UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
4330 EAST WEST HIGHWAY
BETHESDA, MD 20814

This document has been electronically approve and signed.

DATE: August 12, 2020

BALLOT VOTE SHEET

TO: The Commission
Alberta E. Mills, Secretary

THROUGH: John G. Mullan, General Counsel
Mary T. Boyle, Executive Director

FROM: Hyun S. Kim, Acting Assistant General Counsel
Barbara E. Little, Attorney, OGC

SUBJECT: Notice of Availability – "Revisions to the Plan Documented in NIST Technical Note 2048: *Simulation and Analysis Plan to Evaluate the Impact of CO Mitigation Requirements for Portable Generators*"

BALLOT VOTE DUE Tuesday, August 18, 2020

The Office of the General Counsel is providing for Commission consideration the attached draft notice of availability of "Revisions to the Plan Documented in NIST Technical Note 2048: *Simulation and Analysis Plan to Evaluate the Impact of CO Mitigation Requirements for Portable Generators*."

Please indicate your vote on the following options:

I. Approve publication of the attached document in the *Federal Register*, as drafted.

__________________________ __________________
(Signature) (Date)

II. Approve publication of the attached document in the *Federal Register*, with the specified changes.

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(Signature) (Date)

III. Do not approve publication of the attached document in the *Federal Register*.

______________________________ _____________________
(Signature) (Date)

IV. Take other action specified below.

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(Signature) (Date)

Attachment: Draft *Federal Register* Notice of Availability of "Revisions to the Plan Documented in NIST Technical Note 2048: *Simulation and Analysis Plan to Evaluate the Impact of CO Mitigation Requirements for Portable Generators*"

Billing Code 6355-01-P

CONSUMER PRODUCT SAFETY COMMISSION

[Docket No. CPSC-2006-0057]

Notice of Availability: Revisions to the Plan Documented in NIST Technical Note 2048: *Simulation and Analysis Plan to Evaluate the Impact of CO Mitigation Requirements for Portable Generators*

AGENCY: Consumer Product Safety Commission.

ACTION: Notice of availability.

SUMMARY: In July 2019, the Consumer Product Safety Commission (CPSC) announced the availability of, and sought public comment on, a document related to CPSC's efforts to address carbon monoxide poisoning hazards from portable generators: NIST Technical Note 2048: *Simulation and Analysis Plan to Evaluate the Impact of CO Mitigation Requirements for Portable Generators* (NIST TN 2048). The CPSC is announcing the availability of "Revisions to the Plan Documented in NIST Technical Note 2048: *Simulation and Analysis Plan to Evaluate the Impact of CO Mitigation Requirements for Portable Generators,"* a memorandum documenting CPSC staff's revisions to the plan in NIST TN 2048, resulting from CPSC and National Institute of Standards and Technology (NIST) staffs' review and analysis of public comments on the plan.

ADDRESSES: "Revisions to the Plan Documented in NIST Technical Note 2048: *Simulation and Analysis Plan to Evaluate the Impact of CO Mitigation Requirements for Portable Generators,"* is available on the CPSC website at: [INSERT LINK]. The document will also be made available through the Federal eRulemaking Portal at https://www.regulations.gov, under Docket No. CPSC-2006-0057, Supporting and Related Materials. Copies are also available from the Consumer Product Safety Commission, Division of the Secretariat, Room 820, 4330 East West Highway, Bethesda, MD 20814; telephone: 301-504-7479; email cpsc-os@cpsc.gov.

FOR FURTHER INFORMATION CONTACT: Janet Buyer, Project Manager, Directorate for Engineering Sciences, Consumer Product Safety Commission, 5 Research Place, Rockville, MD 20850; telephone: 301-987-2293; e-mail: jbuyer@cpsc.gov.

SUPPLEMENTARY INFORMATION:

The CPSC is engaged in an ongoing effort to address carbon monoxide (CO) poisonings of consumers from portable generators.[1] NIST staff and CPSC staff developed a plan that would enable CPSC staff to estimate the effectiveness of CO-mitigation requirements adopted in two voluntary standards in 2018: *ANSI/PGMA G300-2018, Safety and Performance of Portable Generators* (PGMA G300) and *ANSI/UL 2201-2018*, *Carbon Monoxide (CO) Emission Rate of Portable Generators* (UL 2201). PGMA G300 has requirements for a system that will shut off the generator when specific CO concentrations are present near the generator, as well as notification requirements to alert the user to the presence of CO after the generator has shut off. UL 2201 has requirements for a system that will shut off the generator when specific CO concentrations are present near the generator and a requirement for a reduced CO emission rate.

NIST TN 2048 is intended to provide a reasonable test of how generators complying with each standard operate in a wide range of conditions. In July 2019, the Commission announced the availability of, and sought public comment on, NIST TN 2048 (84 FR 32729 (July 9, 2010)). On August 8, 2019, CPSC staff hosted a public meeting to allow interested parties to ask clarifying questions about information in NIST TN 2048, to assist the interested parties in

[1] On November 21, 2016, the Commission published a notice of proposed rulemaking (NPRM) to address the CO hazard associated with portable generators. (*Safety Standard for Portable Generators,* 81 FR 83,556).

providing their comments.[2] NIST TN 2048 is available on NIST's website at: http://dx.doi.org/10.6028/NIST.TN.2048, and from the Commission's Division of the Secretariat, at the location listed in the **ADDRESSES** section of this notice.

Four sets of comments were submitted into the docket on regulations.gov in response to the Notice of Availability of NIST TN 2048.[3] The purpose of CPSC staff's memorandum, "Revisions to the Plan Documented in NIST Technical Note 2048: *Simulation and Analysis Plan to Evaluate the Impact of CO Mitigation Requirements for Portable Generators*," is to document staff's revisions to NIST TN 2048 resulting from CPSC and NIST staffs' review and analysis of the comments. CPSC staff's memorandum is available at: [INSERT LINK], at: https://www.regulations.gov, under Docket No. CPSC-2006-0057, Supporting and Related Materials, and from the Commission's Division of the Secretariat. Staff is working with NIST to execute the revised simulation plan.

Dated:

Alberta E. Mills, Secretary
Consumer Product Safety Commission

[2] U.S. Consumer Product Safety Commission Log of Meeting, dated August 8, 2019. Available online at: https://www.cpsc.gov/s3fs-public/2019-8-8%20%20Public%20Meeting%20to%20Answer%20Clarifying%20Questions%20on%20NIST%20TN%202048.pdf?wcYot3.N1c5yJ686gJjiRPNaPOteO1I8.

[3] The comments are available online at: www.regulations.gov, under docket CPSC-2006-0057.

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
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BETHESDA, MD 20814

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MEMORANDUM

DATE: August 12, 2020

TO : The Commission
Alberta Mills, Secretary

THROUGH: Mary Boyle, Executive Director

Duane Boniface, Assistant Executive Director
Directorate for Hazard Identification and Reduction

Mark Kumagai, Associate Executive Director
Directorate for Engineering Sciences

FROM : Janet Buyer, Project Manager
Division of Mechanical and Combustion Engineering, Directorate for Engineering Sciences

Matthew Hnatov, Mathematical Statistician
Division of Hazard Analysis, Directorate for Epidemiology

Matthew Brookman, Mechanical Engineer, P.E.
Division of Mechanical Engineering, Directorate for Laboratory Sciences

Sandra Inkster, Ph.D.
Division of Pharmacology and Physiology Assessment, Directorate for Health Sciences

Tim Smith, Senior Human Factors Engineer
Division of Human Factors, Directorate for Engineering Sciences

SUBJECT : **Revisions to the Plan Documented in NIST Technical Note 2048: *Simulation and Analysis Plan to Evaluate the Impact of CO Mitigation Requirements for Portable Generators***

Background

In July 2019, staff of the U.S. Consumer Product Safety Commission (CPSC) and the National Institute of Standards and Technology (NIST) published a plan[a] for CPSC staff to evaluate the effectiveness of the carbon monoxide (CO) poisoning mitigation requirements adopted in 2018. The CO poisoning mitigation requirements were set forth in two U.S. voluntary standards for portable generators: *ANSI/PGMA G300-2018 (Errata Update), Safety and Performance of Portable Generators* (referred to as PGMA G300),[b] and *ANSI/UL 2201-2018, Carbon Monoxide (CO) Emission Rate of Portable Generators* (referred to as UL 2201). This evaluation plan does not—nor could it—replicate every home, condition, and generator operation. Rather, the evaluation plan is intended to provide a reasonable test of how generators that comply with each standard operate in a wide range of conditions, drawing upon scenarios identified by staff in incident data reviews.

Through a Notice of Availability published in the *Federal Register* on July 9, 2019, the Commission solicited public comments on the plan, documented in NIST Technical Note 2048: *Simulation and Analysis Plan to Evaluate the Impact of CO Mitigation Requirements for Portable Generators* (referred to as TN 2048). The 60-day comment period closed on September 9, 2019.[c] During the open comment period, staff hosted a public meeting on August 8, 2019 to allow interested parties to ask staff clarifying questions about TN 2048 to help them formulate their comments.[d] We received four sets of comments in response to the FR notice.[e]

The purpose of this memorandum is to document staff's revisions to TN 2048, resulting from CPSC staff's and NIST staff's review and analysis of the comments. Appendix B contains staff's detailed summary of the comments and staff's responses, including the bases for the revisions summarized here.

Revisions to TN 2048

Section 3. Building Models

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[a] Emmerich, SJ, et al., NIST Technical Note 2048: *Simulation and Analysis Plan to Evaluate the Impact of CO Mitigation Requirements for Portable Generators*. (Available online at: http://dx.doi.org/10.6028/NIST.TN.2048).

[b] ANSI/PGMA G300-2018, *Safety and Performance of Portable Generators*. (Available online at: https://www.pgmaonline.com/pdf/ANSI_PGMAG300-2018 (ErrataUpdateApril2020).pdf.

[c] *Notice of Availability: Plan to Evaluate CO Mitigation Requirements for Portable Generators*, Federal Register, 84 FR 32729, July 9, 2019.

[d] U.S. Consumer Product Safety Commission Log of Meeting, dated August 8, 2019. Available online at https://www.cpsc.gov/s3fs-public/2019-8-8%20%20Public%20Meeting%20to%20Answer%20Clarifying%20Questions%20on%20NIST%20TN%202048.pdf?wcYot3.N1c5yJ686gJjiRPNaPOteO1I8.

[e] The comments are available online at www.regulations.gov, under docket CPSC-2006-0057, document identification numbers 0101 through 0104.

Staff added exterior doors to house models that do not have an exterior door between the kitchen and the outside. This door was added to the back side of the house (side of house opposite the side with the front door), with the exception of houses DH-45(mod) and DH-45. For these two houses, the dining room and kitchen in the floorplan were switched, and an exterior door was added on the left side of the house, entering the room that was the dining room, and is now the kitchen.

Staff also added a window to the workshop room in the detached garage model GAR3. The opening size of the window measures 0.8 m wide x 0.3 m high.

Section 3.2 Door and Window Positions and Sizes

Staff reduced the opening of interior doors from fully open to 10 cm, and staff reduced the height of all interior and exterior doors from 2.1 m to 2.0 m. Additionally, the width of all interior and exterior doors and interior open doorways was reduced from 0.9 m to 0.79 m. The opening of fully open windows on main living floors was changed to 0.8 m wide × 0.5 m high from 0.8 m high × 0.5 m wide. Finally, the height of basement window openings was reduced from 0.5 m to 0.3 m, resulting in 0.8 m wide × 0.3 m high openings.

Section 4. Scenarios

Staff revised all the scenario tables, and the tables are provided in Appendix A. Each table includes new sub-scenarios, where the generator is moved outside and restarted a second time if it had shut off following an initial restart in an enclosed space. This change ensures that in every scenario, the generator runs until the full fuel tank is exhausted, just as the baseline generator runs. Each table also contains revised weight factors. These revisions are discussed in greater detail later in this memorandum.

