PHYSICAL TESTS OF STRENGTH, SPEED, AND ENDURANCE FOR FIRE-FIGHTERS IN PORTLAND, OREGON

by

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APPROVED:

Professor of Education
In Charge of Major

Chairman of School Graduate Committee

Dean, Graduate Division
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</table>
This paper was written with the object of setting up a series of standard physical tests of strength, speed, and endurance to be given every two years to fire-fighter candidates in Portland, Oregon.

The candidates are given a written examination which carries a weight of sixty points, and the physical test which counts forty points. If the candidate passes both tests satisfactorily, his name is placed on an eligible list for an appointment to the fire department when a vacancy occurs.

A control group, composed of thirty fire-fighters, was used to compare their test results with those of the experimental group.

It is very important that a fire-fighter be agile and have no fear of heights. The Portland Fire Department requires that their fire-fighting personnel exercise regularly, and to further this ruling, they have built four wall handball courts within many of their stations for the purpose of exercise and recreation.

Grateful acknowledgement is made to the Portland Civil Service Commission for the building of the equipment used to administer the tests, to the Portland Fire Department for supplying the personnel used in the control group, and for building additional equipment, to the
Portland Police Department for supplying the personnel to administer the tests, and to the Bureau of Parks and Public Recreation for granting the administrator time to supervise the tests.
Chapter I
Introduction

The purpose of this paper is to offer a series of tests which may best determine the true physical qualifications needed by an individual who is to become a fire-fighter in the city of Portland, Oregon.

Since it is taken for granted that everyone entering the fire department is desirous of gaining promotions, it is appropriate at this point, to quote Earnest W. Williams, Assistant Chief of the Lynn Fire Department, Lynn, Massachusetts. (1)

A good officer in a fire department must be of inflexible integrity, sober, truthful, accurate, resolute, discreet, of cool and sound judgment. He must have command of his temper, courage to resist and repel attempts at intimidations, a firmness that is kind. He must take an interest in his work; he must be energetic, a judge on the bench; he must be experienced in his work and accounts. Men who combine these qualifications are not to be picked up everyday. Still, they can be found, but they are greatly in demand, and when found, they are worth their price. Rather they are beyond their price to citizens of any community, and their values cannot be estimated in dollars.

The civil service ruling in Portland, Oregon requires that examinations be held every two years for applicants.

(1) Portland Fire College, Portland Fire Department Test, 1938, unpublished, (Portland, Oregon, 1938, p. 1.)
for firemen jobs.

In the past, various kinds of physical ability tests have been given; however, there has never been a definite study made in conjunction with these tests, and there has been a feeling that although the tests included various phases of strength, agility, and endurance, they were not a true measurement of the necessary physical qualifications a good fireman need possess.

It is very important that the best and most competent men be chosen. The selection of these men necessitates a series of tests, which, when administered to a large group, will show that the men receiving the highest ratings will be best equipped, physically, as fire-fighters.

Another purpose of this paper is to give all persons, regardless of their differences in weight and height, an equal opportunity. The civil service ruling states that the applicant's height may not be under five feet seven inches, nor over six feet three inches. There are some tests which give a decided advantage to the tall individual, and some which give the advantage to the short, stocky person. The series of tests in this study have been picked with the factors of weight and height considered carefully.

At this point it is interesting to note what Andrew C. Sherbert, author of "The History of the Volunteer Fire Department of Portland, Oregon", says about Portland's present
Portland's present day fire department is a close-knit, highly organized structure. It operates with efficiency and a minimum of waste effort. Each member has been selected by competitive examinations from a host of applicants. Intelligent supervision and constant striving for high objectives has placed Portland's Fire Department high among the best rated fire-fighting organizations in America. The young man who enters the service today is to participate in the perpetuation of an institution rich in worthwhile tradition, replete with accounts of outstanding individual and group achievements—and great because of the cumulative result of the labors of those already serving, or who have served before.

Portland has, at present, thirty-eight fire stations. The stations are fully equipped with apparatus. Five-hundred forty-one men, including officers, man the stations, although a total of six-hundred people are employed by the department. All stations are equipped with fire trucks, and eight stations have huge motor-driven ladder trucks. The stations with the ladder trucks are referred to as Truck No. I, Truck No. II, etc. The other stations are referred to as Engine No. I, Engine No. II, etc. Three fire boats are included on the list of fire-fighting apparatus.

An up to date drill tower is the training center where a shift of men is sent daily for the purpose of learning to scale buildings, drive trucks, set up ladders, and to use fire-fighting equipment in general.

The civil service commission requires that policemen and

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firemen candidates meet certain physical requirements, which are listed below: (3)

**Personal Qualifications**

**I- General Appearance:**

The applicant must be free from any marked deformity, from all parasitic or systemic skin disease, and from all evidence of intemperance in the use of stimulants or drugs. The body must be well proportioned, of good muscular development, and show careful attention to personal cleanliness. Obesity, muscular weakness or poor physique must reject. Girth of abdomen may not be more than the measurement of chest at rest.

