

Space Shuttle Program Year-End Roll-Over (YERO)

S063515

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PRCB
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Agenda

- **Background**
- **YERO Exposure: Windows of impact**
- **Options to Accommodate YERO**
 - **On-board: Flight software**
 - **MCC**
 - **KSC**
- **Recommended YERO solution**
- **Forward Work**

Introduction

- **During discussions of Year-End Roll-Over (YERO) supportability for STS-116 at the 11/2/06 PRCB, an action was assigned to develop a plan to provide YERO capability for 2007 through the end of the Shuttle program**
 - Action S063515 - Develop a plan and provide a cost estimate for implementing a comprehensive solution to year end rollover (YERO) issues. Report results to PRCB.
 - Assigned to DA/1-1, EA/1-2, MO/1-3, MS/1-4, MV/1-5, MX/1-6, USA/1-7
 - Integrated through the Orbit Flight Techniques Panel (OFTP) chaired by DA8

- **Subsequently at the 1/25/07 PRCB, a PCIN was submitted to add YERO capability as a requirement in the NSTS 07700 documentation**
 - PCIN S063533 – Baseline Space Shuttle Systems Year End Rollover (YERO) Requirement in NSTS 07700 Vol. X Book 1
 - » Add to NSTS 07700 Vol. X, Book 1, paragraph 3.2.2.1.26
 - » The SSS, including the ground systems, shall support flights spanning the end of the calendar year. Use of automated means, manual means and ground uplinks may be performed to satisfy this requirement. Specific operational periods when end of year transition should not occur are specified in NSTS 0700 Volume III, Flight Design Requirements Document (FDRD)

 - Leap Year and Leap Second compatibility must also be evaluated
 - » Leap Second updates can occur on 6/30 or 12/31

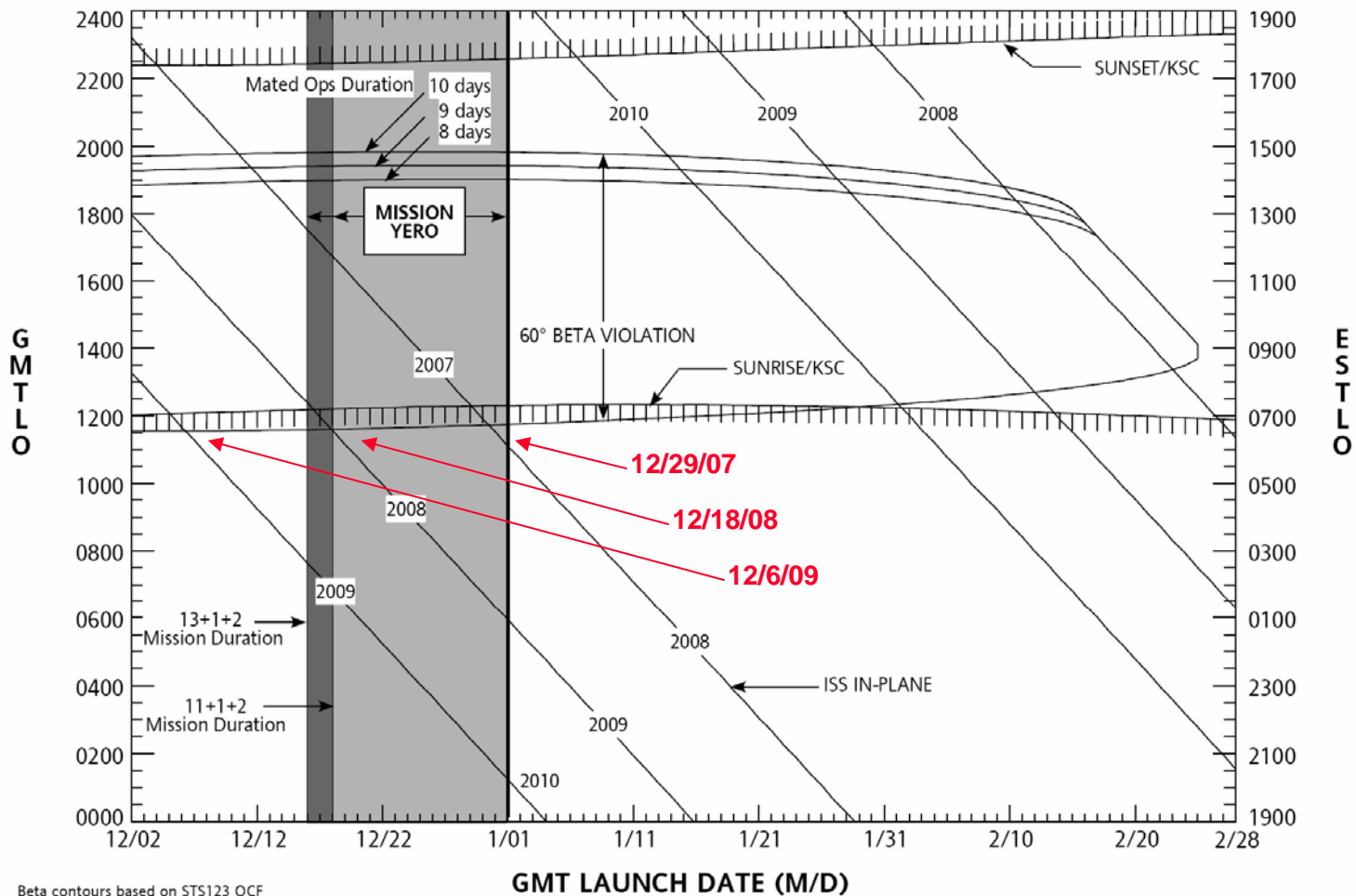
YERO Background

- **Space Shuttle Systems are not designed to universally support YERO without intervention**
 - Orbiter
 - » Master Timing Unit (MTU) rolls to day 001, PASS GPC counts up to day 366
 - MCC
 - » Single facility timing service that rolls to day 001
 - » Some platforms (command server, trajectory server) count up to day 366
 - » Multiple ISS-shared services that roll to day 001
 - » Network rolls to day 001
 - » Shuttle user applications not specifically designed to handle YERO
 - KSC
 - » Firing Room software not specifically designed to handle YERO
- **STS-116 YERO plan was to use procedural solutions to recover from a YERO event**
 - Complete recycle of on-board and ground systems following YERO to wipe out references to the “old” time
 - » IPL (Initial Program Load) all PASS GPC’s
 - » Recycle all MCC platforms
 - Required IPL and uplink to have successful YERO
 - » Increased criticality of some Orbiter hardware

