April 24, 2017

U.S. Consumer Product Safety Commission
4330 East West Highway, Suite 722
Bethesda, MD 20814

Via the Federal e-Rulemaking Portal: http://www.regulations.gov

SUBJECT: Docket No. CPSC–2006–0057 - Comments on Notice of Proposed Rulemaking for a Safety Standard for Portable Generators

Generac is a leading manufacturer of portable generators in the United States, and we have the broadest and most diverse product lineup of portable generators in the industry. We presently have over 100 unique portable generator products ranging in power from 800W to 17.5kW. Our products are designed and optimized for multiple consumer uses including recreation, general purpose, emergency backup, and construction. We produce portable generators that can be fueled by a broad range of fuels including gasoline, liquefied propane, and diesel.

Generac has been an active member of Portable Generators Manufacturers Association, PGMA, since the organization was founded in 2009. Generac joined PGMA because we believe very strongly in the mission of PGMA to develop and influence safety and performance standards for portable generators. We are committed to continuously improving the safety of our products. Generac's engineering team has been actively working to develop product solutions and standards that address this issue. We have explored multiple solution options, such as reduced emissions strategies and detection. Prototypes have been built and tested in multiple operational scenarios. We have been contributing many of the results from these efforts to the PGMA technical committee, in the hopes that PGMA would be able to complete the revision to G300 as quickly as possible. We believe that PGMA has made great progress towards the standard revision in a very short period of time. Generac supports PGMA's approach towards addressing the hazard. Given PGMA's demonstrated progress towards the development of a voluntary standard, we request that the Commission defer the rulemaking activities to allow PGMA the time needed to complete their standard making process.

We appreciate the work CPSC staff has done to prepare the NPRM. The documented studies and tests from NIST's technical notes and the CONTAM models have been instrumental for Generac, and other manufacturers, to compare the impact of detection versus reduction of harmful emissions. Generac believes a CO detection shutoff approach offers superior effectiveness as compared to the reduced emissions strategy outlined in the NPRM and we offer further evidence of this through our comments that will follow. *Generac believes that it is necessary and required by statutory requirement for CPSC staff to further review the alternative strategy of a carbon monoxide detection shutoff system as part of this rulemaking process.*

Generac proposes a device mounted to each portable generator that monitors Carbon Monoxide levels produced with an application specific algorithm. The device determines if the engine is being run outdoors where CO can disperse safely and continue to operate as designed, or to shutoff if misused in an enclosed space causing CO to accumulate. The device automatically shuts off the engine quickly and provides a visual/audible alarm, warning the consumer to take the generator outside. The device will not allow the generator to restart as long as it is left in the enclosed space with CO present. This device is applicable to all sizes of portable generators and the various types of fuels in use now and new hybrid types in the future. The algorithm is based upon a survivable level of CO, not what may be technically feasible on various engine designs now. The device is based upon latest CO Detectors that rely on UL2034 standards of operation, varying environmental conditions and reliability requirements up to and surpassing 10 years.

The relevant statutes applicable to the CPSC NPRM require; “that the benefits expected from the rule bear a reasonable relationship to its costs” and “that the rule imposes the least burdensome requirement which prevents or adequately reduces the risk of injury for which the rule is being promulgated.” Our comments illustrate that a detection and shutoff approach is a much more effective approach to address this hazard (as much as three times more impactful to the avoidance of death than the roughly 33% claim in the NPRM) and will be significantly lower cost to deploy (as much as 5 to 8 times lower cost than the rule analysis claims). For these reasons we believe it is imperative that CPSC take the recommendations presented here and reassess the potential for a shutoff solution as an alternative to the reduced emissions approach. It is unclear as to why the detection and shutdown approach was dismissed by CPSC staff. Our assumption is that it was staff’s judgement that this technology is not reliable or robust enough to be applied to a generator. If so, we disagree with this conclusion. The basis for these erroneous staff judgements is on technologies that were investigated nearly 10 years ago. There have been significant advancements in CO sensing technologies over the past 10 years.

We ask that the Commission consider a suspension of the rulemaking process, to allow us the time to continue working with PGMA and others, to fully develop and complete the revision to ANSI G300. These activities have made great progress to date, and Generac offers its assurances that we will continue to drive forward with the same energy and commitment in order to complete the process quickly. Even with the allowance of added time to fully develop the detection solution and standard, we feel that this will result in product solutions coming to market more rapidly than will be possible if the emissions rule were to move forward. The rule presently requires 1 or 3 years to comply (timing which we at Generac may NOT be able to reasonably meet given the breadth and complexity of our product lines). We are confident that due to the simplicity of the detection and shutoff solution, combined with its applicability across ALL product types without the need to start the development process from the beginning that this solution will come to market across the broad range of products several-fold faster than an emissions rule. Further, the detection solution provides an opportunity to add a shutoff to existing generators that are already in circulation as an accessory device. We estimate there are between 10 and 15 million generators in use in the USA today. Considering the amount of generators in circulation and the typical 10 year life of generators, product changes that are only applicable to new products produced would take in excess of 20 years before we would see broad compliance. This does not consider that the heavy cost increases to generators to comply with an emissions rule would likely extend the lifetime of the generators in circulation beyond their typical lives today in order to avoid the high cost of purchasing new products.

We are mindful that certain parties, including some of the Commissioners, have commented that perhaps manufacturers should consider implementing both solutions (i.e., both an emissions and detection/shutoff approach). However, it is important to note that neither the NPRM nor the PGMA G300 standard currently contemplate or propose such a combined or hybrid approach. Considering a combined approach would only further exacerbate the burden on manufacturers, add unnecessary cost, and not provide any significant increase in benefit over a shutoff approach alone. Therefore, the comments provided herein appropriately do not address the merits or possibility of a combined solution, and focus only on the scope of the NPRM itself.

Generac supports and agrees with the statements and claims made by PGMA in its public comment response to the NPRM. Not all comments made by PGMA will be restated within our comments, but in some cases claims will be expanded upon with further Generac data in support of PGMA's position.

II.B.2. Statutory Authority

Generac disagrees with CPSC's legal authority to regulate the emissions of portable generators. We have submitted a separate comment highlighting these concerns in more detail.

According to Section 9(f)(1) of the CPSA:

"Commission must consider, and make appropriate findings to be included in the rule on… the means to achieve the objective of the rule while minimizing adverse effects on competition, manufacturing, and commercial practices."

Consumer market availability of product will likely change as manufacturer's react to the NPRM with reduced/eliminated product offerings. This proposed rule will adversely *impact competition. Small business manufacturers realize increased costs and longer development time if an engine supplier does not offer CPSC / EPA compliant turn-key solutions. Larger manufacturers with multiple engine platform options will be faced with increased cost of development to optimize engine offerings and/or a reduction in product offerings due to priority of meeting effective implementation dates listed in the NPRM, thereby reducing their product offerings and competitive advantages.*

"Additionally, if a voluntary standard addressing the risk of injury has been adopted and implemented, the Commission must find that: the voluntary standard is not likely to eliminate or adequately reduce the risk of injury, or that substantial compliance with the voluntary standard is unlikely." Id. 2058(f)(3)(D).

ANSI/PGMA G300 *Safety and Performance of Portable Generators* was re-opened fall 2016 in order to implement a section to stop Carbon Monoxide emissions when a portable generator is misused in an enclosed space. This addresses 95% of the deaths CPSC has documented and used as a basis for determining effectiveness of the solution in the NPRM.

The primary objective of the voluntary standard; i.e. a CO detection and shutoff solution, will adequately reduce the risk of injury. Generac is committed to the development of the PGMA G300 standard.

Generac is in favor of a CO detection shutoff solution approach; which we believe to be a more effective solution, and intend to produce compliant product to the voluntary standard accordingly. Furthermore, Generac is committed to continuing to educate and inform users on portable generator safety with the goal of reducing the risk of injury to consumers when portable generators are misused.

"The Commission also must find that expected benefits of the rule bear a reasonable relationship to its costs and that the rule imposes the least burdensome requirements that would adequately reduce the risk of injury

Generac will present the efficacy (see Attachment2) and technical feasibility analysis (see Attachment3, Attachment4) of the proposed alternative. The CPSC staff must weigh these values against the proposed solution while also considering the comments raised against the assumptions presented in the NPRM regarding the proposed benefits presented. The cost/benefit review will find that alternate shutoff solution has more benefit, is least burdensome, and has a higher probability to realize the full potential of benefit than the proposed rule advocating a low emission solution.

III. Product

The NPRM states that because of the advances in electronic fuel injection systems technologies, that incorporating such systems into a Class II single cylinder, Class I and Hand Held engines is technically feasible and not cost prohibitive. Stationary Air Cooled engines used in portable generator applications have unique operating conditions unlike motorcycles and scooters which are moving and have improved cooling.

The design choices that are commonly made by designers of engines and emissions control systems can have dramatic impacts on the emissions rates under various conditions. Likewise, catalyst reliability is also a source for concern and must be addressed. There have been several documented studies and field reports that support the reliability concern.

Some of these concerns include:

- Cold startup engine choking logic, which typically runs the engine rich.
- Wide temperature range ECU map values in cold start conditions
- Operation at elevated altitudes
- Transient conditions that result from load changes on the engine
- Emissions control systems typically default to "open-loop" operation when input conditions are outside of their pre-programmed maps.
- The effects of engine wear over the life of the generator.
- Catalyst degradation and contamination
- Oil carryover into the catalyst that can result from operator miss-use or early engine failure
- System mechanical vibration and jarring of the catalyst and oxygen sensor.
- Thermal stresses that degrade or destroy catalyst operation

Another challenge to the effectiveness of a reduced CO emission portable generator is the fact that the catalyst is not effective until it reaches its operating temperature. This could take several minutes to occur, producing poisonous levels of CO. Once light-off of the catalyst occurs, a reduced CO generator will still continue to produce additional CO. In contrast to reduced CO solution, a CO shutdown solution could completely stop production of all CO by the portable generator in less time than required for catalyst light-off. By limiting the amount of time a portable generator could operate in an enclosed space, and with the production of CO stopped, typical enclosed spaces will begin naturally dissipating the CO, making the CO shutdown solution considerably more effective. Additionally, a portable generator running at no-load or a light load upon startup may extend the time required to light off the catalyst.

