

SECRET

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Report, dated April, 1942, of a Committee presided over

by Mr. Justice Bucknill.

The Loss of H.M.S. "Prince of Wales."

11/2/42
SHIP DEPARTMENT
BLOCK G
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PART I.

INTRODUCTION.

We were appointed a Committee by Secret Office Acquaint A.J.1 of the 18th March, 1942, with the following terms of reference:-

"To review the circumstances attending the loss by enemy action of capital and other heavy ships since the beginning of the war, and to consider whether there are any specific material measures or lines of investigation which might profitably be adopted or pursued, with intent to improve the defence of British Warships against existing or anticipated enemy weapons."

2. We are alive to the desirability, for various reasons, of reporting as soon as possible, and since in our view, and, as we believe, in the general view, the disaster which overtook H.M.S. "Prince of Wales" on the morning of the 10th December, 1941, is the loss which is at the present time of particular interest and importance, we have devoted the main part of our attention in this interim report to this disaster and the conclusions which we draw from it.

3. We have had access to relevant official papers, reports and plans, and to written evidence, and we have interviewed a number of witnesses and taken verbatim evidence from them (SEE Appendix B). Here it should be stated that certain of these witnesses, whose written evidence was previously collected by the senior surviving executive officer of the "Prince of Wales" and is included in Appendix A, made substantial additions to and explanations of their evidence when interviewed by us. We have also had the benefit of the views of various heads of Admiralty departments and others in the Admiralty, whose evidence was likely to be of value to us.

PRELIMINARY NARRATIVE

4. Shortly after 1140 on the 10th December, 1941, H.M.S. "Prince of Wales" was attacked by nine Japanese torpedo bombers. We conclude from the evidence that this attack was carried out in successive groups of two or three aircraft, and that torpedoes were dropped at varying distances not exceeding 2,000 yards. At 1144 the ship, which was steaming at 24 knots, was hit on the port side. Within a space of about four minutes she took on a list of 11½ degrees to port. This list was slightly reduced by counter-flooding, but attacks from 1223 onwards on the starboard side caused further serious damage, and at 1320 approximately the "Prince of Wales" sank.

RESULTS OF THE FIRST ATTACK

5. The blow received in the first attack was indisputably remarkable, combining a very severe concussion with a lifting of the ship and vertical oscillations. Many survivors describe the concussion as far more heavy than was experienced from any subsequent hit.

IMMEDIATE DAMAGE

6. The known immediate damage to the structure as observed at the time was not great, and excepting any buckling or deformation of hatches, or crumpling, or other damage to ventilation trunking, was generally as follows:

- (a) At the after end of "B" engine room there is evidence of damage to the shaft gland at the after end of the thrust-block recess, through which water was pouring in considerable volume.
- (b) The bulkhead at the after end of No. 6 diesel dynamo room was stated to have "caved in".

(c)/.....

- (c) There is aural evidence of damage to the outermain shaft, i.e. that from "B" engine room. This consists of numerous references to banging and thumping from positions as far apart as stations 200 and 290. Whether this is attributable to a bent or broken shaft which inflicted structural damage on bulkheads or other plating, is not known.
- (d) "Y" action machinery room. A steam container was certainly fractured and one witness Leading Stoker James (p.57 of Appendix A), who was in "Y" machinery room, says that the "shaft broke and part fell on dynamo": We think that some object probably connected with the shaft became detached and fell on the dynamo, but do not think that the shaft broke.
- (e) Boy Clark (p.61 of Appendix A) stated that the floor of No. 12 breaker room buckled. This statement should be treated with reserve.

IMMEDIATE FLOODING

7. We have investigated the evidence carefully to endeavour to determine the nature and extent of the flooding which was caused by this attack. We are satisfied from the clear visual evidence of witnesses, or from reasonable deduction or inference, that the following compartments flooded within about four minutes. (For further explanation and references to evidence, see Appendix C):-

- (1) "B" Engine Room (flooding quickly and full well before the starboard attack which took place 40 minutes later).
- (2) No. 6 Diesel Dynamo Room. 184-206 Hold.
- (3) 184-206 Lower Platform Deck.
- (4) "Y" Action Machinery Room. 206-225 Hold.
- (5) Compressor Flat, 206-228 Lower Platform Deck.
- (6) No. 12 Breaker Room. 206-228 Lower Deck.
- (7) Outer Shaft Passage. 228-242 Hold.
- (8) No. 11 Pump Room. 228-242 Lower Platform Deck.
- (9) No. 14 Breaker Room. 228-242 Lower Deck.
- (10) Inner Shaft Passage. 228-242 Lower Platform Deck.
- (11) Outer Shaft Passage. 253-270 Hold.
- (12) Some or all of the group of watertight compartments, 253-274 Lower Platform Deck.
- (13) Inner Shaft Passage. 274-281 Lower Platform Deck.
- (14) Electrical Store. 274-281 Upper Platform Deck.
- (15) Port Side Lower Deck. 274-289.
- (16) Spirit Room. Lower Platform Deck, 281-289.
- (17) Outer Shaft Passage. 242-253 Hold.
- (18) Air Conditioning Room. 243-253 Lower Platform.
- (19) No. 16 Breaker Room. 242-253 Lower Deck.
- (20) Watertight Compartments. 274-289 Lower Platform.
- (21) /.....

