

cc: ✓ ~~SAP~~ 0118 304099
Granted, Chron. Officer (6/15 Release), Requester, Fee log,
ADFM #R-117-95 (\$101.20) & Specialist/SAP

GAS WATER HEATERS

March 20, 1995

Mr. Edward F. Downing, III
Gauthier & Murphy
3500 North Hullen Street
Metairie, Louisiana 70002

Re: FOIA Request #S-304099; Gas Appliances and Flammable
Vapor Fires, ADFM # R-117-95, (\$101.20)

Dear Mr. Downing:

This responds to your Freedom of Information Act (FOIA) request seeking information from the Consumer Product Safety Commission (Commission). The records from the Commission files responsive to your request have been processed and copies of the releasable responsive records are enclosed.

Enclosed are copies:

Arthur D. Little, "Flammable Vapor Ignition Study",
February 17, 1993;

Arthur D. Little, "Flammable Vapor Ignition Study",
April 25, 1994;

Minutes of Meeting of WORKING GROUP ADDRESSING
SUGGESTED REVISIONS TO REDUCE POSSIBLE IGNITION OF
FLAMMABLE VAPORS BY VOLUME I WATER HEATERS,
March 17-18, 1992;

Memo for Howard I. Forman, Chairman Z21 Committee to
Members of Z21 Committee regarding Incidents Involving
Flammable Vapors and Gas-Fired Water Heaters;

Documents on Flammable Vapor Ignition prepared by ESEE
staff member Joe Fandey; and

Z21/CGA Joint Water Heater Subcommittee Meeting
Agendas, September 23-24, Items 1-20.

The Commission's FOIA regulations at 16 C.F.R. § 1015.9, provide for the charging of fees resulting from the processing of FOIA requests. The processing of your request involved: (1) the duplication of 500 pages X \$0.10/page = \$50.00; (2) file searching by clerical personnel, 1 hour X \$12.00/hour = \$12.00; and (3) review time to determine whether records were permitted to be withheld, 2 hours X \$19.60/hour = \$39.20. Forward the total amount due, \$101.20, by check or money order made payable to the **TREASURY OF THE UNITED STATES** with the enclosed copy of this letter to: **Division of Financial Management, ADFM Room 522, U.S. CONSUMER PRODUCT SAFETY COMMISSION, Washington, D. C. 20207.**

Note that after thirty days interest will be charged on amounts billed. Furthermore, if billing is not paid in a timely manner the Commission will require advance payment for your future requests and any pending requests.

The Commission's Freedom of Information Officer, Office of the Secretary, will consider written request for a waiver of the assessed fees when the requester can show that disclosure of the requested information is in the public interest because it is likely to contribute significantly to public understanding of the operations or activities of the government and disclosure of the requested information is not primarily in the commercial interest of the requester. Other factors to be considered are listed in the regulations at 16 C.F.R. § 1015.9(f)(5).

Thank you for your interest in consumer product safety. Should you have any questions, contact Sheila Pugliese by letter, facsimile (301) 504-0127 or telephone (301) 504-0785 ext. 1238.

Sincerely,

Todd A. Stevenson
Freedom of Information Officer
Office of the Secretary

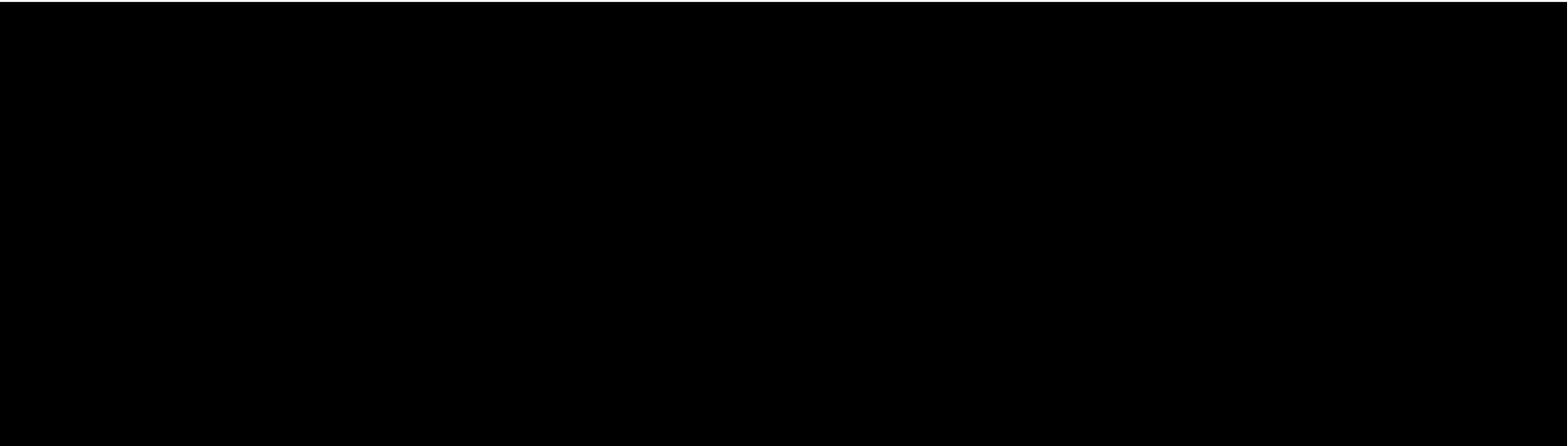
Enclosures

Experimental Testing Task Conclusions

Results of Experimental Tests

2. Water heater on 18" stand reduces the number of ignition sources
 - Typically requires a larger spill
 - Usually requires movement induced by people or room air
 - Ignition less likely in a larger room
 - Delay in ignition could produce a vapor build-up resulting in explosion or severe fire

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Experimental Testing Task Conclusions

Results of Experimental Tests

3. Water heater on the floor did not ignite flammable vapor from under the following conditions:

- 18 oz of gasoline absorbed
- Large room
- With or without movement
- 24" from water heater

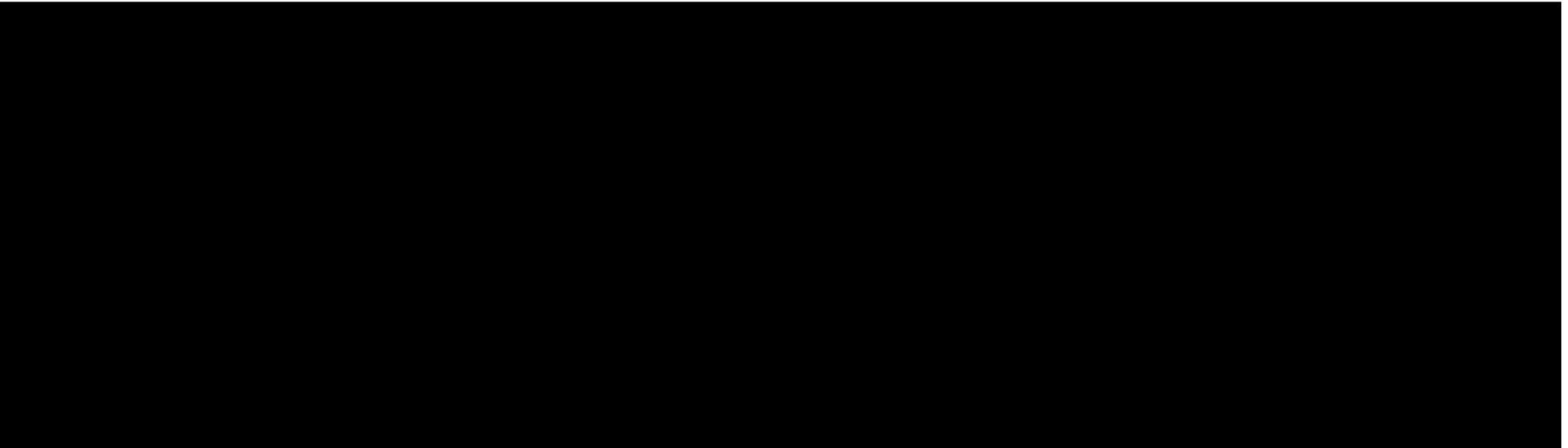
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Experimental Testing Task Conclusions

Additional observations:

- Movement is extremely important and a definite contributor to
- Higher floor and room temperatures increase chances of ignition, but are not major contributors compared to movement
- Ignition at 18" elevation in a smaller room with higher temperatures and movement is a possibility
- Ignition caused by soaked rags in a small room remains a possibility

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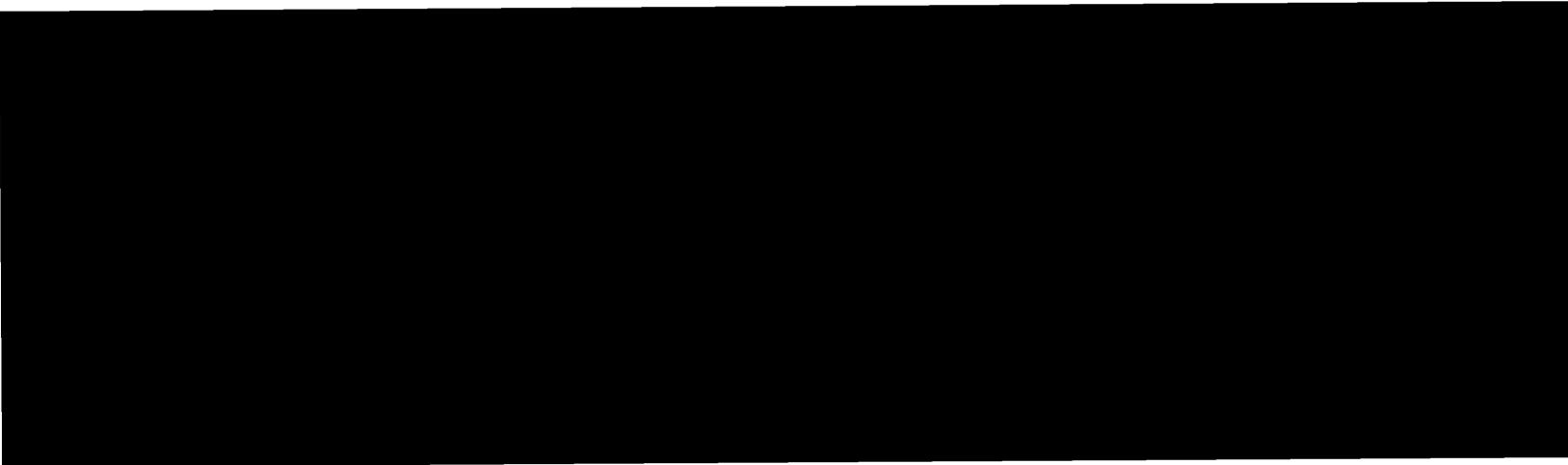


Experimental Testing Task Conclusions

Suggested next steps:

1. 18" elevation tests to document the effect of room size on va and ignition
2. Assess impact of water heater design differences on ignition

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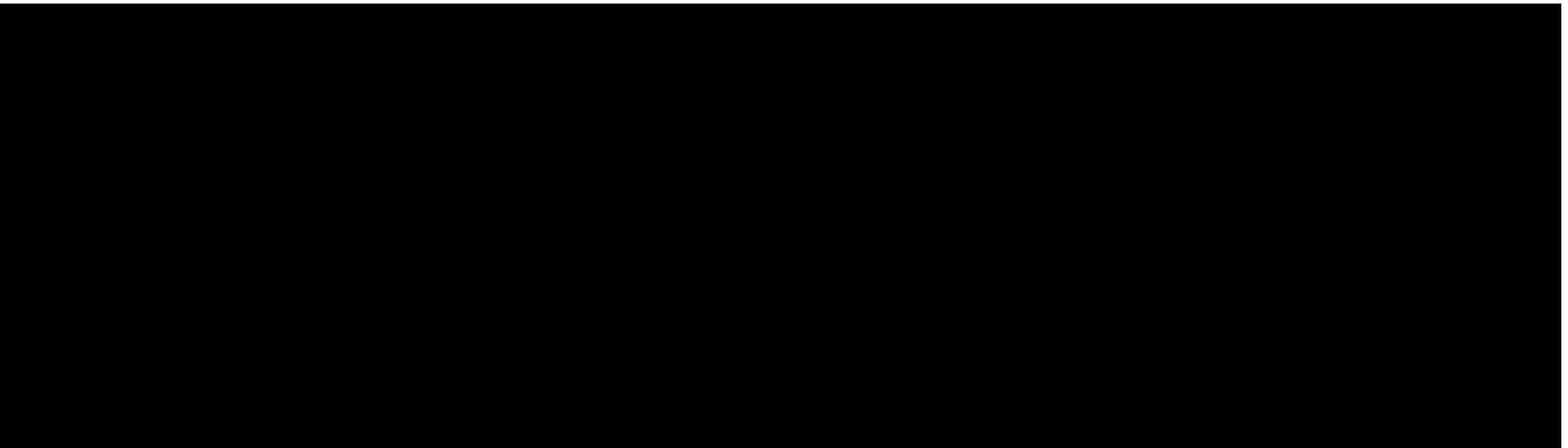


Analysis of Consumer and Installer Activities Task

**The proposed objective is to conduct a statistical survey of
to identify current practices**

- Awareness of dangers involved in using or storing flammable gas water heaters
- Awareness of existing safety promotion efforts
- Amount of gasoline typically stored in households; uses and
- Percent of water heaters installed in garages and fraction of

