



United States
CONSUMER PRODUCT SAFETY COMMISSION
Washington, D.C. 20207

VOTE SHEET

DATE: JUN 8 1994

TO : The Commission
Sadye E. Dunn, Secretary

FROM : Eric A. Rubel, General Counsel *SLBawCPR*
Stephen Lemberg, Asst. General Counsel *SL*
Harleigh Ewell, Attorney, GCRA (Ext. 2217) *HE*

SUBJECT: Options for Gas-Fired Water Heaters Concerning
Ignition of Flammable Vapors

This vote sheet concerns the staff's briefing package on options for Commission action to address the risk that gas-fired water heaters will ignite vapors from flammable liquids that are present in the home. Please indicate your vote on the following options.

- I. ISSUE AN ADVANCE NOTICE OF PROPOSED RULEMAKING ("ANPR") (a draft ANPR is at Tab H of the briefing package). Please check the relevant option below.

- ___ 1. APPROVE THE DRAFT FEDERAL REGISTER NOTICE WITHOUT CHANGE.
- ___ 2. PUBLISH THE DRAFT FEDERAL REGISTER NOTICE WITH CHANGES (please specify).
- ___ 3. OTHER (please specify).

(Signature)

(Date)

- II. DEFER TO THE VOLUNTARY STANDARDS PROCESS (staff will encourage ANSI and GAMA to develop adequate voluntary standards).

(Signature)

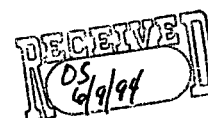
(Date)

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Enthal SD Date 6/8/94

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III. THE OFFICE OF COMPLIANCE AND ENFORCEMENT IS DIRECTED TO ANALYZE THE FEASIBILITY OF ACTION UNDER SECTION 15 OF THE CONSUMER PRODUCT SAFETY ACT.

(Signature)

(Date)

IV. TAKE OTHER ACTION (please specify).

(Signature)

(Date)

Comments/Instructions:

OPTIONS PACKAGE
FOR
GAS-FIRED WATER HEATERS
AND
IGNITION OF FLAMMABLE VAPORS

For Further Information Contact:

Joseph Z. Fandey
Directorate for Engineering
(301) 504-0508 ext. 1293

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Initial SD Date 6/8/94

Executive Summary

This memorandum presents options to address the risk of death and injury associated with gas-fired water heaters igniting flammable vapors. Gas water heaters, of traditional design, draw the air necessary for combustion from the bottom. When they are mounted on the floor that means that they draw their air from near the floor. When gasoline or other heavier-than-air flammable vapors are present, the vapors tend to layer near or on the floor and can be pulled into the flame, be ignited and cause fires.

Each year an estimated 1,961 such fires occur causing an estimated 316 injuries, 17 deaths and \$26 million in property damage, representing an annual estimated societal cost of \$344 million. The typical injury happens when a person is using gasoline for cleaning purposes or when gasoline is accidentally spilled in an area close to a gas water heater.

Two years ago, staff requested the American National Standards Institute (ANSI) Accredited Z-21 sub-committee on water heaters to begin development of a performance standard to reduce the risk of death and injury presented by water heaters igniting flammable vapors. Since that time the water heater industry, through their trade organization, the Gas Appliance Manufacturers Association (GAMA), has funded two studies and a consumer information program but has not moved toward developing a standard. The voluntary standards process has been delayed while these studies were in process and no progress is known to staff towards developing an adequate standard.

Staff has demonstrated that the flammable-vapor-ignition fires associated with water heaters can be virtually eliminated using simple engineering principles about relative vapor densities of air and gasoline and the ability of mechanical barriers to change fluid flow patterns. Staff believes that these principles can be applied to new water heaters with little difficulty or cost.

Options available to the Commission to address this hazard include:

1. Issue an advance notice of proposed rulemaking to develop a performance standard to reduce or eliminate the risk of death or injury from the ignition of flammable vapors.
2. Defer to the voluntary standards process.
3. Pursue action under section 15 of the CPSA.

Staff recommends option 1, that the Commission publish an advance notice of proposed rulemaking to develop performance requirements for new gas-fired water heaters to address the risk of death and injury from the ignition of flammable vapors.

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United States
CONSUMER PRODUCT SAFETY COMMISSION
Washington, D.C. 20207

05#5595

MEMORANDUM

DATE: JUN 8 1994

TO : The Commission
: Sadye E. Dunn, Secretary

THROUGH : Eric A. Rubel, General Counsel *off for EAR*
: Bert Cottine, Executive Director *[Signature]*

FROM : Ronald L. Medford, Acting Assistant Executive Director *RLM*
for Hazard Identification and Reduction
: Joseph Fandey, Project Manager for Fire and Gas Voluntary
Standards, ESEE (504-0508 ext. 1293)

SUBJECT : Options Paper re: Hazards associated with gas-fired
water heaters igniting flammable vapors.

Purpose: To present options for the reduction of flammable vapor ignition hazards and resulting injuries and deaths.

Background:

Staff has been concerned with gas-fired water heaters igniting flammable vapors for several years. Deaths and injuries occur when flammable vapors, most often from spilled gasoline, are pulled into the water heater flame. Water heaters, of traditional design, draw air necessary for combustion from the bottom. When gasoline or other heavier-than-air flammable vapors are present they tend to layer near or on the floor and can be pulled into the flame where they can be ignited and cause fires.

Until the spring of 1991 staff had considered that the solution was one of changing consumer behavior to cause consumers to not use or store gasoline or other flammable vapors in the house.

In the spring of 1991 this approach changed when the staff realized that a mechanical fix (bringing combustion air into the appliance from 18 inches above the floor) could reduce or eliminate the risk of injury associated with water heater ignition of flammable vapors. The

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information that changed the staff's approach was presented to the American National Standards Institute (ANSI) Z-21 Accredited Water Heater Subcommittee in November 1991. In March of 1992, staff formally requested that the ANSI subcommittee develop a performance standard designed to protect against flammable vapor ignition. (Tab A) The industry did not respond by undertaking standard development. Instead the Gas Appliance Manufacturers Association (GAMA) began to study the problem, ostensibly to determine whether there were geographic differences in injury rates. A study was also funded by GAMA to determine whether an 18 inch stand would prevent all ignitions of flammable vapors. When some fires were started, albeit in extreme conditions, the industry concluded that not all fires would be prevented and thereafter declined to consider elevating water heaters.

Instead of developing a product standard, as staff had requested, GAMA developed a consumer education program. The program is of excellent quality and the Commission has acknowledged this effort and voted to allow the use of the CPSC name and logo on certain publications and video tapes contained therein. However, the education program is not a "fix" for the problem, it is merely a means of informing consumers of the potential hazard.

Death and Injury Data:

CPSC Data:

The Directorate for Epidemiology presents 5-year fire, death, injury, and property damage averages for the period 1986-1991. (TAB B) Gas-fueled water heaters igniting flammable liquids are identified annually in only 20% or 1,961 estimated annual fires associated with water heaters, but they account for 54% of the injuries (316), 44% of the of the deaths (17) and 30% of the property losses (\$26,339,000).

Typical injury scenarios fell into three categories; children playing with or near gasoline, gasoline being used as a solvent, or other gasoline spill or leak.

Other Data:

GAMA sponsored work done by A.D. Little Laboratories (included in the supplemental materials available in the Office of the Secretary) examined several data bases including CPSC's and identified scenarios related to the bathroom, utility room, and a combination garage and basement.

basement.

No current building code allows water heaters to be installed in bathrooms; nevertheless, many such installations exist. The two scenarios identified included people becoming "soaked" during activity such as cleaning parts, car repair or fueling operations. When such a person enters the bathroom where a water heater is installed, the vapors fall like water from the clothing and an ignition occurs. The other bathroom scenario involved children becoming covered in paint or a petroleum product and being brought into the bathroom and placed in the bathtub to have the material removed using gasoline as a solvent.

The utility room was associated with two scenarios. One, with a spill outside the room containing the water heater such as in an adjoining garage. The other scenario involved a spill within the room. In these accidents, some activity such as playing, fueling, or other use is often involved.

The garage and basement accidents again involve storage and associated spills, use of gasoline as a solvent, refueling and activities of children. The A.D. Little report indicates that of a data base of 135 incidents involving ignition of flammable vapors by residential gas water heaters, only 27 were known to have occurred in a garage. While 31 of the incidents did not specify the room location, the report's analysis showed that, in incidents where the room location was specified, the garage was involved in 10 of 27 deaths, 5 of 33 injuries and 2 of 11 incidents in which there were both deaths and injuries.

Applicable Codes and Standards:

Staff is aware of two standards which impact ignition of flammable vapors:

- The National Fuel Gas Code, NFPA 54/ANSI Z-223.1 which requires that water heaters installed in residential garages have all burners and burner ignition devices located not less than 18 inches above the floor. §5.1.9. In addition at §5.1.8 there is a requirement that "gas appliances shall not be installed in any location where flammable vapors are likely to be present, unless the design, operation, and installation are such to eliminate the probable ignition of the flammable vapors."

- The ANSI Gas Water Heater Standard, ANSI Z21.10.1 requires a label warning of the risk of injury associated with ignition of flammable vapors.

Staff has noted that the NFPA 54 requirements for garage installations have recently been incorporated into all model building codes. Staff notes that adoption by the model building codes does not guarantee that the provisions will be incorporated into local building ordinances, where compliance is enforced. Even if local jurisdictions adopt these provisions, garages apparently represent only a portion of the problem. Staff also notes that even if all new construction of houses and commercial replacements of existing residential water heaters followed the practice of elevating water heaters in the garage, there is a large portion of the incidents that would not be addressed. Staff believes that there has been very poor adherence over the years (since 1959) that the requirement has been in the National Fuel Gas Code. Moreover, staff believes that the provisions for other than garage installations are virtually never enforced for residential installations.

Additionally, the Division of Human Factors notes that the label is likely to have limited effectiveness and is unlikely to be thought about during activities unrelated to the water heater like lawn mower filling, or other gasoline usages such as for cleaning purposes, even if the label has been read.

Engineering:

Feasibility of a Performance Standard: Work at the Engineering Sciences Laboratory (ESEL) and at the American Gas Association Laboratory, by A.D. Little, demonstrated that when a gas water heater is installed on the floor, one half gallon of spilled gasoline caused dangerous levels of vapor in the area of the water heater burner. Engineering Laboratory work demonstrated that even minor elevation of the water heater (6 inches) significantly reduced the vapor levels reached. At the full 18 inch elevation, good protection was observed. The A.D. Little work also demonstrated greatly improved performance by elevation, but the work was extended to demonstrate that two gallons spilled with a lot of air turbulence forcing the vapors into the water heater could result in conditions where fires were possible.

Not every installation provides enough space above the water heater to allow elevation and proper venting for standard water heaters. To

address this problem, ESEL tested the water heaters on the floor with a 14 inch high sheet-metal barrier sealed to the floor. Even a one gallon spill 18 inches from the center-line of the water heater (so close that without the barrier, the gasoline ran under it) resulted in levels of flammable vapors below those considered unsafe. When these results were shared with the industry, the most important questions raised were about the effect of the barrier on the combustion characteristics of the water heater (to see whether unsafe levels of CO would be released). To answer this question, ESEL tested the water heater with and without the barrier. The results in combustion characteristics were indistinguishable. Staff believes that the combined work by CPSC and A.D. Little demonstrate that new water heaters can be made much safer. The effect of a barrier such as that used by ESEL can be built into a new water heater.

Feasibility of a Retrofit Method: Engineering has demonstrated the feasibility of developing a method to retrofit water heaters already installed in residences. (Tab C) The method used by Engineering was very simple, a piece of sheet metal (roof flashing) 14 inches by 6 feet was taped together using duct tape to form a circle slightly larger than the water heater's circumference and was then taped to the floor. This action forced all air for combustion to be drawn over the 14 inch barrier created. As a result, very little air was drawn from near the floor. This performance can also be incorporated into new water heaters without restricting design options. In order to assist in the retrofit work staff was undertaking, GAMA supplied water heaters which had been tested by the Department of Energy for fuel efficiency. Five water heaters were received at the ESEL and were properly fueled and run to determine the normal exhaust gas velocities that were produced at the top of each water heater. (Tab C) A "typical" water heater was then fitted with a small fan, which was adjusted to produce the same exhaust gas velocity and thereby safely simulate the gas flow which is produced by the burner's fire in normal operation. Using the fan instead of a burning unit allowed the tests to be conducted with gasoline while minimizing potential risk to laboratory personnel. The unit was transported to the National Institute of Science and Technology (NIST), where it was installed in a fire test facility with the fan used to simulate normal operation. Several experiments were conducted where gasoline was spilled on the floor near the water heater (18 inches from its center). Gasoline vapor concentrations in the air were measured at several locations,

most importantly at the burner. The results were that the barrier provided significant protection against flammable vapor ignition.

Industry Activities:

The staff's greatest concern is an apparent unwillingness on the part of the water heater manufacturers to take a serious look at the potential deficiencies (of taking combustion air from near the floor) in the current design of water heaters.

As noted above, the water heater manufacturers, through GAMA, have elected to emphasize consumer education over product improvements which could reduce or eliminate the risk of flammable vapor ignition. While staff believes that GAMA's efforts in the consumer education area are commendable, staff has repeatedly noted that it is not a complete solution. In the January 19, 1994 briefing package in which staff recommended that the Commission grant permission to GAMA to use the CPSC name and logo on certain consumer information materials, staff stated that "Staff considers that this [consumer information campaign] is an important and significant contribution to reducing the death and injury incidents which involve flammable vapors around the home. *However, staff believes that the program will be only partially effective unless combined with technical solutions*" [emphasis added]. (Tab D) The Division of Human Factors had voiced a similar concern regarding labeling. Human Factors stressed that prominent warning labels are necessary, but also noted that "A warning label is not an acceptable substitute..." (Tab E). The Chairman of the ANSI Z-21 Committee received a letter from Factory Mutual Research, and shared that letter with CPSC staff. (Tab F). Therein, Factory Mutual expressed the same concerns about the industry approach of only initiating a consumer information campaign. "If it is easy to handle the flammable liquid indoors, it will be done by some individuals, no matter how many warning labels or education programs to which they are exposed . . . Thus, the hazard [vapors in the home] cannot be eliminated. Therefore, it must be mitigated." Factory Mutual describes the approach taken by the industry as ". . . a public relations response to a technical hazard. Or as the computer-oriented would say, we are trying to solve a hardware problem with a software solution."

Economic Analysis:

Market Information: Based on Department of Energy data, the

Directorate for Economic Analysis (EC) indicates (Tab G) that there are between 40 and 50 million homes in the U.S. that have gas water heaters. Current sales are about 3.5 million units annually, according to the American Gas Association, and replacement rates (between the 4th and 18th year of use, according to *Appliance Magazine*) suggest that an additional 10 million units may be in use by the end of this decade. The five manufacturers that dominate the gas water heater market account for an estimated 99% of production.

Cost/Benefit Data: The total estimated societal costs associated with incidents involving gas water heaters and the ignition of flammable vapors are \$344 million. These costs include deaths, injuries, and property damage. EC estimates that it would be cost-effective to spend from \$59 to \$74 per water heater for modifications that would eliminate virtually all incidents involving the ignition of flammable vapors.

Options:

1. Issue an advance notice of proposed rulemaking to develop a performance standard to reduce or eliminate the risk of death or injury from the ignition of flammable vapors.
2. Defer to the voluntary standards process and encourage ANSI and GAMA to proceed with developing adequate provisions for reducing or eliminating the risk of injury associated with gas water heaters igniting flammable vapors.
3. Pursue action under section 15 of the CPSA.

Recommendation:

There are significant numbers of severe injuries and deaths occurring from gas water heaters igniting flammable vapors that could be cost-effectively prevented by establishing a performance standard which would be adhered to in the manufacture and certification of gas water heaters. Staff notes that even though a request was made 2 years ago, no standard development work has been undertaken by the committee charged with such development. Therefore, staff recommends that the Commission exercise option 1 for new water heaters. Available information indicates that it is technically feasible to develop performance requirements to address this hazard. A draft ANPR appears at Tab H for Commission consideration.



U.S. CONSUMER PRODUCT SAFETY COMMISSION

WASHINGTON, D.C. 20207

March 6, 1992

Allan J. Callahan
Manager, Standards Department
American Gas Association Laboratories
8501 E. Pleasant Valley Road
Cleveland, OH 44131

Dear Mr. Callahan:

Enclosed, for use by you and the Water Heater Subcommittee's working group on flammable vapor ignition, is a position paper from the staff of the CPSC on the subject of the need for standards for preventing such ignition from water heaters.

It is the position of the staff that ignition performance equal to or exceeding that achieved when a "standard" water heater is tested in an essentially draft free room at an elevation of approximately 18 inches (or another value which testing demonstrates to be needed) is a desirable goal. We would suggest that any standard developed be expressed in performance terms to eliminate any unessential design restriction.

The staff recognizes that the committee must consider only safety when making its decisions; nevertheless, the staff examined the benefits of preventing the deaths and injuries associated with the ignition of flammable vapors by water heaters. Staff estimates that net benefits would accrue to the consumer if the cost to implement any design changes was less than about \$40 to \$60.

Staff plans to participate fully with the working group and subcommittee in the examination of these issues and the development of test requirements and standards.

The views expressed in this letter (with enclosures) are those of the technical staff and not necessarily the official position of the Commission.

Sincerely,

Joseph Z. Fandey
Project Manager,
Gas Voluntary Standards

Enclosure

CPSC Working Group on Gas
Voluntary Standards

Position Paper On A
Standard for Gas Water Heaters
To Prevent Ignition of
Flammable Vapors

FEBRUARY 1992

FLAMMABLE VAPOR IGNITION BY GAS WATER HEATERS

BACKGROUND:

On April 4th, 1991, CPSC staff met with Edward Downing, an attorney practicing in Louisiana. At that meeting Mr. Downing presented injury information indicating that about 360 injuries, 20 deaths and \$16,000,000 in property loss were occurring annually from the ignition of flammable vapors by gas water heaters. These estimates mirrored CPSC's own data and were consistent with a 1975 study done for CPSC by Calspan. While staff was concerned with this problem over the years it accepted the position of the industry (as the industry recently reiterated in a meeting with staff) that the problem was not amenable to design fixes but was a result of a lack of consumer awareness of the hazard and knowledge of proper storage and handling of flammable vapors. Mr. Downing's presentation also included videotaped demonstrations of two design fixes which, under the conditions of the test, eliminated the ignition hazard. As a result of that presentation and a subsequent staff review of all available data, CPSC staff revised its plan to include encouraging the ANSI Z-21 subcommittee on Water Heaters to develop performance standards to reduce or eliminate the degree of hazard associated with currently produced (non-sealed combustion) water heaters installed at floor level.

On November 13th, 1991, Mr. Downing made a similar presentation before the ANSI Z-21 Water Heater subcommittee. In subsequent discussions the subcommittee made a commitment to form a working group to study the issue and work toward a performance standard. In support of that effort CPSC staff is providing the following information.

DISCUSSION:

Injury Update -- The most recent information available from the U.S. Fire Administration reports that there were an estimated 380 injuries, 30 deaths, and \$50.6 million in property loss associated with gas-fired water heaters in 1989. Twelve of the 30 deaths were associated with flammable vapors as were 75 percent of the injuries. A more complete discussion of this information is provided at Tab A.

Benefits Associated with the Prevention of Deaths, Injuries, and Property Damage - Using the annual average numbers of deaths and injuries associated with flammable vapor ignition by water heaters, the Directorate for Economic Analysis estimated the benefit which could

be achieved by eliminating this hazard (Tab B).

The estimation of the benefits considered the severity of burns the most frequently seen injury associated with this scenario. It also considered that three-fourths of current annual water heater production, estimated at 3.9 million units, is for replacement and one-fourth for new construction. Finally, the estimates considered that, if the entire production of gas water heater installations could be affected, and if the changes were fully effective injury reduction could accumulate at the rate of up to two deaths, 30 injuries and \$1.2 million in property damage each year. The estimated benefit expected per household could total \$40-\$60 over the expected 11-year life of the gas-fired water heater.

Effectiveness of labeling - The Human Factors Division has examined the possible effectiveness of labeling for preventing these injuries and concludes, at Tab C, that a warning label is not the solution to the hazard and should not be used as a substitute for a design change. However, because raising the water heaters will not eliminate the potential for the ignition of flammable vapors, consumers are still at risk and need to be warned of the potential hazard.

CONCLUSION:

CPSC staff believes that it is technically feasible to reduce the hazards associated with flammable vapor ignition by water heaters. Mr. Downing suggested that an appropriate height is already in the NFPA standard for installation of water heaters in garages, 18 inches. However, whether an 18 inch height or its equivalent is necessary or even sufficient has not yet been determined. The CPSC staff therefore recommends that the subcommittee's working group examine various heights and make a determination of the actual performance requirement necessary to reduce or eliminate the existing hazard. Subsequently, it will be necessary to devise a test method whereby non-height related fixes can be evaluated and certified.

UNITED STATES GOVERNMENT
MEMORANDUM

U.S. CONSUMER PRODUCT
SAFETY COMMISSION
WASHINGTON D.C. 20207

DEC 18 1991

TO : Joseph Z. Fandey, Manager, Gas Voluntary Standards
Project

Through: Robert D. Verhalen, Associate Executive Director
Directorate for Epidemiology
Robert E. Frye, Director, EPHA *RF*

WR
FROM : William Rowe, EPHA, 492-6470

SUBJECT: Fires from Gasoline Ignited by Gas Water Heaters

An estimated three-fourths of the reported deaths and injuries, and over half of the property losses from flammable vapor fires ignited by water heaters involve gasoline vapor and gas water heaters (see the attached table). The data included in this table are for 1989, the most recent year that is available from the U.S. Fire Administration's National Fire Incident Reporting System (NFIRS). In 1989, there were an estimated 30 deaths, 380 injuries, and \$50.6 million in property loss due to gas fired water heaters. The attached table shows an estimated 12 of the 30 deaths were due to flammable vapors (nine gasoline and three other vapors). About 75 percent of the injuries were related to gasoline vapors.

From October 1975 to November 1991 the Consumer Product Safety Commission (CPSC) conducted 41 in-depth investigations (IDI) involving the ignition of flammable vapors by gas water heaters. Only four of the 41 cases contain information on the height of the air intake. Among them, the highest air intake was estimated as 12 inches above the floor.

Discussion:

The hazard of gasoline vapor ignition by water heaters has often been seen as addressable through increasing consumer awareness of fire hazards associated with gasoline and improving gasoline storage containers. Raising the gas water heater air intake 18 inches above the floor through a voluntary standards effort should be encouraged to prevent gasoline vapor ignition by

gas water heaters. The pilot light and burner assembly of gas water heaters are at the bottom, and heaters are usually installed on or very close to the floor. Heavy flammable vapors, typically gasoline, stay close to the floor. If gasoline is spilled in the same room as a gas water heater the vapors can easily be drawn into the water heater and ignited. The hazard is very well demonstrated in a video tape shown to the staff in April 1991.

