

# Year End Rollover (YERO) STS-116 Impacts



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**JSC Mission Operations Directorate  
STS-116 FOR Splinter Session**

**DV2/Carolyn Jarrett  
August 9, 2006**

# Agenda

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- **Why We're Here**

(From OFTP #226, 6-9-06)

- Background
- Overview of YERO Procedure
- Results of YERO Investigation
- FOICB Direction for STS-116
- Forward Plan

- **STS-116 YERO Impacts**

# Background

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- **Current STS-116 launch window is Dec. 14-25**
  - **Potential YERO event in flight if launch after Dec. 16**
- **At one second past GMT 365:23:59:59, the Master Timing Unit (MTU) accumulators on the Orbiter will reset GMT to day '001/00:00:00'. This causes PASS Flight Software (FSW) to fault down to GPC internal time (GPC Oscillator) and annunciate the "TIME MTU" message. PASS FSW continues to increment GMT and MET clocks (GMT rolls over to day '366/00:00:00'). GPC time accuracy is poor with respect to MTU.**

**Worst Case:**

  - **MTU OSC – 0.001 PPM (0.086 MILLISEC/DAY)**
  - **GPC OSC – 87 PPM (7.517 SECONDS/DAY)**
- **1989 STS-32 YERO Investigation (OI-8C)**
  - **DPS procedure forced MTUs to accept GPC time (day 366)**
  - **MOC Environment**
  - **Not flown due to launch slip**
- **2004 FOICB directed YERO team to investigate different option**
  - **Ground Rules: Quiescent Ops only, not launch, reentry, etc.**
  - **Scope: JSC only**

# Overview of YERO Procedure

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- **Part 1 (prior to YERO event)**

- Data checkpoints (historical purposes only)
- Adjust MET to rollover with GMT (avoids “negative” time)
- Realign IMUs to Identity Matrix REFSMMAT  
(Retains valid inertial attitude reference during/after IPL)

- **Part 2 (post YERO event)**

## **Ground Steps:**

- Staggered recycle of all Shuttle-only ground resources  
Includes workstations, servers, FEPs, etc.  
(Logoff/deallocate performed prior to YERO)
- Required because MCC rollover test not performed  
(FEP select-over, checkpoint, allocation, deallocation,  
and logging expected to be problematic)
- ISS not affected, but must close Shuttle displays  
(Flight activity defined without reference year)
- Reconfigure Trajectory Server; Manually input new year
- Reconfigure Command Server; Rebuild command loads  
(Cannot restore from pre-YERO checkpoint)

# Overview of YERO Procedure

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- **Part 2 (Continued)**

- **On-Board Steps:**

- DAP: FREE VERN
- Comm Reconfig (Manual Antenna Selection)
- Mode all GPCs to STBY
- IPL GPC1 (G2) (accepts MTU time)
- Uplink: RNP Matrix, SV, GPS Time Adjust, IMU REFSMMAT, RCS Quantity Monitoring (and others as needed)
- Uplink/load dummy burn target (correct Orbiter mass)
- Configure remaining PASS GPCs; Comm reconfig; Uplink variable parameters and TMBU; Realign IMUs; DAP config

- **Part 3 (prior to deorbit)**

- Uplink RNP Matrix to BFS while it's in Ops 000
- Uplink GPS Delta Time and TDRS SV to BFS while in Ops 3

# Results of YERO Investigation

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- **Successfully completed 4 SAIL tests**
  - YERO Procedure (with landing)
  - YERO Procedure with BFS engage (with landing)
  - Leap Year
  - Leap Second(Used hardware MTU, GPS, COMSEC Box)
- **Final Report published 12/30/05**  
([http://mod.jsc.nasa.gov/dv/dv2/MCC\\_HPAGE/MCCsubpages/YERO/YERO%20Final%20Report.doc](http://mod.jsc.nasa.gov/dv/dv2/MCC_HPAGE/MCCsubpages/YERO/YERO%20Final%20Report.doc))
- **Recommended for contingency use only**
- **SMS used for pre-test and can support training**
- **On-board procedure not included in FDF, but ready for flight-specific re-write**
- **Ground procedures submitted to FCOH**
  - 2.13 Ground Year-End-Rollover Procedures
  - 2.14 Leap Second Procedures
- **Flight Rules/Ground Rules & Constraints reflect contingency-only status**

# FOICB Direction for STS-116

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- **C. Hickey presented FSW YERO position at FOICB on May 22**
  - No issues identified but FSW Certification is cost-prohibitive
  - Flight-specific testing proposed as alternative (both SAIL and SPF)
  - Directed by FOICB to begin test preparations
- **MOD Actions:**
  - Determine which launch dates could result in YERO event and, for each date, whether STS-116 timeline could accommodate YERO procedure
  - Report back to FOICB in 2 months
- **If STS-116 timeline can accommodate YERO event, will proceed with formal testing**

# MOD Forward Work

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## PRCB will:

- **Determine which launch dates MOD can support**
  - YERO event while docked: Timeline impacts
  - Post-undock: No ISS resources (comm, att cntl)
  - YERO not permitted: Launch window impact

