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## Electrical Engineering

**Course Number:** EE-02-103

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## Module 1: Introduction

### Learning Objectives

By the end of this section, you will be able to:

- **Identify** the hierarchy of Unified Facilities Criteria (UFC) governing electrical design projects.
- **Evaluate** when modifications to existing systems necessitate updated electrical safety calculations.
- **Apply** mandatory design standards and regulatory requirements to project documentation and execution.

*Executive Summary:* This chapter establishes UFC 3-501-01 as the foundational baseline for electrical engineering design across all Department of Defense facilities. It mandates the use of current industry standards like NFPA 70 and IEEE C2 while providing a framework for coordination with specialized electrical UFCs, cybersecurity protocols, and environmental regulations.

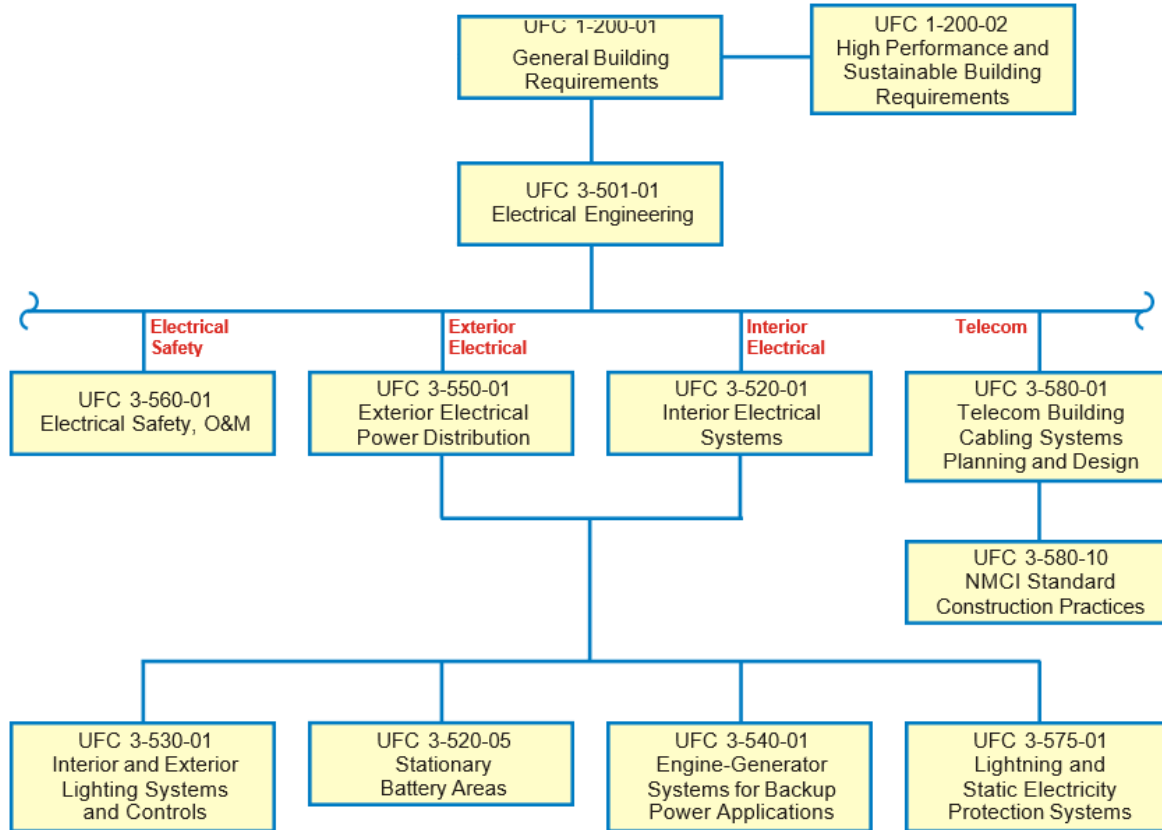
### Design Purpose and Scope

This UFC provides the mandatory **technical requirements** for the general electrical design of projects. You must apply these criteria when developing plans, specifications, and calculations for both **design-build** and **design-bid-build** projects.

- **Minimum Standards:** These requirements represent the minimum design threshold.
- **Exceeding Criteria:** Specific project conditions may require designs that exceed these baselines.

### UFC Hierarchy

UFC 3-501-01 serves as the **top-tier baseline**. All other electrical-related UFCs rely on this document for overarching design analysis and documentation requirements.



**Figure 1-1:** Electrical UFC Delineation

### Upgrades and Modifications to Existing Systems

**Modernization** is not required solely to meet new UFC criteria. However, when you upgrade or modify an electrical system, you must consider the current design criteria.

