

OCTOBER, 1924.

Report No. 162

NATIONAL BOARD OF FIRE UNDERWRITERS
COMMITTEE ON
FIRE PREVENTION AND ENGINEERING STANDARDS

REPORT
ON THE
CITY OF RALEIGH, N. C.
(SUPERSEDING THAT OF 1911)

NATIONAL BOARD OF FIRE UNDERWRITERS

76 WILLIAM STREET, NEW YORK.

H. A. SMITH, President, Hartford. NORMAN T. ROBERTSON, Treasurer, New York.
N. S. BARTOW, Vice-President, New York. SUMNER BALLARD, Secretary, New York.
W. E. MALLALIEU, General Manager.

COMMITTEE ON FIRE PREVENTION AND ENGINEERING STANDARDS

THOMAS H. ANDERSON, Chairman, New York.

C. W. PIERCE, New York.	O. E. SCHAEFER, New York.
MILTON DARGAN, Atlanta.	A. R. PHILLIPS, New York.
J. H. VREELAND, Hartford.	F. E. BURKE, New York.
HENRY W. GRAY, JR., Hartford.	McCLURE KELLY, San Francisco.
FRED A. RYB, Chicago.	E. J. SLOAN, Hartford.
R. P. BARBOUR, New York.	E. H. WEST, Glens Falls.
JOHN KAY, Newark.	C. H. COATES, New York.
J. D. LESTER, New York.	F. M. AVERY, San Francisco.

GEO. W. BOOTH, Chief Engineer, New York.
A. C. HUTSON, Asst. Chief Engineer, New York.
CLARENCE GOLDSMITH, Asst. Chief Engineer, Chicago.
ROBT. E. ANDREWS, Asst. Chief Engineer, San Francisco.

The investigation of conditions in Raleigh, N. C., was made during June, 1924, by Engineers J. H. Howland, John Ashmead, and J. H. Arnold.

Acknowledgment is made of valuable assistance rendered by the Hon. Eugene C. Culbreth, Mayor; the officials of the various city departments concerned, and others.

Office Engineers

ROBERT C. DENNETT

CLINTON T. BISSILL

OCTOBER 31, 1924.

RALEIGH, N. C.

REPORT NO. 162.

(Superseding that of 1911.)

CITY IN GENERAL

The city government is of commission form, of 3 members: Eugene C. Culbreth, Mayor; Charles C. Page, Commissioner of Public Works, and E. G. Birdsong, Commissioner of Public Safety.

Population estimated to be 35,000; the 1920 United States census showed 28,674. The city is the State capital and the seat of several colleges, preparatory schools and State institutions which have been of great importance in the city's growth. Local industries comprise railroad repair shops and cotton, hosiery, cotton seed oil and planing mills. Shipping facilities are provided by 4 railroads.

The area of the city is 7 square miles, about two-thirds of which is built upon. The surface of the city is undulating; elevations in feet above mean sea level range from 241 at the southern city limits to 427 near the western limit. Street grades are mainly moderate. Four streets ra-

diating from the capital are 99 feet wide; all others are 66 feet in width. There are 100 miles of streets of which 30 miles are paved. Unpaved streets are in poor condition, especially in wet weather. Bituminous coal is used as fuel for both manufacturing and domestic purposes, anthracite coal and wood being also used for the latter.

Records of the United States Weather Bureau show that winds of 25 miles and over are infrequent. Winter temperatures are mild, and no interruption to traffic is caused by snowfall. Periods of hot, dry weather are slight.

Records of the State Insurance Commission for 1923 show a fire loss of \$188,791 for 95 fires, an average of \$1,987 per fire, a very high figure. The loss per capita, based on a population of 33,500 was \$5.64, a high figure, and the number of fires per 1,000 population was 2.8, a low number.

FIRE-FIGHTING FACILITIES

WATER SUPPLY

OWNERSHIP.—The system, supplying all built-up parts of the city and approximately 1,000 consumers just outside of the corporate limits, formerly owned and operated by the Wake Water Company and originally built in 1886-87, was taken over by the municipality in June, 1913.

ORGANIZATION.—Administrative control is vested in the Commissioner of Public Works. The 2-year term of the present commissioner, Charles C. Page, expires in May, 1925. E. B. Bain, engineer and superintendent, has been in general charge for 27 years; he is a registered engineer in North Carolina, a member of the American and New England Water Works Associations, and well qualified to perform the duties of his office. W. B. Bandy, assistant to the superintendent, also a registered engineer and member of the American Water Works Association, has charge of construction work. There are 30 regular employees. Long terms of service are the rule.

Records and Plans.—Generally complete but not in convenient form and not properly posted or filed. Pumpage records and pressure charts

at controlling points are regularly filed in the main office. No vault provided.

Quarters.—Main office, with repair shop and store room in the rear, is at 115 Morgan street, where constant watch is ordinarily maintained. Pipe and fittings are kept near water tower.

Fire Service and Emergency Operations.—Fire alarms sound in pumping station and main office. Ordinarily the water tower is kept nearly full and pressures are not raised for fires except to meet excessive draft. At least one responsible employee attends all large fires. One of three motor trucks are generally available for emergency service. Responsible employees have automobiles. Telephones connected to the public exchange are installed where necessary.

GENERAL OUTLINE OF SYSTEM.—Supply, taken from Walnut Creek and impounding reservoirs, flows by gravity to suction well at pumping station. Low-lift pumps raise the water to the purification plant, from which the high-lift pumps take suction and discharge directly to a single system of distribution with elevated tank acting as an equalizer.

Elevations in the city range from 241 to 427;

WATER SUPPLY.

all elevations given in this report are in feet above sea level.

SUPPLY WORKS.—General.—Walnut creek has a drainage area above the lowest point of intake of 13.87 square miles. The minimum annual rainfall recorded in the past 38 years is 32.09 inches; the minimum recorded stream flow for any one day was 73,200 gallons and for a month was an average of 238,000 gallons per day.

Impounding Reservoirs.—Located respectively $2\frac{1}{4}$ and 4 miles above the pumping station on Walnut creek are Lake Raleigh and Lake Mattamusquette, both formed by substantially constructed earth dams with spillways and either core wall or upper slopes of concrete.

Lake Mattamusquette has a full storage capacity of 400,000,000 gallons; it supplies Lake Raleigh about $1\frac{1}{2}$ miles below by way of Walnut creek.

Lake Raleigh, with spillway at elevation 281, has a storage capacity of 140,000,000 gallons. A single line of 24-inch wood-stave pipe, 6,100 feet long, connects to two lines, one 14-inch wood stave and the other 16-inch cast iron, which continue 6,700 feet to a suction chamber at the pumping station. A contract has been recently let to replace the 24-inch wood-stave pipe with 30- and 24-inch cast iron. An emergency intake, formed by small concrete dam with practically no storage capacity, 2,700 feet below Lake Raleigh, connects Walnut creek through screened chamber and short gated branch to the 24-inch pipe. At a 6,000,000-gallon rate through these pipes, the suction chamber will provide a slight head on the low-lift pumps.

The safe yield from the present supply works, which has about reached its limit of development, is estimated at approximately 5,000,000 gallons per day.

Filter Plant.—The low-lift pumps discharge directly to a reinforced concrete coagulating basin, only the top 15 inches of the storage capacity being available for filtering. The filter house, about 125 feet northwest of the pumping station, is a moderate area 1-story and basement brick building with concrete floors and metal covered plank roof on wood trusses. The plant consists of 11 mechanical filter units having a combined rated capacity of 5,500,000 gallons per 24 hours.

From a small concrete well under the filters, the water flows to an elliptical, masonry lined, clear water reservoir holding 2,000,000 gallons at a high water elevation of 201, with independent suction connection to each high-lift pump; an emergency by-pass provides suction to one high-lift pump direct from the filters.

It is planned to utilize a 500,000-gallon basin, formerly used as settling basin as additional clear

water storage, at an overflow elevation of 271, by pumping with the present 4,000,000-gallon low-lift pump, to be relocated in basement of filter house.

Pumping Station.—General.—Erected in 1887 on the north bank of Walnut creek $1\frac{1}{2}$ miles south of the principal mercantile district. Equipment well above the highest flood levels. Fuel bought under contract without bond provision is delivered in carts; seldom less than 100 and ordinarily 150 to 300 tons on hand. Plant operated by a force of 9, in two shifts of 3 to 6 men each.

Equipment.—Consists of three horizontal, compound, condensing, duplex, double-acting high-lift pumps; one Prescott installed in 1913 and one Worthington in 1904 are of 2,500,000 gallons and a McGowan of 3,000,000 gallons rated capacity was put in service in 1908. Discharge piping is well arranged, except that the repair of one valve would put all pumps out of service. The two low-lift pumps are of the Morris, double suction, centrifugal type, one of 5,000,000 gallons driven by an 8-stage Kerr steam turbine, the other of 4,000,000 gallons capacity by a 50 h.p. General Electric induction motor. The latter is to be replaced with a 6,000,000-gallon pump of the same general type which has been delivered and will shortly be installed.

There are 3 boilers of the horizontal, marine, fire-tube type; two of 125-h.p. installed in 1901 and 1908 are of the Walsh and Weidner make and one of 150-h.p. is a Casey-Hedges make of 1912.

