End-to-End Mission Simulation - April 2002 Outline

Test Dates : April 1 (Monday) to April 5 (Friday)

Test Primary Objectives:

- Prepare and test generic commands necessary for sequencing all S/C operations (as flown) during phasing orbit operations:
  - Separation sequence including :
    - RF Configuration
    - Propellant line preparations
    - Autonomy interaction
    - Auto Spin Down Capability
  - All orbital and attitude maneuver types :
    - Spin Up/Down
    - Axial Delta V
    - Spin Axis Precessions
    - SRM Firing
    - Dual Mode DeltaV (3-Axis point followed by transition to spin mode and DeltaV)
    - Component DeltaV (axial followed by radial DeltaV)
  - Mixed mode RF operations. Some w/DSN some w/umbilical)
  - C&DH ops including command sequencing and SSR operations, TLM selection, RF switching
  - G&C activation and checkout via R/T scripts (may be duplicative with other G&C testing already taking place – must check)
  - 3-Axis G&C Encounter operations
  - Instrument activation and checkout via sequencing as required :
    - NGIMS
    - CRISP
  - Instrument activation and checkout via STOL as required:
    - NGIMS

  - Instrument Encounter Operations w/CRISP image simulator
- Test all required operations procedures, command blocks, and scripts in an integrated manner that mimics real-life operations
- Test MOC ground system hardware and software in an operations realistic manner
- Identify/document all problems related to the above
- Train team members in realistic operations of ground system and spacecraft
- Science data interface – off-line data transfer attempt to Cornell possible
- APL/JPL file Transfers over IONET (Schedulers and Navigation team)
- Internet to DMZ (Navigation and DSN Schedulers)

Secondary Objectives:

- DSN CMD, TLM, MON data interface (if DSN interface fully functional)
- DSN SOE interface (if standard SOEs ready for use)
- S/C engineering data plotting/trending (if plotting S/W ready)
- Use of Brassboard simulator for verifying command sequences

What might not be tested (to be tested when software/systems ready):

- External navigation packet processing at JPL
- OpNav FITS file creation/processing

Test Top Level Agenda: S/C Activities to Test

Day 1 S/C Activities : (Note: S/C in Spin mode Day 1) Approximate time required

Note: Latch valve commands shall be exercised
Note: Catbeds, RF, Thruster commands shall be exercised

- Separation sequence, Auto S/C Spin down , NOOP commanding 6 hours
- Contingency Delta V (single mode Axial Delta V maneuver) 2 hours
- 4 part Attitude "Flip" (Sun sync precess maneuver) 4 hours

Day 2: S/C Activities : (Note: S/C in Spin mode for first part and 3-axis for later)

Note: Flight SRM Fire sequence to be used w/o any changes – need fuses
Note: Catbeds, RF, Thruster commands shall be exercised
Note: Latch valve commands NOT exercised

- Dual Mode Combined Delta V 4 Hours
  (3-axis pt, transition to spin mode, axial Delta V followed by radial Delta V)

  Note: Includes test of real-time Burn Update Process (BUP)
- SRM Firing 1 hour
- G&C activation and R/T checkout via STOL scripts TBD Hours

Day 3: S/C Activities:

Note: Latch valve commands NOT exercised
Note: Catbeds, RF, Thruster commands shall be exercised

- Instrument checkouts (via STOL) 2 hours
  - NGIMS (valve check, calibration value check – 1 hour)

  Note: SSR set up and playback will be done via STOL scripts

- Instrument checkouts (via Seg_gen) 3.5 hours
  - CRISP (tracking ~ 40min with movie input)
  - NGIMS (startup, baseline ~2hrs)

  Note: SSR set up and playback will be done via STOL scripts
  Note: Kim S. needs to be at Goddard to start the movie.

