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STATE OF ALASKA
FISCAL NOTE

Revision Date Original, 1983

I. REQUEST

Bill/Resolution No.: Senate Bill 214
 Title: "An act relating to the plumbing Code"
 Sponsor: Senator P. Fischer
 Requestor: Labor and Commerce

II. FISCAL DETAIL

Agency Affected: Labor
 Program Category Affected: Worker Protection
 BRU, Program of Subprogram(s) Affected: Labor Standards and Safety

EXPENDITURES/REVENUES: (Thousands of Dollars)

	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88
OPERATING						
100 PERSONAL SERVICES						
200 TRAVEL						
300 CONTRACTUAL						
400 COMMODITIES						
500 EQUIPMENT						
600 LAND & STRUCTURES						
700 GRANTS, CLAIMS, ETC						
TOTAL OPERATING		0	0	0	0	0
CAPITAL						
REVENUE						

FUNDING: (Thousands of Dollars)

GENERAL FUND		0	0	0	0	0
FEDERAL FUNDS						
OTHER (Specify Source)						

POSITIONS:

FULL-TIME						
PART-TIME						
TEMPORARY						

III. SOURCE OF FUNDS TO OFFSET FISCAL IMPACT OF BILL:

N/A

IV. ANALYSIS: Attach a separate page for any Analysis

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 Division: Labor Standards and Safety

Phone 465-4870
 Date: April 1, 1983

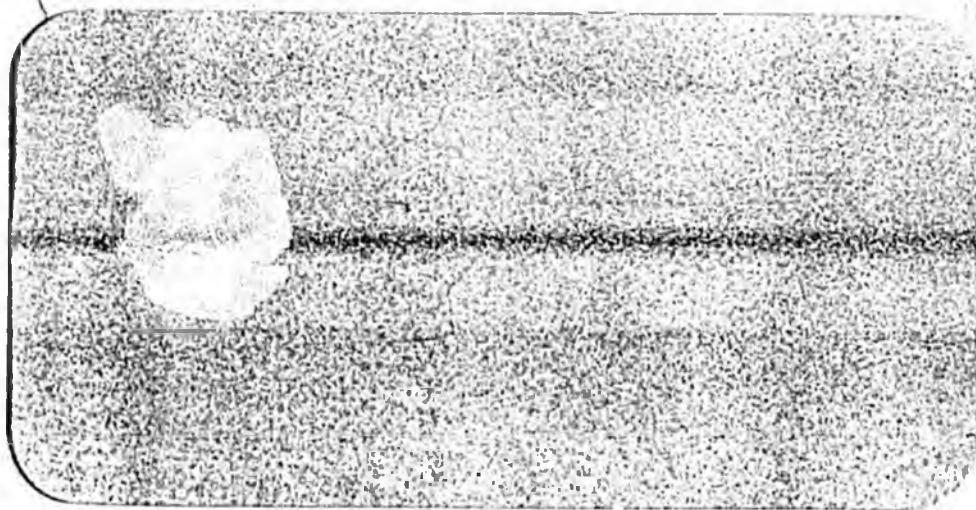
Approved by Commissioner: Jim Robison *Jim Robison*
 Department: Labor

Date: April 1, 1983

LEG:A:38

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Shell Chemical Company





GENERAL

- Q. What is DURAFLEXTM polybutylene?
- A. DURAFLEX is Shell's trademark for the polybutylene resin it produces from crude oil. Polybutylene is a high molecular weight polymer, made by polymerizing butene-1, a common chemical feedstock.
- Q. What are polybutylene resins used for?
- A. The primary use for polybutylene resins has been in hot water piping applications. It is currently in this use in over 25 countries around the world and has accumulated over a decade of successful service in the U.S. and Europe. In addition, polybutylene resins are tough enough to be used as industrial piping for handling highly abrasive slurries and safe enough to be used as films for food cooking applications.
- Q. Why have polybutylene resins found such wide use in hot water piping?
- A. Polybutylene piping offers a large number of advantages over metal and other plastic piping systems: corrosion, scale, and electrolysis resistance; freeze tolerance; high temperature pressure carrying capabilities; and ease of installation due to its flexibility.
- Q. How long will polybutylene piping last?
- A. Tests by independent testing laboratories and authorities project a normal life of at least 50 years under common use conditions. Within the last ten years, over three million houses and recreational vehicles have been built or manufactured using polybutylene plumbing pipe. Service problems have been virtually nil.
- Q. Have polybutylene plumbing systems received wide approval?
- A. Yes, polybutylene is approved by every major national and regional code in the United States and Canada and by agencies of the U.S. and numerous foreign governments. In addition, over 65% of the major metropolitan areas in the United States have approved polybutylene plumbing systems.
- Q. There are a number of polybutylene hot water piping systems on the market. Are there any differences in them?
- A. All pipe is manufactured to meet the appropriate ASTM standard and is equivalent in performance. Insert, compression, and stab fittings are used for pipes up to 3/4-inch in diameter. Although the fittings vary in design, all meet the same pressure test requirements. For pipes with diameters of one inch or greater, polybutylene heat fusion fittings are used.

- Q. Polybutylene tubing is available in several different colors. What do the colors mean?
- A. The pipes are color coded for different end use applications. Gray is the standard color for hot and cold water plumbing pipe. Blue tubing is used for cold water service only. Black is used for applications that require long-term exposure to sunlight. Black resins are available for both water service piping and for hot water piping.

TECHNICAL

- Q. What is the burst pressure of polybutylene?
- A. SDR 11 polybutylene pipes have a burst pressure of 575 psi at room temperature and well over 300 psi at 180°F.
- Q. How high a temperature can the pipe tolerate?
- A. The most common size of polybutylene pipes (SDR 11) carry a 100 psi continuous use pressure rating at 180°F. This is a long term pressure rating and incorporates a 100% safety factor. In addition, polybutylene pipes also carry a 200°F continuous use pressure rating, the only thermoplastic pipe to carry this high a rating. For short term excursions, even higher temperatures can be tolerated.
- Q. What is the melting point of polybutylene resins?
- A. Polybutylene pipe resins melt at 255-259°F.
- Q. Isn't that a problem for fire sprinkler piping?
- A. It could potentially be if the piping were installed exposed in areas with high fuel loadings like chemical warehouses. However, when installed with quick response residential heads, either exposed or concealed, the piping has repeatedly demonstrated in laboratory and real life tests across the United States that it can easily survive the heat generated by room fires.
- Q. What if you get a fire in the space behind the wallboard where there are no sprinkler heads? Won't the pipe be damaged under these circumstances?
- A. If a fire is allowed to burn next to a polybutylene pipe, it will eventually cause the pipe to leak. Tests at the University of Maryland Fire School have shown that the leak will be in the form of a small hole in the pipe wall, typically less than one quarter inch in diameter. The leak will allow water in the pipe to spray out, potentially controlling the fire and certainly tripping the flow

alarm switch on the sprinkler system to warn the occupants of the danger. In contrast, metal piping systems would not leak when exposed to a wall fire and the occupants would not discover the fire until they smell the smoke or the fire bursts through the wall.

- Q. How sensitive is the pipe to freezing and what will happen to it if water does freeze in it?
- A. Although no fire sprinkler piping should be allowed to freeze (this will inactivate the system), freezing can occur in extreme conditions. Since polybutylene pipes are poor conductors of heat, water in them would freeze more slowly than it would in metal pipes. If the pipe should freeze, the flexibility of the polybutylene piping allows it to expand to accommodate the ice. Upon thawing, the pipe returns to its original size without losing any of its strength.

It should be pointed out, however, that the use of a section of polybutylene pipe in a system of rigid pipe may not protect the entire system. Under these circumstances, a freeze failure will most likely occur in the pipe with the lowest yield point: the polybutylene pipe.

- Q. Polybutylene pipe thermally expands and contracts more than metal piping. Is this a problem?
- A. It could be in areas of extreme temperature changes if it were not for the flexibility of polybutylene pipes. Because of their flexibility, the thermal expansion force is easily dissipated by a flexing of the line.
- Q. What are the flow characteristics of polybutylene pipes?
- A. With their smooth bore, polybutylene pipe systems are designed using a Hazen Williams flow factor of 150. This is a conservative value as the data indicate that a value of 160 is more appropriate. Because of their chemical inertness, polybutylene pipes will resist corrosion and liming. As a result, the high flow factor of polybutylene pipes will not have to be derated over the life of the system.
- Q. How long can polybutylene be exposed to the sun?
- A. The grey hot water pipe and blue water service pipe are not harmed by the normal short exposures to the sun characteristic of normal construction practice, but should be protected from the sun during storage. The black pipe has excellent resistance to ultraviolet radiation and can be used in the sun for extended periods of time.

- Q. Polybutylene looks heavy. What does it weigh?
- A. Polybutylene is a strong but very light pipe. For example, a 20 ft length of 1-1/2 inch IPS polybutylene piping weighs just 8 pounds. In contrast, a 20 foot length of 1-1/2 inch schedule 40 black iron pipe weighs 50 pounds, and 20 feet of 1-1/2 inch copper type M tubing weighs 19 pounds.
- Q. How flexible is polybutylene?
- A. Polybutylene can be bent to a radius of 10 times its diameter without affecting its performance, e.g., (1-1/2 inch IPS pipe can be bent in a 19 inch radius.)

INSTALLATION

- Q. Will the flexibility of polybutylene piping make it look like garden hose when it is installed?
- A. Not at all. Being much more flexible than metal pipe, plastic pipe will require more supports and will show some deflection between supports (deviation from perfect horizontal alignment). This does not place any undue stress on the pipe and will not shorten its expected service life.

For comparison purposes, polybutylene pipes are ten times stiffer than garden hose and, of course, are worlds different in performance.

- Q. What support spacing is needed with polybutylene pipe?
- A. The support spacing will vary with pipe diameter, larger sizes requiring less frequent supports. Although supports must be used more frequently than with metal pipe, the requirement is not excessive, e.g., 1-1/2 inch polybutylene pipe has a recommended support spacing of over five feet.
- Q. Are special hangers required?
- A. Hangers should have a smooth surface with no sharp edges that could lead to surface abrasion over long periods of time. Plastic coatings have been used on hangers in the plumbing field to eliminate external abrasion.
- Q. What about wall penetrations? Must these also be protected?
- A. Wall or stud penetrations should be sleeved at the beginning and end of horizontal runs and on both sides of any significant change of direction. As before, low friction plastic sleeves are preferable.

Q. With a burst pressure of 575 psi, is there any chance that the pipe will be broken by the pressure surge caused when fire pumps kick on?

A. NFPA 13E prescribes procedures that should be used when making a connection to the siamese connection on the building. These procedures call for the first responding company to begin pumping at 150 psi pressure with an increase in pressure to 175-200 psi if a serious fire is in progress. Since both these pressures are far less than the pipe's capability, there should be no problem.

Q. Can polybutylene pipes be installed in return air plenums?

A. NFPA regulations state that only noncombustible or low combustibility materials that have a smoke density value of less than 50 as measured by the ASTM E-84 tunnel test can be used in return air plenums.

As polybutylene pipes are used, pressurized with water, they will be virtually impossible to ignite and do not constitute a fire hazard. They may in fact assist in extinguishing any fires that could be generated in return air plenums.

The smoke density requirement should not cause a problem either. Although relevant smoke density values cannot be obtained on plastics by the E-84 tunnel test, a National Bureau of Standards smoke chamber test measurement is available. Comparison of this value to the NBS smoke chamber values for common building materials for which E-84 tunnel test values are also available, shows that smoke generated by polybutylene has an acceptably low density.

COSTS

Q. What about future costs of polybutylene?

A. Polybutylene is made from butene-1, a common chemical feedstock. With gasoline sales forecast to continue dropping, adequate supply and a predictable price for hydrocarbons can be expected. In fact, because of its energy efficient manufacture, polybutylene systems should be less affected by changes in energy prices than metal piping.

Q. What about fitting costs?

A. Although they presently cost more than competitive fittings, fewer of them are required due to the flexibility of polybutylene. In addition, the benefits of mass production as the market continues to grow should reduce their cost in the future.

Q. What cost savings can be expected compared to competitive products?

A. Cost comparisons are subject to many variables but a study by the N.A.H.B. Research Foundation in 1980 showed a 44 percent total installed cost saving compared to a copper plumbing system. In addition, as part of the fire sprinkler tests at Scottsdale in 1982, it was demonstrated that the total costs of retrofitting a polybutylene fire sprinkler system into a single family house was 40% lower than that obtained on retrofitting a black iron system. In addition, recent San Clemente retrofit tests indicated labor savings of more than 50% compared to rigid piping material.

"POLYBUTYLENE FIRE SPRINKLER PIPING"

Meeting the NFPA's goal of halving the number of fire deaths in this country will require action in many areas. The widespread use of residential fire sprinkler systems is one area where significant improvements can be made. However, for residential fire sprinklers to be widely used, they must be demonstrated to be affordable and that has not been the case. Recognizing this, the United States Fire Administration initiated a program in 1980 to develop a low cost residential fire sprinkler system. The program involved the development of fast response sprinkler heads and demonstration of the ability of easy to install polybutylene pipe to meet all of the performance requirements for these systems. That program was successful on both counts as demonstrated by numerous tests at Factory Mutual. As a result, roughly 1000 living units will have residential fire sprinkler systems installed with polybutylene pipe this year.

Because polybutylene is new to this application, I imagine that most of you are unfamiliar with its history of use and performance properties. Accordingly, I would like to give you a very brief history of the development and use of polybutylene pipe and to discuss its properties relative to those of the competitive materials.

Polybutylene came into existence in the 1950's and was first used commercially as a piping material in 1967. Its first major use came in cold water service lines and it has continued in successful use in this application with major utilities for 15 years.

Next polybutylene moved into the mobile home industry. Because of its ability to virtually eliminate in-transit breakage due to vibration, polybutylene rapidly became the primary hot and cold water plumbing pipe used in this industry. Starting from its first use in 1972, it has progressed to the point where it is now used in well over 80% of the mobile homes and recreational vehicles produced in this country.

With expanded availability of polymer resulting from a plant expansion in 1970, an effort was begun to broaden plumbing code acceptance and increase polybutylene's use in residential plumbing systems. At present, polybutylene is approved for hot and cold water plumbing applications in every major national and regional plumbing code in this country - the only plastic pipe so approved. In addition, it has been approved for use in over 65% of the major metropolitan areas in the United States with additional approvals being gained constantly. Acceptance in areas where it has been approved has been excellent. For instance, in Fairfax County, Virginia, where it has been approved for two years, 60% of the new residential construction currently uses polybutylene plumbing.

A residential fire sprinkler pipe should ideally have several characteristics. Since it is tied to the drinking water system, it should be approved for potable water use. It should have good long term flow properties. It should have the ability to withstand many years of exposure to the high temperatures that can occur in an attic during the summer or if the pipe passes next to a recessed lighting fixture. It should be resistant to freeze breakage. And it should have a low installed cost, even in the most difficult retrofit situations.

Polybutylene meets all of these requirements. Every three feet of polybutylene carries the National Sanitation Foundation logo denoting approval for potable water applications. In addition, numerous foreign countries including Canada, Great Britain, Israel, New Zealand, and Finland have also approved polybutylene pipe for drinking water uses.

Although the Hazen Williams flow factor for polybutylene pipes is listed at 150, experimental evidence indicates a value of 160 is more appropriate. Testing is in progress to confirm this. Even more important than short term flow characteristics however, are those exhibited over the long term. Because of its inertness, polybutylene pipes will not suffer a loss in flow capacity over time. By contrast, many metal pipes can corrode or lime up causing a noticeable loss in flow factor. This is particularly critical in systems where the water in the sprinkler piping is not stagnant. Such systems are being used in Cobb County, Georgia, to eliminate the use of back flow preventors and thus reduce overall system cost.

As you would expect from its widespread approval for use as hot water plumbing pipe, polybutylene pipe has excellent high temperature properties. The pipes used in plumbing applications carry a long term continuous use pressure rating of 100 psi at 180°F and 200 psi at room temperature. Since these ratings have a 100% safety factor, the long term burst pressures are actually 200 psi and 400 psi, respectively. The short term burst pressure for polybutylene pipes at room temperature is 575 psi. In addition, polybutylene pipes have also been granted a 200°F pressure rating - the highest rating of any thermoplastic pipe.

For shorter periods of time, polybutylene pipes can tolerate temperatures significantly higher than these. In tests conducted at the University of Maryland Fire School, pressurized polybutylene pipes were exposed to a 1500°F radiant wall at a distance of only eight inches. With a stagnant water pressure of 40 psi, the pipes went 8-20 minutes before a rupture occurred. When it finally occurred, the surface of the pipe was close to 500°F. The rupture that occurred was in the form of a small hole (typically 1/4 inch in diameter) that released a spray of water that could cool the pipe surface preventing further damage. For fires inside a wall next to the sprinkler piping, this behavior would actually be of benefit to the homeowner - the fire would cause a small rupture in the pipe at the point of the fire, possibly controlling it, at least in part, and certainly tripping the flow switch to warn the homeowner of the danger.

Polybutylene's ability to survive very high temperatures was clearly demonstrated in the recent series of tests conducted by the NFPA in Fort Lauderdale. In several of those tests, the polybutylene sprinkler piping was exposed to fires set directly below it. Flames were actually licking at the pipes before the sprinkler heads were activated. In every case, the systems performed acceptably and the fire was completely extinguished. There was no damage to the pipe. It should be noted that we recommend shielding of pipes from flames by wallboard or other acceptable materials. However, even if this precaution is not followed, these tests clearly demonstrate the system can perform acceptably.

Because of its flexibility, polybutylene pipes can be repeatedly frozen and thawed with no loss in strength. Although a sprinkler system should always be designed to avoid freezing as that would inactivate the system, such conditions can nonetheless occur and would result in water damage if the piping system were not freeze tolerant, like polybutylene.

Last, and perhaps most important to the acceptance of these systems, is the ability to install them at a low cost. Clearly, unless fire sprinkler systems are affordable they will not be used and their life saving potential will not be realized. Any meaningful cost comparison must look at the total installed costs, the sum of all material and labor costs.

In general, on a foot-to-foot basis, polybutylene pipes are as inexpensive as the competing metal pipes. However, as production increases, costs of polybutylene pipes should be reduced. Over time, increases in the cost of energy will actually benefit polybutylene since its manufacture involves less total energy usage than any of the metal systems. Long term, polybutylene pipes should be less expensive than any metal pipes.

The installation of pipes made of polybutylene will be significantly faster and easier than that of rigid metal pipes. Because of its flexibility (100 times greater than copper and 400 times greater than steel), it is not necessary to use a fitting to change directions nor is it required to do all of the assembly work in tight spaces. This was graphically shown in the installation work done prior to the fire sprinkler tests conducted by the Rural/Metro Fire Department in Scottsdale, Arizona, this past spring. For those tests, two completed homes were re-fitted with fire sprinkler systems - one in polybutylene and one in black iron. The polybutylene system was assembled on the garage floor, snaked into the attic through a 2 foot square access hole, and dropped into place. Total labor charges for the crew's first polybutylene installation amounted to \$744, far less than the \$1422 for the standard black iron system. As you might expect, further cost reductions are reported with additional experience. No comparisons between polybutylene and copper fire sprinkler systems are available, although total cost savings of 44% have been documented when the National

Association of Home Builders Research Foundation compared the costs of polybutylene and copper in plumbing systems in 1980.

Because of its inertness, polybutylene cannot be joined by solvent cements. In practice, polybutylene piping systems are either heat welded or mechanically joined. The heat welding method is used for diameters greater than 3/4 inch and involves melting a thin layer of polymer on the outside of the pipe and another on the inside of the fitting, pressing the pipe into the fitting, and allowing the molten polymer to solidify together, forming a joint stronger than the pipe itself. This same technique has been used extensively throughout the world with polyethylene gas pipes.

Mechanical joints most commonly utilize an insert fitting and a metal crimp ring. These systems are tight, easy to make, and can provide an easy transition to the screwed fitting needed for the sprinkler head.

To date, the fire sprinklers installed with polybutylene pipes have been done specifically under local approval. However, polybutylene pipes and fittings should soon be approved under NFPA 13D. That approval should be forthcoming when the testing to Factory Mutual's standard on plastic pipe in residential fire sprinklers is completed.

Polybutylene has demonstrated that it can do the job in burn tests at San Clemente, California; Carmichael, California; Scottsdale, Arizona; Springdale, Arkansas; Cobb County, Georgia; Fort Lauderdale, Florida; and at Factory Mutual. With its high performance properties and low installed cost, we believe that polybutylene can and should become the premier piping material for residential fire sprinkler systems.

A. H. Schroer / CBM

A. H. Schroer
October 6, 1982

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Operation Hotel-Safe: Are You Part Of It?

by John Spina

More than 200 people gathered on prime Fort Lauderdale, Florida beach property recently for a very strange event. Hotel and motel dignitaries met on-site with insurance and code officials, product manufacturing representatives, nationally recognized fire officials and government officers. A very large contingent of the media was present also — all three national TV networks, three affiliate network TV crews, and four local TV stations, as well as print and trade media from across the nation.

They came to deliberately set a hotel afire and watch what would happen. Their plan called for doing so ten different times over the three-day period.

They gathered September 8, 9, and 10 to test the operation of new automatic fire sprinklers — a system which could save lives in hotel and motel fires, reduce serious injuries, and dramatically reduce property losses. All this, experts said, can be done at lower costs thanks to modern technology and a unique partnership of federal, private-sector, and fire service leaders.

Hotel & Resort Industry magazine

was in Ft. Lauderdale to cover the event. Our goal is to make you feel as if you were there too. We're confident that you cannot investigate this subject without realizing its importance to our clients — the general public.

The Target: Safer Hotel/Motel Properties

Why all the publicized concern over fire safety in hotels and motels? An examination of the facts tells the whole story.

In the time it takes to read this article, one American will likely die and 22 others will be seriously injured as a result of residential fire in the United States. In that same amount of time, thousands of dollars in property damage will result from these fires.

The death toll and property loss from fires in hotels and motels are included in these grim statistics and, whether or not you choose to investigate the issues involved, you should be aware of the industry's — and your property's — vulnerability to fire.

No longer is the owner and manager of a hotel, motel, or resort property involved in a simple, low-stakes game of chance when it comes to the

threat of fire. Odds are that one out of every four hotel/motel properties will experience a fire annually. Besides the possible life loss and civil suits that can result, the loss of room revenue while reconstruction takes place, and the certain, though unmeasurable, effect on the property's image, the average cost of that hotel/motel fire in property damage is \$6,300.

While tragic fires which claim multiple deaths and injuries — like the MGM Grand fire — result in considerable news coverage, this should not lead you to believe that fires in hotel/motel structures are rare events. According to statistics from the Federal Emergency Management Agency (FEMA), about 1,000 hotel/motel fires occur monthly. Claimed in these 12,000 + fires yearly are an estimated 150-200 hotel guests or employees and more than \$75 million in property loss, again exclusive of the loss of revenue, possible legal costs, of difficult-to-calculate "image" costs.

In 1981, for example, FEMA's preliminary estimates show approximately 12,200 fires in hotels and motels were reported (a considerable

number of fires are not reported to the fire service); 165 people died in those fires; approximately 550 people were injured; and more than \$77 million in property damage occurred.

"These grim statistics," said Ed Wall, deputy superintendent of FEMA's National Fire Academy, "become even more alarming when close examination reveals that many of the fires were preventable or could have been controlled if certain technological and behavioral lessons had been applied beforehand."

One objective which FEMA and the National Fire Protection Research Foundation hoped to accomplish in the tests, said Wall, was "to provide visual evidence of the value of advances in automatic fire sprinkler systems." A review of the tests and remarks of the audience indicate that the goal was certainly achieved.

The Tests: Visual Proof Of Sprinkler Detector Value

From the outset, the tests were designed to replicate actual hotel and resort industry property conditions. Besides the use of a vacant hotel rather than a laboratory setting for

the tests, several steps were taken to insure actual hotel/motel conditions. For example, furniture, drapes, bedding, wall coverings, and window and door arrangements were all specified based on what is found today in the average hotel or motel guest room.

Conditions during the fires also were varied to account for differences that might occur in real-life settings. In some tests, for example, doors were left open rather than closed, accelerants used in the arson-type fires varied, and the piping systems in the rooms were tested both protected and unprotected by drywall or wood construction which is common to resort industry properties.

Perhaps the most important planning step taken to insure a real-life test, however, was selection of the fire scenarios by the sponsors of the tests. Ten different scenarios were used, each drawn from real-life fire incidents in resort industry property. Simulated accidental and arson fires were tested in hotel guest rooms, corridors, linen closets, and in maid carts. Both active fire situations and smoldering fire situations were included in the scenario designs, since both are com-

mon to the hotel/motel fire problem in the United States.

Arrangements also were made for installation of scientific measuring equipment in each of the test areas that samples could be collected to measure heat levels, carbon monoxide buildup, and concentrations of hydrogen chloride (HCL) and hydrogen cyanide (HCN) given off in the fires. HCL and HCN are common toxic gases given off from burning plastics. Many of the furnishings in the average hotel/motel room are produced from this type of material.

Finally, to complete the realistic design of the hotel/motel setting, clusters of various types of heat and smoke detectors were placed in several locations in the rooms. Since such detectors are placed in the rooms by the manager of the hotel or specified members of his staff and not by manufacturers who are more aware of the proper placement, the detector clusters were scattered to allow for readings of fire danger from several different locations. Wiring used in central detector and alarm systems, as well as in electronic voice communications systems, also was installed

both protected and unprotected to test survivability of the systems over time.



A smoldering fire in a wastebasket begins to produce smoke.



The wastebasket bursts into flame.



The wastebasket is totally engulfed in flame and the smoke becomes thick.

Test Results

Raw data from the tests follow:

Test #1: Arson fire in hotel guest room

- **Setting:** A hotel guest room, furnished with shag carpeting, foam mattress, two chairs, table and lamp. Doors and windows were closed for the test. Polybutylene pipe was protected by wooden soffit.

- **Source of Fire:** Arson fire, ignited with a paper wick on a mineral spirits compound. The flammable liquid was spread around the room on the shag carpeting. The fire spread immediately into approximately 3/4 of the room.

- **Raw Data Results:** First smoke detector alert: 7 seconds. Sprinkler flow: 39 seconds. Maximum temp. level: 298°F. Fire extinguished: 4 minutes following ignition.

Test #2: Wastebasket fire in guest room

- **Setting:** Hotel guest room furnished as in previous test. Fiberglass construction drapes with soffit lining added. Vinyl wall coverings added. Pipe is protected by soffit.

- **Source of Fire:** Match thrown into wastebasket containing newspaper and other trash. Basket placed between chair and bed. After several minutes, the fire spread from the wastebasket to the bed.

- **Raw Data Results:** First smoke detector alert: 52 seconds. Sprinkler flow: 6 minutes, 5 seconds after ignition. Maximum temp. level: 165°F. Fire extinguished: 10 minutes after ignition.

Test #3 — Arson fire in corridor

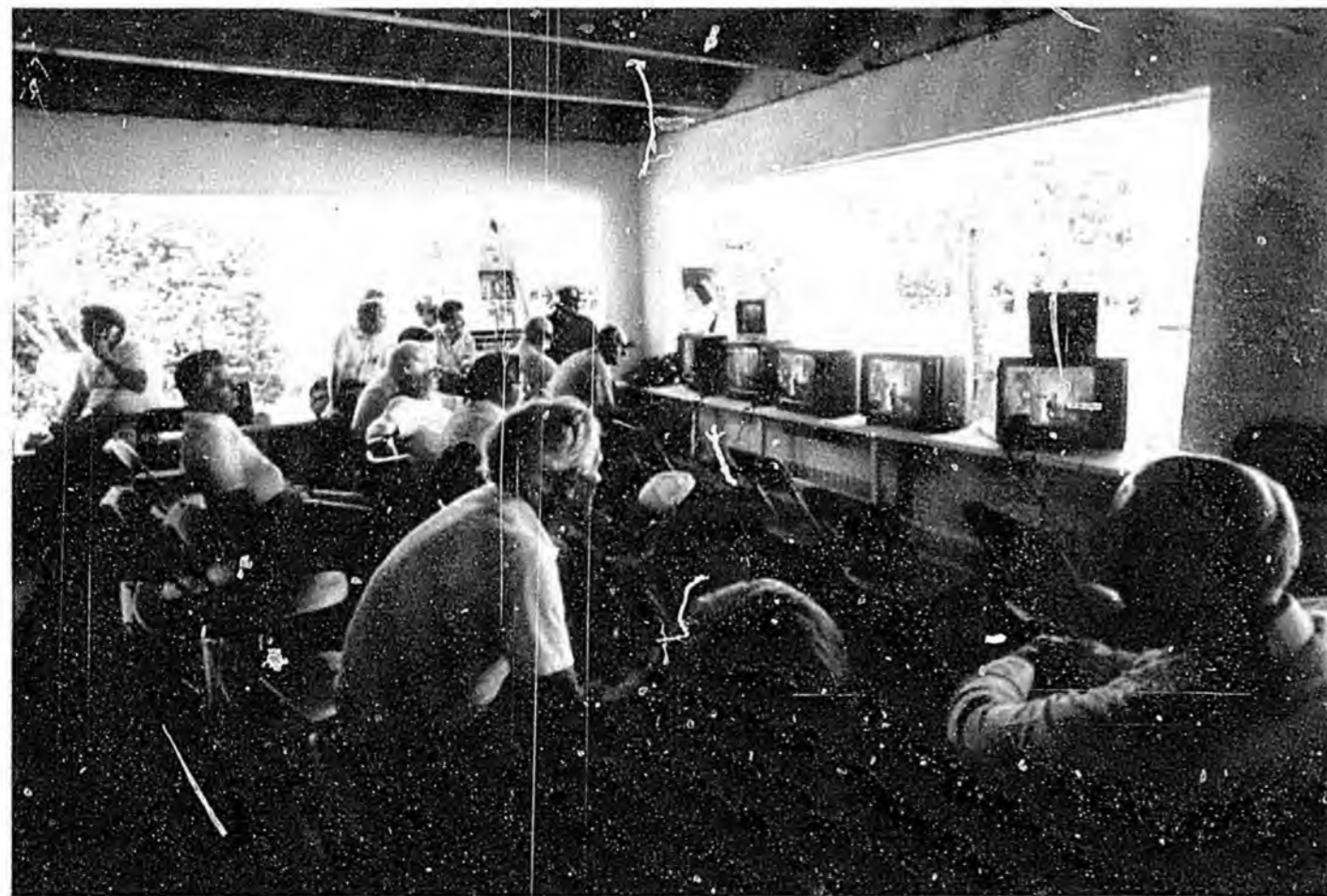
- **Setting:** Corridor of hotel floor is carpeted. Doors and windows in corridor are closed. Maid's cart containing sheets and other bedding material is set afire in center of corridor. Pipe is protected by soffit.

- **Source of Fire:** Arson fire, ignited with a paper wick on a mixture of acetone and mineral oil.

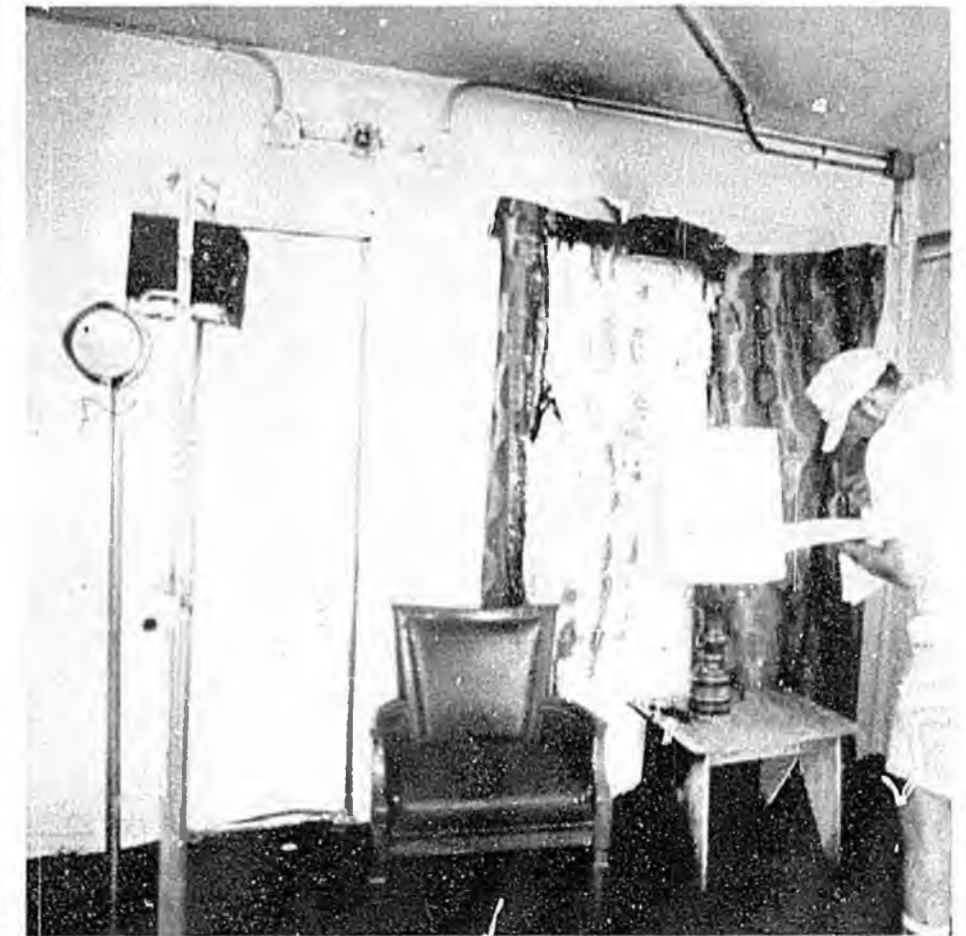
- **Raw Data Results:** First smoke detector: 7 seconds. Sprinkler flow: 15 seconds. Max. temp. level: 130°F. Fire extinguished: 4 minutes.

Test #4 — Smoldering fire in guest room

- **Setting:** Hotel guest room fur-



The researchers and reporters watch the staged fires through television monitors. Sophisticated equipment measures the heat and toxic gases produced in the fire.



The damage from this fire is minimal because the sprinkler was activated.

nished as in previous tests. Doors and windows closed. Pipe is protected by soffit.

• **Source of Fire:** Guest leaves hot iron on bed. Due to very high humidity conditions at test site, test was aborted after three hours. While information for sprinkler analysis was not provided, valuable smoke detector data will be available when scientific analysis is completed.

Test #5 — Arson fire in guest room

• **Setting:** Hotel guest room furnished as in previous tests. Drapes and linings are added. Plastic pipe is unprotected. Doors and windows are closed.

• **Source of Fire:** Half gallon of gasoline is poured onto bed and lit with a paper wick.

• **Raw Data Results:** Heat detector alert: 6 seconds. Sprinkler flow: 6 seconds. Max. temp. level: 119°F. Fire extinguished: 5 minutes.

Test #6 — Fire in maid's cart in storage room

• **Setting:** Small storage room off hotel corridor. No windows in room, door is closed. Maid's cart is placed in room. Plastic pipe is unprotected.

• **Source of Fire:** This was a simulation of an accidental fire. Source was cigarette left in lower trash bag of maid's cart. Because of earlier smoldering test problems, the smoldering stage was passed by and a match was used to light trash bag.

• **Raw Data Results:** First smoke detector: 33 seconds. Sprinkler flow: 2 minutes, 12 seconds. Max. temp. level: 98°F. Fire extinguished: 5 minutes, 28 seconds.

Test #7 — Wastebasket fire in guest room

• **Setting:** Guest room furnished as in previous tests. Wastebasket placed between table and vinyl-covered chair. Rayon/acetone/polyester drapes used in the room. Walls covered with vinyl coverings. Plastic pipe is unprotected. Window is closed. Door is left open.

• **Source of Fire:** Match is thrown into wastebasket containing newspaper and trash. Fire spreads from wastebasket to vinyl chair, then to vinyl wall coverings.

• **Raw Data Results:** First smoke detector: 1 minute, 11 seconds. Sprinkler flow: 14 minutes, 45 seconds. Max. temp. level: 130°F. Fire extinguished: 19 minutes.



In this controlled fire, gasoline is ignited next to the bed.



Detail of the damage to the bed and wall following activation of the sprinkler system.

Test #8 — Fire in maid's cart in corridor

• **Setting:** Maid's cart in carpeted hotel corridor. Cart contains sheets and other bedding materials. Doors in corridor are closed. Pipe is protected.

• **Source of Fire:** Simulation of accidental fire as in Test #6, except maid's cart is in hotel corridor. Ignition of fire as in Test #6.

• **Raw Data Results:** Smoke detector alert: 24 seconds. Sprinkler flow: 1 minute, 53 seconds. Max. temp. level: 93°F. Fire extinguished: 5 minutes, 17 seconds.

Test #9 — Smoldering fire in guest room

• **Setting:** Same as in test #4. Repeat of trial for smoldering fire situation. Same humidity problems were encountered. Test was aborted after two hours. No smoke was present, very little char of bed occurred.

Test #10 — Arson fire in guest room, luggage and contents ignited

• **Setting:** Luggage case is opened and contents (clothing, etc.) is dumped onto bed in guest room of the hotel. The room is furnished as in previous tests. Pipe is not protected.

• **Source of Fire:** Nail polish remover is spread on contents, luggage and bed. Paper wick used to ignite fire.

• **Raw Data Results:** Smoke detector alert: 12 seconds. Sprinkler flow: 1 minute, 9 seconds. Max. temp. level: 158°F. Fire extinguished: 4 minutes, 21 seconds.

Test #11 — Arson fire in guest room, luggage and contents ignited

• **Setting:** Same scenario as in Test #10, except the sprinkler in the corridor was capped and the sprinkler and all pipe and sprinkler hardware in the guest room was removed. The room therefore resembled an un-sprinklered hotel room.

• **Source of Fire:** Mixture of nail polish remover and acetone is spread on contents, luggage, and bed as in Test #10.

• **Raw Data Results:** Heat detector: 4 seconds. No sprinkler present. Max. temp. level: 540°F. Fire extinguished: by Ft. Lauderdale fire department (present during all tests) in approximately 8-10 minutes.

General Conclusions Of The Tests

The raw data results noted for each

of the above tests should not be interpreted in any way to be absolute numbers. Because of minor adjustments that may be necessary due to equipment placement, varying computer conditions and the like, these numbers may slightly change as full analysis of the Ft. Lauderdale tests takes place over time. A full report on the tests will be issued when this analysis is completed. Copies of this report will be made available by writing: National Fire Protection Research Foundation, Capital Gallery, Suite 220, 600 Maryland Ave., SW, Washington, DC 20024. Levels of toxic gases (CO, HCL and HCN) are now being analyzed and will be covered in the project report. Because laboratory analysis is required to determine toxicity levels, general conclusions covered below do not cover the effect of these toxic gases.



Several general conclusions can be drawn from the tests, however, even without benefit of the final data analysis.

By simple comparison of the two similar scenarios of tests #10 and #11, it is obvious that a sprinkler system adds a significant life safety potential to the average hotel room. This same assumption can be extended to all other tests which were completed, in that — even in the longest running fire test — the sprinklers reacted and extinguished the fire in the room of origin within 19 minutes.

Because the fire was extinguished in the room of origin by the sprinkler system, threat of fire death and serious injury to those in surrounding areas of the room is greatly reduced. Final determination of life safety in the test room or area itself must await the issuance of the final report, though the rapid extinguishment of many of the test fires, and raw data on maximum temperature levels indicates promise of positive results in even these areas.

It is also reasonable to conclude that there is definite need for a fire alarm system in hotel rooms whether or not a sprinkler system is present. Again, while final data can only indicate the presence of life-threatening

situations at the time of smoke or heat detector alert, it seems that the early warning alert given in all of the fire tests significantly added to increased life safety potential.

Finally, it appears that the polybutylene system used for installation of the sprinkler systems sustained no damage during the Ft. Lauderdale testing and therefore still holds promise as a lower-cost alternative for retrofitting hotels, motels and resort properties. The Ft. Lauderdale tests, however, were not part of a formal "listing" procedure for the plastic pipe and should not be interpreted as laboratory evidence of system performance.

In summary, then, it appears from the raw data results that a sprinklered hotel is indeed an inherently safer building structure and that the use of plastic pipe systems for accomplishing sprinkler installation deserves further examination by both code officials and hotel/motel owners facing retrofit decisions.

Hotel/Motel Fire Safety: Now A Consumer Concern

The MGM Grand and Hilton Hotel fires led to a great deal of public interest in hotel/motel fire safety. Fire service organizations, as well as individual owners and managers of resort property, have witnessed an increase in the number of consumer questions dealing with fire safety. Questions involving the presence of smoke detectors and "sprinklering" of hotels are often asked.

It is estimated that only two percent of the nation's hotels or motels are now sprinklered. Even a casual glance at fire data on the problem, though, indicates that there are no assurances of safety because the bulk of the industry hasn't yet made the commitment to sprinklers.

Ed Wall, deputy superintendent of the FEMA's National Fire Academy and chief government official at the Ft. Lauderdale site, remarked that "according to FEMA data estimates, property damage as a result of a fire in a sprinklered hotel is only one-fourth of the damage resulting from fire in a non-sprinklered hotel."

With this data as a starting point, it seems appropriate for the industry to begin a cost-benefit analysis of sprinkler systems in various types of resort properties.

Esso Plaisance, a director of fire prevention of New Orleans who was present at the Ft. Lauderdale fire

sprinkler tests, said he gets calls and letters daily from the tour industry, convention planners, and everyday citizens asking about safety standards in hotel properties in his city. "I've gotten to the point," says Plaisance, "where I maintain a listing of the safety features—sprinklers, smoke detectors, alarm systems, staff training, and the like. The questions aren't always easy to answer. People are much more aware of fire danger than they used to be."

Plaisance added that he personally knows of hotel and motel properties that have lost business because of the absence of safety systems. This has resulted, he said, "in property managers and owners asking what they need to do, not only what they have to do."

Echoes of Plaisance's statements were heard throughout the audience at the Ft. Lauderdale test site. When asked about the resort industry's rising interest in increasing its fire safety, John Veelenturf, a vice president of the Sheraton Corporation and its director of safety, said "the introduction of foam plastics and many fuel-derived materials in the last several decades have led to a very changed fire problem than that of the early 20th century." While there's no doubt that code changes will force many owners and managers to install sprinkler systems and take other steps, Veelenturf said leaders in the industry have already begun fire safety programs, like increased staff training, inspection of materials procured for the hotels, and other projects. He added that all of Sheraton's new hotels will be sprinklered and that the corporation is "vigorously pursuing possibilities for retrofitting existing properties."

Another representative from a major hotel chain, who asked not to be identified, added that hotel motel industry leaders are indeed making progress toward improved fire safety. "All of the major chains are taking steps," he said, "because the pressure to do so from the clientele has forced the issue. Many people come in and ask not to stay above the second or third floor. We know their reasons for the request, so we do not have to question them further."

Tony DeStephano, a fire service representative from Maryland and a former restaurant/hotel manager who was present at the site, summed up the public concern in a challenge. He said that guests booking rooms in a hotel or motel frequently ask about

the level they will be booked on, location of exit doors, and presence of smoke detectors and sprinklers. On the latter point, he added:

"Conduct the test yourself. Walk up and ask someone if they like their hotel room. The answer is yes. And the hotel in general? Yes again. And the pool, restaurant, and bar? Again, the guest is satisfied. But ask if their room has a smoke detector or if the room is sprinklered, and suddenly, they are reluctant to answer. Doubts about the safety of the hotel because of these omissions bring visions of a towering inferno to the average person. The average guest may not understand the workings, technology, or sophistication of fire protection systems. He may not even know what that silver-looking thing in the ceiling is, but he knows what he wants—and that's built-in protection."



Sonny Scarff, director of fire protection for Marriott Corporation, agrees with those sentiments. "The public has become increasingly aware of fire safety. Today, all of Marriott's 109 hotels are at least partly sprinklered, and about two-thirds are completely sprinklered. The company has budgeted to retrofit the hotels it owns which are not now fully sprinklered, and is pursuing a goal of having 100 percent sprinklering system-wide within 18 months."

Despite the fact that several of the larger hotel and motel chains are taking steps to increase fire safety, authorities in the fire service are still concerned about the great number of hotels and motels that are not actively pursuing the issue.

John Gerard, executive director of the National Fire Protection Research Foundation and former fire chief in Los Angeles, said that many people may mistakenly believe that it's rare when a guest investigates available hotels for qualities other than space, comfort, location and affordability. "But they are doing just that," said Gerard, and one sure measure being weighed today is that of personal safety—fire safety—during their stay

in a place away from home. If you speak with leaders in the industry, you'll find that people are not only asking those questions, but they're doing so in greater and greater numbers."

Gerard and other fire service and code officials at the test site expressed hope that the positive results of the sprinkler tests would spur interest from both the smaller and larger members of the resort industry trade.

Issues For Review

After three days on-site, the audience became increasingly aware of several factors which have kept resort property owners and managers from immediately adding sprinkler systems to their structures. These boil down to three central issues: codes; change and the fear associated with it; and costs.

Codes: Despite the one in four odds of a fire occurring in a hotel-type property, the general feeling in the audience was that a greater incentive would be necessary to induce an owner to take action. Of course, the obvious incentive is a code requirement.

Because both codes and the enforcement of codes varies from jurisdiction to jurisdiction, it is difficult to address the question of code problems in general or national terms. It is safe to say, however, that the hotel motel owners or managers have a difficult time, technically and financially, dealing with provisions of local building and life safety codes and view the addition of sprinkler systems as something which will be accomplished "when it has to be done," as several stated during the tests.

Sonny Scarff, director of fire protection for Marriott, agrees that this opinion likely prevails in the industry, but is quick to point out that "a single incidence of fire often forces a change of opinion, particularly if facts about the reliability of sprinkler systems are studied by those making the decisions."

Those changes of opinions for both the hotel owner and the code official are the direct result of public pressure. Where sprinkler systems are required, the local officials will be more active in enforcing the code than ever before because the awareness of the public about hotel motel fire safety is higher than ever before.

Local code officials, cognizant of cost considerations facing a hotel owner and public pressure, sometimes have the option of allowing changes

to the strict letter of the law when the code allows for "alternate means of achieving fire protection." Such code allowances may permit a local official to approve use of a conduit not mentioned in the code itself (such as polybutylene) or adopt other measures which may be less expensive alternatives for the owner committed to sprinkler installation.

Richard Johnson, a former code official from Memphis, believes that "unique conditions" previously had to exist before the average code official would exercise this authority freely.

In some cases, Johnson explained, a city may be operating under an antiquated code. If the building owner came in with a sprinkler design because he's experienced a fire and wants to upgrade his fire protection, the code official faces a "Catch 22" situation. If he allows an "alternative means" system, he could be charged with malfeasance; if he holds tight to the letter of the law and another fire occurs, he and the city could be criticized, said Johnson.

Nonetheless, code officials around the country realize the position in which the hotel owner is placed, says Bill Tomes, assistant fire marshal of San Diego. "Many are now aggressively pursuing tradeoffs to increase fire protection and to make it attractive enough for individuals to sprinkle their properties whether or not it's called for in the code."

While it is true that codes present a problem for the hotel owner facing a requirement or perhaps even a voluntary decision to sprinkle a building, there is significant evidence supporting increased cooperation between hotel owners and code officials on tradeoff options.

With this environment, it is possible that it may not be in the hotelman's best interest to "wait until we have to sprinkle buildings." In fact, voluntary action now could be to the hotelman's benefit since his property will be very marketable when the foreseeable code change occurs.

Change and the fear associated with it: Any change in resort industry property management—whether it directly affects the property or only the employee side of the business—is accomplished by an undeniable measure of reluctance or fear of the outcome.

Disruption of operations/aesthetic concerns. Regarding the issue of sprinkler system installation in existing buildings, a number of fears are

self-evident and were discussed during the Ft. Lauderdale testing.

An immediate concern raised is that of disruption of hotel operations during the retrofit period. Naturally, the amount of time a room or floor is out-of-service is important to the hotel management, as is the looks of the new sprinkler system in the hotel environment.

With black iron and copper piping systems, a longer downtime per room is obviously necessary because the system requires soldering, welding, and similar procedures at or near the place of installation. Nonetheless, experts the test site estimated only 3-4 days per floor (30+ rooms per floor) for complete installation. In off-season, this may not be difficult to arrange.

