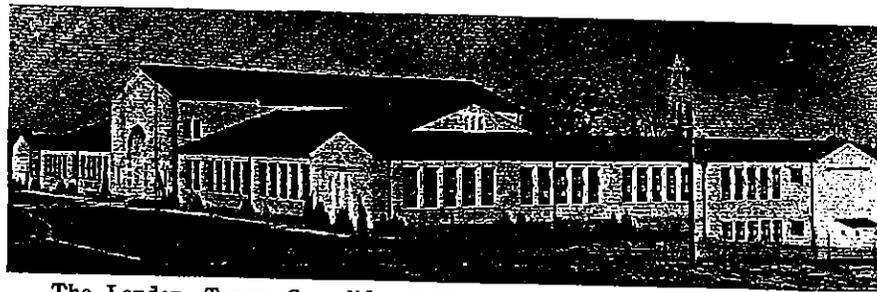


## The London, Texas, School Disaster.

By H. Oram Smith,  
Texas Inspection Bureau.  
(Member N.F.P.A.)

A gas explosion that caused the death of 294 school children and teachers, resulting in one of the major disasters of the present century, occurred in the East Texas oil field district about 3:15 P.M. on March 18, 1937. The site of the explosion was the unincorporated community of London, about four miles east of the little town of Overton in the northwest corner of Rusk County, ten miles from Henderson, Texas. The community consists principally of the school property of the London Independent School District, Inc., comprising the large high school building, several smaller buildings and seven active oil wells owned by the school district. Beyond the school property on all sides were oil well derricks, gas flares, and a distant refinery, all typical of the oil field industry. Because of the wells on its property it had the unique distinction of being about the wealthiest rural school district in the world, catering largely to families of the oil field workers over a territory as much as 15 miles distant in several directions.



The London, Texas, Consolidated High School was a building of modern construction. This picture is taken from the southwest.

The blast occurred with the suddenness characteristic of such explosions, although with some unusual features. Every witness agreed that there was but one explosion and that it was a low rumbling noise, with none of the blast or roar that might be expected. Yet there is evidence of a most terrific force in the great extent of devastation and loss of life that came almost instantly; testimony of bodies tossed 75 feet into the air; an automobile 200 feet distant crushed like an eggshell under a two-ton slab of concrete that had been hurled from the building. And as a further evidence of the terrific force, the established point of origin indicates that the explosion had to break through an 8-inch concrete floor slab before starting on its path of destruction. Many of

*The Quarterly*  
**National Fire Protection Association**  
**April 1937**  
**Vol. 30, No. 4**

the children in rooms directly above this point were literally blown apart or mangled beyond recognition.

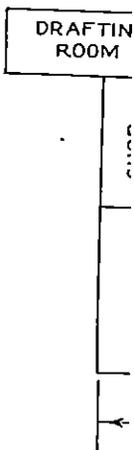
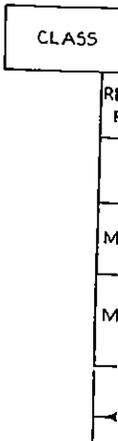
There was very little of the structure left standing after the blast and most of that had to be pulled down to prevent falling after the débris was removed, which was practically overnight. From the earliest photographs taken, the blast seems to have completely demolished the entire front section, 58 by 254 feet, both the north and south wings back to the east 25-foot additions, and the center auditorium wing back to the last 40 feet of the east end, which had to be razed when the supporting wreckage was removed. All that remains of a \$300,000 modern school plant is a badly wrecked two-story addition forming the rear of the north wing which will have to come down and a few broken walls where a similar addition completed the south wing.

