NFPA No.

76

ESSENTIAL ELECTRICAL SYSTEMS FOR HOSPITALS 1967

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Units of measurements used here are U. S. standard. 1 U. S. gallon = 0.83 Imperial gallons = 3.785 liters. One foot = 0.3048 meters. One inch = 25.40 millimeters. One pound per square inch = 0.06805 atmospheres = 2.307 feet of water. One pound = 453.6 grams.

Standard for

Essential Electrical Systems for Hospitals

NFPA No. 76 — 1967

1967 Edition of No. 76

This edition supersedes the 1965 edition and was adopted by the NFPA at its Annual Meeting in Boston, Mass. on May 17, 1967. Changes are shown by a vertical line in the margin of the pages on which they appear.

Origin and Development of No. 76

Following adoption of Tentative editions in 1960 and 1961, NFPA No. 76 was adopted at the 1962 Annual Meeting with the designation, Standard for Essential Hospital Electrical Service.

A revised edition with the current designation was adopted at the 1965 Annual Meeting.

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SCOPE: Deals with life safety from fire and explosion hazards in hospitals, flammable anesthetics, medical gases, emergency electrical systems, protection of persons in hospitals from the hazards of electric shock or other untoward electrical effects and burns and fosters awareness of the various hazards attending the use of associated specialized equipment and procedures. On subjects within the jurisdiction of other NFPA committees the concurrence of the appropriate other committee is required.

Standard for

Essential Electrical Systems for Hospitals

NFPA No. 76 — 1967

Foreword

Medical and nursing sciences are becoming progressively more dependent upon electrical apparatus for the preservation of life of hospitalized patients. For example, year by year, more surgeons in more hospitals perform cardiac operations, in some of which the patient's life depends upon artificial circulation of the blood; in other patients, life is sustained by means of electrical impulses that stimulate and regulate heart action; in still others, suction developed by electrical means is routinely relied upon to remove body fluids and mucous that might otherwise cause suffocation. In another sense, lighting is needed in strategic areas in order that precise procedures may be carried out, and power is needed to safeguard such vital services as refrigerated stores held in tissue, bone, and blood banks.

Interruption of normal electrical service to hospitals may be caused by catastrophes such as storms, floods, fires, earthquakes, or explosions; by pyramiding failures of substations transmitting electrical power; or by incidents within the hospital. For all such situations, electrical systems should be planned to limit internal disruption and to provide for continuity of vital services at all times. Outages may be corrected in seconds or may require hours for correction. This implies that the system of protection must be designed to cope with the longest probable outage which experience indicates is infrequently as long as six to eight hours, but in extreme cases may persist for many days.

Selecting vital areas and functions considered to be essential, designing safeguards to assure continuity in these circuits, and maintaining the electrical components of such essential services so that they will work when called on, are complex problems that warrant standardized guidance for regulating agencies, governing boards and administration of hospitals, and architects and engineers concerned with hospital construction. Such guidance is offered in this standard.

CHAPTER 1. GENERAL

11. Purpose

111. The purpose of this standard is to delineate minimum factors governing the design, operation, and maintenance of those portions of hospital electrical systems whose interruption in any degree would jeopardize the effective and safe care of hospitalized patients.

12. Scope

121. This standard applies to hospitals serving patients who are unable to provide for their own safety. It does not apply to nursing homes, convalescent homes, old age homes, and facilities providing care only for ambulatory patients.

122. No requirement of this standard shall supersede any specific requirement of NFPA No. 70* — National Electrical Code — except that this standard limits the type of the alternate source of electrical power allowable for use in systems designed to assure continuity of electric power in hospitals.

123. This standard does not cover the requirements for fire pumps. Refer to NFPA No. 20,* Standard for the Installation of Centrifugal Fire Pumps.

13. Mandatory and Advisory Rules

131. Mandatory Rules of this Standard are characterized by the use of the word "shall." Advisory rules are characterized by the use of the word "should", or are stated as recommendations of that which is advised but not required.

14. Systems

141. Essential electrical systems for hospitals comprise two systems capable of supplying a limited amount of lighting and power service considered essential for life safety and protection of property during the time the normal electrical service is interrupted for any reason. This service is supplied by two systems: the Emergency Electrical System and the Critical Electrical System.

