

Data Center Generators

STANDBY GENERATOR COMPONENTS · OPERATING MODES · UTILITY RESOURCES · FUEL TYPES · FUEL SYSTEMS & STUDY & REVIEW CODES

01 MUST KNOW

if you remember five things, remember these

- 01 Three main components:** a standby generator is built from the **emergency generator** (produces backup power when the primary source — usually the utility — fails), the **automatic transfer switch (ATS)** (governs which source feeds the load and manages the switch), and the **uninterruptible power supply (UPS)** (a battery-plus-charger that supplies temporary power *while* the ATS completes the switch). Together they help hit the data center's 99.99% annual availability target.
- 02 Nine emergency-generator elements:** **engine** (converts fuel → mechanical energy), **alternator** (stator + rotor → mechanical → electrical energy), **fuel system tank**, **voltage stabilizer** (regulates output, converts AC → DC when required), **cooling & exhaust systems**, **lubrication system**, **battery charger** (24/7 standby to start it), **control panel** (the user interface), and **frame** (the outer body).
- 03 ATS: manual vs. automatic, open vs. closed:** a data-center **low-voltage ATS** can detect a delay in as little as **one second**. A *manual* ATS switches the generator to manual mode for maintenance and testing; an *automatic* ATS senses main-source loss and shifts to the alternate source, then back. Automatic uses **open transition** (break from main *first*, then connect emergency) or **closed transition** (connect emergency *first*, then break from main).
- 04 Two operating modes — don't flip them:** **normal mode** = power flowing as expected from the *main* source. **Emergency mode** activates when the ATS detects a failure in the *main* supply and, together with the UPS, orchestrates a switch to the **backup** (generator) supply. The ATS can receive **two or three power inputs** — a combination of utility lines and generator-produced power.
- 05 Fuel & fuel systems:** six common fuels — **diesel** (least flammable, most common in data centers), emulsified diesel, biodiesel, gasoline, propane, natural gas. The fuel system must deliver **concurrent maintainability** and **fault tolerance** through redundancy, across four units (fuel unit, fuel polishing module, fuel transferring pump, fire safety design), all governed by **NFPA** codes.

02 KEY TERMS

TERM	DEFINITION
Standby generator	Backup power source, properly sized to continuously supply the critical IT load and its supporting infrastructure during an outage or maintenance
Emergency generator	The component that generates backup power when the primary power source (usually the utility) fails
Automatic transfer switch (ATS)	Governs the source of power output to connected devices and manages the transition from one power source to another on failure
Uninterruptible power supply (UPS)	A battery-and-charger combination that supplies temporary power while the ATS performs the source switch and smooths surges/fluctuations
Alternator	Emergency-generator element of a fixed stator and a moving rotor; creates an electromagnetic field to convert mechanical energy into electrical energy
Voltage stabilizer	Regulates the electricity generated by the alternator and converts the AC supply to DC supply when required
Open transition	Automatic-ATS mode that first breaks the connection to the main source, then connects the emergency source (break-before-make)
Closed transition	Automatic-ATS mode that first connects the emergency source, then disconnects the main source (make-before-break)

TERM	DEFINITION
Day tank	The fuel tank that stores fuel for the generator; storage-tank redundancy is added when day-tank capacity is short of the required runtime
Fuel polishing	Cleaning fuel by passing it through a series of filters and water separators (biocides optional) to reverse degradation and prevent contamination
Concurrent maintainability	The ability to perform maintenance on data center equipment without affecting the operations of the data center
Fault tolerance	The ability of the systems to keep operating even if there is a failure

03 EMERGENCY GENERATOR — NINE ELEMENTS

fuel in, regulated electricity out

ELEMENT	FUNCTION
Engine	Main part that produces electricity; converts fuel (diesel, gasoline, natural gas, and others) into mechanical energy — more powerful engine, higher capacity
Alternator	Stator (fixed) + rotor (moves) create an electromagnetic field, converting mechanical energy into electrical energy
Fuel system tank	Stores the fuel; an injector forces it into the engine for combustion, and unused fuel returns after filtration
Voltage stabilizer	Regulates the electricity generated by the alternator; converts AC supply to DC supply when required
Cooling & exhaust	A fan and coolant reduce thermal stress from overheating; the exhaust system expels the hot air
Lubrication system	Keeps all mechanical parts oiled to protect them from wear and tear caused by friction
Battery charger	Automatic device that keeps the battery charged, on 24/7 standby to start the generator in an emergency
Control panel	User interface for start/shutdown, engine and generator gauges, and other manual and automatic controls
Frame	The outer body of the generator

