

DATE: 1/26/2024

TO: Center Directives Manager
Langley Research Center



FROM: 140/Director, Center Operations Directorate

SUBJECT: MEMO Authorizing Continued Use of Expired LPR 7123.2A-4, Facility Configuration Management, Expiration date: May 31, 2022

REF A: NASA Requirement Waiver for NPR 1400.1 (3.5.2.6), NRW 1400-37

In accordance with reference A, I authorize the continued use of the expired subject directive.

LPR 7123.2A-4, Facility Configuration Management
The subject process has been reviewed prior to the expiration date and a summary of the required changes are: Directive is undergoing extensive revision to reflect updated processes.
The directive was also assessed for the risk of continued use after expiration versus the risk of not having the directive available after expiration. The risk of continued use is: The directive sets forth the implementation of org procedures and requirements to manage facility related information using the Facility Configuration Management System (FCMS). The efficient and effective implementation of essential facility document management would be at risk if LPR 7123.2A-4 is not current.
Justification for the delay is: The pending delivery and implementation of a new software interface and related new capability will require a revision to the current document. The extension eliminates unnecessary re-work providing a single update and associated Center review of this document.
The updated directive will be submitted for Centerwide review no later than: <u>May 31, 2024</u>

Please refer any questions or concerns regarding the continued use of this directive to Loretta Kelemen.

Director, Center Operations Directorate

Date

cc:

22/William "Gene" Griffith

DATE: 12/18/2023

TO: Center Directives Manager
Langley Research Center



FROM: 140/Director, Center Operations Director

SUBJECT: MEMO Authorizing Continued Use of Expired LPR 7123.2A-4, Facility Configuration Management, Expiration date: May 31, 2022

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The updated directive will be submitted for Centerwide review no later than: <u>January 31, 2023</u>

Please refer any questions or concerns regarding the continued use of this directive to Loretta Kelemen.

Director, Center Operations Director

Date

cc:

22/William "Gene" Griffith



**Langley
Procedural
Requirements**

LPR 7123.2A-4

Effective Date: May 24, 2018

Expiration Date: May 31, 2023

Subject: Facility Configuration Management

Responsible Office: Center Operations Directorate

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PREFACE

P.1 PURPOSE

This document sets forth procedural requirements for the Langley Research Center (LaRC) Facility Configuration Management (FCM) Program for the Center's facility complexes, buildings, and horizontal infrastructure systems. It defines the requirements of the Center's FCM Program. It describes the implementation of the configuration control requirements in compliance with NASA Procedural Requirements (NPR) 8715.3D, "NASA General Safety Program Requirements" dated 8/1/17 and NPR 7123.1C "NASA Systems Engineering Processes and Requirements" dated 2/14/2020 and is part of the Langley Management System (LMS). It also provides guidance for government and contract personnel in performing their responsibilities for this program.

P.2 APPLICABILITY

- a. This LPR is applicable to all Langley employees and contractors.
- b. In this directive, all document citations are assumed to be the latest version unless otherwise noted.
- c. Processes described that contain the words "shall", "required", and "will" are directives to FCM Program and interfaces.

P.3 AUTHORITY

NPR 8715.3D, NASA General Safety Program Requirements.

NPR 7123.1C, Systems Engineering Process and Requirements.

P.4 APPLICABLE DOCUMENTS AND FORMS

- a. 36 CFR Part 1220.14, NARA Federal Records
- b. 36 CFR Part 1222.12, NARA Creation and Maintenance of Federal Records
- c. NPD 1440.6, NASA Records Management
- d. NPR 7150.2, NASA Software Engineering Requirements, Appendix E. Software Classifications
- e. NPR 1441.1, NASA Records Management Program Requirements
- f. NASA-GB-8719.13, NASA Software Safety Guidebook
- g. NASA-STD-8719.7, Facility System Safety Guidebook
- h. NASA-STD-8739.8, Software Assurance and Software Safety Standard
- i. LAPD 1700.2, Safety Assignments and Responsibilities
- j. LAPD 7000.2, Review Program for Langley Research Center (LaRC) Facility Projects
- k. LAPD 7150.10, Facility Software Classification Policy

- l. LPR 1710.42, Safety Program for the Recertification and Maintenance of Ground-Based Pressure Vessels and Piping Systems
- m. LPR 1710.6, Electrical Safety
- n. LPR 1740.2, Facility Safety Requirements
- o. LPR 1740.4, Facility System Safety Analysis
- p. LPR 7150.2, LaRC Software Engineering Requirements
- q. LMS-CP-4710, Facility Change Request Process
- r. LMS-CP-1741.2, Facility Configuration Management Audit Process
- s. LMS-CP-7151, Obtaining Waivers for Langley Management System (LMS) Requirements
- t. LMS-CP-8715, Facility Risk Tier Determination
- u. COD Facility Engineering Standard for Piping Systems and Pressure Vessels
- v. Langley Form (LF) 605, Facility Change Request
- w. LF 445, LaRC Facility Risk Tier (FRT) Designation Form
- x. LF-599, Facility Configuration Management Audit Form
- y. LF-491, CMMS (i.e. Maximo) Change Form
- z. LF-461, Environmental Project Planning Form

P.5 MEASUREMENT/VERIFICATION

None

P.6 CANCELLATION

Not Applicable – Original Version

Cathy Mangum
Center Associate Director

May 24, 2018
Date

Distribution: Approved for public release via the Langley Management System; distribution is unlimited.

CHAPTER 1.0 – FACILITY CONFIGURATION MANAGEMENT PROGRAM SCOPE

1.1 INTRODUCTION

The LaRC Facility Configuration Management (FCM) Program exists to manage Configuration Controlled Items (CCIs.) CCIs shall be identified and controlled to ensure personnel and facility safety as well as mission reliability of ground-based research facilities, buildings, and horizontal infrastructure systems. Mission reliability is characterized by dependability of a system where there are few, if any, unplanned outages; in the event of an outage, accurate configuration-controlled information enables efficient troubleshooting and prompt restoration of service. CCIs include drawings, documents, and models (e.g. Building Information Models) that have been designated to ensure the successful development, maintenance, sustainability, and support of complex systems, equipment, and facilities. The FCM Program has the following elements:

- a. FCM Owner Teams
 - i. FCM Owner
 - ii. Facility Safety Head (FSH)
 - iii. Facility Coordinator (FC)
 - iv. FSH and FC Alternates
- b. Configuration Control Center (CCC)
 - i. FCM Program Manager
 - ii. CCC Lead
 - iii. Computer server-based Facility Configuration Management System (FCMS)
 - iv. Auditor/Trainer
 - v. 2-D, 3-D drafters/modelers
 - vi. Technical writer
- c. FCM disciplines:
 - i. Pressure Systems Configuration Management (PSCM)
 - ii. Software Configuration Management (SCM)
 - iii. Computerized Maintenance Management System (CMMS, i.e. Maximo)
 - iv. Geographic Information System (GIS)
- d. Technical Authorities
 - i. Safety Manager & Facility Systems Safety Engineers
 - ii. Fire Chief
 - iii. Standard Practice Engineers
 - iv. Others (e.g. IT, Environmental, Security as needed)
- e. Project Managers
- f. FCM Control Board (FCMCB)

- 1.1.1 All LaRC facilities and systems shall be included in the FCM Program and have been designated with safety and mission risk levels and categorized as High, Medium, or Low Risk Tier facilities or systems (See https://sites.larc.nasa.gov/cmoeportal/files/2018/01/Facility-Risk-Tier-List-Dec_18_2017.pdf for current facility risk tier designation)
- 1.1.2 All LaRC facilities and systems will require a safety analysis conducted in accordance with the LPR 1740.4 Facility System Safety Analysis process with a Facility Risk Tier designation per LMS-CP-8715.
- 1.1.3 Configuration Controlled Items (CCIs) shall be managed per LMS-CP-4710 Facility Change Request (FCR) Process. The CCIs will be stored and modified using FCRs in the computer server based FCM System (FCMS.) The types of CCIs required are dependent on the risk tier assigned to the facility as shown in Table 1 below (reference Appendix A for definitions).

Table 1 - CCIs Required Depending on Facility Risk Tier

Low Risk Tier	Medium Risk Tier	High Risk Tier
Hazard Analysis	Hazard Analysis Report	SAR or Hazard Analysis
Emergency Cutoff Procedures*	Mission Critical Systems List	Mission Critical Systems List
Level 1 Drawings*	SOPs & Check Lists	SOPs & Check Lists
	Emergency Cutoff Procedures	Emergency Cutoff Procedures
	Level 1 Drawings	Level 1 Drawings
		Level 2 Subsystem Drawings
		Critical Component Assembly & Bill of Material (BoM) Drawings*
		Interlock List*

*If applicable

- 1.1.4 CCIs required for facility software, pressure systems, and maintenance are described separately in Chapters 2-4. These include Pressure Systems Documents (PSDs), Weld maps, Inspection Plans, Software, Software Configuration Management Plans, and the maintenance asset database.
- 1.1.5 Details on the FCM program are found in the remainder of this document as described below,
- Chapter 2 addresses the FCM Program Requirements
 - Chapter 3 addresses the PSCM Program
 - Chapter 4 addresses the Facility Software Configuration Management (SCM) and processes

1.2 OBJECTIVES

1.2.1 The facility configuration management (FCM) shall:

- a. Establish and maintain a field verified baseline for all facilities and systems with relevant Configuration Controlled Items (CCIs).
- b. Ensure the FCM Owner and all relevant technical authorities and configuration management disciplines [Pressure Systems Configuration Management (PSCM), Software Configuration Management (SCM), Computerized Maintenance Management System (CMMS, i.e. Maximo), and Geographic Information System (GIS)] review changes to CCIs.
- c. Ensure that all CCIs impacted by a change are updated and field verified.
- d. Obtain electronic approval of all new and changed facility drawings and documents held in the computer server based FCM System (FCMS) repository. This includes Supporting Facility Documents (SFDs) such as “as-built” construction drawings, reference models (e.g. Building Information Model (BIM)), and reference documents.

NOTE: Although SFDs are not under Configuration Management, if they are newly created or revised such as for a new construction project then the new or revised documents require approval signatures from FCM owner, technical authorities, and FCM disciplines.

