

THE ROSEBURG, OREGON, FIRE, EXPLOSION AND CONFLAGRATION

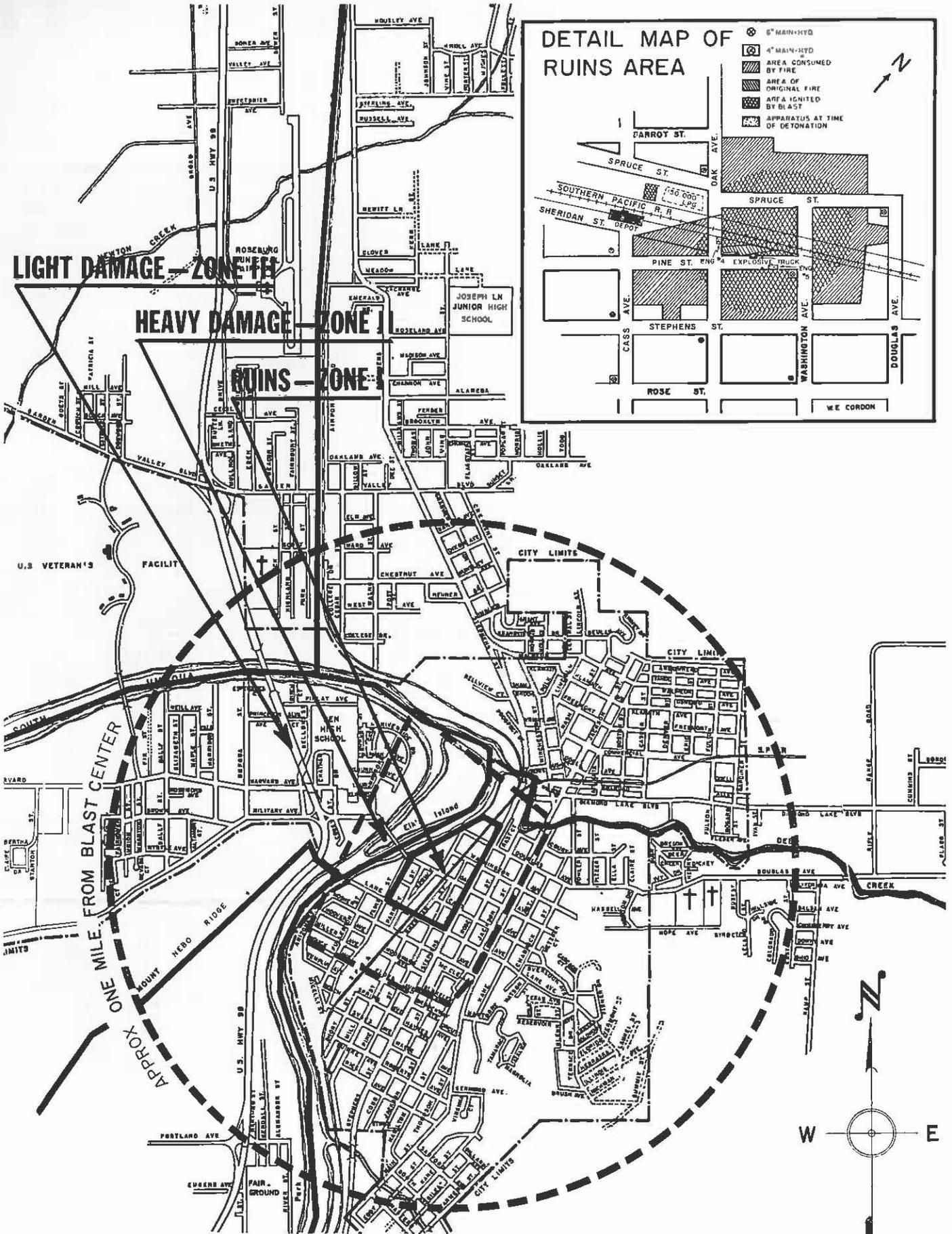
Disaster

August 7, 1959



BLAST CRATER AND DEVASTATED AREA

Report by
THE NATIONAL BOARD OF FIRE UNDERWRITERS
85 John Street, New York 38, N. Y.
222 West Adams Street, Chicago 6, Ill.
465 California Street, San Francisco 4, Calif.
and
OREGON INSURANCE RATING BUREAU
721 S.W. Oak Street, Portland 7, Ore.



ROSEBURG & VICINITY - DAMAGE AREAS

FOREWORD

This unfortunate and preventable disaster should stand as a strong and timely warning to other communities of the explosion perils when commercial explosives or their counterpart blasting agents become involved in fire emergencies. This devastating occurrence should make it obvious that both dynamite type explosives and the more recent innovations of so-called field-prepared or pre-mixed, ammonium-nitrate-containing blasting agents may, under certain fire conditions, be set off by the heat or flame. Emphasis is given to the need for a greater realization that a relatively minor and uncontrolled fire may initiate or "trigger off" a devastating blast when explodable materials are present; and that a conflagration is also possible when such fires and explosions occur in congested areas.

This disaster clearly exemplifies the serious fire and explosion danger accompanying the increasing trend to transport highly hazardous material by motor vehicles over public highways, and the severity of exposure to which even small communities may be subjected unknowingly. It also serves to direct attention towards two important and urgent needs: (1) increased recognition by the manufacturer, shipper and carrier of such articles of commerce, of their broad and continued responsibility for providing proper knowledge of their inherent dangers and the necessary precautionary measures to be taken in any emergency, and (2) better utilization of the existing codes and recommended safe practices, and the enactment of uniform controls and enforcement programs, with improved cooperation between federal and state regulatory bodies and local authorities.

To re-emphasize these vital points, fire emergencies call for prompt and decisive action at all times, and the fire officers have the unquestionable right to demand advance information in order to understand the dangers and risks in their operations and to intelligently apply the necessary skill dictated under emergency conditions. It is also to the best interests of manufacturers, shippers and carriers to have their drivers equally briefed on the hazardous nature of their cargo and the safeguarding measures to be taken in any traffic and road emergencies. Thoughtful attention toward adequate enforcement of existing federal, state and local regulations will go a long way toward the avoidance of impediments to the free and safe flow of commerce.

It is hoped that the Roseburg disaster will in some way have far-reaching effects toward the prevention of similar occurrences in the future. A high price has been paid with life loss and destroyed property. Yet, with the immediate application of a few, simple precautionary measures, the outcome of this grievous mishap would have been completely different. The immediate aim of this report, then, is to bring into sharp focus the attendant problems of the many important modern-day exposure hazards and to point out that proper environmental safety for our villages, small towns and the more populous centers will only be secured through the cooperative efforts of all concerned. Fire safety, in terms of prevention and protection, is not a thing apart but is closely related to our rate of industrial and economic progress and social advances of our communities.