YERO Launch Window Exposure

ISS YERO ANALYSIS LAUNCH WINDOW

Orbit Flight Design/USH-483L
February 6, 2007



Beta contours based on STS123 OCF
 2007-2008 planar lines based on December 2006 Reference Trajectory
 2008-2009 and 2009-2010 planar lines based on December 2006 Reference Trajectory extrapolation with no drag

YERO Flight Plan Exposure

15+1+2 max SSPTS mission (10 docked days)																	
Flight Day/Activity																	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
L/O	OBSS	RNDZ	EVA1	XFER	EVA2	XFER	EVA3	XFER	EVA4	XFER	EVA5	XFER	UNDK	FCS	D/O	+1	+2
12/10	12/11	12/12	12/13	12/14	12/15	12/16	12/17	12/18	12/19	12/20	12/21	12/22	12/23	12/24	12/25	12/26	12/27
12/11	12/12	12/13	12/14	12/15	12/16	12/17	12/18	12/19	12/20	12/21	12/22	12/23	12/24	12/25	12/26	12/27	12/28
12/12	12/13	12/14	12/15	12/16	12/17	12/18	12/19	12/20	12/21	12/22	12/23	12/24	12/25	12/26	12/27	12/28	12/29
12/13	12/14	12/15	12/16	12/17	12/18	12/19	12/20	12/21	12/22	12/23	12/24	12/25	12/26	12/27	12/28	12/29	12/30
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12/16	12/17	12/18	12/19	12/20	12/21	12/22	12/23	12/24	12/25	12/26	12/27	12/28	12/29	12/30	12/31	1/1	1/2
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12/18	12/19	12/20	12/21	12/22	12/23	12/24	12/25	12/26	12/27	12/28	12/29	12/30	12/31	1/1	1/2	1/3	1/4
12/19	12/20	12/21	12/22	12/23	12/24	12/25	12/26	12/27	12/28	12/29	12/30	12/31	1/1	1/2	1/3	1/4	1/5
12/20	12/21	12/22	12/23	12/24	12/25	12/26	12/27	12/28	12/29	12/30	12/31	1/1	1/2	1/3	1/4	1/5	1/6
12/21	12/22	12/23	12/24	12/25	12/26	12/27	12/28	12/29	12/30	12/31	1/1	1/2	1/3	1/4	1/5	1/6	1/7
12/22	12/23	12/24	12/25	12/26	12/27	12/28	12/29	12/30	12/31	1/1	1/2	1/3	1/4	1/5	1/6	1/7	1/8
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1/3	1/4	1/5	1/6	1/7	1/8	1/9	1/10	1/11	1/12	1/13	1/14	1/15	1/16	1/17	1/18	1/19	1/20

YERO Options

There are three basic ways to accommodate YERO:

- **Modify system for transparent operations (YERO automatically taken care of in the background)**
- **Count up to GMT day 366, 367, 368, ...**
- **Roll over to GMT Day 001**

- **Transparent YERO**

- **Modifications are extensive and invasive to on-board and ground systems and affect fundamental timing services for all flights (changes not isolated to YERO)**
- **High Cost, Long Schedule, High Risk**

- **Count Up to GMT 366+**

- **Requires Space Shuttle Systems to be out-of-sync with ISS and the rest of the world**
- **Would require extensive and invasive modifications to ground systems**
- **Minimal on-board impact (No Flight Software changes, Force MTU to accept GPC time)**
- **High Cost, Long Schedule, High Risk**

- **Roll over to GMT 001 (YERO Reset/Recycle/Recovery/Re-sync)**

- **Smallest impact to existing ground-based time management systems (nominal ops)**
- **Small Flight Software modifications will enable streamlined procedural capability**
- **Reasonable Cost, Schedule and Risk**
- **Will result in some periods of time where YERO cannot be accommodated (blackouts)**

Integrated YERO Goals and Objectives

Because YERO can occur at anytime on any Flight Day, several assumptions were made to limit scope of the changes required :

- **Do not accommodate YERO during critical phases**
 - KSC critical operations (after T-11 hold or before post-scrub ET boil-off/inerting)
 - Dynamic Flight (Ascent, First Day PLS (FPLS), Entry, Rendezvous, Undocking)
 - Non-quiescent on-orbit operations
 - » OMS & RCS burns, RNDZ Navigation phase
 - » Schedule around transient/dynamic events like maneuvers, RMS operations, IMU aligns
- **Minimize risk exposure and maintain Fail Ops/Fail Safe philosophy**
 - Minimize impacts to CIL's and Hazard Controls
 - Avoid dependencies on YERO-specific hardware that may require pre-YERO Early Mission Termination requirements for loss of redundancy
- **Minimize impacts to existing time management functions**
 - Avoid changing legacy functions that have extensive shelf-life for non-YERO scenarios
- **Minimize time required to accommodate YERO (on-board and ground procedures)**
 - Allows for greatest capability to adjust timelines for YERO
- **Solution should support YERO for 2007**

