTH MNVRE	RA ET LT SE	HST RELEASE PREP	REL HST	SEP1A RELEASE OPS		RP MM SR DN	FRED STOW		MEAL	PO AP OP TY	EXERCISE														PRE S L E E P	
MS1/EV1 GRUNSFELD	POST SLEEP	HT SN PG RR S NT C		BT AE TR TM		EVA PREP		EMU PG & P/B			FSS STOW		MEAL	PS GT SO CM A	PO AP OP TY		P A L B T K	P O C L P B S K				EXERCISE							PRE S L E E P	
MS3/EV2 LINNEHAN	POST SLEEP	HT SN PG RR S NT C						EMU PG & P/B			FSS STOW		MEAL	PO AP OP TY	Max EVA Duration (6:08)						EXERCISE								PRE S L E E P	
MS4/EV3 NEMMAN	POST SLEEP	HT SN PG RR S NT C		BT AE TR TM		EVA PREP *		EMU PG & P/B		DE ED PR RS S	PTV11 OPS		MEAL	PO AP OP TY	EMU *							EXERCISE							PRE S L E E P	
MS5/EV4 MASSIMINO	POST SLEEP	HT SN PG RR S NT C				EVA PREP		EMU PG & P/B		DE ED PR RS S		RP MR SR DN	MEAL	PO AP OP TY	EMU *						EXERCISE							IN PR GR RR SS	POST EVA W/H2O RECHG	PRE S L E E P
GND CMD*		FO GF EF S	OT A	PSEA TEST MODE		MS CV P F R R F O N	DO PE RN	DO PE RN	DO PE RN	DO PE RN	DO PE RN	DO PE RN	DO PE RN	DO PE RN	DO PE RN	DO PE RN	DO PE RN	DO PE RN	DO PE RN	DO PE RN	DO PE RN	DO PE RN	DO PE RN	DO PE RN	DO PE RN	DO PE RN	DO PE RN	DO PE RN	DO PE RN	DO PE RN
DAY/NIGHT																														
ORBIT		117		118			119			120			121			122			123			124								
TDRS	E M Z																													
TDRS																														
ORB ATT																														
FSS PWD AXIS																														
SOLAR ARRAY																														
NOTES	*TBD	*FILTER CK	*TRIM RELAYS	*REBA/EHIP/PGT BATT TERM	*HST Release 7/20:51	*FOR RELEASE	*RELNAV	*POWER OFF	*LGAs FOR RELEASE OPS																					

2nd attempt RMS Release Prep requirements shown

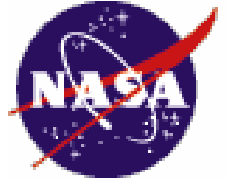
Sleep at 8/07:30
(one hour earlier due to Sleep shift for landing opportunities)



Options assessed for 6th “Scheduled” EVA



Options assessed for 6th “Scheduled” EVA



- **NOTE:**

- To restate:

- » In development of the Initial SM4 Timeline (Chart 5 & 6), Programmatic requirements were adhered to resulting in a 11+2 mission and a EVA capability of 5 “scheduled” and 1 “unscheduled” EVA

- DA8 fully supports this timeline since it optimizes both mission safety and mission success

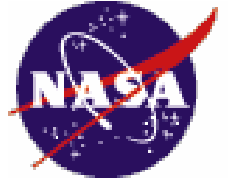
- The Options/Tradeoffs identified on the following charts are assessments/evaluations identifying possible capabilities and the risks associated with each

- Options/Tradeoffs defined in the following charts would require the SSP direction to write waivers and/or changes to the current Mission Safety Critical requirements

- » HST Program to SSP discussions would be required with HST Program making the request



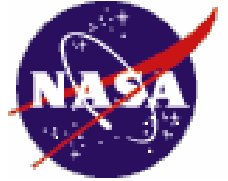
FD9 “Scheduled” EVA #6



- **Replace “Unscheduled” EVA with “Scheduled” EVA 6**
 - **Results in 6 “Back to Back” EVAs**
 - » **Breaking new ground, Crew fatigue concerns**
 - **HST Deploy/Release on EVA 6 Day**
 - » **No additional HST EVA opportunities available (6+0)**
 - **Maximum EVA duration 6.5 hours**
 - » **SCSC requirements**
 - **Limited EVA Task time available while still protecting HST Deploy Day Contingency EVAs**
 - » **“Usable” EVA time ranges from ~ 2.5 hrs to 4 hours dependent on what HST Deploy problem is being protected and what deploy method is being used**
 - » **Example: RMS Release/ Apt Door Contingency**
 - **Apt Door Contingency EVA ~ 1:40 hr**
 - **HST Release Timeline activities prior to Apt Door open ~ 1:00 hr**
 - **HST Re-berth, 2 pivots ~ 1:20 hr**
 - **~2.5 hrs “Usable” EVA time protecting for this contingency**
 - **Possible to gain additional “Usable” EVA time if Apt Door Opened after EVA 5**
 - **Apt Door Open has attitude operational constraints ????**
 - **2nd HST Deploy “Backaway” Deploy**



FD9 “Scheduled” EVA #6 (cont)



- » **Example: Backaway Deploy Berthing Latch**
 - Backaway Deploy procedures ~ .5 hours
 - RMS Grapple ~ .25 hr
 - Berthing Latch EVA ~ 1hr
 - RMS HST Release Activities ~ 1:45
 - 2nd Deploy requires RMS HST release if Berthing Latch Manually open
 - No EVA “Superman” deploys
 - ~4.0 hrs “Usable” EVA time protecting for this contingency
- **No EVA support available for 2nd HST Deploy/Release attempt (after contingency EVA complete)**



FD9 “Scheduled” EVA #6 (cont)



- **Impacts:**
 - **SCSC violation on FD10 to accomplish/complete Late Inspection**
 - » **Loss of required Crew “Off Duty” time on FD10**
- **Open work/Issues**
 - **Programmatic discussion of 6 “Back to Back” EVAs**
 - » **Risk versus mission success/Crew fatigue**
 - **Ensure adequate crew resources to support parallel operations**
 - **Minimizing HST telescope deploy/release prep activities (HST action)**
 - » **Key to allowing this option to work**
 - **HST Program risks to protect HST Deploy/Release contingencies and 2nd attempt protection**
 - » **Using 2.5 to 4 hours on “other” EVA tasks on last HST EVA versus using all EVA to protect /ensure safe and successful Deploy**
 - » **Cannot use more than 2.5 to 4 hr for HST Mission success since Orbiter Safety is part of this equation**
 - **What mission success does 2.5 to 4 hours provide that can’t be accomplished within the 5 EVAs? if EVA priorities are defined/managed?**



FD9 “Scheduled” EVA #6 (cont)



FD8	FD9	FD10	FD11	FD12	FD13	FD14
<ul style="list-style-type: none"> •HST EVA #5 •Rapid Response EVA #6 Review 	<ul style="list-style-type: none"> •HST EVA#6 •HST Release 	<ul style="list-style-type: none"> •OBSS Unberth •Late Inspection Part I (STBD WLE & Nose Cap) •Late Inspection Part II (Port WLE) •OBSS Berth 	<ul style="list-style-type: none"> •EOM-1 •(Cabin Stow, FCS C/O, RCS Hot Fire, etc.) •Crew Off Duty 	<ul style="list-style-type: none"> •Entry 	<ul style="list-style-type: none"> •EOM +1 	<ul style="list-style-type: none"> •EOM +2