The CPSC demonstration engine is not representative of the current overall portable generator market and thus underestimates impact to convert the spectrum of generator classes. NPRM Page 83564 states the Commission selected a commercially available 5.0 KW generator using a 389cc Honda GX390 to develop the prototype portable generator. This is a conservatively-rated professional grade engine used on portable generators rated at 7.0KW (i.e. Honeywell HW7000EH, Black Max BM907000 and Powermate PM0497000.04). A high build quality increases opportunity for prototype success and ignores the majority of generator engines involved in documented CO poisonings. At the time of UA's testing the GX390 was EPA Phase II with useful life certified to 500 hours. The 2012 EPA Phase III emissions updated certification requirement to 1000 hours. Despite advantages of the Honda GX390 the study noted that the head gasket was already leaking at 500 hours, likely due to the high operating temperatures. Patterned head gasket failures are in violation of the Clean Air Act and would require a product recall and remediation. With the current 1,000 hour life-cycle rating, failure and replacement would be expected.

A primary benefit of a CO detection and shutoff solution is that the effectiveness of the solution is not dependent on generator engine size or fuel type (e.g. gasoline, diesel, liquid propane, etc.). This non-discriminatory nature allows a shutoff device to be a one-size-fits-all solution. The result is a decrease in development and implementation time since the solution does not need to be unique for each individual generator model. Therefore, a single shutoff device design can be brought to market relatively quickly to cover a broad range of portable generators.

The NPRM does not consider parallel operation of inverter generators, nor would the proposed rule provide sufficient benefit in this operational mode. Inverter generators are the fastest growing segment of the portable generator market. A common primary feature is the ability to combine the electrical output of two inverter generators into a single output (paralleling). Typical parallel operation of two inverter generators in close proximity results in increased overall CO emissions. This increase in CO emissions would negate the benefits of a reduced CO emissions rate in this application. By comparison, a CO detection and shutoff approach could independently shut down each inverter generator, providing consistent protection whether operated alone or in parallel.

IV.B.2. Risk of Injury / *Incident Data* / *Portable Generator Carbon Monoxide Injuries*

The NPRM should consider and study the growing population of portable generators [Table 9, X.D – Portable Generators in Use] in the market as a result of increased sales. When death incident investigation is completed for 2013 and 2014 and the current market volume increases are considered the trend of CO related deaths may in fact be trending downward. A downward trend suggests that the current regulation on portable generators has had a sufficient and positive impact on the misuse deaths of portable generators.

A shortcoming of CPSC's reduced CO proposal is that it does not substantially reduce the hazard of running a portable generator indoors. Modeling with NIST's CONTAM software has been conducted on the proposed reduced CO solution; the results of this show that CO concentrations still rise to lethal levels (see Fig. 1 below).

These are representative examples based on the TN1925 results received. A complete study using the TN1925 simulation files will be conducted for the shutoff solution.

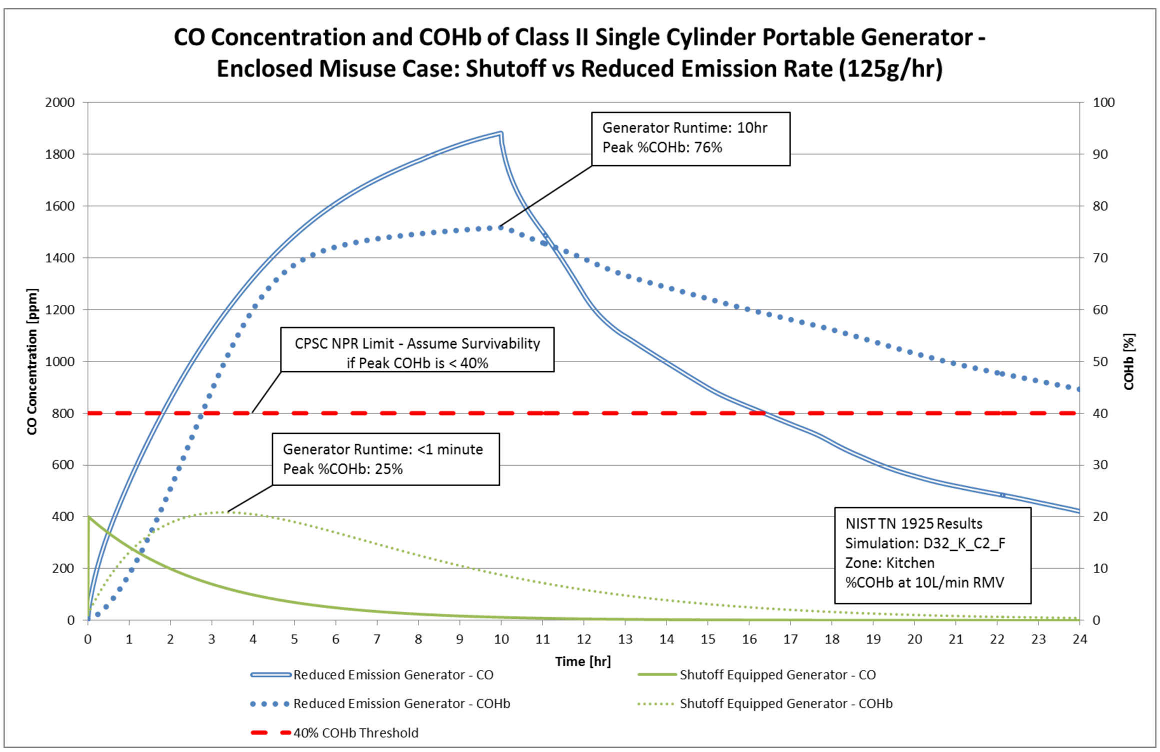

Fig. 1: Comparison of CO Concentration and Resultant COHb Levels for Shutoff and Reduced Emission Rate Simulations. *The plot shows the 24-hour simulation of a reduced emission rate generator and a shutoff equipped generator. The plots consist of the CO concentration and resultant %COHb. Both simulations were evaluated using NIST TN 1925 results with the following characteristics: House – DH32;*

Source Location – Kitchen; Generator Category – Class II-Single Cylinder; Run Schedule – Full; Zone – Kitchen; Date – July 27; RMV – 10 L/min. The reduced emission generator was simulated with a 125g/hr emission rate and run for 10 hours. The shutoff equipped generator was simulated with a 4700g/hr emission rate and ran for less than 1 minute before the 400ppm shutoff-criteria shut down the generator. Using the COHb criteria prescribed in the NPRM, shutoff simulation would have resulted in survival since the peak COHb never exceeded 40%. The reduced emission rate simulation would have resulted in death.

The graph below (Fig. 2) is empirical test data of an enclosed garage with a lower CO rate CO portable generator starting from cold and operating at ≈ 3800 Watts. As Oxygen is steadily consumed faster than it can be replaced, CO production is no longer restrained by the closed loop EFI, catalyst system and spikes upward for even longer run time due to increased fuel efficiency of EFI.

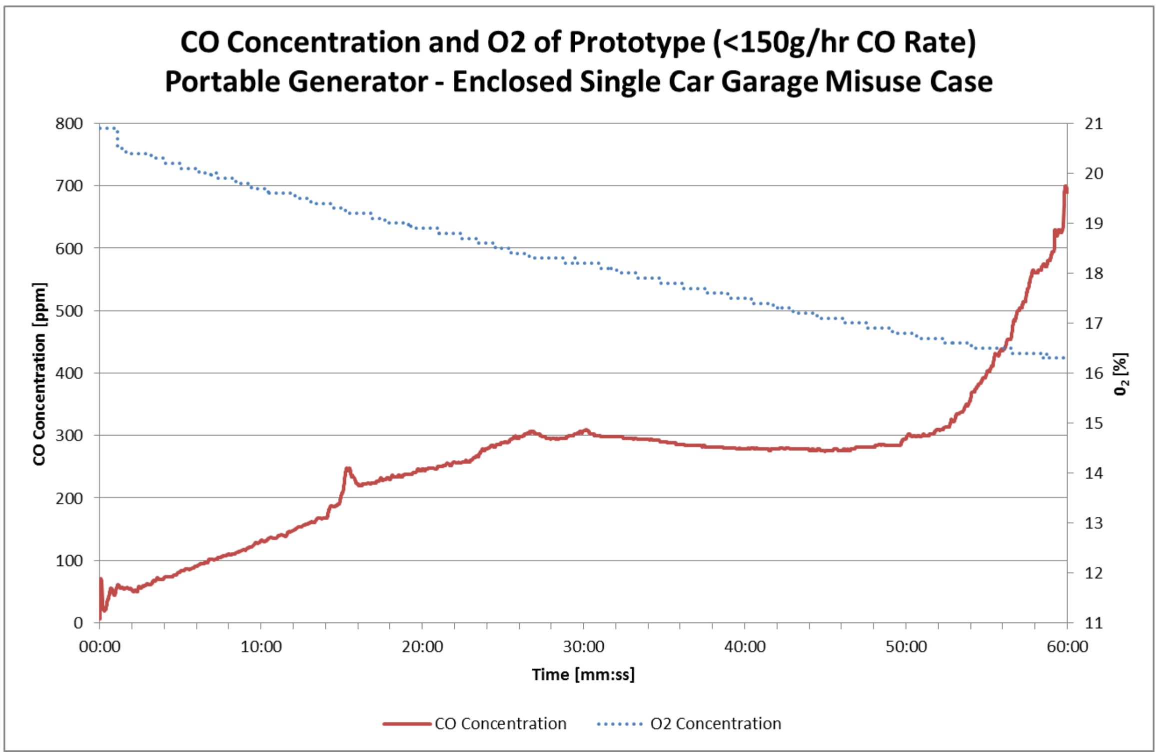

Fig. 2: CO Concentration and O2 of Prototype (<150g/hr CO Rate) Portable Generator – Enclosed Single Car Garage Misuse Case. *The portable generator in this test ran for 1 hour in an enclosed space that is representative of a single car garage. The CO emission rate of the generator was < 150g/hr. CO concentrations steadily rose during the warm-up period of the generator and stabilized once the catalyst was at sufficient operating temperature. As the oxygen content in the space dropped below 17%, the resultant CO emission rate rapidly increased until the end of the 1-hour test.*

The proposal in the NPRM aims to regulate engine CO emissions at specific, steady-state loads. This approach would ignore increased CO emission rates observed during warm-up and load transition periods. These rates are comparable to the CO emission rates of current carbureted generators. Evidence of this increased CO emission rate was observed in NIST 1781 and can be found in Figure 3 below. NIST staff explains, "As shown in [Fig. 3], there was an initial spike of CO in the garage of over 300µL/L when the engine was started and as the oil warmed before operation transitioned to the calibrated AFR." In addition to the explanation provided by NIST staff, the time required for the catalyst to reach its effective operating temperature (light-off) likely contributed to the initial spike in CO.