Staff estimates that the number of simulations is now approximately 200,000 after these revisions to the plan: (1) simulations involving the handheld generator category and the class 2 twin-cylinder generator category are being run using only the building models that represent those buildings involved in fatal incidents reported to CPSC databases, *i.e.*, MH-1(mod) and DH-8 for handheld generators and GAR3 for class 2 twin-cylinder generators; and (2) originally proposed simulations that used 50 percent of each standard's required CO shutoff criteria (discussed below) are being eliminated.

Section 5. Weather Conditions

Staff has changed the orientation of all the houses, such that the left side of each house, as viewed when looking at the front door, is oriented towards the predominant wind direction.

Section 6. CO Concentration Criteria for Shutoff

As mentioned in Section 4, staff has eliminated the planned simulations of 50 percent of each standard's shutoff criteria. Therefore, staff revised Table 10 of the plan as detailed below:

Table 10. CO Shutoff Criteria for Simulations

	PGMA G300 Criteria (ppmv)	UL 2201 Criteria (ppmv)
Instantaneous	>800	400
10-min rolling average	>400	150

Section 8. Simulation Methodology

Staff is simulating all of the scenarios defined in the tables in Appendix A for a 24-hour period over a range of 28 days in different weather conditions, with shutoff criteria associated with each of the two voluntary standards, and with no shutoff criteria for baseline generators. These simulations are being run in all 40 model structures for the class 1 and class 2 single-cylinder generator categories of generators; whereas, for the handheld and class 2 twin-cylinder generator categories, the simulations are being run in only the three model structures identified in Section 4, as reflecting corresponding fatal incident data.

Section A.2 Effectiveness Analysis

As a result of the new scenario tables provided in Appendix A, the options listed in TN 2048 have been revised as follows:

1. No restart, or
2. Restart in the same location, and if shut off recurs, then move the generator outside and restart a second time; or
3. Restart in the same location, but with change in window opening; and if shut off recurs, then move the generator outside, and restart a second time; or
4. Move to a more isolated area (this could be either another room on the first floor of the house that has a door that isolates the generator, a crawlspace, a basement, or a garage) and restart; and if shut off recurs, then move the generator outside and restart a second time; or
5. Move the generator outside and then restart.

CPSC staff assumed probabilities for each of these scenarios and they are subsequently used as the weights for each.

Staff has identified two types of occupants who are potential[f] victims: the *operator* who has direct interaction with the generator, and the *collateral person* who is within the same house or structure as the operator. Based on CPSC data, approximately 25 percent of the incidents involved multiple fatalities. The exposure scenarios might differ significantly for the two types of potential victims because of the potential shorter running time before shutoff of generators

[f] The word *potential* is used here because the simulations with the voluntary standard-compliant generators may not produce COHb levels associated with fatal or injured occupants. However, the reader is reminded that the simulations with the baseline generators are based on incidents in CPSC's databases, each resulting in one or more fatalities.

that comply with the voluntary standards. Also, staff anticipates that after a generator shuts off, the operator is likely to reenter the room where the generator is located (assuming the operator is not already in the room), where the CO concentration is likely to be higher than in other areas of the house.

As part of these scenarios, staff assumes that any location to which the generator is moved would not be occupied by a collateral person. If the generator is moved to the same enclosed space as where a collateral person is located, the collateral person will move to another room within the house.

Staff made assumption about the time between shutoff and restart and the operator's duration in the source location while restarting the generator. For simplicity, and to reduce the already onerous simulation task, a single time between shutoff and restart has been set at 10 minutes, irrespective of the scenario. After restarting the generator, staff assumes that the operator will remain with the generator for 2 minutes to verify that it continues to run, before returning to their original location (which could be the location in which the generator is running).

Based on the assumptions outlined above, the simulations will produce two different exposure profiles for each living space and generator source location (if the generator was not in a living space) in each simulated structure. Staff will weight these profiles accordingly, in the final analysis.

A few of the tables in Appendix A in TN 2048, including Table A.2, A.3.1.1, and A.3.1.2, incorrectly show 502 fatalities where the generator was used in an enclosed space and nine fatalities where the generator was used outdoors. The correct values in these tables should total to 503 and 8, respectively. Staff will use the correct values in the analysis and will correct the tables in the final report.

Section A.3 Analytical Method

As stated above, in the description of changes to Section A.2, staff has devised two different exposure scenarios for the two types of potential victims. The "operator" is defined as the consumer who puts the generator in a particular location and starts it. If the generator shuts off, the simulation assumes that the operator is the one who will return to the generator location, assuming they are not already in the same room, to restart the generator in either the same location, another enclosed location, or outside. For a second restart, the operator also will be the one to move the generator outside before restarting it. These scenarios mean that the operator may be moving into an area where CO concentrations are more elevated. If that is the case, the operator has greater CO exposure than the collateral person, who is in the house at the time of the incident, but has no direct involvement with the generator.

Staff is making the following assumptions:

1. For the initial start location, the operator, the collateral person, or both, may be co-located with the generator.
2. If the first restart is in the same location as the initial start, the operator, the collateral person, or both, may be co-located with the generator.

3. If the first restart is in a different location than the initial start, and either or both the operator and the collateral person are in this area, they will relocate to another room.
4. Second restarts are always after the operator moves the generator outside.

Staff is basing the outcome of the incident scenario involving the operator and the collateral person on predicted levels of carboxyhemoglobin (COHb) reached in their blood. COHb levels are calculated based on the accumulated CO exposure the individual experiences over time. The operator of the generator and the collateral person are assumed to have different exposure profiles, and thus, each would have a different COHb levels. The assumptions for the different exposure profiles are explained below:

1. Collateral Person
    1. CO exposure levels are based on the initial room in which the collateral person was located, with the exception of a restart scenario, where the operator moves the generator into the location occupied by the collateral person. In this case, the collateral person then moves to another location not occupied by the generator. The time in transit to the other location is assumed to be negligible; therefore, the collateral person's CO exposure profile continues, based on the CO profile of the new location that person moves to.
2. Operator
    1. Initial Start: The operator starts the generator and moves to their initial location. This location could be the same as the location containing the generator.
    2. After shutoff, within 10 minutes, the operator will do one of the following:
        1. Go to the location where the generator is operating and restart it at the 10-minute mark. Over these 10 minutes, the operator's exposure is assumed to be the average of the operator's starting location and the location containing the generator. After the generator restarts, the operator remains in the generator location for 2 minutes before returning to their initial location. The operator's initial location could be the same as the location containing the generator.
        2. Go to the location where the generator is operating, and move the generator to a new location before restarting. Again, the transit time is assumed to be 10 minutes. The exposure of the operator during this transit time is assumed to be the average of all three locations – the operator's initial location, the location with the generator, and the final location of the generator. The final location may be outdoors, which is assumed to be zero exposure.

Acknowledgements
The authors would like to acknowledge the contributions of NIST staff to this memorandum and the work supporting it.

Appendix A Scenario Tables

Table 1.a: Information for all tables

Occupants who are potential victims	Weight
Operator	75%
Collateral person	25%

Table 1.b: Common to All Scenarios - Occupant: Collateral person

	Action
1	Collateral person does not change zones, unless the generator is moved by the operator into the room they were occupying. In this situation, the collateral person moves to a common room - living room, if it exists in the house design, or the kitchen.

Table 1.c: Operator - When restarting the generator in situ or moving it within the house

	Action
1	Operator restarts generator after 10 min. (The time represents an estimate of the time it takes to realize the generator has shut off, to physically move it to another zone [if called for in scenario], and to restart the generator.)
2	After restart, operator stays in the zone with the generator for 2 min, then returns to original location. The door between generator zone and the rest of the house is open 10 cm. Window positions are described in the tables.
3	Generator shuts off as dictated by the shutoff criteria in the voluntary standard.

Notes:

1. Door Positions: At 5 min., door to generator zone is opened fully. At 12 min., door is shut to 10 cm. to allow cords to pass through.
2. Windows Positions: At 12 min., changes to window positions will occur as described in the tables.

Table 1.d: Operator - When moving and restarting the generator to outside the kitchen where CO does not enter the home/does enter the home

	Action
1	Operator restarts generator after 10 min. (The time represents an estimate of the time it takes to realize the generator has shut off, to physically move it outside, and to restart the generator.)
2	After restart, operator stays outside for 2 min, then returns to original location. The door between kitchen and outside is open 10 cm.
3	Generator does not shut off until tank is empty.

Notes:

1. Door Positions: At 5 min. after shutoff, door to outside kitchen is opened fully. At 12 min., door is shut to 10 cm. to allow cords to pass through.
2. Window Positions: At 12 min., any open windows will be closed.

Table 1.e: Operator - When moving and restarting the generator to outside the garage where CO does not enter the garage/does enter the garage

	Action
1	Operator restarts generator after 10 min. (The time represents an estimate of the time it takes to realize the generator has shut off, to physically move it outside, and to restart the generator.)
2	After restart, operator stays outside for 2 min, then returns to original location. Details on the bay door position are given in the tables.
3	Generator does not shut off until tank is empty.

Notes:

1. Door Positions: Door between garage and interior of the house is open 10 cm. At 5 min., door to the garage from the house and garage bay door are opened fully. At 12 min., door to interior is shut to 10 cm. to allow cords to pass through and the garage bay door is shut if the scenario calls for it ("CO does not enter garage").
2. Window Positions: All windows to the house will be closed.

Table 2.a. [G300] Scenarios for Houses with No Basement, Garage, or Crawlspace with Generator Initially Operated In the Kitchen

Structure Type: HOUSE		Garage: No		Basement: No	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Kitchen		Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Kitchen window is closed. Exhaust plume mixes in kitchen.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
A	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0500
B1	Operator restarts in kitchen.	0.4500	None.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2025
B2					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0225
B3			Kitchen window is open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2025
B4					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0225
C1	Operator moves generator to other 1st floor room that has an isolating door.	0.2500	Window in room is open fully.	1.0000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2250
C2					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0250
D1	Operator moves generator to outside of kitchen.	0.2500	CO does not enter home.	0.9000	N/A	1.0000	0.2250
D2			CO enters home.	0.1000	N/A	1.0000	0.0250

Table 2.b.i. [G300] Scenarios for Houses with No Basement, Garage, or Crawlspace with Generator Initially Operated In a First Floor Room that has a Door that Isolates It, with Generator Exhaust Plume Mixing In Room [Scenario weight total = 81.25%]

Structure Type: HOUSE		Garage: No		Basement: No	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Other 1st floor room with an isolating door		Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Window in room is open 5 cm. Door to room is open 10 cm. Exhaust plume mixes inside room.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
E	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0406
F1	Operator restarts in same room.	0.6167	None.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2255
F2					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0251
F3			Window is open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2255
F4					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0251
G1	Operator moves generator to outside of kitchen.	0.3333	CO does not enter home.	0.9000	N/A	1.0000	0.2438
G2			CO enters home.	0.1000	N/A	1.0000	0.0271

Table 2.b.ii. [G300] Scenarios for Houses with No Basement, Garage, or Crawlspace with Generator Initially Operated in a First Floor Room that has an Isolating Door with Generator Exhaust Plume Oriented Out of Door to House Interior [Scenario weights = 18.75%]

Structure Type: HOUSE		Garage: No		Basement: No	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Other 1st floor room that has an isolating door			Weight for Home Type: (# deaths allocated to this home * % this location)			
Initial Conditions:	Window in room is open 5 cm. Door to room is open 10 cm. Exhaust plume oriented out door to house interior.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
H	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0094
I1	Operator restarts in same room.	0.6167	None.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.0520
I2					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0058
I3			Window is open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.0520
I4					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0058
J1	Operator moves generator to outside of kitchen.	0.3333	CO does not enter home.	0.9000	N/A	1.0000	0.0563
J2			CO enters home.	0.1000	N/A	1.0000	0.0063

Table 2.c. [G300] Scenario for Houses with No Basement, Garage, or Crawlspace with Generator Initially Operated Outside

