

# Fundamentals of Backup Power Design & Code Requirements Lunch & Learn

By Connor Young





### **Company Background**

- Family owned and operated since 1947
  - 11 locations throughout Ohio Indiana, and Illinois
  - Recently expanded to Chicago and Illinois area
- Generator and power systems distributor for Kohler Power Systems
  - ► Longest running Kohler distributor in the country
  - **>** 2020 Kohler Industrial Distributor of the Year
- Total power system support
  - Systems design and application
  - Sales, rental and equipment delivery
  - Service, planned maintenance, parts and repair







# **KOHLER**<sub>®</sub>





### Kohler Power Systems Division



#### Manufacturer of:

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- ▶ Diesel Generators ranging from 15kW 4000kW
  - ▶ Tier 4 Certified models include 1250kW, 2500kW and 3250kW
- **Gaseous Generators ranging from 8kW 500kW**
- ▶ Diesel & Gaseous Mobile Generators ranging from 30kW 175kW
- Automatic Transfer Switches Standard, Bypass Isolation, and Service Entrance Rated
- Paralleling Switchgear Low, Medium, and High Voltage for Paralleling Generators
- Onboard Paralleling Certain model controllers capable of doing gen-to-gen paralleling





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- BS of Mechanical Engineering Purdue School of Engineering and Technology
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- > Office located in Indianapolis and covers Indiana and southern Ohio area
- Tony Yang

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- Applications Engineer, Power Systems
- BS of Materials Science and Engineering U of Illinois in Urbana-Champaign
- ▶ 4 years at GE Zenith Controls as ATS application engineer
- 14 years at CAT dealership
- > 2 years at Kohler distributor, Power Systems West, in Aurora, CO
- Joined BPS with our Chicago acquisition in 2021



### **BPS Project Process**

- Applications Engineering Team
  - > Typically focus on the design stage of projects
  - Primary technical resource internally & externally
  - Provide design assistance and support to engineering groups
  - Identify reliable solutions for standby power to assure customer satisfaction
  - Contribute technical expertise to customers through Kohler factory visits, new product introductions and professional development training
- How We Provide Value
  - ► Generator Sizing
  - Code & Regulation Input for Emergency Power Systems
  - Equipment Experts
  - Value Engineering

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- One-line & Specification Review
- Spec Writing and Input

An applications engineer is the most universal tool in your toolbox





#### **Top View**

#### Examples of Applications Engineering Support

#### Question

- Where should you run the exhaust?
- Where should we place the silencer?
- What type of muffler should we use given we have to run the exhaust 140 feet with (4) 90° long bends?
- What diameter pipe should we run to accommodate the back pressure?



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#### ► Answer (1)

- Where should you run the exhaust?
  - Proposed Southwestern Wall
- Where should we place the silencer?
  - Vertically to accommodate height restrictions
- What type of muffler should we use given we have to run the exhaust 140 feet with (4) 90° long bends?
  - Low Restrictive, (2) Inlet Silencer to save space
- What diameter pipe should we run to accommodate the back pressure?

▶ 10" Dimeter Exhaust Pipe







IN POWER, SINCE 1920.



### **Topics of Discussion:**

- Where will you find generators
- What are the Key Codes & Standards for Generators
- Common Sizing Questions
  - -Kohler Power Solutions Center
- What essential items are required on a generator
  - -Basic Electrical Package
- Generator Breakers
  - -Ground Fault
- 3 Pole Vs. 4 Pole Automatic Transfer Switches
- NEC 2017 Changes
- Diesel vs. Natural Gas Generators
- Diesel Tank Requirements
- Post Construction Operational Testing





# WHERE WILL YOU FIND GENERATORS?

- Where will you find generators?
- Healthcare (NEC 517)
- Fire Pumps (NEC 695)
- Emergency Life Safety (NEC 700)
- Legally Required Standby (NEC 701)
- Optional Standby (NEC 702)
- Interconnected Electric Power (NEC705)
- Critical Operations Power Systems (NEC708)







# WHERE WILL YOU FIND GENERATORS?

#### Emergency Systems (NEC 700 & NEC 517)

- -Loads essential for safety of human life
  - Exit lights, egress lighting, egress elevators
  - Fire monitoring and exhaust fans
  - Healthcare life safety and critical circuits