The facts and conclusions presented in this report were reached after a careful survey of the grounds and from evidence brought out at the military court of inquiry where the writer was accorded full courtesy. We were under a heavy disadvantage, however, in two main essentials; a majority of the important witnesses were the bereaved parents, relatives or friends of the dead, still under the influence of shock and hysteria; some even feared that blame or censure was intended. The immediate removal of all wreckage to recover bodies destroyed what would have offered valuable evidence. The removal of this débris is worthy of comment since it is probable that in no past disaster of record has it been approached in speed or efficiency, and nowhere but in the oil fields would it have been possible to find the necessary equipment, labor and experience immediately available. In the short space of 17 hours after the work was organized, some 2000 tons of débris were picked up piecemeal and hauled away during an all night rain storm; concrete slabs were broken up, tangled steel cut with torches and the smaller fragments that had to be shoveled were carried off in small baskets and carefully emptied under flood lights to avoid overlooking a hand or foot or any torn portion of a body.

#### Construction and Occupancy.

The school property is a consolidation of the London and New London districts, covering a number of acres over portions of two farms, and comprises a group of widely detached buildings of both brick and frame construction for grammar school, gymnasium, band room, domestic science, etc., in addition to the large high school and auditorium building which was the only one involved in the explosion.

The high school was erected in 1932 with additions in 1934; it was built on ground sloping in two directions, with a down grade from north to south and from west to east. The main section was 58 ft. wide and 254 ft. long, fronting west, with classrooms on each side of a 10-foot central corridor. At the north and south ends, wings extended east to a depth of 136 ft., terminat-



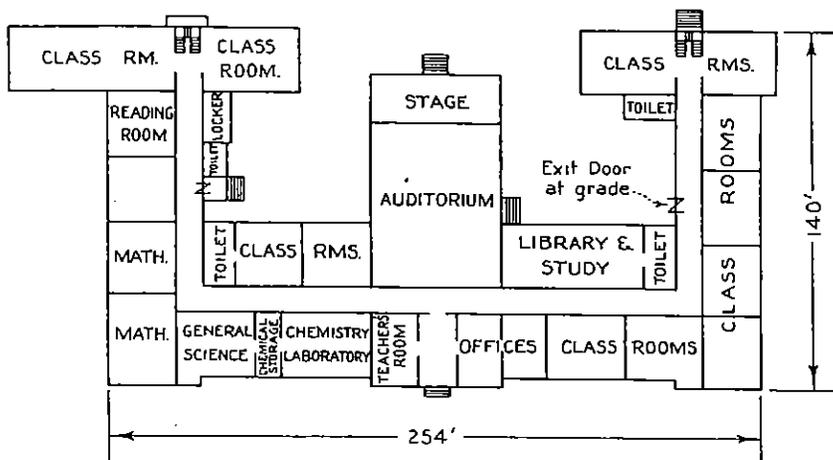
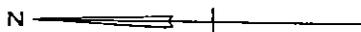
THE LONDON, TEXAS, SCHOOL DISASTER.

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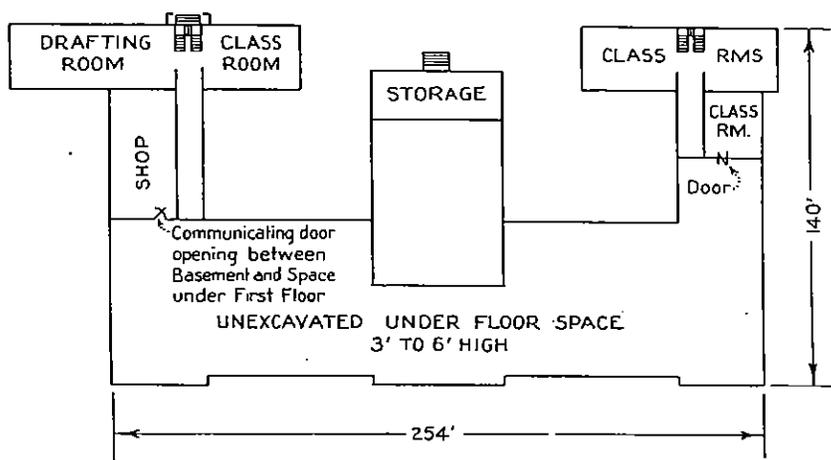
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FIRST FLOOR PLAN



BASEMENT PLAN.

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Plan of the London High School Building.