Acknowledgment of cooperation is made to the officials of the City of Roseburg, especially to the Roseburg Fire Department, and the Oregon State Police and the Oregon State Fire Marshal's office for valuable information given regarding this disaster. Appreciation is also extended to the General Adjustment Bureau for providing loss and map data.

Field data for this report were obtained by Assistant Chief Engineer C. A. Weers and Engineer M. S. Marshall of the San Francisco office of the National Board of Fire Underwriters, through the cooperation of Surveyor R. B. Bryant of the Oregon Insurance Rating Bureau. Technical review and editing of Arthur Spiegelman, Senior Research Engineer, is also acknowledged.

Photographs herein reproduced have been secured through the cooperation of Wide World Photos, Clark's Studio, Photo-Lab Studio, and Dick Gilman, Paul Jenkins and Herb Alden.

LEWIS A. VINCENT, General Manager
National Board of Fire Underwriters

E. W. FOWLER, Chief Engineer

MATHEW M. BRAIDECH, Research Director

Committee on Engineering

A. J. SNOW, Manager
Oregon Insurance Rating Bureau

SUMMARY

A truck containing 2 tons of dynamite and 4½ tons of a blasting agent, trade-named "Car-Prill" (a mixture of prilled ammonium nitrate, ground nut shells and Diesel oil), exploded with great violence and devastated the downtown section of the quiet and peaceful City of Roseburg, Oregon, on Friday, August 7, 1959, at about 1 A.M. The explosion, which was probably initiated by the intense heat from a nearby fire, killed 13 persons and injured more than 125 others. Property damage will probably exceed 9 million dollars with most of the loss sustained in the areas adjacent to and including the principal business district of the city.

This hazardous cargo was being transported by an explosives manufacturer from his plant in Tenino, Washington, and was to be delivered to customers in the vicinity of Roseburg. The truck and its load of 6½ tons of explosive products had been parked en route, for the night, on a city street, just a few feet from a building-materials warehouse, which subsequently caught fire. The fire department was fighting the warehouse building fire when, in a matter of *less than ten minutes*, a disastrous explosion occurred.

A crater 52 feet in diameter and 20 feet deep gave mute evidence to the terrific force of the blast. Most of the buildings in the immediate twelve blocks were completely destroyed. Hundreds of other buildings in the community suffered extensive damage over a 50-block area, and glass breakage was reported as far as 9 miles from the explosion. Tremors were reported as far away as 17 miles.

Adding to the havoc, fires soon appeared in numerous buildings in the surrounding area. These fires were apparently started by radiant heat and flaming debris scattered by the explosion. More than 45 buildings were involved. The conflagration was confined to a 7-block area through the combined efforts of the local fire department and fire companies from neighboring districts and nearby cities. The fire was brought under control in two hours.

The Roseburg fire and explosion emphasizes the need for bolstering present regulations by the adoption of more complete safety codes, with strict enforcement by state and local authorities. Preventive and protective measures for proper fire and explosion safeguarding of hazardous commodities are provided in the National Board of Fire Underwriters "Fire Prevention Code" and in the recently completed National Fire Protection Association "Code for the Manufacture, Transportation, Storage and Use of Explosives and Blasting Agents." Contained therein are the particularly important provisions for notification of local authorities of arrival of shipments of explosives and blasting agents at any location, and the routing of motor vehicles handling such cargo to avoid congested and populated areas. Equally important is the requirement for designated safe stopping places where vehicles carrying explosives and blasting agents may be parked, which should be provided for at state level, as exemplified by regulations of the State of California. Such regulations are needed with respect to private, contract and common carriers.

INTRODUCTION

The early morning fire and explosion that blasted the twelve block area and scattered burning debris over downtown Roseburg, Oregon, on August 7, 1959, left 13 dead and more than 125 injured, with property damage estimated in excess of 9 million dollars. This tragedy ranks among Oregon's greatest losses of the past century.

Industrial disasters involving hazardous materials and explosives are unique in Oregon's past. That this explosion could happen in a predominantly agricultural and lumbering section of this state is evidence of widespread changes that are taking place in our industrial way of life. Truck shipments of hazardous chemicals, blasting agents and explosives to all, and even the most remote, sections of the country are rapidly becoming a highway problem of growing proportions to warrant more serious consideration.

Truck shipments of explosives and blasting agents have become more frequent in recent years, and overnight parking of loaded trucks has apparently become fairly common. Around the time of the disaster, it had been common practice to load and unload trucks of blasting agents of the nitro-carbo-nitrate class at a warehouse located in a residential district of Roseburg. Subsequent to the explosion, an investigation revealed that such a warehouse was situated 300 feet from a school and surrounded on three sides by residences as close as 40 feet. This 1-story, ordinary masonry warehouse building contained about 18½ tons (37,000 pounds) of a blasting agent in 50-pound paper bags. These bags, which bore the I.C.C. yellow label designating the "Oxidizing Material" classification, were piled twelve high and were immediately adjacent to and in contact with fourteen 55-gallon drums containing a flammable liquid and bearing the I.C.C. red label. Other combustible materials were stored in the

warehouse, and no particular effort was made to segregate them.

It is interesting to note that an incident which, in some respects, parallels the Roseburg fire and explosion occurred on the isolated property of a coal company in Unionville, Ohio. On April 3, 1959, a truck transporting a cargo consisting of 4 tons of blasting agent (ammonium nitrate-fuel oil mixture), 150 pounds of 60 percent high-velocity gelatin dynamite and about 2000 feet of detonating fuse, accidentally caught fire due to the tarpaulin contacting the hot exhaust pipe of the motor. The operator and all persons in the area promptly withdrew to a safe location. The truck and its contents burned in an open field for almost *two hours*, when it exploded with great violence. No one was injured, but the explosion completely destroyed the truck and made a large crater 40 feet in diameter and 20 feet deep.

The handling, transportation and storage of explosives and blasting agents is a subject that has received considerable study by safety authorities. A model code, containing the much needed requirements indicated by the Roseburg disaster, has recently been revised and brought up to date by the NFPA Committee on Chemicals and Explosives. In addition, the U. S. Bureau of Mines is preparing a bulletin on the recommended safe practices for field-mixed ammonium nitrate blasting agents. Communities must seek protection behind realistic and enforceable laws and regulations which properly assess the dangers of these materials. To avoid confusion and conflict of interest, appropriate cooperative actions at federal, state and local levels should be taken to minimize the potential explosion dangers of such hazardous materials in fire emergencies and to protect the public at all times.