- (21) Implement Store. 274-289 Upper Platform.
Due to assumed position of torpedo hit (paras. 27 and 30) add:-
- (22) Watertight Compartments, Outer, to Lower Deck. 196-234.
- (23) Watertight Compartments, Inner. 194-242.

The filling of all the compartments enumerated above (with the exception of "B" engine room, which is taken as half full) goes far to explain, but does not entirely account for, the observed list of 11 $\frac{1}{2}$ degrees. We have been careful, however, to accept the complete flooding of only those compartments of which there can be little or no doubt. We think it probable that some of the compartments listed in paragraph 10 as flooding slowly in fact were flooding during this initial period of four minutes, thereby contributing to an uncertain but appreciable degree to the list.

DAMAGE TO ELECTRICAL AND ENGINEERING INSTALLATIONS

8. As a result of the first attack on the port side of the ship, there was an extensive failure of electrical power. The steering gear failed, three-quarters of the long-range anti-aircraft guns were put out of action, both port engines were stopped, and much of the ventilation system ceased to work. Pumps could not be operated, and electrical communications failed to a serious extent.

9. Steering was subsequently restored, but later failed again because of lack of ventilation. Unable to steer, with a heavy list, and with both port engines stopped, the ship became out of control; a signal to this effect was hoisted at 1210.

SLOWER FLOODING

10. Before the starboard attack the following compartments flooded more or less completely and at varying speeds (for further explanation and references to evidence, SEE appendix D):-

- (A) Harbour Machinery Room, C.L. 162-184 Hold and Lower Platform Deck.
- (B) "Y" Boiler Room.
- (C) No. 10 Breaker Room. 184-206 Lower Deck.
- (D) Seaman's Mess. 206-228 Middle Deck.
- (E) 5.25-in. Magazine. Port Lower. 228-242.
- (F) 5.25-in. Magazine. Port Upper. 228-242.
- (G) 5.25-in. Shell Room. Port 228-242, Upper Platform.
- (H) Cypher Office. 238-242.
- (J) Motor Room and C.C.O. 228-242, Port Lower Deck.
- (K) C.C.O. Annex, No. 3 Low Power Room and Motor Room. Starboard 228-242.
- (L) 5.25-in. Magazine and Shell Room. Starboard 228-242.
- (M) Stokers' Mess. 228-242 Middle Deck, Port.
- (N) Stokers' Messdeck. 242-253 Middle Deck, Port.
- (O) Lower Deck Port. 253-274.
- (P) Stokers' Messdeck. 253-274 Middle Deck, Port.
- (Q) Cabins. 274-289 Middle Deck, Port.

GENERAL RESULT OF FIRST ATTACK

11. As a result of damage from the attack on the port side the ship rapidly ceased to be an effective fighting unit. Had she remained without further hurt she might have been saved, but she had lost her ability to manoeuvre and much of her fighting power, and in consequence became an easy victim when the second attack developed on the starboard side.

THE NUMBER AND TYPES OF HITS

12. The flooding sustained by H.M.S. "Prince of Wales" from the first attack on her port side was so serious and extensive that it could, assuming an adequate weight of supporting evidence, be best explained in the light of past experience by several torpedo hits. In fact, having regard to all the evidence which we obtained and examined, we find ourselves unable to arrive at this conclusion. The principal data which has to be considered and our conclusions therefrom fall into various parts as follows:-

I.-VISUAL

(a) Torpedo tracks

13. The sea was calm and clear and torpedo tracks were in consequence easily visible. For this reason there is much evidence, both from witnesses who were on board the "Prince of Wales" and from the "Repulse" and escorting destroyers, of tracks of torpedoes running towards the "Prince of Wales".

14. Certain witnesses say that the torpedoes were running shallow, but it is important to bear in mind that a 45-knot torpedo running at 15 ft. is about 180 yards ahead of its track, while a similar torpedo running at 25 ft. would be about 300 yards ahead of its track (SEE appendix E). It is very doubtful if these facts were appreciated by the witnesses who observed the tracks, and it is unlikely that anyone saw any torpedo which hit the ship on the port side.

15. Two witnesses on board the "Prince of Wales", Commander M.G. Goodenough who was on the staff of the Commander-in-Chief, Eastern Fleet, and a Chief Cook named Palmer, saw a track approaching the "Prince of Wales" and associated it automatically with the subsequent concussion. In fact, the track that they saw must have been that of a torpedo which had missed ahead, as Chief Cook Palmer saw it at only 100 yards away from the ship, and Commander Goodenough was able to follow it in towards the side. Commander Goodenough, in particular, was emphatic that there was only one track within his vision.

