REPORT
ON THE
CLEVELAND CLINIC FIRE
CLEVELAND, OHIO
MAY 15, 1929

BY THE
NATIONAL BOARD OF FIRE UNDERWRITERS
85 JOHN STREET, NEW YORK, N. Y.

AND THE
OHIO INSPECTION BUREAU
HARTMAN BUILDING
COLUMBUS, OHIO
Fire in the Cleveland Clinic

May 15, 1929

Introduction

The Cleveland Clinic Foundation was established by Doctors Crile, Lower and Phillips shortly after the end of the World War. This institution is ordinarily considered as charitable but it is self-supporting, with a small income from an endowment fund.

The Foundation owns most of the property located on the west side of East 93rd street and extending from Euclid avenue south to Carnegie avenue. The clinic building, in which the fire occurred, is a four-story fireproof structure located on the northeast corner of the property and facing Euclid avenue, thus occupying the southwest corner of Euclid avenue and East 93rd street. The eight-story fireproof hospital and the other buildings are south of and well separated from the Clinic building.

The Clinic building is used principally for diagnosis and examination of patients. Patients register on the first floor and take the elevator or the front stairs to the main reception room on the second floor. From here they are sent to the various rooms for examination, diagnosis or minor operations and treatments. There are no bed patients, although anæsthetics are sometimes administered in the building.

The fire occurred in the busiest part of the day, between 11 A. M. and 12 noon, and it is estimated that about 250 patients and employees were in the building at the time. It is reasonable to assume that the only way the patients knew of leaving the building was the front stair well or the elevator and it was near these that so many lost their lives by gas. The rear stair well and elevator were cut off by flames.

Description of Clinic Building

This structure was erected in 1920 and was in good repair. Building is rectangular, 75 by 124 feet, and four stories high, with a basement under about one-third of the structure. Construction is reinforced concrete frame with brick walls and 8-inch tile roof between reinforced concrete joists. Floors are of the same construction as roof, the floor surfacing being both cement and wood. There is a large wired glass metal frame skylight, 30 by 38 feet in size, over an interior court, extending through the second, third and fourth stories, with an ornamental glass ceiling beneath the skylight. A smaller skylight, 11½ feet square, of the same construction, is located over the front stairs. Neither skylight had an emergency opening device. A 4-foot roof space is formed by a dropped ceiling of plaster on metal lath.

There are two elevators and two stairways in independent hollow tile shafts with tin clad doors having wired glass panels; stair doors were self-closing, but on some floors were held open by foot latches. Minor floorway openings consist of a dumbwaiter and record lift in metal lath and plaster shaft with manually operated vertical sliding hollow metal doors; two record lifts first to second in wood enclosures, doors not self-closing; one sheet metal fresh air intake shaft, from basement to louvres above roof, with metal enclosed fan and heating coils in basement; metal ventilating exhaust stacks from laboratories and toilets.

As shown on the attached plan of the basement 19 vertical pipe ducts or chases extended from a pipe tunnel on basement level, and several others from the machine room in the basement to the roof space. These pipe chases were apparently the principal means for the passage of gases throughout the building.
Partitions are metal lath and plaster, wood, gypsum block and tile construction. Wood trim was used throughout.

**Occupancy and Hazards**

The buildings contained the offices of the doctors on the hospital staff, office of the executive department, staff library, examination and treatment rooms, laboratories, pharmacy, small surgeries, art department and X-ray department. Apparatus of various kinds for diagnosis or treatment was kept in this building. In the basement were the pharmacy stock room, X-ray film room in which the fire originated, maintenance shop, and machine room. A large quantity of X-ray films was stored on the first floor in a room enclosed by tile partitions with opening to corridor protected by an approved class A fire door.

Two small low pressure heating boilers were installed in basement, but were no longer used. Steam for heating and sterilizing was piped from central boiler house 200 feet distant and distributed through the building by piping carried through pipe tunnel along the exterior walls as indicated on diagram of basement.

Light and power wiring was good, except for the use of pendant lamps in the film storage room. Smoking was not prohibited. Cleanliness excellent. No exposure.

