WHAT YOU CAN DO

FIREFIGHTERS

The burning of PVC releases acidic fumes and dioxins. Case studies have revealed that the corrosive hydrochloric gas generated from burning PVC can cause death quicker than the actual flames. The dangers from burning PVC has led to many restrictions of its use in public buildings.

- Ask your union to lobby for a PVC-free policy in your community.
- Ask for dioxin sampling in burned out areas and surrounding neighbourhoods and make sure the public is adequately protected.
- Ensure adequate protection for firefighers attending fires involving PVC.

TL: PVC FIRES LIST
SO: Compiled by Greenpeace
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This is a list of accidental fires that have involved the synthetic material polyvinyl chloride.

In all of the fires, PVC was only one of many materials that burned. But in most cases it is clear that if polyvinyl chloride had not been present, the fires either would not have started, would not have emitted life-threatening gases and chemicals, or would not have spread at such a rapid rate.

The list of fires is divided into four sections which describe the different hazards of burning PVC:

a) Dioxins
b) Hydrochloric Acid
c) Fire Spread
d) Electrical Wiring and Cable Insulation

Any given PVC fire might have elements of all four hazards, but for this list a fire was included in a particular hazard section because that hazard was dominant in increasing the tragedy level of the fire.

The sections are also in the order of data availability. For example, there are few accidental PVC fires for which dioxin data is available. Even though all PVC fires will create dioxin, these are the only ones I know of that have been tested and confirmed. I came across not one incident where dioxin tests for burned PVC came up negative.

On the other hand, it is easy to find incidences of electrical wiring/cable fires. However, detailed information is limited. But if it can be concluded that PVC was involved in a wiring/cable fire, one can only infer that the fire spread rapidly, released hydrogen chloride in the smoke, and left dioxin in the ash.

SMOKE INHALATION

The majority of fire deaths are due to "smoke inhalation". Traditionally this has meant carbon monoxide poisoning, but in modern fires, where sythetic materials release a variety of poisonous gases, the general diagnosis of "smoke inhalation" is vague and insufficient. (Journal of the American Medical Association citation)

Therefore, even though it's proven that PVC emits HCl, the PVC industry can argue there is no proof that PVC is responsible for "smoke inhalation" deaths.

It has been possible to measure the lung tissue of a victim to find if they had a lethal dose of either carbon monoxide or hydrochloric acid before they died. However, even if the victim did not have a lethal dose of HCl he could have been incapacitated by the HCl, then died of carbon monoxide poisoning afterward.

Unfortunately, though, it appears that unless a lawsuit is filed, a death diagnosis of "smoke inhalation" is usually not investigated, and is assumed sufficient.

BACK TO THE LIST

At the beginning of each section there are citations describing the PVC fire hazard in question.

At the end of the list there are two pages describing a) the increasing proportion of smoke deaths to fire deaths in structural fires and; b) the danger of fire retardants in prolonging the pre-combustion low-temperature decomposition stage of a fire.

PVC FIRES: DIOXINS AND FURANS

Besides the acidic hydrogen chloride, a wide variety of chlorinated and non-chlorinated organic chemicals evolve from PVC during high temperature pyrolysis and combustion: benzene, toulene, formaldehyde, chloroform, chlorinated biphenyls, dioxins and dibenzofurans, and many others.

The emission during fires of benzene, chlorinated dioxins, and dibenzofurans - known carcinogens - appears to explain the high frenquencies of leukemia, laryngeal and colon cancer, and of the rare soft tissue cancers found in many firefighters at relatively young ages.

One of the trace constituents rarely described is PVC pyrolysis/combustion products in the dioxin/dibenzofuran family. The soot most commonly analyzed in these experiments is generated at high temperature in a helium atmosphere. Dioxin and dibenzofurans require presence of oxygen for formation. They are formed during cooling of gases and soot. Thus, sampling of the hot soot right off the materials, especially material burned in a helium atmosphere, precludes finding them.

Source: Wallace, Deborah. PhD In the Mouth of the Dragon: Toxic Fires in the Age of Plastics. Avery Publishing Group: Garden City, New York. 1990.

Test results demonstrate that in case PVC-containing materials take part in combustion processes PCDF/Ds can be found in the decomposition products in considerable concentrations. Therefore, the results confirm the classification of PVC- containing materials as PCDF/Ds precursors.

In samples from real fires total PCDF/D contents were found mainly in the ppb concentration range, whereas samples from the laboratory combustion tests showed total contents in the ppm range.

The combustion of hard-PVC yielded the highest total PCDF/D concentrations in the generated products followed by combustion of PVC-fibre material and soft-PVC.

In nearly all investigated combustion products the FRG-limit of 5 ppb was exceeded.

Source: J. Theisen, W. Funke, E. Balfanz, and J. Konig. Chemosphere, Vol. 19, Nos. 1-6, pp 423-428, 1989.