Structure Type: HOUSE		Garage: No		Basement: No	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Outside			Weight for Home Type: (# deaths allocated to this home * % this location)			
Initial Conditions:	Exterior door to kitchen is open 10 cm. Start generator in a location outside of kitchen where CO enters home.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario	2nd restart	2nd Reaction	
K	Generator does not shutoff until the tank is empty; therefore, there are no restart scenarios.	Actual Deaths for specific house model	N/A	N/A	N/A	N/A	Actual Deaths for specific house model

Table 3.a. [G300] Scenarios for Houses with Crawlspace But No Basement or Garage, with Generator Initially Operated In the Kitchen

Structure Type: HOUSE		Garage: No		Basement: No	Crawlspace: Yes		FINAL SCENARIO WEIGHTS
Initial Location:		Kitchen	Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Kitchen window is closed. Exhaust plume mixes in kitchen.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
A	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0500
B1	Operator restarts in kitchen.	0.3500	None.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.1575
B2					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0175
B3			Kitchen window is open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.1575
B4					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0175
C1	Operator moves generator to other 1st floor room that has an isolating door.	0.2000	Window in room is open fully.	1.0000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.1800
C2					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0200
D1	Operator moves generator to crawlspace. Exhaust plume mixes inside crawlspace The only exposure in the crawlspace is of operator entering the crawlspace to move the generator and/or restart the generator.	0.2000	None.	1.0000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.1800
D2					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0200
E1	Operator moves generator to outside of kitchen.	0.2000	CO does not enter home.	0.9000	N/A	1.0000	0.1800
E2			CO enters home.	0.1000	N/A	1.0000	0.0200

Table 3.b.i. [G300] Scenarios for Houses with Crawlspace But No Basement or Garage, with Generator Initially Operated In a First Floor Room with an Isolating Door with Generator Exhaust Plume Mixing In Room [Scenario weight total = 81.25%]

Structure Type: HOUSE		Garage: No		Basement: No	Crawlspace: Yes		FINAL SCENARIO WEIGHTS
Initial Location:	Other 1st floor room with isolating door			Weight for Home Type: (# deaths allocated to this home * % this location)			
Initial Conditions:	Window in room is open 5 cm. Door to room is open 10 cm. Exhaust plume mixes inside room.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
F	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0406
G1	Operator restarts in same room.	0.4500	None.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.1645
G2					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0183
G3			Window in room is open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.1645
G4					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0183
H1	Operator moves generator to crawlspace. Exhaust plume mixes inside crawlspace The only exposure in the crawlspace is of operator entering the crawlspace to move the generator and/or restart the generator.	0.2500	None.	1.0000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.1828
H2					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0203
I1	Operator moves generator to outside of kitchen.	0.2500	CO does not enter home.	0.9000	N/A	1.0000	0.1828
I2			CO enters home.	0.1000	N/A	1.0000	0.0203

Table 3.b.ii. [G300] Scenarios for Houses with Crawlspace But No Basement or Garage, with Generator Initially Operated In a First Floor Room with an Isolating Door with Generator Exhaust Plume Oriented Out of Door to House Interior [Scenario weight total = 18.75%]

Structure Type: HOUSE		Garage: No		Basement: No	Crawlspace: Yes		FINAL SCENARIO WEIGHTS
Initial Location:	Other 1st floor room with isolating door			Weight for Home Type: (# deaths allocated to this home * % this location)			
Initial Conditions:	Window in room is open 5 cm. Door to room is open 10 cm. Exhaust plume oriented out door to house interior.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
J	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0094
K1	Operator restarts in same room.	0.4500	None.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.0380
K2					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0042
K3			Window is open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.0380
K4					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0042
L1	Operator moves generator to crawlspace. Exhaust plume mixes inside crawlspace The only exposure in the crawlspace is of operator entering the crawlspace to move the generator and/or restart the generator.	0.2500	None.	1.0000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.0422
L2					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0047
M1	Operator moves generator to outside of kitchen.	0.2500	CO does not enter home.	0.9000	N/A	1.0000	0.0422
M2			CO enters home.	0.1000	N/A	1.0000	0.0047

Table 3.c. [G300] Scenarios for Houses with Crawlspace But No Basement or Garage, with Generator Initially Operated in the Crawlspace

Structure Type: HOUSE		Garage: No		Basement: No	Crawlspace: Yes		FINAL SCENARIO WEIGHTS
Initial Location:	Crawlspace			Weight for Home Type: (# deaths allocated to this home * % this location)			
Initial Conditions:	Generator is in crawlspace. Exhaust plume mixes in crawlspace.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
N	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0500
O1	Operator restarts in crawlspace. The only exposure in the crawlspace is of operator entering the crawlspace to move the generator and/or restart the generator.	0.6167	None.	1.0000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.5550
O2					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0617
P1	Operator moves generator to outside of kitchen.	0.3333	CO does not enter home.	0.9000	N/A	1.0000	0.3000
P2			CO enters home.	0.1000	N/A	1.0000	0.0333

Table 3.d. [G300] Scenario for Houses with Crawlspace But No Basement or Garage, with Generator Initially Operated Outside

Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario	2nd restart	2nd Reaction	FINAL SCENARIO WEIGHTS
Structure Type: HOUSE		Garage: No	Basement: No	Crawlspace: Yes			
Initial Location:	Outside		Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Exterior door to kitchen is open 10 cm. Start generator in a location outside of kitchen where CO enters home.						
Restart Scenarios							
Q	Generator does not shutoff until the tank is empty; therefore, there are no restart scenarios.	Actual Deaths for specific house model	Generator does not shutoff until the tank is empty; therefore, there are no restart scenarios.	N/A	N/A	N/A	Actual Deaths for specific house model

Table 4.a. [G300] Scenarios for Houses with Basement, But No Crawlspace or Garage, with Generator Initially Operated in Kitchen

Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	FINAL SCENARIO WEIGHTS
Structure Type: HOUSE		Garage: No	Basement: Yes	Crawlspace: No			
Initial Location:	Kitchen		Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Kitchen window is closed. Exhaust plume mixes in kitchen.						
Restart Scenarios							
A	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0500
B1	Operator restarts in kitchen.	0.4500	None.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2025
B2					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0225
B3			Kitchen window is open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2025
B4					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0225
C1	Operator moves and restarts the generator in basement. Exhaust plume mixes in basement.	0.2500	Window in basement is open fully.	1.0000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2250
C2					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0250
D1	Operator moves generator to outside of kitchen.	0.2500	CO does not enter home.	0.9000	N/A	1.0000	0.2250
D2			CO enters home.	0.1000	N/A	1.0000	0.0250

Table 4.b. [G300] Scenarios for Houses with Basement, But No Crawlspace or Garage, with Generator Initially Operated in Basement

Structure Type: HOUSE		Garage: No	Basement: Yes		Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Basement		Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Basement stairway door is open 10 cm. Window in basement is closed. Exhaust plume mixes in basement.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
E	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0500
F1	Operator restarts generator in basement.	0.6167	No change.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2775
F2					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0308
F3			Window in basement open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2775
F4					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0308
G1	Operator moves generator to outside of kitchen.	0.3333	CO does not enter home.	0.9000	N/A	1.0000	0.3000
G2			CO enters home.	0.1000	N/A	1.0000	0.0333

Table 4.c. [G300] Scenario for Houses with Basement, But No Crawlspace or Garage, with Generator Initially Operated Outside

Structure Type: HOUSE		Garage: No	Basement: Yes		Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Outside		Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Exterior door to kitchen is open 10 cm. Start generator in a location outside of kitchen where CO enters home.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
H	Generator does not shutoff until the tank is empty; therefore, there are no restart scenarios.	Actual Deaths for specific house model	Generator does not shutoff until the tank is empty; therefore, there are no restart scenarios.	N/A	N/A	N/A	Actual Deaths for specific house model

Table 5.a. [G300] Scenarios for Houses with Garage But No Basement or Crawlspace, with Generator Initially Operated in the Kitchen

Structure Type: HOUSE			Garage: Yes	Basement: No	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Kitchen			Weight for Home Type: (# deaths allocated to this home * % this location)			
Initial Conditions:	Kitchen window is closed. Exhaust plume mixes in kitchen.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
A	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0500
B1	Operator restarts in kitchen.	0.4500	None.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2025
B2					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0225
B3			Kitchen window is open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2025
B4					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0225
C1	Operator moves and restarts generator in garage. Bay door closed.	0.1250	Exhaust facing away from wall that has door to house interior. Exhaust plume mixes inside garage.	0.7500	Restart after moving generator to outside of _garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0469
C2					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0469
C3			Exhaust facing toward the wall that has door to house interior. Exhaust plume pushes some of exhaust into house.	0.2500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0156
C4					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0156
C5	Operator moves and restarts in garage. Bay door is open fully.	0.1250	Exhaust facing away from wall that has door to house interior. Exhaust plume mixes inside garage.	0.7500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0469
C6					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0469
C7			Exhaust facing toward the wall that has door to house interior. Exhaust plume pushes some of exhaust into house.	0.2500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0156
C8					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0156
D1	Operator moves generator to outside of kitchen.	0.2500	CO does not enter home.	0.9000	N/A	1.0000	0.2250
D2			CO enters home.	0.1000	N/A	1.0000	0.0250

Table 5.b.i. [G300] Scenarios for Houses with Garage But No Basement or Crawlspace, with Generator Initially Operated in Garage with Generator Exhaust Facing Away from Wall that has Door to House Interior. Exhaust Mixes in Garage. [Scenario weight total = 75%]

Structure Type: HOUSE			Garage: Yes		Basement: No	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Garage			Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Door to house interior is open 10 cm. Bay door is closed. Generator is in center of garage. Exhaust plume mixes in garage.							
Restart Scenarios								
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight		
E	No restart	0.0500	N/A	1.0000	N/A	1.0000		0.0375
F1	Restart in garage.	0.6167	None.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5		0.1156
F2					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5		0.1156
F3			Bay door is open fully.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5		0.1156
F4					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5		0.1156
G1	Operator opens bay door, moves and restarts generator outside garage.	0.3333	Bay door is closed after operator returns to house. CO does not enter garage.	0.5000	N/A	1.0000		0.1250
G2			Operator leaves bay door open after returning to house. CO enters the garage.	0.5000	N/A	1.0000		0.1250

Table 5.b.ii. [G300] Scenarios for Houses with Garage But No Basement or Crawlspace, with Generator Initially Operated in Garage with Generator Exhaust Facing Toward Wall that has Door to House Interior. Exhaust Plume Pushes Some of Exhaust Into House. [Scenario weight total = 25%]

Structure Type: HOUSE		Garage: Yes		Basement: No	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Garage		Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Door to house interior is open 10 cm. Bay door is closed. Generator is in center of garage. Exhaust facing toward wall with door to house interior.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
H	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0125
I1	Restart in garage.	0.6167	None.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0385
I2					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0385
I3			Bay door is open fully.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0385
I4					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0385
J1	Operator opens bay door, moves and restarts generator outside garage.	0.3333	Bay door is closed after operator returns to house. CO does not enter garage.	0.5000	N/A	1.0000	0.0417
J2			Operator leaves bay door open after returning to house. CO enters the garage.	0.5000	N/A	1.0000	0.0417

Table 5.c. [G300] Scenario for Houses with Garage But No Basement or Crawlspace, with Generator Initially Operated Outside

Structure Type: HOUSE		Garage: No		Basement: No	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Outside		Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Exterior door to kitchen is open 10 cm. Start generator in a location outside of kitchen where CO enters home.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
K	Generator does not shutoff until the tank is empty; therefore, there are no restart scenarios.	Actual Deaths for specific house model	N/A	N/A	N/A	N/A	Actual Deaths for specific house model

Table 6.a. [G300] Scenario for Houses with Garage and Basement But No Crawlspace, with Generator Initially Operated In Kitchen