Pumps and boilers are well maintained and in good operative condition. Two boilers, one low-lift and one or two high-lift pumps are ordinarily in use; steam pressure averages 110 and the high-lift pumps discharge at 110 to 130 pounds water pressure. Electric current from substation of the Carolina Power and Light Company is received over an independent overhead line, 4,000 feet long with outside transformers on pole; interruptions for short periods are frequent. Steam is supplied through a single ungated header in which a break would put out of service all pumps except the electrically operated low-lift unit.

Construction.—The station is a high, 1-story brick building of small area, with 13-inch parapeted brick wall having one unprotected door opening between boiler and pump rooms. Wood floor in pump room, cement in boiler room. Steel roof covered with corrugated iron over boiler room with wood truss and plank covered with slate over pump room.

Oils and miscellaneous tools are kept in small brick building 110 feet distant.

Hazards.—No exposures. Independent stacks for each boiler; 2 of metal extend through roof

one outside, of brick; all well installed. Electric lighting; wiring all in conduit. Oils and waste well cared for.

Protection.—One hydrant with 2 hose outlets between pumping station and filter house. A 2½-inch standpipe with 50 feet of 2-inch hose and nozzle attached in pump room; an additional 100 feet of hose and an extra nozzle hang nearby; 125 feet of ¾-inch hose is provided for boiler and yard use. Nearest fire station 1¼ miles distant.

Water Tower.—Located on West Lane street about 1 mile northwest of the principal mercantile district; riveted steel tank with spherical bottom supported on steel tower; storage capacity 600,000 gallons with overflow at elevation 497. Hydraulic controlling valve and recording pressure gage at base of tower.

CONSUMPTION.—The average daily consumption for the past five years, based on plunger displacement with no correction for slip, is given in Table 1. The records indicate that since 1910 there has been a 35 per cent. increase in the per capita rate in spite of a 47 per cent. increase in the number of metered services.

TABLE 1.—CONSUMPTION.

Year Ending May 31	Average Pumpage, Gallons per Day	Estimated Popula- tion Supplied	Gallons per Capita	NUMBER OF	
				Services	Meters
1920	2,729,404	30,000	91.	4,551	1,424
1921	2,788,782	31,250	89.	4,761	1,712
1922	2,285,114	32,500	70.	5,205	2,134
1923	2,959,205	33,750	88.	5,824	2,717
1924	3,346,528	35,000	96.	6,484	3,230

Maximum.—The maximum rates of pumpage occur in the late afternoon during the hot summer months. Hourly rates frequently exceed 5,000,000 gallons per 24 hours. The maximum for any one day was 4,442,000 gallons on May 11, 1924.

Meters and Service Connections.—About 50 per cent. of all services, including all large consumers, are metered. There are 30 large service connections, mostly 4 and 6 inches in diameter, supplying principally private hydrants, sprinkler equipments and hose standpipes. Controlling valves in nearly all cases are located close to street mains.

PRESSURES.—Recording pressure gages at elevations 356, 242 and 371 respectively, are maintained at the main office, pumping station and water tower. Pressures ranging from 55 to 75 and averaging close to 62 pounds are maintained at the main office gage, at the high corner of the principal mercantile district. At the

pumping station the average pressure is 110 at night and ranges from 120 to 135 during the day and early evening. The water tower is kept nearly full, there being a high and low water electric alarm connected and installed at the pumping station. Pressures are not ordinarily raised for fires.

In June, 1924, readings were taken by a National Board engineer between the hours of 6 and 9 A. M., at 19 hydrants well distributed throughout the city, with the water tower full and a consumption rate close to 5,000,000 gallons per day. For the entire city the average was found to be 69 pounds, with a maximum of 106 and a minimum of 33; in the principal mercantile district, they ranged from 64 to 78 averaging 72 pounds.

DISTRIBUTION SYSTEM.—As shown on the accompanying plan, two force mains extend from the pumping station through and along one side of the principal mercantile district, connecting with the end of a 20-inch line, which continues 4,200 feet to the water tower, from which a 12-inch line extends west. The first installed is 14-inch for the first 3,400 feet, 12-inch for 5,500 feet and 10-inch for the remaining 1,300 feet; the new main is 16-inch for 6,900 feet, 14-inch for 950 feet and 12-inch for the last 2,300 feet. An interconnecting 12-inch loop extends closely around the south and west sides of the high value district. Minor distributors are very largely 6-inch, with moderate amounts of 4- and 8-inch. The excessive increase in 4-inch pipe is due to the acquisition of annexed territory. The absence of 12- and 8-inch pipe to the north and east is particularly marked. Dead ends are frequent in the outlying sections, but in well built-up districts gridironing is mainly good.

The total length of street mains in the principal mercantile district is slightly in excess of 11,000 feet, of which 9 per cent. is 14-inch, 24 per cent. is 12-inch, 7 per cent. is 8-inch, 49 per cent. is 6-inch and 11 per cent. is 4-inch. They are so arranged and interconnected as to give generally adequate deliveries.

PIPES.—Length and Age.—See Table 2. For many years the minimum size laid for hydrant supply has been 6-inch.

Condition and Cover.—All pipe is tar-coated cast iron, of Classes C and D of the American Water Works Association specifications, the latter being in the vicinity of the pumping station. Close to one-fourth was laid over 35 years ago and more than two-thirds of the total pipe now in service was laid or acquired within the past 15 years. Old pipe removed shows some

WATER SUPPLY.

TABLE 2.—PIPES AND VALVES IN SERVICE,
MAY 31, 1924.

Diameter, in Inches	Pipes*			Number of Gate Valves
	Length, Miles	Per Cent. of Total	Miles Laid Since 1911	
4	6.72	12.33	3.68	111.†
6	23.76	61.93	20.97	318.†
8	7.24	13.28	5.18	51.
10	.41	.75	.....	4.
12	3.43	6.29	2.33	26.
14	.84	1.64	.21	4.
16	1.30	2.39	1.20	4.
20	.81	1.49	.81	7.
Totals,	54.51	100.00	34.48	525.

*Includes force mains from pumping station.
†Includes valves on private services.

tubercles and incrustation, but not sufficient to seriously affect its capacity; little sediment was apparent during fire flow tests. Depth of cover is ordinarily $2\frac{1}{2}$ to 3 feet; frozen mains never experienced.

Electrolysis.—See Electricity, page 14.

GATE VALVES.—All 20-inch and the controlling valves at the pumping station are of the spur-gear type set in manholes. Others are direct acting and set in the usual iron extension box. All open to the left and have uniform operating nuts.

Location and Spacing.—Less than 10 per cent. of the valves are close to main intersections, the general practice being to set them at or near property lines at street intersections. Measurements of locations are recorded in note books, less than 20 per cent. of which have been transferred for more convenient use to loose-leaf sectional sheets.

The spacing of valves has in recent years been considerably improved in the central portion of the city, but is still wide in nearly all districts. The average length of main, in and bordering on the principal mercantile district, which would have to be shut off in case of a single break is 1,000 feet, each of the longest two being close to 1,750 feet. In a representative residential section, the average was found to be 1,200 feet with a maximum 2,600.

Inspections.—No systematic inspections have been made in the last four years. An inspection of 26 valves in 4 well distributed groups, and including sizes from 4 to 20 inches, was made by a National Board engineer in June. The valves were found in operative condition, but several of the boxes were on unpaved streets not close to property lines and not readily lo-

cated; in a few instances, delay in operation was occasioned from dirt in boxes and the box covers being below grade or cemented in during street paving work.

Closing of Valves.—The fire department is verbally notified when valves affecting hydrant supply are operated.

HYDRANTS.—**Number and Type.**—The total number of hydrants May 31, 1924, was 464, of which 89 were on private property. All are of the post type and, except for 64 Columbia and 1 Glamorgan, are of the Mathews pattern. There are only 2 with a single hose outlet, 66 with one steamer and 2 hose outlets and the remainder have 2 hose outlets. Less than 100 have 4-inch barrel and branch connection to main; others have 5. to 6-inch barrels and 6-inch branches. Only those recently installed and connected to the larger mains have valve on branch.

Drainage.—All hydrants have automatic drip valve set in pockets of broken stone or brick; those operated drained well. Only one instance of a frozen hydrant has ever been experienced.

Inspection and Condition.—Regular inspections are made each spring and fall when hydrants are operated and packed, greased and overhauled as needed. Of 40 hydrants operated by National Board engineers practically all were found in excellent condition.

Distribution.—The average area served by each hydrant in the principal mercantile district was found to be 92,000 square feet or a 40 per cent. improvement since 1911. In a large well built residential district in the central portion of the city, the average area served per hydrant is 147,000 square feet; in several of the outlying sections the spacing is much wider.

FIRE FLOW TESTS.—See Table 3. Tests were made June 24, 1924, between 6:20 and 8:30 A. M., with the consumption rate close to 5,000,000 gallons per day. All three high-lift pumps were in operation at a fairly uniform discharge pressure of 160 pounds or 25 to 30 pounds in excess of that ordinarily maintained. The water tower was overflowing during the tests.

RECENT IMPROVEMENTS.—Since the inspection by National Board engineers in 1911, the system has been purchased by the city and materially extended to provide for annexed territory; the construction of two impounding reservoirs and pipe connections has extensively augmented the supply; the low-lift pumping and filter capacities have been more than doubled; one boiler was replaced and a small high-lift pump added; the old water tower has been replaced by one of much larger capacity and at a

TABLE 3.—FIRE FLOW TESTS.

