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Data Center Power Systems - Design and Reliability

View Course Details

COURSE DATES AND TIMES

Why Data Center Power Systems Training Matters

This 12-hour instructor-led course teaches the design logic behind that chain: how redundancy concepts like N, N+1, and 2N translate into real equipment configurations, which codes and standards actually govern data center electrical design (and which ones are voluntary industry practice rather than enforceable code), and how engineers, facility managers, and contractors think through capacity planning, single points of failure, and maintenance strategy before a single piece of equipment gets specified.

This Data Center Power Systems Design and Reliability training course covers the conceptual and practical foundations of data center electrical design. Participants will learn to read and reason through a full critical-power one-line diagram — utility service, medium- and low-voltage switchgear, standby generators, UPS systems, transfer switches, and downstream distribution — and understand how redundancy models (N, N+1, 2N, 2N+1) are applied at each stage to meet a facility's target availability.

A dedicated session covers the latest codes and standards landscape for data center electrical design—including which National Electrical Code (NEC) articles genuinely apply, which industry documents (like the Uptime Institute's Tier framework) are voluntary rather than enforceable, and where IEEE reliability-engineering practices fit in.

Special attention is given to reliability engineering: identifying single points of failure, understanding concurrent maintainability, and walking through the actual sequence of events during a utility failure. The course closes with a look at how rising AI/HPC rack densities and rapid load swings are changing electrical design assumptions for new and retrofitted facilities.

Standards & Codes Referenced in This Course

This course reviews the following real, current documents — it does not reproduce or substitute for their full text; students working on actual projects should consult current editions directly.

Document	What it covers
NEC (NFPA 70) Article 645	Information Technology Equipment — optional alternate wiring methods for qualifying IT equipment rooms
NEC (NFPA 70) Article 708	Critical Operations Power Systems (COPS) — risk assessment, commissioning, and testing requirements for facilities formally designated as critical operations areas
NFPA 75	Standard for the Protection of Information Technology Equipment — referenced by NEC 645
NFPA 110 / NFPA 111	Emergency and Standby Power Systems / Stored Electrical Energy Emergency and Standby Power Systems — referenced by NEC 708
NFPA 70B	Recommended Practice for Electrical Equipment Maintenance — referenced by NEC 708
ANSI/TIA-942-C	Telecommunications Infrastructure Standard for Data Centers (most recent revision published 2024)
ANSI/BICSI 002	Data Center Design and Implementation Best Practices (most recently updated 2019)
Uptime Institute Tier Standard	Industry framework (not a code or ANSI standard) defining Tier I-IV availability classifications; voluntary and proprietary
IEEE Std 493 (Gold Book)	Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems
IEEE Std 3006.7	Reliability of 7x24 Continuous Power Systems in Industrial and Commercial Facilities

Note: *The Tier Classification System and "Tier Standard" are proprietary, trademarked terminology owned by Uptime Institute, LLC. This course explains the publicly-discussed Tier framework for educational purposes only, the way any training provider might reference NEC or IEEE terminology. It does not confer Uptime Institute accreditation, and EFTI is not affiliated with, endorsed by, or a substitute for Uptime Institute's own Accredited Tier Designer (ATD) program.*

Learning Outcomes

- Explain the complete data center critical power chain.
- Distinguish electrical codes from voluntary industry standards.
- Explain the four Uptime Institute Tier classifications.
- Compare N, N+1, 2N, and 2N+1 redundancy.
- Identify single points of failure in electrical systems.
- Explain power-system operation during a utility outage.
- Apply basic load, capacity, and diversity calculations.
- Explain concurrent maintainability and system redundancy.
- Describe the electrical impact of high-density AI/HPC loads.
- Evaluate and communicate reliability, cost, and efficiency trade-offs.

WHO SHOULD ATTEND

- Electrical engineers working on data center power systems
- Facility and data center managers
- Electrical contractors and project managers
- Consulting engineers
- Certificate program participants
- Engineers entering mission-critical power work

Prerequisites: A working knowledge of basic electrical power system concepts (voltage, current, three-phase power, one-line diagrams) is recommended. No prior data center-specific experience is required.