Increased CO emission rates during warm-up and load transition periods are technological limitations of EFI and catalyst systems. When used in real-life scenarios, these deficiencies will result in increased CO emissions and, consequently, increased risk to consumers. Using a certification test that deliberately ignores these periods of increased CO emission rates undermines the effectiveness of a reduced CO emission solution.

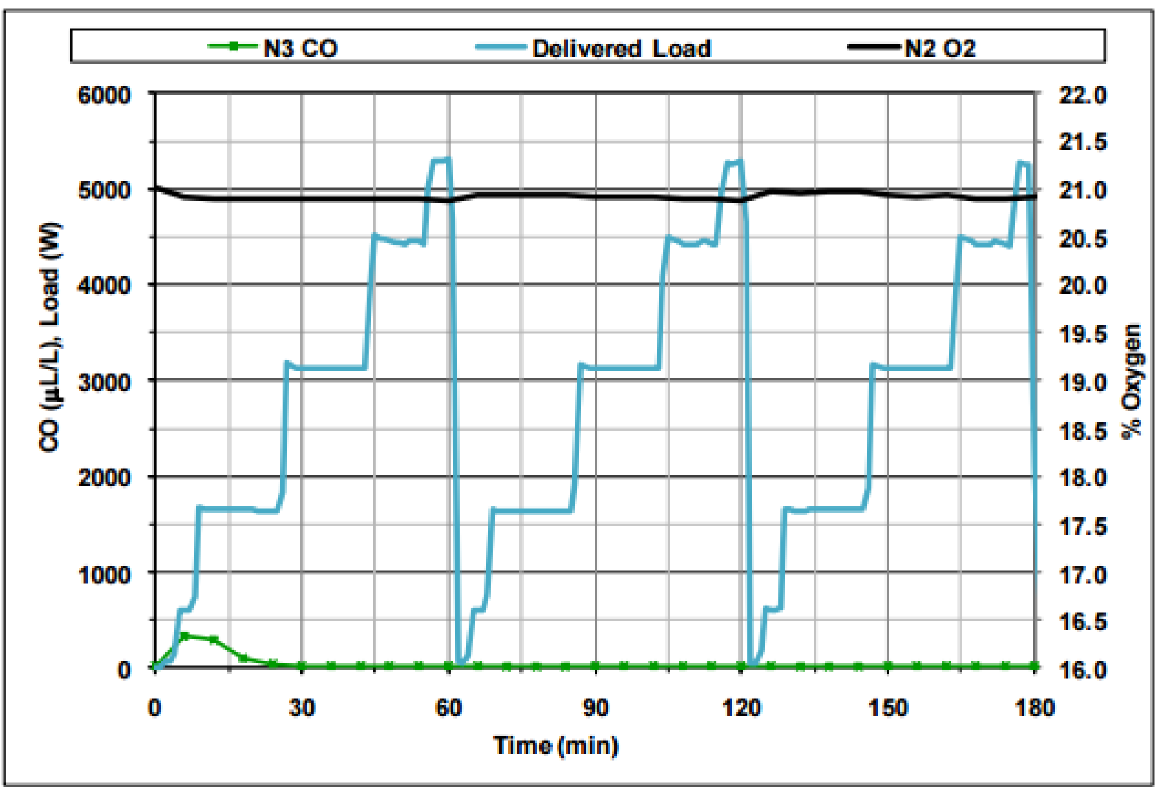

Fig. 3: Garage CO and O2 concentrations w/measured load for Test T (Gen SO1, Configuration 2) [8].

Analysis of Generac empirical testing reveals the same initial spike in CO. Figure 4 below shows the concentration profiles of CO and O_2 for a prototype low CO emission generator (under 150 g/hr) in an enclosed space. At the start of the test, the generator exhibited a high CO emission rate, evidenced by the steep slope of the CO accumulation curve. As the generator began to warm-up the rate of accumulation slowed. Approximately 5 minutes into the test effective operating temperature of the catalyst was achieved and the rate of CO emissions reached steady state. The percentage of O_2 in the room, however, continued to steadily decrease.

As the amount of oxygen decreased beyond 17.5% the EFI system began to supply more fuel to the engine to compensate for the lack of oxygen. This resulted in a rapid increase in the CO emission rate. This continued until the generator was shut off at approximately 23 minutes, when the CO concentration exceeded the range of the CO monitor being used. After the generator was shutdown, the test room was evacuated. CO and O_2 levels quickly returned to ambient.

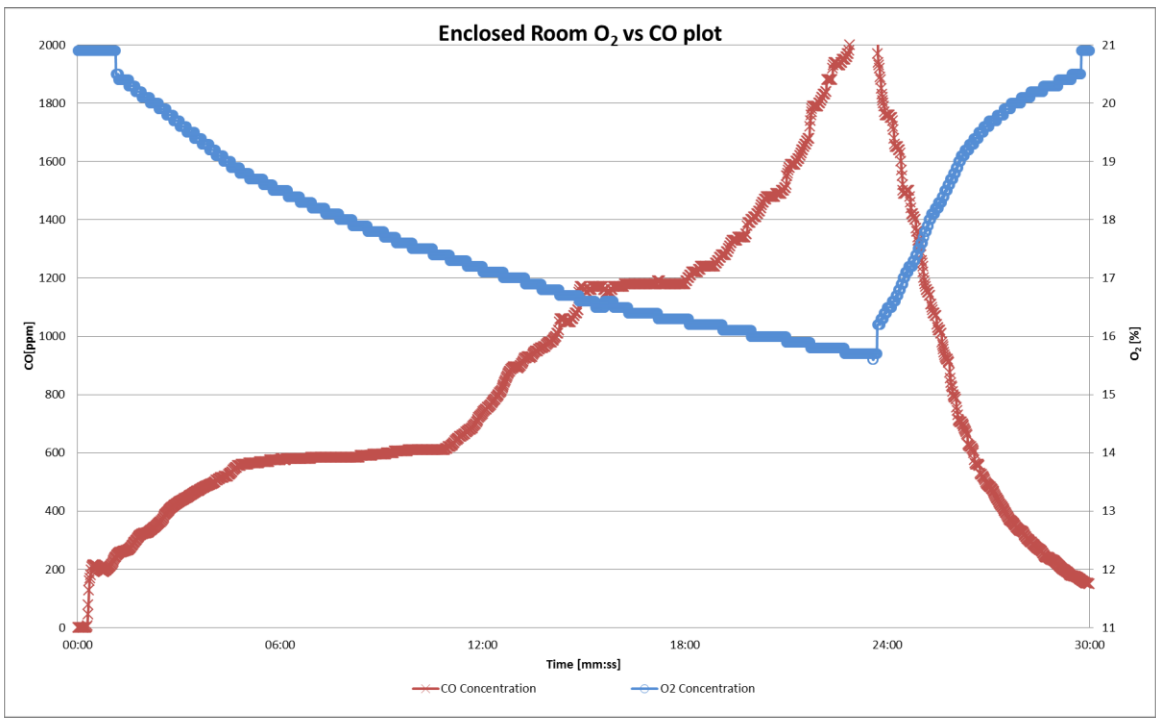

Fig. 4: CO and O_2 concentrations of a prototype low CO emission generator in an enclosed room (<150 g/hr, 0.35 ACH, 5625W load).

A CO shutdown solution would work quickly and automatically to shut down the portable generator and force a task oriented change in consumer behavior. A shutdown would stop the engine (thereby eliminating continued CO production), is very noticeable, and requires no action by the consumer; i.e. survivability is **passive** for a shutdown solution. In order to continue operating the portable generator, it would need to be relocated outside.

On page 83565, the NPRM state that the Commission believes that lower CO production rates found with the prototype generator will provide occupants extended time to escape. However, there is no documentation or studies referenced in the NPRM that confirms more escapes will occur. The CPSC needs to provide a study on which the premise is based or conduct a study to validate it. While the proposition may seem intuitive, a study may show just the opposite is true as early symptoms may result in someone just lying down to relax or sleep.

The Centers for Disease Control and Prevention (CDC) states: "The most common symptoms of CO poisoning are headache, dizziness, weakness, upset stomach, vomiting, chest pain, and confusion. CO symptoms are often described as 'flu-like.' If you breathe in a lot of CO it can make you pass out or kill you. People who are sleeping or drunk can die from CO poisoning before they have symptoms." As a result, it could be expected that the consumer would be inclined to lie down or rest, as they may simply feel tired or mistake their symptoms for the flu. While resting or sleeping, the consumer will continue to be poisoned and unable to take action. Furthermore, data analysis of incidents involving at least one fatality from 1999 – 2011 shows that in at least 27% of all incidents, at least one victim was impaired due to alcohol, illegal drugs or prescription drugs known to impair judgment (see Attachment5). This increases the concern that those impaired individuals cannot be relied upon to react appropriately to any indication of a CO exposure. Generac's position in favor of a shutoff system approach is to reduce the exposure to CO consumers by stopping the generator without user input and its production of CO when a hazardous condition is detected.

V. Overview of proposed requirements

The NPRM presents three different emissions rates from portable generators depending on the size of the unit. This leads to a conclusion that there is no acceptable level and that these tiered levels are based on achievable rates using best available technology rather than conclusive evidence that any of the levels are safe. The impact on consumer safety or the reduction of CO injuries is not clearly presented for each of these tiered levels. There does not appear to be validation of this concept on common smaller engines with very small combustion chambers as well as generators with variable speed and high speed engines. Despite theoretical analysis and predictions, there does not seem to be tangible evidence regarding the impact of introducing this consumer utility equipment fitted with state of the art electronic fuel injection and exhaust systems.