#### Legally Required Standby (NEC 701)

- -Loads that could create hazards, hamper rescue or fire fighting
  - Elevators, communication & lighting systems
  - Hazardous industrial processes (heating & refrigeration)
  - Ventilation and smoke removal
  - Sewage disposal







### WHERE WILL YOU FIND **GENERATORS**?

#### **Optional Standby (NEC 702)**

Laboratories (drugs)	Food storage & processing
-Experiments in process	-Spoilage of produc
-Inventory	-Inability to ship
Radio & TV stations	
-Advertising	
-Non-emergency broadcast	-Customer satisfact
Data centers	Communications companie
-Uptime availability	-911 function batte
Process industries	-Up-time marketabi
-Clean up costs	Gaming industry
Restaurants	-Revenue
-Lost revenue	Grocery chains
-Customer experience	-Revenue loss
Lodging industry	-Perishables
-Security & guest services	Banks / Financial inst.
Retail industry	-Mission critical
-Storm supplies	-Online banking

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-Spoilage of product -Inability to ship ternet service providers -Customer satisfaction ommunications companies -911 function battery backed -Up-time marketability aming industry -Revenue rocery chains -Revenue loss -Perishables anks / Financial inst. -Mission critical -Online banking -Security

**Schools** 



# WHAT ARE THE KEY CODES & STANDARDS FOR GENERATORS?

National Fire Protection Association (NFPA) Independent standards organization

> Mission is to reduce fire risks Standards developed with the ANSI process Standards typically adopted into state statutes Require compliance for AHJ approval





#### Generator related NFPA standards

20 Installation of Fire Pumps
30 Flammable and Combustible Liquids Code
37 Installation & Use of Stationary Engines
54 National Fuel Gas Code
58 LP Gas Code
70 National Electrical Code
99 Health Care Facilities
110 Standard for Emergency & Standby Power Systems

#### Generator related NEC articles

NEC 100 Definitions NEC 215 & 225 Feeders NEC 240 Overcurrent Protection NEC 250 Grounding NEC 445 Generators NEC 517 Healthcare NEC 695 Fire Pumps NEC 700 Emergency Systems NEC 700 Emergency Systems NEC 701 Legally Required Standby NEC 702 Optional Standby NEC 705 Interconnected Electric Power Sources NEC 708 Critical Operations Power Systems





# **Common Sizing Questions**

#### What is the required generator size (capacity)?

-NEC 700.4 (Emergency System)

"...adequate capacity and rating for all loads to be operated simultaneously"

#### -NEC 701.4 (Legally Required Standby)

 "supply of all equipment intended to be operated at one time" -NEC 702.4 (Optional Standby)

#### -NEC 702.4 (Optional Standby)

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- "… in accordance with article 220 or by another approved method"
- Assuming PE stamp will meet AHJ approval
- NEC 2005 required: "supply of all equipment intended to be operated at one time"

-Healthcare Facilities Have their own defined codes

#### How quickly must a generator startup and transfer?

#### Emergency Systems -10 sec start-up time

Critical & life safety loads -NEC 700.12 (Emergency Systems - General Requirements) -NFPA 20, 9.6.2.1 (Fire Pumps) -NEC 517.31, & NFPA 99 6.5.3.1 (Health Care Facilities)

#### Legally Required Standby - 60 sec start-up time -NEC 701.12 (Legally Required Standby)

Option Standby - No defined startup time

-NEC 702 (Optional Standby)

Variably defined start-up -NFPA 110 4.1 (Emergency & Standby Power Systems)

#### Type:

Table 4.1(b) Types of EPSSs

Designation	Power Restoration
Type U	Basically uninterruptible (UPS systems)
Type 10	10 sec
Type 60	60 sec
Type 120	120 sec
Туре М	Manual stationary or nonautomatic — no time limit



# **Common Sizing Questions**

### What transient (voltage & frequency) limits are required?

-Transient requirements are defined by the engineer which is determined by the load supported. Certain loads are sensitive to and have tighter voltage / frequency dips.

-Transients are not defined by the class of load.

