PACE 2012

Integration & Test

14 – 18 May, 2012

From NASA Procedural Requirements, NPR 8705.4, Appendix B

Class B Missions (for comparison)

Single Point Failures (SPFs)

Critical SPFs (for Level 1 requirements) may be permitted but are minimized and mitigated by use of high reliability parts and additional testing. Essential spacecraft functions and key instruments are typically fully redundant. Other hardware has partial redundancy and/or provisions for graceful degradation.

Engineering Model, Prototype, Flight, and Spare Hardware

Engineering model hardware for new or significantly modified designs. Protoflight hardware (in lieu of separate prototype and flight models) except where extensive qualification testing is anticipated. Spare (or refurbishable prototype) hardware as needed to avoid major program impact.

Qualification, Acceptance, and Protoflight Test Program

Formal qualification and acceptance test programs and integrated end-to-end testing at all hardware levels. May use a combination of qualification and protoflight hardware. Qualified software simulators used to verify software and system.

Class C Missions

Single Point Failures (SPFs)

Critical SPFs (for Level 1 requirements) may be permitted but are mitigated by use of high reliability parts, additional testing, or by other means. Single string and selectively redundant design approaches may be used.

Engineering Model, Prototype, Flight, and Spare Hardware

Engineering model hardware for new designs. Protoflight hardware permitted (in lieu of separate prototype and flight models). Limited flight spare hardware (for long lead flight units).

Qualification, Acceptance, and Protoflight Test Program

Limited qualification testing for new aspects of the design plus full acceptance test program. Testing required for verification of safety compliance and interface compatibility.

I&T Overview

- **Most existing NASA and commercial facilities that can accommodate an observatory of this size can handle its environmental testing.**
  - -- The dimensions of the observatory (~10' high by ~ 5' diameter) and its dry mass of ~1,160 kg can be easily accommodated by most NASA and commercial facilities.
- **Payload and bus delivered ready for observatory level I&T**
  - Fully qualified per GEVS
  - No additional stand-alone testing required
- **Subsystems include:**
  - Power: solar array, battery (nonflight thru observatory testing), PSE, harness
  - Thermal: radiators, MLI, heaters, etc.
  - ACS: Star tracker, reaction wheels, magnetic torquers, coarse sun sensors, magnetometer, earth sensors
  - Comm: X-Band for science data, S-Band through TDRSS for critical events, Doppler or GPS for orbit determination.
- **Task durations:**
  - Include transfer and prep/setup overhead
  - Are "success-oriented" and do not include margin/reserve
- **Test-specific assumptions:**
  - Dry vibe (wet vibe could be considered)
  - Wet thermal-vac
  - Thermal-vac includes radiators but not solar array
- **Some unique GSE required:**
  - Electrical: ground test system, flatsat, spacecraft simulators
  - Mechanical: deployment test fixtures (g-negation), dollies, slings
  - Thermal: heater, radiators, TCUs
  - Fluids: prop servicing, GN_2 purge
  - Contamination: OCE instrument kept clean; GN_2 (or dry air) purging and bagging
- **Test conductors from Flight Ops Team; ¾-time for I&T support**
  - Those who will be operating spacecraft during mission train during I&T