Attachment:

**Estimated Fire Deaths, Injuries, and Property Loss from
Flammable Vapors Ignited by Water Heaters, 1989**

Estimated Fire Deaths

Type of Water Heater	Total		Gasoline		Other	
	No	%	No	%	No	%
Total	12	100	9	75	3	25
Gas Fuel	12	100	9	75	3	25
Other Fuel	0	-	0	-	0	-

Estimated Fire Injuries

Type of Water Heater	Total		Gasoline		Other	
	No	%	No	%	No	%
Total	374	100	281	75	93	25
Gas Fuel	349	93	272	73	77	20
Other Fuel	26	7	9	2	16	4

Estimated Property Loss (in Thousands)

Type of Water Heater	Total		Gasoline		Other	
	No	%	No	%	No	%
Total	\$19,400	100	\$14,300	73	\$5,170	27
Gas Fuel	\$15,700	81	\$12,500	64	\$3,200	17
Other Fuel	\$3,700	19	\$1,800	9	\$1,900	10

**Source: U.S. Consumer Product Safety Commission/EPHA from data
obtained from the National Fire Protection Association
and the U.S. Fire Administration**

UNITED STATES GOVERNMENT

MEMORANDUM

U.S. CONSUMER PRODUCT
SAFETY COMMISSION
WASHINGTON, D.C. 20207

8 JAN 1992

TO: Joseph Z. Fandey, ESEE, Project Manager, Gas Voluntary
Standards
Through: William W. Walton, AED, ES ^{W3}
Through: Warren J. Prunella, AED, EC ^{WJP}
FROM: Elizabeth W. Leland, ECPA, 504-0962 ^{EL2}
SUBJECT: Benefits of Preventing Accidents Associated with
Flammable Vapor Ignition by Gas-Fired Water Heaters

Every year, an estimated 20 deaths, 360 injuries, and \$15 million in property damage are associated with fires that start when flammable vapors are ignited by gas water heaters. The burn injuries from these fires are severe and require major long-term medical treatment.

A proposal to the building codes and standards to change the design or location of water heaters potentially could eliminate the risk of these accidents, and up to two deaths, 30 injuries, and \$1.2 million in property damage could be avoided each year. The estimated expected benefits per household over the life of the product could total from about \$40 to about \$60.

I. Introduction

This memorandum provides information about the benefits of preventing accidents associated with the ignition of flammable vapors by gas-fired water heaters. The injury and property damage information is based on data from the National Fire Protection Association (NFPA) and the U.S. Fire Administration (USFA). Industry sources provided information about the severity of the injuries, the costs associated with hospitalization, medical treatment, and lost wages, and the dollar amounts of related jury verdicts and legal settlements. Information about the market for water heaters was obtained from the trade press.

II. Background

In some homes, flammable liquids, such as gasoline, household solvents, and paint thinners, are stored in the same location as the household's gas-fired water heater. Gas-fired water heaters operate by taking in room air about two inches from the floor and passing it over a pilot flame; it is possible that

vapors from flammable liquids can be taken in with the room air, especially when the flammable liquid has been spilled or left exposed to the air. When this happens, the vapors can be ignited and a fire or explosion can occur.

In 1980, the American National Standards Institute (ANSI) adopted into its Z223.1 standard a requirement that gas utilization equipment, including water heaters, should not be installed in any location where flammable vapors likely would be present unless the design, operation, and installation of the water heater was such that the probable ignition of the vapors would be eliminated. The National Fuel Gas Code similarly states that the burners and burner ignition devices of gas utilization equipment that is installed in residential garages should be at least 18 inches above the floor. The CPSC staff is considering submitting to the National Fuel Gas Code a proposal to extend this requirement to the entire residence and a proposal to ANSI to change the voluntary standard for water heaters to provide similar protection.

III. Number and Severity of Injuries

There are two readily-available sources of information concerning the number of injuries and deaths associated with the ignition of flammable vapors by gas-fired water heaters. A report prepared by the NFPA in 1987 for a law firm in Metairie, Louisiana, discussed the origin during 1980-1984 of residential structural fires involving flammable and combustible liquids.(1) According to this report, 2,034 fires, 21 deaths, 361 injuries, and \$16 million in direct property damage occurred each year during that period as a result of ignition of flammable vapors by gas-fired water heaters.(2)

The other source of information is an estimate provided by the CPSC Directorate for Epidemiology based on data from the NFPA and the USFA. According to the Directorate for Epidemiology, 12 deaths, 374 injuries, and \$19 million in property damage occurred in 1989, the most recent year for which data are available.(3) This estimate includes deaths, injuries, and property damage associated with the ignition of flammable vapors by gas-fired water heaters.

The predominant injury associated with these fires is a burn. Information about the severity of the burns resulting from these types of accidents consists of documents from 15 legal cases in which the Metairie, Louisiana law firm represented plaintiffs.(4) Correspondence from the law firm indicates that in those 15 cases the burns were mostly second and third-degree and covered from 17 to 100 percent of the body.

Of the 15 people who were injured, one suffered burns to 17 percent of his body, four suffered burns to 30 to 50 percent of their bodies, five suffered burns to 50 to 90 percent of their bodies, and four suffered burns to 90 percent or more of their

bodies. The ages of the injured ranged from 14 months to 37 years old. Eleven of the 15 victims were children under the age of five years, one was a seven-year-old child, and three were persons over 30 years old.

IV. Cost of Injuries

According to a report prepared for Congress,

"a severe burn is considered by many to be the most devastating injury a person can survive. Numerous studies of severely burned patients point to the deep and complicated emotional reactions that accompany burns. Facial disfigurement caused by a severe burn potentially alters consciousness more drastically and creates more serious emotional problems than other forms of disability because the face represents oneself, one's essential being, more than any other part of the body. (6)

Burn victims must confront not only medical costs, but also lost wages as a result of time away from work and emotional costs associated with changes in personal relationships. Information concerning the total dollar value of the costs for burns resulting from accidents involving the ignition of flammable vapors by gas-fired water heaters is not readily available; however, there is some information from three cases litigated by the Metairie, Louisiana, law firm which indicates that the present value of lost wages alone approximated \$700,000. (7)

Additional information from Personal Injury Valuation Handbooks about three other cases involving the types of burns suffered by the individuals involved in these accidents indicates that the jury verdicts in each case were \$2 million, \$3 million, and \$10 million. (8) In addition, a 1988 study of burn injuries and verdicts for a five-year period indicated that 22 percent of the awards ranged from \$100,000 to \$299,000 and 35 percent of the awards were \$1 million or more. (9) Information from the cases litigated by the Louisiana law firm indicate that one settlement totalled \$7.2 million; all other settlements were at least \$1 million. (10)

V. Product Market Information

According to Appliance magazine, the average product life of a gas-fired water heater is 11 years. In 1990, about 48 million, or 53 percent of United States households had gas-fired water heaters. Sales in 1990 totalled 3.9 million; of these, it is estimated that 2.9 million were sold for replacement and that 1.0 million were sold for new homes. (11)

VI. Benefits Associated with the Prevention of Deaths, Injuries, and Property Damage

The dollar value of the benefits associated with the prevention of deaths, injuries, and property damage will depend on how any change made to the installation and building codes is implemented. ~~Reportedly, there are several methods available to~~ prevent deaths, injuries, and property damage from these types of accidents, including changing the physical design and location of the air inlet on the water heater, adding a flame break, or placing the water heater on a stand so that the air inlet is higher off the floor.

Installation and building codes generally apply to new construction; however, if manufacturers were to change the physical design or location of the water heater, then it is likely that all new water heaters on the market would be changed, whether intended for the replacement market or for the new housing market. In this case, then, nearly four million households purchasing new water heaters potentially could be affected by the change to the building and installation codes. If the changes were fully effective, then about two deaths, 30 injuries, and \$1.2 million in property damage would be avoided each year.

If the change to the building and installation codes were implemented to apply to only those water heaters being installed in new homes, then potentially one million households could be affected. If the changes were fully effective, then about one death, eight injuries, and \$315,000 in property damage would be avoided each year.

VII. Dollar Value of the Benefits of Preventing Deaths, Injuries, and Property Damage

~~The dollar value of the benefits accruing from the prevention of deaths, injuries, and property damage can be estimated using the information described above about injury costs, jury verdicts, and awards. The estimated dollar value of total benefits from the elimination of all deaths, injuries, and property loss associated with these types of accidents ranges from about \$160 million to about \$180 million. These estimates are based on the following: a consensus statistical value of life of \$2 million, discount rates of 5 percent and 10 percent, an estimated average injury cost of \$600,000, (12) the assumption that changes are made to the design of water heaters so that about 4.0 million households are affected, and the assumption that the changes made to the water heaters are fully effective in reducing deaths, injuries, and property damage. The estimated expected benefits per household could total from \$40 to \$50 over the life of the product.~~

Under the same assumptions as above excepting that only those 1.0 million new homes constructed with new water heaters would be affected, the estimated dollar amount saved from the elimination of the deaths, injuries, and property damage would range from about \$50 million to about \$60 million. The estimated expected benefits per household could total from \$50 to \$60 over the life of the product.

Thus, under the latter assumptions, any cost less than about \$50 to \$60 to implement changes to the design or location of water heaters would yield net benefits to the consumer. Under the former assumptions, net benefits would occur if the cost to implement the changes was less than about \$40 to \$50.

FOOTNOTES

- 1/ Kenneth T. Taylor, National Fire Protection Association, Special Report, Residential Structure Fires Involving Flammable, Combustible Liquids, 1980-1984 Fire Experience, July 1987.
- 2/ ibid. These data also are reported in Gauthier, Wendell H., Murphy, Robert M., Downing, Edward F., III, Water Heaters and Flammable Vapors, Gauthier & Murphy, Metairie, Louisiana, p.6.
- 3/ "Fires from Gasoline Ignited by Gas Water Heaters," memorandum from William Rowe, EPHA, U.S. Consumer Product Safety Commission, to Joseph Z. Fandey, Project Manager, Gas Voluntary Standards Project, December 13, 1991.
- 4/ Correspondence from Edward F. Downing, III, Gauthier & Murphy, to Mr. Joe Fandey, U.S. Consumer Product Safety Commission, October 19, 1991.
- 5/ idem.
- 6/ Dorothy P. Rice, Ellen J. Mackenzie, and Associates, Cost of Injury in the United States, A Report to Congress, 1989, pp. 153-156.
- 7/ Correspondence from Edward F. Downing, III, Gauthier & Murphy, to Joseph Fandey, op. Cit.
- 8/ Jury Verdict Research, Inc., Personal Injury Valuation Handbooks, "Burns", p.6. These three cases did not involve the ignition of flammable vapors by gas-fired water heaters, but did involve similar injuries. Two of the cases involved second and third degree burns over two-thirds and 80 percent, respectively, of the victims' bodies and the third case involved severe burns and facial scarring.
- 9/ ibid., P. 2.
- 10/ Telephone conversation between Gauthier & Murphy and Joseph Z. Fandey, ESEE.
- 11/ Dana Chase Publications, Appliance, April 1991.
- 12/ This estimate is based on the material from the Personal Injury Valuation Handbooks. Previous research and studies by the Directorate for Economic Analysis about the costs of lifetime medical care associated with similar types of injuries indicates that this estimate may be conservative.

UNITED STATES GOVERNMENT
MEMORANDUM

U.S. CONSUMER PRODUCT
SAFETY COMMISSION
WASHINGTON, D.C. 20207

NOV 21 1991

TO : Joseph Z. Fandey, Project Manager, ESEE

Through: Dr. Robert D. Verhalen, Associate Executive Director
Directorate for Epidemiology
Jacqueline Elder, Acting Director, EPHF *B for ROV*

FROM : George Sweet, EPHF, 492-6468 *GS*

SUBJECT: Gas Water Heaters

Human Factors was asked to comment on the recommendation that air intake openings on gas water heaters be raised above the floor. Human Factors was also asked to provide input on the use of warning labels on gas water heaters to address the potential for ignition of flammable vapors.

Background

Fires have been started by flammable vapors coming into contact with the pilot light of gas water heaters. In most cases, the air intake openings on gas water heaters are at floor level. Flammable vapors are usually denser than air and therefore, stay near the floor. The vapors can travel significant distances across a floor. Flammable vapors enter the water heaters at the air intake openings which delivers the air flow to the burners. If the vapors reach the air intake openings and come into contact with the pilot light, they are ignited. Recommendations have been made to raise air intake openings above the floor as a means of preventing flammable vapor fires.

Discussion

Raising the air intake openings on gas water heaters appears to promote fire prevention. Logically, it follows that raising the air intake openings would reduce fires occurring from the ignition of flammable vapors because it would be less likely that the dense vapors would rise a sufficient height to enter the water heater through the air intake openings. However, it is not a complete solution, and additional research is required to determine the height that best reduces the potential of vapors being ignited.

A warning label is not an acceptable substitute for raising air intake openings off the floor. It is important that a warning label be placed on the product, however, the warning label is not the solution to the problem, it is an identification of the problem to the consumer. Even though raising the air intake opening should decrease the potential of fires, it will not eliminate the potential for fires. It is conceivable that consumers will perceive the change of height as a complete solution to the problem, resulting in a false sense of security. The consumer must still be warned of the dangerous combination of gas water heaters and substances with flammable vapors. The warning label must be noticeable, easily understandable, and provide complete information in order to be effective. The warning label should be conspicuous, not blending in with the instructions.

Conclusion

Human Factors supports raising the air intake openings of gas water heaters to decrease the potential for fires caused by the ignition of flammable vapors. Even with the adjusted height, it is essential that warning labels be conspicuously placed on gas water heaters to inform consumers of the potential fire hazard when products with flammable vapors are kept in proximity to a gas water heater. Additional research is required to determine the ideal height for the air intake openings in order to enhance fire prevention.



United States
CONSUMER PRODUCT SAFETY COMMISSION
Washington, D.C. 20207

MEMORANDUM

DATE: May 9, 1994

TO : Joseph Z. Fandey
Project Manager Gas Voluntary Standards, ESEE

Through: Robert E. Frye *RF*
Director, Hazard Analysis Division (EPHA)

FROM : William L. Rowe, EPHA (301) 504-0470, ext. 1271 *W. Rowe*

SUBJECT: Summary of Data on Gas-Fueled Water Heaters and Flammable Vapors

Attached is a table summarizing national gas-fueled water heater data. These data are the annual averages based on 1986 through 1991; 1991 is the most recent available year. The data appear to suggest that gasoline and other flammable liquids, in bold on the accompanying table, accounted for:

- ▶ Twenty percent (1,961 incidents) of the fires associated with gas-fueled water heaters.
- ▶ Fifty-four percent (316 people) of the injuries associated with gas-fueled water heaters.
- ▶ Forty-four percent (17 people) of the deaths associated with gas-fueled water heaters.
- ▶ Thirty percent (\$26,339,000) a third of the property loss associated with gas-fueled water heaters.

The importance of gasoline and other flammable liquids was also observed when the location of the fires was reviewed. During the same six years, 46 percent of these fires were in garages.

Attachment

cc:
Dr. Verhalen

There were three primary hazards scenarios, based on a review of 42 recent Epidemiological Investigations, that resulted in the ignition of flammable vapors by gas water heaters: children playing, use of gasoline as a solvent, and spills and leaks.

Children Playing

A 2-year old male died from thermal burns sustained when a water heater ignited gasoline as he played in the utility room near a plastic gasoline container which melted in the fire.

An 8-year old female was staying with her grandparents, and opened the outside door to the utility room where gasoline was stored for a lawn mower . There was an explosion that self extinguished. She died at a burn center two weeks later. The gas company had mailed leaflets to all their customers warning customers about storing combustibles too close to their water heaters.

A 2-year old male died of burns after 2 days in the hospital. He had been using a riding toy in the basement while his mother was cleaning there . She saw him standing in a puddle holding a one gallon can of gasoline. The vapors then reached the water heater and ignited burning the boy and his clothing.

Gasoline as a Solvent

A 9-month old son, his 26-year old father, and his 22-year old mother died of burns from gasoline vapor ignited by the water heater. It was located in the kitchen of their basement apartment where the father was cleaning automotive parts with an open container of gasoline.

A 42-year old female was using gasoline to remove carpet backing from the floor of a newly purchased home. The gasoline was ignited by the gas water heater 20 feet from her. She died 23 days later.

A 17-year old male sustained 2° burns from gasoline and was hospitalized for five days. He was cleaning paint brushes with gasoline near a gas water heater.

Gasoline Spill or Leak

An 80-year old female was admitted to the hospital for smoke inhalation suffered in a house fire. The fire resulted from a dog knocking over a can of gasoline on the porch.

A 14-year old male was hospitalized with 60 percent 3° burns. He disconnected the fuel line of his motorcycle in the basement. The leaking gasoline was ignited by the water heater.

cc: Dr. Verhalen

Attachment

Annual Average Estimates of the Number of Fires, Injuries, Deaths, and Property Loss Associated with Gas-Fueled Water Heaters, 1986-1991

Material First Ignited	Fires		Injuries		Deaths		Property Loss	
	Number	Percent	Number	Percent	Number	Percent	Thousand \$	Percent
Total	9,844	100*	586	100	40	100*	87,420	100.0
Gasoline	1,337	13.6	239	40.8	14	36.0	20,179	23.1
Other Liquid	624	6.3	77	13.1	3	7.9	6,160	7.1
Fuel Gas	1,547	15.7	110	18.9	12	29.0	15,330	17.5
All Other	6,336	64.7	160	27.2	11	27.2	45,751	52.3

Information in "Bold" type represents gasoline and other flammable liquids

Source: CPSC/EPHA, from data obtained from the National Fire Protection Association and the U.S. Fire Administration

* Percentages do not total 100.0 due to independent rounding.

UNITED STATES GOVERNMENT
MEMORANDUM

U.S. CONSUMER PRODUCT
SAFETY COMMISSION
WASHINGTON, D.C. 20207

Date: April 14, 1994

TO : Joseph Z. Fandey, ESEE
THROUGH: Robert T. Garrett, Acting Director ESEL *RTG*
FROM : Albert Eugene Martin, ESEL *AM*
SUBJECT: Water heater test project.

INTRODUCTION

The Engineering Sciences Engineering Laboratory (ESEL) began in January 1993 to design engineering tests, as requested, to investigate the propagation of a vapor cloud from a gasoline spill. Tests of vapor cloud propagation began in September of 1993. ESEL also investigated the performance of a simple device that could prevent the ignition of a gasoline vapor cloud by the flame in the water heater.

APPARATUS AND PROCEDURES

Five water heater samples were received at ESEL. These were connected to water and fuel gas sources per the manufacturers' instruction. These were operated in the combustion test laboratory. The velocity of the exhaust gases was measured with one of the hot wire anemometers in this lab. A D.C. blower was fitted to the top of the exhaust stack. This permits air to be drawn through the water heater at the velocity created by the pilot fire or the burner as appropriate.

The gasoline vapor cloud propagation measurements were made in a test room in the Fire Lab at the National Institute of Standards and Technology (NIST). These tests were performed with ESEL equipment and by ESEL staff. The work was done in a room built with gypsum board walls and fitted with a blow out safety door. These equipments and fixtures are described in Appendix A.

A Rosemont Model 880 analyzer was procured for the tests of vapor cloud propagation. This unit is a Non Dispersive Infra Red (NDIR) gas analyzer set up to measure the percent of "Lower Explosive Limit" (LEL) of gasoline vapors. This LEL unit is calibrated, by Rosemont, so that the user, ESEL, could perform "span calibrations" from a mixture of propane and nitrogen flowed into the analyzer. The ESEL performed this calibration daily using concentrations of 1.79, 0.821 and zero percent propane in nitrogen. These concentrations are equivalent to 94.2, 43.2 and zero percent LEL of gasoline vapor. Additional equipment used in the fire lab test cell was the required pumps, valves, rotameters, gages, thermocouples and tubing connecting the test points to the analyzer.

The data from the analyzer and four thermocouples in the

cell were collected by a 286 computer. This permitted quick analysis of each day's test results.

Tests to measure the effect, if any, of a barrier around the base of the water heater were run using the Hood Test System in The Combustion Test Lab at ESEL. This facility measures the products of combustion of hydrocarbon fires at short intervals. These data are used to compute the mass of combustion components of interest including Carbon Dioxide, CO₂, and Carbon Monoxide, CO.

The water heater was connected to a fuel gas (methane) line and to water inlet and outlet lines. All operating parameters were set to manufacturers specifications. The water heater operation was controlled by using the thermostat setting. Measurement of CO and CO₂ concentrations were noted with and without the barrier. The effect of "blocking" the space between the heater and barrier was also measured.

RESULTS

Appendix A compiles the gasoline vapor cloud propagation tests. This presents graphics of each test showing the percent L.E.L. versus time. Annotations are made for significant events in the test run. These data show that dangerous levels of gasoline vapor concentrations occur at the pilot light when 2000 ml, approximately 1/2 gallon, is spilled 18 inches from the centerline of a water heater sitting on the floor. This is believed to be the most common installation. When elevated six inches these data show that dangerous levels are not reached at the pilot light location.

With the water heater on the floor and a barrier, made of 14 inch wide aluminum flashing, placed around the base and taped to the floor the L.E.L. concentrations are reduced well below safe levels.

Appendix B reports the results of operating a water heater with and without the barrier. These data for CO and CO₂ concentrations are the same in each case.

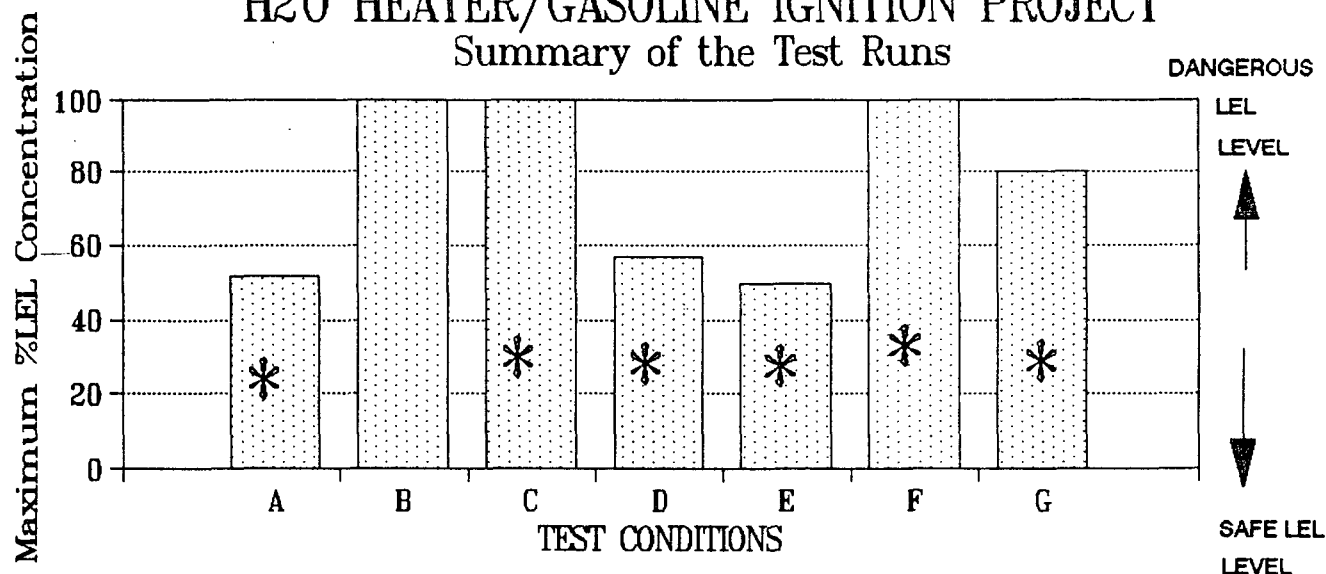
The work performed at ESEL shows that in those communities where water heaters are installed six inches or more above the floor the risk of ignition of spilled gasoline is minimal. These data also show that a simple 14 inch high barrier of light weight sheet metal taped to the floor prevents spilled gasoline vapors from reaching the flame in a water heater.

cc: George Sushinsky ESEL.