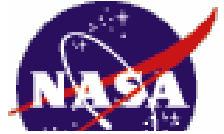
FD9 “Scheduled” EVA #6 (cont)



- **Six scheduled ‘Back to Back’ EVAs violates SCSC**
 - SCSC developed to “ensure safety and well being of crewmembers who perform a wide variety of tasks associated with the vast challenges of a Shuttle mission ensuring a safe mission first and successful mission second”.
- **Understand HST Program’s desire to optimize HST capability with SM4 being the last servicing mission but do not want to compromise safety or incur any additional risks**
 - Risk versus Mission Success (“X” of “Y” HST objectives complete)
 - Goal is to plan, train, and execute the “Safest” and most “Successful” mission as possible
 - Increased risk to telescope capabilities if last remaining HST EVA is not completely dedicated to safe/successful Deploy/Release
 - » Time limitations reduce what can be done to configure HST for release/deploy
- **Increase risks to EVA crewmember**
 - Additional venture into vacuum
 - Need to make sure task is worth the additional risks



FD9 "Scheduled" EVA #6 (cont)



Wakeup at
7/16:30

EVA Start at
7/21:15

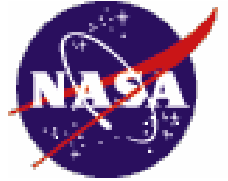
Unberth Ops Start
at 8/01:45/07 14:27:35

EVA Stop at
8/03:45

Presleep at
8/05:30

BETA - 9.2 CT 03/07/02 (066) FD09 MET		Day 007										Day 008										Day 009										Day 010										Day 011										Day 012									
		03/08		01		02		03		04		05		06		07		08		09		10		11		06																																			
CDR ALTMAN	POST SLEEP	GRP B PMUP	EXERCISE																U M B C L	HST UMBTH MNVR	R A E T L T S E	HST RELEASE PREP	SEP REL HST	A R E L S	SEP2A OPS	- - Z X L V V	14.7 RPRSS	P M C O C A	P S R L E E P																																
PLT CAREY	POST SLEEP	GRP B PMUP	EXERCISE				P S T E M T U S P		PTV15 OPS																		G P R M P R D B N	14.7 RPRSS	M C S	P R E S L E E P																															
MS2/R1 CURRIE	POST SLEEP	M C I U *							RMS EVA SUPT										U M B C L	HST UMBTH MNVR	R A E T L T S E	HST RELEASE PREP	SEP REL HST	A R E L S	SEP2A OPS	G P R M P R D B N			P R E S L E E P																																
MS1/EV1 GRUNSFELD	POST SLEEP	A I H B T S N P A E P S G T R M T C	EVA PREP		EMJ PG & P/B		D E P R S		EVA SUPPORT																A A L R E P		POST EVA W/H2O RECHG	P S T G S O C M A	P R E S L E E P																																
MS3/EV2 LINNEHAN	POST SLEEP	1 0 0 P 2 M	EVA PREP		EMJ PG & P/B		D E P R S		EVA SUPPORT EVA Duration (6:30)																* A/L R E P		POST EVA W/H2O RECHG		P R E S L E E P																																
MS4/EV3 NEWMAN	POST SLEEP	B T A E T R M *	EVA PREP		EMJ PG & P/B		D E P R S		EVA																I P N R G P A L R R S S R E P		POST EVA W/H2O RECHG		P R E S L E E P																																
MS5/EV4 MASSIMINO	POST SLEEP	1 0 0 P 2 M	EVA PREP		EMJ PG & P/B		D E P R S		EVA																I P N R G P A L R R S S R E P		POST EVA W/H2O RECHG		P R E S L E E P																																
GND CMD*		F O G E F S	P S E A T E S T M O D E		C V P W F R F O N	H O M C S	D O P E R N	E P S N F S G	P P S E A	N M O O R M E	S H L S G N T A V R	M N C U S	F H S T F O V C H E C K	O T A	A T T D E T & L G B U D A T A	O T A	H G M A B L S	O T A																																											
DAY/NIGHT	117		118		119		120		121		122		123		124																																														
TDRS	E M Z																																																												
TDRS	ORB ATT		BATT CHG		REL		SEP/IGT																																																						
FSS FWD AXIS	-V3																																																												
SOLAR ARRAY																																																													
NOTES	*TBD		*FILTER CK *REBA/EHIP/PGT BATT TERM *REBA/EHIP/PGT BATT TERM		*TRIM RELAYS *POWER OFF *LGAs FOR RELEASE OPS		*FOR RELEASE																		*RELNAV *TRANS TO TRSMCC *HST Release 8/03:47		Sleep at 8/07:30 (one hour earlier due to Sleep shift for landing opportunities)		Activities Not Scheduled: FRED Stow, FSS Stow, P/TV11 Ops																																

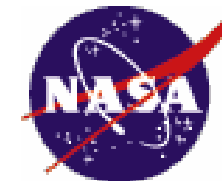
EOM +2 Tradeoff



- **Per Flight Rules (A2-103), the SSP requires the protection of 2 EOM mission Contingency days (EOM+1, EOM+2) in support of a Weather Waveoff and/or a Orbiter Systems Waveoff**
 - Weather Waveoff is used to support Landing Opportunity at Primary Landing Site
 - Systems Waveoff is used to provide an additional “on-orbit” day to understand the systems problem which may cause an unsafe or compromised configuration for entry and ensure the optimal Entry configuration is derived to provide maximum/optimal safety to the crew and vehicle
 - Orbiter should not be exposed to unsafe/compromised entry conditions to further payload data return (mission success).
- **For STS-116/12A.1, EOM+2 was traded to support EVA #4 (ISS critical safety item/SAW) and retain Late Inspection**
 - Both items defined as Safety of Flight/Mission Critical
 - Loss of EOM+2, required Landing the Vehicle on NOM EOM, at any of the available CONUS sites



EOM +2 Tradeoff (cont.)

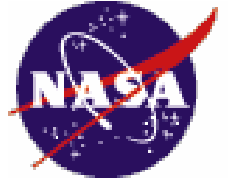


- Removing the requirement for EOM+2 provides an additional “on-orbit” day to support 6+1 EVA capability
 - “Scheduled” EVA #6 on FD9
 - » Six “Back to Back” EVAs
 - FD10 HST Release w/ Rapid Response EVA support
 - » If “unscheduled” EVA is executed it will have domino impacts to timeline
 - SCSC violation on FD11 to accomplish/complete Late Inspection
 - Loss of required Crew “Off Duty” time on FD11

FD8	FD9	FD10	FD11	FD12	FD13	FD14
<ul style="list-style-type: none"> •HST EVA #5 •HST EVA #6 review 	<ul style="list-style-type: none"> •HST EVA #6 	<ul style="list-style-type: none"> •HST Release •OBSS Unberth •Late Inspection Part I (STBD WLE & Nose Cap) 	<ul style="list-style-type: none"> •Late Inspection Part II (Port WLE) •OBSS Berth •Crew Off Duty 	<ul style="list-style-type: none"> •EOM-1 •(Cabin Stow, FCS C/O, RCS Hot Fire, etc.) •Crew Off Duty 	<ul style="list-style-type: none"> Entry 	<ul style="list-style-type: none"> •EOM +1



EOM +2 Tradeoff (cont.)



