S
810

PREM 19/1444

SECRET PART 2

x2.541

CONFIDENTIAL FILING

MILITARY USES OF LASER TECHNOLOGY IN SPACE

THE U.S. STRATEGIC DEFENCE INITIATIVE

DEFENCE

PART 1 : Dec. 1979

PART 2 : JAN. 1985

Referred to	Date	Referred to	Date	Referred to	Date	Referred to	Date
30/4/85							
ENDS							

PART 2 ends:-

SS/Defence to MS/DTI 30/4/85

PART 3 begins:-

RTA to CDL + att A085/1230 1/5/85.

TO BE RETAINED AS TOP ENCLOSURE

Cabinet / Cabinet Committee Documents

Reference	Date
JIC(84)(N)30	1.3.84

The documents listed above, which were enclosed on this file, have been removed and destroyed. Such documents are the responsibility of the Cabinet Office. When released they are available in the appropriate **CAB** (CABINET OFFICE) CLASSES

Signed OWayland Date 28 November 2013

PREM Records Team

SECRETARY OF STATE

MINISTRY OF DEFENCE WHITEHALL LONDON SW1A 2HB

TELEPHONE 01-218 9000
DIRECT DIALLING 01-218 2111/3

MO 26/7/4

30th April 1985

Dear Geoffrey

SDI OPPORTUNITIES

Many thanks for your letter of 19th April. I should, of course, be entirely content for your people to keep in close touch with the Chief Scientific Adviser and others involved here.

I am copying this to the Prime Minister, the Foreign and Commonwealth Secretary and the Chancellor of the Exchequer.

Yours ever

Michael

Michael Heseltine

Geoffrey Pattie Esq MP

USA: Foreign Policy: Pt 2.

E.R.

Overtaken. All amendments including deletion of RUSI now accepted.
CDP 25/4

PRIME MINISTER

SDI: Foreign Secretary's Speech in the Foreign Affairs debate

The Foreign Secretary has accepted virtually all the amendments which you proposed. But he wants to keep in the reference back to his RUSI speech (page 14). He argues that omission of any mention of it will be more provocative in the House than a passing reference. He wants to raise this with you after Cabinet.

The choices are:

(i) to insist on deletion. You stuck by him in the House, despite your views. There is no need for him to drag the RUSI skeleton out of the cupboard and rattle it.

(ii) to accept some compromise formula:

"Those matters are already the subject of widespread and continuing discussion and debate on both sides of the Atlantic, to which my Rt. Hon. Friend the Prime Minister and I have contributed."

C.D.P.

(Charles Powell)

25 April 1985

Foreign and Commonwealth Office

London SW1A 2AH

24 April 1985

Dear Charles,

Foreign Affairs Debate

I attach a copy of the section on SDI in the draft of the Secretary of State's Opening Statement in the Foreign Affairs Debate tomorrow afternoon. I should be grateful to know whether the Prime Minister is content with it.

I am copying this letter to Richard Mottram (Ministry of Defence).

Yours ever,

Len Appleyard

(L V Appleyard)
Private Secretary

C D Powell Esq
10 Downing Street

On the general question of nuclear weapons, with which I have been dealing so far, the issues are undoubtedly complex. But to some extent they are already familiar. However, in the area of space weapons - the second element at Geneva - the issues are not only equally complex. To some extent they present new problems. This is why we must take care to see them in the correct perspective.

One point immediately stands out - but is often overlooked: the extent of Soviet research in this area. In his statement to the Bundestag last week Chancellor Kohl described its scope in some detail. In my own contacts with East European leaders I have emphasised the wide-ranging space research programme which has been conducted over many years in the Soviet Union. There is no room for doubt about the scale of these efforts. I therefore find it hard to understand how the Russians can realistically argue for a unilateral ban on parallel US activity, which is rightly designed to match their own.

It is against that background of massive Soviet research that the Prime Minister and President Reagan agreed at Camp David last December on the four crucial points which are the foundation of HMG's position:

- that the US and Western aim is not to achieve superiority but to maintain balance, taking account of Soviet developments;

- that deployment of active defences would, in view of Treaty obligations, have to be a matter for negotiation;

- that the overall aim is to enhance, not undercut, deterrence; and

- that East/West negotiation should aim to achieve security with reduced levels of offensive systems on both sides.