APPENDIX A

H2O HEATER/GASOLINE IGNITION PROJECT

Summary of the Test Runs



A: 6 in elevation / 2000 mL spill / Pilot cover off

B: On the floor / 2000 mL spill / Pilot cover on

C: On the floor / 2000 mL spill / Pilot cover on / Aluminum Flashing uncaulked to floor pan

D: On the floor / 2000 mL spill / Pilot cover on / Aluminum Flashing caulked to floor pan

E: On the floor / 2000 mL spill / Pilot cover on / Aluminum Flashing with 3 1/4" holes caulked to pan

F: On the floor / 1 Gallon spill / Pilot cover on / Aluminum Flashing with 3 1/4" holes caulked to pan

G: On the floor / 1 Gallon spill / Pilot cover on / Aluminum Flashing without holes caulked to pan

* Forced air blown in the enclosed test chamber

WATER HEATER/GASOLINE IGNITION PROJECT

Summary of Test Results

All tests were performed with heater "C" at 18 in from the centerline of the heater to the point of gasoline spill.

* Forced air blown in the enclosed test chamber.

DATE	TEST CONDITIONS	RESULTS
10/28/93	450 mL of gasoline spilled; Sample line 2 is 2" off the floor; line 3=6" off the floor, line 4=bottom of the air inlet of heater. This arrangement has been used for the test runs through 11/12/93 am. Heater is on the floor	Sample line 1 (pilot) did not reach a dangerous LEL level. The maximum LEL level of 45% occurred around 400 sec (6.7 min) after the spill.
11/1/93	Heater is on the floor; 450 mL of gasoline spilled	Two test runs have been performed--the first run showed the pilot reached a max. of 85% LEL and the second 100%. Both reached max. values 1 or 2 min after the spill.
11/2/93	Heater is on the floor; 450 mL of gasoline spilled	NO DATA; Stack blower lacked power supply.
11/3/93 am	Heater is on the floor; 450 mL of gasoline spilled	Sample line 1 (pilot) reached 100% LEL 100 sec after the spill
11/3/93 pm	Heater is on the floor; 450 mL of gasoline spilled	Sample line 1 (pilot) reached 100% LEL 100 sec after the spill
11/4/93	Heater is raised 12" off the floor; 1000 mL of gasoline spilled	No Data for the morning run; Exhaust fan was on when testing was in progress. Afternoon run shows no indication of dangerous LEL levels.
11/8/93	Water heater was raised 6 in above the floor pan; 2000 mL of gasoline was spilled;	NO DATA; Power failure occurred in the fire research building at NIST.
11/9/93 am	Water heater was raised 6 in above the floor pan; 2000 mL of gasoline was spilled;	Sample line 2 reaches >100% LEL. The LEL concentration @ the pilot never reached a dangerous level; the LEL concentration gradually rose from 1% to 26% over the course of 4600 sec (1 hr., 17 min).
11/9/93 pm	Water heater was raised 6 in above the floor pan; 2000 mL of gasoline was spilled;	Sample line 2 reaches >100% LEL. The LEL concentration @ the pilot never reached a dangerous level; the LEL concentration gradually rose from 1% to 15% over the course of 3500 sec (58 min).
11/12/93 am	Water heater was raised 6 in above the floor pan; 2000 mL of gasoline was spilled;	Sample line 2 reaches >100% LEL @ 120 sec (2 min) after the spill. The LEL concentration @ the pilot never reached a dangerous level; the LEL concentration gradually rose from 1% to 35% over the course of 2800 sec (47 min).

U.S. Consumer Product Safety Commission
Engineering Laboratory

WATER HEATER/GASOLINE IGNITION PROJECT

Summary of Test Results

* Forced air blown in the enclosed test chamber.

DATE	TEST CONDITIONS	RESULTS
11/12/93 pm	Water heater was raised 6 in above the floor pan; 2000 mL of gasoline was spilled; sample line 2=3" off the floor, line 3=4.5" and line 4=6". <u>This sample line arrangement has been maintained for the remainder of the test runs.</u>	Sample line 2 reaches >100% LEL @ 40 sec after the spill. The LEL concentration @ the pilot never reached a dangerous level; the LEL concentration gradually rose from 2% to 36% over the course of 3400 sec (56 min).
11/16/93	Water heater was raised 6 in above the floor pan; 2000 mL of gasoline was spilled	Sample line 2 reaches >100% LEL @ 180 sec (3 min) after the spill. The LEL concentration @ the pilot never reached a dangerous level; the LEL concentration gradually rose from 17% to 25% over the course of 3000 sec (50 min).
11/17/93 am * A	Water heater was raised 6 in above the floor pan; 2000 mL of gasoline was spilled	Sample line 2 reaches >100% LEL @ 180 sec (3 min) after the spill. The fan was pulsed (turned on/off) once @ 2300 sec (38 min) after the spill and turned on for 10 min @ 2400 sec (40 min). The LEL concentration @ the pilot did not reach a dangerous level, but reached a steady state of 52%.
11/17/93 pm * A	Water heater was raised 6 in above the floor pan; 2000 mL of gasoline was spilled	Sample line 2 reaches >100% LEL @ 190 sec (3 min, 10 sec) after the spill. The fan was pulsed once @ 440 sec (7 min) after the spill and pulsed 10 times @ 950 sec (15.8 min). The LEL concentration @ the pilot did not reach a dangerous level, but reached a steady state of 52%.
11/18/93 am *	Water heater was raised 6 in above the floor pan; 2000 mL of gasoline was spilled	Sample lines 2 and 3 reach >100% LEL @ 166 sec and 168 sec, respectively. When the fan was pulsed (turned on/off) ten times, the hot wire anemometer read an air velocity of 459 ft/min and the pilot (line 1) concentration jumped from 7.4% to 45.7% LEL. The pilot never reached a dangerous LEL level.
11/18/93 pm B	Water heater was placed on the floor pan; 2000 mL of gasoline was spilled; pilot cover is ON the heater	Sample line 1 (pilot) reaches >100% LEL 62 sec after the spill. The pilot maintained its >100% LEL level for about 800 sec (13 min). At about 890 sec (15 min), the pilot LEL level dropped to about 73%.

U.S. Consumer Product Safety Commission
Engineering Laboratory

WATER HEATER/GASOLINE IGNITION PROJECT

Summary of Test Results

* Forced air blown in the enclosed test chamber.

DATE	TEST CONDITIONS	RESULTS
11/19/93 pm *	Water heater was placed on the floor pan; pilot cover is ON the heater throughout the remainder of the tests; 2000 mL of gasoline was spilled; aluminum flashing is around the water heater, resting on the floor pan (flashing is not caulked)	Sample line 1 (pilot) reaches a maximum of about 61% LEL @ 2110 sec (35 min) after the gasoline spill. The liquid gasoline crept underneath the flashing. "Pulsing" (turning fan on/off) was performed to determine what sort of characteristics the sample line @ the pilot will exhibit. The pilot reached about 61% LEL after 2 sets of 10 pulses in 1 sec intervals. After every set of pulses, the hot wire anemometer read air velocities from 100 to 200 feet/min. It appears the pilot cover prevents some of the stronger vapor concentration from coming in.
11/22/93 am * C	Water heater was placed on the floor pan; 2000 mL of gasoline was spilled; aluminum flashing is around the water heater, resting on the floor pan (flashing is not caulked)	Sample line 1 (pilot) reaches >100% LEL @ 180 sec (3 min) after the spill. The fan was pulsed 10 times (turned on and off) from the time of the spill to the time when 100% LEL was reached. The liquid gasoline crept underneath the flashing. When the pilot reached >100% LEL, other sample lines were switched and observed. After about 6 min (360 sec) and 10 pulses, the pilot was at 91% LEL. 15 min after the spill, the fan was pulsed 10 times and the pilot reaches 74% LEL. Without the aid of the fan, the pilot does not reach dangerous LEL levels.
11/22/93 pm * D	Water heater was placed on the floor pan; 2000 mL of gasoline was spilled; aluminum flashing is caulked to the floor pan.	Sample line 1 (pilot) reaches a maximum of about 57% LEL @ 880 sec (15 min) after the gasoline spill. The caulking prevented liquid gasoline from going underneath the flashing. "Pulsing" (turning fan on/off) was performed to determine what sort of characteristics the sample line @ the pilot will exhibit. The pilot reached a steady state of about 57% LEL after 6 sets of pulses: 2 sets of 8 pulses in 5 sec intervals, 2 sets of 8 pulses in 1 sec intervals, and 2 sets of 10 pulses in 1 sec intervals. After every set of pulses, the hot wire anemometer read air velocities from 100 to 200 feet/min.

U.S. Consumer Product Safety Commission
Engineering Laboratory

WATER HEATER/GASOLINE IGNITION PROJECT

Summary of Test Results

* Forced air blown in the enclosed test chamber.

DATE	TEST CONDITIONS	RESULTS
11/23/93 pm * D	Water heater was placed on the floor pan; 2000 mL of gasoline was spilled; aluminum flashing is caulked to the floor pan	Sample line 1 (pilot) reaches a maximum of about 57% LEL @ 1360 sec (23 min) after the gasoline spill. "Pulsing" (turning fan on/off) was performed to determine what sort of characteristics the sample line @ the pilot will exhibit. The pilot reached a steady state of about 57% LEL after 5 sets of pulses: 3 sets of 2 pulses in 1 sec intervals, a set of 6 pulses in 1 sec intervals, and a set of 5 pulses in 1 sec intervals. After every set of pulses, the hot wire anemometer read air velocities from 60 to 120 feet/min.
11/24/93 am *	Water heater was placed on the floor pan; 2000 mL of gasoline was spilled; aluminum flashing is caulked to the floor pan	Sample line 1 (pilot) reaches a maximum of about 54% LEL @ 1890 sec (32 min) after the gasoline spill. "Pulsing" (turning fan on/off) was performed a few minutes after sample line 2 saturated (>100% LEL). 2½ minutes after the spill, sample line 2 (3" off the floor) saturated. The pilot reached a steady state of about 50% LEL after 7 sets of pulses: 2 sets of 5 pulses in 4 sec intervals, 2 sets of 8 pulses in 2 sec intervals, a set of 5 pulses in 2 sec intervals, and 2 sets of 10 pulses in 2 sec intervals. After every set of pulses, the hot wire anemometer read air velocities over 200 feet/min.
11/30/93 am * E	Water heater was placed on the floor pan; 2000 mL of gasoline was spilled; aluminum flashing is caulked to the floor pan and has 3 ¼ inch diameter holes (spaced approximately 120° apart around the flashing).	Sample line 1 (pilot) reaches a maximum of about 50% LEL @ 2640 sec (44 min) after the gasoline spill. "Pulsing" (turning fan on/off) was performed a few minutes after sample line 2 (3" off the floor) saturated (>100%). 2½ minutes after the spill, sample line 2 saturated. The pilot reached a steady state of about 50% LEL after 7 sets of pulses: 2 sets of 5 pulses in 4 sec intervals, 2 sets of 8 pulses in 2 sec intervals, a set of 5 pulses in 2 sec intervals, and 2 sets of 10 pulses in 2 sec intervals. After every set of pulses, the hot wire anemometer read air velocities over 200 feet/min.

U.S. Consumer Product Safety Commission
Engineering Laboratory

WATER HEATER/GASOLINE IGNITION PROJECT

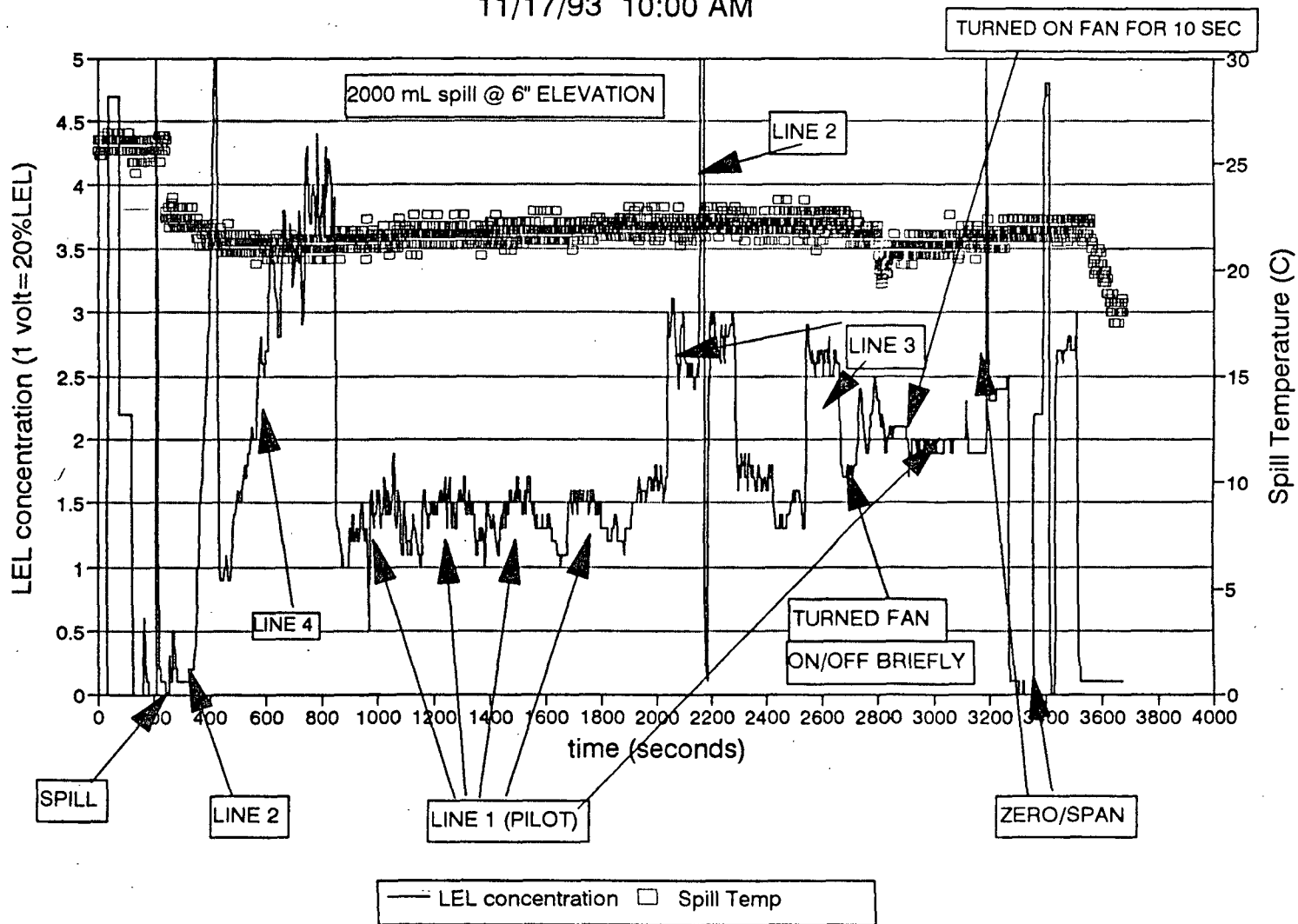
Summary of Test Results

* Forced air blown in the enclosed test chamber.

DATE	TEST CONDITIONS	RESULTS
11/30/93 pm * F	Water heater was placed on the floor pan; 1 gallon of gasoline was spilled; aluminum flashing is caulked to the floor pan and has 3 ¼ inch diameter holes (spaced approximately 120° apart around the flashing).	Sample line 1 (pilot) reaches over 100% LEL @ 940 sec (16 min) after the gasoline spill. Periodic "pulsing" (turning fan on/off) was performed every min or 30 sec., three minutes after sample line 2 (3" from the floor) saturated (>100% LEL). The pilot reached over 100% LEL after 9 sets of 5 pulses in 2 sec intervals, with the exception of the first set which was 5 pulses in 4 sec intervals. After every set of pulses, the hot wire anemometer read air velocities over 200 feet/min.
12/1/93 am * G	Water heater was placed on the floor pan; 1 gallon of gasoline was spilled; aluminum flashing is caulked to the floor pan and has 3 ¼ inch diameter holes (spaced approximately 120° apart around the flashing) that have been covered up with aluminum tape.	Sample line 1 (pilot) reaches a maximum of about 70% LEL @ 2160 sec (36 min) after the gasoline spill. Periodic "pulsing" (turning fan on/off) was performed every 2 min or 1 min, 3½ minutes after sample line 2 (3" off the floor) saturated (>100% LEL). The pilot reached a steady state of about 70% LEL after 19 sets of 5 pulses in 2 sec intervals, with the exception of the first set which was 5 pulses in 4 sec intervals. After every set of pulses, the hot wire anemometer read air velocities over 200 feet/min.
12/1/93 pm *	Water heater was placed on the floor pan; 1 gallon of gasoline was spilled; aluminum flashing is caulked to the floor pan and has 3 ¼ inch diameter holes (spaced approximately 120° apart around the flashing).	Sample line 1 (pilot) reaches a maximum of about 80% LEL @ 2290 sec (38 min) after the gasoline spill. "Pulsing" (turning fan on/off) was performed a few minutes after sample line 2 (3" off the floor) saturated (>100% LEL). 2½ minutes after the spill, sample line 2 saturated. The pilot reached a steady state of about 82% LEL after 7 sets of pulses: 2 sets of 5 pulses in 4 sec intervals, 2 sets of 8 pulses in 2 sec intervals, a set of 5 pulses in 2 sec intervals, and 2 sets of 10 pulses in 2 sec intervals. After every set of pulses, the hot wire anemometer read air velocities over 200 feet/min.

