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of Committee of Twenty
and Report of February, 1910.

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NATIONAL BOARD OF FIRE UNDERWRITERS

COMMITTEE ON FIRE PREVENTION

SPECIAL REPORT

ON THE

HIGH PRESSURE FIRE SERVICE

CITY OF BALTIMORE, MD.

NATIONAL BOARD OF FIRE UNDERWRITERS

135 WILLIAM STREET, NEW YORK.

The investigation of the High Pressure Fire System was made by Engineer J. H. Howland during installation in December, 1909, and January, 1910, and tests of the system were made June 7, 1912, by National Board engineers.

Acknowledgment is made of valuable assistance rendered by the Officials of the Fire Department, The Association of Fire Underwriters of Baltimore City and others.

Office Engineers.

CHAS. H. LUM. A. C. HUTSON.

June 29, 1912.

BALTIMORE, MD.

HIGH PRESSURE FIRE SERVICE.

ORGANIZATION.

On April 23, 1912, the High Pressure Fire System was placed in service; the station equipment has not been finally accepted by the city.

The entire system was designed and its construction supervised by Daniel B. Banks, Consulting Engineer of the Board of Fire Commissioners. Operation, control and maintenance are by August Emrich, Chief of the Fire Department; direct control is by Thomas H. Meushaw, Superintendent of Machinery.

During the installation of the pumping station equipment, a detail of engineers and stokers was made from the uniformed ranks of the fire department to act as inspectors and helpers in the erection of the machinery; these men will be continued in charge of the station, and others detailed at intervals as supernumeraries, so that a competent operating force will always be available.

The station operating force at present consists of six engineers or machinists, and five stokers, all of whom hold State licenses and have had several years' experience; the operating force has quarters in the building and is organized as a fire company; a stoker and an engineer are on duty at all times and other members respond to the operating floor on all alarms in the district covered by the service. The pumping station is provided with the usual fire alarm equipment of fire stations, with an extension gong in the sleeping quarters, which is normally cut out, being connected into the circuit after one round of a box in the district served by the High Pressure System. In the final organization of the operating force it is expected that the station force will remain practically as now designated; maintenance of the piping system will be in charge of the superintendent of machinery, who will have a force at the repair shop available during the day, and at other times can have men detailed from companies nearby. Keys for operating gate valves are in valve manholes and all members of the department are expected to be familiar with the system.

PUMPING STATION.

Location.—The station is located in the southeastern part of the congested value district on the west side of South street, north of Pratt street, and extends through to an alley. On each side of and adjoining the station are 4-story mercantile buildings with blank walls extending 10 to 20 feet above the station roof; across the alley are 3-story buildings with wired-glass windows or fire shutters; directly opposite, on South street, is a vacant lot.

Equipment.—In addition to the pumps and boilers given in the tables below, there are duplicate blowers and feed-water pumps, a traveling crane in pump-room, a feed-water heater, and other appliances necessary for successful operation. Steam end of pumps are steam-jacketed and kept hot at all times, using steam from the exhaust or direct from boilers. The large pumps were designed for a possible speed of 87½ revolutions a minute, giving a delivery of 7,000 gallons a minute against 260 pounds pressure; up to the present time they have been regulated down to a speed of 55 to 65 revolutions. Boilers are separately set and have independent stacks. Steam piping is in duplicate and well installed. Space is reserved and foundations provided for an additional boiler and a fourth large pump.

Layout of discharge pipes from pumps is on a loop system, gated so that the supply may pass through either one or both of the two 24-inch distributing mains. Suction supply from a 30-inch cast iron main connected to a 40-inch domestic supply main approximately 400 feet distant from the station; an auxiliary supply may be taken from well in station, connected by a 42-inch reinforced concrete conduit with the harbor, 250 feet distant; suction pressure from domestic supply main, 30 to 50 pounds, and maximum lift from harbor suction 15 feet. Elevation of center line of pumps, 12.5. Elevations in this report are in feet above mean low water in the harbor.

Construction.—Station is of fireproof construction throughout, except floor surfacing and inside doors in the third story. Pump-room is two stories high, with gallery on one side; company's quarters above; boiler-room is separated from pump-room by fire-wall, with single opening protected by double fire-doors; basement for piping and blowers extends underneath the entire building. Side walls blank; windows on front are of large area, but protected by wired glass in metal frames and with rolling fire-shutters inside; rear wall has single door-opening protected by double fire-doors. Roof, tar and gravel; ventilators have prismatic glass and automatic tin-clad fire-shutters; roof designed to withstand probable failure of adjoining overhead walls.