1.2.2 The Pressure Systems Configuration Management (PSCM) Program shall maintain the configuration of Pressure System Documents (PSD), Weld Maps, Inspection Plans, and component data to ensure the system is safe for the intended pressure and use.

1.2.3 The Facility SCM Program shall:

- a. Document and maintain configuration control of software.
- b. Ensure Safety and Mission Assurance Office (SMAO) reviews changes that affect safety.
- c. Establish and maintain a baseline for designated systems (e.g., computer systems) and the relevant documentation (e.g., Software Assurance Classification Report (SACR), SCMP, drawings, Computer System Inventory List (CSIL)).

1.3 DEFINITIONS

1.3.1 The glossary in Appendix A lists and defines the terms unique to the FCM Program.

1.4 WAIVERS

1.4.1 Requests for waivers to any of the requirements in this LPR shall be submitted to the COD Chief Engineer in writing and processed in accordance with LMS-CP-7151, Obtaining Waivers for Langley Management System (LMS) Requirements.

CHAPTER 2.0 – FACILITY CONFIGURATION MANAGEMENT (FCM) PROGRAM REQUIREMENTS

2.1 REQUIREMENTS

All facility complexes, buildings, and horizontal infrastructure systems shall be included in the LaRC FCM Program. LaRC FCM Program shall:

- 2.1.1 Identify CCIs for each facility which are approved by the FCM Program Manager.
- 2.1.2 Maintain a CCI baseline for all LaRC facilities and systems as defined in Appendix C.
- 2.1.3 Designate CCIs to mitigate both safety and mission risk as defined in the LaRC LMS-CP-8715
- 2.1.4 Identify mission critical systems that are not safety critical (as defined in the Safety Analysis Report (SAR) or other hazard analysis) on a Mission Critical Systems list which will be a CCI.
- 2.1.5 All facility complexes (multiple buildings), buildings (if not part of complex), and horizontal infrastructure systems shall be identified in the FCM System with one of the following:
 - a. Building number (e.g. B2103 for Computational Research Facility).
 - b. Horizontal infrastructure real property asset number (e.g. 880-10 for Fire Alarm Systems; 131-60 for Communications Network).
 - c. Effort Codes (see Appendix D) for legacy facilities.
 - d. Portions of buildings where the function or directorate ownership is different and have different facility personnel assigned than the rest of the building shall be designated in one of two ways:
 1. Individual labs by the building number followed by “-Lab01”, “-Lab02” and so forth.
 2. Subsets or groups of labs by the building number followed by “-Sub01”, “Sub02” and so forth.

NOTE: These designations shall be further defined using the room number(s) associated with those areas of the building (e.g. B1247B-Lab01 for the Arc Heated Scramjet test facility; B1250-Sub01 for the Engineering Directorates Systems Integration and Test Laboratories of the building).

- 2.1.6 FCM Program Manager shall maintain an electronic, server based repository (named “Facility Configuration Management System (FCMS)”). Facility Configuration Management System shall:
 - a. Capture and retain Facility CCIs.
 - b. Capture and retain Supporting Facility Documents (SFDs) which require original release and revision approvals (such as for construction,

manufacturing, and assembly drawings. Other SFDs include obsolete drawings, previous revisions of drawings, and other documents no longer under configuration management.

- c. Capture and retain non-facility drawings such as for Science Directorate, Engineering Directorate, wind tunnel model, and balance drawings, etc. The scope of the repository encompasses all drawings kept in the previous Engineering Drawing File (EDF).
- d. Have a searchable index generated based on text embedded within each CCI.
- e. Track drawing numbers, document numbers, and component location numbers (i.e. LaRC IDs) for the benefit of developing a hierarchy which will be used to fully address a change to a facility such that all associated items are updated and maintained in an accurate condition.
- f. Capture and retain all facility CCIs and SFDs in native format (AutoCAD, MS Word, Pro-E, Rivet BIM model, etc.).

2.1.7 FCM Program Manager through the Configuration Control Center (CCC) shall maintain and process Facility Change Requests (FCRs) in accordance with LMS-CP-4710 to:

- a. Revise all facility CCI and SFD.
- b. Add approved CCI and SFD to the repository.
- c. Change the status of all CCI and SFD in the repository per FCR:
 - 1. CCI to SFD and vice versa.
 - 2. "active" to "obsolete".
 - 3. "as-designed" to "as-built".
- d. Track the status of FCR processing to ensure their timely disposition according to requirements.
- e. Integrate the FCR process with the FCM disciplines of Pressure Systems Configuration Management (PSCM), facility Software Configuration Management (SCM), Computerized Maintenance Management System (CMMS), and Geographic Information Systems (GIS.) See section 2.6 FCM System for implementation details of this integration.

2.2 LaRC FCM PROGRAM ORGANIZATION

Successful implementation of FCM Program relies on defined FCM roles and responsibilities.

2.2.1 The FCM Program Manager shall:

- a. Execute an FCM Audit process in accordance with LMS-CP-1741.2.
- b. Coordinate with FCM Owners on priority of FCRs.

- c. Oversee all Configuration Control Center (CCC) activities.
 - d. Review and approve or reject all proposed new CCIs before they are entered into the FCMS repository as part of the FCM baseline for the facility.
 - e. Report on FCM Program Status to FCMCB quarterly and to the CLC annually
- 2.2.2 Organizational Directors shall appoint FCM Owners for each of their LaRC facilities and systems using LF-1 appointment form per LAPD 1700.2.
- 2.2.3 FCM Owner shall be responsible for:
- a. Integrity of their facility/system CCIs.
 - b. Approving/rejecting FCR changes and revisions to CCIs and SFDs in the FCMS repository.
 - c. Addressing corrective actions from FCM audits in accordance with LMS-CP-1741.2.
 - d. Coordinating with the FCM Program Manager to prioritize FCRs (if needed).
- 2.2.4 Configuration Control Center (CCC) shall be responsible for:
- a. Overall administration of the FCM Program.
 - b. Operating and maintaining the FCMS.
 - c. Processing FCRs including approval, distribution, status keeping, and making changes (configuration change management) to CCIs if not the responsibility of a project activity or FCM discipline.
 - d. Conducting audits of FCM baselines at all facilities and tracking actions to closure in accordance with LMS-CP-1741.2.
 - e. Conduct training for FCM stakeholders including FCM Owner teams, CCC staff, technical authorities, FCM discipline leads, Project Managers and others who need to access FCMS or who have a role in the FCM Program.
 - f. Evaluating proposed CCIs for approval or rejection based on this LPR's requirements.
 - g. Prioritizing FCR processing.
 - h. Ensuring adequate training for all personnel involved with the FCM Program.

2.3 CRITERIA FOR DESIGNATING CCIs

The criteria for designating documents, drawings, and models (e.g. BIM) as CCIs is defined in Table 1, depending on the assigned Risk Tier of the facility.

- 2.3.1 The Risk Tier for the facility is established by SFAB using LF-445, LaRC Facility Risk Tier (FRT) Designation Form in accordance with LMS-CP-8715 "Facility Risk Tier Determination."

2.3.2 The following are considered Configuration Controlled Items:

a. CCI drawings/models:

1. **Level 1 drawings/models:** System level drawing or models used to develop hazard analyses and Standard Operating Procedures (SOPs) as well as to isolate energy for Lockout-Tagout (LOTO) procedures. Level 1 drawings are in most cases Piping & Instrumentation Diagrams (P&IDs), one-line power distribution diagrams, and control loop diagrams. These drawings may be for both safety critical (defined in SAR or hazard analysis) and mission critical systems (defined in Mission Critical Systems List).
2. **Level 2 drawings/models:** Subsystem drawings/models used to perform troubleshooting and repairs when a system has failed as well as to support LOTO procedures. Level 2 (or subsystem) drawings are typically component wiring diagrams (e.g. Motor Control Center (MCC) or a skid or test stand level P&ID (e.g. hydraulic skid).
3. **Assembly or Bill of Materials (BOM) drawings/models:** Drawings/models that could be considered either as Level 1 or 2 drawings depending on whether they are used for SAR and SOP development or only for troubleshooting and repairs. These types of drawings may be for wind tunnel mechanisms (e.g. model injection and support, main drives, and test section movables) or for documenting safety critical materials (e.g. oxygen valves).

NOTE: Drawings that will not be considered facility CCI: wind tunnel models, wind tunnel balances, test articles. Although these drawings may be kept in the FCMS repository they will not be maintained by the CCC as FCM program CCIs.

- b. SARs and Hazard Analysis are required in LPR 1740.4
- c. Mission Critical Systems List
- d. SOP and Checklists as required in LPR 1740.4
- e. Pressure Systems CCIs as required in Chapter 3 and LPR 1710.42
- f. Software CCIs in accordance with Chapter 4 and LPR 7150.2
- g. Emergency Cutoff Procedures (ECPs)
- h. Facility Risk Tier Designation Form, LF-445 (Maintained by GIS within the FSPL system)-risk tier level and rationale are accessible to everyone from the FSPL
- i. Device List

2.4 UPDATING AND DISTRIBUTING A CCI

All CCIs shall be updated in accordance with the redlined documents submitted through an approved FCR.

- 2.4.1 Updating CCIs shall occur after the approved changes of the FCR have been completed.
- 2.4.2 All updated CCIs shall be distributed as outlined in 2.7.4 CCI Working Masters section.
- 2.4.3 FCR initiator with FCM Owner team approval shall designate whether CCIs will be updated electronically by the CCC, by the project activity, or by the facility personnel.
- 2.4.4 The FCM Program Manager will concur or non-concur with the entity updating (redlines to blacklines) the native electronic format of the CCI.

NOTE: In general, CCIs changed as a result of an FCR implemented by the FCM Owner team, will be updated (redlines to blacklines) by the CCC (or by integrated FCM disciplines GIS, CMMS, PSCM, or SCM). Changes implemented by a project are expected to be provided by the project including complete, “as-built”, field verified changes of both CCIs and any new project drawings/models (e.g. BIM, ETAP, Pro-E) that will be placed into the repository as SFDs.

- 2.4.5 For each FCR completed, a notice shall be sent from FCMS to the FCM Owner Team that includes at least the following information: FCR Number, Description of Change, notice of completion.
- 2.4.6 The facility shall receive a hardcopy of the revised CCI as the “Working Master(s)” for drawings and documents but not for GIS maps/floor plans, CMMS, or Software code.