142. The Emergency Electrical System embodies circuits customarily required in hospitals by local codes or regulations to conform with the provision of Article 700 of the National Electrical

*Available from the NFPA Publications Department.

Code (NFPA No. 70) that wiring be run in separate raceways and boxes. This standard specifies those circuits that are mandatory in this classification and prohibits others from being added.

143. The Critical Electrical System embodies other essential circuits which should be selected to meet local needs, whose wiring may be run in raceways and boxes with other wiring. The predicted reliability of the normal electrical source should be considered in determining the areas and functions to be served by this system.

15. Design Considerations

151. The design of essential electrical systems for hospitals should give consideration to the possible interruption of normal electrical service to hospitals which may be caused by such catastrophes as storms, floods, fires, earthquakes, and similar cataclysms to which the hospital locality may be subject, usually local in nature.

152. Electrical design should also take into consideration possible disruption of normal electrical service due to internal wiring and equipment failures within the hospital.

16. Reliability of Two Separate Central Station-Fed Services

161. This standard recognizes that hospitals supplied by two separate central station-fed services should experience greater electric service reliability than those with only a single feed. In dual-feed hospitals the areas and functions to be served by the Critical System may with relative safety be reduced. Regardless of the degree of reliability, however, consideration must always be given that other local circumstances, including the need for providing care to disaster victims, may prompt hospital officials to consult with their architects and engineers, utility planning services, and other agencies with respect to the desirability of increasing the hospital functions that are to be served by the Critical System for improved effectiveness of patient care and safety.

162. Guidance in determining the reliability of electric service continuity may be obtained from the electric utility service records. When a hospital is to be served by two central station feeders, records over the preceding five-year period should indicate the reliability of the central station services. Records indicating such simultaneous interruptions limited to two hours or less, for any single occurrence, should be considered as an acceptable record.

17. Location of Automatic Transfer Equipment and Emergency Prime Mover

171. The physical location of both the automatic transfer equip-

ment and alternate source prime mover is of utmost importance. The integrity of the system will be no better than the integrity of this emergency equipment. Plans for the location of equipment should provide protection against external or internal hazardous conditions that might cause complete failure of the equipment, such as floods and fires.

18. Maintenance of Equipment

181. Maintenance of the automatic transfer devices and the prime mover equipment is fundamentally essential to any consideration of service continuity. When hospital authorities place reliance on auxiliary equipment for assuring the continuity of essential electrical systems, it is vital that automatic equipment operate without exception or delay. Such assurance is dependent upon alert and unabated maintenance of this type of equipment. Organized periodic testing under actual conditions with a full understanding as to the proper test procedures, is absolutely essential, both as to operation and to personnel.

CHAPTER 2. SOURCES OF POWER

21. Required Power Sources

211. The Essential Electrical Systems, as described in Chapter 3, have a minimum of two independent sources of power: a normal source generally supplying the entire hospital and an alternate source for use when the normal source is interrupted.

212. The alternate source of power shall be a generator set driven by some form of prime mover, and located on the hospital premises, except as permitted in 213.

213. Where the normal source consists of generating units on the premises the alternate source shall be either another generating set as described in 212, or an external utility service.

214. All electrical services shall comply with Article 230 of the National Electrical Code, NFPA No. 70.

NOTE: For the greatest assurance of continuity of electrical service it is recommended that, wherever feasible, hospitals should be served by two separate full capacity central station services (Section 700-9, National Electrical Code), connected in such a manner as to pick up the load automatically and so arranged that the load of the Emergency and Critical Electrical Systems will not be transferred to the generator set if either of the central station-fed services is energized. It is recommended that such services be selected and installed with full recognition of local hazards of interruption, such as icing and floods. Battery and trickle charger sets located outside the anesthetizing location may be used as additional provisions for the lighting of operating rooms, for delivery rooms, and stairways, exitways or other emergency incandescent lighting.