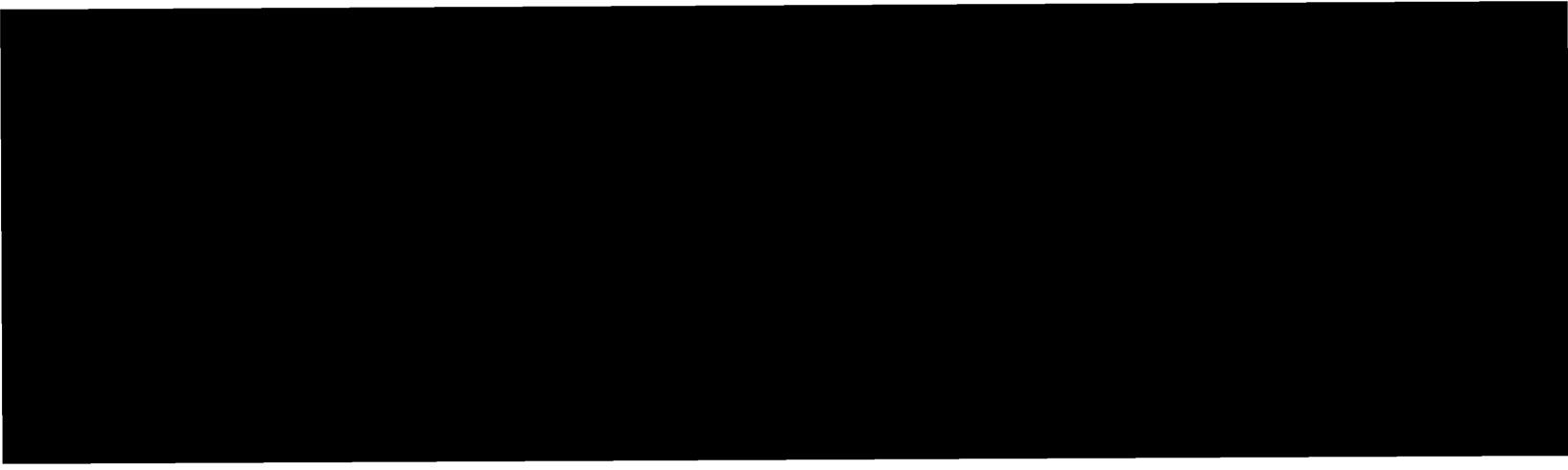
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Experimental Testing Task

APPENDIX

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Features of 8' x 8' x 8' Room Tests:

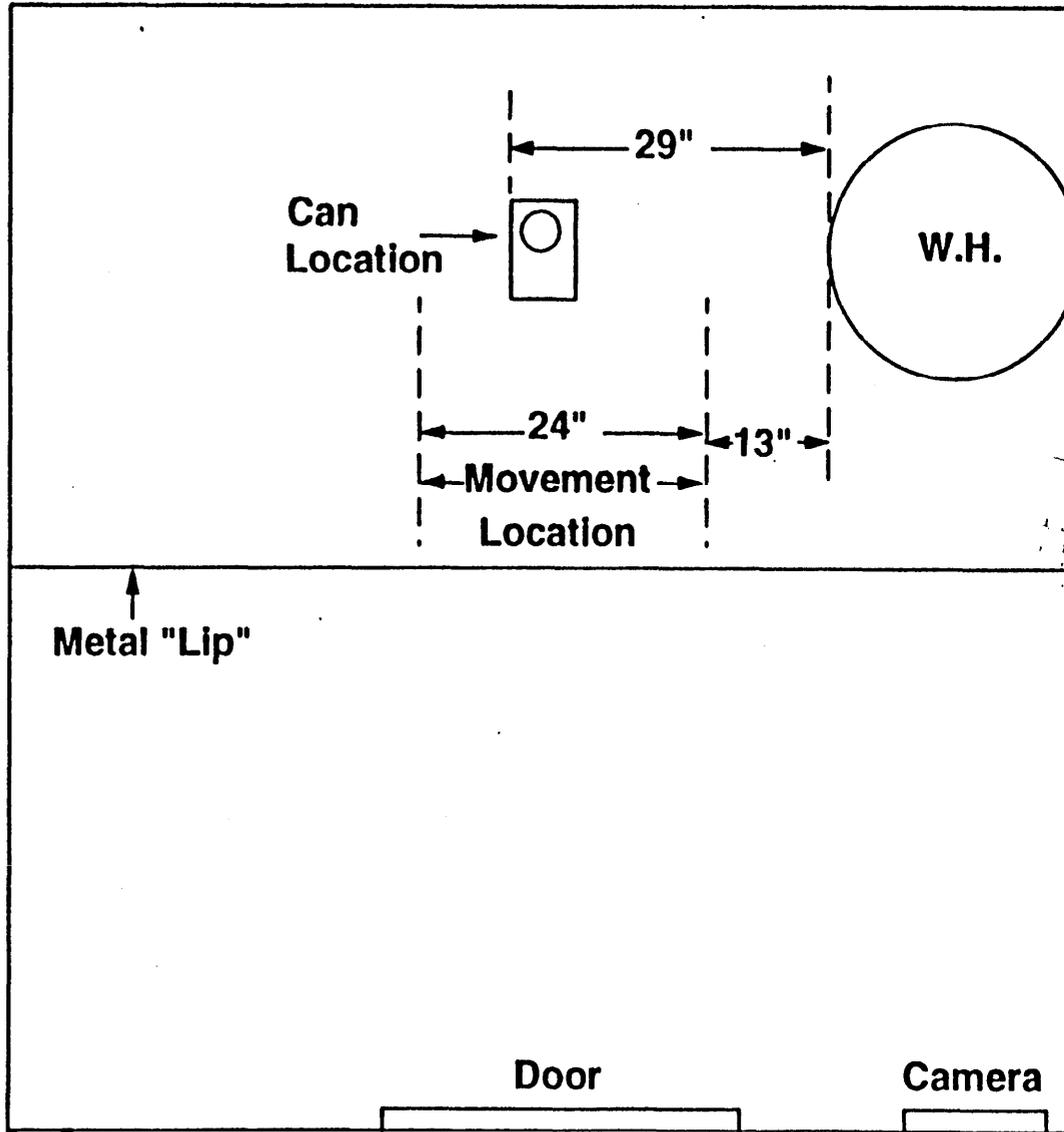
- Room sealed except for top vent for combustion air
- Unheated metal floor on spill area
- Flame ionization detector used to qualitatively indicate flame profiles
- Primarily winter blend gasoline used
- Main burner ignited for all tests

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Experimental Testing Task: Tests in 8' x 8' x 8' Room

Room Floor Plan



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Experimental Testing Task Tests in 8' x 8' x 8' Room

Matrix of Tests completed in 8' x 8' x 8' Room

Test #	W.H. Position	Spill/ Soak	Room Temp F	Floor Temp F	Movement	Spill Dist.	Comments
1	Floor	1 gal	88	57	No	29"	Vented room
2	18" Stand	1 gal	71	52	No	29"	No Ignition
3	18" Stand	1 gal	84	54	Yes	29"	Started movement at 41 min
4	18" Stand	1 gal	79	45	Yes	29"	Movement every 5 min
5	18" Stand	Rags	76	58	No	13"	Reached ~ 64% L.F.L. in 12 min at 2 in height
6	18" Stand	1 gal	60	97	Yes	29"	Movement at 5 s intervals

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Experimental Testing Task Tests in 10' x 20' 8' Room

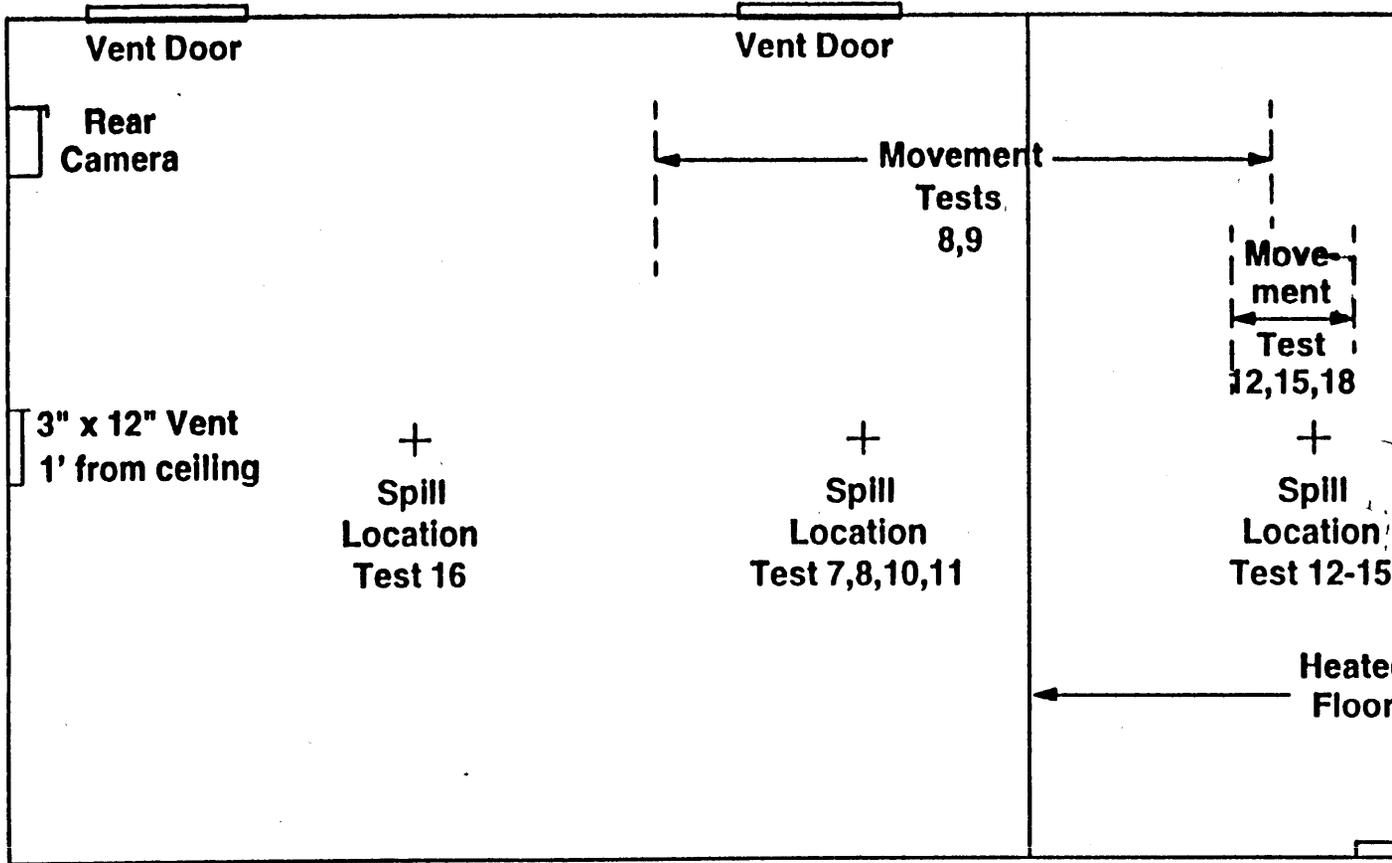
Features of 10' x 20' x 8' Room

- Room sealed except for top vent for combustion air except and 11
- Tests 7-11 and 16 have gasoline spill on concrete
- Tests 12-15 and 17-18 have heated metal floor
- Flame ionization detector used to qualitatively indicate flame profile
- Summer blend gasoline used
- Main burner ignited except for Test 7

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Experimental Testing Task: Tests in 10' x 20' x 8' Room

Room Floor Plan



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Experimental Testing Task Tests in 10' x 20' x 8' Room

Matrix of Tests Completed in 10' x 20' x 8' Room

Test #	W.H. Position	Spill/ Soak	Room Temp F	Floor Temp F	Movement	Spill Dist.	Comments
7	Floor	1 gal	91	68	No	8'	Pilot only
8	18" Stand	1 gal	84	59	Yes	8'	3 movements 2 ft/s, repeated each minute
9	18" Stand	2 gal	87	63	Yes	6'-8'	• • •
10	Floor	1 gal	105	72	No	8'	Ventilation - 2 Air changes/hr
11	Floor	1 gal	85	69	No	8'	• • •
12	18" Stand	1 gal	100	110	Yes	30"	3 movements 2 ft/s, repeated each 30 s
13	18" Stand	2 gal	93	114	No	30"	Windy day
14	18" Stand	2 gal	80	94	No	30"	Vent was baffled (also for subsequent tests)
15	18" Stand	1 gal	84	95	Yes	30"	3 movements 2 ft/s, repeated each 30 s
16	Floor	1 gal	83	68	No	13'	Spill toward back wall
17	Floor	Rags (18 oz)	77	87	No	24"	Not close to LFL (<10%)
18	Floor	Rags (18 oz)	85	88	Yes	24"	3 movements 2 ft/s, repeated each 30 s, <10 LFL

Arthur D Little

Arthur D Little

Arthur D. Little, Inc.
Acorn Park
Cambridge, Massachusetts
02140-2390
USA

Main Number 617.498.5000
Fax 617.498.7200
Telex 921436

February 8, 1993

Mr. Daniel H. Brown
Vice President, Secretary & General Counsel
Rheem Manufacturing Company
405 Lexington Avenue
22nd Floor
New York, NY 10174-0307

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Berlin
Brussels
Cambridge, U.K.
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Tokyo
Toronto
Washington
Wiesbaden

Dear Dan:

I'm sorry we missed you on Friday at our ignition of flammable vapors project review in Chicago. I have enclosed a copy of our presentation for you. If you have any questions or comments please don't hesitate to call me (617-498-6058).

Sincerely,

Richard Topping

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**Flammable Vapor Hazards
Ignition Study**

**Presentation to GAMA:
Water Heater Technical
Committee
February 5, 1993**

**Arthur
Referen**

Agenda

The purpose of this presentation is to inform the GAMA Tech Heater Committee on Consumer Information and Education on and activities of the Flammable Vapor Study.