2.5 TYPES OF CHANGE

Modifications to facilities at LaRC under the FCM Program can be one of four types. The FCR process depends upon which of these types of changes are occurring. The methods are discussed in the paragraphs that follow.

- 2.5.1 Facility Implemented Change
 - a. Facility changes affecting a CCI shall be submitted as an FCR by a member of the FCM Owner team obtaining approval from the FCM owner team, the CCC, and applicable technical authorities and integrated FCM discipline leads prior to implementing the change.
 - b. Complex changes may be entered as a “conceptual” FCR, with a narrative description and the CCI number of the key Level 1 drawing, model, or document but without an attached redlined work package. The conceptual FCR allows notification of the technical authorities and FCM discipline leads

of the change to obtain their comments and input before expending significant resources on developing the work package.

- c. Once approved by the FCM owner team and the CCC, the work package may be developed by the requestor and submitted to obtain approvals from the technical authorities and FCM discipline leads prior to implementation.
- d. Following completion of FCR implementation, the FCM Owner Team shall ensure that redlined “as-built” field verified CCIs are provided. Revision redlines to SFDs are optional. Obtain needed equipment LaRC location IDs (see Appendix E) from the LaRC ID Registry at:

<https://gis-dbweb.LaRC.nasa.gov/ords/apex/f?p=LARCID> for CCIs

2.5.2 Urgent Changes

- a. The FCM Owner, with the concurrence of the FSH, may verbally authorize urgent changes to a CCI provided that:
 - 1. Urgent changes shall be entered into the FCMS as an FCR not more than 3 working days after the decision to implement the change in order to obtain the approval of relevant technical authorities and integrated FCM disciplines.
 - 2. Urgent changes shall be designated on the FCR as “URGENT”.

2.5.3 Project Implemented Change

- b. This method is used for major modifications that are governed by LAPD 7000.2, “Review Program for Langley Research Center (LaRC) Facility Projects.” Prior to the Preliminary Design Review (PDR), the PM, in coordination with the FCM Owner Team, shall ensure that the affected portions of all CCIs impacted by the project are field verified (FV) and redlined to reflect the true configuration of the facility.
- c. At the PDR, SFAB System Safety Engineer presents the results of the preliminary hazard analysis.
- d. Prior to Critical Design Review (CDR) the PM shall enter a conceptual FCR (no work package required) into FCMS and obtain drawing numbers, if applicable, obtain needed equipment location LaRC IDs (see Appendix E) from the LaRC ID Registry at <https://gis-dbweb.LaRC.nasa.gov/ords/apex/f?p=LARCID> for CCIs.
- e. Following CDR, the PM shall attach the work package (see definition) to one or more FCRs in FCMS with the final post-CDR package of drawings or model (including marked up CCIs, obsolete CCI/SFD drawings, and new CCI/SFD drawings) to initiate the final review and electronic signature by all FCM owner team members, technical authorities, and FCM discipline leads. This FCR shall identify which new drawings are CCI and which are to be SFD.

- f. The PM shall have a Field (or Functional) Verification Plan to ensure all CCI drawings are field verified. The plan shall be provided no later than the Integrated System Review (ISR) (if applicable) or commissioning (if applicable).
- g. IMPORTANT: Projects that generate drawings/models (e.g. BIM) shall include funds for updating electronically all drawings/models (both CCIs and SFDs created by the project) to “as-built” condition. The CCC will not update CCIs/SFDs from redlines for such projects.
- h. Following the ISR (if applicable) and prior to the Operational Readiness Review (ORR) (if applicable) or following the completion of construction/commissioning (if ISR and ORR not required) the PM shall submit in the FCMS a change to the original FCR with the final updated “as-built” documents and field-verified drawings/models (including the CCIs.)
- i. At the ORR (if applicable) or following completion of construction/commissioning the FSSE shall provide the final redlined SAR (or hazard analysis). If applicable, the Facility Risk Tier Designation Form 445 shall be updated by the FSSE.

2.5.4 Facility Maintenance Change

- a. This method is governed by Computerized Maintenance Management System (CMMS) Change Request LMS-CP-5616. The CMMS Software/equipment change electronic request form (<https://codnet.ndc.nasa.gov/Forms/viewform.cfm?FormID=1047>), LF-491 is utilized to update the CMMS system (MAXIMO). All facility/system CCIs affected by the maintenance change shall be identified and updated in the FCMS repository.

2.6 FCMS INTEGRATION WITH FCM DISCIPLINES

The Facility Configuration Management System, a computer server based system, shall electronically integrate FCR processing to ensure comment, approval/rejection, and database update by the FCM discipline leads for PSCM, SCM, CMMS, and GIS. This integration shall accomplish the following:

NOTE: Integration is achieved electronically through workflows which distribute FCRs for review and electronic approval as well as for confirmation that FCM discipline databases (GIS, CMMS, Software, PSCM) have been updated as a prerequisite for closing an FCR. The FCMS and CCC achieves this integration.

- 2.6.1 Ensures that all equipment on a CCI are assigned unique location numbers, also known as LaRC location IDs (see Appendix E for full requirements).
- 2.6.2 Utilize CMMS Change Form, LF-491. NOTE: This form is used to change the asset database including adding or changing equipment location LaRC IDs and other data related to assets which are configuration controlled either because

they are shown or referenced in CCIs or because they undergo Preventive Maintenance (PM.) Refer to LMS-CP-5616 for LF-491 processing.

- 2.6.3 Utilize Environmental Form, LF-461. NOTE: This form is used as a tool for evaluating many of the Center's projects and can be used to screen for facility changes that may impact CCIs. Refer to LPR 8500.1 for LF-461 processing.
- 2.6.4 Utilize Facility Work Permit Form, LF-490. NOTE: This form is used to notify facility personnel, safety engineers, and construction inspectors that construction work is about to begin in a facility to which they have been assigned. Refer to LMS-CP-8835 for LF-490 processing.
- 2.6.5 Utilize Dig Permit Form. NOTE: This form is used to obtain approvals prior to digging at the Center to ensure underground utilities are not damaged and that the new underground work is documented in GIS.

2.7 CONFIGURATION CONTROLLED ITEMS

This section identifies requirements unique to drawings or models (e.g. Building Information Model (BIM), Electrical Transient Analyzer Program (ETAP)) and documents (e.g. SOPs, SARs, PSDs) incorporated into the FCM Program and designated as CCI. Section 2.2, "Criteria for Designating CCIs" provides guidelines for which drawings may be designated CCI.

2.7.1 CCI Drawing Field Verification

- a. All engineering drawings in the FCM Program shall be classified as either field verified (FV), functionally verified, or unverified.
- b. Electrical systems that are operational are normally functionally verified per LPR 1710.6 rather than field verified because this would require lifting wires/connectors which would create risk for an operational system.
- c. Additionally, no new drawing shall be brought into the FCM program (designated as CCI) unless it is first FV.
- d. The field verification process shall be a hands-on verification of the validity of the drawing conducted by facility personnel, pressure systems recertification personnel (for PSCM documents), or by project personnel.
- e. A drawing which has been verified shall display a "FIELD VERIFICATION" or "FUNCTIONAL VERIFICATION" statement authenticating that action:
 - 1. That statement shall be electronically signed in FCMS by the person attesting to the field verification.
 - 2. It shall also be electronically signed in FCMS and dated as approved by the PM, FSH, FC, FCM Owner, or Pressure Systems Manager (PSM) for PSCM documents.
 - 3. If FV drawings are found to be discrepant, they shall lose their FV or functionally verified status and shall be identified as unverified:

4. All drawings that are currently in the FCM Program and not FV are subject to an audit finding. The FCM Owner is responsible for ensuring their CCI's are FV.

Figure 2-1: DRAWING VERIFICATION STAMPS

CONFIGURATION CONTROLLED ITEM	
FUNCTIONAL VERIFICATION VERIFIED BY: _____ APPROVED BY: _____ LATEST DATE: _____	Bldg.# or Effort Code

CONFIGURATION CONTROLLED ITEM	
FCM FIELD VERIFICATION VERIFIED BY: _____ APPROVED BY: _____ LATEST DATE: _____	Bldg.# or Effort Code

CONFIGURATION CONTROLLED ITEM	
WARNING UNVERIFIED	Bldg.# or Effort Code

2.7.2 CCI Drawing Changes

- a. When drawings in the FCM Program require change, the drawing shall be redlined. Drawings may be redlined manually or electronically.
- b. Drawings that are redlined manually shall be redlined as follows, then scanned and entered as an attachment to the FCR:
 1. New items shall be added in green ink or black ink highlighted in yellow marker.
 2. Existing items requiring deletion shall be marked out with red ink.
- c. Drawings that are redlined electronically shall be redlined as follows, then attached to the FCR:
 1. All items being changed (added/deleted) shall be outlined in a cloud format
 2. New items shall be added in green
 3. Existing items requiring deletion shall be marked out with red
- d. Redlined drawings shall be processed using the FCR process.

- e. The new revised drawings shall be uploaded into the FCMS and new WORKING MASTER copies delivered to the facility.

2.7.3 CCI Document Changes

- a. Documents may be manually redlined, scanned, and attached to the FCR or have annotated changes made in PDF or in MS Word with change tracking “on” to clearly show all changes made to the revision under CM.