It is on that ~~basis~~ understanding that we give our full support to current US research into strategic defences. Given the long-established and comprehensive programme of Soviet research, we cannot afford to concede to them a potential monopoly in this area. Moreover, current Treaty obligations specifically allow for these efforts on both sides to continue; indeed, it is difficult to see how any verifiable agreement about constraints on research could be achieved.

But while research continues, it is clearly recognised on both sides of the Atlantic that any steps towards deployment must be a matter for the

/most careful

most careful consideration. The Prime Minister made this point in her historic address to the US Congress on 20 February when she emphasised that "should research on either side lead to the possible deployment of new ballistic missile defence systems, that would of course be a matter for negotiation under the ABM Treaty".

Paul Nitze / quote.

There is one other crucially important point to bear in mind when we consider developments in this field. It was very clearly made by President Reagan himself in the speech in April 1983 that originally launched the Strategic Defence Initiative: it will take years and probably decades of effort on many fronts before clear results will be achieved.

It is plain that during the time when that research is taking place we shall all need to consider the impact which possible moves in the direction signposted by the concept of strategic defence

/might have

I suggest omitting this: its a red rag.

might have on a number of strategic concepts. Those matters are already the subject of widespread and continuing discussion and debate on ~~the other~~ both sides of the Atlantic. [I considered some of them in the speech that I made to the Royal United Services Institute six weeks ago.]

(The discussion is, of course, still continuing. But) Already on a number of points a consensus is beginning to emerge. This was made very clear in the important speech made by Secretary Shultz in Austin, Texas, on 28 March. Let me draw attention to some of his principal conclusions:

- for years to come we will have to continue to base deterrence on the ultimate threat of nuclear retaliation;

- any contribution by defences must be orderly, predictable and stabilising in its effect;
- any future decision to deploy defences that were not permitted by treaty would have to be a matter for negotiation.

/Many of

Many of these questions were considered again earlier this week at the Ministerial meeting of the WEU, which I attended with my Right Hon Friend the Secretary of State for Defence. There too there was general agreement that the Camp David Four Points provide a good basis for future Western policy. That the aim must be to achieve balance, not superiority, and to enhance, not undercut, deterrence. That any deployments would have to be a matter for negotiation. And that the aim of the Geneva negotiations should be security at a lower level of offensive forces.

I have one last point to make on this topic. The House will be aware that we have recently received an invitation from the US Administration to participate in the SDI research programme. As the Prime Minister told the US Congress on 20 February, we indeed hope that British scientists can share in this work.

That was also the response of most, if not all, of the WEU Ministers at our meeting in Bonn earlier this week. But they all attached importance as well to the need to sustain and improve the technological capacity of Europe as a whole. On that basis, Ministers

/agreed,

agreed, in the words of Tuesday's communique, "to continue their collective consideration in order to achieve as far as possible a coordinated reaction to the invitation of the United States".

Evidently, there will be practical questions to resolve, and practical arrangements to be made. Only detailed study can provide the answers. [But a simple rejection of the US offer, a Luddite refusal to look beyond tomorrow, is not the way this Government intend to do business.]

(But this Government intends to respond soon & respond positively. [Not for us a Luddite refusal to look beyond tomorrow) file SRW

22 April 1985

Many thanks for your letter of 17 April about R V Jones' paper on the Strategic Defence Initiative. The Prime Minister sees no objection to your publishing this from the Centre for Policy Studies, preferably with a disclaimer of support for its views. She thinks your idea of publishing it together with a recent speech by Bud Macfarlane is a good one.

(C. D. Powell)

The Lord Thomas of Swynnerton

KL VCAFK

MR. SHERBOURNE

PAPER BY MR HART ON THE STRATEGIC DEFENCE INITIATIVE

I have read this very quickly. I agree with a fair amount of it but not all. It is more categoric than the evidence justifies.

He is right:

- on the political background to SDI. But I think it is also more sophisticated than he suggests. A main motive is to draw the sting of the anti-nuclear lobby.

- that the Americans at least under the present Administration are going to press ahead with research and also with testing of key components. But it would be a rash man who would assert with absolute certainty what will happen post-Reagan, for instance if there were another Carter-type administration.

- that we should approach SDI in a positive way as the best means of influencing American thinking. But this does not mean blind acceptance of every single assertion made by the pro-SDI lobby. The Prime Minister's mixture of public support for research with private caution about effectiveness is right.

- that there are specialised areas of the technology where British expertise has a contribution to make. That too is the view of our defence scientists.

- that we should grasp the American offer of participation in SDI research and do so bilaterally rather than pussy-footing around trying to produce a common European response (as the Defence Secretary wants).

