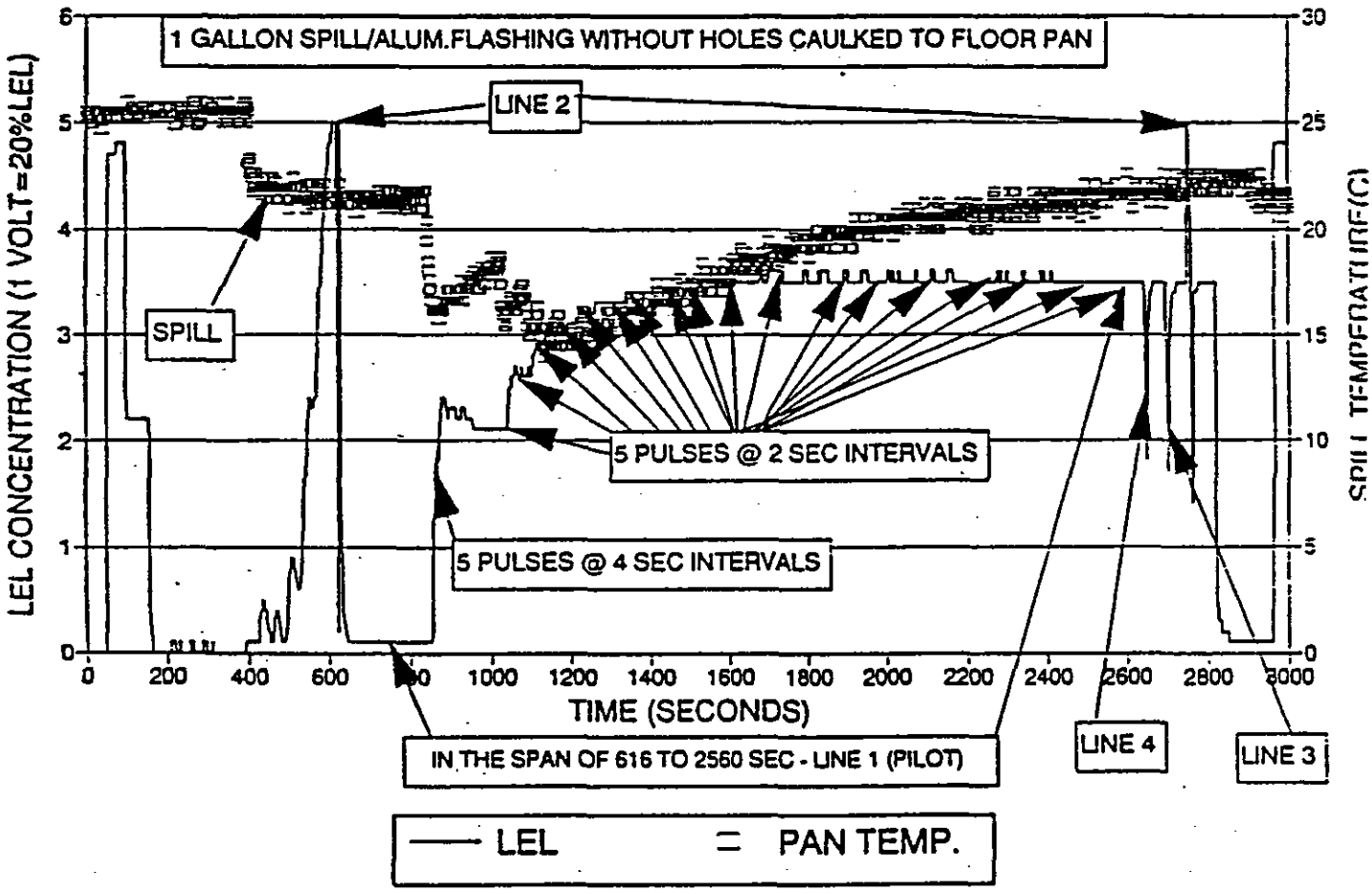
H20 HEATER/GASOLINE IGNITION PROJECT

12/1/93 10:00 am



G

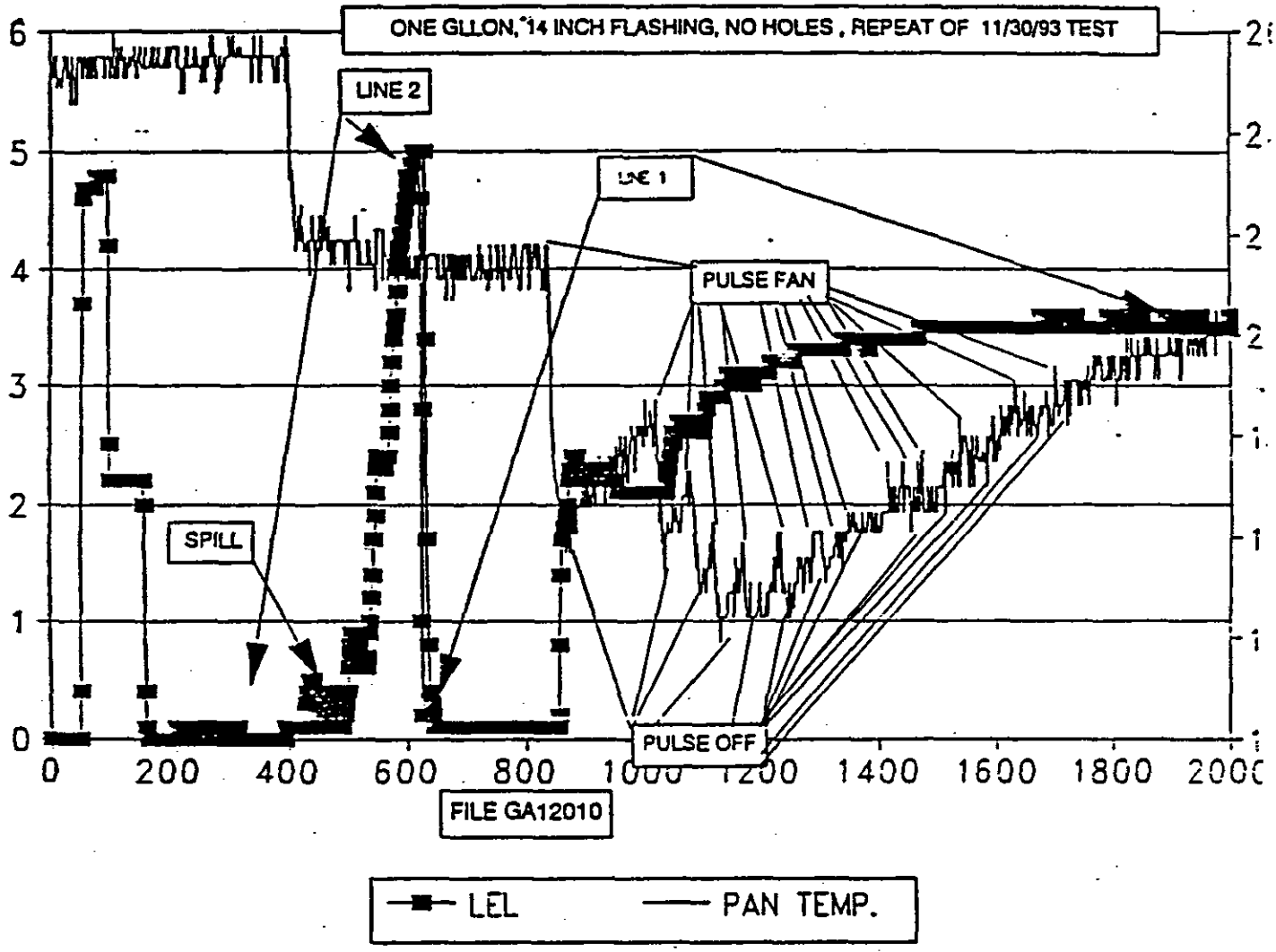
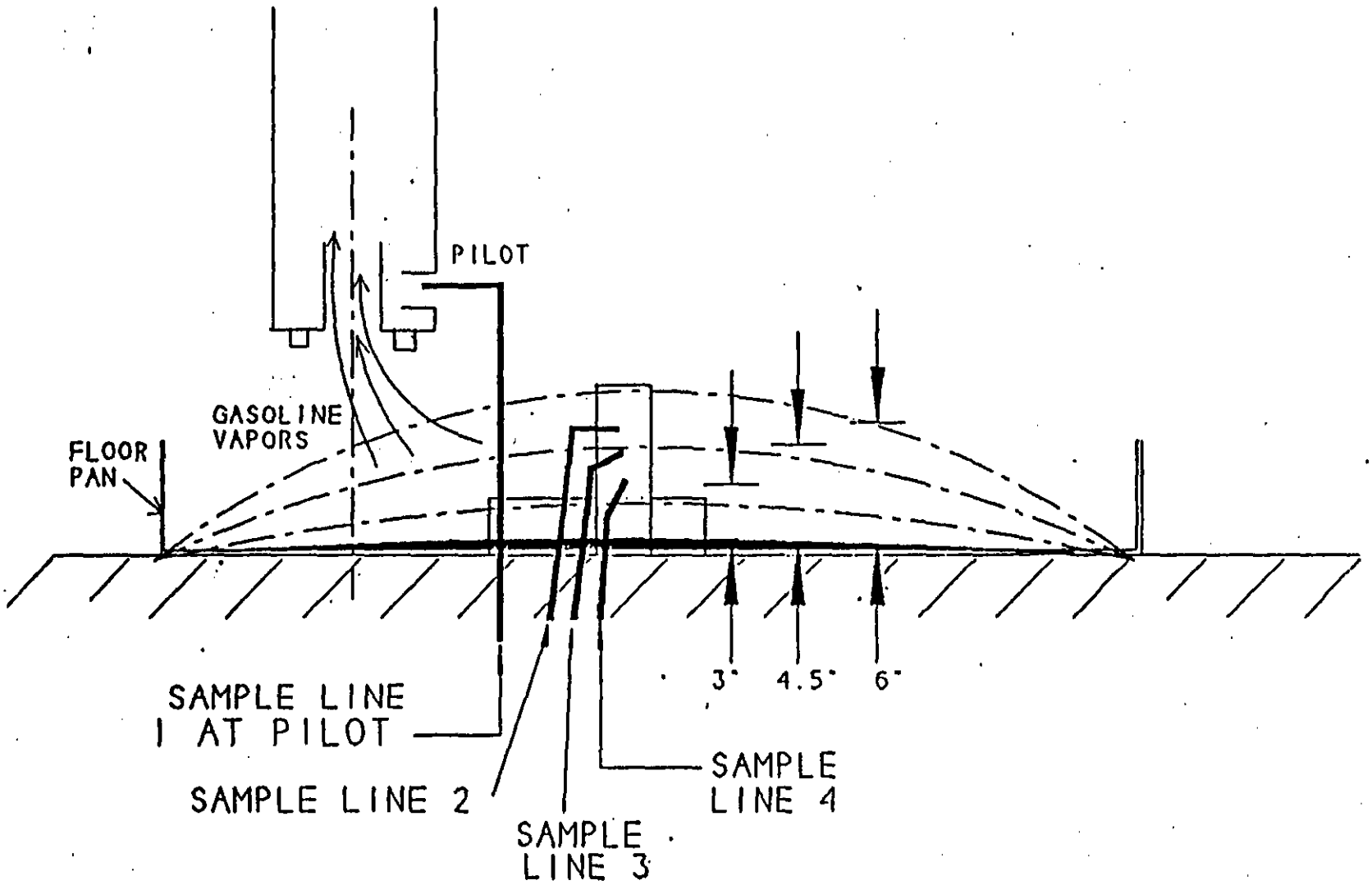