-Exception: Fire pumps - Require 15% voltage dip maximum

ISO 8528 classifications:

-G1 25% voltage dip, 15% frequency dip

-G2 20% voltage dip, 10% frequency dip

-G3 15% voltage dip, 7% frequency dip

-(User Defined) x% voltage dip, x% frequency dip

0.00%		
-5.00% -		
-10.00% -		
-15.00% -		
-20.00%		
-25.00% -	V	
-30.00%		

-Kohler's Defaults: 30% volage dip, 10% frequency dip, 10% harmonic distortion

### What items affect load transients?

-Size of load and its characteristics

-Motor starting codes and starting methods

-Engine size & fuel type (frequency dips)

-Alternator size (voltage dips)





### Kohler Power Solutions Center

### SIZING PROGRAM

Available on your PC or tablet, our easy-to-use sizing program "Power Solutions Center" goes wherever you go. So you can spec and size your power system wherever you want. And with features like drag-and-drop load management, automatic one-line diagrams and accurate specs, it makes your life a whole lot easier.

#### **EXCLUSIVE FEATURES**

- · Quick drag-and-drop load management
- Automatic one-line diagram and steps report
- Pre-populated engineering tools
- Optimum generator set results
- · Summaries, reports and technical documents
- Quick, hassle-free estimates and info
- Secure file storage

DOWNLOAD FOR YOUR PC

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#### https://kohlerpower.com/en/generators/industrial/sizing-program





### What essential Items are required on the generator?

#### **Batteries:**

- # and size of batteries to meet the specified table
- -Storage rack and cables for each battery or unit

-Type shall be nickel cadmium or lead-acid type.

#### **Battery Charger**

- Shall be capable of returning the fully discharged battery to 100 percent of its ampere-hour rating within the time specified in Table 5.6.4.2, item (f).

-As specified in NFPA110.Table 5.6.4.2, item (e), meters with an accuracy within 5 percent of range shall be furnished.

#### Table 5.6.4.2 Starting Equipment Requirements

S	tarting Equipment Requirements	Level 1	Level 2
(a)	Battery unit	Х	Х
(b)	Battery certification	Х	NA
(c)	Cycle cranking	X or O	0
(d)	Cranking limiter time-outs		
	Cycle crank (3 cycles)	75 sec	75 sec
	Continuous crank	45 sec	45 sec
(e)	Float-type battery charger	Х	Х
	dc ammeter	Х	Х
	dc voltmeter	Х	Х
(f)	Recharge time	24 hr	36 hr
(g)	Low battery voltage alarm	Х	Х
	contacts		

X: Required. O: Optional. NA: Not applicable.

NFPA110





# What essential Items are required on the generator?

Remote E-Stop(NFPA110.5.6.5.6):

-All installations shall have a remote manual stop station of a type to prevent inadvertent or unintentional operation located outside the room housing the prime mover, where so installed, or elsewhere on the premises where the prime mover is located outside the building.



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Remote Annunciator (NFPA110.5.6.6.3):

-For Level 1 EPS<mark>, local annunciation</mark> and facility **remote annunciation**, or local annunciation and network remote annunciation

-For Level 2 EPS, local annunciation



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# What essential Items are required on the generator?

**NFPA110.5.6.5.1** A **generator control panel** shall be provided and shall contain the following:

- (1) Automatic remote start capability
- ▶ (2) "Run-off-automatic" switch
- (3) Shutdowns as required by 5.6.5.2(3)
- (4) Alarms as required by 5.6.5.2(4)
- (5) Controls as required by 5.6.5.2(5)







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	Level 1		Level 2			
Indicator Function (at Battery Voltage)	CV	S	RA	CV	S	RA
a) Overcrank	х	х	Х	Х	х	0
b) Low water temperature	X	NA	X	X	NA	0
<ul> <li>c) High engine temperature pre-alarm</li> </ul>	X	NA	X	0	NA	NA
d) High engine temperature	Х	X	X	X	X	0
e) Low lube oil pressure	Х	Х	Х	Х	Х	0
f) Overspeed	х	х	х	X	Х	0
g) Low fuel main tank	Х	NA	X	0	NA	0
h) Low coolant level	Х	0	X	X	0	X
i) EPS supplying load	Х	NA	NA	0	NA	NA
j) Control switch not in automatic position	Х	NA	Х	Х	NA	Х
k) High battery voltage	х	NA	NA	0	NA	NA
1) Low cranking voltage	Х	NA	X	0	NA	0
m) Low voltage in battery	Х	NA	NA	0	NA	NA
n) Battery charger ac failure	Х	NA	NA	0	NA	NA
o) Lamp test	Х	NA	NA	х	NA	NA
p) Contacts for local and remote common alarm	х	NA	х	х	NA	х
q) Audible alarm silencing switch	NA	NA	X	NA	NA	0
r) Low starting air pressure	Х	NA	NA	0	NA	NA
s) Low starting hydraulic pressure	X	NA	NA	0	NA	NA
t) Air shutdown damper when used	Х	Х	X	X	x	0
u) Remote emergency stop	NA	Х	NA	NA	X	NA