16. The considerable lag of the track behind the torpedo is of great importance, since it disposes of most of the value of visual evidence of torpedo tracks as contributory evidence to the number of hits.

(b) View of explosion

17. There is external evidence from the Captain of the "Repulse" and the commanding officers of the three escorting destroyers that they saw only one explosion. The value of this evidence must, however, be tempered by the fact that from the relative movements of the ships concerned, in so far as we are able to assess them, the "Repulse" had an approximately end-on view and her captain was therefore unlikely to be able to distinguish with certainty either the number or the locations of the hits. Two of the escorting destroyers seem to have been well on the starboard bow of the "Prince of Wales" while the third was on the engaged side and may only have had a foreshortened view owing to her position in the destroyer screen and the turn towards the attack made by the "Prince of Wales". The attention of those on board the third destroyer may have been distracted by an attack by machine-gun fire as the aircraft flew over her.

II.-INTERNAL EVIDENCE

(a) Splash

18. There are several witnesses to splash in the neighbourhood of P.3 and P.4/.....

P.4. On the other hand, two witnesses who were aft on the quarter deck say that the hit was abaft "Y" turret, one of whom saw water which welled up over the quarter deck.

(b) Shock

19. There is an overwhelming majority of evidence to the effect that there was only one shock, although a considerable and sustained one. Exceptions to this opinion in their written evidence are Commander (E) Goudy and Shipwright Lieutenant March, but in oral evidence before the Committee it transpired that Commander (E) Goudy only intended to emphasise the prolonged effect which he felt from a single shock. We found from Shipwright Lieutenant March that his own impression at the time had been of one shock, but that after subsequent thought, which was reflected in his statement, and was to some extent influenced by reports that he received of hits in various places, he felt that one torpedo could not be the cause of such extensive damage.

20. One or two other witnesses say that they felt more than one shock, but from the time given by these witnesses it seems clear that they mistook for torpedo hits the explosion of bombs in the attack on the "Repulse" at 1115.

III.--EVIDENCE FROM FLOODING

21. There is substantial evidence of considerable flooding in the neighbourhood of P.3 and P.4 (S.M.S. Plan in Appendix F). There is equally substantial evidence of flooding abaft "Y" turret. Because of this and because of the extent of the flooding, it is difficult to feel satisfied that the damage could have been caused by a single torpedo hit.

22. It has been shown that the value of visual evidence of tracks of torpedoes is not great. On the other hand, the internal evidence is such as to make us doubt whether anyone felt more than one explosion. The problem with which at this stage we find ourselves faced, therefore, is of reconciling a single considerable explosion with damage and flooding which are inconsistent, on available evidence, with a single torpedo hit.

23. From the evidence as to the way in which the enemy made his attack, the possibility of more than one torpedo reaching the ship at approximately the same time cannot be ruled out. The explosion of a torpedo can cause other torpedoes to detonate within a distance of about 160 ft., and a second explosion so caused would be indistinguishable from the first. That two torpedoes should arrive and strike the ship simultaneously would be a most improbable chance. It is more likely that, if there was a second torpedo, it would have been detonated at some slight distance from the ship. This would possibly account for the comparatively small damage which appears to have occurred in the area abaft "Y" turret.

24. We have carefully considered the possibility of the ship being hit on the port side by three torpedoes simultaneously, one aft and two in the way of the main damage, or damaged by their simultaneous explosion, even though three hits were not actually made. It is extremely improbable that three torpedoes would be thus exploded simultaneously so as each to cause damage to the ship, although it is not impossible. It would, therefore, be dangerous to dismiss this hypothesis solely because of its great improbability; but it can, we think, only be accepted if there is no more reasonable hypothesis to explain the main damage in the ship.

25. If the theory that this main damage was inflicted by only one torpedo is as improbable as that of two torpedoes detonating and damaging the ship simultaneously (in addition in both cases to a third and simultaneous hit further aft), one must admit even such a remarkable coincidence as damage by three simultaneously exploding torpedoes. But we have been unable to satisfy ourselves that it is impossible for the main damage to have been done by one torpedo with a heavy warhead if it struck the ship near the foot of the protective bulkhead. We have seen information that the Japanese are using a warhead of about 850 lbs. This is not certain and the nature of the explosive charge is unknown.

26. The argument that the trials carried out on the experimental ship section known as Job 74 demonstrate that such damage could not be done by one torpedo is not sound, because in Job 74 the explosion did not take place near the foot of the protective bulkhead, which was at 28 ft. below the waterline, but at 15 ft. below the waterline. The explosive charge used was 1,500 lbs. of T.N.T.