Structure Type: HOUSE		Garage: Yes		Basement: Yes	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Kitchen			Weight for Home Type: (# deaths allocated to this home * % this location)			
Initial Conditions:	Kitchen window is closed. Exhaust plume mixes in kitchen.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
A	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0500
B1	Operator restarts in kitchen.	0.4500	None.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2025
B2					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0225
B3			Kitchen window is open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2025
B4					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0225
C1	Operator moves and restarts generator in garage. Bay door closed.	0.1250	Exhaust facing away from wall that has door to house interior. Exhaust plume mixes inside garage.	0.7500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0469
C2					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0469
C3			Exhaust facing toward the wall that has door to house interior. Exhaust plume pushes some of exhaust into house.	0.2500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0156
C4					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0156
C5	Operator moves and restarts in garage. Bay door is open fully.	0.1250	Exhaust facing away from wall that has door to house interior. Exhaust plume mixes inside garage.	0.7500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0469
C6					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0469
C7			Exhaust facing toward the wall that has door to house interior. Exhaust plume pushes some of exhaust into house.	0.2500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0156
C8					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0156
D1	Operator moves generator to outside of kitchen.	0.2500	CO does not enter home.	0.9000	N/A	1.0000	0.2250
D2			CO enters home.	0.1000	N/A	1.0000	0.0250

Table 6.b. [G300] Scenarios for Houses with Garage and Basement But No Crawlspace, with Generator Initially Operated In Basement

Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	FINAL SCENARIO WEIGHTS
Structure Type: HOUSE		Garage: Yes		Basement: Yes	Crawlspace: No		
Initial Location:	Basement		Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Basement stairway door is open 10 cm. Window in basement is closed. Exhaust plume mixes in basement						
Restart Scenarios							
E	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0500
F1	Operator restarts generator in basement.	0.6167	No change.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2775
F2					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0308
F3			Window in basement open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2775
F4					Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0308
G1	Operator moves generator to outside of kitchen.	0.3333	CO does not enter home.	0.9000	N/A	1.0000	0.3000
G2			CO enters home.	0.1000	N/A	1.0000	0.0333

Table 6.c.i. [G300] Scenarios for Houses with Garage and Basement But No Crawlspace, with Generator Initially Operated In Garage, with Generator Exhaust Facing Away from Wall that has Door to House Interior. Exhaust Mixes In Garage. [Scenario weight total to 75%]

Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	FINAL SCENARIO WEIGHTS
Structure Type: HOUSE		Garage: Yes		Basement: Yes	Crawlspace: No		
Initial Location:	Garage		Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Door to house interior is open 10 cm. Bay door is closed. Generator is in center of garage. Exhaust plume mixes in garage.						
Restart Scenarios							
H	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0375
I1	Restart in garage.	0.6167	None.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.1156
I2					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.1156
I3			Bay door is open fully.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.1156
I4					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.1156
J1	Operator opens bay door, moves and restarts generator outside garage.	0.3333	Bay door is closed after operator returns to house. CO does not enter garage.	0.5000	N/A	1.0000	0.1250
J2			Operator leaves bay door open after returning to house. CO enters the garage.	0.5000	N/A	1.0000	0.1250

Table 6.c.ii. [G300] Scenarios for Houses with Garage and Basement But No Crawlspace, with Generator Initially Operated In Garage, with Generator Exhaust Facing Toward Wall that has Door to House Interior. Exhaust Plume Pushes Some of Exhaust Into House. [Scenario weight total to 25%]

Structure Type: HOUSE		Garage: Yes		Basement: Yes	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:		Garage		Weight for Home Type: (# deaths allocated to this home * % this location)			
Initial Conditions:		Door to house interior is open 10 cm. Bay door is closed. Generator is in center of garage. Exhaust plume is facing towards wall that has door to house interior.					
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
K	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0125
L1	Restart in garage.	0.6167	None.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0385
L2					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0385
L3			Bay door is open fully.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0385
L4					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0385
M1	Operator opens bay door, moves and restarts generator outside garage.	0.3333	Bay door is closed after operator returns to house. CO does not enter garage.	0.5000	N/A	1.0000	0.0417
M2			Operator leaves bay door open after returning to house. CO enters the garage.	0.5000	N/A	1.0000	0.0417

Table 6.d. [G300] Scenario for Houses with Garage and Basement But No Crawlspace, with Generator Initially Operated Outside

Structure Type: HOUSE		Garage: Yes		Basement: Yes	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:		Outside		Weight for Home Type: (# deaths allocated to this home * % this location)			
Initial Conditions:		Generator located outside kitchen. Door to kitchen is open 10 cm.					
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
N	Generator does not shutoff until the tank is empty; therefore, there are no restart scenarios.	Actual Deaths for specific house model	N/A	N/A	N/A	N/A	Actual Deaths for specific house model

Table 7. [G300] Scenarios for Detached 1-Car and 2-Car Garages (GAR1 and GAR2) with Generator Operated In Garage

Structure Type: DETACHED GARAGE			GAR1 & GAR2					FINAL SCENARIO WEIGHTS
Initial Location:		Garage	Weight for Home Type: (# deaths allocated to this home * % this location)					
Initial Conditions:		Bay door is closed. Generator is in center of garage. Exhaust plume mixes in garage						
Restart Scenarios								
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight		
A	No restart	0.0500	N/A	1.0000	N/A	1.0000		0.0500
B1	Restart in garage.	0.6167	None.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.	0.5		0.1542
B2					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5		0.1542
B3			Bay door is open fully.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.	0.5		0.1542
B4					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5		0.1542
C1	Operator opens bay door, moves and restarts generator outside garage. Operator returns to garage.	0.3333	None. CO does not enter garage.	0.5000	NA	1.0000		0.1667
C2			Bay door is open fully. CO enters the garage.	0.5000	NA	1.0000		0.1667

Table 8.a. [G300] Scenarios for Detached Garage Containing a Workshop or Other Room (GAR3) with Generator Initially Operated in Workshop Room

Structure Type: DETACHED GARAGE			GAR3				FINAL SCENARIO WEIGHTS
Initial Location:	Workshop in Garage		Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Bay door is closed. Generator is in center of workshop room. Workshop door is closed. Exhaust plume mixes in workshop room.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
A	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0500
B1	Restart in same room with generator exhaust plume staying in room.	0.4500	None.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.	0.5	0.1125
B2					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.1125
B3			Window in workshop room is open fully.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.	0.5	0.1125
B4					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.1125
C1	Move and restart in garage. Bay door closed.	0.1250	Door to workshop room is open 10 cm. Exhaust facing away from wall with door to workshop room. Exhaust plume mixes inside garage.	0.7500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.	0.5	0.0469
C2					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0469
C3			Door to workshop room is open 10 cm. Exhaust facing toward the wall with door to shop. Exhaust plume pushes some of exhaust into workshop room.	0.2500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.	0.5	0.0156
C4					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0156
C5	Move and restart in garage. Bay door is open fully.	0.1250	Door to workshop room is open 10 cm. Exhaust facing away from wall with door to workshop room. Exhaust plume mixes inside garage.	0.7500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.	0.5	0.0469
C6					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0469
C7			Door to workshop room is open 10 cm. Exhaust facing toward the wall with door to shop. Exhaust plume pushes some of exhaust into workshop room.	0.2500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.	0.5	0.0156
C8					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0156
D1	Operator opens bay door, moves and restarts generator outside garage. Operator returns to original location.	0.2500	None. CO does not enter garage.	0.5000	NA	1.0000	0.1250
D2			Bay door is open fully. CO enters the garage.	0.5000	NA	1.0000	0.1250

Table 8.b.i. [G300] Scenarios for Detached Garage Containing a Workshop or Other Room (GAR3) with Generator Initially Operated In Garage, with Exhaust Oriented Away from Wall with Door to Workshop Room [Scenario weight total to 75%]

<table>
<tr><td colspan="3">Structure Type: DETACHED GARAGE</td><td colspan="5">GAR3</td><td rowspan="5">FINAL SCENARIO WEIGHTS</td></tr>
<tr><td colspan="2">Initial Location:</td><td colspan="2">Garage</td><td colspan="4">Weight for Home Type: (# deaths allocated to this home * % this location)</td></tr>
<tr><td colspan="2">Initial Conditions:</td><td colspan="6">Door to workshop is open 10 cm. Bay door is closed. Generator is in center of garage. Exhaust is facing away from wall with door to workshop. Exhaust mixes in garage.</td></tr>
<tr><td colspan="8">Restart Scenarios</td></tr>
<tr><td>Scenario</td><td>Response to Shutoff</td><td>Scenario Weight</td><td>Changes from Initial Conditions</td><td>Sub-Scenario Weight</td><td>2nd restart</td><td>2nd Reaction Weight</td><td></td></tr>
<tr><td>A</td><td>No restart</td><td>0.0500</td><td>N/A</td><td>1.0000</td><td>N/A</td><td>1.0000</td><td>0.0375</td></tr>
<tr><td>B1</td><td rowspan="4">Restart in garage.</td><td rowspan="4">0.6167</td><td rowspan="2">None.</td><td rowspan="2">0.5000</td><td>Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.</td><td>0.5</td><td>0.1156</td></tr>
<tr><td>B2</td><td>Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.</td><td>0.5</td><td>0.1156</td></tr>
<tr><td>B3</td><td rowspan="2">Bay door is open fully.</td><td rowspan="2">0.5000</td><td>Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.</td><td>0.5</td><td>0.1156</td></tr>
<tr><td>B4</td><td>Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.</td><td>0.5</td><td>0.1156</td></tr>
<tr><td>C1</td><td rowspan="2">Operator opens bay door, moves and restarts generator outside garage. Operator returns to original location.</td><td rowspan="2">0.3333</td><td>None. CO does not enter garage.</td><td>0.5000</td><td>NA</td><td>1.0000</td><td>0.1250</td></tr>
<tr><td>C2</td><td>Bay door is open fully. CO enters the garage.</td><td>0.5000</td><td>NA</td><td>1.0000</td><td>0.1250</td></tr>
</table>

Table 8.b.ii. [G300] Scenarios for Detached Garage Containing a Workshop or Other Room (GAR3) with Generator Initially Operated in Garage, with Exhaust Oriented Toward Wall with Door to Workshop Room. Exhaust Plume Pushes Some of Exhaust Into Workshop. [Scenario weight total to 25%]

Structure Type: DETACHED GARAGE			GAR3				FINAL SCENARIO WEIGHTS
Initial Location:	Garage		Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Door to workshop is open 10 cm. Bay door is closed. Generator is in center of garage. Exhaust is facing toward wall with door to workshop. Exhaust plume pushes some of exhaust into workshop room.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
D	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0125
E1	Restart in garage.	0.6167	None.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.	0.5	0.0385
E2					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0385
E3			Bay door is open fully.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.	0.5	0.0385
E4					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0385
F1	Operator opens bay door, moves and restarts generator outside garage. Operator returns to original location.	0.3333	None. CO does not enter garage.	0.9000	N/A	1.0000	0.0750
F2			Bay door is open fully. CO enters the garage.	0.1000	N/A	1.0000	0.0083

Table 9.a. [UL2201] Scenarios for Houses with No Basement, Garage, or Crawlspace with Generator Initially Operated In the Kitchen

Structure Type: HOUSE		Garage: No		Basement: No	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Kitchen		Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Kitchen window is closed. Exhaust plume mixes in kitchen.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
A	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0500
B1	Operator restarts in kitchen.	0.4500	None.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1688
B2					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0563
B3			Kitchen window is open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1688
B4					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0563
C1	Operator moves generator to other 1st floor room that has an isolating door.	0.2500	Window in room is open fully.	1.0000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1875
C2					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0625
D1	Operator moves generator to outside of kitchen.	0.2500	CO does not enter home.	0.7500	N/A	1.0000	0.1875
D2			CO enters home.	0.2500	N/A	1.0000	0.0625

Table 9.b.i. [UL2201] Scenarios for Houses with No Basement, Garage, or Crawlspace with Generator Initially Operated In a First Floor Room that has a Door that Isolates It, with Generator Exhaust Plume Mixing In Room [Scenario weight total = 81.25%]

Structure Type: HOUSE		Garage: No		Basement: No	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Other 1st floor room with an isolating door		Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Window in room is open 5 cm. Door to room is open 10 cm. Exhaust plume mixes inside room.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
E	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0406
F1	Operator restarts in same room.	0.6167	None.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1879
F2					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0626
F3			Window is open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1879
F4					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0626
G1	Operator moves generator to outside of kitchen.	0.3333	CO does not enter home.	0.7500	N/A	1.0000	0.2031
G2			CO enters home.	0.2500	N/A	1.0000	0.0677

