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

MEMORANDUM

DATE: August 12, 2020

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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<sup>a</sup> 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),<sup>b</sup> 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.<sup>c</sup> 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.<sup>d</sup> We received four sets of comments in response to the FR notice.<sup>e</sup>

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**

<sup>d</sup> U.S. Consumer Product Safety Commission Log of Meeting, dated August 8, 2019. Available online at <u>https://www.cpsc.gov/s3fs-public/2019-8-</u> <u>8%20%20Public%20Meeting%20to%20Answer%20Clarifying%20Questions%20on%20NIST%20TN%202048.pdf</u> ?wcYot3.N1c5yJ686gJjiRPNaPOteO118.

<sup>&</sup>lt;sup>a</sup> 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: <u>http://dx.doi.org/10.6028/NIST.TN.2048</u>).

<sup>&</sup>lt;sup>b</sup> ANSI/PGMA G300-2018, *Safety and Performance of Portable Generators*. (Available online at: <u>https://www.pgmaonline.com/pdf/ANSI\_PGMAG300-2018 (ErrataUpdateApril2020).pdf.</u>

<sup>&</sup>lt;sup>c</sup> Notice of Availability: Plan to Evaluate CO Mitigation Requirements for Portable Generators, Federal Register, 84 FR 32729, July 9, 2019.

<sup>&</sup>lt;sup>e</sup> The comments are available online at <u>www.regulations.gov</u>, under docket CPSC-2006-0057, document identification numbers 0101 through 0104.

#### Section 3. Building Models

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  $\times$  0.5 m high from 0.8 m high  $\times$  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  $\times$  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:

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

Table 10. CO Shutoff Criteria for Simulations

## 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<sup>f</sup> victims: the *operator* who has direct interaction with the generator, and the *collateral person* who is within the same house or

<sup>&</sup>lt;sup>f</sup> 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.

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 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 assumptions 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 level. The assumptions for the different exposure profiles are explained below:

- 1. Collateral Person
  - 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 10minute 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)
	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.
NT 4	

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: H	OUSE	Gar	age: No	Basem	ent: No	Crawlspace: No						
Ini	Initial Location:		Kitchen	5	W	Weight for Home Type: (# deaths allocated to this home * % this location)							
Initi	nitial Conditions: Kitchen window is closed. Exhaust plume mixes in kitchen.						FINAL						
				R	Restart Scenari	OS			SCENARIO				
Scenario	Response to Shutoff Scenario Weight		Changes fr Condit		Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHTS					
Α	No re	estart	0.0500	N/A	4	1.0000	N/A	1.0000	0.0500				
B1	- Operator restarts in kitchen.			Nana		None.		0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2025		
B2			0.4500	NOT	с.	0.3000	Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0225				
B3			0.4500	Kitchen window		0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2025				
B4				Richen window is open fully.		0.3000	Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0225				
C1	Operator moves ge	nerator to other 1st	0.2500					Windowin room is open fully		1.0000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2250
C2	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 enters home.	0.1	0.0250				
D1	Operator moves generator to outside of		0.2500	CO does not enter home.		0.9000	NA	1.0000	0.2250				
D2	kitch	nen.	0.2500	CO enters	s 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: H	OUSE	Gar	age: No	Basem	ent: No	Crawlspace: No					
Ini	tial Location:	Other 1st floor ro	bom with an isolating door Weight for			Veight for Hom	ne Type: (# deaths allocated to this home * % this location	)				
Initi	ial Conditions:		Windo	w in room is ope	n 5 cm. Door t	to room is ope	n 10 cm. Exhaust plume mixes inside room.		FINAL			
				R	estart Scenari	ios			SCENARIO			
Scenario	Response	to Shutoff	Scenario Changes fro Weight Condition			Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHTS			
E	No re	estart	0.0500	N/A	A	1.0000	N/A	1.0000	0.0406			
F1				None		0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2255			
F2	Operator restarts	s in same room.	0.6167		-		Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0251			
F3	, , , , , , , , , , , , , , , , , , ,			Windowis	dow is open fully	s open fully	Vindow is open fully.	open fully 0.500	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2255
F4			Window is o		pen rully.	0.3000	Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0251			
G1	Operator moves ger	Operator moves generator to outside of		CO does not e	enter home.	0.9000	N/A	1.0000	0.2438			
G2	kitchen.		0.3333	CO enters	s home.	0.1000	NA	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%]

L'Anaust I I	une offenteu out of	Door to mouse meet	of [Beenairo	weights = 10.75	/0]				
	Structure Type: HOUSE			age: No	Basem	ent: No	Crawlspace: No		
Ini	Initial Location: Other 1st floor roo			isolating door	V	leight for Hom	he Type: (# deaths allocated to this home * % this location	)	
Initi	ial Conditions:	V	/indow in roo	m is open 5 cm.	Door to room	is open 10 cm	h. Exhaust plume oriented out door to house interior.		FINAL
Restart Scenarios									SCENARIO
Scenario	Response to Shutott		Scenario Weight	Changes fr Condit		Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHTS
Н	No re	estart	0.0500	N/A	4	1.0000	N/A	1.0000	0.0094
11	Operator restarts in same room.			None.		0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.0520
12			0.6167			0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0058
13	Operator restart	s in same room.	0.0107			0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.0520
14				WINDOW IS C	Window is open fully.		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 e	enter home.	0.9000	N/A	1.0000	0.0563
J2			kitchen.		s 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 Basem		ent: No Crawlspace: No				
Ini	itial Location:		Outside		V	Veight for Hom	he Type: (# deaths allocated to this home * % this location	on)	FINAL
Init	Initial Conditions: Exterior door to kitchen is open 10 cm. Start generator in a location outside of kitchen where CO enters home.				SCENARIO				
	Restart Scenarios					WEIGHTS			
Scenario	Scenario Response to Shutoff		Scenario	Changes from Initial		Sub-	2nd restart	2nd	
Coonano			Weight	Condi	tions	Scenario	Endroodart	Reaction	
к	Generator does not a is empty; therefore, scena	there are no restart	Actual Deaths for specific house model	N//	Ą	N⁄A	N⁄A	N/A	Actual Deaths for specific house model

Table 3.a. [	-				8,		y Operated In the Kitchen		1
Structure Type: HOUSE						Basement: No Crawlspace: Yes			
		Kitchen				e Type: (# deaths allocated to this home * % this location	)	<b>EINIA</b> I	
Initia	al Conditions:				en window is c estart Scenari		st plume mixes in kitchen.		FINAL SCENARIO
					estan Scenan	os Sub-		2nd	WEIGHTS
Scenario	Response	to Shutoff	Scenario Weight	Changes fro Conditi		Scenario Weight	2nd restart	Reaction Weight	
А	No re	start	0.0500	N/A		1.0000	N/A	1.0000	0.0500
B1				Nana		0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.1575
B2	Operator restarts in kitchen.		0.2500	None	None.		Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0175
B3			0.3500	Kitchen window	ie open fully	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.1575
B4					is open rully.	0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0175
C1	Operator moves ger	nerator to other 1st	0.2000		· · · · · · · · · ·	open fully. 1.0000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.1800
C2	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 enters home.	0.1	0.0200
D1	Operator moves gene Exhaust plume mixes The only exposure in	s inside crawlspace	0.2000	Nerra		4 0000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.1800
D2	operator entering the crawlspace to move the generator and/or restart the generator.		0.2000	None	3.	1.0000	Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0200
E1	Operator moves generator to outside of		0.2000	CO does not e	nter home.	0.9000	NA	1.0000	0.1800
E2	kitch	kitchen.		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: H	OUSE	Gar	age: No	Baseme	ent: No	Crawlspace: Yes				
				hom with isolating door Weight for Home Type: (# deaths allocated to this home * %				)			
Initi	al Conditions:		Windo				n 10 cm. Exhaust plume mixes inside room.		FINAL		
			Scenario	Changes fror	estart Scenari m Initial	Sub-		2nd	SCENARIO WEIGHTS		
Scenario	Response	to Shutoff	Weight	Conditio		Scenario Weight	2nd restart	Reaction Weight			
F	No re	estart	0.0500	N/A		1.0000	N/A	1.0000	0.0406		
G1	Operator restarts in same room.			None.		0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.1645		
G2			0.4500			Tiono.		0.3000	Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0183
G3				Window in room i	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						0.3000	Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0183		
H1	Exhaust plume mixe	es generator to crawlspace. ne mixes inside crawlspace osure in the crawlspace is of		None.			1.0000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.1828	
H2	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 enters home.	0.1	0.0203		
11	Operator moves generator to outside of		0.2500	CO does not en	nter home.	0.9000	N/A	1.0000	0.1828		
12	kitch	nen.	0.2300	CO enters h	home.	0.1000	N/A	1.0000	0.0203		

