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OD(79)17

COPY NO **42**

5 July 1979

CABINET

DEFENCE AND OVERSEA POLICY COMMITTEE

FUTURE LIGHTWEIGHT TORPEDO

Memorandum by the Secretary of State for Defence

1. We have to decide whether to proceed with development and initial production of the lightweight torpedo known as Sting Ray or to adopt American alternatives. The options have been explored by an inter-Departmental Official Group, whose report I attach.

2. The lightweight torpedo is the main anti-submarine weapon used by surface ships and aircraft. Of our existing US-designed torpedoes, Mk 44 is obsolete and Mk 46 will be ineffective in the 1980s against modern Soviet submarines, particularly those operating at shallow depth. We need a modern underwater weapon with an advanced homing and guidance system which will be effective in the difficult conditions encountered in the shallow water surrounding the United Kingdom and in resistance to countermeasures. It must be able to inflict sinking damage at all target depths, including shallow targets. It must have potential for further development, as Soviet submarines and countermeasures improve. The Americans are giving high priority to the development of an advanced lightweight torpedo (ALWT), but this is still at the embryo stage. No American torpedo which meets any of the above requirements could become available to us throughout the 1980s.

3. We have already spent £75m on the development of Sting Ray, and the total cost of the project is estimated to be nearly £700m at September 1977 prices; but current contract negotiations may reduce this somewhat. Some difficult technical problems remain, but my advisers are strongly positive in their view that, given the operation of a stringent incentive contract, the project will succeed in the timescale required.

4. The alternative to Sting Ray is to link ourselves firmly to the Americans. We should have first to purchase more Mk 46 torpedoes and incorporate the improvement which the Americans have developed (Neartip); and eventually to acquire their ALWT, with which they plan to replace the Mk 46 Neartip. We ourselves could probably begin to have the ALWT in about 1990.

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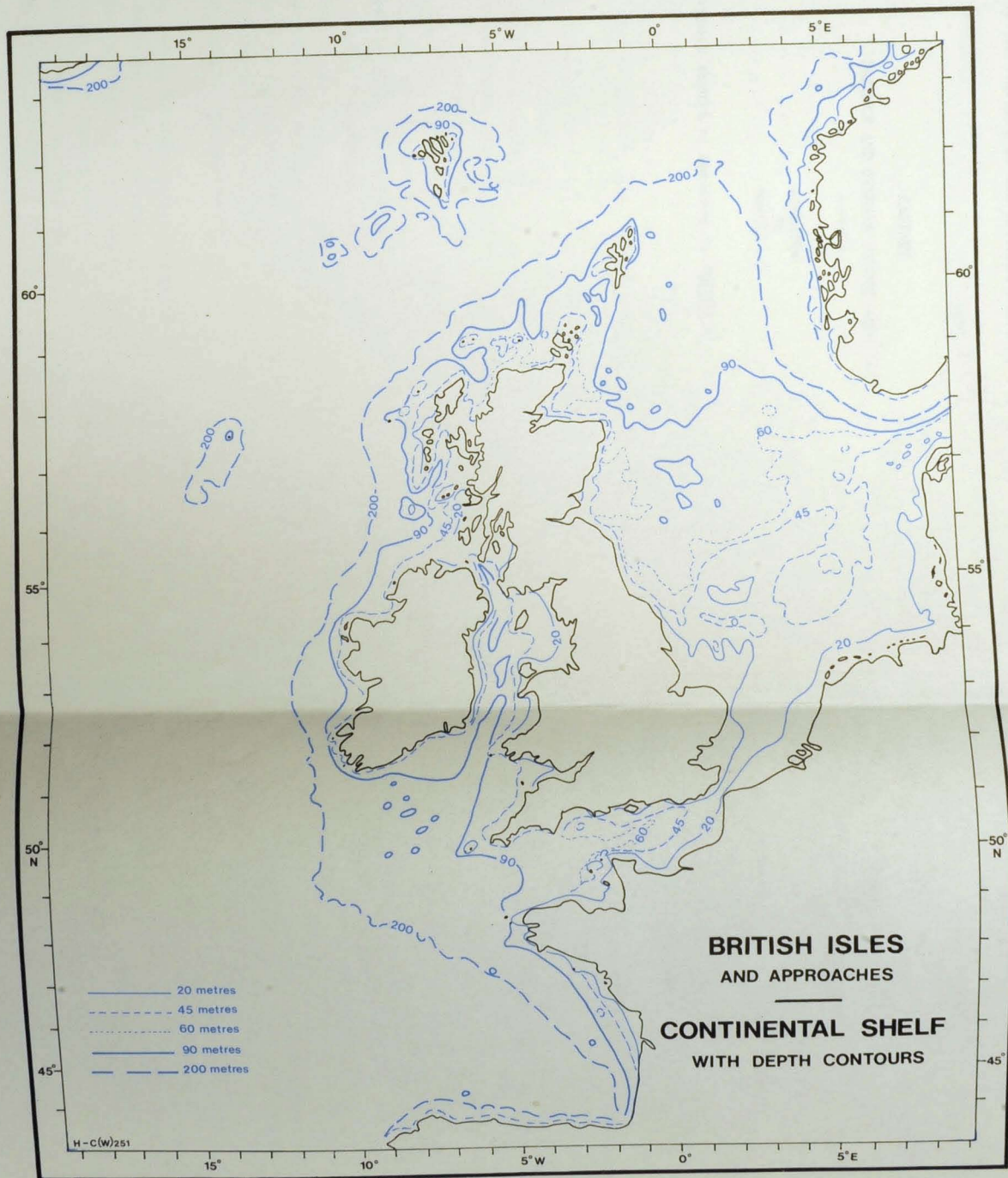
5. I would not favour a national project if there was a reasonable alternative: in major projects collaboration with one or more of our Allies should be our policy. Experience shows that collaboration with the Americans is only a remote possibility. We could certainly not interest them in collaboration on lightweight torpedoes unless we could show them a developed equipment which works effectively. Furthermore, they have declared the ALWT to be a national programme, and they are proceeding accordingly. The French, who are the only other European nation with a design capability in lightweight torpedoes, are interested in collaborating with us in the longer term: my recent discussions with the French Minister of Defence on this matter were encouraging. But the basis for this collaboration will be our expertise in homing technology, based on Sting Ray, with French developments in propulsion systems. If we abandon Sting Ray and buy from the Americans, prospects of collaboration with the French will disappear.
6. In the short term, we could save substantial sums by cancelling Sting Ray and acquiring Mk 46 Neartip instead; but this would be a poor investment, since Neartip does not meet our Service requirements, and like the Americans we should have to replace it as soon as possible by the expensive ALWT. Cancellation of Sting Ray would almost certainly put paid to the British torpedo industry, and it would affect confidence in defence industries generally.
7. In my view, the heavy investment we are making in anti-submarine warfare - the main role of the Royal Navy and an important task for the Royal Air Force - would be wasted if we did not have an effective weapon for our new frigates, aircraft and helicopters to use. Cancellation would invite much criticism at home and abroad. I am in no doubt that an effective lightweight anti-submarine torpedo must be one of our highest priorities. Its importance is such that I am prepared to accommodate it within whatever defence budget ceilings are agreed, even at the expense of other parts of the programme.
8. I therefore propose that we should authorise the continued development and initial production of Sting Ray, and seek to collaborate with one or more of our Allies, and particularly the French, on any subsequent development of this weapon.