27. As the two areas of damage arguably point to hits by more than one torpedo, we lean to the view that the damage was caused by two torpedoes, one of which hit the ship towards the after end of "Y" action machinery room, while the other was detonated aft between Stations 274 and 289.

THE TYPE OF TORPEDO

28. We find it difficult to decide whether the hit in the neighbourhood of P.3 and P.4 was made by a contact or a non-contact torpedo. In support of the argument that it was made by the former type:-

- (a) There is no evidence of oil in the compartments which were flooded, except in "Y" boiler room, even though the oil tanks below these compartments were full.
- (b) The damage was received on the same side from which the ship was attacked. Although it is not impossible for a non-contact torpedo to be designed so as to detonate on the near side of the centreline it is more likely that it would be designed to detonate on the offside.
- (c) We are satisfied that the torpedo hits sustained in the second attack on the starboard side were of the contact type.

29. As against these arguments:-

- (i) The immediate effect of the blow was to lift the ship and cause vertical oscillations. These effects, on the other hand, might well have been caused by the hit about "Y" turret, which would have been somewhat under the ship because of its shape at this point.
- (ii) The extent in length of the flooding suggests analogy with the damage to the "Ark Royal", where a hole of 130 ft. long is said to have been caused by a single non-contact torpedo, and in which ship comparable violent vertical oscillations occurred.

30. On the whole we think that the hit near P.3 and P.4 was made by a contact torpedo. This being so it is necessary to assume that certain compartments outside the protective bulkhead inevitably flooded immediately (SEE Paragraph 7).

CONCLUSIONS CONCERNING THE FIRST ATTACK

31. The "Prince of Wales" carried a very powerful anti-aircraft armament. She was attacked on the first occasion by nine aircraft which made their attack from the same approximate bearing. They did not, therefore, present nearly so difficult a problem as if they had attacked from different bearings. Nevertheless, the fire had little effect on either the scale or the accuracy of the attack.

32. We consider that the first hit occurred towards the after end of "Y" action machinery room and, being low down, caused severe damage to the protective bulkhead and to the outer shaft. The immediate consequences were the flooding of "Y" action machinery room, of the outer shaft passage (stations 228-242), of No. 6 diesel engine room, of most of the compartments above these spaces below the middle deck, and also of compartments outside the protective bulkhead.

33. The caving in of the bulkhead between Y action machinery room and the/.....

the diesel engine room was probably due to the distortion of the protective bulkhead abreast "Y" action machinery room.

34. We consider that the second torpedo exploded abaft "Y" turret. The effect of this explosion probably brought a heavy additional strain to bear on the outer propeller shaft, and the double strain may have so distorted the shaft as to cause it to dislodge or damage the glands through which it passed between "D" engine room and the shaft bracket.

35. The flooding of the inner shaft passage between stations 228 and 242 is difficult to associate with any direct damage as a result of the explosion in view of the absence of damage in 5.25 magazine and shell rooms and the strengthening of the bulkhead between the inner and the outer shaft passage by 60-lb. plating. Its most likely cause is perhaps the fracture of a suction pipe which leads through the bulkhead into No. 11 pump room.

36. Further flooding which took place upwards above the hold level to the lower deck was undoubtedly largely due to hatches which were left open by men escaping, or which were never properly closed or which leaked under pressure.

37. Additional flooding to the middle deck was due to a combination of such factors as faulty ventilation trunks, hatches which either left open or not properly closed or buckled, and leaks past valve spindles.

38. The hit aft caused immediate flooding of the spirit room, inner shaft passage and lower deck space, on the portside between stations 274 and 289, and probably also slower flooding of some of the intermediate compartments on the port side of the platform deck. It may also have caused leakage into the watertight compartments before bulkhead 274 and into the outer shaft passage (stations 258-274). Further upward leakage occurred through hatches that were not tight, manholes that may have been dislodged, ventilation trunks, and leaking rod glands.

39. Failure of electric power in important parts of the ship where damage and flooding occurred had most serious results. Damage control work had often to be carried out with the aid of handlamp and in stifling heat due to the failure of ventilation, and the pumping system of the ship could not be used to keep water down in the compartments which were flooding slowly. Finally, the failure of the ventilation system resulted in the evacuation of machinery spaces and boiler rooms from which the source of electric power was drawn, and the possibility of coping with the damage was thus further reduced.

RESULTS OF THE SECOND ATTACK.

40. Of the subsequent torpedo hits (on the starboard side), the one right forward does not appear to have had a very great effect. The hit abreast of "B" turret and that abreast S.3 and S.4 5.25 mountings caused flooding which, though serious, does not seem to have exceeded in extent or in effect what had been assumed and expected from such hits. In both cases leakage occurred through the protective bulkhead. The hit abreast S.3 and S.4 also brought up the starboard outer shaft. The hit right aft caused considerable flooding of the after part of the ship. The effect of these hits was temporarily to reduce the list to port and at the same time to set the ship deeper in the water. The damage caused by the bomb which penetrated to the main deck and burst at 1244, may have opened the ship's side above that deck and caused further flooding on the main deck level and below, until the ship finally capsized to port.