	Structure Type: H			age: No		ent: No	Crawlspace: Yes		
	tial Location:	Other 1st floor I		-		<u> </u>	Type: (# deaths allocated to this home * % this location)	)	
Initi	al Conditions:	W	indow in rooi				a. Exhaust plume oriented out door to house interior.		FINAL SCENAR
				R	estart Scenar			0.1	
cenario	Response	to Shutoff	Scenario Weight	Changes fro Conditi		Sub- Scenario Weight	2nd restart	2nd Reaction Weight	
J	No re	estart	0.0500	N/A	١	1.0000	N/A	1.0000	0.0094
K1				None	2	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.0380
K2	Operator restart	n in come room	0.4500	None.		0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0042
K3	Operator restarts	s in same room.	0.4500	Window in a	man fully	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.0380
K4				Window is o	ppen rully.	0.0000	Operator moves generator to outside of kitchen where CO enters home.	0.1	0.004
L1	Operator moves gene Exhaust plume mixe The only exposure in	s inside crawlspace	Ispace ce is of 0.2500 Non		None. 1.0000		Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.042
L2	the generator an	erator entering the crawlspace to move the generator and/or restart the generator.		NOTE			Operator moves generator to outside of kitchen where CO enters home.	0.1	0.004
M1	Operator moves ger	nerator to outside of	0.0500	CO does not e	enter home.	0.9000	N/A	1.0000	0.042
M2	kitch	nen.	0.2500	CO enters	home.	0.1000	N/A	1.0000	0.004
ble 3.c. [	G300] Scenarios for	Houses with Crawlsp	ace But No E	asement or Gar	age, with Gen	erator Initial	ly Operated in the Crawlspace		
	Structure Type: H	OUSE	Gar	age: No		nent: No	Crawlspace: Yes		
	tial Location:	C	rawlspace				ne Type: (# deaths allocated to this home * % this location	ı)	
Initi	al Conditions:						t plume mixes in crawlspace.		FINA
cenario	Response	to Shutoff	Scenario Weight	R Changes fr Condit		ios Sub- Scenario Weight	2nd restart	2nd Reaction Weight	SCENA WEIGI
Ν	No re	estart	0.0500	N/A	Ą	1.0000	N/A	1.0000	0.050
O1		e crawlspace is of	0.0107	Non			Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.555
O2		e crawlspace to move nd/or restart the rator.	0.6167	Non	ne. 1.0000		Operator moves generator to outside of kitchen where CO enters home.	0.1	0.06
P1				CO does not e	enter home.	0.9000	N/A	1.0000	0.300

P2

Operator moves generator to outside of

kitchen.

0.3333

1.0000

0.0333

N/A

0.1000

CO enters home.

	Structure Type: H	IOUSE	Gar	age: No	Basem	ent: No	Crawlspace: Yes		_
Init	tial Location:		Outside		v	eight for Hon	ne Type: (# deaths allocated to this home * % this location	)	FINAL
Initia	al Conditions:	E	xterior door t	to kitchen is oper	n 10 cm. Start	generator in a	location outside of kitchen where CO enters home.		SCENARIC
					Restart Scenari			-	WEIGHTS
Scenario	Response	to Shutoff	Scenario Weight	Changes fr Condit		Sub- Scenario	2nd restart	2nd Reaction	
Q		shutoff until the tank there are no restart arios.	Actual Deaths for specific house model	Generator doe until the tank therefore, there scena	k is empty; are no restart	N/A	N/A	N/A	Actual Deaths for specific house mode
able 4.a. [	-			<u> </u>	rage, with Gen	erator Initial	or Initially Operated in Kitchen		
	Structure Type: H			age: No	Baseme		Crawlspace: No		
	tial Location:		Kitchen				ne Type: (# deaths allocated to this home * % this location	)	
Initia	al Conditions:				en window is c Restart Scenari		st plume mixes in kitchen.		FINAL SCENARIC
						OS Sub-		2nd	WEIGHTS
Scenario	Response	to Shutoff	Scenario Weight	Changes fr Condit		Scenario Weight	2nd restart	Reaction Weight	
А	No re	estart	0.0500	N/A	Ą	1.0000	N/A	1.0000	0.0500
B1				Non			Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2025
B2	On a ratar reat	anto in Litaban	0.4500	NON	e.	0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0225
B3	Operator resta	arts in kitchen.	0.4500	Kitahan window	ia anan fullu	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2025
B4				Kitchen window	ris open rully.	0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0225
C1	Operator moves generator in basem	and restarts the	0.2500	Window in base	ement is open	1.0000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2250
C2	mixes in t	•	0.2000	fully.		1.0000	Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0250
D1	Operator moves ger	nerator to outside of	0.2500		enter home.	0.9000	N/A	1.0000	0.2250
D2		hen.			CO enters home.		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

10010 1001	[G300] Scenarios for Structure Type: H		-	age: No	Baseme		Crawlspace: No		
Ini	tial Location:		Basement				e Type: (# deaths allocated to this home * % this location	)	
Initi	ial Conditions:		Basement sta	airway door is op	en 10 cm. Wi	ndow in basem	nent is closed. Exhaust plume mixes in basement.		FINAL
				R	Restart Scenari	OS			SCENARIO
Scenario	Response	to Shutoff	Scenario Weight	Veight Conditions		Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHTS
ш	No re	estart	0.0500	N/A	N/A		N/A	1.0000	0.0500
F1				No obo	No change.		Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2775
F2	Operator restorts an	perator restarts generator in basement.		NO CHA	inge.	0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0308
F3	Operator restarts get	ierator in basement.	0.6167	Window in bas	ement open	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2775
F4					/.	0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0308
G1	Operator moves ger	nerator to outside of	0 2222	CO does not e	enter home.	0.9000	NA	1.0000	0.3000
G2	kitcl	kitchen.		0.3333 CO enters		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: H	OUSE	Gar	age: No	Baseme	ent: Yes	Crawlspace: No		
Ini	tial Location:		Outside		V	eight for Hom	e Type: (# deaths allocated to this home * % this location	)	
Initi	ial Conditions:	E	xterior door t	o kitchen is open	10 cm. Start	generator in a	location outside of kitchen where CO enters home.		FINAL
				R	estart Scenari	OS			SCENARIO
Scenario	Response	to Shutoff	Scenario Weight	Changes from Initial Conditions		Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHTS
н	Generator does not s is empty; therefore, scena	there are no restart	Actual Deaths for specific house model	Generator doe until the tank therefore, there scenar	is empty; are no restart	N⁄A	N/A	N/A	Actual Deaths for specific house model

Table 5.a. [	G300] Scenarios for	Houses with Garage	But No Baser	ment or Crawlsp	ace, with Gen	erator Initiall	y Operated in the Kitchen		
	Structure Type: H	OUSE	Gara	age: Yes		ent: No	Crawlspace: No		
Ini	tial Location:		Kitchen				he Type: (# deaths allocated to this home * % this location	)	
Initi	al Conditions:						st plume mixes in kitchen.		FINAL
				R	estart Scenar				SCENARIO
Scenario	Response	to Shutoff	Scenario Weight	Changes fr Condit		Sub- Scenario	2nd restart	2nd Reaction	WEIGHTS
A	No re	estart	0.0500	N/A	\	Weight 1.0000	N/A	Weight 1.0000	0.0500
B1							Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2025
B2			0.4500	None.		0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0225
B3	Operator resta	arts in kitchen.	0.4500	Kitahan window	in onen fulk	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2025
B4				Kilchen window	Kitchen window is open fully.		Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0225
C1				Exhaust facing a wall that has doo		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	Operator moves and restarts generator	0.1250	interior. Exhaust plume mixes inside garage.		0.7500	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	in garage. Ba	Operator moves and restarts generator in garage. Bay door closed.	0.1250	Exhaust facing toward the wall that has door to house interior. Exhaust plume		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				pushes some of hous	exhaust into	0.2300	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				Exhaust facing wall that has do	, ,	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	Operator moves and	d restarts in garage.	0.1250	interior. Exhaus inside ga	•	0.7500	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	Bay door is	s open fully.	0.1200	Exhaust facing wall that has do interior. Exh	oor to 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				pushes some of hous	f exhaust into	0.2300	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 ger	nerator to outside of	0.2500	CO does not e	enter home.	0.9000	N/A	1.0000	0.2250
D2	kitch	nen.	0.2000	CO enters	s 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: H	OUSE	Gara	age: Yes	Baseme	ent: No	Crawlspace: No		
Init	tial Location:		Garage		W	eight for Hor	ne Type: (# deaths allocated to this home * % this location	)	
Initi	al Conditions:	Door to	house interic		,		tor is in center of garage. Exhaust plume mixes in garage.		FINAL
				R	estart Scenari				SCENARIO WEIGHTS
Scenario	Response	to Shutoff	Scenario Weight	Changes fr Condit		Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHIS
E	No re	estart	0.0500	N/A	N/A		N/A	1.0000	0.0375
F1			No		9	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 in garage.		0.6167		с.	0.3000	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			0.0107	Dev door is once 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				Bay door is	Bay door is open fully.		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 ba	Operator opens bay door, moves and		Bay door is o operator return CO does not e	ns to house.	0.5000	N/A	1.0000	0.1250
G2	restarts generator outside garage.	0.3333 Operator leav open after retur CO enters ti		ning to house.	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%]