ONE GLLON, 14 INCH FLASHING, NO HOLES , REPEAT OF 11/30/93 TEST
LINE 2
LINE 1
PULSE FAN
SPILL
PULSE OFF
FILE GA12010
LEL
PAN TEMP.
0
1
2
3
4
5
6
0
200
400
600
800
1400
1600
1800

FIGURE 1 | SIDE VIEW OF H20 HEATER PROJECT TEST SETUP



LIQUID GASOLINE IS SHOWN IN THE SOLID SHADED MENISCUS

NOT DRAWN TO SCALE

FIGURE 2 | SIDE VIEW OF 1120 HEATER-GASOLINE IGNITION PROJECT TEST SETUP

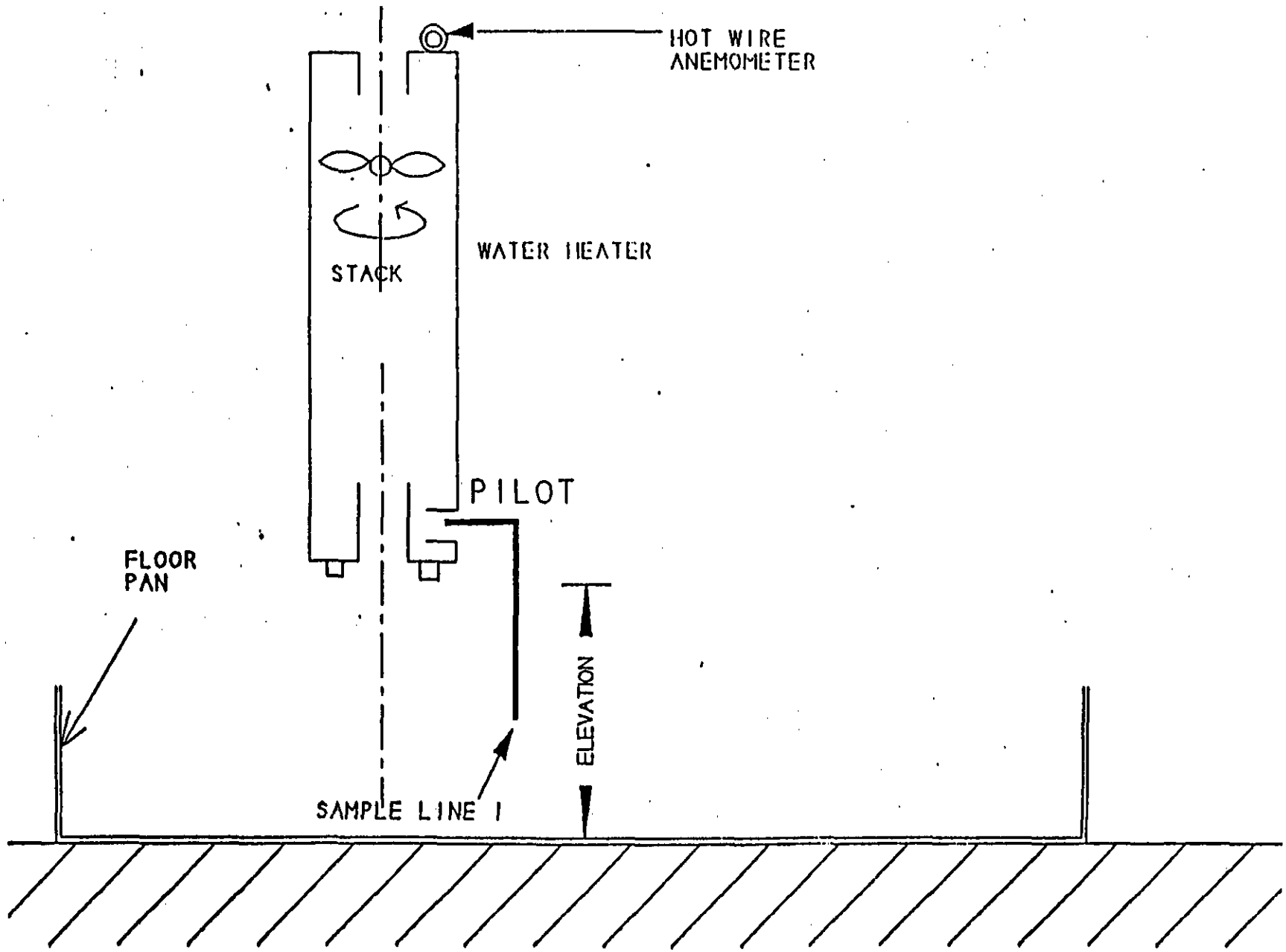
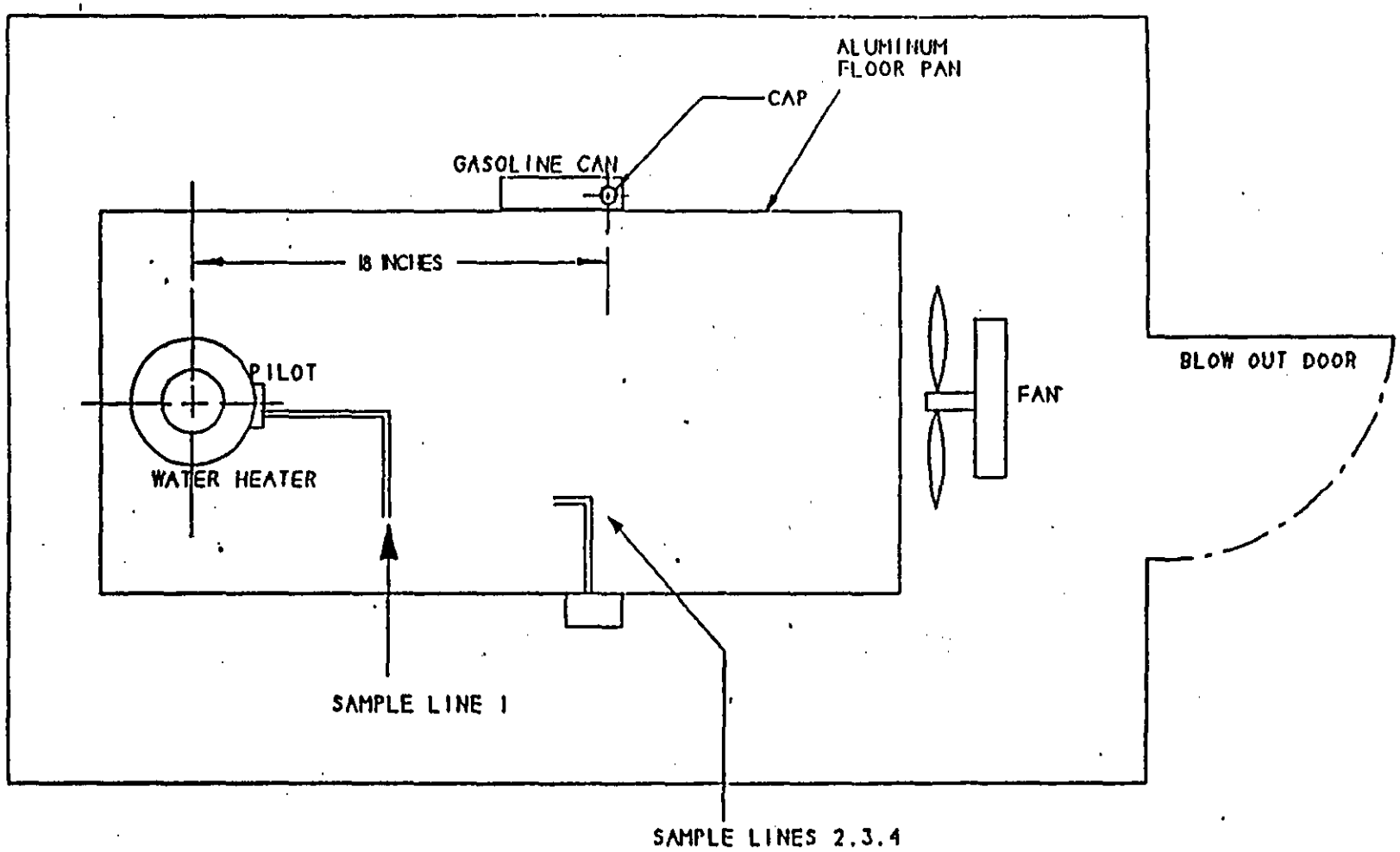
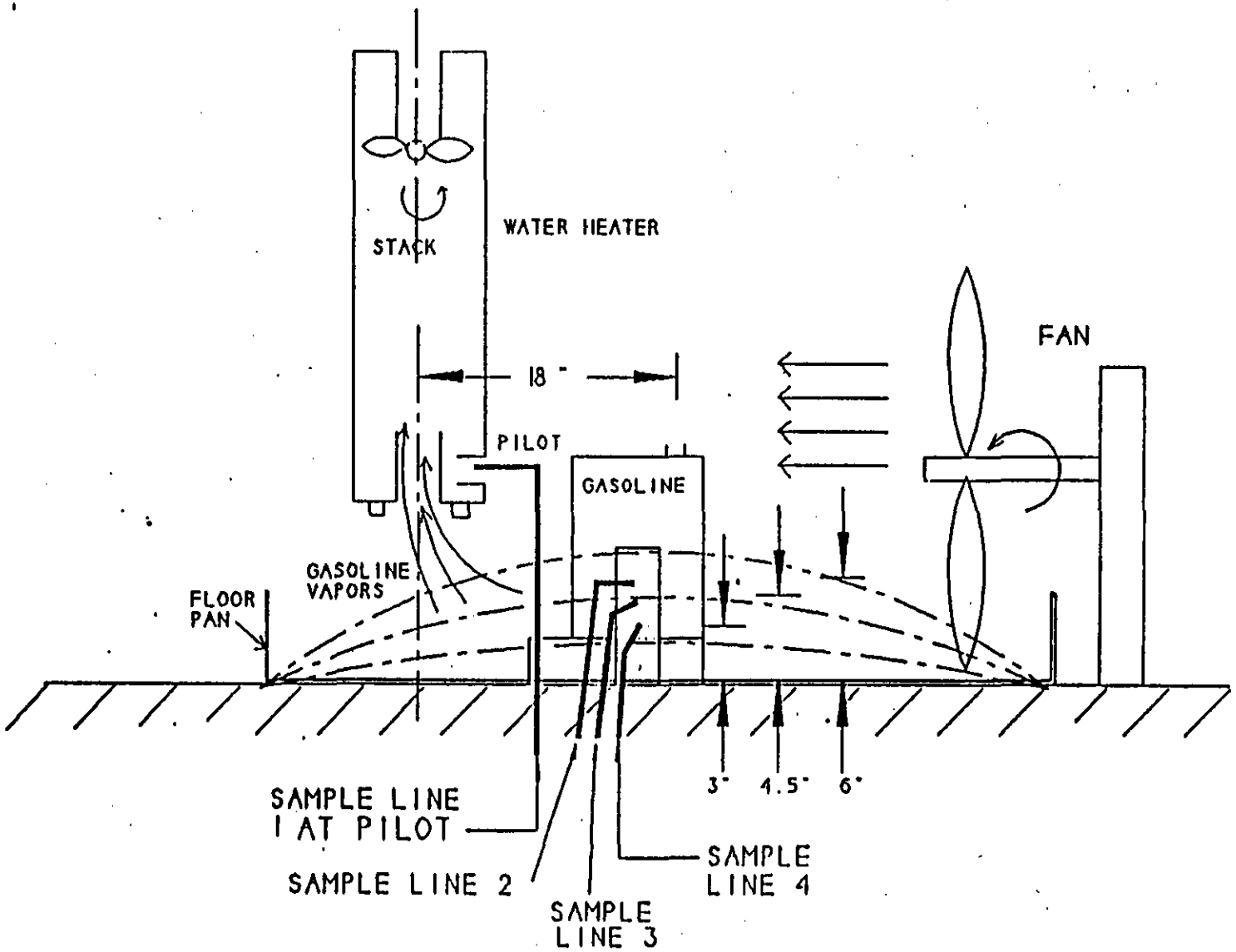


