the deck from end to end of the ship, and it becomes wholly immersed.

In 1866 the president of the Institution of Naval Architects said : “ The circumstances of the sad event of the loss of the ‘London,’ accompanied as it was by the simultaneous loss of another ship of still larger size, and of a higher reputed character ” (the “Amalia,”), “was, I think, an event so remarkable that I should be very sorry indeed if this annual meeting of this Institu­tion were to pass by without some notice being taken of the extra­ordinary circumstances of the loss of that ship, and without some discussion upon what we suppose to be the causes of the loss, and the faults, if any, of the construction of those ships.” “The passengers who pass to and fro are not judges of the question ; they can take no precaution for their own safety ; it is to the skill and science of those who build these ships that the passenger trusts, and to the care which the legislature and the Government are bound to take of their fellow-subjects.”

Subsequently the council of the Institution arrived at the follow­ing conclusions and offered them as recommendations to ship­builders and shipowners :—

“ 1. No general rule can be safely laid down for regulating the proportions of length and depth to the breadth of a ship, and a great variety of propor­tions of length and depth to breadth may he safely adopted, and the ship made sound and seaworthy, by judicious form, construction, and lading.

“2. The construction load-water-line of every ship, and her scale of dis­placement from light to load-water-line, should be appended to every design of a ship, showing the extreme draught **to** which she should be laden ; and measures should be taken to ensure that this information be recorded on the ship’s papers. It is desirable also that along with a ship’s papers, in the possession of the captain, there should always be carried a scale of displacement, a sail draft, and a set of outline plans of the ship, comprising a longitudinal section, and at least four cross sections of the ship. On these plans should be marked the capacity, in tons of 40 cubic feet, of each com­partment of the hold. The surplus buoyancy of each compartment up to the load-water-line, or its power to carry deadweight, should be given in tons deadweight. These papers should always accompany the ship’s register, and a copy of them should be lodged in the custom house of the port from which the ship hails.

“ 3. There is a minimum height of freeboard which cannot be safely reduced in sea-going ships of ordinary fitment ; and it is desirable to fix this minimum height. Freeboard should be understood to be the vertical height of the upper surface of the upper deck (not spar-deck) at the side, amidships, above the load-water-line. The proportion of freeboard should increase with the length. One-eighth of the beam is a minimum freeboard for ordinary sea-going ships of not more than five breadths to the length, and 1/32 of the beam should further be added to the freeboard for each additional breadth in the length of the ship ; this would give—

For a ship of 32 feet beam and 160 feet long, 4 feet freeboard ;

For a length of 192 feet, 6 feet freeboard ;

For a length of 224 feet, 6 feet freeboard ;

For a length of 256 feet, 7 feet freeboard the beam remaining the same. But, as the addition of a spar-deck on long vessels may be considered an equivalent or substitute for the increased freeboard required for extra length, a complete spar-deck would leave the freeboard of these extra lengths at the original height of 4 feet.

“ 4. It is not considered desirable to offer any recommendations with regard to poops and forecastles. It must depend entirely upon the pro­fessional judgment of the designer of a ship, whether, looking to her pro­portions, form, and purpose, the additions of poop and forecastle are expedient and safe. In general, where poops and forecastles are adopted, they should be closed and seaworthy, but their weight may be inexpedient in long fine ships ; and there are cases where a light top-gallant forecastle (*i.e.*, an open forecastle raised above the level of the upper deck) may be useful in keeping heavy seas out of the ship. In general, spar-decks in long ships are preferable to poop and forecastle, and no diminution of freeboard should be allowed for a poop or forecastle.

“ 5. It would add much to the strength and security of steamships if transverse and longitudinal bulkheads, coal bunkers, iron lower decks, and screw alley were all so connected with the hull of the ship and with each other as to form independent cellular compartments, watertight, and having all their communications with the decks and each other by water­tight doors worked from the deck. In proportioning the compartments of a ship (and especially of ships devoted to passengers) it is very desirable so to arrange them that if any *two* adjacent compartments be filled, or placed in free communication with the sea, the remaining compartments will float the ship. It is considered that no iron passenger ship is well constructed unless her compartments be so proportioned that she would float safely were any one of them to fill with water, or be placed in free communication with the sea. Double bottoms are to be regarded as a great element, both of safety and strength, in the structure of a large iron ship.

“ 6. It is very desirable that sufficient ventilation should always be pro­vided in passenger ships to admit of closing all side scuttles and battening down, or otherwise enclosing, all hatches in bad weather.

“ 7. In regard to hatchways and openings in the deck no limits can be set to their size ; but it is desirable to carry the beams of the ship across them without interruption wherever practicable ; they may also be made remov­able where required, being replaced on going to sea. All coamings over engine and boiler rooms in passenger ships should be as high as practicable, of iron, and riveted to the beams and carlings. Openings in the deck may be fitted with solid coverings, hinged in place so as to be readily closed.

“ 8. It being considered that all openings in the sides or ends of vessels are subject to accidents that endanger the safety of ships, it is desirable that the side and stern windows should, in addition to the glass lights, have *hinged dead-lights,* with a view to their being always in place, and that all cargo ports should be strongly secured by iron cross bars.

“ 9. It is believed that all openings from and communications with the sea from engine-room and pipes should be protected by conical, or Kingston, or sluice valves, and similar precautions should be taken for all openings through the bottom of the ship, where damage to pipes or ship would admit water into the holds.

