

- Objectives**
- To provide a Langley Management System (LMS) Center Procedure (CP) that complies with NPR 7150.2, NASA Software Engineering Requirements, for nonsafety-critical Class E software development, maintenance, management, acquisition, and assurance activities. [SWE-001][SWE-005]
[NPR 7150.2A:6.3.5]
 - To develop and implement the plans for managing the software activities.
 - To develop and provide quality software products and services and ensure customer requirements are met.

Approval

Stephen G. Jurczyk, Deputy Director *Original signed on file* Date: May 14, 2013

Scope

This Center Procedure applies to all nonsafety-critical Class E software development, maintenance, management, acquisition, assurance activities and services that are performed, created, and acquired by or for Langley (hereafter referred to as projects). [SWE-001][NPR 7150.2A:P.2.1] This includes new software development and modifications to existing software. This procedure applies to both the nonsafety-critical Class E software products and associated data.

Compliance Requirements

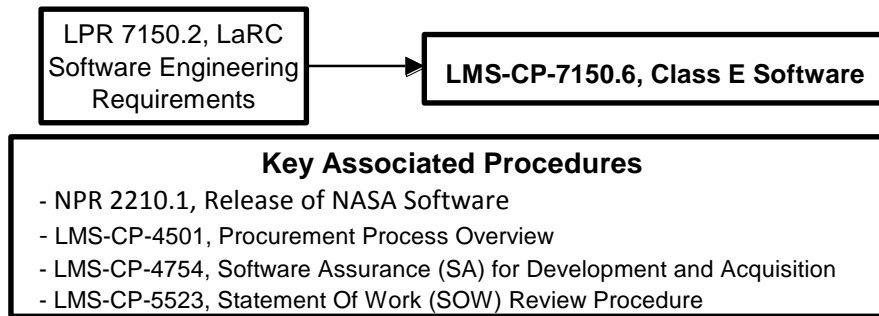
- Text in black is required; software activities shall fully comply with statements in black text. [SWE-139]
- Text in gray is contextual information that provides further description or examples that help clarify the requirement. Gray text is not required to be complied with.
- References are enclosed in brackets “[]”. The references show traceability to source documents.
- References of the form “[SWE-XXX]” refer to requirements numbers assigned to specific requirements in NPR 7150.2, NASA Software Engineering Requirements.

Training & Assistance

For answers to questions or to request training on this procedure, send an email to: larc-dl-support-sepg-help or call the “LMS Software procedure help desk phone number” provided at https://sites-e.larc.nasa.gov/sweng/home_pg/.

Procedure Context Diagram

The context diagram below shows the software engineering-related LMS procedures. This procedure is invoked by executing LPR 7150.2, LaRC Software Engineering Requirements. Referenced procedures are performed in parallel with this procedure as required. Definitions, references, and acronyms are located in LPR 7150.2.