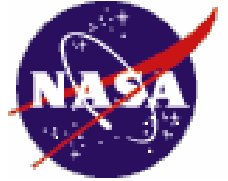
- **Programmatic Risks**

- **Must land on NOM EOM at any of 3 CONUS sites unless Weather or Systems failure occurs**
 - » **Very challenging scenario if Systems failure occurs on last D/O day**
- **Late Inspection delay impacts (FD11 completion versus FD10):**
 - » **Decreases response time available to support possible repair activities**
 - **Only 3 days of “on orbit” stay to support repair (keeping Orbiter at power levels to keep entry critical hardware available)**
 - » **Reduces CSCS capability**
 - **Delaying HST Group C+ Powerdown to FD12 (versus FD11) impacts CSCS stay by ~ 2 to 2.5 days**

- **Programmatic decision required to tradeoff Potential Safety of Flight versus HST Mission Objectives (ACS Repair)**



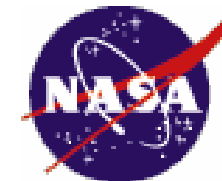
Late Inspection Tradeoff



- **SSP requires Late Inspection of TPS RCC (WLE and Nose Cap) to be performed as a mitigation to MMOD damage**
 - MMOD #2 concern on SSP PRA list
 - HST Mission manifested based on the ability to accommodate Late Inspection verifying TPS RCC integrity prior to entry



Late Inspection Tradeoff (cont)

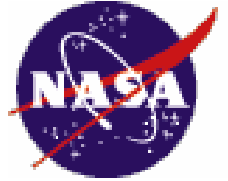


- Removing the requirement for Late Inspection provides an additional “on-orbit” day to support 6+1 EVA capability
 - Similar to SM3B Timeline
 - “Scheduled” EVA #6 on FD9
 - » Six “Back to Back” EVAs
 - FD10 HST Release w/ Rapid Response EVA support
 - » If “unscheduled” EVA is executed it will have some domino impacts to timeline
 - Loss of FD10 Crew ‘Off Duty’

FD8	FD9	FD10	FD11	FD12	FD13	FD14
<ul style="list-style-type: none"> •HST EVA #5 •Rapid Response EVA #6 Review 	<ul style="list-style-type: none"> •HST EVA #6 	<ul style="list-style-type: none"> •HST Release •Crew Off Duty 	<ul style="list-style-type: none"> •EOM-1 •(Cabin Stow, FCS C/O, RCS Hot Fire, etc.) •Crew Off Duty 	<ul style="list-style-type: none"> •Entry 	<ul style="list-style-type: none"> •EOM +1 	<ul style="list-style-type: none"> •EOM +2



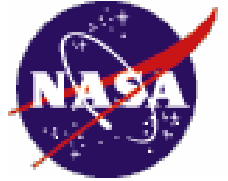
Late Inspection Tradeoff (cont)



- **Programmatic Risks**
 - **Loss of TPS WLE integrity checks could result in a catastrophic failure**
 - » **Late Inspection buys down odds of this risk (1/180 to 1/240)**
 - **Risks are managed within capabilities**
 - **Includes OA prior to Late Inspection**
 - **Actual risks numbers are dependent on mission profile flown**
- **Programmatic decision required to tradeoff Potential Safety of Flight versus HST Mission Objectives (ACS Repair)**



Partial Late Inspection Tradeoff



- **Timeline**

- Deletion of portions of the Late Inspection survey provides minor “get wells” to the timeline
 - » Prevents Crew “OFF Duty” SCSC violations on day after HST Release in the Unscheduled or FD9 Scheduled EVA #6 scenario
 - Full up Late Inspection is moved to the day after Release and requires deletion of Crew Off Duty to complete
 - Deletion of part of the Late Inspection buys back “Off Duty”

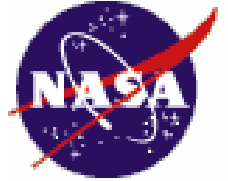
- **Programmatic Risks**

- Partial Late Inspection does buy down the MMOD risk some, but the integrity of the RCC that was not surveyed cannot be established

- **Programmatic decision required to tradeoff Potential Safety of Flight versus HST Mission Objectives (ACS Repair)**



Option - FD2 Rendezvous



- For specific Launch Phase angles, the capability exists to support a FD2 Rendezvous
- Thought is that Rendezvous on FD2 will buy back additional time for EVA activities

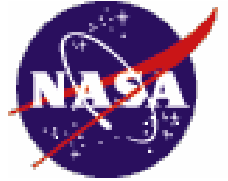
FD3 Rendezvous “Summary Timeline

		MET	0/-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	00/0	1	2	3	4	5	6	7	8	9	10	11	12	13
FD 01	STS													ASC	Post Insert	RMS C/O		SLEEP									
	Orb Att													ASC	-ZLV +YVV	NC-1	FD1 CNFG										
		MET	0/13	14	15	16	17	18	19	20	21	22	23	1/0	1	2	3	4	5	6	7	8	9	10	11	12	13
FD 02	STS	SLP					EMU c/o, P/TV Setup				Meal	RNDZ Prep, FSS			SLEEP												
	Orb Att	-ZLV -XVV	NC-2					U/B FF	STBD	T1	Nose	Port	Tile2	Berth											NC-3	-ZLV -XVV	
		MET	1/13	14	15	16	17	18	19	20	21	22	23	2/0	1	2	3	4	5	6	7	8	9	10	11	12	13
FD 03	STS					RNDZ					GRAPPLE	SRMS SVY	EVA 1 Prep		EVA PROC RVW	SLEEP											
	Orb Att	DUMP	RNDZ					FREE	Batt Chg	-ZLV -XVV																	
	HST Att	RNDZ					CAPT	Berth	-V3 Axis FWD																		

Grapple ^



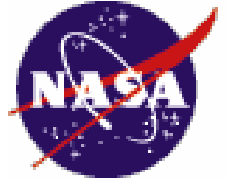
Option - FD2 Rendezvous (cont)



- Ignoring TPS Inspection for the moment, as can be seen on the FD3 Rendezvous “Summary Timeline”, there are many critical/mandatory activities that need to be completed to support On-Orbit configuration as well as the Rendezvous/HST Berth activities and EVA prep activities
 - Orbiter configurations, RMS C/O, 10.2 depress, Photo TV setup, PGSC setup, SSE Survey, FSS Prep for berthing, Rendezvous tool checkout, EMU C/O, EMU Tool configuration, EVA 1 prep, EVA Review
 - EVA Unique: If time at 10.2 < 36 hrs prior to EVA start, a pre-breath of 60 minutes is required (45 before going below 12.5)
 - » Would require going to 10.2 during PI to support EVA 1 @ 1/18:00 without impacting 1st EVA
 - The Rendezvous timeline itself is ~ 5 hours
 - » All the critical activities would have to be executed in parallel with the Rendezvous timeline (task focus risks)
 - » HST Rendezvous/Berth would be delayed to later in the day to provide additional time to complete critical activities
 - Results in time crunch post HST berth to complete EVA prep activities



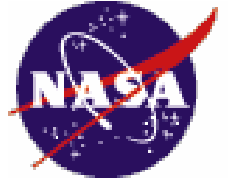
Option - FD2 Rendezvous (cont)