As soon as Day 3 activities are completed, set up and execution of day 4 can begin

Day 4: S/C Activities: Approximate time required

Note: Catbeds, RF, Thruster commands shall be exercised
Note: Latch valve commands NOT exercised
Note: S/C in both Spin and 3 Axis modes

- Encounter Simulation 23.5 hours
  - Load/verify (1 hour at 2kps)
  - Commanding (~ -8hours to + 45min from CA)
  - Playback (~13.5 hours at 255kps)

Day 5: S/C Contingency activities : Approximate time required Operations

- Tests left over or needed to be repeated from previous days
- TAC #2 Maneuver 2 Hours
- G&C #2 Fail over 2 Hours
- TAC failure in 3-Axis mode 2 Hours
- Instrument safing 2 Hours
- What else ?

Logistics

- **Telephones, use MOC Phone #'s x5422 or x7396**
- **Fax : x 6649**
- MOC must remain locked at all times.
- Check you key cards now. If you need MOC access talk to Earleen James x5306 ASAP
- Copy machine in MOC
- Space limited in MOC

Systems Required:	Who	Status
1. Spacecraft and all instruments	Colby	√ scheduled
2. G&C Testbed	Rogers	√ In place
3. MOC , Luke, Vader,R2D2 Lando, IONET, DMZ, APLNET, firewall traffic	Griffith	√
4. Spacecraft COMPLETE autonomy suit	Harvey	TBD
5. Spacecraft mode switch macros	Whittenburg	√
6. I&T staff	Colby	Need to determine actual hours
7. Instrument simulators		√ Done

Software & files Required:	Who	Status
1. IONET to/from working (file transfers)	Griffith	√ In place
2. Command load generation	Tillman	√ done
3. SPK processing S/W for G&C/CRISP	Tillman	√ In place
4. Maneuver Input Files creation :	Rogers	working on them
a. Post separation auto spin down		
b. Contingency Perigee Raise Axial Delta V		
c. Flip – four parts		
d. One Dual Mode Component DeltaV (3-axis pt, followed by axial followed by radial DeltaV)		
5. MD versions of above maneuver files for G&C use	Dunham	generic test versions prepared
6. Maneuver CAS input file processing	Whittenburg	needs work
7. TLM Pages – G&C, Prop , FC, Instruments	Nick/Mark/Alice/TJ	Working set complete
8. Assessment data retrieval, SSR reports, Plotting	Tillman	Engr Data retrieve now avail. Trial version of Plotting avail.
9. DSN SOE creation	Tillman	Not ready in time for test
10. S/C Clock Kernel production and seq-gen formatting	Tillman	March ?
11. Thruster history	Tillman	March ?
12. Attitude kernel production	Tillman	3-Axis done
13. Time convert utility	Tillman	March ?
14. Epoch R/T stream management	Tillman	March ?
15. Proc Dump	Tillman	√ done
16. Flight Software Load/Dump (G&C & C&DH)	Tillman	√ done
17. Memory dump compare (PROC C) S/W	Tillman	√ done
a. C&DH macros		
b. C&DH timetags		
c. C&DH Autonomy		
18. Bit Level Dump Compare	Tillman	March ?

19. DSN Standard SOE's created	Hewitt	√ in progress
20. CA Time File	Navigation	√ provided
21. Command history and parameter viewing	Dewitt	Not ready in time for test

Command Sequencing Related

1. S/C SPK File - encounter only	Nick	√ Done & tested
2. Comet SPK File - encounter only	Nick	√ Done & tested
3. G&C CAS's	Pinkine	√ Done & tested
4. C&DH CAS's	Whittenburg	√ Done & tested
5. NGIMS/CIDA Instrument Encounter CAS's	Bowman	√ Done & tested
6. CFI Encounter CAS's	Harch	√ Done & tested
7. CRIPS Encounter CAS's	Harch	√ Done & tested
8. Operations "Initials" for simulations periods	Whittenburg	√ Done
9. Science request file for Encounter Sim	Harch	3/14/02 Deadline
10. Propulsion CAS's	Holdridge	
a. Spin Up/Down		√ done & tested
b. Axial Delta V		√ done & tested
c. Spin Axis Precession		√ done & tested
d. Radial Delta V		√ done & tested
e. Dual Mode DeltaV (3-Axis point followed by transition to spin mode and DeltaV)		√ done & tested
f. Component DeltaV (axial followed by radial DeltaV)		√ done
g. SRM Fire Sequence		√ done
11. Instrument Activation and functional request file	Bowman/Harch	
a. NGIMS		√ done
b. CRISP		√ done
12. Instrument Activation and functional STOL scrips		
a. NGIMS	Bowman/Tan	√ in progress