FIGURE 3 | FLOOR PLAN OF 1120 HEATER-GASOLINE IGNITION TEST SETUP



NOT DRAWN TO SCALE.

FIGURE 4 | SIDE VIEW OF 1120 HEATER-GASOLINE IGNITION TEST SETUP



NOT DRAWN TO SCALE

FIGURE 5 | H20 HEATER-GASOLINE IGNITION TEST SETUP

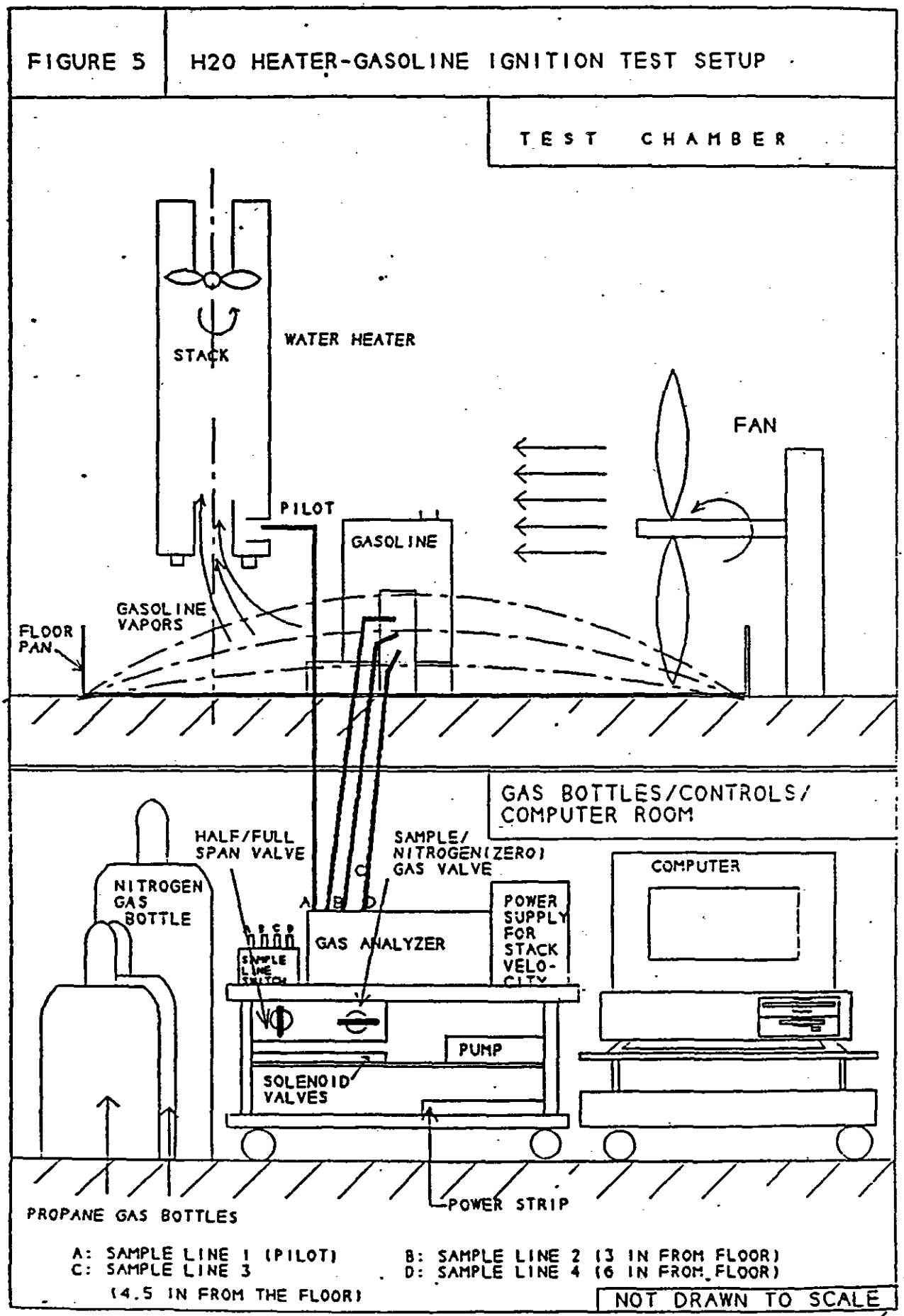


Photo 1
NIST (National Institute of Standards and Technology) fire research building where the water heater/gasoline . ignition tests were performed.

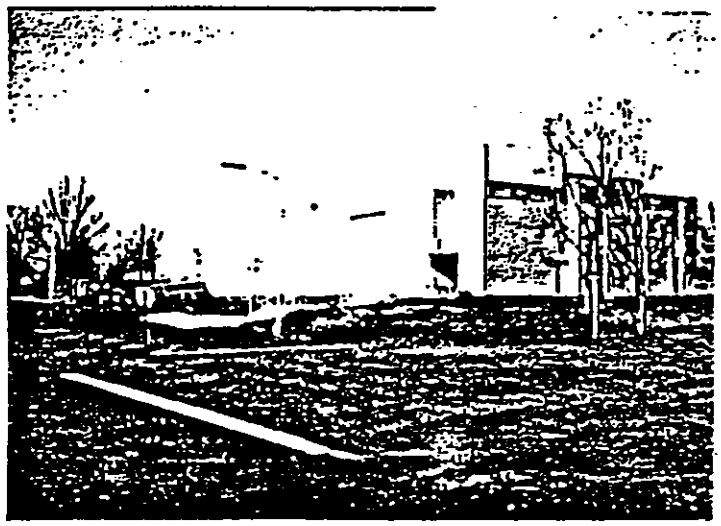


Photo 2
Close up of NIST's fire research building.

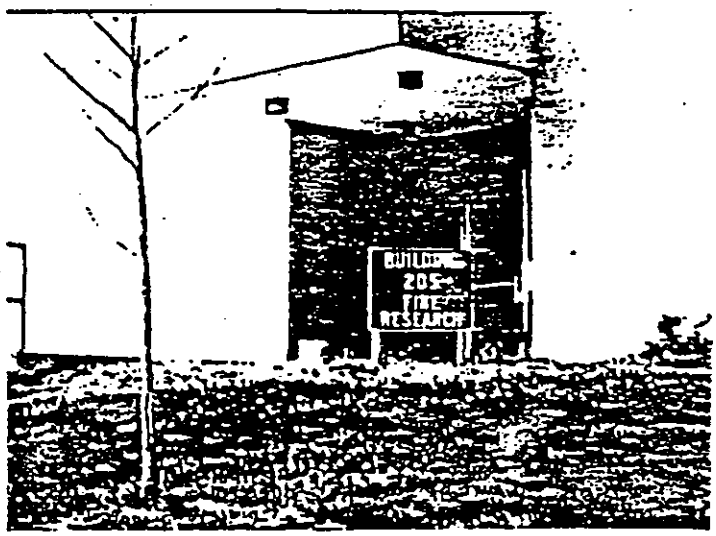


Photo 3
Close up of blow out door latch mechanism.

