

mmins ®

Gaseous Generator Set Installation and Case Studies

PowerHour webinar series for consulting engineers Experts you trust. Excellence you count on.

April 28, 2020 2:00pm Eastern Time / 11:00am Pacific Time (1 PDH issued by Cummins Inc.)

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- Earn Professional Development Hours (PDH)

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Meet your panelists

Cummins instructor:



Michael Sanford Technical Marketing Specialist Cummins Inc.

Your local Cummins contacts:

- > AZ, ID, NM, NV: Carl Knapp (carl.knapp@cummins.com)
- > CO, MT, ND, UT, WY: Christopher Scott (<u>christopher.l.scott@cummins.com</u>)
- > CA, WA, OR, AK, HI: Brian Pumphrey (<u>brian.pumphrey@cummins.com</u>)
- > MA, ME, NH, RI, VT: Jim Howard (james.howard@cummins.com)
- > CT, MD, NJ, NY : Charles Attisani (charles.attisani@cummins.com)
- > Northern IL, MI : John Kilinskis (john.a.kilinskis@cummins.com)
- NE, SD, KS: Earnest Glaser (<u>earnest.a.glaser@cummins.com</u>)
- IL, IN, KY, MO: Jeff Yates (jeffrey.yates@cummins.com)
- > IA, MO: Kirby Holden (kirby.holden@cummins.com)

Cummins facilitator:



Chad Hale Technical Marketing Specialist Cummins Inc.

- > DE, MD, MN, ND, OH, PA, WI, WV: Michael Munson (michael.s.munson@cummins.com)
- TX: Scott Thomas (<u>m.scott.thomas@cummins.com</u>)
- > OK, AR: Wes Ruebman (wes.ruebman@cummins.com)
- > LA, MS, AL: Trina Casbon (trina.casbon@cummins.com)
- > TN, GA: Mariano Rojas (mariano.rojas@cummins.com)
- FL: Bob Kelly (<u>robert.kelly@cummins.com</u>)
- > NC, SC, VA: Bill Morris (william.morris@cummins.com)
- Canada: Ian Lindquist (<u>ian.lindquist@cummins.com</u>)

Disclaimer

The views and opinions expressed in this course shall not be considered the official position of any regulatory organization and shall not be considered to be, nor be relied upon as, a Formal Interpretation.

Participants are encouraged to refer to the entire text of all referenced documents. In addition, when it doubt, reach out to the Authority Having Jurisdiction.



Course Objectives

Gaseous Generator Set Installation and Case Studies

The specification and installation of gaseous generator sets continues to grow in North America in both emergency and non-emergency applications. Although the installation requirements differ only minimally from their diesel counterparts, it is important to understand the basics of gaseous generator sets to ensure they are specified appropriately. This course will explore a number of unique installations that feature gaseous generator sets and will highlight the need for gaseous fuel sources in these applications.

After completing this course, participants will be able to:

- List the basic installation requirements of gaseous generator sets.
- Recognize the broad range of capability of gaseous generator sets.
- Describe potential challenges and advantages of gaseous generator set installations.

What are some of the key installation requirements of natural gas generator sets?

Fuel Supply Basics





Fuel Supply Basics

Primary factors impacting gaseous fuel system installations:

1. The gas supplied to the generator set must be of **acceptable quality**.





Fuel Supply Basics

- 1. The gas supplied to the generator set must be of acceptable quality.
- 2. The gas supplied to the generator set must be of **sufficient pressure**.





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- 2. The gas supplied to the generator set must be of sufficient pressure.
- 3. The gas supplied to the generator set must be available in **sufficient volume**.





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Fuel Supply Basics - Quality

Category	Also Known As	BTU
	Pipeline Gas, Standard Gas	High
Conventional	Associated Petroleum Gas (APG)	High
Natural Gas	Flare Gas, Field Gas	High
	Associated-Dissolved Gas (ADG)	High
	Wellhead Gas	High
Unconventional	Coal Bed Methane (CBM)	High
Natural Gas	Coal Mine Methane (CMM)	~Low
	Anaerobic Digester Gas (ADG)	Low
Biogas	Wastewater Treatment Plant Gas	Low
Syngas	Synthesis Gas, Pyrolysis Gas	Very Low
Industrial Gas	Town Gas	Very Low

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Fuel Supply Basics - Quality



Exhaust Emission Data Sheet C150N6 60 Hz Spark Ignited Generator Set EPA Emissions

		Propane (LP)			
	1/4	1/2	3/4	Full	
Performance Data	Standby	Standby	Standby	Standby	
BHP @ 1800 RPM (60 Hz)	72.4	125.7	180.2	240.0	
Fuel Consumption (SCFH)	288.4	438.5	596.3	783.0	
Exhaust Gas Flow (CFM)	538.0	877.0	1176.0	1494.0	
Exhaust Gas Temperature (°F)	1219.0	1298.0	1279.0	1236.0	
Air to Fuel Ratio	21.1	22.1	22.7	23.3	
Exhaust Emission Data					
HC (Total Unburned Hydrocarbons)*	0.36	0.35	0.33	0.45	
NOx (Oxides of Nitrogen as NO ₂)	1.49	1.28	1.38	1.23	
CO (Carbon Monoxide)	3.21	2.46	2.10	2.14	
				All values above are cited	: g/BHP-hr
HC (Total Unburned Hydrocarbons)*	153	163	159	215	
NOx (Oxides of Nitrogen as NO ₂)	212	202	223	194	
CO (Carbon Monoxide)	749	636	556	557	
				All values above are c	ited: ppmv

Test Conditions Test Conditions apply to both Natural Gas and Propane Data is representative of steady-state engine speed (± 25 RPM) with full load (±2%). Pressures, temperatures, and emission rates were stabilized. Natural Gas: Dry gas received from Supplier (1000 BTU/SCF) Fuel Specification: Propane: Meets the requirements for Commercial Grade Propane under the ASTM D1835 Standard Specification for Liquified Gases. Fuel Inlet Temperature: 60 ± 9 °F at flow transmitter 14.73PSIA ± 0.5 PSIA at Flow Transmitter Fuel Pressure: Air Inlet Temperature: 77 ± 9 °F Barometric Pressure: 22.92 ± 1 in. Hg NOx measurement corrected to 75 grains H2O/lb (10.7 g/kg) of dry air Humidity:

The NOX, HC, CO and PM emission data tabulated here are representative of test data taken from a single engine under the test conditions shown above. These data are subjected to instrumentation and engine-to-engine variability. Field emission test data are not guaranteed to these levels. Actual field test results may vary due to test site conditions, installation, fuel specification, test procedures and instrumentation. Engine operation with excessive air intake or exhaust restriction beyond published maximum limits, or with improper maintenance, may results in elevated emission levels.

