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ESSENTIAL HOSPITAL ELECTRICAL SERVICE

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National Fire Protection Association

International

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ESSENTIAL HOSPITAL ELECTRICAL SERVICE

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The present edition of this standard, Essential Hospital Electrical Service, was adopted by the National Fire Protection Association at its Annual Meeting on May 25, 1962.

Work on this standard was initiated in 1959, under the title Hospital Emergency Electrical Systems, and tentatively adopted in 1960. A revised text was again tentatively adopted at the NFPA Annual Meeting in Detroit, May 1961.

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Paul Guest, U. S. Bureau of Mines. (Alternate to Earle P. Shoub.)

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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 mucus 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 provide vital services with extra features to assure continuity. 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 electrical services considered to be essential, designing safeguards to assure continuity in these services, 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. 101*—Building Exits Code—or 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. Systems

131. Essential hospital electrical service is technically referred to herein as the Protected Continuity System. This has three parts—the Emergency Electrical System, Critical Electrical System I, and Critical Electrical System II.

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

*Available from the NFPA Publications Service.

133. Critical Electrical Systems I and II embody other essential circuits, whose wiring may be run in raceways and boxes with other wiring. These circuits are either recommended or optional. Some circuits will be chosen according to the predicted reliability of the local utility services.

14. Design Considerations

141. The design of Protected Continuity 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.

142. Electrical design should take into consideration conditions that may exist inside a hospital, and be planned to insure continuity of essential electrical service by providing definite limits of internal disruption.

15. Reliability of Two Separate Central Station-Fed Services

151. This standard gives recognition to systems supplied by two separate station-fed services which may with relative safety reduce the scope of a Protected Continuity System. It is recognized that a variety of operating considerations, 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 Protected Continuity System for improved effectiveness of patient care and safety.

152. 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, the record of simultaneous failure of both feeders, 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.

16. Location of Automatic Transfer Equipment and Emergency Prime Mover

161. The physical location of both the automatic transfer equipment and emergency prime mover becomes 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.

17. Selection of Equipment

171. The emergency transfer equipment and prime mover should be of sufficient capacity and rating to serve the essential services safely. This size will vary depending upon the type and size of facility and the consideration as to whether long outages may be anticipated due to local conditions. The estimated maximum length of such possible outage is a principal factor in determining whether additional functions should be supplied by the Protected Continuity System.

172. It is essential that planning of the emergency equipment be comprehensive in order to maintain the integrity and reliability of the system and to insure that the equipment itself is of a design compatible with the entire electrical system.

18. Maintenance of Equipment

181. Maintenance of the automatic transfer 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 services, 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.

NOTE: Recent surveys indicate a 5 per cent failure of automatic operation in hospitals: a poor record, calling for substantial improvement in maintenance attention.

CHAPTER 2. SOURCE OF POWER

21. Required Power Sources

211. The Protected Continuity System, comprised of systems designated herein as Emergency Electrical System, Critical System I and Critical System II, as described in Chapter 3, shall have a minimum of two independent sources of power.

212. Required sources of power for Emergency and Critical Electrical Systems shall be the normal service and a generator set located on the premises and driven by some form of prime mover. All services shall comply with Article 230 of the National Electrical Code.

213. EXCEPTION: Hospitals with electrical systems normally powered by generating units on the premises shall have Protected Continuity Electrical Systems as outlined herein with the source of alternate power provided either by an additional generator set as described herein, of adequate capacity to serve the Protected Continuity Electrical Systems, or by an external service in accordance with Article 230 of the National Electrical Code.

NOTE: For the greatest assurance of improved 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 Protected Continuity Electrical System 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 to augment provisions for the lighting of operating rooms and delivery rooms.

CHAPTER 3. EMERGENCY AND CRITICAL CLASSIFICATIONS

31. General

311. When a hospital is served by two central station feeders, the functions to be served by the Protected Continuity System may be reduced in relation to the reliability of the combined services, as determined by the authority having jurisdiction on evidence of such reliability, including number of outage incidents, time duration of each outage incident and cause, produced by the electric utility. (See Section 152.)

NOTE: Any minimum so determined should be reviewed by appropriate representatives of the hospital with the planning services available from the utility and other appropriate agencies to determine whether special considerations call for additional functions to be included in the design of the Protected Continuity System.

32. Emergency Electrical System

321. GENERAL:

a. Those areas or functions in hospitals, which are required to be connected to the Emergency Electrical System, are listed herein (Article 32). 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 alternate sources of power, as specified in Chapter 2, in such a manner that all lighting and equipment specified herein will be automatically restored to operation in not more than 10 seconds.

322. Exit ways illumination, as required in the Building Exits Code, NFPA No. 101,* Section 52, such as lighting required for corridors, passageways, stairways and landings at exit doors.