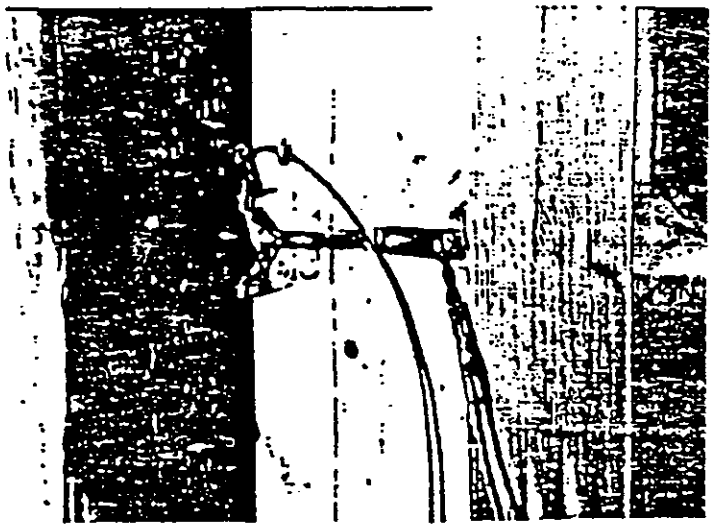


Photo 4
Blow out door

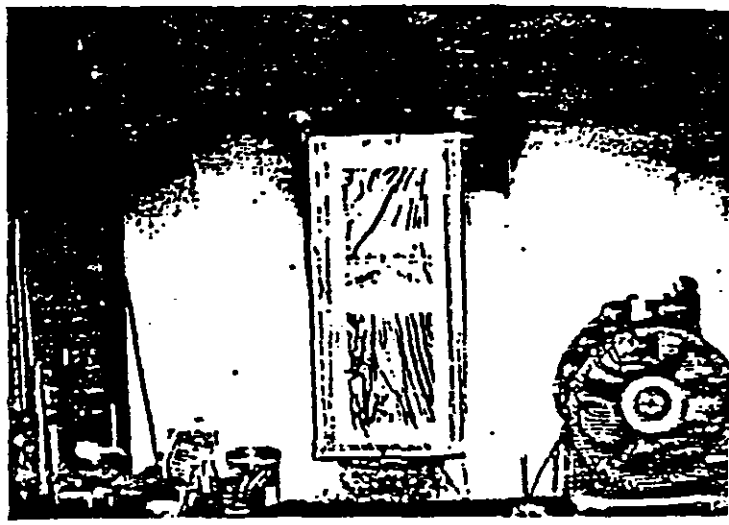


Photo 5
Overall view of the test chamber

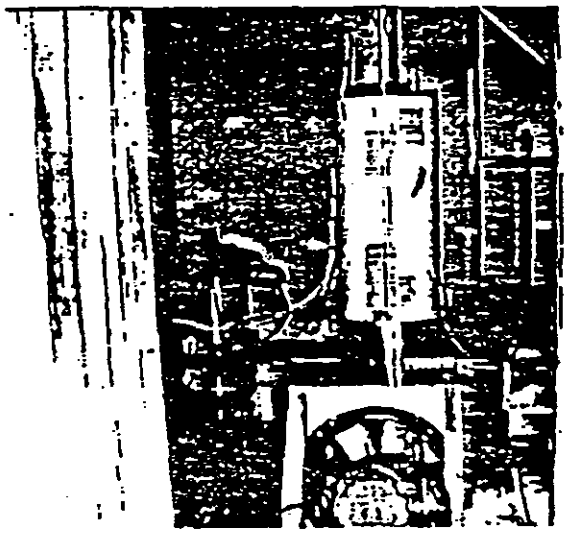


Photo 6
Close up of test setup. Sample lines, hot wire anemometer, and aluminum flashing are shown.

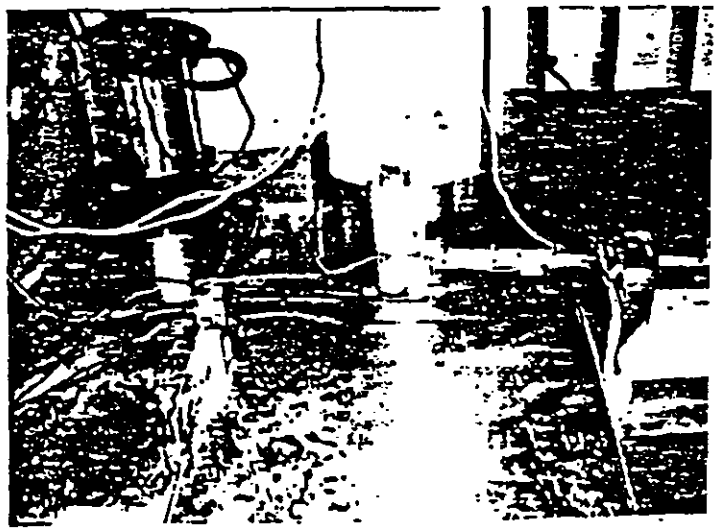


Photo 7
Sample lines "running" to the control room through the wall.

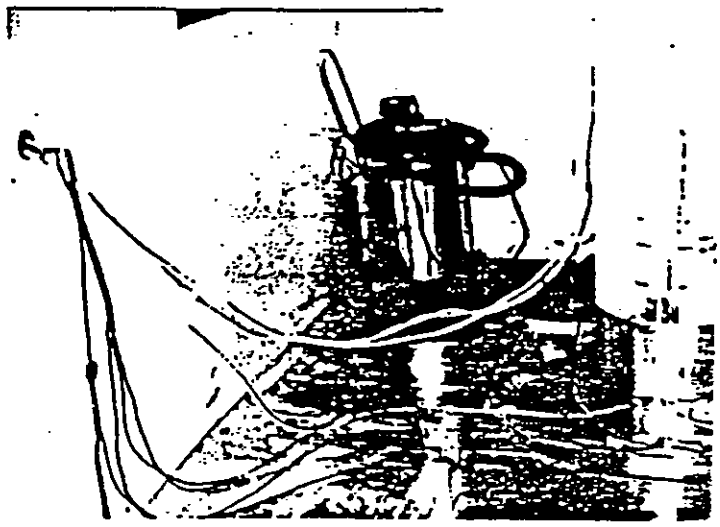


Photo 8
Aluminum flashing is caulked to the floor pan.

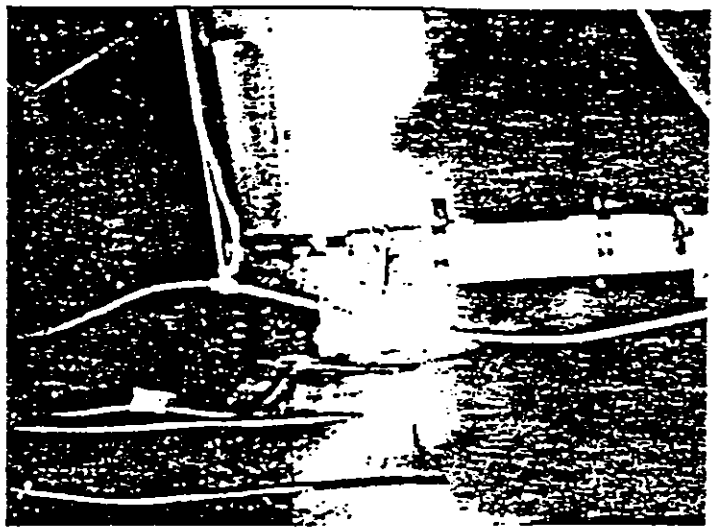


Photo 9
Overall view of the control room.

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

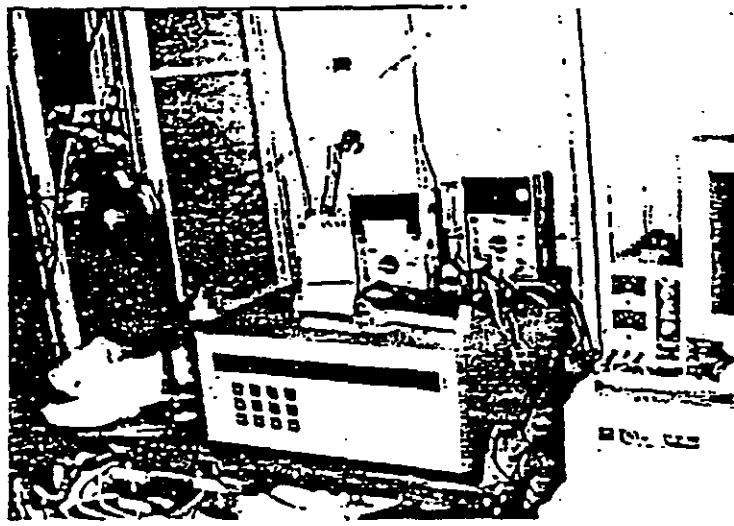


Photo 11
Sample/nitrogen and propane (half and full span) gas valves.

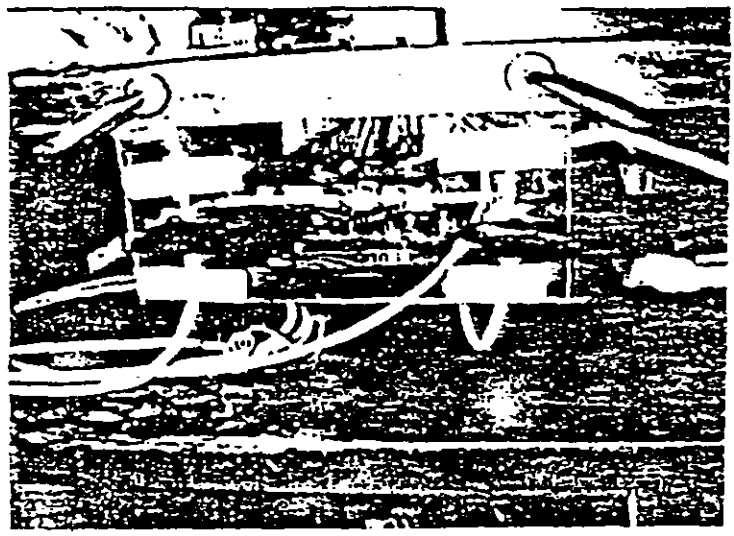


Photo 12
Pump

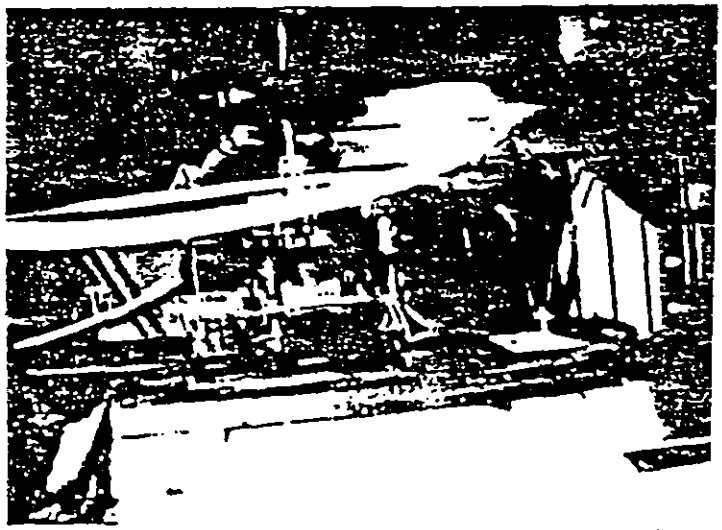


Photo 13
Solenoid valves.

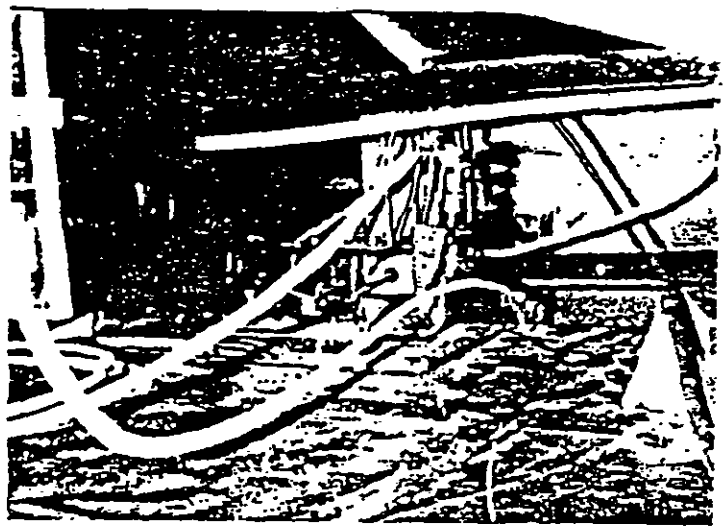


Photo 14
Nitrogen/propane gas bottles.