- Introduction
- Data Collection and Analysis Task
- Analytical Modeling
- Experimental Testing
- Consumer Survey

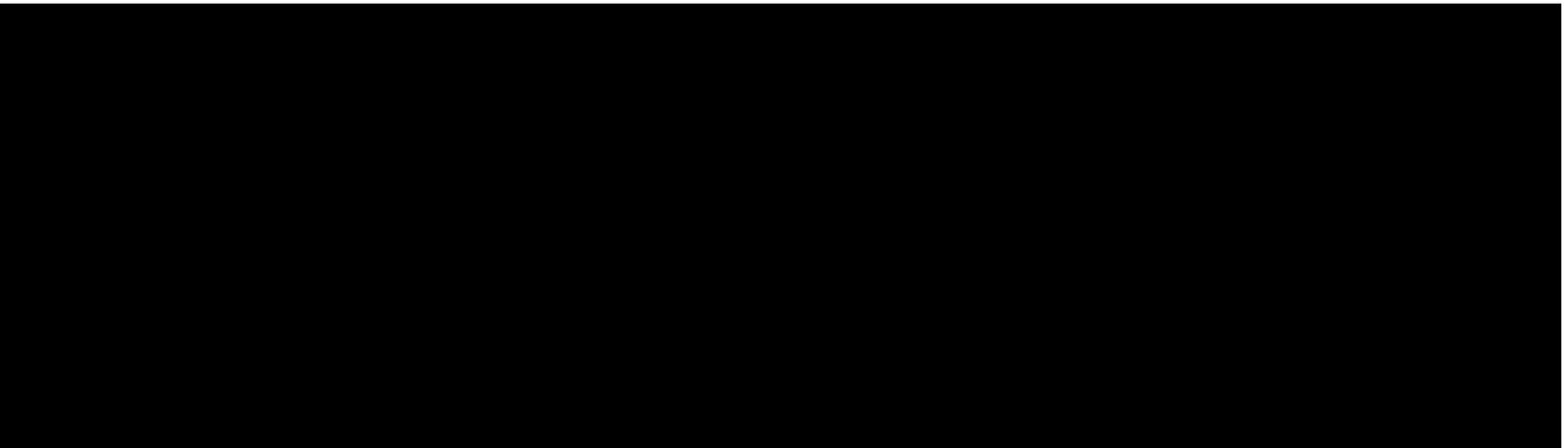
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Program Overview

The purpose of this study is to investigate and characterize the hazards posed by the ignition of flammable vapors. To accomplish this, the effort is divided into three tasks.

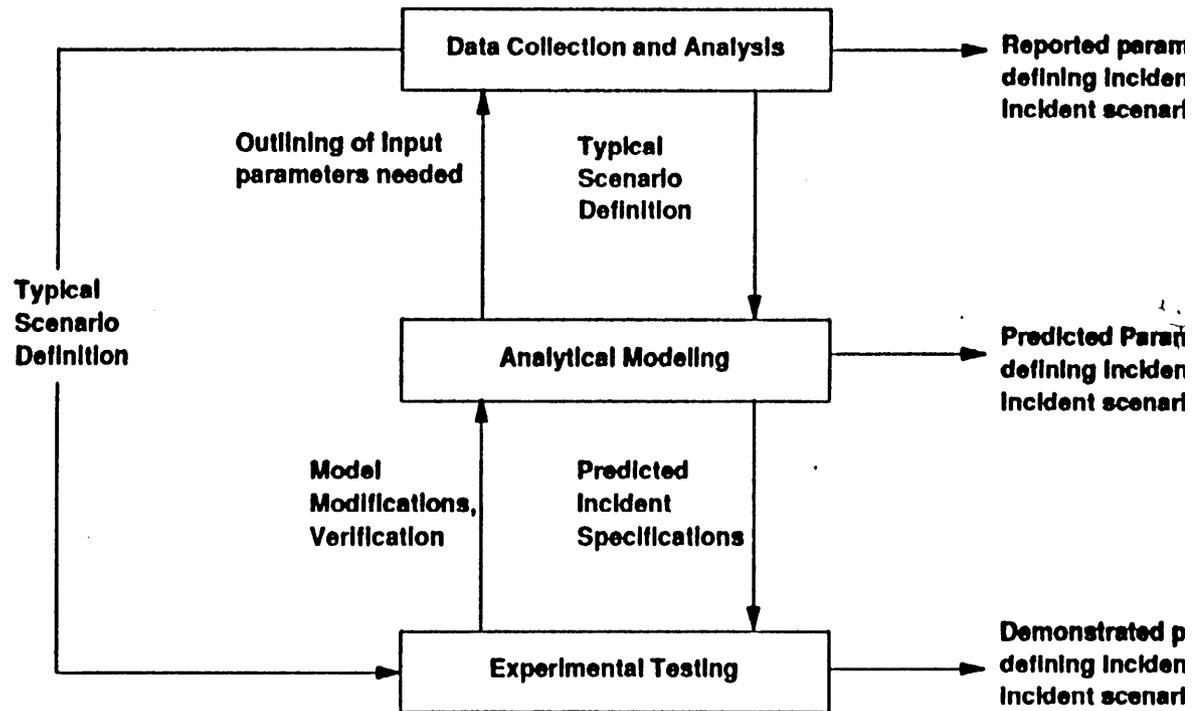
Task	Objective
1. Data Collection and Analysis	Determine the characteristics of incidents
2. Analytical and Experimental Testing	Analytically and experimentally model scenarios defined in Task 1
3. Analysis of Consumer and Installer Activities	Determine installation procedures and effectiveness of labels and instructions

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Program Overview

The interaction and data-flow between these tasks has been c
improve communications on this project.



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Data Collection and Analysis Task

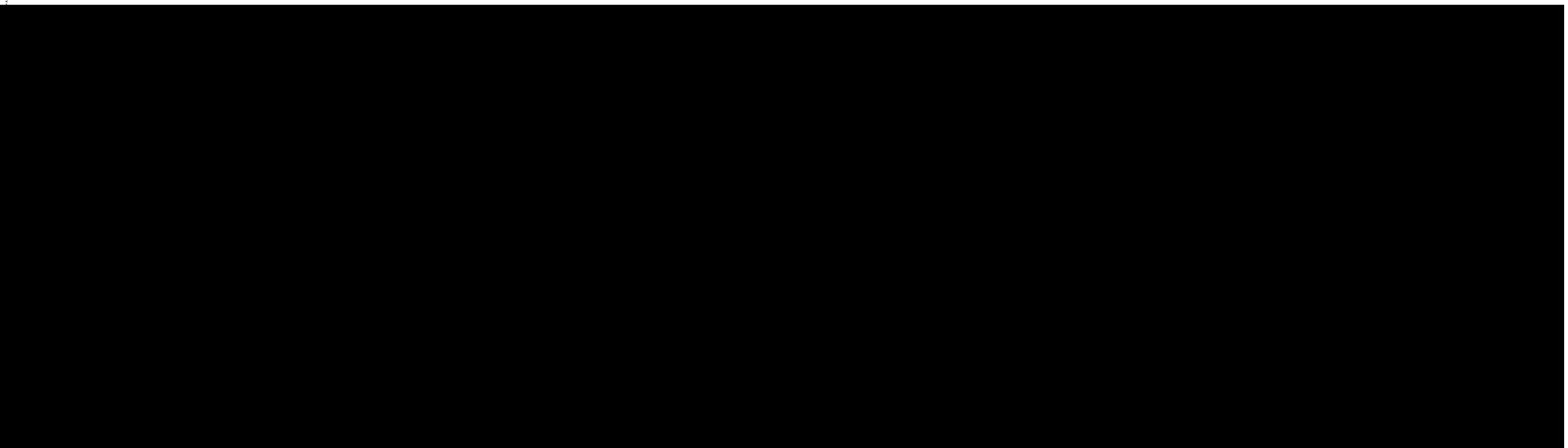
- Scenario development
 - detailed incident database
 - National Fire Incident Reporting System Database (NFIRS)
 - interviews
 - published reports

- Typical scenarios
 - bathroom scenario
 - utility room scenarios
 - garage and basement scenarios
 - garage scenario

- Relevant related issues

- Next steps

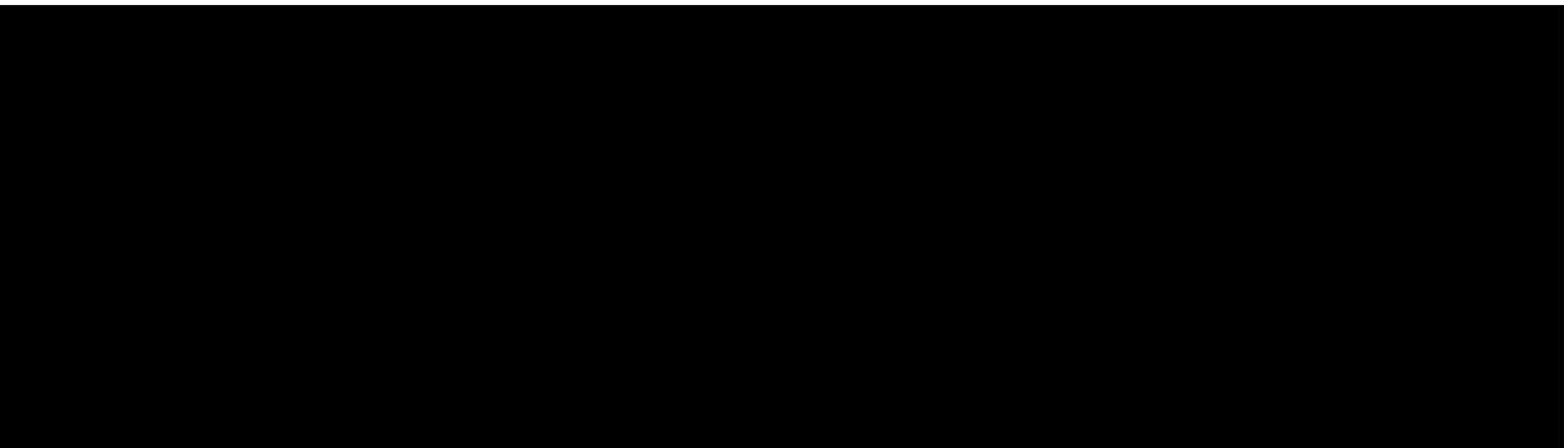
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**The process we used to develop "typical" flammable vapor w
incident scenarios made use of data from many sources.**

- ADL collected and reviewed 167 detailed incident reports from sources and created a PC database file
- NFIRS data analyses: Heiden Associates performed numerous and sorts of this data, results received by ADL 1/9/93
- Interviews of people with knowledge of these incidents
- Published reports and studies from several sources

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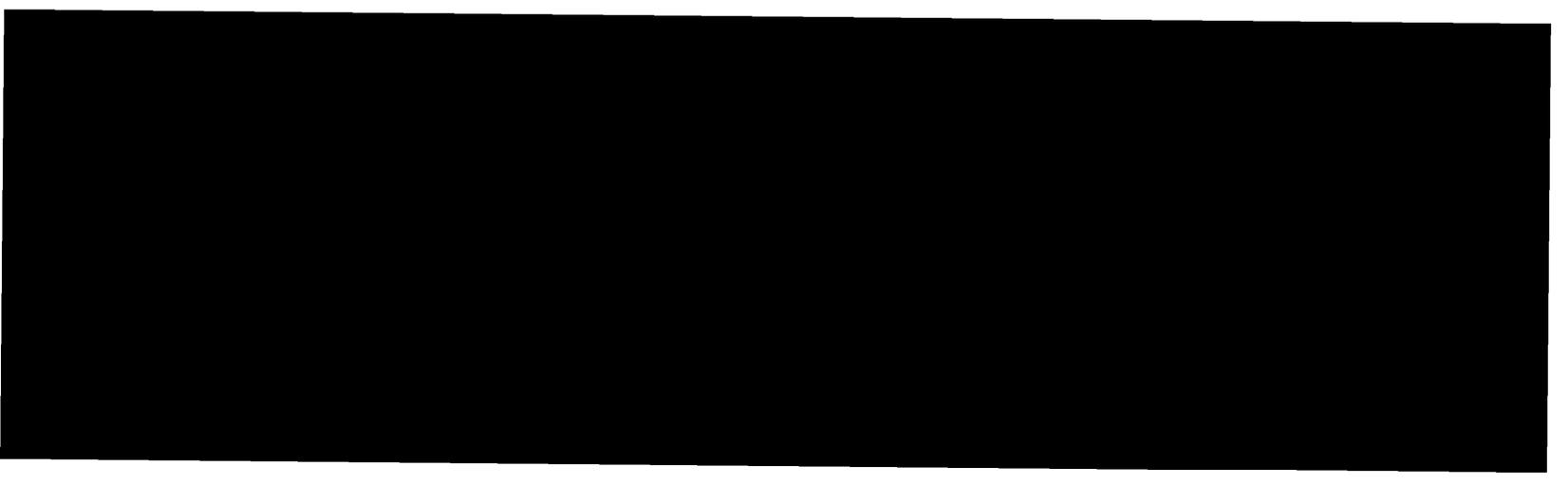


Data Collection and Analysis Task Scenario Development

A database of detailed incident reports has been created to provide insight into the details of gas water heater flammable vapor fires.

- 167 entries from:
 - CPSC In-depth Investigations Reports (42)
 - NFPA's Fire Incident Data Org. Reports (42)
 - NEISS Reports (83)
- Reports provide a good level of detail, though not perfect
- Must be analyzed in conjunction with NFIRS data

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Data Collection and Analysis Task Scenario Development

The analysis of the detailed reports has provided insight into i which should be addressed in the experimental program.

