Systems Engineering View of the NASA Project Life Cycle Process Flow for Flight and Ground Systems

Agency Approval

Project Formulation

Pre -Phase A: Concept Studies
- Produce a broad spectrum of ideas and feasible alternatives
- Determine feasibility based on cost, schedule, technical, and risk studies
- Establish mission needs, goals, and objectives

Phase A: Concept and Technology Development
- Develop baseline mission concept
- Demonstrate feasibility of selected concept
- Establish validated requirements that meet mission objectives
- Establish architectural product design
- Allocate requirements to next lower level
- Identify needed technologies
- Mitigate technical risks

Phase B: Preliminary Design and Technology Completion
- Establish a design solution that meets mission needs
- Establish design dependent requirements and interfaces
- Complete "Implementation" level of design

Phase C: Final Design and Fabrication
- Establish complete, validated detailed design
- Complete all design specialty audits
- Establish manufacturing processes and controls
- Finalize and integrate interfaces
- Produce items that conform to specs and acceptance criteria
- Prepare facilities for production

Project Implementation

Phase D: System Assembly, Integration, Test, and Launch
- Assemble and integrate system
- Verify and validate system
- Accept system
- Integrate pre -launch system
- Establish readiness to launch
- Launch/deploy system

Phase E: Operations and Sustainment
- Perform mission
- Sustain system
- Improve/augment system

Phase F: Closeout
- Implement decommission/disposal
- Analysis of data
- Analysis of returned samples

System Maturity: Feasible Concepts and Alternative Architectures — Top Level Architecture — Functional Baseline — Allocated Baseline — Product Baseline — As-Deployed Baseline

Key Decision Points (KDP) and Reviews:

KDP A, KDP B, KDP C, KDP D, KDP E, KDP F

MCR SRR SDR MDR PDR CDR/PRR SIR TRR SAR ORR FRR PLAR CERR PFAR DR DRR

Technical Development Processes

Begin

4.1 Stakeholder Expectation Definition
- Identify stakeholders and elicit their expectations
- Define concepts of operation
- Define MOEs and traceability
- Candidate stakeholder expectations
- Candidate concept of operations
- Candidate MOEs

Top Tier? Yes / No — Next Higher Tier

4.2 Requirement Definition
- Identify constraints
- Define and validate candidate functional, behavioral, and performance requirements
- Define possible MOPs and TPMs
- Candidate technical requirements
- Candidate MOPs
- Candidate TPMs

4.3 Logical Decomposition
- Define candidate logical decomposition models
- Allocate candidate requirements to logical models, form and validate candidate requirements
- Candidate derived requirements
- Candidate logical decomposition models

4.4 Design Solution Definition
- Define candidate designs
- Analyze alternatives and select candidate
- Generate a more detailed description of the selected solution
- Candidate design specifications, drawings, etc.
- Candidate V&V plans

Next Lower Tier — Last Feasible Product Tier? No / Yes

5.5 Product Transition
- For final product ensure selected candidate design solution is compatible with product transition philosophy
- For phase product prepare for and perform transition
- Delivered phase product
- Phase product documentation

5.4 Product Validation
- For final product ensure selected candidate design solution is compatible with validation philosophy
- For phase product perform trial validation on high-risk candidate requirement
- Validated phase product
- Validation results and reports

5.3 Product Verification
- For final product ensure selected candidate solution is compatible with verification philosophy
- For phase product perform trial verification on high-risk candidate requirements
- Verified phase product
- Verification results and reports

5.2 Project Integration
- For final product ensure selected candidate solution is compatible with product integration philosophy
- For phase product obtain and integrate lower tier phase products
- Phase product (mockup, model, etc.)
- Phase product documents and manuals

5.1 Project Implementation
- For final product determine if candidate solution would likely be bought, made, or reused
- For phase product (mockups, models, study products, etc.) make, buy or reuse the phase product
- Phase product (mockup, model, etc.)
- Phase product documents and manuals

Technical Management Processes

6.1 Technical Planning
- Define the technical work and the concept for overall project
- Schedule, organize, and cost the technical work for project
- Prepare candidate SEMP and other candidate technical plans
- Issue authorized technical work directives for this phase
- Cost estimates, schedules, and resource requests for phase and project
- Product and process measures for phase and candidates for project
- Candidate SEMP and other candidate technical plans
- Technical work directives for phase and concepts for overall project

6.2 Requirements Management
- Capture, validate, and document candidate requirements
- Conduct candidate expectations and requirements traceability
- Manage expectation and requirement changes
- Candidate requirements documents and approved changes
- Requirements management candidate work products

