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CABINET
DEFENCE AND OVERSEA POLICY COMMITTEE

FUTURE LIGHTWEIGHT TORPEDO

Note by the Secretary of State for Defence

1. At the meeting of OD on 23rd July I was asked to arrange to provide further cost information before we reached a final view on the future of the STING RAY project. The Official Group which produced the original report (OD(79)17) has now prepared the attached Note, which puts the agreed costings in the context of those technical, contractual and budgetary aspects of STING RAY which were raised when we considered this project in Committee.
2. The report provides (paras 3&4) the background to the very large cost increases in the period up to 1978. It confirms that for a long period STING RAY suffered from serious under-estimation of its technical complexity, cost and management requirements and that even when this was realised in 1977 and corrective action taken, it still required a great deal of further work by the reorganised management teams of the contractor and MOD to put the project and costs on a satisfactory basis.
3. However, the report also confirms that the corrective action has borne fruit and that substantial technical progress has been made to the point where the main remaining area of technical risk, as seen

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by the MOD, has narrowed to work on homing and guidance. The extent of progress is illustrated by Annex B, which sets out the considerable technical achievements against the money so far spent. Together with the successful negotiation of a powerful incentive contract (described in Annex C) the conditions of which are supported by the Treasury, this augurs well for the successful completion of the development of STING RAY to time and cost.

4. While the programme nonetheless remains an expensive one, this development of a new generation underwater guided weapon is now not out of line with what must be expected of a military project of high technology. Seen in the perspective of the Defence programme as a whole (para 9 of the Note) and as the principal weapon of the aircraft and ships which constitute our highly important anti-submarine warfare capability, and in which we have a substantial investment, STING RAY is a cost effective project. As such, I am prepared to accord it the priority required within the Defence Budget to ensure that funds will be available for both completion of its development and initial production within the PESC period and for its continuing production costs thereafter. As was mentioned at OD, the Chiefs of Staff support this project.

5. In sum, the Note satisfactorily deals with the financial and related questions which were left outstanding at our last meeting. Taken together with the operational case, the importance of which we have already discussed at OD, I believe its findings fully justify our continuing with a new UK lightweight torpedo. We should remove

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the uncertainty surrounding this project as soon as possible: I should be grateful, therefore, if my colleagues would let me know whether they agree with my recommendation that a contract should now be placed for the continued development and initial production of STING RAY.

Ministry of Defence
29 August 1979

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FUTURE LIGHTWEIGHT TORPEDO - COST INFORMATION

Note by Officials

1. At their meeting on 23 July 1979 (OD(79) 5th Meeting, Item 3) the Defence and Overseas Policy Committee asked for further cost information before reaching a final view on the future of the Sting Ray project.

The present position

2. Attached to this note at Annex A is a table showing the estimated costs of Sting Ray, year by year, at the prices used for the current Public Expenditure Survey. The figures for development and production are shown separately to highlight two points. The first is the low ratio of development to production costs in total which is a typical feature of this kind of high technology project with no assured overseas sales. The second point is the considerable overlap between development and production. There is no single point to mark the end of development and thus no obvious stage at which a decision on initial production could be taken separately. The contract which has been negotiated (see also paragraph 7b. below and Annex C) covers both development and an initial production run of 246 torpedoes. This contract is designed to give Marconi Space and Defence Systems Ltd (MSDS) the incentive to complete development successfully and to move on to production while at the same time enabling the Ministry of Defence (MOD) to confirm that the weapon works properly before becoming committed to a long production run.

The history

3. Total expenditure on the project to the end of July this year has been £91 million. A significant amount has been achieved for this; a summary of progress is contained in Annex B. The project has, however, not run smoothly and the estimated cost of development and production has increased markedly in real terms since the project began. An estimate of £26.2 million for development was approved by Ministers in 1975. At that time only the first part of a modest project-definition study had been carried out, and

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consequently no comprehensive and detailed appraisal of the task was made. With the wisdom of hindsight, at this stage there was clearly insufficient understanding of the scale and complexity of what was to become a very complex guided weapon project designed to operate in a notoriously awkward environment. MSDS were the first private company in this country to undertake the development of a torpedo since before the First World War, and at that time they had a lot to learn about the problems of electrical and mechanical engineering in an underwater environment and about the particular techniques of project-management that were needed. They failed to appreciate the scope of any one of their tasks, and neither they nor the MOD realised the extent of their own ignorance. By 1976/77 it had become clear that the amount of time and level of development expenditure needed to achieve the necessary technological advance in the torpedo field had to be far higher than had been envisaged previously. On the basis of the contractor's work so far, and further MOD assessments of the requirement, a revised estimate of £138.2 million (an increase in real terms of £57 million or of nearly 200 per cent) was formulated.