Door to Ho	ouse Interior. Exhaus			-	0	-	Oraulanaan Na		
1	Structure Type: H	OUSE	Gara	ige: Yes		ent: No	Crawlspace: No	<b>\</b>	
	tial Location:		Garage				ne Type: (# deaths allocated to this home * % this location		
Initia	al Conditions:	Door to house inter	ior is open 10	,			nter of garage. Exhaust facing toward wall with door to hou	use interior.	FINAL SCENARIO
				ĸ	estart Scenari			0.1	WEIGHTS
Connerio	Boononoo	to Shutoff	Scenario	Changes fro	om Initial	Sub-	and restort	2nd	WEIGHIS
Scenario	Response	to Shutoff	Weight	Condit	ions	Scenario Weight	2nd restart	Reaction Weight	
Н	No re	estart	0.0500	N/A		1.0000	N/A	1.0000	0.0125
	1010	Start	0.0000	147		1.0000	Restart after moving generator to outside of garage	1.0000	0.0120
11							where CO does not enter garage. Garage bay door is	0.5	0.0385
							open until operator returns to house.	0.0	0.0000
				None	Э.	0.5000	Restart after moving generator to outside of garage		
12							where CO enters garage. Garage bay door is open by	0.5	0.0385
	<b>D</b>		0.0107				operator and remains open.		
	Restart II	n garage.	0.6167				Restart after moving generator to outside of garage		
13							where CO does not enter garage. Garage bay door is	0.5	0.0385
				Bay door is o	an an fully	0.5000	open until operator returns to house.		
				Bay door is op		0.5000	Restart after moving generator to outside of garage		
14							where CO enters garage. Garage bay door is open by	0.5	0.0385
							operator and remains open.		
				Bay door is c	losed after				
J1				operator return		0.5000	N/A	1.0000	0.0417
	Operator opens ba	y door, moves and	0.3333	CO does not e	nter garage.				
	restarts generato	r outside garage.	0.3333	Operator leave	es bay door				
J2				open after return		0.5000	N/A	1.0000	0.0417
				CO enters th	e garage.				
Table 5.c. [	G300] Scenario for H	louses with Garage H	ut No Basem	ent or Crawlspa	ce, with Gene	rator Initially	y Operated Outside		Į
	Structure Type: H	9		age: No	Basem		Crawlspace: No		
Init	tial Location:		Outside	-	M	eight for Hor	ne Type: (# deaths allocated to this home * % this location	)	
Initia	al Conditions:	E	xterior door to	o kitchen is open	10 cm. Start	generator in a	location outside of kitchen where CO enters home.	,	FINAL
					estart Scenari	-			SCENARIO
			Seenaria	Changes fr	om Initial	Sub-		2nd	WEIGHTS
Scenario	Response	to Shutoff	Scenario Weight	Changes from Initial Conditions		Scenario	2nd restart	Reaction	
			weight	Condit	10113	Weight		Weight	
			Actual						Actual
		shutoff until the tank	Deaths for						Deaths for
К		there are no restart	specific	N/A	N I	N/A	N/A	N/A	
	scenarios.	house	ouse				specific house mode		
			model						

	Structure Type: H	IOUSE	Gar	age: Yes	Baseme		Crawlspace: No		
Init	ial Location:		Kitchen		W	eight for Hom	ne Type: (# deaths allocated to this home * % this location	)	
Initia	al Conditions:			Kitchen w	vindow is c	losed. Exhaus	st plume mixes in kitchen.		FINAL
				Resta	art Scenario	os			SCENARIO
			Cooperio	Changes from I	nitial	Sub-		2nd	WEIGHTS
Scenario	Response	to Shutoff	Scenario Weight	Changes from the Conditions		Scenario Weight	2nd restart	Reaction Weight	
А	No r	estart	0.0500	N/A		1.0000	N/A	1.0000	0.0500
B1				News		0 5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2025
B2	Operator rest	arta in kitaban	0.4500	None.		0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0225
B3	Operator resta	arts in kitchen.	0.4500			0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2025
B4				Kitchen window is o	pen rully.	0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0225
C1				0	Exhaust facing away from wall that has door to house		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	Operator moves and restarts generator in garage. Bay door closed.	0.4050	interior. Exhaust plume mixes inside garage.		0.7500	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		0.1250	Exhaust facing toward the wall that has door to house		0.0500	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				interior. Exhaust plume pushes some of exhaust into house.		0.2500	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				Exhaust facing awa wall that has door to	-	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	Operator moves and	d restarts in garage.	0.4050	interior. Exhaust plur inside garage		0.7500	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	Bay door is	s open fully.	0.1250	Exhaust facing tow wall that has door to	to 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				interior. Exhaust plume pushes some of exhaust into house.		0.2500	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 de	nerator to outside of		CO does not enter	r home.	0.9000	N/A	1.0000	0.2250
		hen.	0.2500	CO enters hor		0.1000	N/A	1.0000	0.0250

Table 6.b. [G300] Scenarios for Hou	ses with Garage and Basemen	t But No Crawlspace, with Generate	or Initially Operated In Basement

Table o.b.	[G300] Scenarios for	Houses with Garage	and Basemen	t But No Crawis	pace, with Ge	nerator Initia	Ily Operated In Basement		
	Structure Type: H	OUSE	Gara	age: Yes	Baseme	ent: Yes	Crawlspace: No		
Ini	tial Location:	E	Basement		V	leight for Hom	ne Type: (# deaths allocated to this home * % this location	)	
Initi	ial Conditions:		Basement st	tairway door is op	oen 10 cm. W	indow in baser	ment is closed. Exhaust plume mixes in basement		FINAL
				R	lestart Scenari	OS			SCENARIO
Scenario	Response	to Shutoff	Scenario Weight	Weight Conditions		Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHTS
ш	No re	estart	0.0500	N/A	N/A		N/A	1.0000	0.0500
F1				No cha	1000	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2775
F2	Operator restarts generator in basement		0.6167		iige.	0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0308
F3		ieralor in basement.	0.0107	Window in bas	ement open	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.9	0.2775
F4				fully	Ι.	0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.1	0.0308
G1	Operator moves ger	nerator to outside of	0.3333	CO does not e	enter home.	0.9000	N/A	1.0000	0.3000
G2	kitch	nen.	0.0000	CO enters	s 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%]

	Structure Type: H	OUSE	Gar	age: Yes	Baseme	nt: Yes	Crawlspace: No		
Init	tial Location:		Garage		W	eight for Hom	ne Type: (# deaths allocated to this home * % this location	)	
Initi	al Conditions:	Door to	house interio	or is open 10 cm.	Bay door is cl	osed. Generat	tor is in center of garage. Exhaust plume mixes in garage.		FINAL
			-	R	Restart Scenario	DS			SCENARIO
Scenario	Response	to Shutoff	Scenario Weight	Changes fr Condit		Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHTS
Н	No re	estart	0.0500	N/A	4	1.0000	N/A	1.0000	0.0375
11				Non	0	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
12	Restart in garage.		0.6167	Non	с.	0.3000	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
13			0.0107	Dev dess is soon follo		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
14				Day door is	Bay door is open fully.		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 ba	Operator opens bay door moves and		Bay door is o operator return CO does not e	ns to house.	0.5000	N/A	1.0000	0.1250
J2	restarts generato	Operator opens bay door, moves and restarts generator outside garage.	0.3333 Operator I open after re		es bay door ning to house. ne 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 Basement: Garage: Crawlspace: No **Initial Location:** Weight for Home Type: (# deaths allocated to this home \* % this location) Garage 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 FINAL Initial Conditions: house interior. **SCENARIO Restart Scenarios** WEIGHTS Sub-2nd Scenario Changes from Initial Response to Shutoff Scenario Scenario 2nd restart Reaction Conditions Weight Weight Weight Κ No restart 0.0500 N/A 1.0000 N/A 1.0000 0.0125 Restart after moving generator to outside of garage L1 where CO does not enter garage. Garage bay door is 0.5 0.0385 open until operator returns to house. 0.5000 None. Restart after moving generator to outside of garage L2 where CO enters garage. Garage bay door is open by 0.5 0.0385 operator and remains open. Restart in garage. 0.6167 Restart after moving generator to outside of garage L3 where CO does not enter garage. Garage bay door is 0.5 0.0385 open until operator returns to house. Bay door is open fully. 0.5000 Restart after moving generator to outside of garage L4 where CO enters garage. Garage bay door is open by 0.5 0.0385 operator and remains open. Bay door is closed after M1 operator returns to house. 0.5000 N/A 1.0000 0.0417 Operator opens bay door, moves and CO does not enter garage. 0.3333 restarts generator outside garage. Operator leaves bay door M2 open after returning to house. 0.5000 N/A 1.0000 0.0417 CO enters the garage. Table 6.d. [G300] Scenario for Houses with Garage and Basement But No Crawlspace, with Generator Initially Operated Outside Structure Type: HOUSE Basement: Crawlspace: No Garage: **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. FINAL **SCENARIO Restart Scenarios** WEIGHTS Sub-2nd Changes from Initial Scenario Response to Shutoff Scenario Scenario 2nd restart Reaction Weight Conditions Weight Weight Actual Actual Generator does not shutoff until the tank Deaths for Deaths for N/A Ν is empty; therefore, there are no restart specific N/A N/A N/A specific scenarios. house house model model

Table 7. [G	300] Scenarios for D	etached 1-Car and 2-	Car Garages	(GAR1 and GAR2)	) with Gener	ator Operated	d In Garage		
Stru	ucture Type: DETACH	IED GARAGE				0	GAR1 & GAR2		
Ini	tial Location:		Garage		N	eight for Hom	e Type: (# deaths allocated to this home * % this location	)	
Initi	al Conditions:		В	ay door is closed.	Generator is	in center of g	arage. Exhaust plume mixes in garage		FINAL
				Res	start Scenari	os			SCENARIO
Scenario	Response	to Shutoff	Scenario Weight	Changes fror Conditio		Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHTS
Α	No re	estart	0.0500	N/A		1.0000	N/A	1.0000	0.0500
B1				None.			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 in garage.	0.6167			0.5000	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	- Residit i	i yaraye.	0.0107	Dav daar is an	an fully		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				Bay door is op	en rully.	0.5000	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 ba			None. CO does garage		0.5000	NA	1.0000	0.1667
C2	ů, s	restarts generator outside garage.     0.333       Operator returns to garage.     0.333	0.3333 Bay door is open enters the ga			0.5000	NA	1.0000	0.1667

	ucture Type: DETACH		naming a w	or KShop of Other Koom (GAF	(a) with Gener	rator Initially Operated in Workshop Room GAR3		
	tial Location:		hop in Garad	ne l	Neight for Hon	ne Type: (# deaths allocated to this home * % this location	)	
	al Conditions:			5	<u> </u>	shop door is closed. Exhaust plume mixes in workshop roc	,	FINAL
				Restart Scena		···· ··· ··· ····· ···· ···· ···· ··· ··· ··· ··· ··· ··· ··· ··· ··· ··· ··· ··· ··· ··· ··· ·		SCENARIO
Scenario	Response	to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHTS
А	No re	estart	0.0500	N/A	1.0000	N/A	1.0000	0.0500
B1				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 in same ro	0	0.4500			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	exhaust plume s	staying in room.		Window in workshop room is	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				open fully.		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				Door to workshop room is open 10 cm. Exhaust facing away from wall with door to	st facing door to 0.7500 - xhaust garage.	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		n garage. Bay door	0.1250	workshop room. Exhaust plume mixes inside garage.		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	clos	sed.	0.1200	Door to workshop room is open 10 cm. Exhaust facing toward the wall with door to	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				shop. Exhaust plume pushes some of exhaust into workshop room.	0.2000	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				Door to workshop room is open 10 cm. Exhaust facing away from wall with door to	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	Move and restart in	garage. Bay door is	0.1250	workshop room. Exhaust plume mixes inside garage.	0.7000	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	open	fully.	0.1200	Door to workshop room is open 10 cm. Exhaust facing toward the wall with door to	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				shop. Exhaust plume pushes some of exhaust into workshop room.	0.2000	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 ba restarts generato		0.2500	None. CO does not enter garage.	0.5000	NA	1.0000	0.1250
D2	Operator returns to	00		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%]