For polybutylene systems, the pipe connections are made by a mold system which does not require soldering or welding, and the lightweight, flexible nature of the pipe allows it to be curved and snaked around obstacles. These features also permit much of the set-up and molding work to be accomplished in a distant location, so disruption only occurs in the actual pipe hanging and soffit covering stages, which are necessary with either type of conduit.

Aesthetic considerations are easily handled in retrofit situations by installation of wooden or wall board soffit along the length of the hallway, with protrusions into each room entrance. Soffit on interior pipes also hides the piping and is easily accomplished.

The media in attendance at the Ft. Lauderdale tests were not aware of the recent soffit installation until it was pointed out to them, indicating that the fear of aesthetic concerns may be unjustified.

Plastic pipe damage. While use of a black iron or copper system avoids the issue of the sprinkler system itself burning, several in the Ft. Lauderdale audience expressed concern about the performance of plastic pipe under fire and extreme water pressure.

Tony Schroer, a polybutylene manager for Shell Chemical Company, reviewed scientific test results of the polybutylene system for the audience and many misconceptions were addressed. "Unlike other plastics on the market, polybutylene has very high temperature properties," said Schroer. It is the only plastic pipe carrying a 200°F temperature rating, and has a

914°F igniting point.

Testing conducted at the University of Maryland indicated that Schroer is correct. Researchers believed that "the piping can withstand the ceiling temperatures that can be generated in light hazard occupancy long enough for the sprinkler heads to activate, and thus control the fire and reduce room temperatures that will be generated down to a tolerable level that will not threaten the piping system."

Tests in Ft. Lauderdale under actual fire conditions also indicated no apparent damage to the polybutylene system, when either protected or unprotected by the soffit.

Questions from the audience also dealt with the "addition of another plastic material in an already toxic environment." Schroer noted that when polybutylene is burned in the laboratory, it "burns as clean as a candle." Hydrogen chloride and hydrogen cyanide, common toxic gases from burning plastics, are not given off by polybutylene. "Chances of the fire reaching this level of intensity where the pipe would burn are rare, and if it ever did occur, almost any kind of system would be in danger," Schroer added.

Maintenance fears. A final "fear" noted by some in the audience concerned the amount of maintenance or staff training which may be required in a decision to retrofit hotels with automatic sprinkler systems.

According to John Gerard, executive director of the National Fire Protection Research Foundation, these fears are again unfounded. "The systems require no more maintenance than the normal water distribution system and the monitoring of pressure levels and system checks are generally performed by the fire service or insurance industry officials," Gerard said. Checks of the sprinklers, he added, are really no more complex than those required for boiler or water heater systems.

Costs: Undoubtedly, the major drawback to retrofitting hotels and motels with sprinkler systems involves cost of the systems, cost of labor, and cost of downtime for installation.

Bill Testa, a manager for engineering with the Grinnell Fire Protection Systems Company, estimated the cost of retrofitting hotels or motels "in the ballpark of \$1.50 to \$2.50 per square foot for a steel pipe system, or about the cost of good carpeting."

In independent tests performed for

Shell Chemical Company, a 44 percent cost savings was realized in the use of polybutylene over copper conduit. Shell claims the savings are principally derived from material and labor time differences in this private residence test, which is viewed as representative of possible savings available in hotel/motel retrofit settings.

In either system, though, the costs are significant. As one hotel manager stated, "there is no doubt that the systems can reduce injury and property losses by controlling a fire in the room of origin and that the state-of-the-art will be applied as resources permit the industry to do so. The question remains "when?"

John Veelenturf, a vice president of Sheraton Corporation and chairman of the American Hotel & Motel Association's Fire and Safety Committee, summed up the cost issue in this way: "We will be exploring time and installation benefits of plastic pipe in our process to evaluate retrofitting. But, at the same time, the industry can significantly upgrade its fire safety through rigorous staff training, examination of the furnishings placed in hotels for their fire safety ratings, and placement of smoke detectors and alarm systems which give warning of fire danger."

Insurance industry representatives on-site echoed Veelenturf's statements, again stressing that sprinkler systems represent the state-of-the-art in fire prevention and therefore should be a goal of property owners. Phil Schiff, an account engineer with Allendale Insurance Company, stated that from an engineering point of view, insurance companies will look at anything that will decrease losses. "We're not keeping our heads in the sand. The technology is going in the right direction to achieve insurance rate decreases, though there are still many areas to attack before the fire problem is defeated."

In summary, then, the hotel/motel owner facing an order to install sprinkler systems will encounter high costs. Discussions with code officials, manufacturers, and insurance representatives, however, may result in tradeoff savings not otherwise available.

Assistance for this Hotel & Resort Industry special report was provided by David A. Demme, public affairs officer, Federal Emergency Management Agency, Washington, D.C.

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Sponsors Of The Tests

Federal Emergency Management Agency director Louis O. Giuffrida said the Fort Lauderdale fire sprinkler project "is exemplary of the efforts being undertaken by this administration to promote and enhance federal government and private sector cooperation on life safety efforts . . . The rewards for our efforts will be measured for years to come by an increased measure of protection made available to the American public."

Those sponsoring the event were:

- **Federal Emergency Management Agency (FEMA):** FEMA's mission is to prepare for and respond to a wide variety of emergencies and disasters, including the threat of fire. The agency has no regulatory powers, but instead has served as a catalyst in the development of automatic sprinkler technology as a mitigation measure to reduce residential fire losses. Over the past five years, FEMA has sponsored several million dollars worth of research and development projects for the fire service and private industry to spur development of sprinkler systems.

- **National Fire Protection Research Foundation:** The Foundation coordinated the event under a FEMA cooperative agreement. The Foundation was established in 1982 to respond to the continuing need for research and development of practical technologies and solutions to the fire problem. It plays a broad role in funding and directing fire research through cooperative projects with the government, business, industry and individuals interested in reducing fire losses.

- **Grinnell Fire Protection Systems Company:** Grinnell, one of several manufacturers of sprinkler

heads, made a significant breakthrough in the development of a quick-reaction sprinkler head as a result of FEMA-sponsored research. This head reacts five times faster than traditional sprinkler heads. Grinnell provided the sprinkler equipment and completed all installation work necessary for the Ft. Lauderdale tests.

- **Marriott Corporation:** Marriott made all the arrangements for the use of a vacant hotel in the Ft. Lauderdale tests, and provided furnishings necessary for the rooms used in the burns. The corporation has assumed a leadership role in retrofitting hotel and motel structures with advanced automatic sprinkler systems and has sponsored many life-safety sprinkler promotions in the past.

- **Shell Chemical Company:** Shell produced the polybutylene resin used in manufacturing the plastic pipe employed in these sprinkler tests. The pipe will be undergoing formal lab tests for listing as an approved conduit for sprinkler application.

- **Simplex Time Recorders Company:** Simplex is a leading manufacturer of state-of-the-art fire detection and alarm systems and provided all of the smoke and heat detection systems used in the tests. In addition, Simplex provided components of an emergency voice communications system and its multiplex panel system for monitoring activity in each of the test fires.

FEMA neither endorses nor implies endorsement of any product or service offered by the various sponsors of the Ft. Lauderdale tests. Their participation was coordinated by the National Fire Protection Research Foundation.

Sprinkler Systems: Are They Worth It?

On the final morning of the Ft. Lauderdale tests, a speaker from the hotel industry came to the front of the room and spelled out a fire scenario very familiar to most hotelmen who have studied the industry's fire problem: "A cigarette was mistakenly left on the hotel bed. A smoldering fire gradually flamed, covering the bed and spreading to the walls."

He then stated that this very situation recently occurred in two hotel

properties, one sprinklered and one not sprinklered.

The sprinklered hotel in Oregon sustained approximately \$6,000 damage, no one was killed or seriously injured, and the room was out of service for only three days.

The fire in the unsprinklered hotel in Texas resulted in 12 deaths, a number of injuries, and, as yet, an amount of property damage not being discussed due to pending lawsuits. The damaged section of the hotel lost more than three days of service.



DURAFLEX™ POLYBUTYLENE

PERFORMANCE REPORT

SHELL CHEMICAL COMPANY



Duraflex™ polybutylene pipe helps make lifesaving residential fire sprinkler systems easily affordable and practical.

DURAFLEX™ POLYBUTYLENE PERFORMANCE REPORT SHELL CHEMICAL COMPANY

In the time it takes you to read this report, someone in the United States will die or be seriously injured in a residential fire. Here's how Duraflex* polybutylene pipe can help reduce the growing number of deaths, injuries and property losses due to fire.

When combined with smoke detectors and low-temperature set-off residential fire sprinkler heads, Duraflex polybutylene pipe helps form an in-home fire protection system that's been proven effective in controlling common household fires within seconds. Duraflex pipe makes the system easy and fast to install in both new and existing construction, and easily affordable to most homeowners.

Recent studies reveal that on the average, someone dies or is seriously injured in a fire in the United States every 12 minutes. Another study indicates that residential fires in homes, townhomes, condominiums, apartments and mobile homes, account for 77% of the deaths, 68% of the injuries, and 46% of the property losses annually due to fires.

In what's to serve as a model installation for future systems and code ordinances, the first approved and inspected

*Duraflex™ is a trademark for polybutylene resin made by Shell Chemical Company and for polybutylene pipe manufactured under license from Shell.

residential fire sprinkler system was recently installed in San Clemente, California. The city has included polybutylene pipe in its Residential Fire Sprinkler Code as an approved material. San Clemente Fire Chief, Ron Coleman, said, "Polybutylene pipe can help in holding costs down. The pipe permits fast and inexpensive installation. So it holds the costs of a home sprinkler system to an affordable level, which helps to reduce resistance from homeowners."

Low cost, fast installing Duraflex makes system affordable.

It took less than one day to complete the first installation of this new type fire sprinkler system in a new home located in the San Clemente subdivision of Cypress Shores. Although the home is valued at over \$500,000, the fire sprinkler system was not expensive, representing less than 1% of the home's total construction cost. Because the size of the system installed is proportional to the home's size, the same average percentage cost of less than 1% of the home's construction cost is a good estimate for most new home installations.



Fire Inspector Ed Harrod checks installation of fire sprinkler specifically designed for residential use.

Installation is fast and simple for fire sprinkler systems using Duraflex pipe. Plastic mechanical fittings that can be easily and quickly assembled are used. The connections are made without soldering, welding, gluing, solvents, pipe dope or flux. Lightweight, flexible, Duraflex pipe can be curved and snaked around obstacles, through walls and ceilings, between floors and across attics.



Flexible Duraflex pipe speeds installation.

The pipe's flexibility was a real asset in the first installation because the house was close to completion. The Duraflex pipe could be curved around obstacles and routed easily, minimizing the extent to which the new construction was disturbed. This demonstrated another advantage of the pipe: its applicability to retrofitting the system into existing homes. "We like the pipe," Ron Coleman said, "and it's especially good for retrofitting. With the expansion and wide-spread acceptance we see for residential sprinkler systems, the ability to retrofit existing homes is going to be just as important as new home installations."

Durable Duraflex stands up to temperatures and time.

Reduced maintenance is another plus with Duraflex pipe. Because Duraflex doesn't corrode and it resists scale build-up, it isn't necessary to flush the system out periodically, which must be done with metal pipe systems. Duraflex

pipe can stand up to high attic heat in the summer, and doesn't crack if water freezes in it during the winter. Although it isn't necessary to drain down a Duraflex pipe system, it should still be checked periodically for proper functioning of the automatic alarm devices.

Proper installation is important for maximum effectiveness. Except for the sprinkler heads, all installation materials are plastic. Metal connections and installation parts should not be used as they could act as a heat sink during a fire and damage the system. Both the Duraflex pipe and sprinklers are laid out and located for maximum protection and fast response to a fire anywhere in the building.

San Clemente leads the way to in-home fire protection.

The City of San Clemente Fire Department has been progressive and instrumental in developing a practical and inexpensive residential fire sprinkler system. San Clemente Fire Department officials have been working with manufacturers of fire protection equipment, the United States Fire Administration, and other private companies and public agencies, to establish a national code and an effective, affordable system.

San Clemente originally became interested in residential fire sprinkler systems as a way to compensate for the possible reduction in city services such as fire protection, resulting from

lower tax revenues following California tax reforms. The Residential Fire Sprinkler Code was implemented with a city ordinance requiring sprinkler systems in all new construction, both residential and commercial. The ordinance may be expanded to include some existing buildings, as well.

San Clemente code has four specific objectives.

According to Ron Coleman, there is a four-fold set of objectives the city and the Fire Department hope to accomplish with their fire sprinkler code. First, to minimize residential fires and reduce property loss. Second, to limit and control fire before it reaches flashover. Flashover occurs when an area becomes superheated (800-1,000°F) in developing fires and the oxygen in the air suddenly explodes in a fireball. Flashover is lethal to anyone in the vicinity and it can involve the entire building in flames within minutes. Third, to accomplish these objectives with sprinkler systems. Coleman quoted a Johns Hopkins University study which says, "residential fire sprinkler systems can irrefutably bring about a significant reduction in loss of life and property due to fire." And fourth, to hold down the cost of this fire protection so most homeowners can afford it.

Controlling flashover was particularly important in developing a sprinkler system for residential use. Compared to industrial fires, residential fires

pose several special problems for control by automatic sprinkler systems. Residential properties have smaller room sizes and lower ceilings which cause temperatures and toxic gases to soar to lethal levels more rapidly than in industrial fires. Studies show that temperatures nearly double between the fourth and fifth minutes of a fire. Smaller rooms and lower ceilings also require a different spray pattern for the sprinkler to be effective. The system also has to be unobtrusive, inexpensive and virtually maintenance free to be readily acceptable to homeowners.

The design and test of the system.

Special low-temperature set-off sprinkler heads that release at 165°F have been developed by Grinnell Fire Protection Systems. These respond five times faster than industrial type sprinklers. An improved, wider spray water distribution pattern developed for residential rooms knocks down fire within seconds before it can grow. The cooling effect keeps other sprinklers from being set-off unnecessarily, keeping water pressure at maximum levels. The design and size of the heads keeps them from being too obtrusive. By combining these sprinkler heads with Duraflex pipe, and smoke detectors, fire officials have put together an effective system that can be easily and affordably installed and maintained in most homes.

Tests were conducted by the San Clemente Fire Department on this system prior to writing the city's fire sprinkler code. The tests were designed to demonstrate and check the system's effectiveness in controlling typical household fires, and to identify special considerations to be included in the code. Using an abandoned house planned for demolition, fire officials set three separate test fires inside and in the gar-



Tests conducted on this system proved it can control common household fires in seconds. Time lapse in photos: 20 secs. Test fire builds in photos one and two, and is rapidly extinguished in photo three.

age using common household furnishings and materials. In each of the test fires, the sprinkler heads responded rapidly and halted the fire's growth in seconds. The tests proved that the system, which is now the one described in the city's code, will control most common household fires in less than three minutes. Similar tests conducted by the California State Fire Marshall's office confirmed these results. (See photos page 3.)

Other studies have shown that a system like the one installed in San Clemente will knock down a fire fast enough to save a person lying in a bed next to the fire. In the room of origin, the sprinkler prevented eye-height temperatures and carbon monoxide gas from reaching lethal levels, while adequate amounts of oxygen remained to keep the air breathable.

"Trend of the future" for homes.

Ron Coleman sees the system's advantages catching on fast. He said, "Residential sprinkler systems are the trend of the future. In most new homes, we'll probably see built-in sprinkler systems becoming standard features. The major safety and loss prevention benefits of sprinkler systems will make them very popular, fast. We'll probably see more systems installed in the next 10 years than in the last 100 years."

"Over 400 cities have asked for copies of our standards," Coleman reported, "and many are using us as a model for their own standards." In many areas, voluntary standards for residential sprinkler systems are being implemented, and a growing number of municipalities are enacting mandatory codes. In the near future, these standards

may become virtually a nationwide mandatory building code requirement.



Left to Right: Mr. Charles Brent President of BJS Corporation, consulting engineers on the installation and supplier of the polybutylene pipe; San Clemente's Fire Chief, Ron Coleman, and Fire Inspector, Ed Harrod; and polybutylene plumbing representative, John Rosso.

Coleman concluded, "Another major factor in the growing demand for residential fire sprinkler systems is a change in the philosophy by modern fire managers. They're now looking at built-in technology as a means of improving overall fire safety and protection effectiveness, rather than relying solely on expert fire department personnel and their equipment."

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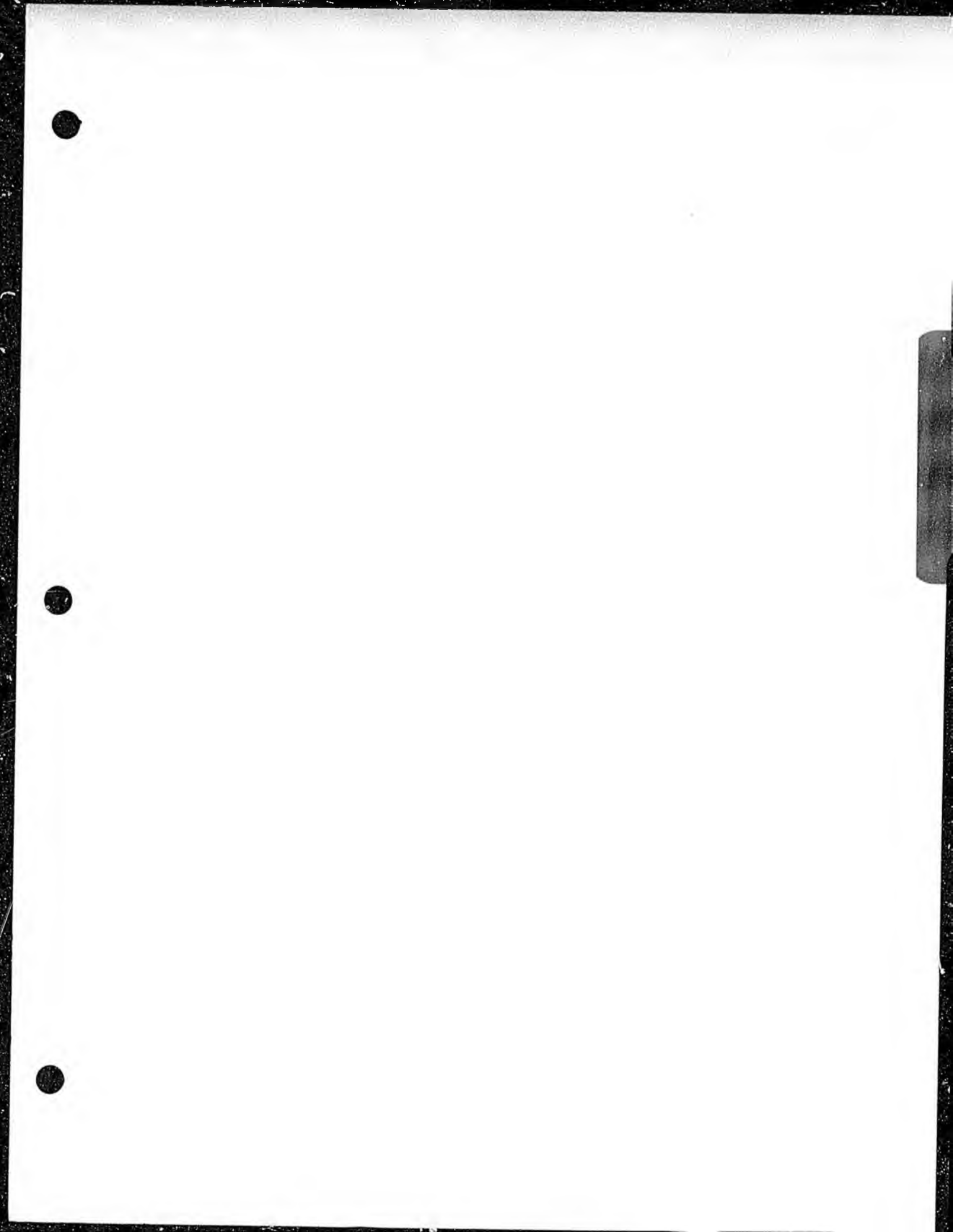
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December 1981

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Shell for answers



Fire Ratings

Unlike metal pipes, all plastic pipes will burn if exposed to a high enough temperature for a long enough period of time. In actual practice, however, ignition of water filled DURAFLEX polybutylene pipes will be virtually impossible. Because of polybutylene's high ignition temperature (914°F) relative to its melting point (255-259°F), exposure of the pipe to a flame will result in a melting of the surface of the pipe. With time, this could eventually lead to the formation of a small hole in the pipe wall that would spray water in the area of the fire. If, despite the flow of water, the fire continues to impinge on the pipe, the hole would enlarge releasing even more water. Only if the flame continued to impinge on the pipe until the pipe was completely broken would there be a possibility of setting fire to the pipe.

In the highly unlikely event that the polybutylene pipes would catch fire, they would burn slowly and cleanly. DURAFLEX polybutylene has an Underwriters Laboratories 94HB rating indicating that it will burn at a rate of less than 1-1/2 inches per minute. Bioassay tests by the method developed by the Fire Safety Center of the University of San Francisco have shown that the smoke from polybutylene is less toxic than that from Douglas fir.

Installation of fire sprinkler systems could necessitate running pipe in return air plenums. Based on the assumption that they will create a fire hazard, NFPA regulations limit the combustibility of materials in these spaces to a fuel loading of less than 3,500 BTU per pound. Although dry polybutylene has a higher fuel loading than this, as installed pressurized with water, it will have a much lower fuel content and will not represent a hazard.

In addition, NFPA regulations also require that materials used in return air plenums have a specific smoke density less than 50 as determined by the ASTM E-84 tunnel test or its equivalent, Underwriters Laboratories method 723. Because plastics melt before they burn, the E-84 tunnel test is not applicable to them. Comparisons can however be drawn to values of maximum smoke density as determined by the National Bureau of Standards smoke chamber test. These comparisons (attached) show that there should be no problem with polybutylene.



TEST REPORT

Prepared For: Shell Development Company
P. O. Box 1380
Houston, Texas 77001

Attention Of: Mr. M. P. Schard

Authorized By: P. O. #RE331TE62

MATERIAL TESTED

1. PB 4101 - Lot 4ACP-004, 124 mils
2. PB 4101 - Lot 4ACP-004, 77 mils
3. PB 4121 - Lot 6ACP-006, 119 mils
4. PB 4121 - Lot 6ACP-006, 78 mils

TEST PERFORMED

Flammability - UL94

TEST RESULTS

<u>Sample Identification</u>	<u>Classification</u>	<u>Burn Rate (mm/min.)</u>
PB 4101 - Lot 4ACP-004, 124 mils	94HB	27.0 (27.0, 27.0)
PB 4101 - Lot 4ACP-004, 77 mils	94HB	32.4 (34.8, 30.0)
PB 4121 - Lot 6ACP-006, 119 mils	94HB	28.5 (27.6, 29.4)
PB 4121 - Lot 6ACP-006, 78 mils	94HB	36.6 (37.2, 36.0)

TEST PROCEDURE

The procedure followed was that as outlined in the UL94 Standard. Materials classed 94HB shall:

- A. Not have a burning rate exceeding 1.5 inches (38.1 mm) per minute over a 3.0 inch (76mm) span for specimens having a thickness of 0.120 to 0.125 inch (3.05 to 3.18 mm), (1/8 inch (3.2 mm) nominal) or
- B. Not have a burning rate exceeding 2.5 inches (63.5 mm) per minute over a 3.0 inch (76 mm) span for specimens having a thickness less than 0.120 inch (3.05 mm), or



Test Procedure cont.

- C. Cease to burn before the flame reaches the 4.0 inch (101.6 mm) reference mark, but shall not comply with the requirements given in paragraphs 3.2, 3.3, or 3.4 for 94 V-0, 94 V-1, or 94 V-2 materials, respectively.

SL TESTING INSTITUTE

Alyce E. Mayer
Alyce E. Mayer
Physical Testing Technician

:mp

Approved by:

William W. Tenero
William W. Tenero
Project Manager

GENERAL

1. Scope

1.1 These requirements cover tests for flammability of plastic materials used for parts in devices and appliances. They are intended to serve as a preliminary indication of their suitability with respect to flammability for a particular application.

1.2 The methods described in this Standard involve standard size specimens and are intended to be used solely to measure and describe the flammability properties of materials, used in devices and appliances, in response to heat and flame under controlled laboratory conditions. The actual response to heat and flame of materials depends upon the size and form, and also on the end-use of the product using the material. Assessment of other important characteristics in the end-use application includes, but is not limited to, factors such as ease of ignition, burning rate, flame spread, fuel contribution, intensity of burning, and products of combustion.

1.3 The final acceptance of the material is dependent upon its use in complete equipment which conforms with the Standards applicable to such equipment. The flammability classification considered for a material may vary, depending on the equipment or device involved and the particular use of the material. The performance level of a material by these methods should not be assumed to correlate with its performance in end-use application.

1.4 The requirements may be applied to other nonmetallic materials if found to be appropriate.

1.5 These requirements do not cover plastics when used as materials for building construction or finishing.

TESTS

2. Horizontal Burning Test for Classifying Materials 94HB

Test Criteria

2.1 Materials shall be classified 94HB on the basis of test results obtained on small bar specimens when tested as described in paragraphs 2.4-2.12.

2.2 Materials classed 94HB shall (also see paragraph 2.3):

A. Not have a burning rate exceeding 1.5 inches (38.1 mm) per minute over a 3.0 inch (76.2 mm) span for specimens tested in a thickness of 0.120-0.500 inch (3.05-12.7 mm), or

B. Not have a burning rate exceeding 3.0 inches (76.2 mm) per minute over a 3.0 inch (76.2 mm) span for specimens having a thickness less than 0.120 inch (3.05 mm).

C. Cease to burn before the flame reaches the 4.0 inch (102 mm) reference mark. See paragraph 2.10.

2.3 If only one specimen from a set of three specimens fails to comply with the requirements, another set of three specimens shall be tested. All specimens from this second set shall comply with the requirements in order for material in that thickness to be classified 94HB.

Apparatus

2.4 The apparatus employed is to consist of the following:

A. Test chamber, enclosure, or laboratory hood free of induced or forced draft during tests.

B. Laboratory Burner - A Bunsen or Tirrill burner having a tube with a length of 4 inches (102 mm) and an inside diameter of 0.370 plus 0.06-0.0 inch (10 plus 1.6-0.0 mm). The tube shall not be equipped with end attachments, such as a stabilizer.

C. Wire Gauze - A 20 mesh (20 openings per 25.4 mm), 0.017 inch (0.43 mm) diameter iron wire gauze, 3 inches (127 mm) square.

D. Gas Supply - A supply of Technical Grade methane gas with suitable regulator and meter for uniform gas flow. Natural gas having a heat content of approximately 1000 Btu per cubic foot (37 MJ/m³) has been found to provide similar results. Other suitable fuel gases, such as butane, propane and acetylene (which have a higher heat value) may also be used. However, Technical Grade methane gas shall be used in case of question.

E. Ring Stand - A ring stand with clamps, or the equivalent, for horizontal positioning of the specimen and the wire gauze.

F. Stopwatch or other suitable timing device.

G. Conditioning room or chamber capable of being maintained at $23 \pm 2^\circ\text{C}$ and a relative humidity of 50 ± 5 percent.

Test Specimens

2.5 Test specimens are to be limited to a maximum thickness of 0.500 inch (12.7 mm). Test specimens of a 5.0 inch (127 mm) length by 0.500 inch (12.7 mm) width are to be provided in the minimum thickness and in the 0.125 ± 0.005 inch (3.18 ± 0.13 mm) thickness. The 0.125 ± 0.005 inch (3.18 ± 0.13 mm) thick specimens are not necessary if the minimum thickness is greater than 0.125 ± 0.005 inch (3.18 ± 0.13 mm) or the maximum thickness is less than 0.125 ± 0.005 inch (3.18 ± 0.13 mm).

Exception: Materials classified 94HB in the 0.125 ± 0.005 inch (3.18 ± 0.13 mm) thickness shall automatically be classed 94HB down to a 0.062 (1.57 mm) minimum thickness without additional testing.

2.6 The specimens shall comply with the following:

A. The maximum width is to be 0.52 inch (13.2 mm).

B. The edges are to be smooth, and the radius on the corners is not to exceed 0.05 inch (1.3 mm).

2.7 If the material is to be considered in a range of colors, melt flows, or reinforcements, specimens representing these ranges are also to be provided. Specimens in the natural (if used in this color) and in the most heavily pigmented light and dark colors are to be provided and considered representative of the color range, if the test results are essentially the same. An additional set of

specimens will be required in the heaviest organic pigment loading, unless the most heavily pigmented light and dark colors include the highest organic pigment level. When certain color pigments (e.g. red, yellow, or the like) are known by experience to have particularly adverse effects, they are also to be provided. Specimens in the extremes of the melt flows and reinforcement contents are to be provided and considered representative of the range, if the test results are essentially the same. If the burning characteristics are not essentially the same for all specimens representing the range, evaluation is to be limited only to the material in the colors, melt flows, and reinforcement contents tested, or additional specimens in intermediate colors, melt flows, and reinforcement contents are to be provided for tests.

Specimen Conditioning

2.8 The specimens are to be conditioned for at least 48 hours at $23 \pm 2^\circ\text{C}$ and a relative humidity of 50 ± 5 percent prior to testing.

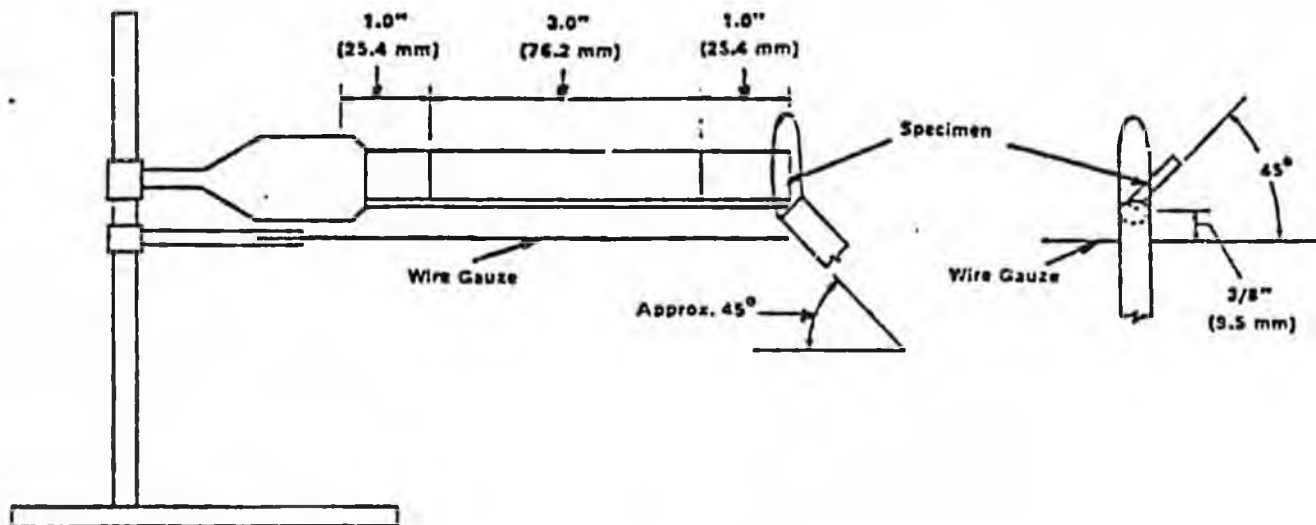
Test Method

2.9 The Burning Test is to be conducted in a chamber, enclosure, or laboratory hood free of induced or forced draft. An enclosed laboratory hood with a heat resistant glass window and an fan for removing the products of combustion after the test is recommended.

2. Each specimen is to be marked across its width with two lines, 1.0 and 4.0 inches (25.4 and 102 mm) from one end of the specimen. The specimen is to be clamped at the end farthest from the 1.0 inch (25.4 mm) mark, with its longitudinal axis horizontal and its transverse axis inclined 45 degrees. The wire gauze is to be clamped horizontally beneath the specimen, with a distance of $3/8$ inch (9.5 mm) between the lowest edge of the specimen and the gauze, and with the free end of the specimen even with the edge of the gauze. See Figure 2.1.

*Replaces page 6 dated January 24, 1980

FIGURE 2.1
HORIZONTAL BURNING TEST FOR 94HB CLASSIFICATION



2.11 The burner is then to be placed remote from the specimen, ignited, and adjusted to produce a blue flame 1 inch (25 mm) high. The flame is to be obtained by adjusting the gas supply and the air ports of the burner until a 1 inch (25 mm) yellow tipped blue flame is produced and then the air supply is to be increased until the yellow tip disappears. The height of the flame is to be measured again and corrected if necessary. The flame is to be applied to the free end at the lower edge of the specimen. The center axis of the burner tube is to be in the same vertical plane as the longitudinal bottom edge of the specimen (and inclined toward the end of the specimen) at an angle of approximately 45 degrees to the horizontal. See Figure 2.1. The flame is to be applied so that the front edge of the specimen, to a depth of approximately 1/4 inch (6.4 mm), is subjected to the test flame for 30 seconds without changing the position of the burner, and is then removed from the specimen. If the specimen burns to the 1.0 inch (25.4 mm) mark before the flame has been applied for 30 seconds, the flame application is to be discontinued when the flame reaches the 1.0 inch (25.4 mm) mark.

2.12 If the specimen continues to burn after removal of the test flame, the time for the flame front to travel from the mark 1.0 inch (25.4 mm) from the free end to the mark 4.0 inches (102 mm) from the free end, is to be determined and the rate of burning is to be calculated.

3. Vertical Burning Test for Classifying Materials 94V-0, 94V-1, or 94V-2

Test Criteria

3.1 Materials shall be classified 94V-0, 94V-1, or 94V-2 on the basis of results obtained on small bar specimens when tested as described in paragraphs 3.6-3.15.

3.1A Some materials, due to their thinness, distort, shrink, or are consumed up to the holding clamp when subjected to this test. These materials may be tested according to the Vertical Burning Test for Classifying Materials 94VTM-0, 94VTM-1 or 94VTM-2, Section 5A, provided specimens can be properly formed.

*Replaces page 7 dated January 24, 1980

BOEING COMMERCIAL AIRPLANE COMPANY

P.O. Box 3707
Seattle, Washington 98124

A Division of The Boeing Company

May 31, 1978
B-8800-1146L

Mr. Pat Hughes
Witco Chemical Corp.
Polymer Division
291 Fairfield Ave.
Fairfield, N.J. 07006

Dear Mr. Hughes:

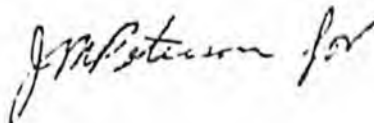
Per your telephone discussion May 22 with Mr. Alan Fenstermaker, enclosed are the data we have obtained regarding your Witco white and Witco clear polybutylene films.

We are encouraged with the flammability and toxic gas characteristics of these films and will continue their evaluation.

Thank you for your cooperation and we look forward to receiving further Witco white samples.

Very truly yours,

BOEING COMMERCIAL AIRPLANE COMPANY




Roy A. Anderson
Organization B-8811
Mail Stop 73-43
Phone (206) 237-9725

Enclosure

11775-102

FILM	2.5 WATTS/CM ² NBS SMOKE CHAMBER (FLAMING MODE)										
	O ₂ (OPTICAL DENSITY)						TOXIC GAS (PPM) @ 4 MIN.				
	1.5 Min.	STD. DEV.	4.0 Min.	STD. DEV.	Max.	STD. DEV.	SO ₂	HCN	NO ₂	CO	HCl
.0018" Mitco Clear Polybutylene	6.37	1.31	11.40	1.39	22.47	3.76	0	0	0	18	1
.0010" Mitco White	3.40	1.78	7.33	2.45	16.53	0.95	0	0	0	20	0

FILM	LIMITING OXYGEN INDEX ASTM D2863 	
	LOI	STD. DEV.
.0018" Mitco Clear	31	1.4
.0010" Mitco White	--	--

 Film sample used was 1/4" wide

TENSILE PROPERTIES ASTM D882 (RATE OF GRIP SEPARATION 2 IN/MIN)	.0018" MITCO CLEAR				.0010" MITCO WHITE			
	* # SPECIMENS AVERAGED = 5		** # SPECIMENS AVERAGED = 5		* # SPECIMENS AVERAGED = 5		** # SPECIMENS AVERAGED = 5	
	AVE.	STD. DEV.	AVE.	STD. DEV.	AVE.	STD. DEV.	AVE.	STD. DEV.
Thickness (ins)	0.0018	0.0000	0.0018	0.0000	0.0010	0.0001	0.0011	0.0000
Breaking Factor (lb/in of width)	10.3	1.3	12.2	0.7	4.6	0.5	9.1	1.9
Ultimate Tensile Strength (lb/in ²)	5.71x10 ³	714	6.95x10 ³	164	1.09x10 ³	154	2.08x10 ³	451
Yield Tensile Strength (lb/in ²)	1.82x10 ³	154	2.14x10 ³	79	565	23	734	83
Ultimate Elongation (%)	262.8	39.9	237.2	9.0	214.9	27.7	89.7	29.5
Elongation at Yield (%)	10.7	3.2	14.3	1.5	18.1	1.4	14.5	1.9
Tensile Modulus (lb/in ²)	2.88x10 ⁴	1.13x10 ³	2.57x10 ⁴	885	6.76x10 ³	710	6.55x10 ³	207

* = 90° to longest dimension

** = 0° to longest dimension

COMPARISON OF NBS SMOKE CHAMBER AND ASTM E-84 SMOKE DENSITY VALUES

<u>MATERIAL</u>	<u>SMOKE DENSITY VALUES*</u>	
	<u>NBS (FLAMING MODE)</u>	<u>E-84</u>
1/2" gypsum board painted	33	7
vinyl covered gypsum board	54	55
5/8" particle board	398	160
1/4" Douglas fir plywood - prefinished	146	86
11/64" Lauan plywood - unfinished	50	67
1/8" melanine finished hardboard	89	230
1/2" acoustical tile (wood fibreboard type)	113	61
1/2" acoustical tile (mineral based)	73	20
Polybutylene**	16 - 22	

* National Bureau of Standards Technical Note 879, "Fire Build-up in a Room and the Role of Interior Finish Materials" by Jin B. Fang.

**Boeing Aircraft Company



EXECUTIVE SUMMARY

Widespread use of plastics has added both convenience and hazards to modern living. Below is a study of the dangers of toxic gases produced by the combustion of plastic pipes . . .

Toxicity of Gases From Polybutylene And Douglas Fir

By CARLOS J. HILADO & PATRICIA A. HUTTINGER
Product Safety Corporation

Because of their versatility and performance advantages, plastics have found their way into numerous applications. This widespread use has in-

evitably brought them into many applications in which safety upon exposure to heat or fire is an important consideration, and their response characteristics need to be known.

One aspect of safety which has caused considerable concern is the possible generation of toxic gases upon exposure to heat or fire. It is

impossible to simulate all possible conditions under which such exposures could occur, but manufacturers conscious of their responsibilities to the consumer and to the general public nonetheless make an effort to evaluate their products by means of available technology to obtain some degree of assurance that there would be no unreasonable risk. Screening of materials is needed, because investigation of every possible formulation for every possible exposure is not feasible.

A laboratory toxicity screening test method has been developed by the authors to serve as a means for comparing materials on the basis of relative toxicity under specified test conditions, using apparatus, facilities and personnel which would be within the capabilities of most laboratories. With the purpose of screening in mind, this method is intended to indicate which materials are more toxic under spe-

Table 1. Toxicity Test Data on Polybutylene Pipe and Douglas Fir (PSC Condition 1 or NASA-USF Procedure B)

material	test no.	time to staggering min	time to convulsions min	time to collapse min	time to death min
DURAFLEX 4127	1	16.32 ± 0.88	17.75 ± 1.02	20.22 ± 2.44	24.35 ± 3.20
	2	16.53 ± 0.27	17.54 ± 1.34	18.70 ± 1.73	22.39 ± 2.77
	mean	16.42 ± 0.15	17.64 ± 0.15	19.46 ± 1.07	23.37 ± 1.39
DURAFLEX 4121	1	16.45 ± 0.45	16.88 ± 0.73	18.47 ± 0.14	21.49 ± 0.95
	2	16.33 ± 1.08	17.77 ± 0.96	18.45 ± 0.88	21.93 ± 0.54
	mean	16.39 ± 0.08	17.32 ± 0.63	18.46 ± 0.01	21.71 ± 0.31
Douglas fir	1	10.92 ± 2.13	14.98 ± 0.58	16.09 ± 1.05	18.57 ± 0.79
	2	12.29 ± 0.69	14.04 ± 0.52	14.41 ± 0.42	16.77 ± 0.40
	mean	11.60 ± 0.97	14.51 ± 0.66	15.25 ± 1.19	17.67 ± 1.27

cified test conditions and not necessarily to explain why they are more toxic (1-11).

A large selection of test conditions can be used. The toxicity screening program used by the Product Safety Corporation employs 16 different sets of test conditions: the rising temperature program at 40°C/min from 200 to 800°C and seven fixed temperatures at 100°C intervals (200, 300, 400, 500, 600, 700, and 800°C), both without forced air flow and with nominal 1 L/min air flow. This program has been used with polyethylene (12), polypropylene (13), polystyrene (14), polycarbonate (15), polyoxymethylene (16), polyethersulfone (17), polyetherimide (18), polytetrafluoroethylene (19) and Douglas fir (20).

Experiments at a succession of fixed temperatures have research value in that they determine the material responses at particular temperatures. The rising temperature method offers the potential for more cost-effective screening by attempting to integrate the effect of successive tem-

peratures, and provides the ability to compare test results with those obtained for over 300 materials previously evaluated under the same rising-temperature conditions.

This report presents the toxicity test data obtained for two samples of polybutylene pipe and one sample of Douglas fir wood, evaluated under the routine screening test conditions of rising temperature at 40°C/min from 200 to 800°C without forced air flow. These test conditions have been described as Procedure B of the NASA-USF toxicity screening test method, and are included in the BART specifications for seat cushioning materials (21).

MATERIALS

The materials evaluated were two samples of polybutylene pipe received from Shell Oil Company, Houston, Texas. The samples were identified as follows:

DURAFLEX Polybutylene 4127 (grey)

DURAFLEX Polybutylene 4121 (black)

For purposes of comparison, a sample of Douglas fir wood was obtained from Underwriters Laboratories, Santa Clara, California. This material met the requirements of UL Standard 127 for testing of fireplace inserts.

DATA AND DISCUSSION

The times to various animal responses are presented in Table 1. Reproducibility was generally good.

Average times to death with the polybutylene pipe samples ranged from 21.5 to 24.4 minutes, compared to 16.8 to 18.6 minutes for Douglas fir wood. On the basis of time to death, the polybutylene pipe samples appeared to be significantly less toxic than Douglas fir under these particular test conditions.

CONCLUSIONS

The polybutylene pipe samples evaluated appeared to exhibit significantly less toxicity than Douglas fir under these particular test conditions.

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Potability

As a result of the continued competition between metal pipes and labor-saving polybutylene pipes in plumbing, charges have been made by the California Pipe Trades Council (CPTC) that polybutylene pipes contain an allegedly toxic material known as DEHP. This is patently untrue! In fact, every component of polybutylene plumbing pipe is approved for food contact applications under the Food and Drug Administration regulations.

As a result of these irresponsible charges, a total of ten additional laboratories have analyzed polybutylene pipes and found them to be free of DEHP. Even the laboratory that conducted the analyses for the CPTC has issued a joint statement with Shell saying that "we have no opinion whether polybutylene pipes in general contain DEHP."

It is Shell's position that the use of DURAFLEX polybutylene plumbing pipe in potable water applications is completely safe.

Schwer

Tribune/TODAY Sunday, May 3, 1981

EBMUD says lab tests prove plastic pipes don't cause cancer

From Tribune and wire reports

Fears that plastic water pipes may contain elements that leak into the water causing cancer and sterility are unfounded, according to new laboratory tests results of samples from the East Bay Municipal Utility District released Friday.

"I think the basis for crying wolf on the cancer issue is premature," said Dr. Marc Lappe, a health hazard expert with the state Health Department. "There is a lot of misinformation."

Tests of the plastic polybutylene pipes that have supplanted in large scale the traditional steel water pipes were ordered April 18 after the State Commission on Housing and Community Development delayed authorization for expanded use of the plastic pipe in California. The commission was told that the chemical DEHP detected in some pipe samples could dissolve into the water causing sterility and cancer.

EBMUD responded immediately by taking samples of water in representative areas served by polybutylene pipes.

EBMUD sent samples to the state and private labs and conducted tests on its own for possible ill effects.

"We didn't find any in the water," said David Spath, senior sanitary engineer for EBMUD. "The sensitivity in the test instrument would have picked up anything more than 6 parts (of DEHP) per billion of water."

Lappe said DEHP was a threat only if found in concentrations of 200 parts per billion. He

added that the study that triggered the controversy detected DEHP only in pipe, but included no evidence of its dissolving in water.

Lappe also said he had written the Commission on Housing and Community Development reiterating previous testimony before the commission that pilot studies on polybutylene pipe indicated no health hazard.

Roger Dickinson, an attorney for the Department of Consumer Affairs, said the studies of plastic and other types of pipe, with longer exposure times of up to 90 days, should settle the issue.

The stakes in the controversy are high, not only for consumers, but for the construction industry, the plumbers who have generally opposed widespread use of plastic pipe, and the petrochemical industry which produces materials for the pipe.

EBMUD spokesman Jim Lattle said the plastic pipe is used because it is easier to handle, is more versatile, resists corrosion and the electrolysis problems of the steel and copper pipes.

The plastic pipe is used primarily for nonconnections from EBMUD's water mains to household connections. Of the 275,000 residential connections serving about 1 million people in the East Bay, about 45,000 to 50,000 are plastic.

Lattle said the tests consisted of samples of water from the pipes to see if any chemical was getting into the water. "If nothing comes from the pipes, then it's all right," he said.

RECEIVED
SANITARY ENGINEERING
BERKELEY



EAST BAY MUNICIPAL UTILITY DISTRICT

MAY 11 1981

May 11, 1981

Mr. Myron Moskovitz
2571 Eunice
Berkeley, CA 94708

Dear Mr. Moskovitz:

As we discussed in our recent telephone conversation, the District provided water samples to the State Department of Health Services and to a private commercial laboratory for independent testing for DEHP. I am pleased to inform you that no DEHP could be detected in any of the water samples collected from polybutylene pipe.

Enclosed is the original laboratory report and the memorandum describing the samples which were analyzed. Even water which had been sitting in a dormant section of polybutylene pipe for three months did not contain any DEHP.

Detectable amounts of several other organic compounds were found. This was expected since they are commonly found in chlorinated drinking water. As per your request, I have enclosed a short paper describing the formation of these compounds, the trihalomethanes. The occurrence of trace amounts (less than one part per billion) of other non-priority organics found in water taken from new polybutylene pipe which was dormant for approximately 120 days is judged to be insignificant.

Based on our sampling and investigations, we at EBMUD are convinced that no health hazard exists due to the use of polybutylene water service pipe. We intend to continue using it in the water system as before. Please let me know if you have any further questions.

Sincerely,

K. E. CARNS, Manager
Water Quality Division

Attachments

KIC/pcs



DEPARTMENT OF HEALTH SERVICES / DEPARTMENT OF INDUSTRIAL RELATIONS

2131 BERKELEY WAY
BERKELEY, CA 94704

(415) 540-2115



April 27, 1981

Mr. Myron Moskovitz
Chairman
Commission on Housing and
Community Development
921 - 10th Street
Sacramento, CA 95814

Dear Mr. Moskovitz:

I have been substantially reassured by the initial testing done by the Radian Laboratory for Shell Chemical Company on the issue of health hazards from DEHP (di-ethyl-hexylphthalate) in one kind of polybutylene pipe. As I indicated in my letter of January 28, 1981, this chemical was of concern because of recently completed cancer tests which had shown it to be carcinogenic when fed in high doses (3,000 to 12,000 ppm) to two species of rodents, and initial data (which we have confirmed) showing some DEHP in one kind of PB pipe.