2.7.4 CCI Working Masters

- a. For each CCI, the facility shall be provided a current revision marked “WORKING MASTER” in red ink. The intent of this procedure is to identify the copy of the current configuration of the facility as described by the Master (reproducible) CCI.
- b. Where there are CCI’s that effect more than one facility, each of the effected facilities (and/or systems) shall be listed on the CCI sticker applied to the drawings.
- c. In addition, only one WORKING MASTER shall be provided and shall be determined by the first facilities (and/or systems) listed on the CCI as to location of the WORKING MASTER. The second facilities (and/or systems), will maintain a copy of the WORKING MASTER.
- d. Where there are CCI’s that effect more than one facility, the Facility Coordinator shall ensure all effected facilities (and/or systems) designated on a WORKING MASTER shall be notified prior to changes being initiated to the as built configuration.
- e. To preclude any adverse impact of changing a drawing with multiple labs or Effort Codes, the FCM Owner shall ensure that a FCR has been approved before modifying the facility.
- f. Adherence to the following additional guidelines promotes accountability and use of WORKING MASTER CCIs:
 - 1. A WORKING MASTER drawing shall always reflect the true (“as-built”) configuration of the facility it represents.
 - 2. Proposed changes to a facility which impact a CCI shall be redlined on a separate copy of the affected drawing or document, not on the WORKING MASTER.
 - 3. Changes, which reflect “as-built” configurations, shall be marked on the WORKING MASTER of each affected CCI (drawing and documents).
 - 4. The current WORKING MASTER (or a copy of it) shall always be present at the facility.
- g. FCM CCI Working Master Documents storage, organization and retrieval

1. All facility CCI Working Master documents shall be distinctly controlled separately from documents used by the facility
2. CCI Working Masters shall be organized and labeled for easy retrieval
3. Per LPR 1740.2, A note in the facility resume shall indicate the location of the Working Master within the facility

2.8 FCM AUDITS

All facilities and systems shall have their FCM baseline audited in accordance with LMS-CP-1741.2 on a recurring basis with all high-risk tier facilities annually, medium risk tier facilities every two years, and low risk tier facilities every three years. Results of the audits are presented at the next FCMCB and the overall performance of the FCM Program is presented once yearly to the Center Leadership Council, Executive Safety Council, or some other Center Director forum.

- 2.8.1 The CCC Auditor/Trainer shall issue LF-599 summarizing the audit results and delineating “action items”.
 - a. LF-599 shall be distributed to the FCM owner team.
 - b. LF-599 shall be stored and tracked to completion in the FCMS.
- 2.8.2 Prior to (or as part of) the audit, the CCC Auditor/Trainer shall conduct training for the FCM Owner team on this LPR, and associated FCM Program LMS documents, and the FCMS.

2.9 FACILITY CONFIGURATION MANAGEMENT SYSTEM (FCMS)

The FCMS system replaces Configuration Management On-Line (CMOL) and the Engineering Drawing File (EDF). FCMS provides for searching and viewing CCIs and SFDs and provides for electronic FCR processing (i.e., FCR Workflow).

- 2.9.1 FCR Initiation/Processing
 - a. At the FCMS homepage, the user selects the “LF 605, Facility Change Request (FCR)” to initiate, approve, or view a FCR. The FCR workflow screen displays three options from which to select.
 - b. The first option allows the user to create a new FCR, the second allows for searching for a particular FCR that is already in the system, and third option allows the user to view the status of FCR over which the user has authority or that require the user’s attention (i.e., review and approval).
- 2.9.2 Configuration Baseline List (CBL) and Supporting Facility Documents (SFDs).
 - a. A CBL can be generated for a facility using FCMS. The CBL represents a list of all CCIs for the Facility.
 - b. Supporting Facility Documents (SFDs) shall also be stored in the FCMS repository but are not part of the CBL. SFDs are documents/drawings that are affiliated with the facility but not under CM control.

- c. Revision of SFD drawings are the responsibility of the facility or a project (if necessary to communicate construction scope to a contractor) since they are not CCI.

2.9.3 Repository for Drawings/Models/Documents

The documents in the FCM Program are stored as described in the following paragraphs.

- a. FCMS shall be the repository for all original CCIs and SFDs and for their revision history. FCMS will preserve these historical records and all subsequent revisions.
- b. Only a CCC Representative or the FCM contractor maintaining FCMS, shall be permitted to withdraw native file versions of CCIs (e.g. AutoCAD dwg or MS Word.doc files) from FCMS.
- c. The FCMS will flag all checked out native CCIs to show what is currently undergoing change. This will be done in order to “check-out” the file for revision per an approved FCR. Native files of SFDs are permitted to be downloaded by anyone, however, an FCR would be required to update an SFD to the next revision (if either the FCM Owner or a Project Manager elected to do so).

2.9.4 Access and Database Maintenance

- a. Access to FCMS shall be by authorized personnel at:
<https://FCMS.ndc.nasa.gov/>
- b. Entry into the FCMS system shall be controlled by use of an employee's Agency User ID (AUID) and associated password, or automatically via CA SSO (i.e. SiteMinder).
- c. In the case of CA SSO-based authentication, a NASA Access Management System (NAMS) application account is required for the user to be granted access.
- d. CCC shall approve any request for an account that requires authority to approve a FCR.
- e. CCIs undergoing revision will be clearly indicated to all FCMS users. If there is a question concerning the currency of a particular document, contact a representative from CCC for assistance and/or confirmation: e-mail: LaRC-COD-CCC@mail.nasa.gov or 864-3333.

2.10 FCM CONTROL BOARD (FCMCB)

The FCM Control Board (FCMCB) permanent membership shall be made up of the following personnel:

- o COD Chief Engineer shall serve as Chairman
- o LaRC Safety Manager

- RD Deputy for Facilities or other designee
- ED Deputy for Facilities and Labs or other designee
- SD Deputy Director or designee
- OCIO Head of IT Infrastructure Branch or designee
- RSD Deputy Director or designee

2.10.1 Additional personnel including technical authorities and FCM discipline leads will be invited by the Chair to FCMCB meetings based on the agenda items.

2.10.2 The FCM Control Board shall:

- a. Resolve disputes on CCIs determinations, FCR prioritization, and other interpretations of this LPR or governing documents between the FCM Program Manager and Owners.
- b. Evaluate the overall health of the FCM program and assign actions or propose changes to LMS documents, software, training, and other elements of the program to address problems or increase effectiveness of the system.

CHAPTER 3.0 – PRESSURE SYSTEMS CONFIGURATION MANAGEMENT (PSCM)

3.1 PROGRAM SUMMARY

- 3.1.1 As part of LaRC's Pressure Systems Recertification Program, a Pressure Systems Document (PSD), Inspection Plans (IPs) and Weld Maps (if applicable) are developed for ground-based high-pressure systems. For additional information about the Pressure Systems Recertification Program, refer to LPR 1710.42, "Safety Program for Recertification and Maintenance of Ground-Based Pressure Vessels and Piping Systems." The Pressure Systems Configuration Management (PSCM) Program maintains the configuration control of all PSDs, IPs, and Weld Maps using the FCR process per LMS-OP-4710.
- 3.1.2 Any change, whether administrative in nature or not, to a high-pressure system covered by LaRC's Recertification Program shall be documented using the FCR process per LMS-OP-4710.
- 3.1.3 After a change has been approved and the work has been completed, all affected documentation shall be field verified and updated in FCMS.
- 3.1.4 Any discrepancies found during the field verification shall be appropriately redlined and reviewed by the Standard Practice Engineer (SPE) for Pressure Systems and the FSH prior to incorporation into the CCI via an FCR.

CHAPTER 4.0 – FACILITY SOFTWARE ASSURANCE AND SOFTWARE CONFIGURATION MANAGEMENT

4.1 GENERAL

- 4.1.1 The use of automated control systems, programmable logic controllers (PLC), standalone controllers and other supported software systems by LaRC research facilities has established the need for configuration control of software.
- 4.1.2 This chapter outlines the requirements for the Software Configuration Management (SCM), Software Assurance Classification, and Computer Inventory programs at LaRC research facilities.
- 4.1.3 This chapter applies to software that resides in hardware (including firmware) and computer systems used in facility operations including PLCs, loop controllers, Facility Automation Systems (FAS), Data Acquisition Systems (DAS), and other facility support systems.
- 4.1.4 The requirements in this chapter apply to High Risk facilities utilizing safety-critical software. The requirements are recommended for all other facilities.

4.2 PROGRAM OVERVIEW

4.2.1 Software Assurance Classification

- a. Each research facility using an automated control system that is responsible for performing safety-critical functions shall develop a Software Assurance Classification Report (SACR). The report identifies software safety-critical functions prior to and during implementation.
- b. The SACR shall be developed in accordance with NASA-STD-8739.8 and placed under configuration control in FCMS.
- c. If a facility does not have a SACR, one is not required until new software is developed/acquired; however, if a facility does not have a process to classify safety-critical systems, a SACR shall be developed as soon as reasonable.

4.2.2 SACR Preparation

- a. The FCM Owner team shall be responsible for the preparation of a SACR. The SACR may be prepared by the FCM Owner Team, or as delegated.
- b. FCM Owner team shall support this effort on an as-required basis.
- c. Any SACR prepared by a support contractor shall be reviewed and approved by the SMAO Facility Software Safety Engineer (FSWSE).
- d. The approach taken is reflected in Figure 4-1 “SACR Preparation Sequence”.

4.2.3 SACR Phases

- a. Describe computer systems operation, identify computer systems and subsystems, compile inventory of computer systems (reference section

4.2.8 Computer System Inventory), evaluate computer systems to determine their safety criticality, and identify software risk mitigations and software hazard causations.

- b. Determine software safety criticality using the criteria as specified in the NASA Software Assurance and Software Safety Standard (reference NASA-STD-8739.8 §4.2).
- c. At this point, the SACR is ready for an FSH Review. The SFAB/SMAO FSWSE conducts a thorough and independent review of the SACR.
- d. Once the SFAB/SMAO FSWSE agrees that the SACR is complete, a Final Facility Team Review is conducted. During this phase, the remaining members of the Facility Team review the SACR.
- e. Finally, the SACR is published. After all of the issues are resolved and the SACR is prepared in final format, it shall be formally approved by the Mission Assurance Branch, Safety Manager, and FCM Owner team. Finally, it shall be incorporated into the CM Program.

4.2.4 SACR Organization

- a. The SACR is divided into sections; Introduction, Project Background/Function Description, Reference Documents, Software Classification, Software Safety Determination, Software Assurance Effort, and Appendices.
- b. The SACR can be further subdivided into subsections such as Hazard Analysis and Software Configuration Management common to all facilities although, on a case-by-case basis, additional special-item subsections (e.g., Computer System Inventory List) can be added.

4.2.5 SACR Changes and Distribution

- a. The SACR is reviewed and updated on an as-needed basis as in the case when an electromechanical device is replaced with a PLC.
- b. Since SACRs are CCIs, they shall be changed and distributed in accordance with the requirements set forth in Chapter 2 of this document.