Stru	ucture Type: DETACH	ED GARAGE					GAR3		
Ini	tial Location:		Garage		W	eight for Hom	e Type: (# deaths allocated to this home * % this location	)	
Initi	al Conditione'	Door to workshop is Exhaust mixes in gar	•	Bay door is closed.	Generator is	s in center of	garage. Exhaust is facing away from wall with door to wo	rkshop.	FINAL SCENARIO
				Resta	art Scenaric	)S			WEIGHTS
Scenario	Response	to Shutoff	Scenario Weight	Changes from Initial Conditions		Sub- Scenario Weight	2nd restart	2nd Reaction Weight	
А	No re	estart	0.0500	N/A		1.0000	N/A	1.0000	0.0375
B1				None.	Nono	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	Destart		0.0107	None.			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	Restart ir	n garage.	rage. 0.6167		so fully		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				Bay door is ope	en rully.	0.5000	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	•	0.3333	None. CO does r garage.	not enter	0.5000	NA	1.0000	0.1250
C2	Ŭ	s generator outside garage. 0.3 or returns to original location.		Bay door is open f enters the gar	-	0.5000	NA	1.0000	0.1250

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%]

Stru	ucture Type: DETACH	IED GARAGE				GAR3		
Ini	tial Location:		Garage	1	Veight for Hom	ne Type: (# deaths allocated to this home * % this location	)	
Initi	al Conditions'	Door to workshop is plume pushes some	•		is in center of	f garage. Exhaust is facing toward wall with door to worksh	iop. Exhaust	FINAL SCENARIO
				Restart Scenar	ios			WEIGHTS
Scenario	Response	to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub- Scenario Weight	2nd restart	2nd Reaction Weight	
D	No re	estart	0.0500	N/A	1.0000	N/A	1.0000	0.0125
E1				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	Destort		0.0107	none.		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	Restart i	n garage.	je. 0.6167	Day daar is spon fully		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				Bay door is open fully.	0.5000	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		y door, moves and	0.3333	None. CO does not enter garage.	0.9000	N/A	1.0000	0.0750
F2	Ū	restarts generator outside garage. 0.3333 - Operator returns to original location.		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

Table 9.a. [	UL2201] Scenarios fo	r Houses with No Bε	isement, Gar	age, or Crawlspa	ice with Gene	rator Initially	Operated In the Kitchen		
	Structure Type: H	OUSE	Gar	age: No	Basem	ent: No	Crawlspace: No		
Ini	tial Location:		Kitchen		8	eight for Horr	ne Type: (# deaths allocated to this home * % this location	)	
Initi	al Conditions:			Kitch	en window is c	losed. Exhau	st plume mixes in kitchen.		FINAL
				R	estart Scenari	os			SCENARIO
Scenario	Response	to Shutoff	Scenario Weight	U U	Changes from Initial Conditions		2nd restart	2nd Reaction Weight	WEIGHTS
A	No re	estart	0.0500	N/A	A	1.0000	N/A	1.0000	0.0500
B1				Non	None.		Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1688
B2	Operator resta	rts in kitchon	0.4500	NOT			Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0563
B3		its in kichen.	0.4500	Kitchen window			Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1688
B4					is open rully.	open fully. 0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0563
C1	Operator moves ge	nerator to other 1st	0.2500	Window in room			Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1875
C2	floor room that has	an isolating door.	0.2300	Window in room is open fully.		1.0000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0625
D1	Operator moves ger	erator to outside of	0.0500	CO does not enter home.		0.7500	N/A	1.0000	0.1875
D2	kitch	nen.	0.2500	CO enters	s 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: H	OUSE	Gara	age: No	Basem	ent: No	Crawlspace: No		
Ini	tial Location:	Other 1st floor ro	om with an is	olating door	ating door Weight for Home Type: (# deaths allocated to this home * % this location)				
Initi	ial Conditions:		Windo	Window in room is open 5 cm. Door to room is open 10 cm. Exhaust plume mixes inside room.					
				R	estart Scenar	os			SCENARIO
Scenario	Response	to Shutoff	Scenario Weight	Changes from Initial Conditions		Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHTS
E	No re	estart	0.0500	N/A		1.0000	N/A	1.0000	0.0406
F1				None.		0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1879
F2	Operator restarts	s in same room.	0.6167		-		Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0626
F3	'			Windowis	nen fullv	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1879
F4			Window is oper		pen runy.	0.0000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0626
G1	Operator moves ger	nerator to outside of	f 0.3333 CO doe		enter home.	0.7500	N/A	1.0000	0.2031
G2	kitch	nen.	0.3333	CO enters	s 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: H	DUSE	Gara	age: No	Basem	ent: No	Crawlspace: No		
Init	tial Location:	Other 1st floor roon	n that has an	isolating door	Weight for Home Type: (# deaths allocated to this home * % this location)				
Initi	al Conditions:	W	indow in roo	m is open 5 cm.	Door to room	is open 10 cm	. Exhaust plume oriented out door to house interior.		FINAL
				R	lestart Scenari	OS			SCENARIO
Scenario	Response	to Shutoff	Scenario Weight	Changes from Initial Conditions		Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHTS
Н	No re	start	0.0500	N/A		1.0000	N/A	1.0000	0.0094
11				None. 0.6167 Window is open fully.		0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.0434
12	Operator restarts	in same room	0.6167			0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0145
13		in same room.	0.0107			0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.0434
14						en tully. 0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0145
J1	Operator moves gen	erator to outside of	0.3333	CO does not e	enter home.	0.7500	N/A	1.0000	0.0469
J2	kitch	en.	0.0000	CO enters	s 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		Basem	nent: No	Crawlspace: No		
Init	Initial Location: Outside				Weight for Home Type: (# deaths allocated to this home * % this location)				
Initial Conditions: Exterior door to kitchen is ope				o kitchen is oper	n 10 cm. Start generator in a location outside of kitchen where CO enters home.				
	Restart Scenarios							WEIGHTS	
Scenario	Response	to Shutoff	Scenario Weight	Changes from Initial Conditions		Sub- Scenario	2nd restart	2nd Reaction	
к		shutoff until the tank there are no restart arios.	Actual Deaths for specific house model	N/A		N⁄A	N⁄A	N/A	Actual Deaths for specific house model