- **With FD3 Rendezvous, FD1 and FD2 provide the time to ensure all this activities are completed safely without compressing the crew timeline**
 - **In support of HST mission, for STS-109, Flight rules provide option of FD2 Rendezvous in MDF scenario (where MDF identified on FD1 prior to NC-1) because of the compressed timeline/and additional risks required to successfully execute this scenario**
 - » **Allowed a High Priority EVA tasks to be accomplished within MDF timeframe**
 - » **Needs to be revisited in lieu of Post Columbia Ascent Debris and MMOD concerns**



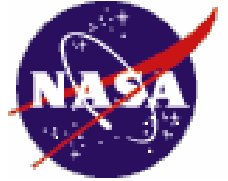
Option - FD2 Rendezvous (cont)



- **TPS Inspection**
 - **FD2 TPS Inspections provide expedited assessment of Orbiter TPS (RCC and Belly Tile Acreage) after Ascent**
 - **Expedited assessment provides early response and kickoff of any activities required to verify/provide integrity to TPS for Entry support**
 - » **Provides maximum “on-orbit” time to evaluate and plan repair activities as required**
 - **Focused Inspections/EVA repair**
 - » **Delay in acquiring this data delays working/executing “corrective” actions**



FD2 Rendezvous Timeline (11+2)



FD1	FD2	FD3	FD4	FD5	FD6	FD7
<ul style="list-style-type: none"> •Ascent •PI •RMS C/O •10.2 	<ul style="list-style-type: none"> •RNDZ Prep •HST Prep •RNDZ •HST Grapple •HST Berth •Battery Charge •RMS Survey •EVA #1 RVW 	<ul style="list-style-type: none"> •HST EVA #1 •Battery Charge •EVA #2 RVW 	<ul style="list-style-type: none"> •HST EVA #2 •Battery Charge •EVA #3 RVW 	<ul style="list-style-type: none"> •HST EVA #3 •EVA #4 RVW 	<ul style="list-style-type: none"> •HST EVA #4 •EVA #5 RVW 	<ul style="list-style-type: none"> •HST EVA #5 •EVA #6 RVW

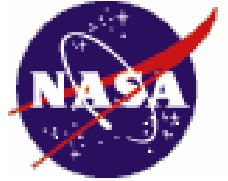
FD8	FD9	FD10	FD11	FD12	FD13	FD14
<ul style="list-style-type: none"> •HST EVA #6 	<ul style="list-style-type: none"> •HST Release •OBSS Unberth •Late Inspection Part I (STBD WLE & Nose Cap STBD, Tile 1) 	<ul style="list-style-type: none"> •Late Inspection Part II (Port WLE, Tile 2) •OBSS Berth 	<ul style="list-style-type: none"> •EOM-1 •(Cabin Stow, FCS C/O, RCS Hot Fire, etc.) •Crew Off Duty 	<ul style="list-style-type: none"> •Entry 	<ul style="list-style-type: none"> •EOM +1 	<ul style="list-style-type: none"> •EOM +2

- FD9 and FD10 Inspections may require violation of SCSC to complete
- Unscheduled EVA execution would require deletion of EOM+2 to allow entire TPS survey to be accomplished

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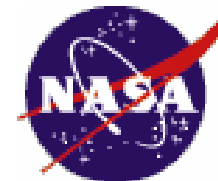


Option - FD2 Rendezvous (cont)



- For the 11+2 mission, FD2 Rendezvous does provide an additional On-orbit day to support 6+1 EVA capability
- Impacts
 - Compressed FD2 Timeline poses additional risks to support Mission success objectives
 - “Pay me now” or “Pay me Later” scenario for TPS
 - Reduced “runway” to react to any TPS concerns

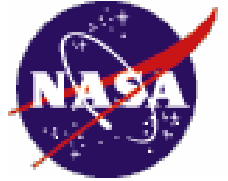




EVA Priorities



EVA Priorities



- **An action has been assigned to the HST Program to reevaluate the SM4 servicing plan and task priorities based on the EVA constraint/limitation of 5 “scheduled” and 1 “unscheduled EVA**
 - **Need priorities to be defined ASAP**
- **ACS repair tasks will need to be integrated into priorities discussion**
- **Difficult to assess optimal EVA plan/management without knowing the specific tasks/time requirements to support ACS repair**
 - **Basically just guessing/looking at infinite options**
 - » **All based on perceived priorities (not good use of team’s time)**
- **Goal is to complete as much as possible within 5 scheduled EVAs once servicing priorities and ACS repair tasks defined**
 - **Don’t see 6th scheduled EVA (limited in time) as “cure all” to complete all activities**
 - » **Hard time trading ACS mission success against additional risks to crew and Telescope (successful deploy)**
 - **Priorities provide optimal mission success without additional risks**

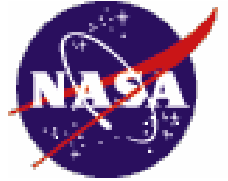




Summary



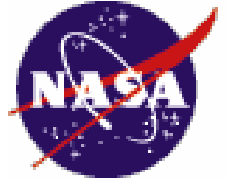
Summary



- **STS-125/SM4 Mission is 11+2 Duration, with 5 “Scheduled” and 1 “Unscheduled” HST EVAs (5+1)**
 - Maximum capabilities available in support of documented SSP Requirements
 - Optimal plan for Mission Safety and Success
- **“Unscheduled” EVA will consist of a “Rapid Response” EVA on HST Deploy/Release Day (FD9)**
 - Rapid response required due to limited EVA availability (1 “unscheduled”)
 - EVA will not be executed unless deploy prep or deploy problems occur (Hi Gain Ant, Umbilical, Berthing Latches, Aperature Door, RMS EE)
 - Focus will be resolving the above “contingencies” that would prevent HST from continuing operations and ensure Orbiter safety is not compromised
 - “Rapid Response” EVA requires minimal Telescope Prep activities to be fully successful
 - » Telescope prep “Long Pole”
 - » HST currently investigating streamlining/minimizing prep activities



Summary (cont)



- **Plan is to utilize 5 “Scheduled” EVAs to the fullest (within 6.5 hour planning guidelines) to achieve maximum Mission Success**
 - Servicing Task priorities and specifics (ACS repair) need to be reevaluated and defined ASAP to allow a plan to be developed to provide optimal success
- **FD3 Rendezvous/HST Grapple will be planned/retained**
 - Provides required time to configure the Orbiter for critical mission activities without compressing the timeline
 - Provides opportunity for early detection, evaluation, and response to any TPS anomalies
 - » Optimizes CSCS capability (if required)





Back Up Charts





HST SM4 Overview Timeline with Late Inspection (Draft Timeline) 11 Day Mission (5 EVAs)

		MET	0/-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	00/0	1	2	3	4	5	6	7	8	9	10	11	12	13	
FD 01	STS													ASC	Post Insert	RMS C/O		SLEEP										
	Orb Att													ASC	-ZLV +YVV	NC-1	FD1 CNFG											
FD 02	STS	0/13	14	15	16	17	18	19	20	21	22	23	1/0	1	2	3	4	5	6	7	8	9	10	11	12	13		
	Orb Att	-ZLV -XVV	NC-2											-ZLV -XVV	NC-3	SLEEP												
FD 03	STS	1/13	14	15	16	17	18	19	20	21	22	23	2/0	1	2	3	4	5	6	7	8	9	10	11	12	13		
	Orb Att	DUMP											RNDZ	FREE	Batt Chg	SLEEP												
HST Att		RNDZ										CAPT	Berth	SLEEP														
		Grapple ^																										
FD 04	STS	2/13	14	15	16	17	18	19	20	21	22	23	3/0	1	2	3	4	5	6	7	8	9	10	11	12	13		
	Orb Att	-ZLV -XVV	EVA 1										Post EVA	RVW	SLEEP													
HST Att		Sun Protect										-ZLV -XVV	Batt Chg	RSU FT	SLEEP													
		Grapple ^																										
FD 05	STS	3/13	14	15	16	17	18	19	20	21	22	23	3/0	1	2	3	4	5	6	7	8	9	10	11	12	13		
	Orb Att	-ZLV -XVV	EVA 2										Post EVA	RVW	SLEEP													
HST Att		-V3 Axis FWD	Sun Protect										-ZLV -XVV	Batt Chg	DUMP	SLEEP												
		Grapple ^																										





