CPSC Staff Recommendations on Revisions to UL 2201

UL 2201 Task Group Teleconference
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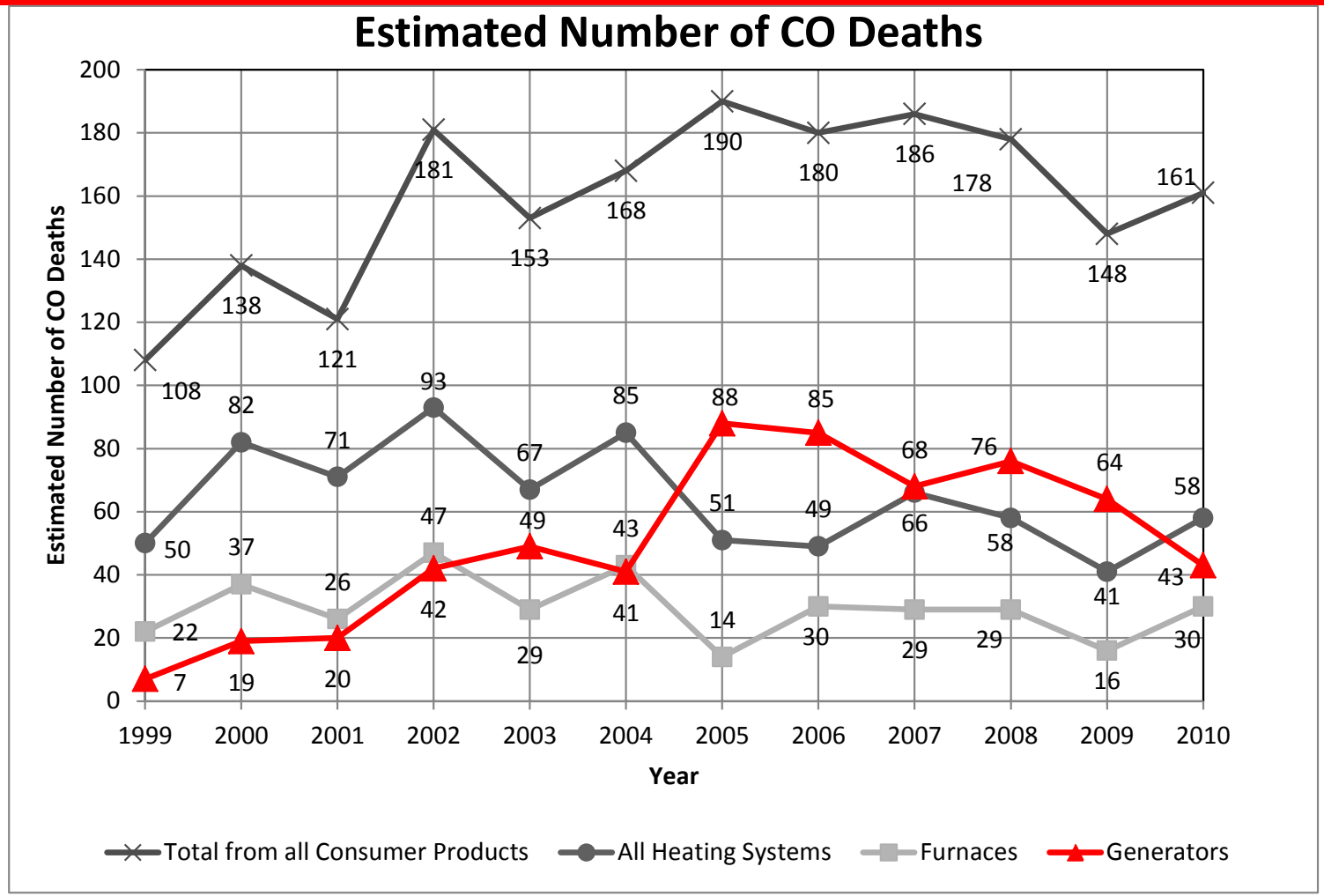
Staff Rationale and Recommendations for UL 2201

- **Epidemiology data**
- **CO emission reduction strategy**
  - Performance requirement that sets a limit on the generator's CO emission rate when the O_2 in the intake air drops below ambient (20.9%). (It also applies when the O_2 is at ambient [outside].)
  - Test method to verify CO emission rate is met.
- **Shutoff strategy**
  - Performance requirement that sets a limit on total amount of CO that can be released when generator is operated in enclosed space to prevent creation of unsafe exposure; if TG wants to pursue, need to define test method for this, as well as test methods that ensure system is tamperproof, durable, and serves as interlock if not functioning.
  - Performance requirement that sets a limit on the generator's CO emission rate when operating continuously at ambient (20.9%) O_2.

