CHAPTER 10

DISASTER PLANNING AND EMERGENCY MANAGEMENT

10.1 INTRODUCTION

Health care institutions must plan, prepare, and respond to any conceivable form of emergency, whether it impacts the community at large or only the hospital. These institutions must be prepared to react to emergencies in all forms and continue to serve the needs of the patients and the community. Although disaster planning and emergency management are generally operational issues, design professionals must understand the objectives and policies of their client hospital.

10.1.1 Internal Disasters

Health care facilities are subject to many scenarios that may impair the functioning of mechanical systems. Typical disaster scenarios include institutional emergencies, such as fire, water intrusion from ruptured water or fire mains, and/or loss of power or other essential utilities. Events that strike within a facility but not the community at-large are classified as internal disasters. Internal incidents that could potentially result in a facility emergency requiring emergency and/or backup planning include the following:

- Fire
- Power disruption
- Water supply disruption or contamination
- Ventilation system failure or contamination
- Heating system failure
- Fuel supply disruption
- Medical gas system disruption
- Steam supply disruption resulting in inoperable autoclaves and humidification failure

- Nosocomial infection outbreaks
- Loss of internal communications
- Loss of external communications
- Structural failure (earthquake, flood, tornado, explosion)
- Supply chain interruption (food, drugs, linens, medical gases, blood products)
- Terrorist attack on the hospital itself (chemical, biological, explosive)
- Elevator failures

10.1.2 External Disasters

Disasters such as bus or multiple-vehicle accidents, accidental release of gaseous chemicals into the community, and multiple trauma caused by natural disasters and/or large fires can happen in any community. Natural events, such as an earthquake, tornado, hurricane, flood or blizzard, are also the cause of many external disasters.

Some communities may bear a greater risk for external disasters, if they are near chemical plants, nuclear plants, or other industrial complexes that increase the possibility of an accident that could predispose the community to contamination or to industrial injuries with potential for mass casualty. External disasters have the potential to produce so many victims that the normal hospital treatment areas and protocols are overwhelmed and alternate emergency spaces and procedures must be used.

A disaster impacting the community (e.g., earthquake, tornado, flood), or a mass casualty incident (e.g., bus/plane/train accident, chemical spill, act of terrorism), can present an added set of considerations, primarily the designation of emergency spaces to serve larger-than-usual numbers of victims. A disaster of this type could result in damage to the facility itself, potentially limiting its response to the community while simultaneously dealing with the impacts to the facility and its occupants.

The following are examples of external disasters and their classification:

- *Multiple trauma disasters*
  - › Accidents (vehicular pile-up; bus, plane, or train accident)
  - › Natural disasters (hurricane, tornado, wildfire, flood, earthquake)
  - › Acts of war or terrorism (explosion)
  - › Apartment fire
- *Chemical disasters*
  - › Accidents (wreck involving chemical rail car or tanker truck)
  - › Act of terrorism using a chemical agent (water supply contamination, airborne dispersal, explosive detonation, or food source contamination)

- *Biological disasters*
  - Unidentified severe illness, potentially infectious (see Pandemic Diseases)
  - Epidemic of known disease with capability for mass transmission by waterborne dispersal, airborne dispersal, or spread by insect, vermin, or avian sources
  - Act of terrorism using a biological agent (water supply contamination, airborne dispersal, explosive detonation, or food source contamination)
- *Nuclear disasters*
  - Industrial accident involving a nuclear facility or transportation of nuclear materials
  - Act of war
  - Act of terrorism
- *Evacuation disaster*
  - Accommodation of patients and staff from an evacuated health care facility
  - Internal or external incident resulting in the need to evacuate patients and staff to another facility

10.1.3 Terrorism and Acts Of War

In the aftermath of the September 11, 2001 attack on the World Trade Center, disaster preparation for institutions and communities is no longer an afterthought. A terrorist attack is frequently directed at the most vulnerable, populous, and emotionally charged targets of a community; therefore, facilities such as schools, buses, and hospitals should be considered high-value terrorist targets. Attacks can take multiple forms: (1) an act of war by an identifiable threat (nuclear, chemical, biological bombs); (2) sabotage or contamination of water, food, or air; and (3) suicide attacks.