13. G&C activation and functional STOL scripts	Pinkine	?
14. BUP Integrated command load for Sims	Whittenburg	?
15. Final Command Sequences	Whittenburg	?

Hardware / Network Required

Existing CONTOUR MOC adequate for this test.

Ops Procedures Required:	Who	Status
1. Command load, dump. compare procedure	Whittenburg	Needed
2. Pass operations (pre, during, post) scripts and procedures	Hall Mulich/Hall	??
3. Ephemeris generation and check	Pinkine	√ Done
4. Command load generation and check	Bowman	Needs automation scripts
5. CONTOUR Activity Request t	Holdridge	√ Preliminary Done

Deliveries Required (days prior to test start)

Item :	Who	Status
22. MD deliver preliminary burn files to G&C	MD	
23. G&C delivers final maneuver files to Mops	G&C	
24. Instrument engineering review of sequences	Insts	√ done
25. CRISP/CFI Instruments deliver instrument requests to Mops	Harch	√ done
26. NGIMS/CIDA Instruments deliver instrument requests to Mops	Bowman	√ done
27. Science review of request files	Harch	√ done
28. MOPs prepares command sequences for days 1, 2 (maneuver part), 3 (needed for instrument checkouts), 4 and 5.	MOps	
29. Reviews and validation for new sequences	MOps	
30. DSN Standard SOE's created	Hewitt	√ in progress
31. Full autonomy rule set for lunch and nominal ops	Harvey	

Day 1 Specific Preparations

1st Verify S/C and ground system states:

- Verify I&T ready to proceed
- Verify S/C comm. Link thru umbilical
- Verify DSN link and voice links ready for launch
- Verify G&C Testbed operational ("little red switch on") and ready for spin mode operations w/nutation
- Verify launch day autonomy loaded and enabled
- Verify all G&C reported states are "Spin Mode"

Ground Timeline – Day 1- Launch, Separation, Auto-spin down, perigee raise, "Flip"

Note: See individual command sequences for S/C timeline
Note: JPL Nav will listen in on the launch activities

DSN: Prepare to start TLM and Monitor Data flow

MOC/DSN: Verify voice link

MOC : Place S/C in launch configuration (I&T team)

MOC : Initialize onboard autonomy for both IEMs (Ray)

MOC: L – 6 minutes: remove charge from battery (starts timeline – launch minus 6 minutes)

MOC: L : Set MET = 0 at Launch

MOC: L +15.25 minutes: Place charge back on battery to simulate Sun entry

MOC: L + 1 hour 3 minutes: Enable S/C separation from 3rd stage rule

GSFC: Switch to RF via DSN

DSN: Start TLM and Monitor Data flow on MOC request

MOC/DSN: Turn Command Mod On on MOC request

MOC: L + 1 hour 19 minutes: **AOS GDS – ENABLE DSN CTV INTERFACE for TLM, CMD**

MOC : Verify TLM at 85 kbps

a. Run nominal pass operations procedures and scripts
b. Verify command uplink, start sending NOOP cmds to S/C
c. Monitor separation sequence