CV: Control panel-mounted visual. S: Shutdown of EPS indication. RA: Remote audible. X: Required. O: Optional. NA: Not applicable. Notes:

(1) Item (p) shall be provided, but a separate remote audible signal shall not be required when the regular work site in 5.6.6 is staffed 24 hours a day. (2) Item (b) is not required for combustion turbines.

(3) Item (r) or (s) shall apply only where used as a starting method.

(4) Item (i) EPS ac ammeter shall be permitted for this function.

(5) All required CV functions shall be visually annunciated by a remote, common visual indicator.

(6) All required functions indicated in the RA column shall be annunciated by a remote, common audible alarm as required in 5.6.5.2(4).

(7) Item (g) on gaseous systems shall require a low gas pressure alarm.

(8) Item (b) shall be set at 11°C (20°F) below the regulated temperature determined by the EPS manufacturer as required in 5.3.1.





# What essential Items are required on the generator?

**NFPA110.7.3.1** The Level 1 or Level 2 EPS equipment location(s) shall be provided with battery-powered emergency lighting. This requirement shall <u>not apply to units located outdoors in enclosures</u> that do not include walk-in access.

-Requires lighting







## **Basic Electrical Package**

#### ▶ Internal generator panel board (BEP) vs. separate lines

- Basic Electrical Pkg (BEP) offered on 350kW+ Diesel, 180kW+ Gas as a standard accessory.
- Small unit enclosures can offer a BEP on 40kW+ if they are Engineered Special, but below this size the electrical package will not fit.
- ▶ For larger units, no BEP is necessary if lights are not desired. If lights are desired, BEP is convenient since Kohler can wire everything very tidily and provide lights and outlets.

#### Questions You Should Ask Yourself Before Selecting a BEP

- -What Size Unit is being installed
- -Are lights desired on the unit?
- -Are outlets desired on the unit?

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- -How many electrical accessories are being installed on the unit?
- -How far is the genset from your building? Cost of Materials for BEP option vs running separate lines?



### **Basic Electrical Package**

#### Load Centers



- Part Number SA27864
- Model QO816L100RB
- QO Load Center
- Main Lug

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• 240V, 100A, 1PH, 8SP



- Part Number SA21039
- Model QO320L125G
- QO Load Center
- Main Lug
- 240V, 125A, 3PH, 20SP



- Part Number SA20461
- Model Q0124M100
- QO Load Center
- Main Breaker
- 100A, 1PH-3W, 24SP
- NEMA1



### **Basic Electrical Package**



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### **Generator Breaker**

#### Does the NEC require a generator disconnect (breaker)?

- The generator (itself) does not need a disconnect (conditional)
  - Generator must have shutdown provisions (internal & external E-Stop)
  - NEC seems to have a preference for including a generator breaker
  - Market norm is to utilize a generator breaker
  - UL2200 may require some generators to have a disconnect (conditional on UL testing

process)



"Where an outdoor housed generator set is equipped with a **readily accessible disconnecting means** in accordance with 445.18, and the disconnect means is located **within sight of** the building or structure supplied, an additional disconnecting means shall not be required where ungrounded conductors pass through the building or structure."

What is "within sight of"? Visible and not more than 15 m (50 ft) distance from each other

Exception - For installations under single management, where conditions of maintenance and supervision ensure that only qualified persons will monitor and service the installation and where documented safe switching procedures are established and maintained for disconnection, the generator set disconnecting means shall not be required to be located within sight of the building or structure served."