Ministry of Defence

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5 July 1979

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COPY NO 43

Note by the Chairman of the Committee on the Future Lightweight Torpedo

CABINET

DEFENCE AND OVERSEA POLICY COMMITTEE

ADDENDUM

TO OD(79) 17

The attached report should be appended to OD(79) 17.

Cabinet Office

9 July 1979

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FUTURE LIGHTWEIGHT TORPEDO

Note by the Chairman of the Official Group on
the Future Lightweight Torpedo

1. The future lightweight torpedo will be a key element in the ability of the British Services to conduct anti-submarine warfare. The Ministry of Defence (MOD) are developing a lightweight torpedo, known as Sting Ray, to be deployed in the 1980s and beyond, by Royal Navy (RN) ships and helicopters and Royal Air Force (RAF) Nimrod aircraft against submarines. The estimated cost of Sting Ray including £75 million already spent has risen to nearly £700 millions at September 1977 prices (or around £800 millions if updated to today's prices.) An interdepartmental group of officials has, therefore, reviewed the project and has examined alternative options to provide a basis on which Ministers can decide how the requirement for a lightweight torpedo should be met. The group's report is attached.
2. The report examines the growing threat which will be posed by the Soviet submarine fleet in the 1980s and describes the requirement for a lightweight torpedo able to attack modern nuclear-powered submarines, particularly in the difficult conditions found in the relatively shallow waters around the United Kingdom. The RN's and RAF's existing American designed Mark 44 and Mark 46 torpedoes will be ineffective against this threat, and Sting Ray, which should begin to enter service in 1985, is at present planned to take their place. The Sting Ray programme, managed by Marconi Space and Defence Systems, has not in the past run smoothly, but following a reorganisation of the management of the project in 1977, the MOD now have much greater confidence that the current technical, cost and timing objectives will be met. Negotiations on an incentive price contract for the completion of development and initial production are almost complete and indicate that a worthwhile reduction on the cost figures above is likely.
3. Looking beyond the 1980s the MOD envisage that an improved ("stretched") version of Sting Ray will be needed to meet further developments in the Soviet submarine threat. The French have a requirement for a new lightweight torpedo, and we are discussing with them the possibility of a collaborative project, known as Barracuda, which would be in effect a "stretched" Sting Ray and which would meet the needs of both countries in the 1990s.

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4. Sting Ray will employ over 4500 people by the end of 1979. If it were cancelled, there might be redundancies but there should be no significant unemployment problems or real social hardship. Nonetheless, cancellation would not only destroy any prospects of future collaboration with the French and of exporting torpedoes and directly related technology but would also have the more general effect of reducing our opportunities to generate skills in fields in which British industry is generally weak such as advanced systems analysis and the application of microprocessors. Moreover, cancellation could well mean the end of the policy of successive Governments of creating a British torpedo industry.

5. An alternative to Sting Ray could come only from the United States. They are about to produce Neartip - an improvement on the existing Mark 46 - which we could begin to acquire within 2 or 3 years at a cost of £150-200 millions at September 1977 prices (or £200-250 millions if updated to today's prices). The United States have stated that Neartip will meet their requirements for the 1980s. Its degree of improvement will, however, be limited, and the Americans are already pressing ahead as fast as possible with the development of an Advanced Lightweight Torpedo (ALWT) for introduction in the later 1980s. They have stated in NATO that it is to be a national not a collaborative development and are proceeding on that basis. If we bought the ALWT, deliveries could probably begin around 1990.

6. The decision on whether to continue the Sting Ray programme is not a straightforward choice between Sting Ray and another torpedo. Because of the overlapping replacement schedules of ourselves and the Americans, any decision needs to take account of plans for the 1990s as well as the 1980s. A number of options is set out in paragraph 24 of the report and these are discussed in paragraphs 25-40. They can be reduced to two alternatives -

- i. to buy the American Neartip and subsequently the ALWT and to cancel Sting Ray;
- ii. to go ahead with Sting Ray and to seek to collaborate on a successor.

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7. Officials have not been able to agree which to recommend. The arguments for and against each are summarised in paragraphs 43 to 45 of the report. The first alternative would be likely to be cheaper overall, though no precise figure can be attached to the plans covering the 1990s. The Treasury's view is that since Neartip represents some improvement over the existing Mk 46, which the United States think sufficient for their needs, the financial savings this option offers in the short and medium term make it the more attractive solution. But in the MOD's view this option should be rejected. They believe that Neartip will not meet the requirement of the British Services, especially with regard to the key factors of shallow water performance, lethality and resistance to countermeasures and that there would thus be an important gap in operational capability until the ALWT became available.

8. The second alternative means continuing with current plans and putting our confidence in the Sting Ray programme. If it runs to course, the programme will produce a torpedo that would satisfy the requirement for the 1980s and would give us a sound basis on which to seek to collaborate on a successor. The prospects for collaboration seem better with the French than with the Americans.