Records List

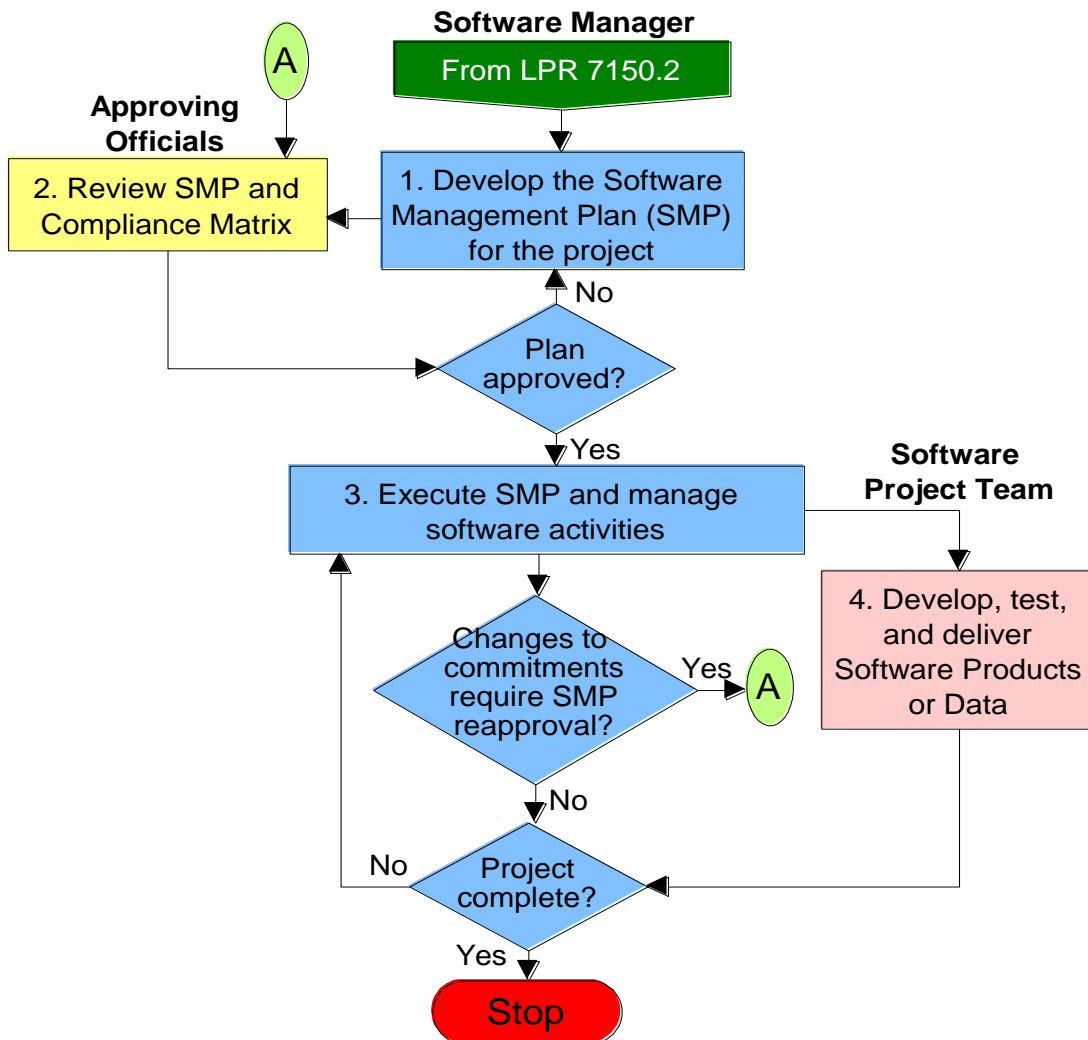
- Software Management Plan (SMP) including the Compliance Matrix
- Tracking Records (e.g., record of authorization for the SMP and associated Compliance Matrix, requirements change tracking records)
- Software life-cycle products (e.g., Software Requirements, software (code and data) and appropriate documentation, test inputs/outputs/results, supplier-provided deliverables/information called out in the contractual agreement or grant)

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Section 1: Perform Software Activities

- Perform the actions defined in the below flow diagram and associated step/action table on the following pages.
- The role of Software Manager can be performed by someone on the Software Project team. The Software Project team may be only one person.
- Actions in the step/action table are broken into subactions; both the actions and subactions specified in the step/action table are required to be performed. The actions defined within steps are often performed in parallel and iteratively.
- **The steps in the flow diagram are not always performed in the order in which they are numbered.** For example, some requirements documentation (covered in Step 4) may need to be done before Step 1 can be complete. **Review the flow diagram steps to determine if the order is appropriate for the project. Rearrange as necessary (e.g., the steps may be rearranged to accommodate spiral, evolutionary, agile, etc., approaches).** As long as all the requirements are fulfilled, rearranging is not considered tailoring.
- The Software Manager may need to gather applicable information to prepare for execution of the actions defined in the flow diagram (e.g., science and engineering technical requirements, concept of operation).
- Note that many of the activities in the step/action table may be flowed down to a supplier through contractual agreements or grants as part of Step 1.
- The actions defined in the flow diagram are performed until the completion or cancellation of the software activity/project.