PVC FIRES: DIOXINS AND FURANS (Examples)

ST. TERESE, MONTREAL, CANADA

July 1993

A fire destroyed a plastics plant Plastibec Ltd, 30 km north of Montreal. The firm is owned by Royale, Inc., which distributes prefabricated houses made almost entirely of PVC. The fire began just after midnight. Firemen gained control of the blaze shortly after 8 am, but smoke continued to billow over the leveled plant. The fire forced 250 people from their homes and burned for 18 hours, producing thick, black, corrosive smoke. St Terese's two elementary schools were closed the next day.

The fire consumed about 15,000 kg (15 tons) of polyvinyl chloride in the factory, which manufactures vertical blinds. The Plastibec plant was Quebec's biggest maker of extruded vinyl window frames, a major producer of vertical blinds, and a plastics recycler. It has about 120 employees.

The Quebec Environment Ministry released test results showing ash from the fire was contaminated with high levels of dioxins and furans, toxic by-products of the combustion of polyvinyl chloride plastic.

The tests found dioxin and furan concentrations in the ash of 18.441 parts per billion/kg, while the soil itself contained 0.55 ppb. Stephane Gingras, Greenpeace campaigner, said of these test results, "This is very serious, not only because of the concentration, but because of the amount produced. This fire produced between 40 and 85 grams of dioxins and furans - the equivalent of that produced by the pulp and paper industry in a year."

The ash from the accident was continually hosed to prevent it from dispersing and the water was collected and disposed of as hazardous waste. A three-week cleanup operation was expected to cost the company at least CAN$ 200,000. It involved trucking the ash and contaminated soil to a toxic waste disposal site outside Quebec.

About 50 firefighters were called out. At least six were treated for smoke inhalation. Thirty firefighters required medical treatment because of the fumes.

The health authorities have sent a warning to the association of Quebec police and fire directors, laying out special measures to be taken when fighting polyvinyl chloride fires in the future.

sources: Gouvernement du Quebec; The Globe and Mail; Canada Newswire

MICROPLAST, LENGRICH, GERMANY

October, 1992

Microplast, a PVC recycling company caught fire. The German environmental protection agency (UBA) found concentrations of 13,700 nanograms of dioxin per kilo (13.7 parts per billion) in residues coming from the Microplast warehouse.

As the company was situated in a rural area, the UBA analyzed agricultural products in the region, and discovered dioxin concentrations exceeding the permitted limits of 5 nanograms per kilo (5 parts per billion).

EUROMAT, DIEST, BELGIUM

27 and 28 November 1992

A fire completely destroyed the PVC factory, Euromat, which produced PVC granules for cars, cable, shoes, and the medical industry. Experts estimate 100 tons of PVC burned. Most of the fire was extinguished after four hours, but the area had to be hosed down for one and a half days. Because the fire continued burning under the cooled plasticized melting surface layer, new outbursts would occur.

Firemen used no protective clothing except for gas masks. 211 people were evacuated from the surrounding area. No government or industry samples were taken and no investigation was done in the neighborhood for damage on vegetation or health.

Independent samples showed levels of dioxins and furans in fire residues as high as 87.750 ng/kg (.087 parts per billion) of all dioxins and furans.

HOLMSUND, SWEDEN

January 10, 1987

A fire occurred in a plastic carpet company in Holmsund, outside of Umeaa, Sweden.

A report was given on the emission of polychlorinated dioxins and polychlorinated dibenzofurans into the surrounding environment after a fire at a plastic carpet company.

The wooden warehouse, containing 200 tons of pure polyvinyl chloride (PVC) and 500 tons of plastic carpets, was completely burned out. Both polychlorinated dioxins (PCDDs) and dibenzofurans (PCDFs) were recovered as pyrolytic products of PVC. Due to the low outdoor temperature of minus 30 degrees Celsius, an inversion layer was formed and the heavy, pungent smoke containing hyrochloric acid remained close to the ground over the surrounding area, including part of a nearby village an out over the Gulf of Bothnia.

Two days after the fire, wipe samples were taken from three parts of the facility that had been filled with smoke. Samples were taken of the snow at six locations 10, 30, 100, 300, 1000, and 1500 meters downwind of the facility and also from five locations that were not downwind. Samples were prepared with radiolabeled PCDD and PCDF isomers and extracted. Toxic equivalent factors (TEF) of tetrachlorodibenzodioxins (TCDDs) and tetrachlorodibenzofurans (TCDFs) were estimated using the Eadon model and the Nordic model. The TEF of TCDD showed a deposition of less than 3 milligrams within 1500 meters from the fire site. The Nordic model showed TEFs higher than those estimated by the Eadon model for all TCDDs and TCDFs calculated.

The authors conclude that the pattern of PCDDs and PCDFs found in the samples obtained after the fire was similar to the pattern seen in a munical waste incinerator with an emission rate of one milligram per hour of dioxins. source: Chemosphere

STONY BROOK, NEW YORK

September 26, 1986

Polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) were detected in soot from a building fire involving PVC and a source of chlorine.