H2O HEATER/GASOLINE IGNITION PROJECT

11/17/93 10:00 AM

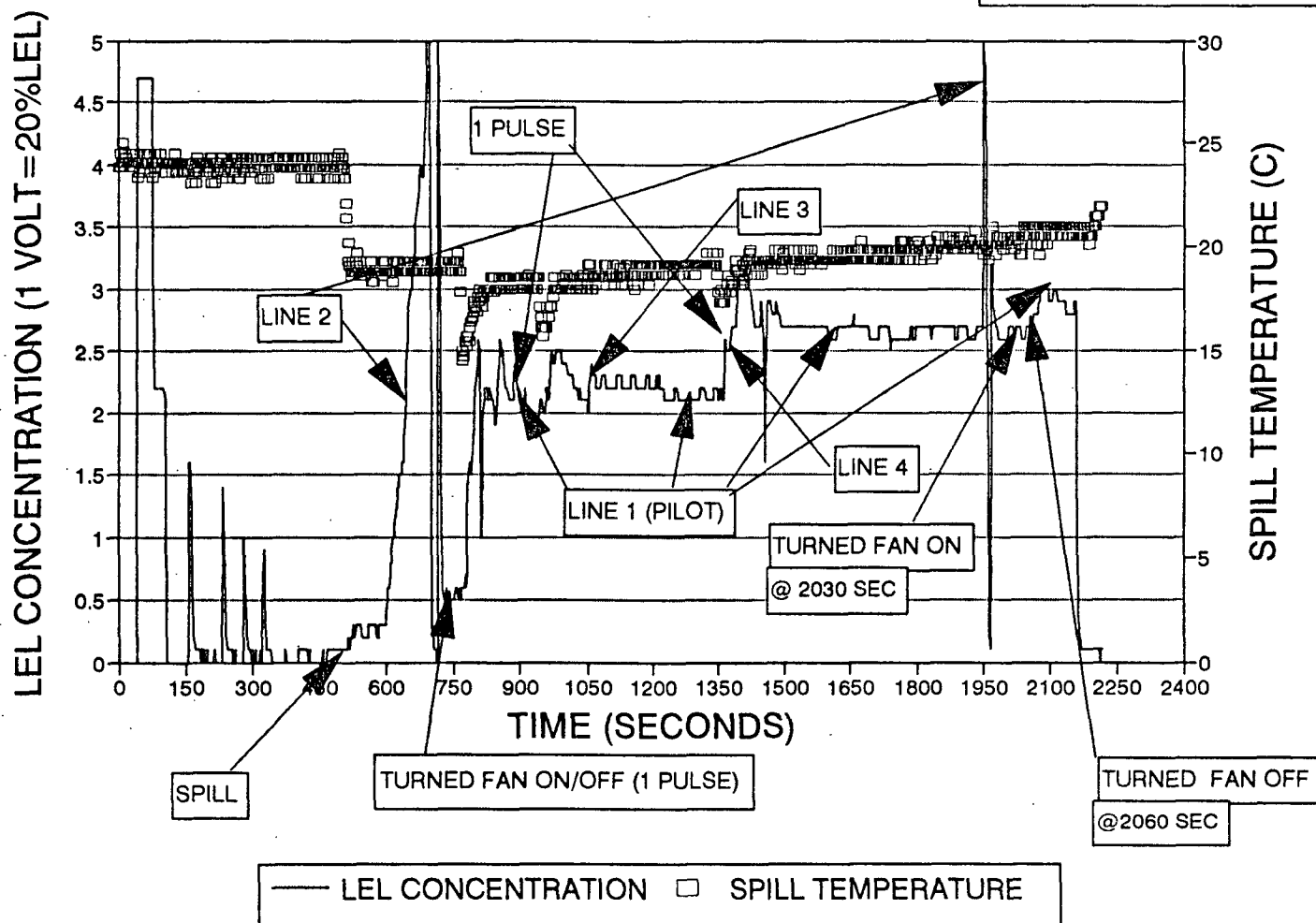


A

H2O HEATER/GASOLINE IGNITION PROJECT

11/17/93 2:00 PM

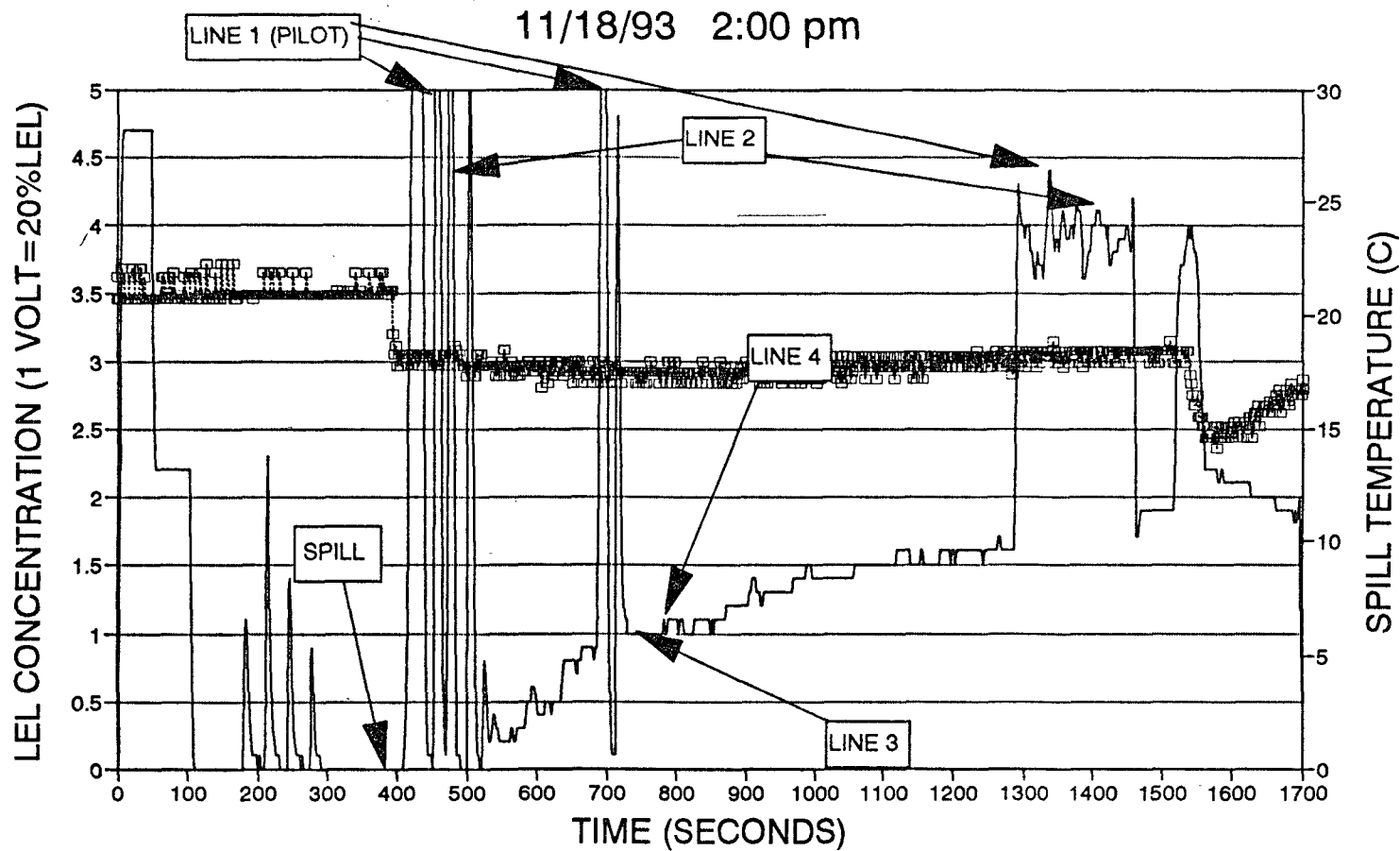
2000 mL SPILL @ 6" ELEVATION



A

H2O HEATER/GASOLINE IGNITION PROJECT

11/18/93 2:00 pm



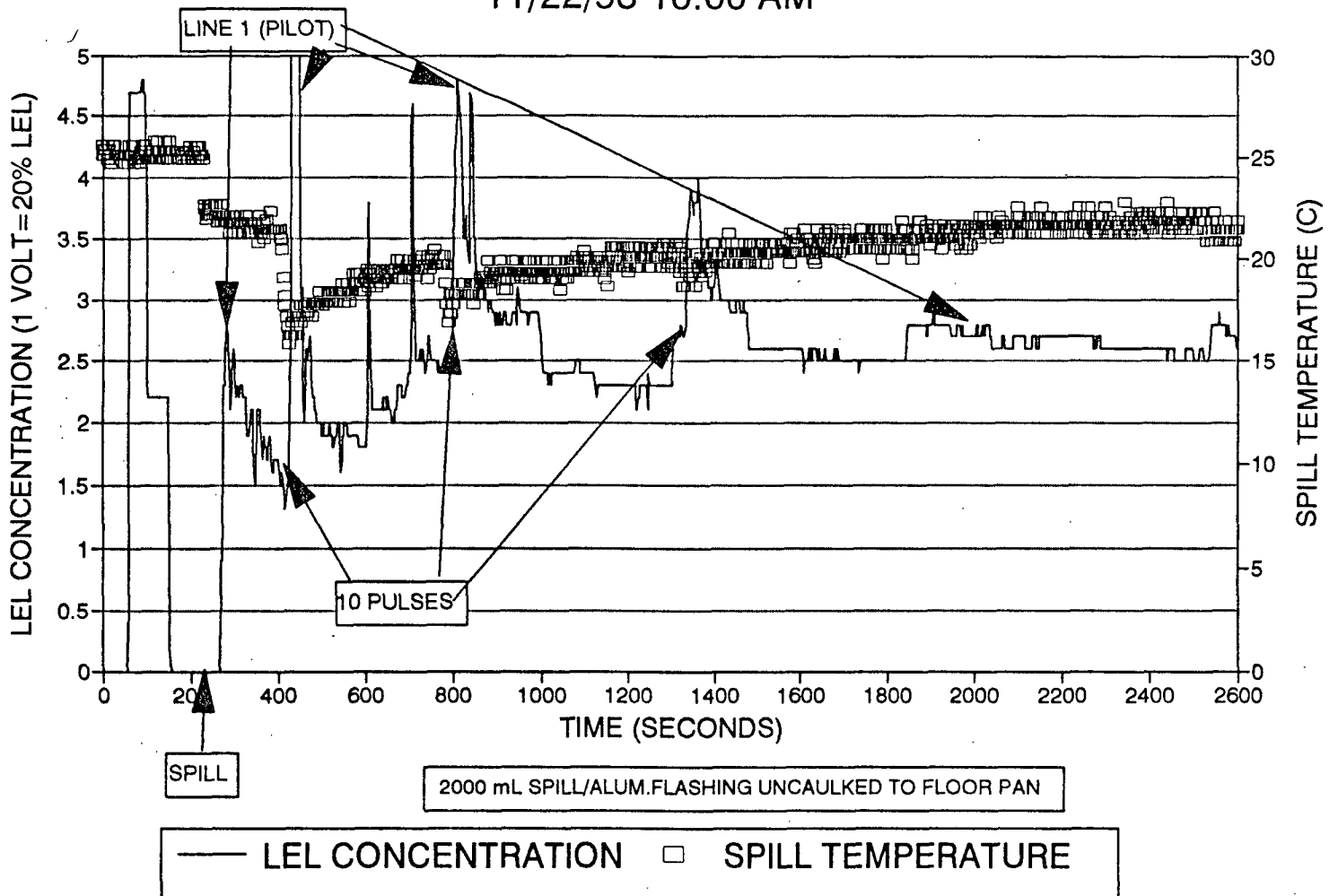
2000 mL SPILL/HEATER IS ON THE FLOOR PAN/PILOT COVER IS ON

— LEL CONCENTRATION - - - SPILL TEMPERATURE

B

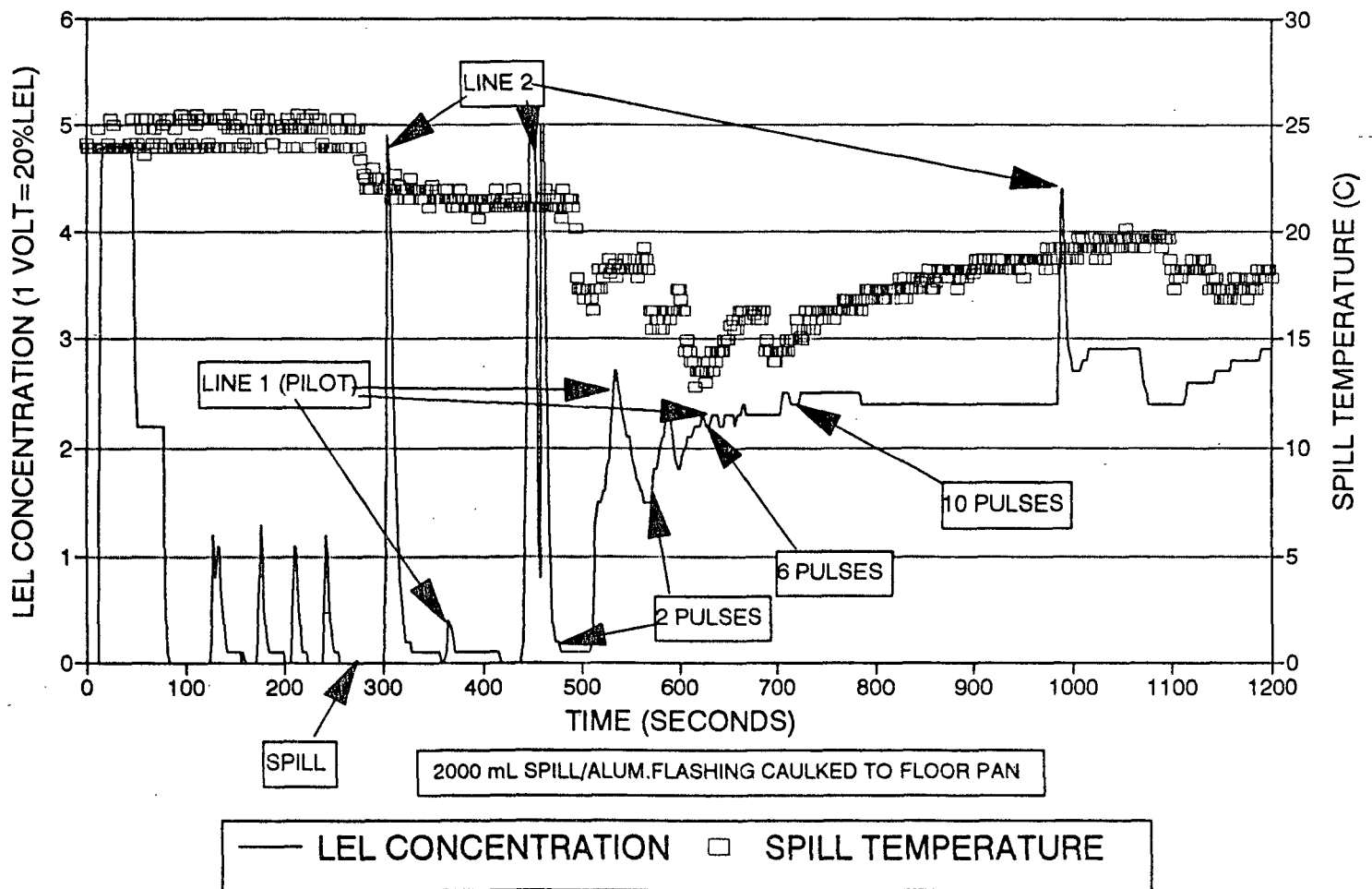
H2O HEATER/GASOLINE IGNITION PROJECT

11/22/93 10:00 AM



C

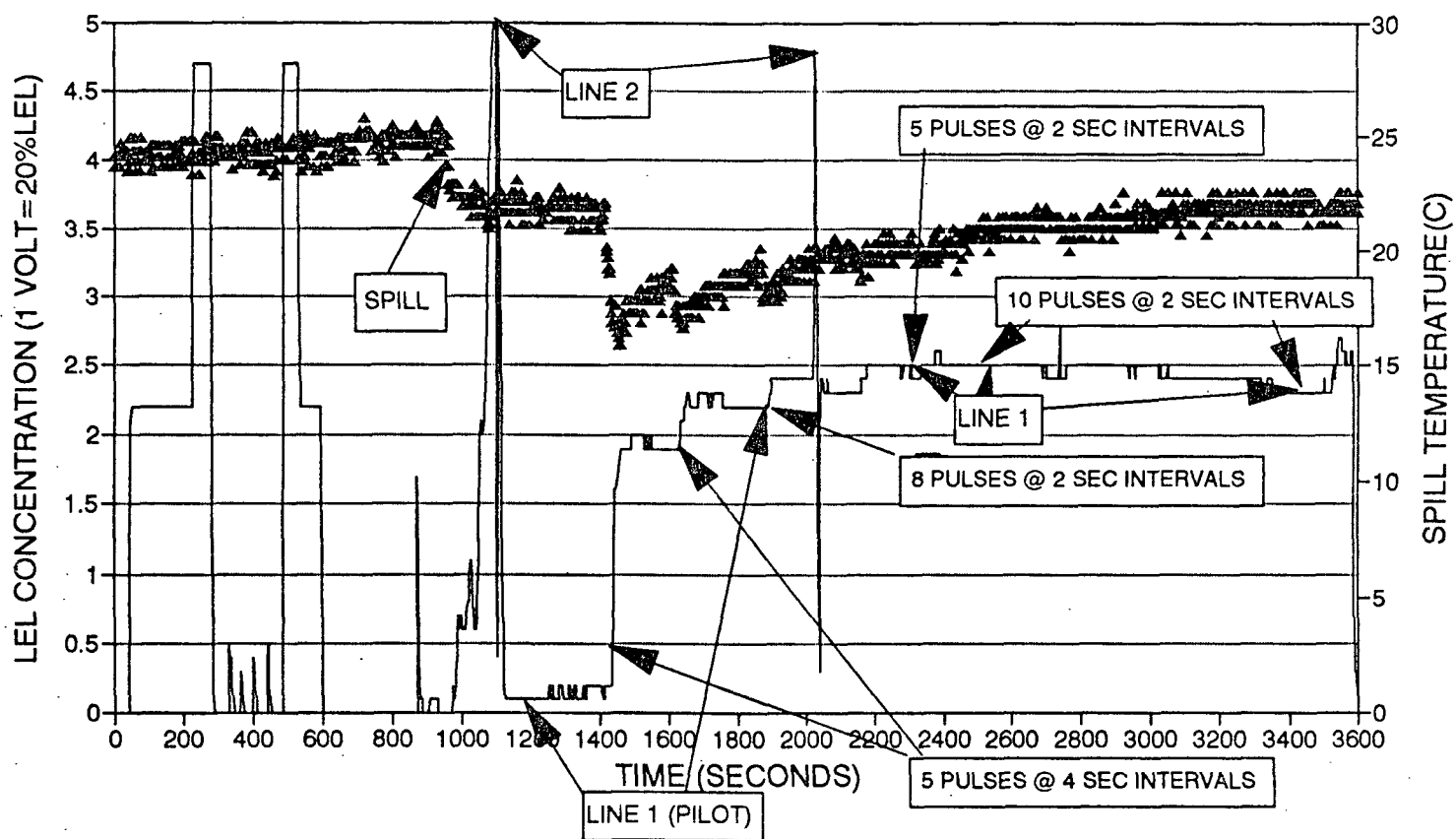
H2O HEATER/GASOLINE IGNITION PROJECT
11/22/93 2:00 PM