Proposed YERO Solution

- **The YERO solution needs to be an integrated response that addresses risk and impact to Orbiter, Flight Software, MCC and KSC**
- **Solution that best satisfies goals and objectives is to roll over to GMT day 001**
 - Can be implemented with procedural workarounds
 - » Small Flight Software change will greatly enhance implementation
 - Minimizes impacts to existing ground systems
 - Can support 2007 YERO
 - Does NOT provide 100% YERO coverage (limitations result in blackouts)
- **YERO Ops Concept**
 - **Preflight:**
 - » YERO recovery will occur during quiescent ground operations that allow for PASS GPC IPL and ground system recycle
 - **In-flight**
 - » Flight Software will be modified to enable YERO reset to rollover to GMT Day 001
 - » YERO recovery will occur during quiescent on-orbit operations that allow for a brief period of DPS and MCC interruption to perform on-board reset and ground system recycle

Flight Software

Options for FSW Support of YERO

- **Evaluated multiple options to accommodate YERO via Flight Software (FSW) modifications**
 - **Transparent YERO: Change PASS to recognize YERO in OPS 2 and continue using MTU**
 - **Modified STS-116 Procedure (No FSW changes needed)**
 - **Bias PASS external interfaces**
 - **Freeze-dry uninitiated PASS prior to YERO (No FSW changes needed)**
 - **YERO Reset**
- **YERO Reset option best satisfies integrated goals and objectives**

YERO Reset Details

- **YERO Reset utilizes manual procedure to initiate Primary GPC Init**
 - Primary GPC Init occurs when a PASS GPC is moded to run and sees no other PASS GPC's in run (Simplex GPC)
 - » Simplex GPC acquires MTU as a time source during Primary GPC Init
 - Uses existing code that has strong pedigree and is often-executed (i.e., following an IPL)
 - Procedure will take all active GPC's to Standby mode and a single GNC GPC will be taken to run to initiate Primary GPC Init
 - GNC GPC will then be in OPS 0 with a Day 001 GMT reference
- **YERO Reset code is enabled and executed during post-YERO OPS 3 transition**
 - Logic will be added to only execute for YERO unique conditions
 - » Compare State Vector time (day 366) to MTU time (day 001)
 - New code will update necessary Major Function Base parameters to New Year state
 - » Update Year and Day parameters used in RNP matrix computations and call routine that computes RNP matrix
 - » Update GPS to GMT time reference conversion parameter to bias adjustment by one year
 - » Update Time of Last GPS Update time tag to current year
 - » Update Nav state vector time tag to current year
 - » Update time used in IMU SOP logic that applies catch-up torquing pulses across the OPS transition
 - » Update time of last IMU alignment to apply correct ramping time to IMU RM thresholds
 - OPS 301 transition will get OPS 3 overlay from G3 archive in upper memory
 - » Failure to retrieve overlay will be handled per existing processes
 - Can obtain OPS 3 overlay from MMU or from another GPC's G3 archive
- **At this point, GNC YERO reset is complete**

YERO Reset Procedure Overview

- **Configure LRU's for YERO Reset OPS 3 transition**
 - Turn on RGA's, ADTA's, MLS, ASA's, FCS CH's (OPS 3 I/O)
 - Take S-band and Ku-Band to non-GPC modes (manual antennas, Ku to STBY)
 - RMS safing (if required)
- **Take SM GPC to STBY**
- **Take GNC GPC to STBY**
- **Take GNC GPC to RUN**
 - Starts Primary GPC Init sequence to get new time from MTU
 - GPC will come up in OPS 0
- **GNC PRO to OPS 301**
 - Retrieve G3 overlay from upper memory (G3 archive)
 - Execute YERO Reset code to update Major Function Base parameters
- **GNC PRO to OPS 201**
- **Take SM to RUN, SM PRO to OPS 201**
 - SM major function base and ops overlay is still in GPC memory (no need to retrieve checkpoint from MMU)
 - SM retains TMBU's and RMS Ops Codes
 - Uplink TDRS state vectors to recover GPC antenna function
 - Uplink TEC's (Time Executed Commands) and SPC's (Stored Program Commands), if required

YERO Reset Procedure Overview (cont.)

- **BFS YERO recovery is unaffected by PASS YERO reset and will be completed with the existing STS-116 procedure**
 - BFS to STBY, PRO to OPS 3
 - Uplink RNP matrix, GPS delta time, TDRS state vector and Orbiter state vector
 - BFS to HALT
 - Can be incorporated into PASS YERO Reset procedures or run stand-alone
- **Pre-YERO Freeze-Dry GNC GPC's will need to be refreshed**
 - Standard set expansion/contraction is all that is needed to update other GNC GPC's
- **Clean-up:**
 - DAP will come up in A1/AUTO/PRI
 - » While docked, RCS drivers will be off and will use standard GPC Recovery procedure of holding DAP FREE during OPS transition
 - TDRS state vectors, TEC's and SPC's will need to be uplinked to SM
 - Flight Specific DAP's, TMBU's and PDRS Ops Codes will not need to be resent
 - Timers and future loaded maneuvers will need to be reset (if required)
 - BFS and Freeze-Dry steps as noted above

YERO Reset Advantages

- **Eliminates dependencies required by STS-116 YERO procedure**
 - No need to re-IPL all PASS GPC's
 - No YERO-specific dependencies on MMU, IPL source select switch, Uplink
 - No reliance on uplinks to restore critical capability
 - No need to put IMU's in a less than desirable configuration pre-YERO
- **Minimizes on-board footprint (time and complexity)**
 - Minimum crew actions that are based on existing certified procedures
 - Out of service time for GNC and SM should be less than 2 minutes
 - Total procedure time should be less than 20 minutes
- **Manageable flight software change**
 - Small code change isolated to YERO-specific path
- **Enables lower impact YERO solution for the MCC**
- **Does NOT change KSC YERO plans**

YERO Reset Operational Impacts

- **Impacts while GNC and SM functions are down:**
 - GNC impacts are similar to a GNC OPS transition
 - OI telemetry will still be down-listed
 - Will lose SM-supported functions: GPC antenna pointing, RMS interface, automatic thermal conditioning
 - Will momentarily lose hazard controls that rely on flight software
 - » e.g. RCS leak monitoring, RCS Auto Manifold Close, RMS Inadvertent Release/Motion
 - » Impacts are acceptable due a very small window of exposure and extremely low likelihood of failure
 - » Mitigation steps will not be taken with the exception of RMS safing
 - RMS will be moved to safe distance and powered off during YERO reset. Crew will monitor for inadvertent release/motion
- **No change to Orbiter hardware criticality or risk classification**
 - Possible Hazard Report updates to add YERO as an operational procedure (documentation)