Why CPSC is Concerned About Generators

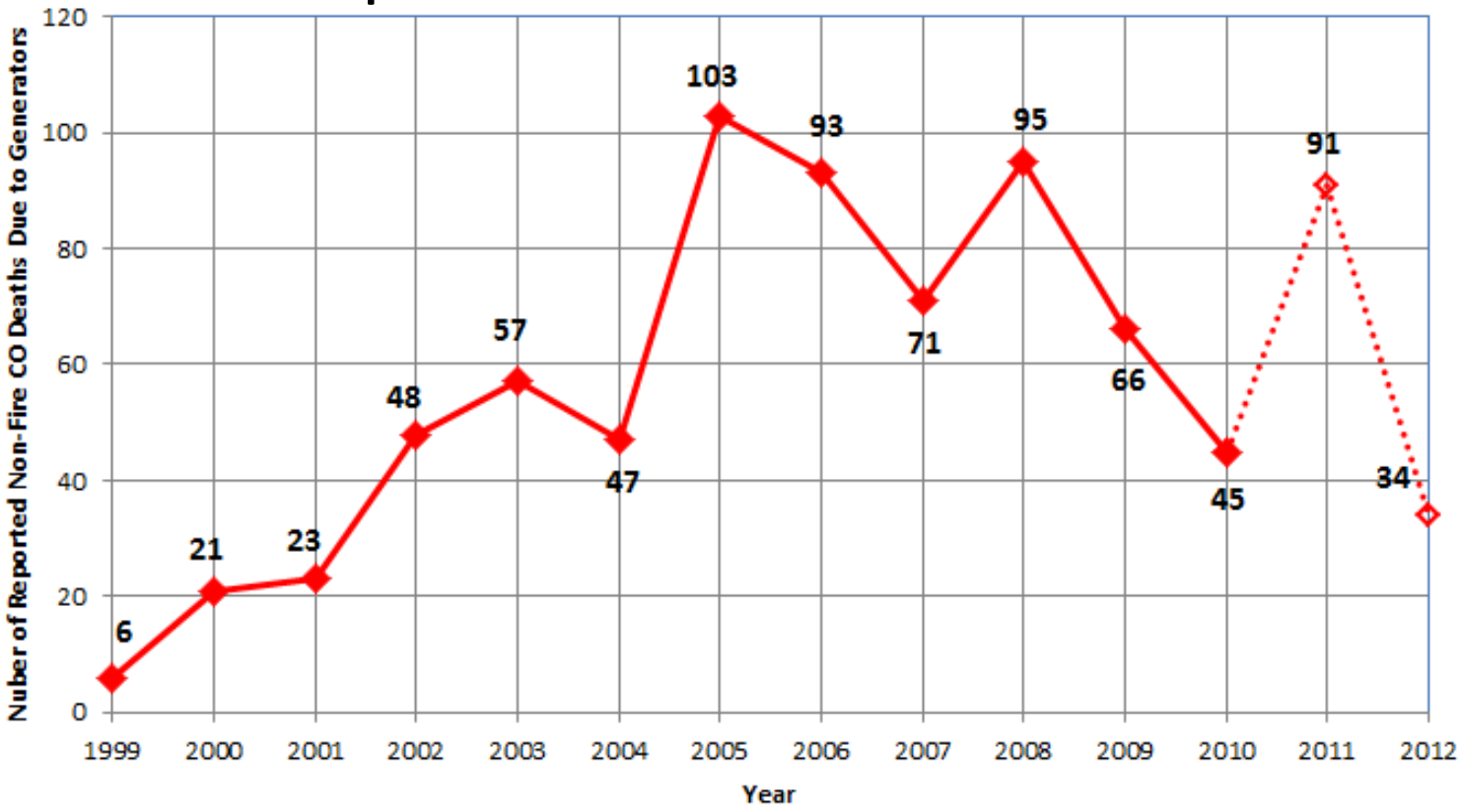


Note: This figure excludes deaths involving multiple CO-producing consumer products.

Sources: Hnatov, Matthew, *Non-Fire Carbon Monoxide Deaths Associated with the Use of Consumer Products, 2010 Annual Estimates*, U.S. Consumer Product Safety Commission, Bethesda, MD, January 2014.