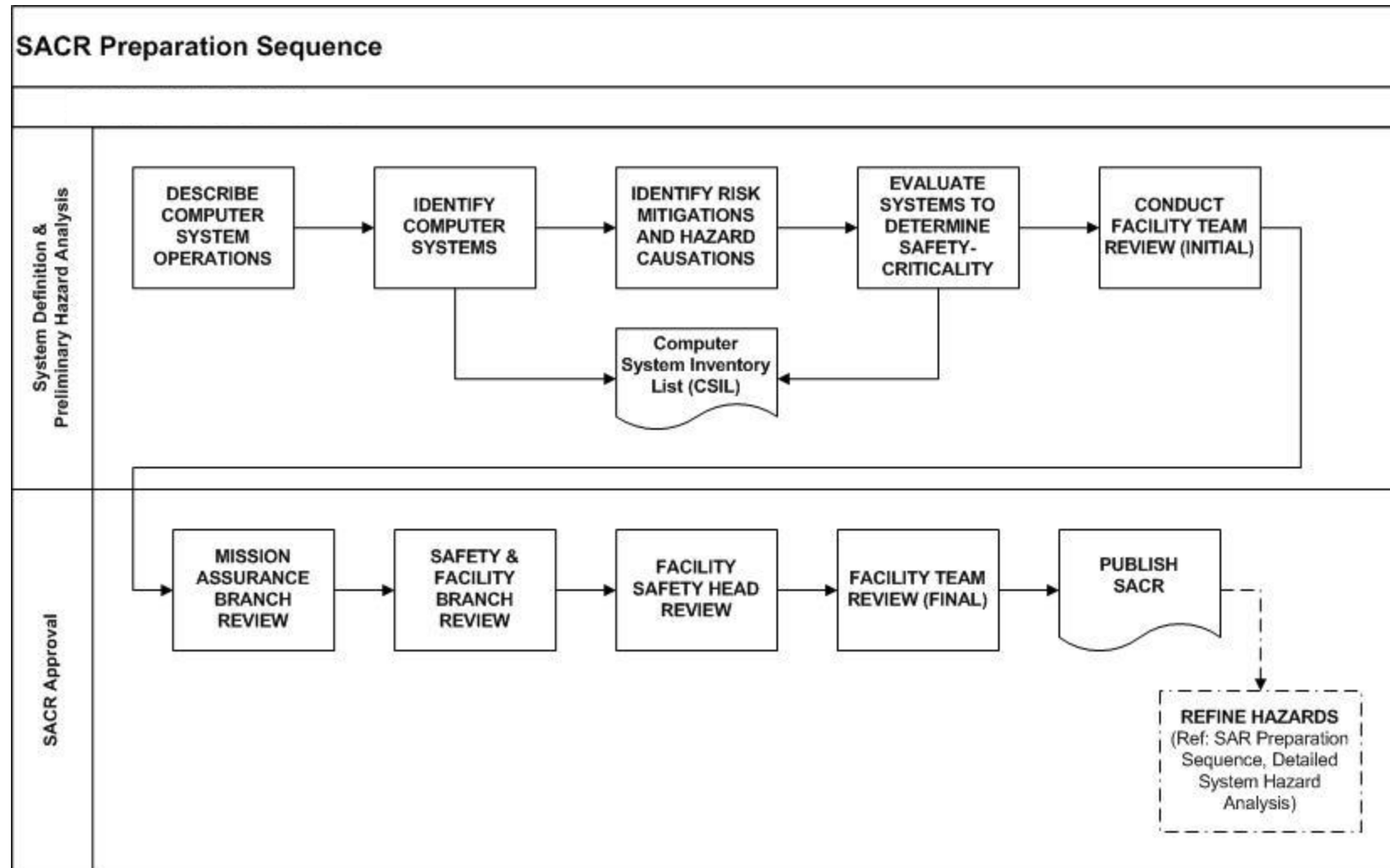


FIGURE 4-1 - SACR PREPARATION SEQUENCE

4.2.6 Software Configuration Management

- a. The configuration control of software products is performed per a Software Configuration Management Plan (SCMP). The SCMP may be facility-specific or may be general with facility-specific elements.
- b. Each research facility shall develop a SCMP.
- c. When a facility employs a system that includes software that performs safety functions (e.g., correct valve sequencing, shutdown the facility in an over-temperature condition), the SCMP shall define a process to identify and review changes that directly affect safety-critical software prior to implementation and during operation and maintenance.
- d. All changes and modifications made to safety-critical requirements, design, code, systems, equipment, test plans, procedures, simulators, models, test suites, shall be evaluated.
- e. All changes to baseline safety-critical software shall be approved.
- f. The SCMP shall be developed in accordance with LPR 7150.2 depending on the software class.
- g. Commencing at the ORR, software changes that might affect facility safety and/or a SAR Undesired Event hazard control (e.g., interlocks, valve sequencing) shall be subjected to a review by the FCM Owner team, a SFAB FSSE/FSWSE, and the SPE for Facility Automation Systems.
- h. Additional measures may be taken to identify and review changes that directly affect safety prior to implementation, such as:
 1. Evaluate hazards for software's contribution (cause, control, etc.).
 2. Conduct software safety analyses; coordinate with the system safety analyses.
 3. Create software safety requirements.
 4. Analyze and report software safety non-conformances to appropriate personnel.
 5. Review system hazard analyses for changes that impact the software subsystem.
 6. Inform system safety personnel of changes in safety-critical software.
- i. The SCMP shall be placed under configuration control in the FCMS.

Note: Some facilities have a facility SCMP which refers to the LaRC FAS Software Configuration Management Plan located on the Virtual Library. The facility SCMP contains facility-specific content and provides link to the LaRC FAS SCMP.
- j. The FCR process shall be used to track and control software changes whenever they might affect facility safety and/or a SAR Undesired Event

hazard control. The FCR also ensures that other CCI documents (e.g., SAR, SACR) are updated as required. The Facility Software Configuration Manager (FSCM) shall initiate the FCR.

- k. If the FSCM has any question about the safety impact of a change, the FSH, a FSE, or a SFAB FSSE/FSWSE shall be consulted.
- l. The FSCM shall be identified in the SCMP.
- m. A new SCMP shall be developed if the existing SCMP does not clearly define a process to review changes that impact safety.
- n. The SCMP is reviewed and updated on an as-needed basis (e.g., changes to NASA or Center processes or procedures for managing safety-critical software, new software is developed and/or acquired).

4.2.7 SCMP Preparation

- a. The FCM Owner is responsible for the preparation and maintenance of the SCMP but may delegate this duty. The actual preparation may be performed by either the Facility Systems Engineer (FSE) or a FSE from a support contractor.
- b. Any SCMP shall be reviewed and approved by the FCM Owner team, Safety Manager, and SFAB FSWSE.

4.2.8 Computer System Inventory

- a. Each research facility utilizing safety-critical software systems shall maintain a Computer System Inventory List (CSIL).
- b. The CSIL shall contain an inventory of software that resides in hardware (including firmware) and computer systems used in the facility operations including PLCs, loop controllers, Facility Automation Systems (FAS), Data Acquisition Systems (DAS), and other facility support systems.

NOTE: How computer systems and software systems (e.g., software applications) are identified in any given facility will depend on a number of factors including the software development methodology (ies) used. Especially for computer systems, each facility might have very unique naming and identification conventions. Whatever identification schema is used; it should facilitate the tracing of safety-critical software between the SACR and the SAR.

- c. For each computer system listed in the CSIL, the computer identifier, the computer model, the configuration control documentation (e.g., drawings), and the software systems (e.g., the application software) shall be identified.
- d. If the required CSIL information is not maintained under FCMS control, it shall be maintained in an appropriate and controlled environment (e.g. COD Virtual Library).

- e. The CSIL shall be reviewed annually and updated as needed (e.g., new software is developed and/or acquired).

4.2.9 CSIL Preparation

- a. The Facility Safety Head shall appoint a Facility Systems Engineer to be responsible for the preparation and maintenance of the CSIL. The actual preparation is performed by either the FSE or a FSE from a support contractor.
- b. Any CSIL shall be reviewed by the SFAB FSWSE.

APPENDICES

APPENDIX A. DEFINITIONS

Bill-of Materials (BoM) – list of parts of an assembly with materials of construction identified, usually part of an assembly drawing. This might be a CCI for high risk components such as a model injection or support system, a tunnel drive shaft, or an oxygen valve.

Building Information Model (BIM) – 3-D model of a building or system with embedded data and analysis tools. Embedded data often includes 2-D construction drawings of the building or system, O&M manuals, materials of construction, commissioning data, etc.

Checklist – Utilized by facilities to provide an avenue for certified operators to complete their work for routine, day-to-day operations of a facility. Checklists are developed and maintained under the FCM Program.

Computer System – A group of hardware components and associated software designed and assembled to perform a specific function or group of functions.

Computer System Inventory List (CSIL) – A CSIL is a listing of Computer Systems for the affected facility.

Configuration Baseline List (CBL) – A list of all Configuration Controlled Items (CCIs) that can be generated using FCMS.

Configuration Controlled Item (CCI) – Facility baseline item considered important to describing how a facility is configured, how it is to be operated, and what risks are associated with its operation. As such, CCIs are revised only through a formal change process under the FCM Program. Examples of CCIs include, but are not limited to, Safety Analysis Reports (SARs), Software Assurance Classification Reports (SACRs), SOPs and checklists, certain Pressure System Documents (PSDs), certain Building Information Models (BIM,) Electrical Transient Analyzer Program (ETAP) Model, Emergency Cutoff Procedure (ECP), Interlock List, Facility Risk Tier (FRT) Designation Form and selected engineering drawings.

Configuration Control Center (CCC) – Centralized staff within Center Operations Directorate (COD) that manages the FCM Program at LaRC. The staff includes the FCM Program Manager, CCC Lead, the trainer/auditor, 2-D, 3-D drafters, technical writer, and FCMS repository administrator.

Configuration Management (CM) – A discipline that establishes a configuration baseline for facilities, selects technical and administrative documents (or models (e.g. BIM, ETAP, Pro-E,)) and exercises administrative control of all approved changes to that baseline.