**II- Nose-Mouth-Teeth:**

Obstruction to free breathing in either nostril, chronic catarrh, or very offensive breath must reject. The mouth must be free from deformities or conditions that interfere with distinct speech or that predispose to disease or hypertrophy of tonsil or thyroid enlargement. Teeth must be clean, well cared for, and free from multiple cavities. Missing teeth may be replaced by crown or bridge work. Where site of teeth make this impossible, dentures will be accepted. Pyorrhea will reject.

**III- Hernia:**

Actual or potential hernia in any form must reject.

**IV- Genitalia:**

Must be free from deformities and from marked varicocele, hydrocele, enlargement of the testicles, stricture or incontinence or urina. Retained testicles or strophy will reject. Any acute and all venereal diseases of these organs must reject.

**V- Varicose Veins:**

A marked tendency to their formation must reject.

**VI- Arms-Legs-Hands-Feet:**

Must be free from affections of the joints, sprains, stiffness, or other conditions, which would prevent the proper and easy performance of duty. First (index), second (middle), third (ring) fingers and thumb must be present in their entirety.

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3. City of Portland, Notice of Examination Portland Civil Service Board 1941, (Portland, Oregon, 1941.)
Great toe must be present in its entirety.

VII - Eyes
The applicant must be free from color blindness, and be able to read without glasses with each eye, standard test types at a distance of twenty feet. 20/20 vision in each eye is required. Loss of either eye, chronic inflammation of the lids, strabismus or permanent abnormalities of either eye must reject.

VIII - Ears
Normal hearing with each ear is required. Chronic recurrent running ear will reject.

IX - Respiration
Must be full, easy and regular. The respiratory murmur must be clear and distinct over both lungs, and no disease of the respiratory organ be present.

X - Circulation
The action of the heart must be uniform, free and steady, its rhythm regular, and the heart free from organic changes. Blood pressure-systolic maximum 135, diastolic 90, pulse pressure 15 to 20. Brain and nervous system must be free from defects. The mere history of mental illness or of epilepsy will reject.

XI - Kidneys
Must be healthy and the urine normal.

XII - Wasserman
Positive reaction will reject.

XIII - Age
Must have passed twenty-first birthday, and must not have passed twenty-sixth birthday. A World War II veteran may be thirty years old.

XIV - Educational Requirements
Each applicant must have completed two or more years in a standard high school.
### XV - Additional Requirements:

<table>
<thead>
<tr>
<th>Height</th>
<th>Minimum Weight</th>
<th>Maximum Weight</th>
<th>Chest Expanded</th>
<th>Minimum Mobility</th>
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<td>5'7&quot;</td>
<td>135 lbs.</td>
<td>175 lbs.</td>
<td>37&quot;</td>
<td>2.5&quot;</td>
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<tr>
<td>5'8&quot;</td>
<td>140 lbs.</td>
<td>180 lbs.</td>
<td>37.5&quot;</td>
<td>2.5&quot;</td>
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<tr>
<td>5'9&quot;</td>
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<td>5'11&quot;</td>
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<td>195 lbs.</td>
<td>39&quot;</td>
<td>3&quot;</td>
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<td>6'0&quot;</td>
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<td>205 lbs.</td>
<td>40&quot;</td>
<td>3&quot;</td>
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<tr>
<td>6'1&quot;</td>
<td>165 lbs.</td>
<td>210 lbs.</td>
<td>41&quot;</td>
<td>3&quot;</td>
</tr>
<tr>
<td>6'2&quot;</td>
<td>170 lbs.</td>
<td>220 lbs.</td>
<td>42&quot;</td>
<td>3&quot;</td>
</tr>
<tr>
<td>6'3&quot;</td>
<td>175 lbs.</td>
<td>225 lbs.</td>
<td>43&quot;</td>
<td>3.5&quot;</td>
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</table>
CHAPTER II
HISTORY OF PORTLAND'S VOLUNTARY
FIRE DEPARTMENT

The following history, compiled by Andrew C. Sherbert, was taken from the Portland Fire College Text. (4)

"Portland was founded in 1844. Her first meager buildings, hewn from the virgin forest, were protected from fire by a bucket brigade, a bucket being carried and replenished by all members of the community. This system was continued until 1850 when the rising village felt the need of more adequate protection. In 1850, a company of volunteer fire fighters was organized with Thomas J. Dryer as foreman. He was the owner of Portland's first newspaper, "The Weekly Oregonian." Through voluntary conscription the organization, which was known as "Pioneer Fire Company No. 1," had acquired a hand pump which was many times more effective in extinguishing fires than was the early bucket brigade.

Through a bill which was effective through the Territorial Legislature of Oregon on April 6, 1851, Portland became an incorporated city. Portland was growing. Already one hundred and thirty-four shingled roofs were to be counted on the town site, and her taxable property was placed at more than one-

4. Portland Fire College, Portland Fire Department Text 1938, (Portland, Oregon, 1938.)
half million dollars. Effective as was the hand pump in extinguishing fires, there was a better method, and the Pioneer Fire Company No. I was determined to have it. However, it was soon realized that it would be impossible to raise enough funds to pay for a steam fire engine by solicited contributors. It appeared that the only certain way to raise the money required for the purchase was to levy a tax on all taxable property in Portland.