STUDENTS RECEIVE

- Data Center Power Systems Training Certificate
- 1.2 Continuing Education Unit (CEU) Credits (12 Professional Development Hours)
- FREE 100-Page Digital Electrical Handbook (Value $20)
- $100 Coupon Toward Any Future Electricity Forum Event (Restrictions Apply)
- FREE Magazine Subscription (Value $25.00)
- Course Materials In PDF Format

COURSE OUTLINE

Data Center Power Systems Design and Reliability - Course Outline

DAY 1 (6 Hours)

Module 1: The Data Center Critical Power Chain

- Overview of the full power path: utility service to MV switchgear to transformers to LV switchgear to standby generators to transfer switches (ATS/STS) to UPS systems to distribution (busway/PDU) to rack-level power to IT load
- Roles and responsibilities at each stage of the chain
- Reading a simplified data center one-line diagram
- Key terminology: normal power, standby power, critical load, non-critical load, A/B power paths

Module 2: Codes & Standards Part 1 — Enforceable Electrical Codes

- NEC Article 645: scope, applicability, and why most IT rooms don't actually require it
- NEC Article 708 (COPS): risk assessment, mitigation strategy, and testing/commissioning requirements
- NFPA 75: the companion standard referenced by NEC 645
- NFPA 110 and NFPA 111: emergency and standby power system classifications referenced by NEC 708
- NFPA 70B: preventive maintenance practice referenced by NEC 708

Module 3: Codes & Standards Part 2 — Industry Standards & Reliability References

- ANSI/TIA-942-C and ANSI/BICSI 002: how these two voluntary standards were developed to complement each other
- The Uptime Institute Tier Standard as a proprietary, voluntary framework rather than an adopted code
- IEEE Std 493 (Gold Book): reliability analysis for industrial and commercial power systems
- IEEE Std 3006.7: reliability practice specifically for 7x24 continuous-power facilities
- Class discussion: matching the right standard to the right project scenario

Module 4: Tier Classification and Redundancy Models

- Data center four-tier framework: Basic Capacity, Redundant Capacity, Concurrently Maintainable, Fault Tolerant
- Redundancy notation explained: N, N+1, 2N, 2N+1
- Distribution path count and why Tier III/IV require multiple active paths
- Common misconceptions: redundant vs. concurrently maintainable

Module 5: Load Estimation, Capacity Planning & Diversity

- Estimating IT and mechanical loads for a new or expanding facility
- Diversity factors and why nameplate capacity isn't actual demand
- Planning for phased growth without over-building
- Power Usage Effectiveness (PUE) as a design and operating metric

Module 6: Utility Service and Medium-Voltage Design Considerations

- Single vs. dual utility feeds and utility-side redundancy options
- Medium-voltage switchgear basics and where it sits in the reliability picture
- Service entrance considerations: metering, protective relaying coordination, utility interconnection
- Group discussion: matching utility service strategy to target Tier level

DAY 2 (6 Hours)

Module 7: Standby and Backup Power Systems

- Generator systems: sizing, paralleling, and synchronization basics
- Standby vs. emergency classifications under NFPA 110 and 111
- Fuel storage, run-time planning, and load-step considerations
- Case discussion: generator failure scenarios and redundancy mitigation

Module 8: UPS Systems and Battery Backup Strategy

- UPS topologies at a conceptual level and reliability goal alignment
- VRLA vs. lithium-ion trade-offs from a design perspective
- Ride-through time requirements driven by generator start time
- Sizing UPS capacity against present load and planned growth

Module 9: Reliability Engineering — Single Points of Failure & Concurrent Maintainability

- Identifying single points of failure in a proposed or existing design
- Concurrent maintainability in practice: what has to be true for maintenance without shutdown
- Group exercise: marking up a sample one-line diagram for failure points

Module 10: Reliability Engineering — Sequence of Operations & Metrics

- Full sequence of events during a utility failure: ride-through, generator start, synchronization, ATS transfer, return to utility
- Introduction to MTBF and MTTR as basic reliability metrics
- How these metrics inform design and maintenance-strategy decisions

Module 11: AI/HPC Loads and Emerging Design Trends

- How high-density AI/HPC racks create faster, larger load swings than traditional IT loads

- Effects on transformer and UPS sizing margins
- Emerging design patterns for retrofitting existing facilities to higher densities
- Discussion: near-term trends engineers should watch for in new project specifications

Module 12: Case Study, Course Review & Q&A

- Group case study: applying redundancy models, standards selection, and reliability concepts to a sample facility scenario
- Instructor-led review of key concepts from Days 1 and 2
- Open Q&A
- Certificate of completion

COURSE SCHEDULE:

Start: 10 a.m. Eastern Time
Finish: 4:30 p.m. Eastern Time