- in his description of the state of the art in research. But the Prime Minister has been more fully briefed than he has (although as always one has to admire the extent of Mr. Hart's sources - to some of whom he gains access by describing himself as the Prime Minister's National Security Adviser).

- that an effective SDI would have serious implications for Trident. But one needs to keep the likely timescale in mind. Trident will probably be well into middle-age before an effective SDI is <u>deployed</u>.

Where I think he is <u>wrong</u> is:

- what he alleges to be the Administration's view of the ABM Treaty. The President would hardly have signed up on the Prime Minister's Four Points at Camp David, and subsequently incorporated them in the US position at Geneva, if he thought them wrong. Weinberger dislikes them and so does Richard Perle: but they are not necessarily the authoritative voice of the Administration. There is, however, the separate point whether the US might denounce the ABM Treaty.

- it can never be true that SDI will afford Europe 'as much' protection as the US if only for reasons of geography. SDI has half-an-hour to deal with the bulk of an attack on the US, but about ten minutes in the case of Europe.

- in his strategic argument. I just don't see how he arrives at the conclusion that we could have an independent British trigger to a basically American system. In the first place at the moment an attack is launched, you can't tell against whom it is aimed. An SDI has to react immediately on the launching of Soviet missiles even if it turns out they are only targetted on Majorca. There is no particular advantage in our being in a position to 'enable' the system: and anyway inconceivable that the Americans would let some-one else do it, any more than they would let us fire their Minute-men.

- to argue that the SDI project is not well managed. It's being run by the same team that gave us the Space Shuttle. I find it hard to credit that the Americans would want us to manage the programmes which they finance (though I am sure that they would welcome a technical contribution).

- in arguing that if the Soviet Union deploys SDI, we should develop Cruise he is arguing against himself. If Cruise is effective against SDI, the Russians will develop Cruise in large quantities, which rather weakens the case for SDI.

- to dismiss as unpatriotic the arguments against SDI. There are serious grounds to think that SDI will never be leak-proof, that deployment would be destabilising, that we are better off with the deterrence provided by nuclear weapons. These points all need to be argued through, and it is far too early to hazard conclusive answers to most of them. All of which points up the sound sense of our current position of supporting research but not committing ourselves beyond that.

C.D. POWELL

19 April 1985

O/20.

(2)

Prime Minister
To see Sir Robin
Nicholson's minute
(attached)
CDP
22/4

Ref. A085/1135

MR POWELL

I minuted you on 4 April about the manpower requirements of the SDI research and development programme.

2. The Prime Minister may like to see the attached copy of a minute by Sir Robin Nicholson, which suggests that the figure of 40,000 in my earlier minute was probably not far out.

Carol Bowdery
Approved by
ROBERT ARMSTRONG
and signed in his absence.

19 April 1985

W0335

SIR ROBERT ARMSTRONG

c Lord Zuckerman

17 April 1985

Lord Zuckerman has given some interesting statistics in his minute to you of 28 March. I was also in the United States before Easter as you know and the figure I was given for expenditure on this strategic defence initiative was \$28bn over five years. Since the total annual expenditure on R & D in the United States is about \$100bn this means that SDI will comprise about 5 per cent of total American R & D over the next five years if the President's plans go ahead. Since the number of scientists and engineers engaged in R & D in the United States is about 750,000, a 5 per cent call on these for SDI would imply about 37,500 people remarkably close to Lord Zuckerman's estimate of 40,000. Of course a key factor is whether the SDI are R & D spending is additional to current spending or replaces some of it. I have found it difficult to get a straight answer on this point even from Dr Keyworth, the President's Scientific Adviser, and I suspect that they have not really thought it through yet. Defence R & D spending is set to rise very rapidly in the United States and this is paralleled by a drop in civil R & D spending using public funds, thus if the skills are compatible the SDI programme could be staffed by scientists displaced from civil programmes. For comparison, the total number of scientists and engineers engaged in R & D in the United Kingdom is about 75,000 of whom about a quarter are engaged in defence R & D in both the public and private sectors. These figures certainly put the magnitude of the American effort in perspective and make clear that, any contribution which British R & D makes to the SDI programme, must be based on quality and specific expertise rather than quantity.