ROSEBURG, OREGON

Roseburg, Oregon, is located in the western part of the state about 190 miles south of Portland. With a population of 12,200 (1958 census), it serves as the seat of Douglas County. The city is the center of considerable lumbering operations and is located in a fertile agricultural area. The terrain of the central area of the city is fairly level, sloping towards a river, but steep grades occur as the distance increases from the central area.

The main business district is quite compact, extending between Douglas and Lane Avenues, a length of 4 blocks, and between Stephens and Main Streets, a width of three blocks. The Umpqua River, which served as a natural barrier during the recent conflagration, bounds the western side of the semi-industrial area in front of the central business district. Buildings are predominantly of ordinary masonry construction two or three stories high, with a moderate number four and five stories in height. Adjoining this district

on the west and located within the general area where the disaster occurred, were (and in some cases are still standing) sales and service garages and various light industrial and warehouse occupancies. Between this area and the river is a narrow district of wood frame dwellings. The major portion of the residential area heavily affected by the blast consists of older type homes, many of them two stories.

Records of the U. S. Weather Bureau Station at the Roseburg airport show that at 1:00 A.M. on August 7, the temperature was 70° F. and the wind from the north at 7 miles per hour. Readings through 6:00 A.M. show temperature and wind velocity gradually diminishing. Relative humidity was recorded at 31 percent at 9:00 P.M. the preceding night. The weather cannot be considered a major contributing factor in the widespread fire damage — in fact the lack of wind prevented the fire from spreading more rapidly.



FIG. 1. Roseburg's business district—less than 3 weeks before the blast.
Outline shows area of heaviest damage.

THE "EXPLOSIVES" TRUCK

The truck loaded with explosives and blasting agents was parked on Pine Street between Washington and Oak Avenues, just a few feet away from the Gerretsen Building and Supply Company warehouse. The driver, at about 8:30 P.M. in the evening of April 6, completed a 290-mile run from the Pacific Powder Company plant in Tenino, Washington. Arriving too late to make deliveries at two points outside the city, he reportedly obtained permission from one of the building supply company warehouse occupants to park his truck on the street alongside the warehouse. Part of his consignment was destined for the Gerretsen magazine located about three miles outside the city limits. The driver locked the truck and checked into a downtown hotel about three blocks away. At about 11 P.M., the driver, aware of the fact that his company had been cautioned recently about leaving the "explosives" truck unattended, went out and checked the truck before retiring.

The truck was owned and operated by the Pacific Powder Company. It was a 1959 Ford 2½-ton-van-type truck painted red, with cab and aluminum body. The rear end of the truck was enclosed by a canvas curtain. There was information that the truck was marked "Pacific Powder Company" on each side with letters said to be about 12 inches high. Front, rear and sides were apparently marked with hinged signs reading "Explosives," with 5-inch letters, 30 inches long. It was further reported that the doors of the cab and the front part of the van were marked "Pacific Powder Co."

The cargo consisted of two items. There was dynamite (40% special gelatin) which was packaged in pasteboard boxes and loaded five or six boxes high in the forward part of the van. The boxes presumably extended the width of the truck and may have been in contact with the truck walls. The other product was a blasting agent, trade-named "Car-Prill," which was packaged in three-ply impregnated (moisture-proof) paper bags. The bags had the usual yellow labels, to identify "Oxidizing Material," except that they were not exact duplicates of I.C.C. labels. There was nothing to indicate that the truck carried blasting caps or any other explosive material. The shipper's invoices read as follows:

PACIFIC POWDER CO.	
INVOICE NO. 1570	8-5-59
Shipment to: Pacific Drilling and Blasting N. Umpqua River	
80 — 50 lb. boxes Special Gelatin 40%	4000 lbs.
Size sticks 2" x 16"	
120 — 50 lb. bags Car-Prill	6000 lbs.

PACIFIC POWDER CO.	
INVOICE NO. 1572	8-5-59
Shipment to: Gerretsen Building & Supply Roseburg.	
60 — 50 lb. bags Car-Prill	3000 lbs.

The descriptions and formulations of each of these products are listed:

Blasting Agent

The ammonium-nitrate-compounded blasting agent ("Car-Prill") involved in this disaster was intended for blasting in the construction of logging roads. It is commonly used for this purpose and is less sensitive and less expensive than dynamite. The blasting agents are usually used in conjunction with dynamite by loading each hole with quantities of both materials.

Testimony at the Interstate Commerce Commission hearing in Roseburg indicated that the blasting agent ("Car-Prill") was manufactured according to the following formulation:

Ammonium Nitrate (Prills)	240 lbs.
Ground Walnut Shells	12 lbs.
Diesel Oil	10 lbs.

This type of material is classified as a nitro-carbo-nitrate* under the regulations of the Interstate Commerce Commission.

* The term "nitro-carbo-nitrate" has been employed in recent years for federal regulatory purposes to cover and group a class of competitive (variously trade-named) and explodable products, less sensitive than dynamite explosives, employed in blasting operations around quarries and open-pit mining. It covers essentially any materials or mixtures, consisting of a fuel and oxidizer (substantially

inorganic nitrates) combination, in which none of the ingredients are considered to be explosives under the usual definition. This class includes among its products any ammonium nitrate preparations sensitized with such carbonaceous materials as liquid hydrocarbons and/or subdivided solids (charcoal, carbon black, or sawdust), or both. For interstate transportation purposes, the Bureau of Explosives and, in turn, the I.C.C. further qualify the "nitro-carbo-nitrate" classification officially, with the requirement that such products, when packaged in accordance with their regulations, cannot be detonated by a No. 8 Test Blasting Cap under their prescribed test conditions. Therefore, any product so classed for interstate shipment must be packaged and shipped in

compliance with the regulations of the Interstate Commerce Commission. Both "nitro-carbo-nitrates" and "ammonium nitrate" (and some of its fertilizer formations) are grouped as "Oxidizing Materials" for normal transportation where I.C.C. regulations apply, and call for a yellow label, although nitro-carbo-nitrates are used as blasting agents. The I.C.C. does not define a "blasting agent," as it is not concerned with the ultimate use of shipped materials. This grouping is encountered in safety codes dealing with manufacture, storage and use, and in certain phases of intrastate transportation, and such products are also evaluated for their sensitivity by the No. 8 Test Blasting Cap technique.