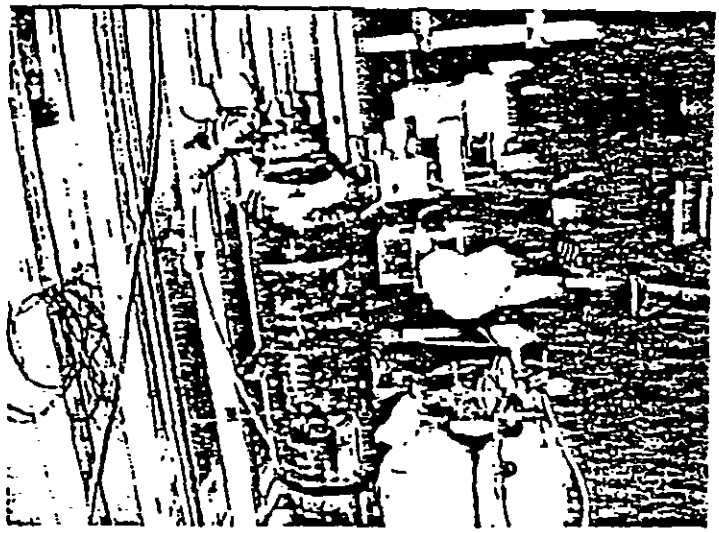


Photo 15

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

ESDOC 552908

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.

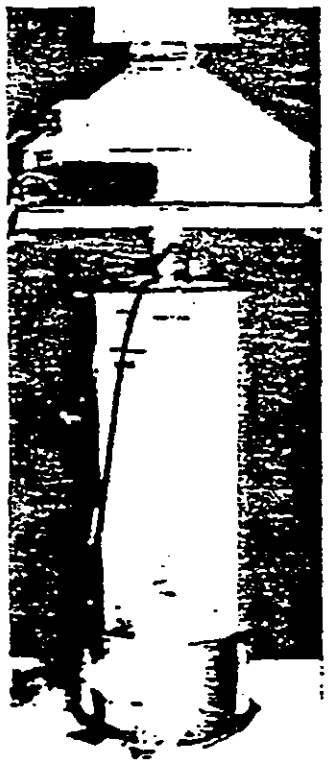


Figure 1

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

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

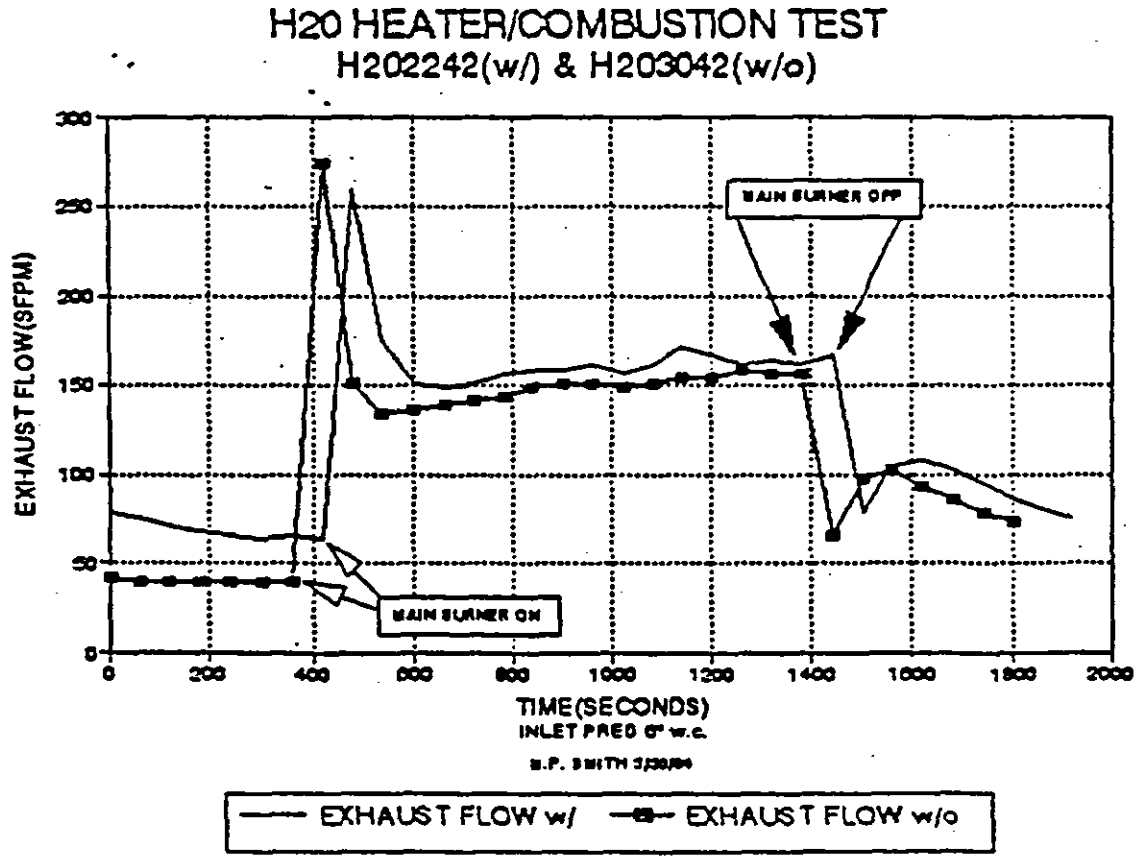


Figure 2

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.

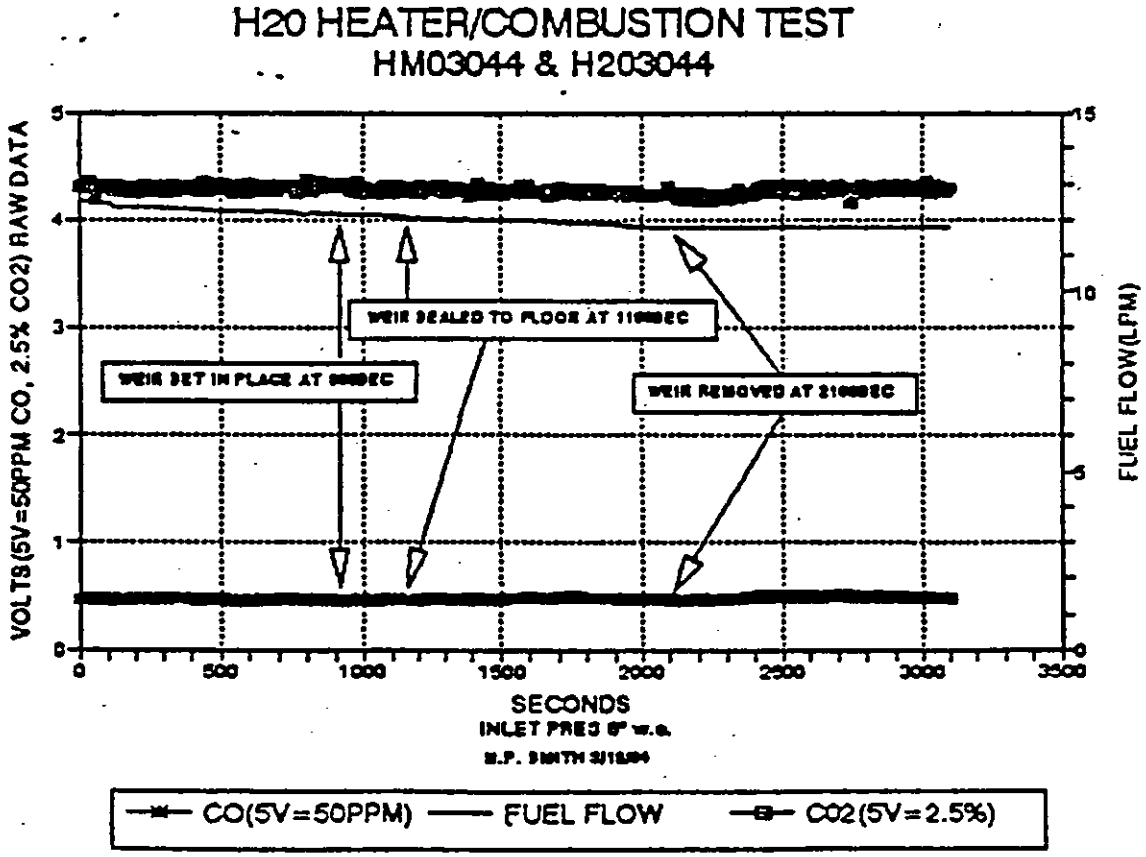


Figure 3

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.