Finally, I do agree with Lord Zuckerman that there are a number of excellent British scientists and engineers who emigrated in the '50s and '60s and now occupy senior positions in the United States. However the position is not entirely black and a few of these are being tempted back to senior positions in the UK where, of course, their American experience is a substantial bonus. However there are signs of a fresh brain-drain in some areas particularly biotechnology and if the American SDI programme were ready to take place on top of their existing R & D activities, I am sure that there will be a substantial import of scientists from abroad and particularly from the United Kingdom.

RBN

ROBIN NICHOLSON

016

DEPARTMENT OF TRADE AND INDUSTRY
1-19 VICTORIA STREET
LONDON SW1H 0ET
Telephone (Direct dialling) 01-215)
GTN 215) 5147
(Switchboard) 215 7877

From the Minister of State
for Industry and Information Technology

GEOFFREY PATTIE MP

CDP
19/4.

Rt Hon Michael Heseltine MP
Secretary of State for Defence
Ministry of Defence
Main Building
Whitehall
LONDON
SW1 2HB

19 April 1985

Dear Michael

SDI OPPORTUNITIES

As work proceeds to identify possible areas for involvement by British industry in the US Strategic Defence Initiative (SDI) research programme I would be grateful if this Department could be closely involved with your own officials.

As you know this Department takes the lead in co-ordinating the British contribution to the US manned space station programme and many of the same UK companies which are on the space station programme could also be involved in SDI.

If we are to make the most of the opportunities and avoid being exploited by the Americans we must, literally, have our act together. I would be grateful if my officials could liaise with your Chief Scientific Adviser as soon as he is in a position to brief us as to the research possibilities.

I am copying this to the Prime Minister, Nigel Lawson and Geoffrey Howe.

Yours ever

Geoffrey

GEOFFREY PATTIE

AP3/AP3ABK

010

SECRET

Prime Minister
CDP 19/4.

Foreign and Commonwealth Office

London SW1A 2AH

15

19 April 1985

Dear Charles,

Strategic Defence Initiative

The Prime Minister will recall that the briefing prepared for her visit to Washington in February contained a detailed description of the various areas in which differences exist between ourselves and the Americans on the subject of Soviet compliance with arms control agreements.

The Prime Minister will want to be aware in that connection that, in response to a US initiative, an MOD/FCO team of officials will be discussing compliance issues (and especially the Krasnoyarsk radar) in Washington on 2 May. The Secretary of State attaches considerable importance to both the political and technical aspects of this discussion. It will be important to use it to get a detailed account of the latest US thinking and to present our own analysis.

The same meeting in Washington will give us the chance to explore US intentions in respect of their obligations under the ABM Treaty.

The Foreign Secretary has of course taken careful note about the Secretary of State for Defence's minute to the Prime Minister of 27 March, in which he recorded the background to the SDI references in the NPG communique. No doubt we can expect similar, though perhaps lesser, pressure in the drafting of the NATO Ministerial communique in June. It will be important in both these contexts to work constructively for a properly balanced approach that is consistent with the Camp David Four Points.

I am sending copies of this letter to Richard Mottram (Ministry of Defence) and Richard Hatfield in Sir Robert Armstrong's office.

Yours ever,

Len Appleyard

(L V Appleyard)
Private Secretary

C D Powell Esq
10 Downing Street

SECRET

19 APR 1985

GRS 680
UNCLASSIFIED
FM BONN 181545Z APR 85
TO IMMEDIATE FCO
TELEGRAM NUMBER 375 OF 18 APRIL
INFO IMMEDIATE MODUK
INFO PRIORITY WASHINGTON, PARIS, ROME

AMENDED DISTRIBUTION 19/4

BUNDESTAG DEBATE ON SDI

SUMMARY

1. KOHL REAFFIRMED TO BUNDESTAG FEDERAL GOVERNMENT'S POSITION ON SDI: SUPPORT FOR RESEARCH, WITH CONDITIONS: NO COMMITMENT ON PARTICIPATION, BUT EXPLORE POSSIBILITY OF JOINT EUROPEAN RESPONSE. OPPOSITION REJECT SDI AND OPPOSE PARTICIPATION IN RESEARCH.