- **Activity was involved in 108 of the 167 reports (65%)**
- **Spills were involved in 65 of the 167 reports (39%)**
- **Flammable liquid usage was involved in 75 of the 167 reports (45%)**
- **Children were involved in 38 of the 167 reports (23%)**
- **Leaks were involved in 26 of the 167 reports (16%)**

Note: This list does not add up to 100% due to combinations of conditions.

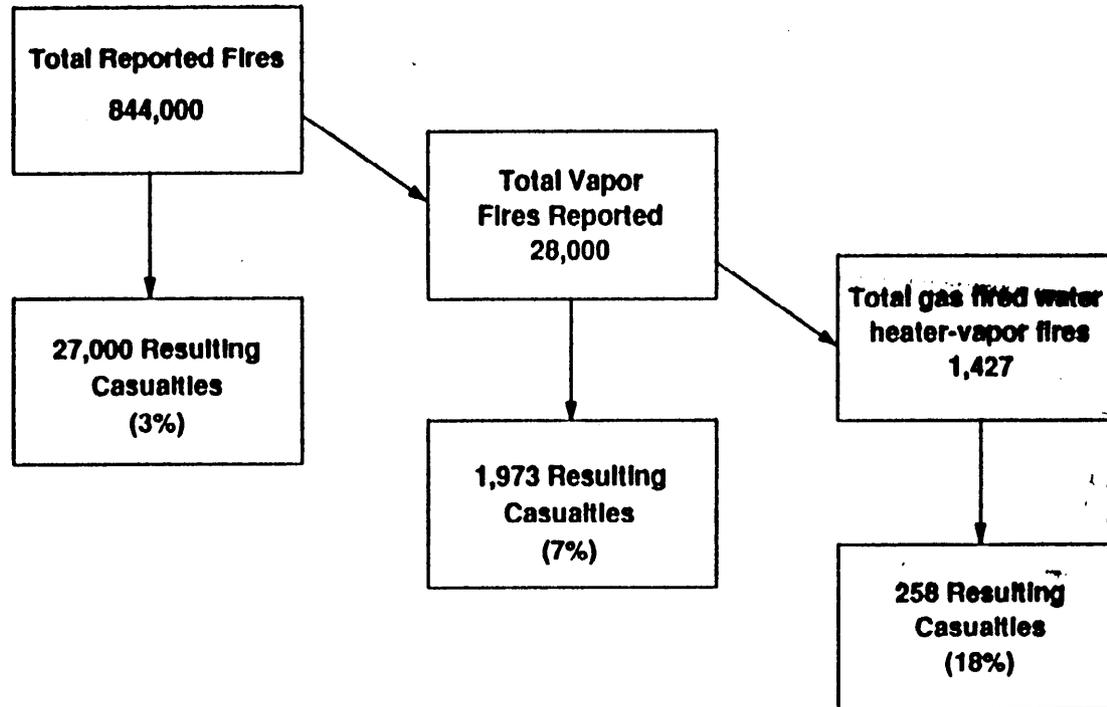
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The National Fire Incident Reporting System (NFIRS) was used to track national trends and understand the extent of the problem.

- **NFIRS has reports for approximately 280,000 fires per year, representing all US fires**
- **Communities participating changes from year to year and within communities**
- **The accuracy of any given NFIRS report depends on who filed the report**

This limits the use of NFIRS data analyses to the identification and analysis of regional and national trends.

From 1988 to 1990 water heater-flammable vapor fires represent 1.0% of all fires reported to NFIRS and 1.0% of all casualties.



The increased casualty rate of gas-fired water heater-vapor fire attributed to personnel activity and proximity at the time of ignition will be incorporated into our experimental plan.

* Casualties are injuries and/or deaths

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Source: NFIRS

Data Collection and Analysis Task Scenario Development

Flammable vapor fires involving gas fired water heaters are 2.6 more likely to result in casualties than the average of all flammable fires.

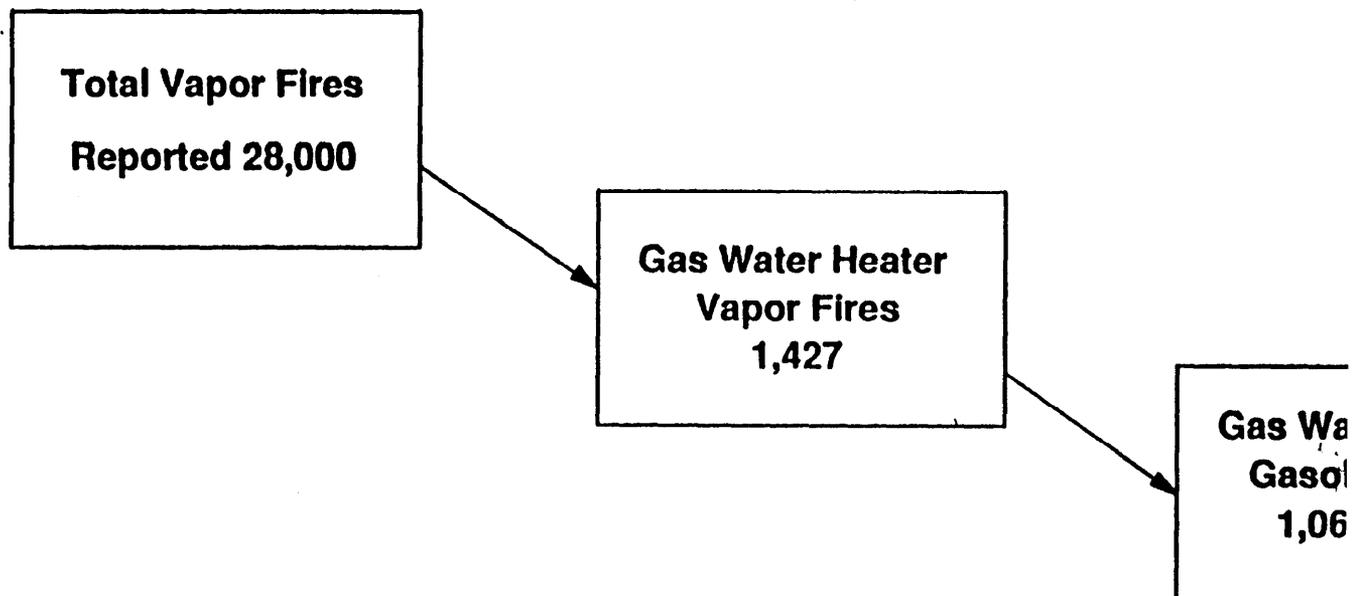
Equipment Involved in Ignition	# Flammable Vapor Incidents	# of Incidents W/Casualties
No equipment involved	10,974 (39%)	753 (38%)
Central heating unit	3,953 (14%)	67 (3%)
Vehicle	2,852 (10%)	77 (4%)
Undetermined, not reported	2,020 (7%)	114 (6%)
Gas fueled water heater	1,427 (5%)	258 (13%)
Portable local heating unit	1,275 (5%)	177 (9%)
Fixed, stationary local heating unit	1,157 (4%)	75 (4%)
Total	28,096	1,972

* Casualty Rate: # of incidents with casualties per 100 incidents

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Source: NFIRS

Gasoline is the most prevalent source of flammable vapor in gas water heater-flammable vapor fires.



Gasoline was selected for our experiments.

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Source: NFIRS

Washing parts, cleaning, refinishing, and painting are 1.8 times likely to result in casualties than the average for all incidents. This activity will be represented in the experimental plan.

Ignition Factor	# of Incidents	# of Incidents W/Casualties
Fuel spilled	441 (31%)	58 (22%)
Combustible too close to heat	282 (20%)	50 (19%)
Other misuse of material ignited	273 (19%)	39 (15%)
Washing parts, cleaning, refinishing, painting . . . (The intimate contact with the gasoline in washing . . . painting is the cause of higher injury rates.)	266 (19%)	86 (33%)
Total (all flammable vapor/water heater incidents)	1,427	258

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Source: NFIRS

Data Collection and Analysis Task Scenario Development

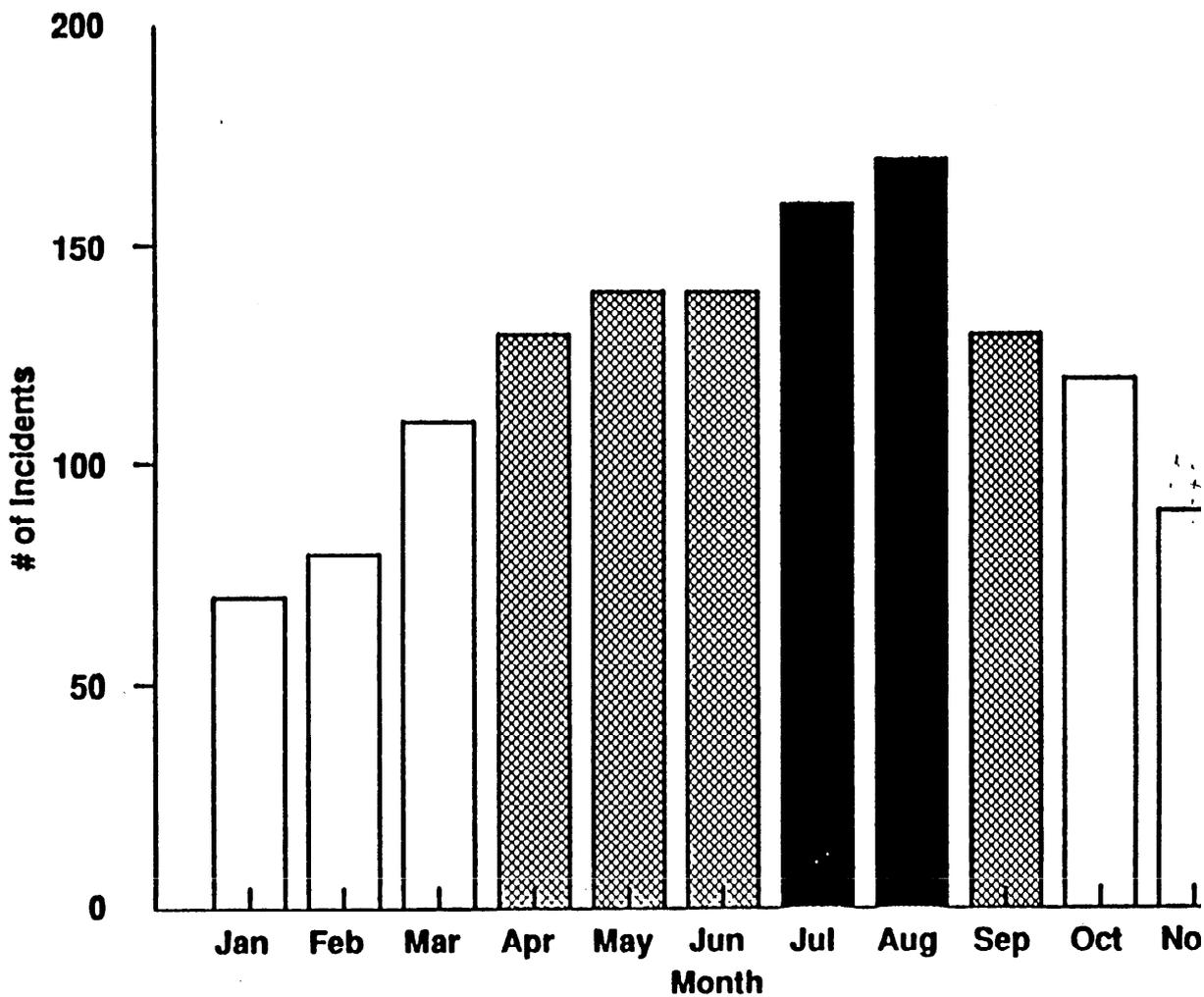
Eighty-five percent of gas water heater flammable vapor fires occur in these six room locations, and account for ninety percent of casualties.