The fire occurred in the early morning hours in an internal room of an unoccupied lecture center building at the State University of New York at Stony Brook. The investigation and cleanup that followed resulted in the detection of dioxins and furans in the deposited soot.

The fire started in a concrete room which was being used as a storeroom for custodial supplies and was extinguished approximately one hour after it started. It was reported that the fire consumed 20 boxes of abrasive floor scrubbing pads, trash bags, PVC floor tiles, quaternary ammonium chloride cleaning solution, part of a desk, a chair, a wooden platform structure, and paper products. Intense heat melted several stacks of plastic chairs, a plastic waste container, a plastic covering on a stereo set, and electrical wiring in a circuit box. Due to discomfort experienced by students who used the lecture hall in the post-fire environment, an extensive series of environmental tests were taken. Results showed dioxins and furans and resulted in the closing of the hall for cleanup.

Although sampling for dioxins and furans did not take place until several months after the date of the fire, the results for 2,3,7,8-TCDD Equivalents were 3.406 ng/gram (EPA) and 5.952 ng/gram (New York State).

STE JULIE, MONTREAL, CANADA
September 2, 1993

Hydrochloric acid was released into the air after 7 tons of PVC went up in flames at Novatech Glass Inc, 50 km southeast of Montreal. The company uses PVC parts in their manufacturing process.

No residents were evacuated, however they were told to wash their garden produce.

Sampling contracted by Novatech showed that the highest level of dioxins and furans in the ash were at 0,0051 ng/kg.

The clean up was executed with all the preventative measures normally used with heavy dioxin contamination.

The fire started just before 9am when a hose attached to an oven broke and sprayed phosphates onto a neon lamp.

Several of the 100 employees at Novatech's Murano St. plant were on the job, but noone was reported killed or seriously injured. At least one worker complained of burning eyes and throat.

No homes, schools, or other buildings were evacuated in Ste Julie. However, officers did drive down residential streets in the area and, using megaphones, urged residents to stay inside with the doors and windows shut.

It took firefighters 20 minutes to arrive on the scene. It took reinforcements another hour to arrive.

Soon after the fire started, the building was rocked by a powerful explosion that sent a fireball into the sky.

By 11 am health and safety officials feared that up to 150 homes and three schools located near the burning plant might have to be evacuated. But the call to evacuate - it would have been made by environment and health officials in consultation with the mayor and police - never came. "We don't want to create a state of psychosis," said Helene Laurin Tardif, acting mayor.

By mid-afternoon the factory was a smoldering wreck, most of its interior gutted. The flames were out, but smoke still poured from the ashes.

Chemicals, such as chlorine, phosgene, dioxins and furans, and hydrochloric acid had been released into the air.

source:The Gazette, LeDevoir, Novatech

FRANKFURT, GERMANY
Hoescht Chemical Plant
March 17, 1993

German chemical firm Hoescht AG said that explosions at its main plant in Frankfurt may have freed the cancer-causing compound dioxin. "Most likely only trace elements of dioxin, if any at all, were released when PVC panels on the building in question were burned," a Hoescht spokesman told Reuters.

Greenpeace activists were denied access to the plant's grounds when asked if they could carry out tests for dioxin created when the fire burned wall panels made of the plastic PVC.

One worker was killed and another was seriously injured in the blast, which sent a black cloud over nearby suburbs.

source: Reuters

PVC FIRES: HYDROCHLORIC ACID

PVC can kill before it ever reaches its temperature of combustion.

The normal aging process of synthetic polymers is called chemical decomposition. Increased heat can also cause decomposition.

The deadly acid gas hydrogen chloride (HCl) (in aqueous form called hydrochloric acid) comes off PVC so quickly and so easily that polymer scientists call it "unzipping."

The early stages of a fire include interrelated chemical and physical degradation.

Many of us consider flames the signal that a fire has begun. Combustion scientists think of a fire as beginning long before actual flame is present. Flame results from a process that begins with a relatively low level of heat. With plastics, the first stage of a fire is invisible; heat causes the molecules to slip and slide, and causes a great acceleration of the aging processes of oxidation, flowing and the loss of additives. Eventually, the heat builds to the softening point, then the melting point.

With PVC, by the time combustion begins, the peak of hydrogen chloride release is usually past.

As the temperature rises, the decomposition accelerates. The temperature eventually reaches a special level called the temperature of quantitative decomposition during which large and predictable quantities of gases are emitted by the polymer.

The 480 degree Farenheit (250 degree C) oven temperature used to roast a chicken on a vertical rack will quantitatively decompose PVC and release clouds of hydrogen chloride. Yet PVC does not actually burn until it reaches about 1112 degrees F (600 degrees C).