	Structure Type: H	OUSE	Gar	age: No	Basem	ent: No	Crawlspace: Yes		
In	itial Location:		Kitchen		V	eight for Hor	he Type: (# deaths allocated to this home * % this location	)	
Init	ial Conditions:						st plume mixes in kitchen.		FINAL
				R	Restart Scenari	os Sub-			SCENARIO
Scenario	Response	to Shutoff	Scenario Weight		Changes from Initial Conditions		2nd restart	2nd Reaction Weight	WEIGHTS
А	No re	estart	0.0500	N/A	4	1.0000	N/A	1.0000	0.0500
B1				None.		0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1313
B2	Operator resta	rte in kitchon	0.3500	- NON	с.	0.0000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0438
B3					wis open fully	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1313
B4				Kitchen window	Kitchen window is open fully.		Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0438
C1	Operator moves get	nerator to other 1st	0.2000	Window in room	nic opon fully	1.0000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1500
C2	floor room that has	an isolating door.	0.2000		ns open rully.	1.0000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0500
D1	Operator moves gene Exhaust plume mixe The only exposure in	s inside crawlspace	0.2000	Non			Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1500
D2	operator entering the the generator ar gener	nd/or restart the	0.2000	None.		1.0000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0500
E1	Operator moves ger	erator to outside of	0.0000	CO does not enter home.		0.7500	N/A	1.0000	0.1500
E2	kitch		0.2000	CO enters	s 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: H	OUSE	Gara	age: No	Basem	ent: No	Crawlspace: Yes		
	tial Location:	Other 1st floor r		0		-	e Type: (# deaths allocated to this home * % this location	)	
Initi	al Conditions:		Windo				n 10 cm. Exhaust plume mixes inside room.		FINAL
				Re	estart Scenari				SCENARIO
Scenario	Response	to Shutoff	Scenario Weight	Changes from Initial Conditions		Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHTS
F	No re	estart	0.0500	N/A		1.0000	N/A	1.0000	0.0406
G1				None		0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1371
G2	Operator restarts	in come room	me room. 0.4500		None.		Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0457
G3		s in same room.		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				window in room	is open rully.	s open rully. 0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0457
H1		erator to crawlspace. s inside crawlspace the crawlspace is of	0.2500	None			Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1523
H2	operator entering the the generator a gene	nd/or restart the	0.2300	None.		1.0000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0508
l1	Operator moves ger	nerator to outside of	side of 0.2500 CO	CO does not e	nter home.	0.7500	N/A	1.0000	0.1523
12	kitch			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         Charage (r deals and constable bits hore)* (r deals deals deals deals hore)* (r deals deals deals deals deals hore)* (r deals deals deals de	Exhaust Pl		Door to House Interi	-	Ū.	,				
Initial Condition:         Window in record is open 5 cm. Door to room is open 10 cm. Extaust plume oriented out door to house interior.         FINAL           Scenario         Response to Shutoff         Scenario         Scenario         2nd restart         2nd restart         2nd restart         Rescion           J         No restart         0.0500         NA         1.0000         NA         1.0000         0.044         Monocide         0.0500         0.0316           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           K3         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 does not enter home.         0.75         0.0316           L1         Exhaust plume mixes inside crawspace. The only exposure in the crawspace is of exters home.         0.2500         Operator moves generator to outside of kitchen where CO does not enter home.         0.75         0.0352           M1         Operator moves generator to outside of kitchen where CO enters home.         0.2500         None.         0.2500         None.         0.2500         No         0.0017           M1         Operator moves genera		Structure Type: H			5					
Scenario         Response to Shutoff         Scenario Weight         Changes from Initial Conditions         Sub- Scenario Weight         2nd restart         2nd Rescion         Changes from Weight         Scenario Weight         Scenario Scenario         2nd restart         Rescion         Scenario Weight         None         Scenario Weight         Scenario Weight         None         Operator moves generator to outside of kitchen where CO does not enter home.         0.75         0.0316         Operator moves generator to outside of kitchen where CO does not enter home.         0.75         0.0352         0.0352           L1         Operator moves generator to outside of kitchen where generator no weig generator to outside of kitchen where generator.         0.2500         None.         1.0000         Operator moves generator to outside of kitchen where CO does not enter home. <td< td=""><td>Ini</td><td>tial Location:</td><td></td><td></td><td>0</td><td></td><td></td><td></td><td>)</td><td rowspan="2"></td></td<>	Ini	tial Location:			0				)	
Scenario         Response to Shutoff         Scenario Weight         Sub- Scenario Conditions         Sub- Scenario Weight         Sub- Scenario Weight         Sub- Scenario Meight         Sub- Scenario Meight         Sub- Scenario Meight         Sub- Scenario Meight         Main Scenario Meight         Sub- Scenario Meight         Main Scenario Meight         Main Scenario Meight <td>Initi</td> <td>al Conditions:</td> <td>W</td> <td>'indow in roo</td> <td></td> <td></td> <td></td> <td>h. Exhaust plume oriented out door to house interior.</td> <td></td>	Initi	al Conditions:	W	'indow in roo				h. Exhaust plume oriented out door to house interior.		
Scenario J         Response to Shuoff         Scenario Weight         Changes from Initial Conditions         Scenario Weight         2nd restant         Reaction Reaction           J         No restart         0.0500         N/A         1.0000         N/A         1.0000         0.0944           K1					R	estart Scenar				
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           K3         Operator restarts in same room.         0.4500         Window is open fully.         0.5000         Operator moves generator to outside of kitchen where CO enters home.         0.25         0.0105           K4         Operator moves generator to outside of kitchen where CO enters home.         0.75         0.0316           L1         Exhaust plume mixes inside crawkspace. The only exposure in the crawkspace is of operator moves generator to outside of kitchen where degenerator.         0.2500         None.         1.0000         Operator moves generator to outside of kitchen where CO does not enter home.         0.75         0.0316           L2         Operator moves generator to outside of kitchen.         0.2500         None.         1.0000         Operator moves generator to outside of kitchen where CO does not enter home.         0.75         0.0352           M1         Operator moves generator to outside of kitchen.         0.2500         CO does not enter home.         0.750         NA         1.0000         0.0352           M2         Kitchen.         Operator moves generator to outside of kitchen.         0.2500         NA         1.0000         0.0117           Table loc.(UL2201)Scenarios for Hou	Scenario	Response	to Shutoff				Scenario	2nd restart	Reaction	WEIGHTS
K1         Co does not enter home.         0.75         0.037b           K2         Operator restarts in same room.         0.4500         Mine.         0.0000         Operator moves generator to outside of kitchen where CO enters home.         0.25         0.0105           K4         Operator moves generator to outside of kitchen where the generator.         0.25         0.0105         0.0316           L1         Operator moves generator to outside of kitchen where the generator.         0.250         0.0105         0.0500         Operator moves generator to outside of kitchen where CO does not enter home.         0.25         0.0105           L2         Operator moves generator to outside of kitchen where enterator 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           M1         Operator moves generator to outside of kitchen.         0.2500         NO117         0.0000         0.0117           M1         Operator moves generator to outside of kitchen.         0.2500         CO does not enter home.         0.250         NA         1.0000         0.0117           M2         Operator moves generator to outside of kitchen.         0.2500         NA         1.0000         0.0517           M2         Operator moves generator to outside of kit	J	No re	estart	0.0500	N/A	4	1.0000	N/A	1.0000	0.0094
K2         Operator restarts in same room.         0.4500         Operator restarts in same room.         0.4500         Operator moves generator to outside of kitchen where CD does not enter home.         0.25         0.0105           K4         Operator moves generator to outside of kitchen where CD does not enter home.         0.75         0.0316           K4         Operator moves generator to outside of kitchen where CD does not enter home.         0.250         0.0105           L1         Exhaust plume mixes inside crawlspace The only exposure in the crawlspace is of operator neutring the crawlspace is of the generator.         0.2500         None.         Image: CD does not enter home.         0.75         0.0352           L2         Operator moves generator to outside of kitchen where generator.         0.2500         None.         Image: CD does not enter home.         0.75         0.0352           M1         Operator moves generator to outside of kitchen where generator.         0.2500         CD does not enter home.         0.7500         None.         Operator moves generator to outside of kitchen where CD does not enter home.         0.250         0.0117           M1         Operator moves generator to outside of kitchen where generator.         0.2500         CD does not enter home.         0.7500         NA         1.0000         0.0257           M1         Operator moves generator to outside of kitchen where kitchen <td< td=""><td>K1</td><td></td><td></td><td></td><td colspan="2">None</td><td>0.5000</td><td>CO does not enter home.</td><td>0.75</td><td>0.0316</td></td<>	K1				None		0.5000	CO does not enter home.	0.75	0.0316
K3     K4     Window is open fully.     Window is open fully.     Model     Operator moves generator to outside of kitchen where CD dens not enter home.     0.75     0.0316       L1     Operator moves generator to crawspace. The only exposure in the crawspace to move degenerator and/or restart the generator.     0.2500     None.     1.0000     Operator moves generator to outside of kitchen where CD denter home.     0.75     0.0316       L2     Operator moves generator to crawspace to move the generator and/or restart the generator.     0.2500     None.     0.2500     Operator moves generator to outside of kitchen where CD denter home.     0.75     0.0352       M1     Operator moves generator to outside of kitchen.     0.2500     CD does not enter home.     0.2500     NONE.     Operator moves generator to outside of kitchen where CD enters home.     0.25     0.0117       M1     Operator moves generator to outside of kitchen.     0.2500     CD does not enter home.     0.2500     NA     1.0000     0.0352       M2     Kitchen.     0.2500     CD does not enter home.     0.2500     NA     1.0000     0.0352       Initial Location:     Crawspace     Crawspace     Weight for Home Type: (# deaths allocated to this home * % this location)     Scenario     Scenario     Changes from initial Conditions     Scenario Weight     CD deas not enter home.     CD deas not enter home.     FINAL	К2	Operator restart	s in same room	0 4500			0.0000	CO enters home.	0.25	0.0105
K4         Operator moves generator to cutside of kitchen where CO does not enter home.         0.25         0.0105           L1 The only exposure in the crawspace is of operator moves generator to cutside of kitchen where co does not enter home.         0.2500         None.         1.0000         Operator moves generator to cutside of kitchen where CO does not enter home.         0.75         0.0352           L2 the only exposure in the crawspace to move the generator and/or restart the generator.         0.2500         None.         1.0000         Operator moves generator to cutside of kitchen where CO does not enter home.         0.25         0.0117           M1         Operator moves generator to cutside of kitchen.         0.2500         CO does not enter home.         0.7500         N/A         1.0000         0.0352           Table loc. [U12201] Scenarios for Houses with Crawspace But No Basement or Garage, with Generator Initial Location:         Co does not enter home.         0.2500         N/A         1.0000         0.0117           Table loc. [U12201] Scenarios for Houses with Crawspace But No Basement or Garage, with Generator Initial Location:         Centers home.         0.2500         N/A         1.0000         0.0117           Initial Location:         Crawspace         Carage: No         Basement: No         Crawspace.         FINAL           Scenario         Response to Shutoff         Scenario ony exposure in the crawspace is of operator restarts	КЗ			0.4000	Windowisc	nen fullv	0.5000		0.75	0.0316
L1     Exhaust plume mixes inside crawlspace The only exposure in the crawlspace to move the generator and/or restart the generator.     0.2500     None.     1.0000     Qperator moves generator to outside of klichen where CO does not enter home.     0.750     0.0352       M1     Operator moves generator to outside of klichen.     0.2500     CO does not enter home.     0.750     NA     1.0000     0.0352       M2     Operator moves generator to outside of klichen.     0.2500     CO does not enter home.     0.750     NA     1.0000     0.0352       Table 10.c. [UL2201] Scenarios for Houses with Crawlspace klichen.     0.2500     CO does not enter home.     0.2500     NA     1.0000     0.0117       Table 10.c. [UL2201] Scenarios for Houses with Crawlspace klichen.     Garage: No     Basement or Garage, with Generator Initial Co enters home.     Co does not enter home.     0.2500     NA     1.0000     0.0117       Table 10.c. [UL2201] Scenarios for Houses with Crawlspace Structure Type: HOUSE     Garage: No     Basement: No     Crawlspace     Scenario     FiNAL       None.     Neight for Home Type: (# deaths allocated to this home % this location)     Initial Location:     Crawlspace     Scenario     Scenario     Scenario     Pad Weight     Pad Weight     Pad Weight     Pad Weight     Pad Weight     Pad Weight     Operator moves generator to outside of klitchen where CO denters home.     0.25     <	K4				Window is c	peri ruiy.	0.3000		0.25	0.0105
L2     Operator entering the crawlspace to move generator.     Operator moves generator to outside of kitchen where generator.     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     Victure Type: HOUSE     Co does not enter home.     0.2500     N/A     1.0000     0.0117       Table 10.c. [UL2201] Scenarios for Houses with CrawIspace But No Basement or Garage, with Generator Initially Operated in the CrawIspace     CrawIspace:     Scenario     FINAL       Initial Location:     CrawIspace     CrawIspace:     Scenario     Scenario     Scenario     Scenario       Scenario     Response to Shutoff     Scenario     Changes from Initial Conditions     Sub- Scenario     Scenario     Scenario Weight     Sub- Scenario     Scenario Weight     Operator moves generator to outside of kitchen where cO does not enter home.     0.0500       01     Operator restarts in crawIspace. The only exposure in the crawIspace is of operator moves generator.     0.6167     None.     1.0000     N/A     1.0000     0.04625       02     Operator moves generator to outside of kitchen where generator.     0.6167     None.     1.0000     N/A     0.0500     0.4625       0     Operator moves generator to outside of kitchen where generator.     0.3333     CO does n	L1	Exhaust plume mixe	s inside crawlspace	0 2500	Non	News			0.75	0.0352
M2         Operator moves generator to outside of normal space but of a construction of the generator.         0.2500         N/A         1.0000         0.0117           M2         Kitchen.         0.2500         CO enters home.         0.2500         N/A         1.0000         0.0117           Table 10.r. [UL2201] Scenarios for Houses with CrawIspace But No Basement or Garage, with Generator Initially Operated in the CrawIspace         CrawIspace         Final Scenario         CrawIspace         Scenario         CrawIspace         Scenario         Scenario         Changes from Initial Conditions         Sub- Scenario	L2	the generator a	nd/or restart the	0.2000			1.0000		0.25	0.0117
M2kitchen.CO enters home.0.2500N/A1.0000.0117Table 10.c. [UL2201] Scenarios for Houses with Crawlspace But No Basement or Garage, with Generator Initially Operated in the Crawlspace.N/A1.0000.0117Table 10.c. [UL2201] Scenarios for Houses with Crawlspace But No Basement or Garage, with Generator Initially Operated in the Crawlspace.N/A1.0000.0117The Initial Location:Carawlspace: YoSecenario Structure Type: HOUSEGenerator is in crawlspace.Yeight for Home Type: (# deaths allocated to this home *% this location)FINALScenarioInitial Conditions:CrawlspaceCenarioSub-CenarioSub-ScenarioPartScenario <t< td=""><td>M1</td><td>Operator moves gei</td><td>nerator to outside of</td><td>0.0500</td><td>CO does not e</td><td>enter home.</td><td>0.7500</td><td>N/A</td><td>1.0000</td><td>0.0352</td></t<>	M1	Operator moves gei	nerator to outside of	0.0500	CO does not e	enter home.	0.7500	N/A	1.0000	0.0352
Structure Type: HOUSE         Garage: No         Basement: No         Crawlspace: Yes           Initial Location:         Crawlspace         Weight for Home Type: (# deaths allocated to this home * % this location)         FINAL           Initial Conditions:         Generator is in crawlspace.         Exhaust plume mixes in crawlspace.         Scenario           Scenario         Response to Shutoff         Scenario         Changes from Initial Conditions         Sub- Scenario         2nd Reaction         Weight           N         No restart         0.0500         N/A         1.0000         N/A         1.0000         0.0500           O1         Operator restarts in crawlspace to move the generator.         0.6167         None.         1.0000         Operator moves generator to outside of kitchen where CO does not enter home.         0.25         0.1542           P1         Operator moves generator to outside of         0.3333         CO does not enter home.         0.7500         N/A         1.0000	M2	kitc	hen.	0.2500	CO enters	s home.	0.2500	N/A	1.0000	0.0117
Initial Location:       Crawlspace       Weight for Home Type: (# deaths allocated to this home * % this location)       FINAL         Initial Conditions:       Generator is in crawlspace. Exhaust plume mixes in crawlspace.       Exhaust plume mixes in crawlspace.       FINAL         Scenario       Response to Shutoff       Scenario Weight       Changes from Initial Conditions       Sub- Scenario Conditions       Sub- Scenario Weight       2nd restart       Reaction Weight       Scenario Weight       2nd restart       Reaction Weight       Scenario Weight       0.0500       0	Table 10.c.	[UL2201] Scenarios	for Houses with Crav	vlspace But N	No Basement or (	Garage, with (	Generator Init	ially Operated in the Crawlspace		
Initial Conditions:       Generator is in crawlspace. Exhaust plume mixes in crawlspace.       FINAL         Scenario         Scenario       Response to Shutoff       Scenario       Changes from Initial       Sub-       Scenario       2nd       Reaction       WEIGHTS         N       No restart       0.0500       N/A       1.0000       N/A       1.0000       0.0500       0.0500         O1       Operator restarts in crawlspace. The only exposure in the crawlspace is of operator entering the crawlspace is of operator netering the crawlspace is of operator.       0.6167       None.       1.0000       Operator moves generator to outside of kitchen where generator.       0.75       0.4625         O2       Operator moves generator to outside of kitchen where generator.       0.3333       CO does not enter home.       0.7500       0.75       0.1542		Structure Type: H	OUSE	Gara	age: No	Basem	ment: No Crawlspace: Yes			
Restant ScenariosSCENARIOScenarioResponse to ShutoffScenario WeightChanges from Initial ConditionsSub- Scenario Weight2nd restart2nd Reaction WeightWEIGHTSNNo restart0.0500N/A1.0000N/A1.00000.0500O1Operator restarts in crawlspace. The only exposure in the crawlspace is of operator entering the crawlspace to move the generator.0.6167None.1.0000Operator moves generator to outside of kitchen where CO does not enter home.0.750.4625O2P1Operator moves generator to outside of ut it is in the crawlspace of operator entering the crawlspace of generator.0.3333CO does not enter home.0.7500N/A1.0000O2Derator moves generator to outside of ut is in the crawlspace of operator entering the crawlspace to move generator.0.6167None.1.0000Operator moves generator to outside of kitchen where CO does not enter home.0.250.1542P1Operator moves generator to outside of ut is in the crawlspace of generator.0.3333CO does not enter home.0.7500N/A1.0000	Init	tial Location:	С	rawlspace		V	eight for Hom	e Type: (# deaths allocated to this home * % this location)	)	
Scenario         Response to Shutoff         Scenario Weight         Changes from Initial Conditions         Sub- Scenario Weight         2nd Reaction Weight         2nd Reaction         WEIGHTS           N         No restart         0.0500         N/A         1.0000         N/A         1.0000         0.0500 </td <td>Initi</td> <td>al Conditions:</td> <td></td> <td></td> <td>Generato</td> <td>or is in crawlsp</td> <td colspan="3"></td> <td>FINAL</td>	Initi	al Conditions:			Generato	or is in crawlsp				FINAL
Scenario         Response to Shutoff         Scenario Weight         Changes from Initial Conditions         Scenario Weight         Case         And Testart         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 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 and/or restart the generator.         0.6167         None.         0.7500         Operator moves generator to outside of kitchen where CO enters home.         0.25         0.1542           P1         Operator moves generator to outside of         0.3333         CO does not enter home.         0.7500         N/A         1.0000         0.2500					R	estart Scenari	OS			
O1     Operator restarts in crawlspace. The only exposure in the crawlspace is of operator entering the crawlspace to move 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.     0.6167     None.     1.0000     Operator moves generator to outside of kitchen where CO enters home.     0.25     0.1542       P1     Operator moves generator to outside of use the senerator.     0.3333     CO does not enter home.     0.7500     N/A     1.0000     0.2500	Scenario	Response	to Shutoff		Ŭ		Scenario	2nd restart	Reaction	WEIGHTS
O1     only exposure in the crawlspace is of operator entering the crawlspace to move the generator.     0.6167     None.     1.0000     Column for the formation of	N	No re	estart	0.0500	N/A	١	1.0000	N/A	1.0000	0.0500
O2     the generator and/or restart the generator.     Operator moves generator to outside of kitchen where CO enters home.     0.25     0.1542       P1     Operator moves generator to outside of 0.3333     CO does not enter home.     0.7500     N/A     1.0000     0.2500	O1	only exposure in th	e crawlspace is of	0.6167	None	Nono			0.75	0.4625
	O2	the generator a	nd/or restart the	5.0101			1.0000		0.25	0.1542
0.3333	P1	Operator moves ger	nerator to outside of	0 2222	CO does not enter home		0.7500	N/A	1.0000	0.2500
	P2			0.3333	CO enters	home.	0.2500	N/A	1.0000	0.0833