DETAIL

2. IN GOVERNMENT STATEMENT TO BUNDESTAG ON SDI TODAY, KOHL WELCOMED US RESEARCH PROJECT: ANY POSSIBILITY OF REDUCING OR ELIMINATING NUCLEAR WEAPONS MUST BE EXPLORED. SOVIET UNION HAS BEEN RESEARCHING BMD FOR YEARS: WAS SOLE COUNTRY TO DEPLOY AN ABM SYSTEM: AND POSSESSED A DEPLOYED ASAT SYSTEM WHICH IN 1983 HAD BEEN TESTED IN SPACE OVER MUNICH. US PLANS WERE SOLELY FOR A LONG-TERM RESEARCH PROGRAMME. POSSIBLE DECISIONS ON DEVELOPMENT OR DEPLOYMENT WOULD NOT BE TAKEN BEFORE THE 21ST CENTURY. FEDERAL GOVERNMENT SUPPORTED THE RESEARCH PROGRAMME '' IN PRINCIPLE''. IT WAS JUSTIFIED, POLITICALLY NECESSARY, AND IN THE WEST'S SECURITY INTEREST.

3. KEY STRATEGIC QUESTION WAS WHETHER SDI COULD BE USED TO ENHANCE SECURITY. STABILITY IN EAST/WEST RELATIONS REMAINED FRG GOAL. EUROPE MUST NOT BE DECOUPLED FROM AMERICA AND ZONES OF DIFFERENTIAL SECURITY AVOIDED. UNTIL A BETTER ALTERNATIVE WAS FOUND, FLEXIBLE RESPONSE MUST REMAIN NATO STRATEGY. INSTABILITY MUST BE AVOIDED IN ANY FUTURE TRANSITION TO A STRATEGY BASED ON DEFENSIVE WEAPONS. SDI MUST BE SEEN IN AN ARMS CONTROL CONTEXT. ABM TREATY PROVISIONS FOR A COOPERATIVE EXAMINATION OF ANY POST-RESEARCH DEVELOPMENT/DEPLOYMENT MUST BE ADHERED TO. SDI HAD HELPED RESTART THE GENEVA PROCESS, AND COULD CONTINUE TO HAVE HELPFUL INFLUENCE ON THE NEGOTIATIONS: IT WAS IN OUR INTEREST THAT THE SUPERPOWERS HANDLE SDI IN GENEVA IN A WAY WHICH DID NOT BLOCK PROGRESS.

4. THE FEDERAL REPUBLIC WOULD WORK CLOSELY WITH ITS EUROPEAN ALLIES ON A RESPONSE TO THE US INVITATION FOR PARTICIPATION IN THE RESEARCH PROGRAMME. KOHL WELCOMED DUMAS' PROPOSAL FOR TECHNOLOGICAL COOPERATION BETWEEN EUROPEANS. KOHL'S VIEWS ON SDI WERE VERY CLOSE TO THOSE OF MRS THATCHER AND CRAXI.

5. SDI OFFERED AN OPPORTUNITY FOR STRENGTHENING EUROPEAN INTEGRATION WITHIN THE ALLIANCE. GIVEN THE SIZE OF THE SDI BUDGET, OPPORTUNITIES IN THE TECHNOLOGICAL FIELD WOULD GO FAR BEYOND THE MILITARY RESULTS. ECONOMIC AND TECHNOLOGICAL CONSIDERATIONS ALAONE WOULD NOT DETERMINE THE FRG RESPONSE, BUT FRG AND EUROPE COULD NOT AFFORD TO FALL BEHIND. ANY COOPERATION MUST BE BASED ON A FAIR PARTNERSHIP WITH A FULL TECHNOLOGICAL EXCHANGE, AND THE EUROPEANS ALLOWED INFLUENCE OVER THE WHOLE PROJECT.

/6.

6. FEDERAL GOVERNMENT DID NOT FEEL UNDER TIME PRESSURE TO RESPOND. THEY WOULD CONSULT WITH INDUSTRY, AND WITH CLOSE EUROPEAN ALLIES AND WOULD SEND AN EXPERT GROUP TO US TO EXAMINE CONDITIONS FOR PARTICIPATION.

7. GENSCHER (FDP) SAID THAT THE CLOSEST COOPERATION ON SDI WITH FRANCE AND OTHER EUROPEAN PARTNERS WAS A POLITICAL NECESSITY. HE POINTED TO THE DIFFICULTIES OF TRANSATLANTIC TECHNOLOGICAL EXCHANGE: THE EUROPEANS MUST BEWARE THAT THEIR TECHNOLOGICAL CONTRIBUTION IN ANY SDI PARTICIPATION SHOULD NOT BE TAKEN-UP WITHOUT FEED BACK FROM THE AMERICANS ON THE RESULTS OF THE PROGRAMME. MORE INFORMATION WAS NEEDED ABOUT PARTICIPATION.

