



Subject: Engineering Drawing System

Responsible Office: Office of the Director – Chief Engineer

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PREFACE

P.1 Purpose

- a. The engineering drawing practices and procedures set forth in this directive are based on established Government-industry standards, supplemented where necessary by a minimum of requirements particular to the NASA Langley Research Center (LaRC).
- b. The purpose of this directive is to provide a uniform but flexible system of drawing preparation, use, and interpretation. A standard drawing numbering system, Engineering Drawing Files (EDF), and drawing and documentation control system are included. This directive will be maintained by the Engineering Drawing System Committee with representatives from selected organizations.
- c. Unless otherwise noted herein, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

P.2 Applicability

- a. This directive is applicable to all engineering drawings generated by LaRC personnel and their supporting service contractors.
- b. In this document, all mandatory actions (i.e., requirements) are denoted by statements containing the term "shall." The terms "may" or "can" denote discretionary privilege or permission, "should" denotes a good practice and is recommended but not required, "will" denotes expected outcome, and "are/is" denotes descriptive material.

P.3 Authority

NPD 7120.4, NASA Engineering and Program/Project Management Policy

P.4 Applicable Documents and Forms

- a. DoD 5220.22-M, National Industrial Security Program Operating Manual
- b. NPR 1600.1, NASA Security Program Procedural Requirements
- c. NRRS 1441.1, NASA Records Retention Schedules
- d. LAPD 1150.2, Councils, Boards, Panels, Committees, Teams, and Groups
- e. LPR 1740.4, Facility System Safety Analysis and Configuration Management
- f. LPR 5300.1, Product Assurance Plan
- g. LF 33, Drawing Record Card
- h. LF 181, Configuration Change Request (CCR)
- i. LF 219, Flight Projects Directorate Change Request Form

The standards listed below are requirements for generating engineering drawings for the applicable domains. Unless identified by date, the edition in effect at the start of the design applies, including addenda and code cases.

- j. ASME Y14.100, Engineering Drawing Practices
- k. ASME Y14.1, Decimal Inch Drawing Sheet Size and Format
- l. ASME Y14.35, Revision of Engineering Drawings and Associated Documents
- m. ASME Y14.5M, Dimensioning and Tolerancing
- n. MIL-STD-403, Preparation for and Installation of Rivets and Screws, Rocket, Missile, and Airframe Structures
- o. ANSI B4.1-1967, Preferred Limits and Fits for Cylindrical Parts
- p. NAS 523, Fastener Code
- q. AWS A1.1-2001, Metric Practice Guide for the Welding Industry
- r. AWS A2.4-2012, Standard Symbols for Welding, Brazing, and Nondestructive Examination
- s. AIA, CSI, NIBS NCS V6, United States National CAD Standard – V6

P.5 Measurement/Verification

None

P.6 Cancellation

This LPR cancels LPR 7320.1 I, dated May 1, 2015.

/s/ Cathy H. Mangum October 25, 2016
Center Associate Director *Date*

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CHAPTER 1 - ADMINISTRATIVE PROCEDURES

1.1 Scope

- 1.1.1 The Engineering Drawing System Procedural Requirement establishes the procedural requirements and practices to be followed in the preparation, maintenance, control, and utilization of engineering drawings. It applies to all engineering drawings generated by LaRC personnel and their supporting services contractors. An engineering drawing is defined as a document that discloses, by means of pictorial and/or textual presentations, the form and function of an item, is assigned a LaRC drawing number, and contains proper approvals. This procedural requirement is not applicable to any sketches, diagrams, informal schematics, or other instructions.
- 1.1.2 This procedural requirement is authorized for use in establishing engineering drawing format and procedures for all research, design, development, fabrication, and installation activities.

1.2 Maintenance of Engineering Drawing Procedural Requirements

- 1.2.1 The Engineering Drawing System Committee (EDSC) is responsible for making revisions or adding supplements to this procedural requirement. See LAPD 1150.2, "Councils, Boards, Panels, Committees, Teams, and Groups" for EDSC member organizations.
- 1.2.2 Requests for revisions or supplements to the procedural requirement shall be addressed to the committee chairperson. Supplements and revisions will be posted on the NASA Langley Management System Web site.