THE INITIAL FIRE

The fire at the Gerretsen Building and Supply Company warehouse on Pine Street was first noticed by a couple driving by in their automobile at about 1:03 A.M. on the morning of August 7, 1959. The husband instructed his wife to drive on to a nearby gasoline filling station to call the fire department, while he attempted to extinguish the fire. By the time the wife had given the alarm, the flames were apparently coming through the wall and roof of the building and beginning to light up the sky. The husband was subsequently killed by the blast.

The "explosives" truck was parked about 3 or 4 feet away from the burning building. It was located near the point where two warehouse buildings adjoined, and the wall closest to the truck was wood with considerable open lattice work. The warehouse fire spread rapidly as the building was of wood frame construction (1-story high connecting through unprotected openings with an adjoining 3-story building of ordinary masonry construction). In addition, flammable materials such as paints, lacquers, thinners and gasoline were reportedly stored in this building. These materials added a substantial amount of fast-burning fuel and could have greatly accelerated the spread of the fire. The building housed a fuel-oil tank truck and was also used for plumbing and woodworking operations. Intense heat from the warehouse fire developed quickly, exposing the "explosives" truck and its contents to rapidly rising temperatures.

The telephone call, prompted by the couple who discovered the fire, was received by the fire department at 1:05 A.M. A regular first alarm response was made from the headquarters station by pumper No. 5 manned by the Assistant Fire Chief and one fireman. However, at 1:06 A.M., the Assistant Chief told the dispatcher to sound the general alarm, which immediately brought in pumper No. 4 and three more firemen from the west side station. The other two pumpers re-

sponded soon thereafter when more firemen reported in for duty.

The first-arriving engine company No. 5 went into action by connecting a 2½-inch hose line to the hydrant at Washington Avenue and Pine Street (see map). The line was directed at the burning exterior of the building. At first, the parked explosives truck was inadvertently used as a shield against the radiated heat, but as the temperatures mounted, the fireman on this line withdrew to the opposite side of the street, protecting himself as much as possible. His hands, however, became badly burned—a fact that saved his life, because he was immediately removed from the scene by a police officer and hospitalized. The Assistant Chief, apparently assisted by two civilians, continued fighting the fire.

The second engine company, No. 4, traveling east on Oak Avenue, stopped before reaching Pine Street, and was thus shielded from the fire by Gerretsen's 3-story corner building. Following their pre-fire training plan, they laid a 2½-inch line from the hydrant at Spruce and Oak (see map). The three firemen manning the pumper were joined by a lieutenant, and they planned to take the line through the south portion of the building.

At this moment, insufficient water had been applied by the first company to reduce the severe fire exposure to the parked truck. From the time of discovery, the fire had been burning for an estimated eleven minutes. Witnesses later testified that flames were impinging on the parked truck and that smoke was issuing from the vehicle. The truck driver, who had been asleep in a nearby hotel, was awakened by the fire sirens and started to run towards the truck load of explosives. The Assistant Chief, from all indications, apparently had just become aware that the vehicle was an "explosives" truck and had ordered the area evacuated, when the explosives detonated.

THE EXPLOSION

It is estimated that the contents of the "explosives" truck detonated at about 1:14 A.M. Thirteen people were killed, and many others were injured as a result of the explosion. A fireball with radiating heat and flames rose to an estimated 300 feet in the air. The entire City of Roseburg was badly shaken by the blast, and windows were broken as far as 9 miles away. Earthquake-like tremors were felt 17 miles away, and a "loud thud" was heard at a distance of 30 miles. The "explosives" truck had disappeared. In its place was a crater 52 feet in diameter and 20 feet deep. About half of the crater was blown out of the concrete paved street, and the other half from the ground beneath the warehouse building. The largest part of the truck recovered was a rear axle which hit a tree over three blocks

away and bounced back 30 feet to the sidewalk. The warehouse where the fire had started and many buildings in the surrounding blocks were leveled; in those that were left standing, windows were knocked out, and walls were opened exposing the interior to fire.

The Roseburg Fire Department suffered from the blast. The Assistant Fire Chief, the two civilians who were helping him, and a police officer on traffic duty were among those instantly killed. A 1000-gpm pumper, No. 5, was wrecked. The firemen operating Pumper No. 4 were shocked, and they suffered ruptured ear drums. Pumper No. 4, however, was still operable. The Roseburg Fire Chief, who was under treatment for a heart condition, was unable to respond to the alarm.



FIG. 2. Close-up view of crater—20 feet deep and 52 feet in diameter.

THE CONFLAGRATION

After the detonation, fires soon appeared beyond the point of origin in buildings in several surrounding areas, started by radiant heat and flying brands. The conflagration which developed was confined mainly to a 7-block area. About 45 buildings were eventually involved in the fire. Many of these buildings, ranging in height from one to four stories and varying in construction, were completely gutted or suffered severe damage.

Engine No. 2 responded soon after the explosion and was followed by Engine No. 3 a few minutes later. After these two remaining engine companies arrived, the men and facilities immediately available for the fire defenses of this city were 31 regular and volunteer firemen and the three pumpers. These consisted of the undamaged 1000-gpm pumper and two 500-gpm pumpers.

It was obvious to the young fire lieutenant, who had assumed command after finding the Assist-

ant Chief dead, that additional help was needed. At about 1:15 A.M., he informed the dispatcher about the fire situation and requested him to call for all the outside aid available. During the ensuing two or three minutes, the firemen on pumper No. 2 laid 1000 feet of hose with four nozzles. After a momentary calm, the immediate area where they were located was suddenly enveloped in fire, and they barely escaped with their apparatus. Their hose lines and nozzles were abandoned.

In the meantime, the crew of pumper No. 4 recovered after the explosion and immediately moved their line back to protect a most important and critical hazard. Less than 400 feet away from the scene of the blast, the 166,000-gallon liquefied petroleum gas (LPG) storage area and the plant supplying this city with gas was located. Fortunately, the seven storage tanks escaped being pierced by flying missiles although large chunks of concrete fell nearby, and the plant's sheet metal walls were hit and penetrated. The outer shell of a liquefied petroleum gas railroad tank car was punctured, but the inner shell remained intact and held the gas. The firemen concentrated on cooling the storage tanks with water (fog) spray and keeping the fire away. As it happened, buildings on three sides of the gas plant burned to the ground, but the tanks were so well protected that

the pressure relief valves did not operate, and no noticeable gas escaped.

Under a previously established aid plan, the Roseburg Rural Fire Department responded with 24 firemen and 3 pumpers of 1000-gpm, 750-gpm and 500-gpm capacity from a station near the city limits. The City of Sutherlin Fire Department, about 16 miles away, responded with one fireman on a 500-gpm pumper. All of these companies were put into action at the fire, the first arriving about 10 minutes after receiving the call for aid.