#### NEC 404.8 Accessibility and Grouping

"Location. All switches and circuit breakers used as switches shall be located.... not more than 2.0 m (6 ft 7 in.) above the floor or working platform." -The larger the tank beneath the generator





### **Generator Breaker**

#### What are the requirements for separation of circuits?

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- The emergency system wiring must be separated
- Emergency system breaker must be in a separate vertical section (NEC 2008) (or)
- Emergency system breaker must be located in the generator connection box

**NEC 700.10 (Emergency Systems - Wiring)** - "... Wiring from an emergency source OR emergency source distribution overcurrent protection to emergency loads shall be kept entirely independent of all other wiring and equipment, unless otherwise permitted"



"(NEC2017) 240.87 Arc Energy Reduction. Where the highest continuous current trip setting for which the actual overcurrent device installed within a circuit breaker is rated or can be adjusted is 1200A or higher, 240.87 (A) and (B) shall apply."





# Grounding and 3 pole vs 4 pole

#### The Need for Ground Fault Protection

In evaluating grounding schemes and transfer switch designs, it is useful to first understand the need for ground fault protection. A *ground fault* is an inadvertent current pathway that develops between an energized conductor and an equipment frame or earth. If the fault energizes equipment surfaces that people can touch, it poses an electrical safety hazard. If an arcing ground fault persists at a level below the amount of current that would open a fuse or circuit breaker, it could also pose a fire hazard. To mitigate hazards, Article 230.95 of the *National Electrical Code* (NEC) states: 277/480V+

"Ground-fault protection of equipment shall be provided for solidly grounded wye electric services of more than 150 volts to ground but not exceeding 1000 volts phase-to-phase for each service disconnect rated 1000 amperes or more."

A common scheme for detecting ground faults is to use a current transformer(s) to monitor current flow through a circuit's phase and neutral conductors, as shown in Figure 1. If the sum of current flow is other than zero, a ground fault is indicated. In that event, the ground fault sensing equipment signals a device to open the circuit to mitigate hazards.



Figure 1: If the amounts of current on the phase and neutral conductors do not sum to zero, the ground fault protection equipment will signal a protection device to open the circuit.





## ARE GENERATORS REQUIRED TO HAVE GFI OR GFP?

### Are generators required to have GFI or GFP?

NEC 2020 - 701.31 Ground-Fault Protection of Equipment.

The alternate source for legally required standby systems shall not be required to provide ground-fault protection of equipment with automatic disconnecting means. Ground-fault indication at the legally required standby source shall be provided in accordance with 701.6 (d) if ground fault protection of equipment with automatic disconnecting means is not provided.

NEC 700.6 (D) (Emergency Systems - Ground Fault).

"To indicate a ground fault in solidly grounded wye emergency systems of more than 150 volts to ground and circuit-protective devices rated 1000 amperes or more. The sensor for the ground-fault signal devices shall be located at, or ahead of, the main system disconnecting means for the emergency source, and the maximum setting of the signal devices shall be for a ground-fault current of 1200 amperes. Instructions on the course of action to be taken in event of indicated ground fault shall be located at or near the sensor location."





### 3 Pole Vs 4 Pole ATS's



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## Grounding and 3 pole vs 4 pole

### **Ground Fault Indication vs Ground Fault Trip**

#### **Emergency Standby Generator Sets**

Emergency (Lv 1 loads) - Ground fault indication ONLY

-You would rather have the breaker melt than trip

Legally required standby - Ground fault protection not required

-The alternate source for Legally required standby systems shall NOT be required to have ground fault protection.

Standby -Ground fault protection not required

-The alternate source for Legally required standby systems shall NOT be required to have ground fault protection.

#### NEC 2020 – 701.31 Ground-Fault Protection of Equipment.

The alternate source for legally required standby systems shall not be required to provide ground-fault protection of equipment with automatic disconnecting means. Ground-fault indication at the legally required standby source shall be provided in accordance with 701.6 (d) if ground fault protection of equipment with automatic disconnecting means is not provided.

#### NEC 2020 -701.6 (d) ground fault.

To indicate a ground fault in solidly grounded wye, legally required standby systems of more than 150 volts to ground and circuit protective devices rated 1000 amperes or more. The sensor for the ground fault signal devices shall be located at, or ahead of, the main system disconnecting means for the legally required standby source, and the maximum setting of the signal devices shall be for a ground fault current of 1200 amperes. Instructions on the course of action to be taken in event of indication ground fault shall be located at or near the sensor location.