It now appears from the preliminary data of Radian that the pipe proposed for in-home use in California (PB 4127) neither contains appreciable amounts (i.e., < 1 ppm) nor leaches detectable levels (i.e., > 1 ppb) of DEHP into deionized water. While these results are provisional in that they require duplication under standard leaching test conditions, they provide substantial evidence that a health hazard from DEHP does not exist in polybutylene pipe.

I hope that the remaining issues regarding any possible health effects from other chemicals I identified in my testimony may now be speedily resolved by appropriate testing.

Sincerely,

Marc Lappé, Ph.D.
Staff Toxicologist
Hazard Evaluation System and
Information Service

cc: William G. Holliman, Jr.
McDonough, Holland & Allen
Beverlee A. Myers, Director
Department of Health Services
Donald Turner, Director
Department of Housing & Community Development
Richard Spohn, Director
Department of Consumer Affairs
Ephraim Kahn, M.D., Chief
Epidemiological Studies Section
Richard Schimbor, Shell Chemical Company

DEPARTMENT OF HEALTH SERVICES

2151 BERKELEY WAY

BERKELEY, CA 94704

(415) 540-2172



August 12, 1981

Marvin Boutwell, Chief
Building & Zoning Inspection Division
Dept. of Public Works
220 E. Bay Street
Jacksonville, FL 32202

Dear Mr. Boutwell:

Enclosed please find a copy of the laboratory results from tests conducted to determine if polybutylene water service pipe leaches Diethylhexylphthalate (DEHP) into drinking water. As you can see the tests demonstrated that DEHP was not leached.

If I can be of any further assistance please do not hesitate to contact me.

Sincerely,

A handwritten signature in cursive script that reads "David P. Spath".

David P. Spath
Senior Sanitary Engineer
Sanitary Engineering Section

Enclosure

RECEIVED

AUG 17 1981

**BUILDING & ZONING
INSPECTION DIV.**



DEPARTMENT OF THE NAVY

NAVAL FACILITIES ENGINEERING COMMAND
XX STOVALL STREET
ALEXANDRIA VIRGINIA 22304

05D/RBB
1 July 81

From: Commander, Naval Facilities Engineering Command
To: Commanding Officer, Southern Division, Naval Facilities Engineering Command

Subj: Use of Polybutylene Pipe in Potable Water Systems

Ref: (a) NAVFACENCOM ltr 05D/RBB of 5 May 1981
(b) NAVENVIRHLTHCEN ltr 71:JPC:hfc 6261 Subj 05071 of 7 May 1981

Encl: (1) Shell Oil Company ltr of June 18, 1981 w/attachments and Mead CompuChem report

1. References (a) and (b) discussed the alleged presence of diethyl hexyl phthalate (DEHP) in polybutylene (PB) pipe which is used for potable water systems.

2. Samples of PB pipe from the Naval Station, Mayport were sent to Mead CompuChem laboratories at Research Triangle Park, NC for testing. Enclosure (1) provides the report of the extraction tests which show that polybutylene pipe does not contribute to the presence of DEHP in water. Additionally, Shell Oil Company states that DEHP is not added at any stage during polymerization, compounding, or fabrication of the pipe; and they confirm their position that the use of polybutylene pipe for potable water does not pose any known hazard to human health.

3. A copy of this letter and the enclosure are being forwarded to the Naval Environmental Health Center, Norfolk, VA and to the National Sanitation Foundation, Ann Arbor, MI who have a continuing interest in the use of plastic pipe for potable water systems.

R.B. EERSSON
By direction

Copy to:
WESTNAVFACENCOM
PWC San Diego
ROICC Jacksonville
ROICC San Diego
NAVENVIRHLTHCEN Norfolk, VA (Occupational Toxicology Service) w/encl (1)
NATIONAL SANITATION FOUNDATION, Ann Arbor, MI (Attn: Mr. R. Collins) w/encl (1)
SHELL OIL COMPANY, HOUSTON, TX (Attn: Mr. R.E. Hanson, Product Safety & Compliance)



DEPARTMENT OF THE ARMY
OFFICE OF THE SURGEON GENERAL
WASHINGTON, D.C. 20310

REPLY TO
ATTENTION OF

DASG-PSP-E

18 August 1981

Mr. A. H. Schroer
Sales Development Manager
Shell Chemical Company
One Shell Plaza
P. O. Box 2463
Houston, TX 77001

Dear Mr. Schroer:

This is in reply to your letter of July 29, 1981. This office does not approve specific commercial products.

Our policy on the use of polybutylene pipe was contained in the message you have requested. A copy of the message is attached.

Sincerely,

A handwritten signature in cursive script, reading "Lee C. Herwig, Jr.".

LEE C. HERWIG, JR.
Colonel, MSC
Sanitary Engineering Consultant

1 0 211705Z JUL 81 PP RR

CDRUSAEMA EA ND//HSE-EW//

DA WASHDC//DASG-PSP-E//

INFO CDRFORSCOM FT MCPHERSON GA//AFEN-FEU-S//

CDRFORSCOM FT MCPHERSON GA//AFND//

CDRHSC FT SA//HOUSTON TX//HSPA-P//

UNCLAS H

SUBJ POLYBUTYLENE PIPE

1. AT THE REQUEST OF FORSCOM (AFEN-FEU-S), AND THE PRIOR CONCURRENCE OF THIS ADDRESSEE, THIS AGENCY HAS EXAMINED THE MEDICAL CONCERNS OF POLYBUTYLENE (PB) PIPE FOR USE WITH HOT AND COLD POTABLE WATER APPLICATIONS.
2. IN THE RECENT PAST, HEARINGS HAVE BEEN HELD ON THIS SUBJECT IN CALIFORNIA. CONCERN WAS RAISED THAT DIETHYLHEXYL-PHTHALATE (DEHP) WAS LEACHING FROM THE PIPE MATERIAL INTO TRANSPORTED POTABLE WATER.
3. SUBSEQUENT STUDIES HAVE BEEN CONDUCTED TO CONFIRM THAT DEHP IS NOT A PROBLEM (NOT PRESENT) IN ^{potable water in contact w/} PB PIPE. THESE STUDIES SET ASIDE AN INITIAL STUDY THAT RAISED THE PUBLICIZED CONCERNS.
4. THIS AGENCY CONTACTED SEVERAL ORGANIZATIONS TO OBTAIN THEIR OPINIONS ABOUT THE USE OF PB PIPE FOR POTABLE WATER APPLICATIONS.

GF.
27 Jul

M. B. KELLEY, CPT, HSC, HSE-EW
SM/584-3816, 20 JUL 81

KENNETH R. BOYD, CPT, HSE-AP, 584-4375

UNCLAS

211705Z JUL 81

A. EPA HAS NOT BEEN ASKED TO COMMENT FORMALLY ABOUT PB PIPE. HOWEVER, THE EPA POC HAS NO BASIS TO SAY ANYTHING NEGATIVE. THE EPA POC RECOMMENDS USING NATIONAL SANITATION FOUNDATION (NSF) CERTIFIED PB MATERIALS.

B. FDA - IN 21 CFR 177.1570 POLY-1-BUTENE RESIN, THE MAIN COMPONENT OF PB PIPE, IS APPROVED FOR REPEATED USE FOOD CONTACT SITUATIONS.

C. AMWA REFERENCES NSF STD 14 FOR ACCEPTABILITY OF PB PIPE FOR POTABLE WATER APPLICATIONS. AMWA POC WAS AWARE OF PB PIPE CONTROVERSY AND MAINTAINS THAT PB PIPE IS SUITABLE FOR USE IN POTABLE WATER APPLICATIONS IF CERTIFIED FOR POTABLE WATER USE BY NSF.

D. NSF POC STATES THAT ALL PB MATERIALS DESIGNATED AS SUITABLE FOR USE WITH POTABLE WATER IN THEIR "LISTING OF PLASTIC PIPING SYSTEM COMPONENTS AND RELATED MATERIALS" ARE APPROPRIATE.

5. IT IS THE OPINION OF THIS AGENCY THAT THE NEGATIVE PUBLICITY GENERATED OVER THE LEACHING OF DEHP FROM PB PIPE IS UNFOUNDED. FURTHER, THAT NSF CERTIFIED, POTABLE WATER GRADE PB PIPE, USED IN ACCORDANCE WITH THE MANUFACTURERS GUIDANCE IS SUITABLE, FROM A MEDICAL POINT OF

3 3 211705Z JUL 81 PP RR

VIEW, FOR POTABLE WATER APPLICATION BY THE ARMY. CARE SHOULD BE EXERCISED, HOWEVER, IN THE SELECTION OF ALL PLASTIC BUILDING MATERIALS DUE TO THEIR POTENTIAL FIRE HAZARD.

6. FURTHER COORDINATION ON THIS SUBJECT MAY BE MADE BY CONTACTING THE CHIEF, WATER QUALITY ENGINEERING DIVISION, THIS AGENCY, AUTOVON 584-3816/3554. THE POC FOR THIS CONSULTATION IS MR. J. VALCIK.

UNCLAS

211705Z JUL 81



Economic Benefits

A great deal of information has been accumulated on the cost saving associated with using polybutylene tubing instead of copper tubing in plumbing applications. The most definitive study on the comparative costs was done by the National Association of Home Builders Research Foundation in 1981 and showed that polybutylene systems could be installed at a 44% lower cost than copper systems.

Because of its newness to the fire sprinkler industry, less information is available on comparative costs. However, the comparisons that have been made are very encouraging. For instance, in the residential retrofit demonstration conducted by the Rural/Metro Fire Department in Scottsdale in 1981, the installed costs of the polybutylene piped system was 40% lower than that of the system piped with black iron. In addition, a recent test in San Clemente showed that a complete polybutylene piped fire sprinkler system could be retrofit in a time of slightly over one man hour per sprinkler head (installation times for metal systems would have been a multiple of this).

OPERATION FIRESTOP



RETROROFIT DEMONSTRATION

San Clemente Test Series 13-1982
Conducted December 2, 1982

ABSTRACT: The following report is a summary of information generated by a residential sprinkler technology demonstration conducted in San Clemente, California. The report contains details of a demonstration retrofit of a single family dwelling using polybutylene pipe and Residential Sprinkler heads by Central Sprinkler Corporation. An overview of the process is provided as well as observation and recommendation for further research.

Ron Coleman

Ron Coleman
Director of Fire Protection
San Clemente Fire Department
100 Avenida Presidio
San Clemente, CA 92672
(714) 361-8240

OPERATION FIRE STOP

(San Clemente Tests Series 13-1982)

OVERVIEW

The following information is an overview of a Retrofit Demonstration. This is an element of the Operation Fire Stop Experiment Series. This project is being conducted by the San Clemente Fire Department to evaluate various concepts of providing built-in fire protection in residential occupancies. This specific document relates to an experiment conducted on December 2, 1982 on the Forster Ranch, located in San Clemente, California. The purpose of this demonstration was to retrofit an existing single family dwelling using state of the art technology, quick responding residential sprinkler heads and polybutylene pipe. The series was also part of a week long course on residential sprinkler system technology. This 36 hour course is a California Accredited Training Course.

OBJECTIVE

The objective of the retrofit test was as follows: To determine if a single family dwelling could be retrofit with existing materials and technology in a reasonable period of time; at a reasonable cost to the property owner, AND result in a system that is aesthetically acceptable to the home occupant.

Polybutylene has already been proven successful as a water conveyance in tests conducted in Scottsdale, Arizona; Ft. Lauderdale, Florida; Cobb County, Georgia; Springsdale, Arkansas; Carmichael, California; and Factory Mutual.

It should be noted that this was not a test of sprinkler head performance. This has been more than adequately proven by other tests, such as the tests required for listing of sprinkler heads.

LIMITATION

In this test we did not evaluate any copper, steel or PVC Systems that required piece by piece installation. Further tests must be done to evaluate that technology.

DESCRIPTION OF THE FACILITY

The retrofit was going to be conducted on a single family dwelling that was constructed approximately in 1967. The building was Type V wood frame structure. It was approximately 1,300 square feet in area. The walls were dry wall. The ceiling were dry wall. The building had a small attic space over most of the habitable areas of the building. The attic space provided a number of 8" clearances to a maximum of 30" of clearance. The roof covering was built-up composition. The building was donated for the experiment by the Estrella property owners. It was due to be destroyed as part of the grading for a major land development to be built in that area.

SPONSORING AGENCIES

Operation Fire Stop and this specific retrofit experiment was a jointly sponsored project. The sponsoring agencies were:

San Clemente Fire Department, Ron Coleman, Fire Chief
Santa Ana College, Fire Technology Division, Dr. Leonard Marks
Central Sprinkler Corporation, Mr. Bill Meyers
Shell Chemical Company, Mr. Marty O'Brien

In addition, participating agencies that assisted in conducting the retrofit were:

Orvin Engineering, Mr. Jack Shaughnessy
Grinnell Sprinklers, John Viniello
Estrella Properties, Inc, Mr. Boyd Ames
California Fire Training & Education System, Inc., Mr. Dick Whanton

PERSONNEL INVOLVED

Orvin Engineering was requested to come to the site a couple of days in advance of the demonstration to evaluate the building for possible retrofit problems. At the time, a plot plan was constructed of the building and a basic schematic prepared regarding head placement, location of the riser and identifying potential problems for installation.

Orvin was not given any specific instructions on how to approach the job of installing the system. As professionals in the field, they were requested to assess the situation as that would if they were faced with a request for retrofit by a property owner. They were given a short workshop on how to use the heat fusion equipment on the polybutylene pipe. This took about 1 hour.

A material list was derived from the schematic by the two primary participating agencies; Shell Chemical and Central Sprinkler Corporation. A complete listing of materials that was brought to the site was prepared from that schematic with about a 10% coverage allowed to adjust for potential errors. All materials for the retrofit were placed onsite the day prior to the actual retrofit demonstration. Invitations were sent out to all potentially interested parties. These included Fire Departments, sprinkler installers, plumbing contractors, building developers and the media. The day of the retrofit approximately 126 individuals came to the site. (It should be noted

that the existence of these large number of participants did have an effect on the time sequence of the installation. Allowing large numbers of people to go in and out of the building and observe the retrofit process did delay the installation by approximately one hour, according to Orvin Engineering.)

At approximately 0630 on the morning of the retrofit, Orvin Engineering was allowed to enter the building. They began their installation by cutting the polybutylene pipe into the links according to the schematic and beginning the assembly process outside of the building. A heat fusion method was used to join all pipe fittings involved in this retrofit. Approximately 90% of the joints were made while the piping was outside of the structure. The crew consisted of two men. There were other members of Orvin Engineering involved in the retrofit as observers. However, they do not contribute manpower or labor to the process.

The sprinkler heads were Central Residential Omega Pendant (1350, 3/8" NPT. 20 TAU). (Cost approx. 10.95 perhead-discounts available 100 heads) They were located in the respective rooms and holes drilled with a hole saw for installation. The hole that was cut 2" diameter (Central Escutcheon Plate is 2 1/4"). Observers who had come to the retrofit were allowed in and out of the building during the period of time that contractors were making the installation.

After approximately 2 hours the assembly of the main stem of the system was completed. The main stem was then inserted into the overhead and the system connected to a riser. The bulk of the pipe assembly and work on the structure was accomplished by approximately 11:30 that morning.

At approximately 12:30, all installation. Participants were allowed to walk through the building taking a look at the general configuration of the retrofit and observing what effects the retrofit had on the ability of the occupant to remain in the structure while the retrofit process was going on.

BURN TESTING

Burn tests were conducted at approximately 1:15. It should be noted that this experiment did not involve testing the validity of quick response sprinkler heads. The burns were conducted only for purposes of providing visibility to the concept. Sprinkler heads are tested in accordance with criteria of UL and FM and are not to be considered part of the experimental process during this retrofit. Nonetheless, a series of fire scenarios were developed to literally test whether or not a retrofit has provided an increased level of protection in the residential occupancy.

The first burn was conducted in a living room situation. The second burn was conducted in a bedroom, the third burn was conducted in a kitchen, the fourth burn was conducted in an open area dining room and the last burn was conducted in a room with no sprinkler head installed.

OBSERVATIONS BY FIRE PERSONNEL

The following observations were made regarding the retrofit process by those individuals who are responsible for conducting the exercise and/or participating as observers:

1. It is possible to conduct a retrofit using polybutylene, in a residential occupancy within one single working day, that is functional and aesthetically pleasing.

2. It is possible to conduct the retrofit of a residential occupancy using existing state of the art technology with a reasonable cost factor associated with it. Based on data collected in this demonstration the entire system was less than \$1,000.00.
3. It is extremely important that in retrofit applications that the structure be adequately assessed in its entirety prior to the start of the installation. That is to say, that the structural features in the attic, crawl spaces and framed out areas be assessed for the movement of installing personnel.
4. One of the most important factors to assess is the underground water supply. It is highly possible that in older buildings, especially those that have suffered water problems in the past, that the replacement of the underground valves and meters may be an important part of the cost effectiveness of the installation.
5.
 - a. The installers must have a thorough and comprehensive understanding of the installation condition prior to arrival on the scene. It is most important that a three dimensional schematic be prepared of the retrofit situation to avoid causing extensive delays. The biggest single factor in this entire process is that of manpower.
 - b. Installers must develop a fail-safe system of cutting holes that prevents false holes from hitting ceiling joists or coming up under other fixtures.
6. There are problems associated with adequately locating and

holding sprinkler heads in place in a retrofit application. One of the most noticeable aspects of a retrofit is that you cannot change the structural configuration of the building. You have to work with what is existing. In our particular case, there were several times where delays occurred because of ceiling joists that were installed right where heads should be spaced. This points to the fact that it is possible that in a retrofit situation, the head spacing will not be exactly as it would have been in a new installation.

7. Another problem in a retrofit situation is how to adequately conduct hydrostatic tests of the plumbing. In new installations, hydrostatics are conducted when the plumbing is in the overhead and there is limited amount of concern about a possible rupture. However, in a retrofit application, techniques must be worked out to assure the integrity of the system prior to it being installed. This appears to be one of the distinct advantages of the flexible polybutylene piping system. A system of conducting hydrostats outside of the structure appears conceivable.
8. a. Another problem that was witnessed was that adequate bracing and control of the sprinkler drops themselves. Two problems appear to be apparent. The first is that when you are screwing the sprinkler head into the pipe, the pipe is flexible and can, therefore, torque as the head is put in unless properly secured. It becomes very important that systems be worked out to assure that the heads will not leak around the threads. Additionally, a problem can occur

when the installer is torquing the head down. Someone has to be up in the attic holding on to the other end to avoid misaligning the plumbing and its hangers.

- b. The second problem here appears to be the fact that the hangers used in retrofit must be designed to keep the head from having nozzle reaction when activated. In one of the experimental fires, the head was compromised by the fact that the plumbing system "bucked up" into the overhead once the pressure was applied. This becomes extremely important as far as the pattern of the head is concerned. Adequate hangers are available to solve this problem.
9. a. A burn-out of one of the rooms was conducted with the polybutylene drained of water. It was protected by the ceiling. The pipe was not damaged after a 14-15 minute fire, despite flashover on the room of origin.

INSTALLER OBSERVATIONS

The following comments were provided by Orvin Engineering Corporation. These observations are from the installer's point of view. They were as follows:

1. The installers found that the heat fusion process produced good results. There were fifty plus fused joints made in the system and there were no leaks of the fused joints. (Leaks did occur around the sprinkler head.) This was due to lack of information on the type of thread sealant to be used.
2. The actual heat fusion procedure was considered to be very simple by the contractors. Most of it was performed outside at the ground level. However, the final connections had to be fused while the men worked off ladders and this part seemed a bit awkward. The ability to prefabricate the system outside, on the ground, is a key factor in keeping costs down.
3. As far as a retrofit aspect went, Orvin Engineering felt that this was not much different than they had ever experienced before. Smaller attic spaces equal a lot of moving around and sub-

subsequently increased manpower costs.

4. The actual material that was used in this retrofit was as follows: 144 feet of one inch polybutylene pipe. There were ten one inch tees, nine 1"x $\frac{1}{2}$ " R.C., there were three 1" elbows, there were nine Central Residential Sprinkler Head utilized, there were twenty-one 1" hangers or pipe straps installed.
5. It should be noted that the riser that was used in this experiment was provided by the San Clemente Fire Department and was of a test configuration utilized in previous test burns.
6. According to Orvin Engineering, the actual time of installation was six hours for two men, plus an additional two hours for one man. Beyond this time, they spent an additional hour laying out the sprinkler head location and general orientation of the structure. (This was conducted the day prior to the retrofit experiment.)
7. Orvin Engineering honestly feels that a full hour of installation time was lost due to the number of on-lookers milling around in the house during the installation.

According to Jack Shaugnessy, the Executive Vice-President of Orvin Engineering, "All in all, I would say the demonstration was successful as it accomplished what I believe it is intended to accomplish. The material proved worthy and relatively simple to install and the residential sprinkler head proved highly effective in the fire test."

Mr. Shaugnessy agreed with the observers from the Fire Department's point of view that any future fire tests that water supply is most important to the effectiveness of the systems and must be thoroughly analyzed.

SUMMARY

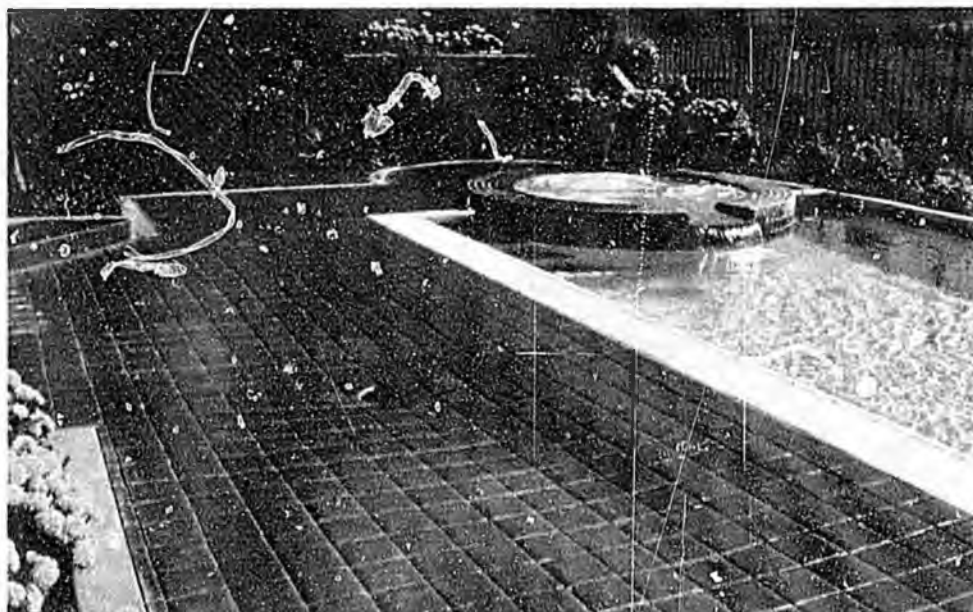
In summary, the sponsors of Operation Fire Stop, the retrofit test (San Clemente Test Burn Series 13-03) was successful. It established that the concept of retrofit application in residential occupancies is technologically feasible. It further, however, identifies the fact that a considerable amount of research must be done in the field of installation criteria, the education process of a structure for a retrofit application.

All participants who are in receipt of this particular documentation are encouraged to submit any observations, points of view, differences of opinion, or additional data for the continued development of this concept. Please feel free to direct your comments to: Ronny J. Coleman, Director of Fire Protection, San Clemente Fire Department, 100 Avenida Presidio, San Clemente, California 92672 (714)361-8240.

PIPER

Published by Shell Chemical Company

Volume III, Number 2, 1982



Unique solar system for heating pools features pipe made from DURAFLEX™ polybutylene resin

An innovative solar swimming pool heater that simultaneously cools the pool deck has been developed by Bomanite Corporation of Palo Alto, California. The Solarpave[®] system utilizes approximately 3000 feet of polybutylene pipe embedded in a colored, sculptured concrete pool deck.

Water from the pool is circulated through the pipe, cooling the otherwise hot deck and warming the pool water. Since concrete stores heat, the system can continue to

heat the pool even after dark.

The Solarpave system is available in a variety of patterns and colors that provide an attractive alternative to solar panels. Bomanite says the Solarpave systems are priced competitively with other solar systems and require little maintenance. Only the pool filter pump is required to circulate water through the low pressure system.

Polybutylene pipe's light weight, flexibility, and resistance to corrosion, scale and electrolytic

actions have led to its extensive use in slab radiant heating systems. More than 50,000 miles of polybutylene tubing have been installed in concrete slabs in Europe over the past decade.

Bomanite has reported that the Solarpave system qualifies for solar energy tax credits in several states. Readers interested in obtaining more information on the Solarpave system or learning the name of their local franchised contractor should contact Bomanite Corp. at 81 Encina Avenue, Palo Alto, CA 94301.

*Duraflex™ is a trademark of Shell Chemical Company for its polybutylene resins. Shell Chemical does not manufacture pipe.

Polybutylene pipe helps make fire sprinkler systems affordable

Low cost, fast installing pipe made from DURAFLEX™ polybutylene resin combined with smoke detectors and more efficient sprinkler heads form a fire protection system that can control household fires within seconds.

This is the system selected for installation in San Clemente, California, in what is considered a model for future systems and code

ordinances. San Clemente is one of the first communities in the U.S. to mandate residential sprinklers.

"Polybutylene pipe can help in holding costs down. The pipe permits fast and inexpensive installation. So it holds the costs of a home sprinkler system to an affordable level, which helps to reduce resistance from homeowners," says Ron Coleman, San Clemente Fire Chief.

It took less than one day to complete the first installation of this new type of fire sprinkler system in a new home in San Clemente. Since the home was valued at more than \$500,000, the fire sprinkler system represented less than 1% of the construction cost. Because the size of the system is proportional to the home's size, an installed cost of less than 1% of the construction cost is a good estimate for most new home installation.

The pipe's flexibility was a real asset in the installation because the house was close to completion. The pipe could be curved around obstacles and routed easily, minimizing the extent to which the new construction was disturbed. This advantage would also be of prime importance in retrofitting the system into existing homes.

Pipe ideal for retrofitting

"The pipe is especially good for retrofitting. With the widespread acceptance and expanded use we see for residential sprinkler systems, the ability to retrofit existing homes is going to be just as important as new home installations," Coleman says.

Because the pipe doesn't corrode and resists scale build-up, it isn't necessary to flush out the system periodically, which must be done with metal pipe systems. Duraflex pipe can stand high attic heat in the summer and doesn't crack if water freezes in it during the winter.

Proper installation is important for maximum effectiveness. Except for the sprinkler heads, all installation materials are plastic. Metal connections and installation parts should not be used as they could act as a heat sink during a fire and damage the system. Both the polybutylene pipe and sprinkler heads are laid out and located for maximum protection and fast response.

Special low-temperature set-off sprinkler heads that release at 165°F have been developed by Grinnell Fire Protection Systems. These respond five times faster than indus-

trial type sprinklers. An improved, wider spray water distribution pattern developed for residential rooms extinguishes fire within seconds before it can grow. The cooling effect keeps other sprinklers from being set-off unnecessarily, keeping water pressure at maximum levels.

By combining these sprinkler heads with polybutylene pipe and smoke detectors, fire officials have put together an effective system that can be easily and affordably installed and maintained in most homes.

Tests were conducted by the San Clemente Fire Department on



(left to right) Charles Brent (president of B.J.S. Corp., distributor for Rahn/Western Pipe Corp.); John Rosso (of Paul S. Robinson Co., manufacturer's representative for Rahn/Western Pipe Corp.); Inspector Ed Harrod and Fire Chief Ron Coleman (both of the San Clemente Fire Department).

this system prior to revising the city's fire sprinkler code. The tests were designed to demonstrate and check the system's effectiveness in controlling typical household fires, and to identify special considerations to be included in the code.

"Trend of the future" for homes

Ron Coleman sees the system's advantages catching on fast. He says, "Residential sprinkler systems are the trend of the future. In most new homes, we'll probably see built-

continued on p. 4

DURAFLEX™ pipe unaffected by Atlanta's sub-zero temperatures

The record setting cold in Atlanta, Georgia early in 1982 provided the acid test for a plumbing system using pipe made from DURAFLEX™ polybutylene resin. Experiencing -5°F temperatures with water in the pipes, an unfinished house outfitted with a polybutylene pipe plumbing system experienced no leaks or cracked pipes.

Built as a pilot project using Duraflex pipe by High Country Homes, Inc. of Marietta, GA, the house is located in an Atlanta suburb. The gas line for space heating had not been run and some of the

outside doors were not yet installed when temperatures plummeted. The water pressure had, however, been turned on prior to the cold spell. Despite freezing solid, the plumbing system experienced no leaks or failures.

Joe A. McHarg of High Country Homes, Inc., in a letter to W. T. Anderson, Director of Inspections, Cobb County, Georgia, said, "I can't help but think of the inconvenience, expense and misery that would have been avoided if this product (polybutylene pipe) had been available 20 years earlier."

As a result of the extreme cold,

the Cobb County inspectors office had received over 1700 calls from residents requesting information on how to shut off their water systems because of leaking pipes. These calls and the subsequent hardships of water damage prompted proposed changes in the construction codes to prevent a recurrence of the problems faced this year.

One of the proposed changes forwarded by Anderson to the County Administrator and Cobb County Commissioners recommends: "Grant the use of polybutylene pipe on water pressure lines in Cobb County."



EDITORS NOTE:

A properly designed and installed plumbing system utilizing Duraflex pipe can be expected to withstand the extreme conditions described above. However, under certain conditions, Duraflex polybutylene pipe may be pushed beyond its limit and fail. These conditions occur when short sections of Duraflex pipe are used between sections of rigid pipe. For best results, precautions should be taken to prevent such conditions.



Above photo shows testing of a sprinkler system that combines polybutylene pipe, metal sprinkler heads and smoke detectors. The San Clemente Fire Department conducted the test prior to revising the city's fire sprinkler code.

in sprinkler systems becoming standard features. The major safety and property loss prevention benefits of sprinkler systems will make them very popular, fast. We'll probably see more systems installed in the next 10 years than in the last 100 years."

"Over 400 cities have asked for copies of our standards," Coleman reports, "and many are using us as a model for their own standards." In many areas, voluntary standards for residential sprinkler systems are being implemented, and a growing number of municipalities are enacting mandatory codes. In the near future, these standards may become virtually a nationwide mandatory building code requirement."



Inspector Ed Harrod of the San Clemente Fire Department checks a sprinkler system that uses polybutylene pipe.

Code bodies grant approval for polybutylene pipe.

Recent code approvals for Duraflex polybutylene pipe for use in hot and cold water plumbing service include:

Commonwealth of Puerto Rico
Oklahoma City, Oklahoma
Arlington, Texas
Peoria, Arizona
State of North Dakota

Jefferson Parish, Louisiana
Lubbock, Texas
Nassau County, Florida
Clark County, Washington
Glendale, Arizona

Where to buy polybutylene pipe

Shell Chemical does not manufacture pipe, but the following independent manufacturers produce pipe from polybutylene resin:

AB&I Plastics
7825 San Leandro Street
Oakland, California 94621
415/632-3467
Attn: Mr. Mel Gray

Bristol Products Co.
P. O. Box 278
Bristol, Indiana 46507
219/848-4402
Attn: Mr. Tony Ernst

Delta Faucet Co.
55 East 111th Street
P. O. Box 40980
Indianapolis, Indiana 46280
317/848-1812
Attn: Mr. George Davis

Trojan Plastics, Inc.
2211 N. 38th Street
Tampa, Florida 33605
813/242-4211
Attn: Mr. Brand Laseter

U. S. Brass
Qest Plumbing Systems
P. O. Box 37
Plano, Texas 75074
214/423-3576
Attn: Mr. B. E. Smith
Vanguard Plastics, Inc.
P. O. Box 346
McPherson, Kansas 67460-0346
316/241-6369
Attn: Mr. Keith Swinehart
Western Products Company
P. O. Box 803
Union City, California 94587
415/471-8856
Attn: Mr. W. J. McGlinchy
Wrightway Mfg. Co.
Beatrice Plumb Products Group
1050 Central Avenue
Park Forest So., Illinois 60466
312/534-0500
Attn: Mr. Ralph W. Arboe

Details of the San Clemente test and installation are available in a new publication, SC:685-81, from Shell.

The Duraflex Polybutylene Pipe is published periodically by the Plastics Business Center of Shell Chemical and is available to anyone wishing to receive it. Comments and questions are welcome.

Address correspondence, including requests for additional copies, to Shell Chemical Communications, Room 1227, One Shell Plaza, Houston, Texas 77002.

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Shell Chemical Company.

PIPER

Published by Shell Chemical Company

Volume IV, Number 1, 1983

Corrosion-resistant Duraflex™ polybutylene pipe specified for Florida medium-rise.

The water in Jacksonville, Florida, is so corrosive that it can eat through copper and galvanized metal pipe.

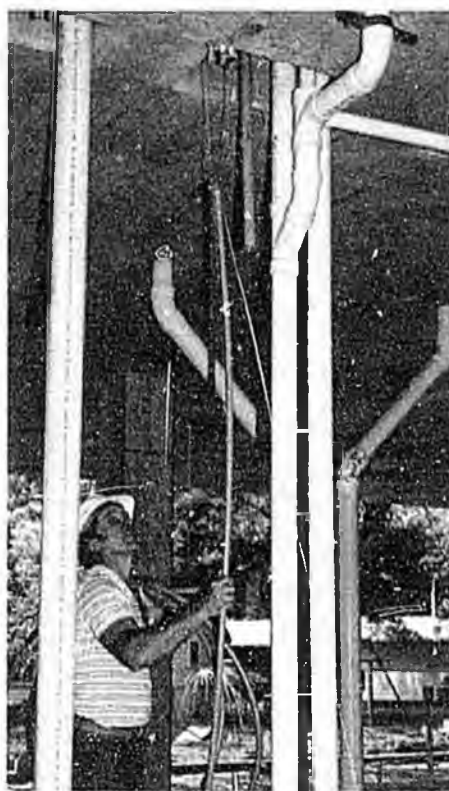
"In Jacksonville, the only way you can use copper or galvanized metal pipe is to treat the water first," says David Batzka.

Batzka served as owner's representative for Sundale Manor, a six-story apartment building currently under construction. To avoid installing a costly water treating system, Batzka specified corrosion-resistant Duraflex* polybutylene pipe for Sundale Manor's potable water system and PVC pipe for the drainage system.

Sundale Manor will be the first medium-rise building in Jacksonville with all-plastic plumbing. Polybutylene pipe received Jacksonville city code approval in late 1981.

W. W. Gay Mechanical Contractor, Inc. is handling the polybutylene pipe installation at the 90-apartment complex.

Job superintendent Jimmy Lasco is the key installer for the polybutylene pipe, which ranges in size from 1/2 inch to three inches in diameter. Heat fusion is used to install the larger (one-inch to three-inch) diameter pipe. Insert/compression ring fittings are used for the smaller diameter pipe. The installers can pressure-test the pipe and fittings immediately.



Billy Knight, who handles all of the heat fusion, says, "Once you learn to heat-weld the pipe, it's really quick and easy. We had some trouble with the first couple of welds, but now it's really simple."

According to Lasco and Knight, the larger diameter polybutylene pipe's flexibility and light weight provided unique advantages over rigid pipe; installation of Duraflex polybutylene pipe became a simple two-man operation. Risers for the pipe were shop-fabricated in an open area outside the building, coiled up for

(Continued on page 4)

Duraflex pipe installed in California solar-based housing project.

In an effort to provide substantially lower utility bills for heating, cooling and hot water, a farsighted county housing authority has initiated the development of the first solar-based public housing project in California.

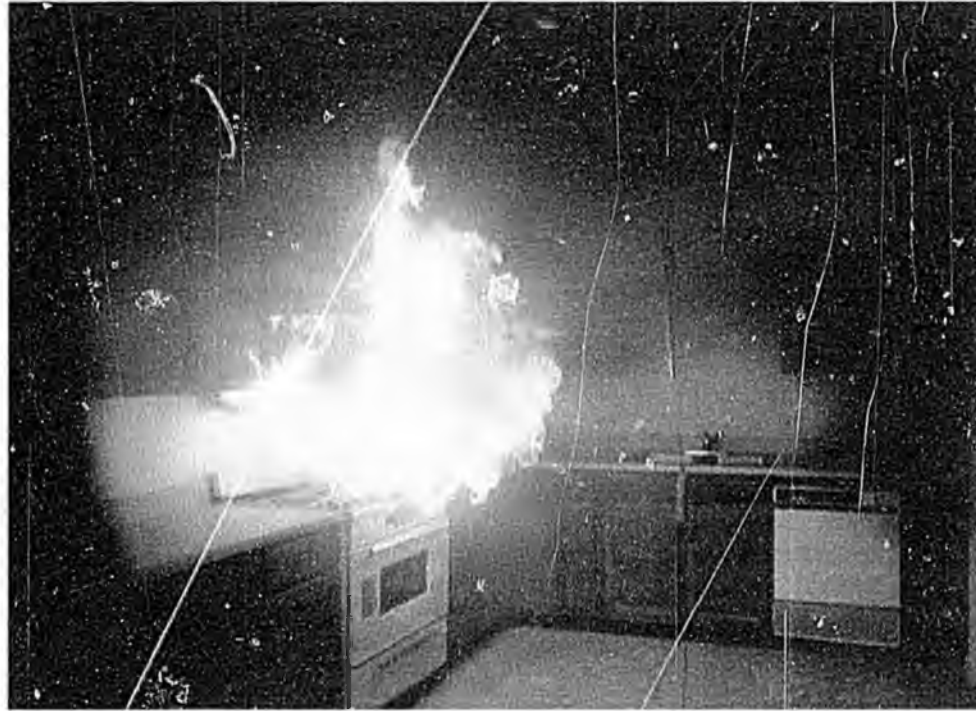
"Solar housing benefits all the taxpayers by conserving energy for other uses. We believe that these homes will serve as a model for other public agencies and for private developers who seek to respond to the energy realities of the 80s," said Roger Salquist, president of Trident Energy Systems, Davis, CA, the developers and installers of the solar system.

The systems are being installed in sixty-two 3 and 4 bedroom single family homes in the Rancho Algodon project outside Delano in Kern County. Completion is scheduled for late 1982.

For heating, Trident uses roof-mounted solar collectors to heat water which is then circulated through coils of flexible pipe made from Duraflex polybutylene resin embedded in the slab of each house. For cooling, a radiant chiller with a counterflow heat exchanger provides three tons of cooling capacity

(Continued on page 3)

Fire sprinkler system tested in Scottsdale.



Fire sprinkler systems retrofitted into two new Scottsdale, Arizona homes quickly extinguished deliberately-set test fires, thereby dramatically reducing the potential damage to the homes.

Federal and local fire officials monitored the tests which ranged from wastebasket fires to kitchen grease fires and burning dry Christmas trees.

Insurance officials estimated damages in the series of duplicated fires in the two homes and compared the losses to the property damage that would have occurred without sprinkler systems.

On the basis of eight tests, damages in the sprinklered fires were estimated at \$17,200 while the average damage estimate without sprinklers totaled \$116,000, a savings of \$98,000 or 85 percent.

"The answer to reducing the number of lives lost in residential fires is in-place protection with automatic suppression systems and smoke detectors," said Harry Shaw of the U.S. Fire Administration (USFA) in Washington, D.C. following the tests.

Sprinkler systems were installed after the two \$70,000 subdivision homes were built. One house was retrofitted with a standard iron pipe system and the

second house used flexible pipe made from Duraflex polybutylene resin and a black iron pipe system. Both systems employed newly developed fast response sprinkler heads.

Grantham Fire Protection, Inc. of Phoenix, Arizona, installed both sprinkler systems in the second house and tabulated material and labor costs. The system using the flexible polybutylene pipe required only half as many man-hours to install as the system with the metal pipe.

"The house was retrofitted with polybutylene in three days using two men and it took four and one-half days and three men to complete the black iron pipe system," said Terry Glenn of Grantham.

In order to install the black iron system, it was necessary to cut a hole in the roof. Sections of the pipe were cut outside the home, brought in through the roof, then threaded into position in the sprinkler head installation.

The lightweight Duraflex polybutylene pipe was assembled in a garage. Sections of the pipe were heat fused and then easily snaked through an attic opening. In addition to installation advantages, the pipe will not crack if water

should freeze inside the pipe and it has the highest heat rating of any thermoplastic pipe, a particular advantage in the "Sun Belt" where attic temperatures soar in the summer.

Scottsdale Administrative Fire Chief Bob Edwards said the cost of installing the polybutylene system was about one percent of the cost of the homes; about 40 percent less than for the iron system.

The tests were conducted by the Rural/Metro Fire Department, an independent corporation contracted by the city, and were financed by the USFA. Factory Mutual, a national testing laboratory, monitored the results.

In a demonstration of confidence in both systems, executives of Rural/Metro



sat on couches in the living rooms as fires were started in nearby wastebaskets. In one house the sprinkler was actuated in 1:17 minutes and in the other house, at 2:55 minutes.

Sentry Insurance Company observers estimated that the damage would have averaged about \$3,500 in each home (in this specific fire test) had there been no sprinkler systems. In actuality, damage was estimated at only \$1,000 in one home in which the sprinkler was actuated first and \$1,500 in the other.

In another comparative test, cake pans of cooking oil were heated on an electrical stove with open flames occurring three to four minutes later. After the sprinkler heads were actuated to extinguish the fires, damage was estimated at \$2,400 in one house and \$3,600 in the second house. If sprinkler systems had not been installed, the insurance com-

(Continued from cover)

which, if needed, can drop the water temperature as low as 38 degrees during the summer. The chilled water is circulated through the pipe in the slab to cool the house.

Not only does the radiant heating system provide an excellent means of using the medium temperature heat from the solar panels, but it also reduces the total energy requirements. The radiant slab and water storage tank can store enough heat in winter to maintain desired room temperatures for several sunless days before requiring back-up from the flash boilers which are installed as part of the overall system.

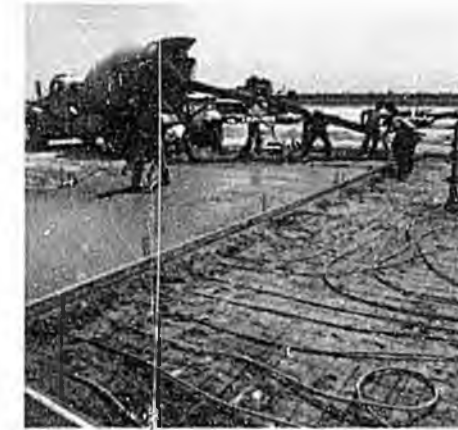
"Rancho Algodon vividly demonstrates that solar is not just a tool of the affluent," said Salquist. "It is even more essential in situations where tight incomes cannot compensate for rocketing utility bills, and the Housing Authority of the County of Kern is one of the first agencies to take this into account." Trident estimates a utility savings of about 75%.

The radiant slabs are constructed by placing a plastic vapor barrier over a sand base eight inches above the grade. This is covered with another inch of sand and a wire mesh. Before the coils of half-inch Duraflex polybutylene pipe are placed into the desired position for each zone, lime is sprinkled over the sand to show crews where to set the pre-fab walls.

pany estimated damage would have been \$6,500 in the first house and \$12,500 in the second house. (Estimates of losses without sprinkler equipment were based on normal fire department responses in terms of time, manpower and equipment. Estimates of damage with sprinkler operation were based on review of actual conditions after each test.)

Besides local media coverage, more than 170 representatives of fire departments, local governments and builder associations witnessed the tests. The test descriptions were recorded and posted for the audience while videotape

Approximately one linear foot of one-half-inch CTS polybutylene pipe per square foot of space was embedded in the slab of each house. Trident chose Duraflex polybutylene pipe for its combination of high temperature properties and flexibility.



"A three man team can lay the pipe for the slabs of four houses in a day," said Geoff McNeilly, Trident crew

replays were also shown. In a majority of the tests, only one sprinkler head was actuated.

Among the interested observers were representatives of the Cobb County (Georgia) Fire Department. Cobb County recently conducted extensive fire sprinkler tests that resulted in building code amendments for multi-family dwellings authorizing the use of polybutylene pipe in sprinkler systems.

The tests demonstrated that effective protection against extensive damage and deaths caused by fires can be economically added to an existing home.

manager at Rancho Algodon. Ties were used to attach the pipe to the wire mesh and maintain desired zone spacing.

There are four or five zones in each of the houses with positive shut-off valves controlling the flow through each zone. Continuous coils of pipe used in each zone were connected to return and supply valves in a manifold box installed just below the concrete surface in the garage. The pipe was laid so that the supply water circulates from the perimeter of the zone to the center before returning to the manifold box.

The Kern County Building Inspection Department tested the system by applying an air pressure of 30 psi for 30 minutes. Under operating conditions, only 3 psi pressure is needed to circulate about four gallons per minute of water throughout the 1000-1200 feet of pipe. Following inspection, about 25 cubic yards of concrete were poured for the standard 4" slab of each house and its garage.

A computerized controller will monitor the air inside the home, the water in the storage tanks and the collectors on the roof. A digital readout indicates the temperature of each. The controller automatically operates the system to collect and store all available solar energy and to maintain the desired setting on a solar dial. Another dial setting establishes the lowest acceptable air temperature and maintains it during periods of low solar conditions.

The California Department of Housing and Community Development is providing construction funding of about \$3.2 million, including the cost of installing the Trident Energy Systems' solar heating and cooling. Kern County Community Development block grant funds will be used for the land purchase cost of about \$207,000.

Elimination of a central air conditioning system, furnace and ductwork will offset a portion of the installation cost for the system. The net installation cost for the Trident system at Rancho Algodon is about \$2,000 a house more than a conventional system.

Rancho Algodon is a project of Lewis Development Inc. of Carmichael, California. Lucky Bell Corporation, also of Carmichael, is the contractor.

(Continued from cover)

transport, and installed by pulling them all the way up through a shaft in the middle of the building. Anchor plates provide a clamp on each floor. Thermal expansion and contraction are accommodated by the flexibility of the pipe.

Duraflex polybutylene pipe's light weight enables one man to carry up to a 500-foot coil of pipe over his shoulder. Project manager Al Boree, of W. W. Gay, has not calculated the time savings for installation yet, but he states, "We are just learning to use polybutylene and, in the long run, we do expect there will be considerable savings in installation time."



Boree views the polybutylene pipe installation as a pilot project to test the pipe's corrosion-resistance and simple, low-cost installation.

According to Boree, "Many normal domestic systems in Jacksonville, using copper or galvanized steel, will leak through electrolysis or corrosion within a few months after initial operation."

Boree mentions an additional benefit offered by polybutylene: its elasticity lessens the effects of water shock. "On this job we are using two shock stops per floor; normally we need two in each bedroom." And, although freeze damage to pipes is not a major problem in Jacksonville, Boree says that the pipe's freeze resistance provides another extra benefit in that the pipe will "never break because of bad weather."

Sundale Manor was completed in October, 1982, with a total of 8,480 feet of Duraflex polybutylene pipe in place at that time. The long-term benefits of polybutylene pipe in this particular building are not yet proven. But, says Jimmy Lasco, "If this works as well as we hope, we'll be using it all the time."

Code bodies grant approval for polybutylene pipe.

Recent code approvals for Duraflex polybutylene pipe for use in hot and cold water plumbing service include:

State of New Hampshire
State of New Mexico
Bay County, Florida
Montgomery County, Maryland
Prince George County, Maryland
Clark County, Nevada

Wacom County, Washington
Bellingham, Washington
Sioux City, Iowa
Las Vegas, Nevada
Scottsdale, Arizona

Where to buy polybutylene pipe

Shell Chemical does not manufacture pipe, but the following independent manufacturers produce pipe from polybutylene resin:

Bristolpipe
P.O. Box 184
Bristol, Indiana 46507
219/848-4402
Attn: Mr. Tony Ernst

Delta Faucet Co.
55 East 11th Street
P.O. Box 40980
Indianapolis, Indiana 46280
317/848-1812
Attn: Mr. George Davis

Trojan Plastics, Inc.
2211 N. 38th Street
Tampa, Florida 33605
813/242-4211
Attn: Mr. Brand Laseter

U.S. Brass
Qest Plumbing Systems
901 Tenth Street
Plano, Texas 75074
214/423-3576
Attn: Mr. B.E. Smith

Vanguard Plastics, Inc.
P.O. Box 346
McPherson, Kansas 67460-0346
316/241-6369
Attn: Mr. Keith Swinchart

Wesflex Manufacturing Co.
P.O. Box 1009
Richmond, California 94802
415/233-6670
Attn: Mr. J. Nusbaum

Western Products Company
P.O. Box 803
Union City, California 94587
415/471-8856
Attn: Mr. W. J. McGlinchy

Wrightway Mfg. Co.
Beatrice Plumb Products Group
1050 Central Avenue
Park Forest So., Illinois 60466
312/534-0500
Attn: Mr. Ralph W. Arboe

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Shell Chemical Company.