4. By 1978, when project-definition was brought to a conclusion and MSDS submitted the first soundly-based development cost plan, it was clear that even the £138.2 million estimate would not be sufficient. The contractor's work showed that more in-water testing was required (rather than simulated testing ashore) and this meant more resources, both in staff numbers and in numbers of trials torpedoes. It was also established that in order to meet the Staff Requirement the torpedo would need a computer of greater capacity and a warhead of completely new design. This, together with the provision of fully adequate contingency allowances, added £65 million in real terms (45 per cent) to the development cost estimate, bringing the total (at September 1978 price levels) to £241.2 million. Since the preparation of this estimate in the autumn of 1978 the only increases in estimated costs have been those due to inflation and the increased rate of value added tax.

Remaining risks

5. The Official Group previously reported that significant technical risk remained in three areas - the warhead, the propulsion system and the homing system. Recent full-scale tests of the warhead have allowed the MOD to

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express confidence in their ability to complete its development within the present estimates of cost and time. The results so far obtained in trials of the torpedo in water have also shown that the required speed and endurance can be achieved, though the torpedo's propulsion system has yet to be tested on the American deep water range.

6. The MOD assess that the chief remaining task is the refinement of homing and guidance to the high level of accuracy that is specified, particularly in shallow water. Acoustic transmissions in the sea are subject to many forms of distortion and interference, and the complexities of identifying and homing onto a target by means of sonar signals are therefore considerable. The contractor is not expected to be able to demonstrate that the homing performance is fully up to the required standard until the latter part of 1982. However, before the extensive contract acceptance trials are begun, the MOD will have satisfied themselves as far as possible that any remaining technical risks are negligible. By that time something like a further £80 million will have been spent on development, and total expenditure on the project - including the start of the necessary overlapping expenditure on production - will amount to about £200 million.

7. The MOD give three reasons for their confidence in the current estimates of cost and time -

a. The prime-contractor's greatly strengthened management, matched by an improved management structure within the MOD, has proved its competence by solid achievements within the current estimate during the last twelve months.

b. An incentive price contract has been negotiated (See Annex C) for the remaining stages of development and the first stage of production, and the contractor will have very strong financial inducements to maintain his high level of performance.

c. The estimates contain allowances for contingencies of both money and time over and above those known to the contractor and accepted by him as reasonable.

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Comparative Costs

8. At Annex D is a comparison between the costs of Sting Ray and the American Neartip. Neartip would cost much less in total although the difference over the next few years is less marked. As the footnote points out, any comparison of costs ought also to take account of the costs of replacing Neartip with the Advanced Lightweight Torpedo (ALWT). Possible improvements in the 1990s to Sting Ray would equally need to be brought into the balance. Cost estimates so far into the future become increasingly speculative and it is noteworthy that the United States estimates for ALWT have apparently already increased significantly since the official group first reported.

9. To put Sting Ray costs in perspective, the Defence Budget for 1980/81 is planned to be just over £8,000 million, about 40 per cent of which is expected to be spent on equipment. On that basis, and at an average annual expenditure of around £50 million over the five years from 1979/80, the costs of Sting Ray, which will be the principal weapon for the ships and aircraft of our anti-submarine forces, represent just over 0.6 per cent of the total defence budget and just over 1.5 per cent of the defence equipment budget. These proportions should not change markedly in later years.