YERO Reset Fault Tolerance & Risk

- **No requirement for YERO-specific hardware**
 - Recall that 116 YERO procedures were dependent on IPL and GNC uplink capability
 - » Added increased hardware criticalities and required pre-YERO early mission termination for loss of redundancy
- **Uplink dependencies:**
 - Uplink is not required to recover GNC functionality
 - Uplink is required to fully recover SM and BFS functionality
 - » Not critical capability and consistent with current operations
 - » If unable to uplink TDRS state vectors to SM, would manage comm via manual antennas
 - » If unable to uplink to BFS, BFS is no-go following PASS YERO reset
 - Loss of BFS does not require early mission termination
- **Failures during YERO Reset**
 - Entering the wrong OPS or violating the standard DPS 10 second rule could result in the need to re-execute the YERO Reset procedure
 - » Similar risk to every other action with human-in-the-loop
 - » Will identify critical steps and train/document accordingly
 - » Recovery plan is to take down the affected GPC and perform YERO Reset on a second GPC
 - Short execution time minimizes exposure

FSW Cost & Schedule

- **Flight Software change will be targeted for STS-122 and subs to provide manifest flexibility**
- **Will implement in MM (Mass Memory) build for STS-122**
- **Requires SCR approval on 2/15/07 to support STS-122 MM release date (4/13/07)**
 - SCR 93160 was submitted on 1/26/07
- **Provides for standard software development and verification processes**

- **Cost - no additional cost to the Program**
 - Reprioritization of work

MCC

MCC YERO Impacts

- **MCC has evolved to support continuous ISS, dual Shuttle/ISS and Shuttle-only activities (in addition to simulations and test/checkout/upgrade activities)**
 - Hardware and Software architecture capitalizes on shared services, including time
 - Single time server (VTS) sets MCC GMT from GPS timing signal
 - ISS on-board architecture is based on GPS time (no rollover issues)
 - External MCC interfaces (Network) have also evolved to support multiple customers
- **Options to support YERO on the ground are very dependent on the options used to support YERO on-board**
 - Current on-board architecture: MTU rolls over and GPC's count up on internal time
 - Current ground architecture: MCC-wide services rollover and some Shuttle-specific services count up
 - MCC functionality is dependent on staying in sync with the spacecraft
- **If Spacecraft and Ground times do not match:**
 - Trajectory
 - » Unable to perform ground-based navigation and trajectory function forwards or backwards across calendar year
 - » Processing of ground-based tracking will be highly-degraded in dynamic phases of flight
 - Commanding
 - » If Command server (GCS) and MTU time disagree, commanding must be done in the clear to bypass time-authentication function in COMSEC
 - » If GCS and Trajectory server (TRS) time disagree, unable to monitor on-board nav or uplink state vector
 - Short term quiescent operations in this configuration are acceptable with additional operational workarounds

Recommended MCC Solution

- **Evaluated multiple YERO options: Transparent, Count Up and Roll Over**
 - MCC architecture cannot easily to support transparent or count up options
 - » Any changes to time management would be extensive throughout all aspects of the MCC distributed architecture
 - For example, user software does not have standard time source (no code constraints for available time sources – MTU GMT, GPC MET, MCC GMT, MCC MET, local time, etc)
- **An integrated solution that minimizes changes to time management is recommended**
 - Best suited to support a procedural workaround that allows GMT rollover (nominal ops)
- **YERO Ops Concept**
 - Implement YERO Reset on-board to allow Orbiter to roll-over to GMT day 001
 - Implement YERO Recycle in the MCC to reset affected platforms after YERO occurs
 - » After the recycle, subsequent mission events are handled via “nominal ops”

MCC YERO Recycle Procedure

- **Similar to existing STS-116 YERO ground procedures**
 - STS-116 version was a complete MCC recycle of all platforms
 - Software audits and testing are underway to verify that recycle footprint can be reduced
 - » Recycle is not likely needed for workstations and most user applications
 - » May not be necessary to recycle at local midnight
 - Updated Trajectory server recycle procedures will reduce downtime for FDO
- **Procedural Overview**
 - Log-off workstations (if required)
 - De-allocate servers and activities
 - Recycle/reboot servers
 - Re-allocate servers and mission activity
 - Log-in and configure workstations
 - Total time: 1.5 hours (approximately 30 min with users logged out)
- **Procedures will continue to be tested in SAIL and SMS**
 - No issues identified during STS-116 testing
 - Procedures are similar to recycles that are performed every day for simulation support
 - MCC fault tolerance will be unaffected by procedures (no reduction in capability)
- **On-board monitoring delay**
 - MCC recycle procedures may be slightly delayed from on-board in order to monitor the MTU roll-over and YERO Reset procedures (testing and verification in work)

MCC YERO Recycle Operational Impacts

- **FEP recycle will cause LOS for about 10 minutes**
- **Command server recycle will impact command capability for 10 minutes**
- **Trajectory server recycle of trajectory server will impact ground-based navigation and burn targeting**
 - Results in restrictions on accommodating YERO recycle close to burns and dynamic events
 - Identical to starting YERO assumptions (No YERO during Ascent, FPLS, Entry, Rendezvous, Undocking)

YERO Delay

- **Capability to delay Orbiter and/or MCC response to YERO from actual GMT midnight is highly desired to gain scheduling flexibility**
 - YERO might occur in the middle of crew sleep or in the middle of intensive on-board activities
 - Delay will not be acceptable for dynamic phases like rendezvous or undocking
 - Valid for limited timeframe: 12-24 hours
- **On-board: MTU rolls over and the GPC's fault down to internal time**
 - Not as accurate as MTU
 - » Without MCC/crew intervention, clock drift will eventually degrade state vector beyond Flight Rule limits
 - » Can be managed via state vector uplinks, manual time corrections or GPS
 - Orbiter is fully-functional on internal time (MTU failure case)
- **MCC YERO Recycle will be staggered**
 - In order to maintain nominal command capability (encryption), the command server will be recycled when the MTU rolls-over at GMT midnight
 - In order to simplify processing of ground tracking data, the trajectory server will be recycled at GMT midnight
 - Once the command and trajectory servers are recycled, the MCC will be out-of-sync with the on-board GPC's (counting up on GMT day 366)
 - » Limited insight to health of on-board nav
 - » Unable to build and send state vector updates

YERO Delay (cont.)