Springdale Mobile Home Test

A low-cost automatic fire sprinkler system utilizing lightweight, flexible polybutylene pipe made from Duralflex™ resin and a new type of sprinkler head was successfully demonstrated by federal officials in a recent test designed to simulate typical mobile home fire scenarios.

The resin for the pipe is the same as used by most mobile home manufacturers for hot and cold water plumbing systems. The high temperature properties of this pipe are particularly important in resisting the heat generated by a fire. Resistance to freeze breakage also is an important consideration in specifying a pipe for a fire sprinkler system.

The test in northwestern Arkansas was the first federal government-sanctioned test in which this kind of pipe was used to transport water to sprinkler heads in a mobile home. An earlier fire test in an abandoned permanent structure in California proved the system worked efficiently. These inexpensive systems have since been incorporated in new homes as well as added to existing homes.

The Arkansas "residential fire sprinkler test" was conducted by the National Bureau of Standards (NBS) for the Federal Emergency Management Agency. Cooperating in the test were Shell Chemical Company (manufacturer of the Duralflex resin), Grinnell Fire Protection Systems Co. (manufacturer

of the sprinkler heads), the Northwest Arkansas Vocational Technical School, Springdale, (Ark.) Fire Department and the Arkansas Fire Academy.

"The test went extremely well," according to Edward Budnick, Head, Fire Protection Systems Research, Center for Fire Research of the NBS. He said it demonstrated that such a system would quickly extinguish a typical mobile home fire with minimal fire and water damage. His views were echoed by Harry Shaw, Director of the U.S. Fire Administration's Home and Public Building Safety Division, who witnessed the tests.

Approximately 100 feet of 1-inch SDR 11 polybutylene pipe was snaked beneath the ceiling insulation of the mobile home. Four arteries branched off from the main line.

Highly sensitive Grinnell sprinkler heads, approved by Underwriters Laboratories, were used in the test. These heads operate about five times faster than the fastest sprinklers used in commercial and industrial buildings and provide a spray pattern higher on the walls.

The pattern cools air around adjacent sprinklers to reduce the possibility of activation of additional heads, thereby preserving adequate water flow to the initial sprinkler head. This also prevents unnecessary water damage to the home and its contents. U.S. Fire



The Duralflex polybutylene line was attached to the existing water supply lines and ran below the roof.

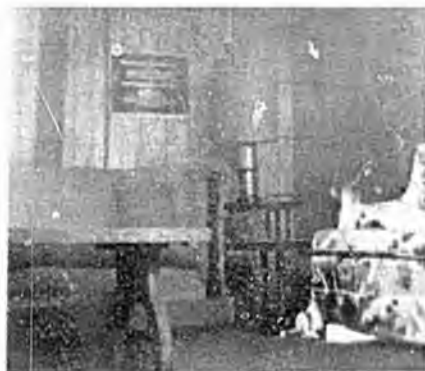
Administration fire tests in recent years indicated the need for faster responding sprinkler devices with improved water distribution patterns to douse typical residential fire conditions.

A paper filled waste basket was ignited in a bedroom of the mobile home. As the fire spread to nearby drapes, the sprinkler head sensed the rising temperature and doused the blaze. Total elapsed time: approximately 40 seconds. The basket and a portion of the drapes were the only casualties.



Within one minute of the fire, the heat activated the sprinkler. Approximately one minute later, eye level temperatures returned to normal.

A second fire was ignited in the living room with similar results. Fire damage was limited to the waste basket and an adjacent overstuffed chair.



These photos show that although a waste basket and chair were damaged in the living room test, there was no structural damage or damage to the nearby couch.

Both tests were monitored by thermocouple sensing devices with the temperature and times recorded for later computer printouts.

To show the benefit of installing such a system, officials set fires in an old, donated mobile home



A fire in a donated mobile home which had no sprinkler system quickly destroyed it. Spectators view the blaze between the two mobile homes.

which had no effective sprinkler system. Within a few minutes, the spectators saw the home burning out of control.

The demonstration was a feature of the "Operation Dixieland" project sponsored by the NBS to increase public awareness of the dangers of home fires and to educate the public about fire prevention.

The need for effective fire sprinkler systems is clearly shown by USFA figures for 1979: 2.7 million reported fires causing 8,400 civilian deaths with 31,000 civilian injuries at a \$5 billion property loss. Residential fires account for 77% of the deaths.

"The U.S. Fire Administration is dedicated to reducing fire losses throughout the country, and the widespread use of improved fire suppression technologies could go a long way toward helping reach that goal," Shaw said.

"Now, for the first time," he added, "we know enough about the characteristics of the residential fire to allow us to design a residential sprinkler system to combat it, contain it or control it or even extinguish it. In 1975 when the

previous NFPA 13D standard was adopted we did not have this knowledge and, as a result, have had problems in utilizing available sprinkler hardware in the residential setting."

In late 1980, the National Fire Protection Association (NFPA) adopted a new residential sprinkler installation standard based on tests sponsored by the USFA. One of its prime objectives is a low-cost, fast-acting, reliable system that protects lives and property adjacent to the fire by containing it within the room of origin.

The USFA said an entire system can be installed for about one percent of the cost of a new home. By using flexible and inexpensive pipe made from Duraflex resin, adding a system to an older home also is substantially simplified by the light weight of the pipe, the reduced number of fittings, and the ease of handling of the pipe in tight spaces.

Federal officials hope that additional evidence will convince insurance companies to discount fire insurance rates for residences and mobile homes protected by such systems. 0



Performance at Elevated Temperatures

When placed under a load, all materials are subject to creep or cold flow that will decrease their pressure carrying capability over time. Among the thermoplastic materials, DURAFLEX* polybutylene resin is distinguished by its resistance to creep, particularly at temperatures up to and beyond the boiling point of water. The high creep resistance at elevated temperatures is the basis for the use of DURAFLEX polybutylene pipes in hydronic heating and plumbing systems in over 25 countries worldwide.

ASTM testing techniques are used to determine the long term pressure carrying capabilities of thermoplastic pipes. These techniques involve measuring, over an extended period of time, the burst pressures of pipes at various test temperatures. To minimize any danger of failure, 50% of the long term pressure carrying capability is used as the design pressure. DURAFLEX polybutylene plumbing pipes (SDR-11) carry a 200 psi long term pressure rating at room temperature, a 100 psi rating at 180°F, and an 80 psi rating at 200°F. Polybutylene is the only thermoplastic pipe to carry a 200°F pressure rating from the Plastic Pipe Institute. It should be borne in mind that these ratings are for continuous use at these temperatures. If the use at these elevated temperatures is discontinuous, much higher pressure carrying capability will result. For instance, the short term burst pressure for SDR-11 polybutylene pipes at room temperature is 575 psi; at 180°F, 350 psi; and at 200°F, 240 psi.

Numerous tests have shown that the pipe will perform satisfactorily in a sprinkler system in both concealed and exposed installations. In the latter, more extreme case, tests at Ft. Lauderdale have shown that pipe exposed directly to a fire was undamaged in the time required to activate a fast response sprinkler head. Radiant panel tests at the University of Maryland Fire School have shown how the pipe could respond in areas that are not protected by the sprinkler system, i.e., behind a wall or ceiling. In these tests, exposure of water filled polybutylene pipes to a 1,500°F radiant panel first melted the outer surface of the pipe. With time, as more of the pipe wall became molten, a small hole formed (less than 1/4 inch in diameter). Because the hole was even smaller than a sprinkler orifice, it would not materially decrease the capabilities of the sprinkler system. In actual service, the water flow resulting from such a hole would trip the flow switch warning the building's residents, and as a result, the life saving capabilities of the system could actually be enhanced when DURAFLEX polybutylene piping is used.

*Shell Trademark



DURAFLEX™ POLYBUTYLENE

PERFORMANCE REPORT

SHELL CHEMICAL COMPANY



Comparison tests confirmed:
Installed cost
of polybutylene plumbing
was 44% less than that
of copper.

DURAFLEX™ POLYBUTYLENE PERFORMANCE REPORT SHELL CHEMICAL COMPANY

Recent quantitative comparison tests have concluded that the total labor and material costs to install a plumbing system with Duraflex™ polybutylene pipe were 44% less than those of copper in virtually identical installations.

The tests were conducted in the Pleasant Valley subdivision located west of Fairfax, Virginia and Washington, D.C., by the National Association of Homebuilders Research Foundation, Inc., an independent research firm. Homes in the subdivision range from modest to luxury offering a variety of handsome energy efficient designs.

For the tests, plumbing installations in two similar, 2½ bath, single-family homes were compared. One home had a full basement and was plumbed with copper plumbing using the traditional cut, fit and solder installation method. The other home had a crawl space and was plumbed with Duraflex® polybutylene plumbing pipe, using insert fittings and aluminum crimp ring connections. The houses were plumbed by a plumber who was experienced in copper installation and who had previously installed five plumbing systems using Duraflex polybutylene.

The polybutylene plumbed house had more cramped working conditions in one area and required slightly more pipe than

the copper house because the crawl space limited direct routing. This meant a slight advantage for the copper installation. The only other difference in the two houses was the location of the water heater and the water meter.

Objective and fair testing yields relevant results

The 44% cost savings realized in the polybutylene plumbed house are based on the material and time savings. Total installed material and labor costs for the polybutylene plumbed house were \$138 less than the copper installation. It took 7 hours and 39½ minutes to plumb the copper house, but only 5 hours and 55½ minutes to plumb the polybutylene house. Material costs included all indoor supply piping and fittings running from the meter yokes to the fixture connections, but did not include valves.

Armed with a stop watch, a specially ruled recording book, a camera and a pen, Hila Anderson, Senior Industrial Engineer with NAHB Research Foundation, Inc., observed, measured, counted and recorded the work performed, actions made, and materials used by the plumber.

To ensure objective, comparable and applicable results, Anderson used several established sampling and factoring methods common in gathering and compiling this type of research data. These included an averaging of the plumber's

efforts and conditions with other plumbers in general. Thus, the results are applicable for an adequately trained plumber to perform the installation with an acceptable amount of personal time and breaks.

NAHB Research Foundation, Rockville, Maryland, a wholly-owned subsidiary of the National Association of Home Builders which operates separately as an autonomous unit, conducted the study. Over 80% of their work is for clients other than the NAHB and its members. Anderson said, "We're interested in anything that helps the building industry, verifying a new product or technique, and telling the industry about it."

Strength and flexibility set Duraflex pipe apart.

The real difference between polybutylene pipe and other plastic pipe is the Duraflex polybutylene resin. Duraflex



Hila Anderson observed and recorded the plumber's actions and materials used.

is a durable, tough plastic. But unlike many other plastics, polybutylene is flexible rather than stiff or brittle. As a result, the pipe made from Duraflex resin can easily withstand household water pressures at elevated temperature, and its flexibility and light weight allow plumbers to curve it around obstacles and bends with fewer connections. Because it is chemically inert, there will be no problems with corrosion, electrolysis, or scale buildup.



Connections and fittings can be made by one of several mechanical methods which are easily learned and performed. Gary Peed, the plumbing contractor for the test houses, said, "The first time I put the pipe (polybutylene) in was slow, but you pick up how to work with it pretty easily. My time is much better now." Each of the installation methods takes advantage of the flexible nature of polybutylene to make quick, strong, and permanent connections. As Gary Peed puts it, "You don't have to solder anything or use any glue. There's less time, energy and equipment involved."

A durable pipe full of advantages.

How does Peed feel about polybutylene pipe in general? "I like it better than copper. It's easier, faster and it's lower in cost. I use it for almost all of my work now."

Other advantages to polybutylene pipe, both builders and plumbers cite: corrosion and scale resistance; self-insulating,

thus energy efficient for hot water lines; and if water freezes in it, the pipe won't break.

Those were the reasons Don Crocen, Superintendent for R.J.L. Associates' Pleasant Valley subdivision, selected polybutylene pipe. Crocen has realized the cost savings which the NAHB Research Foundation tests revealed, stating:

"We're saving on the average of about \$150 to \$200 per house." Another big advantage Crocen cited... "is customer satisfaction. That's very important to us. We want our owners to be happy with the house they buy. This polybutylene pipe helps us supply that satisfaction."

Comparison Tests—Results:

Materials	Copper System	Polybutylene System
Pipe	\$156.93	\$64.84
Solder & Flux	\$ 20.73	negligible
Fittings	\$ 21.79	\$19.12
Suspension Clamps	\$ 1.98	\$ 4.81
TOTALS	\$201.43	\$88.87
Labor at \$15/hr		
Cut & install pipe & fittings	(176.0 min.) \$ 44.00	(146.5 min.) \$36.63
Connect pipes & fittings	(162.5 min.) \$ 40.62	(88.0 min.) \$22.00
Misc.	(51.5 min.) \$ 12.88	(53.5 min.) \$13.37
Mounting Blocks	(41.5 min.) \$ 10.37	(39.5 min.) \$ 9.87
Set-up & Layout job	(28.0 min.) \$ 7.00	(28.0 min.) \$ 7.00
TOTALS	(459.5 minutes) \$114.87	(355.5 minutes) \$88.87
	Copper System	Polybutylene System
Total Costs Material & Labor for supply piping installation	\$316.30	\$177.64
Polybutylene Savings		
Time		104.0 minutes less to install than copper
Money (includes labor costs savings)		\$138.66

Note: For each \$1.00 wage rate differential increase above the \$15/hour figure used in the comparison, polybutylene's advantage increases \$1.73 in savings.

*Duraflex™ is a trademark of Shell Chemical Company for its polybutylene resins. Shell Chemical does not manufacture pipe.



Test homes' subdivision superintendent, Don Crosen, cited customer satisfaction as a polybutylene pipe advantage.

Polybutylene pipe supplies customer satisfaction.

"One of the biggest complaints in a new house is noise in the plumbing," Crosen continued. "This pipe is quiet, no hammer, no vibration. You don't even hear water running. So polybutylene eliminates that source of complaints, and satisfies our customers."

Another problem solved by polybutylene pipe involves hanging the sheet rock. According to Crosen, occasionally a rigid pipe will get bumped hard enough during sheet rock installation to cause it to break, crack and leak. "Often that leak won't show up until after the construction is completed, or worse... after the owner moves in. That's an expensive repair. But because this polybutylene pipe is so flexible, it doesn't break if it gets bumped or knocked. So once again, customer satisfaction," he said.

Satisfaction for builders, too.

Crosen has found satisfaction with polybutylene pipe in many ways, summing up, "It's less expensive. Better for customers. Easier to install, repair and add extra fixtures to later. It won't corrode and minerals won't adhere to it. We get less call-backs for repairs because of polybutylene pipe. It's another way to please our customers."

Crosen added, "It's good for builders and supervisors, too. Supervisors have to deal with the problems. They're less problems with polybutylene pipe."



**Come to
Shell for answers**

Warranty

Polybutylene pipe is manufactured from a material produced by Shell Chemical Company. All products purchased from Shell are subject to terms and conditions set out in the contract, order acknowledgement and/or bill of lading. Shell warrants only that its product will meet those specifications designated as such herein or in other publications. All other information supplied by Shell is considered accurate but is furnished upon the express condition that the customer shall make its own assessment to determine the product's suitability for a particular purpose. No warranty is expressed or implied regarding such other information, the data upon which the same is based, or the results to be obtained from the use thereof; that any product shall be merchantable or fit for any particular purpose; or that the use of such other information or product will not infringe any patent.

Shell Chemical Company Sales Offices Polybutylene

Northeast	600 Summer Street
(203) 327-3600	Stamford, Connecticut 06901
Southeast	320 Interstate N. Parkway
(404) 955-4600	Atlanta, Georgia 30339
Central South	One Shell Plaza
(713) 241-3897	Houston, Texas 77002
West	P.O. Box 7637
(209) 952-1908	Stockton, California 95207

For international sales contact:

Pecten Chemicals,

Inc. One Shell Plaza
(713) 241-6161 Houston, Texas 77002

AN OLD IDEA WITH A NEW TECHNOLOGY

I Historical Background

Automatic sprinkler systems have enjoyed an enviable record of protecting life and property for over one hundred years. Statistics demonstrate there has never been any multiple loss of life in a fully sprinklered building when the system is properly supervised.

According to the National Fire Protection Association (NFPA), the only fatalities in fully sprinklered properties were caused by explosions or flash fires. Self immolation by a person who was too young, too old, too intoxicated or too handicapped in some other way to protect himself properly, has been the cause of death. Unfortunately, the closure of a water supply valve controlling the sprinkler system has rendered the system ineffective in some fire conditions.

During the mid 1970s, the National Commission on Fire Prevention and Control conducted exhaustive research in examining the fire problems in the United States. They published "America Burning" which concluded that this nation, a world leader in technological advancement, suffered from one of the highest death rates and injuries due to fire. As a result of the Commission's work, legislation was enacted in the Congress of the United States which created the U.S. Fire Administration. This Administration's objective was to reduce deaths from fire by 50% before the decade of the 1990s. Although large life loss fires, such as those occurring in hotels and motels, become national media events, statistics clearly show that the residential fire has been, and presently is, what we have characterized as the fire communities public enemy No. 1. From 1977 to 1981 the National Fire Protection Association (NFPA) reported that there was an average of 7,700 civilian fatalities attributed to fire. This would be comparable to having two 747's crash in midair each month. As one fire protection expert commented: "In the course of a normal lifetime, almost a half a million people will die in the United States from fire."

II A New Technology

In cooperation with the U.S. Fire Administration, Factory Mutual Research Corporation conducted a series of fire tests in 1978 in an effort to study current sprinkler technology and its application in residential type fire scenarios. The result of this research concluded that commercial/industrial type sprinkler devices were simply not adequate to protect the type of fire loading expected in residences. The commercial/industrial sprinklers were too slow in their operation and did not provide a high enough wetting pattern to cut off the perimeter fire which can be expected in homes. Additional test programs, funded by the U.S. Fire Administration, in cooperation with the National Fire Protection Association and Factory Mutual, were conducted. These tests substantiate the initial research at Factory Mutual and demonstrated, without question, the need for a sprinkler device

II A New Technology - Continued

with a faster response time and the capability of delivering water which provides wetting higher on the walls to help counter the perimeter fire which is common in residential fire scenarios. Grinnell Fire Protection Systems Company, Inc., in cooperating with these agencies, developed prototype sprinkler heads for these test programs.

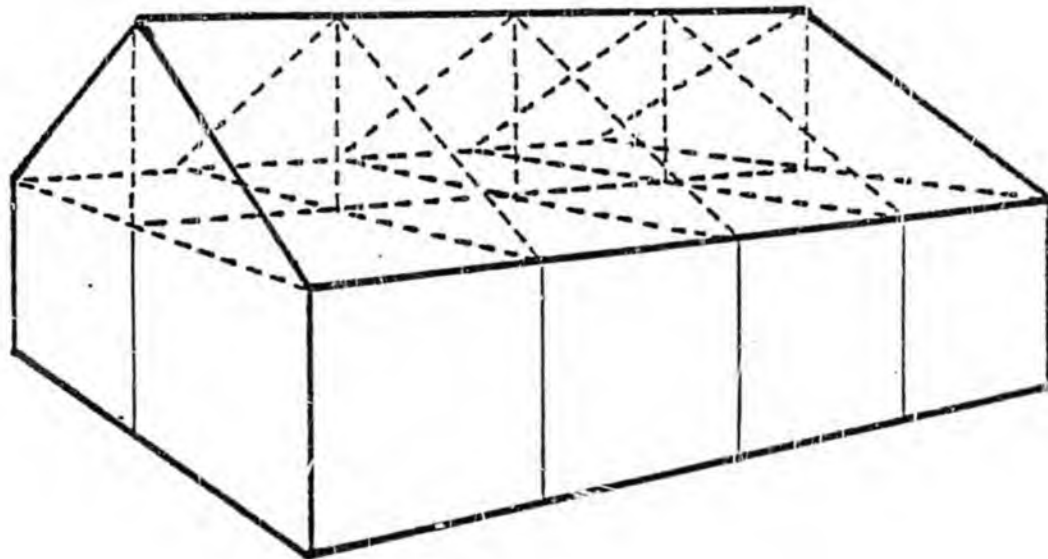
The National Fire Protection Association established a subcommittee of N.F.P.A. 13, which developed a new residential standard for one and two family dwellings and mobile homes. In November of 1980, at the N.F.P.A. meeting in San Diego, N.F.P.A. 13D, Standard for the Installation of Sprinkler Systems in One and Two Family Dwellings and Mobile Homes, was adopted. This new standard, which was based on the results of the fire test program, called for only listed new residential sprinklers for installation in accordance with the criteria established by the N.F.P.A. 13D Committee. Underwriters Laboratories (U.L.) established a new manufacturing standard U.L. 1626, which set some very stringent requirements for sensitivity and water distribution for manufacturers seeking a listing for newly designed residential hardware. In May of 1981, Grinnell Fire Protection Systems Company, Inc. became the world's first manufacturer to successfully pass all U.L. testing procedures and obtained a listing for the world's first listed residential fire sprinkler.

An old idea, utilizing a new technology whose time had come, was now a reality.

III Rationale

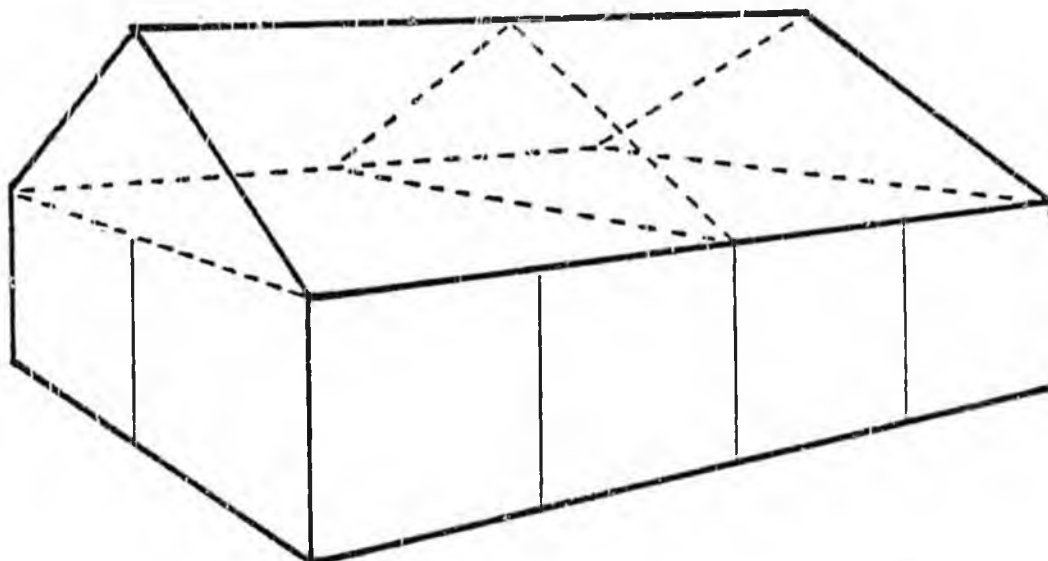
N.F.P.A. #13D-Sprinkler Systems-One and Two Family Dwellings and Mobile Homes (1980) is "intended to provide a method for those individuals wishing to install a sprinkler system for additional life safety and property protection. It is not the purpose of this standard to require the installation of an automatic sprinkler system."

Simply stated, "where" fire protection systems are required is generally covered in building and fire codes, or local ordinances. N.F.P.A. standards, on the other hand, outline the design criteria for "how" the system should be installed in order to protect a particular hazard. A subtle, but important difference. Since the present scope of application of N.F.P.A. #13D (1980) deals with the design installation of automatic sprinkler systems for one and two family dwellings and mobile homes, any system design for occupancies which fall outside the scope of this standard should only be permitted with written authorization from the "authority having jurisdiction." Based on the research conducted in developing this new residential sprinkler technology, as well as fire tests and demonstrations coordinated by the U.S. Fire Administration and Factory



FIRESTOP EACH UNIT IN ATTIC

NON SPRINKLED



FIRESTOP AT 3,000 SF IN ATTIC

SPRINKLED

III Rationale - Continued

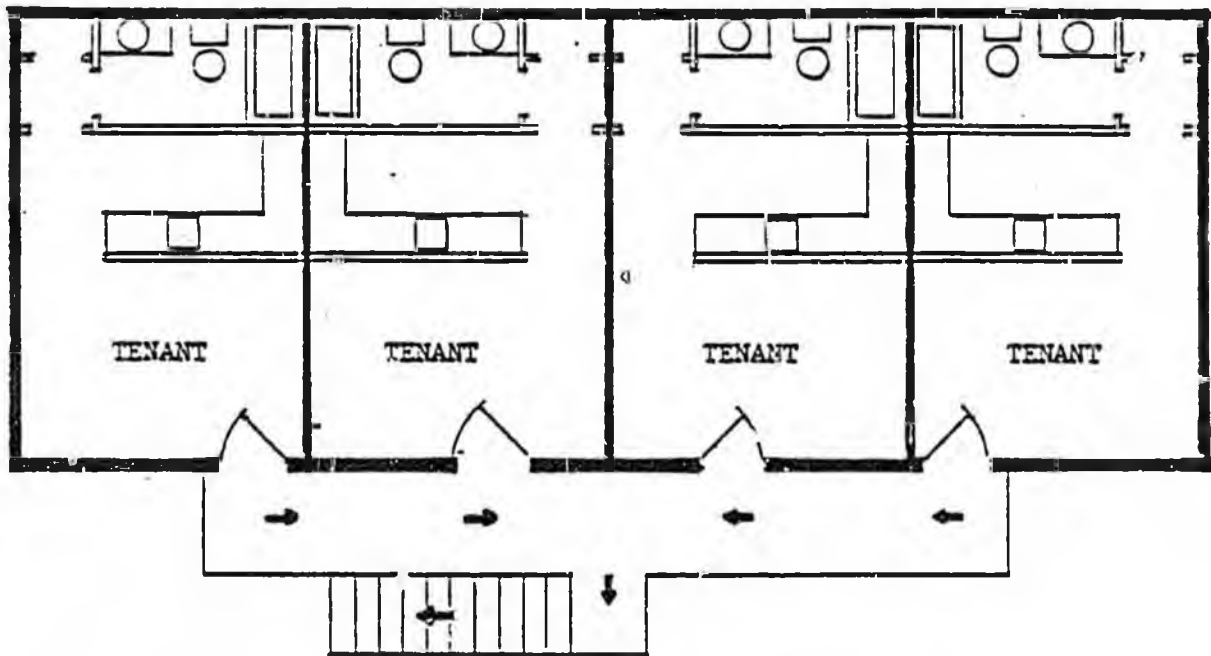
Mutual Research Corporation, a number of "authorities having jurisdiction" are in the process of considering residential fire sprinkler ordinances. The concept of "access trade-offs", as well as "construction trade-offs" is gaining in popularity. As an example, such ordinances may include, but not be limited to, requiring the installation of residential fire protection systems in accordance with N.F.P.A. #130 (1980) in low rise, high density type construction as a means of mitigating one or more of the following fire protection deficiencies.

Access Trade-offs

<u>Without Residential Fire Protection</u>	<u>With Residential Fire Protection</u>
Units must be within 5 minute response of nearest fire station	Waived
Units must not be located more than 150 feet from closest vehicular access way.	Waived
Standard street widths required	Reductions permitted
Street grade of 15% or greater not permitted	Waived
Must adhere to hydrant spacing requirements	Greater hydrant spacing permitted
Fire flow requirements must be met	50% reduction in required fire flow
Hazardous areas - 75 units for single means of ingress or egress	Number may increase
Nonhazardous areas - 150 units for single means of ingress or egress	Number may increase
Access for ladder trucks - 50' from rear of parking stalls to face of unit	Extended to 75' or 100'
When any portion of a building is in excess of 150' from a water supply, it may be required that on-site fire hydrants and mains capable of supplying the required fire flow be installed.	Waived

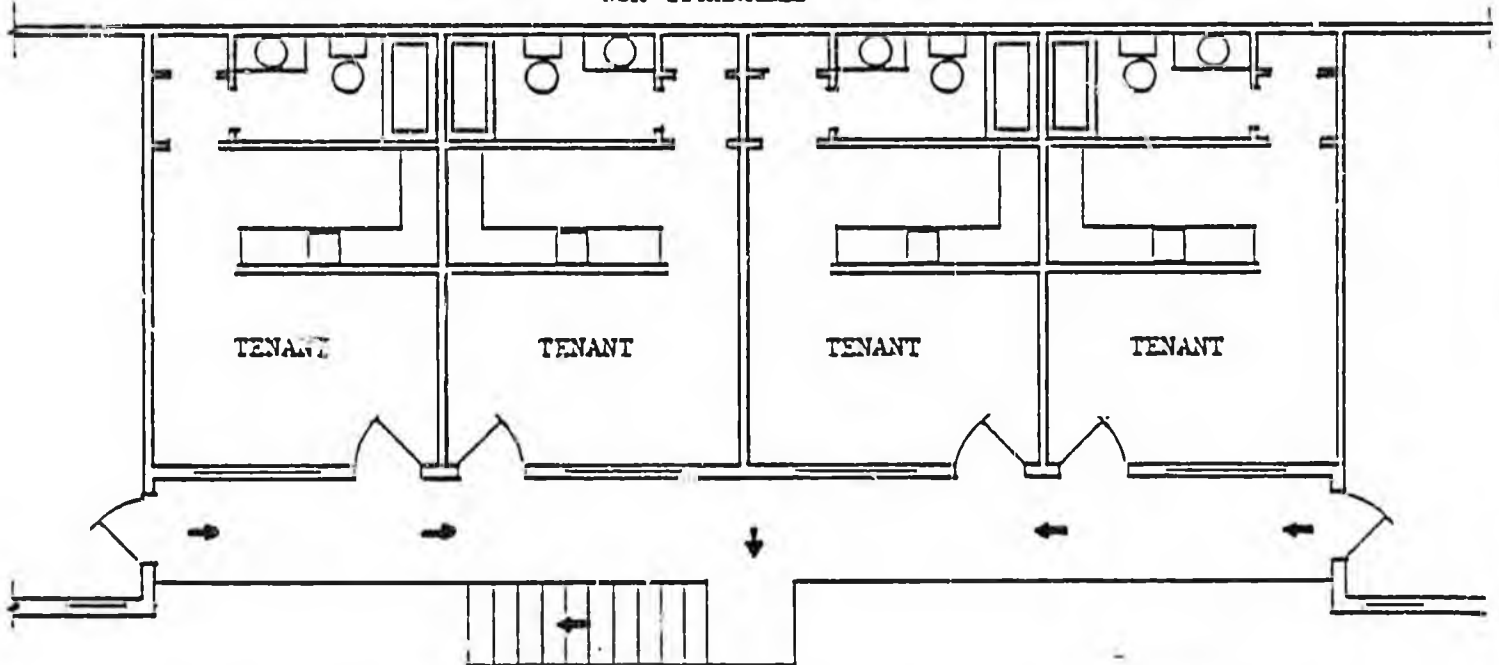
CONSTRUCTIVE TRADE-OFFS

<u>Without Residential Fire Protection</u>	<u>With Residential Fire Protection</u>	<u>Savings/ Advantage*</u>
Tenant separation walls must be made of 5/8" Type X Fire Rated Gypsum Wallboard.	Half-inch standard Gypsum Wallboard may be substituted.	\$23.00 per 1,000 sq. ft.
5/8" Type X Rated Gypsum Wallboard and 3/4" plywood must be used in one-hour floor/ceiling assemblies.	Half-inch standard Gypsum Wallboard and 5/8" plywood may be substituted in floor/ceiling assemblies.	\$55.00 per 1,000 sq. ft.
Fire stops are required in the attic at every unit.	Fire stops in attic required every 3,000 square feet.	\$123.00 each fire stop.
Maximum tenant travel to a fire exit must not exceed 20 feet.	Exits may exceed the maximum required travel from a tenant with one exit may be exceeded by 15 feet for a maximum travel of 35 feet.	Design Freedom
Tenants may not travel by other tenants' doors unless those doors are 3/4-hour fire rated doors in 20 minute frames with 3 UL listed spring hinge closers.	Standard doors and frames with no closers may be used.	\$111.70 each door.
Interior finish must be Class "A".	Interior finish may be Class "C" or better.	Design Freedom
One-hour rating on walls and doors of hazardous areas.	No one-hour rating of doors or walls of hazardous areas.	\$23.00 per 1,000 sq. ft. (walls). \$111.70 each door.
Hazardous area must be one-hour rated walls with 3/4-hour rated doors with 3 UL spring hinge closers. (Hazardous areas are: common storage, common mech. rooms, etc.)	Standard 1/2 inch sheet-rock and standard doors with no closers may be used.	\$23.00 per 1,000 sq. ft. on walls. \$55.00 per 1,000 sq. ft. on ceilings. \$111.70 each door.



One hour party walls are required between tenants. 3/4 hour U.L. entrance doors are required with 20 min. U.L. frames and 3/4 U. L. spring hinge closers. No windows within 15' of other tenants travel. One hour exterior wall facing exit. Max. travel distance for one exit is 20'.

NOT SPRINKLED



Standard 1/2" sheet rock partitions may be used between tenants standard entrance doors, frames and no closers. Unlimited number of windows any place. Standard exterior wall facing exit. Maximum travel distance for one exit is 35'.

SPRINKLED

CONSTRUCTION TRADE-OFFS - Continued

Every 6,000 square feet a four-hour masonry fire separation is required.

The fire rated separation would not be required until 10,000 square feet and after 8,000 square feet, a two-hour separation would be permitted.

\$8,345 each 4-hour wall. Note: Cost of 2-hour sheet-rock wall-\$750.

Buildings must be placed on property to not exceed 50' from paved parking area for aerial rescue operations.

Buildings allowed up to 125' from street or parking area. This allows freedom in design as well as being able to place building in more esthetic surrounding.

Allows maximum use of site and landscaping.

There can be no windows within 15 feet of other tenants travel.

Windows may be placed anywhere desired.

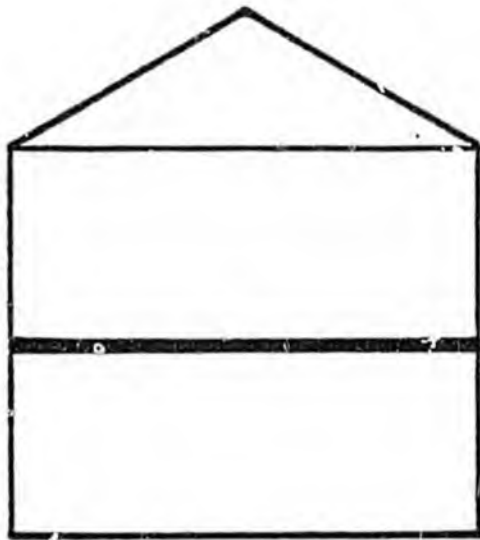
Design Freedom

*Builder/Developer, Cobb County, Georgia.

IV Housing Trends

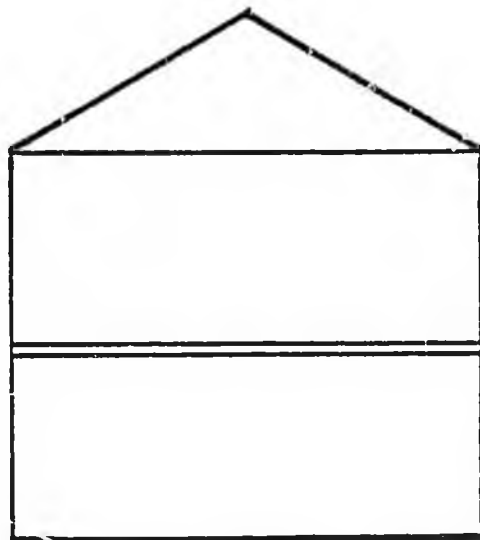
America is facing a severe housing crisis. If the demographic demands of the fertile 50s are not met, this country will face, during the decade of the 80s, a housing shortage unparalleled in the annals of the residential construction industry. Because of rising construction costs, coupled with high interest rates, affordable housing is beyond the economic reach of the majority of our population. Many builders believe that the days of the "sprawling single family dwelling" are coming to an end. In an effort to make greater utilization of skyrocketing land costs, many builders/developers are turning to "high density" construction in the form of low-rise condominiums, townhouses, triplexes, four-plexes, and garden apartments. It is hoped this type of residential construction will make housing more affordable and provide a salvation for a severely depressed housing industry. Unfortunately, the burdens this type of construction is placing on local fire departments is becoming very real indeed.

It is well known that tax reform legislation sweeping the country has caused substantive cutbacks in many municipal budgets. These fiscal constraints are dramatically affecting fire department funding in many cities and towns. Manpower reductions and the lack of ample funding for additional fire stations, new equipment and training programs is seriously hampering the fire fighting effectiveness in many municipalities. High density type construction does not help. Financially



One hour floor-ceiling is required using 3/4" plywood decking and 5/8" type X sheetrock on ceiling.

NON SPRINKLED



5/8" plywood decking and 1/2" standard sheetrock on ceilings.

SPRINKLED

IV Housing Trends - Continued

beleaguered fire departments simply do not have the necessary resources needed to protect these properties. As the result, many municipalities are turning to private fire protection in the form of residential fire sprinklers to supplement already strained public protection.

V Financial Motivations for Residential Fire Sprinkler Systems

In addition to access and construction trade-offs which are gaining popularity among the fire services, a number of financial inducements are being enacted which will provide financial motivation for individuals to install residential fire sprinkler systems.

Insurance Savings

Following the test program in Los Angeles, an Ad-hoc Committee composed of the insurance industry conducted a series of fire tests to consider the impact of residential sprinklers on fire losses in dwelling properties. Although it was acknowledged that the greatest benefit of residential sprinklers will be in saving lives and preventing injuries from fire, the major focus of this test program was on the single factor of determining impact on property loss reduction.

Based on the results of this test program, it was the observation of the Ad-hoc Committee that residential fire sprinkler systems definitely had the ability to reduce claim payment expenses. The committee further recognized that an earlier I.S.O. discount (1977) is less than what seems to be indicated as a result of these tests.

Since 1977, the Insurance Services Office has had filings in many states providing a 5% discount on a total homeowner policy premium covering a dwelling with an approved and properly maintained sprinkler system that covers all areas of the insured structure. Their filings, also, allowed a 2% discount for a similar system that omits specified areas, such as closets, attics and bathrooms.

After considering the report from the Ad-hoc Insurance Committee, and the U.S. Fire Administration's sprinkler comparison test program, the Homeowner's Committee of I.S.O. has made a recommendation that could result in a tripling of the discount for residential sprinkler systems installed in accordance with N.F.P.A. 130 (1980). Discounts up to 15% would be applied to the entire homeowner policy premium for single family residences protected in accordance with N.F.P.A. 130 (1980). Since a homeowner premium is multi-peril in nature, it is estimated that the fire protection portion of the premium usually accounts for 40% of the entire policy. A 15% discount applied to the total homeowner premium translates into a fire insurance discount of almost 37%.

Water Damage

It has been suggested that the installation of a residential fire sprinkler system in a home would cause an insurance company to penalize a homeowner because of the threat of water damage due to sprinkler leakage. Insurance statistics from commercial underwriting departments of several large insurance companies demonstrate that sprinkler leakage is one of the most profitable lines of coverage that insurance carriers underwrite. The payment of claims for the inadvertent discharge of sprinklers is minimal considering the number of exposure units (large numbers of sprinkler installations in commercial/industrial properties) carriers underwrite. As a result of this excellent experience, the ISO recommendation of a 15% reduction on a total homeowner premium when a residence is protected with a system installed in accordance with N.F.P.A. 130 (1980), does not include a penalty for sprinkler leakage.

Since I.S.O. provides rate making advice for its subscribing membership, the implementation of these recommendations will depend on individual carriers. I.S.O. has proceeded with state filings with a number of Superintendents of Insurance and several adoptions of this credit have already taken place. (See Table I enclosed)

Real Estate Tax Reductions

On January 1, 1981, the State of Alaska enacted into law a significant piece of legislation which will impact dramatically the installation of sprinkler systems throughout the state.

The law provides that 2% of the assessed value of any structure would be exempt from taxation if the structure is protected with a fire protection system. The word "structure" is significant in the law as it, also, applies to homes.

In effect, if a home was assessed for \$100,000, for purposes of taxation, the assessed value would be computed at \$98,000, provided it had a fire protection system.

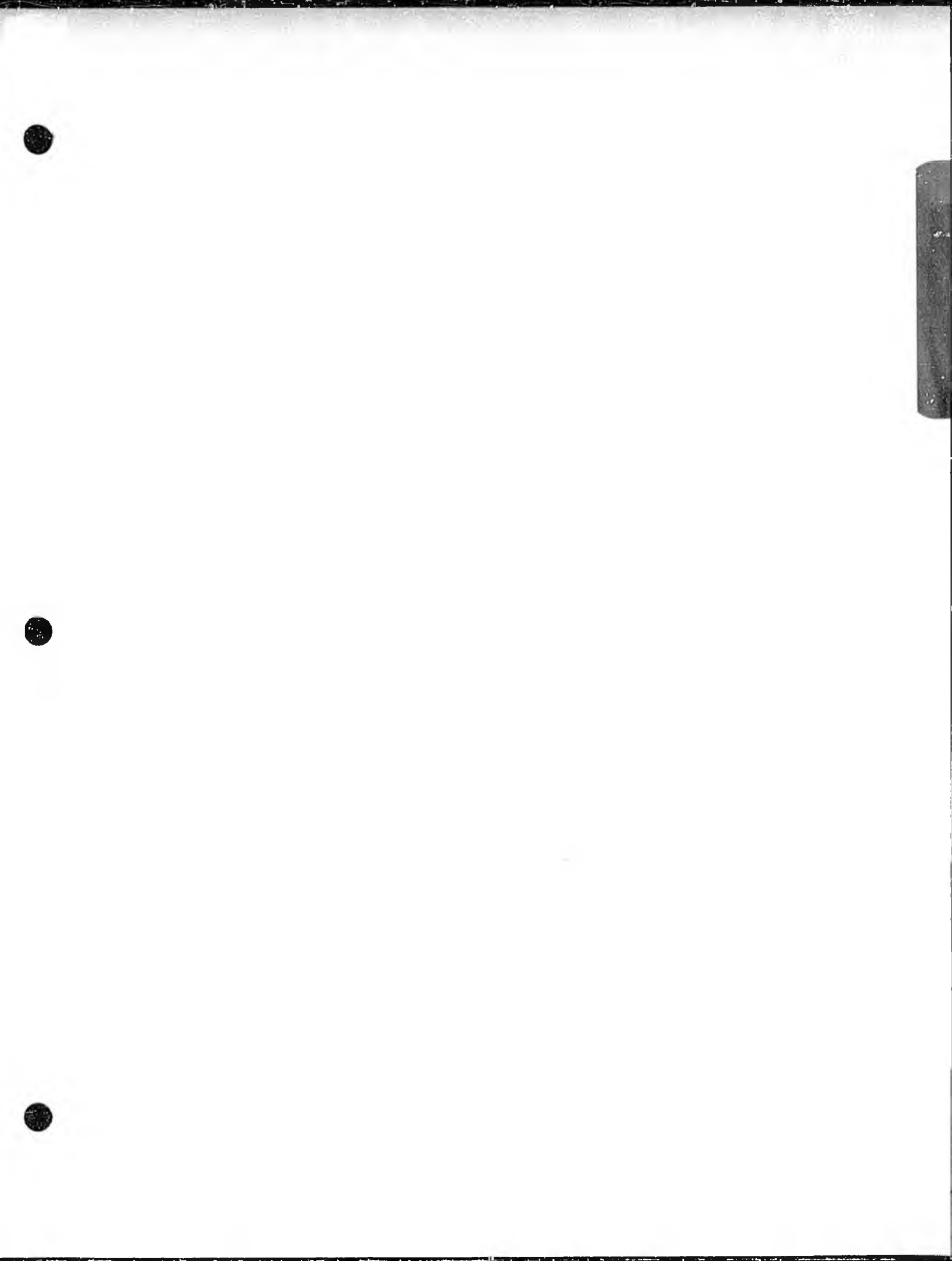
This law has received widespread attention, particularly among the fire services and a number of jurisdictions are studying its implications for potential adoption in other states. (Copy of law is included)

TABLE #1

I.S.O.

STATE ADOPTIONS

ALASKA
ARIZONA
CALIFORNIA
KENTUCKY
MARYLAND
MONTANA
NEVADA
NEW MEXICO
NORTH DAKOTA
OREGON
UTAH
VIRGINIA



Codes

DURAFLEX polybutylene pipes have been approved by every major national and regional plumbing code in the United States and Canada. In addition, over 65 percent of the major metropolitan areas in the United States have approved the use of DURAFLEX polybutylene plumbing pipe.

Under a contract to the United States Fire Administration, Factory Mutual has issued a specification for the use of plastic pipe in fire sprinkler systems for one and two family residences and mobile homes. DURAFLEX polybutylene pipe and fittings have been submitted for testing to this standard and are expected to be approved in the first quarter of 1983. In addition, tests are also under way at Underwriters Laboratories for sprinkler applications in both residential and light and ordinary hazard occupancies.

SPECIFICATIONS, STANDARDS, APPROVALS, ACCEPTANCES, AND LISTINGS FOR POLYBUTYLENE PLUMBING

I. SPECIFICATIONS

ASTM D2581 - Polybutylene Material Specification
ASTM D2662 - Polybutylene Pipe Specification (IPS sizes) water service
ASTM D2666 - Polybutylene Tubing Specification (CTS sizes) water service
ASTM D3000 - Polybutylene Pipe Specification
ASTM D3309-82 - Polybutylene plastic for hot and cold water distribution systems
ANSI 119.1
ANSI 119.2 - Mobile Home and Rec. Vehicle Specifications
AWWA C902-78 - Polybutylene Water Service Sewer Tubing (American Water Works Association)
CSA B137.7 - Polybutylene Cold Water Service (Canadian Standards Association)
CSA B137.8 - Polybutylene Hot and Cold Water Distribution Tubing

II. CODES AND LISTINGS

BOCA (Code) - Building Officials Congress of America (accepts PB per ASTM D3309)
FHA (Listing) - Farmers Home Administration (cold water only)
FHA-HUD (Listing) - Federal Housing Administration (Bulletin 68) UM78 4/25/78 - (hot and cold water approval) UM 76.
ICBO (Code) - International Congress of Building Officials (plumbing approval)
IAPMO (Code) - International Association of Plumbing and Mechanical Officials (Uniform Plumbing Code)
MHA (Listing) - Manufactured Housing Association
NSF (Listing) - National Sanitation Foundation - (Standard #14)
NSPC (Code) - National Standard Plumbing Code (NAPHCC)(Code Table 3.1.3)(plumbing approval) National Association of Plumbing-Heating-Cooling Contractors
PPI (Listing) - Plastic Pipe Institute
RVI (Listing) - Recreational Vehicle Institute
SBCC (Code) - Southern Building Code Congress (accepts PB per ASTM D3309)
UL (Listing) - Underwriters Laboratory
MHMA (Listing) - Mobile Home Manufacturers Association
NFPA - National Fire Protection Association #501.C (mobile home)(plumbing approval)
South Florida Building Code



**LEGISLATION
AND MODEL
RESOLUTION**

MODEL RESOLUTION... _____ FIRE CHIEFS' ASSOCIATION

WHEREAS... expanding and developing communities in our _____ States with underdeveloped public services are particularly vulnerable to catastrophic fire losses and...

WHEREAS... the maximum utilization of private fire protection systems minimizes fire losses and minimizes costs of operating fire department and water utilities and...

WHEREAS... legislation creating incentives for the installation of private fire protection systems will encourage an area wide shift towards maximum utilization of more efficient, less costly fire fighting technology, thereby stabilizing the cost of water utilities and fire departments; along with savings to life and property; the conservation of water and reduced cost of local government services with the widespread installation of private fire protection systems.