CHAPTER 3. EMERGENCY AND CRITICAL CLASSIFICATIONS

31. Emergency Electrical System

311. General:

(a) Those areas and functions in hospitals, which are required to be connected to the Emergency Electrical System, are given in 312. No lighting, receptacles or equipment other than those listed herein, are to be connected to the Emergency Electrical System.

(b) The Emergency Electrical System shall be so installed and connected to the alternate source of power as specified in Chapter 2, that all lighting and equipment specified herein will be automatically restored to operation within 10 seconds after interruption of the normal source.

312. Required Areas and Functions:

(a) Exit ways illumination as required in the Life Safety Code, NFPA No. 101*, Section 5–10, such as lighting required for corridors, passageways, stairways and landings at exit doors, and all necessary ways of approach to exits.

(b) Exit signs and exit directional signs required in Life Safety Code, NFPA No. 101,* Section 5–11.

(c) Alarm systems, including fire alarms actuated at manual stations, by electric water flow alarm devices in connection with sprinkler systems and by automatic fire detection systems (see Life Safety Code, 10-1362, 10-2344, and 6–3211), alarms required for systems used for the piping of-nonflammable medical gases as specified in Standard for Nonflammable Medical Gas Systems, NFPA No. 565,* and generator unit derangement signals.

(d) Fire alerting systems, including hospital paging systems when these are intended for alerting or issuing instructions during emergency conditions, as described in 10–1365 of the Life Safety Code, NFPA No. 101.*

(e) Surgical and obstetrical suite electrical circuits required by the Code for Use of Flammable Anesthetics, NFPA No. 56,* to be ungrounded circuits fed through isolating transformers.

NOTE: Permanently installed overhead surgical lights and receptacles in anesthetizing locations are required to be supplied by ungrounded electrical circuits. It is not the intention of the above requirement that circuits other than those in the anesthetizing locations will be connected to the Emergency Electrical System, nor is it intended that anesthetizing locations other than those located in the surgical and obstetrical suites will be served from the Emergency Electrical System.

*Available from the NFPA Publications Department.

(f) Generator Set Location: Lighting.

32. Critical Electrical System

321. General:

(a) Those areas and functions in hospitals which are recommended to be considered for connection to the Critical Electrical System are as follows:

1. Those areas and functions recommended for all hospitals are given in 322.
2. Those additional areas and functions recommended for hospitals having a single normal source of power are given in 323.

(b) The Critical Electrical System should be installed and connected to the alternate source of power so that the recommended areas and functions in 322 will be automatically connected to the alternate source, within 10 seconds of the interruption of the normal source. Those items in 323 may be automatically restored within ten seconds of interruption to the normal source or be restored manually, or with delayed automatic restoration at the option of the local authorities.

322. Recommended Areas and Functions for All Hospitals:

(a) Surgical and obstetrical recovery rooms: Lighting and receptacles, other than those given in 312(e).

(b) Intensive nursing care units: Lighting and receptacles.

(c) Infant nurseries: Lighting and receptacles.

(d) Medication preparation areas: Lighting.

(e) Nurses' stations: Lighting for nursing work area, unless emergency corridor lighting is located so as to provide emergency illumination.

(f) Dispensing pharmacies: Lighting and receptacles.

(g) Emergency treatment rooms and similar areas, such as fracture rooms, and associated service areas involving functions directly related to emergency treatment: Lighting and receptacles.

(h) Blood-bank areas: Lighting and receptacles in areas used by blood-bank personnel for such activities as typing and cross-matching, including service to blood-bank refrigerators.

(i) Central suction systems serving critical medical and surgical functions: pump motor; lighting and receptacles at the pump location for maintenance and repair activities.

(j) Communication services: Telephone switchboard: Lighting.

(k) Apparatus: Sump pumps and equipment required to operate for the safety of major apparatus, including associated control and alarm systems.

(l) Rooms containing above apparatus: Lighting and receptacles for trouble lights and electrical hand tools at locations of above apparatus.

(m) In buildings of more than four stories an elevator service that will reach every patient floor, ground floor, and floors on which are located surgical suites and obstetrical delivery suites. This shall include connections for cab and machine room lighting and control and signal systems. In instances where interruption of power will result in an elevator stopping between floors, throw-over facilities shall be provided to allow the temporary operation of any elevator for the release of patients or other persons who may be confined.