Table 9.b.ii. [UL2201] Scenarios for Houses with No Basement, Garage, or Crawlspace with Generator Initially Operated in a First Floor Room that has an Isolating Door with Generator Exhaust Plume Oriented Out of Door to House Interior [Scenario weights = 18.75%]

Structure Type: HOUSE		Garage: No		Basement: No	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Other 1st floor room that has an isolating door			Weight for Home Type: (# deaths allocated to this home * % this location)			
Initial Conditions:	Window in room is open 5 cm. Door to room is open 10 cm. Exhaust plume oriented out door to house interior.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
H	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0094
I1	Operator restarts in same room.	0.6167	None.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.0434
I2					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0145
I3			Window is open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.0434
I4					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0145
J1	Operator moves generator to outside of kitchen.	0.3333	CO does not enter home.	0.7500	N/A	1.0000	0.0469
J2			CO enters home.	0.2500	N/A	1.0000	0.0156

Table 9.c. [UL2201] Scenario for Houses with No Basement, Garage, or Crawlspace with Generator Initially Operated Outside

Structure Type: HOUSE		Garage: No		Basement: No	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Outside			Weight for Home Type: (# deaths allocated to this home * % this location)			
Initial Conditions:	Exterior door to kitchen is open 10 cm. Start generator in a location outside of kitchen where CO enters home.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario	2nd restart	2nd Reaction	
K	Generator does not shutoff until the tank is empty; therefore, there are no restart scenarios.	Actual Deaths for specific house model	N/A	N/A	N/A	N/A	Actual Deaths for specific house model

Table 10.a. [UL2201] Scenarios for Houses with Crawlspace But No Basement or Garage, with Generator Initially Operated In the Kitchen

Structure Type: HOUSE		Garage: No		Basement: No	Crawlspace: Yes		FINAL SCENARIO WEIGHTS
Initial Location:	Kitchen		Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Kitchen window is closed. Exhaust plume mixes in kitchen.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
A	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0500
B1	Operator restarts in kitchen.	0.3500	None.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1313
B2					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0438
B3			Kitchen window is open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1313
B4					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0438
C1	Operator moves generator to other 1st floor room that has an isolating door.	0.2000	Window in room is open fully.	1.0000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1500
C2					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0500
D1	Operator moves generator to crawlspace. Exhaust plume mixes inside crawlspace The only exposure in the crawlspace is of operator entering the crawlspace to move the generator and/or restart the generator.	0.2000	None.	1.0000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1500
D2					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0500
E1	Operator moves generator to outside of kitchen.	0.2000	CO does not enter home.	0.7500	N/A	1.0000	0.1500
E2			CO enters home.	0.2500	N/A	1.0000	0.0500

Table 10.b.i. [UL2201] Scenarios for Houses with Crawlspace But No Basement or Garage, with Generator Initially Operated In a First Floor Room with an Isolating Door with Generator Exhaust Plume Mixing In Room [Scenario weight total = 81.25%]

Structure Type: HOUSE		Garage: No		Basement: No	Crawlspace: Yes		FINAL SCENARIO WEIGHTS
Initial Location:	Other 1st floor room with isolating door			Weight for Home Type: (# deaths allocated to this home * % this location)			
Initial Conditions:	Window in room is open 5 cm. Door to room is open 10 cm. Exhaust plume mixes inside room.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
F	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0406
G1	Operator restarts in same room.	0.4500	None.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1371
G2					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0457
G3			Window in room is open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1371
G4					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0457
H1	Operator moves generator to crawlspace. Exhaust plume mixes inside crawlspace The only exposure in the crawlspace is of operator entering the crawlspace to move the generator and/or restart the generator.	0.2500	None.	1.0000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1523
H2					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0508
I1	Operator moves generator to outside of kitchen.	0.2500	CO does not enter home.	0.7500	N/A	1.0000	0.1523
I2			CO enters home.	0.2500	N/A	1.0000	0.0508

Table 10.b.ii. [UL2201] Scenarios for Houses with Crawlspace But No Basement or Garage, with Generator Initially Operated In a First Floor Room with an Isolating Door with Generator Exhaust Plume Oriented Out of Door to House Interior [Scenario weight total = 18.75%]

Structure Type: HOUSE		Garage: No		Basement: No	Crawlspace: Yes		FINAL SCENARIO WEIGHTS
Initial Location:	Other 1st floor room with isolating door			Weight for Home Type: (# deaths allocated to this home * % this location)			
Initial Conditions:	Window in room is open 5 cm. Door to room is open 10 cm. Exhaust plume oriented out door to house interior.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
J	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0094
K1	Operator restarts in same room.	0.4500	None.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.0316
K2					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0105
K3			Window is open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.0316
K4					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0105
L1	Operator moves generator to crawlspace. Exhaust plume mixes inside crawlspace The only exposure in the crawlspace is of operator entering the crawlspace to move the generator and/or restart the generator.	0.2500	None.	1.0000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.0352
L2					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0117
M1	Operator moves generator to outside of kitchen.	0.2500	CO does not enter home.	0.7500	N/A	1.0000	0.0352
M2			CO enters home.	0.2500	N/A	1.0000	0.0117

Table 10.c. [UL2201] Scenarios for Houses with Crawlspace But No Basement or Garage, with Generator Initially Operated in the Crawlspace

Structure Type: HOUSE		Garage: No		Basement: No	Crawlspace: Yes		FINAL SCENARIO WEIGHTS
Initial Location:	Crawlspace			Weight for Home Type: (# deaths allocated to this home * % this location)			
Initial Conditions:	Generator is in crawlspace. Exhaust plume mixes in crawlspace.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
N	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0500
O1	Operator restarts in crawlspace. The only exposure in the crawlspace is of operator entering the crawlspace to move the generator and/or restart the generator.	0.6167	None.	1.0000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.4625
O2					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.1542
P1	Operator moves generator to outside of kitchen.	0.3333	CO does not enter home.	0.7500	N/A	1.0000	0.2500
P2			CO enters home.	0.2500	N/A	1.0000	0.0833

Table 10.d. [UL2201] Scenario for Houses with Crawlspace But No Basement or Garage, with Generator Initially Operated Outside

Structure Type: HOUSE		Garage: No		Basement: No	Crawlspace: Yes		FINAL SCENARIO WEIGHTS
Initial Location:	Outside			Weight for Home Type: (# deaths allocated to this home * % this location)			
Initial Conditions:	Exterior door to kitchen is open 10 cm. Start generator in a location outside of kitchen where CO enters home.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario	2nd restart	2nd Reaction	
Q	Generator does not shutoff until the tank is empty; therefore, there are no restart scenarios.	Actual Deaths for specific house model	Generator does not shutoff until the tank is empty; therefore, there are no restart scenarios.	N/A	N/A	N/A	Actual Deaths for specific house model

Table 11.a. [UL2201] Scenarios for Houses with Basement, But No Crawlspace or Garage, with Generator Initially Operated in Kitchen

Structure Type: HOUSE		Garage: No		Basement: Yes	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Kitchen			Weight for Home Type: (# deaths allocated to this home * % this location)			
Initial Conditions:	Kitchen window is closed. Exhaust plume mixes in kitchen.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
A	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0500
B1	Operator restarts in kitchen.	0.4500	None.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1688
B2					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0563
B3			Kitchen window is open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1688
B4					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0563
C1	Operator moves and restarts the generator in basement. Exhaust plume mixes in basement.	0.2500	Window in basement is open fully.	1.0000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1875
C2					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0625
D1	Operator moves generator to outside of kitchen.	0.2500	CO does not enter home.	0.7500	N/A	1.0000	0.1875
D2			CO enters home.	0.2500	N/A	1.0000	0.0625

Table 11.b. [UL2201] Scenarios for Houses with Basement, But No Crawlspace or Garage, with Generator Initially Operated in Basement

Structure Type: HOUSE			Garage: No	Basement: Yes		Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Basement			Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Basement stairway door is open 10 cm. Window in basement is closed. Exhaust plume mixes in basement.							
Restart Scenarios								
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight		
E	No restart	0.0500	N/A	1.0000	N/A	1.0000		0.0500
F1	Operator restarts generator in basement.	0.6167	No change.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75		0.2313
F2					Operator moves generator to outside of kitchen where CO enters home.	0.25		0.0771
F3			Window in basement open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75		0.2313
F4					Operator moves generator to outside of kitchen where CO enters home.	0.25		0.0771
G1	Operator moves generator to outside of kitchen.	0.3333	CO does not enter home.	0.7500	N/A	1.0000		0.2500
G2			CO enters home.	0.2500	N/A	1.0000		0.0833

Table 11.c. [UL2201] Scenario for Houses with Basement, But No Crawlspace or Garage, with Generator Initially Operated Outside

Structure Type: HOUSE			Garage: No	Basement: Yes		Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Outside			Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Exterior door to kitchen is open 10 cm. Start generator in a location outside of kitchen where CO enters home.							
Restart Scenarios								
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight		
H	Generator does not shutoff until the tank is empty; therefore, there are no restart scenarios.	Actual Deaths for specific house model	Generator does not shutoff until the tank is empty; therefore, there are no restart scenarios.	N/A	N/A	N/A		Actual Deaths for specific house model

Table 12.a. [UL2201] Scenarios for Houses with Garage But No Basement or Crawlspace, with Generator Initially Operated in the Kitchen

Structure Type: HOUSE		Garage: Yes		Basement: No	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Kitchen		Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Kitchen window is closed. Exhaust plume mixes in kitchen.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
A	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0500
B1	Operator restarts in kitchen.	0.4500	None.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1688
B2					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0563
B3			Kitchen window is open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1688
B4					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0563
C1	Operator moves and restarts generator in garage. Bay door closed.	0.1250	Exhaust facing away from wall that has door to house interior. Exhaust plume mixes inside garage.	0.7500	Restart after moving generator to outside of _garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0469
C2					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0469
C3			Exhaust facing toward the wall that has door to house interior. Exhaust plume pushes some of exhaust into house.	0.2500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0156
C4					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0156
C5	Operator moves and restarts in garage. Bay door is open fully.	0.1250	Exhaust facing away from wall that has door to house interior. Exhaust plume mixes inside garage.	0.7500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0469
C6					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0469
C7			Exhaust facing toward the wall that has door to house interior. Exhaust plume pushes some of exhaust into house.	0.2500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0156
C8					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0156
D1	Operator moves generator to outside of kitchen.	0.2500	CO does not enter home.	0.7500	N/A	1.0000	0.1875
D2			CO enters home.	0.2500	N/A	1.0000	0.0625

Table 12.b.i. [UL2201] Scenarios for Houses with Garage But No Basement or Crawlspace, with Generator Initially Operated in Garage with Generator Exhaust Facing Away from Wall that has Door to House Interior. Exhaust Mixes in Garage. [Scenario weight total = 75%]

Structure Type: HOUSE			Garage: Yes		Basement: No	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Garage				Weight for Home Type: (# deaths allocated to this home * % this location)			
Initial Conditions:	Door to house interior is open 10 cm. Bay door is closed. Generator is in center of garage. Exhaust plume mixes in garage.							
Restart Scenarios								
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart		2nd Reaction Weight	
E	No restart	0.0500	N/A	1.0000	N/A		1.0000	0.0375
F1	Restart in garage.	0.6167	None.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.		0.5	0.1156
F2					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.		0.5	0.1156
F3			Bay door is open fully.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.		0.5	0.1156
F4					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.		0.5	0.1156
G1	Operator opens bay door, moves and restarts generator outside garage.	0.3333	Bay door is closed after operator returns to house. CO does not enter garage.	0.5000	N/A		1.0000	0.1250
G2			Operator leaves bay door open after returning to house. CO enters the garage.	0.5000	N/A		1.0000	0.1250