Fuel Supply Basics - Quality



Exhaust Emission Data Sheet C150N6 60 Hz Spark Ignited Generator Set EPA Emissions

Propane (LP)

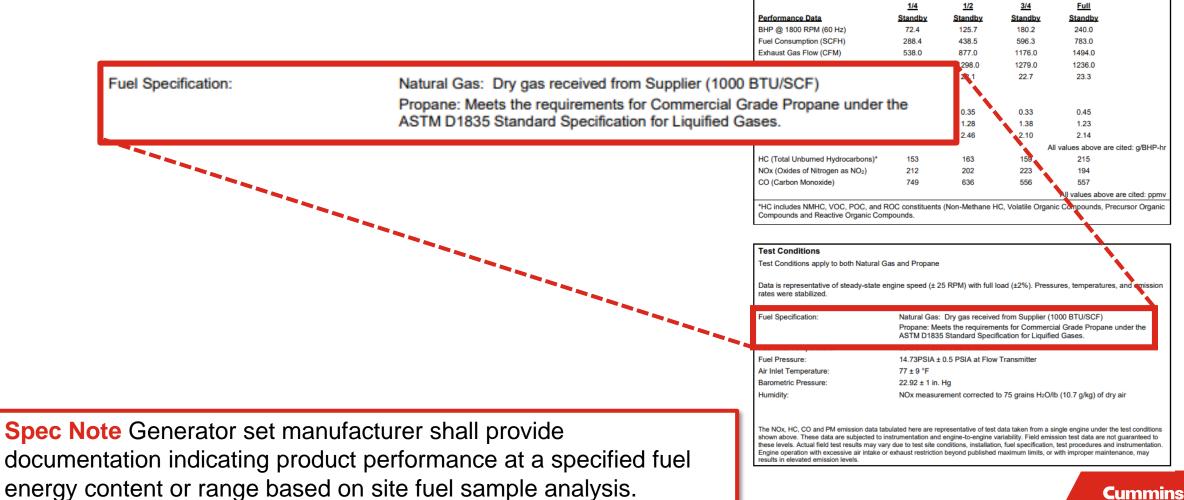
			Propane (LP)			
		Performance Data	<u>1/4</u> Standby	<u>1/2</u> Standby	<u>3/4</u> Standby	Full Standby
		BHP @ 1800 RPM (60 Hz)	72.4	125.7	180.2	240.0
		Fuel Consumption (SCFH) Exhaust Gas Flow (CFM)	288.4 538.0	438.5 877.0	596.3 1176.0	783.0 1494.0
		Exhaust Gas Flow (CFM)	538.0	298.0	1279.0	1236.0
uel Specification:	Natural Gas: Dry gas received from Supp Propane: Meets the requirements for Com	-	or the	290.0	22.7	23.3
			ertne	0.35	0.33	0.45
	ASTM D1835 Standard Specification for L	iquified Gases.		1.28	1.38	1.23
				2.46	2.10	2.14
						All values above are cited: g
		HC (Total Unburned Hydrocarbons	s)* 153	163	159	215
		NOx (Oxides of Nitrogen as NO ₂)	212	202	223	194
		CO (Carbon Monoxide)	749	636	556	557
						All values above are cite
		*HC includes NMHC, VOC, POC, Compounds and Reactive Organic		ts (Non-Methane	HC, Volatile Orga	nic Compounds, Precursor
		Test Conditions				
		Test Conditions apply to both Natu	ral Gas and Propan	е		
		Data is representative of steady-st rates were stabilized.	ate engine speed (±	25 RPM) with full	load (±2%). Pres	sures, temperatures, and e
		Fuel Specification:	Natural Cor	s: Dry gas receive	d from Supplier ((1000 BTU/SCE)
		Fuel Specification.				cial Grade Propane under th
				35 Standard Spec		
		Fuel Pressure:	14.73PSIA	± 0.5 PSIA at Flo	w Transmitter	
		Air Inlet Temperature:	77 ± 9 °F			
		Barometric Pressure:	22.92 ± 1 in	n. Hg		
		Humidity:	NOx measu	urement corrected	to 75 grains H ₂ O	/lb (10.7 g/kg) of dry air
		The NOx, HC, CO and PM emission di shown above. These data are subjecte these levels. Actual field test results m Engine operation with excessive air int results in elevated emission levels.	d to instrumentation an ay vary due to test site	d engine-to-engine conditions, installati	variability. Field em on, fuel specificatio	ission test data are not guarant n, test procedures and instrume
			ake or exhaust restricti	on beyona publishe	a maximum iimits, o	er with improper maintena

Fuel Supply Basics - Quality



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Propane (LP)



Fuel Supply Basics - Quality

Methane Index Number (MN)

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 - Lower MN may be more likely to auto-ignite (knock) and may require power derate and/or timing changes.

Methane number capability

Load	(perce	nt of ra	ted)
100%	90%	75%	50%
72	66	57	42

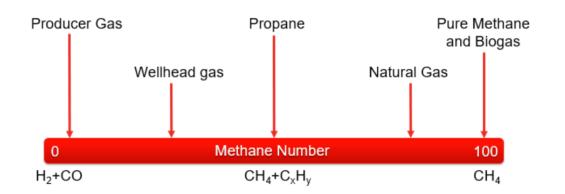
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2000 kW Standby						cum
Model:	C2000 N6E	3				
Frequency:	60 Hz					
Fuel Type:	Natural Gas MI 65+					
Emissions NOx:	1.0 g/bhp-l	hr				
LT Water Inlet Temp:	40 °C (104	°F)				
HT Water Outlet Temp:	92 °C (197	°F)				
Measured sound performance	data shoot:	MSP-306	2			
Prototype test summary data:	uata sileet.	PTS-620	-			
Remote radiator cooling outlin	e:	A057J58				
Fuel Consumption (ISC	3046/1)	See Note	100% of rated load	90% of rated load	75% of rated load	50% of rated loa
Fuel consumption (LHV) ISO304 kW (MMBTU/hr)	3/1,	2,4,6,7	5358 (18.3)	4876 (16.65)	4149 (14.17)	2958 (10
Mechanical efficiency ISO3046/1	, percent	2,4,7	39.8%	39.4%	38.6%	36.1%
Electrical efficiency ISO3046/1, p	ercent	2,4,6,7	38.3%	37.8%	37.1%	34.6%
Engine manufacturer Engine model Configuration Displacement, L (cu.in)		Cummin: QSV91-0 V18 91.6 (555	à4			
Aspiration		Turbocha				
Gross engine power output, kWn	1 (hp)	2113 (28	33)			
BMEP, bar (psi)		18.3 (265	5)			
Bore, mm (in)		180 (7.0				
Stroke, mm (in)		200 (7.8)	7)			
		1514				
Rated speed, rpm		10 (1968)			
Piston speed, m/s (ft/min)		-				
Piston speed, m/s (ft/min) Compression ratio		582 (615				
Piston speed, m/s (ft/min) Compression ratio Lube oil capacity, L (qt)		582 (615 1800)			
Piston speed, m/s (ft/min) Compression ratio		582 (615 1800 N/A)			
Piston speed, m/s (ft/min) Compression ratio Lube oil capacity, L (qt) Overspeed limit, rpm	on,	1800)			
Piston speed, m/s (It/min) Compression ratio Lube oil capacity, L (qt) Overspeed limit, rpm Regenerative power, kW Full load lubricating oil consumpt g/kWe-hr (g/tp-hr) Fuel		1800 N/A 0.4 (0.3)				
Piston speed, m/s (ft/min) Compression ratio Lube oil capacity, L (qt) Overspeed limit, rpm Regenerative power, kW Full load lubricating oil consumpt gkWe-hr (g/tp-hr)		1800 N/A				