- **As a workaround to regain this capability, a second MCC activity will be utilized**
 - » **Second activity will have a separate command and trajectory server that will remain on the old year**
 - » **Will only be used for SV monitoring and maintenance by a limited number of users**
 - » **If a state vector update is needed, MCC will switch command link to second activity**
 - » **Should not be required during delay period (state vector doesn't degrade quickly during quiescent operations)**
 - » **As an alternative, GPS would also be available for state vector updates during the delay period**
 - » **Once on-board YERO Reset is complete, the second activity will be delete**

- **Delay is not possible during dynamic phases of flight**
 - » **Unique and highly-intensive manual operations would be needed (high risk)**

- **YERO Delay Examples:**
 - **YERO occurs during crew sleep**
 - » **Delay on-board YERO procedures until post-sleep**
 - **YERO occurs during high-demand activity (EVA and/or RMS ops)**
 - » **Delay on-board YERO procedures until convenient to avoid distractions**

MCC Cost & Schedule

- **Forward work**
 - Final procedure development and verification:
 - » MCC testing and verification to reduce MCC Recycle footprint
 - » MCC testing and validation of YERO Delay procedures
 - Evaluate possible software changes to reduce impact of Ground recycle on Trajectory server (may slightly reduce YERO blackouts)

- **Cost - no additional cost to the Program**
 - Work will be performed under existing level of effort
 - Will return to PRCB if additional MCC changes modifications will result in significant YERO blackout reduction (not expected)

KSC

KSC Options to Support YERO

- **KSC formed two YERO Investigation teams**
 - Shuttle Engineering Systems Team
 - » Investigated each Shuttle Engineering System (Fuel Cells, Space Shuttle Main Engines, LO2, etc) to determine impacts to vehicle testing or launch countdown.
 - LPS Firing Room Hardware/Software Team
 - » Evaluated Firing Room Hardware and Software to determine YERO impact on Launch Processing System (LPS) hardware and software as well as Ground Operations Aerospace Language (GOAL) software
 - Initially, modifying GOAL software for insertion of Rollover logic was not investigated due to cost impacts
 - KSC has since initiated an assessment of GOAL to see if modifications can be made to reduce YERO cutout (ECD 4/30)
- **KSC options to support YERO are similar to MCC**
 - Existing architecture does not support YERO
 - Transparent YERO would require extensive changes and recertification of Firing Room hardware and software
 - Procedural option best satisfies goals and objectives for YERO support

KSC YERO Procedure

- **An Operational Time Sync procedure is required by DPS after YERO event**
 - Re-IPL all 4 PASS GPC's
 - » DOLILU process will update day of launch, RNP, GPS time adjust, etc.
 - BFS is unaffected
 - » BFS is on internal time until OPS 101 transition, at which time it acquires MTU time
 - Recycle Firing Room
 - » LPS and GOAL must be re-synced by terminating and restarting after YERO
- **Re-sync procedures take 2 hr 40 min to execute (covers both Orbiter and Firing Room)**

KSC YERO Operational Impacts

- **Procedures need to be executed during a safe time period prior to picking up the count at the scheduled T-11 hour hold (18 hours prior to T-0)**
 - Re-sync will result in temporary loss of datastream, Launch Data Bus (LDB) command capability, LPS and GOAL
 - Unable to schedule critical/hazardous activities inside T-11 hold around the YERO re-sync
- **Critical/hazardous operations outside of the T-11 hold must be scheduled to avoid YERO event**
- **In the event of a launch scrub, YERO re-sync procedures cannot be executed prior to ET drain, boiloff and tank inert (scrub plus 24 hours)**
- **YERO also impacts specific scrub turnaround timelines due to complications with scheduling YERO re-sync around critical/hazardous operations**
- **No impact to post-landing operations**
- **Vehicle power-down/power-up will be performed for all non-S0007 YERO events**