D

H2O HEATER/GASOLINE IGNITION PROJECT

11/30/93 9:00 AM



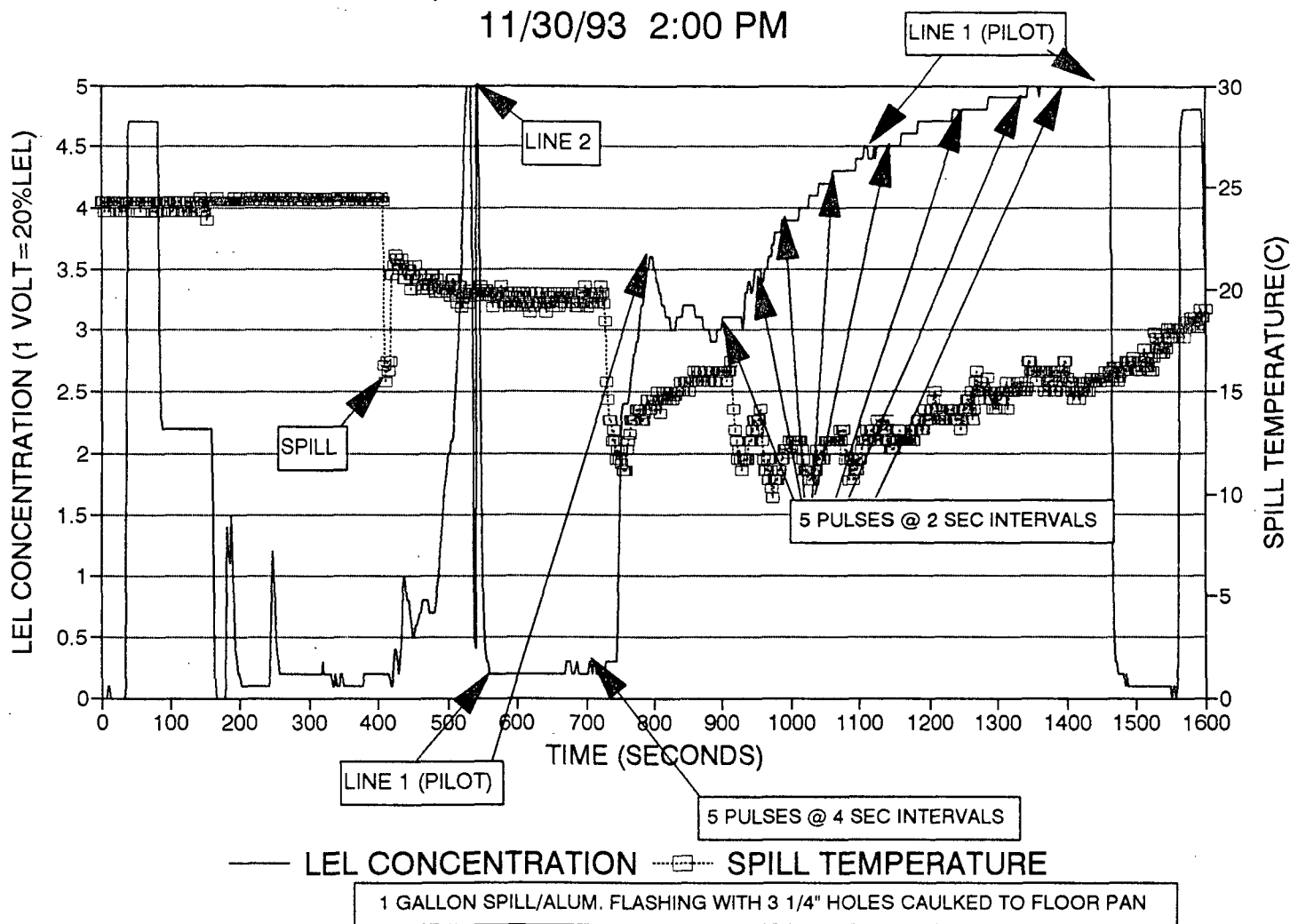
— LEL CONCENTRATION ▲ SPILL TEMPERATURE

2000 mL SPILL/ALUM.FLASHING CAULKED/3 1/4" HOLES EQUALLY SPACED AROUND FLASHING

E

H2O HEATER/GASOLINE IGNITION PROJECT

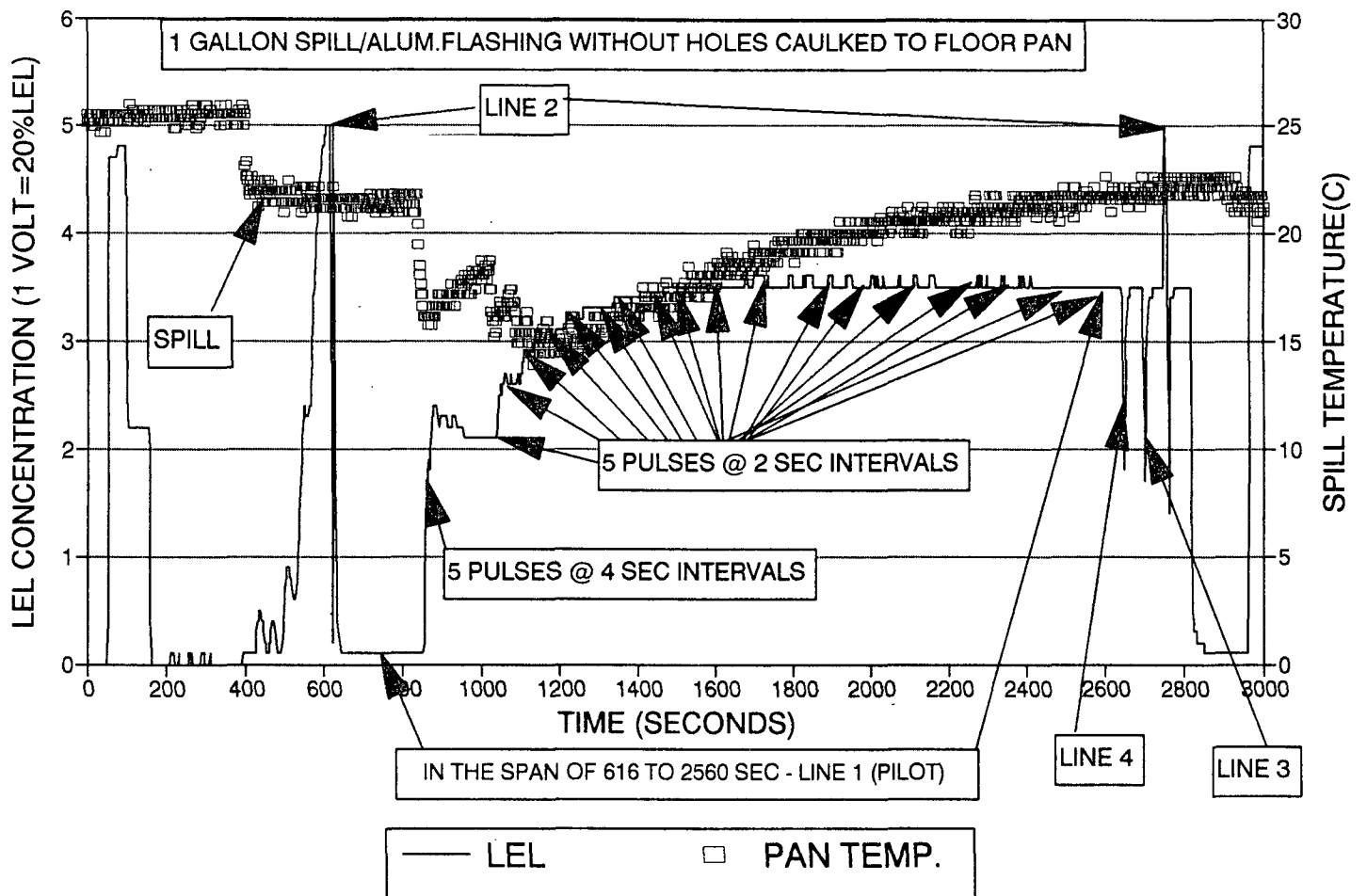
11/30/93 2:00 PM



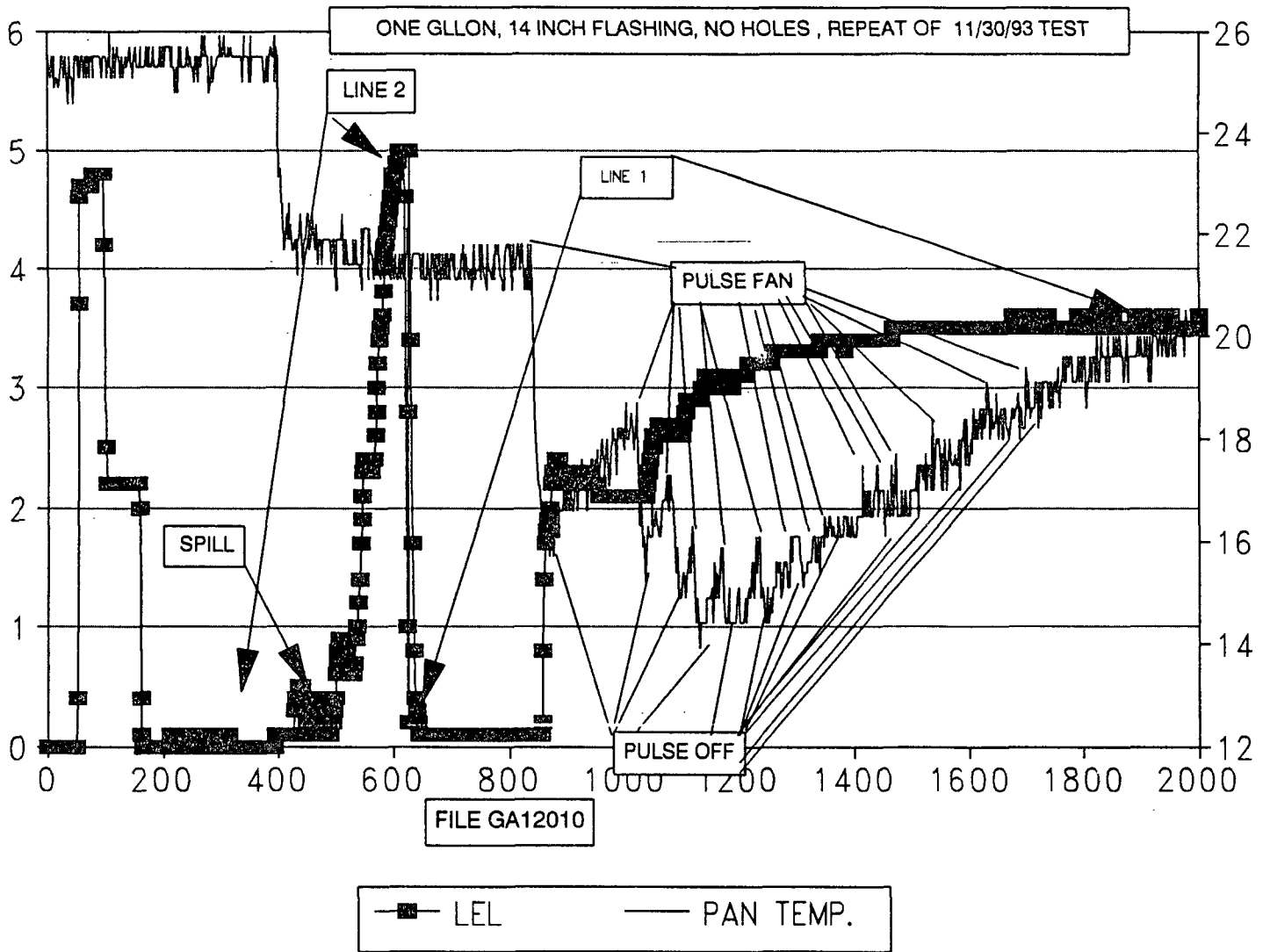
F

H2O HEATER/GASOLINE IGNITION PROJECT

12/1/93 10:00 am



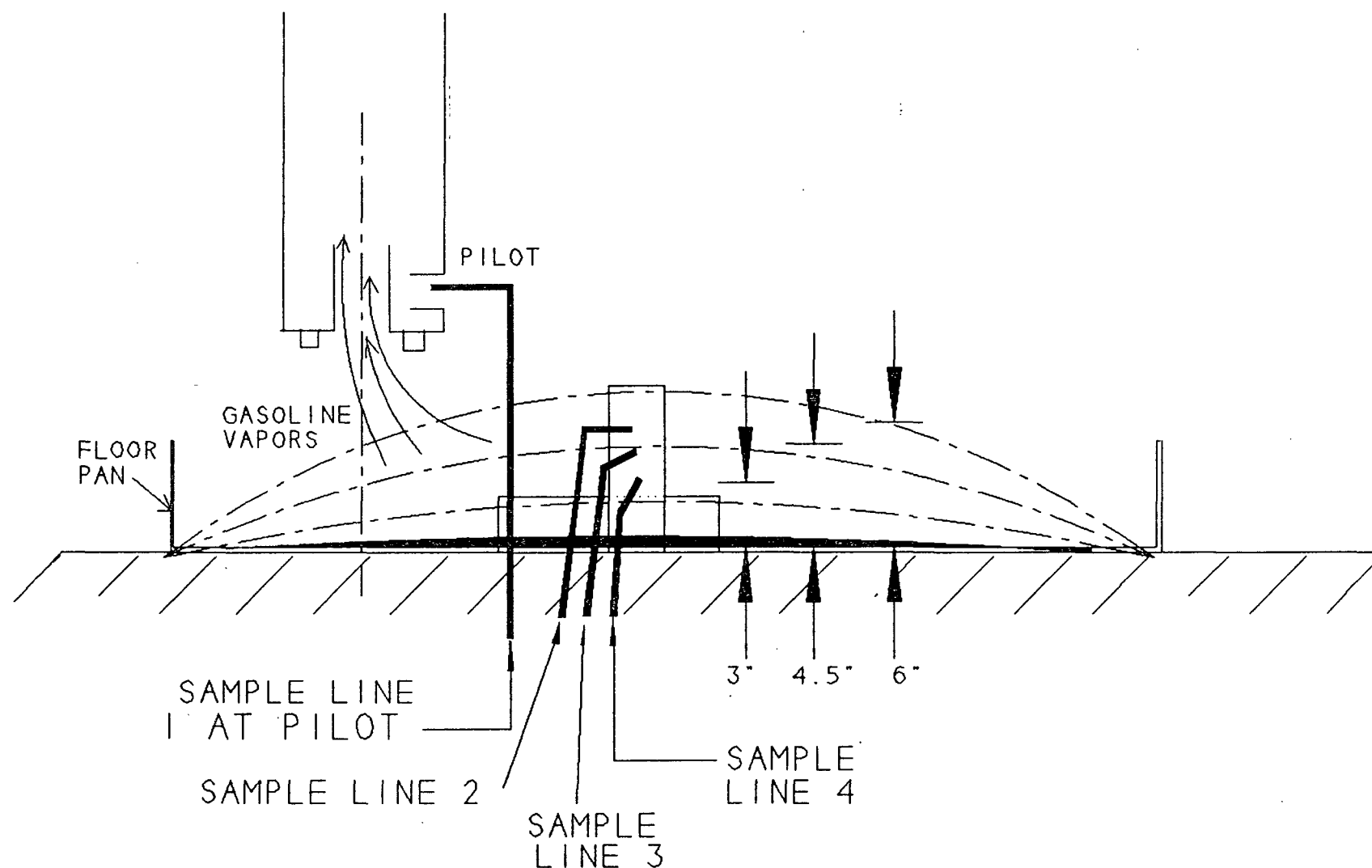
G



1-H

FIGURE 1

SIDE VIEW OF H₂O HEATER PROJECT TEST SETUP

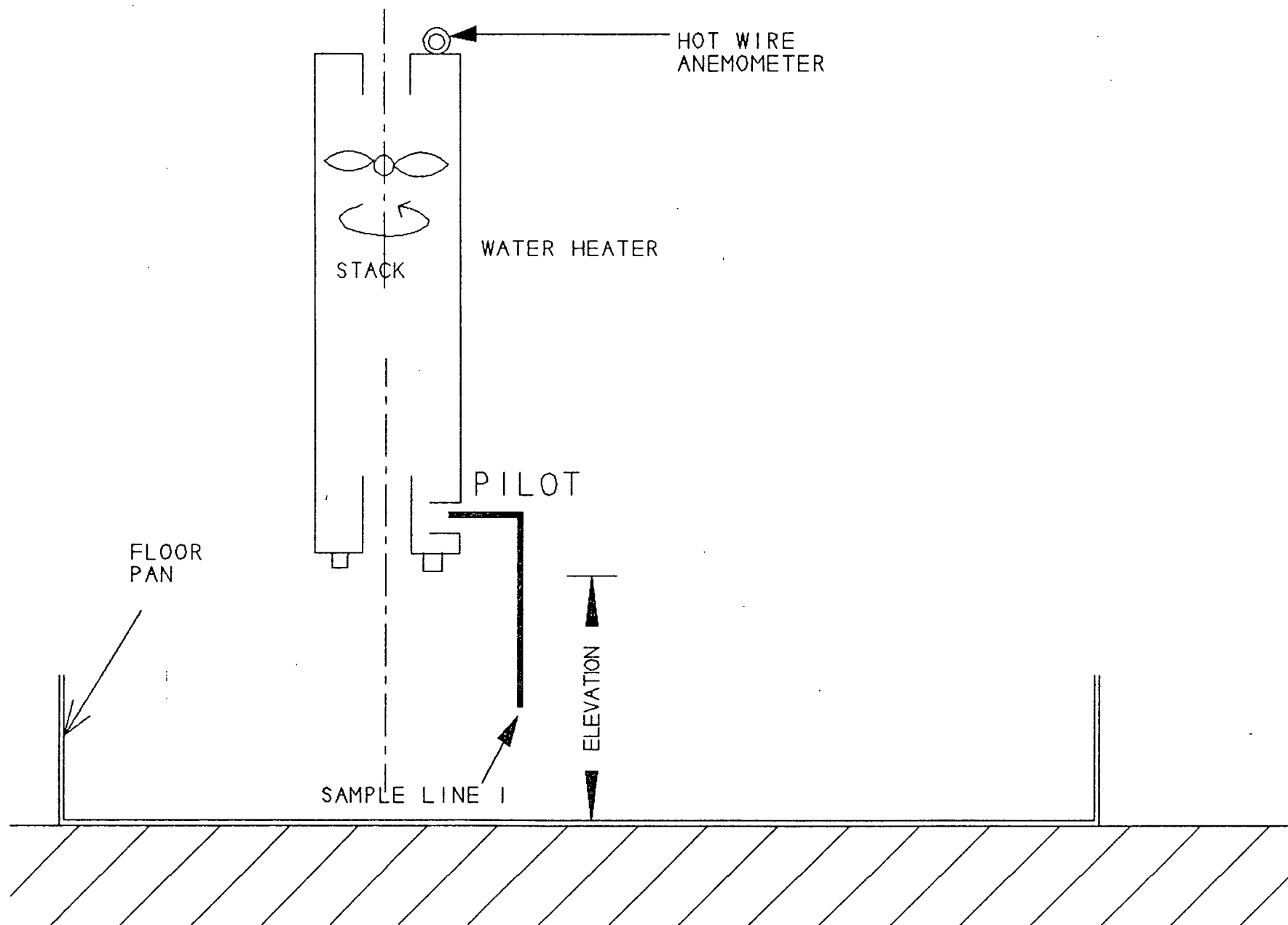


LIQUID GASOLINE IS SHOWN
IN THE SOLID SHADED MENISCUS

NOT DRAWN TO SCALE

FIGURE 2

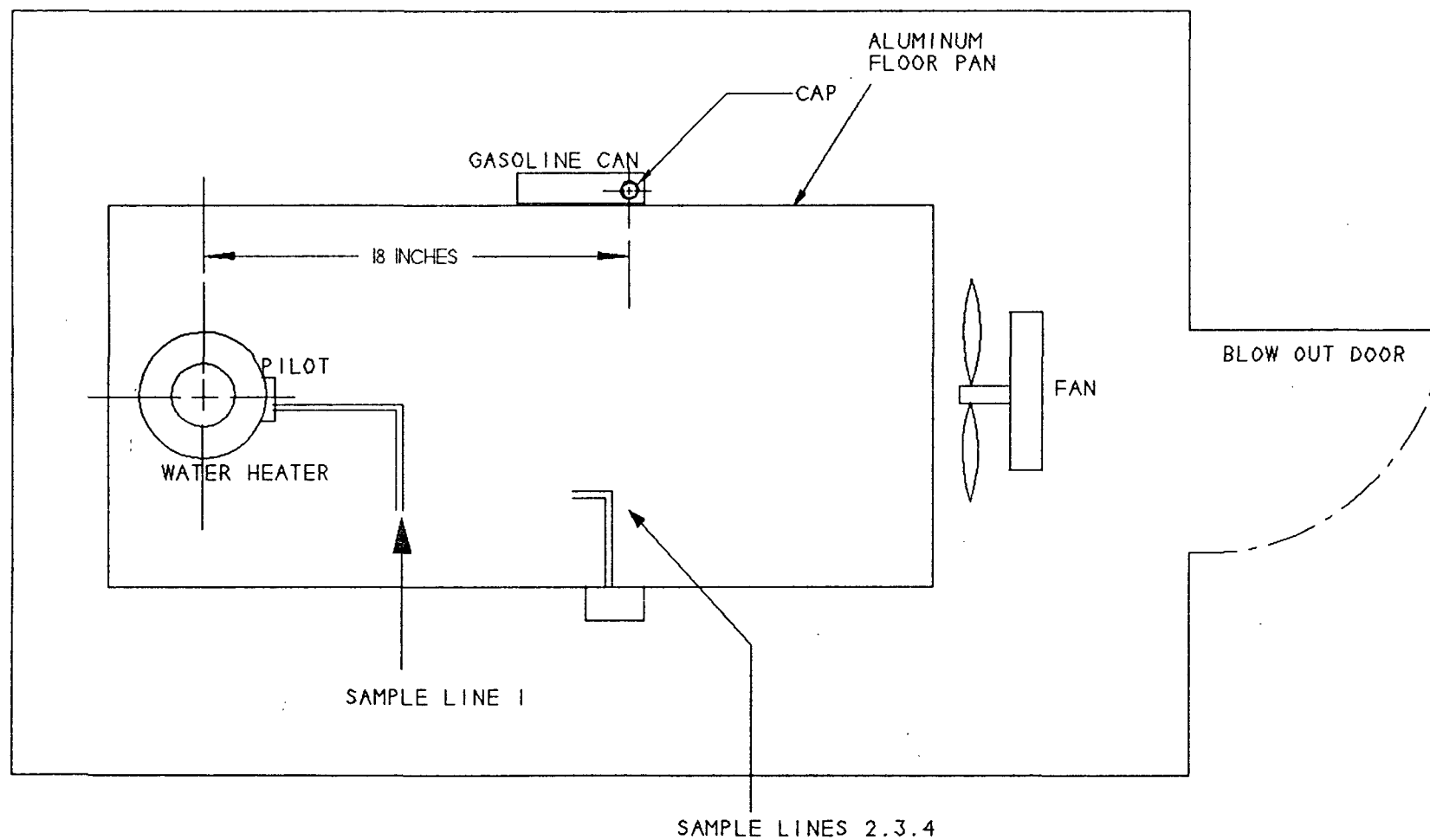
SIDE VIEW OF H₂O HEATER-GASOLINE IGNITION PROJECT TEST SETUP



NOT DRAWN TO SCALE

FIGURE 3

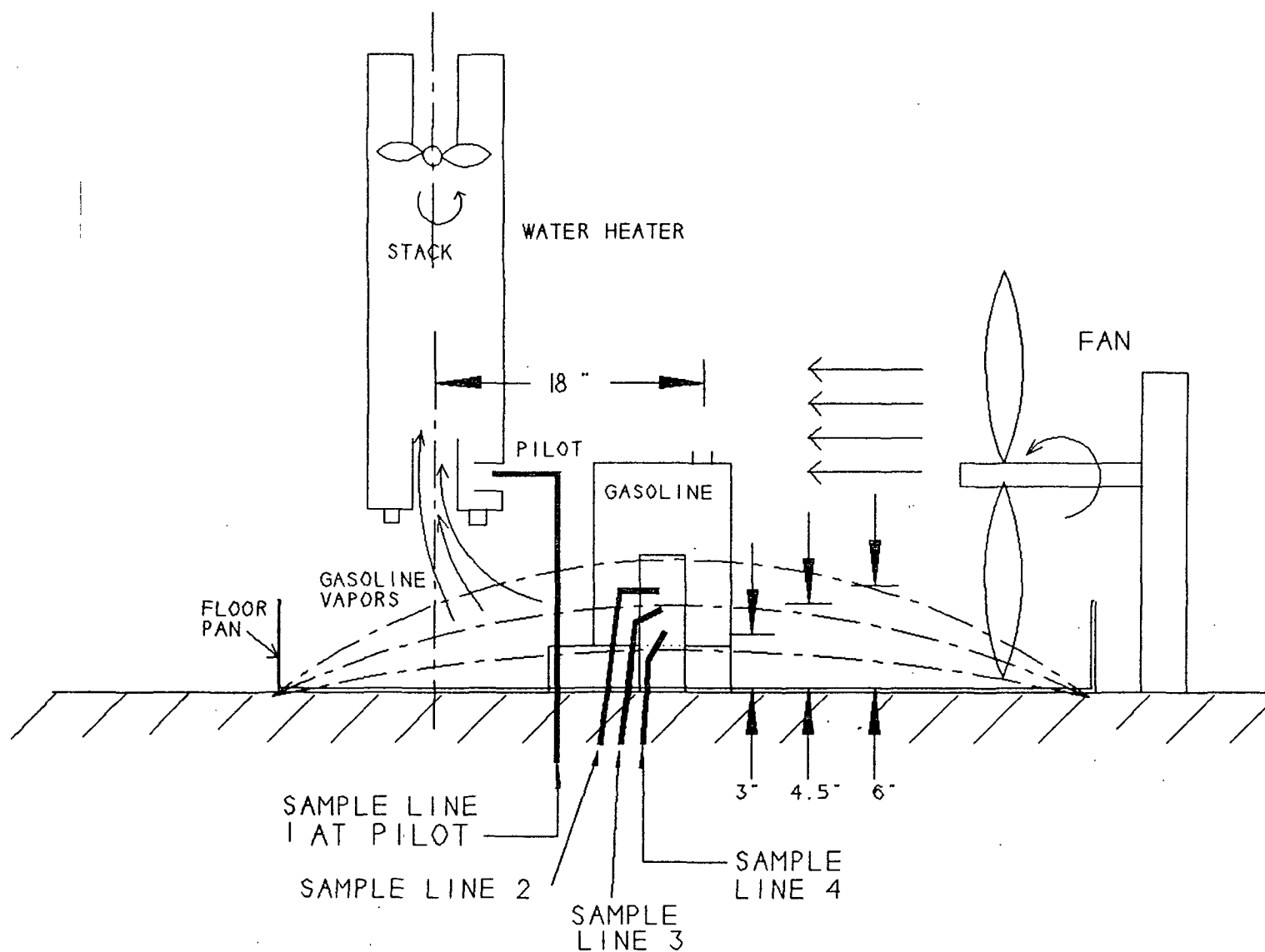
FLOOR PLAN OF H₂O HEATER-GASOLINE IGNITION TEST SETUP



NOT DRAWN TO SCALE.

FIGURE 4

SIDE VIEW OF H₂O HEATER-GASOLINE IGNITION TEST SETUP



NOT DRAWN TO SCALE

FIGURE 5

H₂O HEATER-GASOLINE IGNITION TEST SETUP

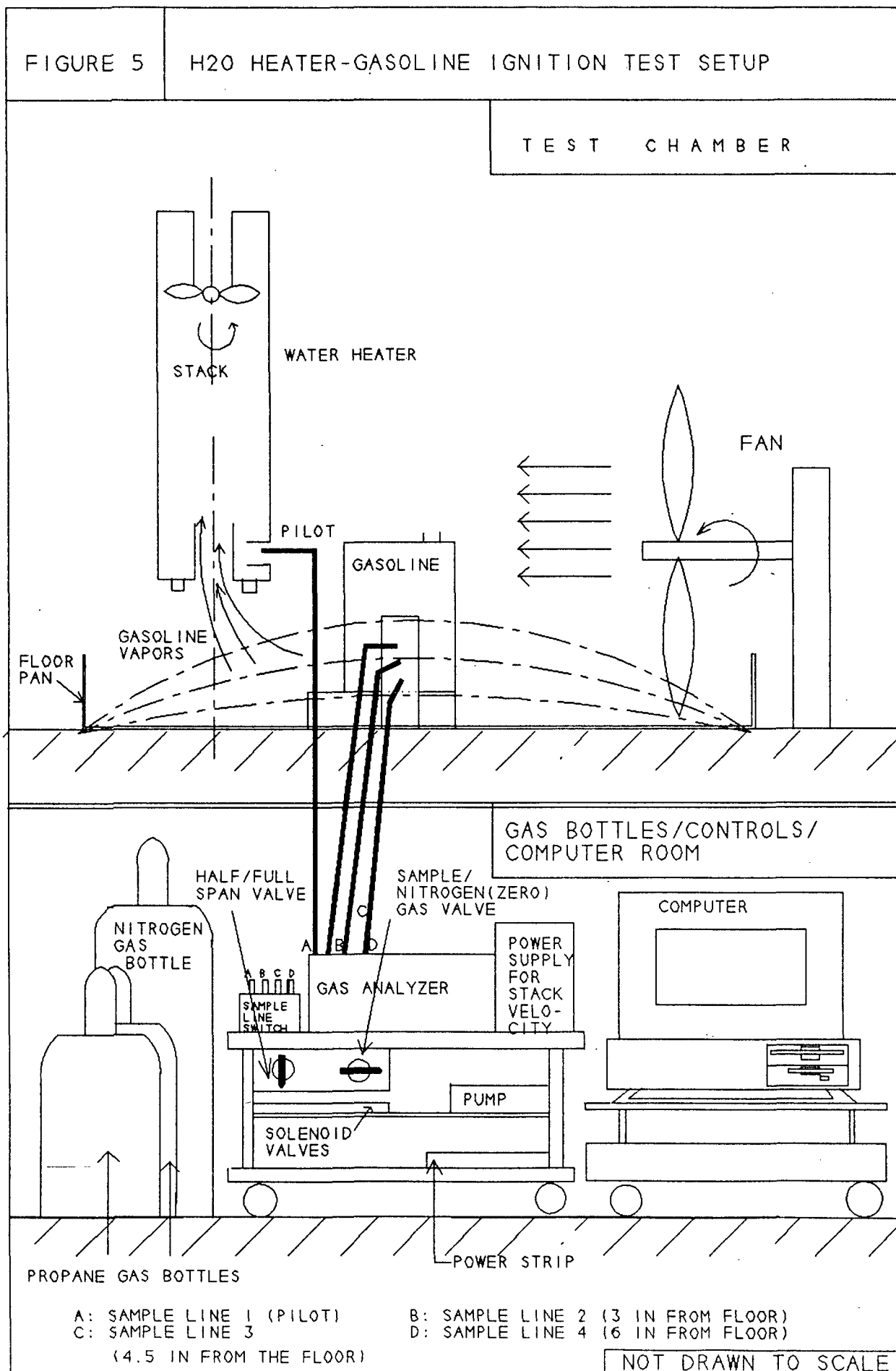


Photo 1
NIST (National Institute of
Standards and Technology)
fire research building where
the water heater/gasoline
ignition tests were performed.