Protection.—Eight-inch risers have been extended to the roof, and it is intended to provide these with monitor nozzles to sweep adjoining buildings, or with hose and nozzles, permitting the fighting of fires across the adjoining roofs.

Operation.—At the station, 150 pounds of steam is maintained on two boilers at all times, and 150 pounds water pressure is kept on the distribution system by the small pump; upon receipt of an

HIGH PRESSURE PUMPING STATION--EQUIPMENT.

PUMPS.

Number and Make.	Class.	Diameter, in Inches.		Stroke, Inches.	At Test.					
		Steam Cylinders.	Water Plunger.		Revolutions per Minute.	Pressure, Pounds. Steam.	Water.	Suction.	Net Water.	Gallons per Minute.
3 Allis-Chalmers	Horizontal, Corliss, twin, simple, non-condensing, crank and fly-wheel	22	13⅜	36	55	146	199	41	158	4,592†
					55	143	199	43	156	4,581†
					54	145	194	42	152	4,500†
1 Epping-Carpenter	Horizontal, duplex, direct-acting, compound, non-condensing	14 & 25	12	16	32	125	150*	..	..	1,000*

* Rated capacity; no test made of this unit.

† Total discharge of the three units operating together, 12,770 gallons per minute at 242 pounds.

BOILERS.

Number and Make.	Type.	Grate Surface, Sq. Ft.	Heating Surface, Sq. Ft.	Rated Horse Power, Each.	Steam Pressure. Maximum Allowed.	Steam Pressure. Average, at Test.	Fuel.
3 Edge Moor	Inclined water-tube, with underfeed mechanical stokers	110	6,800	1,160	200	150	Bituminous Coal.

alarm in the High Pressure area, which extends about 400 feet outside the border-line hydrants, steam is turned on two of the large pumps, which immediately raise pressure to 250 pounds; the small pump stops on water pressure exceeding 150 pounds. The larger pumps are provided with governors, which regulate the speed, and have steam valve controlled by pressure regulators operated by the water pressure in the distribution system; with throttle valves open, the operation of the pumps is entirely automatic, and as stoking of the boilers and forced draft are automatically controlled by the steam consumption, the station can be run for several hours without attendants if necessary. An increase in the speed of the small pump indicates a flow from the system; orders are to shut down the pump if such flow occurs without a fire alarm sounding.

DISTRIBUTION SYSTEM.

General.—The area covered by mains of the system is bounded by Pratt, Eutaw, Franklin, Howard, Saratoga, Gay, Baltimore and South streets; it covers about 170 acres. As recommended in the National Board report of 1905, the area covered by the outlined mains was approximately 300 acres. The general plan followed provides 16-inch mains, three blocks apart in both directions, with 10-inch lines on all other streets. The total length of mains is 8.856 miles, consisting of .066 mile of 30-inch, .025 mile of 24-inch, 3.24 miles of 16-inch and 5.30 miles of 10-inch; there are also 2.00 miles of 8-inch used as hydrant branches. Blanked connections have been left at intersections on border streets to permit extending the system in all directions.

The elevations within the limits of the distribution system range from 8 near the pumping station to 100 at the northwestern corner.

Pipe.—All pipe is lap-welded, soft, open hearth steel, designed for a maximum working pressure of 300 pounds per square inch. The 8-, 10- and 16-inch pipes are 7/16 inch thick and the 24-inch are ½ inch thick; the standard length is 20 feet. The steel is specified to have an ultimate tensile strength of 50,000 to 55,000 pounds per square inch and an elastic limit of at least ½ its ultimate strength.

The pipe lines, including valves, hydrants and other fittings, were tested and made tight at a pressure of 600 pounds per square inch before backfilling. A test of a 500-foot length of 10-inch pipe was witnessed by National Board engineers in

1910, during installation; two joints sweated at 700 pounds pressure, and when these were tightened the pressure was carried up to 1,000 pounds, when the only signs of leakage were through the gaskets between the bonnet and body flanges of the valves at either end of the line.

The system of pipes is expected to be sufficiently elastic to remain tight under all conditions of service, including expansion and contraction due to changes of temperature, settlement and other disturbing factors, and especially fitted to avoid existing obstructions by changing the alignment without the use of specials; provisions are made to avoid the effects of electrolysis by making the electrical conductivity of the joint approximately equal to that of the body of the pipe, and by a pipe coating of mineral rubber asphalt with a thickness of 1/32 of an inch. Pipe has been bonded to return feeders at several points and electrical surveys are being regularly made; the pipe is reported to be negative to the rails throughout. An inspection of pipe in 1912, during the raising of a hydrant, showed the coating in perfect condition after two years' service.