21 August 1979

STING RAY: ESTIMATED TOTAL COST OF DEVELOPMENT AND PRODUCTION

(These estimates are based on the pay and price levels current on 1 September 1978,
including Value Added Tax at 8%)

£M
1979 Survey Prices

Description of Work	Paid to 31.7.79	1.8.79 to 31.3.80	1980/ 81	1981/ 82	1982/ 83	1983/ 84	1984/ 85	Later Years to 1992/93	Grand Total
(i) Development (largely by industry supported by Government Establishments)	91	35.7	30.8	25.4	22.1	16.2	11.6	8.4	241.2
(ii) Production (2,300 warshots, spares, training rounds and in-service support) by industry and Royal Ordnance Factories	-	1.9	6.0	21.2	27.0	40.3	52.7	397.5	546.6
(iii) Total	91	37.6	36.8	46.6	49.1	56.5	64.3	405.9*	787.8

* averaging about £65 million a year for most of this period

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STING RAY: ACHIEVEMENT TO DATE

1. Substantial progress has been made in achieving a torpedo which can be launched from either aircraft or ships and which will have the speed, autonomous homing capability and lethality that will be needed to cripple the fast and hardened submarines now appearing in the Soviet fleet. Furthermore, for the completion of the work, there now exist a viable programme, organised and costed in accordance with modern management principles, together with the necessary resources of manpower and materials to put it into effect, and there is also a stringent incentive contract, fully negotiated and ready for signature.
2. The following are the main specific achievements so far -
 - a. 50 trials in water of Sting Ray prototypes (including 10 launchings from aircraft) and 200 air-drops of representative dummy torpedoes.
 - b. 25 trials in water of the Sting Ray homing system mounted in torpedo test vehicles.
 - c. Demonstration in water that the requirements for speed, endurance and control can be met, and in particular the development of a suitable battery.
 - d. Demonstration in water that the torpedo can home onto an elementary target and that the basic functioning of the homing guidance system is satisfactory.
 - e. Provision of a full range of automatic test equipment (and other less sophisticated test equipment where appropriate) at all sites where work is in progress.
 - f. Provision of sufficient numbers of trials torpedoes, and ancillary equipment to maintain and (with those ordered but not yet delivered) complete the development programme.
 - g. Provision of a computerised simulator for the mathematical modelling of homing and guidance trials (in order to ensure that maximum benefit is obtained from the actual trials in water).

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3. The £91 million spent so far is made up as follows -

	£M
a. Development of the torpedo body	5
b. Development of the homing and guidance system	23
c. Development of the propulsion system	10
d. Supply of test equipment, torpedoes for trials and supporting equipment and staff for trials	34
e. Supporting research and development including the warhead; general support.	19
TOTAL	91

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ANNEX C

THE CONTRACT

- Under the terms of the existing "cost-plus" Contract technical progress was disappointing up to 1977 and the programme subject to delays and cost escalation. Progress since the Autumn of 1977, when the basis of a new package deal with MSDS was agreed, has been considerable. An ambitious programme is now being achieved largely to time and within cost estimates. This is considered due in large part to the commercial challenge offered to the Company under the proposed terms of the new Contract, to which they are already reacting.
- Under the terms of the new contract (which is being negotiated at 1 January 1978 prices) MSDS will be responsible, as prime contractor, for completing the development of Sting Ray, for demonstrating that it meets MOD requirements, and for producing the first 246 torpedoes for the Services. If they should fail to do this within specified limits of cost, and in time to allow entry into service by 31 December 1982, they will stand to lose money which may amount (according to the degree of failure) to all the profit which they could normally have expected to make on the work, together with £5 million of their own money, a total of some £20 million.
- The Incentive Arrangements. The Contract will employ three different incentives acting separately upon cost, time and technical achievement -
 - The Cost Incentive revolves around the Target Cost of £215 million which is the agreed most likely outturn of cost from 1 January 1978, at 1 January 1978 prices, given an efficient performance. The arrangement is for the cost overrun or saving to be shared initially in a ratio of approximately 9:1 between the MOD and the contractor respectively should the outturn cost prove more or less than the target. In short, the lower the cost the higher the profit, and vice versa. If costs should reach the agreed target of £215 million the Company will receive the agreed target fee, but any excess costs up to £226 million will be shared by the Company and the MOD. If, when costs reach £226 million, the programme to meet entry into service is more than nine months late, or if costs reach £236 million (target plus 10 per cent) whether the programme is late or not, then - a particularly powerful incentive not to exceed these figures - the next £5 million of incurred costs will be borne wholly by the Company. After this point cost-sharing is resumed at 9:1; the ratio reaching 3:1 if and when costs exceed £247 million. 8

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b. The Time Incentive is in the form of bonuses, totalling £5 million, to be earned by achievement of defined development, production and/or testing goals by specified dates at approximately six monthly intervals throughout the programme.

c. The Technical Achievement Incentive is also in the form of bonuses, totalling £2 million, payable for achievement of weapon performance beyond the minimum requirements specified in the Contract.