PART II.—RECOMMENDATIONS

INTRODUCTION.

41. Before making our recommendations and as a result of the conclusions in Part I concerning the attacks upon H.M.S. "Prince of Wales" which led to her loss, it is necessary to touch briefly upon the conditions under which the designs for this class of battleship were produced, and the material results which were a consequence of these conditions.

LIMITATION BY TREATY

42. The "Prince of Wales" was a vessel limited by treaty to a standard displacement of 35,000 tons. Since 1939 additions had increased this figure by about 5 per-cent. Naval staff requirements of weapons, protection speed and endurance were the harder to meet because of this limitation of tonnage, and could only be met by reductions in the weight of structure and in the machinery and other internal equipment to an extent inevitably beyond the edge of danger.

43. The consequence in which we are most directly interested is the weakness from which the "Prince of Wales" suffered in her underwater protection. This weakness was aggravated by the fact that contracting Powers were unable to limit the menace of offensive weapons such as torpedoes, mines and aircraft, and the potency of these weapons has, in fact, considerably increased.

44. Comparisons have been made between the "Prince of Wales" and her sister ships on the one hand and that class of German ship, of which the "Bismarck" is the best known example, which were building more or less concurrently. The "Bismarck" should have been restricted to a standard displacement of 35,000 tons in accordance with her Government's expressed adherence to treaties, but in fact it seems likely that she was designed to displace between 42,000 and 45,000 tons.

45. In our opinion it is to the credit of the designers of the "King George V" class of battleship that these ships compare as favourably as they do in defensive power with heavier German vessels, in the construction of which the German Government disregarded treaties because they contained no provision to ensure their observance.

"PRINCE OF WALES" AND "BISMARCK": STRUCTURAL COMPARISON

46. We have discussed with the Director of Naval Construction the points of similarity and dissimilarity as between the "Prince of Wales" and the "Bismarck" and have examined relevant plans and other data. We consider that the placing of the armoured protection in the "Bismarck" was inferior to that in the "Prince of Wales" and that her machinery rooms were comparatively very vulnerable to non-contact torpedoes. Her greater beam enabled her to have greater protection against attack by contact torpedoes, but it must be remembered that she was enabled to have more beam because she had a greater tonnage. Generally speaking, we are of the opinion that taking into account the relative size of the two ships the "Prince of Wales" was in her general features superior in design to the "Bismarck".

LIMITATION BY DOCKS AND CANALS

47. A greater beam both enables a capital ship to have greater stability and allows more space for protection. However, there have continued to be inadequate docking facilities because of financial stringency, and this fact, combined with operational requirements that capital ships should be able to use both the Suez and Panama Canals, has kept within certain limits the maximum beam of British capital ships. The beam of the "Prince of Wales" was 103 ft. and that of the "Bismarck" was slightly over 118 ft.

RECENT EXPERIMENTS/.....

RECENT EXPERIMENTS

48. The design of the side protection of the "Prince of Wales" against torpedo attack was based on the results of the experiments on Job 74.

49. In Job 74 two trials, numbers 4 and 5, were made in which a 1000-lb. charge of T.N.T. which was considered to be as heavy a charge as was likely to be used in a torpedo warhead, was exploded against the float's side at 15 ft. below the centre line. In each case the float's draft was 30 ft. The general structure of the bulge protection was the same in each case, but in No. 4 trial stiffeners were riveted on the inboard side of the protective bulkhead, whereas in No. 5 trial stiffeners were welded for half the length on the outboard side of the protective bulkhead, and for the other half stiffeners were riveted on the outboard side of the protective bulkhead. In trial No. 4 the protective bulkhead plating consisted of two thicknesses, of 35 lbs. D.I. quality. In trial No. 5 the protective bulkhead consisted of one thickness of 60 lbs. D.I. quality. In trial No. 4 the explosion caused no major rupture in the protective bulkhead and its maximum deflection was 18 in. In trial No. 5 the protective bulkhead was ruptured and turned in over an area of about 14 ft. in length and 28 ft. in depth. The rupture was confined to the portion of the bulkhead supported by welded stiffeners. The damage to the protective bulkhead over the portion supported by riveted stiffeners was slight.

The protective bulkhead of the "Prince of Wales" was constructed and supported by riveted stiffeners as in trial No. 4. The protective bulkhead of the "Ark Royal" was constructed and supported by welded stiffeners as in trial No. 5, and was built in place in the ship before No. 5 trial took place. As a result of trial No. 5 the welded attachments of the stiffeners to the bulkhead were reinforced for part of their height by riveted angle bars.