Spec Note Generator set manufacturer shall provide documentation indicating product performance at a specified Methane Number or range based on site fuel sample analysis.

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	Generator Set Data Sh 2000 kW Standby	Th.			
	Frequency: 6 Fuel Type: N Emissions NOx: 1	C2000 N6E 50 Hz Natural Ga I.0 g/bhp-I I0 ℃ (104 92 ℃ (197	as MI65+ hr °F)		
	Measured sound performance data	a sheet:	MSP-3063		
	Prototype test summary date:		DTC 620		
Fuel				50% of rated load	
Minimum gas supply pressure at DM	/IV, bar (psi) ⁷	0.	.24 (3.5)	2958 (10.1) 36.1%	
Min methane index		6	5	34.6%	
	composition				
	Displacement, L (cu.in)		91.6 (5591)		
	Aspiration		Turbocharged (4)		
	Gross engine power output, kWm (hp	p)	2113 (2833)		
	BMEP, bar (psi)		18.3 (265)		
	Bore, mm (in)		180 (7.09)		
	Stroke, mm (in)		200 (7.87)		
	Rated speed, rpm Piston speed, m/s (ft/min)		1514 10 (1968)		
	Compression ratio		11.4:1		
	Lube oil capacity, L (qt)		582 (615)		
	Overspeed limit, rpm		1800		
	Regenerative power, kW		N/A		
	Full load lubricating oil consumption,		0.4 (0.3)		
	Fuel Minimum gas supply pressure at DM	V her (eci)7	0.24 (3.5)		
		v, bai (psi)	65		
	Min methane index				
	Min methane index				

Spec Note Generator set manufacturer shall provide documentation indicating product performance at a specified Methane Number or range based on site fuel sample analysis.

Gaseous Generator Sets Fuel Supply Basics - Pressure

- Pressure and volume must be available at RATED load.
- Be aware of fuel system pressure drop.
- Booster may be installed to raise pressure, if needed.
- Consult generator set manufacturer for specific fuel system requirements.

Fuel system

Gas supply pressure to engine inlet, bar (psi) ⁸	0.2 (2.9)
Minimum methane index	62



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Gas supply pressure to engine inlet, bar (psi) ⁸	0.2 (2.9)
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Related Content	Gaseous Fuel System Sizing T-030: Liquid-Cooled Generator Set
	Application Manual T-035: Gas Power Plant Application Manual

Spec Note Generator set manufacturer shall provide documentation indicating minimum fuel pressure at engine inlet at rated load.

Fuel Supply Basics – Volume

Model: Frequency: Fuel type: kW rating:	C150N6 60 Hz Natural gas 150 Natural g	jas star	ndby					
Emissions level:	EPA Emissio	ns						
	Natural g Standby	jas			Propane Standby			
Fuel consumption	kW (kVA)			kW (kVA)		
Ratings	150 (188				150 (188)			
Load	1/4	1/2	3/4	Full	1/4	1/2	3/4	Full
scfh	718.7	1111.3	1487.2	1915.0	288.4	438.5	596.3	783.0
m³/ħr	20.35	31.47	42.12	54.3	8.17	12.42	16.89	22.2
Engine Engine model Configuration		1	Natural gas Propane Standby Rating Standby Rating QSJ8.9G Cast Iron, In line, 6 cylinders					
Aspiration			Furbocharg					
Gross engine power output, kWr	m (bhp)	1	79 (240)					
Bore, mm (in)		1	14.1 (4.49)				
Stroke, mm (in)		1	44.5 (5.69))				
Rated speed, rpm		1	1800					
Compression ratio			9.7:1					
Lube oil capacity, L (qt)		2	20.8 (22)					
Fuel supply pressure	Pa (in H2O)	1	.5 (6)					
Maximum operating pressure, ki			3.5 (13)					
Air			Natural gas			Propane		
Combustion air, m ³ /min (scfm)			3.7 (483)			13.9 (49		
Maximum normal duty air cleane	er restriction, kPa (in I		0.37 (1.5)				-	
	r restriction, kPa (in H	-	3.7 (15.0)					



C2000 N6B 60 Hz

Model

Frequency



HT Water Outlet Temp: 92 °C (197	°F)								
Measured sound performance data sheet:	MSP-30	53							
Prototype test summary data:	PTS-620								
Remote radiator cooling outline:	A057J58	9							
Fuel Consumption (ISO3046/1)	See Note	100% of rated load	90% of rated load	75% of rated load	50% of rated load				
Fuel consumption (LHV) ISO3046/1, kW (MMBTU/hr)	2,4,6,7	5358 (18.3)	4876 (16.65)	4149 (14.17)	2958 (10.1)				
Mechanical efficiency ISO3046/1, percent	2,4,7	39.8%	39.4%	38.6%	36.1%				
Electrical efficiency ISO3046/1, percent	2,4,6,7	38.3%	37.8%	37.1%	34.6%				
Engine									
Engine manufacturer	Cummins								
Engine model	QSV91-G4								
Configuration	V18								
Displacement, L (cu.in)	91.6 (5591)								
Aspiration	Turbocharged (4)								
Gross engine power output, kWm (hp)	2113 (2833)								
BMEP, bar (psi)	18.3 (265)								
Bore, mm (in)	180 (7.09)								
Stroke, mm (in)	200 (7.87)								
Rated speed, rpm	1514								
Piston speed, m/s (ft/min)	10 (1968)								
Compression ratio	11.4:1								
Lube oil capacity, L (qt)	582 (615)								
Overspeed limit, rpm	1800								
Regenerative power, kW	N/A								
Full load lubricating oil consumption, g/kWe-hr (g/hp-hr)	0.4 (0.3)								
Fuel									
Minimum gas supply pressure at DMV, bar (psi)7	0.24 (3.5	i)							
Min methane index	65								