4. In total these conditions constitute one of the strongest commercial incentive Contracts that the MOD have ever been able to negotiate for a project of this size and complexity. That this has been possible (subject, of course, to final approval) with a Company in the highly profit-motivated GEC Group is the best commercial assurance that the project will be completed successfully to time and cost.

5. The Package Arrangement

a. An essential feature of the proposed Contract is the Contractor's commitment not only to demonstrate his achievement by the use of prototypes but to translate the designs into successful production. Experience has shown that this transition can prove difficult and is seriously hampered if there is any break between the end of development and the preparations for production. Previous weapon projects have suffered substantial increases both in time and cost for these reasons.

b. Quite apart, however, from the case for a "package" contract, the Company have indicated that they will not accept a separation of development and production into two contracts. They are unwilling to undertake the development without the assurance of subsequent production, largely because their aim is not simply production for the Royal Navy but the profits to be gained from overseas sales provided they can reach the market at the right time. Indeed, the Company originally required the Contract to include an order for two thousand torpedoes and have only reluctantly accepted the reduction to 246. Were an attempt now made to untie the development/production package it is doubtful whether the Company would agree to continue with the project, and if they did, the MOD could not expect to get such good terms as are now available. The delay would also undoubtedly lead to increased time and cost.

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6. Rights to Terminate the Contract. Once the Contract is signed the Contractor is committed to complete the work to MOD satisfaction and he has no right to terminate this liability. The MOD, however, have the right to terminate the Contract -

- a. If it appears at any time that the Contractor will be unable to meet MOD requirements within reasonable time (and therefore cost); in which case no compensation is payable to the Contractor but may be to the MOD;
- or
- b. for any other reasons: in which case the Contractor will be entitled to compensation of £5 million and to rundown costs depending upon the stage reached.

There are, of course, regular reviews as to technical progress and costs which would, if necessary, trigger consideration of the need to terminate the Contract.

7. Scope of Contract. The target-cost incentive contract will cover development work by the prime contractor and his sub-contractors from 1 January 1978 (as well as the initial production order referred to) though the incentive arrangements will come into effect only when the contract is signed. The estimated total project cost of £787.8 million (at September 1978 prices) includes former development work as well as subsequent production work, and it also includes the cost of support by MOD establishments and work done by a few holders of minor contracts direct from the MOD.

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COMPARATIVE ESTIMATED COSTS OF STING RAY AND NEARTIP (PAY AND PRICES BASE:
SEPTEMBER 1978)

£M

	1.8.79 to 31.3.80	1980/ 81	1981/ 82	1982/ 83	1983/ 84	1984/ 85	Later Years (to 1992/93)	Total
1. Sting Ray (excluding £91 million already spent)	37.6	36.8	46.6	49.1	56.5	64.3	405.9	696.8
2. Nearthip								
(i) Conversion and new purchase	-	8.5	36.4	59.8	40.0	18.7	18.4	181.8
(ii) Sting Ray residual costs	10.0	10.0	-	-	-	-	-	20.0
(iii) NEARTIP total	-	18.5	36.4	59.8	40.0	18.7	18.4	201.8
3. STING RAY Costs minus NEARTIP Costs	27.6	18.3	10.2	Minus 10.7	16.5	45.6	387.5	495.0

Note. A balanced comparison of costs should take account of the costs of replacing Nearthip with the Advanced Lightweight Torpedo (ALWT) and Sting Ray with a stretched version. Information previously available indicated that ALWT would be likely to cost at least £400 million but recent evidence suggests that the figure would be considerably higher. No estimates have yet been made for a stretched Sting Ray but significant development expenditure could arise in the later 1980s.