More evidence is needed to demonstrate that misusing fuel injected and catalyst equipped engines of all sizes by operating indoors will have a desirable result.

While different size engines do put out different CO rates, CO injury/death is determined by CO concentration. This supports a shutoff device rather than reduced emissions.

If EFI is the primary technical solution for accomplishing the goal of this regulation then Generac believes that the NPRM will eliminate conventional LPG fueled and dual fuel generators from the market, which represent a significant portion of portable generator sales. Generac's product line features single cylinder compression ignition powered portable generators. A CO detection shutoff approach would cover this product. Any proposed requirement should be applicable to all portable generators, not just spark-ignited units. It is noted that compression ignition engines are within the scope of ANSI/PGMA G300.

VI. CPSC Technical Analysis and Basis for Proposed Requirements

Generac would like to echo the comments from PGMA related to the lack of reliability requirements in the proposed standard and the incompleteness of the durability study presented in the NPRM. Generac does not believe that the study is complete and is limited in its assessment of actual impact on the engine due to lean operation and increased combustion temperature. Failure of EFI system components will result in high level CO exposure to consumers.

Whereas NIOSH studies of 2007 and 2011 regarding marine generators (see Attachment6) equipped with the same types of emissions control components proposed for portable generator applications, showed significantly higher CO emissions for 3-5 minutes during warm up. “It is important to note that despite complete degradation of the catalytic converter element, onboard environmental CO concentrations remained consistently low due to a well designed and installed stack exhaust.” These studies affirm that only the exhaust stack kept CO levels safe after 2 separate emissions control systems failed due to degraded catalytic converter element. The NPRM does not take into account ANY provisions to assure durability or feedback to the consumer that the reduced CO emissions rate system is working within proposed limits throughout the intended life of the product. CPSC must include additional requirements to assure the durability of this proposed solution and the effect of excluding accumulated CO during generator warm-up in enclosed spaces. More testing needs to be completed to determine the effect of CO production drift throughout the product life; it is not sufficient as a safety standard to maintain an emission rate only defined as throughout the useful life of the generator.

There are several concerns expressed by CPSC staff regarding a CO shutdown solution that is not similarly addressed in the NPRM for a reduced CO emissions solution. These include reliability, durability, fault detection, tampering, accuracy, sensor performance in different environmental conditions. These requirements must be considered to equally assess **all** alternatives considered and will have an impact on results of the analysis performed to date; an update to these is required per statutory requirements.

VIII. B. Response to Comments / Technical Requirements/Specifications

CPSC has proposed in this NPRM to limit Carbon Monoxide emissions levels to not exceed technologically feasible limits according to engine size. A test plan based upon EPA emissions testing and weighted power modes in ambient oxygen is proposed that does not consider cold engine start-up including catalyst light off and rich fuel mapping to keep running until normal operating temperatures are reached. Closed Loop EFI and Exhaust Catalysts are to be used to limit CO emissions without a supervisory control system to provide feedback or failsafe if a higher rate of CO is produced due to component failure or engine wear over time.

The NPRM outlines a prototype portable generator with both EFI and catalyst. The closed loop EFI prototype engine uses a narrow-band sensor to constantly cycle slightly rich and slightly lean necessitating the CO generated in the rich segment to be converted to CO_2 in the catalyst. If the catalyst ages significantly or fails, significant amounts of the engine exhaust CO will flow through the catalyst unconverted and exit the system. This is dangerous if there is no catalyst monitoring system to evaluate catalyst efficiency.

Catalysts remove CO from exhaust due to a chemical reaction that requires heat and also produces excess heat. If the air/fuel ratio has more fuel than the ideal Stoichiometric ratio, the excess fuel will limit the effectiveness of the catalyst and if uncorrected will, over time will irreversibly damage the catalyst. It is the closed loop EFI that must maintain very tight limits on the AFR to allow the catalyst to work well for many years. EFI alone has benefits to lawn and garden applications due to more precise fuel metering but still at typical richer air fuel ratios for air cooled engines. The two premium EFI portable generators on the market mentioned in the NPRM still use this richer air fuel ratio to help cool the engine to provide longer operational life and value for the consumer. Air cooled engine manufacturers know that there are no free tradeoffs and performance will be reduced while cost and weight will go up if this ruling is enacted.

The NPRM proposes to reduce CO emission rates using Closed Loop EFI and 3-way catalysts. The studies, as performed by UA, dismiss key technological feasibility issues. Portable generator compact sizing, air-cooling, and vibration have a substantial effect on EFI's impact to implementation costs, development, and overall performance.

EFI costs and efficiencies do not scale proportionally with respect to generator size. As displacement decreases, smaller fuel injectors and sensors are more difficult to design and manufacture. Packaging components, injector sizing and placement, max/min turn-down ratio, fuel impingement and wetting, mixture preparation create development challenges. Common single-cylinder portable generator engines range from about 420cc down to 50cc. The 389cc powertrain tested by CPSC has a relatively large cylinder displacements and combustion chambers compared to the full small utility engine segment. The CPSC demonstration engine only represents a single segment of the portable generator market, and does not represent Class 1 and smaller engines.

Closed Loop EFI can reduce CO production rate but the increased heat-release from lean combustion can be detrimental to a catalyst-equipped air-cooled engine's durability, performance, and emissions maintenance. In comparison to the stoichiometric 14.7 Air/Fuel ratio (AFR) used in closed-loop EFI, current carbureted or Open-Loop EFI engines utilize a more fuel-rich range of 10:1 to 13:1 AFR. The richer mixture increases power output and excess fuel helps displace heat from the combustion chamber, thus reducing exhaust gas temperature (EGT). This also results in more unburned hydrocarbons, more importantly, increased CO-emissions. Leaner Closed-Loop fuel mixtures near stoichiometric reduce CO emissions as hydrocarbon compounds have more complete chemical reactions via combustion. The exothermic reaction also produces greater heat release and no additional medium to displace it. Higher EGTs stress engine componentry, most notably the valvetrain and exhaust system, which directly impacts engine longevity.

Performance losses compound with increased operating temperatures. Less fuel creates less power. Combustion efficiency may increase, but total power output potential is reduced. The additional heat from lean combustion is transmitted both through the air-cooled engine cylinder and via exhausted gases. Exhaust Catalysts trap and store exhaust heat so that catalyzation occurs. Alternators are commonly packaged adjacent to the exhaust system. Added heat will directly impact the alternator's electrical output. CPSC noted acceptable durability results but also noted that maximum engine power was governed to about 80% of engine capability with EFI. The durability period used as the basis for this conclusion was 50% of the baseline useful life used by EPA for emissions compliance (i.e. 500 hours vs. 1000 hours), which may be inadequate criteria for the test if performed in 2017.

Dependence upon a catalytic converter as both a safety device (CO-emissions) and EPA regulation (NOx) device should be of great concern due to the risks of damage in accordance with stationary, air-cooled engine applications. Catalyst Degradation Factors over generator life-cycles are critical. How the Commission plans to monitor safe levels of CO and NOx after production testing has not been discussed. The potential for hazardous-to-life emission levels to go undetected is high. The possibility for the washcoat to be damaged by ash, bypassed oil, chemical poisons, and degradation is high due to the agricultural air-cooled engine's nature. Damage to the catalyst, whether chemical or mechanical, will result in bypassing an excess of harmful emissions to the environment. A damaged catalyst downstream of a lean-mixture closed-loop engine would not only produce an excess of CO, but also NOx. Maintenance of catalyst emissions over generator life is not addressed in the current standard.

Catalyst design is critical to function. Single-cylinder engines produce pulsating exhaust stream flows with non-homogeneous mixing. Sizing a catalyst to provide adequate backpressure and appropriate amount of precious metals along the washcoat is crucial to operation. Too much backpressure with high EGT's from lean combustion can irreversibly damage the washcoat, which provides the active precious metal sites where gaseous chemical conversions takes place. Bypass of oil and unburned fuel debris, or ash, can contribute to rapid and irreversible damage to the catalyst washcoat membrane.

Fig.5: Cold-Weather Operation: Ice Plugging On Oil Breather Tube (Typical)

Cold weather operation also threatens catalyst life. Air-cooled engines exhibit significantly poorer performance in sub-freezing temperatures which can significantly compromise emissions performance. Under certain circumstance, cold-weather operation is exacerbated by the freezing and subsequent blockage of the breather tube on the closed crankcase, which significantly increases oil blow-by into the exhaust (see Figure 5). If a genset continues to operate in sub-freezing temperatures, oil agglomeration on oxygen sensor and catalyst substrate surfaces will affect performance, compromising any technological advancement that industry achieves in meeting the stringent NPRM standard.

VIII. E. 1. Response to Comments / *CO Sensor Systems and Exhaust Pipe Extension /* Generator-Mounted CO Sensing Shutoff Systems
X. G. 3. Preliminary Regulatory Analysis / *Regulatory Alternatives* / Alternate Means of Limiting Consumer Exposure: Automatic Shutoff Systems

We believe that detection has significant advantages over the emissions reductions outlined in the NPRM. These advantages include:

- **Fatality Reduction Effectiveness** - Modeling and testing to date comparing shutoff versus emissions reductions are indicating that over twice as many deaths could have been avoided with a shutoff approach. This conclusion is preliminarily based on the data and models that have already been supplied from NIST through the FOIA request. This data was used to compare the effectiveness of a CO detection shutoff system to the NPRM proposed reduced emissions levels (see Attachment2). From this preliminary result it is clear that the shutoff approach is a superior approach to a reduced emission rate. With additional empirical testing and CONTAM modeling utilizing the NIST data files which were received the week of April 17th, Generac expects to show that the shutoff approach is a superior method to reduce the risks from the CO hazard.