*International.* After the explosion which took 294 lives. Only portions of the east wings were standing. This picture shows the oil field workers engaged in removing the wreckage to uncover the corpses of the victims.

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The main or front section was one story high on a concrete foundation wall all sides and on intermediate concrete piers, forming a concealed dead air space from 3 to 6 ft. high, varying with the uneven surface of the ground. The central auditorium had a two-story front as far back as the balcony, continuing as one high story of equal height to the rear stage wall. Both the north and south wings were carried back to a height of two stories, owing to the drop in grade; the second floor in each case being a continuation of the first floor of front section, while the lower floor, known as the basement, was actually on grade level and was the first floor in each of the rear wings. The building was of reasonably good construction, with walls of 4-in. brick backed with 8-in. hollow tile, mainly non-bearing; the loads were carried on steel I-beam columns and girders. The floor over the concealed space was an 8-in. reinforced concrete slab supported on concrete girders, foundation walls and concrete piers; the small area of second floor in each of the two wings was 3-in. concrete slab on steel and reinforced concrete girders. All floors had hard wood overlay on wood sleepers. The roof over the entire building was tile on a one-inch wood deck and 2 by 6 in. wood purlins on light fabricated steel trusses spaced 10 ft. on centers. All upper floor ceilings were metal lath and plaster hung from the steel trusses, forming open attics of 10 to 12 ft. high to the ridge. The rear first floor ceilings were concrete. The building was known as the high school and auditorium, but all portions south of the auditorium, including the entire south wing, were used by the higher grammar grades.

There were two rooms devoted to laboratory and science work, one having 12 laboratory tables, each of which had two ½-in. gas pipes carried up from under the floor with two bunsen burners on each line. These two rooms were located in the front of the main section near the north end of the building. A manual training shop was located in the lower floor of the north wing; it contained several machines driven by individual motors and one portable sander with a heavy cord and plug switch for a wall socket. This shop backed up against the 12-in. concrete foundation wall of the front or main section and communicated with the concealed floor space through a 4 by 4 ft. opening in the foundation wall, having a wooden door normally kept partly open. The shop and the sander, according to the evidence, played a very important part in the disaster as described later.

#### Heating and Ventilating.

The original plan called for a central steam heating plant, but was abandoned before construction started because of the higher cost as compared with individual gas stoves. A common type of gas-steam radiator was adopted after

This picture shows the oil field  
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 After the explosion which took 294 lives. Only portions of the east wings  
 workers engaged in removing the wreckage to uncover the corpses of the victims.





The rear of the school, showing the east end of the three wings, the auditorium in the center. Owing to the slope of the ground, the building was two stories at this end.

the School Board members had consulted several people presumed to be familiar with the subject, including members of other school boards. The device has the appearance of an ordinary steam radiator, but is an individual heating unit comprising a gas burner at the base, under a small water chamber cast into the unit. Steam circulates through the hollow sections of the radiator and heats by radiation like the standard steam type. The burner is partly enclosed, but communicates with the outer air through a circular hole about an inch in diameter where a match can be inserted to light it. The unit is equipped with a small regulator at the gas supply end by which pressure may be adjusted, and has a safety valve or blow-off on the water chamber. It is a well-known make used extensively in the Southwest and is considered as safe as any gas heater on the market. It is used to a large extent without vents, but can be equipped with a vent pipe for a wall flue if desired. There were 72 of these heaters in the building and as there appears to have been some belief that the state school authorities required all classroom heaters to be ventilated, some effort was made to vent only those heaters located in classrooms. A short piece of threaded pipe extended from the vent outlet on the heater into the wall, neatly finished with a collar at the wall entrance, giving the appearance of a properly vented unit, but as there are no flues in the walls this supposed vent simply entered a hole punched into the wall tile.