9. Ministers are invited to choose between the two alternatives set out in paragraph 46 of the report.

Cabinet Office

24 May 1979

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Future Lightweight Torpedo

Note by Officials

INTRODUCTION

1. The full development of a project (subsequently named Sting Ray) to meet the requirement of the Royal Navy (RN) and Royal Air Force (RAF) for a lightweight torpedo capable of meeting the threat of the 1980s and, with further development, of the 1990s was authorised in 1975. By 1976, however, the programme had run into serious technical problems, and the Ministry of Defence (MOD) were dissatisfied with Marconi Space and Defence Systems Limited's (MSDS) management of the project. Nevertheless, following a review in 1977 of alternative solutions, it was decided that the development work already authorised on Sting Ray should continue and that steps should be taken to reorganise and strengthen the management of the development programme both by MSDS and by the MOD. It was also agreed that there should be a further review of the project in late 1978. It was the intention that by the time this review took place a sound basis for continued development should have been established, including the production by MSDS of a comprehensive development cost plan, satisfactory progress in overcoming technical problems, evidence that the new management arrangements were likely to be successful and agreement between the contractor and the MOD on an incentive price for the development work. But in view of further cost escalation it was decided at an early stage in the review that because Ministers would need to decide collectively whether Sting Ray should go ahead as planned or whether an alternative solution should be adopted, there would be advantage in officials evaluating the options on an interdepartmental basis and providing Ministers with an agreed basis on which they could take decisions. This report accordingly examines the threat and the requirement for a new lightweight torpedo, reviews the present position of Sting Ray, takes account of industrial and employment factors, considers the plans of our allies in the North Atlantic Treaty Organisation (NATO) for lightweight torpedoes and then sets out the various ways in which our requirement might be satisfied.

2. We decided very early in our study that we should have talks with the Americans about their intentions in this field. They were in fact unable to receive a British team until February and then it proved necessary to have a further round of talks with them in March.

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THE THREAT

3. The quality of the Soviet submarine fleet has improved considerably in the last few years as a number of new classes of submarine has entered service and the proportion of the total force that is nuclear-powered has increased. Over half the Soviet Union's total of 350 submarines is deployed in their Northern Fleet and could therefore be expected to operate in time of war in the North Atlantic, the Channel and the North Sea. These are areas of primary interest not only to the United Kingdom but also, because NATO's lines of supply and reinforcement run through them, to the Alliance as a whole.

4. The most important characteristics of present and future Soviet hunter-killer, nuclear-powered submarines (SSNs) are their ability to operate in both relatively shallow and deep water, high maximum speed, anechoic coating, use of countermeasures and their resistance to attack. In all these areas NATO's main lightweight torpedoes, the United States designed Mark 44 and Mark 46, are inadequate.

a. Shallow water. Soviet SSNs can operate in water as shallow as about 45 metres and their diesel submarines in as little as 20 metres. Many of these shallow water areas are of particular interest to the United Kingdom, as the chart at Annex A shows. NATO's main reinforcement routes are all funnelled through the shallow South-West and North-West Approaches. Acoustic weapons like torpedoes face special difficulties in operating in shallow water. The torpedo must necessarily run relatively close to either the seabed or the surface, with the risk of capture by either. In addition, wrecks and rocks provide false targets which can distract an inadequate torpedo. Finally, the reflected noise level is greater in shallow water, and this can substantially degrade a torpedo's homing system.

b. Deep water. The most modern Soviet SSNs of today can evade down to 500 metres. By 1982 it is estimated that their diving depth will be some 630 metres and those submarines entering service from 1983 are expected to operate down to 760 metres.

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c. Speed. The maximum speed of the fastest Soviet SSN is at present 32 knots. By 1988 it is expected to be 38 knots. Actual speed is, however, likely to be significantly lower at the start of an attack on a submarine.

d. Anechoic coatings. Most Soviet submarines are coated with acoustically absorbent material which may reduce the homing range of our active homing torpedoes by up to 40 per cent. It is likely that the Russians will continue to improve their anechoic coatings, though there are limits to this process since it affects adversely other of the submarine's characteristics.

e. Countermeasures. Soviet submarines employ countermeasures, and the MOD have work in progress to establish types and effectiveness. It is expected that the Russians will use jammers and echo repeating decoys. A jammer provides an acoustic screen behind which the submarine tries to escape. An echo repeating decoy simulates a target and attempts to lure the torpedo away from the submarine.

f. Resistance to attack. Modern Soviet submarines are designed with double hulls, which reduce their vulnerability to attack by torpedoes. Until recently the United States and the United Kingdom shared a common assessment based on evidence deduced from recovered Soviet hardware, which led the United Kingdom to the view that the blast warheads of NATO's Mk 44 and Mk 46 torpedoes would have no more than marginal effectiveness against the latest Russian double-hulled submarines. But the Americans told us in our recent talks with them that they now believed that the Russians were using a new steel for their submarines and that they conclude from this that Soviet hull platings were thinner and therefore more vulnerable to blast warheads than had been thought. We have discussed the Americans' reassessment with them, but they have not yet given us evidence which would satisfy us that their changed view is right. Exchanges with them are continuing, but it seems unlikely that this issue will be resolved quickly. In the meantime the United Kingdom experts see no reason to change their view of the ability of Russian submarines to withstand blast warheads.

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THE REQUIREMENT

5. The ability to defeat the Soviet submarine threat and thus to safeguard the sea-lanes that converge on and pass through the Eastern Atlantic, Channel and North Sea is of major importance, and the Alliance looks principally to the United Kingdom to supply this capability in these areas, which because of their relative shallowness present particularly difficult anti-submarine warfare (ASW) problems. The lightweight torpedo is the primary ASW weapon for all RN and RAF delivery platforms except submarines (which use heavyweight torpedoes with longer range). These platforms are surface warships; Wasp, Lynx, Sea King and ASW Wessex shipborne helicopters; and RAF Nimrods. The capability of all these platforms to mount a successful conventional attack on submarines will be totally dependent on the new lightweight torpedo.

6. There are two lightweight torpedoes now in United Kingdom service. The Mk 44, which is American designed but British built, was introduced in 1964 and is now obsolete. It cannot be launched in less than 60 metres of water; it is unlikely to be successful against a modern diesel submarine; and is virtually useless against an SSN. But it will still comprise in 1980 some 40 per cent of our total warstock of 2,500 lightweight torpedoes. The Mk 46 was designed by the United States specifically to counter the first Soviet SSNs and has been in service with the RN and RAF since 1972. But it is primarily a deep-water weapon and cannot be used in less than some 90 metres. Moreover, the Mk 46 is becoming increasingly ineffective as the Russians introduce improved classes of submarine. Its acquisition range is seriously reduced by anechoic coatings; it has little discrimination against countermeasures; and its warhead has a low lethality (though the Americans take a more favourable view - see paragraph 4 f above). Continued reliance on the Mk 44 and Mk 46 will therefore leave both the RN and RAF without an effective non-nuclear ASW weapon. Both Services have therefore had since 1968 a formally approved staff requirement for a new lightweight torpedo capable of countering Soviet submarines of the 1980s and, with further development, those of the 1990s as well.