Planning for war-like disasters is typically addressed through the recommendations of appropriate homeland security agencies and the resulting requirements for facility design, construction, and operation need no further mention here. On a smaller scale, acts of sabotage or terrorism may share a commonality to acts of war in the method of delivery and/or similarity of outcomes. A terrorist attack or act of sabotage could be directed at a specific target that would maximize the number of casualties with a low probability of detection. Preventing or limiting damage from sabotage is extremely difficult and costly, requiring extensive planning to assess potential targets and ameliorate risks. These scenarios could range from something as seemingly uncomplicated as placing a chemical or biological agent near a building's air intake, to an all-out attack on a facility. The possibilities are limited only by the terrorist's capabilities, which make prevention through building design a difficult task.

10.1.4 Pandemic Diseases

In recent years, there have been instances in which new strains or variants of known infectious diseases develop, evade the usual controls (such as immunization or antibiotics), and possess the ability to expose and strike large numbers. These are called pandemic outbreaks. Examples of pandemic outbreaks include Severe Acquired Respiratory Syndrome (SARS), which impacted Southeast Asia and Canada in 2003, and Avian Flu (H1N1 and H5N1), with outbreaks reported throughout the world in 2007 and in parts of North America in 2008-2009. Under extreme conditions, pandemic disease outbreaks can virtually shut down a hospital's normal functions during the effort to constrain the spread of the outbreak while treating infected patients. Failure of ventilation systems could result in loss of pressurization between isolation rooms and the general population and lead to the spread of diseases.

10.2 DISASTER PLANNING

Mass-casualty incidents can strike anywhere, including in areas where few suspect such threats. The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) advises in its standards overview that "planning and designing is consistent with the hospital's mission and vision" (JCAHO 1997). When disasters occur, the quality of a facility's response is commensurate with the planning that went into equipping the facility and its staff to respond to the crisis at hand. Disaster planning is the art of studying the potential impacts of different scenarios on a facility, and tailoring an effective defensive strategy to each. Many of the basic strategies are required by codes, but codes provide only a minimum level of protection. Additional protections are frequently unique to the facility and its specific functions. An example might be providing emergency power to ventilation systems that serve an administrative meeting room, so that the room can be adapted to provide overflow areas for patient care during mass casualties. Hospital staff are generally well trained to react and respond to emergencies of all kinds. However, their ability to deliver care can be greatly improved when health care facility planners and designers improve on the capabilities of lobbies, meeting rooms, and other large-capacity spaces to provide overflow for waiting/holding, triage, and treatment areas. This is valuable when a disaster results in mass casualties in the community, or when an internal disaster results in damage to patient care delivery spaces.

Disasters of all types present different levels of hazards. Hospitals and long-term care facilities, with their large populations of infirm or immobile patients, can't easily evacuate when disaster strikes. The facility systems need to be robust and with levels of redundancy not typical of other facility types.

10.3 EMERGENCY MANAGEMENT

When disaster strikes, emergency management is the organizational strategy (in the form of policies, procedures, and directives) for responding to the disaster at hand. Emergency management establishes a line of communications and command throughout all of the involved functional units to maintain an appropriate and disciplined response.

Many institutions now use the incident command structure developed by the Federal Emergency Management Agency (FEMA).