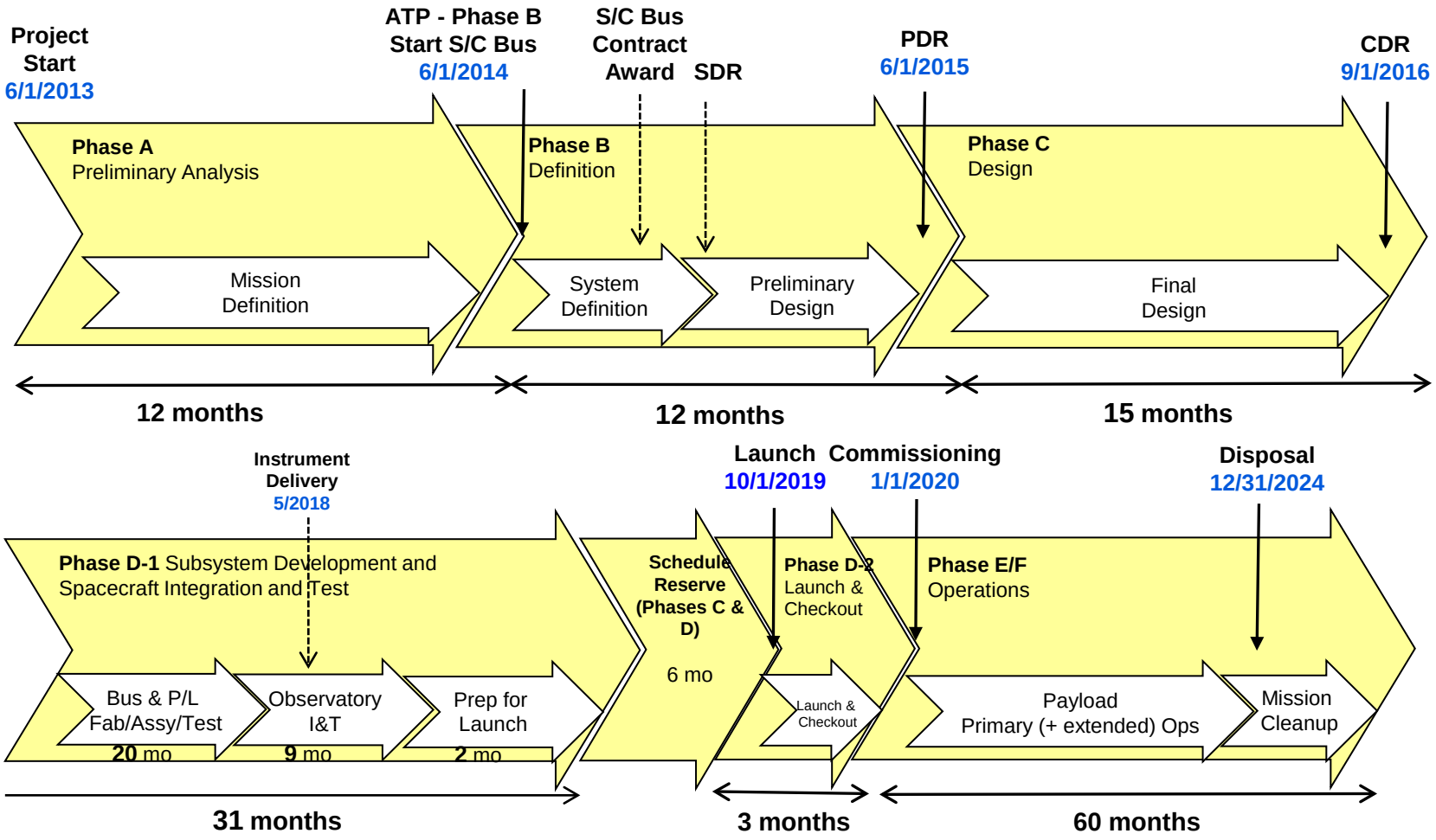
Special GSE Required for I&T effort

- **Electrical & Mechanical simulators:**
  - S/C simulator for testing with the payload
  - Payload simulator for testing with the S/C Bus

- **GN2 (or dry air) purging and bagging of instruments**

PACE Mission Level Schedule

Mission Design Laboratory



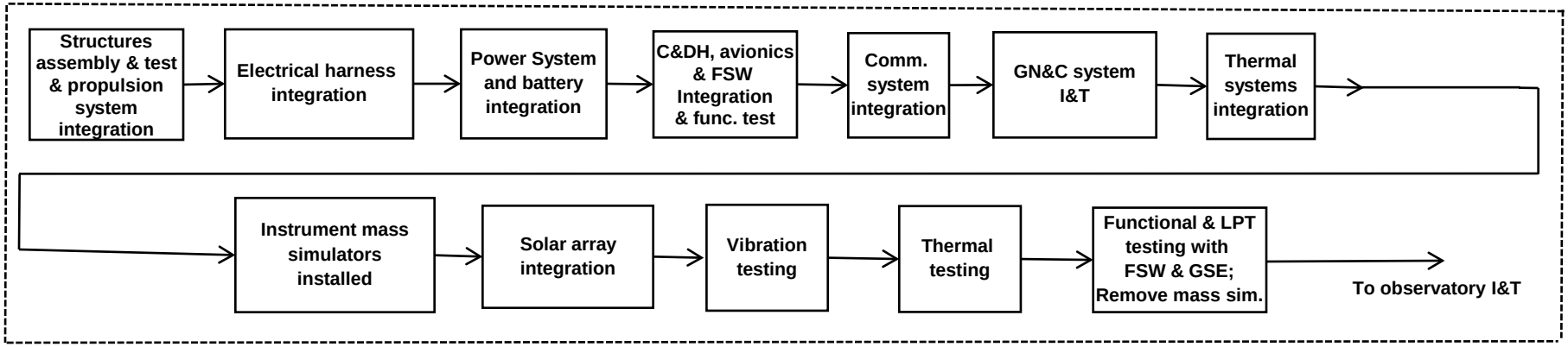
PACE Mission Timeline
(up to launch)