District	Number and Location of Group*	DISCHARGE, GALLONS PER MINUTE					PRESSURE, POUNDS PER SQUARE INCH		QUANTITY				
		Individual Hydrants					Total of Group	Hydrants Closed	Hydrants Open	Required	AVAILABLE FOR		
											Engine Supply	Hydrant Streams	
Principal Mercantile.... Manufacturing..	1. Blount and Davie Sts.			1070	1800	1830	1840	6540†	88	45	5500	†	3400
	2. Blount and Morgan Sts.			640	960	1480	1640	4720†	77	37	5500	†	900
	3. Davie and Harrington Sts.	450	1040	1120				2610†	92	59	3000	†	2600
	4. Woodburn Rd. and Hillsboro St.	800	1000	1080				2880	46	16	2000	2700	.....
Residential....	5. Glenwood Ave. and Fairview Rd.	280	480	860				1340	75	3	2000	1200	600
	6. Mordicai Dr. and Sycamore St.		860	.....	.....			1140	100	6	2000	1000	600
	7. Hargett and Freeman Sts.		300	580	880			1760	74	16	2000	1700	800
	8. Lenoir and Cutler Sts.	1040	1240	.....	.....			2280	98	25	2000	2400	1600

*Location of groups shown on accompanying plan by corresponding numbers.

†Tests largely affected by flow from standpipe; for an extended fire, flow would be limited by pump capacity to 3,500 gallons a minute.

higher elevation; the distribution system has been materially improved by the laying of a second and larger force main, large sized connection to water tower, loop around the west side of the mercantile district and the insertion of a considerable number of valves and large hydrants.

The department superintendent has recommended the installation of a 5,000,000-gallon high-lift pump, the new force main 16-inch for its entire length, and other improvements with a view to the future supply being ultimately derived from the Nuese river.

CONCLUSIONS.—Organization.—Efficient in general management and supervision, but weak in certain features of maintenance particularly as regards suitable office and filing facilities and necessary assistance to keep maps and records up to date.

Supply Works.—The yield from the Walnut creek development is adequate for present needs but is likely to prove insufficient as the population of the city approaches 50,000. Dependence upon a single line of wood-stave pipe next below the small concrete intake is the weakest link in the present supply of raw water; a recent contract provides for the complete replacement of this wood-stave with a 30- and 24-inch cast-iron line. The low-lift pumps, filters and clear water storages are of sufficient capacities but there is inadequate reserve in the former. The inadequacy of the high-lift pumping capacity is the weakest feature in the entire system of water supply; with all of the pumps in service adequate supply cannot be delivered for an extended fire, as storage in the tank would be exhausted; and with one unit out of service but little more than maximum consumption can be supplied. A

single ungated steam header at the pumping station jeopardizes the protection to the entire city.

Consumption.—The per capita rate should be reduced through waste prevention surveys and the more extensive use of meters.

Pressures.—Sufficient to adequately supply automatic sprinklers in buildings up to 9 stories in height and in the more congested portions of the city to furnish small quantities for direct hydrant streams. Due to the lack of proper feeder mains in the extreme northern and eastern sections pressures are seriously reduced under small draft.

Protection.—Fire flow tests made under exceptionally favorable conditions, with the pumps maintaining fire pressures about 25 pounds higher than those usually carried and with the water tower overflowing, indicate that the mains can deliver adequate quantities to high value districts, but for an extended fire, after the supply in the tanks was exhausted, the inadequate pumping capacity would limit the supply to about 60 per cent. of that required in excess of maximum consumption. In 3 of the tests in outlying residential districts the quantities obtained were inadequate.

Mains.—The feeder mains to the principal mercantile district and western portions of the city are well arranged and of adequate carrying capacity. Mains leading to the outlying districts on the north and east are of insufficient size and must be reinforced to give reasonably satisfactory protection. The pipes are in good condition as regards reliability, incrustation, sediment and electrolysis.

FIRE DEPARTMENT.

Valves.—Spacing though considerably improved in the principal mercantile district is still wide in most parts of the city. The former practice of making annual inspections of all valves should be re-established. Except for a few of the boxes and covers they were in good condition.

Hydrants.—Distribution is fairly good in and around the principal mercantile district, but widely spaced in other sections of the city. Hydrants recently installed are of satisfactory type but most of those in service have no large outlets, have undersized barrels and are without independent valves on branches. They are inspected semi-annually and are maintained in excellent condition.

FIRE DEPARTMENT

ORGANIZATION.—Basis.—Full paid since 1912.

Supervision.—Under the supervision of Commissioner of Public Safety E. G. Birdsong, elected May 1, 1923 for a 2-year term. He also has supervision over the Police, Sanitary, Building and Electrical departments.

Officers.—Chief Lewis F. Hicks, age 35, was appointed to his present position June 1, 1923. The chief was a member of the department from 1913-1917 and subsequently organized fire departments at Camp Sevier, Greenville, S. C. and the Federal Base Hospital 126; has attended the Philadelphia Fire Department drill school, and spent eight weeks at Elmira, N. Y. in the American-LaFrance fire engine shops. He is a competent official.

Assistant Chief W. E. Holland, age 34, has been a member of the fire department since June, 1913; appointed to his present position in June, 1923, by the chief.

Membership.—Total membership, 33, including the chief, assistant chief, 4 captains, 4 lieutenants and 23 privates.

Expenses.—During the year ending May 31, 1924, \$43,541 was expended for salaries and \$8,885 for maintenance; a total of \$52,426. This is a per capita expense of \$1.54, based on an estimated population of 34,000.

Appointment and Promotion.—The chief is appointed by the Commissioner of Public Safety, for a 2-year term. Other officers and members are appointed by the chief, with the approval of the commissioner. There are no requirements for appointment except that applicants must be between 21 and 35 years of age.

Retirement and Pension.—No age limit has been set for compulsory retirement; one member is 63, others are not more than 40 years of age.

The Firemen's Relief Fund, instituted by State law in 1907 and last amended in 1921, is supported by State appropriation and $\frac{1}{2}$ of 1 per cent. tax on all fire insurance premiums collected within the State. This fund is designed to care

SUMMARY OF APPARATUS.

	1924		1911	
	In Service	In Reserve	In Service	In Reserve
Fire Engines:				
Pumpers—				
1,000 gallons.....	1	0	0	0
750 gallons.....	2	0	0	0
Steamers—				
600 gallons.....	0	1	0	1
Hose Wagons:				
Automobile Combination....	0	1*	0	0
Horse-drawn Plain.....	0	0	3	0
Ladder Trucks:				
Aerial, Automobile.....	1	0	0	0
Ordinary, Horse-drawn.....	0	0	1	0
Combination, Automobile....	1	0	0	0
Chief's Automobile.....	1	0	0	0
Chief's Wagon.....	0	0	1	0
Fire Alarm Automobile.....	1	0	0	0
Horses.....	0	0	8	1
Hose, 2½-inch.....	8100	0	4200	0
Hose, ½-inch for chemical....	800	0	0	0
Ladders, total length.....	603	0	222	0
Ladders, short, on hose wagons, etc.....	5	0	9	0
Portable Extinguishers.....	5	0	2	0
Deluge Sets.....	1	0	0	0
Siamese Connections.....	2	0	2	0
Ladder Pipes.....	1	0	0	0
Cellar Pipes.....	1	0	0	0
Distributing Nozzles.....	1	0	0	0
Special Couplings (for engines) from other cities.....	2	0	0	0

*In bad condition.

for firemen injured in service; to provide for those dependent on firemen killed in service; and to safeguard any fireman, who honorably served a period of 5 years, from becoming an inmate of any almshouse or actually dependent on charity. The appropriation is administered by State Firemen's Associations, and the tax by a local Board of Trustees.

Companies.—Organization.—Three engine and 2 ladder companies are in service in 3 stations. There are 4 captains and 4 lieutenants for 5 companies. The service and ladder trucks are manned as one company although both respond to alarms in the principal mercantile district and other points where needed. One man is detailed as houseman at fire headquarters, and responds with aerial ladder during meal hours. Members are allowed 1 day off in 4, 10 days annual vacation and 3 hours daily for meals. Substitutes are not employed for vacations but would be in cases of prolonged sickness. Watch at stations is maintained from 10 P. M. to 8 A. M. Men are not required to report to fires on time off but usually do if aware of alarm. Due to meal hours, day off and vacations, there are times when the department strength is only one-third of roster.

This condition obtains during 6 months of the year.

Distribution.—All companies are located within 1,500 feet of the center of the principal mercantile district. One engine company is within and others border the edge of the district. The city limits have been extended so that there are some runs from 1.5 to 2 miles to thinly-built sections and many large institutions.

EQUIPMENT.—**Engines.**—See Table 4. Three American-LaFrance pumpers with rotary pumps are in service and one steamer equipped for towing in reserve; one pumper is equipped for towing the steamer in emergency, the latter usually being towed by an automobile combination hose wagon of questionable reliability. Each engine in service has hand and automatic relief valves, compound suction gauge and 2 hard suctions with 2½-inch reducer, and with 2½-inch hose connection to chemical tank. The reserve steamer has similar equipment but no compound suction gauge.