"The first move toward this end was for the Pioneer Fire Company No. I to offer their services to the newly organized incorporated City of Portland, and thus become a part of the city government and have a voice in municipal affairs. This was done at the ninth meeting of the Common Council, held May 6, 1851. Twenty days later an election was held in which a majority voted in favor of a tax levy for the purpose of purchasing a steam fire engine.

"Three years elapsed before enough money had accumulated in the struggling city's coffers with which to purchase the long desired steam fire engine. The engine was purchased in New York by a fireman committee, and after its long journey "Around the horn", it arrived in San Francisco in July, 1856. It arrived shortly in Portland by boat. This marked the
first important step in the mechanization of the city's fire fighting equipment which was to culminate in the highly organized intricate electric devices used in fighting fires today.

"In the early days Portland had no general water system. Water was obtained from streams, wells, and springs. With the growing use of hand pumps, and the acquisition of the steam fire engine, the need for a more convenient and abundant supply of water for fighting fires became urgent. Accordingly, at a meeting of the Common Council, held January 12, 1856, a plan was adopted in which wooden cisterns, fifteen feet square and nine feet deep, were to be placed at every important intersection in the congested city. These were later replaced by brick cisterns. Subsequently, the various cisterns were connected by a system of conduits, and water was piped from Balch and Carruthers Creeks to keep them supplied. The city, at present, has more than eighty fire cisterns located at convenient points in the metropolitan area. In the event of a failure of the water supply due to a landslide at the Bull Run headworks, earthquakes, or other local calamity which might affect the normal functioning of the water system, the fire cisterns would afford ample protection against the
undue advance of any conflagration.

"To the end that all ordinances pertaining to fire would be observed by the citizens of Portland, the city was divided into two districts, and a fire warden was appointed for each district. It was the duty of each warden to inspect each building in his district to see that fire regulations were being obeyed.

"The original fire limits of the city were bounded as follows: Beginning at the Willamette River, and running through Jefferson Street to its intersection and Second Street; thence along Ash Street to the intersection of the Willamette River; thence along the water front to the place of the beginning.

"In 1860 Portland was a thriving community with a population of three thousand. The fire department had kept pace with the growth of the city. New equipment had been purchased from time to time; stations to house the equipment had been built, and the city was proud of the department and its record of achievements.

"A further milestone in the trend toward the mechanization is shown by ordinance passed in March, 1868 which provided for a sum of money not to exceed five thousand dollars for the purchase of one of H. C. Silsby's three class Rotary Steam Fire Engines."
So proud was the city of the record of her fire fighters that an ordinance was passed on August 25, 1871 which provided for the appropriation of the sum of five hundred dollars to defray the expense of a celebration of the anniversary of the Portland Fire Department.

"The city's smug attitude of assurance suffered a rude shock, however, in the two years that followed. In December 1872, a fire destroyed three important city blocks with a loss estimated at one half million dollars. Inadequate fire fighting equipment was blamed for this conflagration, and agitation was begun immediately for an improved fire department. However, before much had been accomplished in that direction, a second, and greater fire, August 2, 1873, began at First and Salmon Streets, and devastated twenty-two city blocks. This fire was of such magnitude and occasioned on much property loss and personal suffering that the community was long in recovering from its effects.

"On October 1, 1875, the council passed ordinance which provided for the purchase of a bell to be centrally located to call volunteer firemen. The bell was not to weigh less than four thousand pounds nor over four thousand five hundred pounds and was not to exceed a cost of twenty-two hundred dollars. The huge bell was no sooner installed than it was rendered
obsolete by the appearance on the market of an
electric telegraphic alarm system. The electric
alarm having proven its worth, Portland was among
the first American cities to contract for one of
the new telegraphic alarm systems. The ordinance
allowing this purchase was passed on February 17, 1875.
The purchase was made and there were installed twelve
fire alarm boxes at a cost of approximately seventy-five hundred dollars.

"It seems odd that electricity entered the
fire department before the era of the horse, but
such, nevertheless, was the fact. An excerpt from
a record of the council proceedings, January 7, 1880,
is descriptive and explanatory. "The fire department
still maintains its high standard of efficiency.
Owing, however, to the rapid growth of the city
(Portland's population was then twenty-one thousand
five hundred and twenty-three) it is necessary that
horses should be provided for at least two of the
companies to haul the engines. The volunteer firemen
have always responded with alacrity when called on at
all hours of the day or night, but it requires time
after the alarm is sounded for enough of the firemen
to reach the engine houses to haul the engines to the
scene of the fire, and after they do reach the fire,
they are exhausted from the hard work of hauling the
engines over rough, muddy streets, and not able to
do the hard work required of them, for which they
receive no compensation. The horses should be kept
steady for service at a moment's notice.

"Exactly three years later, on January 7, 1883,
by consent of the people, an act was passed estab-
lishing a paid fire department for the City of
Portland. The act also provided for horses, which
marked a colorful period in the history of Portland's
Fire Department. Thus was inaugurated a new municipal
bureau, Portland's "paid fire department" -- and thus
the voluntary fire fighters whose service extended
over a period of thirty-two years, faded out of the
picture.

"With the inauguration of a paid department an
entirely new order prevailed. The roster of volunteer
fire fighters had borne the names of many of Portland's
first citizens, including the leading merchants,
bankers, lawyers, and brokers. During the volunteer
days it was not uncommon to witness customers, clerks,
and proprietors of an establishment rushing together
from a place of business to take their posts at the
fire fighting equipment.