Joints.—The pipe joint used is specially designed for the placing of metal to metal without the use of gasket, lead, cement or filler of any kind, with expanded ends of pipes fitting over an inner separating ring having external surfaces of spherical zones, tightened up by means of bolts and outside steel flanges. Plain faced joints are provided at the valves, made up with corrugated copper gaskets.

Gate Valves.—Gate valves are of semi- and open hearth steel, bronze mounted, of a substantial double-disc type, painted inside and outside with asphalt paint; they were subjected to a test pressure of 600 pounds to the square inch. The 16- and 24-inch valves are geared and the latter are provided with 4-inch by-passes. All valves are enclosed in large valve boxes, built upon a concrete slab; the lower sections of the boxes are of concrete blocks, the upper of reinforced concrete rings. Total number of valves in the present system, 259. Valves are generally located on property lines, ordinarily 4 at each street intersection, so that, in all but two or three cases, any single side of a block may be cut out of service without interfering with service in other parts of the system. Average length of pipe between valves, 300 feet, with a maximum of 480 feet, except as noted below on a 24-inch line; in 16 cases, three hydrants would be affected by a single shut-off, in 62 cases, two hydrants, and in 41 cases, one hydrant. On one of the two 24-inch discharge mains from the pumping station there are, between valves, 6 hydrants set on 900 feet of main; these hydrants have 8-inch gate valve on connection, thus permitting any hydrant to be cut out for repairs without affecting the main.

Each valve box is provided with a key, which in operation cannot be removed from the valve except when it is wide open.

Relief Valves.—Located at various points in the system are relief valves, set to open and waste into the sewers at 305 pounds pressure; air valves are provided at all summits.

Hydrants.—Hydrants are a specially designed flush type, opening against the pressure, having 10-inch barrels, 28 square inches minimum waterway at valve opening and 8-inch branch connection to the main; hydrant branches are inserted through a hole cut in the wall of the main pipe, and thoroughly welded to it, with a liberal fillet built on at the intersection of the two; branches are bent in the form of an off-set, to facilitate connection to the hydrant. Each hydrant was subjected to a hydrostatic test pressure of 600 pounds per square inch. Hydrants are provided with sidewalk cover, upon removal of which there can be connected a special portable service head, which locks into position by a slight turn; heads have four 2½-inch outlets, each provided with a regulating valve, so designed as to also act as a shut-off valve; an outlet in the top of the head permits connecting a monitor nozzle directly thereto.

Total number of hydrants on present system, 226; the average linear spacing is 170 feet and the area served by each, 42,700 square feet. Hydrants are located at street intersections between corner of building lines and curb corners, at alley intersections and alternating on opposite sides of the streets. Markers located on trolley feeder poles and other convenient points are being installed to indicate locations.

Fire Boat Connection.—A 10-inch fire boat connection, with gate valve and check valve, is located at the water front near the foot of Cheapside street.

Connection to Standpipes and Sprinkler Equipments.—No connections have been made to equipments supplying private protection to buildings; in the use of the system it is the intention of the department to have the first company connect to all such equipments by means of short lines of hose from the hydrant to the outside connection, thus assuring positive control of the amount of water and lessening water damage after the extinguishment of the fire. It is the opinion of the department that inasmuch as the High Pressure system is intended primarily for serious fires, the system should not be weakened by connections other than to hydrants; also the department could not maintain proper control over such connections nor be assured that there were no leaks on the system.

SIGNALLING SYSTEM.

Under the system of operation it is not necessary to communicate with the pumping station during fires to secure increased pressure, but to provide for possible emergency, a separate telephone circuit has been run, with instruments at fire alarm headquarters, fire headquarters, the chief's night quarters and the pumping station; this circuit connects to contacts for portable telephone sets in each fire alarm box in the High Pressure district. In addi-

tion to the above there is the usual Morse key and sounder, and also a contact in each box through which a talking connection with portable telephone sets can be made with fire alarm headquarters over the box circuit. From fire alarm headquarters the pumping station can be called over a regular department telephone circuit.

FIRE DEPARTMENT.