**⚠ Safety Constraint:** If a minor project modifies circuit breaker settings or affects existing electrical system calculations, you **must update** those calculations, specifically the **arc flash calculation**, as part of the project.

### Applicability

Compliance with this document is **mandatory** for all electrical system designs at facilities and bases.

- **Outside the United States:** You must comply with both this UFC and applicable **host nation standards**.
- **Design Principles:** Even when dealing with foreign voltages or grounding conventions, follow the principles in this UFC to the extent practical.



## General Building Requirements


Use this document in conjunction with **UFC 1-200-01**, which outlines model building codes and government-unique criteria for safety, antiterrorism, and sustainability.

## Waiver and Exemption Process

Follow the procedures outlined in **MIL-STD 3007** for any required waivers or exemptions from these technical standards.

## Reference Standards

Electrical designs must utilize the **most current version** of any publication or code in effect at the time the design contract is signed.

 **Design Tip:** If a project is significantly delayed after starting, you must evaluate if an update to newer versions of codes is required, which may necessitate redesign work.

## Mandatory Design Standards

The **Designer of Record (DOR)** is responsible for the following core tasks:

- **Code Application:** Apply **NFPA 70** and **IEEE C2** to all designs.
- **Documentation:** Ensure contract documents fully indicate the scope of work and are accurate and coordinated.
- **System Coordination:** Coordinate the electrical design with structural, mechanical, and other applicable disciplines.
- **Site and Environment:** Incorporate sustainable design principles and comply with all applicable environmental requirements.

## Cybersecurity

You must plan, design, and maintain all control systems—including those separate from energy management systems—in accordance with **DoDI 8500.01** and **DoDI 8510.01**.

## Construction and Environmental Permits

Identify all necessary **permits and fees** required for the environmental, construction, and operation phases of the facility at the outset of the design process.

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*Checkpoint Quiz*

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**1. When must a Designer of Record update arc flash calculations for an existing system during a minor modification?**

- a) Only if requested by the facility manager.
- b) Only during a full facility modernization.
- c) Whenever circuit breaker settings or system calculations are affected by the modification.
- d) Only when upgrading to a higher voltage.

**Answer:** (c). Updates are mandatory for safety whenever the protective parameters change.

**2. According to the UFC hierarchy, which document provides the top-tier baseline for all electrical work?**

- a) UFC 3-560-01
- b) UFC 3-501-01
- c) NFPA 70
- d) MIL-STD 3007

**Answer:** (b). This document is the top-tier baseline and reference for all other electrical UFCs.

**3. What version of a code or standard should be used if the design contract does not specify a date?**

- a) The version in effect when the design contract was signed.
- b) The version in effect when construction begins.
- c) The version used in the previous facility design.
- d) The 2015 edition of the UFC.

**Answer:** (a). Designs are intended to use the version current at the time of the contract signing unless otherwise directed.

## Module 2: Design Requirements

### Learning Objectives

By the end of this section, you will be able to:

- **Identify** hazardous and controlled materials commonly encountered in electrical demolition and replacement projects.
- **Select** appropriate corrosion-resistant materials and equipment enclosures for high-humidity or salt-spray environments.
- **Evaluate** the correct design interface and demarcation points between NFPA 70 (NEC) and IEEE C2 (NESC) for various facility types.

**Executive Summary:** This chapter details the technical mandates for designing, modifying, and maintaining electrical systems within DoD facilities. It emphasizes the use of standard catalog products, rigorous safety compliance for outages, and specialized requirements for site-specific conditions such as corrosive environments, HEMP shielding, and structured telecommunications.

### General Design Fundamentals

You must design electrical systems to meet the specific needs of the activity and supporting facilities. All electrical equipment must be the manufacturer's standard catalog products. They must conform to the latest industry and technical society standards at the date of the contract award.

**⚠ Safety Constraint:** Underwriters Laboratories (UL) listing or third-party certification is required for all basic equipment. Shop or field-fabricated assemblies that are not standard catalog products are strictly prohibited.

## Hazardous Materials and Waste, and Controlled Materials

Electrical demolition or replacement projects frequently involve hazardous materials. You must account for the following in your design and safety planning:

- **PCBs (Polychlorinated Biphenyls):** Found in the dielectric fluid of pad-mounted and pole-mounted transformers, switches, oil-fused cutouts, capacitors, and fluorescent ballasts.
- **Mercury:** Present in fluorescent and high-intensity discharge (HID) lamps.
- **Tritium:** Located in self-luminous exit signs.
- **Lead:** Encountered in lead-shielded cables and exterior paint on pad-mounted equipment.
- **Asbestos:** Found in fireproofing (spray-on or tape) and cable fill in manholes, handholes, and ducts.
- **Batteries:** Storage batteries may contain lead, cadmium, lithium, and electrolytes.



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