**Description of Room in Which Fire Originated**

The room in which old films were stored was located on the west side of the basement adjoining the rear elevator shaft. This room had been used as a coal vault prior to the erection of the present detached boiler house in 1928. Walls were brick.

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View of Film Vault.—Film stored on shelves on left. High pressure steam line in center had leak above valve. In upper left and right corners are drop lights. Film stored on wooden shelving and also near steam line.
with one doorway to basement protected by an approved class C tin clad fire door hung in an angle iron frame. The closing device was not in operative condition at the time of the fire. The ceiling was tile between reinforced concrete joists. This room was about 19 by 24 feet in area and 9 feet high. There was a direct communication between this room and the 4- by 6-foot pipe tunnel which made a complete circuit of the unexcavated section of the basement and from which the pipe ducts extended through partitions to the roof space.

This film room was used also for the storage of iron pipe and fittings on wooden rack and in bins, for a few paper records on shelves just north of the pipe rack, and for a few old machine parts and empty cans in a small wooden cupboard. The principal use was for the storage of old nitrocellulose X-ray negatives in Manila envelopes, about three sheets of film to the envelope, on wooden shelves in ordinary steel files. There were three sections of wooden shelves with four shelves each, piled solidly with films stacked on edge. Each section of shelves was 18 inches deep, 6 feet high and 15 feet long. Two rows of three-drawer steel filing cabinets placed back to back ran parallel to the shelving; one-half of the drawers opening to the north were full of films, while those opening to the south were practically empty. The number of films in the room was unknown, even to the X-ray department employees; it is estimated that there were about 70,000 sheets, or 4,200 pounds, of film of all sizes, with some estimates of as much as 10,000 pounds.

Located near the ceiling of this room were water piping, two low pressure steam lines, and one 4-inch high pressure steam line. The steam lines were covered with ½-inch magnesia insulation. The high pressure steam line, carrying about 65 pounds pressure, entered the room from the south, ran to within 4½ feet of the north wall and within 7½ inches of the nearest film shelves, turned east to a point 8 inches from the east wall and then downward 4 feet and horizontally out through the east wall.

A coal chute, about 24 by 26 inches in size, opened into the room through a wooden door with a 24-inch cast iron manhole fitting on the outside. No means of outside ventilation were provided.

Light wiring was in conduit, with several pendant lamps.

Protection
The Clinic building was provided with a standard equipment of approved 2½-gallon soda-cream extinguishers. There were two 4-inch standpipes in the stairways with 75 feet of 1½-inch approved linen hose at each outlet on each floor. Steamer connections were provided for standpipes. There were no automatic sprinklers in any part of the building. Public protection is good, with adequate water supply and with fire department one-quarter mile distant.

Weather Conditions
At the time of the fire the weather was partly cloudy with a five-mile wind blowing from the west. Eddies caused by nearby buildings made the wind appear to be from the southwest. The temperature was 66° F.

Events Preceding the Fire
A leak had been discovered in the high pressure steam line in the film room in the basement. A steam fitter was called in to make repairs, arriving at the building about 9 o'clock; he discovered the leak in the northeast corner of the film room at the point where the 4-inch line turns downward. After removing about 14 inches of the magnesia insulation near the leak a jet of steam about 3 feet long issued from the pipe in the direction of the film rack against the north wall. The workman went to the power house to have the steam shut off and line drained and then returned to his shop to allow the line to cool. Two hours later, or shortly after 11 A.M., he came back to the film room where he discovered a cloud of yellowish smoke about 5 feet square in the northeast corner of the room near the ceiling. He immediately secured a 2½-gallon extinguisher from the machine room, which he emptied in the general direction of the smoke. The steam fitter was overcome by the fumes, fell to the floor, was revived by a draft of fresh air and started for the door of the room on his hands and knees. A slight explosion behind him threw him through the door into the machine room. He ran to the maintenance man who was working at a bench across the basement from the film room and together they made their way through a window and areaway out of the building. Another explosion occurred when the men were at the window. The building superintendent,
who was in the basement when the steam fitter called for an extinguisher, ran out to spread the alarm.