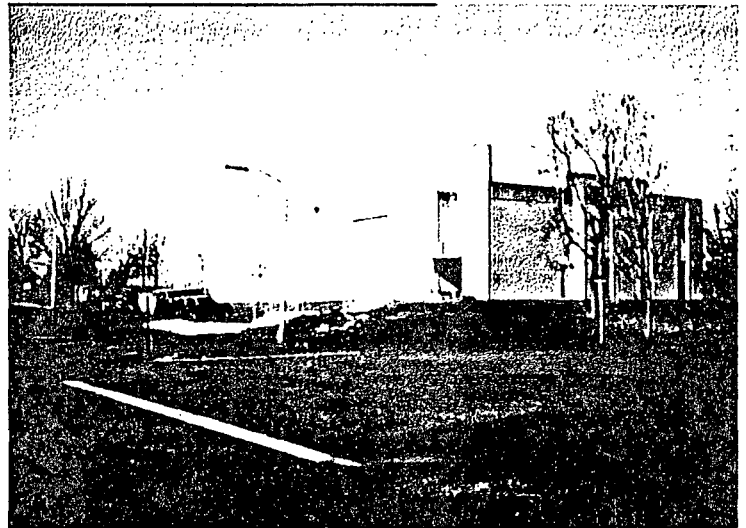


Photo 2
Close up of NIST's fire
research building.



Photo 3
Close up of blow
out door latch mechanism.

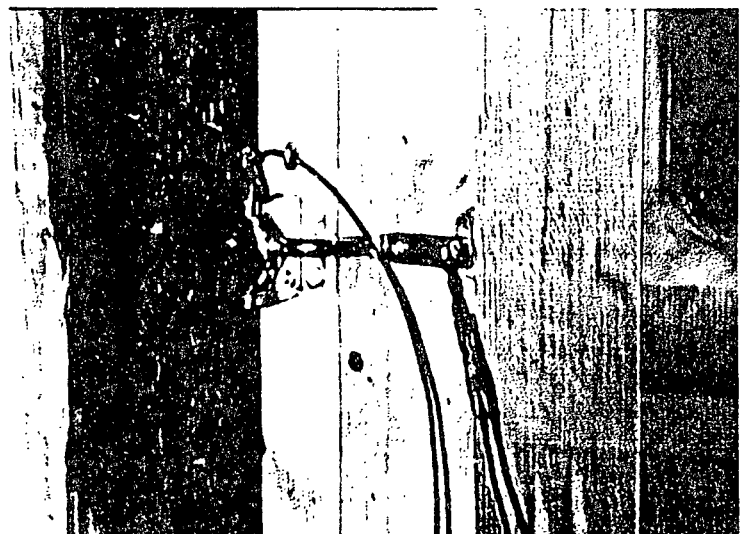


Photo 4
Blow out door

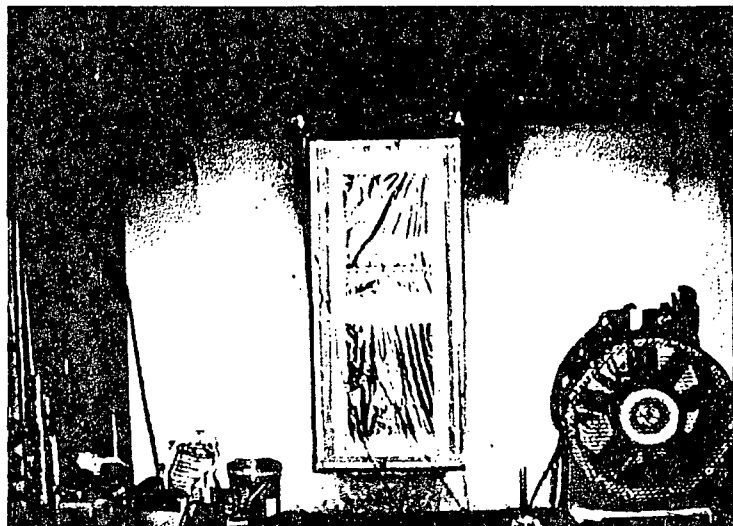


Photo 5
Overall view of the test chamber

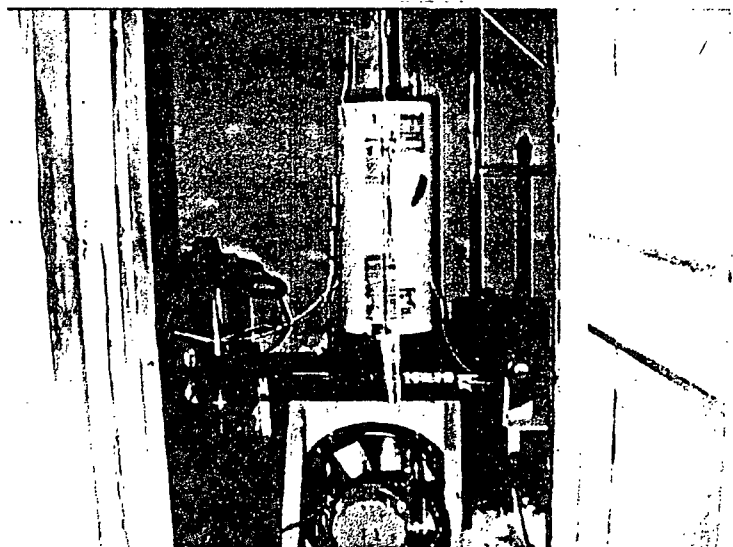


Photo 6
Close up of test setup.
Sample lines, hot wire
anemometer, and aluminum
flashing are shown.

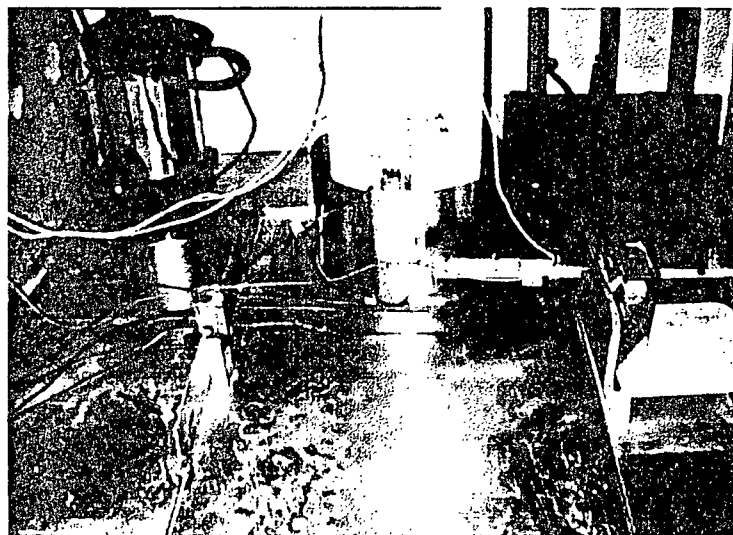


Photo 7
Sample lines "running" to
the control room through
the wall.

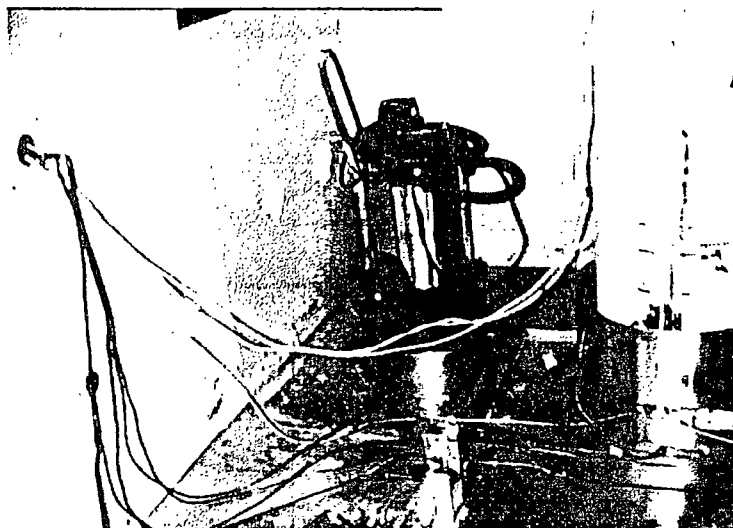


Photo 8
Aluminum flashing is
caulked to the floor pan.

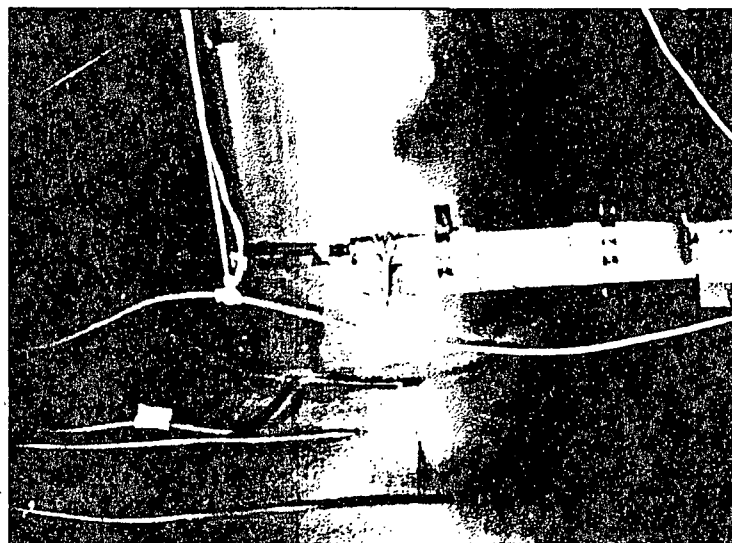


Photo 9
Overall view of
the control room.

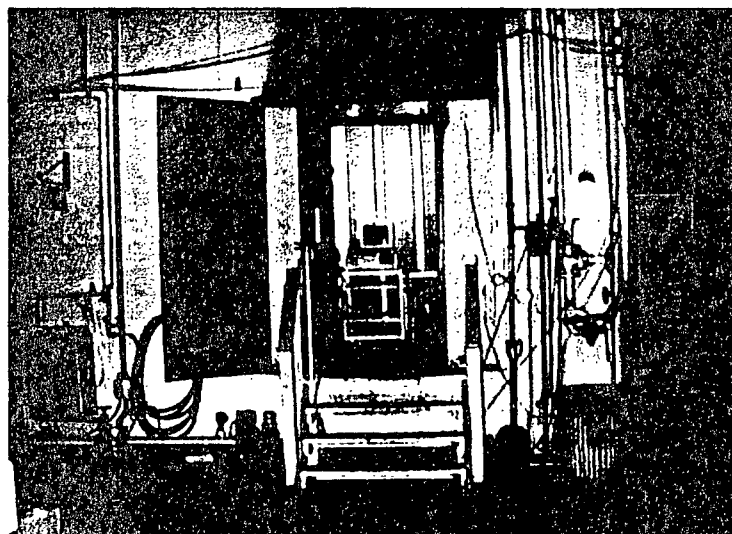


Photo 10
Gas analyzer and power
supply for water heater
stack and stack speed gage.

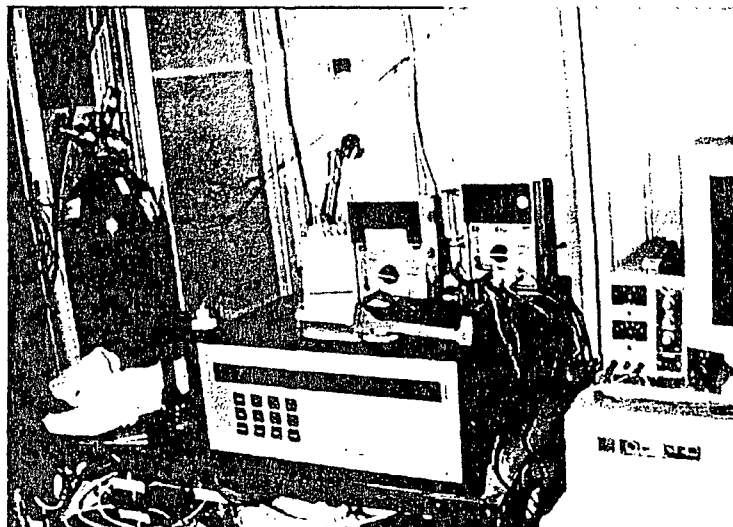


Photo 11
Sample/nitrogen and
propane (half and full
span) gas valves.

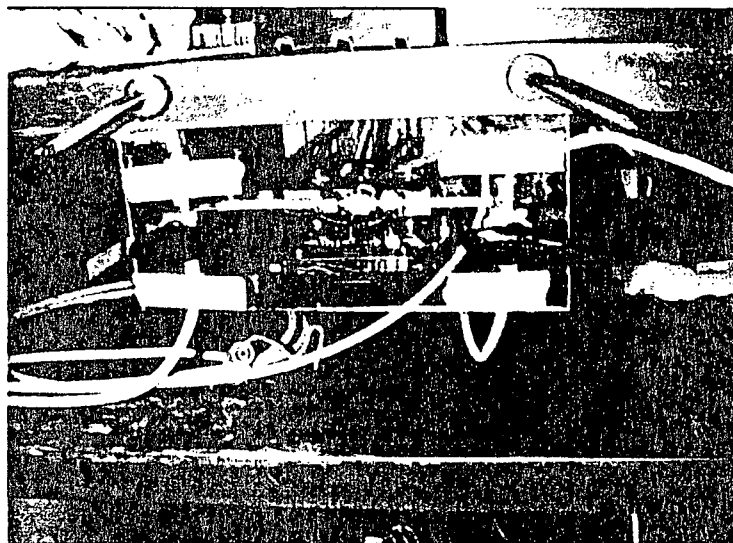


Photo 12
Pump

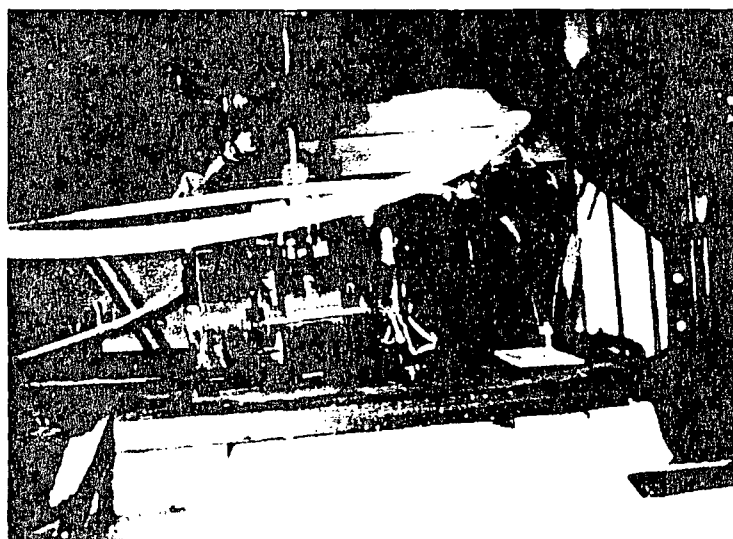


Photo 13
Solenoid valves.

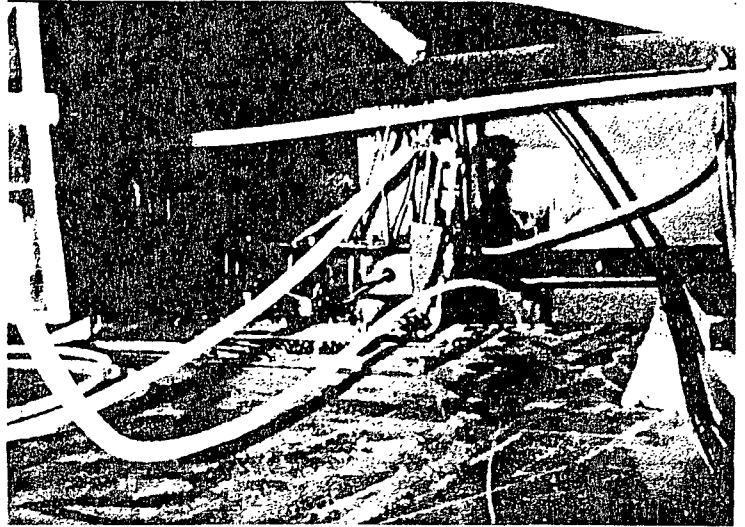


Photo 14
Nitrogen/propane gas
bottles.

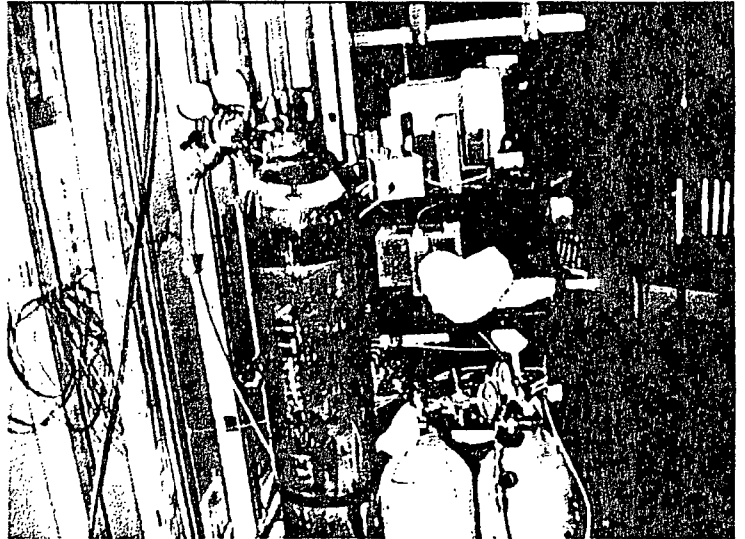


Photo 15

APPENDIX B

UNITED STATES GOVERNMENT
MEMORANDUM

**U.S. CONSUMER PRODUCT
SAFETY COMMISSION
WASHINGTON, D.C. 20207**

April 12, 1994

TO : Joe Fandy, ESEE
Through : Robert T. Garret, Acting Director - ESEL 
FROM : Michael P. Smith, ESEL
SUBJECT : Water Heater Test Project

The attached report documents the final phase of the water heater test project. This along with prior reports concludes the testing for this project.

cc : Albert Martin, ESEL ✓
George Sushinsky, ESEL
James Bradley, ES

INTRODUCTION

These tests determine the effects, on the heater's combustion characteristics, of placing a barrier(weir) around the base of a water heater. Previous tests performed at the National Institute for Standards and Technologies' (NIST) Fire Lab showed that with the water heater on the floor, a nearby gasoline spill can lead to vapor concentrations above the lower explosive level(LEL) at the pilot burner. The compiled data as well as test summaries from these tests were given to the project manager, Joe Fandy, in mid December 1993 at a meeting held in the Engineering Science's Engineering Laboratory's (ESEL) conference room. Further testing showed that this was prevented by placing a weir around the heater and sealing it to the floor.

APPARATUS AND PROCEDURES

The ESEL combustion hood lab was used to gather data on the combustion characteristics of the water heater. The heater tested is a methane gas fired water heater with a capacity of 40 U.S. gallons. The heater has a diameter of approximately 17.75 inches and the base is held 2 inches off the floor by the feet of the heater. The manifold pressure is regulated to 4 inches w.c. and the inlet pressure may range from 5-14 inches w.c.. The sample number of this heater is R-598-0709. It was referred to as heater 'C' in previous testing. The weir used has a height of 14 inches and a diameter of approximately 23 inches. Figure 1 depicts the test setup with the weir in place.

Heater 'C' was placed under the combustion hood and fitted with hoses for fresh water in and hot water out. Tests were made at various inlet fuel pressures. During each run the main

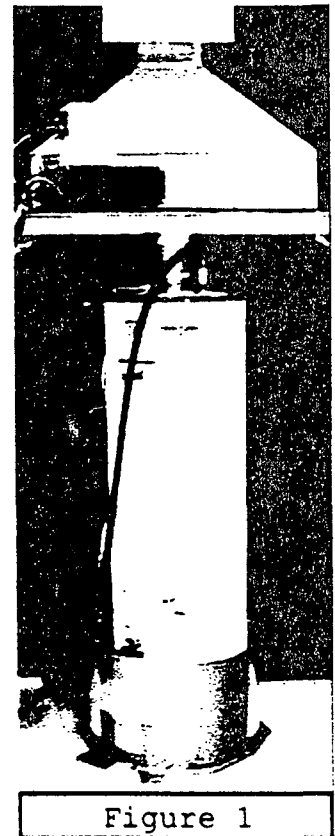


Figure 1

burner was cycled on and off manually using the heater's thermostat. Runs were made both with and without the weir in place. During one run the annular area between the heater and the weir was blocked with a rolled up cotton sheet to determine the effects of choking air to the fire.

RESULTS

Figure 2 compares the exhaust stack velocities of two runs. Both runs were with a fuel inlet pressure of 6 inches w.c.. One was performed with the weir and the other without. The graph shows that the weir had no notable effect on the exhaust flow. The difference in readings is within the accuracy of the instrumentation. On the run made with the weir a gradual

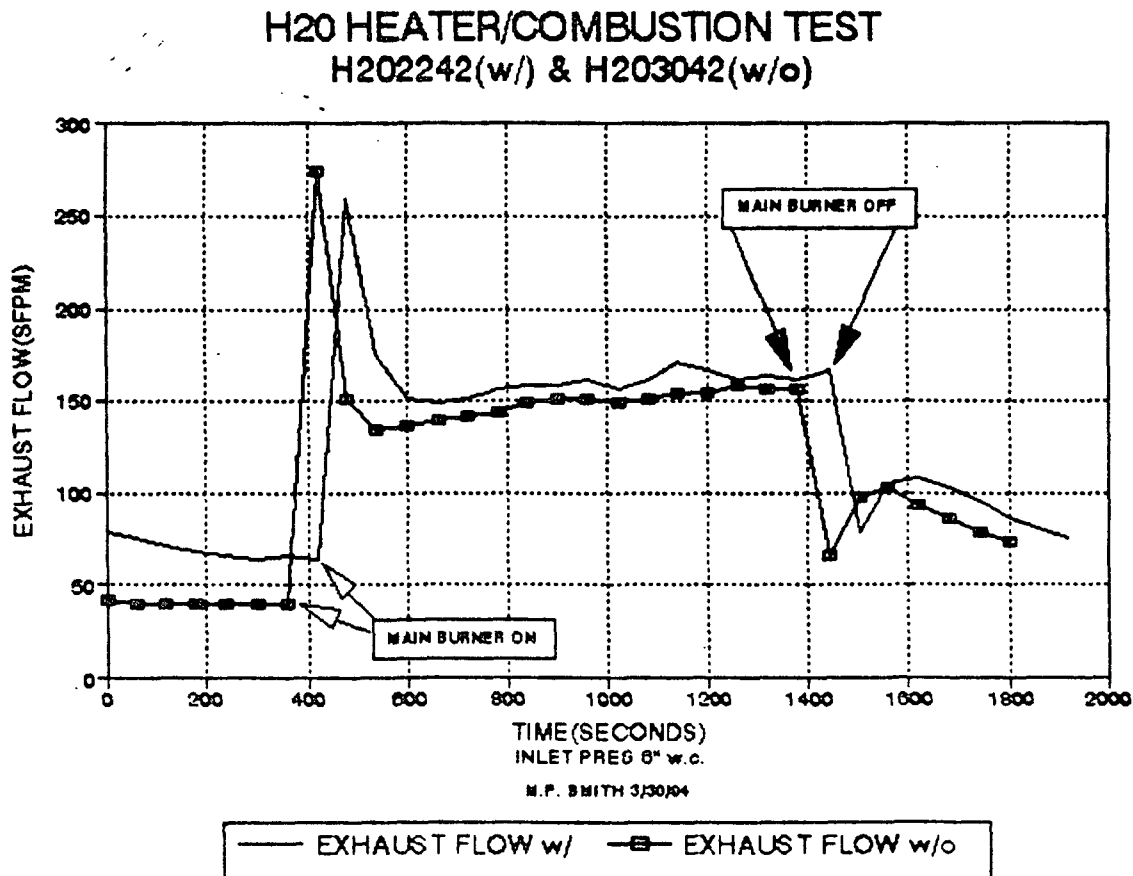


Figure 2

decrease is seen in the flow before the main burner was ignited. This was caused by residual heat in the exhaust stack from the previous run. Because of this the flow gradually decreased, as the stack cooled, to the level created by the pilot burner. The spikes just after the main burner was either ignited or extinguished are caused by the transient characteristics of the hot-wire anemometer.