The designers of the "Prince of Wales" considered that trial No. 4 proved that the type of bulge protection tested therein, and in substance similar to that fitted in the "Prince of Wales" would be effective in resisting a 1000-lb. charge detonated in contact with the side of the ship.

50. In the event this proved incorrect. The reasons for this, unfortunately, are not clear, but the facts are reasonably clear. These are that, as a result of the first torpedo attack, No. 6 diesel dynamo room, "Y" action machinery room, and outer shaft compartments abaft the latter were rapidly and completely flooded. Flooding spread quickly upwards to the compartments above the foregoing and three breaker rooms were soon full of water. "B" engine room flooded fairly fast, as did many other compartments. Finally, it must necessarily be assumed, though evidence from survivors is lacking, that some empty watertight compartments outside the protective bulkhead flooded instantly.

51. This extensive flooding, which is explained more fully in Part I of this report and in Appendices C and D, would not have taken place if the protective bulkhead had fulfilled the function ascribed to it and expected of it.

ALFRED T. BUCKHILL

W. F. WAKE-WALKER.

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J.H. JAMES,
3. 7. 42.

RECOMMENDATIONS CONCERNING STRUCTURE

52. The protective bulkhead in the "Prince of Wales" failed as we have said, to fulfil its purpose. Essential machinery was quickly put out of action by flooding. Hatches and doors failed to prevent the spread of water, and the ventilation system caused an extension of flooding. Compartments which were flooded could not be evacuated without risking the flooding of other compartments. Rod gearing caused minor leaks from flooded compartments.

53. To meet these and other points of weakness, our recommendations are as follows:-

I. We recommend that if the operational objections can be disregarded the beam of capital ships should be increased, so as to improve stability and enable better protection against contact torpedoes to be provided.

II. We consider that an increase in beam should be used to increase the space outside the protective bulkhead, so that the explosion of a torpedo would take place further from this bulkhead.

III. We recommend that the arrangement of the protective bulkhead should be such as to keep the foot of the bulkhead as low as possible in the ship and as near the centre line of the ship as possible, especially where the ship starts to fine down. This may involve a considerable departure from the present method of construction, which consists of a vertical fore and aft bulkhead stepped back as the ship narrows. In the case of ships already built, the possibility of decreasing the vulnerability of the system near the foot of the bulkhead should be considered.

IV. Damage due to a torpedo explosion and subsequent venting will entail flooding outside the protective bulkhead up to some deck which is undamaged. Such arrangements should be made on this latter deck as will ensure that it will remain watertight.

V. While recognising that there must always be an area towards the after end of the ship which is very vulnerable to a contact torpedo, particularly in the vicinity of the stern glands, we consider that every possible precaution should be taken as regards the arrangement of the protective bulkhead, or by other means, to confine the effects of explosion in this area.

VI. The Post-War Questions Committee which submitted a final report dated 27th March, 1920, recommended that a three-shaft design should be adopted for our battleships, basing their recommendations upon their opinions of the advantages of this system in the German battleship "Baden". The Germans have demonstrated their continued preference for three as opposed to four shafts in their big ships by fitting the "Bismarck" with three shafts, but although we have used this system in our recent aircraft carriers we have not adapted it to our capital ships. In our opinion the flooding in the "Prince of Wales" was materially increased owing to damage to the outer port shaft, and consequent damage to athwartship bulkheads through which the shaft passed.

We think that it is advantageous to keep the wing shaft as far away from the ship's side over as great a fore and aft length as possible, and it appears that this can more effectively be secured in a three-shaft than in a four-shaft arrangement. In consequence shafting might be less vulnerable to contact torpedoes and no more vulnerable to non-contact torpedoes. While recognising the effect of a centre shaft on after turrets and magazine design, we recommend that further consideration should be given to the question of fitting three shafts in capital ships.

VII. Important machinery such as dynamos should not be placed in compartments which are likely to be the first to flood, and should be as high up as possible, but under the protective deck.

VIII. All parts of the structure should be designed to be adequate to withstand the hydrostatic pressure to which they may be subjected, in consequence of the maximum list which the ship can experience and still remain afloat. (SEE also Recommendation XVII)

IX. All hatches, doors and scuttles, should be strong enough without shoring /.....

shoring to withstand the maximum hydrostatic pressure to which they might be subjected, and should be watertight under such loading.

X. The possibility of hatches opening in such a way that the water pressure will rather help to keep them closed than force them open, should be investigated.

XI. So far as can be arranged, compartments in which men must work when the ship is liable to underwater attack, should be entered by watertight trunks carried up without an opening, well above the waterline. A corollary of this is that the number of such compartments must be reduced as far as possible when arranging the electrical and other similar services.

XII. The old system of running electric leads and other important services through cable passages which could be kept closed and entered only from above, is considered to be less vulnerable than the system which obtained in the "Prince of Wales" of running these services through large breaker rooms.