323. Exit signs and exit directional signs required in Building Exits Code, NFPA No. 101,* Section 53.

324. 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

*Available from the NFPA Publications Service.

systems (see Building Exits Code, paragraph 2231), 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.

325. Fire alerting systems, including hospital paging systems when these are intended for alerting or issuing instructions during emergency conditions, as specified in Sections 2336(a) and (b) of the Building Exits Code, NFPA No. 101.*

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

327. Obstetrical delivery suite circuits required by the Code for Use of Flammable Anesthetics to be served by 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.

328. Generator Set Location: Lighting.

33. Critical Electrical System I (Automatic Restoration)

331. GENERAL:

a. Those areas or functions in hospitals which are recommended or permitted to be connected to Critical System I are listed herein (Article 33). No lighting, receptacles or equipment, other than listed herein, are to be connected to Critical Electrical System I.

b. Critical System I shall be so installed and connected to alternate sources of power, as specified in Chapter 2, that all lighting and equipment specified herein will be automatically restored to operation in not more than 10 seconds. (See Note following Section 341(b).)

*Available from the NFPA Publications Service.

332. RECOMMENDED AREAS AND FUNCTIONS:

a. Surgical and obstetrical recovery rooms: Lighting and receptacles.

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.

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. Pump motors for central suction systems shall be so connected that operation will be automatically restored.

NOTE: To provide for improved continuity of operation, it is advisable to provide suction systems serving critical medical and surgical functions with dual motor and pump combinations, electrically interconnected.

j. Communication services: Telephone switchboard: Lighting.

333. OPTIONAL AREAS AND FUNCTION:

a. It is highly desirable to connect lighting and receptacles in some rooms or wards containing acute general care beds to Critical System I. Determination of the numbers and locations of such wards or rooms designated for inclusion in Critical System I should take into consideration the number of beds available elsewhere in the building for intensive care nursing.

NOTE: In planning for bedside receptacles to be connected to the Protected Continuity System, 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. Surgical and obstetrical suite areas, other than those served by the emergency electrical system: Lighting and receptacles vital to patient care.

c. Dispensing pharmacies: Lighting and receptacles.

d. Central sterile supply departments, including areas intended for issuance of sterile supplies: Lighting and receptacles.

e. Psychiatric patient bed areas: Lighting only.

f. 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.

g. 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 Protected Continuity Systems to serve such areas as emergency departments, and X-ray departments in the larger hospitals.

h. Nurse call systems in inpatient areas, anesthetizing locations and emergency departments.

34. Critical Electrical System II (Delayed Restoration)

341. GENERAL:

a. This Article lists areas and functions which may be connected to Critical System II.

b. All areas and functions served by Critical Electrical System II shall be subject to delayed restoration. This delayed restoration may be achieved by manual restoration or through automatic restoration with a time lag of at least 20 seconds following the energizing of the system. Extreme caution shall be observed to protect the system and its associated alternate power source from overloading.

NOTE: It may become advisable when additional heavy power loads are to be served by the Critical Systems to subdivide the system, with each subdivision to be individually served by a separate transfer switch, which will usually be selected with a rating in excess of the proposed total connected load. The system should be so designed that the total load that it may carry at any one time will never interfere with the safe operation of the generator set supplying it.

Equipment served by Critical System II may be restored to service either automatically or manually. (See Section 532.) Automatic restoration should be considered according to the need for relatively uninterrupted service. Time delay equipment may be needed to prevent heavy starting surges in connection with the automatic restoration of heavy current-consuming equipment to operation.

342. RECOMMENDED AREAS AND FUNCTIONS:

a. Apparatus: Water pressure, hot water circulation, sump pumps and equipment required to operate for the safety of major apparatus, including associated control and alarm systems.

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

343. Recommended areas and functions for hospitals which are not supplied with electrical energy by two separated central station-fed services considered by local authorities to have sufficient reliability to limit any simultaneous outage to a maximum duration of two hours:

a. Heating systems, including control systems and ventilating systems required for heat distribution, in climates where in the judgment of local authorities the severity of winter temperatures is capable of reducing indoor temperatures in patient areas below a safe level when the heating system is inoperative for more than two hours.

b. 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 elevator stopping between floors, it may be desirable to provide throw-over facilities to allow the temporary operation of any elevator for the release of patients or other persons who may be confined.

344. Optional Areas and Functions:

Note: Suggested items listed in this section include those that may be needed to sustain operation during protracted current interruptions of the kind frequently associated with natural catastrophes, which are likely to result in increased loads of emergency and surgical patients.

a. Central sterile supply: At least one autoclave.

b. Hot water generation.

c. X-ray rooms, minimal developing facilities and associated service areas.

d. Laboratories: Lighting and receptacles.

e. Kitchen: Lighting, cooking facilities and appliances, refrigerated food storage.

f. Laundry: Minimal facilities for washing, extracting and tumbling.