Other apparatus responding at that time were a pumper with 4 firemen from the City of Myrtle Creek, which stood by at one of the Roseburg Rural Fire Department stations, and a pumper with 3 firemen from the Veterans Administration facilities in Roseburg, which stood by at the Roseburg West Side station.

Some of the fires were immediately visible after the explosion, and others appeared within 5 to 10 minutes. Within a short time several concurrent fires were burning in the 7-block area surrounding the scene of the explosion. These fires were spreading rapidly, exposing the liquefied petroleum gas plant and raising additional flying brands into the air.

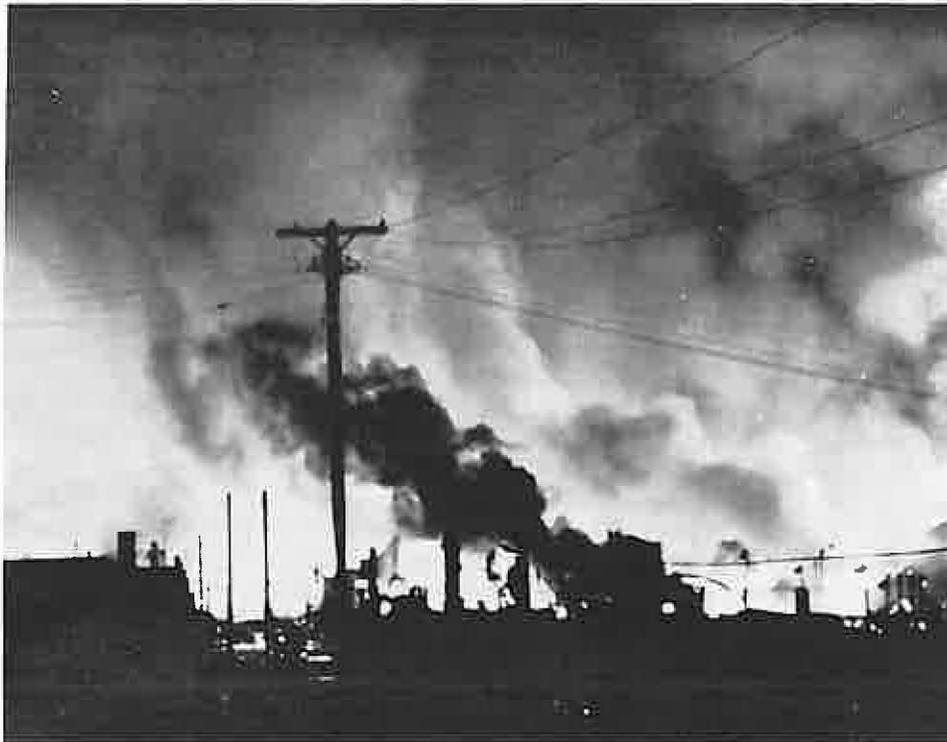


FIG. 3. View during conflagration looking west along Oak Avenue. Blast occurred 1 block behind black smoke.



FIG. 4. Demolished Gerretsen Warehouse Building.

At about this time, a power shut-down caused the failure of the radio base station of the Roseburg Fire Department. In addition, it was difficult to communicate with the incoming outside-aid equipment as they did not have a common radio frequency. No truck-to-truck communication was possible between departments. The serious difficulties in communication added to the fire fighting problems.

Until the outside aid arrived, and, even for some time thereafter, many critical situations were encountered. Now, with the addition of the new forces, there were in action a total of 57 paid or volunteer firemen and 7 pumpers to combat the many simultaneous fires.

One company was temporarily dispatched to extinguish two minor fires started by flying brands downwind from the seven burning blocks. However, these and many other incipient blazes, which could possibly have been started by disrupted gas or electrical appliances, were extinguished by alert citizens. Scores of people were assisted from buildings by neighbors.

Two engine companies were assigned the duty of protecting the liquefied petroleum gas plant, and during the most critical period were cooling the tanks with one 2½-inch and four 1½-inch

streams with spray nozzles, plus small streams from the plant standpipes.

The other companies for the most part were assigned the duty of controlling and confining the fast-spreading fires. The occupancies involved consisted mainly of flour, feed and grain mills and warehouses, automobile showrooms and garages, miscellaneous warehouses, and a soft drink bottling plant. Construction was fairly compact in the blocks involved; accessibility to block interiors was good. Streets were narrow, being only 60 feet in width. Fortunately, the wind was not strong and was decreasing as time passed.

At this point, a crucial decision had to be made by the lieutenant in command to halt the fire spread by preventing it from crossing Stephens Street on the east and Cass Avenue on the south (see map). The threat of fire spread to the other side of the conflagration area was minimized by the river, open spaces and lesser building congestion. With the principal part of Roseburg's business district just behind them, the fire departments made a determined stand along these two streets. At times, fires threatened to spread across Cass Avenue, where a large 3-story flour mill was burning out of control. At 3:00 A.M., about 1 hour and 45 minutes after the explosion, the turning



FIG. 5. Another view of damage in areas adjacent to the blast center.

point came, and the fires which had involved seven blocks were considered to be under control.

Calls for aid had also been made to Eugene and Springfield, Oregon, bringing 3 more pumpers with 14 firemen, which arrived at about 3:00 A.M. These were used for stand-by duty with 2 pumpers at the Roseburg Fire Department headquarters station and 1 pumper at the Roseburg Rural Fire Department Station. About 20 addi-

tional firemen responded from other nearby fire departments.

Final extinguishment and mopping up operations followed throughout the night. In the morning, a 28-square-block area was restricted until all buildings could be inspected. The people were only permitted to enter buildings declared structurally safe. Repairs were undertaken on the other buildings as soon as possible.



FIG. 6. Another view of damage area around crater. Note location of Junior High School building in upper right hand corner.



FIG. 7. View of damage sustained by Junior High School.

REPORT ON EMERGENCY OPERATIONS

Fire Departments

The fire department of the City of Roseburg, at the time of the disaster, consisted of 16 paid men working two 24-hour shifts in each five-day period and 15 active volunteers or call men. On all building fires, a general alarm is sounded by two sirens situated in different parts of the city. All off-duty firemen and all volunteers are expected to respond.