- **Hazard Elimination** - Detection offers the advantage of being able to stop the hazardous condition altogether by shutting the generator off, before the CO levels become potentially lethal.
- **Alerting the consumer** - The shutoff system offers the advantage of annunciation. When the system recognizes the hazardous condition, not only is it possible to stop the generation of harmful CO, but it is also possible to provide an audible or visible alert to the occupants making them aware of the hazardous condition and notifying them to take appropriate action.
- **Universal Application** - The shutoff system is “scalable”. This type of system can be applied to ALL types of portable generators, regardless of size or intended purpose. Generac has tested prototype shutoff systems, and is able to achieve similar results on small handheld generators, liquefied propane generators, diesel generators, and very large V-twin sized engine generators. Emissions control systems are not available for, and cannot be applied to, all types and sizes of the commercially available generators today.
- **No Fuel Source Restrictions** - The shutoff system does not discriminate fuel type or source. As a result, the shutoff system will apply to all fuels that are used for portable generators, both now and in the future. Today there are no known emissions control systems that would allow the reduced CO thresholds to be met for many of these fuel types, and it is unclear what impact there will be as fuel blends evolve in the future.
- **Faster Implementation** - The shutoff system can be implemented much faster on product lines than the emissions reductions suggested by the NPRM. Our testing has already indicated that it will be possible to develop a single shutoff system that can be deployed on multiple generator models very easily. Emissions controls and catalysts would require complete re-development of the system for every engine, consuming far more resources and time. Generac’s product portfolio currently contains more than 25 unique engines.
- **Retroactive Application** - We believe it will be possible to develop shutoff system accessories that consumers could purchase and apply to their existing generators. Generators used for general purpose and home backup scenarios can be expected to have service lives more than 10 years. Our estimates also indicate there more than 10 million portable generators currently owned by consumers.
- **Lower Cost** – We understand the CO shutoff system approach to be the lower cost solution, which consequently will result in an increase in total benefits of the solution. Lower retail cost increases should facilitate improved adoption in retail when compared to a higher cost solution as costs are passed along to consumers.

"When CPSC completed the “Engine Driven Tools Phase 2 Test Report: Portable Generator Equipped with a Safety Shutoff Device”, released in July 2013, the goal was to “determine if an off-the-shelf CO alarm could be used to shut down a generator, thereby limiting the accumulation of CO in the generator operating space." CPSC Staff was able to demonstrate that a CO shutdown device would always shutdown the generator when operated in an enclosed space and in some partially enclosed spaces. Staff did note that generator-specific control algorithms may be required to account for rapid CO production. Analysis of the effectiveness of a shutoff device using a generator specific control algorithm is detailed in (See Attachment2).

The CPSC expressed their concerns after researching four different automatic shutoff methods and concluded that the option was not feasible. CPSC's comment in the NPRM reads: "Allowing the use of automatic shutoff systems…could result in greater reductions in CO poisoning for consumers. However, CPSC staff does not believe that an automatic shutoff is sufficiently proven to be feasible at this time." The NPRM listed four major unresolved concerns in regards to a shutoff solution which will be addressed here:

> "(1) Possibly creating a false sense of safety, which could lead to increased use of portable generators indoors;" (ref: pg 83603)

Generac shares the concern of creating a false sense of safety for use indoors. This is why Generac supports CO detection shutoff system with CO-danger notification feedback. Compare this side effect to a technology that only reduces CO emission rates. Remember: a generator is unsafe to operate indoors when the engine is running. Lowering CO emissions insinuates that the dangerous gas was reduced to a "safe" level. Generac believes that a CO-detection/shutdown solution effectively communicates that CO is a threat to user safety.

Marketing the CO-detection and shutdown device creates immediate contact education. Once a CO detection shutdown device activates and stops a user's generator, experience is gained. Furthermore, Generac expects that instances of activation of shutdown will cause commotion, and perhaps even complaints. These initial nuisances during misuse cases are actually positive learning experiences. A generator equipped with only low-CO emission equipment, however, will continue to emit CO into a room with reliance upon the user's previous education regarding indoor usage dangers.

> "(2) alternatives that require CO sensors falsely could identify hazards, which would detrimentally affect the utility of the generator when used in proper locations, and could lead to consumers overriding the mechanism;" (ref: pg 83603)

Generac recognizes the problematic issues of overly-sensitive detectors and nuisance tripping, which is why an algorithm is used to filter the sensor's environmental data. There is no such space that would be considered a proper location for operation if dangerous levels of CO exist.

This topic also raises another concern of dangerous CO emission levels created when running multiple generators in the same area. A CO-detector will sense unsafe levels of CO in an area, regardless of source type or quantity. Several recorded deaths involved more than one source of CO production. The use of CO shutdown is much safer than reduced CO emissions in these environments.

Overriding of the CO Detection Shutoff device would have several obstacles to overcome. First, simply disconnecting the wires to the device would render the engine unable to run. Second, by the use of tamper-resistant housings and fasteners specified in similar industries, the consumer would have to make very deliberate decisions to damage the generator and void the manufacturer's warranty.

> "(3) the system would have to be shown to be durable and capable of functioning after being stored for long periods and being used under widely different conditions;" (ref: pg 83603)

Sensor technology for CO detectors has made great advances within the past 5 years, in technology, durability, and commercial feasibility. While 5-year sensor life was once unheard of a decade ago, modern residential CO detectors are now available with 10-year life monitoring.

Generac believes the functional longevity of CO detectors is superior to the proposed EFI and catalyst solution. Automotive EFI systems have proven robust, but the industry benefits from economic scale of mass production costs and massive resources. Vibration-isolator mounted, multi-cylinder, and liquid-cooled engines have generally less harsh environments for componentry mounted to a small displacement single-cylinder air-cooled engines mounted in compact platforms. As packaging and engine sizes are reduced, miniaturization of components is necessary and becomes a design issue. Vibration and thermal cycling will challenge durability of any component mounted to the drivetrain of a generator.

The potential damage to catalytic converters used in an air-cooled portable generator application is a greater concern. Vibration can cause the mechanical support of the catalyst body to dislodge, allowing exhaust stream bypass.
Detectors may not only outlast the generator warranty, but also are replaceable and can be retrofitted.

> "(4) use of algorithms to shut off engines with ECUs would have to be engine-specific and tailored to each engine function, requiring a significant amount of additional testing on this system. These concerns would have to be resolved before a standard incorporating an automatic shutoff option could be developed." (ref: pg 83603)

While physical location in proximity to the generator's exhaust stream will require guideline, CO sensors need not be specific to the engine used. The CO detector only needs to sense the content of environment surrounding a generator, independent of engine size, generator type, fuel used, altitude, etc. This suggests an application-specific algorithm, rather than engine-specific. The detector only would be required to send a signal to shut the generator off when the area is considered dangerous. How that signal and action is performed (i.e. Grounding ignition coil) is to the discretion of the manufacturer, but would be similar in operation to a low engine oil switch.

Generac has demonstrated that a CO shutdown solution is feasible and can be made reliable in a portable generator application (see Attachment3, Attachment4).

The NPRM suggests that the "…use of algorithms to shut off engines with ECUs would have to be engine-specific and tailored to each engine function, requiring a significant amount of additional testing on this system." This is not necessarily true. The CO detection shutoff operation proposed by Generac and PGMA is independent of engine management. The shutoff system is actively monitoring the hazard regardless of generator size, fuel type, or intended purpose.

Challenges to implementation of shutoff technology mentioned in the staff's conclusion are similar to those faced for implementation of closed loop EFI. Rejection of the shutoff concept based on concerns about development and validation should be left to industry rather than CPSC. It should at least be considered as an alternative solution.

The NPRM considers alternatives to the emissions based approach such as detection. However, the data that was used to evaluate the robustness, reliability, and life of a shutoff approach is severely dated, being roughly 10 years old. There have been multiple advances in CO sensing devices that are directly applicable to the generator application. Generac's internal testing and data indicates a detection and shutoff device is feasible and reliable over the life of the generator. Generac offers the data presented by SPEC Sensors, LLC in the technical summit sponsored by PGMA and held at CPSC headquarters on April 3rd as evidence in support of our conclusions. (see Attachment3).

In order to evaluate CO sensing technologies in a much broader basis, (i.e. not limited to a single supplier such as SPEC Sensor, LLC) Generac has engaged Sagentia, a leading engineering sciences firm in the field of sensing and detection out of the UK, to complete a thorough evaluation of the suitability of electrochemical cell technology to the portable generator application. Their findings in the attached report indicate that the technology is more than capable of meeting the reliability challenges posed by the portable generator application (see Attachment4).

Sagentia BIO:

Sagentia Science Group was one of the founding companies to form the globally recognized Cambridge, UK high technology and engineering cluster. Sagentia is a global science, product and technology development company, and one of the specialist companies of Science Group.

Sagentia partners with clients in the consumer, industrial, medical and oil & gas sectors to help them understand the technology and market landscape, decide their future strategy, solve the complex science and technology challenges and deliver commercially successful products.

Core to their business is the fundamental understanding of technology. They have a diverse team of scientists and engineers who have developed products across medical, consumer, oil & gas and industrial sectors. Their Science and Technology team specializes in sensor development and integration. Their experience has included sensor design for chemical detection and air quality indication.

Additionally, it has been shown through numerous computer simulations using CONTAM software, as well as empirical testing, that a CO shutdown solution addresses nearly all fatalities resulting from misuse in enclosed spaces. An example of one such CONTAM simulation is provided in Figure 1.

In addition, a thorough evaluation of NIST TN1925 results data demonstrates that a shutoff device would be capable of shutting down a portable generator in every scenario that was modeled (see Attachment2). For the 503 deaths that were considered in the analysis, this approach would result in 100% of the potential deaths being averted. Given that a shutoff-type approach was demonstrated to be significantly more effective in the simulated scenarios, an updated investigation should be conducted to include simulation results for a shutoff approach in the CPSC's benefits analysis.

Considering that CO will continue to build with a reduced CO emission portable generator, and that CO will not continue to build with a CO shutdown solution, one can estimate the effectiveness of each proposal. Based on CPSC's review and analysis of data on CO fatalities, a reduced CO solution would result in an estimated 41% reduction in fatalities per the claim of the NPRM. A CO shutdown solution will address nearly all fatalities resulting from misuse in enclosed spaces, based on the modeling and testing conducted to date by multiple PGMA members. A portable generator that limits CO exposure by stopping the source of CO production will be more effective in preventing carbon monoxide deaths than a reduced CO emission solution when a portable generator is misused in an enclosed space.