	MET	4/13	14	15	16	17	18	19	20	21	22	23	3/0	1	2	3	4	5	6	7	8	9	10	11	12	13
FD 06	STS			EVA Prep	EVA 3								Post EVA	RVW	SLEEP											
	Orb Att	-ZLV -XVV				Sun Protect								-ZLV -XVV												
	HST Att	-V3 Axis FWD						+V2 Axis FWD						-V3 Axis FWD												

	MET	5/13	14	15	16	17	18	19	20	21	22	23	3/0	1	2	3	4	5	6	7	8	9	10	11	12	13
FD 07	STS			EVA Prep	EVA 4								Post EVA	RVW	SLEEP											
	Orb Att	-ZLV -XVV				Sun Protect				-ZLV -XVV				DUMP		-ZLV -XVV										
	HST Att	-V3 Axis FWD				+V2 Axis FWD				135 Deg FWD				-V3 Axis FWD												

	MET	6/13	14	15	16	17	18	19	20	21	22	23	3/0	1	2	3	4	5	6	7	8	9	10	11	12	13	
FD 08	STS			EVA Prep	EVA 5								Post EVA	GRPL	SLEEP												
	Orb Att	-ZLV -XVV				Sun Protect				-ZLV -XVV				Reboost		-ZLV -XVV											Batt Chg
	HST Att	-V3 Axis FWD				+V2 Axis FWD				+V3 Axis FWD				-V3 Axis FWD													

	MET	7/13	14	15	16	17	18	19	20	21	22	23	9/0	1	2	3	4	5	6	7	8	9	10	11	12	13
FD 09	STS			HST Release Ops	FSS Stow	Meal	OBSS Unberth, STBD and Nosecap Surveys						SLEEP													
	Orb Att	Batt Chg	RELEASE	SEP	-ZLV -XVV								DUMP		-ZLV -XVV											
	HST Att	-V3 FWD	RMS																							

Ungrapple ^

	MET	8/13	14	15	16	17	18	19	20	21	22	23	7/0	1	2	3	4	5	6	7	8	9	10	11	12	13
FD 10	STS			Port Survey, OBSS Berth	Crew Conf	CBN STO	Meal	OFF DUTY						SLEEP												
	Orb Att	-ZLV -XVV																								

	MET	9/13	14	15	16	17	18	19	20	21	22	23	10/0	1	2	3	4	5	6	7	8	9	10	11	12	13
FD 11	STS		Filter Clean	FCS C/O	R C S	CBN STO	PA O	Meal	Brief	Cabin Stow	OFF DUTY		Pilot Ops	SLEEP												
	Orb Att	-ZLV -XVV																								

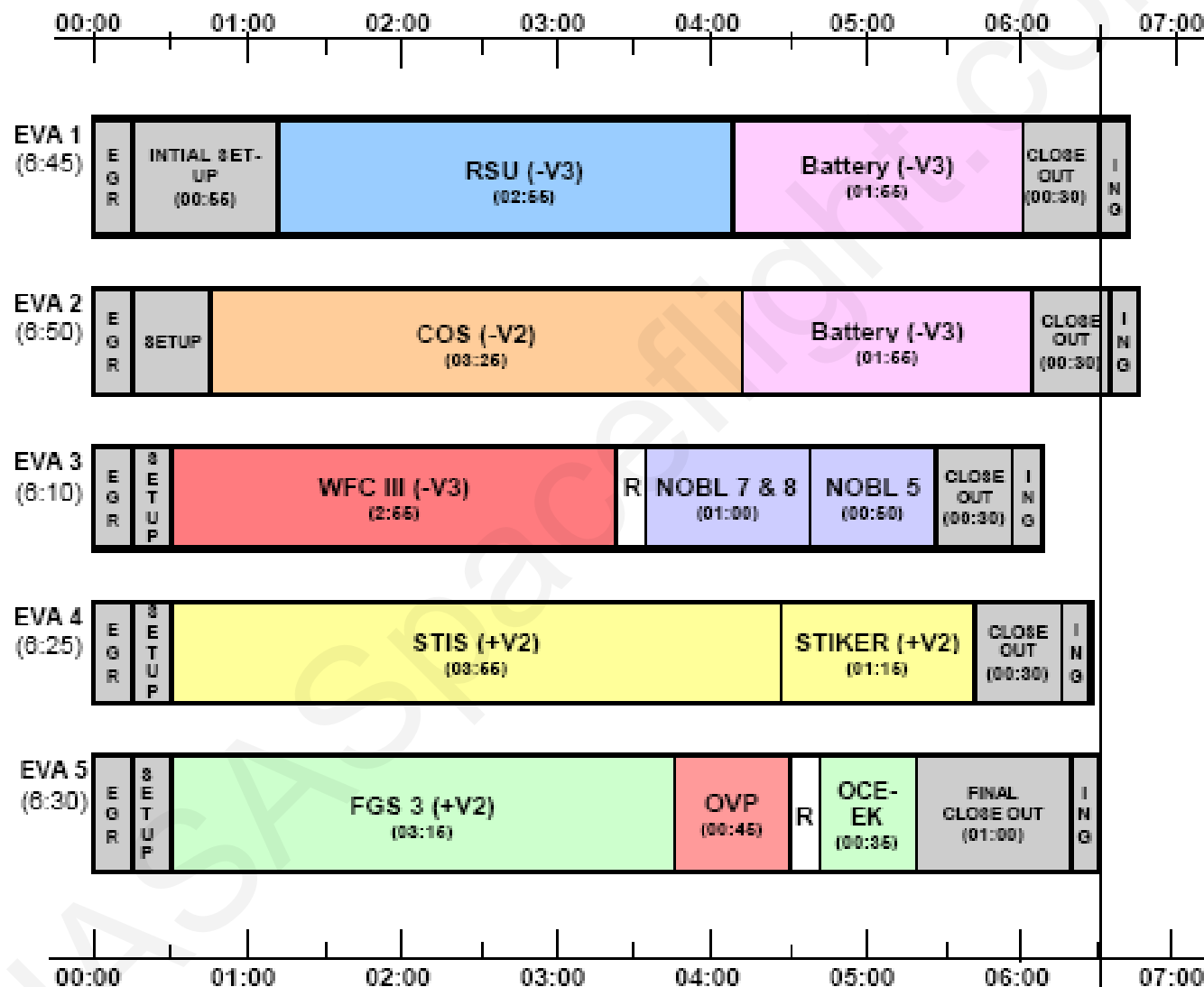
	MET	10/13	14	15	16	17	18	19	20	21	22	23	11/0	1	2	3	4	5	6	7	8	9	10	11	12	13
FD 12	STS		IMU	Deorbit Prep				Entry																		
	Orb Att	-XSI/ENTRY																								