Apparatus response is made from two stations; headquarters station, located in the City Hall at the corner of Oak Street and Main Street, and the West Side Station across the Oak Street bridge about 1½ miles out (see map). Headquarters station houses two 1000-gpm pumpers, one 500-gpm pumper and one salvage truck. This station operates with one officer and two or three men. One of these men handles radio and telephone communications during alarms and is unable to leave the station. The West Side Station has one 500-gpm pumper and operates with two men, one of whom may or may not be an officer depending on the rotation of shift. A fire inspector had been employed on July 1, 1959. At the time of the fire, only ten days had been spent in building inspections by this man.

Within the past year, the City of Roseburg joined with other fire departments in the county to form an outside-aid organization. During this emergency, the other departments cooperated, and the move-up functioned according to plan.

At 1:05 A.M. on August 7th, the Roseburg fire dispatcher received a telephone report of a fire on Pine Street. At the time of the alarm, the Assistant Fire Chief and five firemen were on duty in the city, three at headquarters and three at the West Side Station. As a 1000-gpm pumper No. 5 was responding to the first alarm with the Assistant Fire Chief and a fireman, the Assistant Chief told the dispatcher to sound the general alarm, for a "burner" in the Gerretsen Building and Supply Company.

The general alarm was sounded at 1:06 A.M., and Engine No. 4, a 500-gpm pumper, responded from the West Side Station with three firemen. As additional firemen reported to headquarters for duty, a 1000-gpm Pumper No. 2 left for the fire. As this equipment was leaving the station, the explosion occurred. This was about 1:14 A.M. A few moments later, a 500-gpm Pumper No. 3 responded to the fire.

The individual activities of the Roseburg fire and outside-aid departments have been described in detail in the previous sections of this report.

During the height of the conflagration, seven pumpers were operating at one time. A total of 11,800 feet of 2½-inch hose and 1150 feet of 1½-inch hose was laid, and two portable turrets were used. At this time, 16 streams from 2½-inch lines and 12 streams from 1½-inch lines were used, four of the latter on the liquefied petroleum gas tanks.

Outside fire departments sent the following assistance to Roseburg: the Roseburg Rural Fire Department, 3 pumpers and 24 firemen; the Sutherland Fire Department, 1 pumper and 1 fireman; the Myrtle Creek Fire Department, 1 pumper and 4 firemen; Veterans Administration Fire Department, 1 pumper and 3 firemen; Eugene Fire Department, 2 pumpers and 10 firemen; Springfield Fire Department, 1 pumper and 4 firemen. Additional manpower was also sent by Winston Dillard Fire Department, 8 firemen; North Bend Fire Department, 6 firemen; Coos Bay Fire Department, 5 firemen; and Cottage Grove Fire Department, 1 fireman.

The fire was confined by about 2:15 A.M. and was under control at about 3:00 A.M.

Communications

There is no municipal fire alarm system in Roseburg, and, as previously described, the initial fire preceding the explosion was reported by telephone. Fire department vehicles are equipped with three-way radio transmitter-receivers. The radio system was not disrupted by the explosion, but about 20 minutes after the blast, the power company cut off power in the affected area, and this put the main transmitter out of service, thereafter permitting communication only between vehicles. Fire departments participating in the county-aid plan are not on the same radio frequency, and this was found to be a disadvantage when directing operations of the companies approaching and at the disaster area.

Water Supply

Roseburg's water supply consists of the usual network of inter-connected mains fed by various reservoirs with a total capacity of 3,500,000 gallons. The water main system in the area consists of fairly well gridded 6-inch pipe with some 4-inch pipe. Hydrant spacing is considered to be fair. Water pressures in the city business district range from 85 to 95 psi. A 4-inch main is located under the street about 25 feet from the crater formed by the explosion; however, the only break



FIG. 8 and FIG. 9. Additional views of blast and fire damage.



reported by the water company was a minor crack found the following day in the corporation cock of a discontinued building service. The peak rate of water flow used on the conflagration was estimated by a water company official at 5000 gpm, and the total quantity used was estimated at 1,000,000 gallons. The water supply according to fire department reports was adequate.

Police—National Guard—Others

The Roseburg Police Department suffered an immediate explosion casualty as one of their police officers on traffic duty was killed by the blast. The Police Department was most active in search, rescue, first aid, and evacuation operations after the explosion. By 5:00 A.M., the Police Department, working with the city attorney, had established a pass system limiting access to restricted areas (about 28 blocks in extent) to specially authorized persons.

State Police and Sheriff's officers patrolled the roads entering the city and turned back curiosity seekers. The local Roseburg National Guard Unit was mobilized immediately, and the captain in charge, knowing that he would need more manpower, requested additional aid from the Adjutant General's office. Additional troops arrived at

about 3:00 A.M. The police and troops were stationed in the damaged area to prevent looting and to prohibit persons from entering buildings or areas judged to be in dangerous condition.

The American Red Cross, Civil Defense, Salvation Army, and the police units rendered first aid and assistance to victims and brought some of them to the hospital. Many people who were taken to the hospital for treatment were later released to return to their homes. Blood was flown into the city for emergency cases at 5:00 A.M., but many volunteer blood donors were then available. By 9:00 A.M., the Red Cross had established a canteen and disaster station in the armory opposite the City Hall.

Utilities

Power company personnel, arriving at the scene to find poles broken and wires on the ground, cut off power to the business district and vicinity at about 1:32 A.M. Shortly afterwards, the gas company, fearing the outbreak of fires from broken pipes or dislocated appliances, shut off gas mains to all parts of the city. The complete restoration of these utilities took several days. Service men were required to call at each consumer's premises to inspect and properly activate all equipment.



FIG. 10. Close-up view of typical structural damage.

Building Inspections

With the coming of daylight, the city engineer, working with the building inspector, issued requests to a number of Oregon cities for help in inspecting damaged buildings. Response was prompt, and by the following day, 35 inspectors, engineers and others from cities as far away as Portland had arrived to assist. Preliminary inspections were promptly made and occupants ordered out of unsafe buildings. Special 2-man inspection teams checked flues and electrical wiring systems. When wiring in a building was determined to be safe, notice was given to the power

company and service was restored. A final inspection was made of damaged buildings to check the adequacy of repairs and to find out if the buildings could be safely entered by the public.

Security measures, inspections and other emergency matters were under the general control of the city manager. Operations proceeded in an orderly fashion, and the only reported hysteria after the explosion was on the part of some citizens in the south section of the city because of falling flaming debris. This was momentary, and no panic ensued.

DAMAGE REPORT

The total property damage, according to an initial estimate of the General Adjustment Bureau, was \$9,300,000. There was an estimated total of 6,450 individual losses. Three general zones of damage have been defined, as shown on the map inside the front cover.