1.3 Engineering Drawing Files

The Engineering Drawing Files (EDF) office is responsible for assigning drawing numbers and filing drawings (both electronic and paper printed copies).

1.3.1 Drawing Numbering System

A using organization may request initial assignment of drawing numbers by telephone or email to EDF. The EDF clerk shall enter all available information on the log, including the type of drawing, revision letter, title, size, organization code, name of requester, date assigned, and notify the requester of the assigned drawing number(s). A block of numbers may be issued to organizations as required.

1.3.2 Preparation of Drawing Record Card, LF 33

Upon completion of the new or revised drawing, the originator or the project CM shall prepare LF 33, "Drawing Record Card," by entering data listed in the LF 33 instructions. For organizations that have been authorized to access the EDF database, the information from the Langley Form 33 may be typed directly into the EDF database and submitted to EDF for approval. The EDF clerk is then notified of the drawing input by email.

1.3.3 Submittal of Drawings to EDF

After the initial release of prints by the originating organization's approving official, the originator shall e-mail a copy to EDF as per the instructions on the electronic form. At the discretion of the Project Manager, the originator shall e-mail a pdf copy to the Project Configuration Manager (CM). Note: For facility projects, only as-built drawings are submitted to EDF.

1.3.4 Verification of Drawings

The EDF clerk shall check the drawing for the following:

- a. Drawing submittal – All incoming drawings shall be routed through the EDF receiving area for processing. New and revised drawings are to be processed and made ready for electronic storage.
- b. Valid drawing number – The drawing number shall be checked for duplication. EDF shall notify and return the drawing to the originating organization if required.
- c. LaRC administrative standards – Drawings shall meet LaRC requirements, with the correctly assigned drawing numbers, properly assigned revision letter, and properly identified configurations. The drawing will be returned to the originator if incorrect.
- d. When the drawing is verified, the EDF clerk shall stamp "FILE" on the drawing and process for electronic storage.

1.3.5 Filing of Drawings and Drawing Record Card

- a. The drawings shall be indexed by size and drawing number and placed in files.
- b. Information obtained on LF 33, "Drawing Record Card," shall be entered into the EDF database.

1.3.6 Retention of Engineering Drawings

The retention of Engineering Drawings within the EDF shall be conducted per NRRS 1441.1.

1.4 Drawing Changes

1.4.1 Changes to the engineering drawings must be made by one of three methods:

- a. Drawing revision
- b. LF 181, "Configuration Change Request (CCR)" – Excluding facility drawings. All changes made after formal release of drawings must be authorized in the same manner and processed through EDF for recording and electronic storage. At the Project Manager's discretion, a copy of the CCR shall be forwarded to Configuration and Data Management for recording and electronic storage.
- c. Redline changes

1.4.2 It is the responsibility of the design activity (i.e., LaRC cognizant engineer, designer, draftsman, contracting officer's representative (COR), and others) to ensure that changes and revisions to engineering drawings do not violate Configuration Controlled Documents. Refer to LPR 1740.4.

1.4.3 Drawing Revisions

The procedures described in ASME Y14.100 apply to LaRC-generated drawings. The same functional set of signatures required for the initial release of the drawing shall be required for drawing revisions. At the Project Manager's discretion, this requirement can be waived through the Project Implementation Plan. The waiver will explicitly define the alternative for ensuring appropriate review and approval of changes.

1.4.4 Configuration Change Request (CCR)

A CCR is an interim method of changing the information contained on an engineering drawing or associated document. Such changes are to be incorporated into the drawing by formal revision unless otherwise specified on the CCR. CCRs shall remain active until incorporated by revision and so noted in the revision block. The incorporated CCR shall then be retired to the historical files. Not more than three CCRs may be outstanding against any one drawing at any one time.

