cc FCO

13 10

Prime Minister
The important paper is Annex A which summarises knowledge of the SDI which can be gleaned from published sources. It adds up to a great deal.
2. No need to read the rest, most of which will be familiar to you. FCO & MOD always want you to read the Scientific American article because they agree with it.
CDP 31/i

MINISTRY OF DEFENCE
MAIN BUILDING WHITEHALL LONDON SW1
Telephone 01-218 2111/3

MO 26/7/4

31st January 1985

Dear Charles,

STRATEGIC DEFENCE INITIATIVE

Following the Prime Minister's discussion with Professor Norman on Tuesday 8th January, you wrote to confirm her request for a summary of published knowledge on the technical aspects of the Strategic Defence Initiative (SDI).

I attach the material prepared by Professor Norman for this purpose. Given the large volume and wildly speculative nature of much of the published material, the exercise requires more than just a collection of selected references if it is to provide a coherent picture. We have therefore produced the paper at Annex A summarising the main technologies involved in the SDI, which is derived entirely from published sources. In addition, at Annexes B and C are two recent articles which we believe provide the best analyses of SDI possibilities; the Scientific American article in particular is thought to be one of the most accurate descriptions to appear in the open press. Annex D is an assessment published by Soviet scientists of the likely scale of a US SDI system, and Annex E is a (classified) description of the Soviet efforts on SDI which serves to set the US programme in context. Finally, I also enclose the Fletcher report which is the official US unclassified description of the SDI. It is essentially promotional material, presenting an optimistic picture of the SDI concept without giving details. It is therefore of limited value as a source of information for debate.

The Professor has asked me to draw three points to your attention. First, the few hard facts available in the open literature are largely derived from "leaks" which have not been confirmed by official sources. We should therefore be careful when using the information in the attached paper to make it clear that this is derived from press reports so as to avoid the implication that it is being given official endorsement. Secondly, the factual information in the press has little meaning unless it is related to the overall system requirements, which are classified. To avoid revealing such details the paper does not

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SECRETARY OF STATE

address the SDI system as a whole, nor does it give the critical performance levels required to make individual systems a practical possibility. Finally, whilst the SDI will have to counter a variety of threats, the open press has mainly concentrated on the central example of defence against an ICBM launch. Submarine-launched BMs present additional problems because of their potential for much shorter flight times, say, less than 10 minutes, and the unpredictable point of launch. However, there is little published information on the SDI capability against SLBMs or against other threats such as manned bombers or cruise missiles. These aspects have not therefore been addressed in the paper.

The attached material is necessarily only a small part of the total volume of published information and additional details could be provided on many of the individual aspects if required. Further information is also likely to be available in due course as it becomes published in the open press.

I am sending copies of this letter and the attachments to Peter Ricketts (Foreign and Commonwealth Office) and Richard Hatfield (Cabinet Office).

Yours ever,

Denis Brennan

(D BRENNAN)

STRATEGIC DEFENCE INITIATIVE

PUBLISHED INFORMATION ON TECHNICAL ASPECTS

INTRODUCTION

This paper considers the technical information available in the open press on the US Strategic Defence Initiative programme. The programme is currently in the initial research phase and contracts have been let to look at a wide range of possible weapon systems components, from rocket-based projectiles based upon near-current technology to particle beam weapons which have yet to be proven even under laboratory conditions.

Some of these technologies may not proceed beyond the research stage to workable weapons systems and it is therefore difficult to describe the overall form a deployed SDI system might eventually take. Certain objectives have been defined, but these should not be regarded as more than a guide to the initial research phase.

AIMS AND OBJECTIVES

The US intention is to develop a comprehensive (not necessarily leak proof) Ballistic Missile Defence (BMD) system to be deployed within the next 25-30 years. To meet such a requirement the SDI envisages a multi-layer approach with different weapon systems engaging the missile at each stage of its flight path.

THE TARGET

The flight path of a typical ICBM falls into four phases:

1) Initial Boost phase, lasting 3-5 minutes. This is when the missile is easiest to detect, by its exhaust plume. The booster is an inherently "soft" target compared to a re-entry vehicle (RV), and its destruction would eliminate all its warheads at once.

2) Post-boost phase, lasting 2-12 minutes outside the atmosphere, during which the post-boost vehicle, the "bus", manoeuvres in space and dispenses RVs upon ballistic trajectories to their targets.

3) Mid-Course phase, lasting 15-20 minutes, during which the system passes through its apogee of 1000-1300 km. This phase involves a large number of objects to hit but allows a relatively long period for engagement.