8. EHMKE (SPD, WHO INITIATED THE DEBATE) OPPOSED SDI CONCEPT (DESTABALISING, LEAK-PROOF SYSTEM NOT FEASIBLE, WILL ENCOURAGE ARMS RACE IN SPACE, DIFFERENTIAL SECURITY IN ALLIANCE LEADING TO RISK OF LIMITED WAR IN EUROPE ETC). EUROPEANS SHOULD NOT PARTICIPATE IN THE RESEARCH PROGRAMME EITHER, NOT LEAST BECAUSE THIS WOULD ENTAIL JOINT POLITICAL RESPONSIBILITY FOR THE STRATEGIC CONCEPT, WHATEVER THE DISCLAIMERS. THIS WAS PRECISELY THE US TACTIC. PARTICIPATION WOULD, IN ANY CASE, NOT GIVE ACCESS TO HIGH TECNOLOGY: THE US TRACK RECORD POOR IN THE CIVILIAN SECTOR, AND AMERICANS EVEN MORE SENSITIVE ON MILITARY TECHNOLOGY. EUROPE MUST HAVE A TECHNOLOGICAL RESPONSE, BUT NOT BASED ON MILITARY RESEARCH. WHERE HOWEVER, WAS THE MONEY FOR ANY FEDERAL PROJECT?

BULLARD

US/SOVIET ARMS CONTROL TALKS

LIMITED

ACDD	PS	ADDITIONAL DISTRIBUTION
DEFENCE DEPT.	PS/LADY YOUNG	ARMS CONTROL TALKS
SOVIET D	PS/MR RIFKIND	
NEWS D	PS/MR LUCE	
NAD	PS/PUS	
EED	MR DEREK THOMAS	
WED	MR GOODALL	
PLANNING STAFF	MR JENKINS	
RESEARCH D	MR WESTON	
INFO D	MR DAVID THOMAS	
PUSD	2	

OTO

LORD THOMAS OF SWYNNERTON

HOUSE OF LORDS

4 CDP

Prime Minister

Agree that Hugh Thomas can publish this from the Centre for Policy Studies, with a disclaimer of its views?

Suggest yes.

It's not actually all that good: rather ~~good~~ peters out.

CDP 17/4

Charles Powell Esq
10 Downing Street
London SW1

April 17, 1985

Dear Charles,

Forgive me for troubling you, but I wonder whether the Prime Minister has had a chance to reflect on R.V. Jones' paper on SDI? Of course we would publish it with the usual disclaimers, if we did publish it, and I am suggesting that we accompany it with a recent speech by Bud Macfarlane on the same subject, as well as an introduction by me which would briefly explain that this is an important, fascinating and controversial subject in which the world is likely to be interested one way or another for a long time.

Yours ever

Hugh

Yes M

18 APR 1985

LORD THOMAS OF SWYNNERTON

HOUSE OF LORDS

610

April 1, 1985

Dear Charles:

This is the paper wh. I mentioned - by R.V. Jones

Yrs

Hugh

SOME THOUGHTS ON "STAR WARS"

On 23rd March 1983 President Reagan launched his Strategic Defense Initiative with 'I call upon the scientific community who gave us nuclear weapons to turn their great talents to the cause of mankind and world peace: to give us the means of rendering these nuclear weapons impotent and obsolete', and he called for a programme with the 'ultimate goal of eliminating the threat posed by strategic nuclear missiles'.

On 25th May 1961 President Kennedy had similarly challenged America's scientists and engineers: 'I believe that this nation should commit itself to achieving the goal before this decade is out of landing a man on the moon and returning him safely to earth'. In its time that goal appeared nearly impossible, but the World was quickly to witness how marvellously that challenge was answered. With such a precedent, what are the prospects for the Strategic Defense Initiative as regards technical fulfilment and its military and geopolitical impact? This paper attempts to look generally at some of the relevant factors, drawing mainly on published statements by some of the interested parties in the United States.

President Reagan and those on whose advice he launched his initiative did not expect it to be fulfilled within a single decade. 'It will' he said 'take years, probably decades, of efforts in many fields' and 'may not be accomplished before the end of this century'. But it engendered great optimism. Secretary of Defense Caspar Weinberger said on a Meet the Press interview of 27th March 1983, 'the defensive systems the President is talking about are not designed to be partial. What we want to try to get is a system which will develop a defense that is thoroughly reliable and total, yes, and I don't see any reason why that can't be done' (quoted in R. L. Garwin's testimony to the House of Representatives, 1st December 1983). And General James A. Abrahamson, who early in 1984 was appointed manager of the Pentagon's SDI

programme/

programme, gave an extensive interview to the journal Science (volume 225, pp. 601-602, 10th August 1984) which reported that 'he fully expected the United States to begin deployment of such a system before 2000'.