The NPRM states that a CO shutdown solution would possibly create “a false sense of safety, which could lead to increased use of portable generators indoors.” This assertion is better aimed at the Low CO emission rate solution. The CO detection shutdown strategy has self-test requirements and supervision based on UL2034 that provides feedback to the consumer. There is no feedback required in the NPRM.

Additionally, the NPRM states, “…alternatives that require CO sensors falsely could identify hazards, which would detrimentally affect the utility of the generator when used in proper locations, and could lead to consumers overriding the mechanism”. The NPRM fails to account for alternatives available to the portable generator industry. Manufacturers will tailor control algorithms to the portable generator application. There are also many types of CO sensors in the marketplace with varying degrees of sensitivity to cross-contaminants. Each manufacturer has the ability to choose the most suitable sensor and algorithm for the application. These alternatives were discussed in detail during a public hearing held on March 8, 2017 at CPSC, as well as during the PGMA Technical Summit held on April 3, 2017 at CPSC. *An alternative that monitors the presence of the target hazard (CO) is the most reliable solution to detection of the hazard. The detection of an accumulation of CO is a reasonable occurrence to shut down the generator and consequently the production of CO; this would not be a "false" case.*

Many products and industries use guards and safety devices. While it is practically impossible to prevent every conceivable means of overriding these types of mechanisms, industry has shown that reasonable measures can be implemented to help prevent such action. An attempt to override a CO shutdown system would render the portable generator inoperable. Finally, it is important to note that a “false trip” is a fail-safe condition; i.e. a non-running generator eliminates the CO hazard. Further, if the sensor has shut down the generator as a result of a CO accumulation it is not a "false trip."

Page 83570 section VI (4) of the NPRM states “Staff expects that some additional, but unquantified deaths, could be averted in the remaining 24 percent of fatalities that were not modeled, especially in fatal incidents where a generator was operated outdoors, and/or, that had coexposed survivors.” A similar statement is found on page 83604 (H) “CPSC staff believes that some unquantified proportion of the remaining 156 deaths that were not modeled by NIST, because they occurred at non-fixed home locations (e.g., temporary structures such as trailers, horse trailers, recreational vehicles, or tents), and some that occurred when portable carbureted generators were operated outdoors, would have been prevented.” There has been no data presented in the NPRM supporting the claim that any deaths would have been averted from a generator running outdoors.

IX. A. Description of the Proposed Rule / *Scope, Purpose, and Compliance Dates—§ 1241.1*

"A one year effective date for portable generators with class 2 engines is too short, especially for portable generator manufacturers who do not manufacture their own engines. There must be enough time for the engine manufacturer to develop a solution, and then the portable generator manufacturer to redesign their machines to incorporate it, including any required EPA testing. Generac recommends effective dates of 3-5 years for proposed emission rate changes to all portable generator classes, which is in line with changes to EPA regulations. In Generac's survey response to the CPSC in 2016 it was stated that, "we are estimating that in order to comply with this rule across our entire product range of portable generators we estimate that it would consume our entire engineering product development team for a period of 6 years." The NPRM states "Because of the experience gained by engine manufacturers in recent years, the Commission thinks 1 year from the date of publication of the final rule would provide an appropriate lead-time for generators powered by Class II engines". Although some engine manufacturers may have experience with EFI, this does not include the implementation time needed for redesign, testing (including testing for the proposed CO limits in the NPRM), certification (EPA and CARB), tooling, etc. for potentially multiple families of portable generators. In addition, experience with commercial open-loop EFI systems not operating near stoichiometric air/fuel ratio may not carry over to closed-loop EFI near stoichiometric air/fuel ratio." In addition, the NPRM does not make any provision for extending the effective date for engines that may be challenging to comply with the proposed rule. For example, EPA provides "banking and trading" provisions in their final rules. (see Attachment7)

X. E. Preliminary Regulatory Analysis / *Benefit-Cost Analysis*

In TAB B of the CPSC report "Technology Demonstration of a Prototype Low Carbon Monoxide Emission Portable Generator" (September 2012), it states "mode 1 engine power delivery in the generator application was approximately 20 percent lower than estimates presented in Table 1". Reducing output generator electrical power by 20% effectively increases the generator cost by 20% as measured by the cost per unit of power, prior to consideration of the EFI costs. This effect may be even greater with smaller portable generators.

"It may be feasible for engine manufacturers to incorporate CO testing into their current EPA test requirements, but portable generator manufacturers that do not manufacture their own engines rely on the engine manufacturers for EPA certification. For these portable generator manufacturers, installing fuel injection in place of the carburetor that comes on the engine:

- Would increase the cost impact of this regulation by moving the burden of EPA certification from the engine manufacturer to the portable generator manufacturer.
- Would increase the cost impact of this regulation by not allowing the generator manufacturer to recover the cost of the carburetor as outlined in the NPRM.
- May void the engine manufacturer's warranty."

Deaths averted analysis completed using an interpolation of results to determine the benefit as it relates to the proposed emission rates, i.e. 125 g/h was simulated and not 150 g/h. Interpolation of the success rate of a binary criteria set (live/decease) should be replaced with simulation of proposed values to determine the deaths averted benefits. Furthermore, the simulation should consider the alternative sensitivity case limits presented in these comments to identify the cumulative impact of multiple variable extremes as there is evidence to suggest that reaching multiple extreme sensitivities is within reason.

"The aggregate annual benefits and costs of the rule are estimated to be about $298 million and $153 million, respectively." Evidence is required to outline how the alternative solutions investigated by the CPSC provide less benefit related to cost when compared to the proposed solution. See the enclosed net benefit sensitivity analysis review included in these comments. Generac's review of the proposal and use of the NPRM process to outline superior alternative results are included.

"The Commission considered less burdensome alternatives to the proposed rule on portable generators, but preliminarily concluded that none of these alternatives would adequately reduce the risk of injury." The NPRM suggests that the proposed solution will result in simulated lives saved success of 41.4%. Evidence is required to outline how the alternative solutions investigated by the CPSC provide a less adequate solution when compared to the proposed solution. See the enclosed net benefit sensitivity analysis review included in these comments. Generac's review of the proposal and use of the NPRM process to outline superior alternative results are included.

The impact of the following factors is not considered in the NPRM benefit analysis:

- If portable generator prices increase, the replacement cycle will be much longer as consumers would prefer to repair and maintain older units instead of replacing them. This has been seen in other products such as low-flow shower heads and reduced volume toilets. Additionally, the market for some products, particularly smaller wattage units, would completely disappear if higher prices resulted, leaving some consumers without an option for backup power. This means the high cost of regulation results in reluctance and delay of adoption of new generators. Consumer acceptance will improve with low or neutral cost alternatives, resulting in improved safety.
- Safety Factor evidence should be provided that illustrates that the chosen values account for the compounding effects of impairment, and human factors choices (i.e. escape path).
- "Catalyst failure rates with list of failure modes
- Outline of manufacturer's discretion choices in design decision that will impact CO emission rates outside of the test procedure defined.
- O2 sensor failure rates and unintended consequence
- Generac data of field history; catalyst and O2 sensor issues/failures"

Net Benefit Sensitivity Analysis

The NPRM presents sensitivity analysis documenting the expected net benefits (i.e. benefits minus costs) change per generator with sensitivity considerations to 5 input variables used within the benefit and cost calculations. The variables include: expected product life, discount rate, cost estimates, value of a statistical life, and effectiveness at reducing injuries. In our review of this study Generac disagrees with the base case assumption factors of the following sensitivity values: expected product life, cost estimates and effectiveness. The expected net benefits of a CO shutoff system solution are far superior to the proposed NPRM solution. The NPRM does not consider or report any cases in which more than one input variable is considered in a cumulative analysis. While this approach may not be required these comments will outline the high likelihood that several of the proposed variable inputs will be compounded to result in a net negative expected benefit outcome for the NPRM proposed solution. This will prove that the least burdensome approach is a shutoff solution and not a reduced emission rate.

NPRM Proposed Base Case Inputs:

- 3% Discount Rate
- Portable Generators in Use
- VSL= $8.7 million per statistical life
- Expected product life (years): 11 years
- Compliance Costs & Lost Consumer surplus per unit ranging from $112-$139
- Estimated reduction in addressable deaths (and injuries) ranging from ~ 17% for 2-cylinder Class II engines to ~49% for Class I engines.

Shorter Expected Product Life:

This review will not contest the basis for the 11 year life assumption.

Factors which will result in the realization of a shorter life (Row A) and a reduction in net benefit for the proposed NPRM include: increased system complexity with EFI system components, higher operating temperatures from lean combustion operation, structural integrity of exhaust system, catalyst and mounting hardware resulting from higher temps and catalyst heat storage. Comments submitted related to the failure of head gaskets in two cases reported in "Prototype Low Carbon Monoxide Emission Portable Generator Build Description and Performance Evaluation, The University of Alabama, Tuscaloosa, AL, July 2011," support the conclusion that reduced engine and generator life can be expected as a result of steady state failures. Generac has measured exhaust gas temperatures and monitored spark plug thermocouples showing higher temperatures. These higher temperatures will require redesign with higher cost and higher quality materials in order to attempt the de-rated output at the same life.

Cost Estimates:

The NPRM uses an alternative input of 50% higher cost than the proposed base case for each engine/class type. Factors which will result in the realization of a 50% higher than base case estimate (Row D) include several categories of cost. Cost of compliance for components were reported to CPSC through a manufacturer survey that included higher than baseline costs for: EFI components, catalyst and generator design changes which were not accounted for in the EPA estimate used. Through Generac's survey response the cost reported to the CPSC was 50% higher for the EFI related component costs and carburetor credit. The catalyst cost range was reported as more than 300% greater on the lowest size and more than 600% greater on the largest size in our product range. Our most common product would use a catalyst with an estimated cost greater than 60% the highest estimated catalyst cost reported by the EPA. Further costs which

Generac believes would be required for thermal management would add to the estimated cost overage when compared to the base-case estimate. It is evident that the material cost alone will exceed the base-case estimated by the NPRM.