04 EMERGENCY POWER-TRANSFER SEQUENCE

primary source fails → load rides through

01 Main (utility) power fails → **02** ATS detects the delay — as little as **one second** → **03** UPS supplies temporary power to the load → **04** ATS shifts the load to the **emergency generator** → **05** Generator supplies emergency power → **06** Utility restored → ATS shifts the load **back** to main

05 SIX COMMON GENERATOR FUEL TYPES

diesel is least flammable and most common

FUEL	FLAMMABILITY	SHELF LIFE	NOTES
Diesel	Least flammable	Up to 24 mo	Cost-effective, easily available; may pollute and burn inefficiently; noisy engine
Emulsified diesel	Medium	Up to 24 mo	Diesel mixed with water to reduce emissions; water/diesel ratio is hard to maintain
Biodiesel	Medium	Up to 24 mo	Made from vegetable oil; cleaner, fewer emissions, easy to store and use
Gasoline	Extremely flammable	Up to 12 mo	Easily available, but expensive, inefficient, and storable only in limited quantities
Propane	Highly flammable	Variable	Clean, no residue, available in outages; needs special plumbing that raises install cost

FUEL	FLAMMABILITY	SHELF LIFE	NOTES
Natural gas	Flammable	n/a (pipel)	From gas wells; clean, in bulk, available in outages; lower output, may fail in disasters

06 EXAM TRAPS

where the knowledge check gets you

- × “Emergency mode switches the load to the main power supply.” — Backwards. Normal mode runs on the **main** source; **emergency mode** activates when the ATS detects a failure in the **main** supply and, with the UPS, switches to the **backup** (generator) supply.
- × “The ATS supplies the temporary power during a switch.” — No. The **UPS** provides temporary power *while* the ATS performs the source switch; the ATS only governs and executes the transfer.
- × “Open and closed transition are just two names for the same thing.” — **Open transition** breaks from the main source first, then connects the emergency source; **closed transition** connects the emergency source first, then breaks from the main source.
- × “Gasoline is the safest, least flammable generator fuel.” — Gasoline is **extremely flammable** with a short (≈12 month) shelf life. **Diesel** is the *least* flammable and the most common data-center fuel.
- × “A generator’s ATS always has exactly two power inputs.” — It receives **two or three** power inputs — combinations of utility resource lines and power created by the generator itself — switching between them as voltage monitoring dictates.
- × “Concurrent maintainability and fault tolerance mean the same thing.” — **Concurrent maintainability** is maintaining equipment *without affecting operations*; **fault tolerance** is continuing to *operate even if a failure occurs*. Redundancy is what delivers both.
- × “The engine itself produces the electricity.” — The **engine** converts fuel into *mechanical* energy; the **alternator** converts that mechanical energy into *electrical* energy.
- × “Stored fuel doesn’t degrade, so testing is optional.” — Fuel is vulnerable to microbes, dust, and particulates, and degradation harms combustion — especially where stored fuel is rarely used. Regular **testing** and **fuel polishing** (filters, water separators, biocides) are required.

07 SELF-QUIZ

answers are upside-down below

- Q1** What are the three main components of a standby generator?

Q2 Which generator element converts mechanical energy into electrical energy, and which two parts make it up?

Q3 Which component provides temporary power while the ATS completes the switch between power sources?

Q4 In an automatic ATS, which transition mode connects the emergency source before disconnecting the main source?

Q5 Name the two operating modes of a standby generator.
- Q6** Which single fuel type is the least flammable and the most commonly used in data centers?

Q7 How many power inputs can a generator’s ATS receive?

Q8 State the difference between concurrent maintainability and fault tolerance.

Q9 What process directs fuel from the tank into the engine to produce electricity?

Q10 Which NFPA code is the standard for emergency and standby power systems?

ANSWER KEY (rotate the page)

01 the emergency generator, the automatic transfer switch (ATS), and the uninterruptible power supply (UPS) 02 the alternator; a fixed stator and a moving rotor 03 the UPS (uninterruptible power supply) 04 closed transition (make-before-break) 05 normal mode and emergency mode 06 diesel 07 two or three — combinations of utility lines and generator-produced power 08 concurrent maintainability = performing maintenance without affecting operations; fault tolerance = continuing to operate even if a failure occurs 09 combustion 10 NFPA 110