STEP	ACTION TO TAKE
1	<p>Develop the Software Management Plan (SMP) for the project</p> <p>a. Document any preliminary requirements necessary to make informed planning decisions (refer to Step 4.a). [SWE-049]</p> <p>b. Ensure that:</p> <ol style="list-style-type: none"> 1. Each system and subsystem containing software has been classified in accordance with the software classification definitions in Appendix D in LPR 7150.2. [SWE-020] 2. The LaRC Mission Assurance Branch has: <ol style="list-style-type: none"> (a) Performed an independent Software Assurance Classification Assessment of each system and subsystem containing software according to LMS-CP-4754, Software Assurance (SA) for Development and Acquisition. [SWE-132] (b) Determined that the software is not safety critical in accordance with LMS-CP-4754. [SWE-133] 3. The classification and safety-critical determination results are recorded in or referenced from the SMP. (See SMP, Appendix A.b.). [SWE-020] 4. The NASA software inventory data for the project (e.g., software class, safety criticality) is provided to the LaRC current representative to the Agency Software Working Group. (See https://sites-e.larc.nasa.gov/sweng/home_pg/ for name of current representative.) [SWE-006] <p>c. Document an SMP (e.g., in a log, proposal, or research plan) that includes the items specified in Appendix A and either the Compliance Matrix in Appendix B or a reference to where it is stored. [SWE-013] For the reader's convenience, an electronic Microsoft Word version of Appendix A and B is provided in the "Appendices for LMS-CP-7150.6: Class E Software" at: https://sites-e.larc.nasa.gov/sweng/supporting-products/.</p> <ol style="list-style-type: none"> 1. If part of the work is being performed under a contractual agreement or grant: <ol style="list-style-type: none"> (a) NASA civil servants develop an SMP (sometimes called an acquisition plan) to identify the software class and safety-criticality determinations; Compliance Matrix; schedule; resource estimate; and activities to be performed by the civil servants. [SWE-013] (b) The supplier also produces an SMP to cover the supplier's schedule, resource and costs estimate, staffing, requirements management process, and other activities delegated under the contract or grant. [SWE-013] [SWE-125] (c) Some overlap will occur, but topics are covered in the NASA SMP from a civil servant acquirer perspective and in the supplier's SMP from a supplier perspective. [SWE-013] (d) Compliance Matrix items delegated to the contractual agreement or grant are specified in the agreement or grant. [SWE-125] [NPR 7150.2A:P.2.4] (e) When it is necessary to put in place a new contractual agreement, follow LMS-CP-4501, Procurement Process Overview. [LMS] (f) Review any statements of work/task requests using LMS-CP-5523, Statement Of Work Review Procedure. [LMS] <p>Guidance: It is recommended that the project document in the contractual agreement or grant: that the supplier notify NASA as to whether open-source or commercial-off-the-shelf software will be included in the code; the list of deliverables in electronic form (e.g., Software User's Manual, source files, executable software, procedures for creating executable software, procedures for modifying the software, and a Software Version Description); and the acceptance criteria that the software must meet before it is accepted. If the project needs to control further use and distribution of the resulting software or requires unlimited rights in the software (e.g., right to use, modify, and distribute the software for any purpose), the project can consider having the software copyright assigned to the Government.</p> 2. For projects that involve noncontractual multiparty agreements (support, partnership, and inter-Center agreements), also follow LPR 7150.2, Section 1.4, Multi-Party Software Activities, which specifies the required content for shared agreements involving software activities; the shared agreement content is defined concurrently with the SMP and Compliance Matrix. [SWE-125] 3. Consult with the Office of Chief Counsel and the contracting officer regarding the inclusion of commercial-off-the-shelf (COTS), government-off-the-shelf (GOTS), modified-off-the-shelf (MOTS), reused, or open-source software within a NASA system or subsystem. [LaRC Office of Chief Counsel] <ol style="list-style-type: none"> (a) Additional requirements on the inclusion of open-source software are in NPR 2210.1, Release of NASA Software, Section 1.8.3. (See the NASA Online Directives Information System at http://nodis3.gsfc.nasa.gov/) [LaRC Office of Chief Counsel]
2	<p>Review SMP and Compliance Matrix</p> <p>a. The Software Manager reviews and approves the SMP, including the Compliance Matrix and any applicable supporting acquisitions plans, to ensure it is ready for implementation and provides the plan to the Line Manager for approval. [LMS]</p>