Hnatov, Matthew, *Non-Fire Carbon Monoxide Deaths Associated with the Use of Consumer Products, 2009 Annual Estimates*, U.S. Consumer Product Safety Commission, Bethesda, MD, December 2012. (Docket Identification CPSC-2006-0057-0013 and -0019, available online at www.regulations.gov).

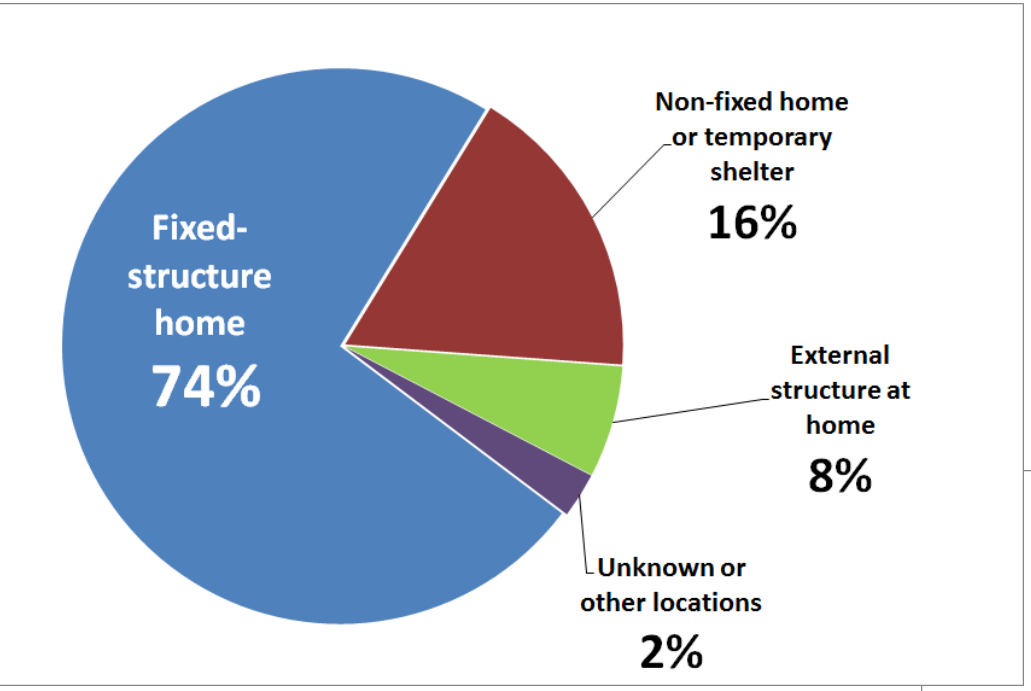
Why CPSC is Concerned About Generators



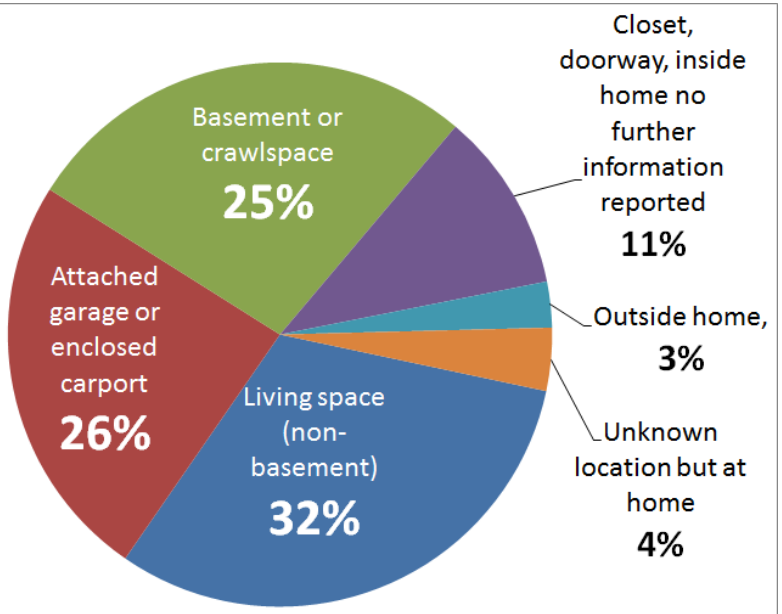
Source: Hnatov, Matthew, *Incidents, Deaths, and In-Depth Investigations Associated with Non-Fire Carbon Monoxide from Engine-Driven Generators and Other Engine-Driven Tools, 1999-2012*, August 2013. (Docket Identification CPSC-2006-0057-0016, available online at www.regulations.gov).