RESOLVED... that the _____ Fire Chiefs' Association in conference in _____ on _____ of 198__ actively promote legislative incentives to move towards the utilization of the best and most economical fire safety technology private fire protection by

- ... Actively promoting legislation that will assure tax credits by exempting the value of private fire protection systems from the true cash value of a building and
- ... Eliminating water stand-by charges that a utility may charge for the connection of a private fire protection system and
- ... Providing low interest loans that will cause financing to be available so that automatic fire sprinklers can be installed in both new and existing buildings.

RESOLVED... On _____ by the _____ in conference at _____ on _____ 198__.

Signed _____

Original Sponsors: Malone and Duncan

Offered: 5/9/80

IN THE HOUSE

BY THE RULES COMMITTEE

SENATE CS FOR CS FOR HOUSE BILL NO. 648
IN THE LEGISLATURE OF THE STATE OF ALASKA
ELEVENTH LEGISLATURE - SECOND SESSION

A BILL

For an Act entitled: "An Act relating to fire prevention."

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

*SECTION 1. AS 18.70 is amended by adding a new section to read:

Sec. 18.70.081. APPROVAL OF FIRE PROTECTION SYSTEMS.

Before October 30 of each year the Department of Public Safety shall prepare and make available a list of approved fire protection systems to the Department of Community and Regional Affairs, the Department of Commerce and Economic Development, and the public.

*SECTION 2. AS 29.53.020(a) is amended by adding a new paragraph to read:

(7) real property to the extent and subject to the conditions provided in (j) of this section.

*SECTION 3. AS 29.53.020 is amended by adding a new subsection to read:

(j) Two percent of the assessed value of a structure is exempt from taxation if the structure contains a fire protection system approved under AS 18.70.081, in operating condition, and incorporated as a fixture or part of the structure. The exemption granted by this subsection is limited to

(1) an amount equal to two percent of the value of the structure based on the assessment for 1981, if the fire protection system is a fixture of the structure on January 1, 1981; or

(2) an amount equal to two percent of the value of the structure based on the assessment as of January 1 of the year immediately following the installation of the fire protection system if the fire protection system becomes a fixture of the structure after January 1, 1981.

*SECTION 4. AS 42.05.331 is amended by adding a new subsection to read:

(d) A utility shall provide for a reduced fee or surcharge for standby water for fire protection systems approved under AS 18.70.081 which use hydraulic sprinklers.

*SECTION 5. AS 44.33.170 is amended by adding a new subsection to read:

(b) Tourist attraction development matching money may also be obtained for the purpose of purchasing and installing a fire protection system approved under AS 18.70.081 for a building used or to be used for the purposes described in (a) of this section.

*SECTION 6. AS 45.95.020(a) is amended to read:

(a) The commissioner shall, under regulations and policies adopted by him, make small business loans to acquire, finance or refinance or equip businesses, including farming equipment, fire protection systems approved under AS 18.70.081, mining and fishing, not exceeding \$500,000. The loans shall be secured by acceptable collateral and may not exceed 75 percent of the appraised value of the collateral offered as security. The rate of interest may not exceed nine and one-half percent a year on the unpaid balance.

*SECTION 7. AS 45.95.020 is amended by adding a new subsection to read:

(a) The commissioner may not disqualify an applicant for, or prejudice an applicant's privilege to receive, a loan to purchase and install a fire protection system solely because of a loan already made to the applicant under this chapter.

Installation Requirements

No piping system will perform properly if it is not installed correctly. Because the materials are different, there are significant differences between the installation of metal pipe and that of DURAFLEX polybutylene pipe. These differences do not result in costly designs or complicated, expensive installations. Quite the contrary, they will greatly simplify the design of the system and significantly reduce the installed costs. Included in this section are information on making and testing fusion joints, pipe function loss as a function of flow rates, pipe support spacing, protection against external abrasion, allowances for thermal expansion, need for boxing or other separation and protection from ultraviolet exposure.

Shell has more detailed design information on these subjects than is included here. This information can be made available as needed for specific installations.

Heat Fusion Techniques

A. Prepare Heating Tool

1. Bolt proper size socket heater faces onto heating tool.
2. Connect tool to 120v AC power source.
3. Allow heating tool to reach 500°F min. - 525°F max.
 - a. If the temperature is other than above adjust temperature by inserting a screwdriver in the hole near the thermometer and turn thermostat adjusting screw clockwise to lower the temperature and counterclockwise to increase the temperature.

B. Prepare Pipe End

1. Cut pipe end square with a tubing cutter.
2. Chamfer the outside corner of the pipe end for pipe 1-1/4" IPS and larger with proper chamfering tool.
3. Clean pipe end. (Pipe must be free of dirt or grease.)
4. Place depth gauge on pipe end.
5. Clamp cold ring around pipe with one side contacting the depth gauge. (Cold ring rounds the pipe end and limits the depth that the heater face and socket fitting slide over pipe end.)
6. With 1/2" and 3/4" pipe use insert stiffener to insure pipe roundness.

C. Prepare Fitting

1. Clean fitting. (Socket must be free of dirt or grease.)

D. Heat Pipe End and Fitting

1. Place pipe end and fitting adjacent to heater elements.
2. Push pipe end, heater and fitting together with an even pressure.
3. With heater in contact with the fitting and cold ring, begin measuring the heating time. Optimum heating times are as follows:

<u>Pipe Size</u>	<u>Heating Time</u>	<u>Pipe Size</u>	<u>Heating Time</u>
1/2"	5 - 7 sec.	1-1/2"	12 - 15 sec.
3/4"	5 - 7 sec.	2"	12 - 15 sec.
1"	10 - 12 sec.	3"	15 - 20 sec.
1-1/4"	12 - 15 sec.	4"	15 - 20 sec.

Good joints will still be made when heating times vary from 75% to 150% of these times.

4. When heating time is complete, remove fitting and pipe from heater with a quick snap action.

E. Join Pipe and Fitting

1. Quickly line up pipe with fitting. Push together until fitting is against cold ring.
2. Hold joint together for cooling time as follows:

<u>Pipe Size</u>	<u>Cooling Time</u>	<u>Pipe Size</u>	<u>Cooling Time</u>
1/2"	30 sec.	1-1/2"	90 sec.
3/4"	30 sec.	2"	90 sec.
1"	45 sec.	3"	90 sec.
1-1/4"	60 sec.	4"	90 sec.

3. When cooling time is complete remove cold ring.
4. Do not stress the fusion joint until it is cool to the touch, usually five minutes.

F. Inspect Joint

1. Make certain that joint is intact and formed properly.

G. Clean Heater Faces

1. Wipe off molten plastic from heater elements before another fusion connection is made.

Support Spacing

The effects of gravity will cause all horizontal pipes to deflect from a perfectly straight alignment. The amount of deflection will depend upon the stiffness of the material and the pipe support spacing. The following table gives the long term deflection that unpressurized water-filled polybutylene pipes will experience. Due to Poisson's effect, pressurization will reduce the amount of deflection. It should be borne in mind that the listed deflections cause a negligible stress on the pipe itself.

HORIZONTAL PIPE SUPPORT SPACING NO AXIAL CONSTRAINT CONTINUOUS BEAM DESIGN

<u>NOMINAL PIPE SIZE</u>	<u>LONG TERM ALLOWABLE DEFLECTION (IN.)</u>		
	<u>0.50</u>	<u>1.00</u>	<u>1.50</u>
<u>CTS</u>			
1/2	20	24	27
3/4	34	40	44
1	38	45	50
1-1/4	42	50	56
1-1/2	46	55	61
2	51	61	68
<u>IPS</u>			
3/4	37	44	49
1	42	50	56
1-1/4	47	56	62
1-1/2	50	60	67
2	56	67	75
2-1/2	61	73	81
3	68	81	90
4	75	89	99

Abrasion Protection

To minimize external abrasion, NFPA approved hanger straps that are smooth and free of sharp edges should be used. To guard against the possibility of sharp edges or burrs, plastic sleeves are recommended for the load bearing surfaces of the hangers. Wall penetrations should be protected by plastic sleeves. Where piping may run through a number of structural members on a horizontal run, it should be sleeved at the beginning and end of the run and at significant changes of direction.

Allowances for Thermal Expansion

Polybutylene pipes will expand 0.85 inches for every 100 feet of run length for every 10°F change in temperature. In residential installations where large temperature swings can occur, the flexibility of polybutylene pipe and the frequent changes of direction, will absorb the forces of thermal expansion through the flexing of the line. The total force exerted on any fixed point will be small.

Light hazard occupancies have longer runs of larger pipe but also have much smaller temperature changes. As a result, the forces will be small and can also be dissipated by flexing of the line between supports. For the rare case where they might be needed, design data is available on the size of the forces and expansion loop design.

Boxing of the Pipe

In the bulk of the fire tests run to date with polybutylene pipe, the pipe was separated from the fire by wallboard as thin as 1/8" plywood. However, tests have also been run with exposed pipe and fast response sprinkler heads. All of these tests were successful, extinguishing the fire with no damage to the pipe. However, until more complete testing is done at Underwriters Laboratories, pipe should be installed with some separation from the room.

Exposure to Sunlight

Nonblack polybutylene pipes have sufficient ultraviolet stability for normal installation practices, i.e., up to three months, but should be stored inside. Black polybutylene pipes can be used in sunlight and have over a decade of such service in industrial applications.

FIRE SPRINKLERS

Fire Sprinkler Installation

The detailed design of a fire sprinkler system is very similar to a plumbing installation design. The water flow rates required to satisfy a sprinkler system, particularly in a residential installation, may be higher than for the building plumbing, but the methods of analysis are substantially the same. The hydraulic design does require a layout of the sprinkler locations and details of the specific auxiliary fire equipment to be installed. Sprinkler layout is dictated by equipment manufacturers' recommendations and National Fire Protection Association (NFPA) standards; NFPA 13-D for residential and NFPA 13 for industrial/commercial applications.

System Selection

Sprinkler systems are installed "wet" or "dry". A wet system is one with water in all lines up to the sprinkler head. This system is normally less complicated and less expensive than a dry system. The dry system requires an electrical connection from the sprinkler head to a solenoid valve. When the sprinkler opens, the current is applied to the valve, opening it, and allowing water to the sprinkler head. More complex, this system is normally used where danger of freezing exists.

Most systems are simple wet systems and experience little change in temperature as the lines run in relatively constant temperature areas. For this reason, expansion/contraction should not normally be a problem, even though the coefficient of thermal expansion of polybutylene is considerably larger than for metal piping. Where required, designs for expansion/contraction can be provided by consulting Section II-P.

The system designs get more complex and may require consultation with manufacturers of equipment or fire safety design engineers as the size of the system increases. Simpler systems, as used in small commercial and residential jobs, can be designed with knowledge of a few basic principles. The following paragraphs outline the procedure for residential design (NFPA 13-D) but the engineering principles of design remain the same for many projects which would fall under the jurisdiction of NFPA 13.

Hydraulic Design

First it is important to recognize the flow requirements of residential fire sprinkler systems. The system must provide a discharge of not less than 18 gpm to any single operating sprinkler, and 26 gpm if two sprinklers are operating (13 gpm to each head). The code states the number of design sprinklers in a wet residential system shall include all the sprinklers in a room up to a maximum of two. In the case where two

sprinkler heads are actuated in the same room, their spray patterns reinforce each other making it possible to get by with a lower flow from each individual sprinkler head. For a two family dwelling, the piping entering the building must be sized to handle a 31 gpm flow. The requirement for an extra 5 gpm is based on the assumption that the family in the other half of the dwelling may be using some of their appliances, e.g., dishwasher, shower, etc., when the fire sprinklers in the other half of the dwelling are actuated.

NFPA standard 13-D has set forth the following requirements for sprinkler head location. The section numbers shown below are directly from the 13-D standard and are included for cross-referencing purposes:

4-1.4 Sprinkler Coverage.

4-1.4.1 Residential sprinklers shall be spaced so that the maximum area protected by a single sprinkler does not exceed 144 sq ft (13.4 m²).

4-1.4.2 The maximum distance between sprinklers shall not exceed 12 ft (3.7 m) on or between pipe lines and the maximum distance to a wall or partition shall not exceed 6 ft (1.8 m). The minimum distance between sprinklers within a compartment shall be 8 ft (2.4 m).

4-6 Location of Sprinklers. Sprinklers shall be installed in all areas.

Exception No. 1: Sprinklers may be omitted from bathrooms not exceeding 55 sq ft (5.1 m²) with non-combustible plumbing fixtures.

Exception No. 2: Sprinklers may be omitted from small closets where the least dimension does not exceed 3 ft (0.9 m) and the area does not exceed 24 sq ft (2.2 m²) and the walls and ceiling are surfaced with non-combustible materials.

Exception No. 3: Sprinklers may be omitted from open attached porches.

Exception No. 4: Sprinklers may be omitted from carports, garages, and similar structures.

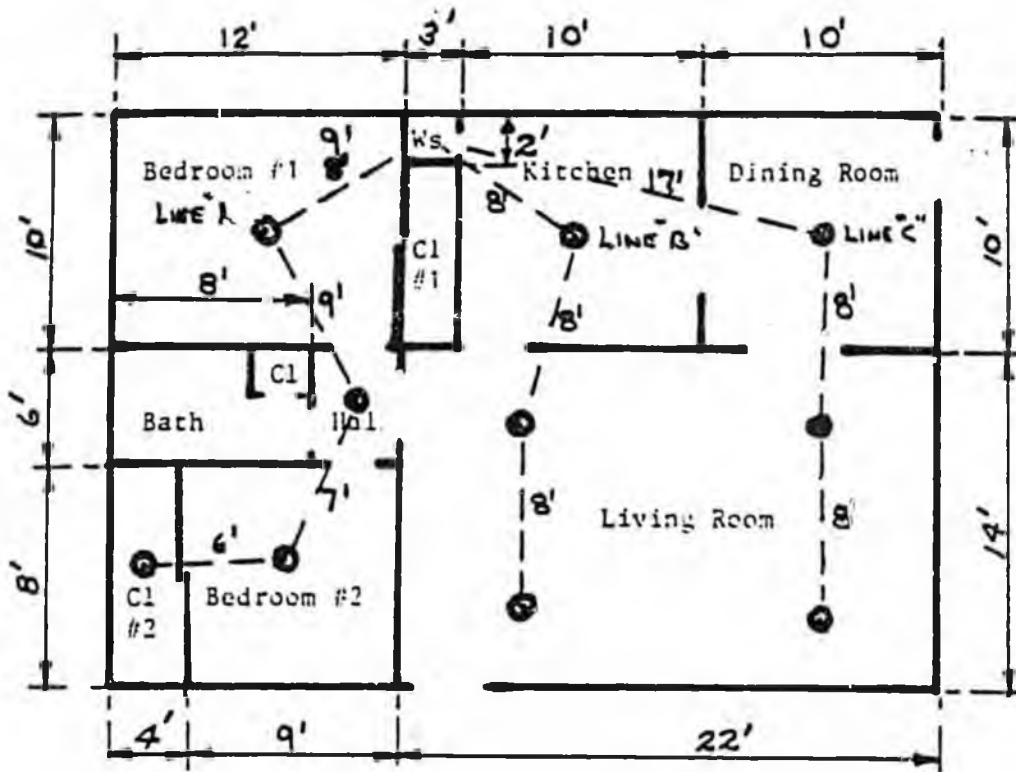
Exception No. 5: Sprinklers may be omitted from attics which are not used or intended for living purposes or storage.

Exception No. 6: Sprinklers may be omitted from entrance foyers which are not the only means of egress.

To illustrate the various steps required to arrive at the preferred design, the house represented in the drawing following will be used as an example. The sprinkler heads have already been positioned in accordance with NFPA 13-D and a proposed piping layout is shown.

FIRE SPRINKLER DESIGN
SPRINKLER HEAD AND PIPING LAYOUT
TYPICAL SMALL RESIDENCE

PRELIMINARY



Legend

- Cl - closer with sheetrock walls
- Ws - water supply
- Bath - porcelain fixtures and ceramic tile walls

The piping layout can generally be made in a number of ways, and economics enters into the selection of the best design. All piping layouts are compromises and in larger more complex designs, several different layouts may need to be developed and evaluated to know which one is most cost-effective. You should remember that costs are effected by both line size and length. If longer lines are used, fewer are required, but the loss of available head pressure in each line due to friction will be greater. This may in turn require a larger size line to accommodate the flow requirements thus illustrating the need to carefully design the piping layout.

To determine the pressure requirement on any piping layout, the following steps should be followed.

1. Calculate sprinkler pressure requirement.
 - A. Get the "K" factor for the sprinkler head to be used (this is published by each manufacturer for each sprinkler head he produces).

- B. Calculate the sprinkler pressure requirements (psi) from the formula:

$$P = \left(\frac{Q}{K}\right)^2$$

CALCULATION OF PIPE HEAD LOSS
FIRE SPRINKLER LINE

	REQUIRED FLOW (GPM)	LINE LENGTH (FT)	LINE HEAD LOSS (PSI)			
			1-1/2" T	1" P	1" T	3/4" T
<u>LINE A (30' long)</u>						
Sprinkler Head	18	-	19.3	19.3	19.3	19.3
Line Between last Two Heads	18	6	0.1	0.4	0.8	3.0
Remainder of Horizontal Line	18	25	0.6	1.8	3.5	12.3
Line Floor to Ceiling	18	10	0.2	0.7	1.4	4.9
Elevation Difference (10')	-	-	4.3	4.3	4.3	4.3
Equivalent Fitting Length	18	21 (equiv.)	0.5	1.5	2.9	10.3
Tees (3)						
Elbows (4)						
Valves and Controls	18		4.0	4.0	4.0	4.0
Total Bldg. Head Loss			<u>29.0</u>	<u>32.0</u>	<u>36.2</u>	<u>58.1</u>

LINE C (33' long)

Sprinkler Head	13		10.1	10.1	10.1	10.1
Line Between Last Two Heads	13	8	0.1	0.3	0.6	2.2
Remainder of Horizontal Line	26	25	1.2	3.5	7.0	24.3
Line Floor to Ceiling	26	10	0.5	1.4	2.8	9.7
Elevation Difference (10')	26		4.3	4.3	4.3	4.3
Equivalent Fitting Length	26	18 (equiv.)	0.8	2.5	5.0	17.5
Tees (2)						
Elbows (4)						
Valves and Controls	26		8.0	8.0	8.0	8.0
Total Bldg. Head Loss			<u>25.0</u>	<u>30.1</u>	<u>37.8</u>	<u>76.1</u>

LINE B (30' long)

Analysis not required - slightly shorter than Line C, therefore, total head loss would be less and sizing would be the same as determined for Line C.

Similarly, the service line head loss can also be calculated for different size piping.

CALCULATION OF PIPE HEAD LOSS
WATER SERVICE LINE
(160 psi)

	REQUIRED FLOW (GPM)	LINE LENGTH (FT)	LINE HEAD LOSS (PSI)		
			2" T	1-1/2" T	1" P
Meter	26		0.1	1.2	3.8
Line - Main to Meter	26	20	0.1	0.8	2.8
Line - Meter to House	26	60	0.5	2.3	8.4
Elevation Difference (5')			2.2	2.2	2.2
Total Service Head Loss			<u>2.7</u>	<u>6.5</u>	<u>17.2</u>

where P is the required pressure (psi) and Q is the required water flow (gpm).

As an example, a sprinkler head with a K factor of 4.1 would require the following pressure at the actual head for:

$$\text{One head operating} \quad P = \left(\frac{18}{4.1} \right)^2 = 19.3 \text{ psi}$$

$$\text{Two heads operating} \quad P = \left(\frac{13}{4.1} \right)^2 = 10.1 \text{ psi}$$

2. Obtain manufacturer's data on head loss through valves, meters, and controls at various flow rates.
3. Obtain the equivalent length of pipe data for fittings to be used and estimate the numbers of each fitting in each line.
4. Calculate the water flow head loss (psi) for each line in one piping layout.
5. Repeat the same procedure for the building service lines including all of the meters, valves, fittings, etc., and add this to the building head loss to obtain the total head loss.

The table below shows the head loss for each individual building line assuming they are made from 1-1/2" tubing, 1-1/4" pipe, 1" pipe and 1" tubing.

To arrive at the most economical design, the minimum main pressure must be obtained from the water department. Since it is essential that the fire sprinkler system operate properly, this minimum pressure must be used.

For the purposes of this example, let us assume that the municipality has a minimum pressure of 50 psi available. The sum of the building and service line head losses must then total less than the 50 psi. The most economical design would then involve a 1-1/2" tubing service line and one inch tubing distribution lines inside the building. If, however, only 40 psi were available, the most economical design would use a 1-1/2" tubing service line and 1" pipe distribution lines. If only 35 psi were available, a 2" tubing service line would be required along with 1-1/2" tubing for line A and 1" piping for lines B & C. It is questionable whether using two different line sizes is practical in this design, however, and the savings would probably not offset the added costs of material supply and handling. On larger sized jobs this would be done. As you can see, the overall economics will be heavily dependent on the minimum pressure available at the main and optimum economics will be obtained by using large sizes for the lower cost service lines.

It can be seen from the calculations for a 3/4" tubing line that the head losses are relatively large. This size tubing will only work for short lines or as a reduced sized section of a longer line. Its relative economics should be considered, however, when designing a system as it can be used with metal insert fittings which are a fast economical joining system for 3/4" tubing lines. Currently lines sized 1" and above must use fused joints.

It should also be pointed out that the design method outlined produced the minimum acceptable pipe sizing for proper functioning of the sprinkler heads. Larger size lines with correspondingly lower pressure drop would provide additional sprinkler water volumes and so would provide a greater safety factor.

Thermal Expansion/Contraction

As shown in Section II-P, the flexibility of DURAFLEX polybutylene prevents it from generating much force, even when it is continuously restrained. Because it requires even less force to bend the pipe, its response to increases in temperature will be to bend, forming its own expansion loop. In residential fire sprinklers where pipe diameters of 1 to 1-1/2 inches are typically used, the force generated will be less than 20 pounds. Even in light hazard (hospitals, motels, hotels, etc.) situations where pipe diameters up to 2 inches can be used, the forces are still less than 200 pounds. These can be easily handled by normal pipe clamps.

The most important consideration in designing for expansion/contraction in fire sprinkler systems is to prevent the sprinkler head from canting (moving off vertical or horizontal wall mount head) as this

will change its flow pattern. A certain amount of lateral movement is normal and is typically allowed for by drilling the hole for the sprinkler oversize by upwards to 1/4 inches (the escutcheon plate will conceal this). If large temperature changes are anticipated, i.e., pipe installed on top of insulation in an attic, the polybutylene pipes should be anchored as close to a fitting as possible. A guide should then be installed within two feet of the other side of the fitting.

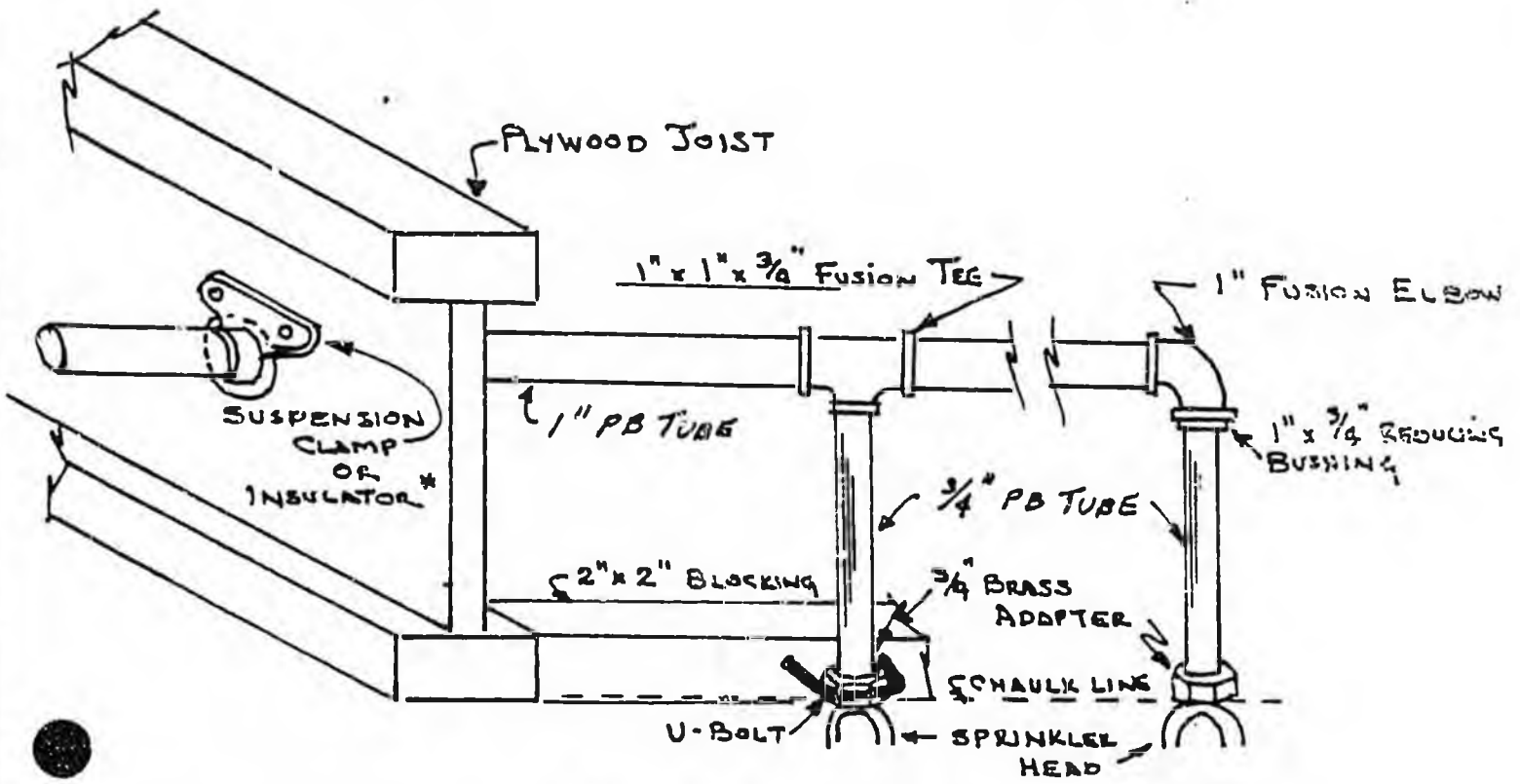
Equipment Selection

When the sprinkler system is connected to the potable water supply, a back flow preventor is normally used to prevent contamination of the drinking water. A further safety factor is that polybutylene pipe has been certified by the National Safety Foundation (NSF) as being safe for potable water and is approved for plumbing hot/cold water distribution systems by all major codes.

The equipment necessary for a complete sprinkler installation will be determined by the design requirements of the system. Components are available from a number of manufacturers who can assist in an economical, satisfactory performance. For a typical residential installation the following equipment could be used:

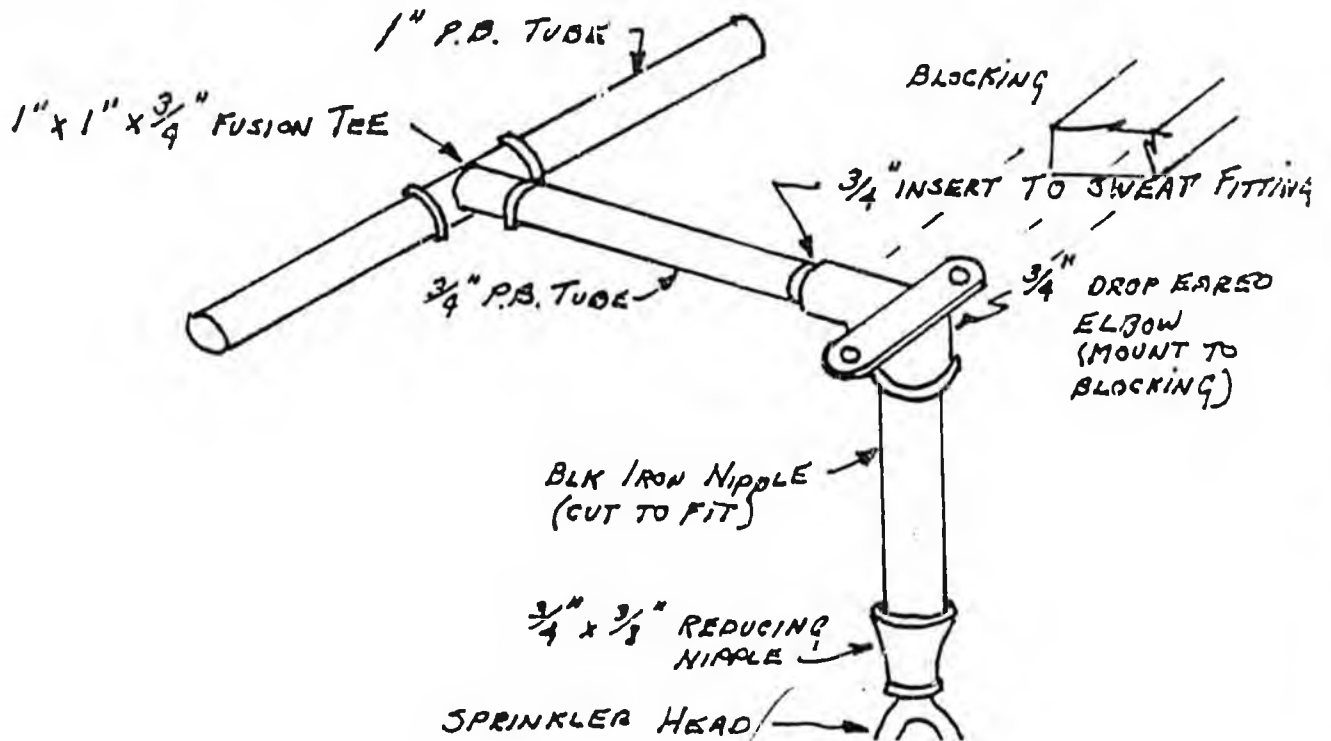
- Residential Sprinkler Heads (Fast Response)
- Check Valve (1" Rubber Faced)
- Drain Valve (1/2" Ball)
- Test Valve (1/2" Ball)
- Main Control Valve (1" Ball)
- Flow Alarm Switch (1" Flow Sensing Switch with Time Delay)
- Alarm Bell (6" Diameter)
- Anti-Water Hammer Device (Not Required With Polybutylene)

FIRE SPRINKLER SYSTEM
Proposed Installation Details

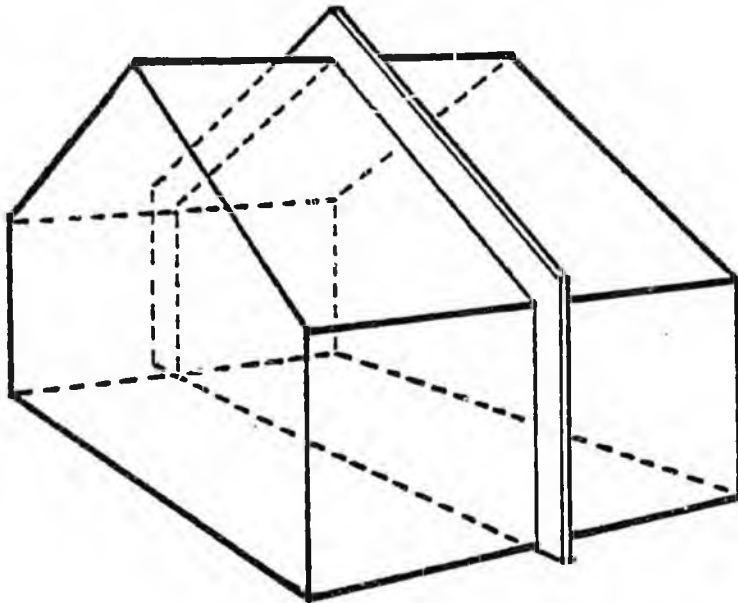


* SEE ITEM 2 - Proposed Installation Details Writeup

ALTERNATE PROPOSAL



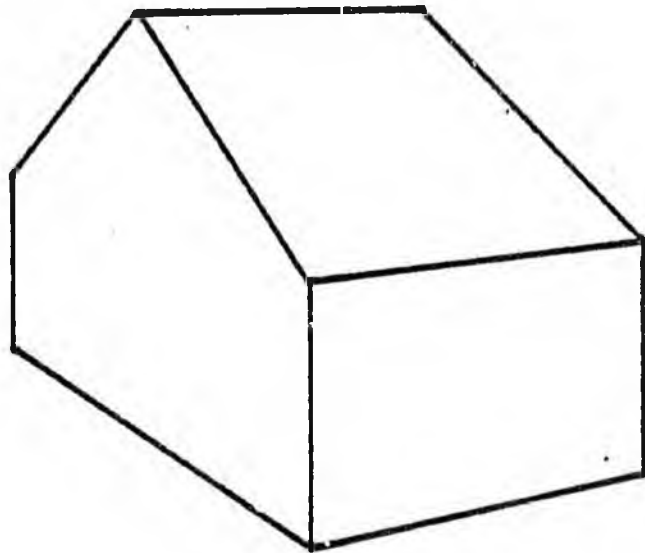
J.E.
8/12/82



6000 SF = a four hour masonry firewall is required.

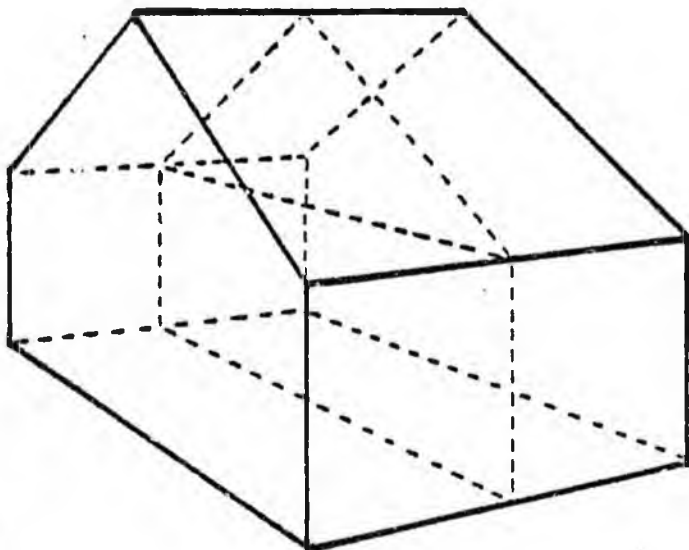
Up to 8000 SF no firewall is required

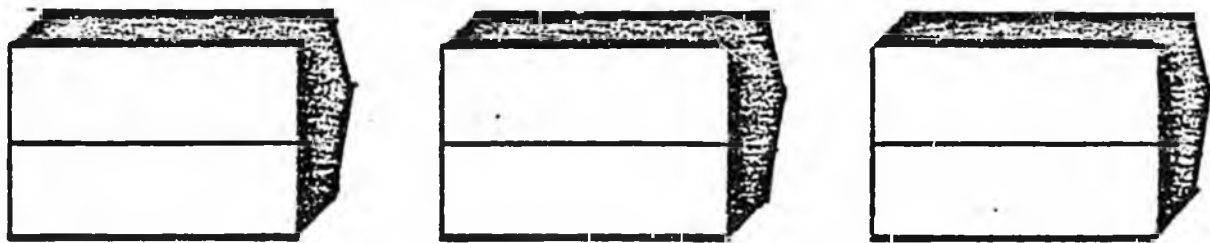
SPRINKLED



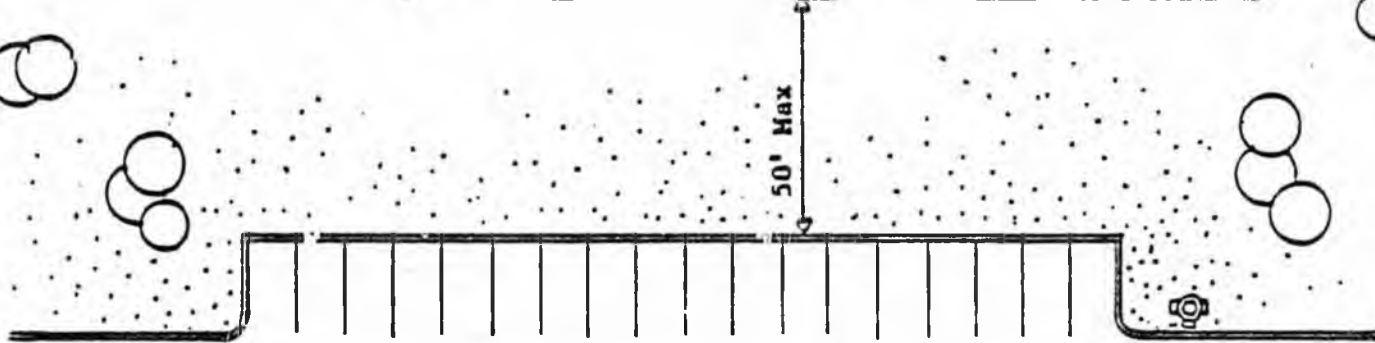
8000 SF to 10,000 SF
A two hour gypsum board firewall is required

SPRINKLED





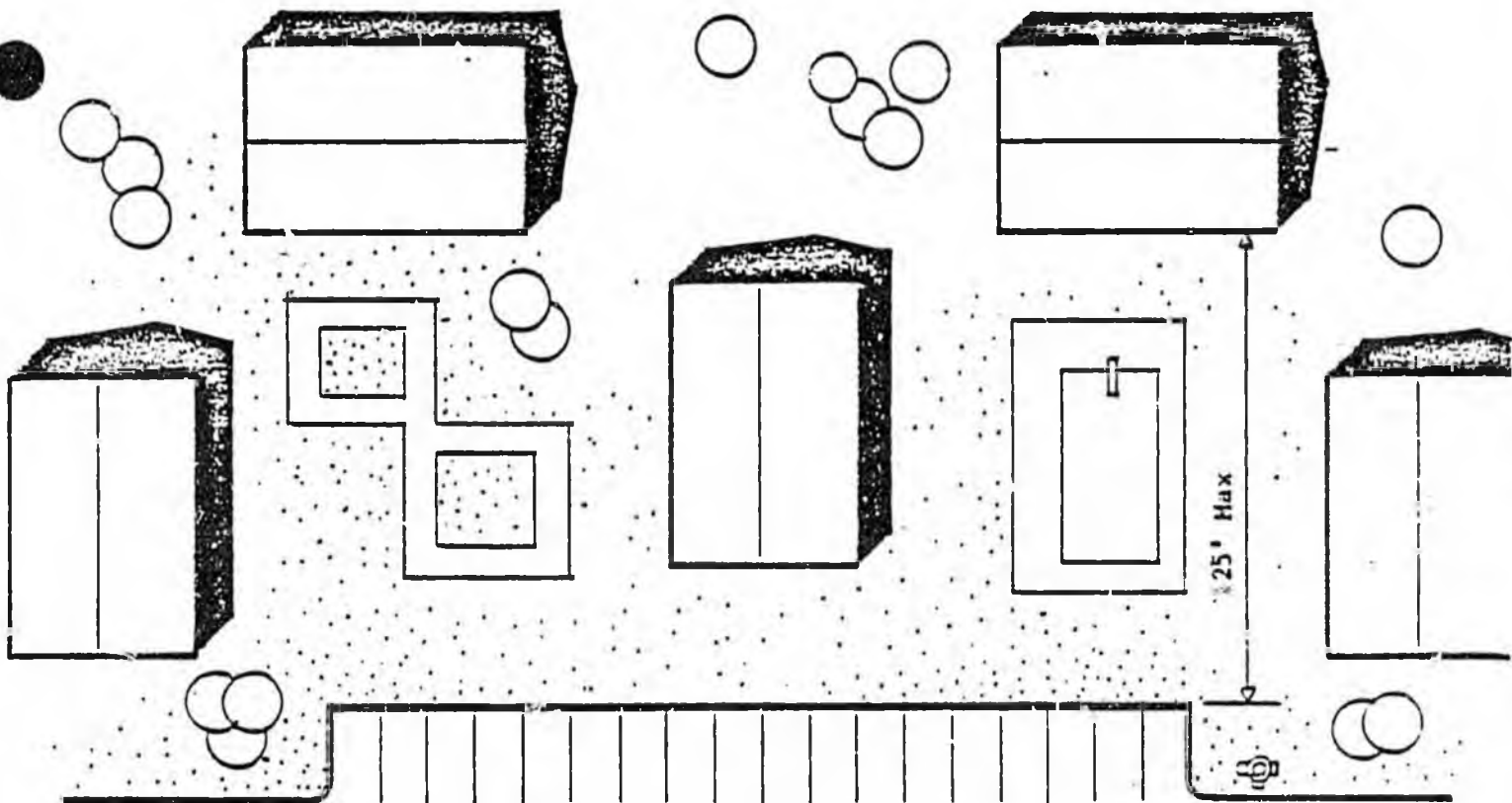
50' Max



50' Max. from back of parking to front of bldg.

Fire Hydrant Spacing at 300'

NON SPRINKLED



25' Max

125' from back of parking to front of bldg.

Fire Hydrant Spacing at 300'

SPRINKLED

Cobb County leads the way in fire sprinklers for homes

□ ADDING SPRINKLERS

3J

By H. Jane Lehman
Staff Writer

Ten years from now, you may wake up from a deep sleep to find yourself, your bed and the rest of your room dripping wet.

But don't curse the leaky plumbing. Instead, call the fire department and then say thanks to your fire sprinklers for saving your home from a roaring inferno.

Although a sprinkling system in every home is most likely years away, Cobb County is busy ushering in the future now. The county government has taken the lead

locally and nationally in pioneering the safety concept.

"I would say that in the next six to eight years that 75 percent of new residences of all types in Cobb County will have sprinklers," said David Hilton, Cobb County fire chief.

With the help of private industry donations of \$10,000, the Cobb County Fire Department has been computer-testing the effectiveness and reliability of sprinkler heads.

As part of a pilot program, apartment and condominium developers are winning variances to build residences with sprinkler systems in Cobb County that would otherwise not meet the fire code. So far, 754 apartment or condominium units with sprinklers have been constructed

or approved, said Lt. Jerry Grier, Cobb County fire inspector.

Within the next few months, Hilton expects an amended fire code including the sprinkler provisions to be adopted. And he is encouraging homeowners to look into retrofitting existing homes with the help of the fire marshal's office.

The most obvious feature of the lifesaving system is the sprinkler head protruding a couple of inches from the ceiling. This hardware is installed in each living area — the living room, dining room, kitchen, den and bedrooms.

The sprinkler heads are connected to the house water supply via a flexible piping made from a newly developed plastic called polybutylene that is used in place of copper

and steel piping. An alarm bell and control valve complete the system.

Each sprinkler triggers independently whenever the room temperature reaches 135 degrees, Hilton said. Then the sprinkler head sprays forth 18 gallons of water a minute. The systems turn off automatically once the fire is extinguished.

The dousing qualities of sprinkler systems are hailed as saving both lives and property, feats that still elude other preventive measures like smoke alarms. Cobb Coun-

SEE Sprinklers

3J

Sprinklers FROM 1B

ty's tests showed that one sprinkler bead was able to control 99 out of 100 fires, Hilton said.

And if the fire breaks out in your neighbor's apartment, the buzzing from his smoke detector probably won't be loud enough to alert you to evacuate the premises.

Sprinklers, unlike smoke detectors, can counteract the lethal effects of poisonous fumes, Hilton explained. Smoke contains carbon monoxide and cyanide, both of which are toxic.

"The water spray aids in washing the air and diluting some of those products," he said.

Cobb County's test results show that fires contained by sprinklers emit less than 300 parts of carbon monoxide per million parts of clean air. Hilton said a human can easily breathe 1,500 parts per million and not suffer ill effects.

During 1981, four people died in fires in Cobb County, Hilton said. Additionally, fires caused an estimated \$3.978 million worth of damage to residential structures, he said.

A sprinkler system can prevent a small blaze from escalating into a large-scale fire. A Cobb County demonstration conducted last week in a specially built

test house showed the dramatic difference sprinklers can make.

The fire department set a wicker basket full of newspapers on fire, which consequently set a nearby chair ablaze.

Hill said one insurance claims adjuster present for the test estimated that almost \$7,000 worth of damage could have been wrought. But the sprinkler kept losses to \$1,067.

Sprinkler systems are nothing new. Commercial structures have incorporated them as safety features for years. During the past decade, frequent discussion has been directed at residential application of the devices, but Cobb County, which began its effort in September 1981, is credited with launching the research into a cost-effective sprinkler system.

Other local counties and communities across the nation are watching Cobb closely and are expected to follow suit. In fact, the DeKalb County Commission is expected to decide Tuesday whether to adopt proposed amendments to its fire protection code.

The new code would mandate sprinklers in any structures over 10,000 square feet or at least three stories tall, which could include apartments and condominiums. It would also require retrofitting of existing buildings by 1997.

DeKalb County's contemplated mandatory use of sprinklers is typical of the controversy surrounding the safety sys-



WATERFORD PLACE: Sprinkler in Cobb home.

tem. Many builders oppose mandatory sprinklers — a ruling adopted in San Clemente, Calif. — suggesting that the public is unwilling to pay the additional costs for the protection.

In fact, for years builders have been free to erect homes with sprinklers, but the systems and construction had to conform to criteria established by the National Fire Protection Association, an independent standard-setting organization. For the most part, that approach was rejected as too expensive.

Hilton estimates that it would cost from \$1,800 to \$2,500 to install the National Fire Protection Association system in a 2,000-square-foot single family house while it was under construction. In contrast, he claims that his fire department's research has come up with a more economical approach costing \$426 per two- or three-bedroom apartment or condominium unit. The savings is accomplished mainly through trade-offs in the fire code.

Many fire codes, including Cobb County's, dictate the placement of doors and

windows that border an individual's escape route from a burning multi-family unit. The purpose is to eliminate openings through which a fire could easily burst and block the path to safety. However, Cobb County is willing to allow greater design flexibility if the units include sprinklers.

Fire codes also mandate fire-resistant doors and walls between adjoining units. These features not only are expensive, but labor intensive to install. With sprinklers, developers can cut out those otherwise unavoidable expenses.

Thomas C. Graham, developer of Waterford Place, the first Cobb County condominiums to include the system, estimated it cost an extra \$400 a unit to install the hardware.

However, the trade-offs work only with multi-family housing, because there is nothing to swap off with single family housing, Hilton conceded. His hope is that Congress will step in with tax breaks for sprinkler installation and that insurance companies will reduce their normal homeowner insurance premiums.

Sprinklers can be installed in existing homes

By H. Jane Lehman
Staff Writer

Although much local interest in residential sprinkler systems has been directed at new construction, it is possible to retrofit existing homes.

However, until Congress decides to enact tax credits or insurance companies begin giving generous premium discounts, there is little financial incentive for homeowners to invest in the system. Developers, on the other hand, are finding ways to offset the costs.

Motivation, therefore, will come from concern for the safety of your family and preservation of your possessions in the unfortunate event of a fire.

Cobb County Fire Chief David Hilton strongly encourages the addition of sprinkler systems to existing homes.

"Retrofit is possible and feasible," he said emphatically.

In fact, he has volunteered the services of his fire marshal's department, (call 428-6348), to give advice to county residents.

Most homeowners will want to pass the job onto a sprinkler contractor or plumber. Unlike smoke detectors, which are relatively simple to install, a fire sprinkler system is a much more complicated.

Basically, installation entails laying the piping along the attic floor, drilling holes through the ceilings to accommodate the sprin-

kler heads and installing a control valve and alarm.

But, there are several clinchers. The system has to be hooked into the water supply where the service line comes into the basement or garage. Usually, a plumber is required to do the tap.

The services of a hydraulic engineer also are advisable. He needs to compute the water supply and the water pressure necessary to operate a sprinkler system. This will determine the size of piping to be used.

Your local water authority can be called upon to conduct pressure and flow tests, although there may be a fee for the service.

"I would not advocate doing-it-yourself," said Buck Buchanan, vice president of sales for Central Sprinkler Corp. His company does not sell the necessary parts to retail customers.

"The real mystique is the hydraulic calculations," he explained. "No matter how much is being used by you or your neighbor, you have to have enough water to flow through to extinguish a fire.

"The last thing I want to see on the 11 o'clock news or read in the newspapers is about a body being carried out of a sprinkler-fitted home where the system didn't work" because it was installed by an amateur, he said.