In *Zone I*, comprising about 12 blocks including the block with the crater, there was *practically total destruction* and an estimated loss of about \$5,560,000. Of this loss, 83% was in mercantile buildings, stock, and equipment, 12% in dwellings and apartments, and 5% in vehicles. There were about 515 losses in this zone. Among the major buildings destroyed were 4 warehouses, 4 sales and service garages, several stores, a feed mill, flour mill, bottling works, as well as several freight cars.

Zone II comprises about 40 blocks around *Zone I* and includes most of the principal business district, minor business districts, and some residential areas. Damage in this zone is described in general as *heavy*, totaling an estimated \$3,180,000. Of this loss, about 81% was in mercantiles and 19% in dwellings. There were about 1041 losses in this zone, the major losses consisting of two hotels, a motel, garage, church, bank, a mercantile group, the courthouse, and the Junior High School.

Zone III, where damage in general was *light*, includes the area within a radius of one mile of the crater, excluding *Zones I* and *II*. Occupancies are mainly single-family residences with an occasional occupancy of varied type such as a store, church, school, or industrial group. Total damage was about \$560,000,

divided mainly between mercantiles, about 21%, and dwellings, 79%. Outside of *Zone III* were scattered cases of damage, mainly broken windows and cracked plaster, one or two being as far away as 9 miles. There were about 4,895 losses in *Zone III*.

All estimates given above are of a preliminary nature and are subject to change as adjusters and engineers continue and complete their inspections and evaluations.

Structural damage was due almost entirely to concussion and very little to flying missiles. Except in the immediate blast area where destruction was practically total, wood frame exterior walls in nearby blocks were generally badly damaged. Concrete block walls, usually 8 inches in thickness and almost entirely without steel reinforcement, frequently suffered total or partial collapse. On the other hand, older brick walls and poured concrete walls generally remained intact; an exception was the parapets which, lacking the lateral support and thickness of the walls below, were often found cracked. Interior plastered partitions were bulged or displaced where the blast wave entered through shattered windows. In some such cases, buildings did not appear to be badly damaged until an examination was made of the interior. New type light partitions such as wall board fastened by metal clips stood up very poorly.

Roof construction suffered heavy damage, in many cases roofs being subjected to upward forces (for which they were not designed) and then dropped to a mislocated position. This action caused failure in upper and lower chords and end details of trusses and split numerous rafters. This type of damage was characteristic in garages. In 2-story and higher buildings, damage was not



FIG. 11 and FIG. 12. Close-up views of typical structural and fire damage.



nearly so common to floor joists as to roof joists. Numerous plaster and wallboard ceilings and fixtures fell, and plaster damage was extensive in hotels and stores. Buildings for a distance of many blocks from the blast source had most or all windows shattered, and in the Junior High School and a number of other buildings, window frames were dislodged, some being blown inward and some outward, in the same building. Shattered window glass penetrated clothing, furniture and other displays in show windows and food, merchandise, and floor coverings in stores. Proprietors burned wearing apparel, mattresses, and other items where glass splinters were considered a possible menace to the consumer. Churches bore heavy losses to stained glass windows.

In residential districts, glass damage and plaster cracks were common, and there were occasionally cracked door casings and cracked chimneys.

Because of the extent of the disaster and the anticipated large number of insurance claims, an emergency office was set up on a catastrophe basis by the General Adjustment Bureau. Experienced insurance adjusters were flown into Roseburg from many parts of the west, and they worked on a 7-day a week basis. Their work permitted prompt adjustment of claims and enabled property owners to expedite repair and reconstruction work.

LAWS AND REGULATIONS ON EXPLOSIVES, BLASTING AGENTS AND HAZARDOUS MATERIALS

The laws and regulations which governed the "explosives" truck and cargo which detonated during the fire can be considered in the following categories:

Roseburg, Oregon

The City of Roseburg did not have any fire prevention code which directly or indirectly controlled the handling, transportation or storage of explosives, blasting agents, or other hazardous materials within the city limits. No permit was required for the transportation, storage, or parking overnight of this "explosives" truck and its contents

Only a few months prior to the explosion, a complete municipal fire prevention code was proposed for adoption but had not yet been acted upon by the city council. Based on the suggested Fire Prevention Code of the National Board of Fire Underwriters, it would have regulated the storage and transportation of explosives and would have prohibited the parking of a truck carrying explosives in populated and congested areas. The Roseburg Council has passed (August 25, 1959) an emergency explosives ordinance patterned after the newer "Code for the Manufacture, Storage and Use of Explosives and Blasting Agents" of the National Fire Protection Association, which was officially accepted by that association during the previous month.

State of Oregon

Regulations of the State of Oregon pertaining to the storage, transportation and handling of

explosives are contained in the following codes:

(a) "Basic Safety Code"—Oregon Industrial Accident Commission; (b) "Safety Code for Logging"—Oregon Industrial Accident Commission; (c) "Safety Code for Construction Work—Blasting"—Oregon Industrial Accident Commission; (d) Rules and Regulations of the Oregon Public Utility Commission.

The regulations for the transportation of explosives in the State of Oregon are in general conformance with the federal regulations of the Interstate Commerce Commission. The Oregon regulations also cover in detail sections relating to the storage, handling and use of explosives.

U. S. Government— Interstate Commerce Commission

The Interstate Commerce Commission regulates the transportation of explosives and other dangerous materials in interstate commerce by means of (a) Code of Federal Regulations: Title 49: Parts 71-78—"Regulations for Transportation of Explosives and other Dangerous Articles by Land and Water in Rail Freight Service and by Motor Vehicle (Highway) and Water" and (b) Code of Federal Regulations: Title 49: Parts 190-197 "Motor Carrier Safety Regulations."

The "Regulations for Transportation of Explosives and other Dangerous Articles" of the Interstate Commerce Commission define the articles subject to the regulation, prescribe rules shippers must observe in preparing them for



FIG. 13. View looking west on Oak Avenue after conflagration was brought under control.

transportation and list precautions carriers must observe in handling them while in transit.

The "Motor Carrier Safety Regulations" of the Interstate Commerce Commission specifically regulate motor carrier transportation. Sections

190 thru 196 are mainly concerned with those regulations governing the vehicle and the operator, while Section 197 details the prescribed rules for the transportation of explosives and other dangerous articles by motor vehicle.