Room	Incidents (#/%)	Incidents with Casualties (#/%)
Garage	440 (20%)	69 (27%)
Heating Equipment Room	311 (14%)	53 (21%)
Laundry Room	209 (10%)	48 (19%)
Kitchen	85 (4%)	23 (9%)
Bathroom	49 (2%)	22 (9%)
Storage Room	121 (6%)	12 (5%)
Total (for these six rooms)	1,215 (85%)	227 (90%)

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Source: NFIRS

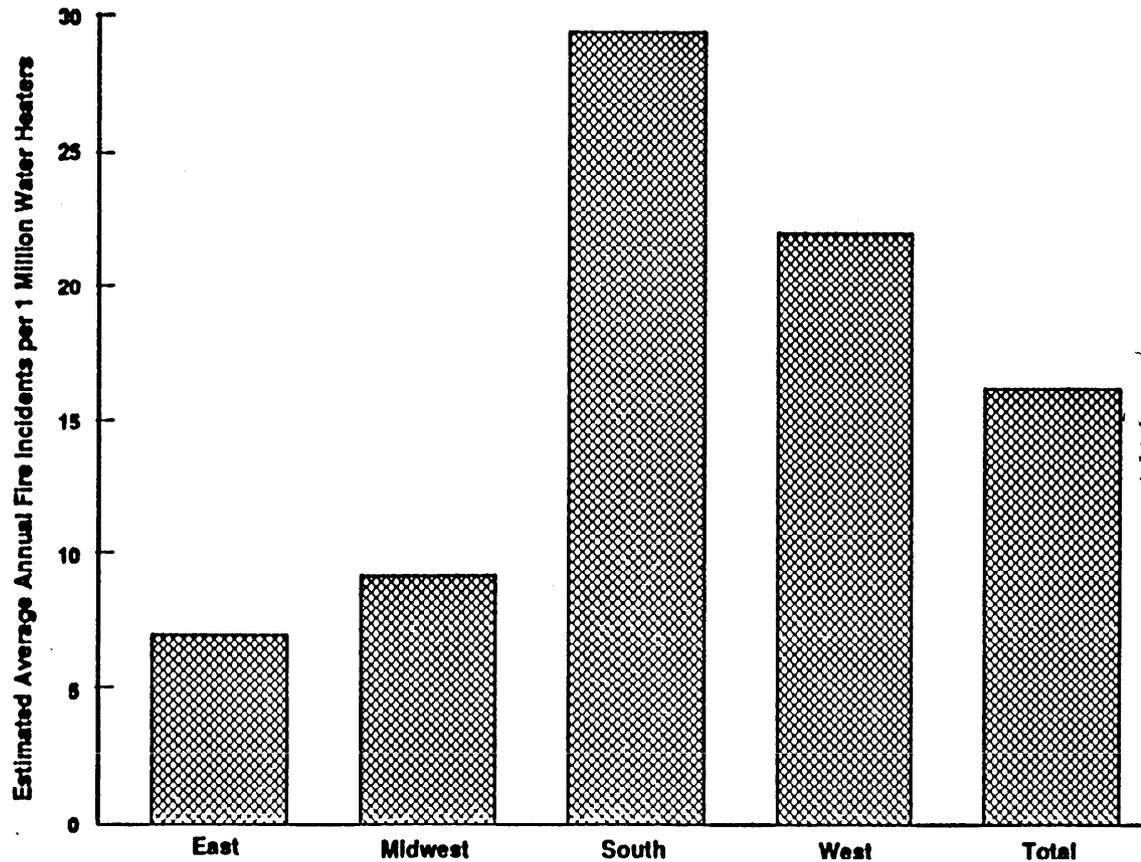
Gas-fired water heater-flammable vapor fires are more likely in summer months.



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Source: NFIRS

The South and West Regions of the country experience three to many incidents per million water heaters in comparison to the Midwest.



* East and Midwest combined and averages, their compared with the combined and value for the South and West.

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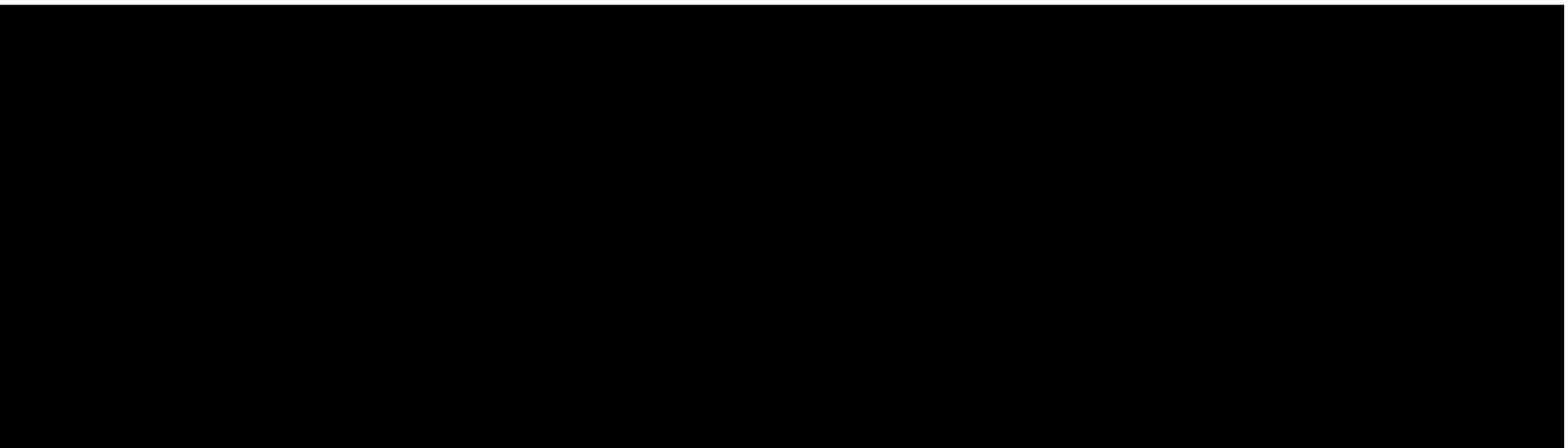
Source: NFIRS

Data Collection and Analysis Task Scenario Development

Interviews were conducted, both in person and by telephone, involving individuals involved with the ignition of flammable vapors by gas water issue.

- National Fire Protection Association (NFPA)
- U.S. and local government officials
- Witnesses
- Attorneys
- Gas companies
- Insurance companies

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Data Collection and Analysis Task Scenario Development

Interviews Conducted:

Person Contacted	Type of Contact	Pho
T. Lemoff, NFPA	In person	(61
R. Fahey, NFPA	In person	(61
C. Peterson, NFPA	In person	(61
J. Fandley, CPSC	In person	(30
E. Leland, CPSC	In person	(30
W. Rowe, CPSC	In person	(30
W. Gorman, Acting Chief Plumbing Inspector, Ft. Worth, TX	Phone	(81
L. Anderson, Failure Analysis Associates	Phone	(41
C. Adams	Phone	(30
D. Wandling	Phone	(51
C. Lamar	Phone	(70
R. Hall	Phone	(91
S. Blackman	Phone	(21
J. Fowler	Phone	(71

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Data Collection and Analysis Task Scenario Development

Interviews Conducted (Continued):

Person Contacted	Type of Contact	Pho
L. Mandel	Phone	(40
J. Merritt and M. Blue, Merritt and Rooney	Phone	(40
E. Downing, Gauthier and Murphy	In person	(50
L. Kolman, Pope and John	In person	(31
S. Murphy, McDermott, Will and Emery	In person	(20
O. Clark, Gas Company of New Mexico	Phone	(50
D. Hosler, Southern California Gas Company	Phone	(21
J. Farris, Ranger Insurance	Phone	(40
K. Struck Nobel Insurance	Phone	(21
R. Beck, Southern Building Code Congress	Phone	(20
W. Malstedt, American Insurance Service Group	Phone	(20
K. McQueen , NCS BCS	Phone	(70

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In general, the interviews provided us with information about previous testing, existence of previous testing and a comparison of scenarios, history and background of the 18" elevation requirements. This information is reflected in the scenarios we developed. Other significant findings from the interviews which are not directly reflected in the scenarios include:

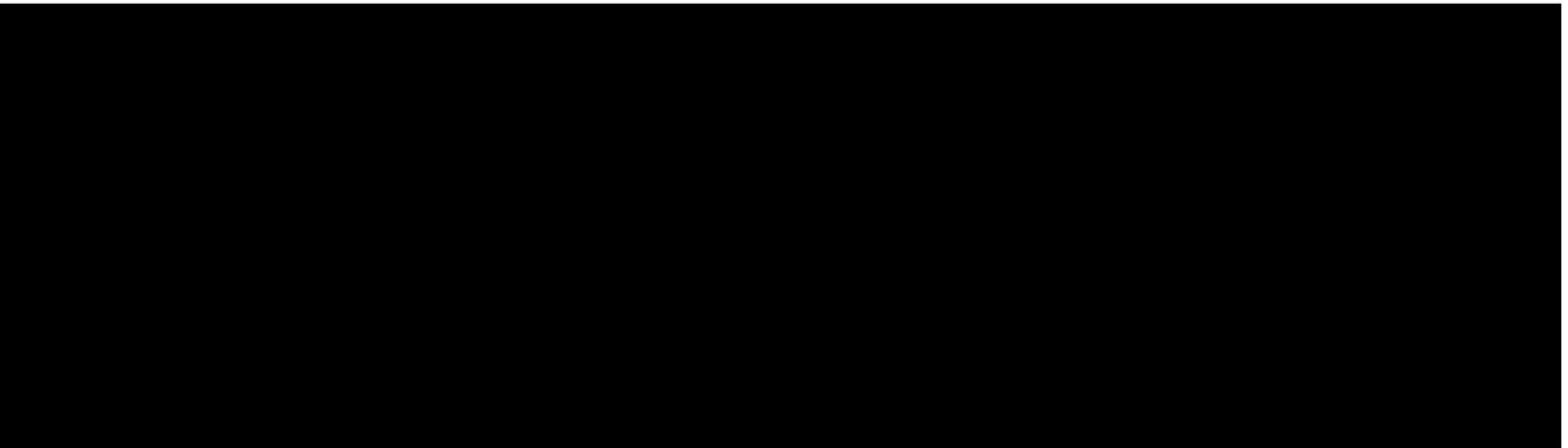
- NFIRS weaknesses
 - when multiple pieces of equipment are mentioned the level of confidence does not usually support a single cooling in the scenario (C. Peterson, NFPA)
 - QC is focused more on filling out the form rather than on the quality of the data (C. Peterson, NFPA)
- Entex, gas company in the Houston area, has more reported service area than NFIRS indicates (according to T. Fibiak, Entex attorney).

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Published reports and studies were also reviewed.

- LA Fire Department study
- Calspan Reports:
 - "Investigation of Safety Standards for Flame-Fired Furnaces, Water Heaters, Clothes Dryers and Ranges", W.A. Buller and D.E. Adams (#YG-5569-D-3)
 - "Identification and Classification of Potential Hazards Associated with the use of Residential Flame-Fired Furnaces, Hot Water Heaters, Clothes Dryers and Ranges", W.A. Buller and D.E. Adams
- Gauthier and Murphy's "Water Heaters and Flammable Vapor Hazards"
- A complete list of documents reviewed for this task is presented in Appendix A.

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The "LA Study" was conducted in 1974 by the County of Los Angeles Fire Department and analyzed local fire data from 1970 to 1973. The following results.

Total Garage Fires (Fires originating in Garage)

Total Garage Fires in which Water Heater was Contributing Factor

Total Garage Water Heater Caused Fires in which Flammable Liquids were Involved

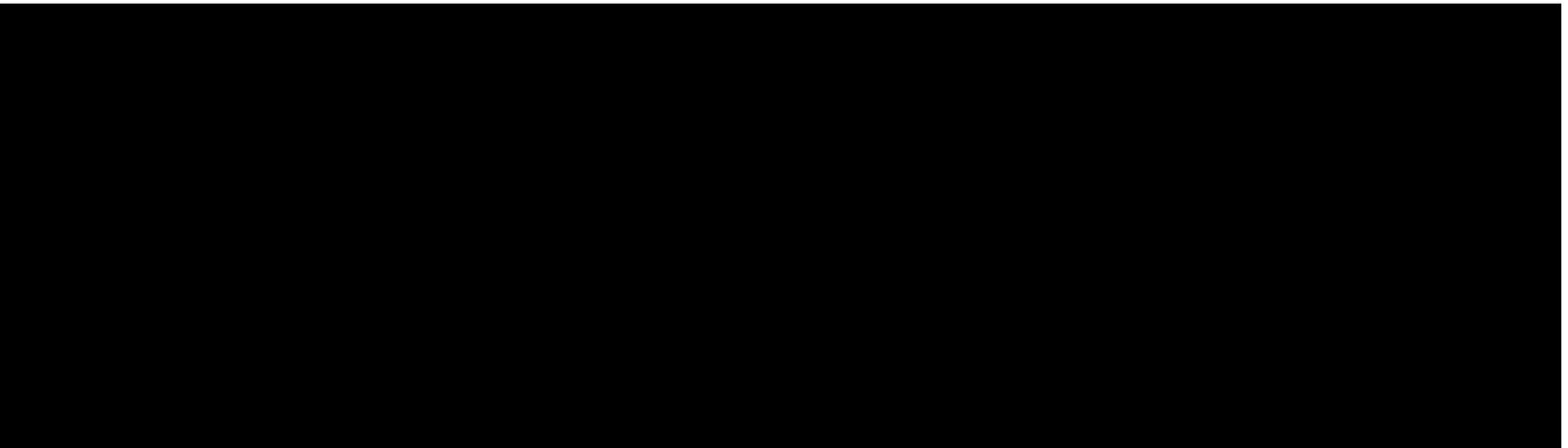
Garage Water Heater Locations

Floor Level

Unknown

Above Floor Level

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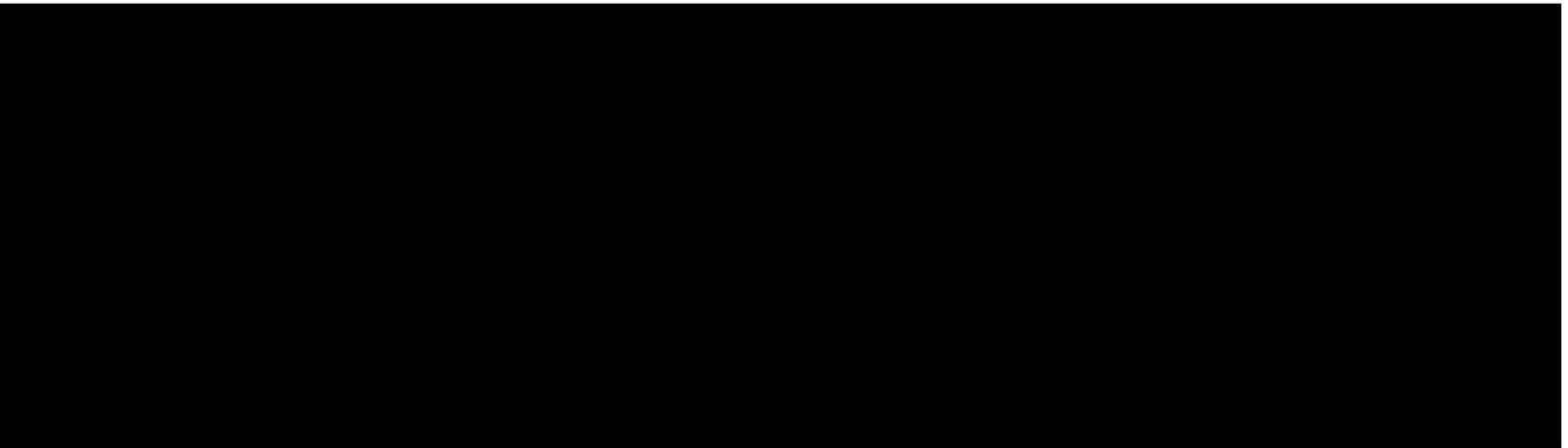


The LA Fire Department Study concluded that the 18 inch elevated prevented gas-fueled water heater- flammable vapor fires because

- Flammable liquids were involved in 95% of garage fires in which a water heater was a contributing factor.
- Only 8% of the fires (5 of 60) involved water heaters which were elevated.
- Because gasoline storage and usage practices were assumed to be the same in all typical garages, it was determined that elevated water heaters provide protection from the ignition of flammable vapors.