7. The main characteristics sought in this new torpedo are -

a. Speed and endurance. It should have a range of 8500 metres at a speed of 45 knots and thus an endurance of 6 minutes. This performance is needed to catch the Soviet SSN which, if not already at high speed, could rapidly accelerate on being attacked.

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b. Range of depth. The torpedo should be able to attack targets from the surface down to 760 metres.

c. Shallow water performance. The torpedo must be capable of being launched into and of operating effectively in water as shallow as 45 metres; and if possible it should be capable of operating in as little as 20 metres. In order to overcome the difficult conditions which shallow water poses for lightweight torpedoes (see paragraph 4a above), the guidance section of the torpedo requires an ability to classify targets accurately and rapidly, whatever their speed (see paragraphs 4c above and 17a below).

d. Anechoic coating. The torpedo should have the ability to minimise the effect on its acquisition range of the anechoic coating of Soviet submarines.

e. Counter counter-measures (CCM) performance. The weapon needs to have a high measure of resistance to countermeasures (see paragraph 4e above). It needs to be capable of defeating jammers and then establishing the best search pattern on passing the jammer. It also needs a memory in order to disregard jammers already encountered. To overcome echo repeating decoys, the torpedo must have the ability to classify its target and to discard anything that lacks all the characteristics of a submarine. The one feature a decoy, which is small, has difficulty in simulating is the size of the target submarine.

f. Lethality. The staff requirement states that the new torpedo should be able to cause the rupture of the submarine's inner hull in order to achieve a 90 per cent probability of making the submarine sink or of forcing it to the surface where it can be destroyed by other means. This is, however, another area where the Americans have very recently taken a different view from ourselves. Hitherto they have required the Mk 46, which in their version has a 20 per cent more powerful warhead than in the United Kingdom version, to have a high probability of causing hull rupture, and they have recently reaffirmed this yardstick of lethality in obtaining Congressional approval for the funding of a Mk 46 improvement programme (Neartip - see paragraph 17 below). But in the talks held in March they told us that in future their criterion would be "mission abort" damage, which is defined

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as the ending of a submarine patrol before the scheduled time or cessation of militarily useful operations. Such damage would not be repairable at sea but might not be so severe as to cause immediate sinking or surfacing. This criterion is less stringent than ours and makes it unnecessary to abandon blast warheads in favour of shaped charges (see paragraph 9a below). The RN and RAF, with their smaller forces, see a need for an assured capability of destroying enemy submarines to avoid the risk of their continuing to participate in the battle, and of achieving this in a single attack to remove the need for long engagements.

g. "Stretch" potential. If the torpedo is to be able to match the threat of the 1990s as well as that of the 1980s, it has to contain the potential for further development.

STING RAY

8. To meet this requirement the MOD are developing the Sting Ray lightweight torpedo. Full development began in 1973, but by 1976 the project was beset with major technical and management difficulties. Since then, however, important changes have been made in the way the project is run, and progress is now good.

Technical Risks

9. Work done particularly in the last year has considerably reduced the technical risks, and the project is now well on the way to meeting the staff requirement. Significant risk remains in three areas -

a. Warhead. To overcome the deficiencies of blast warheads, the MOD are developing a shaped charge warhead. Shaped charges have never been used in torpedoes before and most of the work done so far has been confined to theoretical studies and scaled-down experiments. The first full-scale test in water has, however, been successful and the MOD are confident that a warhead can be produced on time which will achieve the required degree of lethality (see paragraph 7 f above). The MOD are drawing on their very extensive experience in the use of shaped charges in other fields.

b. Propulsion system. This was one of the areas where serious problems were encountered earlier but the difficulties with the propulsor and the sea-water battery appear to have been overcome. This will not be certain, however, until deep water trials have been held during the summer.

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c. Homing system. To provide Sting Ray with a satisfactory performance in shallow water an on-board computer is being developed which will recognise particular sound patterns and react appropriately to the complex environment. Trials of the homing system in water have been limited so far because of the earlier problems with the propulsion system, but such results as have been obtained so far have been good. Nonetheless, the homing system is the most significant of the remaining technical risks.

Management arrangements

10. Following correspondence with Sir Arnold Weinstock of the GEC Group (of which MSDS are a part), MSDS have substantially strengthened the management of Sting Ray in the last 18 months. They have improved the scale and quality of their effort, and they and their main sub-contractors now employ some 2,100 staff on the project. As the prime contractor, MSDS are now responsible for the successful development of the whole of the torpedo, except the warhead (for which the MOD are directly responsible). The firm has produced a new development cost plan which the MOD regard as a sound basis for the management of the remaining stages of the development phase of the project. The MOD have reached general agreement with MSDS on the framework of an incentive price contract covering the rest of development and initial production. This will give the firm every reason to try to complete development successfully and to demonstrate their production capability. They will be paid substantial bonuses for the achievement of important milestones in the programme; but, at the other extreme, they could put themselves at risk by as much as £20 millions if they overrun the target price. The final target price has still to be settled.

Costs

11. On a September 1977 price base, the estimated costs of Sting Ray at the 1977 review were £155 million for development and £374 million for production (for 2,300 torpedoes), whereas the latest estimates on the same price base are £222 million and £475 million respectively (including sunk costs of £75 million). The real increases since 1977 are thus 45 per cent and 27 per cent. They are due to a number of causes: notably a large increase in the amount of hardware needed for tests and trials (the lack of which crippled the previously planned development programme); the expansion of the capacity of the on-board computer from 8,000 to 32,000 words; and the development of the new warhead. The negotiation of the

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incentive contract has led to a better appraisal of the task and the resources required for its completion. As a result of all the work that has been done over the past year the MOD have much more confidence in these cost estimates than in the earlier ones.

In-service date

12. MSDS believe that StingRay can be brought into service in late 1982. The MOD, however, think it more likely that it will be 6-12 months later. The cost estimates quoted in paragraph 11 are based on 1983 as the in-service date.

INDUSTRIAL AND EMPLOYMENT CONSIDERATIONS

13. The great bulk of NATO's lightweight torpedoes of the last two decades have been of American origin. Although the RN have always used British heavyweight torpedoes, the United States have also dominated the heavyweight torpedo field. Nonetheless, successive Governments have followed a policy of building up a British torpedo industry based on MSDS. The industry has already produced the Tigerfish, a heavyweight torpedo; and Sting Ray is its first lightweight torpedo. The British Services require far fewer heavyweight torpedoes than lightweights, and for this reason the continuation of Sting Ray is probably critical for the future of the industry. Sir Arnold Weinstock has said that he sees the torpedo industry as a single whole and that the GEC Group would be unlikely to see any future for themselves in torpedo development and manufacture if Sting Ray were cancelled. This would almost certainly mean that we should in future be totally dependent on the Americans for all kinds of torpedoes, as indeed we have been essentially for lightweight torpedoes until now, and it would vitiate the efforts and expenditure we have undertaken to establish the British industry.