XIII. Compartments, other than magazines, which are only occasionally visited, should not have permanent ventilation fitted, but should be ventilated by temporary means through the access aperture, as required.

XIV. In compartments to which access is by a watertight trunk, the possibility of carrying the ventilation ducts up inside the trunk should be investigated.

XV. The general system of large bulkhead sluice valves, coupled with ventilation trunks of very thin material, helped to extend the flooding in the "Prince of Wales". We recommend that the arrangement of the ventilation system should be considered at an early stage in the design, so as to reduce its complexity to a minimum, and secure the maximum degree of strength. Vertical trunks between decks should be strong enough to resist collapse and so prevent the flow of water vertically from one compartment to compartments immediately above it due to the failure of trunking.

XVI. Where ammunition supply involves the piercing of watertight bulkheads or decks, arrangements for the aperture to be closed quickly must be fitted, to prevent an extension of flooding.

XVII. All bulkheads should be able to withstand the maximum hydrostatic pressure which may be brought upon them, so that shoring is unnecessary, and this factor should be impressed upon personnel in ships, in order to remove the present impression that such bulkheads are likely to fail, with consequent loss of time and energy of Damage Control parties.

XVIII. We consider that the amount of rod gearing at present fitted makes the maintenance of watertightness of decks and bulkheads very difficult. The possibility of a simple hydraulic system, such as is used for releasing depth charges, should be examined.

XIX. Our recommendations so far have been largely concerned with the particular case of a contact torpedo, and of flooding in general. We consider that the explosion of a non-contact torpedo must cause very severe damage inside the ship immediately over the explosion, and to avert this presents a problem for which we see no hope of solution. The most that can be done by way of palliative is to limit, by means of vertical bulkheads, the area over which the damage is spread. With this object the vertical bulkheads should be continuous wherever possible and as close together as possible, but in many cases the minimum essential size of machinery compartments demands spaces which are undesirably large.

We wish to stress that the existence of the non-contact torpedo is one which at present the art of shipbuilding shows no likelihood of defeating, and we would emphasize for this reason that enemy ships in this respect are no less vulnerable than our own.

The disastrous effects of an explosion immediately under the bottom
underline/.....

underline the vital importance of employing every means of preventing the torpedoes from getting there, or preventing it from firing there, and we consider that all possible researches in this direction should be actively pursued.

RECOMMENDATIONS CONCERNING ELECTRICAL EQUIPMENT

54. The system of power distribution enabled the supply main to be split into a number of independent sections, each with its own dynamo, but to take advantage of this system in the event of failure of supply in one section, centralization of control was required. The exercise of this control was dependent upon communications, which in the event failed.
55. As fitted, the group change-over system ensured that a fault on one side of the supply main would affect the other side immediately. The existence of such a fault would not be apparent to the men who were stationed at these points where the fault should be rectified, and it would be necessary to tell them to take action. In this respect also, communications failed in the "Prince of Wales".
56. Breaker rooms which contained essential electrical gear, which was not watertight, communicated with compartments below, and were flooded from these compartments.
57. To meet these and other points of weakness, our recommendations are as follows:-
- I. The system of separate sections of the supply main, which can be linked together, is considered sound. Its efficient operation necessitates centralized control. For this, efficient communications are vital, and no considerations of weight or cost should be allowed to stand in the way of making these communications as safe from failure as possible. At the same time, it must be recognised that central control may break down as a result of damage, and the system must, therefore, be capable of decentralized operation.
 - II. Any system of alternative supply of power to particular services by which a fault on one part of the main affects another part of the main, is unsound, and delay in changing over power supplies is preferable to the introduction of any such possible source of failure.
 - III. Efficient communications are vital for damage control as well as for the maintenance of electrical supply, and must be arranged so as to be effective whether at action or cruising stations, without undue regard to convenience or economy in man-power.
 - IV. Dynamos should be placed under protection, but so that there is the minimum chance of damage from flooding.
 - V. The fusing system must be such that the effect of a fault is restricted to the circuit on which it occurs, and does not cause failure to spread to other circuits.
 - VI. Electrical steering gear should be capable of operating although the steering compartment is flooded.
 - VII. Starters of pumps and other apparatus essential to the maintenance of power to the ship should be splash-proof.
 - VIII. Circuit breakers and automatic switches must be designed so that they do not fail under shock.
 - IX. In the layout of the electrical installations every effort should be made to reduce the number of watertight compartments in which men must be stationed in action, so that the doors of as many compartments as possible can be kept closed.

RECOMMENDATIONS CONCERNING ENGINEERING.

58. The system by which the propelling machinery is divided into units which are largely self-contained, as regards the auxiliary machinery, broke down, partly because units were not self-contained as regards electrical power.

59. To meet this and other points of weakness, our recommendations are as follows:-

I. Units of the propelling machinery and important machinery spaces should, as far as possible, be made self-contained as regards auxiliary services, and special arrangements made to enable electrical power to be used independently of the main electrical distribution system of the ship.