Table 12.b.ii. [UL2201] Scenarios for Houses with Garage But No Basement or Crawlspace, with Generator Initially Operated in Garage with Generator Exhaust Facing Toward Wall that has Door to House Interior. Exhaust Plume Pushes Some of Exhaust Into House. [Scenario weight total = 25%]

Structure Type: HOUSE			Garage: Yes		Basement: No	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Garage			Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Door to house interior is open 10 cm. Bay door is closed. Generator is in center of garage. Exhaust facing toward wall with door to house interior.							
Restart Scenarios								
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions		Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
H	No restart	0.0500	N/A		1.0000	N/A	1.0000	0.0125
I1	Restart in garage.	0.6167	None.		0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0385
I2						Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0385
I3			Bay door is open fully.		0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0385
I4						Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0385
J1	Operator opens bay door, moves and restarts generator outside garage.	0.3333	Bay door is closed after operator returns to house. CO does not enter garage.		0.5000	N/A	1.0000	0.0417
J2			Operator leaves bay door open after returning to house. CO enters the garage.		0.5000	N/A	1.0000	0.0417

Table 12.c. [UL2201] Scenario for Houses with Garage But No Basement or Crawlspace, with Generator Initially Operated Outside

Structure Type: HOUSE			Garage: No		Basement: No	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Outside			Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Exterior door to kitchen is open 10 cm. Start generator in a location outside of kitchen where CO enters home.							
Restart Scenarios								
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions		Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
K	Generator does not shutoff until the tank is empty; therefore, there are no restart scenarios.	Actual Deaths for specific house model	N/A		N/A	N/A	N/A	Actual Deaths for specific house model

Table 13.a. [UL2201] Scenario for Houses with Garage and Basement But No Crawlspace, with Generator Initially Operated In Kitchen

Structure Type: HOUSE			Garage: Yes		Basement: Yes	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:		Kitchen		Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:		Kitchen window is closed. Exhaust plume mixes in kitchen.						
Restart Scenarios								
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions		Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
A	No restart	0.0500	N/A		1.0000	N/A	1.0000	0.0500
B1	Operator restarts in kitchen.	0.4500	None.		0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1688
B2						Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0563
B3			Kitchen window is open fully.		0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1688
B4						Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0563
C1	Operator moves and restarts generator in garage. Bay door closed.	0.1250	Exhaust facing away from wall that has door to house interior. Exhaust plume mixes inside garage.		0.7500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0469
C2						Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0469
C3			Exhaust facing toward the wall that has door to house interior. Exhaust plume pushes some of exhaust into house.		0.2500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0156
C4						Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0156
C5	Operator moves and restarts in garage. Bay door is open fully.	0.1250	Exhaust facing away from wall that has door to house interior. Exhaust plume mixes inside garage.		0.7500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0469
C6						Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0469
C7			Exhaust facing toward the wall that has door to house interior. Exhaust plume pushes some of exhaust into house.		0.2500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0156
C8						Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0156
D1	Operator moves generator to outside of kitchen.	0.2500	CO does not enter home.		0.7500	N/A	1.0000	0.1875
D2			CO enters home.		0.2500	N/A	1.0000	0.0625

Table 13.b. [UL2201] Scenarios for Houses with Garage and Basement But No Crawlspace, with Generator Initially Operated In Basement

Structure Type: HOUSE		Garage: Yes		Basement: Yes	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Basement			Weight for Home Type: (# deaths allocated to this home * % this location)			
Initial Conditions:	Basement stairway door is open 10 cm. Window in basement is closed. Exhaust plume mixes in basement						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
E	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0500
F1	Operator restarts generator in basement.	0.6167	No change.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.2313
F2					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0771
F3			Window in basement open fully.	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.2313
F4					Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0771
G1	Operator moves generator to outside of kitchen.	0.3333	CO does not enter home.	0.7500	N/A	1.0000	0.2500
G2			CO enters home.	0.2500	N/A	1.0000	0.0833

Table 13.c.i. [UL2201] Scenarios for Houses with Garage and Basement But No Crawlspace, with Generator Initially Operated In Garage, with Generator Exhaust Facing Away from Wall that has Door to House Interior. Exhaust Mixes In Garage. [Scenario weight total to 75%]

Structure Type: HOUSE			Garage: Yes		Basement: Yes	Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:		Garage			Weight for Home Type: (# deaths allocated to this home * % this location)			
Initial Conditions:		Door to house interior is open 10 cm. Bay door is closed. Generator is in center of garage. Exhaust plume mixes in garage.						
Restart Scenarios								
Scenario	Response to Shutoff		Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
H	No restart		0.0500	N/A	1.0000	N/A	1.0000	0.0375
I1	Restart in garage.		0.6167	None.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.1156
I2						Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.1156
I3				Bay door is open fully.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.1156
I4						Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.1156
J1	Operator opens bay door, moves and restarts generator outside garage.		0.3333	Bay door is closed after operator returns to house. CO does not enter garage.	0.5000	N/A	1.0000	0.1250
J2				Operator leaves bay door open after returning to house. CO enters the garage.	0.5000	N/A	1.0000	0.1250

Table 13.c.ii. [UL2201] Scenarios for Houses with Garage and Basement But No Crawlspace, with Generator Initially Operated In Garage, with Generator Exhaust Facing Toward Wall that has Door to House Interior. Exhaust Plume Pushes Some of Exhaust Into House. [Scenario weight total to 25%]

Structure Type: HOUSE		Garage: Yes	Basement: Yes		Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Garage		Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Door to house interior is open 10 cm. Bay door is closed. Generator is in center of garage. Exhaust plume is facing towards wall that has door to house interior.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
K	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0125
L1	Restart in garage.	0.6167	None.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0385
L2					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0385
L3			Bay door is open fully.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to house.	0.5	0.0385
L4					Restart after moving generator to outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.0385
M1	Operator opens bay door, moves and restarts generator outside garage.	0.3333	Bay door is closed after operator returns to house. CO does not enter garage.	0.5000	N/A	1.0000	0.0417
M2			Operator leaves bay door open after returning to house. CO enters the garage.	0.5000	N/A	1.0000	0.0417

Table 13.d. [UL2201] Scenario for Houses with Garage and Basement But No Crawlspace, with Generator Initially Operated Outside

Structure Type: HOUSE		Garage: Yes	Basement: Yes		Crawlspace: No		FINAL SCENARIO WEIGHTS
Initial Location:	Outside		Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Generator located outside kitchen. Door to kitchen is open 10 cm.						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
N	Generator does not shutoff until the tank is empty; therefore, there are no restart scenarios.	Actual Deaths for specific house model	N/A	N/A	N/A	N/A	Actual Deaths for specific house model

Table 14. [UL2201] Scenarios for Detached 1-Car and 2-Car Garages (GAR1 and GAR2) with Generator Operated In Garage

Structure Type: DETACHED GARAGE			GAR1 & GAR2				FINAL SCENARIO WEIGHTS
Initial Location:	Garage		Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions:	Bay door is closed. Generator is in center of garage. Exhaust plume mixes in garage						
Restart Scenarios							
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight	
A	No restart	0.0500	N/A	1.0000	N/A	1.0000	0.0500
B1	Restart in garage.	0.6167	None.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.	0.5	0.1542
B2					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.1542
B3			Bay door is open fully.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.	0.5	0.1542
B4					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5	0.1542
C1	Operator opens bay door, moves and restarts generator outside garage. Operator returns to garage.	0.3333	None. CO does not enter garage.	0.5000	NA	1.0000	0.1667
C2			Bay door is open fully. CO enters the garage.	0.5000	NA	1.0000	0.1667

Table 15.a. [UL2201] Scenarios for Detached Garage Containing a Workshop or Other Room (GAR3) with Generator Initially Operated in Workshop Room

Structure Type: DETACHED GARAGE			GAR3					FINAL SCENARIO WEIGHTS
Initial Location:	Workshop in Garage		Weight for Home Type: (# deaths allocated to this home * % this location)					
Initial Conditions:	Bay door is closed. Generator is in center of workshop room. Workshop door is closed. Exhaust plume mixes in workshop room.							
Restart Scenarios								
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight		
A	No restart	0.0500	N/A	1.0000	N/A	1.0000		0.0500
B1	Restart in same room with generator exhaust plume staying in room.	0.4500	None.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.	0.5		0.1125
B2					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5		0.1125
B3			Window in workshop room is open fully.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.	0.5		0.1125
B4					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5		0.1125
C1	Move and restart in garage. Bay door closed.	0.1250	Door to workshop room is open 10 cm. Exhaust facing away from wall with door to workshop room. Exhaust plume mixes inside garage.	0.7500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.	0.5		0.0469
C2					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5		0.0469
C3			Door to workshop room is open 10 cm. Exhaust facing toward the wall with door to shop. Exhaust plume pushes some of exhaust into workshop room.	0.2500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.	0.5		0.0156
C4					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5		0.0156
C5	Move and restart in garage. Bay door is open fully.	0.1250	Door to workshop room is open 10 cm. Exhaust facing away from wall with door to workshop room. Exhaust plume mixes inside garage.	0.7500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.	0.5		0.0469
C6					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5		0.0469
C7			Door to workshop room is open 10 cm. Exhaust facing toward the wall with door to shop. Exhaust plume pushes some of exhaust into workshop room.	0.2500	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.	0.5		0.0156
C8					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5		0.0156
D1	Operator opens bay door, moves and restarts generator outside garage. Operator returns to original location.	0.2500	None. CO does not enter garage.	0.5000	NA	1.0000		0.1250
D2			Bay door is open fully. CO enters the garage.	0.5000	NA	1.0000		0.1250

Table 15.b.i. [UL2201] Scenarios for Detached Garage Containing a Workshop or Other Room (GAR3) with Generator Initially Operated In Garage, with Exhaust Oriented Away from Wall with Door to Workshop Room [Scenario weight total to 75%]

Structure Type: DETACHED GARAGE			GAR3					FINAL SCENARIO WEIGHTS
Initial Location:		Garage	Weight for Home Type: (# deaths allocated to this home * % this location)					
Initial Conditions:		Door to workshop is open 10 cm. Bay door is closed. Generator is in center of garage. Exhaust is facing away from wall with door to workshop. Exhaust mixes in garage.						
Restart Scenarios								
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart		2nd Reaction Weight	
A	No restart	0.0500	N/A	1.0000	N/A		1.0000	0.0375
B1	Restart in garage.	0.6167	None.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.		0.5	0.1156
B2					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.		0.5	0.1156
B3			Bay door is open fully.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.		0.5	0.1156
B4					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.		0.5	0.1156
C1	Operator opens bay door, moves and restarts generator outside garage. Operator returns to original location.	0.3333	None. CO does not enter garage.	0.5000	NA		1.0000	0.1250
C2			Bay door is open fully. CO enters the garage.	0.5000	NA		1.0000	0.1250

Table 15.b.ii. [UL2201] Scenarios for Detached Garage Containing a Workshop or Other Room (GAR3) with Generator Initially Operated in Garage, with Exhaust Oriented Toward Wall with Door to Workshop Room. Exhaust Plume Pushes Some of Exhaust Into Workshop. [Scenario weight total to 25%]

Structure Type: DETACHED GARAGE			GAR3					FINAL SCENARIO WEIGHTS
Initial Location:	Garage		Weight for Home Type: (# deaths allocated to this home * % this location)					
Initial Conditions:	Door to workshop is open 10 cm. Bay door is closed. Generator is in center of garage. Exhaust is facing toward wall with door to workshop. Exhaust plume pushes some of exhaust into workshop room.							
Restart Scenarios								
Scenario	Response to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub-Scenario Weight	2nd restart	2nd Reaction Weight		
D	No restart	0.0500	N/A	1.0000	N/A	1.0000		0.0125
E1	Restart in garage.	0.6167	None.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.	0.5		0.0385
E2					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5		0.0385
E3			Bay door is open fully.	0.5000	Restart after moving generator to outside of garage where CO does not enter garage. Garage bay door is open until operator returns to inside garage.	0.5		0.0385
E4					Restart after moving generator to a outside of garage where CO enters garage. Garage bay door is open by operator and remains open.	0.5		0.0385
F1	Operator opens bay door, moves and restarts generator outside garage. Operator returns to original location.	0.3333	None. CO does not enter garage.	0.7500	N/A	1.0000		0.0625
F2			Bay door is open fully. CO enters the garage.	0.2500	N/A	1.0000		0.0208