#### Room Ventilation.

Room ventilation was mainly through windows on all sides, although two or three small wall vents were located in the rear two-story section. An important weakness in ventilation, however, was the totally inadequate provision for venting the concealed dead space under the main section of building where the destructive gas is presumed to have accumulated. This continuous concealed space had a superficial area of over 15,000 sq. ft. entirely enclosed by a 12-in. concrete wall, but having communicating doors opening into class-



The rear of the school before removal of debris, showing the damage.

rooms of both the north and south wings, two or three feet to a side, and a distance of about three-foot average between them, which only four small windows were at the north end where the distance of circulation.

A great deal of effort had been discontinued the had been costing as much as "wet" or "residue" gas. This is a point that school officials adopted.

When an oil well gas is separated from a flare. It usually line companies set up extracted and the result. This procedure follows no authority to sell a flare to be wasted. To serve notice of a matter of inclination way until the line is schools and even private line. While the gas



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The rear of the auditorium and south wing immediately after the explosion, before removal of wreckage had started. This picture is taken from the east, showing the damage on the side away from the main force of the explosion.

rooms of both the north and south wings. The depth of this space varied from two or three feet to as much as six feet at some points. A conservative estimate of three-foot average depth means about 46,000 cu. ft. of dead space for which only four small 12 by 24-in. vents were provided. Two of these vents were at the north and south ends, 254 ft. apart, and two on the east wall where the distance and angle to the opposite ends could not give proper circulation.

#### Gas Fuel and Pipe Lines.

A great deal of publicity was given to the fact that the school officials had discontinued the use of commercial gas from the utility company that had been costing as much as \$250 a month, and had tapped a free gas line of "wet" or "residue" gas from a gasoline extraction plant without permission. This is a point that requires some explanation of a common practice that the school officials adopted with good intention.

When an oil well is brought in, it flows under its own gas pressure. This gas is separated from the oil and piped off to some distant point and burned in a flare. It usually has a heavy gasoline content and in some locations gasoline companies set up extraction plants to which this gas is piped, the gasoline extracted and the residue gas piped back to the lease from which it came. This procedure follows a standard form of contract; the gasoline company has no authority to sell or dispose of the residue gas, neither can they give permission for anybody to tap the line, although the gas is headed back to an open flare to be wasted. There appears to be an obligation on the gasoline company to serve notice of disconnection should they "find" the line tapped, but as a matter of inclination and general custom they are willing to look the other way until the line is covered. It is therefore a common practice for churches, schools and even private homes to get this free gas if within reach of the pipe line. While the gasoline has been extracted, it is still known as "wet" gas; it

is more or less unstable as to volume, and pressure fluctuates considerably; it contains impurities that are removed in commercial gas. Apart from the inconvenience of keeping the heating units adjusted to the irregular supply and pressure, there is no particular hazard in its use as compared with ordinary commercial gas which has caused similar explosions.

This gas supply reached the building through a 2-in. pipe into a gas regulator of standard commercial type located outside the south wall. It had a capacity of 50 lbs. on the high pressure side reduced to 5 oz. on the domestic supply side. The average pressure on the extraction plant residue line was said to be 25 lbs. From the regulator the 2-in. line entered and extended in a full circulating loop under the entire concealed space of the main section of the building, suspended by metal straps from the concrete slab forming the first floor. Numerous 1½-in. lines extended up to the room heaters from this line. Other 2-in. lines were carried to the rear of the two-story wings and extended through the attics, with drop lines to the heating units on the two floors below. As all gas pipe involved in the area of explosion was blown away, it was impossible to trace the leak or leaks that undoubtedly existed. It developed, however, that all repairs and extensions to gas or water lines, electric wiring, etc., were made by one of the school janitors who were jacks of all trades and probably masters of none. They may have neglected to test the pipes for pressure leak before turning the gas in; failed to pull the threaded joints up tight; omitted to apply lead or other compound at the joint, or even cracked a pipe without knowing it. There is no evidence to indicate observance of the N.F.P.A. Recommended Good Practice Requirements for the Installation, Maintenance and Use of Piping and Fittings for City Gas.