1.4.5 Drawing Redline Changes for Hardware Fabricated in LaRC Facilities

1.4.5.1 Only under critical schedule conditions where the delivery milestone will be missed, the design activity may temporarily modify drawings in the fabrication process, using redlines to reflect changes that must be enacted immediately. Redline changes are not required to be immediately submitted for review and approval of the drawing approvers. Therefore, the personnel implementing the redline changes must be aware that the changes may be disapproved, resulting in scrap or rework and ultimately cost and/or schedule impact. Only the design engineer or Project-approved designee may implement a redline change. Project management shall provide the fabrication organization with a list of approved designees. This notification shall be provided at the start of the fabrication process via memo or email.

1.4.5.2 The redline requestor shall inform the original drawing approvers and Project Manager not less than 3 business days after initiation of the redline change. To implement redline changes for hardware built in LaRC facilities, the design engineer or a Project-approved designee shall do the following:

- a. Redline the production control copy of the affected drawing that shall be the stand-alone master copy of the change until a CCR is submitted or the drawing is revised.
- b. Cross through text one or two lines at a time or cross out text by a series of diagonal parallel lines at uniform spacing through a selection of text.
- c. Print the new text in a legible format in close proximity to the text being changed.
- d. Draw a "cloud" around the change.
- e. Print LaRC Employee X500 User ID (for example, "LA1232AB"), initial, and date close to the cloud.
- f. Make a copy of the redlined drawing for the redline requestor to take back to engineering personnel for incorporation into a revised drawing per paragraph 1.4.3 or a CCR per paragraph 1.4.4.
- g. Notify by email all project personnel who approved the original drawing, and the Project Manager, of the redline change.

- h. In situations where the design engineer or Project-approved designee cannot be present to mark the redline change on the drawing and manufacturing must continue, the design engineer or Project-approved designee may authorize the change by email. The email must specify the change to the requirements to authorize the continuation of the manufacturing process. The change shall not be implemented without the email authorization. The email authorization shall be placed into the fabrication documentation by the fabrication technician. The design engineer or Project-approved designee shall properly mark the drawing with the redline change within 3 business days.
- i. The fabrication organization is responsible for reproducing the master redline copy for fabrication uses.
- j. The project shall incorporate the redline changes into an approved revised drawing per paragraph 1.4.3 or a CCR per paragraph 1.4.4, prior to the quality assurance inspection of the hardware. The quality inspection shall be executed using the “as-built and approved” drawings per paragraphs 1.4.3 or 1.4.4.

NOTE: The project has the responsibility to maintain configuration control of all hardware affected by the redline process.

1.5 Drawing Obsolete/Cancellation Procedure

Drawing obsolete/cancellation shall be done in accordance with ASME Y14.100 .

1.6 Security Classification

- a. DD Form 254, “DOD Contract Security Classification Specification,” prepared in accordance with DOD 5220.22M, “Industrial Security Manual for Safeguarding Classified Information,” shall be used by LaRC to provide specific security classification guidance to contractors who originate drawings.
- b. Specific classification and marking guidance shall be provided by the LaRC Security Classification Officer for drawings originated by LaRC. The classification of the drawings shall be determined by an appropriate security classification guide or other source document and marked in accordance with NPR 1600.1.