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Fuel Supply Basics – Volume

				Generate	or Set Data	Sheet							cu	numins
				Model: Frequer Fuel typ kW ratir	e:			gas sta	ndby					
				Emissio	ons level:		Emissic				Propane	,		_
		_					Standby				Standby	,		
				Fuel col Ratings	nsumption		kW (kVA 150 (188				kW (kVA 150 (188			
				Load			1/4	1/2	3/4	Full	1/4	1/2	3/4	Full
				scfh			718.7	1111.3	1487.2	1915.0	288.4	438.5	596.3	783.0
				m³/hr			20.35	31.47	42.12	54.3	8.17	12.42	16.89	22.2
				Engine					Natural gas Standby R			Propane Standby		j
				Engine mod					QSJ8.9G	line C	Indore			
and the second s				Engine mod Configuratio Aspiration					QSJ8.9G Cast Iron, Ir Turbocharg					1
				Configuratio Aspiration		kWm (bhp)			Cast Iron, Ir Turbocharg 179 (240)	ed and afte				
				Configuratio Aspiration Gross engi Bore, mm (ii	on ine power output, in)	kWm (bhp)			Cast Iron, Ir Turbocharg 179 (240) 114.1 (4.49	ed and afte				
				Configuratio Aspiration Gross engi	on ine power output, in) (in)				Cast Iron, Ir Turbocharg 179 (240)	ed and afte				
	Natural g	jas		Configuratio Aspiration Gross engi Bore, mm (ii	on ine power output, in)				Cast Iron, Ir Turbocharg 179 (240) 114.1 (4.49	ed and afte			/	
	Natural of Standby	•		Configuratio Aspiration Gross engi Bore, mm (ii	on ine power output, in) (in)				Cast Iron, Ir Turbocharg 179 (240) 114.1 (4.49	ed and afte				
uel consumption				Configuratio Aspiration Gross engi Bore, mm (ii	nn ine power output, in) (in) Propane				Cast Iron, Ir Turbocharg 179 (240) 114.1 (4.49	ed and afte				
	Standby	x)		Configuratio Aspiration Gross engi Bore, mm (ii	ine power output, in) (in) Propane Standby)			Cast Iron, Ir Turbocharg 179 (240) 114.1 (4.49	ed and afte				
atings	Standby kW (kVA	x)	3/4	Configuratio Aspiration Gross engi Bore, mm (ii	ne power output, in) (in) Propane Standby kW (kVA))	3		Cast Iron, Ir Turbocharg 179 (240) 114.1 (4.49	ed and afte				
Euel consumption atings had	Standby kW (kVA 150 (188	x) 3)	3/4 1487.2	Configuratio Aspiration Gross engi Bore, mm (i Stroke, mm	nn power output, n) (in) Propane Standby kW (kVA) 150 (188))			Cast Iron, Ir Turbocharg 179 (240) 114.1 (4.49 144.5 (5.69	ed and afte		Propana		<i>;</i>
atings ad fh	Standby kW (kVA 150 (188 1/4 718.7	N) 1/2 1111.3	1487.2	Configuratio Aspiration Gross engi Bore, mm (i Stroke, mm	nn power output, n) (n) Propane Standby kW (kVA) 150 (188) 1/4 288.4	1/2 438.5	59	/4	Cast Iron, Ir Turbocharg 179 (240) 114.1 (4.49 144.5 (5.69 Full 783.0	ed and afte		Propane Standby	y Rating	
atings pad	Standby kW (kVA 150 (188 1/4	N) 1/2		Configuratio Aspiration Gross engi Bore, mm (i Stroke, mm	nne power output, nn) (m) Propane Standby kW (kVA) 150 (188) 1/4) 1/2	59	/4	Cast Iron, Ir Turbocharg 179 (240) 114.1 (4.49 144.5 (5.69	ed and afte			y Rating	

2000 kW Standby

Generator Set Data Sheet

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Model C2000 N6B Frequency 60 Hz Fuel Type: Natural Gas MI 65+ 1.0 a/bhp-hr Emissions NOx: LT Water Inlet Temp: 40 °C (104 °F) HT Water Outlet Temp: 92 °C (197 °F)

Measured sound performance data sheet:	MSP-30	63							
Prototype test summary data:	PTS-620)							
Remote radiator cooling outline:	A057J5	39							
Fuel Consumption (ISO3046/1)	See Note	100% of rated load	90% of rated load	75% of rated load	50% of rated load				
Fuel consumption (LHV) ISO3046/1, kW (MMBTU/hr)	2,4,6,7	5358 (18.3)	4876 (16.65)	4149 (14.17)	2958 (10.1				
Mechanical efficiency ISO3046/1, percent	2,4,7	39.8%	39.4%	38.6%	36.1%				
Electrical efficiency ISO3046/1, percent	2,4,6,7	38.3%	37.8%	37.1%	34.6%				
Engine									
Engine manufacturer	Cummin	s							
Engine model	QSV91-G4								
Configuration	V18								
Displacement, L (cu.in)	91.6 (55	91)							
Aspiration	Turbocharged (4)								
Gross engine power output, kWm (hp)	2113 (28	333)							
BMEP, bar (psi)	18.3 (26	5)							
Bore, mm (in)	180 (7.0	9)							
Stroke, mm (in)	200 (7.8	7)							
Rated speed, rpm	1514								
Piston speed, m/s (ft/min)	10 (1968	10 (1968)							
Compression ratio	11.4:1								
Lube oil capacity, L (qt)	582 (615	5)							
Overspeed limit, rpm	1800								
Regenerative power, kW	N/A								
Full load lubricating oil consumption, g/kWe-hr (g/hp-hr)	0.4 (0.3)								
Fuel									
Minimum gas supply pressure at DMV, bar (psi)7	0.24 (3.5	5)							
Min methane index	65								