#### Development of Evidence.

There were rumors that the explosion was due to nitroglycerine or dynamite. Dynamite was being used at the athletic field in the construction of a running track. One of the teachers testified that when he heard the explosion he thought it was another shot at the field. It was also found that 18 sticks of dynamite were stored in a lumber room under the auditorium stage and went through the explosion intact. By the process of elimination it became obvious that the cause of the explosion was the ignition of a large pocket of gas in the large improperly vented space under the floor. This theory was corroborated by evidence of the heavy concrete floor slab above the space being blown up from below, and testimony that bodies, desks and lockers were found on the bare ground, indicating that the slab floor had been blown out before the bodies and other objects fell.

It appeared most probable that the gas was ignited in one of the rooms where laboratory or shop work was conducted in the northwest corner of the building. The shop where most of the electric devices were used adjoined and



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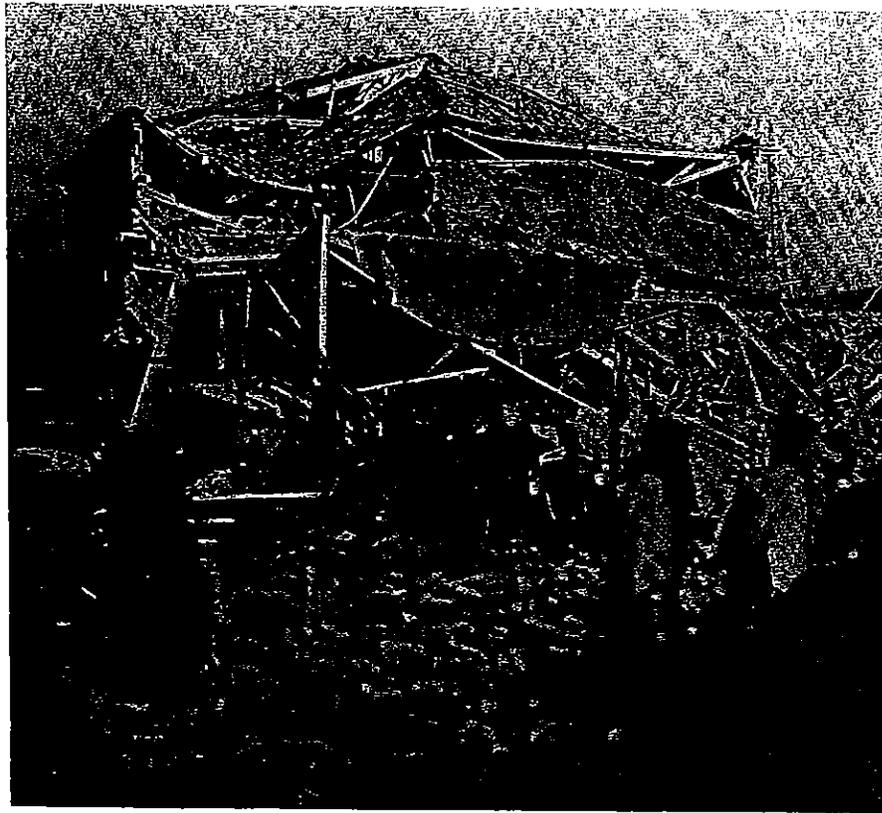
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Wreckage of the auditorium section looking toward the stage.

communicated with the under floor space at this point. Progressing further on this theory it appeared that there should be two classes of dead; those in the immediate path of the blast, who should show evidence of burns and mutilation, and those killed by falling wreckage. This line of investigation developed the fact that all bodies with evidence of burns or with arms and legs blown off and missing came from classes in the northwest rooms and that the worst case of burns was the teacher who was just starting a class period in the woodworking shop. One of these shop pupils who escaped with slight injury testified that the door into the adjoining concealed space was about half open, that the electric switches and wall sockets were within two feet of the open door on the same wall, and that the teacher was in the act of plugging in a portable connection to the sander when the flash and explosion followed.