STEP	ACTION TO TAKE
	<p>b. The Software Manager’s Line Manager reviews and approves the Compliance Matrix and the SMP to ensure they are in compliance with this procedure, to approve the allocation of the Line Manager’s staff and resources (e.g., licenses, travel, etc.), and to approve any tailoring requests in the Compliance Matrix. [LMS] Guidance: Additional approvals may need to be obtained for the SMP (e.g., the Project Manager may need to approve funding and staffing). Note: The NASA Headquarters Office of the Chief Engineer periodically conducts appraisals to check compliance.</p>
	<p>c. If the Compliance Matrix contains requests for tailoring against any of the requirements in this LMS CP, the Software Manager follows LPR 7150.2, Section 2.3, to obtain all the required approvals for the tailoring. [SWE-125] [SWE-122] [LMS]</p>
<p>3</p>	<p>Execute SMP and manage software activities a. When tailoring or waivers have been approved against the software Compliance Matrix, ensure a copy of the approved matrix is provided to the Software Engineering Process Group (SEPG) via email at LaRC-DL-SW-Matrix@mail.nasa.gov. [SWE-128]</p>
	<p>b. Ensure the implementation/execution and maintenance of the SMP. [SWE-014] [SWE-125] Guidance: Projects can maintain software plans by periodically reviewing the software plan, progress, Compliance Matrix; making sure they are up-to-date; and bringing up issues with the relevant stakeholders.</p>
	<p>c. If a system or subsystem evolves to a higher software classification than Class E, revisit LPR 7150.2 to complete Sections 1.2 and 1.3; this procedure no longer applies. [SWE-021] [SWE-132]</p>
	<p>d. If at any time, the project is determined to have safety-critical software, revisit LPR 7150.2 to complete Sections 1.2 and 1.3; this procedure does not apply to the safety-critical software. [SWE-023] [SWE-133]</p>
	<p>e. Maintain the Compliance Matrix against requirements in this LMS CP including those delegated to other parties or accomplished by contract vehicles. [SWE-125] <ol style="list-style-type: none"> 1. Ensure that all matrix items are implemented, and [SWE-125] 2. If the project desires to modify the approved Compliance Matrix, follow LPR 7150.2, Section 2.3.7, to obtain approval for the modifications via waiver. [SWE-125] 3. When waivers have been approved against the software Compliance Matrix, ensure a copy of the approved matrix is provided to the Software Engineering Process Group (SEPG) via email at LaRC-DL-SW-Matrix@mail.nasa.gov </p>
<p>4</p>	<p>Develop, test, and deliver Software Products or Data a. Document the software requirements. [SWE-049] Guidance: The software requirements can be expressed: <ol style="list-style-type: none"> 1. As written statements of purpose, expected capabilities, outputs, and any constraints such as timing performance or units of measure; or 2. As a model (e.g., use cases); or 3. As executable tests, or 4. Graphically as storyboards or as screen shots. The requirements can be recorded in a log, proposal, research plan, SMP, etc. Make sure the requirements are complete, consistent, correct, unambiguous, and verifiable. b. Develop software that meets the requirements. [SWE-077] Guidance: <ol style="list-style-type: none"> 1. Be self-documenting. 2. Include check cases, where applicable, in the code. 3. Have a version number or be part of a version control system. 4. Site references and methods where applicable. 5. Include the name of the responsible party. c. Perform software testing to make sure the software and/or the data produced by the software meet the requirements and record the version identifier of the software tested (e.g., in a test log, note book, or continuous integration system). [SWE-066] d. Deliver the completed software product(s) and/or data to the customer with appropriate documentation. [SWE-077] Guidance: <ol style="list-style-type: none"> 1. The appropriate documentation is negotiated between the customer and the project. 2. Documentation to build, execute, and recreate data or analysis should be recorded by the project. This is essential if code is not a deliverable (i.e., only data or analysis are delivered or published). </p>