Mission Design Laboratory

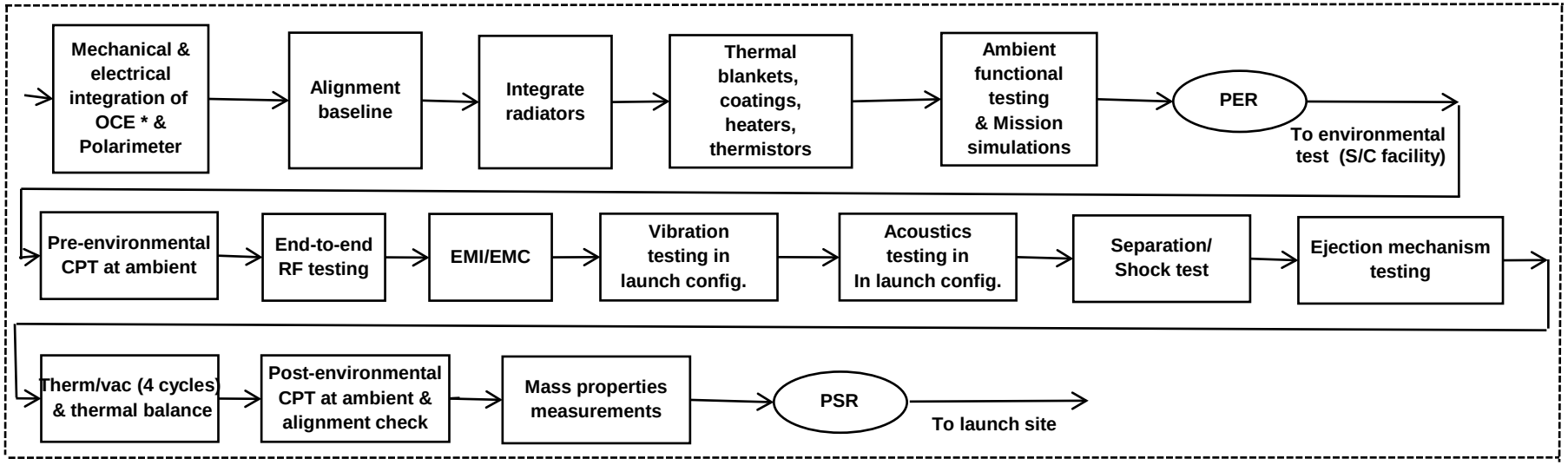
Mission Phase (or other event)	Start Date	Duration			End Date
		days	months	years	
Mission Phase A (preliminary analysis)	6/1/2013	365	12.00		6/1/2014
Mission Phase B (system definition & preliminary design)	6/1/2014	365	12.00		6/1/2015
Mission PDR	6/1/2015				
Mission Phase C (final design)	6/1/2015	456	15.00		9/1/2016
Mission CDR	9/1/2016				
Mission Phase D1 (S/C fabrication, assembly, I&T and pre-launch operations)	9/1/2016	943	31.00		4/2/2019
Fabrication of bus (and instruments, more or less in parallel)	9/1/2016	426	14.00		11/1/2017
Bus I&T	11/1/2017	183	6.00		5/1/2018
Observatory: Integration of instruments with bus; functional testing	5/1/2018	122	4.00		9/1/2018
Observatory: Environmental testing	9/1/2018	152	5.00		2/1/2019
Launch site operations	2/1/2019	61	2.00		4/1/2019
6 months Observatory slack	4/1/2019	183	6.00		10/1/2019
Launch date	10/1/2019				