Figures 3 and 4 show data from the same run. This run was performed with an inlet pressure of 6 inches w.c.. The weir was not set in place until approximately 900 seconds into the test. By 1150 seconds the weir had been sealed, and at 2100 seconds it was removed. Throughout this test, there were no changes in the CO or CO₂ produced by the heater. The gradual decrease in fuel flow was the result of the heating of the burner's components.

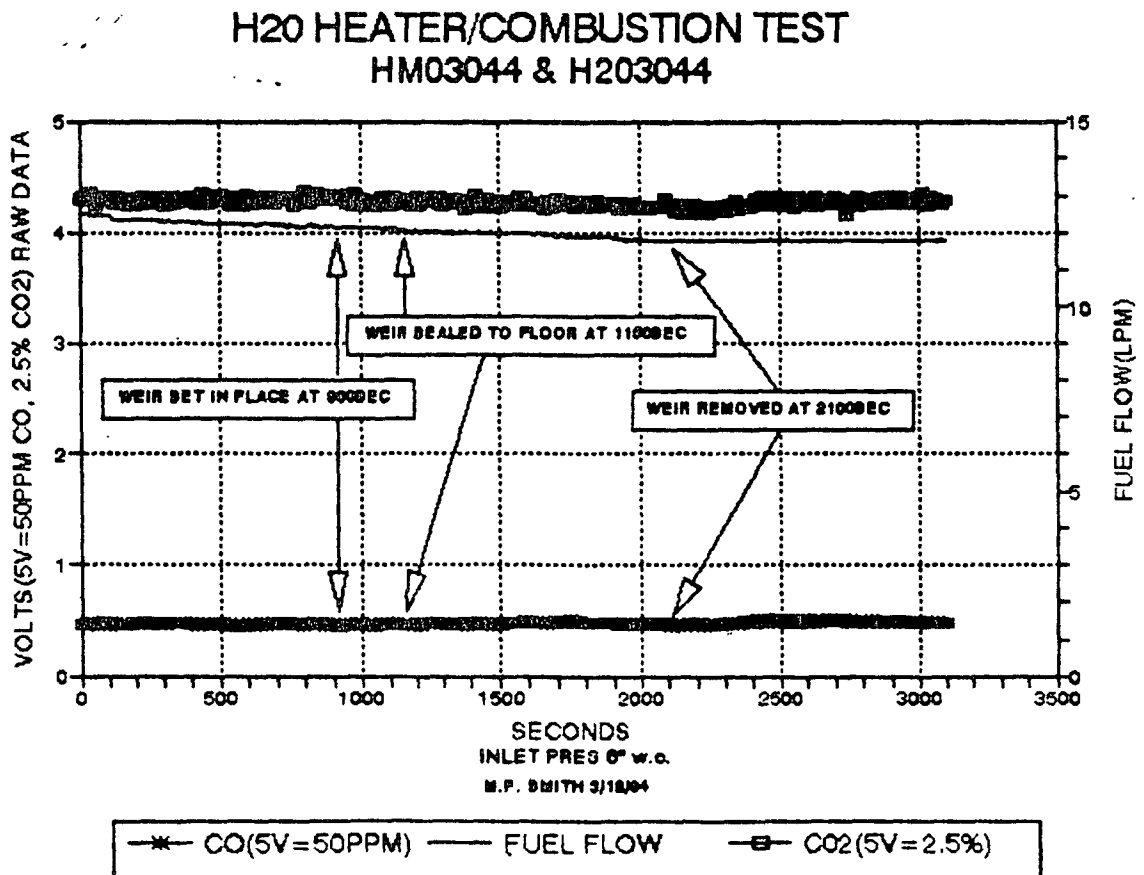


Figure 3

The exhaust flow also failed to show any notable changes with the weir in use.

Figure 5 shows the CO, fuel flow, and exhaust flow for a test where a rolled up cotton sheet was used around the top of the weir to block the air passage way between the weir and the heater.

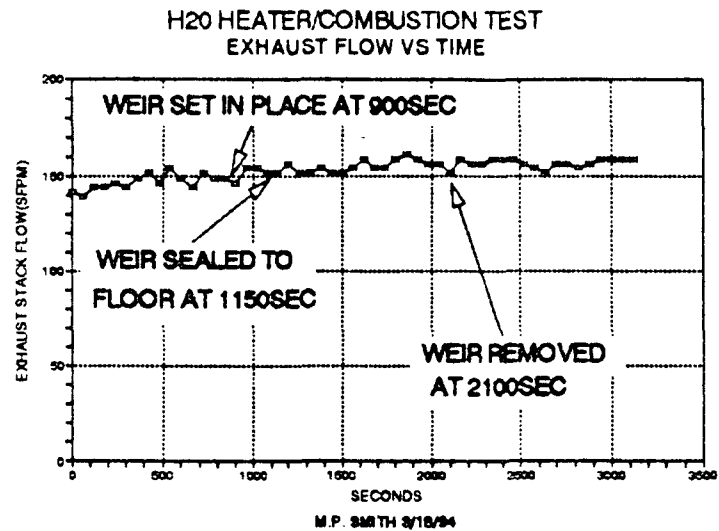


Figure 4

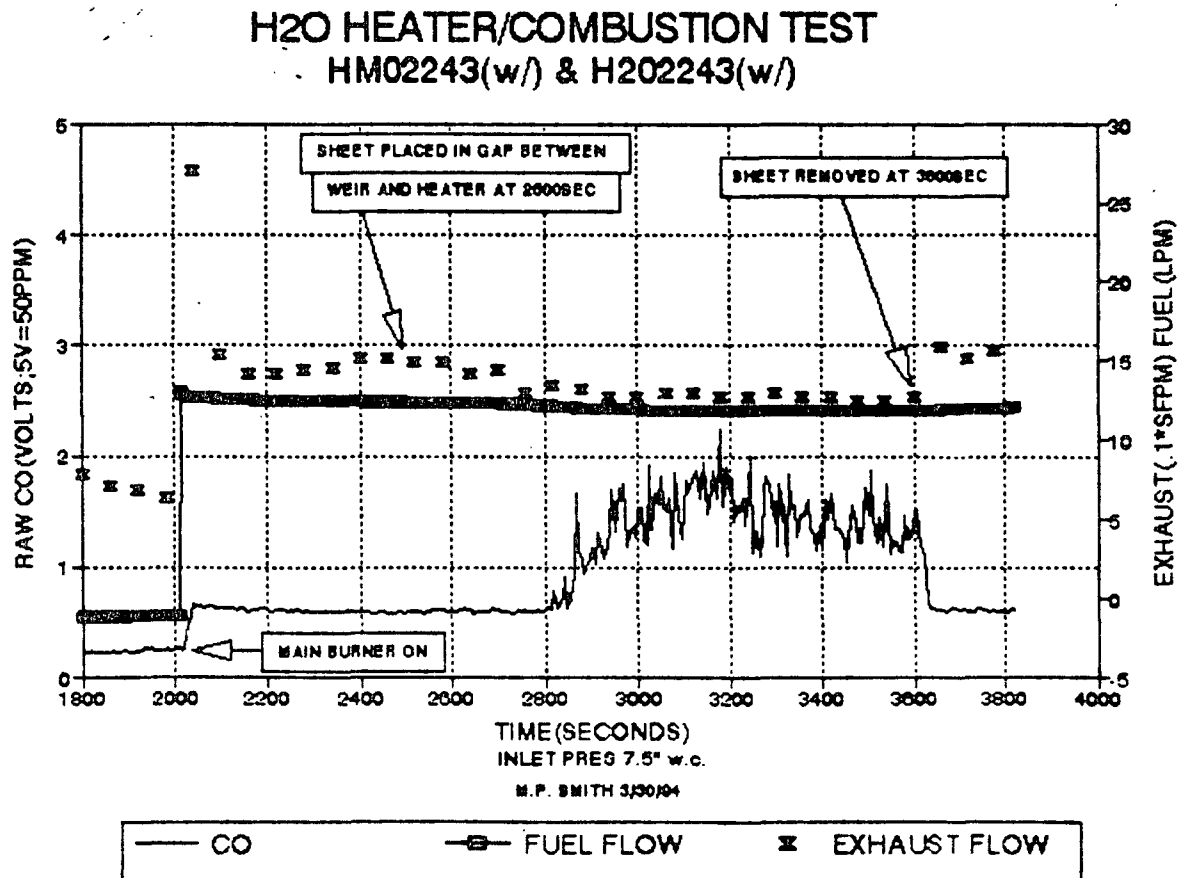


Figure 5

The inlet pressure for this run was 7.5 inches w.c.. Only the pilot burner was on until 2000 seconds when the main burner was ignited. As with previous tests the spikes present in the exhaust flow were caused by the transient characteristics of the hot-wire anemometer. This test demonstrates what happens when a fire is choked. The exhaust flow decreased soon after the sheet was in place. About 300 seconds after the air supply was cut off the fire exhausted most of its oxygen and began to burn below stoichiometric conditions which resulted in high amounts of CO being produced. The reduction of fuel flow was the result of normal heating as explained earlier. Once the sheet was removed the fire quickly returned to its normal state of dynamic equilibrium.

DISCUSSION

These tests have demonstrated that placing a weir around the base of a water heater has no notable effect on the heater's combustion characteristics. These were the expected results. The area around the outside of the heater between the base and the floor was approximately 104.5 square inches. The annular area between the weir and the heater was approximately 171 square inches. As long as the weir provides an area for the heater to breath through which is equal to, or larger than, the area the furnace would otherwise breath through there should be no adverse effects on combustion. Previous testing at NIST showed the weir's effectiveness in preventing gasoline vapors from reaching the heater's burner. Current data along with data from previous testing demonstrate that the placement of a weir around the base of a water heater is an acceptable way to keep combustibile vapors away from the heater's burner.

CONCLUSIONS

While previous testing has shown that using a weir is an effective way of preventing vapors from gasoline spills from being ignited by a water heater's burner, there was a question as to the effects it could have on the heater's air supply. These

ESDOC 552908

tests show that the use of a weir has no adverse effects on the combustion performance of the water heater.

UNITED STATES GOVERNMENT
MEMORANDUM

U.S. CONSUMER PRODUCT
SAFETY
COMMISSION
WASHINGTON, D.C. 20207

January 19, 1994

TO: The Commission

THROUGH: Sadye E. Dunn, Secretary *[Signature]*
THROUGH: Jerry G. Thorn, General Counsel *[Signature]*
THROUGH: Eric C. Peterson, Executive Director *[Signature]*
THROUGH: Bert G. Simson, Assistant Executive Director, EXHR *[Signature]*
THROUGH: James E. Bradley, Acting Associate Executive Director, ES *[Signature]*
William S. West, Director, ESEE *[Signature]*

FROM: Joseph Z. Fandey, ESEE, Project Manager (504-0508 ext.1293) *[Signature]*

SUBJECT: Request for Commission endorsement of an information campaign for the dangers of flammable vapors

I. **Issue:** Whether the Commission should endorse the campaign, for grades kindergarten through eight, and allow the use of the Commission's name and/or logo in the consumer education materials developed by the Gas Appliance Manufacturers Association (GAMA).

II. **Background:** For several years, staff has been concerned with the problem of gas appliances, especially water heaters, igniting flammable vapors. Two years ago, staff requested that the voluntary standards organization, American National Standards Institute (ANSI) Z-21 subcommittee on water heaters, set up a special working group to study these ignitions in an attempt to develop a strategy to reduce or eliminate them. Shortly after the working group first met, the GAMA Consumer Information and Education Committee, Water Heater Division, sponsored two phases of an initial response. One was scientific and one was informational. Staff has received final reports on the first two phases of scientific study and will report separately.

At a GAMA reported cost of several million dollars, the GAMA consumer education program takes a multiple approach with video segments for television, a program for children in kindergarten through eighth grade including a comic book and other print products, and communications to the plumbing trade. Once the program was developed, GAMA representatives came to CPSC and made a presentation of the materials to two Commissioners and staff. This presentation showed the entire program in context. A similar presentation is included on the video tape in the package

CPSC 6 (b)(7) (D) cleared
for release of
information

previously distributed to the Commissioners (a copy is available for viewing in the Office of the Secretary). The video portion has been shown on television this past summer, most notably during the NBA basketball championship play-offs.

When GAMA announced their plans for the informational program, staff discussed with GAMA the possibility of working together in the development of a cooperative educational program; however, GAMA felt that it did not have enough time to ask for CPSC participation or prior endorsement before showing the pieces during the period of highest risk (the summer). Now that the time pressure is over, GAMA is taking this opportunity to request CPSC participation through endorsement, (Tab A).

III. Discussion: The Commission is being requested to endorse the information campaign that GAMA developed advising consumers about the hazards of flammable liquids. Staff notes that the National Fire Protection Association (NFPA) allowed the use of its trademarked "Sparky"® the Fire Dog. The CPSC General Counsel reviewed the materials and reports he sees no legal impediments to supporting the campaign (TAB B). Subsequent to the General Counsel's opinion, staff made contact with GAMA about the specific language which GAMA would like, should an endorsement be granted by the Commission. The specific language discussed was "...developed (or sponsored) by GAMA in cooperation with the Consumer Product Safety Commission" or other words to that effect which the Commission determines to be preferable. The Commission could decide whether to allow use of such words with or without the CPSC logo.

The GAMA made a studied attempt to get useful information to the attention of a broad cross-section of "at risk" consumers. To the extent that it convinces consumers to avoid having gasoline and other flammable vapors present in the home or around gas appliances, it will reduce the risk of injury. Staff considers that this is an important and significant contribution to reducing the death and injury incidents which involve flammable vapors around the home. However, staff believes that the program will be only partially effective unless combined with technical solutions.

When the request from GAMA was received, this writer responded that the Commission would be requested to consider the matter (Tab C). During the review of the materials received in order to develop this package, staff found a number of points of emphasis, error or variation from what has been consistent staff position on warnings. Staff, therefore, could not then recommend that the Commission endorse the program. However, staff has had several meetings and telephone conversations with GAMA, after which significant improvements in the printed materials were made (TAB D). In addition, one label which was included in the ANSI standard without incorporating staff comments will be removed from the program. Therefore, staff feels that, as revised, and not including the label from the ANSI standard, staff can recommend that the Commission favorably consider allowing the program to include the use of the CPSC logo with the requested statement.

Staff believes that CPSC endorsement would make the program more attractive to TV and other potential outlets as a public service.

IV. Options:

1. Grant the request to use CPSC's name with the phrase "...developed (or sponsored) by GAMA in cooperation with the Consumer Product Safety Commission." This granting could apply to each program component remaining after the removal of the label.
2. Extend option one by allowing the CPSC logo in conjunction with the phrase from option one.
3. Deny the request.

V. Recommendations: Staff recognizes the contribution which GAMA is making to product safety with this program. Staff recommends that the Commission commend the GAMA effort, grant the request and allow the use of the CPSC name and/or logo on the materials presented (except the label) with the statement "developed by GAMA in cooperation with the Consumer Product Safety Commission."

UNITED STATES GOVERNMENT

MEMORANDUM

U.S. CONSUMER PRODUCT
SAFETY COMMISSION
WASHINGTON, D.C. 20207

NOV 21 1991

TO : Joseph Z. Fandey, Project Manager, ESEE

Through: Dr. Robert D. Verhalen, Associate Executive Director
Directorate for Epidemiology
Jacqueline Elder, Acting Director, EPHF

FROM : George Sweet, EPHF, 492-6468

SUBJECT: Gas Water Heaters

Human Factors was asked to comment on the recommendation that air intake openings on gas water heaters be raised above the floor. Human Factors was also asked to provide input on the use of warning labels on gas water heaters to address the potential for ignition of flammable vapors.

Background

Fires have been started by flammable vapors coming into contact with the pilot light of gas water heaters. In most cases, the air intake openings on gas water heaters are at floor level. Flammable vapors are usually denser than air and therefore, stay near the floor. The vapors can travel significant distances across a floor. Flammable vapors enter the water heaters at the air intake openings which delivers the air flow to the burners. If the vapors reach the air intake openings and come into contact with the pilot light, they are ignited. Recommendations have been made to raise air intake openings above the floor as a means of preventing flammable vapor fires.

Discussion

Raising the air intake openings on gas water heaters appears to promote fire prevention. Logically, it follows that raising the air intake openings would reduce fires occurring from the ignition of flammable vapors because it would be less likely that the dense vapors would rise a sufficient height to enter the water heater through the air intake openings. However, it is not a complete solution, and additional research is required to determine the height that best reduces the potential of vapors being ignited.

Page 2

A warning label is not an acceptable substitute for raising air intake openings off the floor. It is important that a warning label be placed on the product, however, the warning label is not the solution to the problem, it is an identification of the problem to the consumer. Even though raising the air intake opening should decrease the potential of fires, it will not eliminate the potential for fires. It is conceivable that consumers will perceive the change of height as a complete solution to the problem, resulting in a false sense of security. The consumer must still be warned of the dangerous combination of gas water heaters and substances with flammable vapors. The warning label must be noticeable, easily understandable, and provide complete information in order to be effective. The warning label should be conspicuous, not blending in with the instructions.

Conclusion

Human Factors supports raising the air intake openings of gas water heaters to decrease the potential for fires caused by the ignition of flammable vapors. Even with the adjusted height, it is essential that warning labels be conspicuously placed on gas water heaters to inform consumers of the potential fire hazard when products with flammable vapors are kept in proximity to a gas water heater. Additional research is required to determine the ideal height for the air intake openings in order to enhance fire prevention.

bcc:

Verhalen

Official

EPHF:SWEET:phg:11/21/91✓



Factory Mutual Research

1151 Boston-Providence Turnpike
P.O. Box 9102
Norwood, Massachusetts 02062
Telephone (617) 762-4300
Fax (617) 762-9375

15 April 1994

Attention: Dr. Howard I. Forman, Chairman
ANSI Z21 Accredited Standards Committee
Post Office Box Number 66
Huntigdon Valley, Pennsylvania 19006

Subject: GAMA Consumer Safety Awareness Campaign

Dear Dr. Forman:

I just received your letter of 8 April 1994. Like you, I am impressed with Jack Langmead's abilities and sincerity, but I cannot share your apparent unreserved endorsement of this campaign as a solution to the flammable vapor-ignition hazard problem.

This is a public relations response to a technical hazard. Or, as the computer-oriented would say, we are trying to solve a hardware problem with a software solution.

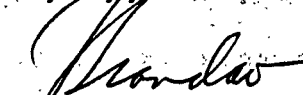
In my industry, we refer to "human element" problems as contributing factors to losses, but have long recognized that, no matter how thorough our educational efforts, inherent hazards cannot be eliminated or even adequately mitigated through such efforts.

Flammable vapors exposed to sources of ignition are an inherent hazard. They can only be prevented by removing one or the other. We would say that flammable liquid operations cannot be conducted within a building without putting that building (and its occupants) at inherent risk. If its easy or convenient to handle the flammable liquid indoors, it will be done by some individuals, no matter how many warning labels or educational programs to which they are exposed. Similarly, the ignition sources cannot all be removed (hot surfaces, static discharge, sparks from dropped tools, et cetera) without bulldozing everyone's home and starting over. Thus, the hazard cannot be eliminated. Therefore, it must be mitigated.

Mitigation involves isolating all obvious controllable sources of ignition from exposure to the vapors, as much as is possible. Clearly, elevating the pilot on a water heater is a very doable mitigation strategy. To argue that it is not 100 percent effective as justification for doing something with a much lower probability of success is indefensible. I realize that elevating the pilot will cost money and create market resistance, but that cannot be a concern of the committee. We do not exist to promote an industry. We are intended to be one of the countervailing forces to resist industry's natural self-serving tendencies.

While I applaud GAMA's educational efforts, I cannot accept them as grounds for our delaying or deferring requiring hardware changes to minimize the likelihood of a gas appliance's pilot or burner becoming an ignition source for flammable vapors.

Very truly yours,


Armand V. Brandao, P.E.
Manager
Fuels Section
Approvals Division

Direct Telephone: (617) 255-4860



United States
CONSUMER PRODUCT SAFETY COMMISSION
Washington, D.C. 20207

MEMORANDUM

DATE: April 18, 1994

TO : Joseph Z. Fandey
Project Manager for Fire and Gas Voluntary Standards

Through: Warren Prunella, AED, Economic Analysis *WPP*

FROM : Robert Franklin, Economist, ECSS (504-0962) *RF*

SUBJECT: Economic Issues Concerning Modifying Water Heaters to Prevent the Accidental Ignition of Gasoline Vapors.

Information provided to the staff of the Consumer Product Safety Commission (CPSC) by an attorney indicates that the risk of accidental ignition of gasoline vapors by gas water heaters can be substantially reduced by modifying the design or installation of water heaters. Further investigation by the staff of the CPSC seems to substantiate this conclusion. This memorandum discusses some economic issues that need to be considered in developing the Commission's options for reducing the incidents of gasoline vapors being ignited by gas water heaters.

Number in Use and Annual Sales of Gas Water Heaters

According to the Department of Energy's Residential Energy Consumption Survey of 1990, 40 million to 50 million U.S. households have gas water heaters. All other things being equal, the number of gas water heaters in use will likely increase over the foreseeable future as the number of households in the United States increases. Based upon current sales trends and the replacement rate for gas water heaters, there may be an additional 10 million units in use by the end of this decade.

Annual sales of residential, gas water heaters have been increasing. From 1960 through 1965, an average of just under 2.5 million gas water heaters were shipped annually. Since 1987, over 3.5 million units have been shipped annually (American Gas Association). The number of shipments in any particular year is influenced by the volume of new housing starts in particular and overall economic conditions in general. Shipments of water

heaters will also be affected by changes in the retail price of natural gas relative to the retail price of electricity and by energy-related regulations that favor the use of natural gas over electricity.

Structure of the Industry

The water heater manufacturing industry is highly concentrated. According to *Appliance Magazine*, the five largest water heater manufacturers have a combined market share of 99 percent. The high degree of concentration in the water heater industry should facilitate standards development and enforcement. It is a much less onerous task to coordinate standards development and enforcement in a market dominated by a small number of large manufacturers than it is in a market in which there are many small and medium size manufacturers. This applies to both voluntary and mandatory standards.