14. The total numbers employed on StingRay by industry at present are 3,700, of whom a relatively high proportion are qualified engineers. This figure is expected to reach a peak of over 4,500 at the end of 1979. There will then be a decline as developments begins to draw to a close and production starts to build up. When production is at its maximum in 1988 employment will reach a second peak of 4,300. By then the proportion of engineers will be small. Most of the employment provided by Sting Ray is and will continue to be in the south of England.

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15. If Sting Ray were cancelled, there might be some redundancies. But an analysis by the Department of Employment of the local labour market in the areas concerned and of the skills of those engaged on the project points to the conclusion that there would be unlikely to be any significant unemployment problems or real social hardship. MSDS might well switch staff to other projects, and where they did not, it is not expected that many of those made redundant would have difficulty in finding other work.

16. Because of the Sting Ray programme, the United Kingdom is more advanced than its allies in some areas of torpedo technology, which thus has an export potential, as is shown by the approaches of United States firms to MSDS and French interest in Sting Ray technology. Furthermore, Sting Ray is generating skills in fields in which British industry is generally weak, such as advanced systems analysis and the application of microprocessors. Cancellation would represent a withdrawal from areas of high defence technology and the loss of more general opportunities to develop techniques and expertise of broader value to the economy. Such considerations may not be decisive, but they could attract criticism in the event of cancellation.

FOREIGN LIGHTWEIGHT TORPEDOES: UNITED STATES

17. The United States plan to introduce a new Advanced Lightweight Torpedo (ALWT) in the late 1980s and in the interim to rely on the Mk 46 uprated by a near-term improvement programme (Nearthip). The production of Nearthip has begun. The primary purpose of this improvement programme is to restore the capability lost as a result of Soviet use of anechoic coatings. In relation to Soviet submarines of the 1980s Nearthip will have much the same maximum speed, diving depth and ability to deal with anechoics as Sting Ray. But it will be significantly inferior to Sting Ray in the following important respects -

a. Shallow water performance. The following table summarises the relative performances of both weapons in shallow water -

	Minimum Acceptable Homing Depth	Minimum Depth for Launch	Resistance to Shallow Water Confusion	Active Acquisition Range Against Low Doppler Target
NEARTIP	Between 91-60m	60m	Moderate	300m
STING RAY	45m	45m	Good	1100m

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Sting Ray has a high capacity digital computer which gives it the ability to classify targets which Neartip lacks. Neartip has particular difficulty with targets at speeds under 4 knots, whereas Sting Ray's techniques allow it to deal with stationary submarines.

b. Countermeasures resistance. The performances of Neartip and Sting Ray against countermeasures are summarised as follows -

TYPE OF CM	NEARTIP	STING RAY
Simple Echo Repeater	Decoyed	Immune
Complex Mobile Decoy	Decoyed	Affected at long range, but becoming immune as range closes
Jammer	Performance greatly degraded	Performance slightly degraded

Neartip has no ability to compute coherently. It relies on analogue techniques to deploy a limited guidance programme, and its counter countermeasures performance is insignificant. Sting Ray's 32000 word digital computer, on the other hand, enables it to operate effectively against both jammers and echo repeating decoys.

c. Lethality. Neartip has the same blast warhead as the present American Mk 46 torpedo (which is more powerful than the British version). The United States Navy (USN) claim that it offers a high probability of hull rupture against today's Soviet submarines and of 'mission abort' against new classes of submarines in the late 1980s. United Kingdom technical experts believe that its capability to rupture current targets is marginal, while the 'mission abort' criteria are not acceptable to the British Services (see paragraphs 4 f and 7 f above). The new warhead for Sting Ray, on the other hand, should be capable of inflicting sinking or surfacing damage.

d. "Stretch" potential. Neartip is only an improved version of a torpedo that was developed in the 1960s. It has no "stretch" potential in its guidance and homing to overcome its shallow water deficiencies or in its resistance to countermeasures. Sting Ray, however, is an entirely new weapon and will possess the scope for further development which will allow it to keep pace with the changing threat in the 1990s.

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18. The Americans have recently confirmed that they believe that Neartip will provide an adequate capability against the Soviet submarine threat until the end of the 1980s; and it is about to enter service with the USN in substantial numbers. Nonetheless, because of the shortcomings described in paragraph 17 the MOD, who have kept in close touch with the Neartip project for a long period, have concluded that the weapon does not meet the RN and RAF requirement and that it is therefore not acceptable as the future lightweight torpedo. We have tried to establish why there is a difference of view between ourselves and the Americans on the adequacy of Neartip and why they appear to have a different requirement from ours. Perhaps the most important factor is that the USN's ASW forces are not planned to operate in shallow water to the same extent as the United Kingdom's and they do not therefore attach the same importance as we do to shallow water performance. Second, their less stringent requirement for lethality may reflect a different view of how they would use lightweight torpedoes. Because of the high cost of torpedoes and because we have relatively few delivery platforms, the RN and RAF seek the highest possible probability of achieving a kill with each weapon launched. But the Americans have many more means of delivering torpedoes than us and they may accordingly reckon to achieve the same measure of damage to the enemy by delivering more, though less lethal, torpedoes than we would. A further consideration which must weigh heavily with the Americans is that they have been committed to Neartip for some years and they have no alternative to it, unless they buy Sting Ray. But they would find it very difficult, politically and industrially, to admit now that Neartip was less effective than had been supposed. We return to this question of the difference of approach between ourselves and the Americans in the section below on options.

19. The Mk 46 is the main torpedo in service with those of our European allies who have an ASW capability. They will have to decide before long whether they are going to adopt Neartip, stick with the unimproved Mk 46 or buy Sting Ray. The Americans are beginning to try to sell Neartip. They may well have some success because, whatever we may think of its deficiencies, it will undoubtedly be better than the present Mk 46 and the purchase of a Mk 46 derivative rather than a wholly new torpedo offers economies in maintenance and support costs. As yet there are few signs of overseas interest in purchasing Sting Ray. Maintenance costs apart, the higher unit price is a factor which customers are bound to take into account. No Navy is, however, likely to

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commit itself to Sting Ray until the project's future is more assured, and firm delivery dates and prices can be quoted. Furthermore, Sting Ray is more likely to compete with ALWT than with Neartip.