#### Explosive Gas Mixture Under Floor.

This practically established the fact that the large under floor space of the main section was pretty well saturated with an explosive mixture of gas and air from a source of gas leakage that will never be determined. Some of this gas

mixture passed the open door into the shop and was ignited by an arc formed when the two prongs of the portable switch touched the socket before it was driven into place. The resulting flash followed the gas back under the building, creating the superheated gas and pressure necessary to blow the building up. While the northwest corner of the building was blown out first, there was no appreciable interval in the collapse of other portions. The blast traveled the entire 254 ft. of building instantly and literally blew it to pieces. Witnesses testified that the roof was lifted at one corner at the same time that walls were blown out at another corner.

The theory of released gas from the oil fields floating into the premises was discounted by the fact that the building is located on high ground, while floating gas would be confined to the lower levels. The U. S. Bureau of Mines engineers drilled all over the school campus and found no seepage of gas from any underground source. The question of using the residue or wet gas had no bearing, since any leaking gas under the same circumstances would produce the same result. The much publicized theory of accumulated gas in the hollow tile walls was started through ignorance of the conditions. There was no way in which free gas could enter the walls. Furthermore, it was not a wall explosion. The question of faulty gas heater vents was discussed at the court hearing as well as in the press comments and while the whole question of the heater installation is subject to criticism, it had no bearing on the explosion.

The only point of attack on the conclusion of accumulated gas in the under floor space was the testimony of one of the janitors that he had entered that space at 10 o'clock that morning, 5 hours before the explosion, and had lighted matches to smoke and find his way about in the dark; indicating that there was no gas leaking at that time. This is conceded to be possible, as his point of entry was at the extreme south end of the building and his travel distance not over 50 ft., according to his own evidence. He was therefore about 200 ft. away from the area where the explosion originated and gas might have been leaking at the north end of the building without reaching an explosive mixture 200 ft. away. Furthermore, with the great amount of gas pipe and fittings up to two inches in size, it would have been possible for a leak to start after his departure, and form an explosive mixture in much less than five hours.

#### No Fire Following Explosion.

No fire followed the explosion, presumably due to the small amount of combustible material. The main structure was of concrete steel and tile as previously described. The windows were metal factory sash. Apart from the interior wood trim at the doors and the furniture, everything was practically non-combustible up to the wooden roof deck. This roof deck was covered on the outside with tile and was cut off from the interior by metal lath and plaster ceilings.

While early report count shows that the dead teachers, 12 women teachers, this writing there are these will recover.

There is no record time of the explosion, killed or injured, and building were killed at

Those who survived are many reports of injuries windows were not mortally who were in the shop injuries. They were in addition.

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The school building safety except for the under the building was in a panic, but not necessary without ventilation, but it became a serious

### The Loss of Life.

While early reports put the total casualties at a larger figure, the final count shows that the deaths totaled 294, including 120 boys, 156 girls, 4 men teachers, 12 women teachers, 1 woman visitor and a 4-year-old boy visitor. At this writing there are still 39 injured in hospitals; it is reported that all of these will recover.

There is no record of the total number of persons in the building at the time of the explosion, but it appears that the majority of the occupants were killed or injured, and that practically all of those in the main part of the building were killed at once or were fatally injured.

Those who survived were in the wings, mostly on the upper floor. There are many reports of jumping from windows, which appears probable, as the windows were not more than 10 ft. above the grade. There were three boys who were in the shop where the explosion originated who escaped with slight injuries. They were in the far end of the room and were blown into the rear addition.

There were many reports of persons who survived by reason of protection of desks and other objects of furniture. It is probable that some children and teachers crawled under desks, but it appears doubtful that there was enough time for any teacher to direct an entire class to get under their desks. The survivors who were immediately able to get out were assisted from under the wreckage in conditions varying from slight shock to broken limbs or fatal injuries. Many were pinned under the wreckage for long periods and were released only when heavy material was lifted by the use of jacks.

### Conclusions.

It has been established beyond reasonable doubt that the explosion was due to leaking gas from a pipe or pipes under the building, and that ignition was from the arc of an electric switch in the manual training room at the moment that the teacher plugged a portable connection into a wall socket close to the open door. The court of inquiry exonerated all school officials of personal blame; no one individual was responsible. It was the collective faults of average individuals, ignorant or indifferent to the need of precautionary measures, where they cannot, in their lack of knowledge, visualize a danger or hazard.