Appendix B Summary of Public Comments and Staff Resolutions

Summary of Comment	**Resolution of Comment**
Window dimensions in basements are typically smaller than those in main living areas; thus, the basement window opening in TN 2048 is too large. Commenter recommends 0.3 m high by 0.8 m wide opening for basement windows.	Staff agrees. The height of the basement window opening was changed to 0.3 m from 0.5 m per commenter's recommendation.
A published paper provides typical interior and exterior door dimensions that shows that in TN 2048 the door height for both types of doors is too tall and the width of interior doors is too wide.	Staff agrees. Door heights were changed to 2.0 m from 2.1 m and the interior door widths were changed to 0.79 m from 0.9 m per commenter's recommendation. Staff also changed the door widths for interior open doorways and exterior doors to 0.79 m.
For interior doors that are not to the source room, the door position should be open 5 cm, as was simulated in benefits analysis for the NPR, not fully open as stated in TN 2048.	While fully open doors as described in TN 2048 are expected to be the most conservative assumption for evaluating generators with shut-off capability, staff changed the door opening to 10 cm as a compromise to keep the analysis reasonably conservative, as was generally done for the NPR, while acknowledging that not all doors would be fully open at all times in most real buildings.
For interior doors to the source room, the door position should be open 5 cm, as was simulated in benefits analysis for NPR, not open 10 cm, as stated in TN 2048.	For the evaluation of the NPR, staff used a reasonable yet conservative source room door opening of 5 cm. Staff is taking a similar reasonable yet conservative approach to evaluating shutoff systems by having the source room door open wider than 5 cm. Staff is using 10 cm because this is consistent with the interior doors on the non-source room, as described above, and provides a non-exaggerated estimate, without being fully open. Furthermore, this is approximately the same door size opening that PGMA members used in their testing.
When the generator is located outdoors, different weight factors for the scenarios of CO entering the kitchen or garage should be used for G300 generators compared to UL 2201 generators. TN 2048 has equal weight factors for both generators outside both locations (50% probability of CO entering the kitchen or garage and 50% probability of CO not entering). This is not in alignment with CPSC's in-depth	The G300 voluntary standard requires an information label on the generator that tells consumers to point exhaust away and includes an arrow on the generator to show the location of the exhaust. UL 2201 does not have these requirements. Therefore, for the restart scenario when exhaust does not enter the kitchen from outside, staff increased the weight factor for a G300 generator from 50 percent to 90 percent. (Staff notes this is higher than the percentage proposed by the commenter when considering the kitchen door is open to allow for passage of the extension cord.) However, for many generators, the exhaust is not on the same side as the electrical outlets, and staff expects the user likely would have the outlet

investigation (IDI) data, which indicates only 3% of incidents associated with portable generators due to CO exposure occur when the generator is operated outside.	side of the generator facing the house to minimize the length of cord needed to plug in appliances, so even a UL 2201 generator would be less likely to have exhaust directed towards the house. Thus, for a UL 2201 generator, the weight factor was increased from 50 percent to 75 percent. (Staff notes that the 25 percent probability staff assigned to a UL 2201 generator restarted outside with the CO coming in is much higher than that proposed by the commenter.) For generators restarted outside a garage, the weight factors for the scenario of CO not entering the garage for both G300 and UL 2201 generators were left at 50 percent. Staff's rationale for this is that the garage has a much larger opening than a kitchen door that is open 10 cm and, based on incident data review, staff believes many consumers are less likely to be concerned about CO entering the garage compared to the living space. Staff notes that these scenarios are for consumers who initially start a voluntary standard-compliant generator in an enclosed space and then *restart* the generator outside. Staff does not believe the probability of the scenarios where CO enters the house from a restart outside is relevant to the low percentage of incidents in CPSC's databases where the generator was outside. In those incidents, the consumer never made the choice to initially operate the generator inside.
A commenter recommended weight factors for all scenarios for G300 generators and different weight factors for UL 2201 generators based on equations they developed that rely on assertions and assumptions including the following:	Staff disagrees with the commenter's proposed weight factors for the reasons provided below.
• Unless the generator is located within 5 feet of the doorway to a connecting space, and directly in line with the width of that doorway, the exhaust plume stays substantially in the space where the generator is operating (or outside if the generator is outside).	Staff disagrees with this comment because our test data does not support it. Nonetheless, staff performed additional empirical tests and model validation to improve the characterization of scenarios where the portable generator is either (1) in a garage with the exhaust jet facing towards a wall that has a door connecting to the house interior, but not directly in line with the door, or (2) into an open garage from a location outside but in front of the garage. The methodology described in TN 2048 for these scenarios, however, remains the same.
• The information label required in PGMA G300 is 97 percent effective.	The commenter claims 97 percent effectiveness based on a focus group they convened; however, the commenter did not provide any details regarding the focus group or the questions that were posed to participants. Generally, focus groups on a warning or information label would assess the extent to which the label

	successfully communicates the intended message to participants. This might include questions about how participants would respond when presented with the label. Importantly, however, questions to participants about how they would respond to the label only inform how well the participants, and similar consumers, understand the appropriate response when presented with label, not their actual behavior. Even if 97 percent of participants understood the intended message and stated that they would perform the recommended behavior, this does not mean that 97 percent of consumers would actually take this action in a real-life use scenario, or that users of generators with this label would perform the recommended behavior 97 percent of the time. Consumer compliance with warnings depends strongly upon the specific circumstances surrounding the hazard, and warning label research has shown that even small "costs," in terms of time and effort, have been shown to reduce behavioral compliance with warnings. Generator use includes many of these costs, such as finding and purchasing a long enough power cord to place the generator far from the home, finding a means of preventing theft of the generator, keeping the generator dry to avoid the potential shock or electrocution hazard, and addressing concerns about noise to neighbors, all of which will likely limit the overall effectiveness of the label. Furthermore, the pertinent question is not what percentage of all generator users would respond appropriately to the label, but rather, what percentage of generator users who otherwise would use the generator in an unsafe location would change their behavior in response to the label. Many of the fatal incidents in CPSC databases involved consumers using generators under desperate circumstances of a power outage with cold and/or wet conditions, or no power due to nonpayment of their utility bill. Unless the focus group consisted of people who had previously made the decision to run the generator indoors and were in such situations, staff questions the relevance of the results of the focus group testing, even if the participants were instructed to pretend such conditions existed.
• When a generator is placed in a room or garage, there is equal probability that it will be placed anywhere within the full square footage of that space. This will make it less likely the generator will be placed in a location where the exhaust plume pushes the exhaust into an adjacent space and delay when shutoff occurs.	Staff thinks it is unreasonable to assume that a generator could be placed anywhere in a room or garage with equal probability for a number of reasons, including: • Most rooms have furniture and many other obstructions that do not make it equally probable to put a generator anywhere in that space. • The area surrounding the doorway is one of the few locations that is likely to be consistently unobstructed.

	• The extension cord length may be a limiting factor that prevents consumers from putting a generator further into a room. • CPSC has incident data where the generator was placed near a door with the exhaust blowing into an adjacent space. In spite of the factors above, which staff thinks supports the 25 percent probability in TN 2048 for the exhaust plume pushing the exhaust into the adjacent space, staff reduced the weight factor from 25 percent to 18.75 percent for the scenarios where the generator is in a first floor room that has an isolating door. Staff arrived at this by assuming a 75 percent probability that the generator will be placed near the door (as opposed to 100 percent assumed in TN 2048) to the 25 percent chance that the exhaust is pointed towards the door as opposed to away from the door. For the scenarios where the generator is in the garage with the exhaust facing the wall that has a door to the house interior but not in alignment with the door, staff has left the probability for this scenario at 25 percent.
• A disable scenario should be added for UL 2201 generators. This is needed because some UL 2201 generators may inform users about the shutoff feature (even though not required), but UL 2201 does not require the shutoff feature to be tamper-resistant to prevent a UL 2201 generator from starting if the shutoff is disabled.	Staff does not believe reasonable rationale was provided for including a disable scenario. Based on emissions and shutoff criteria, and as documented in the test results in NIST TN 2049, a UL 2201 generator will usually take longer to shut off relative to a G300 generator in the same conditions in the same source location. As a result, staff thinks that a user is less likely to interpret its shutoff as a malfunction and thus less likely to tamper. While tampering with shutoff sensors may be possible for either standard, staff concluded that this was not a condition necessary to model for either voluntary standard.

• The 25 percent probability of a no-restart scenario as proposed in TN 2048 is reasonable.	Staff reconsidered the probability of no-restart scenario proposed in TN 2048 because staff believes that the likelihood of a consumer abandoning attempts to run their generator after an initial shut off is close to zero because the motivations for using a generator in the first place are still present. Nonetheless, staff gave it a 5 percent probability for both G300 and UL 2201 generators with the rationale provided in a later response to a comment about assigning different probabilities to the two different generators. Furthermore, because staff believes that in reality consumers will continue to attempt to restart the generator due to their circumstances and desire for power, a second restart was added if the generator shuts off a second time. The second restart occurs after the user moves the generator outside. The baseline generator will be simulated as operating until it runs out of fuel; to best assess likely CO exposures, staff feels voluntary standard-compliant generators should also be simulated as running just as long, until they exhaust a full tank of fuel.

Relating to the comment above, the commenter stated that the plan in TN 2048 assumes worst case scenarios as well as heavily weighting scenarios that are unlikely to occur. The commenter requests that staff perform a sensitivity analysis that compares the results using the assumptions (weight factors) in TN 2048 to the commenter's suggested assumptions (weight factors based on the commenter's assertions stated in the five above rows and other assumptions). If the results of the study are dramatically different, depending on which set of assumptions are used, then a human factors study is requested to determine appropriate assumptions for the study. Similar comments requested CPSC perform a human factors study to support our assumptions about door and window positions, restart scenarios, weight factors (probabilities) etc. in the absence of scientific data.	For the reasons stated above, as well staff's responses to other comments provided below, staff disagrees that the plan assumes worst case scenarios and is heavily weighted towards scenarios that are unlikely to occur and so staff rejects the commenter's proposed weight factors. Staff believes the scenario tables provided in Appendix A of this memorandum are reasonable. Nonetheless, staff will consider ways to assess the sensitivity of the effectiveness estimates. A human factors study is not within the scope of this work. Furthermore, staff has the same concerns regarding a human factors study for this issue as those discussed above for the focus group.
If a generator shuts down after a few minutes, or is restarted and shuts down again, the 24 hour exposure period does not make sense.	Staff disagrees that the 24 hour period does not make sense. Occupants will continue to be exposed to CO in the house after the generator shuts off. Their estimated COHb levels are expected to reach peak levels quite some time after the CO concentrations peak. In NIST TN 2049, in a vast majority of the tests, the peak COHb levels were attained one to two hours after the generator shut off. (Furthermore, at the time of shutoff, the occupants' COHb levels were well below the level typically associated with CO poisoning symptom onset. Staff believes this further adds to the reasonable expectation that some consumers may try to restart the generator after shutoff, even if they are aware that shutoff may be due to the presence of CO, given the lack of symptoms.) Since staff does not know what the COHb profiles resulting from the simulations will look like, a 24-hour simulation period is believed to be reasonable to ensure that both the CO accumulation and decay is captured within the simulation sufficiently to assess the occupants' health effects.