CHAPTER 2 - ENGINEERING DRAWING REQUIREMENTS

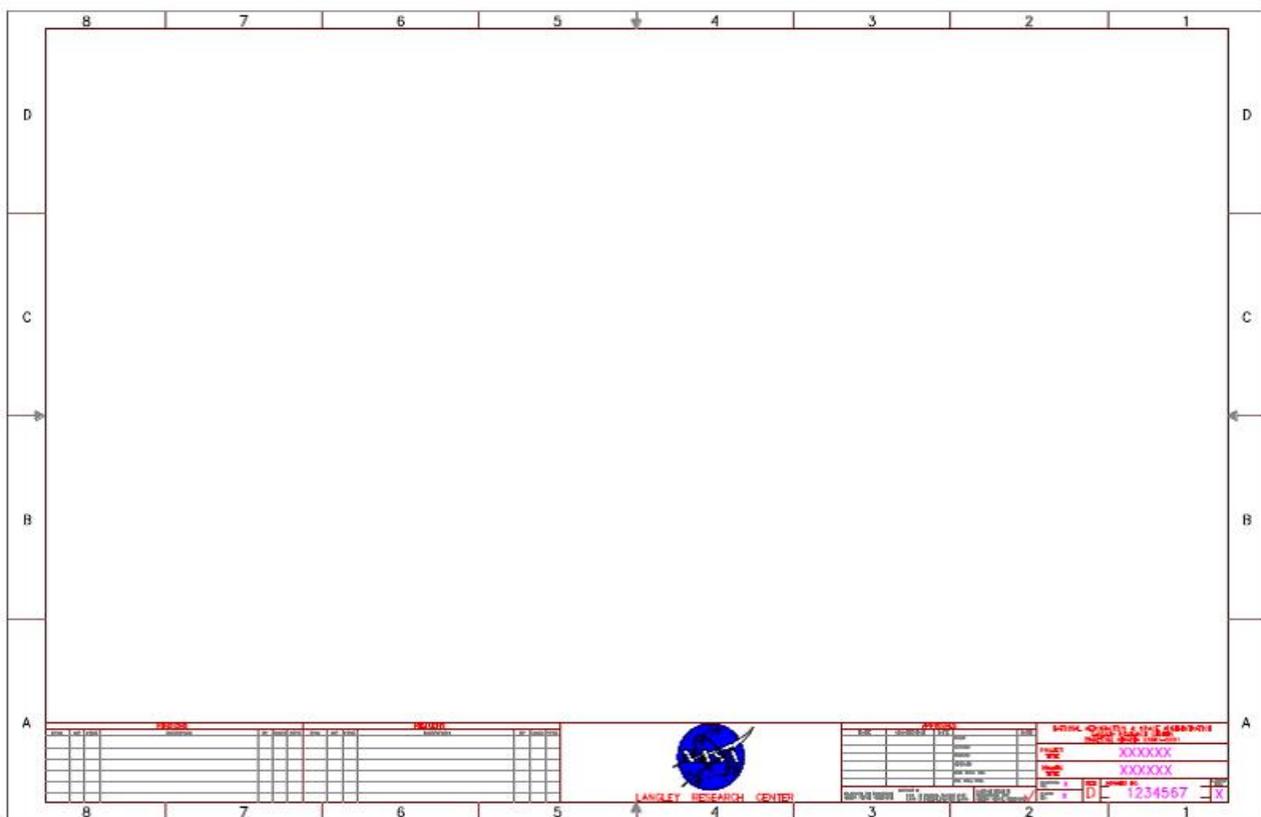
2.1 Size and Format

2.1.1 Drawing Sizes

Finished sheet format sizes and the size-designated letter are those listed in ASME Y14.100. Multiple sheet drawings are permissible.

2.1.2 Basic Sheet Format

The general format and arrangement of data on drawings shall be in accordance with ASME Y14.100. An alternate basic sheet is authorized for facility drawings as shown below.



2.1.3 Title Block

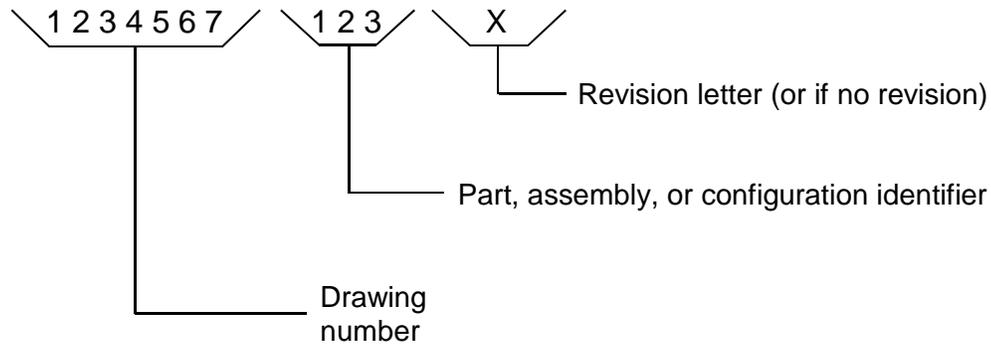
The basic drawing title block in the lower right-hand corner of each drawing shall be in accordance with ASME Y14.100. An alternate title block is authorized for use with facility drawings.