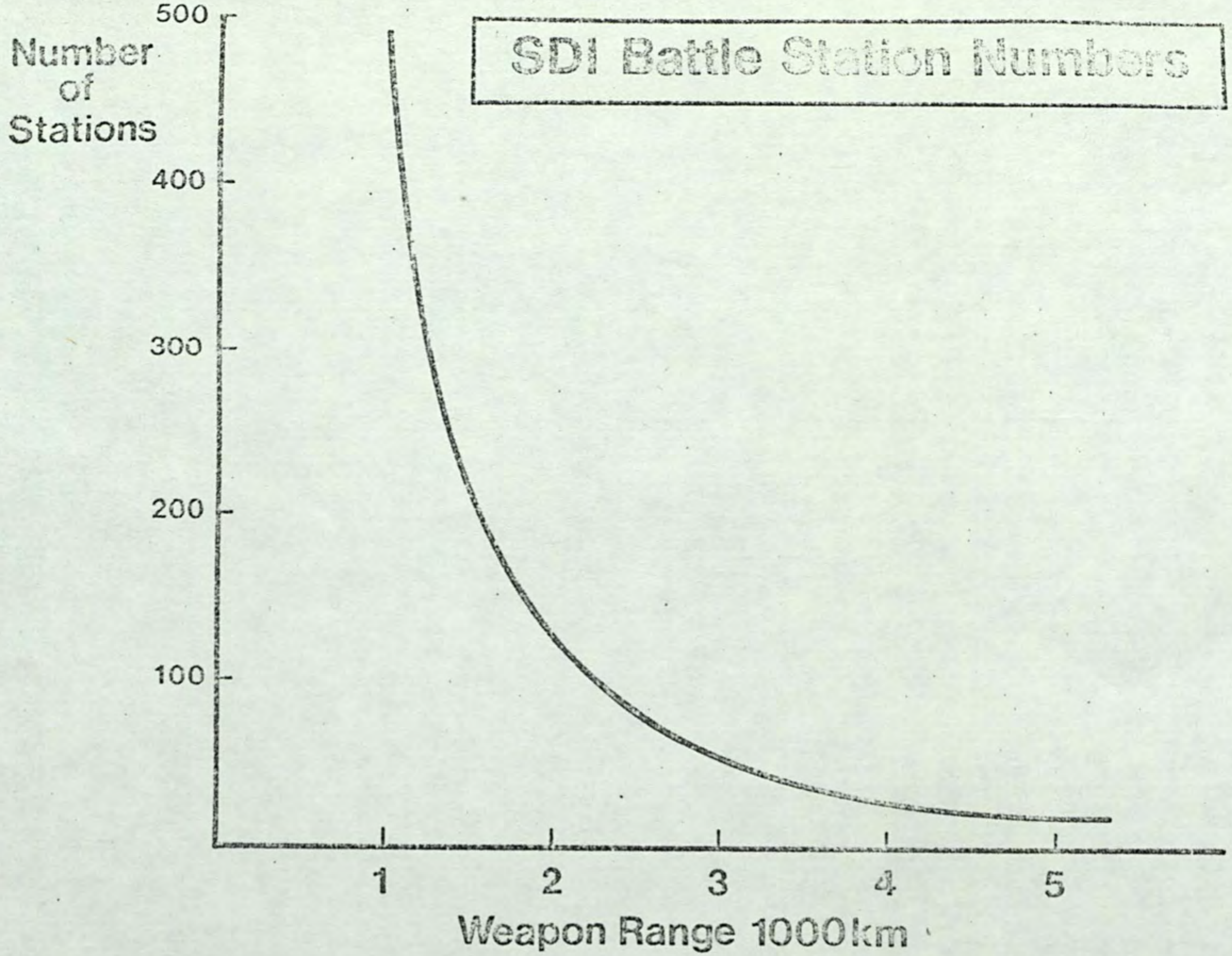
4) Terminal phase, lasting one minute or less, when the individual RVs enter the atmosphere. This is the area of current ABM defences the capabilities of which are widely known. It is not included in the proper SDI programme as such, but is funded under other headings.

To be effective a BMD system will need to incorporate weapons to engage targets in each of these stages.

TECHNICAL REQUIREMENTS OF AN SDI WEAPON

The primary requirement for an effective weapon system is range, since this controls the number of weapon platforms (satellites) required and therefore the overall feasibility of the system. The graph at Figure 1 illustrates the trade-off involved and whilst the figures are speculative it can be seen that a range of thousands of km is required in order to keep the number of satellite systems to practicable levels. At this range directed energy weapons have the advantage, over kinetic energy (KE) weapons, of travelling at the speed of light and thus having a much quicker engagement time. Hence the emphasis placed on such technologies in discussion of the SDI. Kinetic energy weapons

FIGURE 1



SDI Battle Station Numbers
Number of Stations
500
400
300
200
100
1
2
3
4
5
Weapon Range 1000km

would need to be located much closer to their targets, owing to the slower speed of their projectiles, although they have other advantages in terms of reliability and technical feasibility.

The basic requirement of the directed energy weapons is that the combination of their energy and their capability of being focused onto a small area should provide an energy density on the target which is lethal in a very short time (perhaps less than one second), whilst not requiring inordinate amounts of fuel. Focusing will require achieving very fine angles of divergence, in the nanoradian (10^{-9} radian) range. Different beam weapons have different energy efficiencies and divergence properties; hence the search for the best combination to produce an effective weapon.

TECHNOLOGIES

The SDI programme is sponsoring research costing some $26 Bn over 5 years into the following areas:

1) KINETIC ENERGY WEAPONS

These have the advantage of being the most practical weapons to develop in the short term since they can be based upon near-current technology. Studies reported of KE weapons include:

- Ground-based interceptors.