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Fuel consumption

Ratings Load scfh m³/hr

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Fuel Supply Basics – Volume

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Fuel consumption

Ratings Load scfh m³/hr

			Model: Frequer Fuel typ kW ratir Emissio	e:				ndby					
			Fuel co	nsumption		Natural g Standby kW (kVA)				Propane Standby kW (kVA)		
			Ratings Load			150 (188) 1/4	1/2	3/4	Full	150 (188) 1/4	1/2	3/4	Full
			scfh			1/4 718.7	1/2	3/4	Full 1915.0	1/4 288.4	438.5	3/4 596.3	Full 783.0
								-		-			
			m³/hr			20.35	31.47	42.12 Natural gas	54.3	8.17	12.42 Propane	16.89	22.2
			Engine Engine mod Configuration Aspiration	ne power output, n)	kWm (bhp)	20.35			ating line, 6 cyl ed and afte	inders			22.2
Natural Standby			Engine mod Configuratio Aspiration Gross engin Bore, mm (ii	ne power output, n)	kWm (bhp)	20.35		Natural gas Standby Ra QSJ8.9G Cast Iron, Ir Turbocharg 179 (240) 114.1 (4.49)	ating line, 6 cyl ed and afte	inders	Propane		22.2
Standby			Engine mod Configuratio Aspiration Gross engin Bore, mm (ii	nn ne power output, n) (in) Propane		20.35		Natural gas Standby Ra QSJ8.9G Cast Iron, Ir Turbocharg 179 (240) 114.1 (4.49)	ating line, 6 cyl ed and afte	inders	Propane		22.2
	.)		Engine mod Configuratio Aspiration Gross engin Bore, mm (ii	nn power output, n) (in) Propane Standby)	20.35		Natural gas Standby Ra QSJ8.9G Cast Iron, Ir Turbocharg 179 (240) 114.1 (4.49)	ating line, 6 cyl ed and afte	inders	Propane		22.2
Standby kW (kV)	.)	3/4	Engine mod Configuratio Aspiration Gross engin Bore, mm (ii	nn ne power output, n) (in) Propane Standby kW (kVA))	20.35		Natural gas Standby Ra QSJ8.9G Cast Iron, Ir Turbocharg 179 (240) 114.1 (4.49)	ating line, 6 cyl ed and afte	inders	Propane		22.2
Standby (W (kV))	<u>3/4</u> 1487.2	Engine Engine mod Configuratio Aspiration Gross engi Bore, mm (i Stroke. mm	in power output, in) Propane Standby kW (kVA) 150 (188))		4	Natural gas Standby Ri DSJ8.9G Cast Iron, Ir Turbocharg 179 (240) 114.1 (4.49) 144.5 (5.69)	ating line, 6 cyl ed and afte	inders	Propane	e Rating	22.2

2000 kW Standby	
Model:	C2000 N6B
Frequency:	60 Hz
Fuel Type:	Natural Gas MI 65+
Emissions NOx:	1.0 g/bhp-hr
LT Water Inlet Temp:	40 °C (104 °F)
HT Water Outlet Temp:	92 °C (197 °F)

Generator Set Data Sheet

Measured sound performance data sheet:	MSP-30	63						
Prototype test summary data:	PTS-620)						
Remote radiator cooling outline:	A057J589							
Fuel Consumption (ISO3046/1)	See Note	100% of rated load	90% of rated load	75% of rated load	50% of rated load			
Fuel consumption (LHV) ISO3046/1, kW (MMBTU/hr)	2,4,6,7	5358 (18.3)	4876 (16.65)	4149 (14.17)	2958 (10.1)			
Mechanical efficiency ISO3046/1, percent	2,4,7	39.8%	39.4%	38.6%	36.1%			
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Engine manufacturer	Cummin	s						
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Aspiration	Turboch	arged (4)						
Gross engine power output, kWm (hp)	2113 (28	333)						
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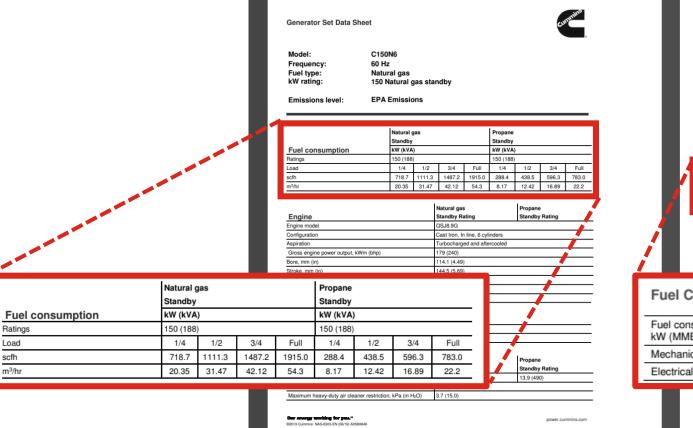
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Fuel Supply Basics – Volume



2000 kW Standby	Sheet					cummin	l I.		
Model:	C2000 N6B								
Frequency:	60 Hz								
Fuel Type:	Natural Gas								
Emissions NOx:	1.0 g/bhp-hr								
LT Water Inlet Temp:	40 °C (104 °F								
HT Water Outlet Temp:	: 92 °C (197 °F	.)							
		MSP-3063					-		
Measured sound performance Prototype test summary data:		MSP-3063 PTS-620	-				-		
Remote radiator cooling outlin		A057J589					-		
Fuel Consumption (ISC	03046/1) s	See Note	100% of rated load	90% of rated load	75% of rated load	50% of			
Fuel consumption (LHV) ISO304 kW (MMBTU/hr)		Note 2,4,6,7	5358 (18.3)	4876 (16.65)	4149 (14.17)	rated load 2958 (10.1)			
Mechanical efficiency ISO3046/1	1, percent 2	2,4,7	39.8%	39.4%	38.6%	36.1%	· 📕		
Electrical efficiency ISO3046/1,	percent 2.	2,4,6,7	38.3%	37.8%	37.1%	34.6%			
Engine manufacturer	10	Cummins					-		
Engine model	-	QSV91-G					-		
Configuration		V18					-		
	9	91.6 (559)	1)				-		
Displacement, L (cu.in)	т	Turbochar	rged (4)				-		
Displacement, L (cu.in) Aspiration			22)						
		2113 (283	33)						

Fuel Consumption (ISO3046/1)	See Note	100% of rated load	90% of rated load	75% of rated load	50% of rated load
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Spec Note Generator set manufacturer shall provide documentation indicating maximum fuel consumption at rated load.

