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## RECORD OF REVISIONS

| Rev | Date | Description | POC | OIC |
|---|---|---|---|---|
| 0 | 06/28/99 | Revised to become Chapter 3 of Facility Engineering Manual (FEM), superseding Civil Facilities Engineering Standards, Volume 3, Revision 8, 6/5/98. | Edward J. Hoth, *FWO-UI* | Dennis McLain, *FWO-FE* |
| 1 | 08/16/04 | Chapter divided into four sections based on UniFormat. General material moved to ESM Ch 1 Section Z10. FEM now ESM. Other changes throughout. | Edward J. Hoth, *FWO-UI* | Gurinder Grewal, *FWO-DO* |
| 2 | 10/27/06 | Administrative changes only. Organization and contract reference updates from LANS transition. IMP and ISD number changes based on new Conduct of Engineering IMP 341. Master Spec number/title updates. Other administrative changes. | Edward J. Hoth, *MSS-UI* | Kirk Christensen, *CENG* |
| 3 | 05/27/15 | Revised Codes and Standards, Design Guidance recommendations, other minor technical and admin updates. | Jerome Gonzales, *ES-UI* | Larry Goen, *ES-DO* |

## CONTACT THE CIVIL ENGINEERING STANDARDS POC

for upkeep, interpretation, and variance issues

| | |
|---|---|
| **Ch. 3, G10-30GEN** | **Civil POC/Committee** |

# G10-30GEN GENERAL CIVIL REQUIREMENTS

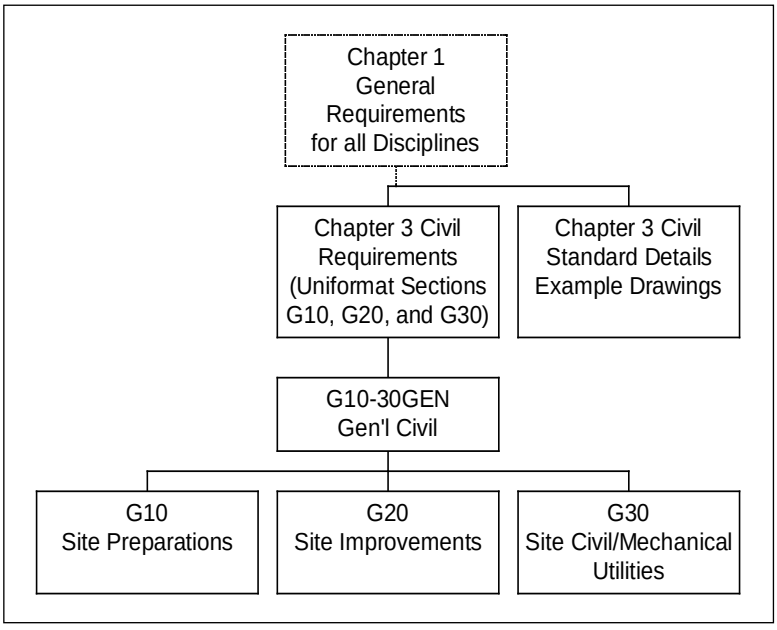
## 1.0 APPLICATION OF CIVIL CHAPTER

### 1.1 General

A. The purpose of this chapter of the LANL Engineering Standards Manual (ESM) is to provide civil systems that prevent accidents and mitigate consequences; are free from hazard; are efficient, convenient, and adequate for good service; and are maintainable, standardized, and adequate for future expansion. Code requirements are minimum requirements that are augmented by the site-specific requirements in this chapter.

B. Civil design, material, equipment, and installations shall comply with site-specific requirements in this Chapter and Chapter 1 of the ESM.[1]

This hierarchy and the organization of this chapter and its relationship to others is depicted below:




[1] LANL P342 Engineering Standards is the institutional mandate for this manual.