Engine Tests.—See Table 5. The engines in

inspected and tested and entire unit carefully overhauled before dependence is placed on it for fire duty.

Hose Wagon.—An automobile hose wagon is used for towing the reserve steamer. Because of the condition of this wagon no hose is carried nor is the chemical tank charged.

Ladder Trucks.—See Table 4. Two American-LaFrance ladder trucks are in service; one, a combination city service truck equipped with a 50-foot extension and 8 other ladders including 2 with roof hooks; and the other, a 75-foot quick-raising aerial ladder carrying in addition to the aerial a 45-foot extension and 7 other ladders including 2 pompiers. The aerial also carries a ladder pipe equipped with a 1½-inch tip.

Hose.—Hose is 2½-inch, double-jacketed, cotton, rubber-lined, purchased under suitable service guarantees. It was tested to 300 pounds in May, and is said to be less than four years old. All hose is dried in tower at headquarters station, and is then rolled and stacked. Hose is shifted on wagons occasionally. The amount on hand allows 2,700 feet for each company.

TABLE 4.—FIRE COMPANIES.—LOCATION AND EQUIPMENT.

Company	Location	MEMBERS			APPARATUS			Hose Carried, Feet	2½" Spare Hose, Feet	Ladders Carried	Extinguishers and Tanks, Gallons
		Total	LEAST NO. ON DUTY		Type	Motor h.p.	Put in Service				
Engine 1	Headquarters: Morgan St., near Salisbury St.	8	3	5	750-Gallon Pumper	73	1922	1500-2½"	4800	1-28'	1-2½
Engine 2	Salisbury St., bet. Davie and Carbarus Sts.	7	3	4	1000-Gallon Pumper	73	1918	1000-2½"	*	1-12'	1-40
Engine 3	Hargett and Blount Sts.	7	3	4	750-Gallon Pumper	73	1914	1000-2½"	*	1-12'	2-2½
								200-¾"		1-24'	1-40
Ladder 1	Headquarters	8	4	6	City Service	73	1922			9 Ladders; total length, 235'	1-40
					75' Spring-Raising Aerial	73	1915			9 Ladders; total length, 283'	2-2½

*All spare hose kept at Headquarters.

service and reserve were tested in June, 1924, by National Board engineers to determine their condition and the ability of their operators. They were mainly well operated but capacity could not be obtained. Engine 2 would only deliver 74 per cent. of capacity; the intake manifold on this engine's motor has been replaced. Engine 3 delivered only a little over 300 gallons per minute at 50 pounds, and the test was discontinued. The steamer was operated by Professor Charles B. Parks of State College and fired by the chief; the former ran the steamer in volunteer days and is said to be available at all times. Other members of the department are also said to be available for this duty. The steamer performed satisfactorily; but its evident condition showed that the boiler should be

Couplings.—Hose couplings of this and neighboring cities are of the usual screw type and following dimensions:

Connection	Nominal Size, Inches	Outside Diameter, Male Threads, Inches	Threads, per Inch
Raleigh Hose	2½	3½	6
Raleigh Hydrants	2½	3½	6
	4	4½	6
Durham Hose	2½	3	8
Goldboro Hose			
Payetteville Hose	2½	3½	8
Wilson Hose			
Henderson Hose	2½	3½	8
National Standard	2½	3½	7½

FIRE DEPARTMENT.

TABLE 5.—FIRE ENGINES.

Engine No.	Make	Type	Put in Service	Renovals	DIAM., INCHES		Stroke, Inches	Reasonable Capacity, Gallons per Minute	RESULTS OF ENGINE TESTS.					
					Cylinder	Pump			Gallons Obtained at Test	Per Cent. of Rated Cap. Obtained	Steam Pressure, Pounds	Net Water Pressure, Pounds	Speed, Revolutions per Minute	*Slip of Pumps, Per Cent.
1	American-La France.	Gasoline	1922	Motor Overhauled 1923	...	Rotary	...	750	385 742	52 99	...	207 108	383 626	.....
2	American-La France.	Gasoline	1918	Motor Overhauled 1923	...	Rotary	...	1000	356 741	36 74	...	200 103	187 337	.....
3	American-La France.	Gasoline	1914	Motor Overhauled 1923	...	Rotary	...	750	...	...	See Text	...	...	...
Reserve	Metropolitan.....	Steam	1905	.....	7½	4½	7	600	679	96	74	108	337	8

*Reasonable slip of pumps in good condition, less than 7 per cent.

Two adapters for Durham hose are carried by Engine Company 1.

Minor Equipment.—Minor equipment, while fairly uniform, is incomplete; it includes on each hose-carrier: Two $\frac{3}{4}$ shut-off nozzles with tips from $\frac{7}{8}$ to $1\frac{1}{4}$ inches, axe and lanterns; two also have hand chemical extinguishers, double male and female connections, hose shut-off, and a plaster hook. The ladder trucks carry: Axes, buckets, crow bars, door opener, hose straps, lanterns, picks, plaster hooks, rope, roof cutters, wire cutters and wye connections. The aerial ladder carries, in addition, a life net, life belts, smoke mask, and burst-hose jackets. The appliances for handling special streams consist of 1 deluge set, 1 cellar pipe, 1 distributing nozzle, 1 ladder pipe with a $1\frac{1}{2}$ -inch tip and 2 wye connections. The hose wagon used for towing the steamer is equipped with a turret pipe in need of repairs.

Chief's Automobile.—**Fuel.**—The chief is provided with an automobile roadster. The assistant chief uses his private Ford coupe, which is maintained by the city. The headquarters station is provided with an outside underground 700-gallon gasoline tank with visible measure curb pump from which fire department and all other city automobile apparatus obtain fuel. The chief's car is used as a fuel wagon in emergency, gasoline being carried in ordinary 5-gallon cans.

Repairs.—Minor adjustments and repairs are made at headquarters where a work bench and some hand tools are located. These adjustments and repairs are made under the supervision of the chief who is an expert automobile mechanic. Other repairs are made in local garages. Spare parts are said to be readily obtainable from Atlanta.

Stations.—Two of the 3 stations are brick, the other is part brick and frame. Stations are fairly well arranged for fire service; but two are small and all are in need of repair. Apparatus room floors are of cement. The drill and hose tower at headquarters has been condemned by the building inspector. Heating is by stoves except at headquarters where a steam boiler is installed in a part cellar. Hose drying facilities are provided at headquarters station only.

OPERATION.—**Discipline.**—Rules and regulations adopted and printed in 1913 are used as a guide by the department. The chief has power to suspend or dismiss members subject to approval by the commissioner. The penalty for ordinary infraction of the rules is loss of time off. Discipline is apparently excellent.

Drills and Training.—Members are given setting-up exercises each morning. Companies are drilled at headquarters, weather permitting, in the use of ladders and laying hose. Engines are pumped occasionally from hydrant.

Response to Alarms.—The entire department responds to a box alarm. Both ladders respond to alarms in the principal mercantile district and some school boxes. For box alarms in residential sections only the service truck goes. The amount of apparatus responding to a telephone alarm is governed largely by the district from which the alarm is sent. All companies are located within a short distance of the principal mercantile district. Runs to most outlying points are long. The condition of some of the streets tends to delay response of apparatus. Grade crossings are said to seldom delay response. The chief answers all alarms in the principal mercantile district and sleeps at fire station when assistant chief is off duty.

Fire Methods.—Fire department records do not show how fires are extinguished. The weakness of manning, the too few companies and condition of fire apparatus do not warrant the chief making full use of his chemical equipment except at ordinary fires; the result is an excessive water damage, particularly in the principal mercantile district. Shut-off nozzles with $\frac{3}{8}$ - to $1\frac{1}{4}$ -inch tips are generally used. Hose is carried up stairs or ladders into buildings. Outside connections to standpipes would be used where available. After fires, hose is rolled up, taken back to headquarters and dry hose obtained. No salvage work is done by the department.

Inspections.—The assistant chief takes a new man into the fire limits monthly, making inspections of rubbish conditions mostly. Other hazards noted are reported to the building inspector. No notes or records are kept, as the main idea is to familiarize members with construction of buildings; hydrant inspections are made infrequently.

Reports and Records.—Company journals are kept. A written report of every alarm is made by company officers to the chief, who forwards copies to his Commissioner, and the State Insurance Department.

IMPROVEMENTS.—Since the 1911 report the department has been placed on the full-paid basis and the apparatus motorized. The increase in pumping capacity has been offset somewhat by the indifferent condition of pumpers; ladder service has been improved by the installation of aerial and city service ladder trucks. A sufficient quantity of $2\frac{1}{2}$ -inch hose is kept on hand. The chief has recommended the organization of 2 additional companies.

CONCLUSIONS.—Since the 1911 report the city has increased in population 75 per cent. and has practically doubled in area; but the fire department has not kept pace with this growth. The number of fire stations is the same as in 1891; the fire force has been increased by but 10 men since 1913. Sufficient pumping capacity to adequately handle fires in the buildings erected and in course of erection in the district and other parts of the city has not been provided. Engines in general were found incapable of delivering rated capacities at adequate pressures, even though considerable work overhauling motors has been done in the past year. Minor equipment is incomplete and appliances for handling powerful streams are insufficiently supplied.