Once the decomposition temperature is reached, lethal concentrations of hydrogen chloride appear within two to three minutes at a distance of one to two feet from a four-ounce piece of PVC. The plastic becomes a true toxic hazard during quantitative decomposition when there is no flame to warn anyone who may be nearby.

As HCl is heavier than air, heat is the only reason for the rising HCl plume from decomposing PVC.

Potentially 58 percent of the weight lost by rigid PVC during the various fire stages can be attirbuted to hydrogen chloride.

Wallace, Deborah. In the Mouth of the Dragon

PVC FIRES: HYDROGEN CHLORIDE

(Examples)

DALE CITY, PRINCE WILLIAM COUNTY, VIRGINIA, USA

April 9, 1992

Faulty electric cable wrapped around water pipes to prevent freezing apparently set off a blaze that killed a Dale City woman and her two sons.

The cable, called heating tape, which is used by thousands of homeowners to prevent water pipes from freezing, is involved in 2600 fires each year, resulting in an estimated 20 deaths, 110 injuries and $24.8 million in annual property loss, according to officials of the US Consumer Product Safety Commission.

The fire at the Elm Farm Trailor Park in the 3500 block of Davis Ford Road killed Lillie Tompkins, 37, a school bus driver, and her two sons, Benjamin, 13, and Adam, 16, and spread to three other trailors, burning out the interiors of two. It caused $120,000 in damage.

The investigation showed that the heating tape ignited a plastic water shut-off valve and the flame spread to PVC piping, which produced toxic smoke and gases.

The toxic smoke entered the trailor toward the rear, fire officials said, close to the bedroom where the teenage boys slept with the door closed, allowing the fumes to concentrate. It is likely the youths were overcome by fumes early.

Bradley Tompkins told officials that he and his wife ran to the boys' room and were unable to open the door.

Outside, Lillie Tompkins broke a window to the boys' room and tried unsuccessfully to climb in. As her husband worked on the outside, she pulled away from neighbors holding her back and ran inside the burning trailer.

"When she went back through that door she had pretty much sealed her fate," an official said. "Witnesses told us fire was around the door when she went in."

source: The Loudon Times

CAMDEN, NEW JERSEY

September 10 1992

Over 100 people were evacuated from a four-block area for about seven hours after a fire at the Custom Mill recycling plant. Ten firefighters and police officers were examined for exposure to polyvinyl chloride. A pallet with 50 50-pound bags of PVC caught fire in the Custom Mill building, apparently as a result of a breakdown in processing. The product is received in granular form and the plant pulverizes it into powder. The bags contained the powdered form. The burning PVC created hydrogen chloride gas, which burns the eyes, nose and throat. Four firefighters were treated at a local hospital and released.

source: Camden newspaper

EAST CALGARY, CANADA

July 24, 1991

Smoke from a potentially lethal landfill fire blew over the town of Forest Lawn. During the first few hours of the fire, a hazardous materials response unit tested the potentially toxic smoke every 10 or 15 minutes for dangerous chemicals.

"We could have every kind of chemical they make in there right now and even a chemist wouldn't know what kind of chemicals could be released when they burned together," said Capt. George Hemming, spokesman for the Calgary fire department.

Early samples showed the presence of polyvinyl chloride. Firefighters and hazardous waste specialists were equipped with special breathing devices to protect them from chemicals that might be released. The fire burned for at least 24 hours.

source: Calgary Herald

GARY and HAMMOND, INDIANA
February 11, 1993

At 5:00 am as many as 6,000 people were told to evacuate their neighborhood because of a fire in an auto junkyard called H&H Dump. "Auto Fluff", which is used in cars, is mostly PVC, therefore emits toxic gases when burned.

Officials also blocked off Clive Avenue, a major artery for commuters to jobs in northwestern Indiana and nearby Chicago.

To avoid runoff of hazardous chemicals, hazardous materials experts of the Indiana State Police and the US EPA sought earth moving equipment to bury the fire instead of extinguish it with water or foam.

source: UPI report, Greenpeace Investigation

BOSTON, MASSACHUSETTS
July 2, 1975

A rush-hour fire in an underground trolley car was a nightmare for passengers and firefighters. There were no firefighting facilities within the tunnel, so the Fire Department had to stretch the hose lines in from the street. Nearly 400 passengers from the burning train and two other trains in the tunnel left the tunnel on foot safely. However, 34 fire fighters were hospitalized for possible inhalation of smoke from burning plastics, including PVC asbestos floor tiles, in the train cars.

Since the fire was near Boston's border with the town of Brookline, both jurisdictions' fire departments sent apparatus. They were met not only by hot, smokey fire, but also found some passengers still groping their way through the smoke to the station.

As a precaution, 62 members of the Boston Fire Department and 13 members of the Brookline Fire Department reported to the Boston City Hospital for examination for fear of possible inhalation of smoke from burning plastics. Twenty-one of the Boston firefighters and 13 firefighters from Brookline were held overnight.

source: Fire Journal

MGM Grand Hotel, Las Vegas, Nevada
November 21, 1980

The MGM Grand Hotel occupied a city block and rose twenty six floors. The design and operation of the hotel violated codes and practices for smoke control.