2.1.4 Drawing Titles

Drawing titles shall conform to the procedures for creating title block nomenclature entries for drawings and for parts detailed thereon as specified in ASME Y14.100.

2.1.5 Numbering of Drawings and Parts

The LaRC standard numbering system provides for a seven-digit (maximum) drawing number, centrally controlled and issued by the Engineering Drawing Files, a three-digit (maximum) dash number identifier for parts, subassemblies, assemblies, or configurations of assemblies as determined by the design activity, and a revision letter.



The desired method of marking and identification of parts must be specified on the drawing and shall conform to LPR 5300.1.

2.1.6 Additional Data Blocks

Additional data blocks are authorized as set forth in ASME Y14.100ASME.

2.1.7 Drawing Notes

Drawing notes shall be in accordance with ASME Y14.100 or NCS V6 for buildings.

2.1.8 CAGE CODE

The official CAGE CODE Number for NASA LaRC is 25305. This number shall be reflected in the Drawing Title Block under the CAGE CODE entry block.

2.2 Basic Requirements

2.2.1 Purpose of Drawings

The purpose of drawings is to convey sufficient engineering requirements, characteristics, and information to manufacture or procure an item or to procure materials or services. Drawings shall be complete for the purpose intended. Good drafting technique is essential; however, drawings have no artistic value and drafting technique is not an end in itself. A good drawing is one that can be easily and completely understood by craftsmen, production planners, buyers, and others who must use the drawing.

2.2.2 Legibility

- All line-work shall be sharply defined and of uniform density.
- Lettering shall be clear and adequately spaced.
- All line-work and lettering shall be sufficiently opaque to be legible in full-size copies prepared by any generally accepted method of reproduction.

2.2.3 Mechanical and Photographic Processes

- a. Mechanical and photographic processes may be used to reduce preparation time.
- b. Printed material shall be typewritten in lieu of hand-lettered whenever possible.
- c. When making new drawings that are similar to existing drawings, use photographic or other reproduction techniques to obtain a permanent, reproducible copy of the existing drawings and then revise to produce the new drawings, which shall be renumbered and released as a new drawing.
- d. When a number of drawings or sheets of a drawing are required, which are similar in most respects, draw one sheet containing all common data, print permanent reproducible copies, then add the remaining data to each.

2.2.4 General Drawing Practice

General drawing practice shall be in accordance with ASME Y14.100.

2.2.5 Dimensions and Tolerances

ASME Y14.100 shall be used to establish uniform practices for stating and interpreting requirements shown on drawings.

Chapter 3 - DRAWING AND DOCUMENTATION CONTROL

3.1 Definition

Drawing and documentation control as used herein provides assurance that all released drawings reflect the current design status or after fabrication, the as-built status of all hardware.

3.2 Applicability

The procedures outlined in this section shall be applied to all drawings and/or electronic files produced at LaRC for the fabrication, construction, and maintenance of component hardware and facilities. Exception: The existing LaRC Research Facilities Configuration Management Program, as defined by LPR 1740.4, and the existing subsurface utility drawings program will remain unchanged.

3.3 Drawing Media Types

Three types of drawings are recognized as being produced at LaRC and affected by this procedural requirement:

- 3.3.1 Type 1 is a hard copy, hand-drawn print, where only the original exists and all changes are made to that original for each revision.
- 3.3.2 Type 2 is a hard copy, electronically generated original drawing, where changes are made in the drawing data file and a new hard copy original is generated for each revision.
- 3.3.3 Type 3 is a totally electronic drawing (no hard copy original exists), where a Portable Document Format (PDF) data file is generated for the original and for each subsequent revision. As-built native files are also stored in EDF.

3.4 Release Approval

- a. The Organizational Head or designee(s) of each organizational unit responsible for the generation of drawings, either in-house or on contract, is authorized to approve drawings for release. It is the responsibility of these individuals to ensure conformance with the provisions contained within this procedural requirement. The "release approval" of drawings in no way relieves the individual engineer, designer, draftsman, COR, and others who generated the design from the responsibility of ensuring the structural integrity and/or mission suitability.
- b. The project manager has authority to designate the set of signatures required for the release of his/her project drawings.