Chief officers are experienced, but are appointed for short terms; and the only specifications for membership are maximum and minimum age limits. Several drills were observed and the work indicated considerable training. The drill tower should be placed in safe condi-

tion to facilitate continuance of training. Discipline is apparently excellent.

Fire methods are not considered satisfactory, but should not be entirely condemned as they are used in an attempt to hold fire to place of origin with a very weak fire department inadequately equipped and lacking reserve strength.

FIRE ALARM SYSTEM

ORGANIZATION.—The fire alarm system is under the supervision of the Commissioner of Public Safety. It is maintained by J. W. Mangum, Superintendent of Fire Alarm and Police Patrol, appointed for a 2-year term. He has held office from 1905 to date except for four years between 1909 and 1913, and also has supervision over the building and electrical departments. He is assisted by one lineman.

HEADQUARTERS.—The small operating and battery rooms are on the first floor of a 2-story brick addition to Station 1, separated by fireproof partitions, wired glass windows and fire doors from the rest of building; repeater and switchboard in one room and batteries in the other. There is no private fire protection; portable extinguishers are on fire apparatus.

EQUIPMENT.—Apparatus at Headquarters.—The 4-circuit slate switchboard, originally installed in 1903, and the 4-circuit automatic repeater with 4 alarm contacts, originally installed in 1894, were removed to their present location in 1913.

Circuits enter headquarters in conduit from overhead and terminate direct on the switchboard. They are protected by $\frac{1}{4}$ -ampere link fuses and saw-tooth lightning arresters on the switchboard and 1-ampere link fuses on the battery racks. The 220-volt single phase, 60-cycle charging circuit is protected by 60-ampere cartridge fuses at entrance and about 3-ampere link fuses and automatic circuit-breaker on switchboard. Saw-tooth lightning arresters are provided at fire stations.

Batteries.—Current for operating is supplied by 106 six-ampere hour storage cells in duplicate sets, mounted on glass rods on porcelain insulators on a wooden rack. Each set is charged every 12 hours at one-half ampere rate from the motor-generator set at 220 volts D.C. through lamp resistance. Provision is also made for charging at 550 volts D.C. The battery is well maintained and is capable of operating the system for about 60 hours. There are practically no spare parts.

Apparatus at Fire Station and Elsewhere.—Each fire station is equipped with a combination gong and indicator, Morse key and an automatic

FIRE DEPARTMENT AUXILIARIES.

lighting switch. In addition, gongs are provided at the pumping station, the power station, the office of the water department, the residences of the chief, State fire marshal and the water superintendent. A tower bell striker is in service at fire headquarters.

Boxes.—Description.—Total number, 71; 57 are of non-interfering and 14 of succession, type; one is auxilialized. The one private box is accessible to the public. All boxes are of the trigger pull type, with Morse key, bell or sounder, door shunt, and lightning arrester not grounded; two have brush-break contacts. Doors are equipped with key or handle under glass guard, except ten which have the trigger pull under glass panel.

Six boxes are on iron pedestals; others are secured to poles generally located on street corners. Red indicating lights are not in use; five boxes have white lights. Boxes are painted every two years and are to be painted this year. Boxes examined were found in good condition; they are timed to send blows at two-second intervals.

Distribution.—Box distribution is mainly good in the principal mercantile district but only fairly good elsewhere. Approximately \$1,200 was spent for new boxes in the past fiscal year. Thirty additional locations were noted at which fire alarm boxes should be placed.

Circuits.—Four all-metallic, normally closed box circuits connect the alarm apparatus in fire stations, a tower bell striker and 6 gongs. The total length of circuits approximates 30 miles, all aerial except for 3 wires which are carried underground, in 2-inch metal conduit, for about 600 feet. The longest circuit is about 12 miles and there are many long loops to boxes in outlying sections. Wiring is No. 10 copper, double braid, weatherproof except for underground piece which is double braid, rubber covered. Overhead wires are on telephone poles and in a number of places on poles carrying high potential circuits up to 4,500 volts. Leads down poles are No. 14 rubber-covered wire in metal conduit from cross-arm to box. Wiring in stations is mostly No. 14 rubber-covered wire run open.

Telephones.—Each fire station is connected with the public exchange of the telephone company by a single party line.

OPERATION.—Routine and Maintenance.—The superintendent devotes such time as his other duties permit to the maintenance of the fire alarm system. Circuits are apparently in excellent condition. They are tested at least once daily for current, voltage and grounds. Boxes are said to be tested monthly. Records are lacking. A fireman is detailed as houseman at fire headquarters to handle alarms telephoned there while he is on duty.

Alarm Transmission.—Four rounds of box alarms are automatically transmitted over the system. Telephone alarms are transmitted to the fire station called for or to fire headquarters. A company receiving a telephone or verbal alarm responds, after first giving 2 taps over the system, and, if necessary, pulls the nearest box for assistance. During the year ending May 31, 1924, there were 193 alarms, 105 of which were box, 84 telephone and 4 verbal; 37 alarms were false.

IMPROVEMENTS.—Since the 1911 report, the headquarters equipment has been moved to a better location; 35 boxes have been added, 14 of which are of the succession type; the circuit mileage increased from 12.5 to 30 miles; new batteries and a motor-generator for charging them have been installed.

CONCLUSIONS.—The fire alarm system is under suitable supervision, and is well maintained. It is of suitable type and in good condition but lacks some features which make for reliability. Batteries are of good type, well installed and with good charging arrangements. The type of apparatus in use in fire stations is unsatisfactory, as too much dependence is placed on visual indicators and no duplicate circuits and alarm apparatus are provided. Circuits are practically entirely aerial and in good condition; alarm circuits in fire stations should be in conduit. Boxes are apparently in good condition but are not conspicuous, lacking distinctive marks on poles and red lights indicating locations at night; they are well distributed in the principal mercantile district; in outlying districts, distribution is inadequate and many additional boxes are needed.

Tests are apparently satisfactory but no records are kept and no map is on file showing location of boxes and route of circuits. The method of handling telephoned alarms is unsatisfactory.

Fire alarm headquarters is too small to permit expansion of the system to meet present, and provide for future, needs of the city.

FIRE DEPARTMENT AUXILIARIES

FIRE MARSHAL.—In accordance with a State law it becomes the duty of the chief of a fire department to investigate all fires within 2 days after their occurrence, and furnish the insurance commissioner, within one week, with a written statement of all the facts relating to the cause and origin of the fire, and such other information as may be called for by the blanks provided by the commissioner. The insurance com-

missioner or his deputy, have, in connection with such investigation, all the powers of an examining court, may subpoena witnesses, administer oaths, and, upon finding evidence of arson or other willful burning, cause the arrest of the suspected person.

Records kept by the insurance commissioner show that during 1923 one investigation was conducted in Raleigh.

POLICE DEPARTMENT.—Chief, A. E. Glerm. Active force, 42.

Equipment.—Two motorcycles are used by patrolmen; a taxi is hired for patrol when needed. A police signaling system, with 15 Gamewell boxes, equipped with telephones, on 2 all-metallic circuits, is maintained by the city electrician. Patrolmen report hourly.

Fire Service.—Alarms of fire are received from the tower bell. The patrolmen on adjoining beats report to all fires and establish fire lines. Co-operation between the fire and police department is good.

TELEPHONE SERVICE.—The Southern Bell Telephone Company serves 4,104 subscribers over 1-, 2-, and 4-party lines through one exchange located in a 2-story semi-mill constructed building. Windows are protected against severe exposures; internal hazards are well guarded. Cables are underground in the business district and some important thoroughfares; no ducts are reserved for city use. Single party lines run to each fire station. All lines are protected and cable sheaths bonded. During the fiscal year ending May 31, 1924, 44 per cent. of all alarms were received by telephone. Calls are not supervised.

PUBLIC SERVICE CORPORATIONS.—One man from the North Carolina Power and Light Company responds to all alarms and renders what service is necessary. Alarms are received at the substation on a gong.

PRIVATE FIRE APPARATUS.—Outside of the principal mercantile district most of the manufacturing establishments have fire pumps, hydrants and hose; some have automatic sprinkler equipments.

STRUCTURAL CONDITIONS AND HAZARDS

BUILDING DEPARTMENT

ORGANIZATION.—General.—In 1909, the duties of building inspector were transferred from the chief of the fire department to the city electrician, who also supervises the fire alarm and police telegraph systems. He is elected by the council for a two-year term. No qualifications are prescribed. His duties are to enforce State and municipal laws, issue permits, inspect all buildings under construction, make an annual inspection of all buildings in the city and a quarterly inspection of all buildings within the fire limits, and to make reports to the State Insurance Commissioner.

Personnel.—J. W. Mangum, an experienced contractor, has been building inspector and city electrician from 1905 to 1909, and from 1913 to date. He devotes all his time to the duties of his several offices; and one assistant devotes his time to fire and police signaling systems.

Permits and Records.—A permit must be obtained before any building may be commenced. Applications are made on the stubs of permit books furnished by the insurance commissioner and require very little data. Plans and specifications in duplicate are required, one of which is stamped and returned to be used as a working sheet; the other is permanently filed. Permit cards are required to be posted. Permits are issued in triplicate, one being forwarded to the city engineer and another to the police department.