CONCLUSIONS

Witnesses before the Interstate Commerce Commission investigators reported that flame and intense heat from the fire engulfing the warehouse impinged upon the truck and engulfed it. While both the dynamite or the blasting agent could have been detonated by fire, the opinion of the explosives experts was that the dynamite probably exploded first, thus initiating an explosion of the nitro-carbo-nitrate blasting agent. The investigators also revealed that this truck was left locked and unattended, while parked in a congested area, in disregard of the I.C.C. Motor Carrier Safety Regulations.

The lack of prior knowledge of the presence of the "explosives" truck in the City of Roseburg placed the fire department at a great disadvan-

tage. For without control by a fire prevention ordinance or any other permit system for explosives it was not mandatory for the shipper or consignee to notify the Roseburg Fire Department of the presence of the truck and its dangerous cargo in the city. With some forewarning, the initial fire fighting operations could have been directed towards cooling and removing the "explosives" truck from the fire scene. However, proper regulation and enforcement would have prevented the overnight parking of the unattended "explosives" truck in the congested area of the city.

The importance of well-trained officer personnel in fire department operations was exemplified in Roseburg. Despite the loss of the Chief and Assistant Chief, a young lieutenant was capable

of assuming command and handling a difficult job. Leadership training should not be overlooked by fire departments, and officers should be given the opportunity to exercise this important quality from time to time. In addition, the value of pre-fire planning and training was demonstrated by the excellent protection given to the LPG plant.

Obtaining proper equipment and manpower for fire departments is an important consideration for all municipalities. The chain of events at Roseburg might have been different if the initial companies responding to the fire had been adequately manned. In addition, a standby power source for the base radio station and planning for interdepartment communications would have been most helpful in maintaining continuous communications after the electric power was shut down at Roseburg.

Complete and adequate enforcement (at federal level) of the Interstate Commerce Commission regulations for explosives and dangerous articles is difficult to achieve. Some states have sought the answer by the adoption and enforcement of the Interstate Commerce Commission regulations on a state level, thereby bringing the manpower of the state enforcement agencies to

bear on the problem. In 1957, a federal survey indicated, however, that only four states had achieved full conformity with the Interstate Commerce Commission motor carrier safety regulations and the regulations governing the transportation of explosives and other dangerous articles.

The transit of explosives-laden trucks through or near congested and heavily populated areas has long been a problem in many states. In at least one state, the hazard has been handled by a well developed regulatory program. The Vehicle Code (Division 11d) of the State of California was adopted to regulate the operation of any vehicle carrying explosives on any public highway within this state. Owners of vehicles used for such transportation must obtain a permit from the state highway patrol, and the vehicles must be driven along routes designated by the state fire marshal. These routes are established after hearings attended by interested representatives and are designated on maps which also show places for inspection stops and where drivers may stop for food, fuel, or other necessities. It is the responsibility of the driver to avoid, so far as practicable, congested thoroughfares and places which could present undue danger.

RECOMMENDATIONS

(1) Undoubtedly, the most important recommendation is the need for the enactment and cooperative enforcement at state and local levels of laws and regulations covering the storage, handling and transportation of explosives and blasting agents. Adoption of the National Board of Fire Underwriters' "Fire Prevention Code" is recommended as an overall regulation for broader fire prevention control of the storage and handling of various hazardous materials and devices, as well as conditions that result from their use or occupancy of buildings or premises. Where more detailed regulations covering explosives and blasting agents are desired, the "Code for the Manufacture, Transportation, Storage and Use of Explosives and Blasting Agents," prepared by the National Fire Protection Association, is recommended for use as a guide in the preparation of legal regulations. It recognizes that explosives and blasting agents present a definite hazard to the public and to police and fire departments when improperly handled or when involved in fire, collisions and similar emergencies, and a permit system to alert these departments is incorporated in this Code.

(2) Approved routes for the transportation of

explosives and blasting agents, and the adoption of pertinent federal regulations, should be considered for enactment on a state-wide level and cooperative enforcement at all levels. Emphasis should be placed on the avoidance of travel through heavily populated communities and congested highways.

(3) Inspection programs conducted by local fire departments should include inquiries into the storage of explosives, blasting agents and hazardous chemicals in plants and warehouses.

(4) Laws and regulations governing the storage, handling and transportation of explosives and blasting agents should be carefully studied and understood by state and local authorities, and, with the aid of an educational program, municipal fire departments should become familiar with regulatory details pertinent to safeguarding such hazardous cargo in fire emergencies.

(5) Changing situations brought about by technological advances call for frequent review, reappraisal and improvement in fire prevention safeguards. To provide for these changes, enabling acts or brief adopting ordinances, which authorize local authorities having jurisdiction to promulgate a

regulation under the guidance of nationally recognized and periodically revised standards, should be considered, together with the establishment of a Bureau of Fire Prevention for their enforcement. Suggestions in this regard are contained in the aforementioned Codes.

(6) Firemen training programs should cover fire problems involving explosives and blasting agents. Such emergencies can present considerable risk to fire department personnel. In the absence of explosives, fires involving blasting agents may be fought with copious quantities of water when such fires are attacked in the early stages. However, if explosives are present in the same fire, the immediate area should be considered unsafe and promptly evacuated; firemen should seek protective cover and be prepared to handle any additional fire problems that might develop as a result of such an explosion. Subsequent cleanup and salvage operations of such hazardous and contaminated materials should be conducted with due consideration for their safe disposal.

(7) Management and drivers of private, contract and common carriers should be thoroughly familiar with the hazardous nature of the articles comprising their cargo and the pertinent federal,

state and local rules and regulations regarding their transportation by motor vehicles. Constant attendance of motor vehicles carrying explosives should be a primary responsibility of all carriers. Fire prevention and fire protection procedures for all types of fires should be fully understood, and training reference should be made to the "Recommended Good Practices for Truck Fire Protection" (1955) and the "Standard for Motor Freight Terminals" (1959) published by the NFPA.

(8) The systematic post-disaster inspection procedure conducted in Roseburg on all buildings in the "28-block damage area" should serve as a model for other municipalities when faced with problems of re-entry into disaster areas and rehabilitation of various occupancies.

(9) Adequate manning of fire departments should be sought by municipalities.

(10) An auxiliary electric power generator is recommended for fire department base radio stations in order to provide continuous communication during power failure or shutdowns. Adequate radio communications should be established between fire departments cooperating in outside-aid plans. Where conditions permit, the use of a common frequency with outside fire departments should be utilized.

The National Board of Fire Underwriters, established in 1866, is an organization of more than 200 stock fire insurance companies, maintained for the purpose of conserving life and property from fire by providing engineering, statistical, and educational services to both the public and its member companies. It maintains a staff of technically trained experts and research engineers to evaluate fire and explosion hazards and make recommendations for their alleviation.