KSC YERO Impact Summary

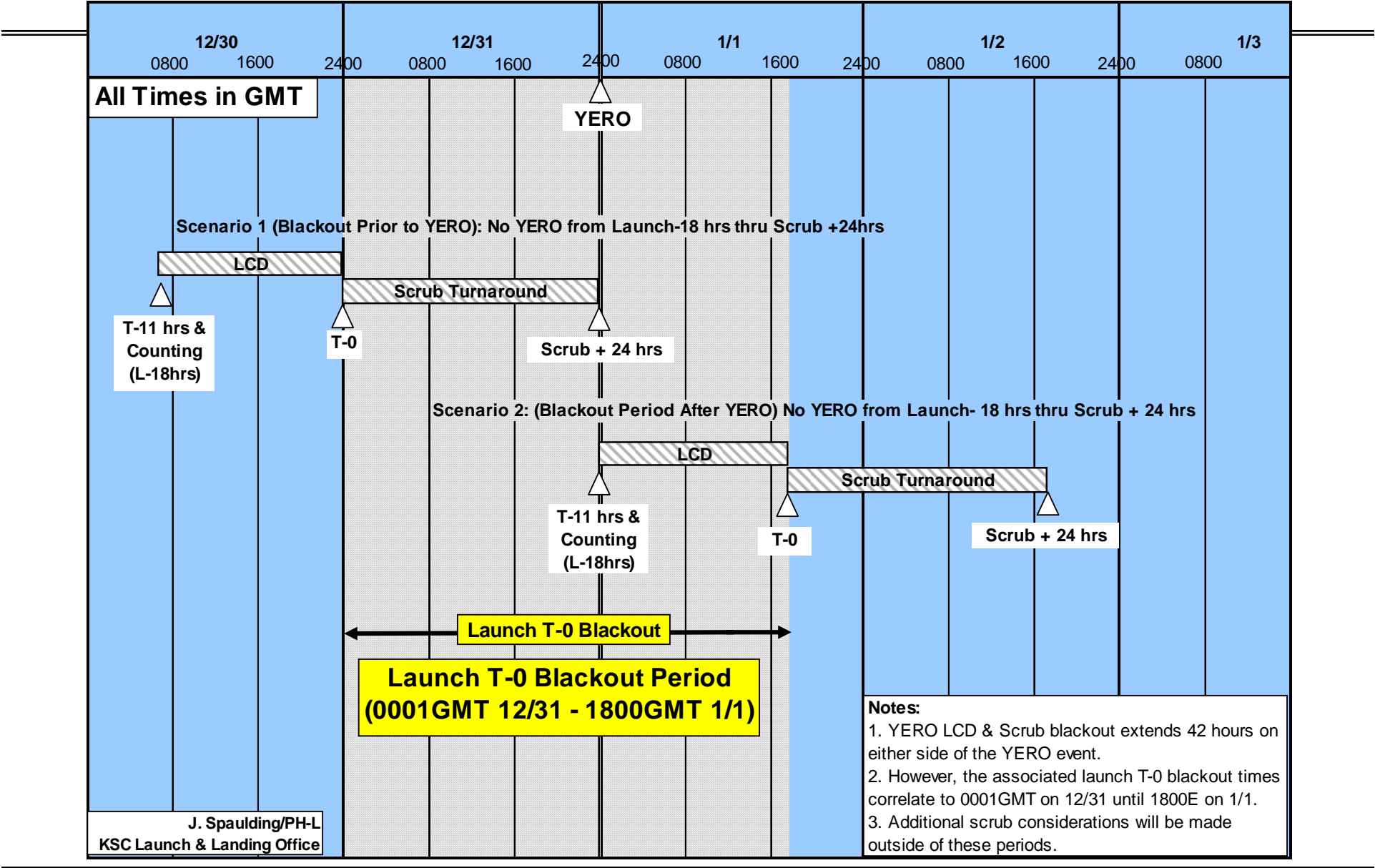
- **KSC Launch T-0 Blackout Periods:**

- T-11 hr hold (L-18 hrs) to T+24
- Launch T-0 cannot occur between 0001 GMT on 12/31 and 1800 GMT on 1/1
- Refer to chart on Page 32

- **KSC Scrub Turnaround Impacts:**

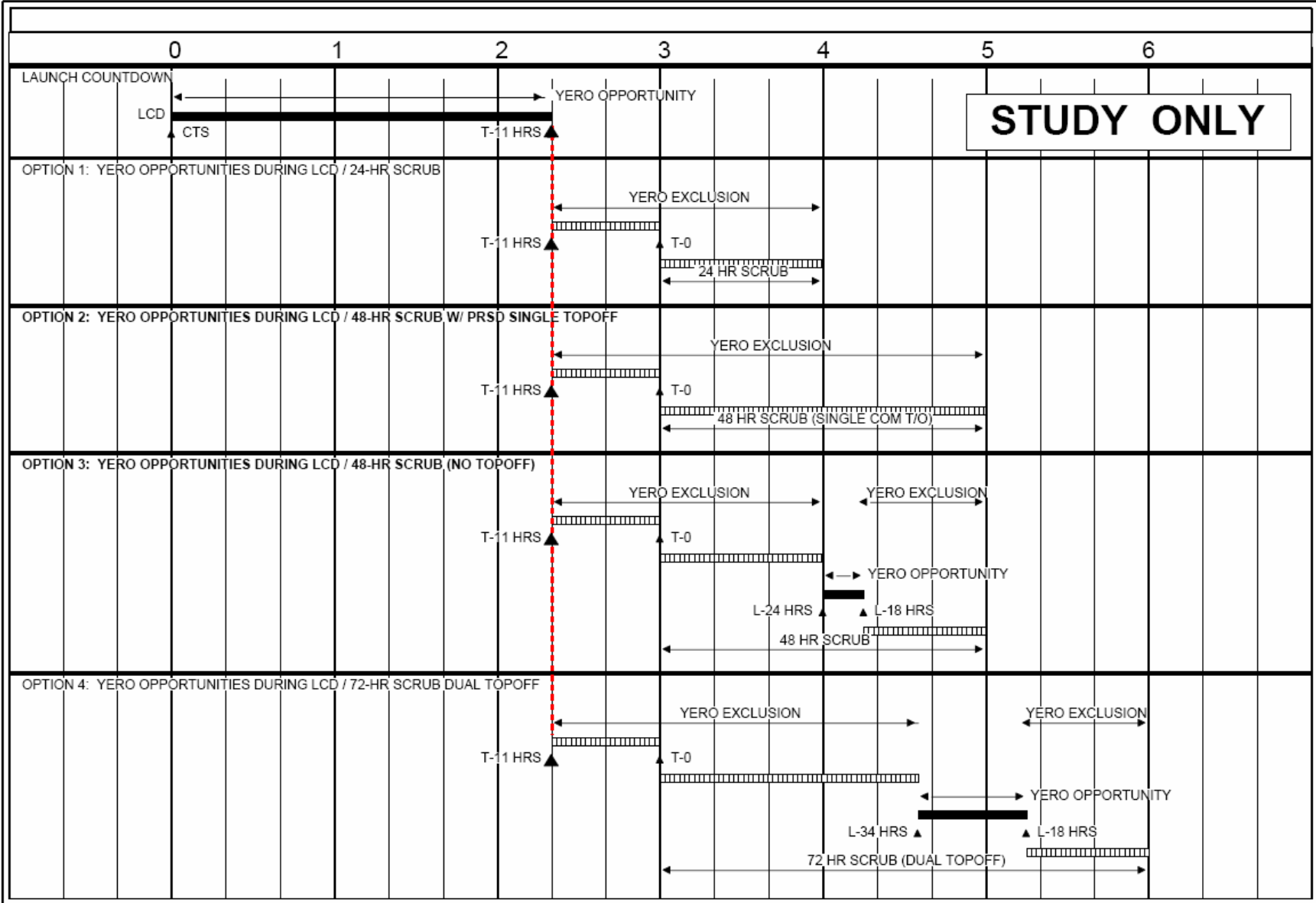
- Cannot accommodate YERO in a 24-hour scrub
- Cannot accommodate YERO in a 48-hr scrub with PRSD top-off
- **Can accommodate YERO in a 48-hr scrub without PRSD top-off during specific timeframes**
- **Can accommodate YERO in a 72-hr/96-hr scrub with dual PRSD top-off during specific timeframes**
- **If YERO cannot be accommodated within scrub turnaround scenario or if additional constraints impact YERO scheduling, one additional launch day will be required to perform the planned YERO recovery procedure**
- Refer to chart on Page 33