Additionally, the cost-benefit analysis does not take into account manufacturing labor or overhead costs associated with the additional components resulting from EFI. Further, the estimate assumes that the additional product cost is passed directly to the consumer with no mark-up. The CPSC questioned in the manufacturer survey if a 29% markup was appropriate for engine manufacturers selling to generator manufacturers however chose to include no markup for those engine sales or markup to consumers in retail. This assumption is wrong and underestimates the cost to consumers and retail. Additionally it will increase the cost of consumer surplus. These cost estimates provided do not include the significant impacts that will be realized by our supply chain partners.

Finally, the implementation of EFI would result in higher warranty cost to manufacturers of portable generators as a result of the system design complexity increases. Removal of a carburetor and replacement with and ECU, fuel injector, throttle body, multiple sensors, exhaust modifications, additional wiring harnesses, charging systems, fuel management and delivery systems and engine modifications are undoubtedly more complex than a generator design in use today.

In contrast, Generac expects the costs to comply with a carbon monoxide detection shutoff system to be <u>*5-8x less costly*</u> than the compliance cost of the NPRM proposal.

<u>Effectiveness at Reducing Injuries:</u>

The NPRM uses alternate input values of 25% less (Row G) and 25% more (Row H) effective than estimated in the baseline solution. Generac has reviewed the assumptions made in the assessment of the solution proposed in the NPRM and has also analyzed the alternative shutoff solution effectiveness utilizing the death's averted analysis used by the CPSC in the NPRM.

Generac disagrees with the NPRM on several assumptions made that will directly impact the proposed effectiveness and will result in the realization or worsening of the 25% less effective sensitivity input. First, the effectiveness of the solution will be reduced based on the premise that all proposed victims will recognize the onset of CO poisoning and the building CO hazard and remove themselves from the hazardous situation. This is a misguided assumption. Generac conducted a review of <u>all</u> fatal incidents from 1999-2011 received through a FOIA request. Within that review it was found that at least 27% of all fatal incidents that occurred from 1999 -2011 involved at least one person who was impaired. This means a drug known to impair judgment was found in their blood during autopsy (i.e. alcohol, illegal drugs or prescription drugs known to impair judgment). These victims in an impaired state cannot be counted on to make a rational decision which needs to be taken into account. An impaired person would clearly be less likely to recognize a CO hazard and take appropriate action and thus the effectiveness of the solution and victim deaths averted should be reduced in the benefits analysis by at least 27%.

Other factors which were not considered relate directly to the operation of the generator and the corresponding CO output in the simulated cases of the proposed solution. A closed-loop EFI generator with catalyst will produce higher amounts of carbon monoxide at start-up. This factor should be investigated further to understand the breadth of performance across all generator classes while considering the design options available to meet the required steady state emission rates proposed. The inclusion of a higher proposed rate is required to capture the real world conditions of CO produced during start-up preceding catalyst light-off and during transient load conditions. EFI programming logic is only as robust as the development behind it. The potential exists for a closed-loop EFI system to operate “outside of the map.” There are also conditions and manufacturer programming factors that will lead to the unit switching to open-loop or enriching fuel mixture as a fallback condition to protect the engine. For example, when an EFI system's sensors detect an engine overheat condition the programmed response could demand that the fuel delivery be increased. This is a common method used to lower the combustion temperature and allow the temperature to recover to an acceptable level. The consequence of this change in fuel delivery is an increase in the CO emission rate above what is required by the NPRM proposed steady-state test. These operating condition factors should be analyzed to determine the impact on the CO rate produced and the results included in an updated simulation of the TN1925 study. The NPRM has stated that a benefit of EFI will be improved runtime as a result of fuel efficiency gain, but has not modified the runtime used in the proposed simulation of deaths averted to match those gains. Instead the runtime for carbureted generators was used in the NIST TN1925 study to determine the deaths averted. The longer run time available as a result of EFI will increase the exposure duration to victims and should be analyzed to determine the impact on victim COHb %.

Finally, the effectiveness of the solution should account for the likelihood that there will be some instances of emission system failures which are not protected against in the proposed NPRM. Consumers will be unaware of mechanical failures of sensors, exhaust system connections, or catalyst failures. These potential issues have been presented in our comments and must be considered as contributing factors to the effectiveness of the proposed NPRM. The analysis performed on "less stringent" emission regulation found the benefits to be less effective and thus some loss in effectiveness is likely when mechanical failure modes are considered. These failures will result in an ineffective solution and must be accounted for.

In the presentation of these potential items which will negatively impact the effectiveness of the proposed solution Generac believes that the proposed solution will be *at least 25%* less effective that the base-case analysis. The NIST TN1925 analysis used as the basis for the NPRM benefits should be repeated while accounting for:

- victim awareness and impairment
- higher in use CO production during startup, transient conditions and foreseeable programming conditions that increase ECU fuel demand
- extended run time from gains in fuel efficiency, and
- the potential for mechanical failure of any component that would negatively impact the CO emission rate.

A shutoff solution will result in a greater than 25% increase in effectiveness at reducing injuries and deaths. This result was investigated by Generac utilizing the NIST TN1925 simulation results and analysis of the simulation result files from that study. Using an example of an application specific algorithm it can be demonstrated that a shutoff solution will provide 100% effectiveness in averting deaths in the cases that were simulated for the NPRM analysis. This result means that *all* of the 503 deaths analyzed for the benefits analysis would have resulted in a survival outcome from the simulation using the criteria established by the NPRM benefits analysis. In contrast this is compared to the success rate of the proposed solution; 208 of 503 deaths averted, resulting in a 41.4% effectiveness. In terms of the sensitivity analysis provided the alternative solution would only require an improvement of 52 additional deaths averted; 260 of 503, to capture the full higher effectiveness benefit. Given that the alternative is estimated to avert all 503 deaths simulated; or a ~ 242% effectiveness increase, Generac will assume with 100% probability that the alternative will exceed the 25% higher than base-case effectiveness within the sensitivity study. The NIST TN1925 analysis used as the basis for the NPRM benefit analysis should be repeated to compare the result of a CO shutoff system to the updated results of the NPRM proposed solution.

Base-Case Analysis Sensitivity Results with Net Expected Benefit Deltas:

ROW	Input Variable and Value(s) Used in Sensitivity Analysis	Handheld	DELTA	Class I	DELTA	1-cyl Class II	DELTA	2-cyl Class II	DELTA
		Net Benefits per Generator, by Portable Generator Engine Class/Type							
ROW	BASE CASE ANALYSIS	$122		$137		$101		($135)	
	Expected Product Life								
A	Shorter Expected Product Life: 8 yrs	$107	($15)	121	($16)	88	($13)	-135	$0
B	Longer Expected Product Life: 15 yrs	144	$22	161	$24	124	$23	-134	$1
	Discount Rate								
C	7% Discount Rate	$66	($56)	78	($59)	52	($49)	-136	($1)
	Cost Estimates								
D	50% Higher than base-case for each class/type	61	($61)	78	($59)	45	($56)	-204	($69)
	Value of a statistical Life								
E	Lower VSL: $5.3M	48	($74)	60	($77)	36	($65)	-136	($1)
F	Higher VSL: $13.3M	221	$99	241	$104	189	$88	133	$268
	Effectiveness at reducing injuries								
G	Lower Effectiveness: 25% lower than estimated	62	($60)	75	($62)	49	($52)	-136	($1)
H	Higher Effectiveness: 25% higher than estimated	185	$63	202	$65	157	$56	-134	$1

Figure 6: *Table illustrates the variable values and resulting benefit/cost deltas from NPRM Sensitivity Analysis*

The net expected benefits of the proposed NPRM solution were adjusted based on the rationale provided to include the compounded impact of multiple sensitivity variables. The results shown in Figure 7 identify a range of net expected benefits per generator of $0 to -$205 with *no positive benefit* on any class type generator.

ROW	**Proposed NPR Rule:** Mostly Likely Input Variables and Sensitivity Analysis Value Adjustment	Handheld	Class I	1-cyl Class II	2-cyl Class II	Rationale Points of Most Likely Cases
		Net Benefits per Generator, by Portable Generator Engine Class/Type				
ROW	BASE CASE ANALYSIS NET EXPECTED BENEFITS	$122	$137	$101	($135)	
	Expected Product Life					
A	Shorter Expected Product Life: 8 yrs	($15)	($16)	($13)	$0	Complexity, Higher Operating Temperatures, Increased Probability of Mechanical Failures
	Cost Estimates					
D	50% Higher than base-case for each class/type	($61)	($59)	($56)	($69)	Higher EFI, Catalyst and Component Design Cost, Labor and Overhead, Warranty, Retail Markup, Consumer Surplus
	Effectiveness at reducing injuries					
G	Lower Effectiveness: 25% lower than estimated	($60)	($62)	($52)	($1)	Impairment Effecting Awareness, Underestimated CO Production, Emission Component Failure(s)
	ADJUSTED EXPECTED NET BENEFITS (per Generator)	**($14)**	**$0**	**($20)**	**($205)**	Adjusted Values may Decrease Further if Effectiveness is Proven to be More Than 25% Lower

Figure 7: *Table illustrates the negative adjusted net benefit per unit for the Proposed NPRM solution and rationale for benefit sensitivity adjustments*

The net expected benefits of the alternative shutoff solution studied by Generac were adjusted based on the rationale provided to include the compounded impact of multiple sensitivity variables. The results shown in Figure 8 identify a range of net expected benefits per generator of -$74 to $262 with *positive benefit on all* class type generators other than the 2-cylinder Class II generator.

ROW	**Alternative Shutoff:** Mostly Likely Input Variables and Sensitivity Analysis Value Adjustment	Handheld	Class I	1-cyl Class II	2-cyl Class II	Rationale Points of Most Likely Case
		Net Benefits per Generator, by Portable Generator Engine Class/Type				
ROW	BASE CASE ANALYSIS	$122	$137	$101	($135)	
	Cost Estimates					
D	5-8x Lower Cost of Compliance (Minimum $60+)	$60	$60	$60	$60	Generac Estimated Compliance Cost is Less Than 50% of the Proposed Base-Case for Each Class/Type
	Effectiveness at reducing injuries					
H	Higher Effectiveness: 25% higher than estimated	$63	$65	$56	$1	Generac Estimated Effectiveness
	ADJUSTED EXPECTED NET BENEFITS (per Generator)	**$245**	**$262**	**$217**	**($74)**	Benefits Expected to be Higher Than Adjusted Values; Further Simulation Required

Figure 8: *Table illustrates the positive adjusted net benefit per unit for Generac's Shutoff Solution and rationale for benefit sensitivity adjustments*

In summary, the high potential for negative net expected benefit adjustments to the base-case analysis of the NPRM proposed solution contrast those of the alternative shutoff solution. As shown; in Figure 9, the alternative of a shutoff solution is the superior and least burdensome approach to the NPRM proposed solution and requires further investigation rather than outright dismissal from the CPSC. Generac expects that these results will be confirmed in the final regulatory analysis forthcoming.