********** Separation sequence part 2 – Propulsion **********

MOC : Verify propulsion venting sequence

MOC: Verify propulsion line priming

********** Auto Spin Down **********

MOC: Verify auto spin down to 22 rpm when S/C nutation within preset limits

MOC: Verify maneuver shutdown

MOC: Send command to enable contingency perigee raise maneuver

MOC: Monitor Delta V

MOC: Verify maneuver shutdown

********** Attitude ~180 deg Flip **********

MOC: Load attitude Flip part 1 commands

MOC: Enable Flip part 1

MOC: Monitor attitude actual vs. expected performance

MOC: Verify maneuver shutdown

MOC: Load attitude Flip part 2 commands

MOC: Enable Flip part 2

MOC: Monitor attitude actual vs. expected performance

MOC: Verify maneuver shutdown

MOC: Load attitude Flip part 3 commands

MOC: Enable Flip part 3

MOC: Monitor attitude actual vs. expected performance

MOC: Verify maneuver shutdown

MOC: Load attitude Flip part 4 commands

MOC: Enable Flip part 4

MOC: Monitor attitude actual vs. expected performance

MOC: Verify final maneuver shutdown

MOC: Place S/C in safe configuration (I&T)

NAV: Verify delivery of NAV packets

Ground Timeline – Day 2 – Dual Mode Delta V, SRM Fire , G&C Activation and Checkouts

MOC : Place S/C in 3-Axis Mode, TAC 1 ON , G&C 1 and 2 ON , IEM 1 & 2 ON (I&T team)

MOC : Initialize onboard autonomy for both IEMs (Ray)

MOC/DSN: Verify voice link

GSFC: Switch to RF via DSN

DSN: Start TLM and Monitor Data flow on MOC request

Verify S/C and ground system states:

- Verify S/C comm. Link thru umbilical (not DSN)
- Verify DSN TLM, CMD, MON Data flow
- Verify G&C Testbed operational ("little red switch on") and ready for spin mode operations w/nutation
- Verify nominal autonomy loaded and enabled
- Verify SRM system safe for fire sequence

MOC/DSN: Turn Command Mod On on MOC request

MOC: Verify Telemetry and Command (NOOP)

MOC: Load command sequence, dump, compare (Karl)

MOC: Monitor 3-axis point to burn attitude

MOC: Monitor transition to Spin Mode

MOC: Monitor Delta V setup and execution

MOC: Verify Delta V shutdown

********** SRM Fire **********

MOC: Load SRM fire commands w/time tag

MOC: Enable SRM fire

MOC: Verify both SRM fuses blown (pri and sec) at nominal time

MOC: Verify SRM shutdown

********** G&C Checkout **********

MOC: Place S/C in proper configuration
MOC: Activate G&C in Spin Mode
MOC: Finish G&C spin mode checkouts
MOC: Spin down and transition G&C to 3-Axis Mode
MOC: Verify proper 3-Axis mode operations
MOC: Complete G&C functional checkout

MOC: Place spacecraft in safe configuration (I&T)

DSN: Terminate TLM, CMD, MON data link

NAV: Verify delivery of NAV packets

Ground Timeline – Day 3 – Instrument Activation and Checkouts (Seq-gen and STOL)

MOC : Place S/C in 3-Axis Mode, TAC 1 ON , G&C 1 and 2 ON , IEM 1 & 2 ON (IEM2 as RT SSR Pwr'd) (I&T team)

MOC : Initialize onboard autonomy for both IEMs (Ray)

MOC/DSN: Verify voice link

GSFC: Switch to RF via DSN

DSN: Start TLM and Monitor Data flow on MOC request

Verify S/C and ground system states:

- Verify S/C comm. Link thru umbilical (not DSN)
- Verify DSN TLM, CMD, MON Data flow
- Verify G&C Testbed operational ("little red switch on") and ready for spin mode operations w/nutation
- Verify nominal autonomy loaded and enabled

MOC/DSN: Turn Command Mod On on MOC request

MOC: Verify Telemetry and Command (NOOP)

MOC: Load command sequence, dump, compare (Karl)
(Includes SSR set up for record.)