## 2.0 ACRONYMS AND DEFINITIONS

| Acronym | Definition |
|---|---|
| **BMP** | Best management practice |
| **ESM** | LANL's Engineering Standards Manual |
| **FDCC** | Federal Geodetic Control Committee (of the National Geodetic Survey of NOAA) |
| **GIS** | Geographic Information System |
| **NAD** | North American Datum (National Geodetic Survey of NOAA) |
| **NGVD** | National Geodetic Vertical Datum (National Geodetic Survey of NOAA) |
| **POC** | Point of contact. For the ESM chapter/discipline Technical Committee POCs see http://engstandards.lanl.gov/POCs.shtml |
| **UTM** | Universal Transverse Mercator |

## 3.0 CODES, STANDARDS, AND REGULATIONS

### 3.1 General

A. See ESM Chapter 1 Section Z10.

### 3.2 U.S. Government

A. DOE-STD-1020, Natural Phenomena Hazards Analysis and Design Criteria for *DOE* Facilities

B. American with Disabilities Act (28CFR Part 36)
http://www.ada.gov/2010ADAstandards_index.htm

C. National Pollutant Discharge Elimination System (NPDES) General Permit for Discharges from Construction Activities
(http://water.epa.gov/polwaste/npdes/stormwater/EPA-Construction-General-Permit.cfm)

D. Energy Independence and Security Act (EISA) Section 438
(http://water.epa.gov/polwaste/nps/section438.cfm)

E. EPA Clean Water Act (CWA) Section 404 Dredge and Fill Permits administrated by the US Army Corp of Engineers
http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits.aspx

### 3.3 New Mexico

A. NM Department of Transportation (NMDOT), Standard Specification for Highway and Bridge Construction, and Addenda. http://dot.state.nm.us/content/nmdot/en/Standards.html

B. New Mexico CWA Section 401 Water Quality Certification
https://www.env.nm.gov/swqb/WQA/

## 3.4 National Standards

*Guidance: For LANL users, a variety of other civil standards are available from IHS, LANL's online national standards service, at http://www.lanl.gov/library/onsite.php*

A. **AASHTO (**American Association of State Highway and Transportation Officials); http://www.transportation.org/Pages/default.aspx Applicable Standards including:

1. Standard Specifications for Highway Bridges
2. Standard Specifications for Transportation Materials and Methods of Testing
3. Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.

B. **ACI** (American Concrete Institute); http://www.concrete.org/general/home.asp Applicable standards including ACI 318, Building Code Requirements for Structural Concrete.

C. **AWWA** (American Water Works Association); http://www.awwa.org/. Applicable standards on Concrete Pipe, Disinfection Chemicals, Disinfection of Facilities, Ductile-Iron Pipe and Fittings, Filtration Media, Fluoridation Chemicals, Meters, Pipe Installation, Plant Equipment, Plastic Pipe, Scale and Corrosion Control Chemicals, Service Lines, Softening and Coagulation Chemicals, Steel Pipe, Storage, Taste and Odor Control, Valves and Hydrants, and Wells for potable and waste water treatment and distribution.

D. **MUTCD** (Manual on Uniform Traffic Devices) http://mutcd.fhwa.dot.gov/. **MUTCD** defines the standards used by road managers nationwide to install and maintain traffic control devices on all public streets, highways, bikeways, and private roads open to public travel.

## 3.5 LANL Documents

*LANL desires that projects (both during and after completion) minimize impact to the environment. Proper storm water management, sediment and erosion control, low impact development, and sustainable design are important elements in minimizing impacts.*

A. Projects that disturb over 1 acre, or are part of a common plan of development over 1 acre, are subject to National Pollutant Discharge Elimination System Storm Water Construction General Permit requirements. See ESM, Chapter 3, Section G10 6.0.C.

B. Federally funded development and re-development projects with a footprint greater than 5,000 $ft^2$ must also meet Energy Independence & Security Act Section 438 storm water management requirements. See LANL ESM, Chapter 3, Sections G10 (*6.0 B*) and G20 (*1.0 B*).

C. Refer to the LANL Site and Architectural Design Principles Document and the LANL Sustainable Design Guide, (see LANL ESM Chapter 4-Architectural) for information on design integration of hardscape surfaces and landscaping with stormwater management.

D. Refer to the LANL Storm Water BMP Manual for additional guidance on storm water management, sediment and erosion control, and low impact development features. The LANL entity requesting the project shall set specific requirements in these areas along with the responsible Facility Manager.

E. ESM Chapter 14-Sustainable Design contains the minimum requirements for sustainable design along with guidance on compliance.

## 4.0 DESIGN DOCUMENTATION

### 4.1 General

A. See ESM Chapter 1 Section Z10, Design Output Submittals Subsection.

B. In addition, documentation shall include, but is not limited to, the following:

1. The following drawing types are required as necessary to convey the required work: Grading and Site Plans; Landscaping Plans; Utility Plot Plans; Road Plans, Profiles, and Cross Sections; Storm Drain Plans and Profiles; Sanitary Sewer Plans and Profiles; Water Supply and Distribution; Radioactive Liquid Waste, Caustic, Acid, and Other Chemical Plans and Profiles.
2. Drawing content and format shall comply with the LANL CAD Standards Manual (*including its Civil section, Section 302*).