Some of our hazard analysis…

Location where incident occurred

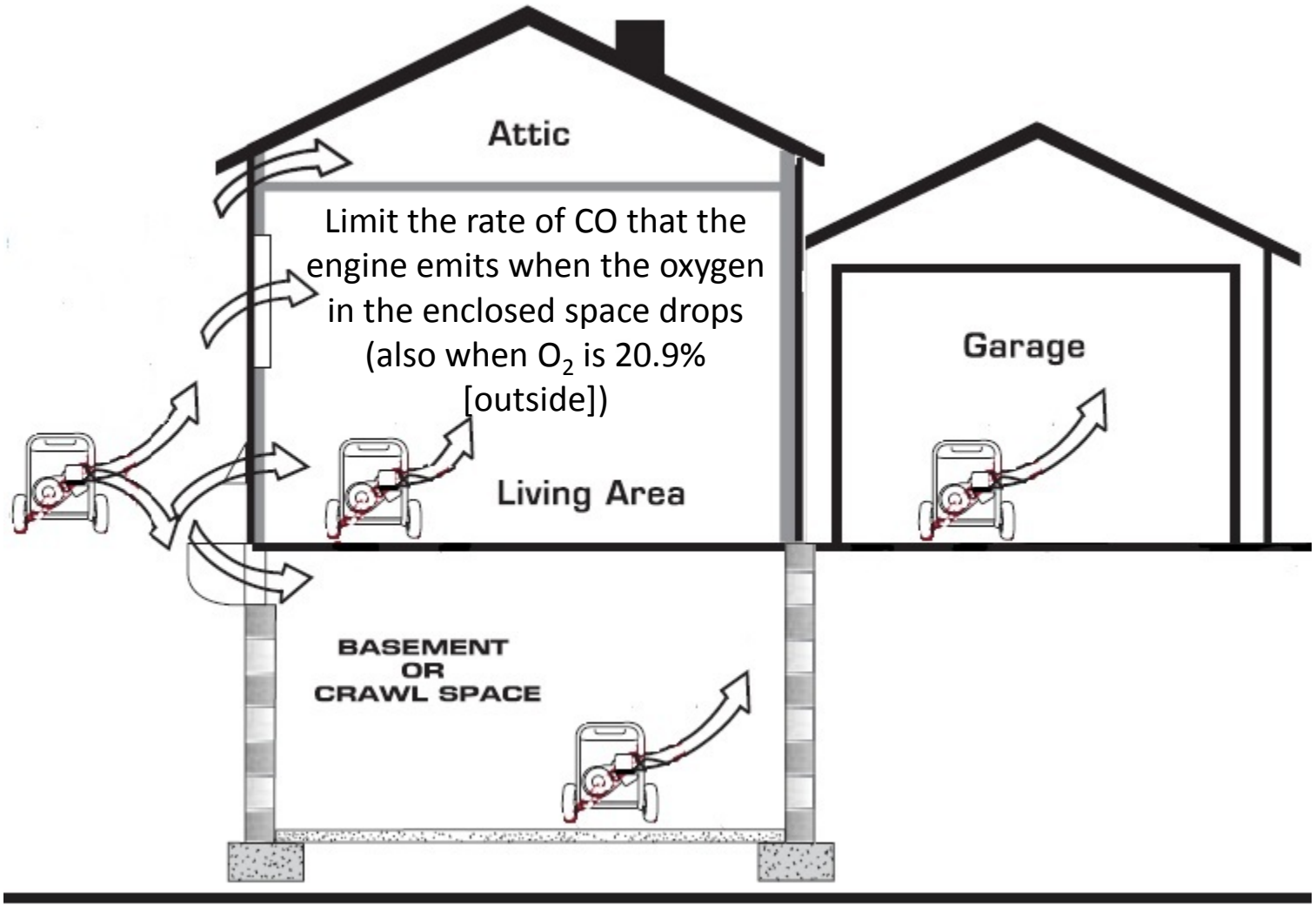


Specific location of generator in incidents that occurred in fixed-structure home location