"The newer system promised to be the better since
the authority was to become more centralized. Discipline
could be maintained. The paid fireman held his position
because of personal qualifications suited for that type
of work. Under the new system, three permanent firemen and seven callmen were to be quartered in each station house, ready instantly to spring into action when an alarm sounded.

"By 1883 Portland's population had grown to twenty-five thousand. Buildings were being constructed higher and five and six story structures were becoming quite common. The taller buildings brought increasing problems of fire fighting. Fire fighting had become a business of tremendous seriousness. The new personnel needed to be composed of men who were physically able and temperamentally suited to battle fire from the top most rungs of tall, swaying ladders.

"In the early days of the paid fire department a deterrent to achievement and efficiency was caused by the close linking of the department with politics. Men were appointed or released as much on grounds of political affiliation as on the basis of individual ability. In the first twelve years, from 1883 - 1895, there had been five fire chiefs appointed.

"In 1903, a signal step was taken in the direction of greater efficiency of municipal bureaus. That year marked the inauguration of civil service in Portland. Civil service cleaned out the evils of political control, and maintained a standard in which fit men were placed in city positions. The fire department benefitted from the effect of the innovation of the
civil service. Under civil service each man experiences a feeling of security and a sense of permanency not possible formerly when a change of administration might easily mean the loss of his job.

"The decade, 1900 to 1910 saw great population gains in Portland. Rising from ninety thousand in 1900, Portland boasted a population of two hundred fifteen thousand ten years later. This tremendous increase in population in so short a period was due in part to the Alaska gold rush, which brought many settlers to the northwest.

"A check on the efficiency of the fire department may be measured in dollars and cents through the figures released annually by the fire bureau relative to total and per capita fire losses. In 1883, the first year of the paid fire department, Portland's fire losses aggregated $319,000.00 in round figures. By 1910, fire losses had increased to $905,000.00. In 1914, the fire loss reached the staggering amount of $1,762,493.46. This was equal to a per capita loss of $6.89.

"Portland's citizens demanded more adequate fire protection, though how it was to be accomplished, few were able readily to explain. As a result of this and through the efforts of Jay Stevens, appointed fire marshall in 1914, there was established in Portland, in 1915, the Fire Prevention Bureau which has been
functioning successfully ever since. The success of this innovation became apparent upon the publication of the National Fire Underwriters figures for 1915, which disclosed that Portland's fire losses had been reduced nearly a half million in comparison with the year previous.

"Since the inauguration of the Fire Prevention Bureau, Portland's annual fire losses have crept steadily downward, amounting in 1936 to $443,040.28. This was equal to a per capita loss of $1.35. The national per capita loss average was $2.05 in 1936.

"The first department automobile made its appearance in 1907. It was a new Pierce Arrow, purchased for Chief Campbell's use. It was kept in readiness for instant use, and in the case of an alarm, the chief dashed away at top speed before the battalion chiefs could get their old fashioned buggies in line. So well did the automobile work that it sealed the doom of the fire horse. Agitation immediately began toward motorizing all the equipment and apparatus.

"The first piece of motor propelled fire apparatus was put into service in 1911. At the close of the year 1913, the department had seventeen pieces of motor equipment in service, and by June, 1915, the department's motor apparatus had increased to
twenty-six pieces. In April, 1920, the department became completely motorized.

A table from the annual report dated 1945 shows the state of equipment of the present fire department. (5)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Quantity</th>
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<tr>
<td>Drill Tower</td>
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</tr>
<tr>
<td>Fire Boats</td>
<td>3</td>
</tr>
<tr>
<td>Squad Wagons</td>
<td>1</td>
</tr>
<tr>
<td>Disaster Car</td>
<td>1</td>
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<tr>
<td>First Aid Car</td>
<td>1</td>
</tr>
<tr>
<td>Turret and Hose</td>
<td>1</td>
</tr>
<tr>
<td>Hose and Pump Turret</td>
<td>10</td>
</tr>
<tr>
<td>Turret Hose and Booster Pump</td>
<td>4</td>
</tr>
<tr>
<td>Hose and Booster</td>
<td>8</td>
</tr>
<tr>
<td>Hose and Pumper</td>
<td>14</td>
</tr>
<tr>
<td>Pump and Chemical</td>
<td>5</td>
</tr>
<tr>
<td>Water Truck</td>
<td>1</td>
</tr>
<tr>
<td>100' Aerial Truck</td>
<td>1</td>
</tr>
<tr>
<td>85' Aerial Truck</td>
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<tr>
<td>75' Aerial Truck</td>
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<tr>
<td>City Service Truck with Booster Pump</td>
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<tr>
<td>Compressor Car</td>
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<tr>
<td>Gas Truck</td>
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</tr>
<tr>
<td>1 and 1/2 ton Hydrant Truck</td>
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<tr>
<td>Water Hydrants</td>
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<tr>
<td>Cisterns</td>
<td>62</td>
</tr>
<tr>
<td>Fire Alarm Boxes</td>
<td>1156</td>
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<tr>
<td>Fire Alarm Circuits</td>
<td>56</td>
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</table>

The Tests
CHAPTER III

Before picking any tests for the Portland Fire Department, letters were sent to eleven large cities, and one county, asking the chief examiners of the civil service commissions to send the tests which they administered to applicants for firemen jobs. A table showing what other cities are doing may be found on the following page.