20. The ALWT, which will succeed Neartip, is still at a very early stage, and although a British team (including a Treasury representative) visited the United States in February to obtain more information about it, details of its characteristics and estimated cost are still far from firm and will no doubt change as the project develops and trade-offs become necessary. The Americans have recently accelerated the ALWT programme as much as possible (which may be an indication that they recognise that Neartip has shortcomings), and they are now aiming to start to introduce the torpedo into service in small numbers in 1987 and to achieve full production in 1989. From 1979-1982 two competing teams of contractors will conduct an advanced development programme to the stage where in-water trials of the two rival torpedo designs have been carried out. The winning firm will become the prime contractor and will carry out the full-scale development of the ALWT from 1982-1986. At the end of this phase full production will begin.

21. The main characteristics sought in the ALWT are -

Minimum launch depth	-	20 metres
Maximum depth	-	1000 metres
Speed	-	55 knots
Propulsion range	-	14000 metres.

22. These objectives are much more ambitious than those for Sting Ray (see paragraph 7 above), and it is likely that at least some of them will be modified during development. The proposed gains in speed and endurance would be valuable, especially in deep water, but would not necessarily produce greater effectiveness in shallow water or when countermeasures are used, since in both cases the chances of hitting the target depend primarily on homing capability. Similarly, it is thought that although the ALWT might show some improvement over Sting Ray in shallow water against fast targets, it is unlikely to show any significant gain compared with Sting Ray seeking a slow moving target. The minimum launch depth of 20 metres of water is also ambitious but may well be achieved in due course: the comparable figure for Sting Ray is

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at present 45 metres, but this might well be reduced in any further development. Although the ALWT is planned to be able to dive to much greater depths than Sting Ray, intelligence reports suggest that the maximum operating depth of Sting Ray (760 metres) is likely to be adequate for the foreseeable future.

FOREIGN LIGHTWEIGHT TORPEDOES: FRANCE

23. The French have the Mk 46 at present. They have a stated requirement to replace it by the early 1990s. They do not appear to be contemplating purchasing Neartip or Sting Ray. At the moment they are keeping their options open between a national development programme and a joint venture with the United Kingdom, known as Barracuda, in which our advances in homing technology based on Sting Ray might be married with their developments in propulsion systems. It is clear that they need United Kingdom technology at the moment and that they are very unlikely to develop their own expertise in the next 2-3 years. For this reason the French have shown a keen interest in the progress of Sting Ray. We have been discussing the possibility of collaborating with them for the last two years, and both countries are working towards a Memorandum of Understanding to cover a joint demonstrator programme. Even if Sting Ray were to proceed, however, the outcome of these discussions with the French cannot be taken for granted.

OPTIONS FOR MEETING THE REQUIREMENT FOR A LIGHTWEIGHT TORPEDO

24. We have considered several ways in which the requirement of the RN and RAF for a lightweight torpedo could be met. The following options are discussed in more detail below -

- a. purchase Neartip and ALWT (and cancel Sting Ray)
- b. purchase Neartip and collaborate with United States on ALWT
- c. retain Sting Ray and purchase ALWT; United States purchase Sting Ray and retain ALWT
- d. retain Sting Ray; United States purchase Sting Ray; collaborate with United States on ALWT
- e. retain Sting Ray; United States retain Neartip; collaborate with United States on ALWT
- f. retain Sting Ray; collaborate with France on Barracuda.

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a. Purchase Neartip and ALWT (and cancel Sting Ray)

25. This course involves buying Neartip in the short term and the ALWT in the longer term and abandoning Sting Ray. One of the arguments for this option is that it would provide fairly quickly some improvement in capability in the early 1980s compared with the present Mk 46 and in about 1990 a torpedo which it is reasonable to expect will meet all our needs in terms of operational effectiveness. We should be continuing to rely for our lightweight torpedoes on the United States who have met the great bulk of our requirements (and those of our allies) for the last 20 years. The American capability in the difficult field of developing and producing torpedoes is much more established and well proven than our own, and if we adopted this course, we should no longer be dependent for success on finding a satisfactory solution to the remaining technical risks in the Sting Ray programme (see paragraph 9 above). Moreover, it is arguable that when the American stock requirements are so much larger than those of the British Services, it would make more sense, in view of the high development cost of Sting Ray, to give up any attempt to sustain a viable United Kingdom torpedo industry and to decide now to rely entirely on the Americans to meet our future needs.

26. A further consideration in favour of this option is cost, though comparisons are difficult to draw in this area. The estimated cost of Neartip is subject to fluctuations in exchange rates and the pace of inflation in the United States, and in any event it is not possible to get firm figures from the Americans without entering into serious negotiations to purchase. Subject to this, the total cost of acquiring the same warstock of Neartip torpedoes as Sting Ray (partly by conversion of existing Mk 46 torpedoes and partly by buying new torpedoes) is estimated to be £150 - £200 million at September 1977 prices (including estimated cancellation charges on Sting Ray). Even if it is assumed that because of its lower lethality we should need to acquire more Neartip than Sting Ray (see paragraph 18 above), Neartip still has a considerable cost advantage over Sting Ray whose estimated future development and production costs are £622 million (see paragraph 11 above). (Neither of these figures takes account of costs of £75 million already incurred on Sting Ray development). But a balanced comparison of costs should also include the figures for the ALWT and any further development, in this case on a national basis, of Sting Ray in the 1990s. Because the ALWT is still at a very early stage, cost estimates must be regarded as speculative. The Americans are working to a target figure of £100,000 a torpedo. To this must be added an allowance of 10 per cent for

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the normal American levy and administrative charges and at least £10 million a year for 10 years for spares and support. The prospects, as with any project at such an early stage, are that costs will be substantially higher in the event, suggesting that a full warstock of ALWT would be likely to cost at least £400 million and probably more. It is even more difficult to arrive at a figure for a "stretched" Sting Ray since no feasibility study has yet been undertaken, but it should be less than the cost of the ALWT since, unlike the ALWT, the project would not be an entirely new one. Even so, it seems that the combined costs of a purchase of Neartip and the ALWT would be likely to be somewhat less than those of Sting Ray and "stretched" Sting Ray.