**Origin of the Fire**

Of the theories advanced as to the origin of the fire three are logical. The first is that decomposition of the nitrocellulose film was caused by the rise in temperature brought about by the uncovered steam line and by the leaking high pressure steam. Steam at 65 pounds pressure has a temperature of approximately 312° F.; decomposition in film starts at about 275° F. The film nearest the leak in the northeast corner of the room could be expected to decompose first and it was in this corner that the steam fitter found the cloud of smoke.

The second theory, and perhaps the most widely accepted, is that the films were ignited from an incandescent lamp attached to a portable cord suspended in front of the shelving in such a way as to start decomposition from the heat of the lamp.

Another theory is that a lighted match or a cigarette stub was dropped on or near the films by someone who had gone into the room shortly before the fire.

**Story of the Fire**

Alarms were turned in from several places by telephone. First alarm officially recorded was at 11:30 A. M., the second at 11:34 and the third at 11:44 from Box No. 315 at Euclid avenue and East 89th street, two blocks west of the building. The companies located at Euclid avenue and East 105th street, under Battalion Chief Graham, were first to respond. The odor of burning nitrocellulose was noticed several blocks east of the building, and the building was almost obscured by a dense cloud of yellowish brown vapor. A second alarm was sent in at once.

The first alarm brought two pumpers, one ladder truck, one rescue squad and two battalion chiefs. Second alarm brought two more pumpers, one more ladder truck, another battalion chief, and the second assistant department chief. Battalion Chief Graham ordered ladders raised on the west side of the building and began a circuit of the premises. Battalion Chief Flynn joined him at this time. Reaching the southwest corner of the building they saw fire through windows in the rear stair shaft and ordered a hose stream on it. A great volume of flaming gas was coming out of the two basement windows nearest the east side. On the east side the chief found the windows filled with people. No one had been seen at the west or rear windows.

At this time the order was given for a third alarm with specific instructions to send two more rescue squads. Chief Graham and a member of the rescue squad put on gas masks and tried to enter the building. They reached the front stair landing below the second floor but were forced out of the building by the concentration of the gases. An attempt was made to use an oxygen helmet, which failed because it was not properly adjusted on the man.

A 30-foot ladder was raised to the roof, and two firemen were attempting to reach persons in a window when an explosion occurred tearing out both skylights and parts of the ceiling of the fourth story. No explosion had been heard since the arrival of the department, a matter of some eight to ten minutes. The blowing out of the skylights liberated a vast cloud of brown vapor, clearing the building of gas; people then could be seen at all windows, which was the first time anyone had realized that so many people were in the building. The rescue work began in earnest. Men with stretchers, both firemen and volunteers, removed people from the inside and every available ladder was used in removing people from the windows. Victims were also lifted through the small skylight over the front stairs to the roof where attempts were made to revive them. Immediately after the explosion, fire broke out in curtains and light combustible material in six different places throughout the building. Various hose lines were put into operation, principally in the basement and in the rear stairway and elevator shaft, where the gases of decomposition were burning in a typical blow torch flame.

The rescue work continued. People were brought to the front lawn to be examined by Clinic physicians and rapidly dispatched to hospitals in every available vehicle. Approximately 250 people, doctors, nurses, employees and patients, had been in the building. By 1:15 P. M. everyone had been removed and the fire was out except for smouldering window frames and a little wood in the roof space near the rear stairs.
Rescuers found the dead and dying piled in the stair landings and in the hallways at the front elevator. By far the greatest number of victims were on the third floor. Life nets were used but very few people jumped from the windows. Most of those taken out of the building on ladders leaned out of the windows or hung on sills outside until rescued.

**Nature and Action of Gases from Decomposing Films**

The X-ray films stored in the room in the basement were the oldest of any films in the building. These films consisted of a sheet of nitrocellulose with a very thin coating of sensitized gelatin on one or both sides.

The products of decomposition vary under different conditions of temperatures and pressures; no one can say definitely just what gases were formed by the decomposition of the films under the conditions prevailing in the film storage room at the time. The following elements were all present in combination: carbon, oxygen, nitrogen, and hydrogen. From the results it is evident that the gases formed in the building included various combinations of these elements, the oxides of nitrogen and of carbon, and probably free hydrogen, as well as unstable compounds of all these elements.