The police cooperate with the inspector to see that no building construction is started without a permit. Due to lack of assistance and the many duties assigned to the building inspector, records are in poor condition, and generally consist of only the stub books of permits. Filing facilities are poor. Appeals from the inspector's decisions are made to the Insurance Commissioner.

Inspections.—The inspector inspects all buildings for which permits have been issued, as often as possible, special attention being paid to footings before construction is started. Each building is said to be inspected at least twice during construction, or oftener if necessary. In so far as his other duties permit, he complies with the State law requiring quarterly and annual inspection of buildings.

BUILDING LAWS.—General.—State laws of 1921, amended in 1923, in regard to erection and inspection of buildings govern these matters locally. Stairways of all schools are required to be enclosed in smokeproof towers and heating plants cut off from main buildings. Provisions governing the thickness of walls are good, except that only 4 inches of brick work is required between ends of floor beams entering a wall from opposite sides. Parapets not less than 13 inches thick must extend 18 inches above the roof and be coped. Openings in fire or party walls of brick or stone buildings must be protected by standard fire doors on either side of the wall.

EXPLOSIVES AND INFLAMMABLES.

Requirements for chimney construction are good. Within the fire limits frame construction may not be erected, altered, repaired or removed except upon permit of the building inspector. Standpipes are required in all business buildings more than 56 feet in height and of more than 5,000 square feet area and in all buildings over 80 feet in height; chemical extinguishers must be provided on each floor. Fire escapes are required on all hotels over 2 stories in height unless provided with sufficient inside stairways so placed to provide adequate means of egress in case of fire. Buildings found by the inspector to be dangerous because of liability to fire, overloaded floors, decay or other causes must be condemned by him and repaired or removed by the owner.

Municipal Ordinances.—The municipal building code is practically a reprint of the State statutes on the subject of buildings, as summarized above. The zoning ordinance of 1923 provides that no building may exceed 150 feet in height at the street line, but may exceed this height if set back. Four height districts are prescribed in which dwellings are restricted to $2\frac{1}{2}$ stories or 40 feet and other buildings are restricted to from one to two times the width of abutting streets. Areas are restricted only in so far as percentage of lot area permits. Fire escapes are required. Other matters bearing on fire protection and prevention are not mentioned.

Fire Limits.—The fire limits, as shown on the accompanying map, extend about a half block beyond the limits of the principal mercantile district on all sides except at the northeast.

Enforcement.—The existing laws are as well enforced as the inspector's many duties permit.

LOCAL CONDITIONS.—The principal mercantile district consists of 12 blocks containing 13 buildings of fireproof, 230 of joisted brick and 30 of frame construction, exclusive of sheds and additions.

Fireproof construction covers 10 per cent. of the area built upon. The taller buildings are of steel frame or reinforced concrete construction, others are of the brick bearing wall type; two have temporary wooden roofs. Five buildings are 6 stories or over in height, the tallest being 3 office buildings of 10, 11 and 12 stories. Six buildings are of large and 3 of excessive area, the largest being the 4-story federal building of 12,700 square feet, the 4-story museum of 11,400 and the 4-story county court house of 10,700 square feet area. Floor openings are protected in 3 buildings, part protected in 3 and unprotected in 4 buildings; exposed windows are protected in 6 buildings. Standpipes and hose are provided in 6 buildings and chemical extinguishers in all.

Frame construction covers 6 per cent. of the area built upon and consists of dwellings, mer-

cantiles, sheds and additions. Sixteen buildings are 2 stories in height; only 3 exceed 2,500 square feet in area. Four buildings are iron clad and 2 are brick veneered; 7 have wooden shingled roofs.

Joisted brick construction covers 84 per cent. of the area built upon. The highest are two buildings of 5 stories; and 5 are 4 stories in height. Thirty-two buildings are of large, and 3 of excessive, area, the largest being the 2-story auditorium of 17,800 square feet area and a 3-story mercantile and office building of 10,500 square feet area. Unprotected or poorly protected communications form large or excessive areas in 9 and 2 cases, respectively, the largest being the group of 3-story hotel buildings, of 22,100 square feet area, and a group of 2- and 3-story buildings occupied as farm implement, mercantile and warehouses, of 15,200 square feet area. Exposed windows are protected in 24, and part protected in 6 buildings; protection in 1 case consists of open sprinklers. Floor openings are generally unprotected; and open wells exist in 13 buildings.

Walls are mainly of fair thickness; parapets are mainly low. Fire escapes were found on most buildings requiring them. Three buildings are protected by automatic sprinklers, 14 have inside standpipes, and chemical extinguishers are provided in moderate amount.

CONCLUSIONS.—State laws include a few brief but good general provisions for certain details of construction. They, however, do not require construction to be in accordance with modern standards and are of only slight value from a fire prevention standpoint. Except for establishing fire limits, somewhat deficient in extent, the municipal laws make no further regulations of value. The building inspector, because of the inadequate laws, multiplicity of duties and lack of assistants, is unable to secure the good results that might otherwise be obtained. The increased amount of fireproof construction and sprinkler installations have improved structural conditions somewhat in recent years, but as a whole they are generally weak.

EXPLOSIVES AND INFLAMMABLES

ORGANIZATION.—Supervision.—State laws require that the building inspector make quarterly inspections of all premises within the fire limits and annual inspections elsewhere, for accumulations of combustible materials, and that he submit detailed reports to the insurance commissioner; hazardous conditions must be removed or remedied at once upon order of the inspector, except when the owner or occupant

may appeal to the commissioner for further investigation and await his decision. The commissioner, fire chief or fire committee shall make an immediate inspection of hazardous conditions upon complaint of persons having an interest in them or adjacent property.

Inspections.—The building inspector, owing to his many other duties, makes inspections for hazards only when other work brings him upon the premises. Records of inspections are forwarded to the insurance commissioner.

LAWS AND ORDINANCES.—A license from the County Board of Commissioners or chief of the fire department is required before dynamite cartridges, bombs, or other combustible of like kind may be stored or sold. Two hundred and fifty pounds of powder may be kept in labeled portable iron chests; retailers must keep powder in cans which together with fire works and other explosives must be placed in movable cases located as directed by the chief of the fire department. Fire works may be discharged only upon written permission of the mayor or chief of police. Not more than 10 wooden barrels containing illuminating oils may be kept on hand. Unlimited quantities of gasoline, benzine, naphtha or similar explosives, may be kept in underground tanks in approved locations. Shavings must not be deposited or burned within 30 yards of any building nor in any street. Waste materials must be kept in metal receptacles and removed daily. The manufacture, storage or sale of matches of the single dip type is prohibited; packing and storage of other types is specified. It is the duty of the insurance commissioner and superintendent of public instruction, to have fire prevention taught in schools and colleges. Motion picture booths must be approved by the insurance commissioner.

LOCAL CONDITIONS.—One hardware store carries gunpowder, the storage being in two 25-pound kegs. A wholesale drug house in the business district had 10 barrels of oil on tap, and small amounts of drugs and chemicals, well stored. Oil in hardware stores was found on tap in amounts as large as 11 barrels, stored with fair precautions. At garages in the business district, conditions are generally fair except that 2 have wooden floors. Gasoline is in underground tanks with approved pumps in buildings or at curb. One thousand pounds of carbide in original drums was noted at one location.

A dry cleaning establishment is located in a 1-story brick building on the edge of the principal mercantile district. Gasoline is underground but was found in open pans; and the operator wore iron-bound shoes. Machines were

neither protected nor grounded. At cigar stores, matches are usually kept loose in drawers behind counters. Several accumulations of rubbish in building and block interiors were noted.

There are 3 wholesale oil storages within the city. At one no protection is provided to storage and the mutual exposure between it and low value frame dwellings is serious.

CONCLUSIONS.—The laws, although providing for good general supervision, are not specific, and requirements governing many explosive and hazardous substances are not specified. Conditions at oil storages and dry cleaning plants indicate the need of more rigid supervision. The irregularity of, and inability of the building inspector to make, inspections allow very serious conditions to arise, and little improvement can be expected until adequate laws are adopted, and a suitable inspection force provided for, to adequately enforce all laws.

ELECTRICITY

ORGANIZATION AND CONTROL.—An ordinance requires that a competent and experienced person be elected biennially as city electrician. His duties are to inspect all electrical construction inside and outside of buildings and to enforce all ordinances relating thereto. By State law, he is required to inspect new installations before current may be supplied.

Personnel.—J. W. Mangum, an experienced electrician, has been city electrician and building inspector since 1913.

Inspections and Records.—Contractors notify the city electrician when new installations are ready for inspection. Wiring is inspected before concealed and again when fixtures have been installed. The electric light company does not furnish current to a new installation until the written approval of the city electrician has been issued. In connection with his quarterly and annual inspections of buildings, the city electrician reinspects much of the old wiring and requires defects to be remedied. About 300 installations have been condemned and remedied within the past year. Records consist of stubs of applications and certificates and are incomplete; and filing facilities are poor.

LAWS AND REGULATIONS.—Ordinances and statutes require all wiring to conform to the National Electrical Code; the former also makes some provisions for location and protection of overhead circuits and the latter requires all wiring to be inspected and approved by the local inspector before current may be supplied.

CONFLAGRATION HAZARD.