The study did not attempt to determine or factor in the percentage of installed water heater base which was elevated. Without this information, the significance of the 5 elevated incidents cannot be assessed.

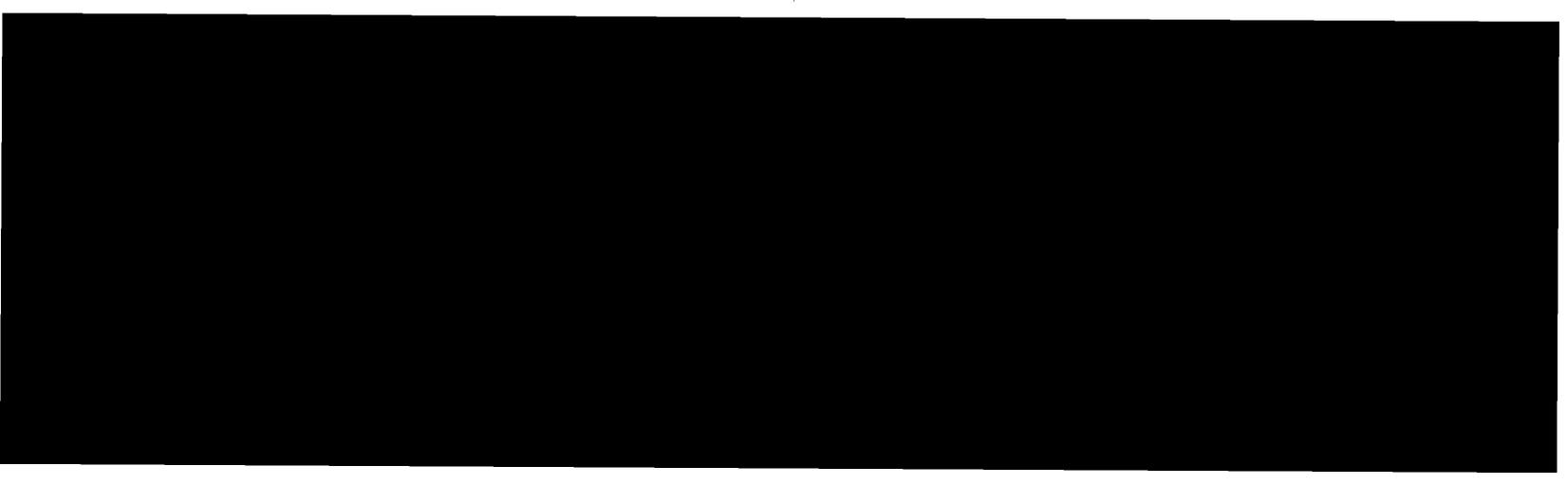
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The Calspan reports were sponsored by the Consumer Product Commission in 1974. The study focused on the adequacy of codes, from a safety perspective, for flame-fired appliances. findings from this study include:

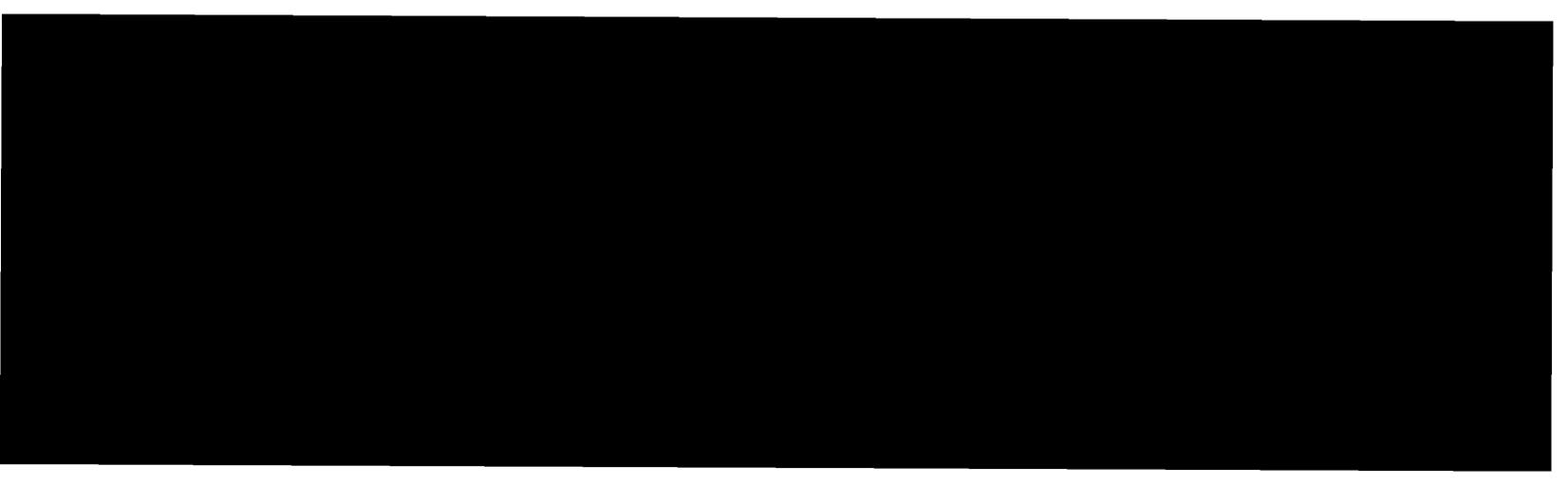
- "The most serious direct hazard of gas-fired water heaters is accumulated gas ignition" (pg. 97 of YG-5569-D3)
- For normally functioning appliances: "In terms of frequency of injury, the accidental ignition of vapors from flammable liquids is a number one hazard associated with the mere presence of the liquid considered in this study.²" The reference is a 1947 article in the Journal of Pathology.
- Recommendations for gas-fired water heaters include:
 - prohibition of other than direct vent units in garages
 - adoption of electric pilot
 - consideration of a flammable vapor concentration sensor
 - educate the public about the danger of using materials such as gasoline

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Gauthier and Murphy's report offers the 18" elevation as the presents excerpts of reports from several researches to sup solution.

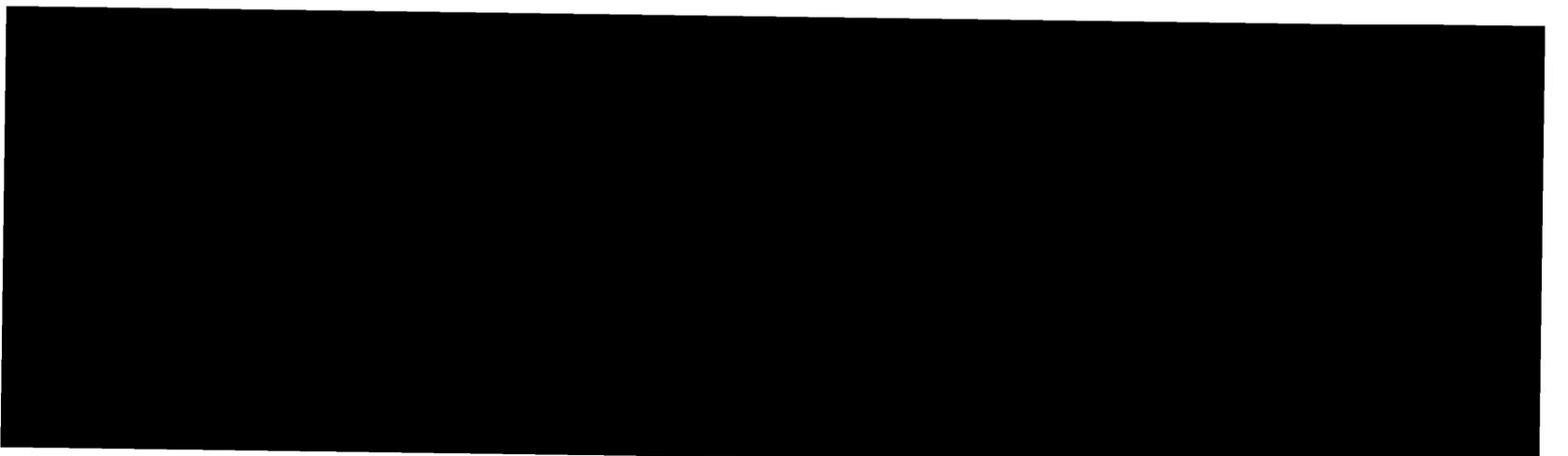
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Information obtained from the review of NFIRS data and detailed reports were integrated to develop composite scenarios which are "typical scenarios."

- NFIRS data that is provided for Heating Equipment Rooms, Rooms, Supply Storage Room, and Other Storage Areas was combined into a general "Utility Room" category.
- NFIRS data does not recognize the term basement in the context of intended use of the area is reported, such as storage area or equipment area. is used.
- NFIRS data is coded to include Lavatory, Locker Room and into a single entry. This data was synthesized into a general category.
- No kitchen scenario was developed because our detailed incident database did not contain enough incidents to form a conclusive typical kitchen scenario.

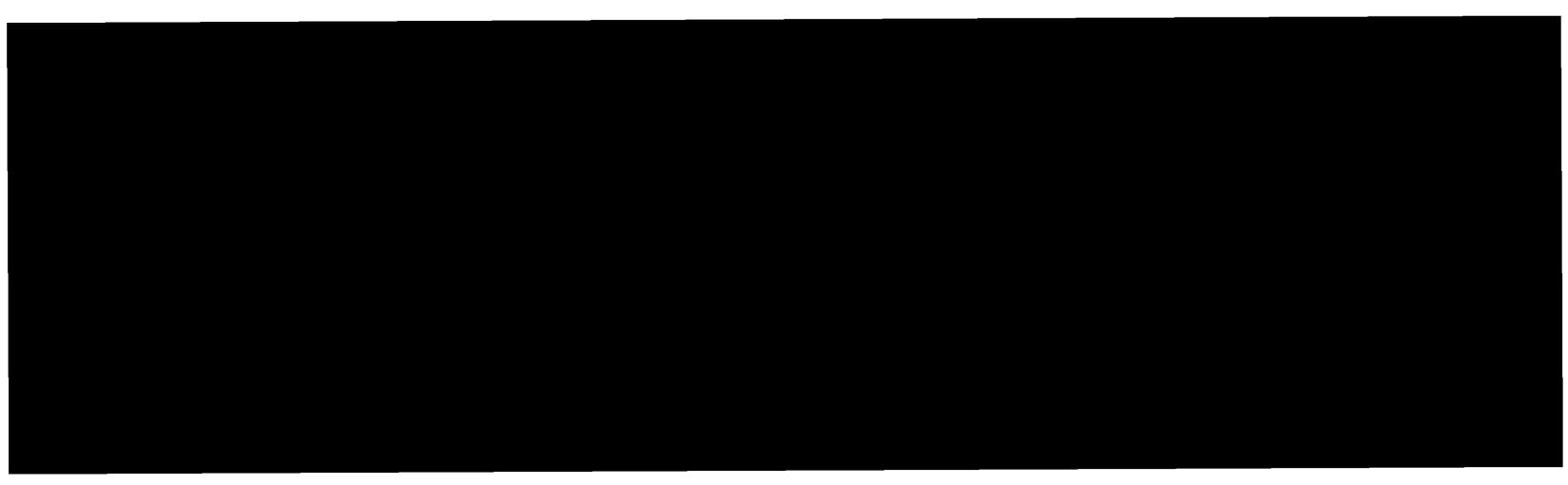
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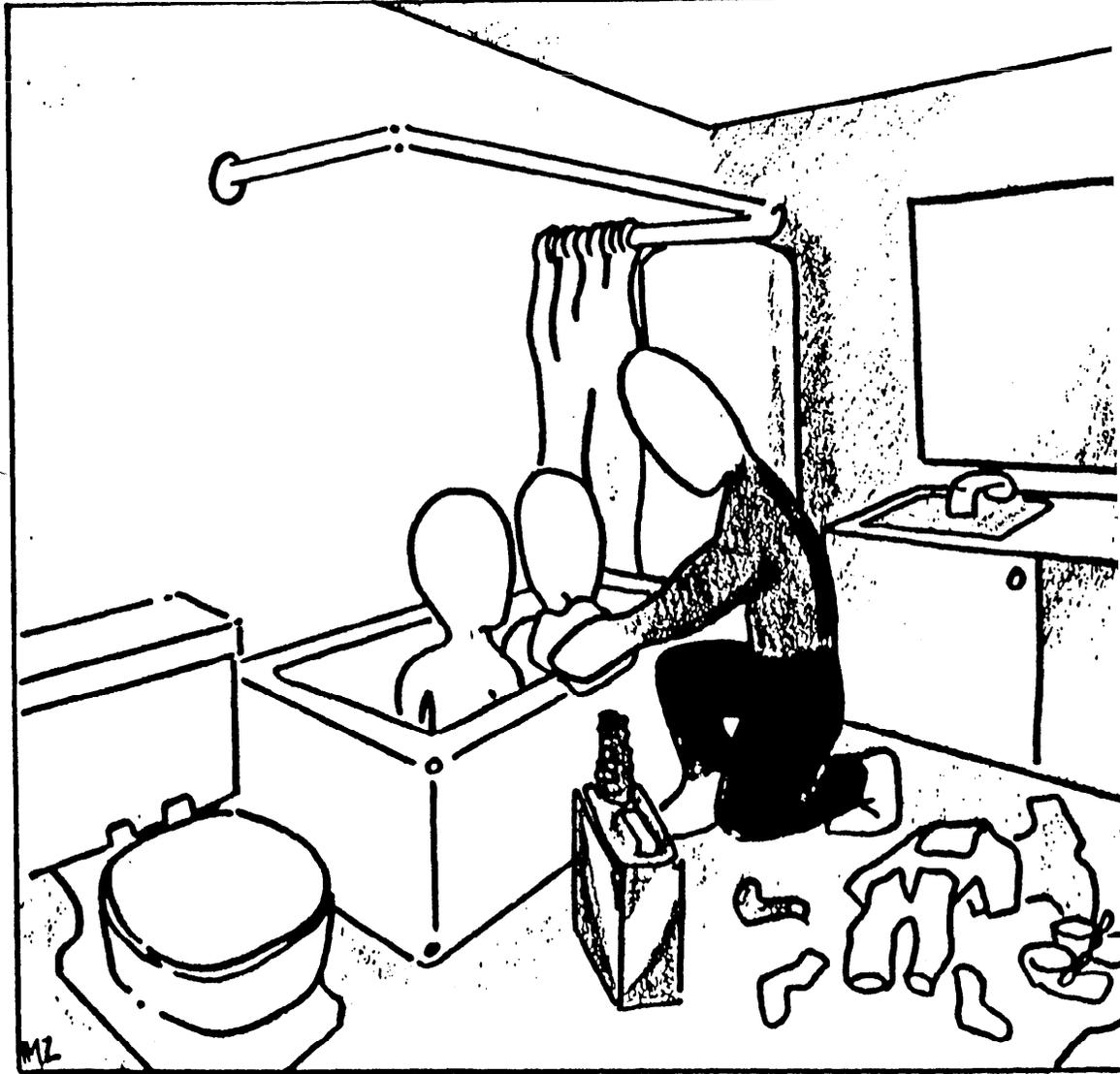
After review of the flammable vapor incident reports compiled from NFIRS, NFPA FIDO, CPSC NEISS and IDI data, seven representative scenarios have been developed.