EXPECTED NET BENEFITS (per Generator)	Handheld	Class I	1-cyl Class II	2-cyl Class II
Proposed Base Case Analysis	$122	$137	$101	($135)
ADJUSTED Proposed	**($14)**	**$0**	**($20)**	**($205)**
ADJUSTED Shutoff	**$245**	**$262**	**$217**	**($74)**

Figure 9: *Table illustrates the superior adjusted net benefit per unit results for Generac's Shutoff Solution compared to the proposed NPRM solution*

Generac has been, and will remain committed to, developing the best solution to this hazard. We believe that solution is a CO detection and shutoff system for the reasons expressed here today. As our development of both the ANSI G300 standard revisions and the product designs continue to progress, we feel that this will become even more evident.

We ask that the Commission suspend the rulemaking process, to allow us the time to continue working with PGMA and others, to fully develop and complete the revision to ANSI G300. These activities have made great progress to date, and Generac offers its assurances that we will continue to drive forward with the same energy and commitment in order to complete the process quickly. Suspending the rulemaking would allow us to share our efforts, and avoid the unnecessary duplication of efforts that has been slowing progress to date.

The questions related to the unintended consequences that might arise as a result of this rule have been raised on multiple occasions, but have not been adequately addressed by CPSC. Generac is concerned that there has been no analysis completed to insure that the substantial increase in cost of portable generators resulting from this rule will not limit the population of people who will be able to afford a generator if they need to purchase one. One of the primary and most extensive uses for portable generators is in response to emergencies, where power to the home is no longer available. As indicated in the NPRM, power outages from weather driven emergencies can last for several hours to days. In these cases, portable generators are commonly used to power household appliances such as HVAC systems for both heat and air depending on the season, and well pumps which provide water to the home. As an example, the loss of air conditioning in the summer months during an extended power outage can allow for temperatures in the home to climb to very unsafe levels where heat stroke, heat exhaustion, and other heat related illnesses can occur. Heat related injuries can be more common for elderly or those with certain medical conditions. On average 113 people die every year from weather related heat and 32 from cold. (ref: http://www.nws.noaa.gov/om/hazstats.shtml) We saw this very situation during the Derecho event that took place in the US in June of 2012. During that event, 22 heat related deaths were caused as a result of the 5 million people who were without power. (Pierobon 2012). What is unclear is how many heat related potential deaths and injuries were avoided as a result of a portable generator being used to supply emergency power for the air conditioning to operate. We offer this as a single example where portable generators are actually used to protect life and other items of value such as food contained within a refrigerator. We believe CPSC is obligated to quantify the full impact resulting from the substantial cost increase on affordability and resulting in reduced availability of backup power in emergency situations, where life can be threatened. We believe the CPSC should study and address this concern. Alternatively, support for an automatic shutoff, which will not have the same substantial cost burden and result in reduced affordability, could be considered as a more appropriate solution.

There are other potential unintended consequences that could result from this rule that should also be evaluated. Generac is concerned that, with any product related solution to this problem, there will be a population of consumers who, based on seeing that the product has CO mitigation technology, will believe that it is safe to operate their generator indoors, and begin doing so when they otherwise would not have. Thus, the frequency of indoor use will rise. The analysis in the NPRM suggests that the rule will result in roughly 33% of the deaths that occur from improper use of generators in enclosed spaces. By contrast, we have shown through our previous separate comments that a detection based approach can prevent nearly all of the deaths resulting from the same conditions. There will be substantial difference in the impact of this unintended consequence depending upon which strategy is used to mitigate the hazard; reduced emissions or automatic shutoff. As a simple illustration using these assumptions, three consumers operate their reduced emissions generators indoors as a result of believing it is now safe to do so, two of them would likely be killed. By contrast, if the same three consumers operate their automatic shutoff generators indoors all three would likely survive.

The last comment we offer on this topic is the unintended consequence differences between detection and emissions resulting from feedback, or lack thereof in the case of the proposed emissions rule. The detection and shutoff approach offers the advantage of hazard identification and subsequent notification to the consumer. In the event that a consumer attempts to operate the generator in an enclosed space where exhaust gases containing CO are allowed to build to unsafe levels, the shutoff would disable the generator and then annunciate the hazardous condition to the consumer. It is also possible that the hazard condition could latch into an “off” state until the consumer performed a “reset” action ensuring that the consumer understood the reason for the shutoff. It may not always be possible to identify the location where the generator is chosen to operate is a “safe” location or not. In cases where consumers operate shutoff equipped generators in unsafe locations, whether obviously so or not, they will essentially be getting “trained” by the feedback from the shutoff system that the location in question is not safe, and it is likely they will take steps to identify a safe location where the generator doesn’t shutoff giving them feedback once again as to where it is safe and where it is not safe to operate the generator. It is also likely that in future situations where the generator is used they will begin operating it in the previously learned safe locations. The emissions approach is passive and does not give any feedback as to whether the generator is in a safe or unsafe operating location. Thus, it is not possible to “train” consumers where to properly operate their generators.

This illustrates that the potential for unintended consequences will be influenced by the technological path chosen.

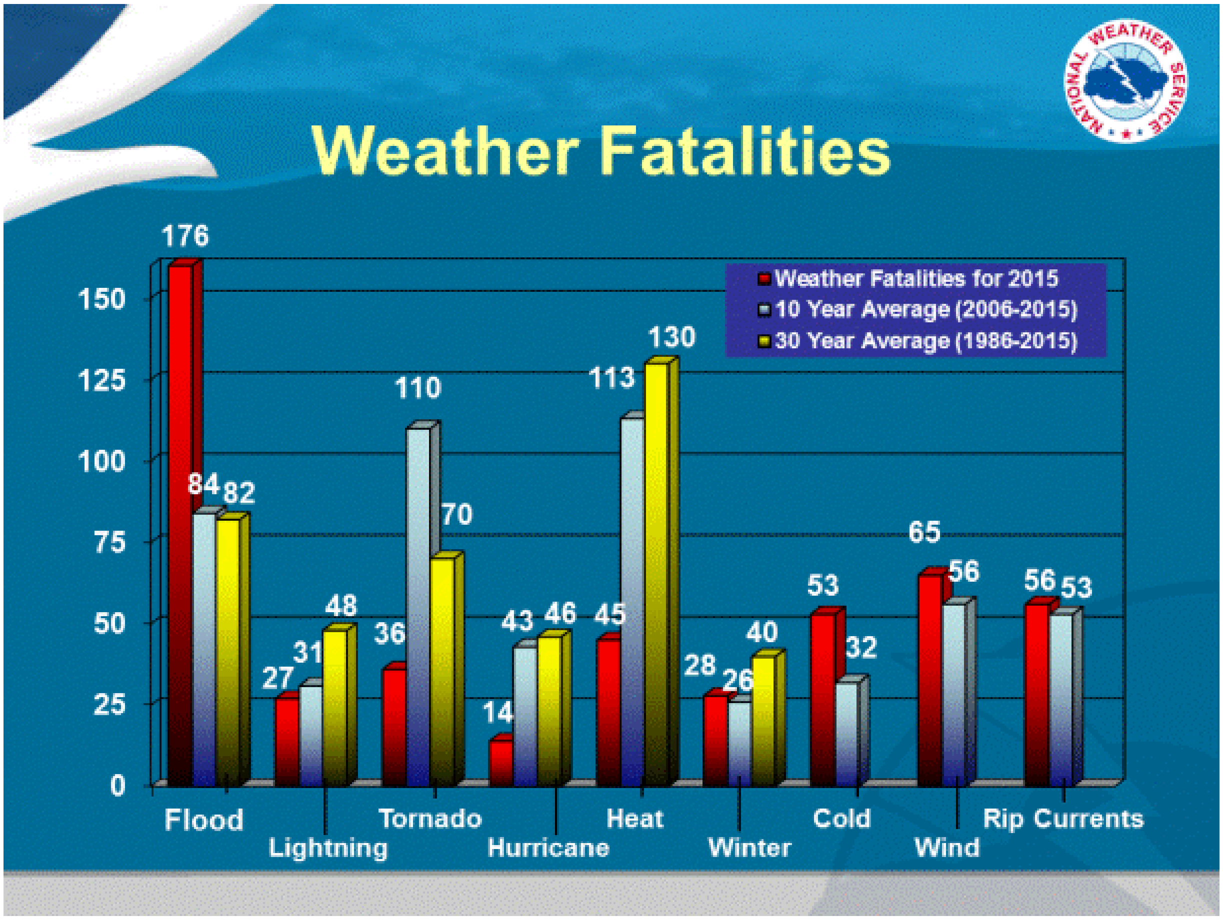

Figure 9: *Statistic from Office of Services and the National Climatic Data Center*

As seen in Figure 9: There were 1,021 heat-related deaths in 1995. Eighty-nine percent of the deaths occurred in permanent homes, with only five percent in the open.

References

[Attachment2] Carbon Monoxide Sensing Automatic Shutoff Device
[Attachment3] SPEC Sensors CO Sensors for Portable Generators
[Attachment4] Sagentia Report for Generac CO Sensor Apr-24-17
[Attachment5] Generac IDI Report Review
[Attachment6] EPHB 289-14a_CDC Houseboat Survey
[Attachment7] Generac NPRM Comments Emissions Apr 22 2017
[8] S. Emmeich *et al.*, "Modeling and measuring the effects of portable gasoline powered generator exhaust on indoor carbon monoxide level," NIST, Gaithersburg, MD, Technical Note 1781, Feb. 2013. Available: http://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.1781.pdf.