Healthcare
Electrical Reference Architecture for Large Hospitals in North America
Catalog
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Introduction

The main objective of this electrical distribution design is to address continuity of service for enhancing patient care and satisfaction.

The NFPA 99 Health Care Facilities Code establishes criteria for levels of health care services or systems based on risk associated with the impact (to patients, staff, or visitors) of a failure (of an activity, system, or equipment).

According to NFPA 99, the following items define the failure consequences for the given categories:

- Category 1 is likely to cause major injury or death
- Category 2 is likely to cause minor injury
- Category 3 is not likely to cause injury
- Category 4 would have no impact on patient care

Categories 1 and 2 require a backup power source, such as a generator, to restore power to critical and life safety loads within 10s after interruption of the normal source.
Electrical Distribution Principle
The continuity of service in the hospital is mainly managed by:
- Multiple energy sources: electrical utilities, generator backup system, UPS with battery.
- Redundant energy path significantly reduces the mean time to recovery in case of outage. This design is also necessary to implement maintenance in the 24/7 hospital building.

Utility Sources
The hospital building should reinforce utility energy sourcing through double-separated incomers.

Medium Voltage (MV) System Management
The MV system is dependent on the utility sources available, hospital profile, redundancy scheme, and cost. MV system redundancy can include composite primary and/or secondary selective radial systems. Source transfer automation and protection reduces outages and recovery time.

Essential Electrical System (EES)
An EES is comprised of alternate sources of power and all connected distribution systems, designed to help maintain continuity of electrical power to designated areas and functions of a health care facility during disruption of normal power sources.

Designated areas and functions are described in three branches:
- **Life Safety Branch**: in accordance with the NFPA 101: Life Safety Code, applies exclusively to circuits essential to life safety systems, such as emergency lighting and other systems that aid in exiting the hospital
- **Critical Branch**: supplies power for task illumination, fixed equipment, select receptacles, and select power circuits spaces and functions related to **patient care**
- **Equipment Branch**: comprised of power equipment and associated control systems

Generator Backup System
The generator backup system should manage outage recovery within 10s for the corresponding load classification.

UPS for Operating Room and Specific Equipment
A UPS can help maintain continuity of service for the operating rooms, intensive care units, and other critical medical applications related to patient safety. Additionally, a UPS helps maintain service for long cycle or critical processes where even a brief outage can have a financial impact to the hospital and discomfort for the patient.
Reduce Risk and Enable a Future Ready Design

Utility A  
MV Service Entrance Equipment

Utility B (Back Up)

Generator Paralleling Switchgear

Load Bank

To Chiller Plant & Other Buildings

Emergency Distribution

To Automatic Transfer Switches (ATSs)

Main Building Normal Distribution LV Substation

Auto Control

PFCC

Light Panel

Lighting & Receptacles

Normal Branch

Dist. Panel

Dist. Panel

Dist. Panel

UPS

Dist. Panel

Dist. Panel

Dist. Panel

VFD

M

Backup

Dist. Panel

Dist. Panel

Dist. Panel

Medical Machines

Emergency Lighting & Communication, Fire Alarm Systems

Life Safety Branch

Operating Rooms

IT Loads

Patient Rooms

Equipment Branch

Equipment Branch

Fire Pump

Critical Branch

M

Fire Pump

To Automatic Transfer Switches (ATSs)

ATS
Reduce Downtime by Identifying Potential Issues

The Power Monitoring and Control system reinforces and maintains energy availability performance for the full life cycle of the hospital.

This system should be composed of:

**Power Monitoring and Control**

Power monitoring monitors the electrical distribution from main incomers to the final distribution with animated one-line diagrams.

Source control (incomers, generators), network control (automatic transfer switch [ATS], UPS) and load control (load shedding) are automated to maximize uptime without user intervention.

Connected hardware provides the ability for remote control and supervision of electrical distribution automation.

**Alarming**

By automatically sending notifications for alarms and events to designated users using mobile devices, users can quickly identify system abnormalities and take appropriate action.

Alarms are focused on the UPS by centralizing all UPS battery remaining time.

A centralized alarming system for the operating ward is also recommended by NFPA Standards.

The breaker coordination dashboard analyzes and monitors breaker settings compared to baseline, "as-designed" breaker coordination.

**Thermal Monitoring for the Medium Voltage Switchboard**

Thermal monitoring (TH110) detects abnormal temperature rises in MV equipment and LV busway.
Power Events Analysis
The EcoStruxure Power Events Analysis isolates the power system and reduces downtime with the following features and capabilities:

- High resolution, high accuracy event sequence record to find origins of fault
- Cross-system event correlation to help reconstruct sequence of events
- Speed the diagnosis of power incidents by automatically creating a visual timeline of the incident showing related events, waveforms, and trends
  - Gain deeper insight about the cause and impact of an incident by seeing a visual timeline before, during, and after the incident
  - Record analysis for later viewing, with custom annotations and custom filters to show only what is most relevant
  - Continuously record, replay, and analyze power system events visually using animated electrical one lines, floor plans, and riser diagrams

Asset Advisor
The EcoStruxure Asset Advisor evaluates live data from your critical connected assets and applies advanced analytics to identify potential threats. With this data, Asset Advisor gives you the power of choice for critical decisions, either to take action yourself or to leverage Schneider Electric’s Service Bureau to do so on your behalf.