### NEC 2017 Changes

#### **NEC Adoption by State**

NEC<sup>®</sup> in Effect 1/1/2020







### NEC 2017 Changes Generator Docking Stations

Code: NEC 700.3F Year 2017

- **N** (F) Temporary Source of Power for Maintenance or Repair of the Alternate Source of Power. If the emergency system relies on a single alternate source of power, which will be disabled for maintenance or repair, the emergency system shall include permanent switching means to connect a portable or temporary alternate source of power, which shall be available for the duration of the maintenance or repair. The permanent switching means to connect a portable or temporary alternate source of power aportable or temporary alternate source of power shall comply with the following:
  - (1) Connection to the portable or temporary alternate source of power shall not require modification of the permanent system wiring.
  - (2) Transfer of power between the normal power source and the emergency power source shall be in accordance with 700.12.
  - (3) The connection point for the portable or temporary alternate source shall be marked with the phase rotation and system bonding requirements.
  - (4) Mechanical or electrical interlocking shall prevent inadvertent interconnection of power sources.

(5) The switching means shall include a contact point that shall annunciate at a location remote from the generator or at another facility monitoring system to indicate that the permanent emergency source is disconnected from the emergency system.

It shall be permissible to utilize manual switching to switch from the permanent source of power to the portable or temporary alternate source of power and to utilize the switching means for connection of a load bank.

Informational Note: There are many possible methods to achieve the requirements of 700.3(F). See Figure 700.3(F) for one example.

Exception: The permanent switching means to connect a portable or temporary alternate source of power, for the duration of the maintenance or repair, shall not be required where any of the following conditions exists:

- (1) All processes that rely on the emergency system source are capable of being disabled during maintenance or repair of the emergency source of power.
- (2) The building or structure is unoccupied and fire suppression systems are fully functional and do not require an alternate power source.
- (3) Other temporary means can be substituted for the emergency system.
- (4) A permanent alternate emergency source, such as, but not limited to, a second on-site standby generator or separate electric utility service connection, capable of supporting the emergency system, exists.





### NEC 2017 Changes **Generator Docking Stations**



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Portable Generator **Docking Station** 



**Triple Switch** 



The requirement of NEC article 700 emergency systems applies to buildings such as:

Hospitals and healthcare facilities, public safety communications, places of large assembly (including hotels, theaters, sports arenas, etc.) and industrial processes where the interruption of power would create serious health hazard





### NEC 2017 Changes Start Circuit Monitoring

#### Code: NEC 700.10 Year 2017

(3) Generator Control Wiring. Control conductors installed between the transfer equipment and the emergency generator shall be kept entirely independent of all other wiring and shall meet the conditions of 700.10(D)(1). The integrity of the generator control wiring shall be continuously monitored. Loss of integrity of the remote start circuit(s) shall initiate visual and audible annunciation of generator malfunction at the generator local and remote annunciator(s) and start the generator(s).

(D) Fire Protection. Emergency systems shall meet the additional requirements in (D)(1) through (D)(3) in the following occupancies:

- (1) Assembly occupancies for not less than 1000 persons
- (2) Buildings above 23 m (75 ft) in height
- (3) Health care occupancies where persons are not capable of self preservation
- (4) Educational occupancies with more than 300 occupants

#### Critical Loads:

-If load failed, could lead to a loss of human life. -Fire pumps, hospital ventilators, life safety loads, etc. -Control Wire Monitored Required

#### Building and Occupancies:

-Buildings larger than 75ft in height -Occupancy more than 1000 -Educational facilities with more than 300 people -Control Wire Monitoring Required







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### Diesel vs. Natural Gas Generators

- Diesel Generators
  - Typically take the edge when it comes to longevity, performance and power
  - Better transient performance and starting load acceptance
  - Better resiliency to high ambient temperature and altitude conditions
  - Provide higher power density
  - Onsite fuel supply

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- Some installations require an onsite fuel source by code in case of unreliable utility
- Less flammable fuel source (compression ignition)
  - No spark plugs, reducing maintenance costs

- Natural Gas Generators
  - Lower emissions, cleaner fuel source
  - Better fuel efficiency and operating costs
  - No concern of wet stacking caused by running under lighter loads
  - No fuel storage or maintenance
  - Run time not restricted to onsite fuel supply
    - LP tanks with liquid or vapor withdrawal can be used to provide onsite fuel supply consider derate
  - Lower operating noise level