Buchanan predicts that a number of companies with the technical expertise soon will move into the retrofitting business, once public awareness of sprinkler systems grows.

Selasco Corp. is one Atlanta company already planning to get into retrofitting, according to Tom Multer, vice president of sales and engineering. The sprinkler contractor, which heretofore had sold sprinkler equipment for commercial buildings only, would charge from \$125 to \$175 per sprinkler head. Most homes require between five to 10 heads, he said.

If you did have the know-how to attack the plumbing and the hydraulic calculations, Ha Sanders, a hydraulic engineer, estimated it would cost less than 50 cents a square foot to install a system yourself in a one-story house. In contrast, hiring a contract sprinkler would run closer to \$1 a square foot, he said.

Multer's firm also sells the sprinkler system components individually. The list price is \$10 per head. Polybutylene one-inch pipe goes for approximately 50 cents a foot. It costs the same as steel pipe, Multer said, but because the plastic pipe is more flexible, it takes substantially less time to install.

Together, a control valve and alarm would cost around \$300, Multer said.

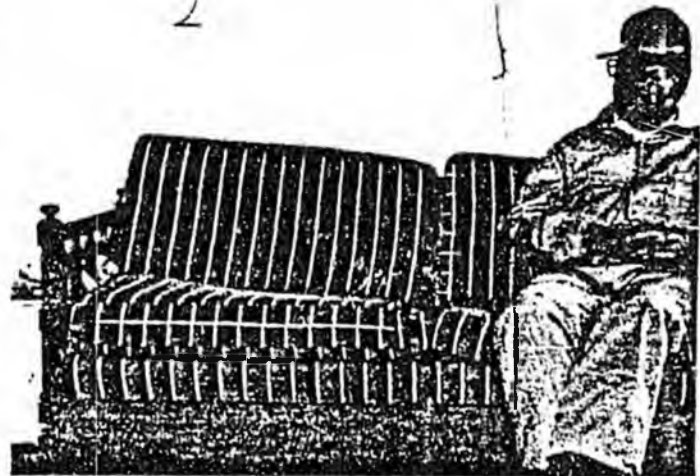
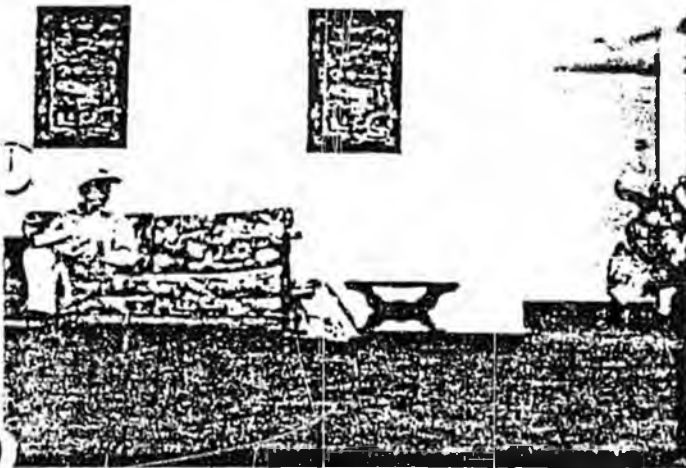
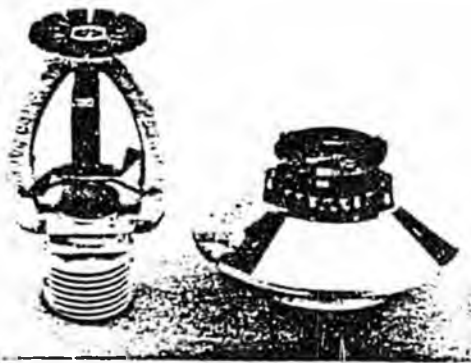
An alternative to installing the piping in the attic space would be to hide it under molding where the wall meets the ceiling, Hilton suggested. Then side wall sprinklers could be used.

Selasco sells molding especially designed for that purpose with channels ranging from 2 inches square to 4-inches square, Multer said. It's priced at about \$4 a foot.

Preliminary Data

Rural/Metro Fire Sprinkler Tests

Scottsdale, Az. April 19-21, 1982



Ron Butler (Right) and Lou Witzeman await sprinkler action, sitting on sofas

Tests Demonstrate Fire Sprinklers

In New \$70,000 Subdivision Homes

The Rural/Metro fire sprinkler tests were held in Scottsdale, Arizona, a community provided with fire protection by Rural/Metro Corp., from April 19 through 21, 1982. A total of nine tests were conducted in the living rooms, kitchens and bedrooms of two \$70,000 subdivision homes in which sprinkler systems had been retrofitted. A planned 10th test was aborted.

The tests were largely funded by the Federal Emergency Management Agency. Other co-sponsors included the Phoenix Fire Department and Arizona State Department of Emergency Services. Womack-Mastercraft, Inc., provided the two homes, which were repaired after the tests and are being put on the market with sprinkler systems installed. More than 250 persons representing much of the country and many interested organizations attended the tests, witnessing the actual burning periods on closed circuit television sets installed in a tent across the street and viewing the burn rooms before and after each test.

Objectives

Objects of the test series included:

Objective 1: To combine the results of many years of study and experimentation into one summary, conclusive test of the residential sprinkler concept in the ultimate real environment of subdivision homes built for resale.

Objective 2: To test state-of-the-art sprinkler technology as currently approved. To this end one home, generally designated as the "West House" or "Home A", in data on these tests was equipped with approved Grinnell heads on an iron pipe system to specifications of N.F.P.A. Standard 13D.

Objective 3: To study installed costs and test in actual use a proposed polybutylene piping system, or Shell Oil Company on a fast-acting head manufactured by Central Sprinkler Company but not yet approved. The new head and polybutylene pipe in effect provide a test of advancing technology. This system was installed in the "East House" or "Home B". Since it did not represent an at-that-time approved system, a duplicate iron pipe system was also installed in the attic of this home so it could be fitted with approved heads after the test and turned back to the builder for sale as a fully approved system.

Objective 4: To affirm faith and provide a conclusive test by placing two persons in the burning homes. To this end Ron Butler, president, and Lou Witzeman, board chairman of Rural/Metro Corp., were seated on sofas ignited for the first time in the tests. Both Butler and Witzeman have been active students of the residential sprinkler concept for many years and the City of Scottsdale, at the urging of Rural/Metro, passed one of the nation's landmark early commercial sprinkler ordinances approximately seven years ago.

See Tests, Page 2

Sprinkler Test Chronology

(continued from Page 1)

Test Chronology Monday, April 18

Four tests were held the first day of the series. The first two were being tested in the West house and the last two were being tested in the East house. The first test in the West house involved the coffee maker. The second test in the West house involved the coffee maker. The second test in the East house involved the coffee maker. The second test in the East house involved the coffee maker.

Note: preliminary test data, compiled by Factory Mutual Laboratories, is reproduced elsewhere in this report in comprehensive chart form. Likewise, damage estimates of the fires set in the tests and of presumed dollar losses had the homes not been sprinklered are also plotted, with data provided by Sentry Insurance Company.

Two tests and three tests Monday were grease fires on stoves in the West house of the two houses. In each test a pan of grease was heated to 475 degrees at which time the clock was started for the test. The first West house test burned 2:15, the second at 4:12. In the East house sprinklers operated 30 seconds after open flame was recorded in the second house at 3:00.

Damage resulting from these two tests was the highest of the series. Even so, given the fact that the fire loss was estimated at \$2,600 for the West house and \$4,400 for the East house, data will show the speaker system protection was estimated to be \$1,500 in the West house and \$1,000 in the East house.

Tuesday Tests

Five tests in the speaker operation of the West house. East house sequence were both in the West house. These were started by setting wastebaskets adjacent to the beds on fire with the wastebaskets heated so as to engage the beds. The beds were completely equipped with normal bed covers, sheets and so forth. The first of these tests resulted in a two-foot extension (possibly caused by the fact that the fire spread beneath the bed cover). These tests resulted in the highest carbon monoxide and smoke damage of the entire series of tests. 500 parts per million in the West test and 110 ppm in the second test.

Tests 7 and 8 were scheduled to be kitchen fires with the flames being caused by the fire from plastic bakeware coffee makers, but the test of these two was abandoned because the coffee maker refused to do its thing when they were set to blow a fuse of lines. The second test in the East house was set up as a kitchen fire, but upon activation 100 minutes after plug and then after three minutes at 3:15 and after three minutes on this alarm, the coffee maker and speaker system failed and the bottom of the coffee maker speaker system failed at 4:47.

Wednesday Tests

Eight tests were scheduled for the first day of the series. Both Christmas trees in these tests (two will be on Christmas, 1981) were set up in the East house. The Christmas trees were transported to the test site and set up in the living rooms of the two houses. They were started with a red candle and a large spray of kerosene for low flame photographs during the first test.

The first test in the West house (kitchen coffee maker) speaker response in the living room and kitchen area with the first test beginning 15 seconds after operation. Temperature at 10 feet test (East) 100 degrees, 100 degrees, 100 degrees, 100 degrees. The first test in the East house (kitchen coffee maker) speaker response in the living room and kitchen area with the first test beginning 15 seconds after operation. Temperature at 10 feet test (East) 100 degrees, 100 degrees, 100 degrees, 100 degrees.

In contrast to the first Christmas tree test, the second test in the West house was a kitchen fire. The first test in the East house was a kitchen fire. The first test in the East house was a kitchen fire. The first test in the East house was a kitchen fire.

Sprinklers Save 85% of Fire Loss in Tests

Property savings of 85 percent due to fire sprinklers were recorded in the Rural/Metro fire sprinkler tests by observers of Sentry Insurance Company who monitored each test to determine estimated losses after test fires, and also losses which their experience indicated would have occurred had the properties not been sprinklered.

Fire losses in the sprinklered fires were estimated at \$17,200. Estimated losses without the sprinklers were set at \$116,000 for a saving of \$98,800 or 85.17 percent.

The estimates were based on eight of the 10 scheduled tests. Tests 7 and 8 were not summarized because one of them, Test 7, was aborted due to malfunction of the coffee maker it was planned to use for ignition.

Estimates of losses without sprinkler equipment were based on normal fire department responses in terms of time, manpower and equipment. Estimates of damage with sprinkler operation were based on review of actual conditions after each test.

Even without the Christmas tree fire tests, which produced the highest estimates of loss without sprinkler systems, there was still a 75.59 percent saving in the comparison of sprinklered and unsprinklered property fire losses. Interestingly, although the Christmas tree tests produced the highest estimates of loss without sprinkler systems they did not produce the highest estimates of loss with sprinklers installed — the highest loss occurred in the kitchen grease fires.

Estimated Damage (Calculated on Basis of Damage with Sprinkler System and Without Sprinkler System) Rural/Metro Fire Sprinkler Tests, April 19, 20, 21, 1982

Test Number:	1	2	3	4	5	6	7	8	9	10	Total
A Carpets — repair, replace, clean	\$ 800	\$ 150	\$ 150	\$ 150	\$ 400	\$ 250	\$ 1,100	\$ 650	\$ 650	\$ 3,750	
B Floors uncarpeted — as at A above					150	75	50	50		475	
C Walls, ceilings — paint, clean, seal	300	350	250	700	425	200	950	800		4,775	
D Drywall repair			500		150	150	300			1,100	
E Deodorization	100	100		150	150	150	150	150		950	
F Electrical repairs			300	150						450	
G Kitchen light panels			100							100	
H Kitchen cabinets, touch			1,500	500						2,000	
I Furnishings drapes — clean, repair, replace	300	400	300	400	700	500	150	150		2,900	
J Utility — cleaning					250	150	150			550	
K Fireplace — cleaning							150			150	
L Unidentified					200					200	
Totals	\$ 1,500	\$ 1,000	\$ 3,600	\$ 2,400	\$ 2,150	\$ 1,100	\$ 2,000	\$ 1,750	\$ 1,750	\$ 17,200	
Medium damage estimate without sprinklers	\$ 3,500	\$ 3,500	\$12,500	\$ 6,500	\$12,500	\$12,500	\$32,500	\$12,500	\$ 110,000		
Low range damage estimate without sprinklers	3,000	2,000	10,000	5,500	10,000	10,000	25,000	25,000	11,500	91,500	
High range damage estimate without sprinklers	4,000	4,000	15,000	7,500	15,000	16,000	40,000	40,000	140,500		
Indicated saving by fire sprinkler systems	\$ 2,000	\$ 2,500	\$ 8,900	\$ 4,100	\$10,350	\$11,400	\$29,500	\$30,750	\$ 98,800		

Preliminary Data — Rural/Metro Fire Sprinkler Tests

Test Number	1	2	3	4	5	6	7	8	9	10
Test Description	Living Rm W House Couch	Living Rm E House Couch	Kitchen W House Grease	Kitchen E House Grease	Bedroom W House Bed	Bedroom E House Bed	Kitchen W House Coffee Pot	Living Rm W House Xmas Tree	Living Rm E House Xmas Tree	
	Min Sec	Min Sec	Min Sec	Min Sec	Min Sec	Min Sec	Min Sec	Min Sec	Min Sec	Min Sec
Ignition	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
Vapor	10	10	40	120	70	24	2:00	07	04	
Open Flame	33	31	3:15	4:12	1:10	52	3:35	07	04	
Smoke Detector Activated	1:10	2:07	4:34	5:20			0:57		1:07	
Speaker Activation	2:55	1:17	3:45	4:50	1:56	1:04	6:47	15	10	
Control by Sprinklers	4:15	3:55	5:12	3:07	4:00	4:00	7:07		4:5	
Speaker Shutdown	4:40	4:15	6:50	7:15	4:46	4:25	7:50	2:15	2:04	
Ceiling Temperature (F)	161	130	109	455	256	160	169	600	205	
Temperature at 5 ft (F)	00	82	82	109	124	01	05	00	70	
Temperature at 3 ft (F)	00	80	82	00	82	01	01	01	74	
Carbon Monoxide — PPM	162	219	4100	0	693	110	164	400	300	
No. Flashes Activated	1	1	1	1	2	1	1	6	2	

Data in this chart was prepared on basis of final test items and observations that were available at time of printing. All data from Factory Mutual Laboratories.



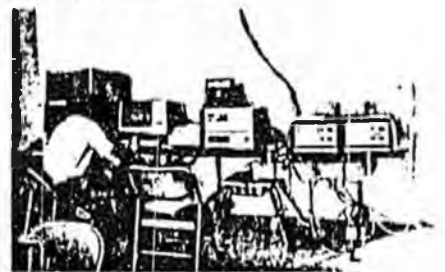
How to light a Christmas tree...



...carefully



Audience Views Tests



Factory Mutuals "Command Post"

Shaw Summarizes Sprinkler Progress, Praises R/M Tests

Mr. Lou Witzeman
Chairman of the Board
Rural/Metro Fire Department
2857 North Miller Road
Scottsdale, Arizona 85257

Dear Lou:

The "Scottsdale-Phoenix" quick reaction residential sprinkler fire test program conducted by Chief Bob Edwards during the week of April 19, 1982, was the climax of a five year research and development program to provide a low cost, life safety, residential fire protection system. The history of the research and development program included the evaluation testing by Factory Mutual Research Corporation, under the direction of Dr. Kung, where a requirement for a quick reaction sprinkler with a special distribution pattern was established.

The requirements were satisfied by the Grinnell Fire Protection Company with the development of a quick reaction sprinkler with a sensor five to fifteen times faster than the current commercial and industrial sprinklers. Earl Page, President of Grinnell, committed the necessary resources to help solve the residential fire problem.

The development of the quick reaction sprinkler was followed by an extensive test program which was supported by Robert Grant, President of the National Fire Protection Association (NFPA). Technical support was provided by Factory Mutual. The tests were conducted by the Los Angeles Fire Department under Chief John Gerard with Don Manning as site manager, and the Charlotte Fire Department under Chief Jack Lee. Art Cote of NFPA was the program manager.

The test program was followed by the development of a product acceptance standard by Underwriters Laboratories, and the adoption of a new 1980 NFPA 13D, one- and two-family and mobile home sprinkler standard.

In May 1981 the Grinnell model became the first sprinkler listed under the new standard.

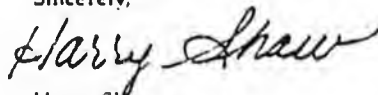
The "Scottsdale-Phoenix" sprinkler test program using Central and Grinnell sprinklers under the sponsorship of Rural/Metro Fire Department, Inc., the Arizona Department of Emergency Services and the Phoenix Fire Department, demonstrated the life safety characteristics of the quick reaction sprinkler system the only way it should be demonstrated — with people in the room of fire origin throughout the entire fire test — from ignition to extinguishment.

Lou, your participation as the first occupant of a room of fire origin during a test of the NFPA 13D system is not only a major contribution to the promotion of the residential sprinkler program but also an expression of confidence to all who have participated in the development of the system.

I believe as you do that the answer to reducing the number of lives lost in residential fires is in-place protection with automatic suppression systems and smoke detectors. I am confident that with leaders in fire protection such as you, that the quick reaction sprinkler will soon be used in residences, hospitals, nursing homes, hotels and motels, and boarding homes, with the result that fire deaths will be reduced significantly.

In closing I want to commend Chief Bob Edwards for a well-managed and very informative demonstration. It was a pleasure to participate.

Sincerely,



Harry Shaw
Assistant Administrator
Office of Fire Protection
Engineering and Technology
U.S. Fire Administration

Bob Edwards



Ron Butler



Butler, Edwards Planned Testing

More than 10 months of planning and detailed implementation were required for the Rural/Metro fire sprinkler tests. The tests were carried out under the direct supervision of Bob Edwards, R/M Scottsdale Administrative Chief, in consultation with Ron Butler, President of the firm.

Major tasks of the project were twofold: to coordinate the vast number of individuals and agencies involved and to plan the detailed logistical support involved in finally staging the tests over a three-day period without delaying any aspect of the tight schedule for those days.

Both Edwards and Butler were assisted by a large number of R/M staffers to whom individual aspects of the testing — crowd management, in-place fire fighting backup, furniture placement, documentary photography, backup of Factory Mutual, staffers and other functions — were assigned. Butler and Edwards praised this group of individuals highly for the smooth and coordinated test operation.

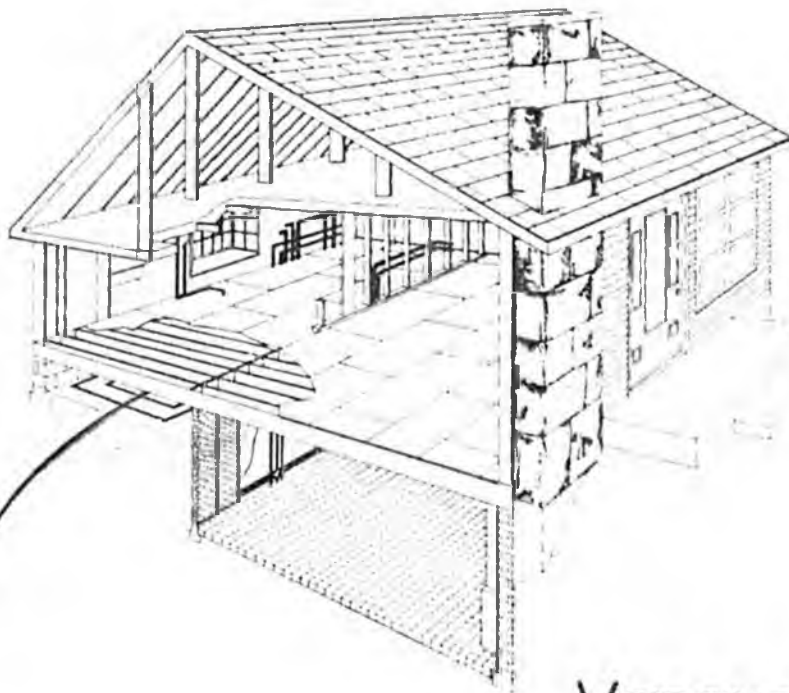
It didn't look as smooth during all of the two weeks prior to the actual test date. As is inevitable in such massive planning, blips occurred: the computer shipped in for documentation refused to do its thing for almost five days; the night before the test a large tent under which spectators were to watch the interior views over three CATV sets (and very necessary in Arizona's heat) failed to turn up and a replacement was hastily recruited from the Arizona National Guard; placement of three water meters of three different sizes for the tests was held up until the last minute because no one at the water company could understand what kind of an idiot wanted three meters on his house; a pipe fitter's strike interrupted installation of the sprinkler system in one house, and plastic pipe fittings shipped by air freight to meet a crunching deadline took three days to arrive (they evidently went where the airlines send the suitcases). Other than these and a number of other little problems, however, it all went very smoothly.

After a hectic last weekend of preparation during which all hands turned out for a stitch-it-all-together session, all was in place and ready to go by the time the tests started at 10 a.m. Monday.

Many Agencies Helped With Tests

Planning and implementation of the Rural/Metro fire sprinkler tests was a massive job. Among those particularly deserving of thanks for their participation in planning and testing itself were:

National Fire Protection Association; The City of Scottsdale; Phoenix Fire Department; United States Fire Administration; Division of Emergency Services, State Fire Marshal's Office; Womack-Mastercraft Homes, Division of Lennar Corp., Grantham Fire Protection Company, Grinnell Fire Protection Company, Central Sprinkler of Pennsylvania, Factory Mutual Testing Laboratory, Shell Oil Company, Vanguard Plastics, Ode Electric Company, The City of Phoenix, Digital Corporation, Marriott Corporation.



Vanguard
Plastics Inc.

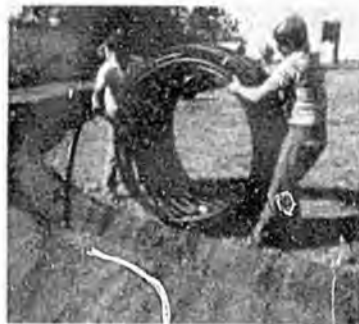


Vanguard GEO-PIPE



Vanguard Polybutylene *Geo-Pipe* is made of sturdy, durable and flexible polybutylene thermoplastic and is the premium quality pipe for geothermal heat pumps.

CHARACTERISTICS



GEO-PIPE

"125" psi

Polybutylene Pipe
for Earth Coupled
Heat Pumps

ASTM D-2662

Vanguard
Plastics Inc.

VP

The Polybutylene People

--High Heat Transfer

Geo-Pipe has low wall thickness for maximum heat transfer so important to efficient geothermal heat pump operation.

--Strength

The high design stress of polybutylene allows *Geo-Pipe* to operate continuously at 125 psi pressures, and withstand surges more than twice as great.

--Wide Temperature Range

Geo-Pipe will operate continuously at 140° F., and take temperature surges as high as 200° F. Yet, *Geo-Pipe* will withstand below-freezing temperatures without effect.

--Corrosion and Chemical Resistance

Geo-Pipe's corrosion resistance will withstand the most corrosive soils. Stress crack resistance is the highest of all polyolefins. Anti-freeze solutions such as ethylene-glycol and propylene-glycol have no effect on *Geo-Pipe*.

Electrolysis cannot occur.

--Flexibility

Geo-Pipe has three times the flexibility of polyolefins with the same pressure rating. This means fast and easy installation.

--Long Term Integrity

Test and actual performance in similar application show that *Geo-Pipe* will retain all the above minimum properties beyond 11.4 years. Theoretical useful lifetime should run beyond 50 years.

--Long Coil Length

Geo-Pipe comes in coil length of 300' for 2" pipe, and 500' for 1 1/2" pipe. Therefore, fewer connections are necessary.

--Straight Lengths

For in-house connection, 20' straight lengths are available for easy handling and neat appearance.

--Connections

Only nylon, 300 series stainless steel, or brass IPS insert fittings are to be used with *Geo-Pipe*. Only all 300 series stainless steel clamps are to be used to connect fittings.

Vanguard GEO-PIPE

GENERAL SPECIFICATIONS:

All polybutylene pipe described in this bulletin shall conform to all applicable requirements in the latest revision of ASTM D-2662 specifications for polybutylene (PB) plastic pipe that is inside diameter-controlled, unless otherwise specified.

MATERIAL:

Polybutylene extrusion compound from which the herein described pipe is extruded shall conform to all applicable requirements in the latest revision of ASTM D-2581 standard for polybutylene PB 2110 Type II, Grade 1 plastic material.

CLASSIFICATION AND DIMENSIONS:

1. Rating--The PB pipe shall be rated for use with water at 73.4° F at a hydrostatic design stress of 1000 psi and a maximum working pressure as listed in table below
2. Dimension--The Standard Dimension Ratio (SDR) for all PB pipe described herein shall be 11.5 for iron pipe size (IPS-ID) for in-house use, and 15 for earth couple pipe.



EARTH COUPLED PIPE IPS-ID, ASTM D-2662

Nom. Pipe Size (in.)	Ave. I.D.	Min. Wall	Approx. Wt. per 100 ft.	Std. Coil Length*	Working Pressure @ 73.4° F.	Bend Radius
1	1.049 + .010 - .020	0.091 + .020	13.9	100**	160 psi	12.5"
1 1/2	1.610 + .015 - .020	0.140 + .020	33.5	200**	160 psi	19"
1 1/2*	1.610 + .015 - .020	0.107 + .20	24	200'/500'	125 psi*	19"
2*	2.067 + .015 - .020	0.138 + .022	40	300'	125 psi*	24"

*SDR 15 for use with earth couplings only **Also, available in 20' st. length

TEST SPECIFICATIONS:

MINIMUM BURST PRESSURE

In accordance with ASTM D-1599, the minimum burst pressure shall be 350 psi at 73.4° F.

SUSTAINED PRESSURE

ASTM D-2662 Standard Specification requires that PB pipe satisfy minimum 1000 hour sustained pressures of 300 psi at 73.4° F and 290 psi at 100° F without failing, bursting or weeping, as defined in method D-1598

ENVIRONMENTAL STRESS CRACKING RESISTANCE

PB Pipe shall not be susceptible to environmental stress cracking, per ASTM specification D-1693.

WORKMANSHIP

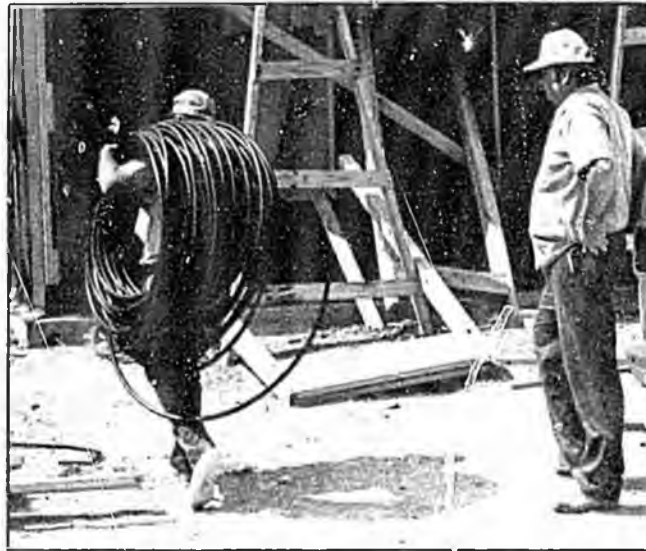
PB Pipe shall be homogeneous and lack visible defects such as cracks, holes or foreign inclusions which would affect its service use. It shall be uniform in color, opacity, density and other physical properties.

MARKING: The PB pipe described herein shall be PERMANENTLY INDENT MARKED to indicate the manufacturer, the nominal size, SDR, PB 2110, date, code, ASTM D-2662, rating psi @ 73.4° F, and the NSF-pw seal indicating potable water approval.

GEO-PIPE

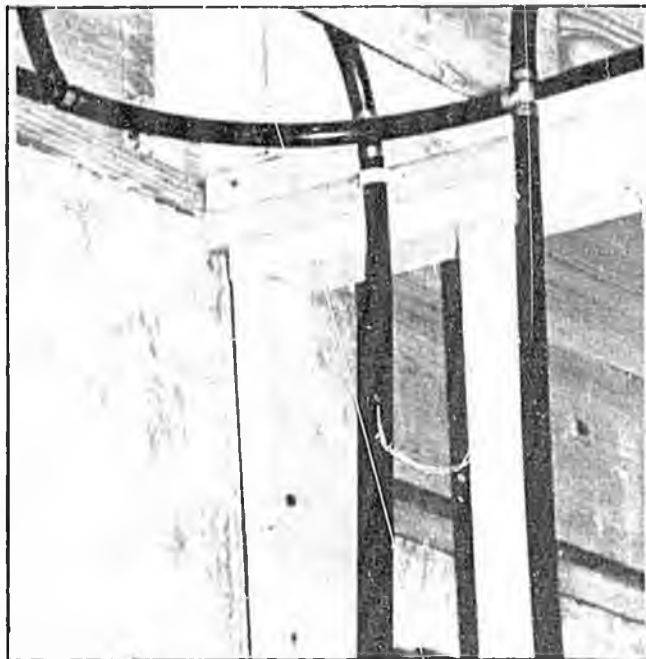
"125" psi
Polybutylene Pipe
for Earth Coupled
Heat Pumps
ASTM D-2662

Vanguard
Plastics Inc. **VP**
The Polybutylene People



Vanguard polybutylene tubing forms the basis for a practical, economical and versatile plumbing system that makes it possible to reduce plumbing installation time by as much as 50% without an increase in material costs. Flexible polybutylene tubing is approved for hot water plumbing service, yet costs only about half as much as copper. Compared to rigid CPVC, the material cost is about the same, but you save on installation time and fittings.

Goes Almost Anywhere



Vanguard polybutylene tubing is lightweight and easily flexed around corners and over obstructions so it can be installed almost anywhere.

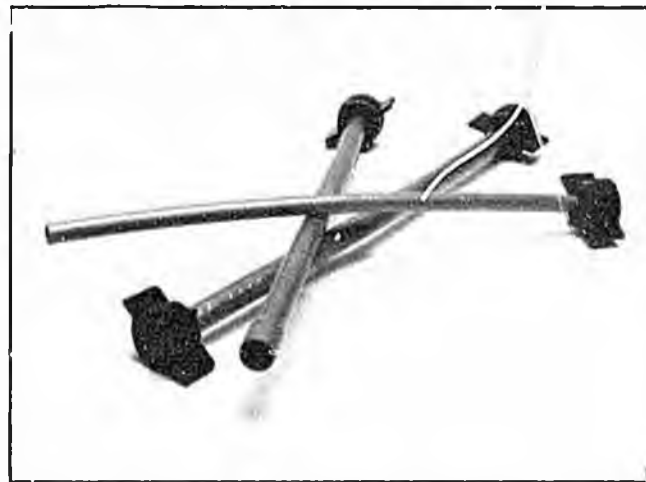
Reliable Performance

Vanguard polybutylene tubing is unaffected by temperature extremes. Freeze it. Thaw it. It won't split or crack. Vanguard polybutylene tubing will also withstand water pressures well in excess of 100 psi, and dampens water hammer rather than propagating it.

Quiet and Easy to Live With

With Vanguard polybutylene tubing there is almost no sound of rushing water. Polybutylene will not scale or corrode, and it also acts as an insulator.

No-Strain Basin and Closet Supplies



Turn a tough, tight-quarters job into a simple, no-strain connection with Vanguard polybutylene risers. Several riser styles available in any length. Plastic handtight center set nut, or plastic hex ball-cock nut are available with riser for fixture connection. Riser may be connected at stub-out or stop valve by several means: compression, flare, insert, or half inch male thread.

Approved



Vanguard polybutylene tubing and manufacturer's recommended fittings have been tested and accredited for use in the distribution of potable water. Risers have been approved by IAPMO.

General Specifications

All polybutylene tubing described in this bulletin shall conform to all applicable requirements in the latest revision of the ASTM D-3309 specification for polybutylene (PB) plastic tubing, unless otherwise specified.

Material

Polybutylene extrusion compound from which the herein described tubing is extruded shall conform to all applicable requirements in the latest revision of ASTM D-2581 standard for polybutylene, PB 2110 Type II, Grade 1 plastic material.

Classification and Dimensions

1. Rating—The PB tubing shall be rated for use with potable water at 180°F at a hydrostatic design stress of 500 psi and a maximum working pressure of 100 psi (160 psi at 73.4°F).
2. Dimension—The Standard Dimension Ratio (SDR) for all PB tubing described herein shall be 11 for copper tube size (CTS-OD) only.

Hot and Cold Water Tubing CTS-OD, SDR-11, ASTM D-3309

Nom. Tubing Size (in.)	Ave. O.D. ±.003	Ave. I.D. .250	Min. Wall .062 +.010	Working Pressure @		Design Stress @	
				73.4°F	180°F	73.4°F	180°F
1/4	±.003	.250	.062 +.010	160 psi	100 psi	1000 psi	500 psi
3/8	±.003	.375	.062 +.010	160 psi	100 psi	1000 psi	500 psi
1/2	±.004	.500	.062 +.010	160 psi	100 psi	1000 psi	500 psi
3/4	±.004	.715	.080 +.010	160 psi	100 psi	1000 psi	500 psi
1"	±.005	.921	.102 +.010	160 psi	100 psi	1000 psi	500 psi

Test Specifications

Minimum Burst Pressure

In accordance with ASTM-1599, the minimum burst pressure shall be 440 psi at 73.4°F and 320 psi at 180°F.

Sustained Pressure

Polybutylene tubing properly assembled with manufacturer's recommended fittings, will maintain sustained pressures of 220 psi for a minimum of 1000 hours at a temperature of 120°F when tested in accordance with ASTM method D-1598.

Thermocycling

Polybutylene tubing properly assembled with manufacturer's recommended fittings, will not separate or leak when thermocycled 1000 times between the temperatures of 60°F and 180°F when tested in accordance with procedure outlined in ASTM Standard D-3309.

Workmanship

Polybutylene tubing shall be homogeneous and lack visible defects such as cracks, holes or foreign inclusions which would affect its service use. It shall be uniform in color, opacity, density and other physical properties.

Marking

The polybutylene tubing described herein shall be PERMANENTLY INDENT MARKED to indicate the manufacturer, the nominal size, SDR-11, PB 2110, date, code, ASTM D-3309, 100 psi @ 180 F, and the NSF-pw seal indicating potable water approval.



General

Vanguard polybutylene is a high quality, economical thermoplastic piping material approved for potable hot and cold water distribution. It comes in coils or straight lengths, stores easily inside or out, is lightweight, rugged and durable for safe handling, and, because of its flexibility, is easy to install.

Storage and Handling

Vanguard polybutylene tubing is furnished in coils of 100 to 1000 feet, and 20 foot straight lengths in bundles containing 500 to 1000 feet. Tubing colored black can be stored outside without damage from weather. Colors other than black should be protected from sunlight if stored more than 6 weeks outside. Avoid dragging tubing over rough terrain or contact with sharp objects that may cut or puncture the tubing.

Installation

Vanguard polybutylene tubing is fast and easy to install when used with recommended fittings.

Before installation, tubing should be inspected for cuts, punctures or excessive abrasion that may have resulted from shipping or handling damage. Damaged spots may be cut out and recoupled to form continuous lengths.

Tubing should be blown out before final connections are made to eliminate any dirt, sand or sawdust that may have entered the tubing during installation.

Plastic expands and contracts more than metal when subjected to temperature changes. Therefore, allowances must be made when installing polybutylene tubing. An extra 4 inches per 100 feet of tubing per 45°F

expected temperature change will compensate for thermal contractions (.085 inches per 10°F per 100 feet). Hangers used for support of tubing should be snug, but not so rigidly anchored as to prevent expansion and contraction.

Since polybutylene is flexible it is recommended that smooth metal or plastic hanger straps be used for support every 3 feet. Hanger straps should be free of sharp edges. Staples are not to be used.

Water service entering the system should not have pressures exceeding 100 psi. Although polybutylene will withstand pressure surges well in excess of its rated capacity, water hammer arrestors should be used in conformance with local codes.

Polybutylene tubing should not be curved with a radius of less than ten times the O.D. (eg., 1/2" OD tubing should not be curved with a radius of less than 5").

Pressure testing should be conducted before enclosing the wall. A test pressure of 150% of the system design pressure is normally used. Check all connections. Testing may be done immediately upon completion of the final connection.

Cutting

Tubing cutters especially designed for cutting Vanguard polybutylene to length are recommended. They are inexpensive and will produce a square, clean cut.

Fittings

Vanguard polybutylene tubing can be joined by recommended crimp ring, flare, compression and heat fusion fittings systems. The systems may require the use of special hand tools readily available.

Vanguard
Plastics Inc.

831 North Vanguard Street
McPherson, Kansas 67460
316 241 6369



THE POLYBUTYLENE PEOPLE



HOT AND COLD WATER
PLUMBING PIPE

The Toughest Pipe at the Lowest Cost.

Pipe made with Duraflex[®] polybutylene resin from Shell Chemical Company is the toughest *and* the most economical plumbing you can buy.

When you match Duraflex pipe against copper, galvanized, CPVC or any other plumbing material used for hot and cold water service you'll see there's no comparison. You won't find a better pipe for homes, townhouses and apartment buildings at any price.

Duraflex pipe is tough — tougher than any other plumbing pipe. It resists corrosion, rust, scale and freezing. It can be used for water systems with

pressures up to 200 psi at 73°F (cold water pipe) and up to 100 psi at 180°F (hot water pipe).

And Duraflex pipe is less expensive than other types of plumbing pipe

Material costs will be less than half as much as the cost of copper. In addition, its price is more stable than the cost of

copper, allowing contractors to bid jobs more accurately. Duraflex pipe is less expensive than CPVC and also saves on installation time.

Flexibility Simplifies Installation.

Duraflex pipe is lightweight and flexible, which means it's easy to install.

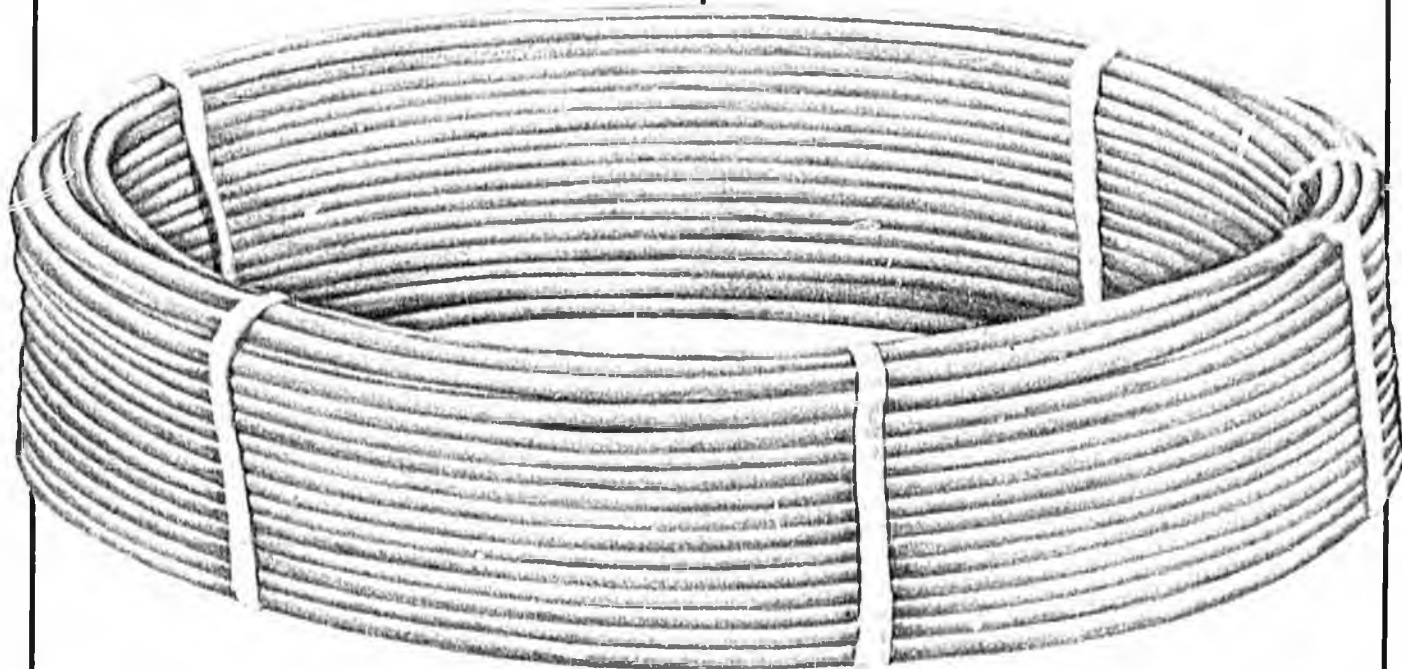
Because it weighs about one-ninth as much as copper, Duraflex pipe can be handled by one person. It bends easily, so elbows aren't needed every time you turn a corner. You can pull it through wall studs in tight spaces, simplifying retrofit jobs.

You also can curve it to meet fixtures, reducing the number of costly and time-consuming fittings required.

Duraflex pipe offers other savings. You have less waste with Duraflex pipe compared to other plumbing because it comes in coils up to 1,000 feet in length. You can cut the amount you need and save the rest. It also is available in



*Duraflex[®] is a trademark of Shell Chemical Company for its polybutylene resins. Shell Chemical does not manufacture pipe.



straight lengths for areas where plumbing will be exposed after construction is completed.

A Choice of Fitting Methods.

Duraflex pipe can be joined using one of four common methods. (Shell does not endorse or recommend any joining method. They are listed merely for completeness of information.)

A tubing cutter and a wrench are required if you use *compression fittings*. A flaring tool is needed for *cold flare fittings*. Low-cost tools are readily available for *crimp-type fittings*. And heat fusion that uses *Duraflex pipe and fittings* requires a specially designed tool.

Because you eliminate sweat joints, open flames and slow curing solvent

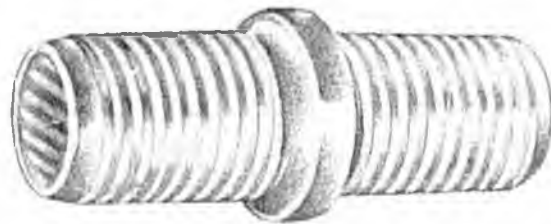
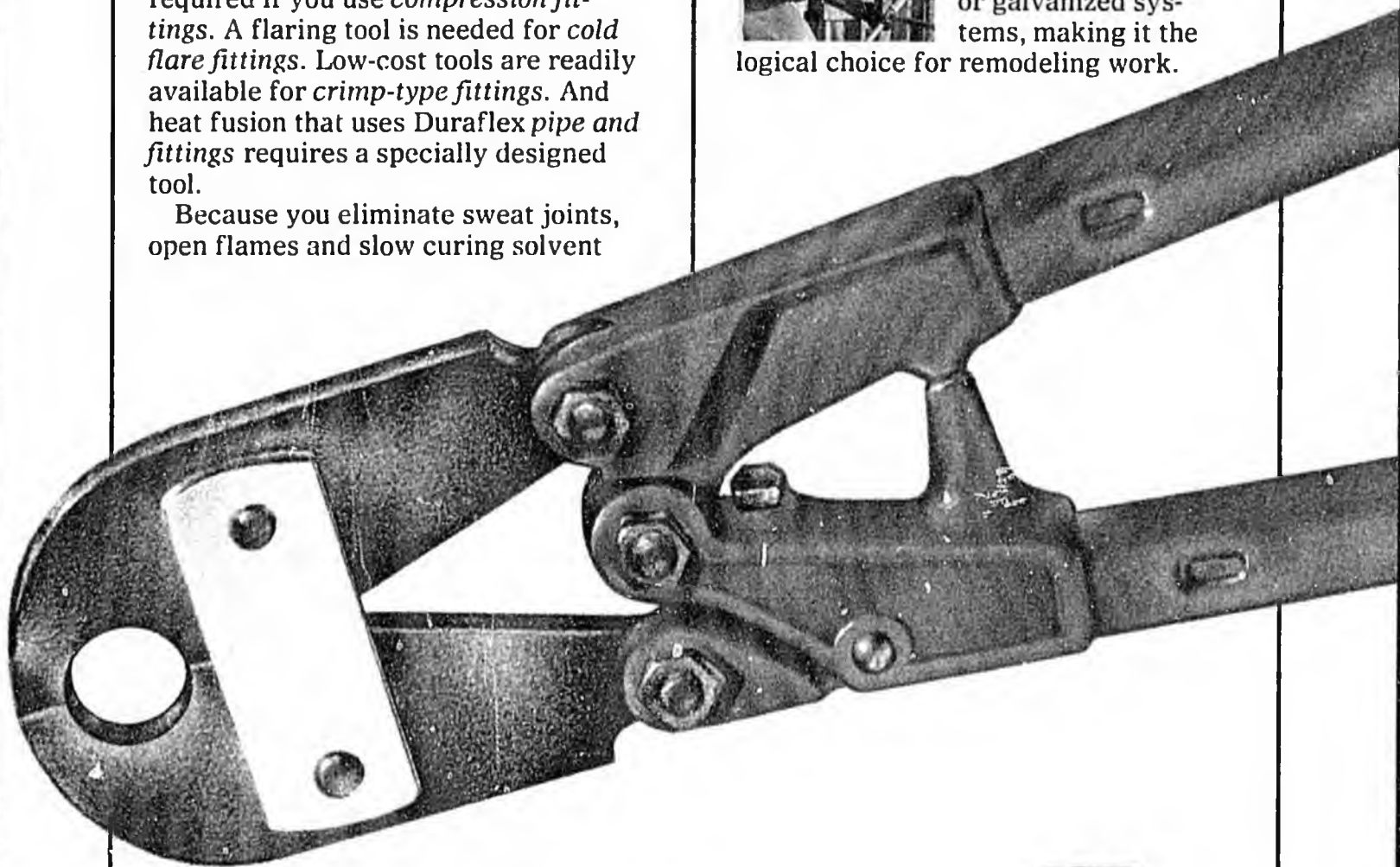
cement, you improve the safety of your operation. You don't have to wait for joints to cure before making pressure

checks. Water can be turned on when the last pipe connection is completed.



Adapters are available for connecting Duraflex pipe to existing copper, CPVC or galvanized systems, making it the

logical choice for remodeling work.





Freeze Resistance Protects Homes.

Homes, townhouses and apartments with Duraflex plumbing pipe have an extra degree of protection against damage that might occur when

pipes burst during freezing weather.

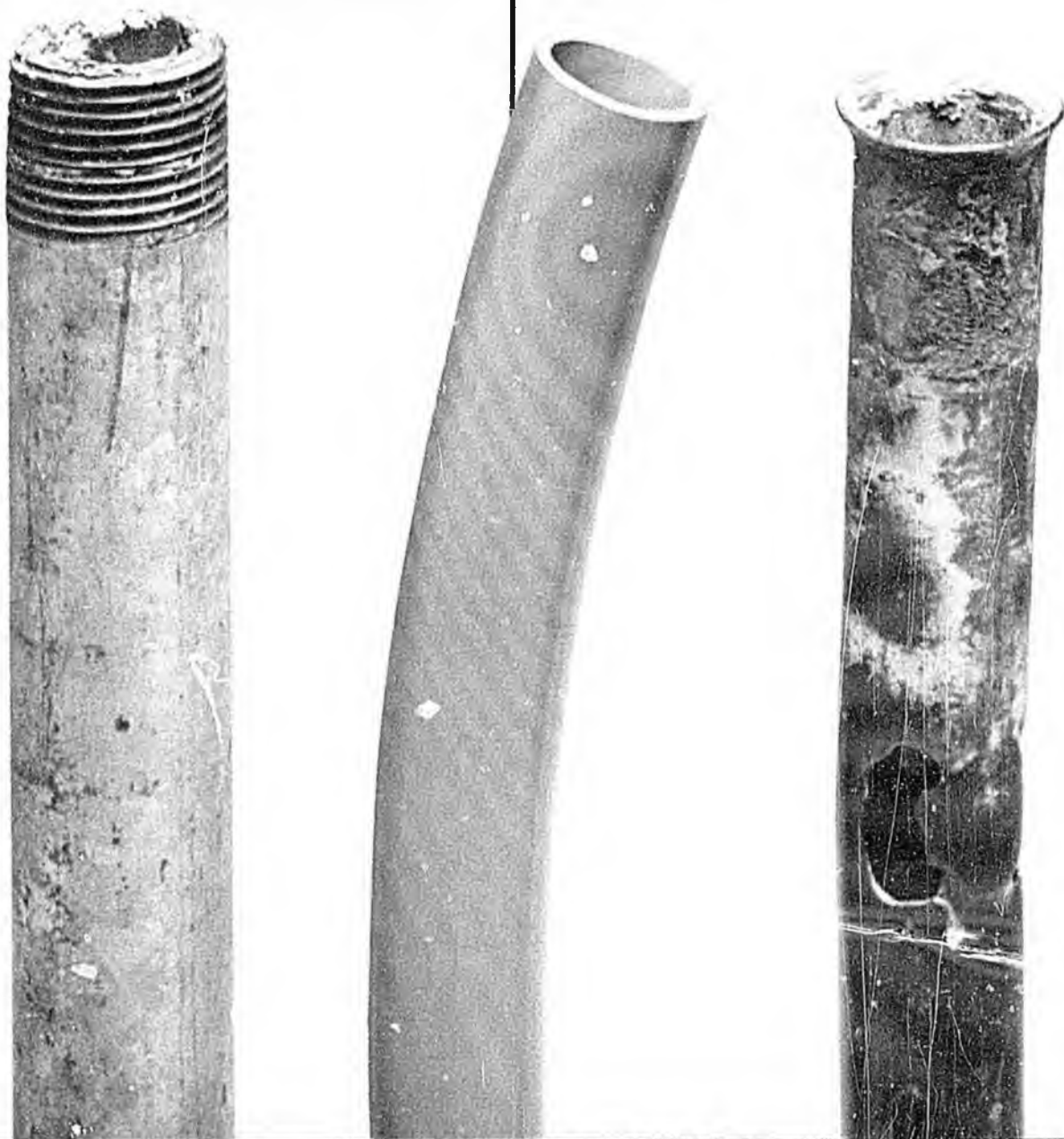
When water freezes, it expands, causing ordinary copper plumbing to crack and eventually burst. But Duraflex pipe expands to accommodate frozen water and then regains its original shape after the water thaws with no loss of strength. Duraflex pipe won't split or crack under subfreezing conditions. However, when short lengths of

polybutylene pipe are connected to rigid fittings or pipe, the pipe may not be able to expand sufficiently to protect the whole system. In such cases, protect against freezing.