Also related to the commenter's proposed weight factors, a comment about G300 having the notification and information label requirements and UL 2201 not having them stated that this should be taken into account in considering the probabilities of the scenarios after the generator shuts off. For this difference, the chances for the consumer to restart a G300 generator indoors should be considered lower than a UL 2201 generator. UL 2201 generators should be assumed to have a higher probability of the user repeatedly restarting indoors since there is no requirement for instructions on what to do after automatic shutoff.	Staff disagrees with the comment. In spite of G300's notification and information label requirements, staff thinks that a consumer not being symptomatic when shutoff occurs and the likelihood of the shutoff occurring relatively quickly lend to the consumer either interpreting the shutoff as either a malfunction of the system or not taking it seriously. This adds to the reasonable expectation, as stated in responses above, that there is a higher probability that consumers will restart a G300 generator in an enclosed space compared to outside. As for a UL 2201 generator, staff assumes the same probabilities for the vast majority of the scenarios as assumed for the G300 generator. Staff considers that after 2 shutoffs indoors, a consumer will try restarting outdoors.
For UL 2201 generators: 1. Use higher CO emission rates proposed by the commenter. Catalysts degrade over time and manufacturers' expected life of a generator could be 10 years, which is longer than the manufacturers' claim of the engine's rated useful life when certifying that the engine will meet EPA small engine emission regulation throughout its life. 2. Use a higher heat release rate and, therefore, account for increased deaths and injuries due to heat and fire. Risk of fire is increased with engine misfire, which can cause larger amounts of HC and CO to be exhausted through the catalyst, which can lead to thermal runaway. 3. Account for failure of the system to shut off at the CO concentrations required in the standard's tests since direct detection of CO using a CO sensor is not required.	Staff disagrees with this comment. 1. EPA conducted extensive small engine testing using catalysts, finding them to be durable and lowering the risk of fire and burn compared to non-catalyzed exhaust systems. Engine manufacturers are required by EPA to certify their engines' emission rates for the rated useful life of the engine. If generators are used longer than the manufacturers' rated useful life of the engine, emissions degradation can occur with all engines, not just those complying with UL 2201. Staff thinks it is reasonable to use the CO rates proposed in TN 2048. 2. The particular test in TN 2049 noted by the commenter regarding the heat release rate was one in which the generator ran for 4.5 hours. Staff has observed similar temperatures during testing of current generators operating in a closed garage for equivalent periods of time. Additionally, as noted in Appendix 1 of TN 2049, while the average block temperature of generator G7 at 100 percent load was 33 deg C warmer than generator G6, its exhaust temperature was cooler by 75 deg C. The differences at 50 percent load were 20 deg C and 106 deg C, respectively. As for thermal runaway, catalysts are used in many small handheld engines for a variety of products hand carried by the user. Staff is not aware of incidents involving fires with these products from that type of scenario. 3. There is no data to support this comment. Furthermore, staff has concerns about how well the test chambers and test procedures required in both UL 2201 and G300 represent performance of the generator's shutoff system when the generator is operated in real-life scenarios.

The enclosed space tests may allow generators to meet the shutoff criteria using parameters to indirectly detect CO but the system may not function the same in a real-life scenario. 4. Account for the shutoff system being deliberately bypassed since there are no requirements for tamper-resistance or provisions that prohibit the manufacturer from providing an override switch.	4. While staff recommends having tamper-resistance requirements to prevent the user or manufacturer with ability to bypass the shutoff system, staff disagrees with including such scenarios in the effectiveness analysis for reasons provided in response to an earlier comment.
Use higher CO emission rates for G300 generators because the rates provided in TN 2048 are approximately half the CO rate allowed by EPA regulations of 610 g/kW-hr.	Staff disagree with this comment. Staff derived the CO emission rates in TN 2048 from engine manufacturers' published EPA certification data. The rates being used are the weighted rates among 6 different loads. This method allows the emission rate to be normalized rather than model multiple rates due to varying engine loads. Staff believes this estimate of CO emission rates is reasonable.
In assessing the exposure of the operator who restarts the generator, the amount of time the operator is in the source location to restart should be different for G300 generators compared to UL 2201 generators.	This comment led staff to recognize that the plan in TN 2048 did not include analyzing the exposure of the operator who restarts the generator. Staff added operator exposure to the plan because while the operator is restarting the generator, this person may be exposed to the highest CO concentrations than anywhere else in the house or garage. As to the amount of time the operator is in the source location to restart the generator, as stated previously, due to the lower emission rate of a UL 2201 generator relative to its shutoff criteria compared to that of a G300 generator, staff believes that UL 2201 generators in all but the handheld generator category are not likely to shutoff as quickly as G300 generators. Although staff believes that if the first shutoff occurs relatively quickly, the operator is more likely to stay longer after restart, to ensure it stays running, the scenarios assume the operator stays for 2 minutes irrespective of the standard's shutoff criteria.
Conduct empirical testing to quantify exhaust infiltration from outside when the exhaust is not oriented perpendicular to a structure opening and when exposed to wind blowing in multiple directions.	Empirical testing was done in a variety of wind speeds and directions. The direction of the exhaust was perpendicular to the house because CPSC's databases have fatal incident data from outdoor generator use with the exhaust directed this way and the simulations are attempting to replicate fatal incidents.

TN 2048 says the houses will be oriented such that the predominant wind direction for the simulated weather conditions will be directed toward the garage door for houses with garages or toward the front of the house for houses without a garage. This will aid in always pushing the exhaust into the home.	In the simulations, the fraction of the generator's CO emission rate entering the house or garage when the generator is operated outside of it will be the same regardless of wind direction; thus, the wind will not push more exhaust into the house or garage from outside. Furthermore, when the generator is initially started or restarted outside, it is outside the kitchen door, not the front door as stated by the commenter, in all scenarios except when the generator is initially started or restarted in the garage. In all house models, the kitchen door is on the back or side of the house (22 have it on the back, 8 on the right, and 7 on the left), not on the front of the house. Lastly, there is considerable variability in the wind direction throughout the hourly data of the 28 days of weather being used in the simulations, so the commenter is not correct in stating that the wind is always in a direction where it will aid in pushing the exhaust into the home. Nevertheless, staff has changed the orientation of all the houses such that the left side, as viewed when looking at the side of the house with the front door, is oriented towards the predominant wind direction.
Statistically significant empirical testing needs to be performed to ensure the model accurately represents the real world. Applying a single fraction to represent exhaust migration does not represent all real world scenarios.	There are many factors that will affect model accuracy and there are infinite number of possibilities that could happen in real world scenarios. It is not possible to test as suggested in this comment. Staff believes the proposed approach using the existing data is reasonable.
Use shutoff criteria based on 5-minute rolling average.	There is no requirement for this in the standard. Manufacturers could do this as well as an infinite number of variations from requirements in the standards to ensure compliance; however, staff does not have resources to pursue these. As such, staff will not modify the approach proposed in TN 2048 (*i.e*. it will use a 10-minute rolling average).
Use probabilities of occupants in different rooms of the house based on tables from the EPA Exposure Factors Handbook	Staff questions how applicable the EPA's data are for households during a power outage scenario, particularly due to extreme weather conditions or electrical service termination, where consumers are using a generator for power. Consumers' behavior most likely will be different in these atypical circumstances relative to the normal circumstances underlying EPA's tables. Staff does not have applicable data to determine movement of occupants within the home, therefore using equal probability is a reasonable estimate.

Conduct the simulations exactly the same as with the NPR to allow a comparison between the effectiveness of the voluntary standards with the NPR.	The purpose of the simulations is to assess the potential effectiveness of the voluntary standards on deaths and injuries. Staff is not trying to compare the voluntary standards to the NPR. Furthermore, with the introduction of shutoffs and other measures in these two standards, the approach of letting the generator run indoors until it runs out of fuel is less likely.
Perform simulations in homes with typical residential air exchange rates.	Assessing the effectiveness of the voluntary standards on CO-poisoning incidents demands that the simulations reflect the characteristics of homes involved in those incidents, not the characteristics of "typical" residential homes. Thus, staff concludes that using CONTAM with models of houses that represent the houses in which the incidents occurred is more appropriate than using houses with typical air exchange rates.
Using the shutoff ratio described in TN 2049 to determine when the simulation should shut off the generator is not appropriate. Some manufacturers may set the shutoff level lower than that required by the standard due to difference in CO concentration at the sensor compared to above the center of the generator where the compliance test for either G300 or UL 2201 requires the shutoff concentration be measured (1-2 inches or 1 foot above the generator, respectively). The determination of shutoff ratios in NIST 2049 should have been based on those locations and not the CO sensor location.	NIST and CPSC staff performed additional physical testing to evaluate the difference in concentrations at these locations during testing and found no compelling data to support changing the methodology in TN 2048.

Evaluate the health effects of children and elderly separately, if their COHb criteria for injury and fatality are different than those of healthy adults.	Staff does not propose any changes to its COHb criteria for assessing the effectiveness of PGMA G300 and UL 2201 in reducing deaths and serious generator-related CO poisoning injuries in healthy adults, who account for the majority of generator-related CO poisoning cases. However, staff wishes to clarify that its lower proposed threshold of ≥15% COHb, where it expects healthy adults might experience adverse symptoms that could possibly prompt them to seek medical attention, is also aligned with the National Research Council's Acute Exposure Guideline Level 3 (NRC AEGL-3) for CO, which represents a threshold limit where life-threatening adverse health effects or death could occur in the general population, including susceptible individuals. The NRC's AEGLs (three tiers) were developed specifically to guide response to rare, acute, emergency exposure situations for a wide range of chemicals/substances considered extremely hazardous; they are recognized by EPA and international emergency planners and responders. The NRC AEGL-3 for CO is based on a range of approximately 14% to 17% COHb in the sub-population recognized as being most susceptible to CO poisoning at the lowest CO exposure levels (*i.e.*, individuals with coronary artery disease (CAD) who are at risk of CO-induced cardiac ischemia and myocardial infarct). Individuals with CAD are more susceptible to CO poisoning effects than other sensitive populations such as fetuses, children, pregnant women, or the elderly in general. The 14% to 17% COHb AEGL-3 level is predicated on an uncertainty factor of 3 being applied to 40% COHb, the level recognized as an appropriate lower threshold for lethal CO exposures in healthy individuals. Thus, staff's proposed ≥15% COHb non-lethal criterion in healthy adults could be interpreted alternatively in terms of the NRC AEGL-3, and so could also be used to identify scenarios where generator-related CO poisoning could result in deaths of susceptible individuals, but not healthy individuals. (See details of NRC CO AEGLs in https://www.epa.gov/sites/production/files/2014-11/documents/carbon_monoxide_final_volume8_2010.pdf).

Provide the rationale for the criteria for estimating potential severity of injuries for the survivors of formerly fatal exposures.	Staff has long recognized that CO poisoning effects can progress as a continuum of increasingly severe symptoms, the manifestation and perception of which are dependent on the peak level of CO (ppm) reached, the rate of rise to the CO peak, and the duration of exposure. This is further influenced by the health status and activity level of an exposed individual. Furthermore, at rapidly rising CO exposures, victims can be rapidly incapacitated, lose consciousness, and even die without necessarily experiencing mild CO poisoning symptoms. For supporting evidence regarding symptomology expected in healthy and sensitive populations at different COHb levels and ranges; See **tables 2-1, 2-2, and 2-6** in NRC CO AEGLs in https://www.epa.gov/sites/production/files/2014-11/documents/carbon_monoxide_final_volume8_2010.pdf. Also, see previous Health Sciences staff discussions on COHb levels and expected symptoms in Tab G in staff's briefing package on its technology demonstration of a prototype low CO portable generator and Tab K, particularly appendices C, D and F, in staff's briefing package for the NPR. Regarding the use of 25% COHb by experts as one criterion indicating that HBO treatment is warranted for a CO poisoning victim, see the following medical literature reports: • Hampson NB, Piantadosi CA, Thom SR, Weaver LK. Practice recommendations in the diagnosis, management, and prevention of carbon monoxide poisoning. Am J Respir Crit Care Med 2012;186: 1095–1101 • Rose JJ, Wang L, Xu Q, McTiernan CF, Shiva S, Tejero J, and Gladwin MT. Carbon Monoxide Poisoning: Pathogenesis, Management, and Future Directions of Therapy Am J Respir Crit Care Med Vol 195, Iss 5, pp 596–606, Mar 1, 2017 • Eichhorn L, Thudium M, Jüttner B: The diagnosis and treatment of carbon monoxide poisoning. Dtsch Arztebl Int 2018; 115: 863–70. DOI: 10.3238/arztebl.2018.0863