(n) Any other area or function deemed necessary by the hospital authorities as being essential to the hospital operation and with the approval of the authority having jurisdiction.

NOTE: Some service facilities may be operated only periodically during outages of electrical service. It may be feasible to program the use of such facilities in such a way that only one of the service facilities will be required for operation at any one time. While this may be accomplished by manual restoration of such service to the various pieces of equipment, it is strongly urged that extreme caution should be observed in the selection of generator and transfer switch capacity in order that the system will not be overloaded by the probable combinations of equipment that may be operated at any one time.

323. Additional Recommended Areas and Functions for Hospitals with a Single Normal Source of Power:

(a) Lighting and receptacles in some rooms or wards containing acute general care beds. The locations may be influenced by the number of beds elsewhere in the building for intensive care nursing.

NOTE: For bedside receptacles, it is important to consider the dependence of many patients on such electrical equipment as portable suction pumps, diagnostic equipment such as electrocardiographs, heart pacers and oxygen tents.

(b) Psychiatric patient bed areas: Lighting only.

(c) Main electrical control centers and transformer rooms: Lighting and receptacles installed for the purpose of powering trouble lights and electrical hand tools. Generator rooms: Receptacles.

(d) Telephone switching equipment and intradepartment communication systems: Outlets serving such switching and telephone signaling equipment.

NOTE: Departmental installations, known as digital dialing systems and used for intradepartmental communications may become relatively useless during a failure of electrical service to the area. In the event of such failure, those systems which have lighted selector buttons in the base of the telephone instrument or in the desk units known as "Director Sets" will be out of service to the extent that the lights will not function and that the buzzer used to indicate incoming calls will be silenced. The lack of electrical energy will not prevent the use of telephones for outgoing calls, but incoming calls will not be signaled, nor will intercommunicating calls be signaled. This communication failure should be taken into consideration in planning Essential Electrical Systems to serve such areas as emergency departments, and X-ray departments in the larger hospitals.

(e) Nurse call systems in inpatient areas, anesthetizing locations and emergency departments.

(f) Refrigerated medical storage: Power for refrigerators or central refrigerator systems supplying bone banks, tissue banks, and the storage of biological preparations. Such refrigerators may include those installed in nurses' stations and other similar locations for medicinal storage. (For blood banks see 322(h).)

(g) Any other area or function deemed necessary by the hospital authorities as being essential to the hospital operation and with the approval of the authority having jurisdiction.

NOTE 1: It may be advisable, due to heavy power loads, to subdivide the Critical Electrical System into one or more systems using separate transfer devices.

NOTE 2: Some service facilities may be operated only periodically during outages of electrical service. It may be feasible to program the use of such facilities in such a way that only one of the service facilities will be required for operation at any one time. While this may be accomplished by manual restoration of such service to the various pieces of equipment, it is strongly urged that extreme caution should be observed in the selection of generator and transfer switch capacity in order that the system will not be overloaded by the probable combinations of equipment that may be operated at any one time.

CHAPTER 4. ELECTRICAL CHARACTERISTICS

41. Capacity of System

411. The Emergency and Critical Electrical Systems shall each have adequate capacity and rating for the operation of all lighting and equipment to be served by each system.

42. Electrical Characteristics

421. Electrical characteristics of the generator set and transfer switches shall be suitable for the operation of all lighting and equipment they are intended to supply.

NOTE: The capacity of transfer switches should be adequate to carry full load currents, and to withstand the thermal and electromagnetic effects of short circuit currents.

CHAPTER 5. ARRANGEMENT OF WIRING

51. Automatic Operation

511. The Emergency System and Critical System shall be so arranged that in the event of interruption of the normal source, the alternate source shall be automatically placed in operation.

NOTE: Appendix B — Diagrams offer guidance in typical hospital wiring arrangements for both single and double normal source hospitals. These are intended for reference only as an aid in design of essential systems.