TIG ^ ^ KSC LANDING





HST SM4 EVA Timelines



12-8-06

JSC EVA/T. Gonzalez-Torres



HST/SM4 Mission Timeline, EVA's and CRYO Margins



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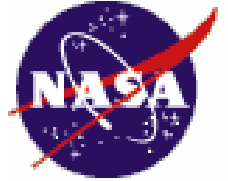
**DA8/A. Ceccacci
February 12, 2007**



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DA8/Ceccacci 281-483-0699

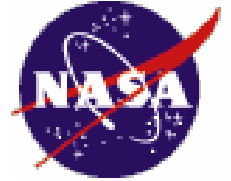
Mission Timeline Overview



- **Pre-Mission Timeline developed/developed/planned to protect (in priority order):**
 - **Shuttle Operational Flight Rules**
 - » **Example – FD2 Surveys, Focused Inspection (if required), Late Inspection, Extension Day Requirements (2 extension days required), EVA length (6:30 hrs), optimize MMOD protect attitude, D/O Opportunity Planning, etc.**
 - **Underline Indicates new programmatic requirements since last Servicing mission (STS-109/SM3B)**
 - **SCSC (Shuttle Crew Scheduling Constraints)**
 - » **Example – Crew day length, Pre/Post Sleep, sleep shifting for D/O, Off Duty, etc.**
 - **Nominal Shuttle house keeping**
 - **Flight Requirements/Mission Objectives/Mission Priorities**



SM4 Mission Draft Timeline (11+2)



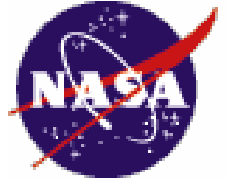
FD1	FD2	FD3	FD4	FD5	FD6	FD7
<ul style="list-style-type: none"> •Ascent •PI •RMS C/O 	<ul style="list-style-type: none"> •TPS Surveys (RCC & Tile Acreage) •EMU C/O •RNDZ Prep 	<ul style="list-style-type: none"> •RNDZ •HST Grapple •HST Berth •Battery Charge •RMS Survey •EVA #1 RVW 	<ul style="list-style-type: none"> •HST EVA #1 •Battery Charge •EVA #2 RVW 	<ul style="list-style-type: none"> •HST EVA #2 •Battery Charge •EVA #3 RVW 	<ul style="list-style-type: none"> •HST EVA #3 •EVA #4 RVW 	<ul style="list-style-type: none"> •HST EVA #4 •EVA #5 RVW

FD8	FD9	FD10	FD11	FD12	FD13	FD14
<ul style="list-style-type: none"> •HST EVA #5 	<ul style="list-style-type: none"> •HST Release •OBSS Unberth •Late Inspection Part I (STBD WLE & Nose Cap) 	<ul style="list-style-type: none"> •Late Inspection Part II (Port WLE) •OBSS Berth •Crew Off Duty 	<ul style="list-style-type: none"> •EOM-1 •(Cabin Stow, FCS C/O, RCS Hot Fire, etc.) •Crew Off Duty 	<ul style="list-style-type: none"> •Entry 	<ul style="list-style-type: none"> •EOM +1 	<ul style="list-style-type: none"> •EOM +2

Based on latest EVA Timelines



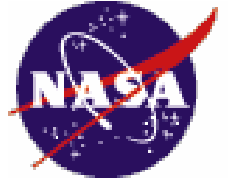
Possible Timeline Threats



- **Focused Inspection requirements**
- **FD2 TPS Inspection Completion**
- **SM4 Scheduled/Unscheduled EVA Impacts Due to Inspections (Focused/Late)**



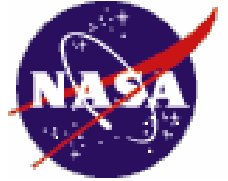
Focused Inspection Planning



- **Goal is to complete RCC and Tile Belly Acreage TPS Surveys on FD2 (~ MET 1/01:00)**
 - Includes completing any required “survey playbacks” prior to crew sleep
- **Imagery review begins as soon as first piece of survey data reaches the MCC**
- **Goal is to complete imagery review and schedule Focused Inspection CHIT meeting by NLT FD3 rendezvous timeline start (~ MET 1/15:00)**
 - **Have initiated discussions with TPS Imagery Inspection Group on this accelerated review**
 - » High confidence this can be completed with the additional flight experience we will gain prior to STS-125 (Detailed assessment still required)
 - **Streamline of Focused Inspection procedure development required**
 - » High confidence this can be completed with the additional flight experience we will gain prior to STS-125 (if not there already)
- **Mandatory to determine health of Orbiter TPS as soon as possible so required follow on actions can be initiated**
 - EVA repair, Rescue mission, etc.



Focused Inspection Planning (cont)

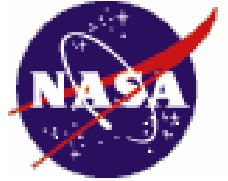


- **Focused Inspection Process:**

- Review survey data to identify AOI (area of interests) candidates to be considered for Focused Inspection
- Focused Inspection CHIT meeting to select mandatory AOI (if any) to be surveyed and specific imagery requirements (sensor, views, etc.)
- Procedure development, validation and crew review



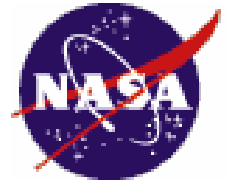
Focused Inspection Planning (cont)



- If Focused Inspection required timeline overview (based on accelerated review):
 - FD2:
 - » Surveys Complete (imagery processing begins as soon as data becomes available)
 - FD3:
 - » Focused Inspection CHIT meeting complete by Rendezvous timeline start
 - » HST RNDZ Day
 - » HST Berth
 - » RMS Survey
 - » OBSS Unberth
 - » At Sleep –X hours give crew pre-lim procedure and locations for review and comments prior to sleep
 - FD4:
 - » Focused Inspection prior to EVA
 - Need to ensure no crew resource issues to support Focused Inspection and EVA prep (don't anticipate any)
 - » OBSS Berth
 - » EVA #1
 - Actual content based on duration of Focused Inspection (# of AOI's)
 - Possible that Focused Inspection survey time requirements may not provide sufficient time to execute any of EVA#1 tasks



Focused Inspection FD4 (accelerated review)



FD1	FD2	FD3	FD4	FD5	FD6	FD7
<ul style="list-style-type: none"> •Ascent •PI •RMS C/O 	<ul style="list-style-type: none"> •TPS Surveys (RCC & Tile Acreage) •EMU C/O •RNDZ Prep 	<ul style="list-style-type: none"> •RNDZ •HST Grapple •HST Berth •Battery Charge •RMS Survey •OBSS Unberth •EVA #1 RVW 	<ul style="list-style-type: none"> •Focused Insp •OBSS Berth •HST EVA #1 •Battery Charge •EVA #2 RVW 	<ul style="list-style-type: none"> •HST EVA #2 •Battery Charge •EVA #3 RVW 	<ul style="list-style-type: none"> •HST EVA #3 •EVA #4 RVW 	<ul style="list-style-type: none"> •HST EVA #4 •EVA #5 RVW