Note: Service facilities such as those listed in items c, d, and e above 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.

g. 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 Section 332(h).)

h. Any other hospital areas or functions may be connected to Critical Electrical System II with due caution for proper sizing of overcurrent protection devices, transfer switches and generator sets.

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.

412. Hospitals which install approximately 100 per cent generator set capacity, based on peak operating load, and suitable switch gear for transferring the hospital electrical load from the normal source of power to the generator set power supply, will comply with the requirements of this standard if the Emergency Electrical System as specified in this standard is installed. (See Article 32.) The Emergency Electrical System as required herein shall have a separate automatic transfer switch connecting it to the alternate power supply.

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 current continuously, to handle surge 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 I shall be so arranged that in the event of interruption of the normal supply, the alternate system shall be automatically placed in operation.

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 supply except when normal service is interrupted. Controls and switching equipment shall be so arranged that interruption of the normal service will automatically disconnect the Emergency, Critical I and Critical II Systems from the normal power source, start the generator and automatically connect the Emergency and Critical I Systems to the generator when the generator has attained its rated speed. Critical II Systems may be connected manually or automatically by means of time delay switches in such a sequential manner as not to overload the generator. There shall be a delay of not less than 20 seconds after electrical service is established for the Emergency Electrical System and Critical System I before electrical service shall be restored to Critical Electrical System II. When normal power is restored while the alternate source of power is connected, a switch may be operated automatically or nonautomatically to disconnect the alternate source of power and to reconnect the normal service. If operation is automatic, a time delay feature should be provided to avoid short time re-establishment of normal service. (See Note following Section 721 for precautions relative to short time operation of generator set.)

52. Overcurrent Protection

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

522. Critical System I and Critical System II shall be connected to one or more transfer switches and each system shall be protected by overcurrent protective devices of proper design and capacity, not common to the other, arranged in such a manner that the interruption of service in either wiring system due to internal failure will not disrupt service to the other system.

NOTE: It is recommended that in those instances where hardship will not be encountered Critical System I and Critical System II should be connected individually to separate transfer switches with proper overcurrent protection, so as better to insure continuity of service to Critical System I. In developing engineering design intended to insure continuity of electrical service to vital hospital functions, primary consideration should be given to the prevention of overloading wiring devices by limiting the possibilities of power surges due to instantaneous re-establishment of connections to heavy loads.

53. Equipment (See also Section 512.)

531. Controls of all equipment served by Emergency and Critical System I shall be of the type that will automatically restore operation after interruption of current supply.

532. Equipment served by Critical System II may be either of a type that after a power interruption will restore itself automatically to service with appropriate time delay sequencing, or that will require manual restoration to operation.

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.

542. Critical System I and Critical System II are 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 Building Exits 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 Protected Continuity Systems shall be specifically designed for such service and to operate in conjunction with each other. Generator units, including fuel tanks, exhaust lines and all appurtenant parts, shall be installed in accordance with Section 20 of Standard for the Installation and Use of Combustion Engines and Gas Turbines (NFPA No. 37). 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: It is desirable that some latitude of excess capacity should be provided in the selection of equipment for the alternate source of power and that provisions in panel boards should facilitate addition of future feeders or branch circuits to the Critical Systems as development of hospital needs progresses.

NOTE: In areas where hospital grounds may be subject to flood under extraordinary abnormal conditions, it is desirable to place the generator set and all associated equipment above any anticipated flood level, and to provide means for facilitating the disconnecting of circuits which feed Emergency and Critical services in areas which under flood conditions may be submerged.

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 I 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. This provision shall be deemed to meet requirements for immediate restoration of service.

NOTE: In very large hospitals where the load of Emergency and Critical Electrical Systems may be so substantial that a single generator will not be able to energize the system within the minimum

time allocated, it may be necessary to install more than one generator. Consideration should be given to the possibility in such instances of powering the Emergency Electrical System or the Emergency Electrical and the Critical System I from a separate generator. It will be noted that the minimum time factor specified in Section 321(b) and 331(b) does not apply to the alternate power source for the Critical System II.

623. Maintenance of Temperatures:

a. Diesel engines: Provision shall be made for maintaining a temperature of not less than 70 degrees Fahrenheit in the generator room and for maintaining a water jacket temperature of not less than 90 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 and for maintaining a water jacket temperature of not less than 90 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. Fuel Tanks

631. Fuel tanks shall be installed in accordance with provisions of Chapters 4 and 5 of the Standard for Installation and Use of Combustion Engines and Gas Turbines (NFPA No. 37).* Gasoline engines used as prime movers shall be equipped with a tank integral with the engine and conforming to requirements of Article 51 of NFPA Standard No. 37.*

*Available from the NFPA Publications Service.