INSIDE WORK.—In June, 1924, 15 new and 20 old representative installations were inspected by an engineer of the National Board to ascertain the quality of supervision maintained and the general condition of light and power wiring. In the new work inspected, some of which was not completed, an average of about 2 defects per equipment was found, showing that a generally good class of work is being secured and that the inspection is efficient. Most of the defects noted were such as might have occurred after approval.

In the old work inspected, 164 defects were noted, an average of 8 per equipment; although a number of equipments are in poor condition, the occasional reinspections have kept most of the old installation in a generally fair condition. About $\frac{3}{4}$ of the defects noted were due to the misuse of flexible cord; the others occurring most frequently were: Those due to incompetent workmanship, additions or alterations, which had not been reported to the inspector for inspection or approval.

OUTSIDE WORK.—Alternating current generated outside the city is transmitted at 34,000 volts and at 6,600 volts through a residential district to an auxiliary steam station of the Carolina Power & Light Company, located northwest of the business district, from which it is distributed at 2,300 volts for commercial light and power. Secondary current at 110-220 volts is distributed for house lighting and small motors. Street lighting is by series incandescent. Transformers are mounted on poles and are in three cases in well constructed vaults of buildings.

The same company operates the local overhead trolley street railway system.

Telephone cables are underground in the business district and in main thoroughfares elsewhere; distribution is along buildings or from poles in block interiors. All other light, power and signal wires are overhead, along most of the streets, and would form serious obstructions throughout the business district.

ELECTROLYSIS.—The water department has had some trouble with services. A bond was installed and the trouble eliminated. The telephone company, which makes regular tests, reports no trouble from this cause.

CONCLUSIONS.—The city electrician has control over both old and new inside and outside wiring which is required to conform to the National Electrical Code. The inspector is competent, and although handicapped by many other duties, new work is in good, and old work in generally fair, condition. Light and power wires are generally overhead and with telephone service and other signaling system wires would form

overhead wire obstructions along many streets and alleys. There has been little damage from electrolysis; regular tests are made by the telephone company.

CONFLAGRATION HAZARD

PRINCIPAL MERCANTILE DISTRICT.—

Limits.—Beginning at Morgan and Salisbury streets; Morgan, Blount, Davie, Salisbury, Martin, MacDowell, Hargett and Salisbury to place of beginning.

General.—The district consists of 12 blocks, and covers 41 acres, 32 per cent. of which is in streets. It is practically square, and with an additional block on the west. A park adjoins the district on each of three sides; the district is otherwise surrounded mainly by frame dwellings and mercantiles. Several office buildings and mercantiles are of high value; otherwise, values are moderate to low. The higher values are along or near Fayetteville street, which is 99 feet wide; other streets are mainly 66 feet in width. Streets are well paved and grades are slight. Four of the blocks are 420 feet square; others are 210 feet by 420 feet. The interior blocks are well built up; those on the borders of the district have some open spaces, and 71 per cent. of the block area of the district is built upon.

Fireproof construction is of some importance and in four places forms fire breaks. Frame construction consists mainly of dwellings and additions at the extreme borders of the district, and is not a material factor in the hazard. Most of the buildings are of joisted brick construction, low and mainly of small area; these, however, are constructed without regard to fire protection or prevention.

Streets are of only fair width, except for the main dividing street, and although accessibility to block interiors is generally good, there is some congestion in parts of the district. Several occupancies are hazardous; and some of the buildings are of large or excessive area. There is very little private fire protection. The water supply is not available in adequate quantities for extended fires. The fire department is weak in men and equipment and would be hampered by overhead wire obstructions. The probability of serious fires is high in spots.

The block in which the most serious conditions exist is bounded by Fayetteville, Hargett, Wilmington streets and North Exchange place, (Sanborn, page 24, block 112). This block is small. Buildings are mainly 2 stories high, but one is 4 stories and there are several frame fronts, rears and cornices. The block is solidly built except for a little open space in the center.

There are several poorly protected communicating openings, and no effectual protection to many exposed windows. The entire block is subject to one fire.

In the block bounded by Hargett, Fayetteville, Martin and Salisbury streets, (Sanborn, page 24, block 111), 3 buildings of fire-resistive construction have been erected at or near the northern end. Some frame construction has been removed or replaced and 4 buildings extend through the block. Although a serious fire is probable at the southern end of the block where exposures are serious, it should be prevented from involving the entire block. The hazard as a whole has been reduced to normal for the district.

OUTSIDE THE PRINCIPAL MERCANTILE DISTRICT.—Along the railroad in the western part of the city are a few cotton and knitting mills, cotton seed oil works, iron works, railroad repair shops, lumber yards and minor industries. The more important are equipped with automatic sprinklers or with hydrants and hose; and as the several plants are isolated, no conflagration hazard is presented.

There are a number of schools, colleges, hospitals and public institutions, some of which are large, with various amounts of private fire pro-

tection. In the remainder of the city most of the buildings are frame dwellings, and in the more compactly built portions, there is considerable danger of spreading fires because of the wooden shingle roofs.

CONCLUSIONS.—In the principal mercantile district, structural conditions have been somewhat improved in recent years by the erection of several fire-resistive buildings and the removal of some frame construction. Several blocks are compactly built up, mainly with joisted brick buildings of moderate height and area and having unprotected vertical and horizontal openings. Several buildings are of excessive area. The main street affords a vantage point for fighting fires; but the fire department is seriously undermanned and the water supply only moderately adequate and with some unreliable features. Overhead wires form obstructions. Serious fires are probable at several points.

Manufacturing plants are isolated and the more important ones are equipped with automatic sprinklers or other private fire protection, and serious fires in them should be local. Residential sections are mainly frame with wooden shingle roofs, and in compactly built portions, conflagrations are probable.

RECOMMENDATIONS

Recommendations marked with a star (★) are deemed of most importance and their early adoption is urged.

WATER SUPPLY.

Records.

1. That an up-to-date map and sectional detail sheets of the entire system of distribution and card catalog records of all valves and hydrants be prepared and corrected annually and together with other important records be filed in a fireproof vault.

Pumping Station.

★2. That the steam line be looped and gated so as to ensure but one boiler or pump being put out of service in the event of any one blow out.

★3. That an additional high-lift pump of at least 5,000,000 gallons capacity be installed at the earliest possible date.

Note.—The above improvements are necessary for present adequacy. For complete reliability, duplication of the raw water supply main below the intake, an additional low-lift and a second 5,000,000-gallon high-lift pump would be required, but in view of the limited supply available from the present drainage area and the possible development of an additional supply at some other point no recommendation is made for these at the present time.

4. That a standard mill yard hose house, equipped with 100 feet of 2½-inch hose with nozzle and hydrant wrench attached, be erected over the yard hydrant between pumping station and filter plant, and that three hand chemical extinguishers be suitably located about the pump and boiler rooms.

5. That an indicator be installed in pump room to show continuously the water level in the Lane street tower, which should be kept practically full at all times.

Mains.

6. That the distribution system be strengthened by the early installation of the mains indicated in the table below, and that the following be adopted as the standard minimum sizes of mains used for hydrant supply for all future construction:

a. In residential districts, 8-inch; 6-inch to be used only where they complete a good gridiron and in no case in blocks 600 feet or more in length.

b. In mercantile and manufacturing districts, 8- and 12-inch; the former to be used only in sections where they complete a good gridiron and the latter for long lines not cross connected.

7. That dead ends be eliminated wherever practicable, all 4-inch pipe supplying hydrants be replaced and long unsupported lines of pipe be cross-connected so that not more than one hy-

drant will be on a 6-inch main between intersecting lines and not more than two hydrants on an 8-inch main between intersecting lines.

RECOMMENDED MAINS.

Hydrant Inches	Along	From	To
12	St. Marys, Gaston and Devereux Sts., Boylan Ave., Wills Forest St., Glenwood Ave. and Fairview Road	North St.	Woodland St.
12	Halifax, Pine, Blount and Cedar Sts. and Mordica Drive	Oakwood St. ..	Poplar St.
8	Oakwood and Swain Sts.	Person St.	Newbern Ave.
8	Haywood and Lenox Sts.	Hargett St.	Blount St.
8	Washington Street	West from Glenwood Ave.	
8	Jefferson Street	West from Glenwood Ave.	

Gate Valves.

8. That the distribution system be equipped with a sufficient number of gate valves so located that no single case of accident, breakage or repair to the pipe system in important districts will necessitate shutting from service a length of main greater than the side of a single block, or a maximum of 500 feet, or in other districts greater than two sides of a single block or a maximum of 800 feet.

9. That all valves be inspected annually and large valves more frequently and that records be kept of inspections, operation and condition.

Hydrants.

10. That all hydrants with connection 4 inches or less, or with small barrel or foot valve, be replaced by those able to deliver 600 gallons a minute with a friction loss of not more than 2½ pounds. This substitution to be made immediately in important districts and elsewhere according to a plan by which all will be replaced within a reasonable period.

★11. That additional hydrants be installed in those sections not properly protected. For good hydrant distribution there should be at least one hydrant to every 85,000 square feet in the principal mercantile district and 110,000 square feet in residential districts.

FIRE DEPARTMENT.

Organization.

★12. That department strength be increased at once by 10 men, and that substitutes be provided for vacation.