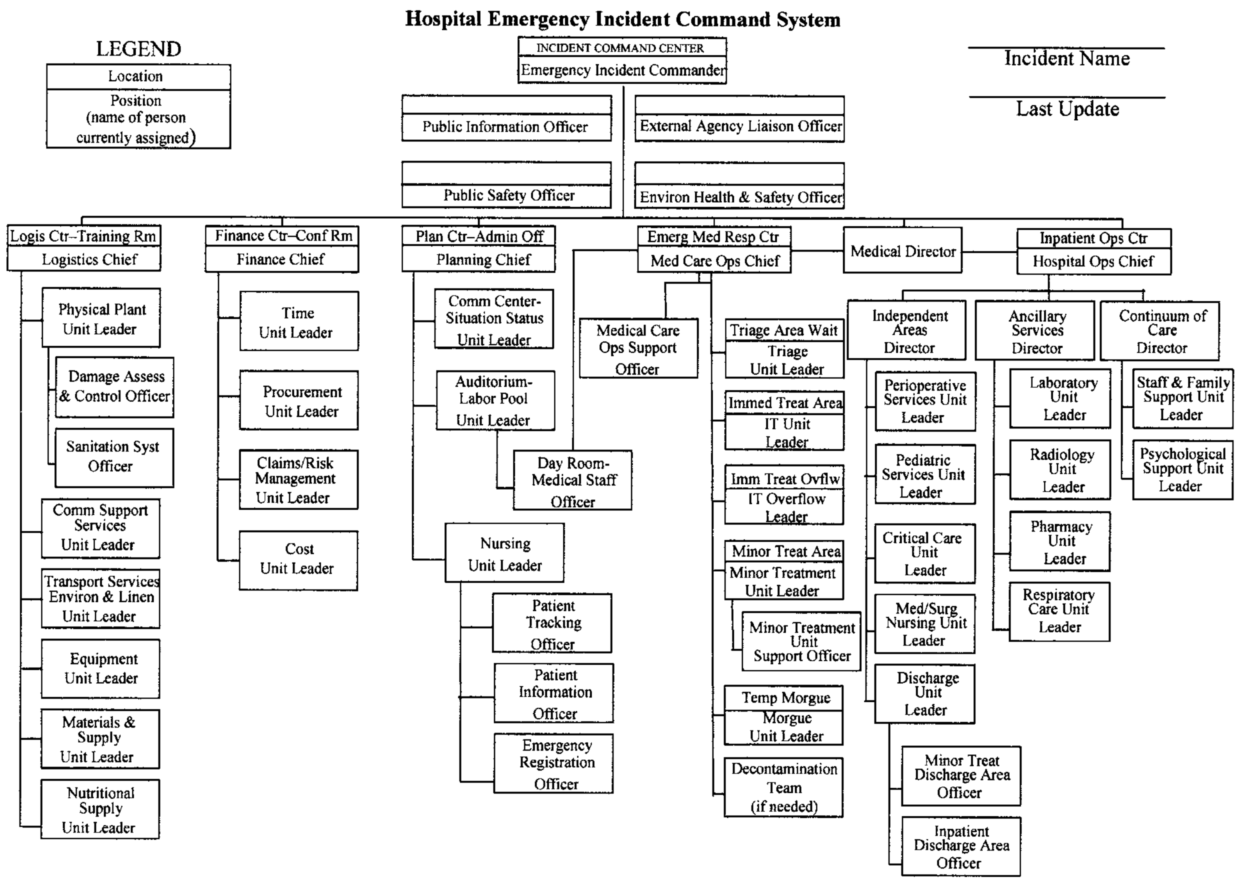

Figure 10-1 *Hospital Emergency Incident Command System Organization Chart*

Figure 10-1 is a typical hospital incident command structure. Use of the incident command approach in preparing to manage a disaster also helps in identifying adjunct space needs, such as emergency triage rooms, communication centers, and areas for storage of emergency supplies and equipment.

The value of any emergency management plan is diminished without building facilities that are able to cope with disaster. Therefore, disaster planning and emergency management must be conducted jointly to assure that the facility is capable of the expected response action.

10.4 DISASTER PREPAREDNESS

10.4.1 Natural Disaster Response

A hurricane is one example of an external disaster that may also inflict substantial damage on a hospital or to its infrastructure, such as the power supply. Under such a scenario, a hospital's abilities to meet the community's needs would be impaired. For this reason, the FGI *Guidelines*, section 1.2-6.5.1 (FGI 2010), requires a needs assessment to evaluate the ability to withstand a regional disaster and maintain operation under the likelihood of loss of externally supplied power, gas, water, and communications. In addressing such a case, internal disaster contingencies would be initiated, and the emergency generators operated to meet basic needs.

10.4.2 Trauma Disaster Response

Readiness for trauma disasters is a basic and minimum degree of preparation for disaster readiness, and is mandated by the JCAHO (JCAHO 1997). A sudden volume of trauma victims, larger than can be normally accommodated by the hospital's emergency facilities, requires areas for temporary triage and treatment (first aid, medical, surgical, and casting); space for observation of patients and convalescent care; and additional services, such as sterilization capability, internal and external communications, transportation of patients within and to/from the hospital, and supplies of water, medicines, cots, stretchers, food, fuel, clothing, medical gases, and first aid.

10.4.3 Chemical Disaster Response

Readiness for chemical disasters requires the basic (trauma) preparations plus decontamination (wash) and special waste containment capabilities. Preparation of the decontamination area is clearly outlined in *Managing Hazardous Materials Incidents, Volume II, Hospital Emergency Departments,* obtainable from the Centers for Disease Control (DHHS 1992).

Although diseases due to chemical exposure are not contagious, ventilation isolation is advisable to prevent deleterious chemicals from contaminated clothing, debris, or air from entering the hospital or spreading within.

10.4.4 Biological Disaster Response

A pandemic disease outbreak involves multiple victims of a contagious disease. This situation requires basic preparations (section 10.4.2) as well as isolation protocols, waste isolation, and separate ventilation. Patients should be isolated from the general hospital population but not necessarily from each other. A temporary 'ward' type environment involving a single large space with multiple beds (and screens) may be deployed. Action may need to be taken to prevent patient contact and airborne contamination from reaching uninfected inhabitants. Preparations may include a plan to cohort infected patients and staff from the rest of the facility.

Under a cohorting plan, designers planning for a pandemic outbreak should assess the ventilation systems of an existing facility to ensure that the systems are zoned to isolate flow from one area of the building to another. Areas at high risk should be designed with the flexibility to segregate large numbers of patients and staff from the rest of the facility. Multiple air-handling systems will provide the greatest flexibility, and each system should be designed so that all air normally returned can be fully exhausted. HEPA filters may be an effective deterrent to infections that are bacterial or transmitted by droplet nuclei, such as tuberculosis, but will be largely incapable of stopping viruses, which are smaller than 1 μm. Other considerations may include providing an airlock capability in corridors connecting different treatment areas. This might be accomplished through use of an auxiliary exhaust fan and door controls in areas where the air systems are independent of one another. Because a pandemic outbreak has the potential to quarantine a large number of staff, a cohorting plan must also include preparations for converting existing spaces on the clean side of the quarantine area into storage spaces for isolation controls (such as protective clothing) and also creating a holding area on the contaminated side for temporary storage of contaminated materials until they can be properly disposed.

The preparations for a bioterrorism disaster are similar to those for chemical disasters. Requirements include basic preparations (see section 10.4.2), plus decontamination (wash) procedures, waste containment, and ventilation isolation (Simon 1997).

10.4.5 Nuclear Disaster Response

Wash/decontamination facilities are the central component of nuclear disaster readiness. As in chemical disasters, specialized protective gear and clothing are necessary for workers in the wash area; in this case, radiation protective gear and clothing are needed. As in chemical disasters, everyone in the community exposed to the radiation must be decontaminated and supplied with safe clothing. Basic preparations (see section 10.4.2) and nuclear waste containment capabilities are also required. Communication with outside authorities and community rescue teams is essential (FEMA 1984; Ricks 1984).

10.4.6 Evacuation Response

A hospital may become dysfunctional and require evacuation due to destruction or failure of internal services. Special areas within the facility are obviously not required, but communication and patient transportation capabilities are critical. Elevator service in a multistory building is essential.

A nearby hospital may become nonfunctional and need to evacuate its patients to a receiving facility. The receiving facility may already be full with its own patients and, therefore, need to provide alternative patient care spaces. These spaces require all of the mechanical and supply services that are necessary in ordinary treatment and convalescent areas. Communication and transportation capabilities are paramount.

In either evacuation case, the movement of patients, staff, or equipment may overwhelm the ability to meet a patient's particular needs. Removal of critically ill patients from their protective environments may expose them or other patients to greater risks. These factors must be taken into account when developing an evacuation plan.

10.5 FACILITY NEEDS FOR DISASTER PLANNING AND EMERGENCY MANAGEMENT

10.5.1 General Principles

The mechanical services required to manage various disaster scenarios are remarkably similar for each situation. Several general considerations are helpful in planning for such occurrences:

- Designate alternative diagnostic and treatment areas for use when ordinary hospital areas are overrun or out of commission.
- Install exhaust capability in areas that might be used to treat people who have communicable diseases and in areas accessible to the general public.

- Designate large areas that already have ventilation isolation, such as lobbies or waiting areas, for alternative use.
- Install external wash and/or decontamination capability with containment.
- Provide redundant storage of ordinary supplies, food, water, medicines, cots, etc.
- Provide redundant communication and transportation capabilities.
- Provide redundant sterilization capability.
- Use existing smoke control systems and defend-in-place procedures in cases of internal chemical or biological contamination.
- Provide security for hospital air intakes, mechanical equipment, and for the entrance of people and materials.

10.5.2 Essential Services for Emergency Response

Power

Power must be supplied to all of the designated auxiliary emergency treatment areas. The triage area requires power for lighting, ventilation, communication, diagnostic equipment, suction machines, defibrillators, monitors, portable X-ray machines, IV pumps, respiratory therapy equipment, and possibly for sterilization equipment. Power outlets for these uses must be available in the spaces designed as alternative treatment areas. Power systems are described in greater detail in section 10.6.

Water

Uncontaminated water is necessary for washing (hands, patients, instruments, and medical equipment), food preparation, sterilization, and possibly for medicinal preparation. Disruption or contamination of the ordinary hospital water supply will require access to an alternate supply. This alternate supply can be from a well or from storage tanks or trucks. The capacity should be sufficient for 96 h of operation (FGI 2010).

Ventilation

The FGI *Guidelines* require that the triage area of an ordinary hospital emergency facility "be designed and ventilated to reduce exposure of staff, patients and families to airborne infectious diseases." This is best accomplished by 100% exhaust and the transfer or intake of uncontaminated air. Recirculated 99.7% HEPA-filtered air is an acceptable alternative, but would require more fan power. ANSI/ASHRAE/ASHE Standard 170 specifies that a triage area be maintained at 12 ach (air changes per hour), with a minimum of 2 ach of outdoor air, and negative pressure relative to adjacent spaces (ASHRAE 2008).

Sterilization

Sterilization can become a problem if a hospital's steam generation capability is interrupted. Autoclaves that use an alternative energy source should be provided to maintain operations when the main plant is offline. Sterilization is necessary for surgical instruments, fluids, linens, and reusable equipment. Most sterilization equipment operates at pressures ranging from 40 to 50 psig [276 to 345 kPa]; this is higher than available from low-pressure steam boilers. Some jurisdictions re–strict unmanned boiler operation to pressures less than 15 psig [103 kPa]. Consult local codes for such requirements.

Waste Isolation

Waste isolation requirements for various scenarios are discussed in the following:

- *Trauma disasters:* Waste/clothing can be disposed of in the usual manner.
- *Chemical disasters:* Waste/clothing must be held in such a manner that all personnel are safe from contact with the waste. With chemical terrorism, the waste must be retained and made available for examination by the proper authorities.
- *Nuclear disasters:* Waste/clothing must be held in a radiation-shielded area and disposed of later in a manner dictated by the proper authorities. Incineration is not an option because of the possibility of introducing radioactive molecules into the air.
- *Biological disasters:* In an epidemic involving an identified disease, waste/clothing can be disposed of according to standard isolation and disposal techniques. With bioterrorism, waste must be held and isolated for examination by the proper authorities. In the case of unidentified infective agents, waste must be isolated for examination by the proper authorities and by appropriate laboratories.

10.5.3 Specialized Spaces for Providing Emergency Services

Triage Space

Victims of a disaster are brought to a triage area where those who have the most life-threatening injuries are identified for immediate treatment. In cases of nuclear or chemical exposure, victims must first be brought through an area for total body cleaning and clothing disposal before entering triage. Workers in the cleaning area must have appropriate protective clothing. The triage area of a hospital is usually the emergency room. The emergency room's waiting room and/or other hospital waiting rooms can be used for additional triage space if they are accessible to the outside and are equipped with isolated ventilation, electricity, water, communications, etc.

Wash Area (Decontamination)

Nuclear disasters require total body washing and total clothing change for all exposed victims (ambulatory and nonambulatory), whether admitted into the facility or not. Decontamination facilities are located outside of the medical facility and can be collapsible, tentlike enclosures.

Total body washing and new clothing are also necessary in massive chemical exposures and in biological terrorism exposures. Special protective gear and clothing are necessary for wash area personnel. Not only will victims require decontamination but also those in the community who have responded to the emergency, such as firefighters, EMS personnel, and other civil agents.

Isolation Space

A space other than the triage area or the general hospital can be designated for isolation of patients thought to be infectious. A designated isolation area should have total exhaust and negative pressurization. Care must be taken that air is exhausted well away from habitable areas.

Treatment Space

Ordinarily, emergency rooms and operating rooms serve as treatment areas and should adequately serve as disaster-treatment areas, unless they are damaged by the disaster. Delivery rooms can be taken over as disaster treatment and operating rooms. If the hospital medical staff is large (having more available doctors than existing treatment rooms), auxiliary areas can be designated as disaster-treatment areas; such areas should be equipped with clean air and emergency power.

Sterilization capability (autoclaving) is a critical component of the treatment area. Designated auxiliary treatment areas, as well as existing treatment areas, must have access to fail-safe sterilization capability. This may consist of an emergency autoclave powered by the emergency electrical system or by liquid petroleum. Gas sterilization systems (ethylene oxide) are unacceptable as the only method of sterilization in disaster situations because of the increased time they require for sterilization and for evacuating the gas.

10.6 POWER

10.6.1 Background

Electrical power is an essential element in the care and treatment of patients. Nearly every service needed to provide patient care requires power to operate. Many of these essential devices are small appliances (such as monitors for displaying a patient's vital signs, or infusion pumps) and get their power from receptacles. As the number of appliances used in patient care increases, a larger burden is placed on the power system. Because of this, reliability and redundancy of power systems is of maximum importance. All hospitals have defined minimum requirements regarding what must operate in a power emergency; but these are not the same for all situations. Where a hospital is located (with respect to climate) can significantly impact its minimum power demands. Emergency power needs frequently go well beyond basic code requirements and will reflect the mission of the institution and the role it serves in its community.

A redundant source of normal power should be considered for most large hospitals, and particularly for acute-care and trauma centers. Redundant normal power is delivered by double-ended main switchgear (Figure 10-2). Should a fault occur in the on-line feeder circuit, an automated tie breaker will close and transfer the load to the backup feeder circuit(s). When properly programmed, the transfer occurs in milliseconds. This will result in a detectable "blink," but not enough for contact relays to fully open; thus, most inductive loads, such as motors, will continue to operate through the transfer. Double-ended services are highly reliable, depending on the quality of the utility provider's distribution network. When redundant normal power systems are used, backup power is needed only if both sources of normal power are lost at the same time. Ideally, each feeder is supplied from substations in different locations to minimize the likelihood of an interruption due to equipment failure. In the worst case, an outage might be the result of a disaster that caused major damage to the electric utility distribution system (such as hurricane, tornado, or flood), but it could also be the result of an act of terrorism.

10.6.2 Essential Electrical System

Primary and redundant normal power, and generator-supplied emergency power, comprise the Essential Electrical System as defined by *NFPA 99: Health Care Facilities Code* (NFPA 2012). Generators may be used exclusively for emergency purposes or they may also be used for peak demand control, internal voltage regulation, load relief for the local utility, or cogeneration. When used for other than emergency purposes, two or more generators are required to meet the connected loads, including the essential components of the emergency electrical system (e.g., generator fuel pumps) and essential auxiliary equipment (e.g., medical air compressors, medical vacuum pumps, fire pumps).

The emergency power system must also provide essential services for the space or room housing the generators, including lighting, ventilation, and heating, if the ambient temperature in the space could be less than 40°F [4.4°C]. All dampers and components of the ventilation system must be supplied by the emergency power system.

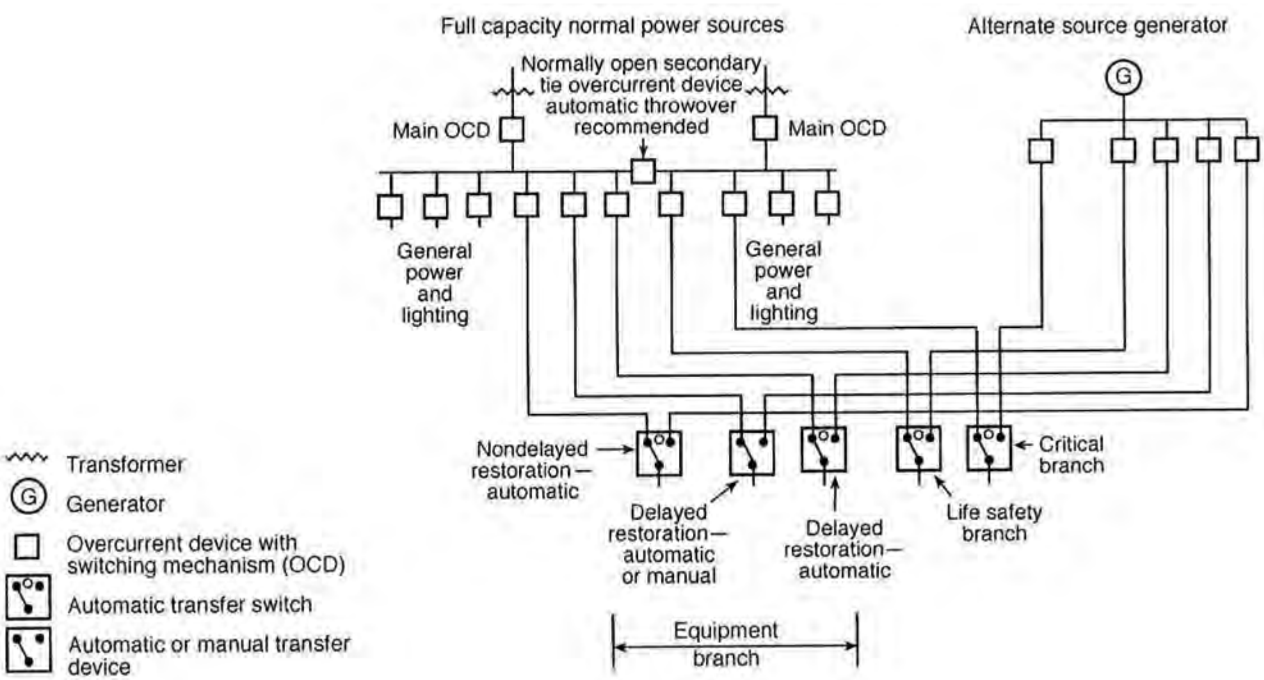

Figure 10-2 *Typical Hospital Normal and Emergency Main Distribution Diagram*

Source: NFPA (2012). Reproduced with permission from NFPA99-2012, *Health Care Facilities,*

Emergency Power Systems

In the event of a loss of power, an alternative source of power is required to serve the emergency electrical system. This consists of the life safety and critical branches and the equipment system that supplies the major equipment necessary for patient care and basic Type 1 operation (see Table 10-1).

On-site backup generators are the usual source of emergency power. When the generator(s) start, switching relays called automatic transfer switches close according to defined protocols to pick up the building's electric loads.

As the name implies, the life safety branch provides power for required life safety services, including the fire alarm system; lighting for egress; emergency communications; services for the generator and generator room; elevator lighting, control, and communications; automatic doors for building egress; and smoke dampers and components complying with NFPA 72 (NFPA 2013a).

Critical branch loads include essential patient care services that could result in loss of life or serious injury. These may be divided into two one or more branches and should include power for task illumination, fixed equipment, and selected power circuits serving the patient care areas and functions as described in NFPA 99.

Table 10-1 *Emergency Power Services*

Life Safety Branch	Critical Branch	Equipment: Nondelayed and Delayed Automatic Start	Equipment: Delayed or Manual Start
Fire alarm system, lighting for egress, exit lighting, emergency communications; services for the generator and generator room (as described in NFPA-99); elevator lighting, control, and communications; automatic doors for building egress; smoke and fire dampers and components; medical gas alarm systems	Nurse-call systems, task illumination, fixed equipment; selected power circuits serving the patient-care areas; other functions in accordance with the range and level of specific services offered by the facility	Medical vacuum, medical air compressor, and anesthesia evacuation (WAGD) systems; pumps and other systems required to maintain safety of major apparatus; smoke control and evacuation systems, kitchen hood ventilation systems (if required to operate during a fire in or beneath the hood); ventilation systems including airborne infectious isolation rooms, protective environment rooms, fume hood exhaust fans, fans for systems where radioactive materials are in use	Heating for operating, delivery, labor, recovery, intensive care, coronary care, nurseries, emergency treatment rooms, general patient rooms, and jockey or make-up water pumps for fire protection; elevators providing patient transfer to patient care, surgical, obstetrical, and ground floors during interruption of normal power; ventilation systems for surgery and obstetrical suites, intensive care, coronary care, nurseries, and emergency treatment spaces; hyperbaric and hypobaric facilities; autoclaving and sterilization equipment

Because hospitals vary in the level of care and services they provide, critical branch loads will vary by facility. An acute-care hospital, with a large number of patients requiring greater levels of life support and advanced or critical care, may have significant critical care loads; small general hospitals may have very few. It is frequently a challenge meeting the demand for critical branch power in large, acute-care hospitals.

Equipment System

Equipment loads are typically auxiliary loads that are necessary to keep the facility operating at a defined level of service. These loads include medical vacuum systems, medical air compressors, elevators, boilers, pumps, ventilation equipment, cooling equipment, and other devices. These are frequently motor loads which, if enough motor starts were to occur simultaneously, could overload the emergency power system. Equipment loads connected to the emergency power system must be stared at appropriate intervals after the emergency system has been energized.

As required by NFPA 99, the life safety and critical branch loads must be picked up within 10 s of an outage. Multiple generator systems can be independent when they supply transfer switches serving dedicated load components. Most plants using multiple generators are paralleled, whereby they are automatically synchronized so they can operate together to increase capacity. When operating a paralleled plant, NFPA 110 mandates that the emergency system loads not exceed

Figure 10-3 *Emergency Load Transfer Switch*

the capacity of one generator, so that the system will not overload should the paralleled plant not be up to capacity within 10 s of the first generator start (NFPA 2013b). Transfer switches may have manual bypass capability so they can be switched to another generator should it be necessary to take a generator off line for maintenance or repair.

After the life safety and critical loads have been supplied, the emergency system can begin acquiring equipment loads at an appropriate rate that will prevent overloading of the generator. Equipment loads can be transferred via delayed automatic or manual transfer. Loads that are allowed to be subject to delayed automatic transfer include medical vacuum, medical air compressor, and waste anesthesia gas disposal (WAGD) systems; pumps and other equipment required to maintain the safety of major apparatus; smoke control and evacuation systems; kitchen hood ventilation systems that are required to operate during a fire in or beneath the hood; and ventilation systems, including airborne infectious isolation rooms, protective environment rooms, fume hood exhaust fans, and fans for systems where radioactive materials are in use. These loads may also be connected to the critical branch if a delayed connection is not appropriate.

Loads that may be either delayed automatic or manually transferred to the emergency system include heating for operating, delivery, labor, recovery, intensive care, coronary care, nurseries, emergency treatment rooms, general patient rooms, and jockey or makeup water pumps for fire protection; elevators providing patient transfer to patient care, surgical, or obstetrical areas and the ground floor during interruption of normal power; ventilation systems for surgery and obstetrical suites, intensive care, coronary care, nurseries, and emergency treatment spaces; hyperbaric and hypobaric facilities; autoclaving and sterilization equipment; controls for all equipment covered under this section; and other selected loads that are essential to the facility operational plan.

Heating of general patient care rooms during disruption of normal power is not required when

- the outdoor design temperature is greater than 20°F [–6.7°C]; or
- the outdoor design temperature is less than 20°F [–6.7°C], but selected heated rooms are maintained for confined patients; or
- the facility is provided with a redundant source of normal power.

Emergency Power for Cooling Systems

Because of high power demand, air-conditioning equipment is generally not served by emergency power. However, in facilities in cooling-dominated climates, inability to cool the facility may impair the delivery of services and put patients at risk.

An HVAC design approach that segregates critical process loads to smaller dedicated systems, such as imaging equipment rooms, can help hold down emergency power needs. If a large cooling load is anticipated or planned during extended emergency operations, it is worth considering alternative utility sources for one or more of the cooling plants, such as direct-fired reciprocating or absorption chillers.

The majority of HVAC equipment will be served by the equipment power branch and, therefore, may not transfer within the 10 s period during which the life safety and critical branch loads are picked up. An extended delay can cause many motor starters and control devices to fail open and not automatically reclose, requiring them to be manually restarted. Direct digital control (DDC) panels may also fail or lose critical data, requiring them to be reset; in the worst case, control programs may fail completely and need to be reloaded. During and while recovering from an emergency, there may not be enough skilled maintenance staff available to restore equipment on a timely basis. Designers should, therefore, require that DDC panels serving high-priority equipment be provided with uninterruptible power supplies. To allow remote restarting, motor starters should be equipped with addressable relays that can be commanded by the building management system.

Most facilities will lack the resources to provide enough emergency power generation to supply all operational needs. Generally, except when it is the result of a large-scale failure of the building's electrical system, most extended outages will be the result of a natural disaster impacting the community and its electric utility. In such a case, many normal services such as outpatient treatment may be curtailed, and the utilities for these services can be redistributed to those areas of the facility that are involved with emergency care. See section 4.3.3 for discussion on prioritizing redistribution on power ("cooling triage"). The designer should always confer with the facility managers to understand the planned emergency requirements for the project, and thus to ensure that the owner's expectations are met.

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