Among other synthetics, the hotel had a plenum (space between the casino ceiling and the floor of the first

story) that contained PVC drainage pipes (tons of plastic), and a vast electrical network, with all wires insulated in PVC plastic. Wallcovering, rigid moulded furniture, and fake leather upholstery also contained PVC.

PVC, which decomposes readily, existed in the same environment in the casino as ABS, which burns readily and emits hydrogen cyanide, and as PMMA, which burns readily and emits methylmethacrylate, which is its monomer and an irritant and nerve poison. In general, combined dosing has proven worse than single-type dosing, toxicologically.

The fire started at 7:30 am in the casino deli electrical system. The fire spread to the plenum igniting the sythetic materials. A fireball ,raced through the 200 yard long casino. The plastics hidden in the wall and ceiling determined the fireball speed and direction in only a few minutes.

What was unusual about this fire was the smoke: its quality, quanitity, density and the number of people it killed.

The most striking fact about about the MGM fire was that the great majority of those killed (61 out of 85) died on the 19th through the 26th floors of the hotel.These victims were as far away from the fire as they could be and still be in the building. The smoke had risen to the top floor, accumulated, and sunk downward, then up out of the building top. Control over the fan system was lost when its PVC tubing melted in the early stages of the fire, so the fans continued to push smoke around the building.

Most of the people who died on the bottom floors died of smoke inhalation before they burned. Forty seven percent of all victims showed a sublethal level of carbon monoxide in the lungs. The avenues of the fire spread to the top floor included the air handling system, the elevator shafts, the seismic joints, the fire stairs, the electrical and plumbing systems, and even the broken windows on the windward side of the building.

Over 500 were injured. Some of them had neurotoxic reactions totheir exposures. Many of the injuries, which were also incurred by firefighters were respiratory problems, sleep difficulty, irritability, depression, skin sensitivity and dryness, and problems with microcirculation in the extremities.

Attributed to chlorinated hydrocarbons were: uterine dysfunctions, excessive sweating, muscle spasms and shaking, skin rashes, acne and discolorations. Some of the strongest symptom patterns were psychological. Depression, irritability, nightmares, inability to concentrate, and relational problems with friends and family were common in survivors. Irritants and hydrocarbons both have been found to influence psychological function, especially through the catecholamine system.

In some of the victims, the red blood cells had completely disintegrated. The destruction of red blood cells has been seen in victims of other plastics fires and in lab animals exposed to PVC fumes. Hydrogen chloride destroys oxygen-carrying hemoglobin, the protein that forms the major content of red blood cells.

Some of the elements in the soot found in the lungs of the victims appears to be from PVC products: antimony, zinc, and lead, iron, chlorine, nickel, calcium.

It was concluded that the synthetic polymeric products in the casino were the source of the soot found in the rooms and in the victims broncii, because wood does not contain these elements in large quantities. It was also concluded that at least some of the soot came from the PVC products, specifically.

Sixty-one people died twenty stories above the fire from soot and fumes given off by burning plastics in the ground floor casino.

Source: In the Mouth of the Dragon by Deborah Wallace

PVC FIRES: FIRE SPREAD

When the fire does ignite, the combustible gases emitted during decomposition flare rapidly, and the fire spreads quickly.

Wallace, Deborah. In the Mouth of the Dragon

PVC FIRES: FIRE SPREAD (Examples)

SARATOGA SPRINGS, NEW YORK
Wilmarth Hall, Skidmore College
5 April 1976

A fire in a three story dormitory left one person dead. Sixty people were treated and released from the hospital and 23 others were hospitalized, some in serious condition.

The walls in the dormitory were covered with a vinyl wallcovering that had been painted.

At approximately 4:00am a fire started in the first-floor trash- holding closet. The fire quickly spread to the corridor through the louvre in the door.

First-in firefighters observed that the only fire they found was in the trash-holding closet. At the same time, due to the intense heat, extensive quantities of smoke were being given off by the decomposing vinyl wallcovering and the carpeting.

Once the fire reached the hallway, the only fuel for it was the carpeting and the vinyl wall covering. The destruction of the wallcovering was considerable throughout the south end of the building.

Smoke spread between floors mostly by way of the air-handling system. Several shafts also showed evidence that they had carried smoke to the upper floors. Most of the students on the second and third floors stated that the smoke there was extremely thick, and that the only evacuation route was through the windows.

Two women who were trying to escape were incapacitated by the smoke. Firefighters searching building found them unconscious in the lobby.

The occupant of Room 117 was apparently trying to get dressed when she died of smoke inhalation.

source: Fire Journal

CAMBRIDGE, OHIO
July 31, 1979

Ten people died and another 82 were injured in a fire at a Holiday Inn. The fire was almost a carbon copy of the Holiday Inn fire that killed ten in Greece, New York on November 26, 1978.

