CPSC Activities to Address CO Poisoning Hazard of Portable Generators

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Overview

• What Is the CPSC?
• Generators: Why CPSC Is Concerned
• CPSC Activities to Address Generator CO Hazard
  – Participation in Development of UL 2201
  – Technology Demonstration of Low CO Emission Prototype using Existing Emission Control Technology
  – Investigations of Shutoff Strategies
• Strategy: Limiting Engine’s CO Emission Rate
• Q & A
U.S. Consumer Product Safety Commission

• Independent federal agency
• Created in 1972
• Responsible for consumer product safety including imported consumer products
• Five Commissioners, appointed by the President and confirmed by the Senate
Protecting the public against unreasonable risks of injury from consumer products through education, safety standards activities, regulation, and enforcement.
CPSC – Addressing Hazards

• Hazard identification
  • collection and analysis of injury and death data
  • research on emerging and potential product hazards
• Hazard reduction
  • developing voluntary consensus safety standards with industry
  • adopting and enforcing mandatory standards
• Enforcement
  • market and import surveillance, testing and certification
  • recall of products; arranging for their repair or replacement
• Outreach
  • informing and educating consumers, manufacturers, other stakeholders and responding to their inquiries
Four Types of Safety Concerns

• Product fails to comply with a mandatory safety standard or ban under the Acts
• Product fails to comply with voluntary standards relied upon by the Commission
• Product contains a defect which could create a “substantial product hazard”
• Product creates an “unreasonable risk” of serious injury or death
What Is a Consumer Product?

- Jurisdiction over thousands of different types of consumer products under the Consumer Product Safety Act

- Excludes use in the workplace and products covered by other federal agencies, such as:
  - Cars and related equipment (NHTSA)
  - Boats (Coast Guard)
  - Airplanes (FAA)
  - Food, drugs, medical devices, cosmetics, tobacco products (FDA)
  - Firearms (ATF)
  - Pesticides (EPA)
  - Tobacco Products (ATF)
Why CPSC Is Concerned About Generators

Number of Reported CO Deaths Associated with Portable Generators

Some of Our Hazard Analysis…

**Location where incident occurred**

- Fixed-structure home: 75%
- Non-fixed home or temporary shelter: 18%
- External structure at home: 6%
- Unknown or other locations: 1%

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

- Living space (non-basement): 34%
- Basement or crawlspace: 24%
- Attached garage or enclosed carport: 26%
- Closet, doorway, inside home no further information reported: 9%
- Outside home: 3%
- Unknown location but at home: 4%
CPSC Activities to Address CO Hazard with Portable Generators

- **2003**: Began participation as non-voting member on STP for UL 2201
- **2004**: Hosted roundtable
- **2006**: Staff report “Review of Portable Generator Safety”
- **2006**: Briefed Commission: most reliable way to reduce the CO poisoning risk is to reduce CO emission rate
- **2006**: Commission voted to approve ANPR
CPSC Activities to Address CO Hazard with Portable Generators

• **2007**: FR for mandatory label, effective May 2007
• **Ongoing**: Reports supporting ANPR; see Docket ID CPSC-2006-0057 on www.regulations.gov or CPSC website www.cpsc.gov
• **2014**: Staff sent letter to UL with recommendations based on research findings to address hazard in UL 2201:
  – A performance requirement that sets a limit on the engine’s exhaust CO emission rate
  – A test method for measuring generator’s CO emission rate
  – Requested formation of task group to develop recommendations into proposal
    • 36 stakeholders, including CPSC staff, volunteered for task group
    • Task group holds teleconference meetings every 4-6 weeks
    • If task group successful, STP for UL 2201 will determine if proposal is included in UL 2201
DANGER

Using a generator indoors CAN KILL YOU IN MINUTES.

Generator exhaust contains carbon monoxide. This is a poison you cannot see or smell.

NEVER use inside a home or garage, EVEN IF doors and windows are open.

Only use OUTSIDE and far away from windows, doors, and vents.
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-mode hourly load profile applied to generator
Garage Bay Door Fully Closed, Garage/Utility Room Door Fully Closed, and HVAC Fan On

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6-mode hourly load profile applied to generator
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Prototype used same engine as in unmodified carbureted 5.0 kW unit.
- Carburetor replaced with closed loop EFI, calibrated for stoichiometric AFR at all loads
- 3-way catalyst, primarily to target NOx reduction, integrated in shrouded muffler

97% reduction

Time (min)

CO (ppm)

Garage O2

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180

0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 11000 12000 13000 14000 15000 16000 17000 18000 19000 20000 21000 22000
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% O₂) with 5.5 kW applied
~500-1000 g/hr CO emission rate near ambient (20.9% O₂) with 3.0 kW applied

CO emission rate increases by ~100 g/hr for each 0.1% decrease in O₂ until O₂ 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 5.5 kW applied
< 30 g/hr CO* with 3.0 kW applied

Emission rates do not appear to increase as O₂ level decreases

* (with some exceptions, when AFR was off-design)
Effect of Oxygen Level on CO Emission Rate on Carbureted 5 kW Generator
Putting the Carbureted Generator’s CO Emission Rates in Perspective...

- The carbureted generator’s CO emission rate at ambient oxygen with partial load applied was nominally 500 g/hr.
- At approximately 17.5 percent oxygen with near rated load applied, the generator’s CO emission rate was nominally 3750 g/hr.
- In contrast, the measured CO emission rate of an 1996 Oldsmobile Cutlass while idling was 0.66 mg/sec (2.37 g/hr).*

Staff Recommendation To UL Is A Performance Requirement That Puts A Limit On The Exhaust CO Emission Rate While A Generator Is Operating Continuously, Regardless Of Whether It Is Operated In An Enclosed Space Or Outdoors

Limit the rate of CO that the engine emits when the oxygen in the enclosed space drops (also when O₂ is 20.9% [outside])
Shutoff Concepts Investigated by CPSC Staff

- CO sensing system mounted on generator
- Remotely located CO sensing system that communicates with generator; relies on user to place sensing unit in proper location
- GPS system mounted on generator; relies on poor signal strength to infer generator is located indoors
- Programmed engine control unit (ECU) on prototype; relies on electronic fuel injection (EFI) system sensors to infer indoor operation
Limiting Engine’s CO Emission Rate Used by EPA to Address Risk of Acute CO Poisoning Hazard

– In 2002, EPA adopted a 4.4 g/kW-hr CO emission standard for large SI engines that power equipment designed for use in enclosed spaces.

– In 2008, EPA adopted a 5.0 g/kW-hr CO emission standard specifically for engines that power marine generators.
  
  • EPA limit for all other small SI engines is 610 g/kW-hr

– Although not intentionally done to reduce CO poisoning hazard, introduction of catalytic converters on cars in 1975, which reduced CO emissions by 76%, resulted in 81% reduction in vehicle-related CO deaths and injuries.
Questions?

• All documents located at: 
  www.regulations.gov under docket CPSC-2006-0057
  And

• For further info: 
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