KSC YERO Launch T-0 Blackout Periods



YERO Launch / Scrub Opportunities

OPR: J. Spaulding 1-9306
08FEB07 14:28



STUDY ONLY

n:\cc\sts-117\scrub options\YEROscrubs arp

UNITED SPACE ALLIANCE

SOURCE: MRC

KSC Cost & Schedule

- **Forward work**
 - Final procedure development and verification
 - Assessment of GOAL software to see if modifications can be made to reduce YERO blackout (ECD 4/30/07)

- **Cost - no additional cost to the Program**
 - Work will be performed under existing level of effort
 - Will return to PRCB if results of GOAL assessment show that modifications will result in significant YERO blackout reduction

Summary

YERO Blackout Summary

- **Preflight:**
 - T-0 Impacts:
 - » Launch T-0 cannot occur between 0001 GMT on 12/31 and 1800 GMT on 1/1
 - Scrub Turnaround Impacts:
 - » Cannot accommodate YERO in a 24-hour scrub
 - » Cannot accommodate YERO in a 48-hr scrub with PRSD top-off
 - » Can accommodate YERO in a 48-hr scrub without PRSD top-off during specific timeframes
 - » Can accommodate YERO in a 72-hr/96-hr scrub with dual PRSD top-off during specific timeframes
 - » May require extending scrub turnaround by one day to accommodate YERO
- **In-flight:**
 - FD1 Ascent Day (protecting for FPLS)
 - FD2 RNDZ burns
 - FD3 RNDZ day (through docking, protecting for delays)
 - Undock and Separation
 - Entry day (through wave-off revs and subsequent backout)
 - May have additional blackout times based on complex/critical operations
 - » Will be defined by flight-specific IPT (Integrated Product Team)
- **Restrictions will be documented in the FDRD and Level B Ground-Rules & Constraints**

YERO Blackout Resolution

- **Blackouts can be accommodated in several ways:**
 - Enforcing launch cutout (for example, don't launch if YERO occurs on RNDZ day)
 - Replan or delay mission activities (same example, but launch into FD4 RNDZ with YERO on FD3)
 - » Might require use of +1 day or loss of content (for example, move undocking earlier to avoid YERO)
 - Use YERO Delay capability, if possible
 - Because YERO will move 23 minutes later each day in the Flight Plan if launch is delayed, multiple timeline options will need to be evaluated for a given launch window
 - » Increases Flight Planning workload right before launch

The YERO Solution

- **The Integrated solution that best satisfies goals and objectives is to force to entire system to roll over to GMT day 001**
- **Preflight**
 - KSC will perform PASS GPC IPL and recycle the Firing Room
- **In-flight**
 - Flight Software will be modified to enable YERO reset to rollover to GMT Day 001
 - Orbiter will perform YERO Reset and MCC will perform YERO recycle
- **Scheduling**
 - Launch opportunities and mission activities will be scheduled to avoid YERO blackouts as documented in the FDRD
- **Leap time events**
 - For Leap Year, the YERO procedures will be preceded by setting the MTU to day 366
 - For Leap Second, the ground systems will be adjusted with the appropriate time bias until the completion of the joint Shuttle/ISS mission
- **Cost & Schedule:**
 - Work identified will be accommodated within existing level of effort (Orbiter, FSW, MCC, KSC)
 - YERO support will be ready for 2007

Forward Work

- **Document YERO blackouts (FDRD, Level B GR&C)**
- **Flight Software**
 - Approve SCR 93160 to implement YERO Reset capability in the Flight Software for STS-122
 - Proceed with standard FSW build and verification processes
- **MCC**
 - Continue testing and verification of MCC Recycle and YERO Delay
 - Develop and verify MCC procedures
- **KSC**
 - Review GOAL software for possible YERO improvements
 - Develop and verify KSC YERO re-sync procedures
- **Integrated Procedures and Flight Rule**
 - Develop and verify on-board YERO procedures (FDF)
 - Update Orbit Pocket and Malfunction Procedures as required
 - Create/Update Flight Rules for YERO
- **Perform Integrated Verification and End-to-End Checkout**
 - This is in addition to standard processes for development of flight software, MCC procedures and FDF procedures listed above
 - Will involve entire SSP community (MOD, MER, CB, Network)
- **Flight-Specific Training**

YERO Recommendations

- **Approve proposed YERO solution and operational concept**
- **Close all parts of action S063515**
 - Assigned to DA/1-1, EA/1-2, MO/1-3, MS/1-4, MV/1-5, MX/1-6, USA/1-7