“ 10. It is considered that all steam vessels, if of iron, should have a brass­barrelled hand-pump to every compartment except the forward and after ones (the former to have a sluice cock), or that, as a substitute for these pumps, there should be patent pumps having independent connexions to this extent. They should also have a donkey engine and pump capable of pumping from the bilge and from the sea, of feeding the boilers, and of

throwing water on deck. All vessels should have one or more bilge-pumps, worked by the large engines, with bilge injection pipes if the engines have condensers. In large vessels the donkey engines should have a separate boiler high above the water-line, and also communication with the main boilers. All vessels should have a set of bilge pipes connecting every hold and the engine compartments with these pumps. As a security against fire there should be pumps on the upper deck, fitted as force pumps, and pro­vided with a sufficient length of hose (with the necessary copper delivery jets) to reach either extremity of the vessel, and also provided with suction hose or pipes from the sea. The cocks by which the working of the pumps is regulated should be carefully arranged and marked, and great care should be taken that both cocks and pipes are accessible. A plan of the whole should accompany the ship’s papers, and the crew should be periodically exercised in their use.

“ 11. The stowage of a ship, whether done by contract or not, should be done under inspection of the captain of the ship, and should be conducted under his own orders only ; and he alone should be held responsible for the good stowage of his ship. Ships are often very badly stowed, the weights being sometimes too low, thus causing them to roll with such rapid and violent motions as to carry away the spars, and otherwise endanger the safety of the ship, and at other times too high, thus making the ships crank, and liable to turn over. A ship may, however, generally, whatever her form, be so stowed as to avoid both dangers. As the character of the ship in these respects varies, so does the number of oscillations she would make per minute if she were set rolling in still water, by men running across her deck, or other means, and then allowed to come to rest ; that is, if the ship be crank the number of oscillations per minute will be few, and if she be too stiff they will be numerous ; but, under the same conditions of stowage, the number will always be very nearly the same, whatever the amount of the impulse to set her rolling may be. Although this peculiarity has long been known to scientific men, no such observations have been made in merchant ships as would justify any specific rule on the subject. It is, however, most desirable that information should be collected upon it, and that the attention of the owners and captains of vessels should be called to it.

“ 12. It is believed that the present rules of the Board of Trade regarding boats, life-boats, and their tackle are good in principle. The responsibility for keeping all boats in constant readiness and efficiency obviously rests on the captain, ami must fix on him the blame for all neglect and its consequences. Every open boat built of iron or steel should be fitted with sufficient watertight spaces to float her.

“ 13. The system of proportioning anchors and cables by Lloyd’s, and of proving under licence of the Board of Trade by Act of Parliament is so far satisfactory ; but, as the proof-test alone cannot establish the excellence of the cable, the reputation of the makers must be relied upon.

“ 14. In order to provide for the rapid clearance of the upper deck from water which may break over the ship, flap-boards should be fitted to the lower part of the bulwarks, sufficient in number and in area to admit of the rapid escape of the water.

“ 15. Water-closets on decks below or near the water-line may be the means of gradually and imperceptibly flooding the ship, and endangering her safety, unless the pipes and valves are strong and are carefully fitted.”

It is in the directions indicated in these recommendations that the honesty and skilfulness of the modern builder of steam and sailing ships of war come into play, and some judgment may be formed by the general public of the character of the ship by inquiring into matters upon which the council thought it neces­sary to make such recommendations. The guarantee which the public have of the fitness of passenger ships for service, as a question of proper construction and state of efficiency, is the sur­vey and certificates of the Board of Trade. The law runs thus :—

The owner of every steam vessel constructed or intended to carry passengers (except vessels which fall within the definition of foreign-going ships con­tained in the Mercantile Marine Act, 1850, and are employed in the convey­ance of the royal public mails or despatches under contract with and under the superintendence of the lord high admiral or the commissioners for executing the office of lord high admiral) shall cause such steam vessel to be surveyed twice at least in every year, at the times hereinafter directed, by a shipwright surveyor and by an engineer surveyor appointed for the purposes of this Act by the lords of the said committee, such shipwright surveyor in the ease of an iron steam vessel being a person properly qualified to survey iron steam vessels, and shall obtain a declaration of the sufficiency and good condition of the hull of such steamer, and of the boats and other equipments thereof, required by this Act ; and also, if the lords of the said committee so require, a statement of the number of passengers (whether deck passengers or other passengers) which such vessel is constructed to carry, under the hand of such shipwright surveyor, and a declaration of the sufficiency and good condition of the machinery of such steamer under the hand of such engineer surveyor; and in such declarations it shall be dis­tinguished whether such vessel is in construction and equipments adapted for sea service as well as for river or lake service, or for river or lake service only ; such declaration shall state the local limits within which such vessel is, in the judgment of the surveyor, adapted for plying ; and in the case of seagoing vessels the declaration of one of the surveyors shall contain a statement that he is satisfied that the compasses have been properly examined and adjusted ; and such owner shall transmit such declarations to the lords of the said committee within fourteen days after the dates thereof respect­ively.

As to the fifth recommendation of the council of the Institu­tion of Naval Architects, it must be observed that there is at present no law relating to the subdivision of steamships. There was a clause (No. 300) in the Merchant Shipping Act of 1854, which was virtually a reproduction of clause 20 of the Steam Navigation Act of 1851, and which read as follows :—

“ 1. Every steamship built of iron of 100 tons or upwards, the building of which commenced after the 28th day of August 1846, and every steamship built of iron of less burden than 100 tons, the building of which commenced after the 7th August 1851 (except ships used solely as steam tugs), shall be divided by substantial transverse watertight partitions, so that the fore part of the ship shall be separated from the engine-room by one of such partitions, and so that the after part of such ship shall be separated from the engine- room by another of such partitions.

“2. Every steamship built of iron, the building of which commences after the passing of this Act, shall be divided by such partitions as aforesaid into not less than three equal parts, or as nearly so as circumstances permit.

“3. In such last-mentioned ships each such partition as aforesaid shall be of equal strength with the side plates of the ship with which it is in contact.