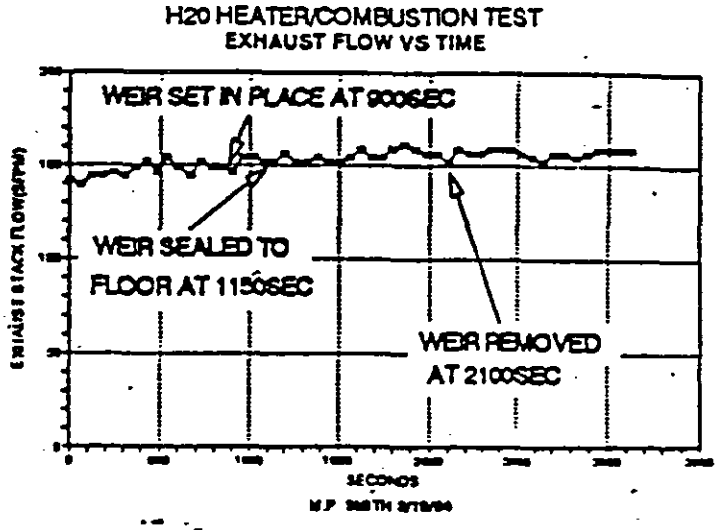


Figure 4

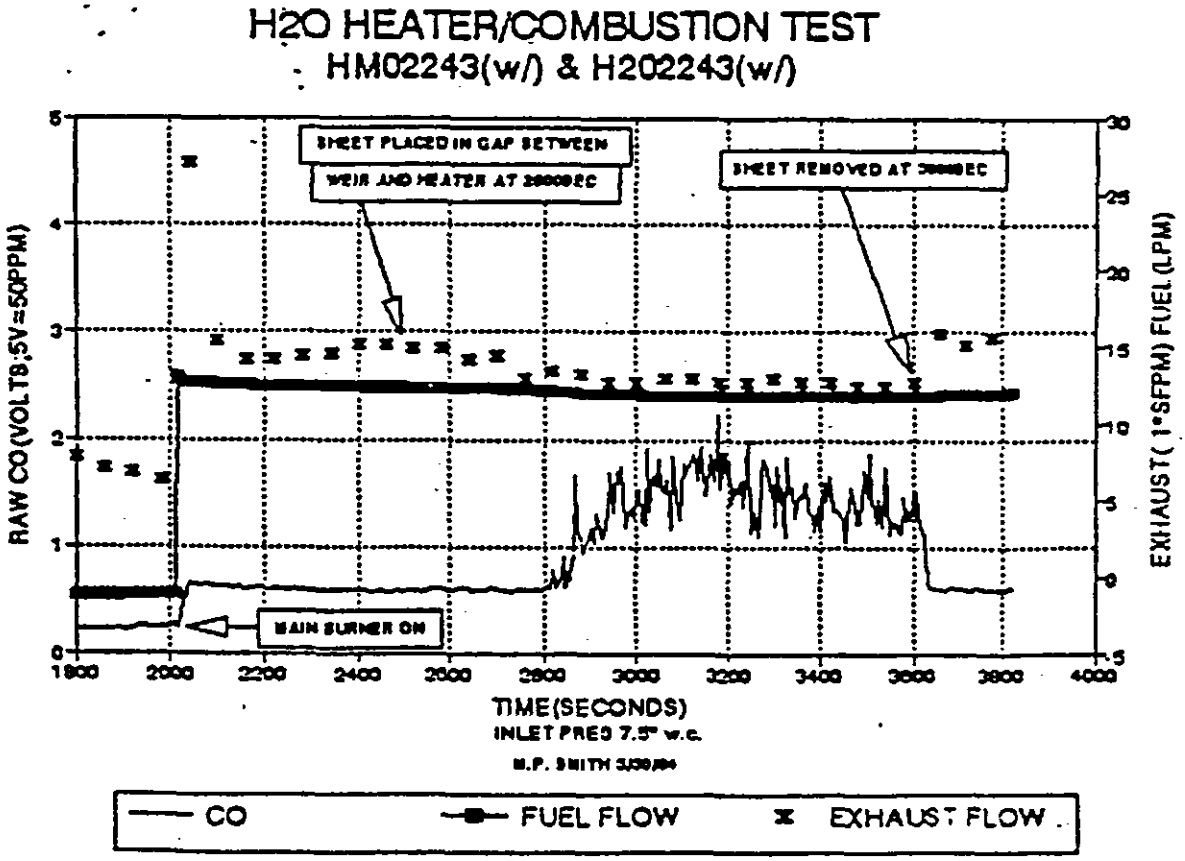


Figure 5

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 combustible 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

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

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

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

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 2 1 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.

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, inherrent hazards cannot be eliminated or even adequately mitigated through such efforts.

Flammable vapors exposed to sources of ignition are an inherrent 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 inherrent 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 WP

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

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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 assoicated 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.

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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.

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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 WP

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

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).

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DRAFT 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 123°F, 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 injures, $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 NFGC 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

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1901 North Moore Street • P.O. Box 9245 • Arlington, Virginia 22209 • 703/525-9565

June 27, 1994

The Honorable Ann Brown
Chairman
Consumer Product Safety Commission
4330 East West Highway
Bethesda, Maryland 20814

Re: Staff Option Package on
Gas-Fired Water Heaters

Dear Chairman Brown:

Thank you for agreeing to meet with us today concerning the staff's Option Package for Gas-Fired Water Heaters and Ignition of Flammable Vapors. Staff has recommended that the Commission institute a rulemaking proceeding to develop a performance standard for new gas-fired water heaters to address the risk of flammable vapors ignition. Before you vote on the staff recommendation, the Gas Appliance Manufacturers Association (GAMA) wants to be sure you are aware of ongoing water heater industry activities to address this risk. We also want you to understand that a technical solution to eliminate ignition of flammable vapors by gas-fired water heaters is not as simple as staff may have led you to believe.

In a letter dated June 14, 1994 (copy attached), we complained to the Commission's Executive Director, Bert Cottine, that the staff Options Package does not give the Commissioners an up-to-date account of what the water heater industry has been doing to address this issue. Our letter describes an ongoing joint effort to test a new burner and the planned development of a test protocol for measuring compliance with any new performance standard in this area. We asked the Executive Director to provide a copy of our letter to each Commissioner in advance of the Commission's meeting on June 22. For reasons we do not know, this was not done. We regret that the Commissioners did not have this information in time for discussion at the June 22 meeting.

The water heater industry continues to believe that the best way to reduce death and injuries from ignition of flammable vapors

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is to educate the public on the dangers of storing and using gasoline and other flammable liquids indoors. The real problem is not gas water heaters, but consumer misuse of gasoline and other flammable liquids. The Commission should recognize that a gas water heater is only one of many possible ignition sources in the home. Incident data will show ignition of flammable vapors by gas dryers, electric washers, refrigerators and other appliances in addition to gas water heaters.

Nevertheless, as reflected in our June 14 letter, the water heater industry has been investigating whether practical water heater design changes are possible to reduce the incidence of ignition of flammable vapors in the home. These efforts began before the industry became aware that the Commission staff was preparing an options package for the Commission, and they will continue whether or not the Commission commences a rulemaking proceeding in this area. Issuance of an ANPR is not needed to provide an impetus for industry action; the impetus is already there.

Considering the ongoing industry activities that may support the development of a voluntary standard, it is premature for the Commission to commence a rulemaking proceeding at this stage. The Commission has not been given adequate information to propose a practical, effective performance standard or technical solution for preventing ignition of flammable vapors by gas water heaters. The water heater industry itself does not yet have a technical solution.

In its Options Package and draft ANPR, Commission staff claims to have found a "simple" solution to prevent gas water heaters from igniting flammable vapors, i. e. encircling the water heater with a 14" high sheet metal dam that is then taped to the floor (see Options Package at pages 8, 16 and 91). In his presentation to the Commission on June 22, the staff project manager, Joseph Fandey, seemed less confident about this supposed solution, calling it merely "a demonstration of principle," and conceding that Commission staff "have not done the live fire work that would be necessary to say this is definitely a way to go." What happened to make Mr. Fandey become less certain of this solution? The morning of the June 22 briefing, Mr. Fandey learned that, in two "live fire" tests of the proposed 14" high dam by International Approval Services, gasoline vapors were ignited by the water heater in 30 seconds in one test and in $3^1/_2$ minutes in the other test.

The 14" high dam proposed by Commission staff is not the "simple" solution that the Options Package may have led the Commission to believe. Moreover, Commission staff appears not to have considered the possibility that the dam could increase

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the risk of carbon monoxide production, a potential hazard to consumers the Commission certainly would want to avoid.

The staff Options Package discusses elevation of gas-fired water heaters 18 inches off the floor as another effective way to prevent ignition of flammable vapors. At the June 22 briefing, Mr. Fandey cited a decreasing incidence of fires caused by water heaters in garages in California and Oregon in the years since 18" elevation of water heaters in garages has been mandated in these states as evidence that elevation of water heaters is an effective way to prevent ignition of flammable vapors. However, fire incidence data for California and Oregon shows a declining incidence of flammable vapors ignition by water heaters in all areas of the home, including areas where there is no requirement to elevate the water heater. Thus, the data is at best inconclusive about the effects of the requirement to elevate water heaters in garages.

In tests conducted by Arthur D. Little, Inc. elevation of the water heater 18 inches often did not prevent ignition of gasoline vapors under a variety of test conditions. A copy of the Arthur D. Little study is being provided to you.

In its draft ANPR, Commission staff disparages the Arthur D. Little study as not particularly useful, and at the June 22 briefing, Mr. Fandey dismissed the study as "really done in contemplation of litigation rather than in an attempt to find a solution." To us, this shows an unreasonable bias on the part of Commission staff. The Arthur D. Little study is the most methodical, fully documented testing of the effects of water heater elevation on flammable vapor ignition ever conducted. Neither Commission staff nor Ed Downing, the Louisiana attorney on whom Commission staff relies so much, has produced any study nearly as thorough and substantiated as the Arthur D. Little study. For example, Commission staff's own testing in this area consisted of apparently only two tests using instrumentation to simulate actual water heater operation. The Arthur D. Little study involved 40 "live fire" tests.

In its draft ANPR, Commission staff condemns the Arthur D. Little study for using 2-gallon gasoline spills and unreasonably high floor temperatures up to 123°F (allegedly to increase the rate of gasoline vaporization). During his June 22 presentation to the Commission, Mr. Fandey also criticized Arthur D. Little for moving a dummy figure in the room so fast that it created unrealistic turbulence of the gasoline vapors. These comments ignore the variety of conditions under which water heaters ignited gasoline vapors in the Arthur D. Little study, and again demonstrate an unreasonable bias on the part of Commission staff.

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In the Arthur D. Little tests of water heaters installed on an 18" stand, fires did occur with gasoline spills of 2 gallons, but fires also occurred with gasoline spills of $^1/_2$ gallon, 1 gallon, and $1^1/_2$ gallons when there was movement in the room. The movement in the room was not exaggerated, as Mr. Fandey contended at the June 22 briefing. The human cutout used on the moving sled was a child size flat board having no arms or moving parts. We believe that the more complex movements of real people would produce greater vapor dispersion than the dispersion created by the dummy form used in the tests.

Also, in the testing of water heaters installed on an 18" stand, the occurrence of fires was not dependent on the floor temperature. Fires occurred with floor temperatures of 45°F, 54°F, 60°F, 72°F, 81°F, 87°F, and 114°F, for example. This refutes Commission staff's assertion that overheated floors were used in the Arthur D. Little tests to enhance gasoline evaporation. For a concise summary of the results of the tests, we refer the Commission to amended Tables 9 and 10 in the Arthur D. Little report we are providing.

Finally, GAMA takes very seriously statements made by Mr. Fandey at the June 22 briefing that GAMA has not shown a willingness to cooperate with Commission staff and has not exhibited good faith in dealing with Commission staff. We do not believe that these claims are supported by the record. In October 1992, at the very beginning of Arthur D. Little's work for GAMA in this area, GAMA and Arthur D. Little representatives met with Mr. Fandey, William Rowe and Elizabeth Leland and briefed them on our plans for incident data collection and analysis. We asked for Commission staff support of this effort. In February 1993, Arthur D. Little presented the results of its incident data collection and analysis in a meeting with Mr. Fandey and Al Martin of Commission staff at GAMA's offices. At this same meeting, the Arthur D. Little representatives presented a draft of the methodology they planned to use to test the potential of water heater elevation to prevent ignition of flammable vapors. In May 1993, Mr. Martin observed a full day of testing by Arthur D. Little at International Approval Services laboratories in Cleveland. In December 1993, Larry Mulligan of Commission staff spent two days at Arthur D. Little in Cambridge learning to use Arthur D. Little's vapor dispersion model so that it could be applied to Commission staff's own testing. On all of these occasions, constructive suggestions from Commission staff were welcome.