Load

scfh

Concept Check

Three key factors impacting gaseous generator set installation include:

- a) Gas Supply Pressure
- b) Gas Supply Volume
- c) Gas Supply Quality
- d) All of the Above

Concept Check

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- a) Gas Supply Pressure
- b) Gas Supply Volume
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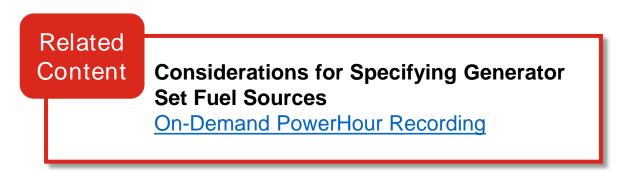
Installation Considerations

- Natural gas is available through extensive and reliable pipeline network.
- Natural gas pipeline avoids fuel transportation, handling and storage issues associated with on-site fuel storage.
 - No fuel tank cleaning required.
 - Limited degradation of fuel over time.
 - No requirement for regular fuel testing.
- Can be easily backed-up with on-site fuel storage (LNG or LPG).



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Compliance and Reliability

NFPA 110-2019

5.1.1 The following energy sources shall be permitted to be used for the emergency power supply (EPS):

- (1) Liquid petroleum products...
- (2) Liquified petroleum gas...
- (3) Natural or synthetic gas

Compliance and Reliability

NFPA 110-2019

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Exception: For Level 1 installations in locations where the probability of interruption of off-site fuel supplies is high, on-site storage of an alternate energy source sufficient to allow full output of the EPSS to be delivered for the class specified shall be required, with the provision for automatic transfer from the primary energy source to the alternate energy source.

Compliance and Reliability

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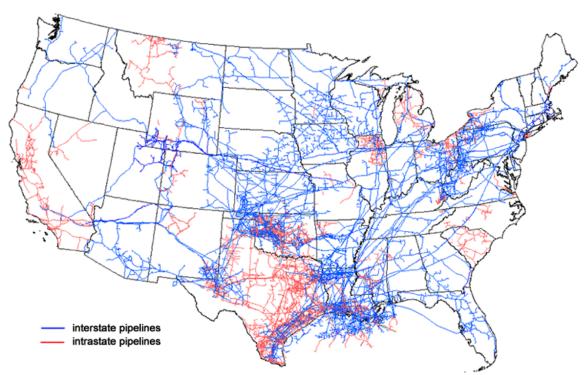
Natural Gas Council

Natural gas is a secure, reliable and resilient choice for customers

- Operational reliability
 - 2017 survey of 51 interstate pipelines 99.97% of contractual commitments
 - Geographic dispersion of production reduces vulnerability to local weather
 - Transportation network interconnected, offering multiple pathways for rerouting
- Contractual continuity of service
 - Firm or interruptible contracts

Compliance and Reliability

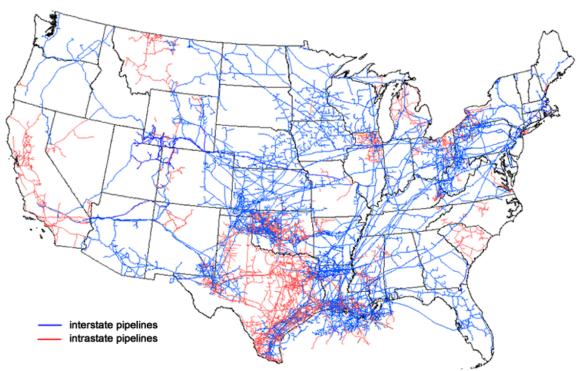
Map of U.S. interstate and intrastate natural gas pipelines



Source: U.S. Energy Information Administration, About U.S. Natural Gas Pipelines

Compliance and Reliability

Map of U.S. interstate and intrastate natural gas pipelines



Source: U.S. Energy Information Administration, About U.S. Natural Gas Pipelines

Spec Note Specify natural-gas fueled generator sets for emergency power systems where permitted by the local Authority Having Jurisdiction.

Applications and Capability

















Installation Review

Application: Standby and Demand Response

Segment: Wastewater Treatment Plant

Location: Wisconsin, US

Key Acceptance Criteria

- 1500 kWe Installed Capacity
- Extended Run Time with Limited On-Site Storage Capacity
- NFPA 110 Type 10 Starting
- 100% Nameplate Load Acceptance

Installation Review

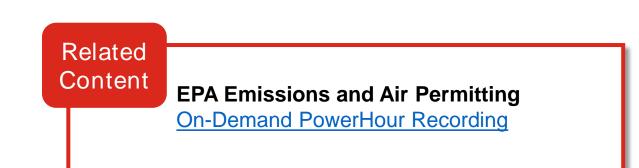
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EPA Certified stationary non-emergency. Capable of extended grid paralleling.

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Related Content Paralleling Power System Design and System Level Control On-Demand PowerHour Recording

EPA Certified stationary non-emergency. Capable of extended grid paralleling.

Large single generator set or multiple paralleled units.

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Large single generator set or multiple paralleled units.

On-site fuel storage limits usage of diesel generator sets.

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Related

Content

- NFPA 110 Type 10 Starting
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On-site fuel storage limits usage of diesel generator sets.

Challenging for some sparkignited engines.

NFPA 110 Type 10 Requirements for Emergency Power Systems On-Demand PowerHour Recording

Installation Review

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100% Nameplate Load Acceptance

