

- (f.) He must be able to explain the method of testing and altering the setting of the slide-valves, and method of testing the fairness of shafts, and adjusting them.
- (g.) He must be able to calculate the suitable working-pressure for a steam boiler of given dimensions, and the stress per square inch on crank and tunnel shafts when the necessary data are furnished.
- (h.) He must understand the construction of steering-engines, evaporators, feed-filters, and feed-heaters.
- (i.) He must understand the construction of centrifugal, bucket, and plunger pumps, and the principles on which they act.
- (j.) He must be able to state how a temporary or permanent repair could be effected in case of derangement of a part of the machinery or a total breakdown.
- (k.) He must write a legible hand, and have a good knowledge of arithmetic up to and including vulgar and decimal fractions and square root; he must also understand the application of these rules to questions about safety-valves, coal consumption, consumption of stores, capacities of tanks, bunkers, &c.
- (l.) He must be able to pass a creditable examination as to the various constructions of paddle and screw engines in general use, as to the details of the different working-parts, external and internal, and the use of each part.
- (m.) He must possess a creditable knowledge of the prominent facts relating to combustion, heat, and steam.

48. *First-class Engineer.*—A candidate for a first-class engineer's certificate must be not less than twenty-two years of age.

49. In addition to the qualification required for a second-class engineer,—

- (a.) He must have served at sea for twelve months with a second-class certificate of competency or service on regular watch on the main engines or boilers of a foreign-going steamship of not less than 99 nominal horse-power as senior engineer in charge of the whole watch, or have served at sea for eighteen months with a second-class certificate of competency or service as first engineer of a home-trade steamer of not less than 99 nominal horse-power; or two years with a second-class certificate of competency or service as second engineer of a home-trade steamer of not less than 99 nominal horse-power; or two years and a half with a second-class certificate of competency or service as third engineer of a home-trade steamer of not less than 99 nominal horse-power, if during the whole of that period he has been the senior engineer in charge of the whole of a watch on the main engines and boilers; or possess or be entitled to a first-class certificate of service.

*On and after 1st January, 1915, the candidate will be required, in addition to the qualifications required for a second-class engineer—(1) to have served at sea for eighteen months with a second-class certificate of competency or service on regular watch on the main engines or boilers of a foreign-going steamship of*

*not less than 99 nominal horse-power as senior engineer in charge of the whole watch; or (2) to have served at sea for twenty-seven months with a second-class certificate of competency or service as first engineer of a home-trade steamer of not less than 99 nominal horse-power, or three years with a second-class certificate of competency or service as second engineer of a home-trade steamer of not less than 99 nominal horse-power; or (3) to have served three years and nine months with a second-class certificate of competency or service as third engineer of a home-trade steamer of not less than 99 nominal horse-power, if during the entire period he has been the senior engineer in charge of the whole of a watch on the main engines and boilers; or (4) to possess or be entitled to a first-class certificate of service. The service described in paragraphs 47, 48, 49, and 50 of the regulations may as heretofore be accepted as qualifying for examination in accordance with the conditions specified in those paragraphs.*

- (b.) He will be required to make an intelligible hand-sketch, or a working-drawing of some one or more of the principal parts of a steam-engine; and to mark in, without a copy, all the necessary dimensions in figures, so that the sketch or drawing could be worked from.
- (c.) He must also be able to take off and calculate indicator diagrams.
- (d.) He must be able to calculate safety-valve pressures, and the strength of the boiler shell, stays, and riveting.
- (e.) He must be able to state the general proportions borne by the principal parts of the machinery to each other, and to calculate the direct stress, the torsional stress, and the bending stress in round bars, and the direct stress and the bending stress in rectangular bars, with given loads.
- (f.) He must be able to explain the method of testing and altering the setting of the slide-valves, and to sketch about what difference any alteration in the slide-valve will make in the indicator diagram, and also the method of testing the fairness of shafts, and of adjusting them.
- (g.) He must be conversant with surface condensation, superheating, and the working of steam expansively.
- (h.) His knowledge of arithmetic must include the mensuration of superficies and solids and the extraction of the square and cube roots, and the application of these rules to questions relating to the power, duty, and economy of engines and boilers, and to the stresses in rods, shafts, and levers of the engine. He should also be able to calculate the effect of the application of the lever, pulley, inclined plane, and other mechanical powers.
- (i.) He must understand the construction of, and be able to maintain in working-condition, the auxiliary machinery which is placed under his charge—viz., refrigerating machinery, electric-light engines and dynamos, electric motors fitted to ship's boats, hydraulic machinery, and the various descriptions of steering-engines, &c.