- 1 Bathroom Scenario
- 2 Utility Room Scenarios
- 3 Garage and Basement Scenarios
- 1 Garage Scenario

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Bathroom Scenario



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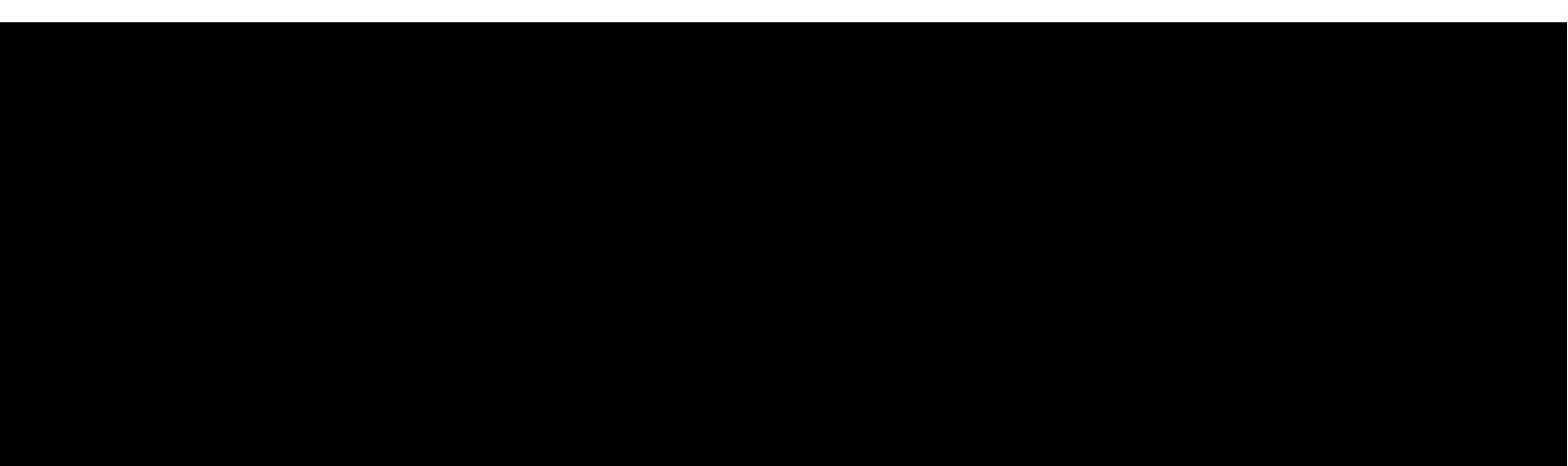
Bathroom Scenario: Although bathroom installation of fuel heaters is prohibited, flammable vapor ignition by water heaters in bathrooms do occur, and the injury ratio is more than twice

A common scenario involves a person becoming "soaked" with gasoline during some activity such as cleaning parts, car repair or fueling operation. The person goes to the bathroom and removes their clothing to take a shower. Upon exiting the tub, there is a flash fire.

A similar scenario involves children becoming covered in paint or grease brought into the bathroom to have the material removed using gasoline. Children are usually in the tub with a guardian using a gasoline solvent to clean them. In this case there is also water being used for rinsing.

Spillage of gasoline was not reported as a contributing factor in any of the reviewed cases.

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Bathroom Scenario

Location: Small bathroom, 10 ft x 7 ft x 8 ft

Features:

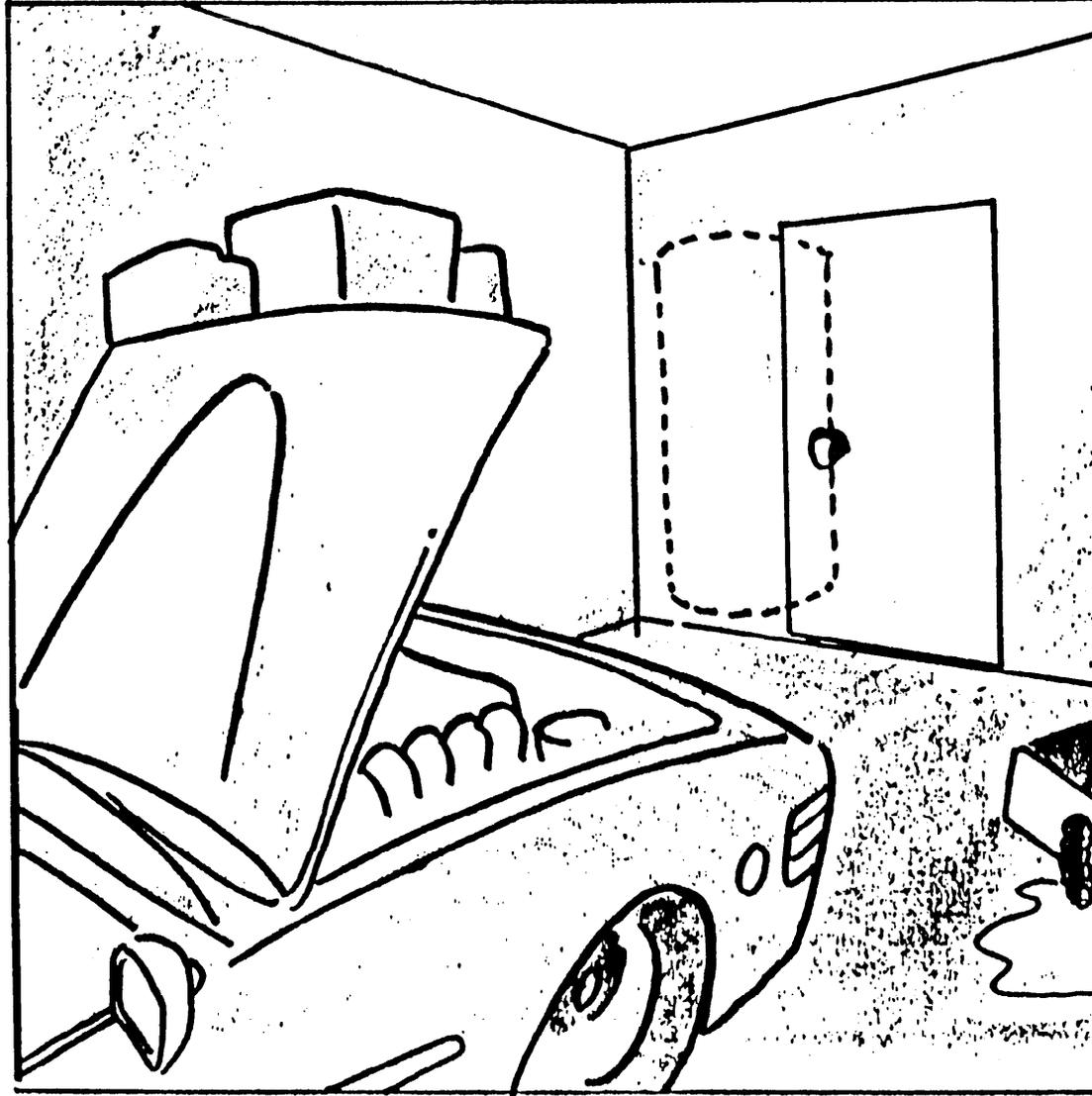
- Combination bathtub and shower unit
- Sink, Toilet, Window, 3ft x 4ft
- 30 gallon gas fired water heater, located in corner

Quantity: 1 gallon of gasoline in container

Source: Evaporation of liquid from clothing in center of room

Activity: 1 to 2 persons moving within the room. water heater

Utility Room Scenario 1: Spill outside of room

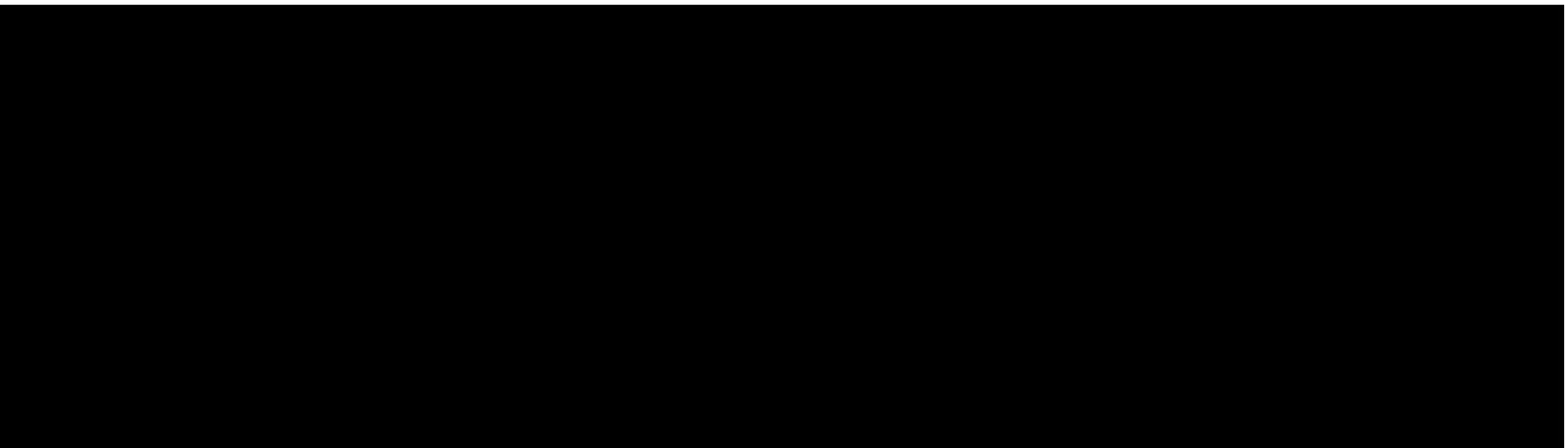


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Utility Room Scenario 1: Spill outside of room

A common scenario involves a person using gasoline outside of the utility room for some purpose such as cleaning or fueling. The fuel is either spilled on the ground or vapors from evaporation of the puddle or vapors from gasoline on the utility room water heater located on the utility room. There is no activity or operation of the water heater in the direct vicinity of the water heater. Possible operation of other equipment in the room at the time of the release.