Next, through the cooperation of the Portland Civil Service Commission and the Portland Fire Department, a control group of thirty firemen, whose ages ranged from twenty-three to twenty-nine years, and who had been in the department from two to eight years, were given the same series of tests which were also given to the experimental group. The experimental group consisted of three hundred and eight applicants for firemen jobs.

Before any applicant could take the series of physical ability tests of strength, speed and endurance, he was required to take two tests which were set up by the fire department. The first one consisted of jumping from a second story window of the drill tower into a fireman’s net. The second consisted of climbing up, over and down a seventy-five foot aerial ladder. If the applicant was unable to complete either of these two tests, he was eliminated as a candidate.

The next text was called Dynamic Balance, and was
## TABLE I

**TESTS GIVEN IN OTHER CITIES**

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<td>High Jump</td>
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<td>Rope Climb</td>
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<td>Weighted Sack or Dummy</td>
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originated by Ruth Bass. In this test eleven circles, each eight and one-half inches in diameter were drawn on the floor. The subject stands on the starting circles with his right foot and leaps (not steps) into the first circle with the left foot, leaps into the second circle with the right foot, and so on from circles to circles, alternating feet. The subject must leave the floor entirely in leaping from circle to circle before alighting. He must alight on the ball of the foot, and must not touch the heel to the floor. He should remain stationary in each circle for five seconds so that the total time of the trip should, ideally, take fifty seconds. The score for the trip is fifty minus one point for each error. The errors are as follows:

1. Touching the heel to the floor.
2. Moving the foot while standing in the circle.
3. Hopping upon the supporting foot.
4. Touching the floor outside the circle.
5. Touching the other foot to the floor.
6. Touching any other part of the body to the floor.

Each error counts one penalty point; thus, if the individual, in endeavoring to maintain the balance in any one circle, hops four times, this is counted as four separate errors. Each subject was given one trial. See figure on the following page. (Figure one.)

Figure I
Diagram of the Bass Test

Notes:
- 18" from (X) to (1)
- 33" between each circle from (1) through (10)
The next test was called the Criss-Cross Test. (Figure II, page 23) The candidate was first instructed by the administrator as to the procedure of the test. The instructions were given as follows:

Candidate stands at starting line (A), and at a pre-arranged signal from the administrator runs to pick up dummy at (B). He then runs around the right side of dummy fireplug (C), and runs with dummy toward dummy fireplug (D), staying to the right of (D). He proceeds toward (E), runs to the right of (E), and continues to (F) where a second dummy is lying on a 5' x 7' mat. He deposits first dummy on mat, picks up second dummy and proceeds to the right of (G) toward (D). He runs to the right of (D) toward (H), and runs to the left and around (H), proceeds to (B) where he deposits the second dummy, and, finally, continues to (I) which is the finish line.

One second was added to the candidate's time for each error he made, such as going around the wrong side of a dummy fireplug, or for knocking over a fireplug. There were very few errors made.

The next series of six tests were taken from the Sargent group of speed, strength, and endurance. (7)

The tests were devised to measure a combination of speed, speed, and endurance of the human body, published privately, (Cambridge, Massachusetts, 1902.)
Figure II

Diagram of the Criss-Cross Test

...
strength, and endurance. In devising these tests Dr. Sargent utilized, for convenience, simple calisthenics movements of a type which were commonly used in gymnasium classes. The six exercises were so chosen as to bring into action all of the large muscle groups both in trunk and limbs, and yet not to subject any one group of muscles to undue strain.

The test is arranged to reduce the effect of knack, trick, or special skill to a minimum. They are as follows:

First exercise:

Lie in a supine position upon the floor with elbows flexed and finger tips touching the front and top of the shoulders. The feet are placed under some object. The subject flexes his trunk forward until the elbows touch the knees. The shoulders always touch the floor after each flexion of the body.

Method of scoring: One times number of times elbows touch knees in one minute divided by twelve.

Second exercise:

Support a wooden stick or wand, about three feet long and one inch in diameter, from the backs of two chairs placed about two feet apart so that the wand is about thirty inches from the floor, or just high enough to permit the body to clear the floor when supported from arm's length, as described. Grasp the bar with the palms of the hands
toward the face, arms stretched and body held horizontal on a line with the thighs, roughly forming a straight line from the shoulders to the knees. The knees are flexed to a right angle so that the feet are directly under the knees when the shoulders are just off the floor. While maintaining this position, pull with the arms until the chest touches the bar. The body must be kept straight.

Method of scoring: One times the number of times the chest touches the bar in one minute, divided by six.

Third exercise:

Lie on the floor face downward, knees bent at a right angle, and the body from the knees to the shoulders in a straight line. The hands rest upon two blocks of wood or books about four inches thick, which are placed slightly farther apart than the shoulders. From this position push the body up until the arms are straight or fully extended, and then lower the body until the chin is on a level with the upper surface of the blocks supporting the hands.