********** NGIMS Checkout **********
MOC: Execute NGIMS startup, baseline1A, baseline2A, and baseline3A
MOC: Monitor NGIMS instrument currents and temperatures

MOC: Perform NGIMS BA pressure checks (3) at points in baseline sequences
MOC: End of NGIMS sequence.
MOC: Perform NGIMS STOL scripts

1. Valve Check (10min)
2. Calibration Value Check(1hr)

MOC: Power down NGIMS via STOL script. Playback data via STOL, if desired.
Do not stop SSR recording.

********** CRISP TRACKING TEST **********
MOC: Power up CRISP IMAGER (everything except SPECTROMETER) via STOL script
MOC: Monitor CRISP currents and temperatures
MOC: Begin CRISP tracking sequence (~40min)
MOC: Power down CRISP via STOL script
********** CRISP TRACKING TEST **********

MOC: Playback SSR via STOL

CORNELL: Verify Instrument data transfer from APL to Cornell

Ground Timeline – Day 4 – Encounter Test

MOC : Place S/C in 3-Axis Mode, TAC 1 ON , G&C 1 and 2 ON , IEM 1 & 2 ON (I&T team)

MOC : Initialize onboard autonomy for both IEMs (Ray)

MOC/DSN: Verify voice link

GSFC: Switch to RF via DSN

DSN: Start TLM and Monitor Data flow on MOC request

Verify S/C and ground system states:

- Verify S/C comm. Link thru umbilical (not DSN)
- Verify DSN TLM, CMD, MON Data flow
- Verify G&C Testbed operational ("little red switch on") and ready for spin mode operations w/nutation
- Verify nominal autonomy loaded and enabled

MOC/DSN: Turn Command Mod On on MOC request

MOC: Verify Telemetry and Command (NOOP)

MOC: Load encounter command sequence, dump, compare (Karl)

MOC: Power Up Instruments via STOL script
MOC: Execute encounter sequence

Encounter Simulation time line (time from CA which is 2003-316/20:47:09)

-06:00 CRISP/CFI slew to NGIMS boresight corrected position
-05:51 NGIMS TM-On
-05:50 NGIMS functional encounter test 1
-05:35 CIDA functional test
-05:34 NGIMS functional encounter test 2
-05:38 NGIMS functional encounter test 3
-05:25 CRISP initialize mirror and track on ephemeris
-05:00 CIDA encounter
-05:00 CRISP/CFI periodic approach imaging sequences (at appropriate s/c tilt positions)
-04:23 NGIMS far encounter
-00:08 NGIMS pre-encounter

-00:02 CRISP encounter imaging (closed loop tracking with movie input)
-00:02 CFI end sequence
+00:01 CRISP post encounter imaging
+00:03 NGIMS post encounter
+00:14 NGIMS post encounter calibration
+00:30 CIDA functional test
+00:30 CRISP end sequence
+00:41 NGIMS end sequence
+01:00 CIDA end sequence

********** Details to be provided at review **********

CORNELL: Verify Instrument data transfer from APL to Cornell

Ground Timeline – Day 5 – Contingency Tests

MOC : Place S/C in Spin Mode , TAC 1 ON , G&C 1 and 2 ON , IEM 1 & 2 ON (I&T team)

MOC : Initialize onboard autonomy for both IEMs (Ray)

MOC/DSN: Verify voice link

GSFC: Switch to RF via DSN

DSN: Start TLM and Monitor Data flow on MOC request

Verify S/C and ground system states:

- Verify S/C comm. Link thru umbilical (not DSN)
- Verify DSN TLM, CMD, MON Data flow
- Verify G&C Testbed operational (“little red switch on”) and ready for spin mode operations w/nutation
- Verify nominal autonomy loaded and enabled

MOC/DSN: Turn Command Mod On on MOC request

MOC: Verify Telemetry and Command (NOOP)

MOC: Load command sequence, dump, compare (Karl)

********** Details to be provided at review **********