In both cases, the primary factors that led to deaths were combustible interior finish, unprotected verticle openings, and inadequate notification of the occupants.

The interior wall covering of the guest room wings included two types of combustible vinyl. A plain vinyl was used on most the corridor walls. Around guestroom doors, a striped vinyl material was utilized. Under these solid vinyl wallcoverings were several thicknesses of material, which included vinyl, fabric and paper. The surface vinyl materials behaved quite differently during the fire incident. The striped vinyl melted, dripped, and burned, while the plain vinyl burned in place.

The nylon shag carpeting also contributed to the fire.

At the time of the fire there were approximately 200 registered guests in the 107 rooms of the hotel. Only four of the guest rooms were unoccupied.

The fire was discovered at 3:25 am by two people playing a pinball machine in the passageway that connected the guest-room wings and the lobby-restaurant area. They smelled smoke and saw it traveling at ceiling level in the guest-room corridor, which was visible from the passageway.

Fire growth and development was rapid. The fire apparently started in the corridor on the first floor. The shag carpeting and combustible wallcovering ignited and spread the fire, producing heavy smoke. The fire and products of combustion traveled horizontally down the corridor and then into the open stairway. The fire quickly spread up the wallcovering of the stairway and down the second floor corridor of the north wing.

Apparently hotel room occupants became trapped in their rooms fairly early in the fire, and thus attempted to escape through heavy plate glass (difficult to break) exterior windows. There were no survivors who used the corridors for evacuation. There was not a great deal of flame in the building, but there was a moderate amount of heat.

Besides injuries related to escape methods, survivors had smoke inhalation injuries.

The county coroner listed cause of death for all ten fatalities to be smoke inhalation and carbon monoxide poisoning. One of the victims died in a hospital four days after the fire. All of the fatalities were on the second floor in the north wing corridor.

Where it was not burned the striped vinyl wall finish had pulled away from the wall and melted throughout the north wing. The plain vinyl burned and charred in place in the area of fire origin, the stairway at the northend, and partly into the second floor.

The initial fire development created untenable conditions in the corridors before the manual alarm system was activated.

Source: Fire Journal

New York, New York
February 13, 1975

The World Trade Center consists of two 110-story towers that rises from a large shopping and business complex.

This fire emphasizes the hazard of nonfire-stopped vertical cableways and the additional problems created by combustible cable insulation - in this case, polyvinyl chloride. Were it not for these two problems, there would have been no vertical spread of this fire.

Shortly before midnight a fire was discovered on the eleventh floor of the North Tower of the 110-story World Trade Center in Manhattan. The fire spread vertically up and down PVC insulated telephone cables. More than 125 men fought the fire, and 28 sustained injuries. The loss was estimated at over $1 million.

At 11:55 pm, a cleaning crew on the eleventh floor reported to the command center that smoke was emerging from an office suite on that floor. The command center notified the NYC Fire Dept. The first fire-fighting crews to reach the floor were met by very heavy heat and smoke. They found the fire involving the southeast corner of the floor. More than 125 fire fighters with more than 20 pieces of equipment responded. It was discovered that fire was spreading vertically both up and down along a set

of PVC insulated cables. Although the fire traveled as high as the 16th floor along these cables, fire-fighting efforts essentially contained the fire to the telephone closets on each floor.

Feeding on the contents of the office areas, the fire severely damaged about 20 percent of the eleventh floor area, the floor of origin. There was extensive damage to the telephone equipment. The walls and doors to the core area prevented the fire from entering the core and were still intact after the fire. Since the walls to Suites 1107 and 1109 did not penetrate the ceiling, fire entered these two suites and did considerable damage.

The fire started in a file room. The fire spread not only within the office suite on the 11th floor, but also into the telephone closet, where it ignited plywood, plastic terminal strips, and PVC insulated wire. Once the large PVC insulated cables were ignited, there was nothing to stop the fire from spreading. The fire spread downward to the tenth floor, where it burned out the telephone closet on that floor and did some damage to the area near the closet. The fire burned upward as high as the sixteenth,floor, and created minor damage to the area near the closet outside the twelfth floor.

Source: Fire Journal

FORT WORTH, TEXAS

Fort Worth Ramada Inn
June 14, 1983

In the early morning hours, a pile of new carpeting ignited. Helped by synthetic interior finishings, including vinyl wall covering along the corridor and stairwell, the fire spread quickly throughout the hotel. The vinyl wallcoverings showed a burn pattern that indicated heavy decomposition and charring during the early part of the fire, when flames were confined to the piles of carpet.

Five people were killed in their rooms. By the time flames actually threatened rooms and their occupants, the occupants had either escaped through the windows or died from smoke inhalation. At the time of incapacitation leading to death, the major fuels were carpet, carpet padding and the vinyl wallcovering.