High Pressure Equipment.—Two High Pressure companies have been established, each manned by picked men of 2 to 5 years' fire service. Company 1 is located with Ladder 2, Paca street near Fayette street, 400 feet west of the area covered; Company 2 is located with Engine 32, Gay street near Water street, on the eastern edge of the district covered. Each company is provided with an automobile hose wagon carrying 2,000 feet of 3-inch hose, two hydrant heads, three turret nozzles, and the usual assortment of shut-off nozzles and minor equipment. Hose wagons of Engine Companies 1, 2, 3, 4, 6, 7, 15 (both sections), 23, 27 and 32 each carry a hydrant head and key and a turret nozzle. Some of the turret nozzles are detachable from the wagons and can be attached direct to a fifth outlet on the top of the hydrant head or to a special hydrant head with only the one outlet on top.

Use of the High Pressure System.—A High Pressure company and 4 or 5 engine companies respond to all first alarms; the second High Pressure hose wagon responds with the second alarm assignment. The High Pressure company connects immediately to the High Pressure system, and the first two engine companies to water department hydrants; the other engine companies connect their engines to water department hydrants for a reserve force, but use the High Pressure system with their hose wagons.

Members of the department are made familiar with the location of hydrants through frequent inspections during the winter, and by means of a blue-print map at each station.

Upon arrival of the hose wagon, two men, with hydrant head and key, run to the hydrant; one man removes the cover, which if stuck can be easily broken; the other places the head in position and, by a slight turn, locks it into position. Water is turned on with the key, and hose attached to one or all outlets; by means of the regulators on the head, any desired pressure can be given each line up to full pressure without calling up the pumping station.

Tests made showed that, starting from the middle of the street, two men could remove the hydrant cover, place the head in position and turn on the water in 18 to 25 seconds.

The system has been used very successfully at three serious fires since placed in service; frequent drills in its use are being held and will be continued.

Recent Improvements.—Since the National Board report of February, 1910, in addition to the installation of the High Pressure system and the two High Pressure companies, the following companies have been established:

Engine 34, Caroline street near Gough street;

Engine 36, Edmondson avenue and Bentalou street;

Engine 37, Ridgeley and West streets;

Engine 39 (fire boat *Deluge*), foot of President street;

Engine 40, with Ladder Co. 12;

Ladder 18, with Engine Co. 20.

Ground has been purchased and buildings erected for engine companies at Fulton avenue and Baker street and at Light and Montgomery streets.

The manual force is 786 men, an increase of 106; a repair shop has been equipped, with 8 men detailed for operation; an automobile combination hose wagon provided for Engine Co. 32; 10,000 feet of 2½-inch hose and 8,200 feet of 3-inch hose were purchased in 1911 and bids are being asked for 7,000 feet of 2½-inch hose. Seventy-two per cent. of the fire alarms wires are underground and the remainder are being placed underground; red lights to indicate boxes are being installed in the underground district.

TESTS OF THE SYSTEM.

On June 7, 1912, several tests of the system were made by National Board engineers. To test the readiness of the pumping station, a fire alarm box was pulled at 4.30 A. M. at Lexington and Howard streets. Immediately upon arrival of the High Pressure hose company, the system was put into service, using 3-inch lines siamesed into a 2½-inch nozzle. At the station, an engineer and stoker were on duty; at 4.31 the remainder of the crew had responded from sleeping quarters; by 4.31:15, two large pumps had been started and pressure increased to 190 pounds, reaching 280 pounds by 4.33, at which time water was turned on by the hose company; at 4.34 the discharge was 1,050 gallons a minute, and at 4.37 it was 1,440 gallons, pump pressure at the station being maintained at 240 to 250 pounds; streams from two more 2½-inch nozzles were started at 4.37:40, giving a total discharge of 4,000 gallons a minute. A second High Pressure company, using six 3-inch lines siamesed into three 2½-inch nozzles, was put into service on Liberty street, making a total flow of 7,100 gallons a minute; both steam and water pressures were well maintained at the pumping station.

A second test, to determine the capacity of the station, was started at 10 A. M.; lines were run to six 2½-inch and six 2-inch nozzles, discharging on Pratt street. Pumps were run individually, with discharges as given in Table 1, and were stopped and started under conditions similar to a breakdown of a unit at time of fire; a uniform discharge was maintained and pumps were well and easily

handled. Pump governors were set for a cut-off at about 52 revolutions per minute. With all three large pumps running, the total discharge was 12,770 gallons per minute, against an average pump pressure of 242 pounds, suction-pressure of 31 pounds and net water pressure of 211 pounds; steam was uniformly maintained at 150 pounds. The average number of revolutions of the pumps was 50.6 per minute.