512. Automatic switching equipment shall be approved for emergency service and shall be designed and installed with interlocking provisions that will prevent the interconnection of normal and alternate sources of power in any operation of the automatic switching equipment. The operation of the equipment shall be so arranged that the load will be served by the normal power source, except when normal source is interrupted. Controls and switching equipment shall be so arranged that interruption of the normal source will automatically start the alternate source generator, and when it has attained rated voltage, automatically disconnect the normal source of power and connect the Emergency and Critical Systems to the alternate source. Certain Critical System loads may be restored manually or by means of time delay switches in such a sequential manner as not to overload the generator. When the normal power source is restored, the switch should operate automatically to disconnect the Emergency and Critical Systems from the alternate source and connect them to the normal source. For such automatic operation, a time delay feature should be provided to avoid short time re-establishment of the normal source causing erratic operation of the transfer switch. (See note following 721 for precautions relative to short time operation of the generator set.)

52. Overcurrent Protection

521. The emergency electrical system shall be connected to a transfer device supplying no other part of the hospital wiring system. It shall be protected by overcurrent devices in such a manner that interruption of service in other hospital wiring systems due to internal failure will not disrupt service to the Emergency System.

522. The Critical Electrical System should be connected to one or more transfer devices supplying no other part of the hospital wiring system. Each subdivision of the Critical System should be protected by overcurrent devices in such a manner that interruption of service in other hospital wiring systems, or other subdivision of the Critical System, due to internal failure will not disrupt its service.

NOTE: It is extremely important that the various overcurrent devices in the Emergency and Critical Systems be coordinated to protect against cascading operation on short circuit faults. Primary consideration should also be given to the prevention of overloading wiring devices by limiting the possibilities of large current inrushes due to instantaneous re-establishment of connections to heavy loads.

54. Wiring Requirements

541. The Emergency Electrical System wiring shall be kept entirely independent of all other wiring and equipment and shall not enter the same raceways, boxes or cabinets with other wiring, except as permitted in Section 700–17 of the National Electrical Code. Exceptions are (a) transfer switches, and (b) exit lighting fixtures which are supplied from two sources. Section 230–73 of the National Electrical Code also applies to the connection of the Emergency System to the generator.

542. The Critical System is not subject to the provisions of Section 700–17, National Electrical Code, and the wiring of these systems may occupy the same raceways, boxes or cabinets with other wiring, except that such wiring may not occupy the same raceways, boxes or cabinets as wiring for Emergency Electrical Systems.

543. Provisions of Section 700–18 of the National Electrical Code with respect to switches installed in emergency lighting circuits shall apply to lighting requirements for exit lighting required under the Life Safety Code, except that as provided in Section 700–20(b) of the National Electrical Code, switching arrangements to transfer corridor lighting in patient areas of hospitals from overhead fixtures, to fixtures designed to provide night lighting may be permitted, provided the switching system is so designed that switches can only select between two sets of fixtures and cannot extinguish both sets at the same time.

544. Provisions of Section 700–18 of the National Electrical Code with respect to the location and installation of switches in lighting circuits other than those controlling exit way lighting and exit directional signs, shall be applied in the light of the interpretation that personnel ordinarily assigned to work in an area illuminated by fixtures connected to the Emergency Electrical System shall be considered as authorized personnel. (This provision applies particularly to ungrounded circuits in anesthetizing locations connected to Emergency Systems.)

CHAPTER 6. GENERATOR SETS AND PRIME MOVERS

61. Installation

611. Generator sets and prime movers installed as a source of power for hospital essential electrical systems shall be specifically designed and assembled for such service.

(a) The equipment used shall be either reserved exclusively for such service or normally used for other purposes. If normally used for other purposes, two or more units shall be installed, each of which shall have sufficient generating capacity to serve the essential electrical system. At least one of these units shall be available within the time limit set forth in 622.

(b) Generator units, including fuel tanks, exhaust lines and all appurtenant parts, shall be installed in accordance with Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines (NFPA No. 37) except as provided in this chapter. Adequate space shall be provided for housing and servicing the generator unit and associated equipment for its starting and control. Service transformers shall not be installed in this area.