CM Update – The process of reviewing and documenting changes on a continuing basis. During this process, the reproducible masters (originals) of the affected documents are revised to incorporate the changes as shown on redlined documents. Revisions are initiated and tracked by the use of the FCR Form.

Critical Component Assembly and Bill of Materials Drawings –Used for conducting troubleshooting, maintenance, modifications, and determining material compatibility.

Computer System Inventory List (CSIL) – list of hardware associated with the software under CM.

Device List – List of all components required to run a test facility and used for troubleshooting by linking the component to the drawing number.

Effort Code (EC) – A legacy identification number that identifies a specific facility or group of facilities in the Facility CM Program. For active facilities with and EC this may be used to find that facilities CCI's and SFDs. New facilities will be identified by their real property designation and further subdivided with Laboratory space designations.

Electrical Transient Analyzer Program (ETAP) – Model of the electrical distribution system switching diagrams and low voltage systems which allows for protective device coordination and arc flash analysis.

Emergency Cutoff Procedure (ECP) –Operating procedures used to isolate utility systems from the facility/building in the event of a failure.

Facility Configuration Management Control Board (FCMCB) – Board chaired by the COD Chief Engineer and including FCM points of contact from all directorates that own LaRC facilities (COD, RD, ED, SD, RSD, SMAO.) The board meets quarterly to resolve disputes between FCM owners and the FCM Program Manager as well as review status on the health of the FCM program.

Facility Configuration Management (FCM) Disciplines – distinct FCM activities that store and update their own unique Configuration Controlled Items (CCIs) using their own systems, procedures, and personnel. These disciplines are Pressure Systems Configuration Management (PSCM), Software Configuration Management, Computerized Maintenance Management System (CMMS, i.e. Maximo), and Geographic Information Systems (GIS). The Configuration Control Center (CCC) will

advise these disciplines via the Facility Configuration Management System (FCMS) when a Facility Change Request is likely to require their CCIs to be updated and obtain their comment and/or approval on FCRs. The FCM disciplines that need to update their CCIs as a result of an FCR will notify the CCC via FCMS when their CCI has been updated.

Facility Configuration Management Owner – Individual who defines the FCM baseline for an assigned facility, building, or system; sets priority for FCR processing in coordination with FCM Program Manager; is accountable for audit corrective actions; approves all FCM baseline changes; may initiate FCRs; and is designated by their Organizational Director.

Facility Configuration Management (FCM) Representative – Personnel supporting the LaRC Facility CM Program.

Facility Change Request (FCR) – Langley Form 605, “Facility Change Request,” prepared by LaRC FCM Owner, FC, FSH, FSE, PM, or TPOC and processed by the Configuration Control Center (CCC.) The FCR is processed electronically via the FCMS. It is used in the LaRC FCM Program to request approval of and record all changes in the affected facility and to its supporting CCIs and integrated FCM disciplines (PSCM, CMMS, GIS, FSCM).

Facility Manager (FM) – An individual who ensures safe and efficient utilization of the facility in support of research programs internal and external to NASA.

Facility Risk Tier (FRT) – An overall assessment of the facility risk using both safety and mission risk levels used to determine the types of CCIs required for a facility to adequately mitigate these risks.

Facility Safety Head (FSH) – An appointed individual who is responsible for providing the Facility Team direction, obtaining required support from knowledgeable research personnel, and approving all CCIs affecting the facility.

Facility Software Configuration Manager (FSCM) – A representative of the facility that supports the SCM activity for a particular facility.

Facility Systems Engineer (FSE) – Technical expert for assigned system. A representative of the facility, designated by the directorate who operates the facility, who performs system engineering analyses, and/or reviews existing analyses and supports the FCM activity for the facility. Electrical Distribution System, Compressor Station, Steam System, National Transonic Facility, 8’ High Temperature Tunnel, and Transonic Dynamics Tunnel have FSEs assigned.

Facility Software Safety Engineer (FSWSE) – A representative of SFAB, SMAO, or a support contractor who participates in the development of the initial Facility System Safety Analysis, and/or an upgrade of an existing one, and supports the SCM activity for a particular facility.

Facility System Safety Analysis – A continuing analysis throughout all phases of the facility's life cycle involving the identification and control of hazards and the assessment of risks in operating that facility.

Facility System Safety Engineer (FSSE) – A representative of SFAB, SMAO, or a support contractor who performs an initial Facility System Safety Analysis, and/or an upgrade of an existing one, and supports the CM activity for a particular facility.

Facility Team – Personnel assigned to establish and prepare the Configuration Controlled Items (CCIs) for a LaRC facility during the initial Systems Safety Analysis or any subsequent upgrade effort. The team is composed of the FSH, FC, SFAB FSSE, and SFAB FSWSE assigned to the System Safety effort and the Facility Configuration Management (FCM) Representative.

Field Verified (or Functional Verification) – The process by which the accuracy of a CCI is verified. That accuracy is attested to by affixing a "Field Verified" statement, signed by the person doing the verification, and signed and dated by the Project Engineer, FSH, or FC. NOTE: For Functionally Verified relating to electrical work refer to LPR 1710.6, "Electrical Safety," definition.

Geographic Information System (GIS) – System designed to capture, store, manipulate, analyze, manage, and present spatial or geographic data.

Hazard – A condition that has the potential to result in injury, death, loss of major equipment, or damage to the environment.

Interlock List – All software, mechanical, and electrical interlocks to run a facility used for SOP development /modification/troubleshooting/interlock verification.

Level 1 Drawings – Drawings required to develop the SAR (or hazard analysis), checklists, lockout tagout procedures, and the SOPs. These are system level schematic drawings such as Piping & Instrumentation Diagrams (P&IDs,) one-line power distribution drawings, or control loop diagrams.

Level 2 Drawings – Subsystem drawings needed to troubleshoot and repair or maintain a system but not needed for day-to-day operation. These can also be thought of a 2nd level on a drawing tree below the Level 1 (or system) drawings.

Mission Critical Systems List – Defines systems required to run test facility that have low or no safety impact but need to be documented with CCIs to mitigate mission risks such as missed milestones.

Pressure Systems Configuration Management (PSCM) Program – A program to continuously update the In-service Inspection/Recertification effort.

Project Manager (PM) – The engineer assigned by COD to manage repairs, rework, or modifications to an existing research facility or construction of a new facility.

Redlining – The process of identifying changes on facility documentation by making color-coded annotations on the documents themselves. Deletions to be made are lined through with red markings; additions are shown in green ink or in black ink with yellow highlighting. Redlining of drawings may indicate proposed changes or changes to show the “as is” condition.

Research Facility (Facility) – Ground-based apparatus or equipment directly associated with research operations, and sufficiently complex or hazardous to warrant special safety analysis and control.

Safety Analysis Report (SAR) – A report under the control of the FCM Program that documents the formal Facility System Safety Analysis of a particular facility.

Safety-Critical – “Essential to safe performance or operation.”

Safety-Critical Item – A safety-critical system, subsystem, condition, event, operation, or process that if not implemented or fails to perform as expected poses an unacceptable level of risk (e.g., RAC 1) to equipment and or personnel.

Safety-Critical Items List – A listing of safety-critical items for the affected facility.

Safety-Critical Software – Safety-Critical Software - Software is classified as safety-critical, if it meets at least one of the following criteria: a. Causes or contributes to a system hazardous condition/event, b. Provides control or mitigation for a system hazardous condition/event, c. Controls safety-critical functions, d. Mitigates damage if a hazardous condition/event occurs, e. Detects, reports, and takes corrective action, if the system reaches a potentially hazardous state. References: NASA-STD-8739.8, Software Assurance and Software Safety Standard, §4.2; NASA-GB-8719.13 NASA Software Safety Guidebook, §2.1.3 What is Safety-Critical Software?

Safety Manager, SFAB, SMAO – This individual reviews and approves all System Safety Analyses and reviews all changes to the SARs, SOPs, and checklists under the CM Program.

Software – “Software is defined as the computer programs, procedures, scripts, rules, and associated documentation and data pertaining to the development and operation of a computer system. Software includes programs and data. This definition includes commercial-off-the-shelf (COTS) software, government-off-the-shelf (GOTS) software, modified-off-the-shelf (MOTS) software, reused software, auto generated code, embedded software, firmware, and open source software components.”, NPR 7150.2A NASA Software Engineering Requirements, §P.1 Purpose.

Software Assurance Classification Report (SACR) – A report under the control of the CM Program that documents the formal Software Assurance Classification of a particular research system or facility.

Standard Operating Procedures (SOPs) – Detailed, written, step-by-step instructions to be routinely followed in operating a facility. SOPs contain all of the information considered pertinent to safe and efficient operation of the facility. SOPs are the source documents for Operational Checklists and are the basis, in part, for the facility Hazard Control Analysis. SOPs may also be used for training certified operator personnel. SOPs are under the control of the FCM Program.

Standard Practice Engineer (SPE) for Pressure Systems – The Pressure Systems SPE serves as the Center expert and final authority on the application of national consensus standards and LaRC requirements concerning ground-based pressure systems. He/she is responsible for reviewing all new designs and all plans for modifications or repairs to LaRC pressure systems.

Supporting Facility Documents (SFDs) – Those documents identified on the SFD list that are useful reference drawings, documents, or models, but that do not meet the criteria for CCIs. Examples include previous revisions, obsolete drawings/models, and previous construction/renovation drawings.

Working Masters – Copies of the latest-revision CCIs (SARs, SACRs, SOPs, drawings, and so forth), which are stamped “WORKING MASTER” in red and kept at the facility.

