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Electrical Design of Healthcare Facilities

Introduction

Healthcare facilities have more stringent electrical design requirements than commercial or industrial facilities due to the critical nature of care they provide and the increasing dependence on electrical equipment for preservation of life. There are several agencies and organizations that develop requirements for healthcare electrical distribution design and implementation, such as the National Fire Protection Agency (NFPA). Examples of guidance include NFPA 99, Health Care Facilities Code, which defines the risk categorization and essential electrical system types, and "NFPA 70, National Electrical Code, Article 517" and the authority having jurisdiction (AHJ) define the implementation of electrical distribution systems.

Key Points

All electrical power in a healthcare facility is important, though some loads are not critical to the safe operation of the facility. As a result, healthcare electrical systems typically fall into one of two categories: non-essential electrical systems and essential electrical systems (EESs). Non-essential loads include general lighting, general lab equipment, non-critical service equipment, patient care areas, etc. These electrical loads are not required to be fed from emergency generators. Essential loads comprise a system capable of supplying a limited amount of lighting and power service which is considered essential for life; in acute-care facilities, patient care areas and many lab functions often run on essential power. Furthermore, EESs can be categorized as either risk category 1, Type 1 systems or risk category 2, Type 1 or Type 2 systems. Type 1 systems have life safety, critical, and equipment branches, while Type 2 systems only have life safety and equipment branches.

Important Aspects: Design of Healthcare Facilities

1. **Risk Categories**: NFPA 99 assigns a risk category to each space within a healthcare facility based on the risk associated with a failure of the power distribution system serving that space. The risk category of a space within a healthcare facility determines whether that space is required to be served by an essential electrical system. The following are the essential electrical systems risk categories:
   - **i.** Risk category 1: Failure of electrical power or equipment will cause major injury or death of the patient.
   - **ii.** Risk category 2: Failure of electrical power or equipment will cause minor injury to the patient.
   - **iii.** Risk category 3: Failure of electrical power or equipment will cause patient discomfort.
   - **iv.** Risk category 4: Failure of electrical power or equipment will not have any impact on the patient.

2. **Risk Categories by Type:** If an EES is required to serve a space, the risk category also dictates whether the essential electrical system must meet type 1 or type 2 requirements. The essential electrical system risk categories dictate type requirements as follows:
   - **i.** Risk category 1: Requires a Type 1 EES.
   - **ii.** Risk category 2: Requires a Type 1 or Type 2 EES.
   - **iii.** Risk category 3: EES is not required.
   - **iv.** Risk category 4: EES is not required.

3. **Type 1 EES Design:** A Type 1 EES has the most stringent requirements which meet or exceed the requirements of Type 2 systems. Type 1 systems are required to have a minimum of two independent power sources: one normal power source that typically supplies the entire facility, and one or more alternate sources that supply power when the normal source is interrupted. All EES power sources must be classified as Type 10, Class X, Level 1 generator sets per NFPA 110 (generator starts within 10 seconds). A Type 1 EES consists of three separate branches capable of supplying power considered essential for life safety and effective building operation during an interruption to the normal power source. The three separate branches are the life safety branch, the critical branch, and the equipment branch. See Figure 1.

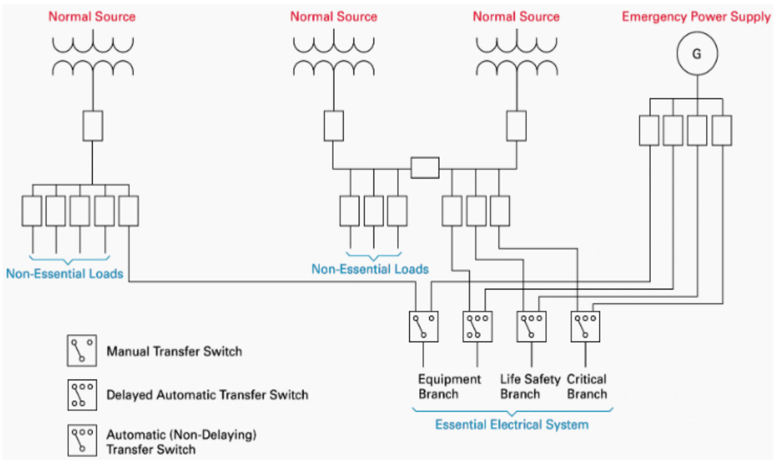

Figure 1: Typical large hospital electrical system – Type 1 EES

   - **a.** **EES Life Safety Branch**: The life safety branch supplies power for lighting, egress lighting, exit signs, alarm systems, emergency communication systems, generator accessories, elevator cab lighting/controls, etc. Life safety branch wiring and equipment must be independent of other electrical loads.
   - **b.** **EES Critical Branch:** The critical branch supplies power for critical areas, specialized patient care task illumination, nurse call systems, telephone equipment rooms, patient's general care beds, angiographic labs, coronary care units, emergency room treatment areas, etc.
   - **c.** **EES Equipment Branch:** The equipment branch consists of

major equipment necessary for patient care and Type 1 operations. The equipment branch supplies power for central suction systems for medical and surgical functions, sump pumps for safe operation of major apparatus, compressed air systems for medical and surgical functions, smoke control and stair pressurization systems, and kitchen hood supply and exhaust systems (if required to operate during a fire).

d. Per NFPA 99/National Electric Code (NEC) 517, some of the equipment in healthcare facilities must be on a delayed automatic transfer switch (ATS) or manual transfer switch. Equipment supplies from a delayed ATS shall include heating equipment; elevators; supply, return and exhaust ventilation system for surgical areas; supply, return and exhaust for airborne infectious/isolation rooms; hyperbaric facilities; etc. In small facilities, it is permissible to feed multiple branches or systems of the EES from a single ATS, provided that the maximum demand on the EES does not exceed 150KVA.

Conclusion

Designing electrical systems for healthcare facilities requires a holistic approach that combines technical excellence, regulatory compliance, and patient-centric planning. By prioritizing the above considerations, electrical engineers and healthcare facility administrators can ensure the development of safe, resilient, reliable, and future-ready healthcare environments.

Further Reading

1. IEEE 607-2007: Standard for recommended practice for electrical systems in healthcare facilities. (2007). The Institute of Electrical and Electronics Engineers, Inc. https://ieeexplore.ieee.org/document/4299432
2. McCabe, E., Fletcher, C., Hockenberry, S., & Lauf, D. (May 11, 2023). Prioritizing resilience: Best practices on energy resilience for healthcare facilities. *National Governors Association.* https://www.nga.org/publications/prioritizing-resilience-best-practices-on-energy-resilience-for-healthcare-facilities/
3. Guyer, J.P. (2014). *An Introduction to Electrical Systems for Medical Facilities*. CreateSpace Publishing.