Method of scoring: One times the number of times the arms are extended in one minute divided by six.
Fourth Exercise:

Stand with the feet about twelve inches apart, the trunk bent well forward and the legs as straight as possible, with arms extended so that the backs of the fingers touch the floor just in back of a real or imaginary line drawn between the heels. From this position swing the arms directly forward until they are in line with the body, then bring the body to the vertical position, finishing the exercise with the body bent backward, the fingers clenched and above the head. Care must be taken to see that the legs are kept as straight as possible and that the arms are straightened rigidly over the head and kept on a line with the body.

Method of scoring: One times the number of times the back is straightened in one minute divided by twelve.

Fifth Exercise:

Stand upon the heels with the toes raised from the floor. Now raise on the toes until the heels are about three inches from the floor, and return to the starting position with the toes off the floor. It is permissible to maintain one's balance by touching the wall with the hand about waist high as long as this renders no other assistance. During the exercise the body must be held rigid and must
not be allowed to sway forward and backward.

**Method of scoring:** One times the number of times the toes are raised from the floor in one minute divided by one.

**Sixth Exercise:**

Flex the legs and thighs and squat down on the heels holding the trunk and head in an upright position with the arms and fingers thrust forward. Now rise to a straight standing position with the arms bent at right angles, shoulders thrown back and fingers clenched after the body rises. It is not permissible to grasp any object to assist in maintaining the balance.

**Method of scoring:** One times the number of times the body rises in one minute divided by six.

**Equipment used:**

The equipment used was made by the Portland Fire Department, duplicating the apparatus described by Dr. Sargent; however, it was made sturdier to withstand the use of hundreds of applicants. The equipment was made at low cost since the aim was to test strength, speed, and endurance with a minimum cost in apparatus.

**PRELIMINARY ARRANGEMENTS:**

Two weeks before the date of the physical examinations, the chief in charge of the drill tower was
contacted and permission was obtained to use the drill
tower area in laying out the physical examinations.
During the testing period, two of the tests formerly given
were dropped, and one new test was added. The two tests
dropped were the Toe-Heel and Dynamic Balance. The new
test added was the Standing Broad Jump. The Toe-Heel
and Dynamic Balance were dropped due to difficulty in
administration, and the Standing Broad Jump was added
because it was easy to administer and conformed with the
activities of a fire-fighter.

EQUIPMENT USED:
1. Ladder Climb: Seventy-five foot ladder (furnished
   by the fire department)
3. Criss-Cross: Two eighty pound dummies, two mats,
   and painted lines to mark course.
4. Broad Jump: Two painted lines four feet apart,
   and a six foot tape or rule.
5. Push Ups: Two five inch by five inch by eight
   inch wooden blocks and a mat. Blocks
   should be adjustable for distances apart.
6. Pull Ups: A horizontal bar at least three and
   one half feet long suspended above the
   ground at settings of thirty inches,
   thirty-six inches, and forty inches.
7. Bending: A board two feet by three feet with
foot prints painted one foot apart, and a painted line connecting the back of the heels.

8. Squatting: No equipment required.

Stop watches were used in the time events. Clip boards were made available to all score-keepers. A table, file baskets, and a chair were provided for the person taking roll call at the gate. A sign and standard were placed at each event to indicate the number of that event.

PERSONNEL:

The police department furnished eight patrolmen who acted as administrators of the events, and one who helped with the roll call at the gate. These men were placed on special duty for three days by the chief of police. There was a general field supervisor of all the events.

SCHEDULING OF PERSONNEL:

The candidates were scheduled to appear in groups at half hour intervals on one of the three days the physical examinations were held.

ADMINISTRATION:

On the first day of the examination all administrators and score-keepers were called together, assigned to a particular event and instructed by the general field supervisor as to the proper supervision of each event. Score-keepers recorded only the errors, time, distance,
or frequency on sheets, and no attempt was made to figure the raw score in the field. Two men were assigned to each event except the Static Balance, Ladder Climb, and Net Jump. Although the duties of administrators and score-keepers were not too complicated, they were, frequently, too much for one man, and for that reason, two men were assigned. In each case, except the Static Balance, the score-keeper was assigned from the civil service staff, and the administrator was assigned from the police department. This reduced the chances for favoritism to any candidate, and promoted equal standards throughout the examination.
EXAMPLE TEST SCORE

Examination
Identification Number 7

CIVIL SERVICE BOARD OF PORTLAND, OREGON

Examination for

FIRE FIGHTER

Summary of Test Results

1. Written Test: Total Raw Score is score on Test 1 plus score on Test 2. This total is adjusted to 100 points basis as shown below.

\[ \text{Net Score} = 0.61(\text{Total Raw Score} - 73) + 75 \]

2. Tests of Physical Condition

Static Balance: Score = 6 minus 2 points for each error made on best try

\[ \text{Net Score} = 6.00 \]

Dynamic Balance: Score = 50 minus 1 point for each error

Score 15 \( \times \) 0.1 = Net Score 1.50

Criss-Cross: Score = 50 minus time in seconds

\[ 50 - \text{Time} = 24.9 \times 0.7 = \text{Net Score} 17.43 \]

Condition Tests: Score = combined score on abdominal exercise, push-ups, pull-ups, bends, squats, and toe-heel (toe-heel score divided by 4)