Content An Introduction to Generator Set Sizing Software

On-Demand PowerHour Recording

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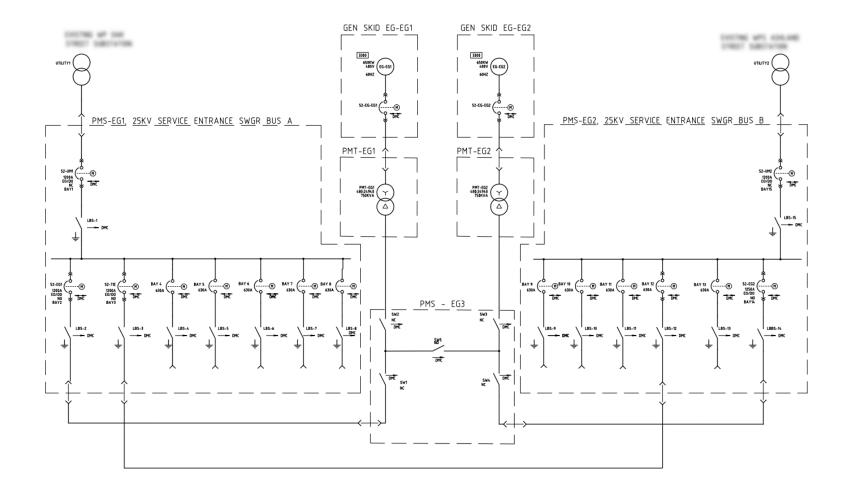
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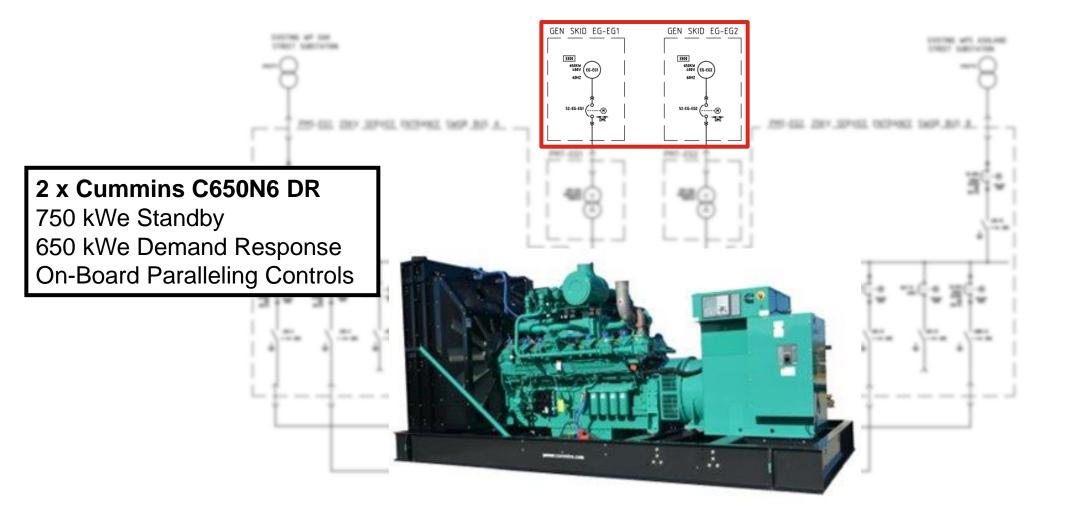
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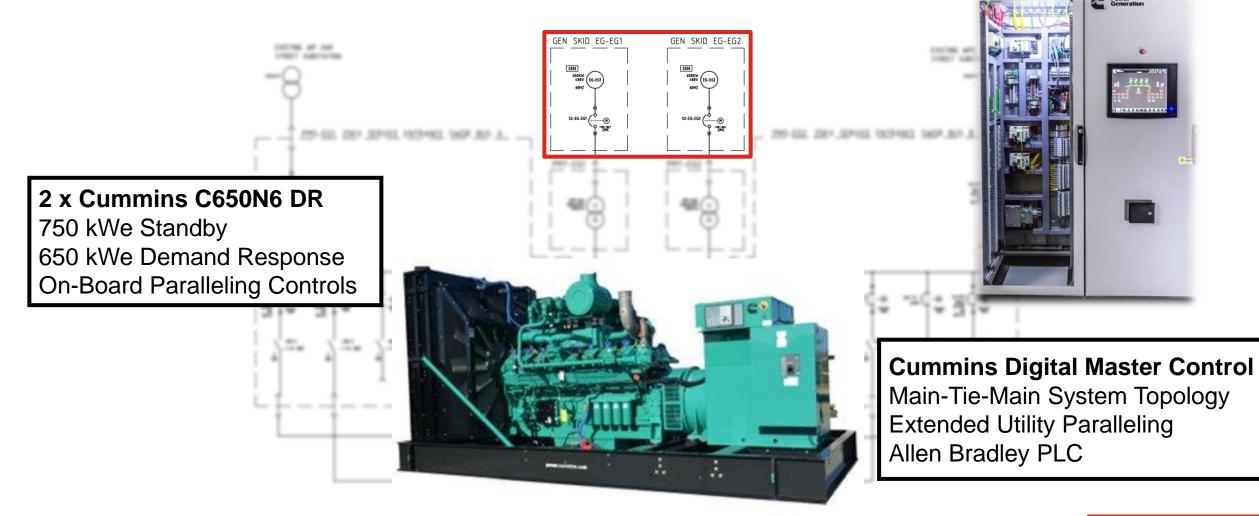
Installation Review



Installation Review



Installation Review



Installation Review

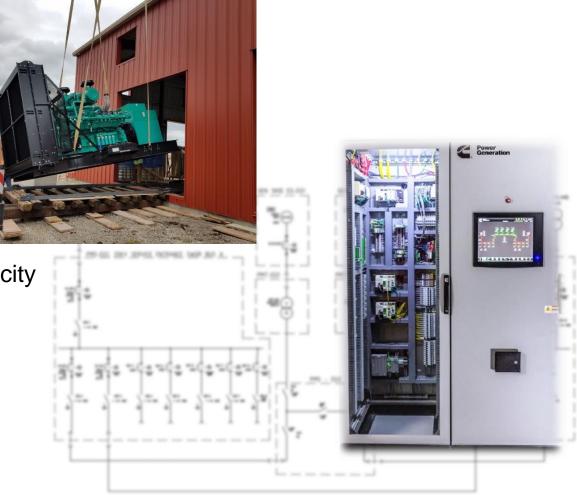
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Installation Review

Application: Standby and Hurricane Relief

Segment: Medical Center (763 Licensed Beds)

Location: Louisiana, US

Key Acceptance Criteria

- NFPA 110 Type 10 Starting for Life Safety Loads
- Extended Run Time (>24 Hours)
- Operational Flexibility

Installation Review

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Key Acceptance Criteria

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High operating cost to power optional loads throughout extended outage.

Related Content Considerations for Specifying Generator Set Fuel Sources On-Demand PowerHour Recording

Installation Review

Application: Standby and Hurricane Relief **Segment:** Medical Center (763 Licensed Beds) High operating cost to power optional Location: Louisiana, US loads throughout extended outage. **Key Acceptance Criteria** NFPA 110 Type 10 Starting for Life Safety Loads Extended Run Time (>24 Hours) Operational reliability needs limit reliance on fuel storage and delivery. Operational Flexibility Related Content **Considerations for Specifying Generator Set Fuel Sources On-Demand PowerHour Recording**

Installation Review

Application: Standby and Hurricane Relief

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Related Content

EPA Emissions and Air Permitting On-Demand PowerHour Recording High operating cost to power optional loads throughout extended outage.

Operational reliability needs limit reliance on fuel storage and delivery.

EPA Certified stationary non-emergency. Capable of extended grid paralleling.