Corrosion, Rust and Scale Resistant.

Pipe made with Duraflex polybutylene resin offers added protection because it won't corrode, rust or rot. Duraflex resin is inert, so it resists the corrosive elements in water that can eventually eat holes in metallic pipe.

Duraflex pipe also is totally unaffected by soil conditions or electrolysis. And it resists scale buildup from hard water that can block other plumbing systems.





The Seal of Approval.

Plumbing pipe for hot water service made with Duraflex polybutylene resin meets the following codes, standards and regulations:

National Sanitation Foundation (NSF)

Plastics Pipe Institute (PPI)

National Standard Plumbing Code (NSPC)

Southern Building Code Congress (SBCC)

Building Officials Code

Administration (BOCA)

International Congress of Building Officials (ICBO)

Federal Housing Administration (FHA) UM-68

HUD Mobile Home Construction and Safety Standard

Canadian Standards Association (CSA)

Manufactured Housing Institute (MHI)

American Society of Testing and Materials (ASTM)

American National Standards Institute (ANSI) A119,2/NFPA 501.C

International Association of Plumbing and Mechanical Officials

Numerous State and Local Codes

Duraflex pipe for both hot and cold water service is available from manufacturers in sizes ranging from 1/4 inch to 3 inches in diameter.

3/4"

1/2"

1/4"

TECHNICAL DATA

Applications

Since it was first commercially produced in 1967, Duraflex pipe has been used for a large variety of hot and cold water applications, including:

Plumbing and Heating

- Domestic Hot Water Supply
- Hydronic Heating
- Slab Radiant Heating
- Solar Heating and Cooling
- Commercial Hot Water
- Fire Sprinkler Piping

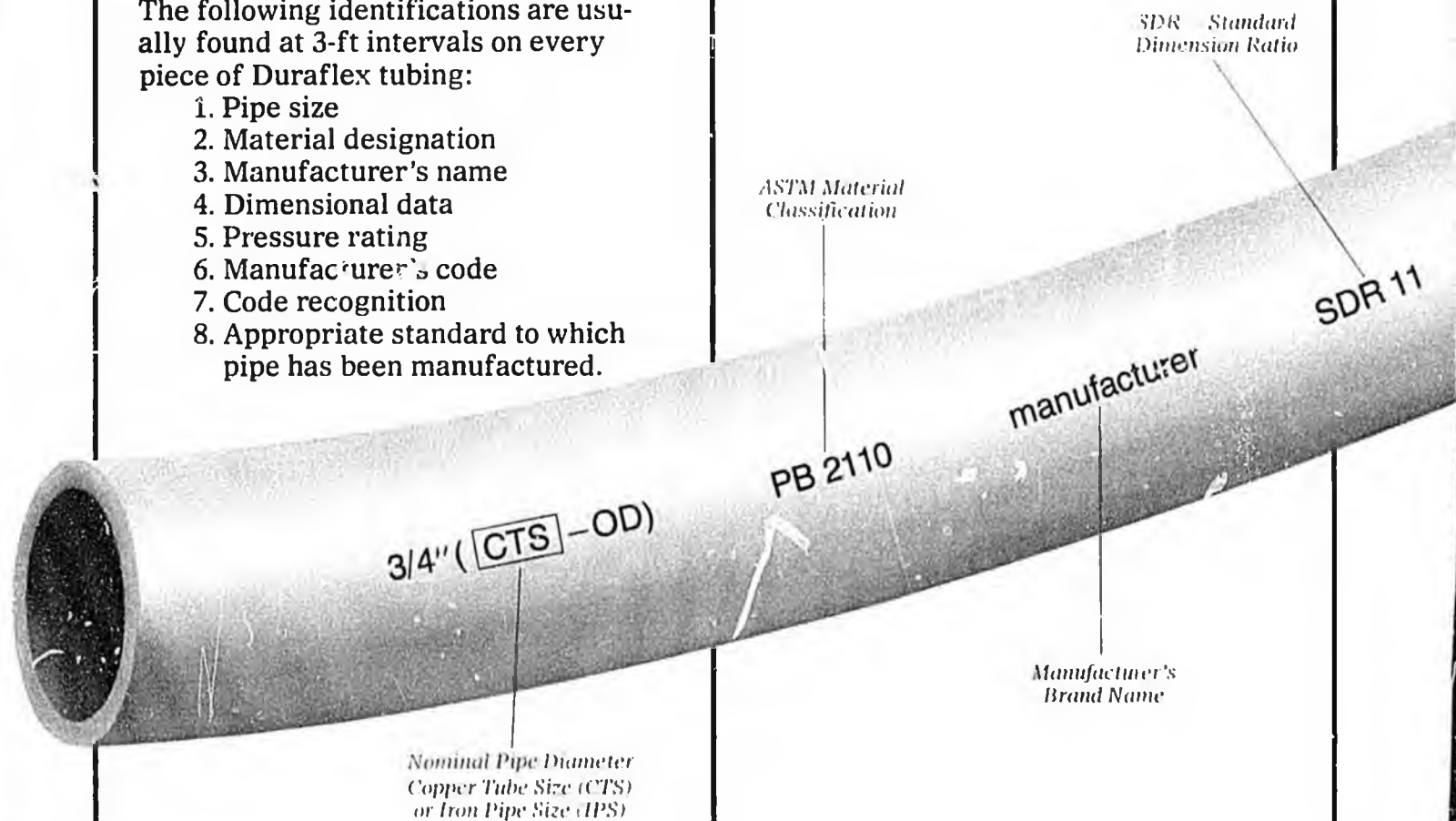
Water Supply

- Municipal Water Service Systems
- Yard Piping
- Deep Well Submersible Pumps
- Drip Irrigation
- Ditch Irrigation
- Rural Water Supply
- Ground Water Heat Pumps

Pipe Identification

The following identifications are usually found at 3-ft intervals on every piece of Duraflex tubing:

1. Pipe size
2. Material designation
3. Manufacturer's name
4. Dimensional data
5. Pressure rating
6. Manufacturer's code
7. Code recognition
8. Appropriate standard to which pipe has been manufactured.



100 psi@180°F

Pressure Rating
in p.s.i. for Water

code no.

Manufacturer's Lot No.
Date Code

NSF-pw

National Sanitation
Foundation

D-3309

ASTM Specification

Pipe Storage

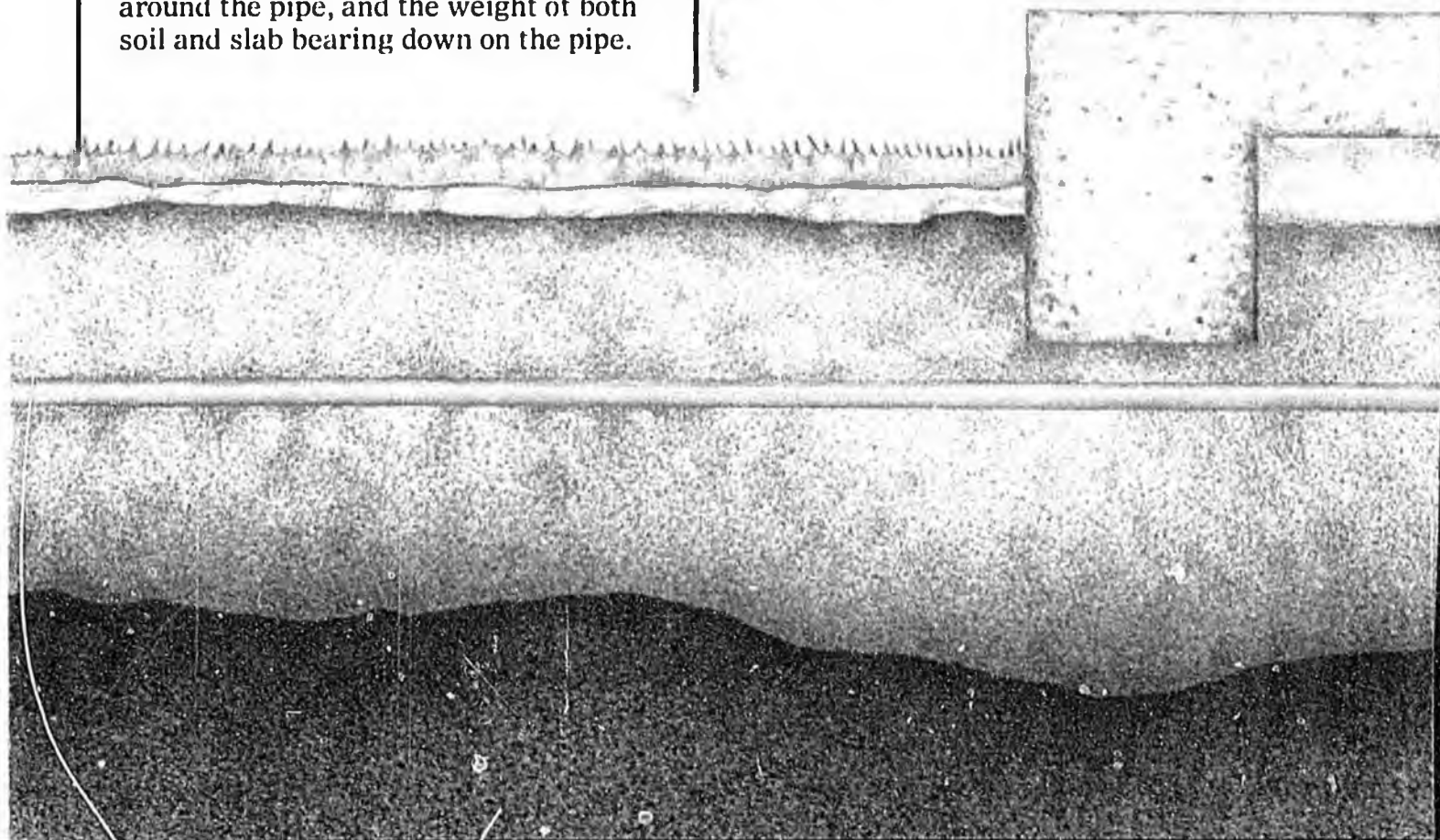
Thermoplastic materials such as Duraflex polybutylene resin are susceptible to ultraviolet attack as a result of continued outdoor exposure. The amount of ultraviolet damage will depend on the material, formulation, exposure time, geographic latitude, climate conditions, etc. Black grades of Duraflex polybutylene resin (4101 and 4121) are formulated for continuous exposure and can be stored outside. The other grades (4103, blue; 4127, gray; 4128, beige; and 4129, brown) are not formulated for continuous outdoor exposure and should be stored under cover. Outdoor exposure of these grades should be limited to reasonable construction and installation periods.

Buried Pipe

Running Duraflex pipe under a slab does not significantly affect its properties.

Duraflex pipe buried under a slab is compressed by earth and slab loadings. The amount of compression depends on the temperature of the water in the pipe, the compaction of soil around the pipe, and the weight of both soil and slab bearing down on the pipe.

Under typical conditions (pipe buried 3 feet under a 4-in.-thick slab with 90-percent soil compaction around the pipe), the pipe is compressed by 1 percent at room temperature and 2 percent at 180°F. Both of these values are well within the design limit of 5-percent deflection. Because of its chemical resistance, Duraflex is totally inert to any chemical interaction with concrete and thus can be used safely within and through a slab. In addition, because it is immune to electrolysis it also can be placed in contact with supporting steel mesh. As a matter of good installation practice, fittings should never be used in or under a slab.

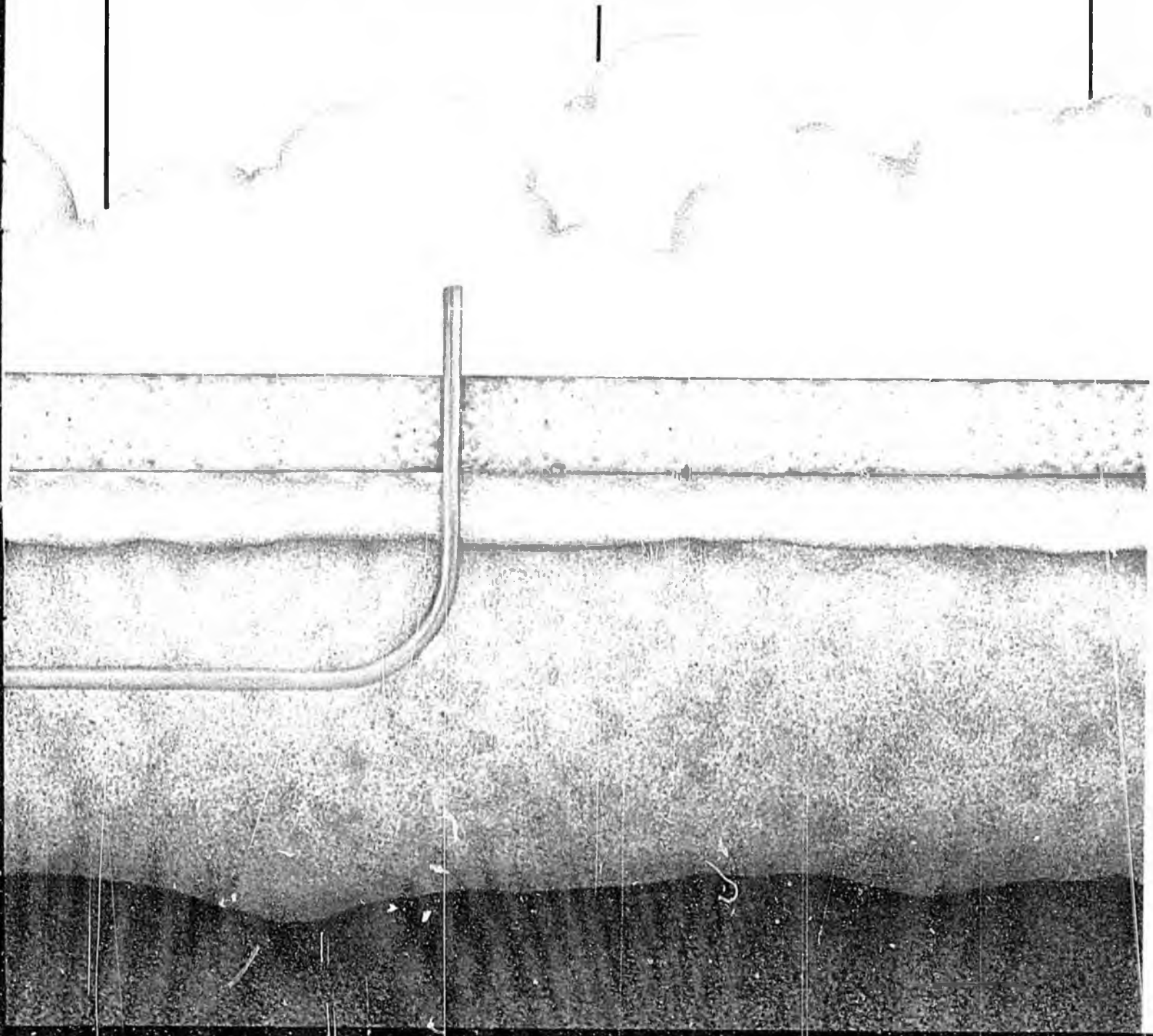


Freeze-Thaw Resistance

Properly extruded Duraflex pipe has sufficient elasticity and ductility to withstand the expansion of frozen water. To demonstrate this, three samples of 3/4-in. CTS Duraflex pipe were

frozen overnight and thawed daily for a six-day period. After six days, all of the samples were still intact and quick-burst tests showed no apparent loss of strength.

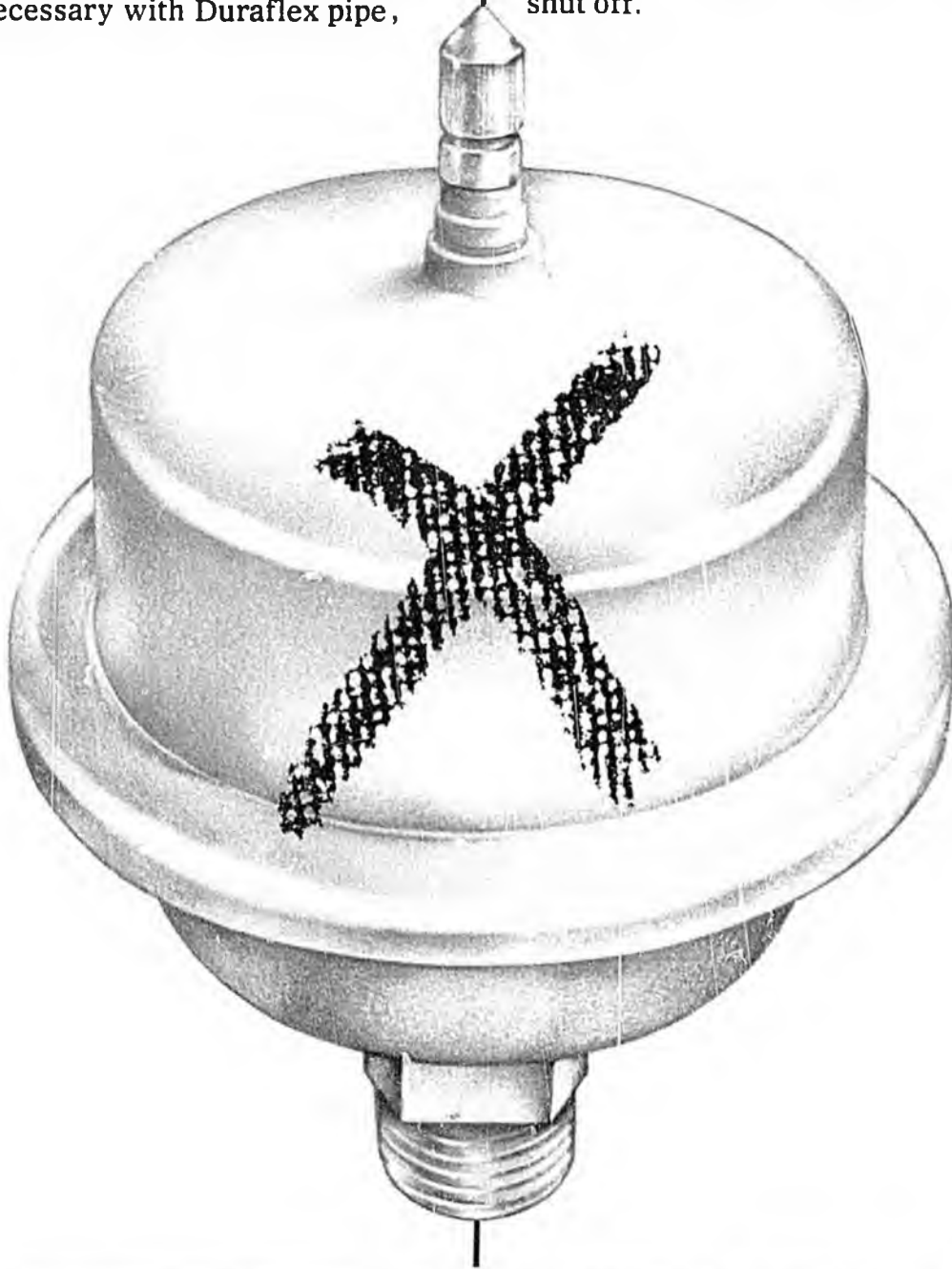
Control Not Subject to Freeze-Thaw Cycle	Frozen Under 50 PSI Internal Pressure	Frozen Under 100 PSI Internal Pressure
Burst Pressure (psi)	Burst Pressure (psi)	Burst Pressure (psi)
490	485	490
495	480	485
505	490	495
497 <i>Average</i>	485 <i>Average</i>	490 <i>Average</i>



Water Hammer

Because Duraflex pipe is more flexible than either CPVC or copper, it is less affected by water hammer caused by rapid shut off. Water hammer arrestors are unnecessary with Duraflex pipe,

although some local code authorities may still require their installation. The chart below shows the calculated pressure surge (psi) for Duraflex, CPVC, copper and galvanized pipe in a rapid shut off.



Velocity (fps)	Pressure Surge (psi)		
	2	4	8
Duraflex pipe	14	30	59
CPVC	45	90	180
Copper	106	212	422
Galvanized Iron	110	225	464

Pipe Support

Being flexible, Duraflex pipe must be supported. For $\frac{1}{2}$ and $\frac{3}{4}$ inch plumbing pipe, support intervals of 32 inches can be used. Longer support intervals can be used with larger pipe. If the pipe is passing through studs, the pipe should be sleeved (plastic sleeves are available for this purpose).

Bending Radius

A minimum bending radius (ratio of the bend radius to the diameter of the pipe) of 10 is recommended.

Hot Water Heater Considerations

Duraflex tubing is easily capable of withstanding the malfunction of a water heater. It is made in accordance with ASTM D3309 and is designed to operate continuously at 180°F, 100 psi. This is within the expectations of any normal household plumbing system.

In the event of a hot water heater malfunction, Duraflex pipe may be exposed to a higher temperature and pressure for a short period. (Temperature/pressure relief valves normally are designed to release at 210°F and 150 psi.) Tests conducted under the auspices of the National Sanitation Foundation have shown that at 210°F, Duraflex plumbing tubing has average burst values of over 275 psi and can sustain a pressure of 150 psi continuously for over 20 months without failure.

As a general precaution Duraflex

pipe should not be installed within 18 inches of a burner or direct source of heat.

Fire Potential

The smoke hazard from Duraflex plumbing is minimal, and the incremental contribution to a residential fire from Duraflex plumbing is *infinitesimal*.

The average three-bedroom house would require an estimated 15 pounds of Duraflex pipe for its total plumbing service. This same house would also contain *several thousand pounds* of other combustible products such as rugs, furniture, bedding, draperies, etc. In addition, the same house would contain *tens of thousands of pounds* of combustible construction materials such as wooden beams and flooring, shingles, weather stripping, etc.

Duraflex resin is a saturated organic polymer composed of carbon and hydrogen; therefore, it burns slowly and cleanly in a manner similar to a candle. Its combustion products are similar to those derived from burning other organic materials such as paper, cotton and wood and less onerous than those obtained from burning wool, leather, or other complex materials.

Furthermore, Duraflex resin *will not* produce an acrid, toxic smoke. Comparative bioassay tests under simulated fire conditions have shown that combustion products of Duraflex polybutylene pipe are less toxic than those of Douglas fir.

Disclaimer

The information contained in this guide is based on data obtained by Shell research and is considered accurate. However, **NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.** This information is furnished upon the condition that the person receiving it shall make his own tests to determine the suitability thereof for his particular purpose.

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Shell Chemical Company

P.M. 1
MAR 31 1983

V. CEQA SUMMARY

This chapter covers various information not presented earlier but required by the California Environmental Quality Act (CEQA) for Environmental Impact Reports. As this document is a preliminary environmental review, this section has not been fully developed. When the draft and final versions of the EIR are proposed, it is likely to expand and some of the findings will undoubtedly change or at least be stated more confidently.

A. Significant Unavoidable Environmental Impacts

For this preliminary environmental review of a very subtle and complex proposal, SRI chose to describe our current overall conclusions about the proposed plumbing code changes and our reasons for them, without making definitive findings of significance except where they were clearcut.

First, we discovered nothing to suggest that the issues discussed earlier as the prime ones are insignificant or that other issues are dominant. The only new issue of potential significance that surfaced was the permeation of buried plastic pipe by contaminants in soil and the resulting possible public health impacts. Although the possibility that such effects could occur from permeation of water supply lines from the meter to the house is plausible, any potential problem would also occur--probably in much greater proportion--from the public water distribution system. This problem should be re-examined when better understood and if found significant should influence state policies with respect to plastic use in both public and residential systems. With

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adequate education of building inspectors on the permeation issue, improper installation of plastic water service in contaminated soils should be rare.

As to public health impacts from chemicals leaching from water pipe into potable water, we find that significant impacts are possible but unproven, both for plastic pipes--especially the chlorinated varieties--and for metal ones, specifically copper systems. If the upper ranges of possible concentrations of leachates are regularly reached, the cumulative risks to public health may be high enough to be of concern by typical standards of acceptable risk, for example, a lifetime cancer risk of one in a million. The chemicals of concern are lead from the solder in copper pipes, possibly leading to neurologic disorders, and carbon tetrachloride, perchloroethylene, and trichloroethylene from plastic (especially PVC and CPVC) pipes, possibly resulting in cancer.

Two major considerations limit the significance of the findings. First, the status of information about long-term levels of leachates is exceedingly flimsy. Reasonable further testing could resolve at least part of the uncertainty (see Section VI). Second, the risk assessment procedure is moderately conservative. If risks still appear to be of concern after concentrations are better known, more attention would need to be devoted to assuring that the assessment procedure took into account detailed properties of the chemical. Finally, thorough initial flushing would effectively mitigate the effects of the rapidly leaching materials, especially the solvents used with plastic pipe. Overall, current information does not establish an environmental preference between copper and plastic pipe, with neither clearly likely to cause a great number of deaths or serious illnesses.

For worker safety and health, a similar situation exists. Both lead from solder fumes in installing copper pipe and solvents from installing ABS, PVC, and CPVC pipe could be hazardous if plumbers have high exposures by inhalation; dermal absorption could also be significant in the case of solvents. The diseases of concern for solder fumes are related to the lead exposure and are neurologic. The solvents may also cause nerve damage, and

they may be involved in liver damage or reproductive problems as well. However, they are not implicated in cancer unless benzene is more common than thought. Unless the NIOSH report about to be released resolves the range of exposures satisfactorily, further testing would be useful before completing the EIR. Safety issues generally favor plastic over metal, which appears to lead to more burns (hot solder and especially flux) and strains and contusions (from heavier metal pipes). PB (like PE, although its uses are not proposed for change) poses little if any worker safety and health concern. Use of gloves, other protective equipment, ventilation, and simple care will significantly reduce any potential hazards from either plastic or metal pipe, but these practices have not achieved widespread acceptance among plumbers.

Fire safety is a very real concern with plastic DWV pipe; ABS is combustible, and PVC and CPVC will at least soften and slump in fires. If these plastics are installed as direct substitutes for metal, as they already are in non-fire-rated residences, they will degrade the fire resistance of structures. The gaskets in no-hub cast iron will also fail in fires and cause the pipe to fall, leaving fire passages. But the proposed code changes apply to fire-rated, fire-resistive construction that could retain its fire rating if appropriate installation procedures are developed and enforced. In such conditions, no degradation of fire resistance would occur. This issue thus turns on enforcement, not science. The potable water pipes, kept cooler by the water inside and of much lower mass, are not a significant fire safety issue.

As with fire safety, smoke toxicity is an issue in which plastic can only be less environmentally acceptable than metal. However, whether the difference is significant is less certain. Both ABS, which seems likely to contribute the majority of pipe mass in California, and the polyolefins PB and PE produce combustion products that are not highly toxic; few if any additional fatalities or serious injuries would be likely from their combustion. PVC and CPVC both produce significant quantities of hydrogen chloride vapor in fire environments, and this corrosive material could, under certain circumstances, make a difference in the probability of human

survival in lines. The frequency of such occurrences is clouded by lack of a generally accepted test for smoke toxicity. This problem is currently being addressed both by the State of California Department of Industrial Relations and by the State of New York. We believe DHCD should pay close attention to results from those studies, but does not need to delay a decision solely on those grounds.

No other significant adverse impacts are likely to result from the expanded use of plastic plumbing pipe if relatively simple mitigation measures are taken. Plastic drain pipes may be slightly noisier than cast iron pipe. See the following section (V-B) for further elaboration.

Overall, the SRI study team sees little evidence that expanded use of plastic plumbing pipe would cause significantly greater environmental problems than the materials it would replace. Unfortunately, lack of evidence is not the same as lack of hazard. We believe it is especially important to gather more information on leaching of chemicals from both plastic and metal pipe systems into potable water and on the exposures of plumbers to material from plastic (ABS, PVC, CPVC) and metal (copper) plumbing systems.

Table V-1 summarizes our present assessment of our relative environmental concern about pipe systems. There we show our relative degrees of concern for different materials for each of the major areas of impacts. A high rating does not necessarily mean an impact that is significant in the sense of CEQA, but does mean that the material rated seems to us more likely to be environmentally harmful than other materials on that dimension. For example, the chlorinated plastics clearly are of highest concern for smoke toxicity, but may not pose any significantly higher impacts in the proposed new DWV uses (fire-resistive construction).

Table V-1

RELATIVE DEGREE OF CONCERN REGARDING
POTENTIAL ENVIRONMENTAL IMPACTS*

Impact Area	Potable Water				Drain, Waste, and Vent			
	Plastic		Metal		Plastic		Metal	
	PP/PE	PVC/CPVC	Copper	Galv. Steel	ABS	PVC/CPVC	Copper/Gal. Steel	Cast Iron
Public Health	3	4	3	3	0	0	0	0
Worker Safety	1	2	4	2	2	2	3+	3
Worker Health	0	3	4	2	4	4	3+	3
Fire Safety	3	2	0	0	5	4	0	0
Smoke Toxicity	1	3	0	0	3	5	0	0
Other Impacts	0	0	0	0	1	1	0	0

Key: 0 - No concern
 1 - Considerably less concern than average
 2 - Less concern than average
 3 - About average concern
 4 - More concern than average
 5 - Considerably more concern than average

Note: High relative concern does not necessarily imply high absolute concern; significance of ratings depends on mitigation measures taken.

* More for copper, less for galvanized.

B. Insignificant Effects

The following environmental effects of expanded uses for plastic plumbing pipe may occur but are probably insignificant by any reasonable interpretation of CEQA:

- Plastic pipe systems may fail slightly more frequently than metal systems until a body of experience with installation errors has accumulated.
- Plastic pipe will consume slightly more petroleum than metal pipe, but slightly less energy overall.
- Plastic pipe will contribute a slightly different load of pollutants to public waste water treatment systems, but the direction of impact, let alone its magnitude, is uncertain.
- Plastic DWV pipe will be slightly noisier than metal systems if installed so as to contact wall surfaces; this may be more significant than otherwise in the multifamily, fire-rated construction that is affected in the DWV code changes.
- Plastic DWV pipe could be damaged by pipe cleaning equipment, but because of its resistance to corrosion, the frequency of such cleaning should be low.
- Plastic pipe will slightly decrease the life-cycle cost of plumbing and therefore of housing, but not enough to change demand patterns or growth.
- Small shifts in employment from metal pipe manufacturing to plastic pipe manufacturing will occur.
- A small reduction in the work of plumbers will occur, mostly as a result of repair and renovation work by do-it-yourselfers.

C. Effects of Alternative Actions

In addition to the proposed project, e.g., the proposed change to the 1982 Uniform Plumbing Code (UPC) allowing certain new uses of plastic plumbing pipe as described in the Project Description, this environmental review has examined the potential effects of alternatives to the proposed project on the quality of the natural and human environment. The eventual EIR will consider alternatives as well as the project itself to provide a

baseline for evaluating the significance of the impacts and to provide possible alternative courses of action should the proposed project create significant adverse impacts that cannot be successfully mitigated. With this goal in mind, the alternatives we have selected for analysis are no changes to the state code, partial approval of plastic pipe use, and complete rejection of all plastic pipe (that is, reversal of earlier provisions allowing certain uses of plastic pipe).

Under the no-action alternative, there would be no changes in the state code regarding the use of plastic plumbing pipe. All currently approved uses for plastic pipe would continue to be permitted and no new uses of plastic pipe would be allowed. None of the impacts attributable to the use of plastic pipe in expanded applications would be observed; any public health and worker safety and health effects of currently allowed plastic and metal piping systems would persist.

The partial approval alternative would amend the state code to permit certain new uses of plastic pipe, but not all of the new uses proposed under the project. Counting cold and hot water supply in a given application as one new use, the proposed project would change the code to permit 11 new uses of plastic pipe (i.e., 1 new use for ABS pipe, 3 for PB pipe, 1 for PVC pipe, and 6 for CPVC pipe). Considering all the possible combinations of these uses, over 2,000 partial approval alternatives are possible.

Our analyses of the environmental consequences of the proposed project have guided our selection of the subset of the partial approval alternatives to be considered in the EIR. That is, we define the partial approval alternative(s) to permit those new uses of plastic plumbing pipe that are least likely to have significant adverse effects on the quality of the natural and human environment. At present, the only partial alternative that seems reasonably certain to meet this requirement is to allow PB for hot and cold water supply both outside buildings and inside buildings that are not fire-rated or within the fire-resistive construction of fire-rated buildings. No other new uses of plastic pipe would be allowed. Parenthetically, there seems little reason to prohibit PB in exposed

locations of fire-rated buildings as long as the penetrations of fire-resistant construction are designed to maintain the rating of that construction. The state of information on the impacts of this alternative is generally the same as on those of the metal water pipe currently allowed for these two uses. Although PB will certainly burn and metal will not, the additional risk of fire spread appears minimal, as does that of smoke toxicity. Leachates from PB have not been shown to be risk-free, but neither have those from copper or galvanized steel. Of the two plastic alternatives, PB is somewhat less likely to be a public health hazard than CPVC, although the relative ratings of PB, CPVC, copper, and galvanized steel will not be clear without further testing (see Section VI). PB is clearly a preferred material, from the worker safety and health viewpoint, compared both with metal systems and with plastics that require cementing.

Under the option of disallowing currently allowed uses of plastic pipe, any impacts of these materials would disappear and those of metal systems reappear. The possibility of permeation of water supply piping by organic contaminants would decrease to the extent that PVC and PE supply lines would be replaced by metal with impermeable joints (but even metal pipe joints can be permeable). Leachates from PVC and PB would be replaced by those from copper, with no clear impact, positive or negative, on public health. The metal pipes would be somewhat more likely to corrode in soil than plastic (galvanized steel is not recommended for buried supply lines). Only small changes in worker safety and health would result from the changes in water supply piping.

Any major impacts of disallowing current uses of plastic pipe would be associated with the widespread use of ABS (and less widespread use of PVC) in DWV applications. Fire load and fire spread would be reduced in nonfire-rated construction. It is probable that few fatalities or little property damage would be avoided by this action, but both are possible benefits. Smoke toxins would also decrease somewhat, especially if PVC were replaced. The decrease in plumbers' exposures to solvent cements would be offset by increased work-related injuries from working with cast iron and, to some extent, with soldered joints in copper DWV. Whether the net effect

on worker safety and health would be positive or negative is difficult to predict, given the current lack of information on plumbers' exposures.

Finally, the alternative that would disallow current uses of plastic would transfer some profits and jobs from the plastics to the metal pipe industries. Since large quantities of DWY are involved, these impacts would probably be greater than those for the prime project alternative of allowing expanded uses of plastic pipe. Houses could become more expensive, depending on the prices of cast iron and copper, but probably not enough to significantly affect the demand for housing.

In summary, the alternative of approving only the expanded uses of PB appears to pose fewer environmental risks than does the full proposed project given the state of current information. Because metal systems also pose some unique risks and may be comparable to plastic systems in other risk areas, we are not prepared to say that the no-project alternative or the alternative that would disallow current uses of plastic are environmentally preferable to the partial approval alternative, or even to the full proposed project.

D. Cumulative and Long-Term Implications

Increased use of plastic plumbing pipe can contribute to cumulative environmental impacts in two ways.

First, the sum of the environmental impacts of plastic pipe could be significant even when no one individual impact is deemed significant. In the case of plastic pipe, the most plausible example is for the various leachates that could each contribute to public health impacts. For example, no one leachate might reach the level of 10^{-6} lifetime risk for cancer, but the cumulative risk of all leachates acting together might exceed that level. Given the current uncertainties about the public health impacts, especially those concerning the long-term levels of leachates in drinking water, we are unable to determine whether the cumulative impact is

significant. A similar situation is found with worker health impacts, where the risk of one solvent might be insignificant, but that of two or more could be significant. For fire safety, the cumulative impact of all the proposed new uses for plastic pipe are likely to be dominated by the new DWV uses; the contribution of PB pipe is likely to be negligible. The same is true of smoke toxicity, except that the combined effect of HCl, CO, and other toxicants could be significant even when the effects of any one alone were not.

A second issue of cumulative impact is the question of whether the expanded use of plastic water pipe would add to the impacts of other similar actions and in total create a significant effect even though the use of plastic water pipe is not itself significant. We can consider two levels of cumulative impacts:

- . Cumulative impact of expanded and existing use of plastic plumbing pipe.
- . Contribution of plastic plumbing pipe to total use of plastic products.

As has been made clear earlier, the expanded uses of plastic pipe are in many ways rather small in comparison to existing approved use of plastic pipe. Most new California houses are already being plumbed with ABS DWV if they are not fire-rated; the addition of 10% (by weight) more plastic pipe as PB or (less likely) CPVC water pipe will be of little consequence for fire safety, especially as water piping is less sensitive. The increase for plastic pipe in fire-rated construction, of course, is total since no plastic is being used now; however, if ways of maintaining the rating are developed as required by code, little fire safety impact would be expected. Similarly, the cementing of plastic potable water pipe is probably much less of a problem for workers than the cementing of already approved ABS DWV. Thus, the greatest issue of cumulative impact involves public health impacts, in which plastic in residences can add to plastic in public utility distribution systems. We have no way of estimating the relative contribution of each to the total hazard, as the source of contaminants

found in the water supply (control) during leaching tests is not known. We doubt that the combined effects of distribution and residential piping would be significant if neither one alone were, but we cannot rule out that possibility. Similarly, permeation of plastic distribution pipes by toxic substances is more likely than it is for residential piping systems, but the significance of either, in terms of an overall risk assessment, will not be clear for a long time.

With regard to plastics in total, the expanded uses of plastic pipe will be a relatively small contribution in most respects. Plastics are by now endemic in our society. Most of the contaminants of PVC and CPVC that could be public health hazards will be ingested in much greater quantities from other PVC products such as food containers or, in the case of some of the chlorinated methanes, simply from waste products reaching the raw water supply. Those from PB and PE are similar to those from PE food contact materials. If plasticizers do contaminate plastic pipe, they will still do so at much lower levels than they do in any number of plasticized products to which people are regularly exposed, such as flexible vinyl upholstery (where they would yield inhalation rather than ingestion exposures). But equally clearly, plastic pipe does contribute to the total load of plastic-related hazards in California--for example, to the total of all combustible plastics in residences. The hazards from the total use of plastics are undoubtedly appreciable, even though nearly impossible to estimate. Whether or not they are greater or less than the hazards of the materials they replace is perhaps even more difficult to state. About all that can be said is that plastic pipe is not an unusually prominent or special case among plastics in general.

CEQA also requires an assessment of whether long-term environmental costs will be incurred as a result of short-term economic or other benefits. Certainly, any public health impacts of plastic pipe that do occur will probably be delayed for decades, as will some of the worker health or smoke toxicity impacts. However, for the purpose of determining the environmental consequences of the expanded uses of plastic pipe, those

should be counted as current impacts, and not discounted in comparison with current benefits. We believe that, when it is viewed from this perspective, this CEQA issue is irrelevant to the decision at hand.

E. Significant Irreversible Changes

CEQA also requires an assessment of environmental changes or consumption of resources that would be permanent and irreversible. For example, the mining of a mountain is an essentially irreversible impact, whereas most air pollutants and their impacts would disappear once the source of pollution is removed.

In the case of the expanded use of plastic plumbing pipe, there would be a small permanent commitment of petroleum resources (but not other energy sources) to the manufacture of the pipe constituents. Total energy resources would be conserved to a slight degree. If any deaths occurred as a result of diseases caused by leachates or occupational exposures, or from fire or smoke toxicity, they would also be irreversible. If plastic pipe were later disapproved, the occurrence of new fatalities would gradually disappear. Some of the leachates from plastic pipe are mutagens and some mutations can be heritable. Thus, it is possible that a heritable--and more likely than not adverse--mutation could persist in the population as a result of drinking from plastic water pipes. Neither the specifics of the leachates in water from plastic pipe nor the overall state of the art of genetic risk assessment allows an evaluation of this possibility at present. If the impacts of plastic pipe eventually were judged unacceptable, it is possible that the metal pipe industry would have declined by that time to the point at which it would prove difficult to revive, but that possibility is also extremely speculative. Overall, we believe that the reversibility of the impacts is not as important an issue to resolve as the magnitude and significance of current impacts.

F. Growth-Inducing Impacts

California's population is projected to increase from the 1980 total of 23.8 million people to 25.0 million by 1985 and to 27.9 million by 1990 (California Department of Finance, 1981). The proposed code change is not likely to significantly affect this forecast population growth for the following reasons. First, the reduction in the cost of housing construction that would result from use of the newly permitted plastics in place of currently approved plumbing materials is so small that it would have virtually no effect on the sales price or rent of dwelling units in the state. Therefore, there will be no change in the demand for housing and consequently no additional in-migration of residents who would be attracted by a drop in the price of housing. Second, the plumbing material substitutions that are likely to result from the proposed code change would not significantly affect employment opportunities in the state and so would not affect the in-migration and out-migration forecasts. Nor would either housing prices or employment opportunities significantly affect shifts in population from one part of California to another.

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TOXIC METALS IN DRINKING WATER

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PREFACE

Historically, there has been a keen awareness that certain metals play a central role in human disease processes. However, recently the issue of metal-induced adverse health effects has moved into an area of both greater prominence and urgency.

Many of these toxic metals reach humans via the water they drink and arise from leaching of the pipes through which it is transported. Thus, it was felt a review of this topic would be both timely and needed.

We believe this review will serve to focus needed attention on the issue of how toxic metals reach humans via the water they drink and thereafter induce or participate in the induction of a variety of diseases.

We are grateful for the review and comments of this paper by Dr. S. D. Lee of the U.S. Environmental Protection Agency and by Dr. A. Furst of the University of San Francisco.

It has long been recognized that metals play a central role in the cause or aggravation of a variety of diseases (Ref. 3). This situation has posed some perplexing paradoxes. Many metals are essential to good health and a deficiency state is to be avoided. However, under certain circumstances, an overabundance of certain metals causes disease. As more and more information has accumulated that positively relates metals to human diseases, intense interest has been focused on the sources of these metals in the environment and on how they reach man.

It is now known that human intake of metals occurs from exposure to a variety of sources: food, air, soil and drugs. Another very important and readily available source is drinking water. This fact has been recognized by the EPA who has promulgated drinking water standards for several metals known to be harmful (Table #1).

Drinking water and the source of the metals it contains are the subject of this report.

Metals enter drinking water from a variety of sources, some natural and some man-made. Natural sources include simple dissolving of minerals from the earth through which the water percolates or over which it flows. Some metals arise from fallout of windblown dust. Man-made sources include industrial waste discharge into water along with emissions from automobiles or power plants. Another very important means by which metals enter water is by leaching from the surface and joints of pipes used for potable water distribution. It is well documented (Ref. 5,6,7) that metals leach into water from a variety of metal pipes (lead, copper or galvanized).

For the purpose of this discussion we will focus on several toxic metals which are found in drinking water and which leach from the pipes through which the water is transported. We will examine factors that contribute to this leaching and diseases the metals cause.

The potential problem is by no means small, since most dwelling units in the United States are supplied with water through metal pipes. These materials have long been and remain the standard of the plumbing industry. Indeed, most plumbing codes, including that of the State of California, still permit the use of lead pipe in addition to copper joined with lead or tin solder and galvanized (zinc coated) steel pipe.

LEAD

The first example of a harmful metal which reaches man via drinking water is lead. It is estimated that 10-15% of daily human lead intake is via drinking water (Ref. 12).

Therefore the U.S. EPA under the Safe Drinking Water Act, has established a Maximum Contaminant Level for lead of 0.05 mg/liter or 50ppb (parts per billion)(see Table #1).

This is a worthwhile effort and merits continued concern. However, based on a large number of surveys it has been established that a high percentage of the water-borne lead we drink comes from the metal pipes through which the water is commonly transported to and within the residence.

For example, in a recent study by the Carroll County Health Department in Maryland, lead in tap water within homes was measured. Lead concentrations were shown to exceed the Maximum Contaminant Level 24% of the time (see Table #2, **reference therein**). Measurements of the water entering the plumbing system showed little or no lead. In each home studied the drinking water was carried through copper tubing joined with lead solder. This evidence clearly implicates the in-house copper plumbing as the source. Other studies confirm this finding (Ref. 4,5,6,7). No matter what restrictions are placed on the quality of water supplied by a public utility, human beings will still be at risk if they live in homes with metal plumbing.

Evidence suggests this problem of lead solubility is linked to both the pH (acidity or alkalinity) of the water as well as the level of other minerals it contains (see for example the Seattle EPA Study). Acidic water, which is low in minerals, causes more lead to leach out of pipe and joints. This is not surprising inasmuch as it has been long known that waters that are so constituted are by nature highly corrosive and over a period of time will destroy a metal plumbing system. Unfortunately, such waters are widely distributed throughout the U.S.

What, then, can be said of the consequences of this dissolved lead and human disease? In a phrase, too much and none of it good. The list of diseases and symptoms which have been associated with ingestion of lead is long and we will not document each individual reported study here (**see Bibliography for a list of references**).

Suffice it to state that lead adversely affects almost every aspect of human physiology. It is neurotoxic (Ref. 7,8,12), i.e., it causes both pathologic and distinct and degenerative changes in the nervous system. The pathologic changes range from headaches through memory loss and delirium to death. Subtle changes including mental retardation and other behavioral changes, are particularly noted in minority group children (Ref. 8,12) living in the inner city commonly classified as ghettos.

Lead is hemotoxic causing a shortened life span of red blood cells, alteration of hemoglobin, and interference with normal blood oxygen transport (Ref. 12). Additionally, lead has been implicated as a cause of adverse reproductive effects. Miscarriages, premature membrane rupture and preterm infants have all been tied to lead intoxication (Ref. 12).

Recent data from animal studies suggest that lead contributes to or causes excess renal tumors establishing that it has carcinogenic or mutagenic properties (Ref. 13). The U.S. EPA Carcinogen Assessment Group (CAG) has recommended that the Maximum Contaminant Level in drinking water be reduced from 50 to 25ppb because of its suspect carcinogen status. If the carcinogenicity of lead is further substantiated then truly this adds another dimension to public health concern.

Clearly, lead is a "bad actor" and its presence in potable water can be traced in part to the combination of metal plumbing systems (copper or lead) and common water characteristics.