BACKUP

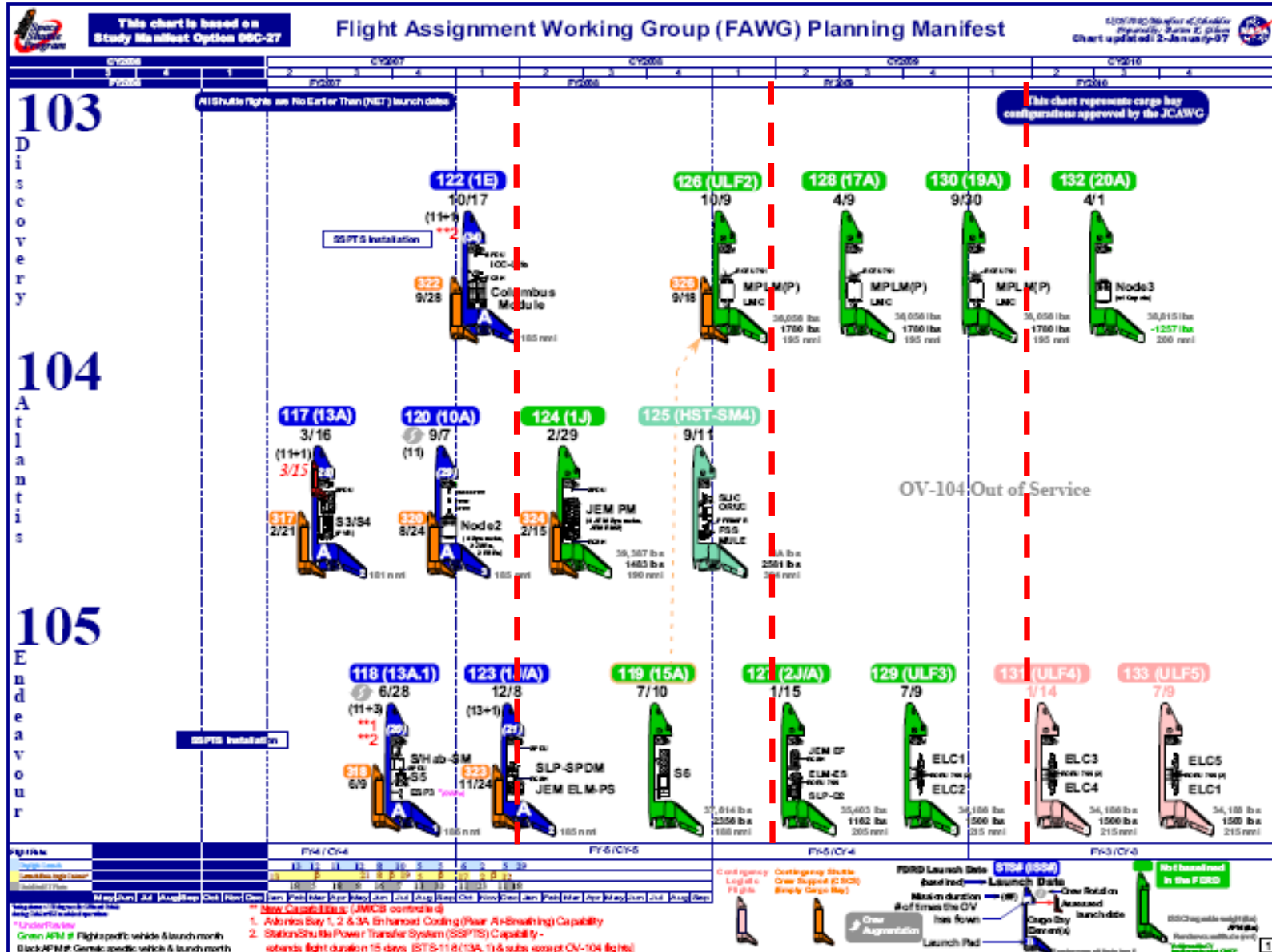
YERO Leads

BACKUP

-
- **DA – DA8/Michael Moses, DV/Carolyn Jarrett, DF/Ronnie Montgomery**
 - **MV – Pedro Rivera, Curt Cooper, Monika Hill**
 - **MO – Darryl May**
 - **MS – Alan Currie, Darrell Stamper**
 - **EA – Brad Loveall**
 - **KSC – Louie Marchica, NTD/Jeff Spaulding**
 - **Flight Software – Pat McLellan, Paul Tice**
 - **Safety (NC) – Chris Ramsay**
 - **Boeing – Lynna Wood, Mark Fuggit**
 - **USA – Nat Hardee**
 - **CB – Kevin Ford**
 - **XA – Tara Jochim**

YERO Manifest Exposure

BACKUP



STS-116 YERO Procedures

BACKUP

-
- **Part 1: On-board Setup**
 - Completed by crew prior to crew sleep on 12/31
 - **Part 1a: Ground Recycle at GMT midnight**
 - Recycle MCC platform to reset time-based dependencies
 - Occurs while crew is asleep
 - 1.5 hour procedure
 - **Part 1b: Ground Recycle at Local midnight**
 - Recycle MCC platform to reset time-based dependencies
 - Occurs while crew is asleep
 - 1.5 hour procedure
 - **Part 2: On-board PASS**
 - Performed after crew awake on 1/1
 - IPL the PASS set to wipe out references to “old” time
 - Uplink reference data to restore GPC’s
 - 1.5 hour procedure
 - **Part 3: Onboard BFS**
 - Bring up the BFS to establish updated time from MTU
 - Uplink reference data
 - 0.5 hour procedure

STS-116 YERO Ground Procedures

BACKUP

- Existing STS-116 YERO ground procedure is a complete MCC recycle
 - Covers unknowns by recycling all hardware and software after the time changes
- Procedure is run twice: at GMT midnight and again at Local midnight
 - Log-off workstations
 - De-allocate servers and activities
 - Recycle/reboot servers
 - Re-allocate servers and mission activity
 - Log-in and configure workstations
 - Total time: 1.5 hours (approximately 30 min with users logged out)
- Procedures have been tested in previous SAIL and SMS tests and have resulted in no issues
- Community was briefed on specific impacts of the ground recycle in preparation for STS-116
 - No issues identified