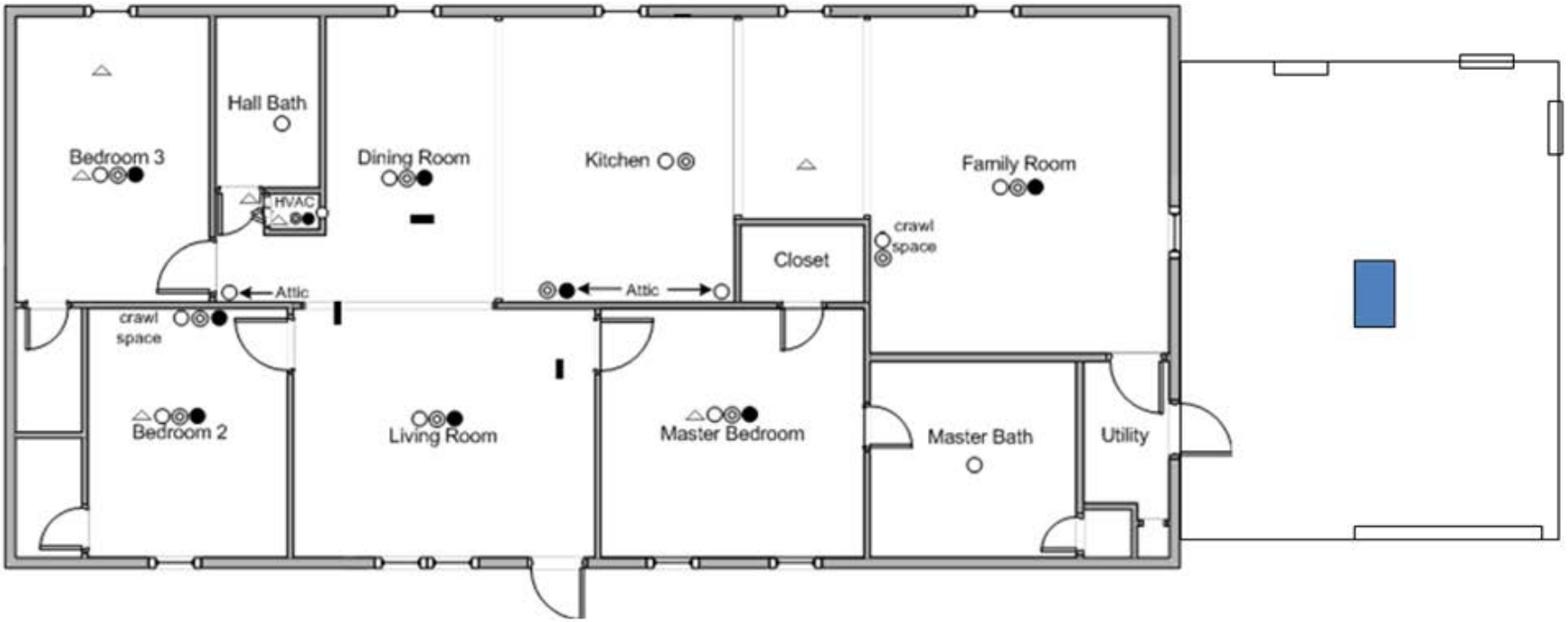
Recommended Performance Requirement

puts limit on the exhaust CO emission rate while generator is operating continuously in an enclosed space (limit also applies when it is operated outdoors)



Hazard Characterization of Common Incident Scenario: Generator operation in SFH attached garage