The oxides of carbon would be the monoxide and dioxide. The latter is harmless but the carbon monoxide is a lethal gas as well as being inflammable and explosive. Approximately 30 per cent of the gases were carbon monoxide which contributed to the destruction of life as well as property.

Of the oxides of nitrogen it is probable that nitrogen peroxide was the only one present in any quantity. Nitrous oxide, if formed, would have no serious effect and probably would break down at the temperatures existing into its elements of nitrogen and oxygen. Nitric oxide, if formed, would be converted at once to nitrogen peroxide. Nitrogen peroxide probably constituted about 30
per cent of the gases and would cause death because of its corrosive action on the human tissues. In very dilute mixture it will produce headache and illness, and some authorities say that breathing 1 per cent of this gas in air will result in death. When this gas comes in contact with water it dissolves to form nitric acid and nitrous acid together; this is an oxidizing agent and burns the human tissues.

Although all the elements of hydrogen cyanide were present it is doubtful if the gas itself was formed during the reactions. Possibility of prussic acid, hydrogen cyanide and phosgene being present is remote.

The hydrogen present in the compounds constituting the original films may have been evolved either as a free gas which burned or exploded or combined with carbon or nitrogen. In any event it undoubtedly added to the combustible and explosive constituents.

Lack of air in the room prevented free burning of the film, hence a great quantity of gas was formed. The yellowish brown vapors rapidly passed out of the film room into the machine room and through the pipe tunnel up the pipe ducts and through the entire building. The gases must have been heated past their ignition point, hence flashed on contact with air. As the fumes became mixed with air they burned intensely in the rear stairway and elevator and in the southeast corner of the

inner skylight igniting gases confined in roof space or by ignition of gases in the pipe shafts on west side where evidence of fire is found.

Results of the Fire

It has been announced that 121 persons lost their lives in this catastrophe, and about 50 others were treated in hospitals for the effect of the gas. Those affected by the gas included doctors, nurses, patients, employees, firemen, policemen, volunteer rescuers, and spectators. A few people were injured by falling glass when the skylight was blown open, and one person was killed in a fall to the ground. No one was burned to death or killed outright by the explosion. The larger number died from the effects of the gases, some living several hours or days after exposure.

 Flames caused a relatively small part of the damage. The film room was blackened and all of the films burned. The wood film shelves were completely burned except for a few charred uprights. The films in the metal cabinets burned, leaving the cabinets intact except for the paint. The evidence shows that the heat in this room was not very intense. Edges of paper records were charred, the wood pipe rack and bins slightly blackened and the wood cabinet only blistered.

The rear stairway as far as the third story, the rear elevator shaft and much of the rear part of the third story showed evidence of intense heat, due to the burning gases. Above the third story there was very little heat and practically no evidence of flame.

Fire showed in three pipe shafts on the west side, in the southwest corner of the roof space and in curtains along the north wall of the fourth story. The southeast corner of the basement showed considerable evidence of heat. The concrete under the reinforcing bars in the joists had broken away at this point. Copper blades of knife switches which were open were bent in the direction of the draft (toward the east). Wood window and door frames in the rear wall as high as the third story were badly burned from the outside. The rest of the machine room showed evidence of intense heat near the ceiling and was blackened throughout.

The small film dry room on the first floor, which communicated with the pipe tunnel through an 8-inch square hole in the floor, was badly burned. This room communicated with the film storage room on the first floor, but a pair of wood swinging
doors, 1-inch thick, and a pair of approved corrugated metal fire doors prevented fire from entering the film storage room.

An examination of the ventilating and heating systems would seem to indicate that these in no way contributed to the spread of the fire or heated gases. From the condition of interior walls and partitions, it is evident that the gases found their way into the pipe tunnels previously described and ascended to all floors by means of the pipe chases. At the base and top of partitions, around the edges of medicine cabinets, switch plates and other electrical fixtures, and in fact every crevice where gas could leak through, are unmistakable evidences of the gases which left their mark in the form of dark brown condensate stains. This condition is evidenced on all stories throughout the building.