### 4.2 Calculations

A. See ESM Chapter 1 Section Z10, Design Output Submittals Subsection. In addition:

B. Provide drainage calculations where applicable.

C. Provide earthwork calculations of cut and fill volumes.

D. Provide pressure analysis for system material selection, flow volumes, and fluid analysis for sizing gas, water, steam/condensate, storm water drainage, and sewer systems.

E. Provide road design calculations including horizontal and vertical alignment, curve data, super elevation, minimum sight distances, and pavement thickness. Take traffic counts and future volume projections (obtained from the Operations and Infrastructure Program Office / Infrastructure Planning Group) to establish design parameters if required.

### 4.3 Sealing Construction Documents

A. See ESM Chapter 1 Section Z10.

# 5.0 SURVEYING

## 5.1 General

A. The degree of accuracy for construction, control, property, and topographic (including existing structures and utilities) surveys shall be consistent with the nature and importance of each survey. As required by law (i.e., applicable State statutes) control and property surveys at LANL shall be performed by, or under the supervision of, a professional land surveyor registered in the State of New Mexico.

B. Conform to Table G10-30GEN-1 (at end of this document) for specific survey categories.

C. Due to security restrictions and hazardous conditions at some LANL sites, surveyors must contact appropriate divisional personnel, Operations Managers for Work Control Procedures, and ESH&Q authorities to obtain necessary escorts and training.

D. Review and oversight of surveying, survey data, and permanent survey monument installation shall be accomplished by LANL Utilities and Institutional Facilities, (U&IF) Utility Mapping Department (UMAP). *This will be accomplished with a project specific task through the Engineering Service Request (ESR) System.*

## 5.2 Permanent Survey Monuments

A. Coordinate the placement, number and location of permanent survey monuments for horizontal and vertical control with and approved by the LANL Project Leader and LANL U&IF, UMAP. Provide the location and description of the nearest permanent survey monument on construction drawings. Tie these monuments by Grid Bearing, ground distance and elevation to the New Mexico Coordinate System and referenced to NAD of 1983 and the NGVD of 1929.

B. Any surveyor that sets a permanent survey monument shall prepare legible notes, sketches, or other reproducible documentation that show the location of the new monument relative to the on-site horizontal and vertical control network to the applicable New Mexico Coordinate System, to the NAD of 1983, and to the NGVD of 1929. Provide the convergence, scale factor and elevation at the monument. Coordinates for NAD 83 shall be in feet.

C. A description of the surveying equipment and procedures used to establish the new monument shall accompany copies of field notes, calculations, reductions, and closures. Submit similar information for any found monuments. Consider permanent survey monuments properly positioned and represented only after the LANL U&IF, UMAP has approved survey procedures and calculations and has verified conformance to standards and specifications for Order 2-I surveys or greater.

D. Identify permanent survey monuments with a metal cap set in conformance with National Geodetic and New Mexico Survey Practice. Permanently stamp identification numbers into the metal cap.

E. Document these identification numbers within the survey field notes and shown on the design drawings and within related documents.

F. Tentative point identification for permanent survey monuments may be assigned by the surveyor; however, permanent point identification must be assigned and recorded according to these standards.

G. Install two steel angle guard posts or bollards painted white adjacent to permanent control monuments in high traffic areas to preclude vehicular damage. Do not remove permanent survey monuments without prior authorization from LANL U&IF Institutional and Facilities Group.

## 5.3 Bench Marks

A. Establish a minimum of one permanent benchmark for vertical control in each new development area. Establish a minimum of three benchmarks if there are no existing benchmarks within a 3 mile radius of each new development area. Additional benchmarks may be established, as necessary. Benchmarks may coincide with permanent survey monuments or temporary control monuments.