13. That in addition to the above, provision be made at an early date for the manning of the service truck by at least 6 men and of the recommended engine companies by 6 men each. Eventually the department strength to be such as to give the following minimum:

	Day	Night
Engine Companies 1, 2 and 3 and the		
Aerial Ladder Company-----	6	8
Other Engine Companies-----	4	6
Service Ladder Company-----	5	7

14. That all paid members, including chief officers, be appointed under civil service regulations for indefinite terms, with removal only for cause after trial.

Companies and Apparatus.

★15. That present Engine 3 be replaced with a new motor pumper of at least 700 gallons capacity and carrying a 40-gallon chemical or water tank; and that the old engine be reconditioned, loaded with 1,000 feet of 3-inch hose, equipped with a turret pipe, and placed in reserve at headquarters.

16. That engine companies, each equipped with a motor pumper of at least 700 gallons capacity and carrying a 40-gallon chemical or water tank, be installed in the vicinity of Glenwood avenue and Aycock street, and at Hillsboro and Harris streets.

Equipment.

17. That the following equipment be furnished where not already provided:

a. To each hose-carrier: Burst-hose jacket, door opener, chemical extinguishers, crow bars, distributing nozzles, plaster hook, siamese, hydrant hose gate, pipe holder, brooms and 2 waterproof covers.

b. To each ladder truck: Hose roller, brooms, lanterns, forks, shovels, marine lights and 4 waterproof covers.

Hose.

18. That pumpers carry at least 200 feet of 3-inch hose, with a total of at least 1,000 feet of 2½-inch and 3-inch hose with each company, with a complete spare shift in quarters; all hose to be fitted with 2½-inch couplings, properly beveled, and of National Standard dimensions.

Operation.

19. That the drill tower be repaired and members receive training there in the use of appliances and fire-fighting methods.

20. That pumpers be tested annually and after extensive repairs, in accordance with the requirements of the National Board of Fire Underwriters. Pumpers developing less than 90 per cent. of their reasonable capacity, should be overhauled, their crews drilled, or both.

21. That systematic and frequent inspections of buildings be made by company and department officers to acquaint them with local conditions; records of such inspections to be kept both by notes and sketches.

22. That a complete system of records of all fires, fire methods, losses, apparatus, and all department matters be kept. This work could be delegated to the houseman.

FIRE ALARM SYSTEM.

Headquarters.

★23. That fire alarm headquarters be removed to a fireproof building especially constructed to reduce as far as possible all liability to interruption of service. Building to be of sufficient size to adequately meet present fire alarm needs and provide room for expansion. In the new location all apparatus to be placed on incombustible mountings and no unnecessary combustibles permitted in the operating room.

Apparatus.

24. That the following equipment be installed:

At Headquarters:

a. A terminal board of incombustible material, with approved heavy-current fuses, lightning arresters and sneak current fuses for each circuit, and a register and time stamp for both incoming and outgoing signals.

b. Means for transmitting alarms manually. This could be a dial transmitter located at point recommended for the receipt of telephoned alarms.

c. In addition to present equipment, an eight-circuit switchboard conforming to standard regulations, to take care of the recommended additional boxes and alarm circuits, and provide for expansion.

At Fire Stations:

d. A gong on an alarm circuit and a register and sounding device on a box circuit, with means for transferring the register to the alarm circuit.

Circuits.

25. That the reliability of circuits be increased by:

a. Placing circuits underground wherever possible, using rubber insulated copper wire in lead sheath, in available conduits of the telephone company.

b. Connecting not more than 20 boxes and instruments on any box circuit; and supporting fire alarm wires on poles carrying other than high-tension wires.

c. Remodeling wiring in fire stations to conform to the requirements of the National Electrical Code.

RECOMMENDATIONS.

Boxes.

26. That street boxes be installed so that a box shall be visible within 500 feet of every building in the principal mercantile district and elsewhere within 800 feet of every building in closely-built sections.

27. That old type boxes be replaced by boxes of modern succession type with trigger, key or handle under glass guard, or single-acting door.

★28. That a department telephone switchboard be installed, preferably at police headquarters, where a man is on duty at all times, with individual circuits to each fire station and the public telephone exchange and with provisions for calling all companies simultaneously. One trunk line from the telephone exchange to be reserved exclusively for alarms of fire. That fire station telephones connected to this switchboard be reserved for department business.

Operation.

29. That all telephone alarms be transmitted as box alarms, after first notifying the nearest company by telephone.

30. That a map showing location of boxes and circuits be prepared and complete records kept of all tests and troubles.

BUILDING DEPARTMENT.

★31. That a complete building code be adopted to conform to modern requirements for construction and fire prevention as given in the National Board building code.

32. That the building inspector be appointed for an indefinite term with removal only for cause, and that he be furnished sufficient assistants to adequately make inspections and keep complete records; and that fireproof filing facilities be provided.

33. That the fire limits be extended to properly safeguard the business district.

34. That combustible roof coverings be required throughout the city on all new or repaired roofs.

EXPLOSIVES AND INFLAMMABLES.

35. That a complete code of regulations governing the manufacture, sale, storage and transportation of explosives and inflammables be adopted by ordinance, the chief of the fire department to be held solely responsible for its enforcement; and that members of the fire department make effective inspections of all buildings and premises in their respective districts, and file complete records of each inspection. It is recommended that the suggested ordinances on these subjects promulgated by the National Board of Fire Underwriters be used as a guide in framing new regulations.

ELECTRICITY.

36. That all overhead wires, except trolley wires, in the streets, alleys and block interiors of the closely-built sections, be placed underground; and that the use of distributing poles be discontinued where possible.

37. That systematic tests be made for electrolysis and that dangerous conditions be eliminated.

CONFLAGRATION HAZARD.

38. That owners of existing defectively constructed buildings, which are so located as to form conflagration areas, be required to suitably protect floor, window and party wall openings.

39. That automatic sprinkler equipments, with outside siamese hose connections and controlling valve near main in street, be required in all buildings which, by reason of their size, construction or occupancy, singly or combined, might act as conflagration breeders.

GENERAL SUMMARY

CITY IN GENERAL.

Population about 35,000. City is the State capital and the seat of several colleges and institutions. Manufacturing industries of minor importance. Grades moderate. Unpaved streets in poor condition. Winter temperatures mild. Loss per fire very high; loss per capita high; number of fires low.

FIRE-FIGHTING FACILITIES.

Water Supply.—Municipal works under good supervision; records unsatisfactory. Supply adequate but somewhat unreliable. High-lift pumping capacity inadequate; serious interruption of service possible; low-lift pumps, filters and clear water storage of generally adequate capacities; main feeders to central portions of good capacity; seriously deficient to some outlying districts. Pressures good. Consumption moderately high. Gridironing mainly good. Gate valves fairly well spaced; condition good. Hydrants in excellent condition; spacing somewhat wide.

Fire Department.—Full paid. Under suitable supervision. No civil service regulations; chief officers appointed for 2-year terms. Companies insufficient in number; undermanned. Engine capacity inadequate, and pumps generally in poor condition. Chemical service adequate. Sufficient hose. Minor equipment incomplete. Powerful stream appliances deficient. Discipline excellent. Drills and training good. Fire methods unsatisfactory but are the result of having to operate with weak department and no reserve. Response to alarms handicapped by long runs and condition of some streets. Fire stations in need of repairs.

Fire Alarm System.—Automatic system; well maintained; headquarters outgrown. No duplicate alarm circuits to, nor apparatus at, fire stations. Majority of boxes non-interfering type; cases painted biennially; locations not distinctively marked; distribution good in principal mercantile district; only fairly good elsewhere. Circuits overhead; in good condition; on many poles with high-tension wires. Batteries well installed and in good condition; practically no spare parts. Tests fairly satisfactory. Records lacking.

Fire Department Auxiliaries.—Duties of fire marshal well performed by the State Insurance Commissioner. Co-operation between police and fire departments good. Public service corporations render what service is deemed expedient. Telephone service fairly well distributed; considerably used in transmitting fire alarms. Private fire protection fairly good in large establishments. Slight outside aid available.

Summary.—Water supply generally adequate, with unreliable features; deficient in pumping capacity; in high value districts adequate quantities not available for extended fires. Fire department well organized, but very weak manually and mechanically. Fire alarm system of proper type but inadequate; headquarters outgrown.

STRUCTURAL CONDITIONS AND HAZARDS.

Building Department.—A few brief State regulations fairly well enforced by the municipal inspector; municipal requirement about the same as State. Fire limits slightly inadequate. Structural conditions improved, but still weak.

Explosives and Inflammables.—Laws deficient. Inspections of little value, although enforcement well provided for. Local conditions only fair.

Electricity.—Laws include the National Electrical Code and give the city good control. New inside work good; old work generally fair. Telephone lines mostly underground; other wires mainly overhead and would form obstacles to fire department operations. No recent trouble from electrolysis.

Conflagration Hazard.—In the principal mercantile district fire-resistive construction is present in moderate amount, but construction is mainly joisted brick of moderate to low size and height, closely grouped in part and with very little protection against exposure. Several buildings are of excessive area. Streets, except the main street, are of only fair width. The fire department is weak and the water supply only moderately adequate. The danger of serious fires is high in spots. The manufacturing plants are isolated and generally well equipped with private fire-fighting facilities, offering only local conflagration probabilities. The compactly built frame residential sections present the usual serious hazard due to flying brands on wooden shingle roofs.