Appendix A: Software Management Plan (SMP)

The Software Management Plan shall contain: [SWE-013]

- a. **Project title.** [SWE-013]
- b. **Software Classification and Safety Criticality.** The software classification of each of the systems and subsystems containing software and the safety-criticality determination (Example: All the systems containing software on the project are Class E and non-safety-critical). [SWE-020]
- c. **Schedule.** Start date and estimated completion date (along with any other key dates that progress needs to be tracked against). If software activities are ongoing, then the dates may be the period of performance (e.g., one year) rather than specific start and end dates. [SWE-013]
- d. **Resources.** If human resource utilization is not managed at a higher level (e.g., branch or project level) then document an estimate of effort (include both civil servant and contractor effort) that covers either: [SWE-015] [SWE-013]
 1. The entire software life cycle, or [SWE-015.a] [SWE-013]
 2. If the software activity is ongoing, then the effort estimate may be for a period of performance (e.g., one year) rather than the whole life cycle. [SWE-015.a] [SWE-013]
- e. **Compliance Matrix.** The completed Appendix B, Compliance Matrix, is included as an appendix to the SMP. [SWE-125] A Microsoft Word version of the Compliance Matrix (as specified in Appendix B) is provided in the "Appendices for LMS-CP-7150.6: Class E Software" at: <https://sites-e.larc.nasa.gov/sweng/supporting-products/> .
 1. For those requirements delegated to other parties (e.g., other Centers, agencies, grantees, or partners) or accomplished by contract vehicles, identify the responsible party that the requirement is delegated to in the Compliance Matrix. [SWE-125] [NPR 7150.2A:P.2.2]
 2. Document the tailoring requests against requirements in this procedure in the Compliance Matrix; tailoring is defined in LPR 7150.2, Section 2.3.2. [SWE-125]
- f. **Testing.** Describe how the project will test software product(s) and/or data. [SWE-013] [SWE-066] The description of the test could be as simple as documenting actions to be completed such as: 1) comparison of actual software results with specific lab results or past experience, independent checks against low order/simplified models, using alternate methods of calculation, 2) checking to see if the model considers all relevant physics and if the inputs fully capture the case of interest; or 3) a similar algorithm to confirm that the product meets the requirements; or 4) before the software or data is released, software will undergo review by 1-2 technical peers and by a branch head to independently verify that it executes as intended, that it is well written and it is based on sound theory. A formal test plan or procedure is not required.
- g. **Data Management.**
 1. Describe how the project will version control, backup, and release/deliver software product(s) and data. [SWE-013] [SWE-085]
 - **Version control** - Example: Increment version number in file name when the file is changed. Additionally, for codes that will have a long life, the code versions could be controlled by the Software Manager using the above mentioned version control method with notes put in the comments at the top of the source code files explaining the revision history. For codes that involve multiple developers an automated configuration management system may be more appropriate.
 - **Backups** - Example: Backups done nightly by LaRC Center-wide contract; or backups done nightly by the system administrator.
 - **Release/Delivery** - See LPR 7150.2, Appendix A, for definitions and Appendix E for related laws and policies. Some projects may consider delivery and release to be the same activity
 2. Description of how the project will keep track of requirements changes. [SWE-053] This can be as simple as defining who has the authority to make changes and either using electronic revision marks and versioning file names as discussed above, keeping a revision history, or making hand markups to the requirements documented in the log or research plan, or using a configuration management tool to implement change request.
 3. Document where the software products, data, and corresponding test inputs/outputs and results will be stored. [SWE-013] [SWE-066] [SWE-085] For example: Software products, data, and corresponding test inputs/outputs and results will reside on the Software Manager's desktop under the directory with the same name as the Project Title. It is recommended that sufficient information be recorded to recreate any data delivered or published.