CADMIUM

Conditions which favor lead leaching from pipes and joints also favor leaching of cadmium and copper. For cadmium, the EPA (Table #1) has recommended a drinking water standard of 0.01 mg/liter (10ppb). In man, drinking water is the source of 10% of daily cadmium intake and once again metal plumbing is implicated. As we shall discuss, cadmium leaching is commonly associated with both galvanized and copper pipe (Ref. 5,9). Cadmium is a common impurity in the zinc used to galvanize steel pipe.

Like lead, cadmium adversely affects a broad spectrum of human physiological processes. Symptoms of cadmium intoxication range from acute poisoning to more long-term damage to the liver and kidneys (Ref. 14).

Attention to the role of cadmium in human disease traces its origins to Japan wherein a peculiar disease known as Itai-itai was first described over a decade ago by Tsuchiya (Ref. 11). This disease has one outstanding characteristic: proteinuria (protein in the urine). This symptom is now known to be secondary to destruction of kidney tubules essential to their proper function. Also, cadmium has been linked to hypertension and increased cardiovascular disease (Ref. 2,3,9).

To make matters worse, it can now be shown that the adverse health effects from cadmium are additive with those from lead. This further compounds the problem since the same water quality factors promote leaching of both metals from metallic plumbing systems (Ref. 15).

Most disturbing is the recent finding that cadmium also produces adverse effects on the reproductive system (Ref. 14). This metal has been shown to be spermatotoxic (kills sperm) and fetotoxic (toxic to the growing fetus) (Ref. 14,16). As a result, cadmium intoxication has now been directly linked to increased mortality of the newborn (Ref. 16).

Limited data also suggests a role for cadmium in carcinogenesis, however this role is not yet firmly established nor clearly defined.

Thus, even acting alone, cadmium can be considered to be a very serious environmental toxin. This fact coupled to the finding that its actions are often additive to an equally serious toxin such as lead should serve to further heighten public health concern.

Because the presence of both lead and cadmium in drinking water is increased by corrosive water, the public health problems they pose are significant on both a national and global scale. In the U.S., aggressive water is most commonly found on the East Coast and in the vast area west of the Sierras. Fortunately, less aggressive water is generally found in the Intermountain areas where rainfall is sparse and wells are deep. However, a quick review of the population distribution in the U.S. reveals that high population density and corrosive water are, more often than not, synonymous.

COPPER

In contrast to cadmium and lead, copper presents a more complex picture. Copper is essential to life and for years the primary focus of concern has been on alleviation of a deficiency state rather than on its toxicity per se. Recently, however, this emphasis has begun to shift. Currently, the U.S. EPA Drinking Water Standard for Copper is 1mg/liter or 1000ppb. However, this is based on the levels required to avoid a bad taste or smell (organoleptic) rather than on a recognized health effect. Despite this current status, increasing evidence is accumulating which implicates excess copper in the cause or aggravation of disease.

Regarding toxicity, for example, early reports have now been confirmed which link copper to hemolysis (red cell damage) and mental disturbances (schizophrenia) (Ref. 17,18). Interestingly, copper related diseases seem to have a predilection for the young (infants), chronically ill or genetically predisposed humans (Ref. 18,19).

There have been reports of infant illness (poisoning, prostration, edema, lung damage) and death which have occurred as a result of copper accumulation in drinking water. In one case the level implicated was 0.8mg/liter or 800ppb, which is less than the current Drinking Water Standard (Ref. 20). In addition, kidney disease patients on dialysis, who have been inadvertently intoxicated by copper-laden water, have experienced red cell damage and varying degrees of mental disorientation including psychosis (Ref. 20).

In other subjects, nausea, diarrhea and jaundice have been observed secondary to copper intoxication, (Ref. 20). In a pattern of consistency, excess copper has been linked to hemolysis (red cell rupture) in a group of patients suffering from a disease which is characterized by a genetic deficiency of a red cell enzyme called Glucose-6-phosphate dehydrogenase (Ref. 19). This enzyme is essential to proper energy metabolism and cell life and its deficiency predisposes the cell to early death and damage.

Thus, copper intoxication, like lead and cadmium intoxication clearly can lead to illness and death.

Finally, and most important for our purposes, evidence suggests that the increased use of copper pipe in the last 20 years is implicated in the growing problem of zinc deficiency which we are now observing (Ref. 7,21). It has been suggested that the excess copper we receive from the attack of aggressive water on copper pipes retards the uptake of zinc from the food we eat. This retardation causes a metabolic imbalance that seriously affects a variety of cellular and organ processes. The particular effects of zinc deficiency are dwarfism, circulatory abnormalities, and a loss of the sense of taste (Ref. 22).

Recently, a survey of copper and cadmium in water has been made from a variety of sources and transported through several types of pipe. These data which are derived from a report by H.A. Schroeder, are summarized in Table 3. As can be seen, transporting water through copper or galvanized pipe can cause a significant rise in the level of either cadmium or copper or both. The potential health effects of such leaching, as noted above, can be extremely serious.

OTHER METALS

The story by no means ends with lead, cadmium and copper, for indeed other metals play a role in disease. Certain chemical forms of nickel play a role in carcinogenesis (Ref. 23), while chromium is both toxic and a suspect carcinogen (Ref. 24). Even iron, which like copper is essential, has been shown, in excess, to interact with copper to contribute to psychotic disturbances such as schizophrenia (Ref. 25). Recently, excess iron has also been linked to a greater incidence of heart disease in both men and postmenopausal women (Ref. 10).

Given these facts it is not surprising that public concern over these long ignored hazards of metals has recently heightened. Indeed, public health bodies, such as the American Medical Association and the U.S. EPA, have recently expressed concern over the leaching of toxic metals into potable water from various metal pipes (Ref. 3,13,20). Nevertheless, metal piping continues to be the "standard" in most plumbing codes.

This is due to the fact that the scientific findings, however frightening, must be balanced against one immutable reality: humans must drink water to survive. Yet another reality is that only a select few individuals can obtain this water from crystal clear springs high in a pristine forest. Most humans must, at some point, turn on the tap to obtain water for drinking, as well as for cooking and bathing. Consequently, a means of transporting water to man is needed. Given these circumstances a clear question emerges. Is poisoning by heavy metals leaching into drinking water from the metal pipes that transport it, a necessary consequence of urbanization with which humans must live or is it a problem society can solve?

SUMMARY

It is our belief that the problem need not be tolerated and, in fact, that the solution has been at hand for several years. The facts we have marshalled in this brief paper from a host of sources, lead clearly to the following conclusions:

1. Metals in drinking water are proven culprits in disease and death.
2. The diseases they cause run the gamut from nausea and birth defects through psychosis to cancer.
3. Metal piping systems, including those made of copper and galvanized steel, are a primary cause of human exposure to these toxic agents.
4. The problem posed by metal pipes will not disappear easily for they result from the natural properties of water and metals themselves.
5. If metal pipe is used, water contamination by toxic metals leached from the pipe is virtually certain. As always, hypothetical risks must be weighed against those which are certain, quantifiable and preventable. Preference must always be given to the elimination of known risks such as those posed by metal pipe since this is the only sound public health posture.

* * * * *

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* * * * *

TABLE 1
NATIONAL PRIMARY DRINKING WATER REGULATIONS
(Metal Contaminants)

Contaminant	Maximum Contaminant Level (mg/l)*
Arsenic	0.05
Barium	1.0
Cadmium	0.010
Chromium	0.05
Lead	0.05
Mercury	0.002
Nitrate (as N)	10.0
Selenium	0.01
Silver	0.05

* 1mg/l (milligram per liter) is the equivalent concentration of one part per million, or about one teaspoon in 1300 gallons of water.

TABLE 2
 DISTRIBUTION OF LEAD IN EARLY MORNING WATER SAMPLES
 TAKEN FROM RANDOMLY SELECTED CARROLL COUNTY HOMES*

Water Lead ppm	Total Number of Samples	Percentage of Total
0.00	119	33
0.01-0.05	153	43
0.06-0.10	24	7
0.11-0.20	28	8
0.21-0.30	9	3
0.31-0.40	6	2
0.41-0.50	6	2
0.51 & Above	5	2
Total	350	100

* All home water distribution systems consisted of copper tubing with lead solder.

67% of the County total random early morning samples have the presence of water lead.

24% of these samples have water lead in excess of 0.05ppm allowed by the Federal Safe Drinking Water Standards.

This table is taken from a report prepared by the Carroll County Maryland Health Department entitled, "Control of Lead and Copper in Private Water Supplies". Authors: J. Lovell, R. Isaac and R. Singer.

TABLE 3*
 COPPER AND CADMIUM IN WATER
 (Levels Expressed as ppb)

Water	Copper	Cadmium	Remarks
Natural Waters			
Connecticut River	-	14.6	Polluted
Brook, Vermont	3	0.5	Clear
Spring, New Hampshire	4	2.5	Clear
Sea Water, Caribbean	-	0.3	Clear
Municipal Waters			
Reservoir Inlet	16	2.1	Clear
Spillway	55	2.5	Clear
Main, Town	150	18.0	Cast Iron Pipe
Tap, Hospital			
Cold, Running	170	8.3	Cast Iron Pipe
Cold, Stagnant	730	77.0	Galvanized and Copper Pipe
Hot, Running	440	21.0	Galvanized and Copper Pipe
Tap, Hard	36	1.0	Galvanized Pipes
Tap, Soft	279	3.5	Galvanized Pipes
Tap, Soft	1240	8.3	Copper Pipes

* Data abstracted from H.A. Schroeder, Trace Elements in Man, 1969.(9)

EPA Drinking Water Standards: Copper = 1000ppb (sec)
 Cadmium = 10ppb (prim)



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STUDY REVEALS TOXIC METALS IN SCHOOLS' DRINKING WATER

LOS ANGELES, CALIF., July 29 -- Nearly half of California's public schools surveyed for a study released Thursday contain lead and other toxic metals in their drinking water which exceed federal health standards.

Metal pipe, used by all of the schools in the study, can leach compounds of lead, copper, chromium and nickel which are linked to disabilities ranging from poisoning to long-term neurological and genetic disorders, said Dr. Anthony V. Colucci, the environmental health consultant who directed the study.

Colucci said that his study, although a "pilot" project covering a small number of Bay Area and Los Angeles metropolitan elementary and upper-level schools, leads to the "inescapable conclusion" that metal pipe tests must be expanded to a comprehensive state-wide basis. "The state is not systematically conducting any tests of this sort that I know of," Colucci told a news conference.

Samples from ten schools, taken from drinking water and kitchen taps during the week of July 21, found two facilities with lead compounds, one facility with copper, and one with chromium which exceed the Environmental Protection Agency standards for maximum contamination levels. However, two other schools reported high levels of chromium, a known carcinogen.

In addition, four schools recorded a high nickel contamination level. Colucci described nickel as being a known carcinogen. Schools sampled covered inner city, suburban and rural locations which included students from a variety of economic and cultural backgrounds. Hooper Elementary School, with 1,574 students in South Central Los Angeles, for example, has excessive concentrations of lead and chromium, Colucci said.

The other Los Angeles school which exceeded the lead levels was Oneota Elementary in South Pasadena.

Colucci, a former senior health scientist for the EPA, said that "the problem of toxic metals leaching from pipe does not stop at the school doors." The study found excessive toxic metals contamination at both housing and business locations.

The consequences of excessive lead exposure in humans is well-documented. For example a study in Boston linked high lead concentrations to behavioral problems in almost 100 percent of the inner-city children exposed.

And in England, it has recently been reported that lead contamination of the drinking water is a serious problem. Excessive lead builds up in the body's tissues and causes pathological changes such as headaches, memory loss, delirium and death. Lead, a suspected carcinogen, also causes certain behavioral changes and can lead to mental retardation.

Copper, another metal which builds up in the body, has recently been linked with red blood cell damage, mental diseases, diarrhea and jaundice. "There is one case of an infant dying from excessive copper exposure, with 800 parts per billion," Colucci noted. "One of our schools, Roosevelt Elementary, had copper concentrations nearly twice that level."

Colucci pointed out that plastic pipe is the logical alternative to metal pipe. Plastic pipe is the only system cleared by the National Sanitation Foundation and the East Bay Municipal Utility District, and the plastic pipe industry is the only one which has volunteered to fund an environmental impact report for the California Department of Housing and Community Development that will meet the highest professional standards.

"Metal pipes must be subjected to the same scrutiny as plastic pipes have been with the same rigorous simulated and field tests done on pipes of all ages," Colucci said. He added that it is time for the California Health Department to conduct a systematic survey of school water delivery systems, and that regular testing should be conducted on an ongoing basis.

Michael Dennehy, a director of the Plastic Pipe and Fittings Association, the organization that commissioned the study, and vice president of R&G Sloane Manufacturing Company of Los Angeles said, "We have always contended that plastic pipe is being unfairly singled out for the EIR in California, but we have volunteered to fund an appropriate study. Isn't it time metal pipe is subjected in its own EIR to the same scrutiny, especially in light of this study?"

Dennehy added that the California legislature should call a halt to the proposed Papan legislation concerning plastic pipe, AB2636, and immediately begin a study of the real threat to California homeowners and schoolchildren: metal pipe.

"The Papan bill is a sham because of the provisions for an April 1984 ban, which would go into effect if plumbers or anyone else delayed acceptance of a completed EIR by legal challenge," Dennehy stated. "And it's dangerous because it would deprive Californians of the safest and most economical water delivery system available."

(Editor's Note: A table listing the schools, locations and sample data is attached.)

METAL CONTENT IN DRINKING WATER
Highlights of Environmental Research Laboratory Analysis

EPA's maximum allowable contaminant levels are listed in parts per billion below the column headings of lead, copper and chromium. National Sanitation Foundation's allowable level is listed for nickel, a known carcinogen for which the EPA is currently establishing a standard.

● = Exceeds EPA or NSF level ND = Not Detectable

<u>SCHOOL SITES</u>	<u>Lead</u> 50 ppb	<u>Copper</u> 1000 ppb	<u>Chromium</u> 50 ppb	<u>Nickel</u> 50 ppb
L.A. METROPOLITAN AREA				
1. Roscoe Elem., Sun Valley	ND	86	29	ND
2. Hooper Elem., S. Ctrl. L.A.	●320	200	●64	ND
3. Oneonta Elem., So. Pasadena	●160	43	29	ND
4. Valley View Elem., N. Hillywd.	6	23	ND	ND
BAY AREA				
5. Roosevelt Elem., San Leandro				
Location #1	ND	●1600	ND	41
Location #2	ND	●1900	ND	36
6. Colonial Acres Elem., S.L.				
Location #1	ND	10	ND	24
Location #2	ND	ND	ND	ND
7. Stanton Elem., Castro Vly.				
Location #1	ND	51	ND	ND
Location #2	ND	240	ND	ND
8. Brownell Elem., Gilroy	ND	34	ND	170
9. So. Valley Jr. High, Gilroy	ND	31	ND	ND
10. Gilroy Sr. High, Gilroy	ND	48	ND	52
OTHER SITES				
Residence, L.A.	●390	270	ND	ND
Commercial Site, Sun Vly.	ND	38	29	ND
Residence, Gilroy	ND	19	ND	ND
Residence, Morgan Hill	ND	24	ND	ND
Commercial Site, L.A.	●101	38	ND	ND

after the water thaws with no loss of strength. Polybutylene offers the greatest protection of any plumbing material against splitting or cracking at sub-freezing conditions.

Polybutylene piping systems have been tested under actual installation conditions and found to show no change in performance after numerous freezings. Even though the fittings of acetal copolymer are rigid, the system is protected by flexible polybutylene piping.

As the water begins to freeze in the fitting and expands, the pressure it generates in the direction of liquid flow forces the ice into the pipe, which expands to accommodate the additional pressures. Total internal pressures are thereby relieved and the fitting is protected.

MORE PROTECTION, INSULATION

Because of polybutylene's excellent insulating properties, the flexible plastic piping material also

THE BIG DIFFERENCE—A section of Vanguard polybutylene tubing, top, was unaffected by freezing water. However, a copper water line, below split after water inside froze. Vanguard polybutylene, because of its flexibility, expands to accommodate frozen water and then regains its original

shape after the water thaws with no loss of strength. Thousands of homes plumbing with copper and galvanized steel piping sustained damage when a severe cold snap hit the southern states recently. Vanguard polybutylene piping systems will be on display in NAHB booth No. 3326.

delays freezing of the water supply much longer than either copper or galvanized piping. Copper and galvanized pipe are great conductors and actually dissipate heat rapidly. Laboratory tests have determined that the heat loss factor for polybutylene is 13 times better than copper.

Residents of many southern states wouldn't have been hauling in bottled water and bathing at neighbors' houses if their homes had been plumbed with polybutylene piping. Many of those residents still are without running water — plumbers in some areas still have been unable to answer all service calls because of the unusually large number of freeze problems associated with copper and galvanized piping.

PROVEN IN TESTING

Polybutylene, although a relatively new plumbing material, has been proven as a superior plumbing product in test after test. Many builders in areas where the freeze hit hard this year have decided to use nothing but polybutylene piping in their new construction and remodeling projects.

Following the cold snap, Vanguard was inundated with unsolicited testimonials from builders, plumbers and homeowners whose structures weathered the freezing temperatures without damage to the plumbing.

Dozens of others whose buildings were damaged by water gushing from split metal piping called Vanguard to inquire about the availability of polybutylene.

One homeowner in the

Midwest whose home (plumbed with polybutylene) was left unattended over the holidays returned in early January to find the upstairs plumbing frozen solid. An attic area had been improperly insulated, exposing the piping to temperatures as low as 5 degrees F.

Although water froze solid inside the polybutylene piping, there were no leaks. "I was gone for more than a week, and if the water lines had frozen and split, I could have had \$20,000 to \$30,000 in damage," said the owner of the \$250,000 home.

"As it was, we opened the area to the heated portion of the house and the ice thawed withing several hours," he explained.

Another example of polybutylene's rugged reliability was in evidence at

a new apartment complex in Oklahoma City. The relatively large complex was plumbed with polybutylene and then pressured with water in mid-December. Unprotected against freezing temperatures, water inside the pipes froze solid. But there wasn't one leak in the entire system.

Said one plumber, "If most of the large cities in Texas had been plumbed with polybutylene, freeze damage from the cold snap would have been very insignificant.

Unfortunately, damage cause by frozen piping in Texas alone already has been estimated in the millions. Those plumbing problems were not only costly in terms of damage. They might eventually force insurance companies to raise their rates to compensate for losses.

**SEE VANGUARD IN
BOOTH NO. 3326**

Vanguard
Plastics Inc.
331 North Vanguard Street
McPherson, Kansas 67460
316 241-6369



SB 214 TITLE & SPONSOR SUMMARY
AMENDED TITLE:
AN ACT RELATING TO THE PLUMBING CODE

14:16 5/22/84 PAGE 1 OF 2

PRIME SPONSOR: FISCHER, P. .
CO-SPONSORS:

CURRENT STATUS: 3/29/83 IN (S) LABOR & COM

SB 214 SENATE ACTION

14:16 5/22/84 PAGE 2 OF 2

DATE SEQ PAGE

LEGISLATIVE ACTION

03/29/83 01 0520

FIRST READING -- COMMITTEE REPORTS
LABOR & COMMERCE
RULES

Introduced March 20 and referred to Community & Regional Affairs.

Plumbing
Code
(adopting
updated)

SENATE BILL NO. 214, by Senator P. Fischer. Would adopt as the minimum Plumbing Code for Alaska, the 1982 edition of the Uniform Plumbing Code, adopted at the 52nd Annual Conference of the International Association of Plumbing & Mechanical Officials. Adopts Chapters 1-13 and appendices, useful tables, and installation standards, but excludes Part I, Administration, pages 1a - 6a. The existing minimum code for Alaska is the 1979 edition adopted in September, 1978. (Amends AS 18.60.705, "Plumbing Code," and definitions section for AS 18.60, definition of "code.") Does not provide for an effective date (becomes law 90 days after Governor's signature).

Introduced March 29 and referred to Labor & Commerce.

See also HB 508

FAIRBANKS CENTRAL LABOR COUNCIL

A. F. of L. - C. I. O.

FAIRBANKS, ALASKA

1-

(907) 479-6281

April 22, 1983

Senator Bob Mulcahy
Pouch V
Juneau, Alaska 99811
(Mail Stop 3100)

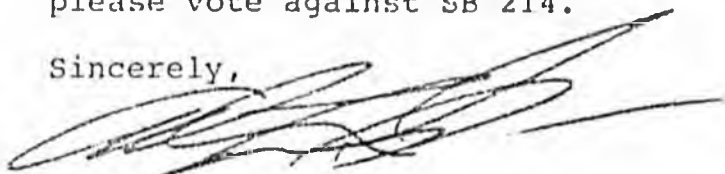
Re: Senate Bill 214

Dear Senator Mulcahy :

The Fairbanks Central Labor Council has unanimously adopted the resolution opposing Senate Bill 214. The gravamen of the bill is to delete the 1975 Uniform Plumbing Code as the official minimum plumbing code for the state. The bill replaces the 1979 edition with a 1982 edition. The 1982 edition was the product of a tremendous amount of lobbying and as a result, it is totally permissive. This means there are almost no standards. Plumbing work done by union plumbing contractors and union men has always been a guarantee of a good functional job. If we reduce to the standards of the 1982 version of the code, every kind of get rich quick short cut will be codified and everyone will have to drop to those standards to meet the competition. The result will be non-thawable pipes, leaks, and tremendous dissatisfaction with the plumbing industry.

For the benefit of the public, who needs the protection, and the plumbing industry, that must maintain its reputation, please vote against SB 214.

Sincerely,



ARTHUR LYLE ROBSON, Secretary-Treasurer
Fairbanks Central Labor Council

ALR:CLM

CENTER FOR SCIENCE IN THE PUBLIC INTEREST

1755 S Street N.W. • Washington, D.C. 20009

(202) 332-9110



July 11, 1983

Rocky Plotnick Weller
Researcher, Senate Labor and Commerce
Pouch V
Juneau, Alaska 99811

Dear Rocky:

We have done zero research on plastic pipe, but the California Department of Consumer Affairs apparently has. The enclosed section is taken from a fairly recent report of theirs. For details, you might want to contact Stephen Gould, Manager, Research and Special Projects, Division of Consumer Affairs, 1020 N Street, Room 501, Sacramento 95814; (916) 322-7674. With the change in administration, Stephen may be gone (I hope not); the last time I chatted with him was over a year ago.

Good luck.

Sincerely,

Kirk

Kirk A. Johnson, M.S.
Staff scientist

DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
DIVISION OF CODES & STANDARDS Administrative Section
P. O. Box 1407, Sacramento, CA 95807 (916) 445-9471



November 10, 1982

INFORMATION BULLETIN SHL 82-5

TO: CITY BUILDING OFFICIALS
COUNTY BUILDING OFFICIALS
HOUSING CODE OFFICIALS
FIRE OFFICIALS
HEALTH OFFICIALS
ENVIRONMENTAL HEALTH OFFICIALS
INTERESTED PARTIES (SHL)
DIVISION STAFF

RE: PLASTIC PIPING SYSTEMS

The Department of Housing and Community Development has undertaken an Environmental Impact Report under the provisions of the California Environmental Quality Act before authorizing the expanded use of plastic pipe. The Environmental Impact Report is required because a significant controversy exists, and because evidence exists, although disputed, that plastic pipe may cause actual or potential significant adverse environmental or public health effects by leaching hazardous or carcinogenic chemicals, and/or may pose fire safety or worker safety hazards. The types of pipe being studied are PVC, CPVC, and PB for potable water and ABS and PVC for drain, waste and vent.

The Environmental Impact Report will also evaluate existing uses of plastic and metal pipe. Until the Environmental Impact Report is completed and reviewed, the expanded use of plastic pipe is not approved by the state beyond the uses adopted by the state in 1979.

Because of an order of the California Supreme Court, the Uniform Plumbing Code, 1982 Edition, is being distributed in California with a notice inserted by IAPMO which notifies recipients, among other things, that the Environmental Impact Report is being prepared and that the expanded use of plastic pipe "is not permitted in California." This notice of IAPMO, and its manner of insertion in the code, has caused misunderstanding as to the current status of the approved use of plastic pipe in California.

The Department of Housing and Community Development adopted the Uniform Plumbing Code, 1979 Edition, as part of the State Housing Law on December 31, 1979. The 1979 Edition is the current edition being enforced under the State Housing Law.

In accordance with the 1979 Edition, plastic pipe may be used as follows:

Drainage Systems

Section 401 - Materials

(a) Drainage pipe shall be cast iron, galvanized steel, galvanized wrought iron, lead, copper, brass, ABS, PVC, or other approved materials having a smooth and uniform bore, except: 1. That no galvanized wrought iron or galvanized steel pipe shall be used underground and shall be kept at least six (6) inches (152.4mm) above ground. 2. ABS or PVC installations limited to residential construction, not more than two (2) stories in height.

(b) Drainage fittings shall be of cast iron, malleable iron, lead, brass, copper, ABS, PVC, or other approved materials having a smooth interior waterway of the same diameter as the piping served and all such fittings shall conform to the type of pipe used.

Water Distribution

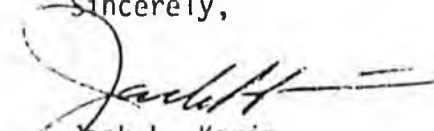
Section 1004 - Materials

(a) Water pipe and fittings shall be of brass, copper, cast iron, galvanized malleable iron, galvanized wrought iron, galvanized steel, lead, or other approved materials. Asbestos-cement, PE, or PVC water pipe manufactured to recognized standards may be used for cold water distribution systems outside a building. All materials used in the water supply system, except valves and similar devices shall be of a like material, except where otherwise approved by the Administrative Authority.

In addition, local jurisdictions may have adopted amendments to the 1979 Plumbing Code allowing additional uses of plastic pipe due to "local conditions" pursuant to their authority under the code. These ordinances are valid only if they were adopted in compliance with CEQA and other requirements of law.

At the present time, local amendments proposing the expanded use of plastic pipe beyond that authorized by the 1979 code should be undertaken with caution and in a manner to ensure strict compliance with applicable law. The State of California has determined that sufficient information has been presented to require the preparation of an Environmental Impact Report. Therefore, for any new application of plastic pipe materials involving water supply for human consumption covered by the EIR (PB, PVC, CPVC), it is the opinion of this department that a negative declaration by a local jurisdiction is not sufficient, and such action would likely subject the jurisdiction to litigation. Local jurisdictions are advised to await the department's completion of its Environmental Impact Report, currently underway. The California Environmental Quality Act must be complied with if a local jurisdiction decides to amend its code.

Sincerely,



Jack L. Kerin
Chief



OFFICE OF THE STATE ARCHITECT
ADVISORY BULLETIN

DECEMBER 31, 1982

TO: ARCHITECTS, ENGINEERS, SCHOOL DISTRICTS AND
COUNTY SUPERINTENDENTS

RE: USE OF PLASTIC PIPE IN PUBLIC SCHOOL BUILDINGS

The Structural Safety Section of the Office of the State Architect (OSA/SSS), which is charged with administering the "Field Act", has responded as follows to inquiries regarding the use of plastic piping in public school construction:

1. The current State Building Standard which applies to plumbing systems in public schools is the State Plumbing Code, Part 5 of Title 24, CAC, issued in Register 68, No. 41 dated November 2, 1968.
2. The restrictions on materials which can be used for piping and fittings for drainage systems, vent systems or water distribution systems are contained in Article P2 of Part 5, Title 24. In addition to the specific materials listed in Section P208, P211, P212 and P215 of Article P2, provision is made for use of "other approved materials" as determined by the enforcing authority.
3. The State Architect had determined in 1974 that in public school projects plastic pipe of the appropriate type and class could be used only for vent piping in buildings; waste lines in portable buildings; drains carrying acid wastes from laboratories; and plumbing lines carrying gas, water and drainage wastes underground outside of buildings. This has been the policy enforced by OSA/SSS since that date.
4. On the 10 November 1982 the Division of Codes and Standards of the Department of Housing and Community Development issued an Informational Bulletin No. SH 82-5 regarding plastic piping systems which states in part:

"The Department of Housing and Community Development (HCD) has undertaken an Environmental Impact Report under the provisions of the California Environmental Quality Act before authorizing the expanded use of plastic pipe.


The Environmental Impact Report is required because a significant controversy exists, and because evidence exists, although disputed, that plastic pipe may cause actual or potential significant adverse environmental or public health effects by leaching hazardous or carcinogenic chemicals, and/or may pose fire safety or worker safety hazards. The types of pipe being studied are PVC, CPVC, and PB for potable water and ABS and PVC for drain, waste and vent.

The Environmental Impact Report will also evaluate existing uses of plastic and metal pipe. Until the Environmental Impact Report is completed and reviewed, the expanded use of plastic pipe is not approved by the state* beyond the uses adopted by the state in 1979**."

* (For residential uses.)

** (Uniform Plumbing Code, 1979 Edition)

5. Because of the particular concerns raised regarding the potential health hazards that may exist when plastic pipe is used in transporting potable water for use by school age children the Office of the State Architect is recommending that plastic pipe not be used on school sites for potable water distribution systems until the Environmental Impact Report being prepared by HCD is completed and reviewed.
6. Until the results of the Environmental Impact Report are reviewed and evaluated the OSA/SSS will continue to limit the use of plastic pipe for plumbing systems in public school projects to vent piping in buildings, waste lines in portable buildings and drains carrying acid wastes from laboratories.



Barry A. Wasserman
State Architect
(916) 445-4167

DKJ:dw

DEPARTMENT OF HOUSING AND COMMUNITY DEVELOPMENT
DIVISION OF CODES AND STANDARDS - Administrative Office
P. O. Box 1407, Sacramento, CA 95807
(916) 445-9471



September 22, 1982

Plastic Pipe Task Force Members:

The contract between the Department and the Society of the Plastic Industry (SPI) has been signed by SPI and is in the mail to the Department. The contract between the Department and SRI International is in final form awaiting SRI's signature. A copy of both contracts, when signed, will be entered into the record and mailed to you.

The Department's Contracts Office estimates full state approval of the SRI contract and will occur by October 25. Consequently, a new EIR timetable reflecting an October 25 starting date has been prepared. We should know by October 14 if this latest revision will be the actual schedule.

There has been some question as to the procedure for submitting information to SRI. The task force has agreed that all information from task force members or the public should be submitted to the Department. The information will then be entered into the record and forwarded to SRI as well as other task force members. (Information submitted by task force members should be in 16 copies or reimburse the Department at 10 cents per page for reproducing 16 copies). Unsolicited information should not be submitted directly to SRI.

Thus if you have information on plastic pipe that you feel is important for SRI to have, submit a copy into the record. SRI will be provided a complete set of all items in the record for the duration of the project.

If you have any questions on the status of the EIR, please give me a call (Sacramento: (916) 445-3338 or El Sobrante: (415) 223-0160).

Sincerely,

Michael C. McMillan
EIR Coordinator

September 22, 1982

Plastic Plumbing Pipe EIR

EIR Timetable

1982

- Oct. 25 Contractor begins work on environmental review document.
- Nov. 8 Department and contractor progress report meeting.
- Nov. 23 Department and contractor progress report meeting (morning).
Task Force meeting with contractor (afternoon).
- Dec. 6 Contractor submits first draft of Public Health section
of the environmental review document.
- Dec. 21 Task Force meeting with contractor regarding Public Health
section.

1983

- Jan. 20 Complete copy of environmental review document, including revised
Public Health section, submitted to Department.
- Feb. 7 Department distributes draft RFP to Task Force for testing identified in
environmental review.
- Feb. 22 Task Force meeting with contractor on environmental review (morning).
Task Force meeting on draft RFP for testing (afternoon).
- Feb. 23 Task Force meeting on draft RFP for testing continues (as needed).
- Mar.-Aug. Possible six-month period to select testing laboratory, complete
testing, and interpret results.
- September (A timetable for activity following the testing period will be prepared
in September 1983.)

STATE OF ALASKA

BILL SHEFFIELD, GOVERNOR

DEPARTMENT OF LABOR

LABOR STANDARDS and SAFETY DIVISION
MECHANICAL INSPECTION

3301 EAGLE STREET
POUCH 7-020
ANCHORAGE, ALASKA 99510
(907) 264-2447

January 23, 1984

FILE: AKMI (IR 3)

Dear Sirs:

Several items of the Uniform Plumbing Code should be brought to your attention. All of these sections are covered by the 79 edition of the Uniform Plumbing Code, which is published by IAPMO and adopted by AS 18.60.705. For clarity we refer to the Uniform Mechanical Code, which is adopted by 13 AAC 50.020.

1. Sec. 404 - 405. Fixture crosses are required in all back-to-back installations, as per these sections. Fixture crosses are not double LTTY'S or sanitary crosses.
2. Sec. 405. Changes in direction of drainage flow. Enclosed are four drawings which illustrate approved fittings of equivalent sweep.
3. Sec. 405. Cleanouts. A cleanout is required two feet outside of the building, and inside at the furthest end of the building drain (Sec. 103). A readily accessible (d) cleanout is required on all sink drains, first floor only (preferably either above or below the trap arm inlet.)
4. Sec. 506 (f). Calls for minimum size vent of three inches in diameter. This means all vents. This applies to all of Alaska except southeastern.
5. Sec. 604. Indirect Waste Receptors. Indirect wastes (floor sinks) work very well in restaurant and bar applications and will avoid a lot of problems in these applications.
6. Sec. 613. Vertical Wet Venting. Proper application of this section appears to be very difficult in the field, and we urge you to be very careful in its application.
7. Sec. 804 (e). Special Joint. Unions are required on all pieces of equipment as per this section.
8. Sec. 1005. Valves. Water shall be piped individually to each apartment with a main cut off valve OR individual stops on all outlets. This means tubs, shower valves, and all hose bibbs, and to be readily accessible.
9. Sec. 1006. Supply Tanks. All holding tanks of potable water shall conform to this section.

10. Sec. 1007. Water Supply. Check water pressure. Provide floor drains where tanks, boilers, etc. are installed. Crawl spaces require equipment pads.
11. Section 2119. UMC requires a floor drain.
12. Section 2104. 404 UMC, a hot water heater, is covered in the scope of these definitions. In areas where freezing occurs, discharge of relief valves cannot be run to the outside. The discharge shall be in an area where it is visible.
13. Sec. 1215 (e). Do not install any liquified petroleum gas appliances in pits or basements. We consider this a life and death hazard and will shut off upon discovery. Also see Section 504 UMC.
14. Sec. 1310. All spark or flame items must be at least 18 inches above floor in locations outlined in this section.
15. Sec. 1305 and Sec. 1306 require a separate hi-limit control on all energy fired units.
16. Appendix C. This section outlines minimum restroom requirements for all buildings. It is your duty to bring any deficiencies to the attention of the owner/builder to avoid changes in the middle of the job.

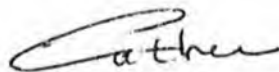
If we may be of further service to you, please contact:

Dave Barce, Plumbing Inspector
3301 Eagle Street
Pouch 7-020
Anchorage, Alaska 99510
264-2447

Al Anaka, Plumbing Inspector
Box 2385
Sitka, Alaska 99835

Adele Bacon, Plumbing Inspector
675 7th Avenue, Station J
Fairbanks, Alaska 99701
452-8105

Sincerely,



Don Cather
Chief
Mechanical Inspection

CHANGE IN DIRECTION OF DRAINAGE PIPING

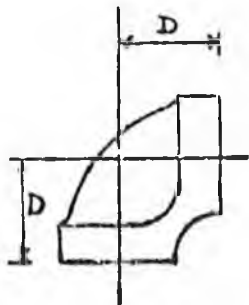
While Section 405 of the U. P. C. specifies certain fittings that may be used in making a change of direction in drainage lines, the appropriate use of 90° bends or elbows can be related only to "equivalent sweep."

The sweep or radius of a drainage fitting must be correlated with its position or function in the system in order to prevent excessive turbulence and maintain adequate flow velocities.

The following 90° fittings in both Cast Iron and plastic should be used as indicated:

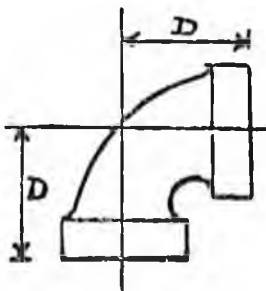
FOR DURHAM

A
90° Elbow



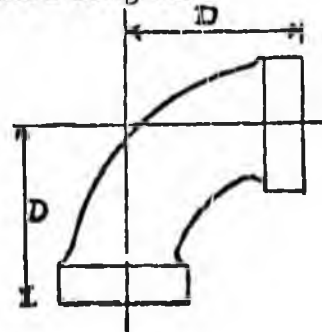
<u>Size</u>	D
1-1/2"	1-15/16"
2"	2-1/4"

B
90° Elbow
Long turn



D
2-1/2"
3"

C
90° Elbow
Extra long turn



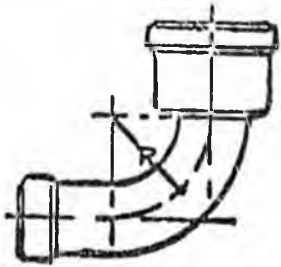
D
3-1/2"
4"

- A Use of 90° elbow -- Vent only
- B Use of long turn 90° elbow
Horizontal to vertical (OK also in trap arms)
- C Use of extra long turn 90° elbow
Horizontal to vertical
Horizontal to horizontal
Vertical to horizontal

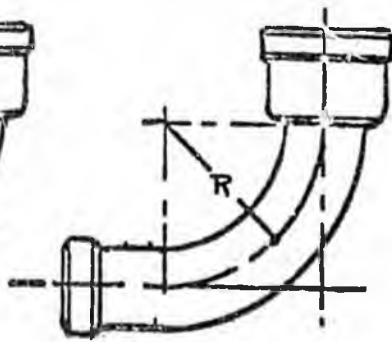
FOR CAST IRON SOIL PIPE

Note: Since the dimensions given apply to both bell and spigot and No-Hub, radii are shown because center to end dimensions vary.

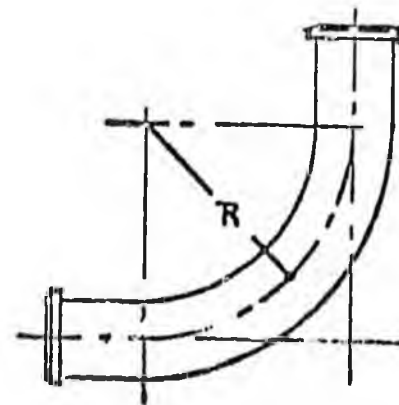
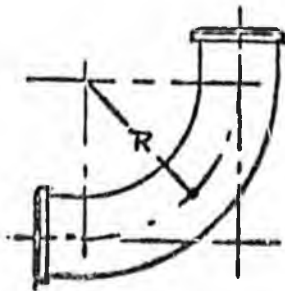
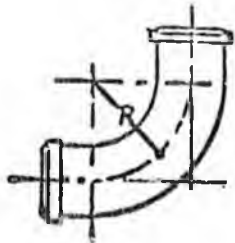
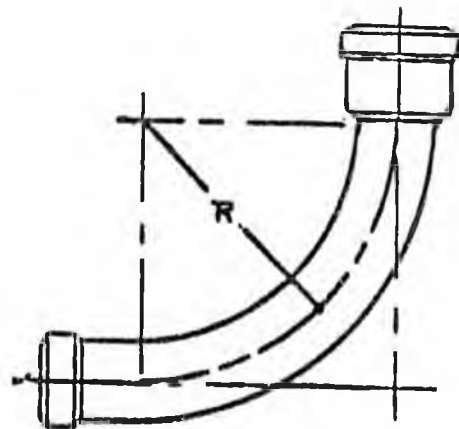
A--1/4 Bend



B--Short Sweep



C--Long Sweep



<u>Size</u>	R	R	R
2"	3"	5"	8"
3"	3-1/2"	5-1/2"	8-1/2"
4"	4"	6"	9"
5"	4-1/2"	6-1/2"	9-1/2"
6"	5"	7"	10"

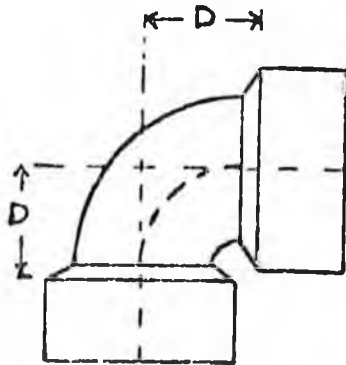
A Use of 1/4 bend -- Horizontal to vertical

B Use of short sweep -- Vertical to horizontal
Horizontal to vertical
Horizontal to horizontal

C Use of long sweep -- Same as short sweep

FOR PLASTIC

1
1/4 Bend Vent

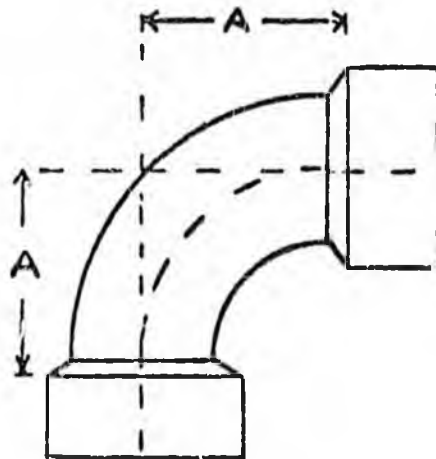


Size

D

1-1/2"	1-3/16"
2"	1-1/2"
3"	1-7/8"
4"	2-1/2"

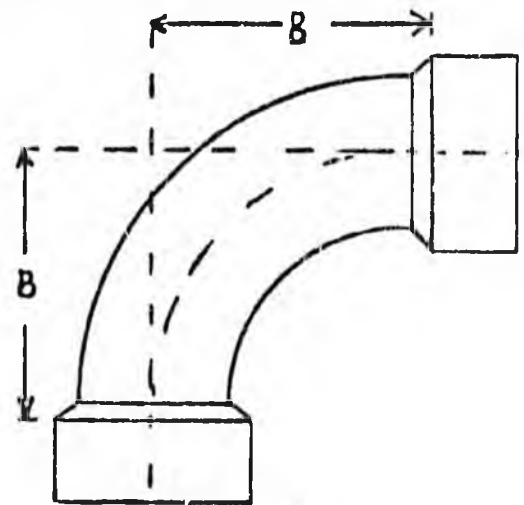
2
1/4 Bend



A

1-3/4"
2-5/16"
3-1/16"
3-7/8"

3
Long Sweep 1/4 Bend

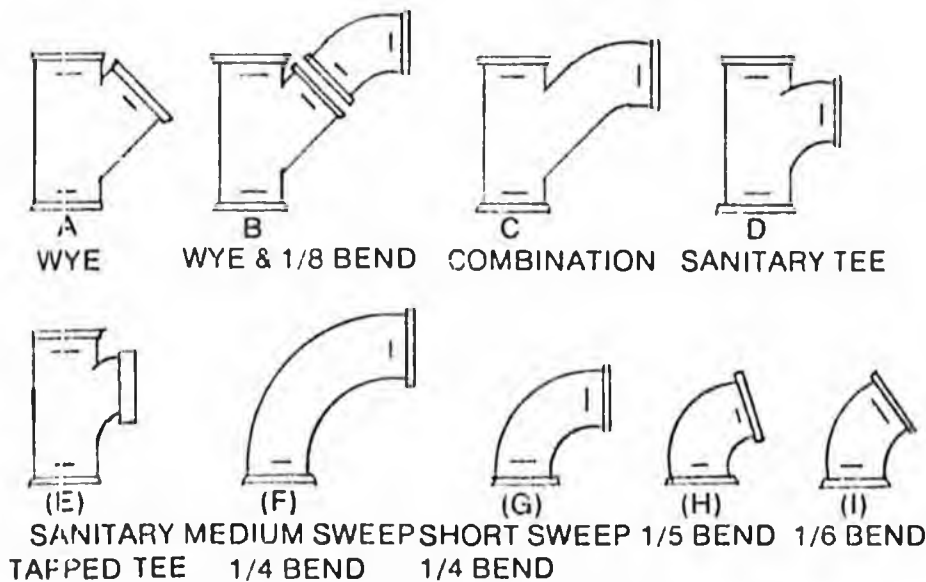
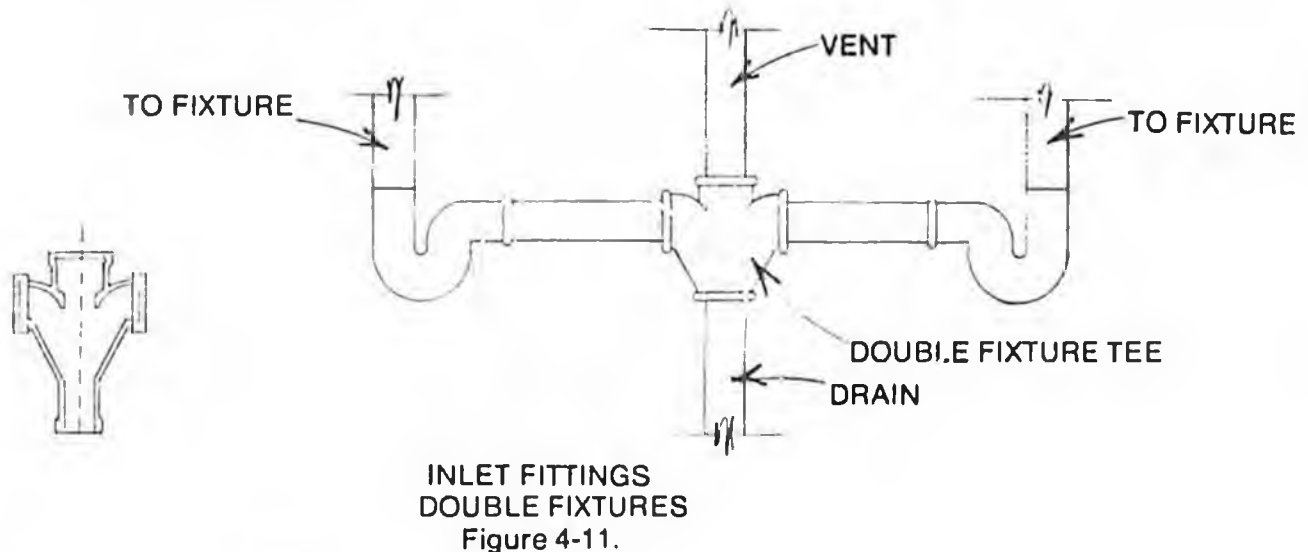


B

2-3/4"
3-1/4"
4-1/16"
4-14/16"

- 1 Use of 1/4 bend vent
Vent fitting only
- 2 Use of 1/4 bend
Horizontal to vertical (OK also in trap arms)
- 3 Use of long sweep 1/4 bend
Horizontal to vertical
Horizontal to horizontal
Vertical to horizontal

flow in a horizontal pipe is dependent on the slope or grade of the pipe. If the pipe is sloped or graded one-fourth (1/4) of an inch per foot (20.8 mm/m) the velocity of flow will be approximately two (2) feet per second (0.6 m/s). Any interruption to the flow presented by short or abrupt changes of direction will slow down the velocity flow. The adverse effects of this slowdown are: pipes flowing full causing air pressure changes within the drainage system in sufficient velocity to carry away solids, etc.



HORIZONTAL TO VERTICAL
Fittings "A" to and including "E" may be used for vertical drain piping picking up horizontal branches

Fittings "F" to and including "I" may be used for horizontal drain piping changing to a vertical direction.

VERTICAL TO HORIZONTAL
Fittings "A", "B" and "C" may be used for this type of change in direction. Fitting "I" may be used when installed in a true vertical position.

HORIZONTAL TO HORIZONTAL
Fittings "A", "B" and "C" may be used for this type of change in direction

CLEANOUTS

Horizontal drainage piping is required to have cleanouts at specific locations. In the event of a stoppage, a point of entry is provided where special tools may be used to remove stoppages. Essentially, the upper end of all horizontal drainage piping is the most logical point. The only exception to this is short horizontal runs of drain piping less than five (5) feet (1.5 m) in length.

This exception does not apply to horizontal runs serving sinks or urinals. Once a cleanout is installed at the upper end of a horizontal drainage line additional cleanouts are required if the length is a straight run which exceeds one-hundred (100) feet (30.5 m) and in which case a cleanout is required at intervals of not more than one hundred (100) feet (30.5 m) between cleanouts. Also, a cleanout is required for each change of direction if the total aggregate change exceeds one hundred and thirty five (135) degrees.