Work Package—All new and revised CCI and SFD drawings, documents (SOP, CL, Device List, SAR, SACR, CIL, ECPs, or other items that define the change to be approved on the FCR

APPENDIX B. ACRONYMS

ASIP	Agency Strategic Implementation Plan
BIM	Building Information Model
BoM	Bill of Materials
CCC	Configuration Control Center
CCI	Configuration Controlled Item
CDR	Critical Design Review
CM	Configuration Management
CMMS	Computerized Maintenance Management System (i.e. Maximo)
CMOL	Configuration Management On-Line
COF	Construction of Facility
COD	Center Operations Directorate
COTS	Commercial-Off-the Shelf
CP	Center Procedure
CSI	Computer System Inventory
CSIL	Computer System Inventory List
DAS	Data Acquisition System
EC	Effort Code
ECP	Emergency Cutoff Procedure
EDF	Engineering Drawing Files
EOC	Emergency Operations Center
EPA	Environmental Protection Agency
ETAP	Electrical Transient Analyzer Program
FBL	Facility Baseline List
FC	Facility Coordinator
FCM	Facility Configuration Management
FCMCB	FCM Control Board
FCMS	FCM System
FCR	Facility Change Request
FM	Facility Manager
FRT	Facility Risk Tier
FSCM	Facility Software Configuration Manager
FSE	Facility Systems Engineer
FSH	Facility Safety Head
FSSA	Facility Systems Safety Analysis
FSSE	Facility System Safety Engineer
FSWSE	Facility Software Safety Engineer
FV	Field Verified
GIS	Geographic Information System

GN2	Gaseous Nitrogen
GOTS	Government-Off-the-Shelf
HA	Hazard Analysis
ISR	Integrated System Review
JHA	Job Hazardous Analysis
LAPD	Langley Policy Directives
LaRC	Langley Research Center
LF	Langley Form
LMS	Langley Management System
LN2	Liquid Nitrogen
LOP	Langley (or Laboratory) Operating Procedure
LPR	Langley Procedure Requirement
LRE	Langley (or Laboratory) Risk Evaluation
MTBF	Mean Time Between Failure
NPR	NASA Procedural Requirement
OP	Operational Procedure
ORR	Operational Readiness Review
PDR	Preliminary Design Review
PEB	Project and Engineering Branch
PHA	Preliminary Hazard Analysis
PLC	Programmable Logic Controller
PM	Project Manager
PM	Preventive Maintenance
PSCM	Pressure Systems Configuration Management
PSD	Pressure Systems Document
RF	Radio Frequency
SA	Software Assurance
SACR	Software Assurance Classification Report
SAR	Safety Analysis Report
SCM	Software Configuration Management
SCMP	Software Configuration Management Plan
SCR	Software Change Request
SFAB	Safety and Facility Assurance Branch
SFD	Supporting Facility Document
SMAO	Safety and Mission Assurance Office
SPE	Standard Practice Engineer
SOP	Standard Operating Procedure
TPOC	Technical Point of Contact

APPENDIX C. RECORDS

C.1 All Federal employees are required by law and Agency policy to maintain and preserve certain records. Documents listed in C.2 have been identified as meeting the statutory definition of Federal records as contained in 44 U.S.C. Section 3301, referred to in the National Archives and Records Administration (NARA) Regulations: 36 CFR Part 1220.14 and 1222.12, and NASA Policy Directive (NPD) 1440.6, NASA Records Management.

C.2 Identified documents:

- a. Standard Operating Procedure(s)
- b. Checklist(s)
- c. Safety Analysis Report(s)
- d. Configuration Controlled Items
- e. Pressure Systems Document(s)
- f. Software Configuration Management Plan(s)
- g. Software Assurance Classification Report(s)

APPENDIX D. EFFORT CODES**TABLE D.1 -ASSIGNED ACTIVE LEGACY EFFORT CODES (ECS) RETAINED IN THE REVISED FCM PROGRAM**

Effort Code	Facility Number	Facility Name
00	---	All or Multiple Facilities
01	890-30	High Pressure Air System (includes B1247E)
03	1265	8-Foot High Temperature Tunnel
04	1267	Component Verification Facility
05	1247D	Hypersonic Blowdown Tunnels & 20-Inch Supersonic Wind Tunnel
05-01	1247D	20-inch Mach 6 Tunnel
05-07	1247D	Supersonic Low Disturbance Tunnel
05-08	1247D	High Pressure Air Vacuum Systems
05-09	1247D	20-inch Supersonic Wind Tunnel
05-10	1247D	Probe Calibration Tunnel
05-11	1247D	Grazing Flow Impedance Tube
05-12	1247D	Curved Duct Test Rig
05-13	1247D	Dielectric Barrier Discharge (DBD) Plasma Actuator Test Apparatus
14	1241	Drive Control Facility
16	1251A	31-Inch Mach 10 Tunnel
17	1251A	15-Inch Mach 6 High Temperature Tunnel
18	648	Transonic Dynamics Tunnel
19	1212C	14 x 22 Foot Subsonic Tunnel
21	1146(1234)	16 Ft. Transonic Tunnel (Jet Exit Test Facility)
22	1208	Acoustics Research Laboratory
23	1148	Structures and Materials Laboratory
24	1251	Unitary Wind Tunnel
25	1247B	Arc-Heated Scramjet Test Facility
29	1262	Aircraft Landing Dynamics Facility
33	1297	Landing and Impact Research Facility
34	1242	0.3m Transonic Cryogenic Tunnel

36	1221A	Jet Noise Laboratory
50	1295	Vacuum Sphere Control & 60' Space Simulator
53	1268A	Test Evaluation Simulator
54	1268A	Development and Test Simulator
55	1268D	Cockpit Motion Facility
61	644	Twelve Foot Low Speed Tunnel
62	645	20-Foot Vertical Spin Tunnel
66	1268A	Differential Maneuvering Simulator
71	1221D	Vitiated Heater, Test Cell No. 2
72	1221C	Isolator Dynamics Research Lab
75	1256	Combined Loads Test Systems Facility (COLTS)
80	1221C	Combustion Heated Scramjet Test Facility, Test Cell No. 1
84	1244	Hangar Complex
85	1232A	Hevi-Duty Brazing Vacuum Furnace (HDBVF)
86	1293B	16-Meter Thermal Vacuum Chamber
90	1267A	CNT, BNNT, & Autoclaves
91	1238B	Composite Shop Autoclave
97	1293A	Space Structures Research Laboratory
98	822-10	West Area Heating Plant and Steam Distribution (includes B1215, 1206A, 1154)
99	1236	National Transonic Facility (NTF)
100	1241	NTF LN2 Plant
102	1205	Materials Research Laboratory
103	1220	Information Systems Research Facility
104	1225	Advanced Development Lab
105	1230A	Gas Calibration Lab
110	1250	Engineering Directorate Systems Integration and Test Branch
300	812-30	Switching Diagrams
301	812-30	Manhole Drawings
302	812-30	Electrical Panel Boards
303	812-30	Major Electrical Substations
501	---	Utility Metering Drawings

APPENDIX E. LaRC LOCATION ID

E.1 GENERAL

This Appendix describes a location identification system for equipment in LaRC facilities. The purpose of this system is to provide a location identification number for equipment for use in facility configuration controlled documents, e.g., Drawings, Standard Operating Procedures (SOP), and Safety Analysis Reports (SAR's). This number is also utilized in the Computerized Maintenance Management System (CMMS) database as the "LaRC Location ID," also referred to as "LaRC ID" in this document. The LaRC ID should not be confused with the asset number which uniquely identifies a piece of equipment wherever it may be located.

1. All equipment shown on a CCI drawing or any asset in the CMMS shall have a LaRC location ID assigned.
2. The web based LaRC ID Registry tool used to provide the next available LaRC ID for a given facility may be found at:

<https://gis-dbweb.LaRC.nasa.gov/ords/apex/f?p=LARCID>

- a. This tool is the single official database of LaRC IDs and is used to sustain the location hierarchy for the equipment as well as provide new, unique numbers to facility and project personnel.
- b. The LaRC ID Registry tool is integrated with the electronic LF-491 CMMS change form.
- c. The LaRC ID Registry shall assign LaRC IDs automatically to any new component submitted on the electronic LF-491 unless the person submitting or approving the LF-491 enters a legitimate LaRC ID.

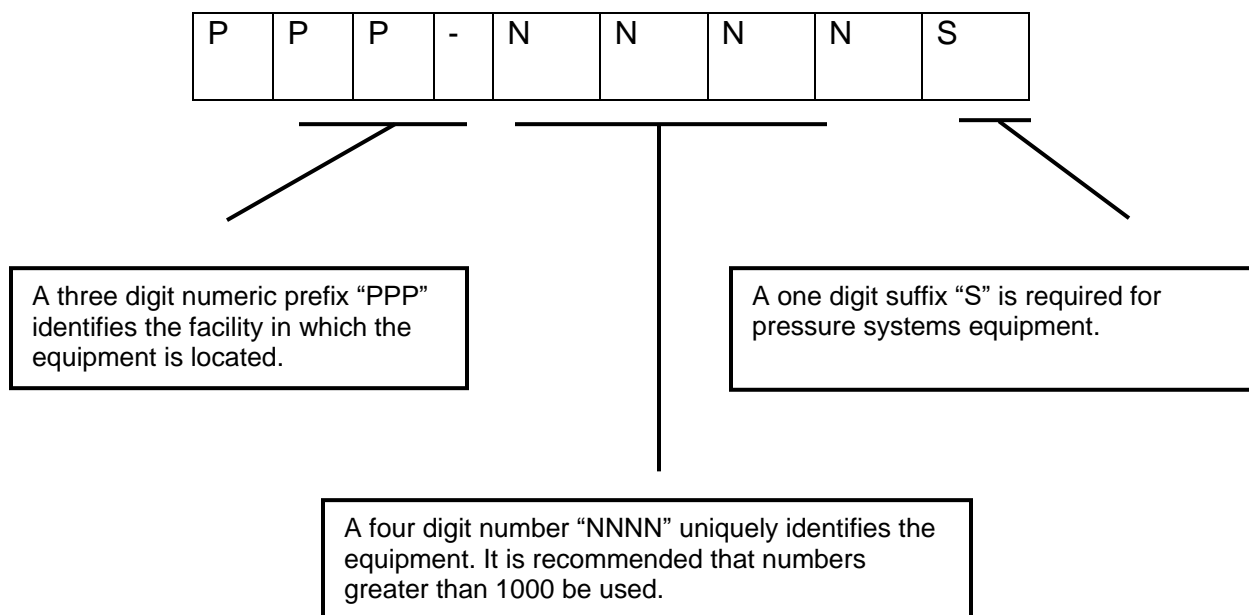
E.2 NUMBERING SCHEMES

There are three numbering schemes: 1) Legacy, 2) Mechanical and Process equipment, and 3) Electrical.