The Deputy Administrator of the National Aeronautical and Space Administration, Dr. Hans Mark, more cautiously told a conference on new technology sponsored by the National Academies of Sciences and of Engineering in Washington in May 1984: 'It is difficult to make any really firm statements about the time scale on which the deployment of such a system could be achieved. My own guess is that by the middle of the next century a defensive system could be in place that would make it necessary to change the doctrine of mutually assured destruction'.

Mark's estimate of 2050 appears the closer to realism when the technical difficulties of the programme are considered. While two groups appointed by the White House, the Defensive Studies Group and the Future Strategy Group, 'failed to detect any invincible technical obstacles that would prevent the attainment of the President's goal' and recommended that eighteen to twenty-seven billion dollars be allocated to the problem up to 1990 (Science, 25 November 1983), Dr. Richard DeLauer, the Under-Secretary of Defense for research and development, estimated that the R and D portion of the programme had at least eight components 'every single one..... equivalent to or greater than the Manhattan Project' (quoted in Space-based Missile Defense, published by the Union of Concerned Scientists in March 1984). Early in 1945 Lord Cherwell told me that the Manhattan Project had already cost sixteen hundred million dollars; this would be about eight billion dollars in 1983 terms, and so on DeLauer's estimate the R and D portion of SDI might cost 60 billion dollars or more. To put this sum into perspective, the current U.S. Defense budget is approaching 300 billion dollars, and assuming that the proportion of this allocated to R and D is about 11% (as it was in previous years - and the figure for Britain is 12%), the amount available for defense R & D in total is about 30 billion dollars. Thus the estimate for Star Wars R & D, although huge, is not out of question if spaced over ten years.

What/

What is an effective defence?

What is more questionable is whether the many technical and logistic problems can be solved so successfully that an Anti-Ballistic-Missile (ABM) defence could be effective. How do we define 'effective'? We may start by looking at the complementary problem of what would be an effective attack on a country as large as the United States or Russia, for the British Government has already offered an answer in its 1984 Defence Estimates where it states that four Trident submarines each armed with 16 missiles will provide 'a credible and effective deterrent'. On this criterion an effective defence for America or Russia must be one that would ensure that less than 64 missiles would get through. According to the International Institute of Strategic Studies, the Russians currently have 1398 Intercontinental Ballistic Missiles (ICBM) launchers , and so an effective defence would have to destroy all but 60-70 of these, or around 95%. True, the Trident D5 missiles have each 14 warheads, and the nearest Russian missile, the SS18, has no more than 10, but by the time any SDI could be deployed, the Russians could well have caught up. Alternatively, we might consider individual warheads: the British Trident force will have 916, and the Russian ICBMs have currently about 6400, of which some 85% would therefore have to be destroyed to fall below the criterion of an effective attack. But a lower number of warheads per missile means that fewer would be lost for a given number of missiles destroyed in the boost phase, against which the main thrust of SDI is likely to be made. These simple numerical considerations leave aside the question of the operational survival of a country after the impact of the several hundred warheads which even a 95% effective defence might fail to stop, but we will take 95% as the credible figure for an effective defence.

The/

The interception of ballistic missiles

The basic problems for an ABM defence are to detect the approach of a threatening missile as quickly as possible, and to project something at it that will get near enough to it to ensure its destruction, and at sufficient distance to minimize harm to friendly objectives and territory. For this purpose the trajectory of the missile may be regarded in four phases. For the first four minutes or so (150 seconds for the MX, 300 for the SS18) it is accelerating upwards from the ground, emitting huge amounts of light and heat from its exhaust plume, and carrying its multiple warheads in one integral packet. By the time the boost up to final speed is finished, the missile will have travelled 200 to 400 kilometres, and it will be in free flight above the atmosphere, and can now, over the next 5 to 10 minutes (the 'busing' phase), disperse its multiple warheads programmed for their independent targets; These then proceed as an expanding swarm throughout the long mid-course phase until they re-enter the Earth's atmosphere heading for their targets, and heating up by aerodynamic compression as they do so in their terminal phase.

Mid-course Attack

Of the three phases, that of midcourse is the most difficult to attack economically, especially if the independent warheads are accompanied by decoys which may simulate them to both radar and infra-red detection.