The school building was of good construction and planned for reasonable safety except for the gas installation. The excessive area of concealed space under the building was poor practice for a building of this type and occupancy, but not necessarily a structural weakness in itself. When bottled up without ventilation, however, and filled with gas pipe lines and electrical circuits, it became a serious fault. The four small vents were just about what

would be required for a six-room cottage; they were not only too small and too few, but were so far apart that they could not create circulation.

The use of numerous separate heaters with gas fuel lines extending all over the building was a subject of severe criticism. Many of these units had been disturbed by teachers or students for various reasons; they had been moved by pulling the free end away from the wall, putting a strain on the fixed gas connection. When burners got out of adjustment and flared up, a teacher or one of the older boys became a self-appointed fixer. The first principle of safety requires that all hazardous devices in school buildings be made proof against tampering or interference.

This method of heating was entirely wrong and in combination with the unventilated floor space was responsible for the explosion. The difference in cost of a properly cut off steam heating plant should never be considered where the lives of many school children and teachers are involved.

While the gas heater vents did not contribute to the disaster, the evidence showed a disregard for the hazard of non-ventilated gas fires in crowded school rooms. In this respect, the school officials, architects and heater salesmen were equally at fault. The few attempts to ventilate into the dead space of a blank wall where no flues existed, were obvious deceptions to cover up an omission. It is hardly conceivable that the practical men involved in this installation could have considered such makeshifts as filling the requirement for ventilation.

#### Inexpert Workmanship on Gas Piping.

The original electrical and plumbing installations were made by contractors of presumed qualification, but many alterations, repairs and additions, including the installation of the residue gas supply line, were made by one of the janitors. They were no doubt good workmen, experienced in a variety of oil field jobs, who were well recommended, but were not qualified electricians or gas fitters. Evidence of poor workmanship on some remaining electrical extensions suggests the probability of similar faults in the installation of gas lines. In the handling of gas and electrical work, where a small fault can produce dire results, school officials should call upon trained workmen at least to supervise such installations.

The use of residue gas from the gasoline extraction plant was not a matter of major importance, as ordinary commercial gas under like circumstances would have produced the same result. While the pressure on the discharge pipe line from the plant was not under regulated control, the school regulator reduced it to the customary safe level and there was no evidence to support the rumor that a gas line had blown out. Its use, however, is considered poor policy for a school property where so many separate heating units had to be frequently adjusted because of variation in pressure and quality of the gas.

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The value of a distinctive malodorant in all gas supply systems by which leaking gas may be readily detected, is clearly evident. It is especially important in or adjacent to oil field territory where a leak might not be detected, owing to the constantly prevailing odor of petroleum gas common to those sections.

Practically all faults of construction and installation in this building were due to lack of supervising power such as would apply in communities having city ordinances. It serves to focus attention to the need of state laws on standards of construction, as well as approved standards for the installation of heating systems, electrical equipment, gas and oil systems and all features affecting the welfare of the public in schools, public buildings and all other buildings where large numbers of people congregate.



Volunteer grave diggers preparing for the mass burials.

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oman who tipped over  
ed to death by the fire.

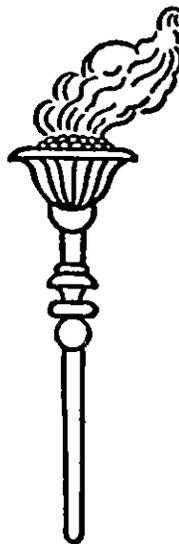
e in the radio circuit in  
ny. Fire that trapped  
it. (L-3777.)

en tent in which an old  
a spark or short circuit  
he man was helpless as  
ndants extinguished the

# QUARTERLY

OF THE

## National Fire Protection Association



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*Entered as second-class matter December 15, 1928, at the Post Office at Boston, Mass., under act of March 3, 1879.*

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