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Utility Room Scenario 1: Spill outside of room

Location: Utility Room, 10 ft x 10 ft x 8 ft

Features:

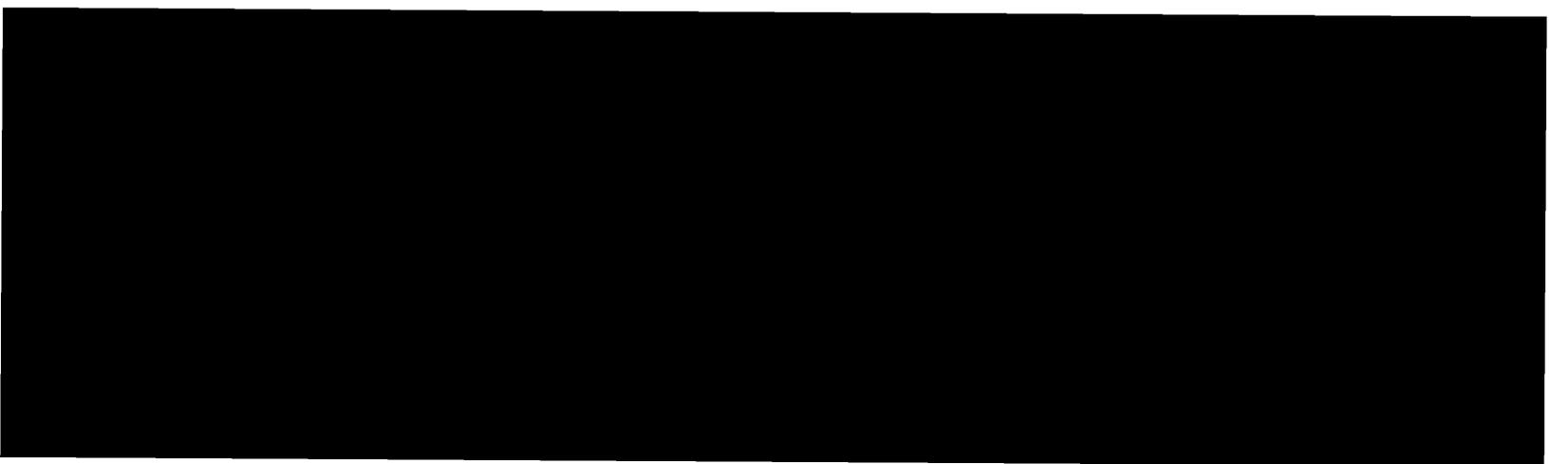
- Other appliances such as:
 - gas fired furnace
 - washer and dryer (electric or gas fired)
 - gasoline utilizing equipment such as lawn motorcycles
- 30 gallon gas fired water heater, located in co

Quantity: 1 gallon of gasoline in container

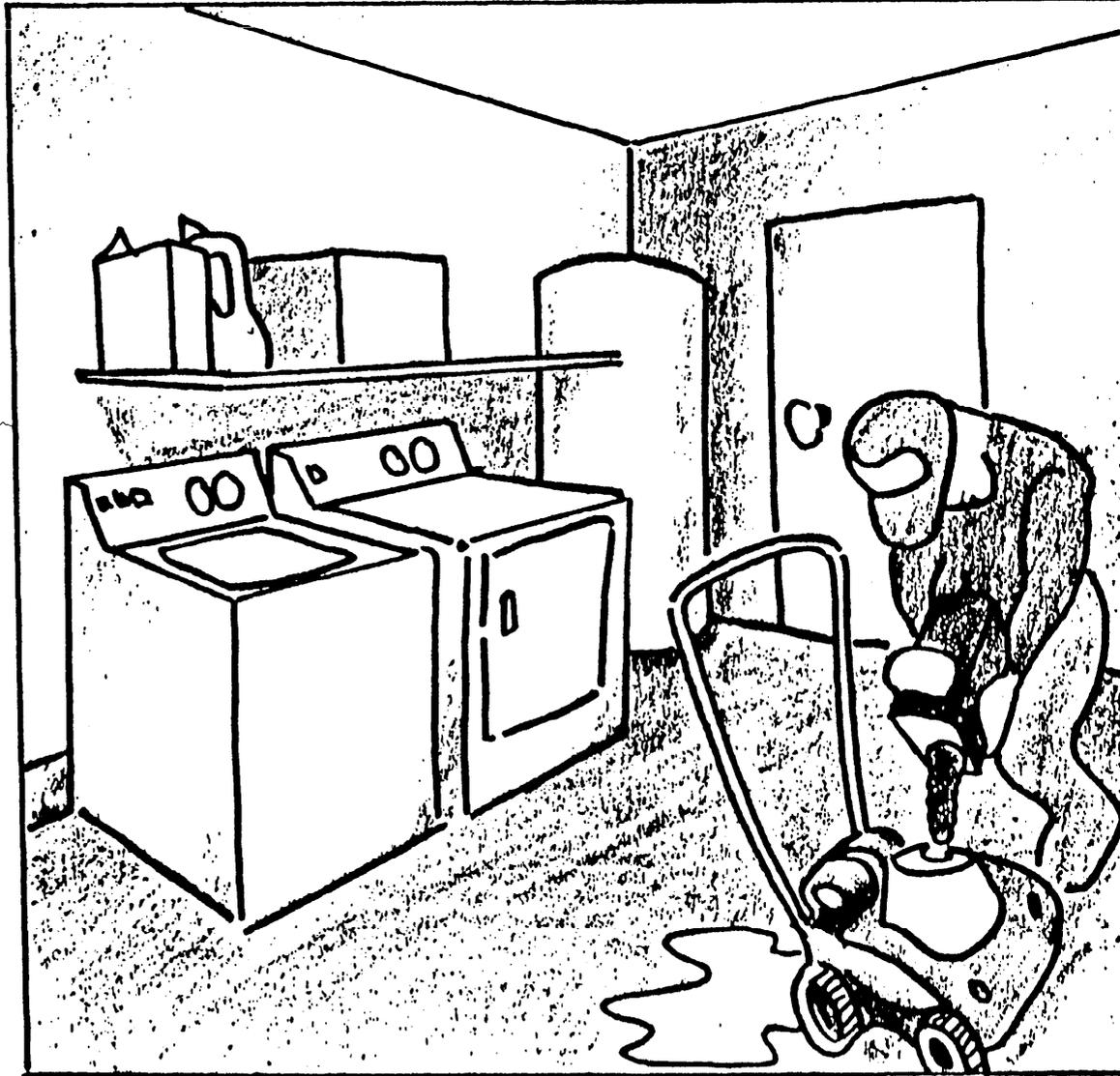
Source: Evaporation of liquid from use outside of utility room to the water heater

Activity: No activity or movement in the direct vicinity of the
– Possible operation of other equipment in the room of the release

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Utility Room Scenario 2: Spill inside of room



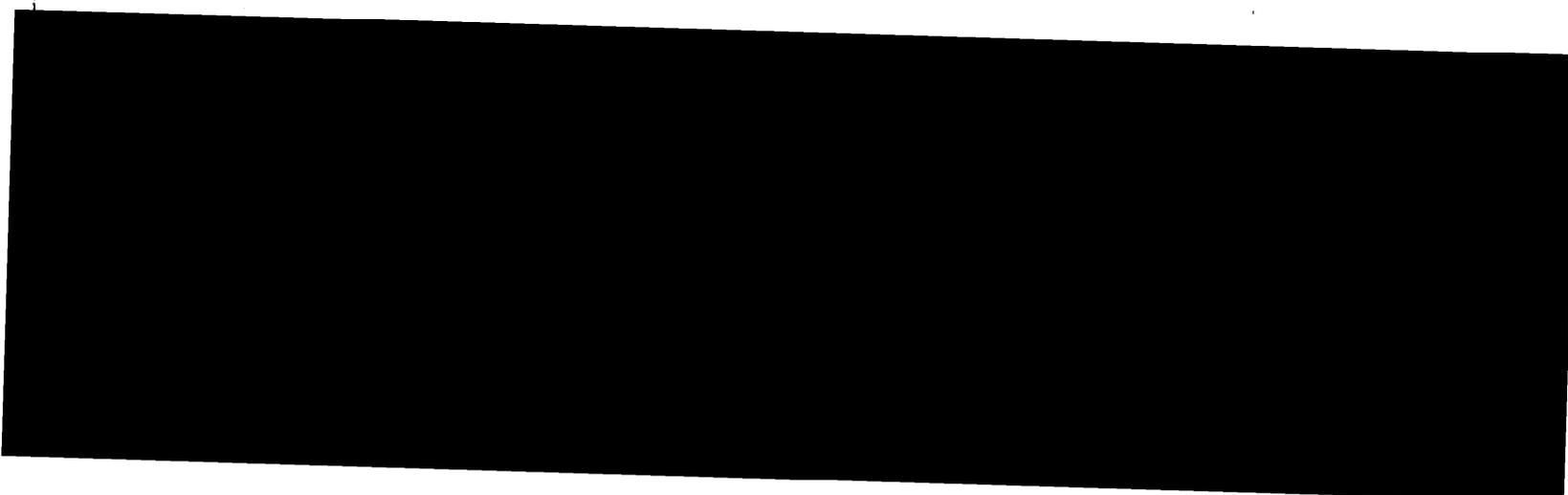
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Utility Room Scenario 2: Spill inside of room

A common scenario involves a person using gasoline inside of the room for some purpose such as cleaning or fueling. The fuel is either spilled or vapors from evaporation of the puddle or vapors from gasoline use of a water heater located in the utility room. There is activity or movement in the direct vicinity of the water heater. Possible operation of other equipment in the room at the time of the release.

A version of this scenario involves children playing in the utility room and spilling a large amount of gasoline (1-5 gallons) in the vicinity of the water heater.

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Utility Room Scenario 2: Spill inside of room

Location: Utility Room, 10 ft x 10 ft x 8 ft

Features:

- Other appliances such as:
 - gas fired furnace
 - washer and dryer (electric or gas fired)
 - gasoline utilizing equipment such as lawn mowers, motorcycles
- 30 gallon gas fired water heater, located in corner

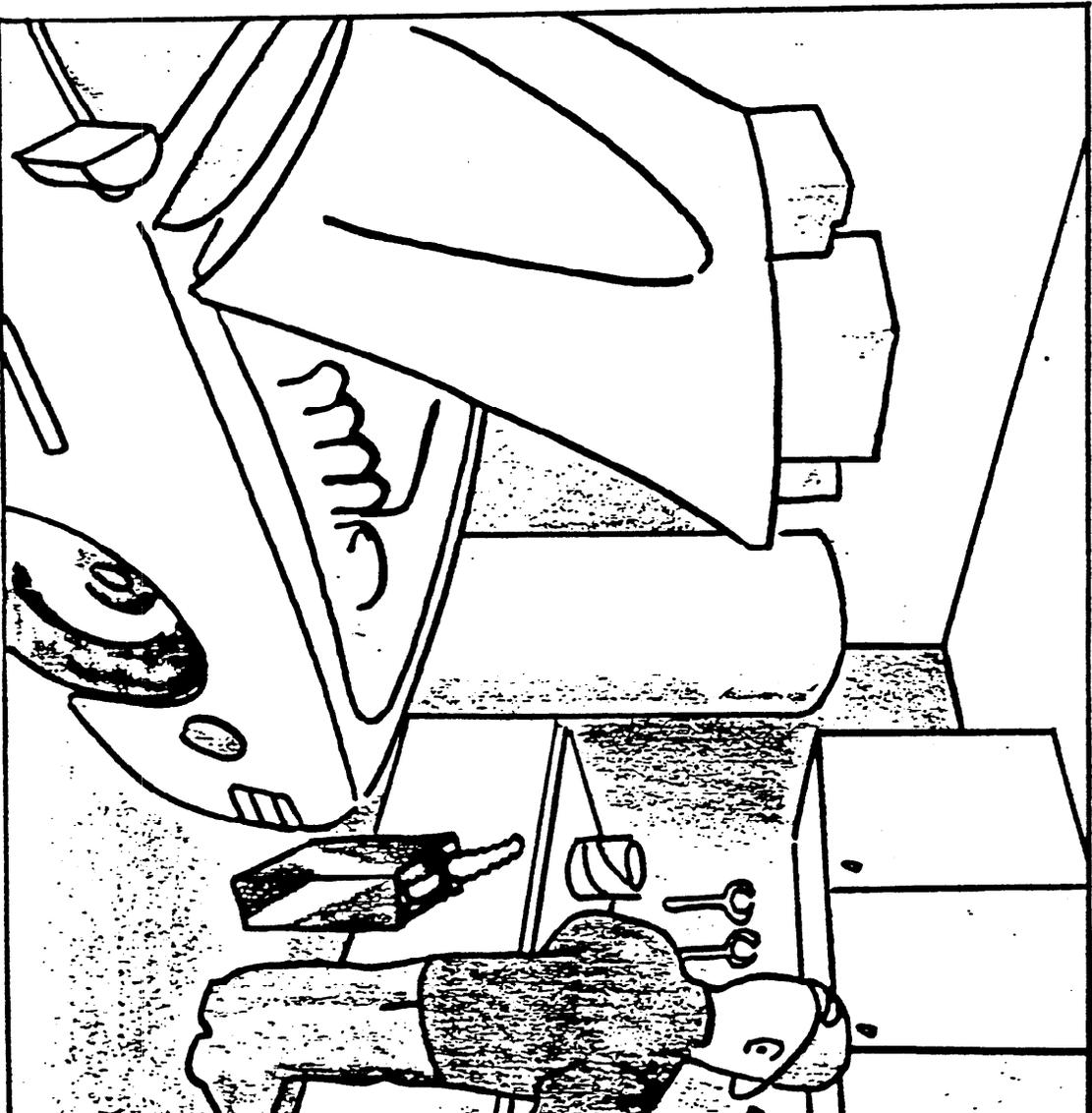
Quantity: 1-5 gallon of gasoline in container

Source: Spillage of gasoline in the room from accident, fueling

Activity: Activity or movement in the direct vicinity of the water heater
Possible operation of other equipment in the room at the time of the release.

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Garage and Basement Scenario 1: Gasoline Usage



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Garage and Basement Scenario 1: Gasoline Usage

A common scenario involves a person using gasoline inside a basement garage for some purpose such as parts cleaning, auto repair, cleaning removal stains/rubber backed carpet from the floor. The vapors from use travel to the water heater located in the vicinity. There is air movement in the direct vicinity of the water heater.

Only a small amount of gasoline used at any one time.

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