NOTE: For additional guidance see "Engine Installation Manual," Internal Combustion Engine Institute, 201 N. Wells, Chicago, Illinois. For additional material on diesel engines, see "Diesel Engines for Use with Generators to Supply Emergency and Short Term Electric Power," Publication 1132, available from National Academy of Sciences — National Research Council, Washington, D. C.

62. Generator Set

621. The generator set shall be of sufficient capacity and proper rating to supply adequately circuits of the Emergency and Critical Electrical Systems.

622. The generator set capacity for the Emergency Electrical System and Critical System shall be sufficient for picking up the load and supplying the full current demands of these systems, stabilized within plus or minus five per cent frequency stability, within ten seconds after loss of the normal power source. This provision shall be deemed to meet requirements for immediate restoration of service.

623. Maintenance of Temperatures:

(a) Diesel engines: Provision shall be made for maintaining a temperature of not less than 50 degrees Fahrenheit in the generator room or for maintaining a water jacket temperature of not less than 70 degrees Fahrenheit.

(b) Gasoline, natural gas and liquefied petroleum gas engines: Provision shall be made for maintaining a temperature of not less than 50 degrees Fahrenheit in the generator room or for maintaining a water jacket temperature of not less than 70 degrees Fahrenheit.

624. Provision shall be made for adequate replenishment of air required for engine combustion and for the cooling of engines cooled by the recirculation of water through engine radiators.

625. Battery-starting systems for internal combustion engines shall be provided with a battery providing a minimum of 60 seconds continuous cranking time.

NOTE: Starting equipment should be arranged to provide for a starting cycle of short cranking times, set to terminate with enough battery reserve to permit additional cranking after the cause of the nonfunction has been discovered.

63. Safety Devices

631. Prime movers serving generator sets shall be equipped with an automatic engine shutdown device for engine overspeed and an audible or visual alarm device shall be provided to indicate this condition.

64. Derangement Signals

641. Audible and visual signal devices, powered by an electric storage battery (see Section 700–12, National Electrical Code), shall be provided for the following purposes:

(a) To give warning of the derangement of the alternate power source, including excessive water temperature, water jacket temperatures below those required in 623. low lubricating oil pressure and high lubricating oil temperatures;

(b) To indicate that the generator set is carrying the load;

(c) To indicate when the main fuel storage tank contains less than a three-hour operating supply.

642. A visual signal device shall be provided when practical to indicate when the battery charger is properly functioning.

643. Audible warning signals, except for battery charging malfunction, shall be so arranged that they will operate outside of the generator room in a location readily observed by operating personnel at a regular work station.

NOTE: In the planning of the location of required derangement signals and other indicating instruments of the Emergency System, consideration should be given to locating them in such a way as to permit closed-circuit television monitoring.

CHAPTER 7. MAINTENANCE

71. Maintenance Requirements

711. The generator set or other alternate power source and associated equipment including all appurtenant parts, shall be so maintained at all times as to be capable of supplying service within the shortest time practicable and within the time interval specified in 311(b) and 321(b).

72. Inspection and Test

721. Generator sets serving Emergency and Critical Systems shall be inspected daily and shall be exercised for at least 30 minutes under load conditions at intervals of not more than seven days.

NOTE: When indications such as the issuance of storm warnings indicate that power outages may be likely, good practice recommends the warming up of generator sets by a regular 30-minute exercise period. Operation of generator sets for short intervals should be avoided, particularly with compression ignition engines, since if condensation vapors formed before the engine becomes properly warmed up are not dissipated, they will form varnish in the cylinders and acid in the oil crankcase which are harmful to the engine.

722. Automatic transfer switches shall include a test switch, or other device, to allow for frequent testing of the transfer operation under full load conditions, at regularly scheduled intervals — normally not exceeding seven days.

73. Battery Maintenance

731. Storage batteries used in connection with hospital Emergency and Critical Systems shall be inspected at intervals of not more than seven days and shall be maintained in full compliance with manufacturers' specifications. Defective batteries shall be repaired or replaced immediately upon discovery of defects. (See Section 700–4, National Electrical Code.)

74. Written Record

741. A written record of inspection, performance, exercising period and repairs shall be regularly maintained and available for inspection by the authority having jurisdiction.