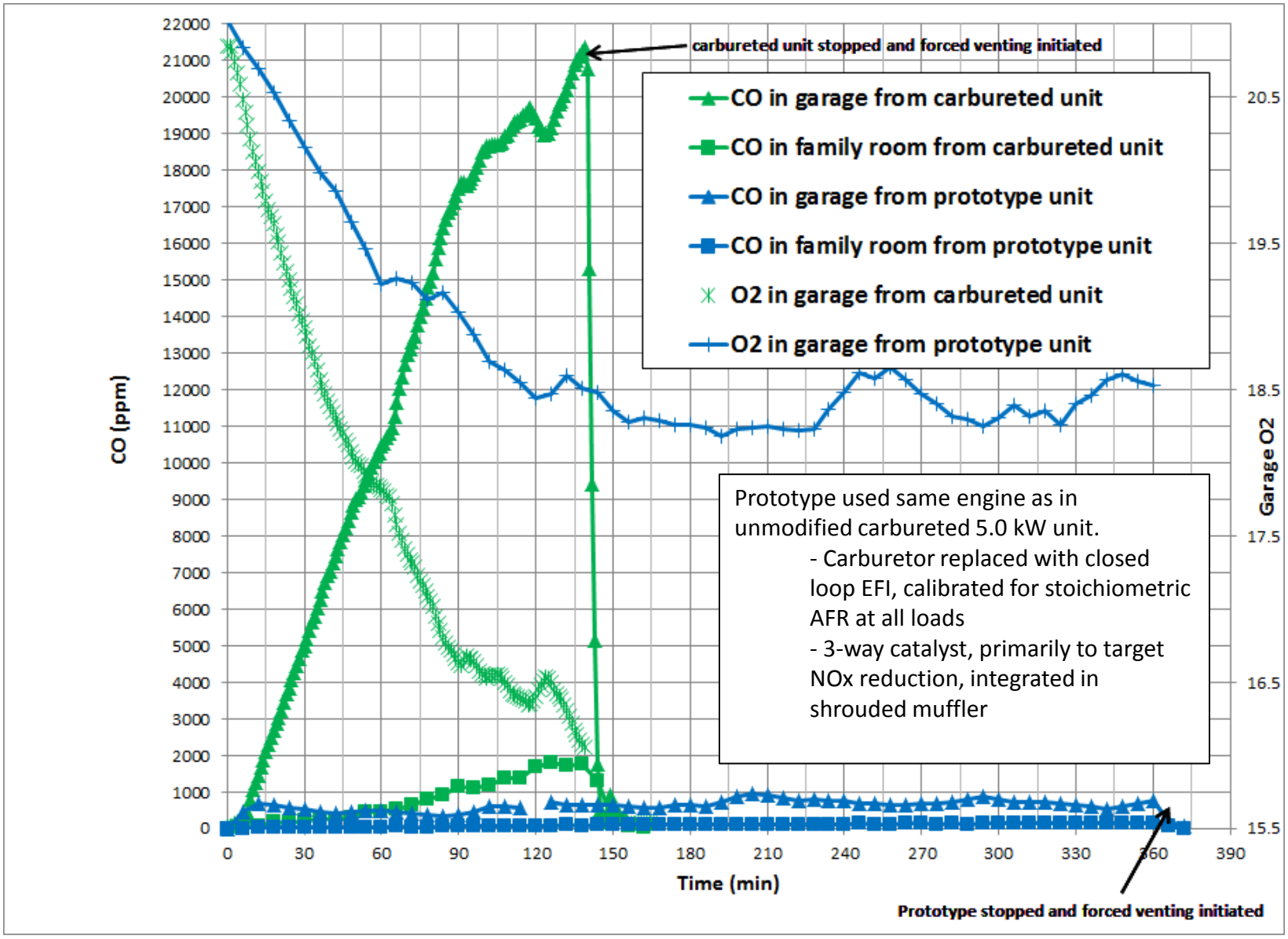
National Institute of Standards and Technology (NIST)



Garage and Family Room CO Concentration Profiles from Unmodified, Carbureted 5 kW unit and Prototype 5 kW Unit

6-load hourly load profile applied to generator

Garage Bay Door Fully Closed, Garage/Utility Room Door Fully Closed, and HVAC Fan On



Generators' CO Emission Rates

Calculated from chamber (shed) tests

Carbureted 5 kW unit (Unmod Gen X)

~1200-1500 g/hr CO emission rate near ambient (20.9% O_2) with 5.5 kW applied

~500-1000 g/hr CO emission rate near ambient (20.9% O_2) with 3.0 kW applied

CO emission rate increases by ~100 g/hr for each 0.1% decrease in O_2 until O_2 drops to ~17% - 18%

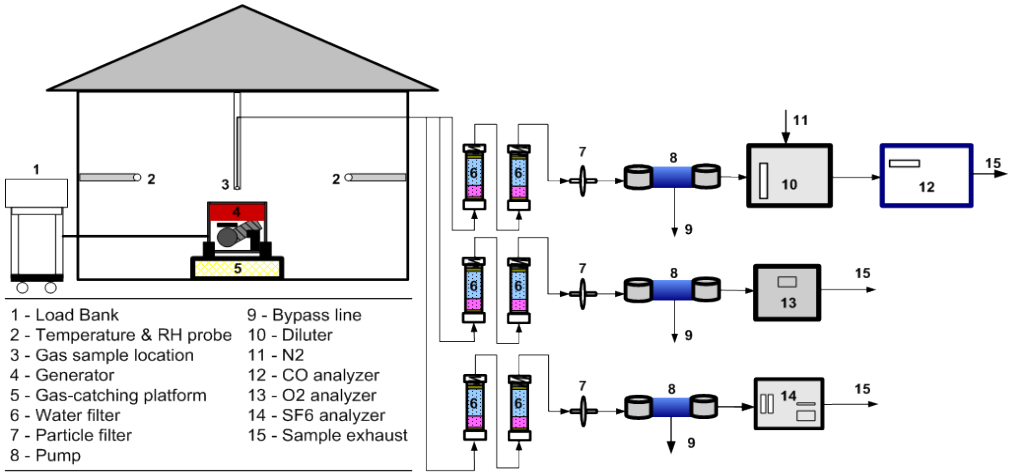
Closed Loop Fuel Injected 5 kW unit with catalyst (Gen SO1; same model engine as on unmod Gen X)