In conclusion, we do not believe that the staff has made a persuasive case that a rulemaking proceeding is needed to force the water heater industry to examine possible technical solutions to prevent ignition of flammable vapors by gas-fired

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water heaters. Such efforts are already underway, but a technical solution has not yet been found. As discussed above, the Commission itself does not have a practical, proven technical fix it can recommend. The Commission should continue to rely on voluntary efforts by the industry. GAMA will make a good faith effort to keep Commission staff apprised of ongoing developments and to provide opportunities for Commission staff to participate in the process.

Thank you again for your consideration of our views and comments.

Sincerely,

C. Reuben Autery
President

CRA/ljb
Attachment

C

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

MEMORANDUM

DATE: November 14, 1994

TO : Ronald L. Medford, Assistant Executive Director for Hazard Identification and Reduction

Through: James E. Bradley, Acting Associate Executive Director, Directorate for Engineering Sciences

FROM : Donald W. Switzer, Project Manager for Fire and Gas Voluntary Standards, ESEE (504-0508 ext. 1303)

SUBJECT: Comments on Letter from C. Reuben Autery, President, Gas Appliance Manufacturers Association

On June 27, 1994, C. Reuben Autery, President, Gas Appliance Manufacturers Association (GAMA) sent a letter to Chairman Ann Brown commenting on the contents of the Options Paper for Gas-Fired Water Heaters and Ignition of Flammable Vapors and the tone of a staff briefing. The letter contains a number of inaccuracies. The purpose of this memo is to provide you with staff responses to the allegations made in the letter. Staff's comments are keyed to the index numbers inserted into the left column of the attached letter.

STAFF COMMENTS

1 On April 7, 1994 Don Switzer, the Commission representative to the ANSI Z21 Committee (the parent committee of the water heater subcommittee that staff requested to develop performance standard for this issue) informed the ANSI Z21 Committee's Chairman's Advisory Committee that the timetable for the briefing package had been accelerated. Staff also informed the committee that one of the options included in the package would be to publish an Advanced Notice of Proposed Rulemaking. Both Mr. Jack Langmead, Vice President of GAMA, and Mr. Daryl Hosler, chairman of the water heater subcommittee were in attendance. Neither Mr. Langmead, nor Mr. Hosler, mentioned the ongoing industry activities that are reported in the Autery letter. Agenda Item 18 of the Chairman's Advisory Committee was a report of standards writing activities planned or underway. There was no

mention of planned water heater test method development either in the text of the agenda item, or in the discussion. GAMA and the chairman of the water heater subcommittee had opportunity to inform staff of planned work and did not. Neither did they inform the Project Manager of any planned work, although they knew that an ANPR would be presented as an option to the Commission.

2 The letter to Bert Cottine does not "describe" the testing or activities that are underway. It mentions that work is underway, but does not provide specifics. Had staff known of the ongoing work, staff would certainly have attempted to gather additional information and would have factored it into our recommendations to the Commission. As it is, industry held this information private and submitted it at the last moment (without detail) to the Commission.

3 Mr. George Sweet of the Division of Human Factors responds: "It is a basic human factors principle that the best way to improve product safety is to design the hazardous feature out of the product. Educating the public does not reduce the hazard unless the people are motivated to comply with the message. More effective safety protection is offered through passive interventions (which have built-in safety features that do not require any action from the consumer) as opposed to warnings (which require the consumer to do something). As stated in the Commission briefing, most consumers do not think about their water heaters on a regular basis, some may not even realize it has a pilot light. An education program could be effective in making some people aware of the hazard of flammable vapors being ignited by water heaters, however, it will not prevent the hazard from occurring. For these reasons, the staff recommended an ANPR to find out if a design fix is possible."

4 Staff certainly recognizes that there are other sources of vapor ignition in the home. However, the data indicate that water heaters are by far the largest contributor to this type of accident. Figure 1, *Top Twenty Appliances Igniting Gasoline Vapors in Dwellings - 1991* indicates that water heaters account for more than 65% of the incidents, followed by gas cooking surfaces with about 7%, followed by four other gas appliances. These 6 products account for over 85% of the gasoline vapor ignition incidents. Staff intends to investigate possible ways to eliminate the other gas-fired appliances as possible ignition sources.

5 The staff does not believe it can propose a "practical, effective performance standard or technical solution for preventing ignition of flammable vapors by gas water heaters" at this time. Staff does, however, believe that performance standard provisions must be developed to address

this hazard. Without a standard development activity to develop necessary coverage, the state of the art for water heaters vis-a-vis vapor ignition, will not change.

6 The staff does not intend for the 14-inch sheet metal dam to be considered "the solution" to flammable vapor ignition by water heaters. None of the citations referred to in the Autery letter (pages 8, 16, and 91 of the briefing package) characterize the dam as a "simple" solution. The dam does, however, demonstrate that a significant reduction in the potential for accidents could be achieved by taking combustion air from above the level of flammable vapors. Prior to the June 22, 1994 briefing, staff discussed at length the need to characterize the dam concept as just that, a concept that holds potential. The information on the 2 tests performed by International Approval Services did not cause the staff to "become less certain of this solution" because staff never considered the dam to be the solution. Finally, staff was well aware of the need for "live fire" testing long before the communication concerning the IAS testing. Staff had begun to examine resource implications for this type of testing in advance of the June 22, 1994, briefing.

7 Staff did consider the possibility that the dam could increase the risk of carbon monoxide poisoning. Appendix B of the ESEL test report (page 66 of B.P.) examined the possibility of excess CO production caused by installation of the dam. Tests were run both with and without the dam in place. There was no significant difference in CO production between when the dam was installed and when it was not. ESEL also performed additional testing where a rolled up cotton sheet was placed in the annulus between the water heater and the dam to determine the effect of restricting combustion air flow by draping clothes over the dam. Once again the CO production was not significant.

8 The data for the State of California is presented graphically as Figure 2. It shows an apparent decline in the number of garage fires in relation to the number of non-garage fires.

9 Mr. Autery has taken this comment out of context. The ADL work is of little use for standards development. Staff had requested that the subcommittee develop performance requirements to address this issue and expected that the work undertaken would be for that purpose. The work performed by ADL is not standards development work. Standards development consists of carefully identifying environmental conditions that are encountered in the field, and developing a standardized, reproducible methodology to address the hazard, and then performing extensive testing to verify that the conditions established in the laboratory produce consistent results. By varying multiple test

parameters, the ADL testing did not establish reproducible test conditions. Quoting from page 1 of the Phase 2 report, "The overall goal of the project is to develop a comprehensive understanding of the extent of the hazard identified, and the effectiveness of current mitigating measures." This is not the scope of a standards development program.

10 Mr. Autery is incorrect in asserting the testing performed by the Commission staff "consisted of apparently only two tests using instrumentation to simulate actual water heater operation". In actually, ESEL performed twenty-five tests, as detailed on pages 41-45 of the briefing package.

11 The large number of test conditions investigated in the ADL report is precisely the reason the staff "disparages" the ADL work as standards development.

12 A major issue is CPSC's participation in developing the test program. Staff believes that in order to effectively participate in any type of testing program, one ought to be involved in developing the goals, protocol, and methodology of the program. It is also critical to be involved in the analysis of resulting data, and development of conclusions based on the data. At the February, 1993, meeting where ADL staff presented the results of the Phase 1 Epidemiological study, CPSC staff requested to be included in further development of the Phase 2 test protocol. This request was not honored by ADL or GAMA. In fact, staff was not provided with a copy of the ADL report in draft form for comment. Staff finally received copies of the reports after it had been distributed in final form to the industry.

With regard to Mr. Martin's participation in the testing at International Approval Services in May, 1993, Mr. Martin was on site as an observer. The test protocol and methods had already been established, and testing was nearly completed. Mr. Mulligan's trip took place after the Phase 2 testing was complete and is not relevant to a discussion of staff's participation in test program.

Attachments

Gama

1901 North Moore Street - P.O. Box 9245 - Arlington, Virginia 22209 - 703/525-9565

June 27, 1994

The Honorable Ann Brown
Chairman
Consumer Product Safety Commission
4330 East West Highway
Bethesda, Maryland 20814

Re: Staff Option Package on
Gas-Fired Water Heaters

Dear Chairman Brown:

Thank you for agreeing to meet with us today concerning the staff's Option Package for Gas-Fired Water Heaters and Ignition of Flammable Vapors. Staff has recommended that the Commission institute a rulemaking proceeding to develop a performance standard for new gas-fired water heaters to address the risk of flammable vapors ignition. Before you vote on the staff recommendation, the Gas Appliance Manufacturers Association (GAMA) wants to be sure you are aware of ongoing water heater industry activities to address this risk. We also want you to understand that a technical solution to eliminate ignition of flammable vapors by gas-fired water heaters is not as simple as staff may have led you to believe.

In a letter dated June 14, 1994 (copy attached), we complained to the Commission's Executive Director, Bert Cottine, that the staff Options Package does not give the Commissioners an up-to-date account of what the water heater industry has been doing to address this issue. Our letter describes an ongoing joint effort to test a new burner and the planned development of a test protocol for measuring compliance with any new performance standard in this area. We asked the Executive Director to provide a copy of our letter to each Commissioner in advance of the Commission's meeting on June 22. For reasons we do not know, this was not done. We regret that the Commissioners did not have this information in time for discussion at the June 22 meeting.

The water heater industry continues to believe that the best way to reduce death and injuries from ignition of flammable vapors

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is to educate the public on the dangers of storing and using gasoline and other flammable liquids indoors. The real problem is not gas water heaters, but consumer misuse of gasoline and other flammable liquids. The Commission should recognize that a gas water heater is only one of many possible ignition sources in the home. Incident data will show ignition of flammable vapors by gas dryers, electric washers, refrigerators and other appliances in addition to gas water heaters.

Nevertheless, as reflected in our June 14 letter, the water heater industry has been investigating whether practical water heater design changes are possible to reduce the incidence of ignition of flammable vapors in the home. These efforts began before the industry became aware that the Commission staff was preparing an options package for the Commission, and they will continue whether or not the Commission commences a rulemaking proceeding in this area. Issuance of an ANPR is not needed to provide an impetus for industry action; the impetus is already there.

Considering the ongoing industry activities that may support the development of a voluntary standard, it is premature for the Commission to commence a rulemaking proceeding at this stage. The Commission has not been given adequate information to propose a practical, effective performance standard or technical solution for preventing ignition of flammable vapors by gas water heaters. The water heater industry itself does not yet have a technical solution.

In its Options Package and draft ANPR, Commission staff claims to have found a "simple" solution to prevent gas water heaters from igniting flammable vapors, i. e. encircling the water heater with a 14" high sheet metal dam that is then taped to the floor (see Options Package at pages 8, 16 and 91). In his presentation to the Commission on June 22, the staff project manager, Joseph Fandey, seemed less confident about this supposed solution, calling it merely "a demonstration of principle," and conceding that Commission staff "have not done the live fire work that would be necessary to say this is definitely a way to go." What happened to make Mr. Fandey become less certain of this solution? The morning of the June 22 briefing, Mr. Fandey learned that, in two "live fire" tests of the proposed 14" high dam by International Approval Services, gasoline vapors were ignited by the water heater in 30 seconds in one test and in $3^{1}/_{2}$ minutes in the other test.