II. Consideration should be given to the reduction of the size of the engine room compartments by placing the gearing in a separate compartment to the turbines.

III. The liability of the propeller shaft glands to leak because of damage to the shaft needs investigation.

RECOMMENDATIONS CONCERNING ORGANISATION AND TRAINING

60. The anti-aircraft fire of the "Prince of Wales" did not prevent the attack upon her from being pressed home.

61. There are several instances of doors and hatches which should have been closed being inadequately closed, and more instances of doors being left open by men on leaving compartments, thus causing extensions of flooding.

62. Failure of communications hampered the work of the damage control organisation.

63. To meet these and other points of weakness, our recommendations are as follows:-

I. We consider it reasonable to expect that the powerful anti-aircraft armament of H.M.S. "Prince of Wales", after considerable training and practice, should have been able to inflict heavy casualties before torpedoes were dropped, if not prevent the successful conclusion of attacks, and we wish to stress the importance of a ship being properly "worked up" and efficient before she has to take her place in the line.

II. Conditions in a ship which receives severe damage, when men below may find themselves suddenly in darkness in a listing ship, with perhaps the sound of rushing water, produce conditions which throw a very severe strain on the nerves of young and inexperienced men, who must comprise the larger part of ships' companies during war. It is essential that their discipline should be such that their actions will be based on ensuring the safety of the ship, rather than on their own self-preservation. Their training must include realistic practices.

III. The stress that is laid on men wearing their life-saving belts and on the provision of floats and life-saving apparatus has the psychological effect of emphasising the possibility that a man may have to swim for his life. Although these precautions are essential, we consider that it is necessary to take steps to counterbalance their demoralising effect by emphasising that the first duty of everyone is to save the ship.

IV. DAMAGE CONTROL - The prime requirement for the operation of any damage control organisation is efficient communications, and these must be made as free as possible from the likelihood of failure.

...../

V. CHARGE OF DAMAGE CONTROL ORGANISATION - Conditions under which this organisation comes into use are such that it is essential that the officer in charge of it shall have adequate knowledge of his task and the prestige necessary to carry it out. Other officers essential to this organisation should not be given duties in connection with the armament which will at the critical moment keep them from their damage control work.

A. T. BUCKNILL (CHAIRMAN)

W. F. WAKE-WALKER

MAURICE DENNY.

J. H. JAMES (SECRETARY)
April, 1942.

D. D. N. C.

H.M.S. PRINCE OF WALES
Loss of

116
1A/2

The Deputy Controller has circulated under date 12.2.42 further extracts from reports of REPULSE, VAMPIRE, EXPRESS and ELECTRA.

The following extracts are considered of sufficient significance to be brought to D.N.C.'s notice as soon as possible:-

1. Commanding Officer H.M.S. VAMPIRE on page 20 states that PRINCE OF WALES received one hit amidships on the port side and took on a heavy list to port. Her upper deck becoming eventually nearly awash.

2. Commanding Officer H.M.S. EXPRESS on page 22 reports that at about 1140 PRINCE OF WALES was hit by one torpedo.

When PRINCE OF WALES sank the following holes were seen:-

- (a) Large hole starboard side amidships, below the armour belt. The plates although buckled did not appear ragged.
- (b) In the forefoot.

3. Commanding Officer H.M.S. ELECTRA. Report is on page 23 but does not mention details of hits on PRINCE OF WALES.

4. Captain L.H. Bell on page 17 states "Except possibly in the case of the first hit, all hits on PRINCE OF WALES were judged to be with contact pistols."

On page 18 states that "At 1144 PRINCE OF WALES was hit port side abreast after superstructure. Heavier concussion than subsequent explosions but quite definitely only one explosion. Ship quickly listed to about 10 to 15° to port. Speed dropped to 15 knots.

5. Captain W.G. Tennant, H.M.S. REPULSE on page 1 states "PRINCE OF WALES was hit on the port side right aft during this attack and a large column of water appeared to be thrown up, larger than subsequent columns of water which were thrown up when REPULSE was hit later on.

1/21/50
14/2/42

D.N.C.
13 FEB 1942

17

D.N.E. 4134/48

Spa Hotel,
Bath.
12th February, 1942.

1A/3

SECRET

CIRCULATE
UNDER COVER

LOSS OF H.M. Ships PRINCE OF WALES
REPULSE.

With reference to copies of reports from
PRINCE OF WALES circulated under M.0251/41 further extracts
reports from REPULSE, VAMPIRE, EXPRESS and ELECTRA, are
circulated herewith for information.

(sgd.) C.E.B. SIMEON.

DEPUTY CONTROLLER.

Distribution.

- N.C. (3)
- in C. (2)
- E.E. (2)
- H.O. (2)
- T.M. (2)
- S.D.
- C.N.S.W. (2)