Appendix B: LaRC Compliance Matrix for Class E Software (not Safety Critical)

Instructions: For each STEP and Appendix listed below, complete the 3rd and 4th column of this matrix or equivalent; complete all remaining columns for each tailoring request. Obtain the approvals listed at the bottom of the matrix. See "Appendices for LMS-CP-7150.6: Class E Software" at: <https://sites-e.larc.nasa.gov/sweng/supporting-products/> for a Microsoft Word electronic copy of this Matrix.

Note: To add additional rows within a STEP, right click on a cell in the middle of the row, select "Insert," select "Insert Rows Above" or "Insert Rows Below"; follow a similar process for adding columns.

Name of Project: _____

Date Approval Requested: _____

[SWE-125]

LMS Procedure		Planned Implementation		Tailoring		
Step #	Step Name	Step or substep ID#	Responsible party	If an LMS CP step is tailored, explain the tailoring requested	Impacts/risks associated with the tailoring request	Justification for tailoring requests (why impacts and risks are acceptable)
1	Develop the Software Management Plan (SMP) for the project					
2	Review SMP and Compliance Matrix					
3	Execute SMP and manage software activities					
4	Develop, test, and deliver Software Products/Data					

LMS Procedure		Planned Implementation		Tailoring		
Appendix #	Appendix Name	Appendix item or subitem ID#	Responsible party	If an LMS CP Appendix item is tailored, explain the tailoring request	Impacts/risks associated with the tailoring request	Justification for tailoring requests (why impacts and risks are acceptable)
A	Software Management Plan (SMP)					

Approvals Required for Planned Implementation

¹Software Manager: _____ Date: _____ Approved (Yes, No) Sig.² _____

³Software Manager's Line manager: _____ Date: _____ Approved (Yes, No) Sig.² _____

Additional Approvals Required if Tailoring is Requested (Follow requirements for obtaining approvals in LPR 7150.2, Section 2.Tailoring and Waivers.)

⁴Applicable project personnel: _____ Date: _____ Approved (Yes, No) Sig.² _____

Mission Assurance Branch (C201): _____ Date: _____ Approved (Yes, No) Sig.² _____

⁵Software Engineering Process Group Rep: _____ Date: _____ Concurred (Yes, No) Sig.² _____

⁶Technical Authority (Directorate Head): _____ Date: _____ Approved (Yes, No) Sig.² _____

⁷Other: _____ Date: _____ Approved (Yes, No) Sig.² _____

¹ Approval by Software Manager confirms that the project plans to complete all LMS-CP-7150.6 requirements and any requested tailoring specified in the above Compliance Matrix.

² Optional: Written or electronic signature.

³ The line manager reviews and approves this Compliance Matrix to ensure the project complies with LMS-CP-7150.6, Class E Software, and to approve tailoring requests.

⁴ Individuals accepting the risk associated with the tailoring.

⁵ The Software Engineering Process Group representative from the Software Manager's Directorate.

⁶ The Software Manager's Directorate Head.

⁷ This may be the LaRC Director SMA Office, NASA HQ CE, or HQ Chief SMA (see LPR 7150.2A for approvals required).