### Diesel vs. Natural Gas Generators

#### Cost Comparison

- For generators 150kW and below, diesel and natural gas prices are comparable At these sizes, natural gas is popular choice due to removed fuel maintenance and cost
  - ▶ 125REOZJG (diesel) \$40,183; KG125 (natural gas) \$33,504
- Above that size, the capital cost for natural gas units increases substantially making diesel a more attractive option
  - ▶ 300REOZJ (diesel) \$69,265; 300REZXC (natural gas) \$111,127
- Application Comparison (Emergency Standby)
  - Small kW applications below 150kW, natural gas popular choice due to comparable performance and capital cost, along with cleaner emissions and no fuel maintenance
  - For critical, high kW applications, diesel units are preferred (or may be only) option
    - Performance and response characteristics make diesel the desired choice for hospitals, data centers, manufacturing, heavy industrial
    - As the natural gas engine size increases (and fuel efficiency), the less capable it is to accept transients
      - Rich burn to lean burn combustion process takes longer affecting response time





# Natural Gas or Diesel?

Natural Gas must be deemed reliable by AHJ before supporting Lv 1 loads.

### 2018 City of Columbus

#### EMERGENCY GENERATOR

 Identify the location of the emergency generator. Emergency generator is required to be provided with 1-HR rated construction where there are assembly occupancies of more than 1000 persons, NEC70-Art. 700.12. Provide location of the generator on the plan set.

Natural gas generators may not be used to fulfill requirements for fire pumps (NEC70-Art.695), emergency power (NEC70-Art.700), legally standby power (NEC70-Art.701) due to Columbia Gas will not supply a separate service and meter for standby generators and the Columbus Fire Department requiring shut off of all gas to the site. Due to the inability of a natural gas generator to receive a separate service disqualifies it as a reliable source of power. Replace the natural gas generator with a standby generator that will qualify as reliable power (I.E. diesel or propane fuel sourced generators)

### 2019 City of Columbus

**Memorandum:** In order to prevent someone from inadvertently shutting off the gas supply to an emergency or standby power generator and to assist the gas supplier and fire department personnel in an emergency, designers should consider incorporating the following recommendations in addition to the minimum code requirements, into their designs for natural gas-fueled emergency and standby power systems:

- Locate the generator on the outside of the building, at ground level and be visible from the rightof-way;
- Provide a separate tap designated for the generator with the meter located as close as practical to the generator. Owners should be made aware that a separate tap may affect metering and rates;
- Provide only valves necessary for the proper operation and isolation of the system and all valves on the supply side of the meter should be electronically supervised by a listed fire alarm control panel. Where a fire alarm control panel is not provided, the valves may be locked in the open position;
- Provide signage approved by the Division of Fire and the gas supplier at all valves indicating the existence of the emergency or standby power generator; and
- Paint generator gas supply piping red.





### **Diesel Tanks**







### **Diesel Tanks**

### Design Standards for Storage Tanks

-NFPA 30 -Flammable and Combustible Liquids Code -UL142 **Standard for Steel Aboveground Tanks** for Flammable and Combustible Liquids -UL2085 Standard for **Protected Above Ground Tanks** for

Flammable and Combustible Liquids

### Aboveground Storage Tank Definition

- "Tank." A vessel containing more than 60 gallons (227 L). (OFC 1301:7-7-2)

-Storage Tank. Any vessel having a liquid capacity that exceeds 60 gal (230 L), is intended for fixed installation, and is not used for processing. (NFPA 30)





# Diesel Tanks (Permitting)

A permit shall be applied for to remove, install, abandon, alter or place temporarily out of service any stationary flammable or combustible liquid storage tank or any line or dispensing device connected thereto. OAC 1301:7-7-34(A)(4) (OFC 3401.4) - OAC 1301:7-7-0l(E)(l)(a) (OFC 105.1.1) The permit shall be obtained from the state fire marshal when such permits are not issued by the local fire code official.