	Structure Type: H	IOUSE	Gar	age: No	Basem	ent: No	Crawlspace: Yes			
Ini	tial Location:		Outside		v	eight for Hor	ne Type: (# deaths allocated to this home * % this location	)	FINAL	
Initi	al Conditions:	E	xterior door t		kitchen is open 10 cm. Start generator in a location outside of kitchen where CO enters home.					
				-	Restart Scenari					
Scenario	Response	to Shutoff	Scenario Weight	Changes fr Condit		Sub- Scenario	2nd restart	2nd Reaction		
Q		shutoff until the tank there are no restart arios.	Actual Deaths for specific house model	until the tank therefore, there	Generator does not shutoff until the tank is empty; therefore, there are no restart scenarios.		N/A	N/A	Actual Deaths for specific house model	
Table 11.a.			· · · · ·	o Crawlspace or Garage, with (			· ·		1	
	Structure Type: H	IOUSE		age: No Baseme			Crawlspace: No			
	tial Location:		Kitchen	12it-1		Weight for Home Type: (# deaths allocated to this home * % this location) s closed. Exhaust plume mixes in kitchen.				
เทเน	al Conditions:				en window is c Restart Scenari		st plume mixes in kitchen.		FINAL SCENARIO	
				[		Sub-		2nd	WEIGHTS	
Scenario	Response	to Shutoff	Scenario Weight	U U	Changes from Initial Conditions		2nd restart	Reaction Weight		
А	No re	estart	0.0500	N/A	4	1.0000	N/A	1.0000	0.0500	
B1				Non	0	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1688	
B2	Operator resta	arts in kitchon	0.4500	Non	с.	0.3000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0563	
B3	Operator resta	and in Kitchen.	0.4300	Kitchen window	vis open fully	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1688	
B4				Kitchen window is open fully.		0.3000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0563	
C1		and restarts the ent. Exhaust plume	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	mixes in b		0.2000			1.0000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0625	
D1	Operator moves ger	nerator to outside of	0.2500	CO does not enter home.		0.7500	N/A	1.0000	0.1875	
D2	kitc	hen.	0.2000	CO enters home.		0.2500	N/A	1.0000	0.0625	