27. The primary argument against this option is the MOD's firmly held view that, for the reasons set out in paragraphs 17 and 18, Neartip is not an adequate way of meeting the threat in the 1980s and that its purchase would be an uneconomic way of securing only a marginal improvement in capability no more than a year or so before Sting Ray would begin to be available in 1985. In taking this view the MOD feel that they are not necessarily challenging the stated assessment of the Americans that Neartip will meet the threat as they perceive it. The MOD believe that the factors mentioned in paragraph 18 and in particular the lower priority that the USN attaches to shallow water performance and the less stringent damage criteria of the USN explain why the Americans are looking for different capabilities in the short term. Moreover, though it is noteworthy that the characteristics sought in the ALWT are much closer to those of Sting Ray, there is no certainty that the ALWT in its final form will meet RN and RAF requirements in those areas of capability such as shallow water performance which are critical for us but less important for the Americans. Looking still further ahead, if we continue to be dependent on the Americans in the long term, we could not be sure that their weapons would continue to meet United Kingdom requirements or that their replacement schedules would suit our re-equipment or budgetary patterns.

28. A further argument against this option is that it would mean that we would be a captive market for the Americans for lightweight torpedoes. While we could no doubt negotiate a fair deal on Neartip because we could still credibly threaten to go ahead with Sting Ray, by the time we came to purchase the ALWT there would probably be no alternative torpedo and our bargaining position would be weak. This could mean that the cost advantage

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of buying Neartip and the ALWT, which may in any case not be very large, would disappear entirely. It should also be borne in mind that this option would require substantial expenditure in foreign exchange, and could lead to criticism over the £75 million already sunk in Sting Ray.

29. Cancellation of Sting Ray would result in some loss of future employment opportunities and possibly in some immediate redundancies, as well as affecting our general capability in the field of advanced electronic technology and our prospects for exporting torpedo technology (see paragraph 16 above). Moreover, it would also be likely to bring about the end of the industry as a whole, thus reversing the policy of successive Governments in this field (see paragraph 13 above), and put us entirely in the hands of the Americans for the supply of torpedoes. The MOD are now considering alternative British and American procurement options for the next heavy-weight torpedo, but the end of the British torpedo industry would foreclose the British heavy-weight option.

b. Purchase Neartip and collaborate with United States on ALWT

30. This option involves both buying Neartip to meet our short-term requirement and engaging with the Americans in a joint development and production programme of the ALWT. In order to retain the capability which would allow us to collaborate on the ALWT, the Sting Ray programme would have to continue until we could establish a collaborative programme with the United States.

31. The advantages and disadvantages of buying Neartip are the same for this option as for option a. The main gain of this option is that it would keep the United Kingdom in the torpedo business, even though inevitably we should be the junior partner in any joint project with the Americans. This would give us a better chance of ensuring that the ALWT met our requirement than if we bought it off the shelf as in option a; it would sustain the British torpedo industry; and it would allow us to share in any sales to other countries. This option should also be cheaper than a purely national programme, since we should be sharing the development costs of the ALWT, though there would be some continuing expenditure in the interim on the Sting Ray programme. It is impossible to put figures on this option, however, particularly as we cannot assess at this stage what the costs of a collaborative project would be.

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32. The principal difficulty about this option is that we can have no confidence that the Americans would be prepared to collaborate on the ALWT. Ideally, members of the NATO Alliance should not duplicate expensive research and development programmes but should co-operate in them to make the most rational use of scarce resources. But the Americans have never yet participated in a full collaborative development and production programme on any equipment. The United States forces prefer to design equipment to their own specification and then sell it to their allies, rather than be ready to modify a design to accommodate differing requirements. And it is very likely that there would be objections to collaboration from Congress and American industry. The Americans have already embarked on a competitive advanced development programme for the ALWT lasting until 1982 (see paragraph 20 above), and it is difficult to see how the United Kingdom could anyway become involved in the project before this phase is over, if at all. Moreover, the Americans have always told us and their other NATO allies that the ALWT would be a national project, and this is consistent with their desire to get the torpedo into service as quickly as possible, for collaboration commonly leads to delay. It seems that if we were to have any hope of getting the Americans to change their present plans and to agree to collaborate with us on the ALWT, this would require an approach to them at the highest level. It should, however, be borne in mind that as recently as summer 1978 we sought at this level to engage the United States in co-operation on a main battle tank and were unsuccessful. There can therefore be no certainty that such an approach would be successful.

33. If, nonetheless, the Americans were prepared to consider a collaborative project, we would expect the necessary negotiations to last 18-24 months, given the complexity of the issues that would have to be settled, and the United Kingdom could not realistically become involved in the ALWT project before the competitive advanced development phase is over in 1982. During this interval of three years (which would take us close to the in-service date of Sting Ray) we should need to keep the United Kingdom capability alive and to do so in such a way as to remain a credible partner in a major and technologically sophisticated development programme. A technology demonstrator programme would be quite inadequate: its technical content would be too narrow and it would start with a major rundown of the existing Sting Ray development teams and physical facilities which could only subsequently be rebuilt, if at all, at considerable cost in time and money. We might find

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that the British industry had suffered such a blow to its confidence and such a loss of technical expertise that the American firms did not regard it as a credible partner. We concluded that only the continuation of Sting Ray would provide any basis for collaboration on ALWT, or indeed on any other collaborative programme. This option could, therefore, involve our spending of the order of £90 million on Sting Ray development, in addition to the cost of purchasing Neartip, over the next three years.

c. Retain Sting Ray and purchase ALWT: United States purchase Sting Ray and retain ALWT

34. Under this option the United Kingdom would develop Sting Ray and the United States the ALWT, with each buying its own and the other's product. It would involve the Americans cancelling Neartip and probably delaying ALWT.

35. This course would maintain the Sting Ray programme, and production would have to be stepped up considerably to meet American needs as well as ours. But this would mean building up the British industry only to run it down when we moved on to the ALWT. Moreover, it is impossible to believe that the Americans would cancel Neartip at this late stage in favour of Sting Ray. They are heavily committed to Neartip; and its cancellation would leave their industry without any lightweight production work until the late 1980s when the ALWT was ready. For these reasons we do not consider this option further.

d. Retain Sting Ray; United States purchase Sting Ray; collaborate with United States on ALWT

36. This would be a highly attractive option for us, but because it would involve the cancellation of Neartip we do not believe, for the reasons given in the previous paragraph, that it is a realistic possibility. We therefore consider it no further.

e. Retain Sting Ray; United States retain Neartip; collaborate with United States on ALWT

37. Under this option the United Kingdom would continue with Sting Ray and introduce it into service as planned; the United States would go ahead with Neartip as they intend to; and both countries would collaborate on the ALWT. This course has two primary advantages. First, it would provide, in the form of Sting Ray, a weapon which, provided its development is successfully completed, would undoubtedly meet the RN and RAF's requirements in the 1980s. Second, it

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would provide a satisfactory basis on which to offer ourselves as collaborative partners to the Americans and would avoid the duplication of expenditure on Neartip as would be the case with option b. Moreover, if our efforts to collaborate eventually failed, we should still have in Sting Ray a weapon capable of meeting the threat throughout the 1980s and of being further developed to meet the needs of the 1990s.