1. Legacy numbering scheme: Non-redundant LaRC ID numbers on existing Configuration Controlled Drawings shall be retained unless changed per Facility Change Request. This includes numbers that are not consistent with the numbering schemes shown below.
 - a. Where the three digit facility code (Table E-2) is not used on the CCI drawings it will be assumed based on the building or facility number designated on the drawings and will be appended to the equipment identifier on the CCI when entered into the CMMS or other databases such as FCMS and LaRC ID Registry.
 - b. Any legacy component location identifier string is acceptable up to 25 characters. Often the LaRC ID number on older drawings includes prefix letters identifying the type of equipment (e.g. "V" for valve, "PI" for pressure

indicator, “F” for filter) and uses the same number for different components in the same region of the drawing.

- c. Where repeat equipment identifiers (including the prefix) are found, then the repeated instances shall be changed to ensure uniqueness so that a LaRC ID represents a single function associated with a real property location (e.g. building or horizontal infrastructure system).
2. Mechanical and Process equipment: The LaRC location ID system for new locations uses at most eight (8) digits while legacy IDs can use up to 25. The required format for all new equipment “LaRC Location IDs”:



- a. The three-digit prefixes (PPP) identifying LaRC buildings are shown in Table E-2.
- b. The unique four-digit number (NNNN) is assigned by the equipment owner or his/her designated representative, or automatically by the LaRC ID Registry if not otherwise specified for new equipment per the LF-491 CMMS change form.

Thus, typical LaRC ID would be:

067-0155 for an electrical breaker located in Building 1247E, or

040-3025N for a nitrogen system valve in Building 1221, or

144-2510 for a parking lot light

- c. In some instances a LaRC ID may not contain a dash after the three digit prefix. Some electronic data systems and electronically searchable information may not display a dash. Legacy documents and equipment tags also may not include a dash after the three digit prefix. In such cases a dash

is understood to exist. For all LaRC IDs containing a three digit prefix, the registry will record a dash after the three digit prefix.

E.3 APPLICABLE EQUIPMENT TYPES

1. Mechanical Systems

- a. All mechanical components shown on a CCI schematic or assembly diagram shall be assigned a LaRC ID. Examples of mechanical system components that shall have LaRC ID assigned:
 - Drive shaft bearings and couplings
 - Cranes
 - Model support and injection mechanism components
 - Air Handling Units
 - Cooling tower components
 - Blowers
 - Fans
 - Actuators

2. Pressure Systems

- a. All permanently installed pressure system equipment (or components) at LaRC shall have LaRC ID numbers assigned by either the Facility Coordinator or by the Project Manager using the LaRC ID Registry. These would normally be specified on Piping & Instrumentation Diagrams (P&IDs) but could also be used on control loop and electrical power and wiring diagrams. Reference "COD Facilities Engineering Standard for Piping Systems and Pressure Vessels, Appendix 3 "Requirements for Process and Instrumentation Diagrams (P&ID)". Exceptions to LaRC ID numbering are as follows:
 - Pipe spool pieces
 - Pipe fittings (e.g. tees, elbows, reducers, instrumentation bosses)
 - Caps
 - Plugs

Examples of pressure system components that shall have LaRC ID assigned:

- Valves (all types including drains and checks)
- Filters
- Flowmeters
- Pressure Vessels
- Tanks
- Instruments (all types – transducers, gages)
- Flexhoses

- Expansion Joints
 - Pumps
 - Motors
 - Heat Exchangers
 - Burst Disks
 - Vacuum Breakers
 - Flow control devices (orifices, cavitating venturis, etc.)
 - Flow Straighteners
 - Accumulators
- b. A complete LaRC ID is comprised of a three-digit building identifier prefix, a unique four-digit number, and a one-digit media identifier suffix (e.g., 064-3142J, 067-3412A, and 041-5484S). Under no circumstances shall two pieces of equipment have the same eight-digit number.
- c. The following list of suffixes shall be used as part of the pressure systems numbering system to identify the gas or liquid flowing through the equipment:

TABLE E-1 - PRESSURE SYSTEMS SUFFIXES FOR LaRC IDS

SUFFIX	FLOWING MEDIA
A, B, C, D or E	Air
F	Fuels (except Hydrogen)
G	Poisonous, Toxic, or Corrosive fluids
H	Hydrogen
J or K	Helium
L, M, or N	Nitrogen
P	Hydraulic Fluids
Q	Lubricating Oils
R	Other Inert Fluids
S	Steam
T	Condensate
U or W	Water
V	Vacuum
X	Oxygen, Oxidizers
Y	Refrigerants (e.g., Freon®)
Z	Fluid Combinations

NOTE: In Table E-1 the letter “Z” designates that more than a single fluid medium can be transported through the pressure system component.

2. Electrical Systems

- a. All new drawings for electrical system equipment shall have LaRC IDs or “device numbers” assigned as a 4-digit number with the equipment prefix appropriate to the building, substation, or horizontal infrastructure in accordance with Table E-2. Refer to the “300-DL” device list for the equipment types with “assigned device numbers.”
- b. Existing CCI drawing electrical equipment may use existing identification nomenclature with the equipment prefix appended per Table E-2. This conforms to the “Legacy Numbering Scheme” in E-2.1.

E.4 LaRC Location ID EQUIPMENT TAGGING

1. A LaRC location ID number tag shall be affixed to each piece of equipment and should appear similar to the following illustrations:

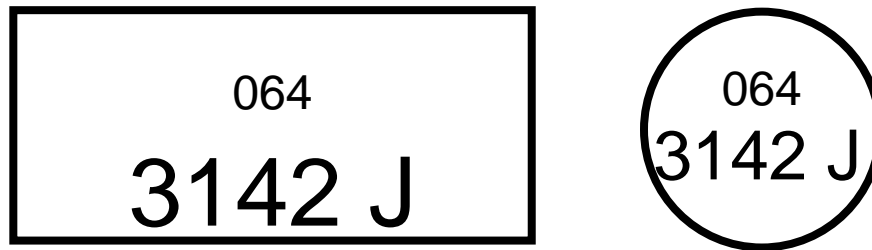


FIGURE E-1 - SAMPLE LaRC ID TAGS

2. LaRC ID new or replacement tags shall be made of a material compatible with the intended service and environment. For example, phenolic tags in the steam utility tunnels have been found to degrade rapidly and are therefore not compatible for that application.
3. It shall be the responsibility of the Facility Coordinator to take corrective action when duplicate numbers are identified. This shall be done through use of the LaRC ID Registry.
4. For new facilities, or the addition or modification to existing facilities, engineering design personnel shall estimate the total LaRC IDs required, and then request a block of numbers from the LaRC ID Registry. All drawings that will become CCI shall have LaRC ID numbers applied by Critical Design Review (CDR).

E.5 IMPLEMENTING THE LaRC LOCATION ID SYSTEM

It shall be the responsibility of the Facility Coordinator or the Project manager, depending on how a change is being executed to use the LaRC ID Registry to have unique LaRC IDs assigned to new equipment on CCIs.

TABLE E-2 - LaRC ID PREFIXES

Building No. or Infrastructure Item	Prefix
641	010
642	021
644	015
645 & 645A	014
647	012
648, 648A & 648B	019
650	020
1101	301
1122	179
1146 & 1146 E	022
1147	082
1148	023
1154 & 1154A	083
1158 & 1158A	114
1159	115
1166	162
1167	163
1169	132
1170	133
1171	134
1172	135
1173	136
1174	182
1175	166
1176	177
1177	178
1181	180
1186	176
1187	181
1188	173
1189	174
1190	170
1191	172
1194/1194A	030
1195, 1195A, 1195B, & 1195C	033
1196	185
1197	168
1198	160

Building No. or Infrastructure Item	Prefix
1199	085
1200 & 1200A	074
1201	039
1202 & 1202A	075
1205	076
1206 & 1206A	081
1208 & 1028A	097
1209	125
1211	155
1212, 1212C	043
1214	165
1215	041
1216	169
1219	037
1220	049
1221, 1221A,B,C,D,E, & F	040
1222 & 1222B	054
1225	044
1227	086
1228	056
1230, 1230A & 1230B	047
1232	055
1232A	053
1233	034
1235	058
1236, 1236A, B, C, & D	059
1237A, 1237B & 1237C	093
1238, 1238A & 1238B	027
1239	087
1240	081
1241	061
1242, 1242A & 1242B	122
1243	088
1244, 1244A, B, C & D	060
1245	081
1246	081
1247B & 1247H	064
1247A,1247C & 1247F	065

Building No. or Infrastructure Item	Prefix
1247D	066
1247E	067
1248	080
1250 & 1250A	077
1251	050
1251A, B, C, D, & E	150
1253 & 1253A	089
1254	158
1255	137
1256, 1256A, 1256B	063
1261B	124
1262	068
1265A-E	028
1266	090
1267, 1267A, 1267B	031
1268, 1268A, B, C, & D	070
1273A	106
1274B	069
1277	145
1285	139
1286	110
1289	096
1290	084
1292, 1292A & B	038
1293A, B, C, D	062
1295, 1295A, B, C, E	250
1296	031
1297, 1297A-G	071
1298	072
1299, 1299F	073
Forklifts	094
Slings	098
Lifting Devices	099
Emergency Lights	101
Link Boxes (GW)	141
Outside Light (Poles)	144
812 Electrical Distribution System	146

Building No. or Infrastructure Item	Prefix
880 Fire and Other Alarm Systems	147
630-37 Trailer (Tube-Type)	152
843-10 Water – Fire Protection (including Hydrants)	154
411-20 Aviation Gasoline Storage	302
411-30 Diesel Oil Storage	159
411-40 Storage Tanks	303
842-10 Water Distribution System (Potable)	164
822-10 Steam Lines	304
890-30 COMPRESSED AIR DISTRIBUTION SYSTEMS	305
872 Security Systems	306
832 Sewer System	307
871 Storm Drainage	308
891-70 Utility Tunnels & Manholes	309
824-10 Natural Gas Lines	310
Lifting Systems	311
131-60 Comm. Network	312
Emerg. Lights/AEDs	313
Utility Metering	314
690 Flag Poles & Monuments	315
812-20 Exterior Lighting	316
851 Roads	317
852 Sidewalks & Parking	318