Score 210 \( \times \) 0.14 = Net Score 29.40

Total Raw Score 54.13

Total Raw Score is adjusted to 100 point basis as shown below

\[ \text{Net Score} = 0.8(\text{Total Raw Score} - 55) + 75 = 74.30 \]
Note: Only those candidates whose net written test score was 75 or higher were admitted to the tests of physical condition and only those candidates whose physical condition tests score was 75 or higher and whose general average was 75 or higher were placed on the eligible list.
CHAPTER IV

RESULTS OF THE CONTROL GROUP AS COMPARED WITH THE EXPERIMENTAL GROUP

The control group, which was mentioned in Chapter III, was composed of thirty firemen whose ages ranged from twenty-three to twenty-nine years, and who had been firemen from two to eight years. This group was given the same series of tests which were given to the experimental group. The control group rated higher than the experimental group in all tests except the pull-ups. (See Table II on the following page.)

It is interesting to note that the control group received higher scores than the experimental group in both the abdominal and bending exercises. This might be accounted for by the fact that most of the men in the control group played more than an average amount of handball at the fire department's handball courts. The comparisons in the criss-cross tests were very close. This test was based on time in seconds, and in this test the mean for the control group was 24.33 seconds, while the mean for the experimental group was 24.62 seconds. The results of the toe-heel test were based on frequency or number of times the toes were raised from the floor in one minute. In scoring, this number was divided by four. The mean for the control group was 22.64 while the mean for the experimental group was 22.14.

The control group rated much higher in the dynamic
TABLE II
A COMPARISON OF THE MEANS OF THE CONTROL GROUP AND THE EXPERIMENTAL GROUP

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<th>TESTS</th>
<th>CONTROL GROUP MEAN</th>
<th>EXPERIMENTAL GROUP MEAN</th>
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<td>Dynamic Balance</td>
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<tr>
<td>Toe-Heel</td>
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<tr>
<td>Squatting</td>
<td>53.52</td>
<td>51.03</td>
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</table>

Note: The large score indicates superiority. In the Criss-Cross Test, the low score is better.
balance test than did the experimental group. This may be accounted for by the fact that the firemen are required, as part of their weekly routine, to scale ladders and undergo exercises which help to develop balance. However, the dynamic balance test was found to be difficult to administer inasmuch as there were so many different ways to deduct points for errors made. The results of the dynamic balance test produced a skewed curve in both the control group and the experimental group, with most of the applicants receiving low scores. As a result of this, it will be recommended that this test be dropped from the group in future testing.

The experimental group received the higher rating in the pull-ups. The grade was based on frequency, and in this test the mean for the control group was 46.60 pull-ups per minute, while the mean for the experimental group was 48.84 per minute, approximately two pull-ups more per minute.

An additional study was made in regard to the control group. Before the tests were given to this group, the men were graded by their superior officers in regard to their ability as firemen. The officers were requested not to consider personal likes or dislikes, but to grade the men who came under their command as to their efficiency in action, and under conditions of actual fires or drills. The officers graded the men under their command in one of the following groups. (See Table No. III on the page
following.) The relationship by inspection between the ratings given by the fire department officers and the actual grades received on the test by the control group was very low. However, the control group represented a narrow range of ability, and it is planned to include in the control group, at the next testing period, some non-applicants of approximately the same ages.

As a point of interest, all of the tests except the Static Balance and Dynamic Balance were correlated. (See Table IV on page 38)
### TABLE III

A COMPARISON OF GRADES GIVEN CONTROL GROUP WITH ACTUAL GRADES RECEIVED IN TEST

<table>
<thead>
<tr>
<th>Grade by Fire Captain</th>
<th>Grade in Dynamic Balance</th>
<th>Grade in Criss-Cross</th>
<th>Total Grade in Ab-Dominal, Push Ups, Pull Ups, Bending, Toe-Heel &amp; Squatting</th>
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Note: The groups are:

A......Superior
B......Excellent
C......Good
D......Average
E......Fair
### TABLE IV
CORRELATIONS OF TESTS

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<th>X7</th>
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<tbody>
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<td>Griss-Cross X1</td>
<td></td>
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<td>.19</td>
<td>.18</td>
<td>.31</td>
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</tr>
<tr>
<td>Broad Jump X2</td>
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<td></td>
<td>.25</td>
<td>.17</td>
<td>.08</td>
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<tr>
<td>Abdominal X3</td>
<td>.19</td>
<td>.25</td>
<td></td>
<td>.36</td>
<td>.23</td>
<td>.41</td>
<td>.34</td>
</tr>
<tr>
<td>Push Ups X4</td>
<td>.18</td>
<td>.17</td>
<td>.36</td>
<td></td>
<td>.64</td>
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<td>.60</td>
</tr>
<tr>
<td>Pull Ups X5</td>
<td>.31</td>
<td>.08</td>
<td>.23</td>
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<td>Bending X6</td>
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<td>Squatting X7</td>
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**Conclusion:** None of the tests are so highly correlated that one could predict one from another with sufficient accuracy to warrant elimination of any section.
SUMMARY

The purpose of this paper is to illustrate a series of physical tests which will measure, with a reasonable degree of accuracy, the physical capacities which are needed to carry out the duties of a fire-fighter in Portland, Oregon.