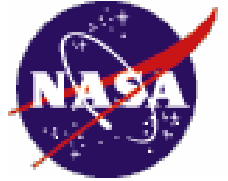
FD8	FD9	FD10	FD11	FD12	FD13	FD14
<ul style="list-style-type: none"> •HST EVA #5 	<ul style="list-style-type: none"> •HST Release •OBSS Unberth •Late Inspection Part I (STBD WLE & Nose Cap) 	<ul style="list-style-type: none"> •Late Inspection Part II (Port WLE) •OBSS Berth •Crew Off Duty 	<ul style="list-style-type: none"> •EOM-1 •(Cabin Stow, FCS C/O, RCS Hot Fire, etc.) •Crew Off Duty 	<ul style="list-style-type: none"> •Entry 	<ul style="list-style-type: none"> •EOM +1 	<ul style="list-style-type: none"> •EOM +2

•EVA #1 execution and/or content “TBD” and is based on the time required to complete Focused Inspection which is dependent on the number of AOIs that require inspection, their location, and # of views (114 -10, 121- 6, 115 -0, 116 -0)

•Possibility that downstream EVA’s and planning will be affected



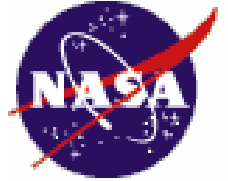
FD2 TPS Scheduled Surveys



- **Goal is to complete RCC and Tile Belly Acreage TPS Surveys on FD2**
 - Very high confidence this can be completed
 - LDRI for RCC, ITVC for Tile
- **If unable to complete on FD2, remaining procedure(s) will require completion post HST berth on FD3**
 - Scheduling required (and available) post HST berth to deconflict with Rendezvous timeline
 - Flows well with SRMS survey tasks
 - FD2 survey order STBD, Nose Cap, Port
 - » Most likely that Port survey would need to be scheduled on FD3 if survey cannot be completed as planned
 - Anticipate no clearance concerns with HST with FD2 procedures as written (will need to verify)
 - OBSS Unberth/Berth procedures while HST is berthed being developed



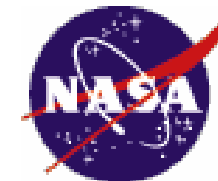
FD2 TPS Scheduled Surveys (cont)



- **Delay in collecting survey imagery has potential impact to Focused Inspection planning/execution**
 - Delay in data review results in delay of Focused Inspection Process
 - Focused Inspection execution would be NET FD5
 - » Data review would not be completed until some time during crew sleep FN3 (if not later)
 - Time not adequate/sufficient to define Focused Inspection specifics and procedure development/verification/crew review for FD4 execution
 - For STS-114, 121 “milestone” to support FD4 Focused Inspection was pre-sleep FD3.
 - Accelerated/rush of procedure development/verification
 - Final procedure to crew < 2 hours prior to execution



Focused Inspection FD5 (FD2 survey delayed)



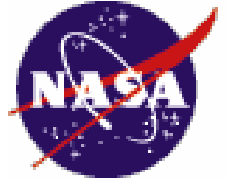
FD1	FD2	FD3	FD4	FD5	FD6	FD7
<ul style="list-style-type: none"> •Ascent •PI •RMS C/O 	<ul style="list-style-type: none"> •TPS Surveys (RCC & Tile Acreage) •EMU C/O •RNDZ Prep 	<ul style="list-style-type: none"> •RNDZ •HST Grapple •HST Berth •Battery Charge •RMS Survey •EVA #1 RVW 	<ul style="list-style-type: none"> •HST EVA #1 •MFR removal •Battery Charge •OBSS Unberth •EVA #2 RVW 	<ul style="list-style-type: none"> •Focused Insp •OBSS Berth •HST EVA #2 •MFR Install •Battery Charge •EVA #3 RVW 	<ul style="list-style-type: none"> •HST EVA #3 •EVA #4 RVW 	<ul style="list-style-type: none"> •HST EVA #4 •EVA #5 RVW
FD8	FD9	FD10	FD11	FD12	FD13	FD14
<ul style="list-style-type: none"> •HST EVA #5 	<ul style="list-style-type: none"> •HST Release •OBSS Unberth •Late Inspection Part I (STBD WLE & Nose Cap) 	<ul style="list-style-type: none"> •Late Inspection Part II (Port WLE) •OBSS Berth •Crew Off Duty 	<ul style="list-style-type: none"> •EOM-1 •(Cabin Stow, FCS C/O, RCS Hot Fire, etc.) •Crew Off Duty 	<ul style="list-style-type: none"> •Entry 	<ul style="list-style-type: none"> •EOM +1 	<ul style="list-style-type: none"> •EOM +2

•EVA #2 execution and/or content “TBD” and is based on the time required to complete Focused Inspection which is dependent on the number of AOIs that require inspection, their location, and # of views (114 -10, 121- 6, 115 -0, 116 -0)

•Possibility that downstream EVA’s and planning will be affected



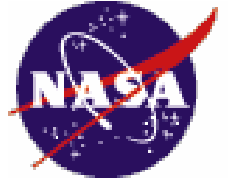
SM4 Scheduled/Unscheduled EVA Impacts Due to Inspections (Focused/Late)



- **SM4 EVA's (Scheduled and Unscheduled) are limited and could be greatly impacted by Inspection (Focused and Late) requirements**
- **TPS Health determination #1 Mission priority**
- **Focused Inspection required for detailed assessment on AOI to "clear" TPS for Entry (Ascent debris environment)**
- **Late Inspection not tradable with HST Mission success**
 - » **MMOD #2 concern on SSP PRA list**
 - » **HST Mission "manifested" based on ability to accommodate Late Inspection**



SM4 Mission Draft Timeline (11+2)



FD1	FD2	FD3	FD4	FD5	FD6	FD7
<ul style="list-style-type: none"> •Ascent •PI •RMS C/O 	<ul style="list-style-type: none"> •TPS Surveys (RCC & Tile Acreage) •EMU C/O •RNDZ Prep 	<ul style="list-style-type: none"> •RNDZ •HST Grapple •HST Berth •Battery Charge •RMS Survey •EVA #1 RVW 	<ul style="list-style-type: none"> •HST EVA #1 •Battery Charge •EVA #2 RVW 	<ul style="list-style-type: none"> •HST EVA #2 •Battery Charge •EVA #3 RVW 	<ul style="list-style-type: none"> •HST EVA #3 •EVA #4 RVW 	<ul style="list-style-type: none"> •HST EVA #4 •EVA #5 RVW

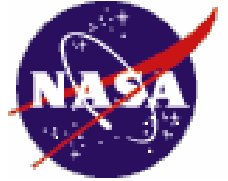
FD8	FD9	FD10	FD11	FD12	FD13	FD14
<ul style="list-style-type: none"> •HST EVA #5 	<ul style="list-style-type: none"> •HST Release •OBSS Unberth •Late Inspection Part I (STBD WLE & Nose Cap) 	<ul style="list-style-type: none"> •Late Inspection Part II (Port WLE) •OBSS Berth •Crew Off Duty 	<ul style="list-style-type: none"> •EOM-1 •(Cabin Stow, FCS C/O, RCS Hot Fire, etc.) •Crew Off Duty 	<ul style="list-style-type: none"> •Entry 	<ul style="list-style-type: none"> •EOM +1 	<ul style="list-style-type: none"> •EOM +2

• Red Font Indicates Shuttle Program Requirements/days that cannot be traded for Mission Success (EVA's)