Advanced analytics enable a much more predictive approach to maintenance by using advanced pattern recognition and machine learning to detect equipment issues before they become operational and provide early warnings.

Power Advisor
The EcoStruxure Power Advisor provides data quality management by performing regular system health checks that find missing or incorrect data, devices missing in the hierarchy, stagnant or misreported values, etc.

Power Advisor also helps ensure your system is reliable with recommendations to improve data quality and system evolution with expert support throughout the entire life cycle.
Helps Ensure Protection


Main Low Voltage Breaker
The Low Voltage Masterpact™ MTZ circuit breaker can be remotely operated from outside the arc flash zone using Bluetooth® technology.
Isolates the Power System and Reduces Downtime

The electric equipment operating in the patient vicinity produces a leakage current. This leakage is not intended to be applied to a patient, but could pass from exposed metal parts of an appliance to ground.

To reduce the risk, an isolated ungrounded electrical distribution system is designed into the building, creating a small local network with low leakage capacitance. These systems include limits and methods for checking the system integrity. Line Isolation Monitors (LIMs) continuously check the impedance of the total isolated ungrounded system to ground.

Isolated systems are now commonly used to protect against electrical shock in many areas, among them:

- Intensive care units (ICUs)
- Coronary care units (CCUs)
- Emergency departments
- Special procedure rooms
- Cardiovascular laboratories
- Dialysis units
- Various wet locations

By adding the optional Fault Locator System to the isolated ungrounded electrical distribution system, the branch circuit with resistive fault can be identified quickly, allowing the hospital staff to determine the next step after the alarm condition occurs.
Save Money by Reducing Energy Cost

The energy management system is key to reducing operational cost during the building life cycle.

Utility Billing Verification

The shadow bill, which compares energy consumed during the billing period, provides evidence of errors to the utility, which can have fast financial return.
Understanding the billing “levers” can help change the behavior (examples: peak shaving, demand response).

Cost Allocation

This allocates energy cost to different departments or to identified loads, and often leads to reduction as a result of change in behavior.

Energy Usage Analysis

This analyzes how much energy is consumed by the various load types or areas to identify where to focus energy conservation initiatives.
By implementing energy usage models, the actual consumption can be compared against expectation.

Power Factor Correction

Measuring and correcting power factor or reactive power (kVAR) caused by inductive loads like motors can result in a fast ROI by reducing penalties charged by many utilities.

Sustainability Reporting

Greenhouse gas reporting is based on equivalent tons of CO₂ emissions, saved trees, km driven, etc.
The building energy rating is directly linked to the energy consumption by square meter. Carbon emissions are reported and segmented by source, scope, and pollutant, and can be indexed to various metrics you specify.

Maintain Compliance to Regulations and Sustainability

Building Energy Rating
Carbon Emission Awareness
Microgrid Application

The EcoStruxure Microgrid Application helps protect facility operations against extreme weather, cyberattacks and grid instability (avoiding costly downtime). Strategic partners provide Energy-as-a-Service (EaaS) with flexible governance models, enabling you to control your financial and operational risks. With seamless DER integration, you get actionable insights on when to consume, store, and sell energy for the greatest financial advantage.

Application outputs include:

- User interface: animated one-line diagrams gives situational awareness of the state of your power system from anywhere and allows operators to perform remote control
- Reporting: comprehensive reporting on power quality, power, and energy usage with EcoStruxure Power Monitoring Expert or EcoStruxure Power SCADA Operation with Advanced Reporting and Dashboards
- Notifications: ability to automatically notify appropriate personnel of power system events via email or SMS
- Control and command: EcoStruxure Microgrid Operation (EMO) can perform automatic control for load sharing, DER management, load shedding, black-start sequence, grid management, etc.
Save Money by Optimizing Maintenance

The NFPA 110 includes maintenance and testing requirements for performance of emergency power including sources, transfer equipment, controls, supervisory equipment, and all related electrical and mechanical auxiliaries.

Diesel Generator Backup System
The diesel generator sets in service should be exercised at least once monthly, for a minimum of 30 minutes, using one of the following methods:

- Loading that maintains the minimum exhaust gas temperatures as recommended by the manufacturer
- Under operating temperature conditions and at not less than 30 percent of the Emergency Power Supply (EPS) standby nameplate kW rating

Diesel-powered EPS installations that do not meet these requirements should be exercised monthly with the available EPSS load and exercised annually with supplemental loads at no less than 50 percent of the EPS nameplate kW rating for 30 continuous minutes and at no less than 75 percent of the EPS nameplate kW rating for 1 continuous hour for a total test duration of no less than 1.5 continuous hours.

LV Circuit Breaker Preventive Maintenance
The condition based maintenance is based on the operation and tripping of the breaker in the main LV switchboard environment. This automatic tracking system optimizes the annual preventive maintenance.

UPS Monthly Test
UPS testing typically complies with NFPA 110 or NFPA 111.
Increase Electrical System and Asset Reliability

**Power Quality Monitoring, Correction, and Compliance Reporting**

Good power quality limits the risk of disrupting or damaging the critical loads. Monitor the status of power quality in the system based on industry recognized thresholds, and identify areas to correct power related issues that may impact equipment.

Comprehensive power quality reports, per the EN50160, IEC61000-4-30, IEEE 519 standards, provide accurate diagnosis on sag/swell, harmonics, and transient.

**Power Quality Reports**

Power Quality Reports

Accusine™ PCS+