All survivors were out of the hotel within a few minutes after the fire was discovered. Even so, 36 people had to be treated for smoke inhalation, symptoms including abnormal blood gases and blood PH, breathing difficulties, headache, blood pressure instability, and heartbeat irregularity.

The vinyl wallcovering along the stairwell, exposed to growing heat and chemicals of pyrolysis and combustion, began to emit hydrgen chloride and plasticizer, a highly combustible organic compound. A cloud of thermal products began to move laterally along the ground floor and second floor corridors. This cloud contained carbon monoxide, hydrogen cyanide, and nitrogen oxides from the carpet; and hydrogen chloride, plasticizer, and possibly styrene and various hydrocarbons from the padding and wallcovering.

Source: In the Mouth of the Dragon by Deborah Wallace

PVC FIRES: ELECTRICAL WIRING AND CABLE INSULATION

When PVC is exposed to even low levels of heat decomposition can occur, which releases the combustible gas, hydrogen chloride. If heat reaches high enough levels the concentrated gas ignites and spreads fire rapidly across wiring and cables, which are usually stored together, and which can be spread throughout a building uninterrupted.

PVC FIRES: ELECTRICAL WIRING AND CABLE INSULATION (Examples)

SUFFOLK, NY, USA
December 28, 1991

A fatal subway fire trapped 900 straphangers in a smokey tunnel where two people sustained fatal injuries and 148 more suffered smoke inhalation. Two died, one of a heart attack, and the other, who had a history of asthma, of smoke inhalation. In addition, 188 riders suffered injuries, mostly from smoke inhalation. Passengers were trapped in the train for 36 minutes. Four people who had been trapped on the train described the incident as a nightmare that seemed to have no end, telling of passengers vomiting, having heart attacks, gasping for air and trying to break windows to escape the reddish-brown smoke created by burning PVC.

There was a five-minute gap between the time train operators tried to contact the TA command center and when the command center received word of the blaze. Although no samples were taken at the time of the fire, the city ordered McDogell Owens, specialists in researching fires and explosions, to analyze materials from the fire.

Attorneys for 40 people sued the TA for trapping them in the Clark Street tunnel, seeking a total of $15 million in damages on the basis of their fear of exposure to toxic, cancer-causing polyvinyl chloride burned in the exposed piece of cable. One claimed that TA was negligent "in failing to have a proper evacuation plan and a delay in the rescue attempt."

The cable that is believed to have caused a short circuit and started the fire was encased in PVC. The smoke that poured through the IRT tunnel after the short circuit explosion came from the burning PVC that insulated the cable, the cable itself and the wooden cover over the subway line's third rail.

A similar fire involving halogenated wire occurred in the Port Authority Subway System in 1982. The City Council President Carol Bellamy's response was to seek the removal of PVC from the subway stations, citing its potential to emit deadly fumes during a fire. At the time, an environmental physiologist, Deborah Wallace, warned that the combination of PVC, the increasing number of track fires and problems with subway doors "renders the public unsuspecting sitting ducks."

According to Metropolitan Transportation Authority figures, there were more than 3000 fires in the system in 1981.

Since then environmental groups, riders advocates, and unions have petitioned the TA to replace the PVC with newer and more chemically stable compounds.

The Transit Authority declined to follow Ms. Bellamy's suggestion, saying it did not consider the presence of PVC to pose a hazard. But the authority also said in 1982 that it did not plan to use the material in future wiring projects.

TA spokesman Bob Previdi said TA has been replacing the PVC with new materials as part of its normal replacement schedule since 1988.

Transit Authority blamed the blaze on the Brooklyn Heights neighborhood where it occurred, saying that debris left by homeless people was the cause. They also claimed the opposition by neighborhood groups to the location of a new electric power substation in the Brooklyn Heights neighborhood kept the Clark Street station from being modernized sooner, which would have prevented the fire.

Wallace said victims probably were exposed to 500 ppm of PVCs in the fumes they breathed. The federal government says more than 5 ppm over a fifteen minute period is dangerous.

No air samples were taken, instead the length of the PVC cable burned was measured to determine exposure.

Sources: New York Times; Newsday

NEW YORK TELEPHONE EXCHANGE BLAZE, NY, USA

February 27, 1975

At 12:18am a fire broke out in cables leading to a major New York Telephone switching station in lower Manhattan. Seven hundred firefighters worked for 16 hours. 300 were sent to the hospital and the neighborhood was enveloped in a thick, acrid smoke plume that sent hundreds to seek medical help.

Months before the fire, a combustion chemist/engineer circulated a report around AT&T alerting executives to the potential fire problems at the switching exchanges. His predictions were based on the building design and the enormous concentrated amount of plasticized PVC cable sheathing and wire insulation.