Installation Review

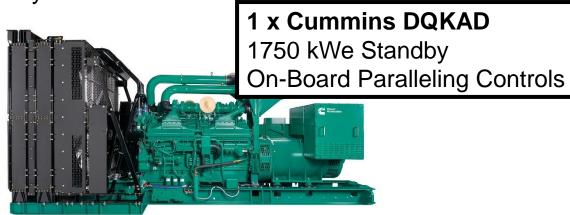
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1 x Cummins DQKAD 1750 kWe Standby On-Board Paralleling Controls **4 x Cummins C1750N6CB** 1750 kWe Continuous On-Board Paralleling Controls



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1 x Cummins DQKAD 1750 kWe Standby On-Board Paralleling Controls **4 x Cummins C1750N6CB** 1750 kWe Continuous On-Board Paralleling Controls



Related Content

Concept Check

When recommending the preferred fuel source for on-site power generation, which of the following project or site requirements should be considered?

- a) NFPA 110 Type requirements (Life Safety loads)
- b) Extended outage operation
- c) Operational flexibility (non-emergency usage)
- d) On-site fuel storage limitations
- e) All of the above

Concept Check

When recommending the preferred fuel source for on-site power generation, which of the following project or site requirements should be considered?

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Course Summary

Gaseous Generator Set Installation and Case Studies

- List the basic installation requirements of gaseous generator sets.
- Recognize the broad range of capability of gaseous generator sets.
- Describe potential challenges and advantages of gaseous generator set installations.

Specify:

- Project performance requirements based on the application limitations (loads, power factor, transient limits, emissions, start-time and other code-driven requirements).
- Gaseous generator sets in emergency and non-emergency applications when appropriate and permitted by the authority having jurisdiction.

Additional Resources

Cummins White Papers

- Understanding EPA NSPS Emissions Regulations for Stationary Spark-ignited Engines
- The Latest Evolution Of Distributed Energy Resources: Opportunity For Business Within The PJM

Cummins PowerHour On-Demand Webinars

- Considerations for Specifying Generator Set Fuel Sources
- Specifying Gaseous Generator Sets
- Lean Burn Natural Gas Generator Sets in Standby-Peak Shaving Applications
- Introduction to Generator Set Sizing Software
- EPA Emissions and Air Permitting

POWER TOPIC 8003 | TECHNICAL INFORMATION FROM CUMMINS POWER GENERATION

UNDERSTANDING EPA NSPS EMISSIONS REGULATIONS FOR STATIONARY SPARK-IGNITED ENGINES

White Paper Cummins Conten

On June 12, 2006, the Environmental Protection Agency (EPA) proposed the New Source Performance Standards (NSPS) to regulate emissions from stationary spark-ignited engines and then finalized these standards on January 18th, 2008. Until the issuance of the SI NSPS, there were no Federal (US) emissions regulations for stationary natural gas or propane engines. Emissions regulations for stationary engines were usually governed by state and local permitting authorities and varied by the annual operating hours for the application.

This paper explains how the EPA NSPS apply to spark-ignited engines used in generator sets.

IMPORTANT EPA DEFINITIONS

Stationary power sources such as diesel, natural gas or propane generator sets are regulated differently than non-road engine/generators such as rental or portable equipment. Additionally, emergency and non-emergency generator sets are regulated differently. Therefore, it is important to know how the EPA distinguishes emergency from non-emergency stationary engines and how the regulations for stationary applications differ from non-road engine regulations.

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Q&A

Please type your questions, comments and feedback in the **Zoom Q&A** window.

After the PowerHour, a complete list of questions and answers will be published on powersuite.cummins.com.



Michael Sanford Technical Marketing Specialist Cummins Inc.

Your local Cummins contacts:

- > AZ, ID, NM, NV: Carl Knapp (<u>carl.knapp@cummins.com</u>)
- > CO, MT, ND, UT, WY: Christopher Scott (<u>christopher.l.scott@cummins.com</u>)
- > CA, WA, OR, AK, HI: Brian Pumphrey (<u>brian.pumphrey@cummins.com</u>)
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- Northern IL, MI : John Kilinskis (john.a.kilinskis@cummins.com)
- NE, SD, KS: Earnest Glaser (<u>earnest.a.glaser@cummins.com</u>)
- IL, IN, KY, MO: Jeff Yates (jeffrey.yates@cummins.com)
- > IA, MO: Kirby Holden (kirby.holden@cummins.com)



Chad Hale Technical Marketing Specialist Cummins Inc.

- > DE, MD, MN, ND, OH, PA, WI, WV: Michael Munson (michael.s.munson@cummins.com)
- > TX: Scott Thomas (m.scott.thomas@cummins.com)
- > OK, AR: Wes Ruebman (wes.ruebman@cummins.com)
- > LA, MS, AL: Trina Casbon (trina.casbon@cummins.com)
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- FL: Bob Kelly (<u>robert.kelly@cummins.com</u>)
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- > AZ, ID, NM, NV: Carl Knapp (carl.knapp@cummins.com)
- > CO, MT, ND, UT, WY: Christopher Scott (<u>christopher.l.scott@cummins.com</u>)
- > CA, WA, OR, AK, HI: Brian Pumphrey (<u>brian.pumphrey@cummins.com</u>)
- > MA, ME, NH, RI, VT: Jim Howard (james.howard@cummins.com)
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- > Northern IL, MI : John Kilinskis (john.a.kilinskis@cummins.com)
- > NE, SD, KS: Earnest Glaser (earnest.a.glaser@cummins.com)
- IL, IN, KY, MO: Jeff Yates (jeffrey.yates@cummins.com)
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- > DE, MD, MN, ND, OH, PA, WI, WV: Michael Munson (michael.s.munson@cummins.com)
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- > OK, AR: Wes Ruebman (wes.ruebman@cummins.com)
- > LA, MS, AL: Trina Casbon (trina.casbon@cummins.com)
- > TN, GA: Mariano Rojas (mariano.rojas@cummins.com)
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- NC, SC, VA: Bill Morris (<u>william.morris@cummins.com</u>)
- Canada: Ian Lindquist (<u>ian.lindquist@cummins.com</u>)

Closing

Watch out for a follow-up email including:

- A link to the webinar recording and copy of the presentation
- A certificate issuing one professional development hour (1 PDH)

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- Considerations for Specifying Generator Set Fuel Sources, May 20
- The Role of a System Level Control in a Power System, May 21
- Ensuring Power System Reliability through Service Specifications, June

Please contact Michael Sanford if you have any questions related to the PowerHour webinar (<u>michael.sanford@cummins.com</u>)