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

Structure Type: HOUSE		Garage: No		Basement: Yes		Crawlspace: No								
Initial Location: Baser		Basement	sement		Weight for Home Type: (# deaths allocated to this home * % this location)									
Initial Conditions: Basement stairway door					en 10 cm. Wi	ndow in basem	nent is closed. Exhaust plume mixes in basement.		FINAL					
Restart Scenarios SC														
Scenario	o Response to Shutoff		Scenario Weight	Changes from Initial Conditions		Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHTS					
Е	No re	estart	0.0500 N/A		A	1.0000	N/A	1.0000	0.0500					
F1				No change.		0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.2313					
F2	Operator restarts ger					0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0771					
F3	Operator restarts ger	ierator in basement.	0.6167	Window in bas	Window in basement open	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.2313					
F4				fully	<i>'</i> .	0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0771					
G1	Operator moves ger	es generator to outside of		CO does not e	enter home.	0.7500	N/A	1.0000	0.2500					
G2	kitcł	nen.	0.3333	CO enters home.		0.2500	N/A	1.0000	0.0833					
Table 11.c.	[UL2201] Scenario fo	or Houses with Baser	nent. But No	Table 11.c. [UL2201] Scenario for Houses with Basement, But No Crawlspace or Garage, with Generator Initially Operated Outside										

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

Structure Type: HOUSE		Garage: Yes		Basement: No Crawlspace: No						
Initial Location:		Kitchen			Weight for Home Type: (# deaths allocated to this home * % this location)					
Initia	al Conditions:		Kitchen window is closed. Exhaust plume mixes in kitchen.							
				R	estart Scenari	OS			SCENARIO	
Scenario	Response	to Shutoff	Scenario Weight	Changes from Initial Conditions		Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHTS	
А	No re	estart	0.0500	N/A		1.0000	N/A	1.0000	0.0500	
B1				None.		0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1688	
B2	Operator reat					0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0563	
B3	Operator restarts in kitchen.		0.4500	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				Kitchen window	is open rully.	0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0563	
C1				Exhaust facing away from wall that has door to house		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.		0.0469	
C2	Operator moves an	Operator moves and restarts generator	0.1250	interior. Exhaust plume mixes inside garage.		0.7500	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	in garage. Bay door closed.	0.1250	Exhaust facing toward the wall that has door to house interior. Exhaust plume		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				pushes some of hous	exhaust into		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				Exhaust facing wall that has do	, ,	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	Operator moves and	l restarts in garage.		interior. Exhaust plume mixes inside garage.		0.7500	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	Bay door is open fully.	0.1250	Exhaust facing toward the wall that has door to 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				pushes some of	interior. Exhaust plume pushes some of exhaust into house.		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 ger	nerator to outside of		CO does not e	enter home.	0.7500	N/A	1.0000	0.1875	
	kitchen. 0.2500		CO enters		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 Gara		age: Yes	e: Yes Basement: No		Crawlspace: No				
		Garage	arage		Weight for Home Type: (# deaths allocated to this home * % this location)					
Initi	Initial Conditions: Door to house interio				is open 10 cm. Bay door is closed. Generator is in center of garage. Exhaust plume mixes in garage.					
				R	estart Scenari				SCENARIO WEIGHTS	
Scenario	Response to Shutoff		Scenario Weight	Changes from Initial Conditions		Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHIS	
E	No re	estart	0.0500	N/A	A	1.0000	N∕A	1.0000	0.0375	
F1	- Restart in garage.			Non	e. 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			0.6167			0.0000	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			0.0101	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				Bay door is	Bay door is open fully.		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		operator	Bay door is o operator return CO does not e	ns to house.	0.5000	NA	1.0000	0.1250	
G2	restarts generato	restarts generator outside garage.		0.3333 Operator leave open after return CO enters the		0.5000	NA	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%]

Door to He	ouse Interior. Exhaus			-	2	_			
	Structure Type: HOUSE		Garage: Yes Baseme			Crawlspace: No	-		
	tial Location:		Garage Weight for Home Type: (# deaths allocated to this home * % this location)						
Initi	al Conditions:	Door to house inter	ior is open 10 cm. Bay door is closed. Generator is in center of garage. Exhaust facing toward wall with door to house interior.						
				R	estart Scenari				SCENARIO
	_		Scenario	Changes fr	om Initial	Sub-		2nd	WEIGHTS
Scenario	Response to Shutoff		Weight	Conditions		Scenario	2nd restart	Reaction	
	N		, s			Weight		Weight	
Н	No re	estart	0.0500	N/A	4	1.0000	N/A	1.0000	0.0125
11	- Restart in garage.			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
12			0.6167		. 0.3000		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
13			0.0107	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
14						0.5000	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 ba	y door, moves and	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	restarts generato			Operator leave open after returr CO enters th	ning to house. ne garage.	0.5000	N/A	1.0000	0.0417
Table 12.c.	[UL2201] Scenario fe	or Houses with Gara	ge But No Ba	sement or Crawl	lspace, with G	enerator Initi	ally Operated Outside		
	Structure Type: H	IOUSE	Gar	age: No Basement: No			Crawlspace: No		
Init	tial Location:		Outside			Weight for Home Type: (# deaths allocated to this home * % this loca		I)	
Initi	al Conditions:	E	xterior door t	o kitchen is open	10 cm. Start	generator in a	location outside of kitchen where CO enters home.		FINAL
				R	Restart Scenari	os			SCENARIO
Scenario	Response	to Shutoff	Scenario Weight	Changes from Initial Conditions		Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHTS
к		shutoff until the tank there are no restart arios.	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 fo	or Houses with Gara	ge and Basen	nent But No Craw	vlspace, with	Generator Ini	tially Operated In Kitchen	-		
Structure Type: HOUSE			age: Yes	Baseme		Crawlspace: No		FINAL		
Init	tial Location:						ne Type: (# deaths allocated to this home * % this location		)	
Initia	Initial Conditions:			Kitchen window is closed. Exhaust plume mixes in kitchen.						
				R	estart Scenar	ios			SCENARIO	
Scenario	Response	to Shutoff	Scenario Weight	Changes fro Condit		Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHTS	
А	No re	estart	0.0500	N/A	<u>۱</u>	1.0000	N/A	1.0000	0.0500	
B1				New	_	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1688	
B2	0	ata in litakan	0.4500	None	9.	0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0563	
B3	Operator resta	arts in kitchen.	0.4500	Kitahan windaw			Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.1688	
B4				Kitchen window is open fully.		0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0563	
C1				Exhaust facing away from wall that has door to house		use 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	Operator moves an	erator moves and restarts generator	0.1250	interior. Exhaust plume mixes inside garage.			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	in garage. Bay	y door closed.	0.1250	Exhaust facing toward the wall that has door to house	to house t plume 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				interior. Exhaust plume pushes some of exhaust into house.		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				Exhaust facing wall that has do		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	Operator moves and	l restarts in garage.	0 1250	interior. Exhaust inside ga	•	s 0.7500	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	Bay door is open fully.	0.1250	Exhaust facing wall that has do	oor to 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				interior. Exhaust plume pushes some of exhaust into house.			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 ger	nerator to outside of	0.0506	CO does not e	enter home.	0.7500	N/A	1.0000	0.1875	
D2	kitch		0.2500	CO enters	s 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: H	OUSE	Garage: Yes		Basement: Yes		Crawlspace: No				
Init	Initial Location: E		Basement		V	Weight for Home Type: (# deaths allocated to this home * % this location)					
Initia	al Conditions:		Basement st	airway door is op	oen 10 cm. Wi	ndow in baser	ment is closed. Exhaust plume mixes in basement		FINAL		
				R	lestart Scenari	OS			SCENARIO		
Scenario	Response	to Shutoff	Scenario Weight	Changes fr Condit		Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHTS		
E	No re	estart	0.0500	0.0500 N/A		1.0000	N/A	1.0000	0.0500		
F1				No cha	1000	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.2313		
F2	Operator restarts go	aaratar in bacamant	0.0407	No change.	iiige.	0.3000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0771		
F3	Operator restants get	Operator restarts generator in basement.		с С		Window in basement open	sement open	0.5000	Operator moves generator to outside of kitchen where CO does not enter home.	0.75	0.2313
F4				fully		0.5000	Operator moves generator to outside of kitchen where CO enters home.	0.25	0.0771		
G1	Operator moves ger	ator moves generator to outside of		CO does not e	enter home.	0.7500	N/A	1.0000	0.2500		
G2	kitchen.		0.3333	CO enters	s 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		Gar	age: Yes	Baseme	nt: Yes	Crawlspace: No		
Ini	tial Location:		Garage		Weight for Home Type		he Type: (# deaths allocated to this home * % this location)	)	
Initi	Initial Conditions: Door to house		house interio	or is open 10 cm.	Bay door is cl	osed. Generat	tor is in center of garage. Exhaust plume mixes in garage.	is in center of garage. Exhaust plume mixes in garage.	
				R	Restart Scenario	DS			SCENARIO
Scenario	Response	to Shutoff	Scenario Weight	Changes fr Condit		Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHTS
Н	No re	estart	0.0500	N/A	4	1.0000	N/A	1.0000	0.0375
11	Restart in garage.		None.		e. 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
12			0.6167	NOT	none.		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
13			0.0167	Dav daar is	an an fuille	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
14				Bay door is	Bay door is open fully.		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.		noves and	Bay door is o operator return CO does not e	ns to house.	0.5000	N/A	1.0000	0.1250
J2			0.3333	Operator leave open after return CO enters th	ning to house.	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: Basement: Crawlspace: No Weight for Home Type: (# deaths allocated to this home \* % this location) Initial Location: Garage 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 FINAL Initial Conditions: house interior. **SCENARIO Restart Scenarios** WEIGHTS Sub-2nd Scenario Changes from Initial Response to Shutoff Scenario Scenario 2nd restart Reaction Conditions Weight Weight Weight No restart 0.0500 N/A 1.0000 N/A 1.0000 0.0125 Κ Restart after moving generator to outside of garage L1 where CO does not enter garage. Garage bay door is 0.0385 0.5 open until operator returns to house. 0.5000 None. Restart after moving generator to outside of garage L2 where CO enters garage. Garage bay door is open by 0.5 0.0385 operator and remains open. 0.6167 Restart in garage. Restart after moving generator to outside of garage L3 where CO does not enter garage. Garage bay door is 0.5 0.0385 open until operator returns to house Bay door is open fully. 0.5000 Restart after moving generator to outside of garage L4 where CO enters garage. Garage bay door is open by 0.5 0.0385 operator and remains open. Bay door is closed after M1 operator returns to house. 0.5000 N/A 1.0000 0.0417 CO does not enter garage. Operator opens bay door, moves and 0.3333 restarts generator outside garage. Operator leaves bay door open after returning to house. 0.5000 M2 N/A 1.0000 0.0417 CO enters the garage. Table 13.d. [UL2201] Scenario for Houses with Garage and Basement But No Crawlspace, with Generator Initially Operated Outside Structure Type: HOUSE Garage: Basement: Crawlspace: No 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 FINAL SCENARIO **Restart Scenarios** WEIGHTS Sub-2nd Scenario Changes from Initial Response to Shutoff Scenario Scenario 2nd restart Reaction Conditions Weight Weight Weight Actual Actual Generator does not shutoff until the tank Deaths for Deaths for is empty; therefore, there are no restart specific N/A N/A N/A N/A Ν specific scenarios. house house model