40-50 g/hr CO (with some exceptions, when AFR was off-design) with 5.5 kW applied

< 30 g/hr CO (with some exceptions, when AFR was off-design) with 3.0 kW applied

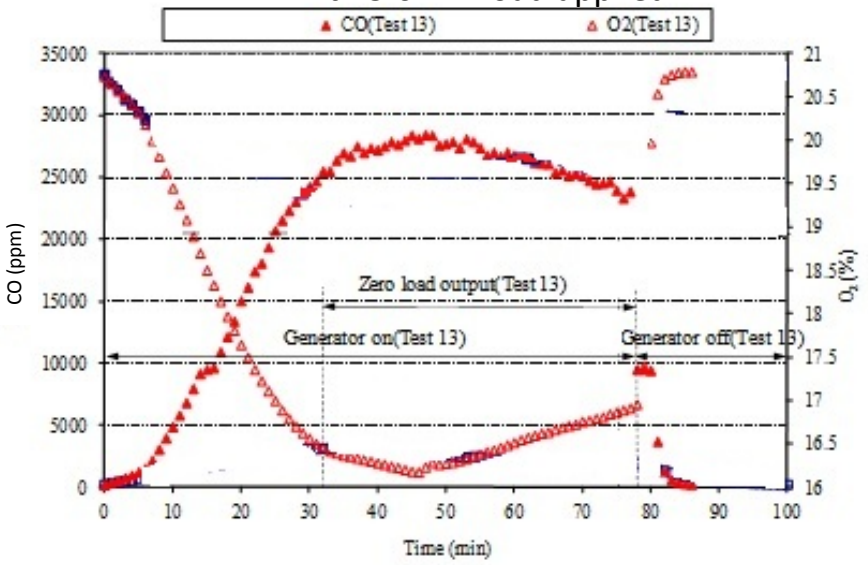
Emission rates do not appear to increase as O_2 level decreases

Recommended Method for Testing Generator CO Emission Rates at Reduced O_2

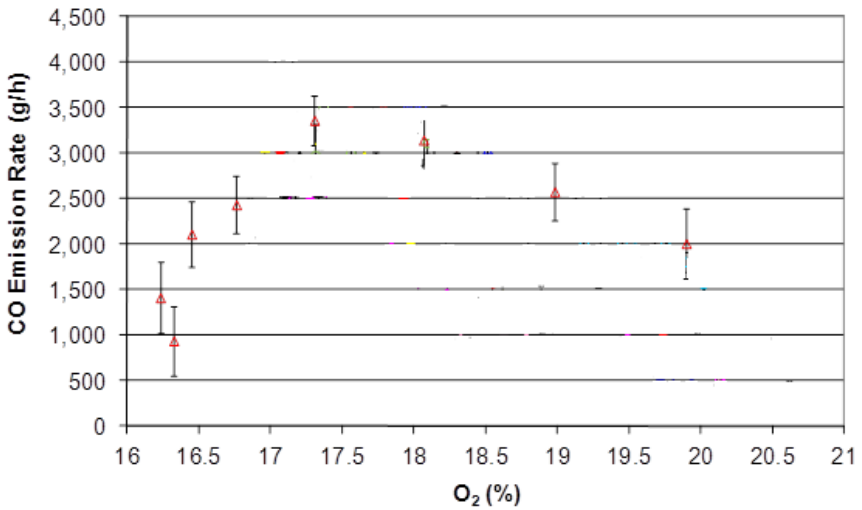


$$S_{CO} = \rho_{CO,in} A_{out} V_s \frac{C_{CO,t2} - C_{CO,t1} e^{-A_{out}\Delta t}}{1 - e^{-A_{out}\Delta t}}$$