- Satellite-based clusters of guided rocket-driven projectiles with a warhead of several kg and terminal velocity of 5-10 km per second.

- Electromagnetic "rail gun" systems using projectiles weighing perhaps 1 kg with a terminal velocity of around 20-30 km per second, although velocities of up to 200 km per second have been discussed, making engagement at longer ranges conceivable.

The possibility of other, more sophisticated options has also been hinted at, but there are no details of these available from published sources. The chief technical challenge for KE weapons is to provide accurate terminal guidance of the projectiles at the very high speeds required for a successful engagement.

2) DIRECTED ENERGY WEAPONS

Technologies believed to be under study include:

- CO_2 lasers (infra-red wavelength) with poor efficiency (3-10%) currently requiring high power inputs. A CO_2 laser weapon has already been tested in a 747 against current guided missiles.

- Hydrogen fluoride lasers (infra-red wavelength), which could be small enough to be space based.

- Free electron lasers, which may have the advantage of higher efficiencies (20-30%) and therefore lower fuel input for each kill. They have the advantage of being tunable in frequency and can therefore operate in the U.V. region, which offers a narrower beam width. They would almost certainly be ground based.

- Excimer (excited dimer) lasers based on a very short-lived molecule such as xenon fluoride, which would also operate in the U.V. region and be ground based.

- X-ray lasers, triggered by a nuclear explosion to provide the required energy levels and exclusively space based (since X-rays cannot penetrate deeply into the atmosphere). There have been references in the press to experiments with such devices at the Nevada Test site, but the US Authorities have refused to confirm or deny these.

- Microwave beams, again at high energy levels, causing damage to electronic systems. These are difficult to focus precisely.

It is reported that an energy output of a few MW has now been achieved with the hydrogen fluoride laser, so that a requirement of say, 25 MW for a weapon system is likely to be reached. The U.V. lasers, however, are thought to be in a much less advanced state of development.

Ground-based beam weapons would be best placed on high mountain tops; it is reported that the US have developed adaptive optics to cope with the problem of atmospheric distortion of the beam. The beams could be reflected off satellite-borne mirrors in geosynchronous orbit (36,000 km altitude) to "fighting" mirrors on satellites at lower orbits which would actually engage the target. The vast range required, at least 70,000 km, dictates the use of U.V. rather than I.R. lasers, since the former undergo less divergence by diffraction (the shorter the wavelength, the less the divergence). The highest quality optics would also be required; mirrors of anywhere between 5-100 m diameter are reported as necessary, fabricated to a precision only achieved so far on smaller mirrors in laboratory conditions.

3) NEUTRAL PARTICLE BEAM WEAPONS

It is reported that methods are being developed for producing a directed beam of hydrogen atoms travelling at close to the speed of light. Particle beam weapons would be space-based since, on passing through the atmosphere, an electron would be stripped off each atom and the resulting beam of positive ions would bend in the earth's magnetic field.

TRACKING AND SURVEILLANCE

The ability to identify missile launches as early as possible to give the maximum interception time, to pinpoint accurately the location of targets from boosters through to single RVs, and to do so sufficiently quickly to allow multiple engagements, is crucial to the overall feasibility of the SDI system. Rapid tracking of the targets to within 100 nanoradians of arc is required, which is being investigated in the current TALON GOLD project. Such accuracies have been achieved in laboratories after a period of hours for the equipment to stabilise, but the technique must be developed considerably before there is a capability for tracking moving targets in real time. Observation is based upon radar and long wave I.R. at present but work is said to be continuing into novel methods based on optical laser systems. Longwave I.R. was used in the Homing Overlay Experiment in June '84 as the basis of the sensor on a ground-launched interceptor that destroyed a dummy Minuteman warhead outside the atmosphere.

COMMAND AND CONTROL: BATTLE MANAGEMENT

These are the keys to the whole system, which will require very reliable fail-safe software and very high performance integrated circuit technology. There is no published information on the overall requirements of such a system or its likely configuration.

COUNTER MEASURES

The open press has included frequent speculation on possible counter-measures to an SDI defence system. Among the more feasible speculations are the following:

- Rotating the booster, to spread the heating effect of directed energy weapons over larger areas.

- Hardening boosters, possibly with a combination of heat absorbing and ablative material. The MX is said to use a carbon-loaded phenolic resin coating which improves its hardness by several orders of magnitude. There is a penalty in increased mass.

- Increasing rocket motor power to shorten the boost phase, reducing the time when the BM is most vulnerable. A reduction from 400 seconds to 60 seconds is claimed to reduce the payload by only 20% and is feasible.

- Boost decoys such as scout rockets, empty boosters etc.

- Nuclear detonation in space just before launch to confuse enemy sensors.

- Depressed trajectory flight paths - already technically feasible.

- Deployment of mid-course decoys, chaff, metal particle clouds.

- Assault on the BMD system itself, using ASAT weapons. Further satellites might then be required to defend the system, at increased cost.

Such measures reduce the effectiveness of a BMD system by requiring faster reaction times and higher energy levels. They do not necessarily defeat every layer of such a system, however, or make its application non cost-effective.