model

Structure Type: DETACHED GARAGE			GAR1 & GAR2						
Ini	Initial Location:		Garage Weight for Home Type: (# deaths allocated to this home * % this location)					)	
Initi	Initial Conditions:		Bay door is closed. Generator is in center of garage. Exhaust plume mixes in garage						
				Rest	tart Scenari	os			SCENARIO
Scenario	Response to	Shutoff	Scenario Weight	-	Changes from Initial Conditions		2nd restart	2nd Reaction Weight	WEIGHTS
А	No resta	art	0.0500	N/A		1.0000	N/A	1.0000	0.0500
B1				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	Destart in a		0.6167	None.	ione.	0.0000	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	Restart in g	jaraye.	0.0107		<b>C</b> 11	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			Bay door is		en rully.	0.5000	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 o		0 2222	None. CO does garage.		0.5000	NA	1.0000	0.1667
C2	restarts generator o Operator returns	0 0	0.3333	Bay door is open enters the ga	-	0.5000	NA	1.0000	0.1667

	ucture Type: DETACH			· · · · · · · · · · · · · · · · · · ·	.,	enerator Initially Operated in Workshop Room GAR3			
Ini	tial Location:	Works	shop in Garage Weight for Home Type: (# deaths allocated to this home * % this location)						
Initi	al Conditions:	Bay door i	s closed. Generator is in center of workshop room. Workshop door is closed. Exhaust plume mixes in workshop room.						
				Restart Scenar	os			SCENARIC	
Scenario	Response	to Shutoff	Scenario Weight	Changes from Initial Conditions	Sub- Scenario Weight	2nd restart	2nd Reaction Weight	WEIGHTS	
А	No re	estart	0.0500	N/A	1.0000	N/A	1.0000	0.0500	
B1				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 in same ro	U	0.4500		0.0000	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	
В3	exhaust plume s	staying in room.		Window in workshop room is	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				open fully.		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				Door to workshop room is open 10 cm. Exhaust facing away from wall with door to	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	Move and restart ir	Move and restart in garage. Bay door	0.1250	workshop room. Exhaust plume mixes inside garage.		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	closed.	sed.	0.1200	Door to workshop room i open 10 cm. Exhaust facin toward the wall with door	naust facing with door to ume pushes aust into	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				shop. Exhaust plume pushes some of exhaust into workshop room.		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				Door to workshop room is open 10 cm. Exhaust facing away from wall with door to	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	Move and restart in garage. Bay door is	garage. Bay door is	0.1250	workshop room. Exhaust plume mixes inside garage.	0.7300	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	open fully.		0.1250	Door to workshop room is open 10 cm. Exhaust facing toward the wall with door to	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				shop. Exhaust plume pushes some of exhaust into workshop room.	0.2300	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			0.2000	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%]

Stru	Structure Type: DETACHED GARAGE			GAR3					
Initial Location:		Garage	Garage Weight for Home Type: (# deaths allocated to this home * % this location)						
Initi	al Conditions:	Door to workshop is Exhaust mixes in gar	•	open 10 cm. Bay door is closed. Generator is in center of garage. Exhaust is facing away from wall with door to workshop. age.					
				Restart S	cenarios			SCENARIC WEIGHTS	
Scenario	Response	to Shutoff	Scenario Weight	Changes from Initia Conditions	al Sub- Scenario Weight	2nd restart	2nd Reaction Weight		
А	No re	estart	0.0500	N/A	1.0000	N/A	1.0000	0.0375	
B1				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	Destarti				0.5000	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	- Restart in garage.		0.6167		h. 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				Bay door is open ful	ly. 0.5000	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		erator opens bay door, moves and estarts generator outside garage.		None. CO does not e garage.	nter 0.5000	NA	1.0000	0.1250	
C2	U U	o original location.	0.3333	Bay door is open fully. 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%]

Stru	ucture Type: DETACH	IED GARAGE					GAR3				
Ini	Initial Location:		Garage	Garage Weight for Home Type: (# deaths allocated to this home * % this location)							
Initi	ial Conditions:	•	•	pen 10 cm. Bay door is closed. Generator is in center of garage. Exhaust is facing toward wall with door to workshop. Exhaus f exhaust into workshop room.							
				Re	start Scenari	OS			SCENARIO WEIGHTS		
Scenario	Response	to Shutoff	Scenario Weight	Changes fror Conditio		Sub- Scenario Weight	2nd restart	2nd Reaction Weight			
D	No re	estart	0.0500	N/A		1.0000	N/A	1.0000	0.0125		
E1						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	Bostort i		0.6167	None.	NOTIC.	0.0000	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		Restart in garage.			oop fully	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				Bay door is of	r is open fully.		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		perator opens bay door, moves and	0.3333	None. CO does garage		0.7500	N/A	1.0000	0.0625		
F2	° °	restarts generator outside garage. Operator returns to original location.		Bay door is oper enters the g	•	0.2500	N/A	1.0000	0.0208		

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 <i>restart</i> 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, st
	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.	<ul> <li>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:</li> <li>Most rooms have furniture and many other obstructions that do not make it equally probable to put a generator anywhere in that space.</li> <li>The area surrounding the doorway is one of the few locations that is likely to be consistently unobstructed.</li> </ul>

	<ul> <li>The extension cord length may be a limiting factor that prevents consumers from putting a generator further into a room.</li> <li>CPSC has incident data where the generator was placed near a door with the exhaust blowing into an adjacent space.</li> <li>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.</li> <li>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.</li> </ul>
• 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.

<ul> <li>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.</li> <li>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.</li> </ul>	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.	<ul> <li>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.</li> <li>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.</li> </ul>
<ul> <li>For UL 2201 generators:</li> <li>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.</li> <li>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.</li> <li>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.</li> </ul>	<ul> <li>Staff disagrees with this comment.</li> <li>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.</li> <li>Staff thinks it is reasonable to use the CO rates proposed in TN 2048.</li> <li>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 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.</li> </ul>

<ul> <li>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.</li> <li>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.</li> </ul>	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>i.e.</i> 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 $\geq 15\%$ 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>i.e.</i> , 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 $\geq 15\%$ 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 <u>https://www.epa.gov/sites/production/files/2014-11/documents/carbon_monoxide_final_volume8_2010.pdf</u> ).

Provide the rationale for the criteria for estimating potential severity of injuries for the survivors of formerly fatal exposures.	<ul> <li>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.</li> <li>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.</li> <li>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:</li> <li>Hampson NB, Piantadosi CA, Thom SR, Weaver LK. Practice recommendations in the diagnosis, management, and prevention of 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</li> <li>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</li> </ul>
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