## If YERO option is permitted...

## STS-116 Team will:

- **Determine placement of YERO procedure in flight timeline (for portions which can be delayed)**
  - Part 2 takes about 2-1/2 hours to complete (including ground and onboard steps)



# MOD Forward Work

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## YERO Team will:

- **Determine which YERO steps may be delayed, and for how long**
- **Identify impacts and point-of-contact for affected areas**
- **Develop flight-specific procedure for STS-116 (on-board and ground)**
- **Support integrated STS-116 SAIL/MCC test in conjunction with FSW verification team (include other centers, where possible)**
- **Revisit MCC rollover test (may piggy-back with ISS BCC test)**
- **Work with DT to develop flight-specific YERO sims for STS-116 team (on-orbit and entry teams)**
- **No leap second this year (per IERS, 7-19-06) (ISS and SSP procedures already developed)**

# STS-116 YERO Impacts

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- **Initial Look at STS-116 Impacts**
  - Impacts if delay 8 - 10 hours
  - Impacts if delay 3 - 4 days
  - Window of exposure
  
- **YERO Team Contact List**

# Impacts if Delay 8-10 hours

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- **Part 1 performed any time prior to rollover**
  - Allow 15 min. crew time
  - Don't have to wait until IMU align complete
- **Ground recycle must be performed on schedule**
  - Applications not certified for rollover (can't test everything)
  - Recent load testing indicates that 50 users can logon/logoff concurrently
  - More important to phase logoff than logon
- **ComSec equipment must be set to clear mode prior to crew sleep if YERO procedure not complete**
  - INCO can handle antenna selection etc. as long as they have command capability
  - Can also send time-tagged commands to disable/enable command during planned LOS

**Note: Any planned periods of command-in-the-clear must be kept confidential. Announcing them would invite malicious intrusion.**

# Impacts if Delay 8-10 hours (cont.)

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- The "TIME MTU" message will wake the crew, assuming current ISS sleep schedule
  - This can only be inhibited/restored via GMEM (Not like TMBU)
- Part 2: Onboard steps performed as soon as possible after crew wake
  - Allow 1 to 1-1/2 hours crew time
  - Commander/Pilot may choose to perform before sleep rather than wait (especially if alarm will sound)
- Part 3: No impact to timeline if performed during Deorbit Prep (BFS not available until Part 3 complete.)
- No Shuttle attitude maneuvers and no undock until Part 2 complete, but can hold inertial attitude if DAP reloaded.

**Note: In case of emergency, if the crew does not have time to complete onboard Part 2 steps prior to undock, may chose to stay even if this results in a disabled Shuttle. ISS is Safe Haven. (Not safe to land in mismatch config.)  
This may be PRCB call.**

# Impacts if Delay 8-10 hours (cont.)

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- **GPS will be available for Nav updates for a short time (few hours)**
  - Unaided when GPC clock error exceeds 245ms (fast) or 2s (slow)
  - May require GPS age-of-aiding updates
  - May lose GPS during plasma effect (TACANs available on OV103)
- **Some impact to telemetry**
  - Displays/applications may have funny timestamps
  - FEP will disseminate all downlinked data and assign a local timestamp in addition to the onboard timestamp(s). Which one gets used is application specific.
  - ODRC can manually re-index files, but until they do it may be hard to pull data.
- **Planning system impact unknown**
  - May have to recycle Shuttle-unique resources
- **Flight rule violations:**
  - Anytime deorbit requirement
  - 100ms time accuracy
  - Command in the clear for long period

# Impacts if Delay 3 to 4 Days

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- **Part 1 still performed prior to rollover, ground recycle performed on schedule. Only onboard steps delayed.**
- **Impact: Same as for 8 hours only magnified**
  - **State Vector accuracy may degrade up to 31 miles/day**
  - **Greatly increased opportunity for human error during interim**
  - **There is no way to test effect of long duration mismatch. We cannot predict which ground applications may have problems, and failures may not be easily detected (may give erroneous data rather than no data).**
- **YERO team does not recommend delaying this long. (No delay at all is preferable.)**

# 116/12A.1 Window of Exposure

Source: M. Moses, OFTP #226 6-9-06

no (+1) day													
FD 1	FD 2	FD 3	FD 4	FD 5	FD 6	FD 7	FD 8	FD 9	FD 10	FD 11	FD 12	EOM+1	EOM+2
launch		rndz	EVA 1		EVA 2		EVA 3		undock		deorbit		
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
12/15	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
12/16	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
12/17	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
12/18	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
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
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
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
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
12/23	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
12/24	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
12/25	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

# YERO Contact List

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**DPS:**

Jim Hill  
Ron Montgomery

**INCO:**

Joe Fanelli

**FSW:**

Carlos Valrand

**FD:**

Mike Moses

**Nav:**

John Hutchins  
Carolyn Propst  
Charles Yu

**Boeing/BFS:**

Robert Winkler

**FDO:**

Dick Theis

**IV&V:**

Mel Rother

**GNC:**

Jason Helms  
Mike Interbartolo

**MCC Facility:**

Scott Bossert  
Bill Trueblood  
Susan Weingarten

**SAIL:**

Jim Caldwell

**GPO:**

Tom Schmidt