#### **Dave Foos Tank Testing Rates**

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0 -1000 Gallons 1001 - 1500 Gallons 1501 - 2000 Gallons Over 2,000 Gallons 3426 gallon \$1350.00 includes the permit, decals
\$1,500.00
\$1750.00
please call for a quote
\$2661.00

#### **Barry Powell Tank Testing Rates**

0-500 Gallons 500+ Gallons

\$1550 \$1700



## Diesel Tank (Clearances)

Depending on the size of the tank and tank type ... distances to buildings property lines and public ways shall be met in accordance with 2011 Ohio Fire Code Chapter 34 and NFP A 30 (2008 edition).

	Minimum Distance (ft)			
Tank Capacity (gal)	From Property Line that Is or Can Be Built Upon, Including the Opposite Side of a Public Way	From Nearest Side of Any Public Way or from Nearest Important Building on the Same Property		
275 or less	5	5		
276 to 750	10	5		
751 to 12,000	15	5		
12,001 to 30,000	20	5		
30,001 to 50,000	30	10		
50,001 to 100,000	50	15		
100,001 to 500,000	80	25		
500,001 to 1,000,000	100	35		
1,000,001 to 2,000,000	135	45		
2,000,001 to 3,000,000	165	55		
3,000,001 or more	175	60		

Table 22.4.1.1(b) Reference Table for Use with Tables 22.4.1.1(a), 22.4.1.3, and 22.4.1.5

For SI units, 1 ft = 0.3 m; 1 gal = 3.8 L.

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Table 22.4.1.1(a) Location of Aboveground Storage Tanks Storing Stable Liquids — Internal Pressure Not to Exceed a Gauge Pressure of 2.5 psi (17 kPa)





## Diesel Tank (Labeling)

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**Placards shall be in accordance with NFPA 704**. Tanks of 100 gallons in capacity or more shall bear a label and placard identifying the material therein. (OAC 3403.5 and OFC 2703.5)

"No smoking" signs shall be posted within 25 feet of outdoor storage, dispensing or open use areas. (OFC 2703.7.1)





# Diesel Tank (Appurtenances)

**2005 Ohio Fire Code** - A Spill container having a capacity of not less than 5 gallons shall be provided for each fill connection



**Overfill prevention shall be provided.** An alarm shall sound at 90% tank capacity when filling and an overfill prevention device shall be capable of stopping the flow of product into the tank at 95% capacity. OAC 1301:7-7-34(D)(2)(v)(h); OFC 3404.2.5.8. EXCEPTION: Tanks of 1,320 gallons or less.







# Diesel Tank (Appurtenances)

Normal vent lines are required to be located 12 feet above the adjacent ground level and shall be unobstructed and outside of any enclosure, such as those tanks utilized as sub-base generator tanks.



**Emergency venting** is required for both the primary tank and the secondary containment / closed diked area.







## **Diesel Tank (Protection)**

The public shall be safeguarded from access to or unauthorized entry to the storage area. The tank can be enclosed in a chain link fence, no less than six (6) feet in height and no less than three (3) feet out from the tank on all sides unless the property has a perimeter security fence to prohibit public access to the storage tank area.



The vehicular barrier protection (bollards, guardrail, bumper posts) shall be located on all sides of the tank subject to vehicle damage. These are required to be no less than three (3) feet from the tank and four (4) foot on center. Minimum height is required to be no less than 36 inches.







# Post Construction: Operational Testing

Diesel:

- ▶ NFPA110.8.4.2\* Diesel generator sets in service shall be exercised at least once monthly, for a minimum of 30 minutes, using one of the following methods:
  - (1) Loading that maintains the minimum exhaust gas temperatures as recommended by the manufacturer
  - (2) Under operating temperature conditions and at not less than 30 percent of the EPS standby nameplate kW rating
- ▶ NFPA110.8.4.2.3\* Diesel-powered EPS installations that do not meet the requirements of 8.4.2 shall be exercised monthly with the available EPSS load and shall be exercised annually with supplemental loads at not less than 50 percent of the EPS nameplate kW rating for 30 continuous minutes and at not less than 75 percent of the EPS nameplate kW rating for 1 continuous hour for

#### Natural Gas:

NFPA110.8.4.2.4 Spark-ignited generator sets shall be exercised at least once a month with the available EPSS load for 30 minutes or until the water temperature and the oil pressure have stabilized.

#### Automatic Transfer Switches:

▶ NFPA110.8.4.3.1\* Where multiple ATSs are used as part of an EPSS, the monthly test initiating ATSs shall be rotated to verify the starting function on each ATS.







# Questions? Comments







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