Firemen must be in good mental and physical condition, must have good balance, be reasonably agile, and must not have a fear of heights.

Civil service rules in Portland, Oregon require that examinations be held every two years for firemen and policemen appointments. However, up to the present time, no definite study has been made on this subject in Portland. Although tests have been given regularly, there has been a feeling that they were not a true measurement of the physical capacities a good fireman need possess.

Another object of this study is to use tests which do not require expensive equipment, and which give a fair measurement of the combination of speed, strength and endurance.

Before anyone may receive his appointment as a fireman, he must meet certain height, weight, and health requirements which are set up by the fire department and administered by the Civil Service Board. These personal qualifications are listed in Chapter I.

A history of Portland's Paid Fire Department is given in Chapter II. The history begins when Portland was founded
in 1884, and is carried to 1920 when Portland's Fire Department was completely mechanized.

Before picking any tests for the Portland system, letters were sent to eleven large cities and one county, asking that the civil service commissions of these cities and county send copies of tests which they had been administering to applicants for firemen jobs. [See Chart I on page 19] Next, through the cooperation of the Portland Civil Service Commission, and the Portland Fire Department, a control group of thirty firemen was picked. The ages of these firemen ranged from twenty-three to twenty-nine, and they had been working in the fire department from two to eight years. The same series of tests were given to a control group as were given to the experimental group.

Before any applicant could take the tests of speed, strength and endurance, he was required to take two tests administered by the fire department. The first one consisted of jumping into a fireman's net from a height of twenty-five feet. The second test consisted of climbing up, over and down a seventy-five foot aerial ladder. If the individual failed to carry out either of these two tests, he was eliminated as a candidate.

Following the ladder climb and net jump were nine other physical tests. The first one consisted of walking the edge of a two by four rail which was fifty feet long and which was raised ten inches from the ground. This
test was called Static Balance, and is explained and illustrated in Chapter III.

The third test was called the Criss-Cross test, and is also explained and illustrated in Chapter III.

The next series of six tests were devised by Dr. Dudley Allen Sargent. These six tests measure a combination of speed, strength, and endurance. The explanation of these tests may be found in Chapter III.

The final results showed the control group to rate higher than the experimental group in every test except the pull-ups, which were part of the series of six tests devised by Dudley A. Sargent.
RECOMMENDATIONS

1. Because the examinations were so fatiguing, several comments were received that some medical examination be given prior to the physical. This could not be supported by the city budget, so it is suggested that the candidates be thoroughly informed of the strenuous exercises to be given.

2. It would help the candidates if the number system on the score sheets agreed with the numbers for the field station.

3. Many men were handicapped by not having tennis shoes. The announcements sent to candidates telling them of the date of the examination listed tennis shoes as part of the equipment to bring, however, some overlooked this, and were definitely at a disadvantage.

4. It is suggested that the next time the physical tests are given that a test of agility be added. These tests include strength, speed, endurance, and power, but do not include any one test of agility, which should be of great importance in becoming an efficient fire-fighter.

5. Some suggestions were made to break up the series of three very tiring events - abdominal, push ups, and pull ups. A study would have to be made of this, however, inasmuch as such a plan might destroy the validity of the test.

6. More enthusiasm must be created during the first morning of the test. The first candidates made a poor
showing compared to the second and third day candidates. Norms or record performances from the previous years should be held up as goals for each candidate.

7. Because of the difficulty in administering the Dynamic Balance Test to a group of this type, it is recommended that this test be eliminated, and a more suitable one used in its place.

8. Because of the difficulty in administering the Toe-Heel Test, it is recommended that this test be eliminated.

9. It is recommended that the standing broad jump be added to the tests. This is a measurement of power, and is a type of action used by fire fighters.

10. It was found that one minute of rest between each of the series of six tests was not long enough. It is recommended that the period of rest be longer and uniform for all candidates.

11. There should be further revision of the tests on the basis of experience and possible experiment.

12. If possible, biennial physical ability tests should be given to all firemen of lowest two grades.

13. Medical examinations should be given before the tests.

14. Biennial medical examinations should be given to all firemen.

15. Further experimentation to include non-applicants.
CONCLUSIONS

The relationship of grades given each member of the control group by his superior officer as compared to actual grades received in the tests by control group members was low. This might be explained by the fact that personalities have a strong bearing in the former grading, and the tests in this paper deal mainly with speed, strength, and endurance.

These tests were first administered to Portland, Oregon firemen candidates in 1941, next in 1943, and again in 1946. The applicants who pass the tests are placed on an eligible list in accordance with their grades received. If they do not receive an appointment to the fire department within two years after having taken the tests, they are required to take them again.

Fire Captains and Battalion Chiefs, who were questioned as to their opinion of the tests, stated that they were well satisfied with the results obtained.

The tests, thus far, have proved satisfactory, since they require no expensive equipment, and they are administered easily. They require a minimum of time per man to administer, and are equally difficult for all candidates.

In 1946 the Toe-Heel Test, and the Dynamic Balance tests were eliminated, while the Standing Broad Jump was added. As yet, it is too early to determine how successful the change in the series of tests will prove.
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