B. Reference benchmark elevations to the NGVD of 1929.

C. Level section misclosures between fixed bench mark elevations shall equal or exceed Third Order Accuracy, as defined in FGCC Standards and Specifications for Geodetic Control Networks and shown below.

| Accuracy Standards for Level Closures [2] | | |
|---|---|---|
| First Order* | Second Order# | Third Order* |
| 0.017 ft. $M^{1/2}$ | 0.035 ft. $M^{1/2}$ | 0.05 ft. $M^{1/2}$ |
| * M is the distance in miles of the total level route running forward and back between fixed elevations or along a level loop. | | |

D. Legible level notes or electronic data and calculations shall be prepared by the surveyor.

E. Identify permanent benchmarks with a metal cap as specified in Section 5.2, Permanent Survey Monuments.

F. Do not remove permanent benchmarks without prior authorization of LANL U&IF. Provide the location of description of benchmarks in the immediate vicinity of new construction on construction drawings.

## 5.4 Surveys for New and Existing Utilities, Roads, and Parking Areas

A. Determine coordinates and elevations for utilities, roads, and parking areas at their principal points of definition. Provide this information on the construction drawings.

B. The principal points of definition for utility systems shall include utility poles, obstructions, manholes, valve boxes and other appurtenances for heating and cooling lines, sewers, and overhead and underground power and communication/data systems. Principal points of definition for potable water and natural gas distribution systems shall be valve boxes, main line intersects, fire hydrants, and other appurtenances.

[2] Source: Standard and Specifications for Geodetic Control Networks, FGCC.

C. The principal points of definition for roads shall be roadway centerline intersects. Road alignment surveys shall include stationing, bearings and curve information tied to these principal points of definition. Where applicable, provide the following information on the construction drawings:

1. Stations and deflection angles for each point of intersection.
2. Right-of way lines and markers.
3. Spot elevations (centerline, edge of pavement, top of curb, gutterline at curb returns, valley gutters, and at intersects) at minimum intervals of 100 ft.
4. Pavement width and curb and gutter width where applicable.
5. Other improvements (e.g., drainage inlets/outlets, wheelchair ramps, fire hydrants, sidewalk, curb and gutter).
6. Topographic features within the project limits.
7. Elevation contours.
8. Overhead and underground utility crossings (plan and profile).
9. Roadway drainage crossings (angular or perpendicular to roadway).
10. Location and description of underground utility witness markers.

## 5.5 Surveys for Location of Existing Underground Utilities

A. Where exact routes of underground utilities are not defined within record drawings and such information is essential to subsequent design efforts, the surveyor shall coordinate necessary electronic line detection and exploratory excavation activities with the LANL's U&IF, UMAP. Locate such utilities by survey and document on the construction drawings. Principal points of definition shall be the same as in Article 5.4.

## 5.6 Survey Information Submittal

A. Record surveys in field books or electronic files.

B. Submit information gathered from surveys for sampling, utilities, roads, parking areas, structures, and control to the LANL U&IF, UMAP As-Built Program to become a part of the LANL GIS Database using the procedures outlined in the Survey Procedure of this section.

TABLE G10-30GEN-1 [3]
Geometric Relative Positioning Accuracy Standards for
Three-Dimensional Surveys Using Space System Techniques

| Survey Categories | Order | (95% confidence level) Minimum geometric accuracy standard | | |
|---|---|---|---|---|
| | | Base Error | Line-length Dependent Error | |
| | | e (cm) | p (ppm) | a (1:a) |
| Global-regional geodynamics; deformation measurements | AA | 0.3 | 0.011 | : 1000,000,000 |
| National Geodetic Reference System, "primary" networks; regional-local geodynamics; deformation measurements | A | 0.5 | 0.1 | : 10,000,000 |
| National Geodetic Reference System, "secondary" networks; connections to the "primary" NGRS network; local geodynamics; deformation measurements; high-precision engineering surveys | B | 0.8 | 1 | : 1,000,000 |
| National Geodetic Reference System, (Terrestrial based); dependent control surveys to meet mapping, land information, property, and engineering requirements | 1 | 1.0 | 10 | 1: 100,000 |
| | 2-I | 2.0 | 20 | 1: 50,000 |
| | 2-II | 3.0 | 50 | 1: 20,000 |
| | 3 | 5.0 | 100 | 1: 10,000 |

Note: For ease of computation and understanding, it is assumed that the accuracy for each component of a vector baseline measurement is equal to the linear accuracy standard for a single-dimensional measurement at the 95% confidence level. Thus, the linear one-standard deviation(s) is computed by:

$$s = \pm = \langle e + (0.1dxp)_2 \rangle / 1.96$$

where d is the length of the baseline in kilometers.

[3] Table taken from "Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques"