Electrical Level 4

Standby and Emergency Systems 26403-14

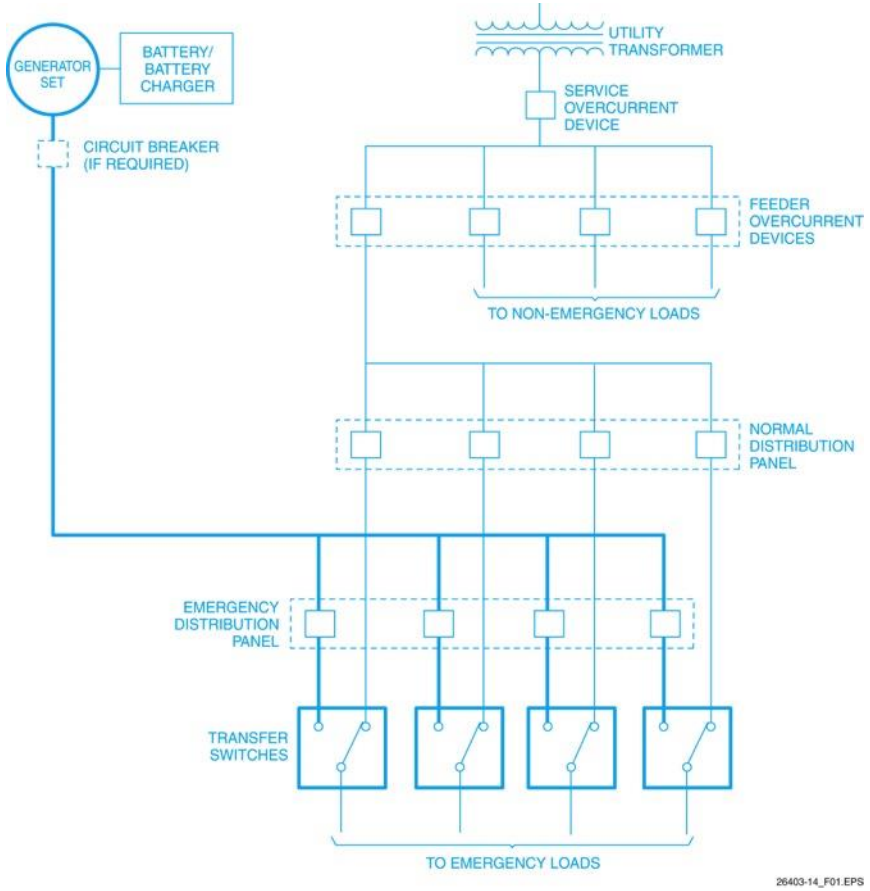
Objectives

When trainees have completed this lesson, they should be able to do the following:

1. Explain the basic differences between emergency systems, legally required standby systems, and optional standby systems.
2. Describe the operating principles of an engine-driven standby AC generator.
3. Describe the different types and characteristics of standby and emergency generators.
4. Recognize and describe the operating principles of both automatic and manual transfer switches.
5. Recognize the different types of storage batteries used in emergency and standby systems and explain how batteries charge and discharge.
6. For selected types of batteries, describe their characteristics, applications, maintenance, and testing.
7. Recognize double-conversion and single-conversion types of uninterruptible power supplies (UPSs) and describe how they operate.
8. Describe the *National Electrical Code*® (*NEC*®) requirements that pertain to the installation of standby and emergency power systems.

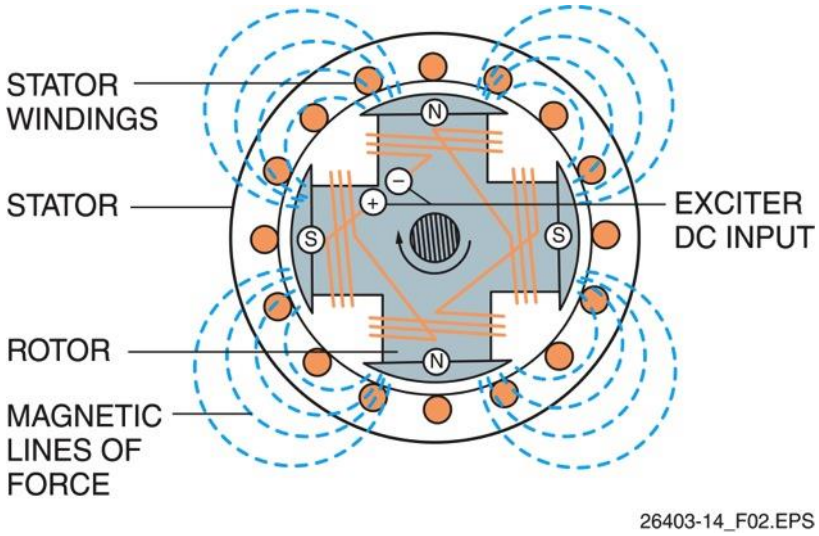
This is a knowledge-based module; there are no Performance Tasks.

Introduction; Emergency and Standby Power System Components



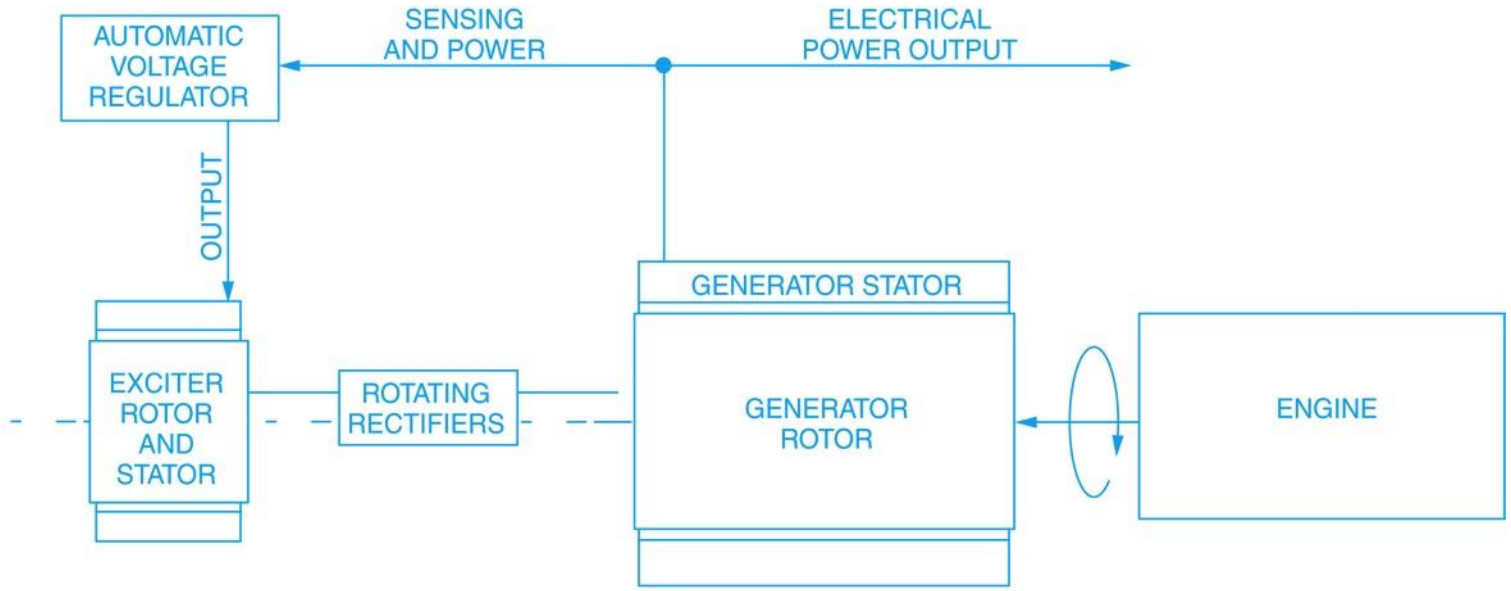
Cross-Sectional View of a Four-Pole AC Generator

- An AC generator converts rotating mechanical energy into electrical energy.
- When the engine is running, it turns the rotor, which contains the field windings. The field windings are energized by the exciter DC input and cut across the stator windings, inducing a voltage in the stator.

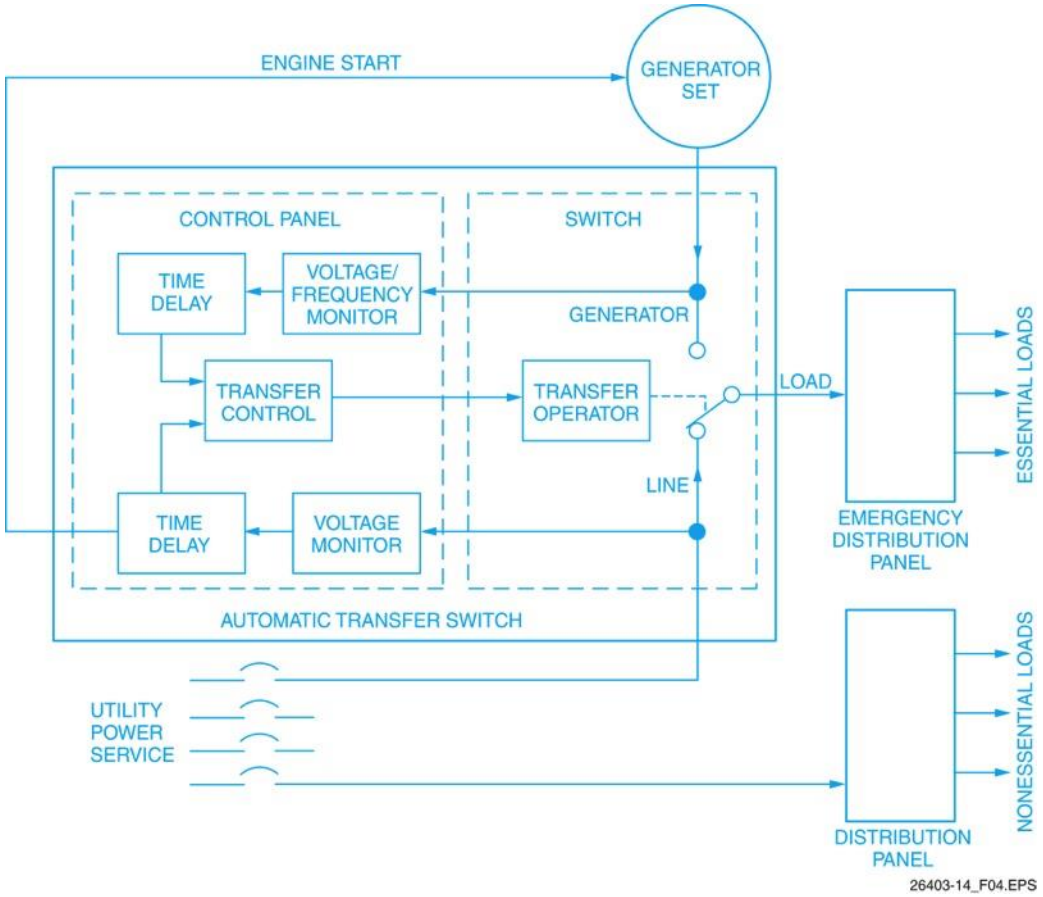


Self-Exciter Generator Schematic

The excitation system input is controlled by a voltage regulator, which increases or decreases the exciter voltage as it senses changes in the output generator voltage due to changes in the load.



Simplified Emergency/Standby Power Distribution with Automatic Transfer Switch



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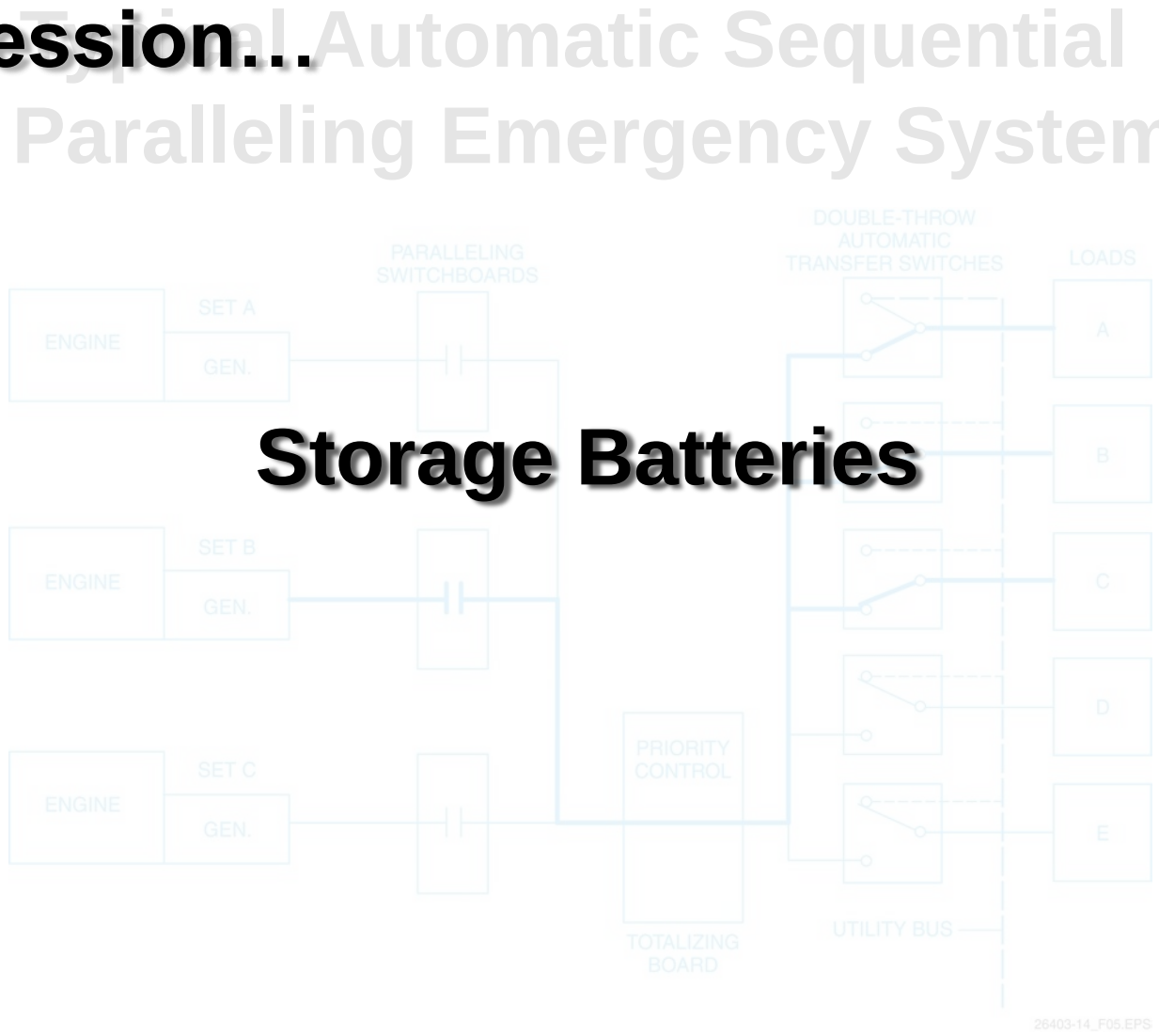
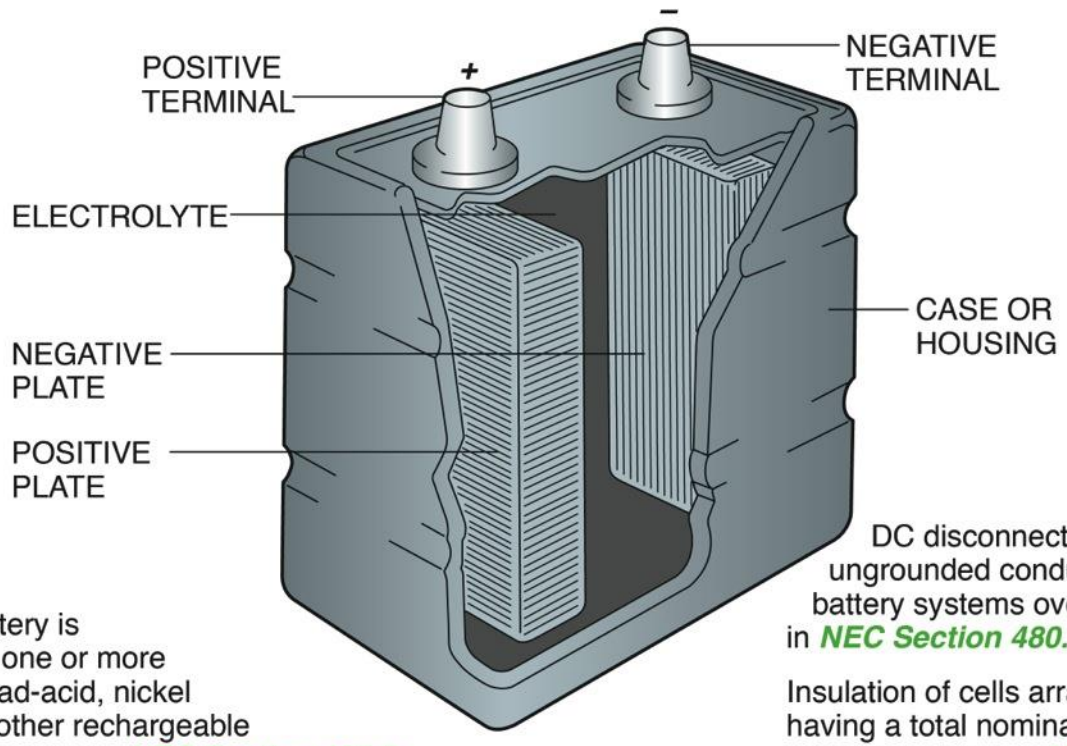


Storage Batteries

Storage Batteries

Battery voltage is computed on the basis of 2.0V per cell for lead-acid types and 1.2V per cell for alkali types.



A storage battery is composed of one or more cells of the lead-acid, nickel cadmium, or other rechargeable electrochemical types. ***NEC Section 480.2***

DC disconnect methods for ungrounded conductors of stationary battery systems over 50V are covered in ***NEC Section 480.6.***

Insulation of cells arranged in groups having a total nominal voltage of not over 250V is covered in ***NEC Section 480.7.***

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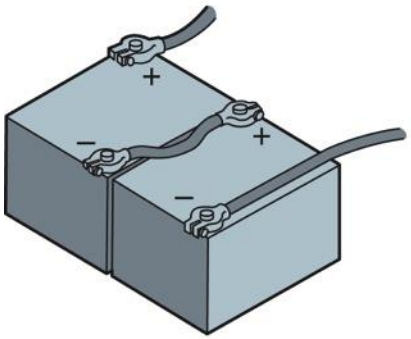
Chemical Reaction in a Lead-Acid Battery



$$\text{ELECTRICITY} + 2PbSO_4 + 2H_2O \underset{\text{DISCHARGING}}{\overset{\text{CHARGING}}{\rightleftharpoons}} PbO_2 + Pb + 2H_2SO_4$$

VOLTAGE & CURRENT	POSITIVE & NEGATIVE ELECTRODES	WATER	POSITIVE ELECTRODE	NEGATIVE ELECTRODE	ELECTROLYTE

Pb = LEAD
PbO_2 = LEAD PEROXIDE
$PbSO_4$ = LEAD SULFATE

H_2O = WATER
H_2SO_4 = SULFURIC ACID

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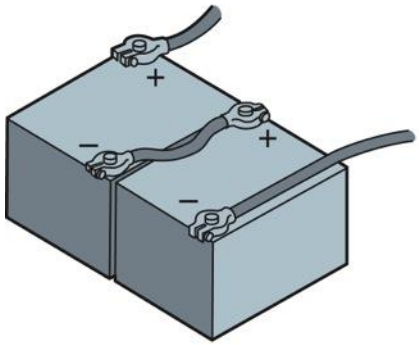
- Lead-acid batteries are secondary batteries, meaning that power must be applied to begin the chemical reaction.
- When the battery is being charged, power is stored chemically in the electrode and electrolyte. When the battery is used to supply power, the chemical reaction is reversed.

Chemical Reaction in a Nickel Cadmium Battery



$$\underset{\text{VOLTAGE \& CURRENT}}{\text{ELECTRICITY}} + \underset{\text{NEGATIVE ELECTRODE}}{Cd(OH)_2} + \underset{\text{POSITIVE ELECTRODE}}{2Ni(OH)_2O} \underset{\text{DISCHARGING}}{\overset{\text{CHARGING}}{\rightleftharpoons}} + \underset{\text{NEGATIVE ELECTRODE}}{Cd} + \underset{\text{POSITIVE ELECTRODE}}{2Ni(OH)_3}$$

Cd = CADMIUM
Ni = NICKEL
OH = HYDROXIDE

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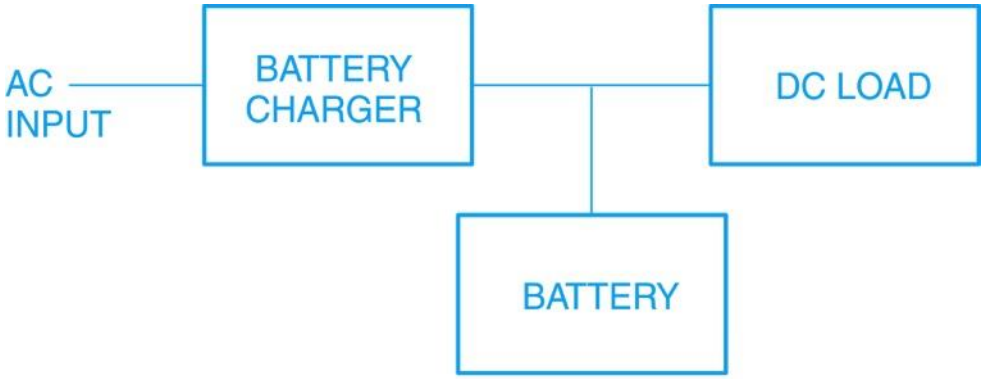
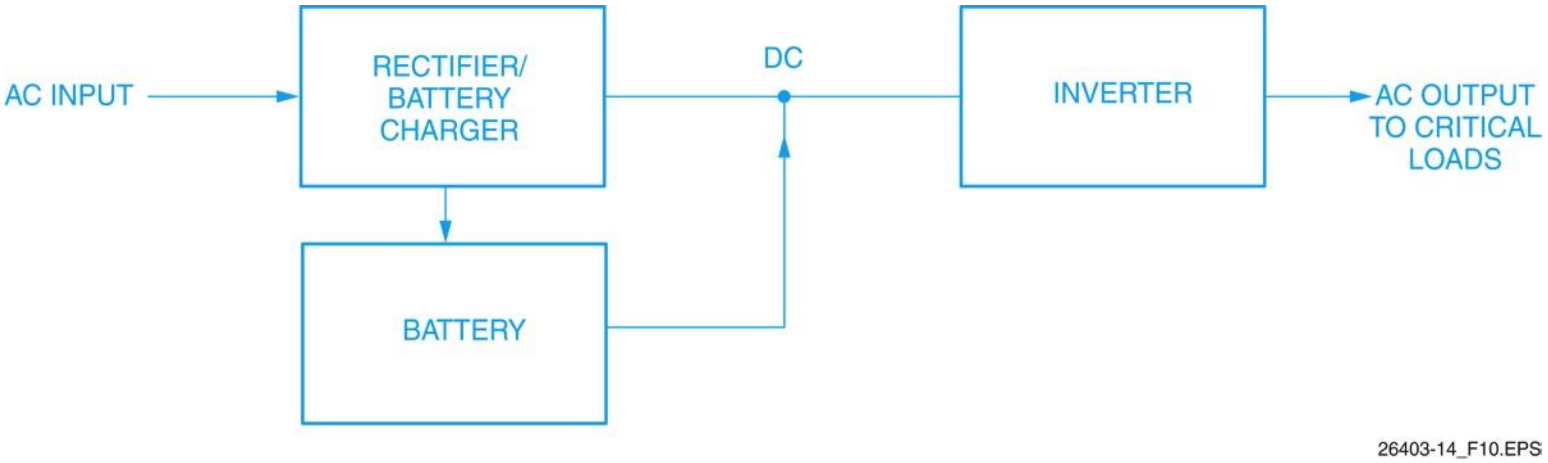
- Nickel cadmium batteries are more expensive than lead-acid batteries, but provide superior durability in extreme-temperature environments.
- Like lead-acid batteries, nickel cadmium batteries are secondary or storage-type.

Stationary Battery in Float Operation



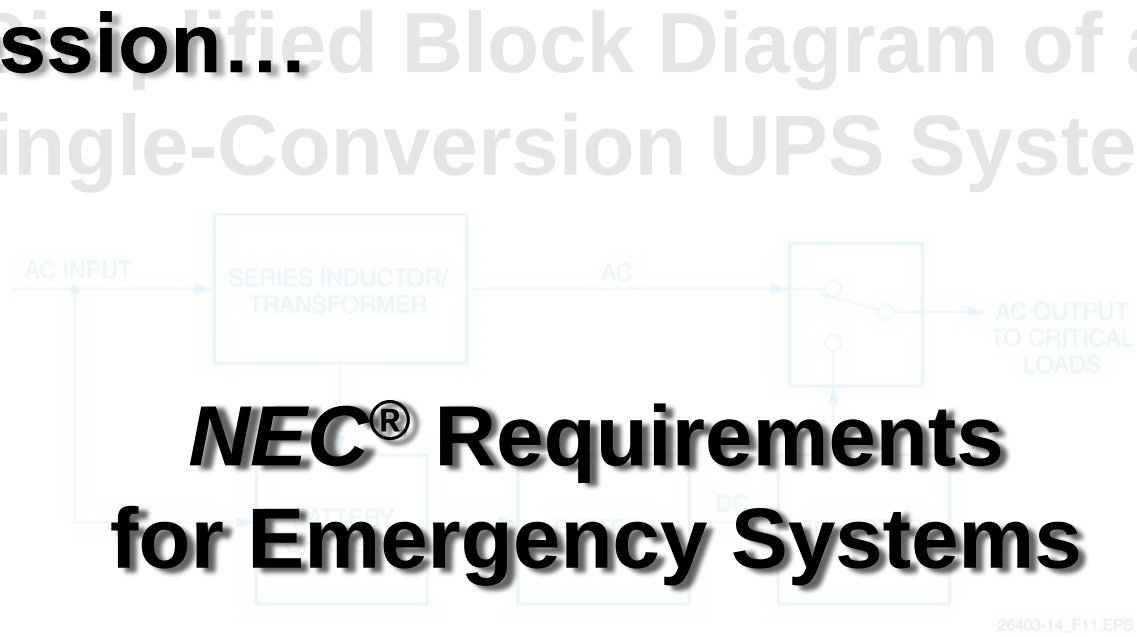
- Standby batteries are often used to power emergency lighting systems in which they are operated in the float mode of operation where the battery, battery charger, and load are connected in parallel.
- If AC input power is lost, the battery instantly carries the full load.

Static Uninterruptible Power Supply



- In double-conversion UPS systems, the incoming AC power is first rectified and converted to DC. The DC is then supplied as input power to a DC-to-AC converter. The inverter output is AC.
- A battery connected in parallel with the DC input provides power if the input power fails.

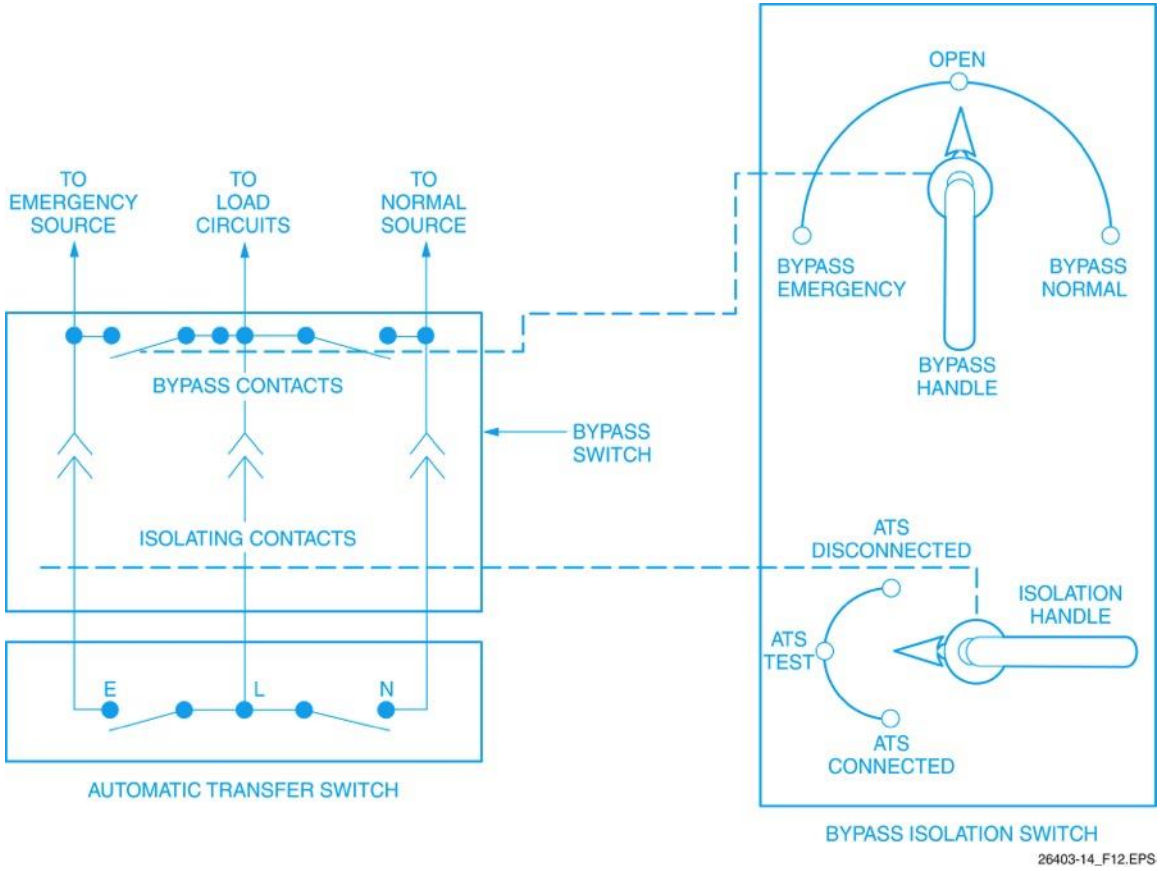
Next Session…



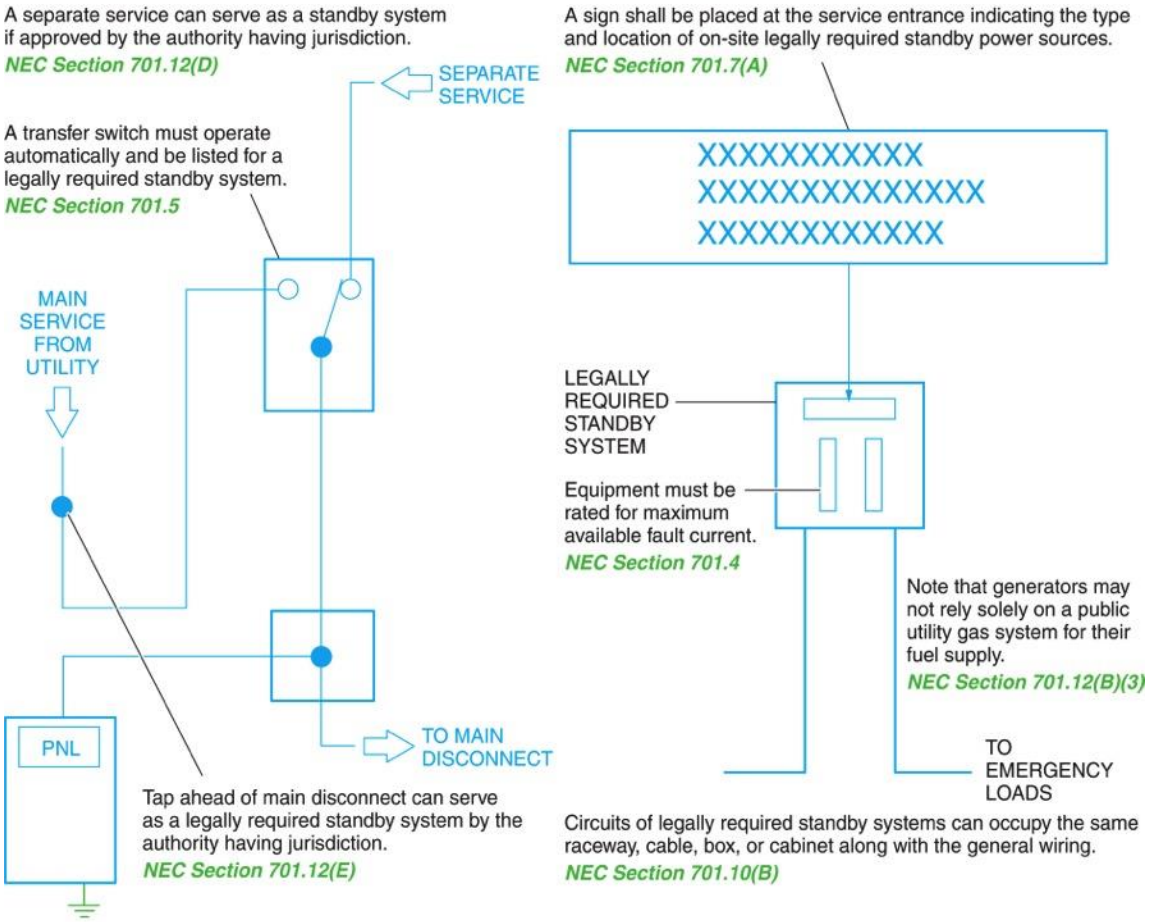
NEC® Requirements for Emergency Systems

- In single-conversion UPS systems, the incoming AC power is supplied directly to the critical loads through a series inductor or transformer.
- The normal AC power also supplies a small battery charger used to maintain the UPS batteries in a fully charged condition.

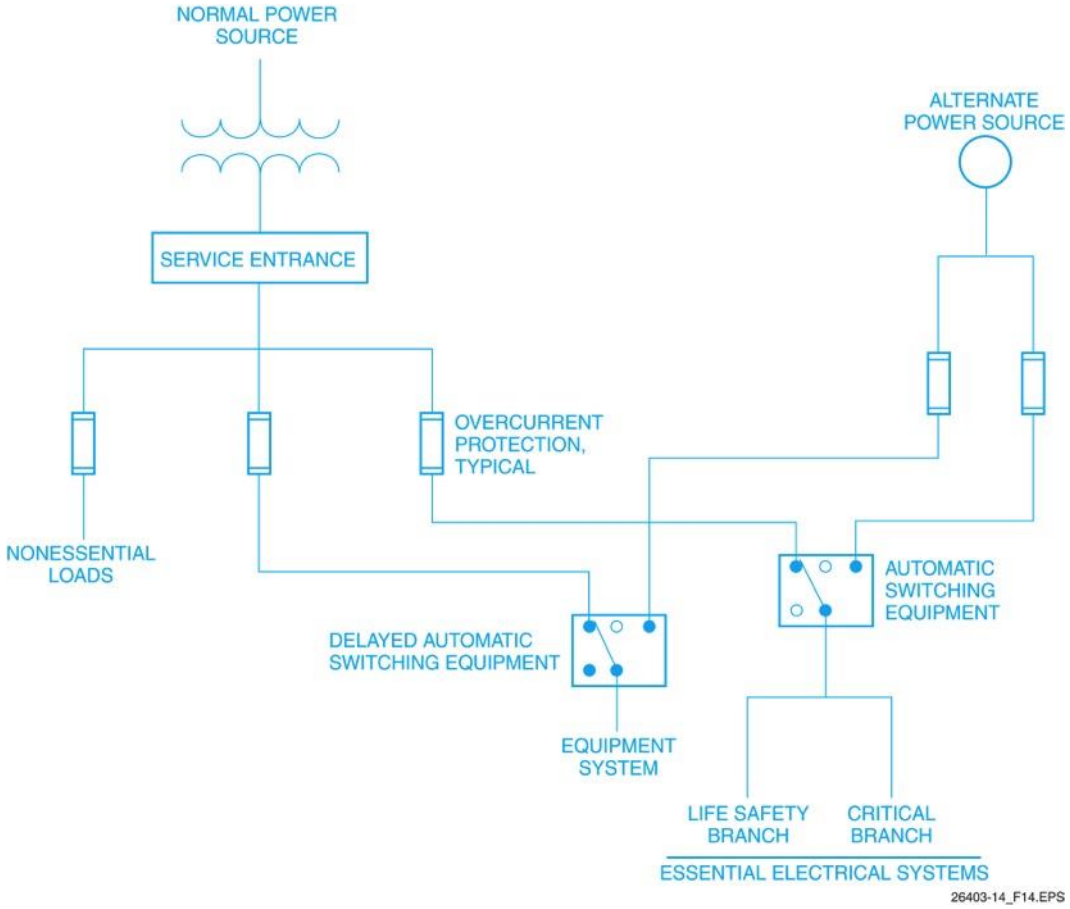
NEC® Requirements for Emergency Systems



Summary of *NEC*® Installation Requirements Governing Legally Required Standby Systems

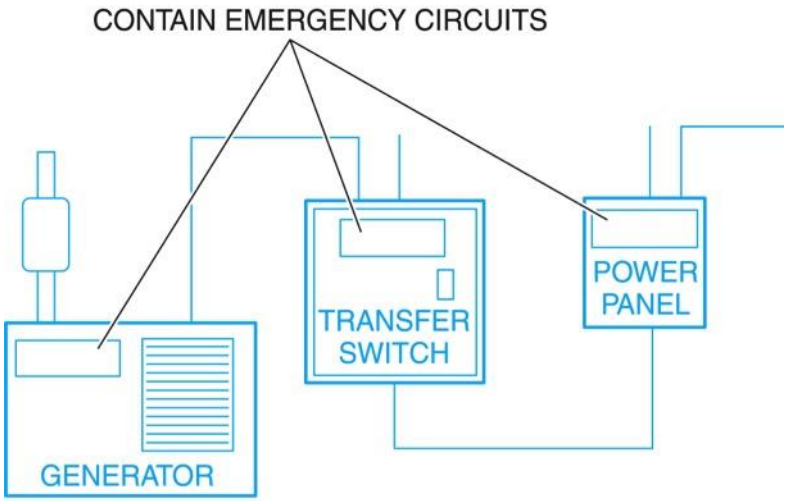


Emergency System Circuits for Light and Power



Summary of *NEC*® Requirements for Emergency Circuit Identification

- The life safety branch must supply power to corridor and stairway lighting, exit signs, alarms, communication systems, elevators, automatic doors, and the generator location.
- The critical branch must supply power to anesthetizing locations, isolated power systems, patient care areas, nurse call systems, blood/bone/tissue banks, and essential task power/lighting.



Labels, signs, or some other permanent marking must be used on all enclosures containing emergency circuits to readily identify them as components of an emergency system.

NEC Section 700.10(A)

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Next Session…

Typical Emergency Lighting Units

- Emergency lighting units contain a rechargeable battery, a battery charger, and one or more lamps.
- These units maintain the battery fully charged and automatically energize the lamps upon loss of the normal power supply.

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Wrap Up

Wrap Up

3-2-1

3 – Write 3 important things learned during class

2 – Write 2 questions you have about the material

1 – Write 1 thought you had about the material

Next Session…

MODULE EXAM

Review the complete module to prepare for the module exam. Complete the Module Review as a study aid.