Number and Cost of Incidents

The number of incidents involving the ignition of flammable vapors by gas water heaters varies from year to year. A study prepared for a law firm in Louisiana showed that from 1980 to 1984, there were an average of over 2,000 fires involving gas water heaters and flammable vapors annually (Gauthier, Murphy, and Downing). These fires resulted in an average of 361 injuries, 21 deaths, and over \$15 million in property damages annually. The Directorate for Epidemiology reports that in 1991 there were a total of 1,211 fires involving gas water heaters and flammable vapors. Of these fires, 845 involved gasoline. The fires involving gasoline resulted in 165 injuries and 21 deaths. In 1991, the average property damage resulting from fires involving gas water heaters was \$17,500 (CPSC, 1993). Using this figure, the property damage in 1991 associated with gas water heaters igniting gasoline vapors can be estimated at \$15 million.

Although the nature and severity of all the injuries is not known, it is known that at least some of the injuries involve second and third degree burns. Severe burns are among the most costly personal injuries that can be suffered in terms of direct medical expense, loss of income, physical pain, emotional trauma, and damage to interpersonal relationships. Elizabeth Leland reported in a 1992 memorandum that in 1988, 22 percent of the jury awards for burn injuries ranged from \$100,000 to \$299,000 and 35 percent of the awards exceeded one million dollars (CPSC, 1992). A CPSC sponsored study estimated that the average societal cost of a hospitalized fire burn was \$900,000. The largest component of this cost was "pain and suffering," which was estimated to be \$785,000 per case. The other components of the costs included medical costs, lost productivity, and

administrative and legal costs (Miller, p. 74). Therefore, if one assumes that all of the 165 injuries in 1991 were burns requiring hospitalization, the total social costs of these injuries may be as high as \$150 million.

Using these estimates, the total cost to society of fires involving the ignition of gasoline vapors by gas water heaters in 1991, may be over \$200 million. This estimate includes \$150 million in cost of injuries, \$15 million in property damage, and \$42 million for the social cost of the 21 fatal injuries.

Reducing the Costs

The evidence available strongly suggests that raising the combustion air intakes 12 to 18 inches from the floor will substantially reduce, if not eliminate, the risk of a gas water heater igniting gasoline vapors. The risk of gas water heaters igniting other flammable vapors may also be reduced. If no action is taken to reduce the risk the incidents will continue to occur. And since the number of gas water heaters in use are expected to increase, all other things equal, the number of incidents occurring annually will likely increase. However, if modifications are made that substantially reduce or eliminate the risk, the number of incidents occurring each year will be reduced as the existing water heaters are replaced with the safer models.

According to *Appliance Magazine*, the average useful life of a water heater is 11 years, with most being replaced between the 4th and 18th year. If a standard eliminated the risk of new water heaters igniting gasoline vapors, by the 10th year after such a standard became effective fewer than 50 percent of the gas water heaters in use when the standard became effective should still be in use. The number of incidents occurring annually should likewise be reduced. By the 25th year, fewer than 10 percent of the old units should remain in use and the number of incidents occurring should be similarly reduced. Assuming that 1991 was a typical year, within 10 years of a standard becoming effective, the annual social costs can be expected to have fallen from \$200 million a year to under \$100 million a year. Within 25 years the annual social costs can be expected to be close to zero.

On a per unit basis, the expected social costs related to incidents involving gas water heaters and the ignition of gasoline vapors is \$4 to \$5 per year (\$200 million in social costs divided by the 40 million to 50 million units in use in 1991). Assuming an average useful life of 11 years and a discount rate of 5 percent, a design modification that eliminates this risk would on average be worth \$35 to \$45 over the life of the unit. If the a design modification also reduces the risk incidents involving gas water heaters and flammable vapors other than gasoline, the value of the modification would be greater.

At the present time, a new gas water heater with a 50 gallon capacity can be expected to cost at least \$200 and another \$150 to install.

References

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CPSC (1993), "1991 Residential Fire Loss Estimates," CPSC Memorandum from Linda Smith (EPHA) to the Commission (September 16, 1993).

Gauthier, Wendell H., Robert M. Murphy, and Edward F. Downing, III, Water Heaters and Flammable Vapors, Gauthier & Murphy (law firm), Metairie, Louisiana.

Miller, Ted R., et al., Estimating the Costs to Society of Cigarette Fire Injuries: Final Report, (July 1993).



United States
CONSUMER PRODUCT SAFETY COMMISSION
Washington, D.C. 20207

MEMORANDUM

DATE: April 21, 1994

TO : Joseph Z. Fandey
Project Manager for Fire and Gas Voluntary Standards

Through: Warren Prunella, AED, Economic Analysis *WLP*

FROM : Robert Franklin, Economist, ECSS (504-0962) *RF*

SUBJECT: Updated Estimates of the Societal Costs of Fires
Associated with Gas Water Heaters and Flammable Vapors

On April 18, the Directorate for Economic Analysis provided you with estimates of the societal costs associated with gas water heaters and the ignition of gasoline vapors (CPSC, 1994a). These estimates were based solely on the number of incidents in one year, 1991. Since that memorandum was written, the Directorate for Epidemiology has provided estimates of the annual average number of fires, injuries, deaths, and property damages associated with gas water heaters over the six year period from 1986 to 1991 (CPSC, 1994b). Because these estimates cover more years, we have revised our estimates of the average annual societal costs of these incidents.

The estimates provided in our original memorandum of April 18 were based only upon the incidents involving gasoline vapors. The estimates were limited to incidents involving gasoline because most of the experiments conducted on the problem have involved gasoline. However, we understand that modifications to water heaters that reduce the risk of gasoline vapors being ignited will also reduce the risk of other flammable vapors being ignited. Therefore, this memorandum provides estimates of the societal costs of incidents involving gas water heaters and all flammable vapors as well as estimates of the societal costs of incidents involving gasoline vapors only.

Societal Costs of Injuries

There were an average of 316 people injured each year between 1986 and 1991 in incidents involving gas water heaters and flammable vapors (CPSC, 1994b). Of these, 239 involved

gasoline. Many of these injuries involved severe burns. A CPSC sponsored study estimated that the average societal cost of a hospitalized fire burn, including medical costs, lost productivity, administrative costs, legal costs, and pain and suffering was \$900,000 (Miller, p. 74). The largest component was "pain and suffering," which was estimated to be \$785,000 per case. Pain and suffering includes not only compensation for physical pain but also includes compensation for emotional trauma, damage to social relationships, and so on caused by disfigurement. If one assumes that all of the injuries involve fire burns requiring hospitalization, the annual societal costs of the injuries may be as high as \$284 million. The annual societal costs of those injuries associated with gasoline vapors only may be as high as \$215 million.

Societal Costs of Deaths

An average of 17 people die each year in incidents involving residential gas water heaters and all flammable vapors. Of these, an average of 14 incidents annually involved gasoline. Ideally, an estimate of the societal cost of a death should consider factors such as the suffering of the victim before death, the value of the lost production to society, and the premature loss to society of someone who may have filled multiple roles such as friend, parent, child, sibling and so on. The policy of the Directorate for Economic Analysis has been to assume a \$2 million cost to society for each death. Following this policy, the cost to society of deaths involving all flammable vapors is \$34 million annually. The cost to society of deaths involving gasoline vapors only is \$28 million.

Property Damage

The property losses from fires involving residential gas water heaters and all flammable vapors is estimated to be \$26 million annually. The property losses from fires involving gasoline vapors only is estimated to be \$20 million (CPSC, 1994b).

Total Societal Costs

Fires involving residential gas water heaters and all flammable vapors cost society about \$344 million annually. The total cost to society of only the incidents that involve gasoline vapors is about \$263 million annually. Because there are an estimated 40 to 50 million residential gas water heaters in use in the United States, the expected cost to society of these incidents per water heater is \$6.88 to \$8.60 for incidents

involving all flammable vapors. Incidents involving gasoline account for approximately \$5.26 to \$6.58 of this amount.

Assuming a discount rate of 5 percent and an average useful life for a water heater of 11 years, modifications that prevented virtually all incidents involving the ignition of flammable vapors by gas water heaters would be worth between \$59 and \$74 over the life of the water heater. Modifications that only prevented the ignition of gasoline vapors would be worth between \$45 and \$57 over the life of the product.

These estimates are based upon the information available about the incidents involving gas water heaters igniting flammable vapors during the six year period from 1986 to 1991. These estimates may be revised should new information become available.

References

CPSC (1994a), "Economic Issues Concerning Modifying Water Heaters to Prevent the Accidental Ignition of Gasoline Vapors," CPSC Memorandum from Robert Franklin (ECSS) to Joseph Z. Fandey (ESSE) (April 18, 1994).

CPSC (1994b), "Summary of Data on Gas-Fueled Water Heaters and Flammable Vapors," CPSC Memorandum from William L. Rowe (EPHA) to Joseph Z. Fandey (ESEE) (April 18, 1994).

Miller, Ted R., et al., Estimating the Costs to Society of Cigarette Fire Injuries: Final Report, (July 1993).

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Billing Code 6355-01

CONSUMER PRODUCT SAFETY COMMISSION

16 CFR Part 1212

Gas Water Heaters

Advance Notice of Proposed Rulemaking; Request for Comments and Information

AGENCY: Consumer Product Safety Commission.

ACTION: Advance notice of proposed rulemaking.

SUMMARY: Based on information currently available to the Commission, the Commission has reason to believe that unreasonable risks of injury and death may be associated with gas water heaters that provide insufficient resistance to igniting vapors from flammable liquids that are spilled in the vicinity of the water heater. Each year, approximately 1,944 fires are caused by gas water heaters igniting flammable vapors, especially gasoline. These fires annually cause approximately 316 burn injuries and 17 deaths. This advance notice of proposed rulemaking ("ANPR") initiates a rulemaking proceeding under the authority of the Consumer Product Safety Act ("CPSA"). One result of the proceeding could be the promulgation of a rule mandating performance standards for gas water heaters.

The Commission solicits written comments from interested persons concerning the risks of injury and death associated with the ignition of flammable vapors by gas water heaters, the regulatory alternatives discussed in this notice, other possible means to address these risks, and the economic impacts of the various regulatory alternatives. The Commission also invites interested persons to submit an existing standard, or a statement of intent to modify or develop a voluntary standard, to address the risks of injury described in this notice.

DATE: Written comments and submissions in response to this notice must be received by the Commission by [insert date that is 60 days after publication].

ADDRESS: Comments should be mailed, preferably in five (5) copies, to the Office of the Secretary, Consumer Product Safety Commission, Washington, D.C. 20207-0001, or delivered to the Office of the Secretary, Consumer Product Safety Commission, Room 502, 4330 East-West Highway, Bethesda, Maryland 20814; telephone (301) 504-0800.

FOR FURTHER INFORMATION CONTACT: Joe Fandey, Directorate for Engineering Sciences, Consumer Product Safety Commission, Washington, D.C. 20207; telephone (301) 504-04508, ext. 1293.

SUPPLEMENTARY INFORMATION:

A. Background

For a number of years, the staff of the Consumer Product Safety Commission ("CPSC" or the "Commission") has been aware of incidents in which residential gas water heaters ignite the

vapors from flammable liquids that are spilled in the vicinity of the water heater. Because the staff was not aware of any features that could be incorporated into water heaters to prevent such ignitions, the staff believed that the only way to address this risk was to try to change consumers' behavior.

In the spring of 1991, however, a New Orleans attorney, Edward F. Downing, III, made a presentation to the staff that included video tapes of tests which showed that raising water heaters on an 18-inch-high stand greatly reduced the risk of gasoline vapor ignition. (This elevation of water heaters by 18 inches was already required by the National Fuel Gas Code for gas water heaters installed in hazardous locations and garages.) Mr. Downing's tests also showed that ducting the air from 18 inches above the ground had the same effect as raising the water heater.

These measures reduce the risk of ignition because the vapors from gasoline and other flammable liquids are significantly heavier than air and accumulate in a layer at the floor of the room. By ensuring that the air coming into contact with the flames in the water heater is obtained at some distance off the floor -- either by raising the water heater or ducting the air to a height of 18 inches -- the bulk of the flammable vapors can be kept separate from the potential source of ignition. Accordingly, in many cases, the concentration of flammable vapor that constitutes the lower explosive limit ("LEL") for that substance will not be achieved.

The CPSC's staff arranged for Mr. Downing to make the same presentation for the American National Standards Institute

("ANSI") Z-21 Subcommittee, which is responsible for the ANSI voluntary standard for water heaters (ANSI Z21.10). That presentation occurred on November 13, 1991. Subsequently, an ANSI working group was formed to address this ignition issue. In addition, the Gas Appliance Manufacturers Association ("GAMA") funded a study of elevated water heaters to review available fire data and to examine the effects of elevation on ignition prevention. However, despite the staff's request, it was not allowed by GAMA to participate significantly in the development of, or testing during, the study.

In March of 1992, the Commission's staff formally requested that the ANSI subcommittee develop a performance standard that would provide ignition prevention performance at least equal to that achieved when a specified water heater is tested in a draft-free room at an elevation of 18 inches (or at another height if testing showed it to be needed). When the GAMA-funded study became available, it showed that, under some test conditions, flammable concentrations of vapors could be produced at the water heater.

The Commission's staff does not consider the resulting study to be particularly useful for its stated purpose. Although ignition occurred in a number of the scenarios tested with elevated gas water heaters, the test conditions were far more likely to result in ignition than those that probably caused many of the fires that have occurred in consumers' homes. For example, the GAMA study used relatively large amounts of gasoline in their spills (up to 2 gallons). Although the amount of gasoline

involved in the fires in consumers' homes is not known, it seems unlikely that consumers store or handle gasoline in quantities that would produce very many 2-gallon spills. In addition, GAMA's study heated the room and floor to unreasonably high temperatures, up to 1230F, which significantly increases the rate of vaporization. Even under this study's severe ignition conditions, however, a substantial benefit to elevating the water heaters was shown. In addition, fire data in the study suggest that elevating waters heaters may help reduce the number of fires.

When the GAMA-funded study was presented to the ANSI working group, a motion was made to disband the working group because stands for water heaters would not prevent all fires. The CPSC staff person at the working group meeting objected to that proposal, and described plans for CPSC testing of ways to retrofit existing water heaters to provide protection against ignition of flammable vapors. The working group then decided that if the staff could demonstrate a retrofit method which would prevent ignition, there would be no strong basis for not doing so in new water heaters. Accordingly, the working group agreed not to disband before the staff's work was completed.

The staff believed that even if satisfactory voluntary standards were developed, it would be important to protect the millions of consumers who already have gas water heaters that present a risk of ignition. The retrofit, to be practical, would have to be inexpensive, easy to install, and effective.

The Commission's Engineering Laboratory staff conducted tests of a potential retrofit at the fire-testing facility at the National Institute of Standards and Technology ("NIST"). This retrofit involved the installation of a barrier made from a 6-foot piece of sheet metal roof flashing formed in a 14-inch high circle around the base of the water heater and sealed to the floor with duct tape. Flammable vapors would have to go over this barrier before they could be exposed to the flames from the water heater.

CPSC testing of this retrofit showed the ability of a dam, or weir, at the base of the water heater to keep flammable vapors from the potential ignition source. These test results were presented to the ANSI working group, and GAMA then announced plans to test burners and perhaps other alternative designs to reduce the ignition risk.

In addition, CPSC staff subsequently performed additional work showing that the use of a dam or weir has no effect on the ability of a water heater burner to operate without producing increased levels of carbon monoxide. However, despite the information that the Commission's staff has provided to the ANSI working group, the staff has not received any indication that industry is taking steps to develop a satisfactory performance standard to address the risk of igniting flammable vapors.

In view of the lack of progress of the ANSI subcommittee toward implementing a performance standard for gas water heaters, the Commission has decided to publish this advance notice of proposed rulemaking ("ANPR"). Publication of this document

commences a proceeding that ultimately could require gas-fired water heaters to meet specified performance requirements to address the identified risk of ignition of flammable vapors.

B. Statutory Authority

This proceeding is conducted under provisions of the Consumer Product Safety Act ("CPSA"), 15 U.S.C 2051-2084. A proceeding to promulgate a regulation establishing performance or labeling requirements as a consumer product safety standard is governed by the requirements in sections 7 and 9 of the CPSA. 15 U.S.C 2056, 2058.

To commence a rulemaking proceeding, the Commission must issue an ANPR as provided in section 9(a) of the statute. 15 U.S.C. 2058(a). If the Commission decides to continue the rulemaking proceeding after considering responses to the ANPR, the Commission must publish the text of the proposed rule, along with a preliminary regulatory analysis, in accordance with CPSA section 9(c). 15 U.S.C. 2058(c). If the Commission then wishes to issue a final rule, it must publish the text of the final rule and a final regulatory analysis that includes the elements stated in section 9(f)(2) of the CPSA. 15 U.S.C. 2058(f)(2). Before the Commission may issue a final regulation, it must make statutory findings concerning voluntary standards; the relationship of the costs and benefits of the rule; and the burden imposed by the regulation. CPSC sec. 9(f)(3), 15 U.S.C. 2058(f)(3).

C. The Product

The products that are the subject of this proceeding are gas-fired water heaters that are used in residences. The Commission estimates that there are between 40 and 50 million homes in the United States that have gas water heaters. The Commission is also interested in information on whether other

flame-producing appliances (such as gas-fired clothes dryers, furnaces, or ovens) are potential sources of ignition for flammable vapors.

D. The Industry

Information from the American Gas Association indicates that annual sales of residential gas water heaters have increased from 2.5 million units in the early 1960's to 3.5 million units in the late 1980's. Five manufacturers dominate the gas water heater market, with 99% of production.

E. Risks of Injury and Death

An average of 316 people were injured and 17 people died each year between 1986 and 1991 in incidents involving gas water heaters and flammable vapors. Of these incidents, an average of 239 injuries and 14 deaths each year involved gasoline. Many of the injuries involved severe burns.

For the period 1986 through 1991, gasoline and other flammable vapors accounted for the following percentages of incident categories associated with gas-fired water heaters: 20% (1,944 incidents) of the fires; 54% (316 people) of the persons injured; 44% (17 people) of the deaths; and 30% (\$26,339,000) of the property loss.

The societal costs from fires involving flammable vapors and gas-fired water heaters may exceed \$300 million per year. Fires involving only gasoline are estimated to cause annual societal costs that may be as much as \$215 million for injuries, \$28 million for deaths, and \$20 million in property damage.

Assuming a discount rate of 5% and an average useful life of 11 years for a water heater, the estimated value of modifications that prevented virtually all incidents involving the ignition of flammable vapors by gas water heaters would be between \$59 and \$74 per water heater.

F. Existing Standards

The ANSI Z-21 standard, discussed above, does not contain any performance requirements intended to prevent flammable vapors from coming into contact with the flames in gas water heaters. It does contain a labeling requirement applicable to water heaters for other than recreational vehicle installation. However, CPSC has not endorsed the warning label recommended by GAMA and has commented previously that the warning label needs more concise wording to help the consumer focus on the hazard being addressed. In any event, a warning label should not be used in place of a performance standard. To achieve product safety, the most effective approach is to design the hazardous feature out of the product. If labeling is used, it should, wherever possible, be used in conjunction with product modifications that address the risk.

The National Fuel Gas Code ("NFGC") has adopted a requirement, originally in the National Electric Code, that water heaters in garages be elevated so that the burner and pilot light are at least 18 inches off the floor. However, this requirement does not apply to water heaters located elsewhere in the home. In addition, there is a requirement that "gas appliances shall not be installed in any location where flammable vapors are likely to

be present, unless the design, operation, and installation are such to eliminate the probable ignition of the flammable vapors." The Commission's staff believes that this latter provision has not been considered as routinely applicable in homes to locations other than garages. Although one report indicates that 73% of U.S. homes have a garage (Flammable Vapor Hazards Ignition Study - Task 1 Report, Arthur D. Little, Inc., GAMA 1993) ("Task 1 Report"), not all homes with garages have the water heater in that location.

In addition, the Commission's staff believes that compliance with this provision of the NFGC has been poor. This lack of conformance may improve as this provision is adopted by model building codes, such as the Southern Standard Building Code and the Council of American Building Officials ("CABO") code. However, adoption by model building codes does not guarantee that the provision will be incorporated into local building ordinances, where compliance is enforced.

Moreover, garage ignitions apparently represent only a portion of the problem. The Task 1 report referenced above assembled a database of 135 incidents involving ignition of flammable vapors by residential gas water heaters for which there were detailed incident reports; only 27 of these incidents were known to have occurred in a garage. (Thirty-one incidents did not specify the room location.) The report shows that, in the incidents where the room location was specified, the garage was involved in 10 of 27 deaths, 5 of 33 injuries, and 2 of 11 incidents in which there were both deaths and injuries.

Therefore, even if all new construction of houses and commercial replacements of existing residential water heaters followed the NFPA requirement for water heaters in garages, there is a large portion of the incidents that would not be addressed.

The Commission is not aware of any other standard for residential gas water heaters that addresses the risk of burn injuries, deaths, and property damage from gas water heaters igniting flammable vapors. Therefore, for the reasons stated above, the Commission believes that the existing standards would not eliminate or adequately reduce this risk.

G. Regulatory Alternatives Under Consideration

The Commission is considering alternatives to reduce the number of injuries and deaths related to the ignition of flammable vapors by gas-fired water heaters.

1. *Performance standard.* For the reasons discussed above, it appears that a performance standard can be developed that will reduce the risk of gas water heaters igniting flammable liquids.

2. *Labeling and instructions.* Another alternative is labeling the product to warn against this hazard and providing information on the risk in the product's instructions. The Commission believes such steps are necessary. However, as noted above, these steps alone are not likely to adequately reduce the risk and should be used in conjunction with product modifications, where possible.

3. *Voluntary standards.* For the reasons stated above, it appears that there is no voluntary standard in existence, or

likely to be developed and implemented, that would adequately reduce this risk of injury.

H. Solicitation of Information and Comments

This ANPR is the first step of a proceeding which could result in a mandatory performance or labeling standard for gas-fired water heaters that present an unreasonable risk of igniting flammable vapors in residences.

All interested persons are invited to submit to the Commission their comments on any aspect of the alternatives discussed above. Specifically, in accordance with section 9(a) of the CPSA, the Commission solicits:

(1) Written comments with respect to the risk of injury identified by the Commission, the regulatory alternatives being considered, and other possible alternatives for addressing the risk.

(2) Any existing standard or portion of a standard which could be issued as a proposed regulation.

(3) A statement of intention to modify or develop a voluntary standard to address the risk of injury discussed in this notice, along with a description of a plan (including a schedule) to do so.

Comments should be mailed, preferably in five (5) copies, to the Office of the Secretary, Consumer Product Safety Commission, Washington, D.C. 20207-0001, or delivered to the Office of the Secretary, Consumer Product Safety Commission, Room 502, 4330 East West Highway, Bethesda, Maryland 20814; telephone

(301) 504-0800. All comments and submissions should be received
no later than [insert date that is 60 days from publication].

Sayde E. Dunn, Secretary
Consumer Product Safety Commission