A test for leakage of the system indicated a loss of 26 gallons per minute, at a pressure of 250 pounds, part of which was through the pumps and part due to air valves operating on the system.

Test of the hydrant head indicated a loss in the outlet and the regulator valve equivalent to about 10 pounds for a flow of 300 gallons a minute from a single outlet, 20 pounds for 500 gallons, and 25 pounds for 600 gallons; these cannot be considered excessive losses. The hydrant heads have been provided with a screen to catch coarse material; the tests showed that these became clogged and introduced a very high friction loss, amounting to 30 pounds for 2,300 gallons a minute flowing; as these screens are not necessary to the operation of the hydrants, their removal is advisable.

CONTEMPLATED ADDITIONS.

The plans contemplate the installation of an additional boiler and another pump similar to the larger ones now installed. It is also proposed to have an auxiliary steam line from the United Railway & Electric Company's power station on Pratt street, 1,000 feet distant. A contract has been let, over the protest of the fire commissioners, for a pipe line from the pumping station to the city hall and court house, to be used in heating the buildings with steam from the boilers of the High Pressure system; it is estimated that, for this service and for a proposed scheme of generating electric current to light the same buildings, as much as 700 boiler horse power may be required.

CONCLUSIONS.

The High Pressure system as now in service covers the greater part of the congested value district, and not only adds greatly to its fire protection, but, by lessening the number of engine companies needed to extinguish a serious fire within the zone covered, it materially increases the effectiveness of the fire department in covering other parts of the city in the event of a second fire. However, there are sections exposing the district covered, within which a fire might gain such headway that even with this system the fire department would not be able to control it; for this reason the system should be extended to include the entire congested value district and any other hazardous sections exposing it.

With the introduction of high pressure systems, and the consequent use of large nozzles and large streams, the total amount of water thrown upon a fire is greatly increased; it is stated that the pumps may be operated at a capacity of 50 per cent. in excess of that obtained at the test, but when allowance is made for one unit out of commission for repair or overhauling, it is probable that during a serious fire, and certainly with two simultaneous fires, the system will be overtaxed, and the effectiveness of the streams reduced. To offset this, an additional pump and boiler, provisions for which were made in the plans, should be installed; if the system is extended, their installation will be still more necessary. The installation of the contemplated auxiliary steam line from the power station of the United Railway & Electric Company would be an added safeguard to the system; if the boiler plant at the High Pressure station is used to heat and light the city hall and court house as planned, either this auxiliary line or the fourth boiler is imperative for reliable operation, and both will be necessary when the fourth pump is installed.

The pumping station, although not outside of the conflagration zone, is well and safely constructed, and with the addition of the planned protective features upon the roof, should not be affected by a conflagration. The equipment is well installed, of a very reliable type and is being well operated; it has withstood tests as severe as any probable in fire service. Many ingenious automatic arrangements controlling the operation of pumps and boilers increase reliability and lessen the number of men necessary for operation.

The organization of the service under the superintendent of machinery has worked out well, and, with the few changes which may be found necessary by experience, should be satisfactory as now operated.

The distribution system has been installed two years and shows no signs of deterioration; the slight leakage, absence of electrolytic action and total freedom from breaks or other trouble, appear to justify the departure from the usual design of such systems; with the type of regulator valve used on the hydrants, quick shut-off of the flow has been made, but with no harmful effect to the system. The valve and hydrant distribution is excellent, and the pipe sizes and gridironing are sufficient to enable a good concentration of fire flow without serious loss of pressure.

The type of hydrant is unusual for such service, but it appears not to increase the time consumed in getting into action at fires; it is believed that the system of inspections adopted and the steps taken to secure familiarity with locations will result in hydrants being quickly found, and the ease with which heads can be attached removes one of the main objections to the use of flush hydrants. The separate head permits of the use of regulator valves permanently attached, thus giving excellent control of the pressure on hose lines. The hydrant and head under test show a sufficiently low friction loss, except in the screen, the use of which is not

necessary; the regulators increase the loss materially, but not sufficiently to lessen fire protection unless too great a quantity is taken from one outlet.

Operation of the plant is prompt and reliable; with the automatic arrangements at the pumping station and the constant operating pressure at fires of 250 pounds, the latter made possible by the use of the regulator valves on hydrants, there is not the necessity for communicating with the pumping station to secure any pressure desired.

W. E. MALLALIEU,
General Agent.
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Respectfully submitted,

COMMITTEE ON FIRE PREVENTION,

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