6.3 Interface Management
- Prepare candidate interface management procedures
- Review candidate technical documents to identify possible interfaces
- Evaluate candidate products for interface compatibility
- Conduct candidate control to manage changes to candidate interfaces
- Candidate Interface Control Documents
- Approved candidate interface requirement changes and other work products

6.4 Technical Risk Management
- Identify technical risks for candidate concepts
- Conduct technical risk assessment on concepts
- Monitor the status of each technical risk periodically
- Implement risk mitigation and/or contingency plans on concepts
- Technical risk mitigation and/or contingency actions on concepts
- Technical risk reports and other work products

6.5 Configuration Management
- Identify baselines to be under configuration control for phase and candidates for project
- Manage configuration status and change control of phase products
- Conduct configuration audits on phase product and plan for project
- List of configuration items under control for phase and planned for project
- Current phase baselines
- Configuration management reports and work products

6.6 Technical Data Management
- Collect and store required technical data for phase and plan for project
- Maintain stored phase technical data
- Provide phase technical data to authorized parties
- Form of technical data products and electronic exchange formats
- Delivered phase technical data

6.7 Technical Assessment
- Assess technical work productivity (measure progress against plans)
- Assess product quality (measure progress against requirements)
- Conduct horizontal and vertical progress technical reviews for phase
- Assessment results/findings
- Technical review reports
- Corrective action recommendations

6.8 Decision Analysis
- Establish guidelines and define criteria for evaluating alternative solutions
- Identify alternative solutions and select evaluation methods and tools
- Evaluate alternatives and select recommended solutions
- Report results with recommendations, impacts, and corrective actions
- Alternative selection recommendations and impacts
- Decision support recommendations and impacts

(Columns for Phase A, Phase B, Phase C, Phase D, Phase E, and Phase F repeat the 4.1–5.5 Technical Development Processes and the 6.1–6.8 Technical Management Processes with phase-specific wording.)

Phase E column (Operations and Sustainment)

Configure for Operations
- Create/review operational plans and procedures
- Train personnel
- Ensure facility readiness
- Set system for desired operational scenario
- Operational plans and procedures
- Training records

Operate the System
- Operate per established concepts and procedures
- Ensure product, people, and facilities are ready for product transition
- Identify unexpected results and coordinate with technical team
- Identify and coordinate operational procedure improvements
- Operation logs
- Updated operational procedures
- Anomaly documentation

Maintain the System
- Perform maintenance/refurbishment per established plans and procedures
- Maintain system spares and logistics per established plans and procedures
- Procure/make "to print" replacement parts as needed
- Perform consumables replacement per plans and schedules
- Spares/maintenance logs
- Updated logistics procedures

Manage the System
- Monitor the technical parameters
- Manage system resources per established plans and procedures
- Establish and manage resource priorities
- Coordinate anomaly resolution with appropriate stakeholders and technical personnel
- Generate and track corrective actions as necessary
- Resource logs
- Anomaly documentation
- Corrective actions

Upgrades or Changes Needed? Yes / No
Ready to Decommission or Dispose? Yes / No

Assess Trends
- Monitor TPMs
- Notify and coordinate with technical team when parameter trends exceed warning thresholds
- Identify and coordinate trending improvements
- Capture all trending work products
- Trend reports
- Anomaly documentation
- Corrective actions

Phase F column (Closeout)

Prepare for Disposal
- Inform stakeholders
- Gather information for disposal decision
- Develop/refine detailed plans and procedures for disposal
- Disposal plans
- Disposal procedures
- Decision documentation

Perform Disposal
- Ensure all procedures, people, and facilities are ready for disposal
- Execute disposal per plan
- Disposal documentation
- Anomaly reports
- Corrective actions

Project Termination
- Close out all actions
- Establish trends of critical parameters
- Transition personnel per plan
- Archive all project and disposal documentation per plan
- Action closeout reports
- Personnel actions
- Final data archives

End

Legend

Process Name (ref. ¶ in 6105)
- Typical Activities
- Typical Products

Key Decision Point (KDP)
Review

- CDR – Critical Design Review
- CERR – Critical Events Readiness Review
- DR – Decommissioning Review
- DRR – Disposal Readiness Review
- FRR – Flight Readiness Review
- KDP – Key Decision Point
- MCR – Mission Concept Review
- MDR – Mission Definition Review
- MOE – Measures of Effectiveness
- MOP – Measures of Performance
- ORR – Operational Readiness Review
- PDR – Preliminary Design Review
- PFAR – Post-Flight Assessment Review
- PLAR – Post-Launch Assessment Review
- PRR – Production Readiness Review
- SAR – System Acceptance Review
- SDR – System Definition Review
- SEMP – Systems Engineering Management Plan
- SIR – System Integration Review
- SRR – System Requirements Review
- TPM – Technical Performance Measure
- TRR – Test Readiness Review