38. There are, however, two main obstacles to this course. First, there is the basic unlikelihood about the American willingness to collaborate on the ALWT referred to in paragraph 32 above. Second, the Sting Ray and ALWT timescales overlap to some extent, and it is doubtful whether the British torpedo industry would be able to take on a collaborative project while it is still heavily engaged in the Sting Ray programme. But it is clear that the Americans will not be prepared to delay the ALWT programme to suit us. The problem of timescales also has financial implications: the MOD would have to begin funding the collaborative project just when expenditure on Sting Ray is at its height and they have made no provision in their long-term costing for this additional commitment.

f. Retain Sting Ray; collaborate with France on Barracuda

39. Under this option we would go ahead with Sting Ray as planned and seek to collaborate with France on Barracuda which would come into service in the 1990s. As explained in paragraph 23 above, we are already exploring the possibility of co-operation with the French. This option amounts to continuing on our present course and is in line with the encouragement to European co-operation in the torpedo field given by British, French and German Defence Ministers at their meetings in 1977 and 1978. Its advantages are that, provided Sting Ray's development is completed successfully, the British Services will have a torpedo that satisfactorily meets their requirement as early as 1985; and that the timetable for collaboration with the French does not give rise to the same resource problems as co-operation on the ALWT (see paragraph 38 above). More generally, the French are more likely partners in a collaborative project than the Americans. We have co-operated with them on many occasions in the past, and although they would no doubt drive their usual hard bargain in negotiating a collaborative arrangement, we should probably find them easier partners than the Americans once they were committed to a joint programme.

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40. The disadvantages of this option are that we might not gain as much technologically as we would by co-operating with the Americans on the ALWT; and that while it would no doubt be cheaper than a national programme to develop a "stretched" Sting Ray in the 1990s, it could well be more expensive than options a. and b.

CONCLUSIONS

41. In considering how the requirement of the RN and RAF might be met it is important to look at the problem comprehensively and to take account of longer term needs as well as those of the present. Thus the choice is not a simple one between Sting Ray and Neartip. We also need to take into consideration the ALWT and plans for a "stretched" Sting Ray. This makes the issue more complicated. For example, the timescales of these projects all differ: Neartip would not be available to us before 1981 or 1982; Sting Ray should be introduced from 1985; the ALWT, if the United States target date is kept, would be available to us about 1990; and "stretched" Sting Ray or Barracuda from the early 1990s. Again, by taking into account longer term requirements and plans, cost comparisons become much more difficult because there is little or no reliable information about costs at this early stage for the later projects. Nonetheless, these difficulties have to be accepted, since short term choices tend to determine longer term options and vice versa.

42. Of the six options which we have examined above we do not recommend options b, c, and d. The remaining options boil down to two alternatives -

- i. To buy Neartip and subsequently the ALWT and to cancel Sting Ray.
- ii. To go ahead with Sting Ray and to seek to collaborate on a successor.

43. We have not been able to agree which of these two courses to recommend. The first alternative would require the United Kingdom to rely permanently on the Americans for lightweight torpedoes; but that is essentially what we have done hitherto. Neartip would give us an improvement in the Mk 46 in the next two or three years which, in the view of the Americans, would be sufficient to meet the threat throughout the 1980s, and by 1990 we should start to acquire a torpedo which can be expected to meet all our needs. By

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adopting this course we should also be contributing to Alliance standardisation and rationalisation. We could expect to make major savings in the short term and could well make some savings overall compared with the second alternative at paragraph 42 ii. above, though we have been unable to quantify these. On the other hand, to pursue this option means ignoring the strongly held view of the MOD that there are differences between the American and British requirements which arise because our ASW forces operate in different waters and in different ways and that while Neartip may meet the American requirement, it will not satisfy ours, especially in its shallow water performance, lethality and resistance to counter-measures. Its deficiencies in shallow water mean in particular that it is an inadequate replacement for the Mk 44 torpedo which is already almost totally ineffective. Even as a replacement for the Mk 46, its value would be limited and the ALWT would have to be introduced as soon as it became available. We also have to have in mind whether it is desirable that we should reverse the policy of successive Governments of creating a British torpedo industry and so become totally dependent on another country for a weapon which, with its various delivery platforms, is critical to the ASW role which in recent years has become the RN's principal task and has been an area of heavy investment by the RAF. If this alternative were to be adopted, early talks with the United States would be essential and the timing of the cancellation of Sting Ray would have to take account of the negotiations with the Americans on the purchase of Neartip.

44. To adopt the second course at paragraph 42 ii. is to accept that the MOD's confidence that Sting Ray, notwithstanding its earlier technical misfortune, bad management and cost escalation, will now be successfully completed on time and at the currently estimated costs is well founded. In the light of all that has been done to improve the running of the project (see paragraphs 10 and 11 above) it can be argued that this is a reasonable view to take. Certainly, we all accept that if Sting Ray fulfils its present promise, it will undoubtedly meet the requirement of the RN and RAF in the 1980s. The principal difference of view among officials is that the MOD believe that only Sting Ray will satisfy the requirement in the 1980s. The Treasury argue that since Neartip represents some improvement over the Mk 46 (which the United States think sufficient for their needs) the significant financial savings make this the more attractive solution.

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45. If we go ahead with Sting Ray, it will provide a good basis on which to seek to collaborate with the French on Barracuda or possibly, despite the difficulties, with the United States on the ALWT. While not finally ruling out some arrangement with the United States, we believe that the better prospect for collaboration would lie with the French with whom we are already in discussion (see paragraph 25 above) and we consider that the right course would be to pursue our discussions with the French rather than open up a new avenue at this stage. If we were to broach the possibility of an arrangement with the Americans, the French would no doubt hear of it and we would, therefore, need to consider carefully before making any approach to the Americans what the French reactions might be.

46. Ministers are invited to decide whether -

i. We should cancel Sting Ray and buy Neartip and subsequently the ALWT; or

ii. We should continue with the development and initial production of Sting Ray and seek to collaborate in the longer term with France on Barracuda, or possibly with the United States on the ALWT.

24 May 1979