CO and O2 shed data from testing Gen B (carbureted) with 5.0 kW load applied

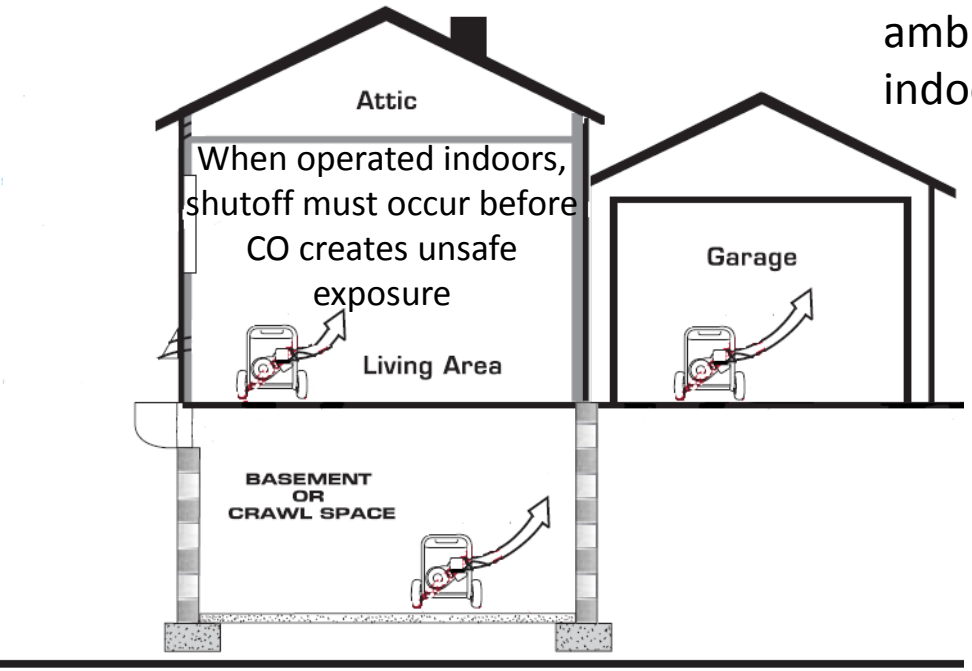


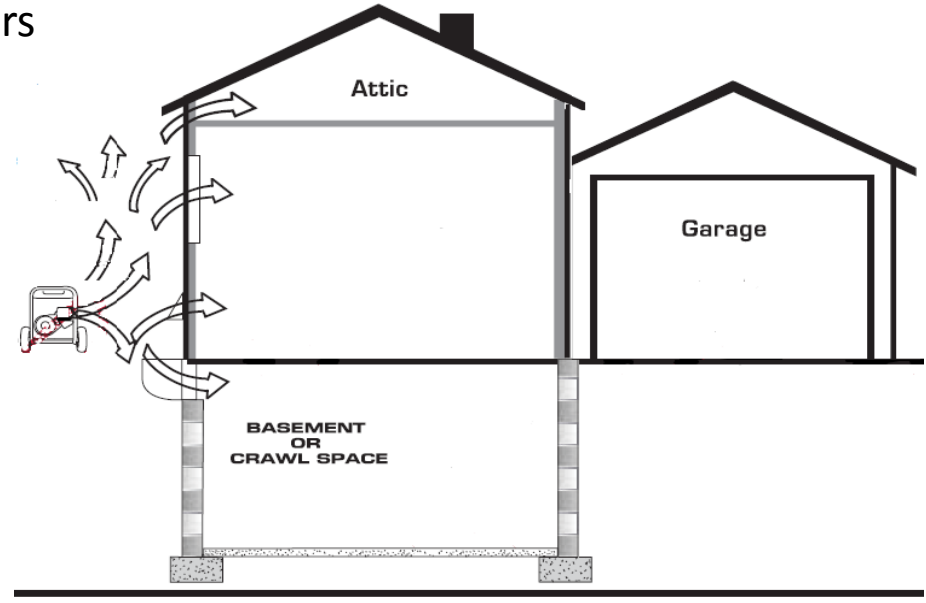
Calculated CO emission rates for Gen B (carbureted) with 5.0 kW load applied



Recommendations for possible exception to CO emission rate limit at reduced oxygen (Generators equipped with a shutoff system):

If shutoff does not work when generator is operated outdoors, CO emission rate reduction when O_2 is ambient is needed for when exhaust infiltrates indoors





In addition, the shutoff system must be:

- automated, tamper-resistant to deter users from disabling its function, resistant to causing nuisance shutoffs (i.e. causing the generator to shutoff when operated outdoors), and include a supervisory circuit for the control circuit, (i.e., preventing the generator from being able to start if it, or its sensor, were to fail or otherwise not be able to shut off the generator in scenarios that would create an unsafe exposure).
- durable and work throughout the generator's operational life, without calibration or service, so designs must consider the wide variety of environments in which consumers use their generators and store them during prolonged non-use periods.