•FD1, FD2, FD3, FD9 (Late Inspection), FD10, FD11, FD12, FD13, FD14



Unscheduled EVAs

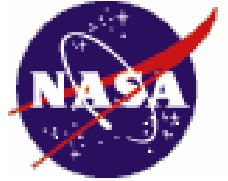


- Program requirements limit “Unscheduled EVA” opportunities
 - Only option available is EVA #6 on FD9 with HST Deploy post EVA
 - » Results in SCSC violation (Loss of crew “Off Duty” time on FD10 to accomplish/complete Late Inspection)
 - » Limits EVA#6 duration to protect crew day length and support HST release
 - Limits tasks that could be scheduled performed
 - Current thought is to have a rapid response EVA for Berthing latches, EE, or Apt Door
 - Will know the evening before if the HiGain antenna deploy EVA may be required

FD8	<u>FD9</u>	<u>FD10</u>	FD11	FD12	FD13	FD14
<ul style="list-style-type: none"> •HST EVA #5 •Rapid Response EVA #6 Review 	<ul style="list-style-type: none"> •HST EVA #6 •HST Release 	<ul style="list-style-type: none"> •OBSS Unberth •Late Inspection Part I (STBD WLE & Nose Cap) •Late Inspection Part II (Port WLE) •OBSS Berth 	<ul style="list-style-type: none"> •EOM-1 •(Cabin Stow, FCS C/O, RCS Hot Fire, etc.) •Crew Off Duty 	<ul style="list-style-type: none"> •Entry 	<ul style="list-style-type: none"> •EOM +1 	<ul style="list-style-type: none"> •EOM +2

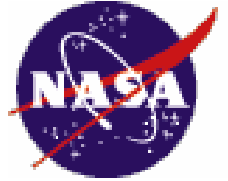


SM4 EVA Opportunities



- **SM4 EVA Opportunities Operational Impacts:**
 - **Maximum SM4 EVA's that could be performed is 6 (5+1)**
 - » **FRD requirement of 7 (5+2) cannot be met due to Shuttle program requirements**
 - **SM4 Mission priorities must be well defined**
 - » **Focused Inspection requirements may result in delaying partial or all of a EVA tasks**
 - **Lowest priority EVA/task in jeopardy**
 - **EVA #6 would consist of mandatory task(s), limited by time, to ensure Final Payload Bay closeout is completed prior to HST Deploy**
 - » **EVA duration ~ 4.5 hours**
 - » **Additional risk with HST Deploy since additional "rapid response" would possibly not be available after EVA #6 tasks completed**





STS-125/HST SM4 Cryo Margins

DF73/Steve Patlan
February 9, 2007

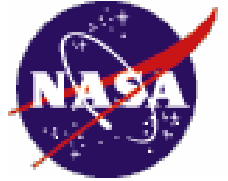


Mission Operations Directorate
Flight Director Office

DA8/Ceccacci 281-483-0699

59

Nominal Mission (5 EVA)

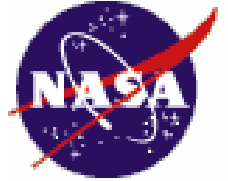


	65% Deg Fuel Cells		50% Deg Fuel Cells		25% Deg Fuel Cells	
	Margin (lbm)	Padhold (hrs)	Margin (lbm)	Padhold (hrs)	Margin (lbm)	Padhold (hrs)
H2	22.3	66.9	24.6	73.5	28.8	85.4
O2	77.3	78.3	95.5	96.6	128.6	129.5

- 109-like profile, HST = 499 kWh
- HST berthed 140.5 hrs (6 days)
- 5 scheduled EVAs @ 10.2; 1 cabin depress/repress
- Includes FD2 & post-unberth Late Inspection day
- 2+2+2 Deorbit Opportunities



+1 Contingency EVA

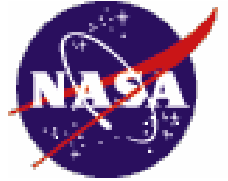


	65% Deg Fuel Cells		50% Deg Fuel Cells		25% Deg Fuel Cells	
	Margin (lbm)	Padhold (hrs)	Margin (lbm)	Padhold (hrs)	Margin (lbm)	Padhold (hrs)
H2	20.2	60.6	23.5	67.2	26.7	79.1
O2	60.6	61.5	78.8	79.9	111.9	112.8

- HST berthed 148.5 hrs (6+ days)
- HST = 522 kWh
- 5 scheduled EVAs @ 10.2; 1 cabin depress/repress
- Rapid response EVA (4.5 hr), HST deploy end of FD9
- Includes FD2 & post-unberth Late Inspection day
- 2+2+2 Deorbit Opportunities



+2 Contingency EVAS

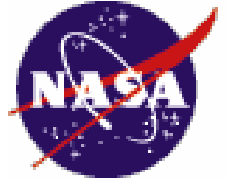


	65% Deg Fuel Cells		50% Deg Fuel Cells		25% Deg Fuel Cells	
	Margin (lbm)	Padhold (hrs)	Margin (lbm)	Padhold (hrs)	Margin (lbm)	Padhold (hrs)
H2	11.8	35.4	15.1	45.3	18.3	54.9
O2	-11.9	0.0	6.3	6.3	39.4	39.6

- HST berthed 168 hrs (7 days)
- HST = 578 kWh
- 5 scheduled EVAs @ 10.2; 1 cabin depress/repress
- Unscheduled EVA + rapid response EVA
- Includes FD2 & post-unberth Late Inspection day
- **Extension/weather day replaced by HST EVA day**
- 0+2+2 Deorbit Opportunities



+1 Day Ability



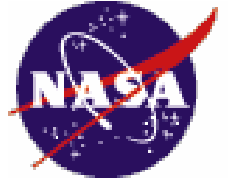
- **65% FCPs assumed until L-90**
 - Current OV-104 FCPs estimated 50% degraded for SM4
- **SM4 Additional Day Costs**
 - 15.738 KW (Average Mission Power) x 24 hours
 - » O2 – 274.4 lbm
 - » H2 – 32.8 lbm

6 EVA S	65% Deg Fuel Cells		50% Deg Fuel Cells		25% Deg Fuel Cells	
	Margin (lbm)	Padhold (hrs)	Margin (lbm)	Padhold (hrs)	Margin (lbm)	Padhold (hrs)
H2	20.2	60.6	<u>23.5</u>	67.2	26.7	79.1
O2	60.6	61.5	<u>78.8</u>	79.9	111.9	112.8

– **Even at 50% degraded capability, far short of obtaining a +1 Day**



ICBC -3D Cost



- **ICBC Heaters:**

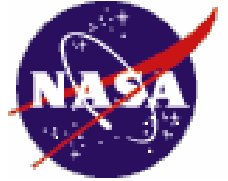
- 252 htr ops hrs, Post Insertion to Deorbit Prep
- 10% - ZLV hrs per A2P1 (ops hrs may be conservative)
- 12.5 lbm O2

- **ICBC PGSC:**

- 760XD w/chassis (AC), if dedicated (not shared)
- 252 ops hrs (probably conservative T. Myers/IMAX)
- 13.4 lbm O2



Summary



- **TPS Inspections may possibly have an impact on the number of EVAs/EVA tasks performed during the mission**
 - Need to ensure EVA task priorities are well defined
- **Based on Shuttle Program requirements, the maximum amount of SM4 Mission success EVAs that can be accomplished is 6 (5 scheduled + 1 unscheduled)**
- **Additional +1 Day Mission day is unachievable**
 - 5 Tank Cryo Load and Mission Power requirements limiting factors