The 14" high dam proposed by Commission staff is not the "simple" solution that the Options Package may have led the Commission to believe. Moreover, Commission staff appears not to have considered the possibility that the dam could increase

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the risk of carbon monoxide production, a potential hazard to consumers the Commission certainly would want to avoid.

The staff Options Package discusses elevation of gas-fired water heaters 18 inches off the floor as another effective way to prevent ignition of flammable vapors. At the June 22 briefing, Mr. Fandey cited a decreasing incidence of fires caused by water heaters in garages in California and Oregon in the years since 18" elevation of water heaters in garages has been mandated in these states as evidence that elevation of water heaters is an effective way to prevent ignition of flammable vapors. However, fire incidence data for California and Oregon shows a declining incidence of flammable vapors ignition by water heaters in all areas of the home, including areas where there is no requirement to elevate the water heater. Thus, the data is at best inconclusive about the effects of the requirement to elevate
8 water heaters in garages.

In tests conducted by Arthur D. Little, Inc. elevation of the water heater 18 inches often did not prevent ignition of gasoline vapors under a variety of test conditions. A copy of the Arthur D. Little study is being provided to you.

9 In its draft ANPR, Commission staff disparages the Arthur D. Little study as not particularly useful, and at the June 22 briefing, Mr. Fandey dismissed the study as "really done in contemplation of litigation rather than in an attempt to find a solution." To us, this shows an unreasonable bias on the part of Commission staff. The Arthur D. Little study is the most methodical, fully documented testing of the effects of water heater elevation on flammable vapor ignition ever conducted. Neither Commission staff nor Ed Downing, the Louisiana attorney on whom Commission staff relies so much, has produced any study nearly as thorough and substantiated as the Arthur D. Little study. For example, Commission staff's own testing in this area consisted of apparently only two tests using instrumentation to
10 simulate actual water heater operation. The Arthur D. Little study involved 40 "live fire" tests.

In its draft ANPR, Commission staff condemns the Arthur D. Little study for using 2-gallon gasoline spills and unreasonably high floor temperatures up to 123°F (allegedly to increase the rate of gasoline vaporization). During his June 22 presentation to the Commission, Mr. Fandey also criticized Arthur D. Little for moving a dummy figure in the room so fast that it created unrealistic turbulence of the gasoline vapors. These comments ignore the variety of conditions under which water heaters
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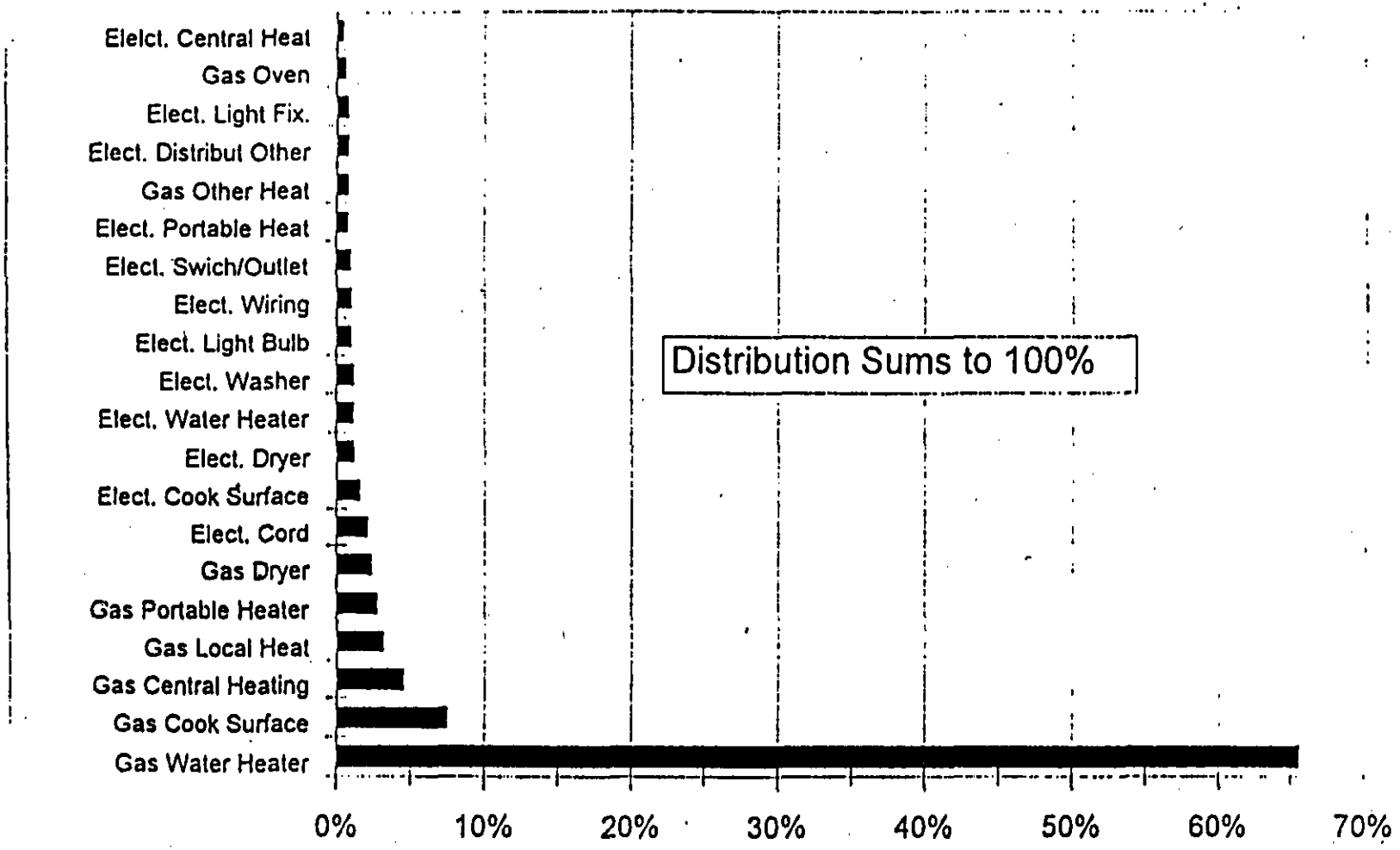
Thank you again for your consideration of our views and comments.

Sincerely,

C. Reuben Autery
President

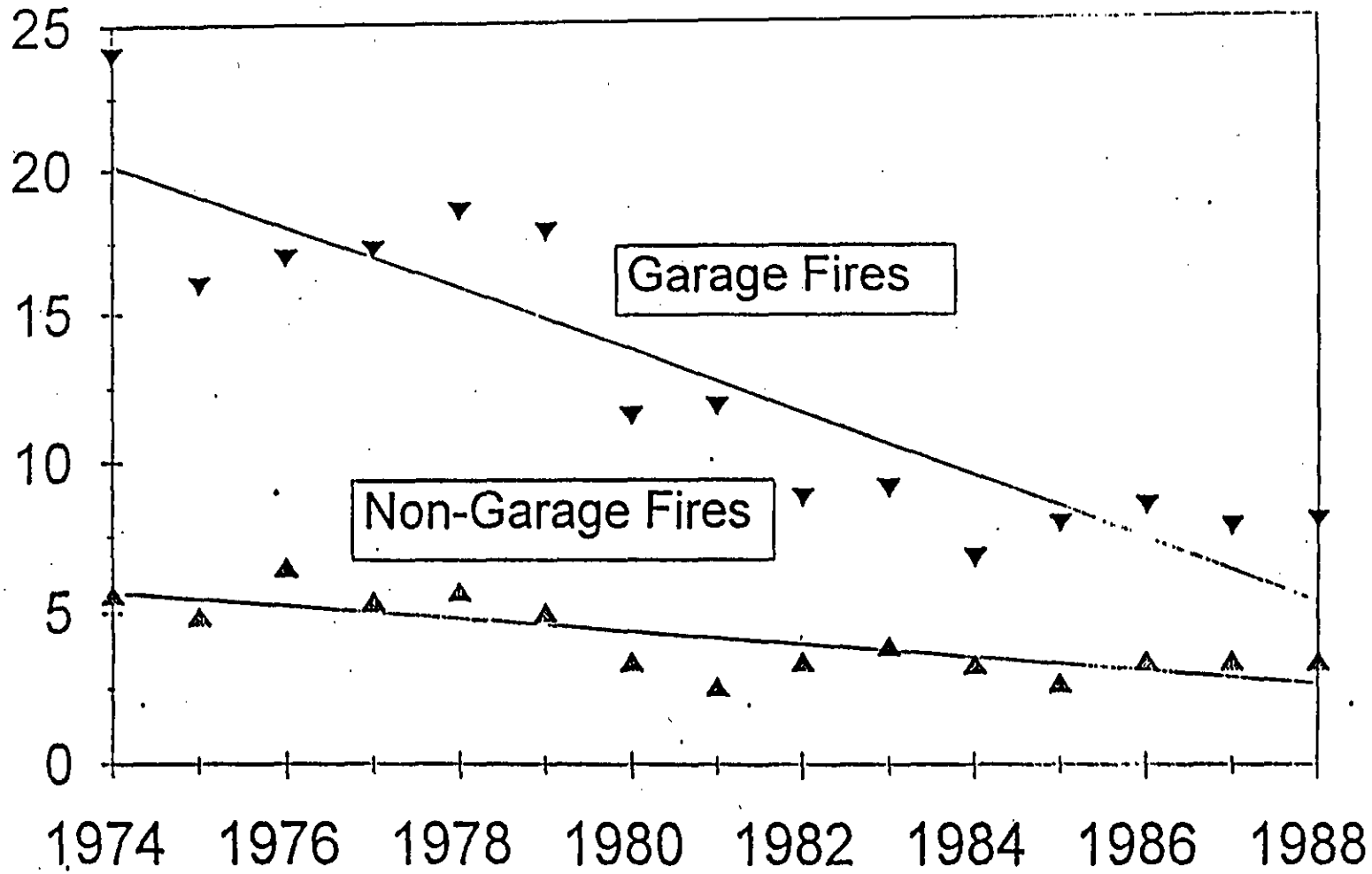
CRA/ljb
Attachment

FIGURE 1: TOP TWENTY APPLIANCES IGNITING GASOLINE VAPORS IN DWELLINGS, 1991



SOURCE: U.S. CONSUMER PRODUCT SAFETY COMMISSION AND THE U.S. FIRE ADMINISTRATION

FIGURE 2: CALIFORNIA GAS WATER HEATER FIRES INVOLVING GASOLINE



SOURCE: ARTHUR D. LITTLE INC. "FLAMMABLE VAPOR HAZARDS IGNITION STUDY, TASK 1 REPORT", TABLE 5.