3.5 Approval Process

It is the responsibility of the design activity (i.e., LaRC cognizant engineer, designer, draftsman, COR, and others) to ensure that no drawings are released without proper approvals.

3.5.1 Type 1 Drawings

- a. Upon completion of a drawing, the Organizational Head or designee(s) within the cognizant organization shall review and sign the original, listing name, LaRC Employee X500 User ID, and date.
- b. Upon revision to an original drawing, the Organizational Head or designee shall sign or initial in the approval space of the revision block. If a CCR is used to make a change, the responsible person shall sign in the appropriate approval block and the original approval signatures shall be typed in the appropriate spaces. It is the responsibility of the Organizational Head or designee(s) to ensure that the drawing is properly marked with a revision notice, and that an updated drawing record card is provided to EDF at the time of approval.
- c. At any time that revisions are extensive enough to require redrawing of an existing part, the original drawing shall be marked as being obsolete, superseded by a new drawing. The new drawing shall indicate which drawing it supersedes. It is the responsibility of the Organizational Head or designee(s) to ensure that both drawings are properly marked before signing the new drawing.
- d. It is the responsibility of the design activity to ensure that all recipient organizations of the original drawings also receive copies of the revision.
- e. As a part of the project records, a log of all drawings and their recipient organization shall be maintained. It is the responsibility of the design activity to ensure that this record is up-to-date and available for notifying organizations of revisions to drawings.

3.5.2 Type 2 Drawings

- a. Upon completion of a drawing, the Organizational Head or designee(s) within the cognizant organization shall review and manually sign the hard copy original, listing name, LaRC Employee X500 User ID, and date.
- b. Upon revision to a drawing, the drafter shall type the names of the original signatories in the appropriate spaces. The Organizational Head or designee(s) shall initial in the approval space of the revision block on the newly revised original reprinted hard copy. It is the responsibility of the Organizational Head or designee(s) to ensure that the drawing revision is approved by all original parties or designee(s).
- c. EDF personnel shall ensure that the previous drawing file is properly marked as obsolete, or superseded by a new revision on file. All previous editions of the drawing shall be retained as prior revisions in the EDF repository.
- d. If a CCR (LF181) or a Flight Projects Directorate Change Request Form (LF219) is used to make a change, the responsible person shall electronically sign in the added approval block in the drawing data file. It is the responsibility of the Organizational Head or designee(s) to ensure that the drawing revision is approved and properly signed by all original parties or designee(s).
- e. It is the responsibility of the design activity to ensure that all recipient organizations of the original drawings receive copies of the revision or notification that a revision is available in the EDF system.

3.5.3 Type 3 Drawings

- a. Upon completion of a drawing, the Organizational Head or designee(s) within the cognizant organization shall review and electronically sign the original, listing name, and date.
- b. Upon revision to a drawing, the Organizational Head or designee(s) shall electronically sign the data file to approve the revision. The original approval signatures shall be electronically added in the appropriate spaces. It is the responsibility of the Organizational Head or designee(s) to ensure that the drawing revision is approved by all original parties or designee(s). Upon the release of a revised drawing, a PDF of the electronically signed drawing revision shall be transmitted to the EDF repository for storage. As-built native files are also submitted.
- c. EDF personnel shall ensure that the previous drawing file is properly marked as obsolete, superseded by a new revision on file. All previous editions of the drawing shall be retained as prior revisions in the EDF repository.
- d. If a CCR (LF181) or a Flight Projects Directorate Change Request Form (LF219) is used to make a change, the Organizational Head or designee(s) shall electronically sign in the added approval block in the drawing data file. It is the responsibility of the Organizational Head or designee(s) to ensure that the drawing revision is approved and properly signed by all original parties or designee(s).
- e. It is the responsibility of the design activity to ensure that all recipient organizations of the original drawings receive copies of the revision or notification that a revision is available in the EDF system.