The official Fire Department report lists 239 FDNY employees injured during the fire. One man died of a heart attack two weeks later. His autopsy revealed older, heavy deposits of greasy soot that had eaten its way completely through the lung on the pleural side. At the time of the death he still had lungedema, and he had dead patches on the lung.

Others became sick later. Delayed symptoms from inhalation of smoke from PVC or Teflon sometimes resemble flu, and firefighters may not have connected their "flu" with this fire.

A later survey of the injured firefighters showed other symptoms including acid-burned respiratory tracts, eyes and skin; inability to get enough oxygen because of lung damage; loss of control over limbs; impairment of the whole perception process; nausea and feelings of weakness and exhaustion; and confusion and disorientation.

Two of the men surveyed later died of rare cancers - one from a brain tumor and one from liver cancer. A third was the only ,firefighter who sued, because his lungs were so damaged that at the time of his court date, they were functioning at only 50 percent of what was normal for his size and age.

Sixty four percent of the firefighters reported permanent effects. The most common complaints included impaired disease resistance, coughing, hoarseness, sensitivity to smoke, asthma and repetitive bronchitis.

PVC in the stage of decomposition and combustion can deliver an acute dose of toxicants which result in permanent serious injury and even delayed fatalities.

If a local building code allows large quantities of PVC in a building, the fire department and other city agencies must budget and plan for major disaster, including the hospitalization of hundreds of people at a time.

Source: In the Mouth of the Dragon by Deborah Wallace

SMOKE INHALATION DEATHS INCREASING IN PROPORTION TO BURN DEATHS IN STRUCTURAL FIRES:

Approximately 467,000 residential structural fires occurred in the United States in 1990. These fires are estimated to have caused 4,115 deaths, 20,560 injuries, and $4,253 billion in property loss. When compared to similar data available since 1980, fire incidence decreased 38 percent and fire deaths declined 25 percent, but fire injuries were reduced only 2 percent.

Data shows that between 1979 and 1985 the 17 percent decrease noted in total fire deaths was accompanied by a 34 % drop in fire burn deaths and a 6 % decrease in smoke inhalation deaths. Their analysis

indicates that smoke inhalation deaths accounted for about two-thirds of fire deaths compared to almost one third for burns. As a possible explanation for the relative increase of smoke inhalation deaths over burn deaths, the authors suggest that the furniture and building materials used today may produce smoke which is generated faster and is more toxic than that produced by materials used in the past.

Source: Toxicological Aspects of Firesmoke: Polymer Pyrolysis and Combustion. Rita A. Orzel, PhD. Occupational Medicine: State of the Art Reviews-Vol 8, No. 3, July-September 1993. Philadelphia, Hanley & Belfus, Inc. p. 415

According to the Consumer Product Safety Commission, an increasing proportion of all deaths from structural fires in the United States over recent years has been attributable to smoke inhalation. Between 1970 and 1985, for example, total deaths from structural conflagrations decreased from approximately 5,000 to 4,000 per year, while the number of deaths attributed primarily to smoke inhalation stayed relatively constant at about 3,000 annually. Studies elsewhere have estimated that about 30 % of all major burn victims suffer smoke inhalation injury, with corresponding estimates for fire fatality cases ranging up to 80 %. That smoke inhalation has come to be listed as the primary cause of death for nearly 75 % of structural fire deaths in the United States may reflect changes in coding practices, greater progress in treating cutaneous burns than inhalation injury, increased toxicity of fire smoke, or some combination of these factors. Changes in firesmoke toxicity, in turn, could result from changes in building materials, or consumer proucts.

Source: Clinical Smoke Inhalation Injury: Systemic Effects. Dennis J. Shusterman, MD, MPH. Occupational Medicine: State of the Art Reviews- Vol 8, No 3, July-September 1993. Philadelphia, Hanley & Beltus, Inc.

PVC FIRES: FIRE RETARDANTS

Materials can be modified using fire retardants; while these compunds can improve resistence to a fire they tend to make smoke production considerably worse.

Source: Firesafe Composites Design for Living. Bacon, M. Material Edge. No. 14, Nov/Dec 1989, p. 25/36. 1989

Most plastics have a number of chemicals added to them, such as fire retardants, stabilizers, lubricants, plasticizers, and colorants. These additives can only modify the problem somewhat. Fire retardants cannot alter the decomposition temperature-they can only delay the outbreak of flames. Generally, the gases emitted during the decomposition stage of a fire are more toxic than those emitted during actual burning. Thus, in many fires, the decomposition stage is the real killer. It is a killer because of its insidious and invisible nature, its high toxicity, and the long period of time between attainment of quantitative decomposition temperature and ignition temperature. In this respect, fire-retarded plastics are worse than non-fire-retarded plastics.

Source: Wallace, Deborah. In the Mouth of the Dragon

http://www.greenpeace.org/~toxics/wycd/cp-youcan6.html
http://www.greenpeace.org/%7Etoxics/reports/gopher-reports/pvcfires.txt