Top-Level I&T Flow Chart

Mission Design Laboratory



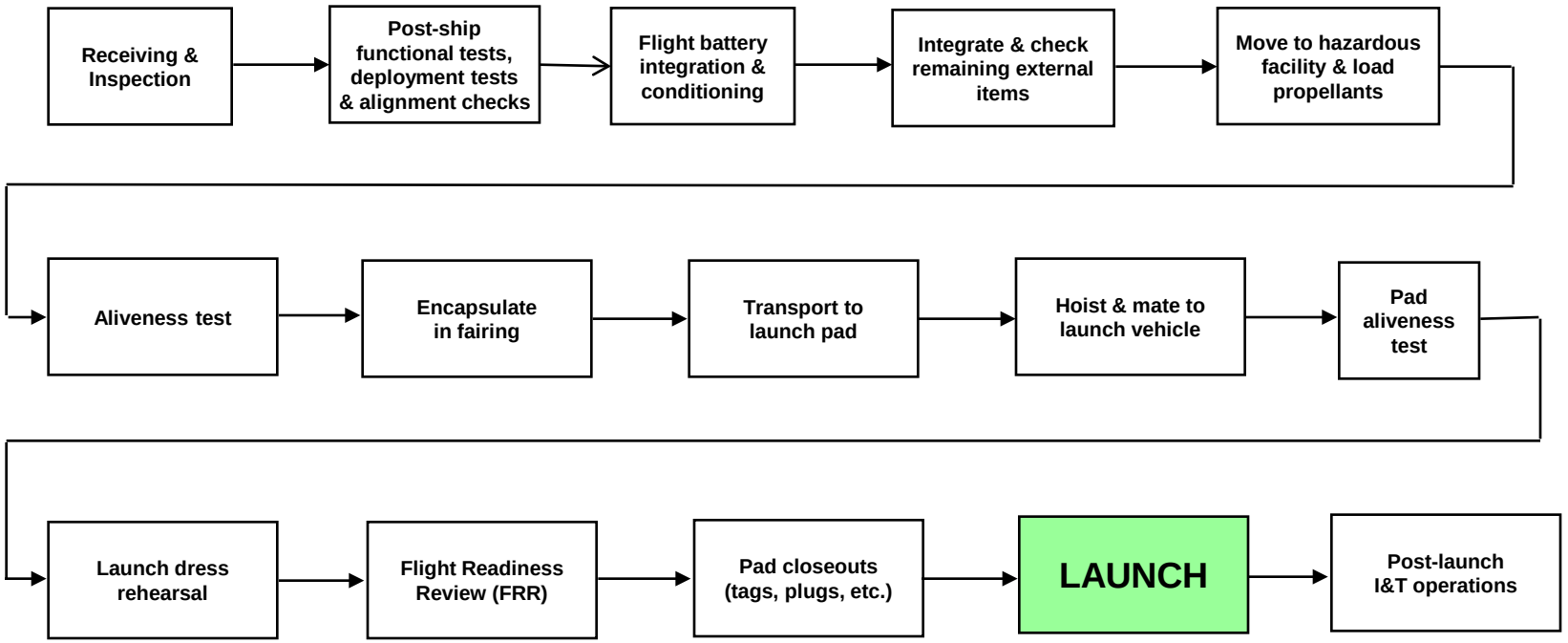
Bus I&T – 6 months



Observatory I&T – 9 months

* Contamination concerns with instruments; needs GN2 (or dry air) purging and bagging.

Top Level Flow for Launch Site Operations



Summary

Test Facilities

- **Most existing NASA and commercial facilities that can accommodate an observatory of this size can handle PACE environmental testing**
  - The observatory has a total dry mass of roughly 1,160 kg (~1.3 tons), and its dimensions are about 10’ in height by about 5’ in diameter.

- **Contamination**
  - The OCE Instrument needs to be kept clean; need GN2 (or dry air) purging and bagging.

Issues/Potential Risks/Future work

- **Issues:** Contamination control is a major issue for the OCE instrument.
- **Potential Risks:** None anticipated
- **Future work:** Detailed I&T plan

Acronym list

- CPT – Comprehensive Performance Test
- EGSE – Electrical Ground Support Equipment
- EM – Engineering Model
- EMC – ElectroMagnetic Compatibility
- EMI – ElectroMagnetic Interference
- ETU – Engineering Test Unit
- FRR – Flight Readiness Review
- GSE – Ground Support Equipment
- I&T – Integration and Test
- LPT – Limited Performance Test
- LRD – Launch Readiness Date
- MGSE – Mechanical Ground Support Equipment
- PER – Pre-Environmental Review
- PSR – Pre-Ship Review
- SES – Space Environment Simulator
- SGSE – Spacecraft Ground Support Equipment
- SPF – Single Point Failure
- TVAC - Thermal Vacuum