It is widely rumored that there were active chemicals stored in the basement of this building, the fumes from which caused the deaths. The correctness of this rumor is not borne out by the facts, since there were no chemicals in the film room and the pharmacy stock room contained empty dispensing packages, a few cases of petrolagar, dental cream, a negligible quantity of pills, rubber stoppers, a drum half full of glycerine and two cans of sugar. None of the laboratories on the upper stories were involved.

The fire door on the entrance to the film storage room in the basement failed to close automatically owing to the counterweight lever striking against a steam pipe. The fire door between the elevator hall and the machine room was prevented from closing by the weight becoming jammed between the wall and the upper hinge. The fire door between the stair and elevator hall was blocked open with a barrel. The fire door on the entrance to the tunnel to the boiler house closed properly, preventing the spread of fumes to the hospital and other buildings in the group. The failure of three of the doors to close enabled the fumes to pass from the film room out into the machine room and thence into the stair and elevator shafts to the upper floors. All fire doors withstand the fire very
well and can be put back in service when painted. The tin clad wired glass panel doors on the stair and elevator shafts in the southwest corner of the building served their purpose but will have to be replaced. Those that were closed withstood the heat and permitted very little fire damage in the first, second and fourth stories. The stair door on the third story which was held open by a foot latch permitted the fire in the rear stair shaft to gain access to the third story.

A report was published to the effect that the failure to operate of the film room fire door was the cause of the loss of life and property. The result, had this door closed properly, is problematical; however, the arrangement of the pipe tunnel and vertical ducts and the part they played in the fire and explosion indicates that the property damage and loss of life would not have been materially less, in view of the fact that the film vault was not properly vented and not equipped with automatic sprinklers.

Conclusions

This catastrophe thoroughly emphasizes the danger, especially to life, arising from the storage of nitrocellulose film in a manner not consistent with its hazardous qualities.

One of the characteristics of nitrocellulose film is decomposition or flameless combustion at a relatively low temperature, with the evolution of a large volume of gases of a variable chemical composition but known to be harmful from a life standpoint and of such nature that gas explosions may occur. These conditions were borne out by this fire.

A very important point to be appreciated in such fires is, as noted, the presence of nitrous fumes. Water will absorb a considerable portion of these fumes. The water spray from automatic sprinklers is, as a result, very effective in reducing the possibility of danger from this undesirable feature. While only a small percentage of the other gases are absorbed by water, the water spray cools them below the ignition point and also saturates them with moisture. They therefore will not take fire spontaneously when they issue from vault or room and are more difficult to ignite subsequently, due to their water vapor content.

Other fires and tests made of this material have proven the danger of explosion from the gases of decomposition, the toxic quality of the fumes and the intense heat when actual burning occurs; an outstanding feature is the rapidity of burning.

A summation of the causes and effects indicates that storage without suitable venting of the room and without automatic sprinklers will always introduce an extreme life hazard, and the probability of considerable damage to the building.

There are two reasonable methods of assuring proper safeguards. The first is through a compulsory substitution of a type of film which does not have the characteristic of that made of nitrocellulose material. There has been a film of this character on the market for a number of years and in certain territories its use has become very general through recognition by hospital staffs of the more hazardous character of the nitrate film. The second preventative method is the adoption by States or municipalities of stringent requirements covering the storage and handling of the nitrate film. Storage outside the building and well removed from other structures is preferable and where this is not possible the regulations of the National Board of Fire Underwriters, which provide for ample vents, automatic sprinkler protection and other safeguards, should be carried out in their entirety. These regulations are also applicable to and should be made to cover the storage and handling of similar film in portrait and commercial studios and in doctors' offices. It is therefore the duty of the various State and city authorities to enact suitable ordinances or laws requiring all hospitals and similar institutions to store and handle X-ray film of other than acetate or safety, base in strict accordance with the regulations of the National Board of Fire Underwriters; copies of these regulations can be obtained by addressing the National Board of Fire Underwriters at 85 John street, New York City; at 222 W. Adams street, Chicago, Ill., or at Merchants Exchange Building, San Francisco, Cal., or they can be obtained through the local office of the State fire insurance boards or bureaus.

Inspection and report by F. E. Greene, Inspector, Ohio Inspection Bureau, and H. E. Newell, Engineer, National Board of Fire Underwriters.

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