The Homing overlay Experiment

That it is already possible in principle to intercept and destroy an ICBM in mid-trajectory was demonstrated by the Americans (after one or two failures) on 11th June 1984, when an intercepting missile with an infra-red sensor and on-board computer was successfully launched from Kwajalein Atoll in the Marshall Islands to destroy by direct impact a dummy Minuteman warhead launched from Vandenberg Air Force Base, some 4500 miles away. A few seconds before impact the intercepting vehicle expanded an umbrella-like 15 foot disc of aluminium spokes loaded with small steel weights, and this was sufficient to catch the incoming warhead. But, great feat though this was, it would be more difficult by orders of magnitude to intercept and destroy a large proportion of a salvo of missiles launched without warning, especially if accompanied by decoys. Moreover the Kwajalein demonstration is reported to have resulted in interception "at an altitude of more than 100 miles" (Defense Electronics,

Electronics, December 1984) which suggests that the missile was nearing its terminal phase rather than strictly in mid-course.

Terminal Phase Attack

Interception in the terminal phase would be less difficult for several reasons. There would be more time for detection, and less distance for a defending missile to cover, and decoys easier to distinguish because they would behave differently both aerodynamically and thermally. Defence of point targets, such as one's own missile launchers, might thus be feasible - but it is difficult to contemplate with enthusiasm the prospect of many missiles being destroyed over civilian-occupied territory, especially if these involved nuclear explosions. There is a small-scale precedent in the V2 bombardment of London in 1944-45, when Anti-Aircraft Command started to fire in the hope of creating swarms of shrapnel in the path (predicted from radar) of V2's launched from Holland, but this was swiftly stopped when calculations showed that the falling shrapnel was likely to cause many more casualties than would be saved by its destruction of V2s.

Boost Phase Attack

It is generally agreed, by both proponents and critics of SDI, that the boost phase is easily the most attractive to attack, because the vulnerability of the ICBM then outweighs the remoteness of the phase from the defences. A single hit on the rising missile would be likely to upset every one of its multiple warheads; and it is emitting large amounts of light and heat which are easy to detect, even from geostationary satellites 22,000 miles above the Equator, and the missile is relatively easy to home on to - except for the important proviso that it is the missile and its boosters, rather than the exhaust plume which have to be hit.

For a missile launch to be detected, the detector has to be within sight of the launch. The geographical distribution of territory over the globe being as it is, this means that for the Americans to detect missile launchings in

Russia/

Russia, their detectors have to be on satellites, and they then have two main choices. The first, and much the more economical, is to have these satellites in geostationary orbits above the Equator - but supposing that the satellite has detected a launch, what action can be taken? Even if a material device could be fired, either from the detecting satellite or from a part of the World's surface accessible to the Americans, this device could not travel fast enough to reach the rising missile during its boost phase - even at 5 miles a second it would have to be fired from within a range of 1200 miles for a boost phase lasting 4 minutes even if detection, recognition and firing were instantaneous. So any destructive energy fired at the rising missile would have to travel at a far greater speed, and the obviously attractive possibility would be some form of laser or particle beam device, mounted on a satellite.

Geostationary Lasers

Looking first at lasers in geostationary orbit, and these would need much energy to be effective at 20,000 miles range, the Union of Concerned Scientists in America has estimated that to deal with a salvo of 1400 Russian ICBMs would require power plants in orbit costing 40 to 110 billion dollars: for this they have assumed that such plants would cost 300 dollars per kilowatt, compared to 1000 to 3000 per kilowatt for nuclear power plants. Here they might be pessimistic, just as Lord Cherwell was in 1943, when he argued that the gearing associated with the pumps in the V2 rocket would have to be very heavy to handle the power that they were required to transmit, but he had depended on the advice of experts who could only think of continuously running gears, and not of a simple turbine driven by hydrogen peroxide which had only to function for a very short life. But even if the Concerned Scientists have heavily over-estimated - and this is questionable - the power bill for the

lasers/

lasers would still be substantial, and it is only one part of the total cost. And even if the laser power can be generated, and concentrated into beams that are sharp enough to be no more than one metre in diameter at 20,000 miles range, the detecting and aiming systems have to be good enough to hit and follow a moving target for a few seconds to better than this accuracy at this range. Moreover, the laser has to be aimed at the rising missile itself, and not at its plume; these demands are for several reasons beyond anything feasible to-day. To ease the problem of hoisting heavy lasers into orbit, it has been suggested that the lasers might be ground-based, and aimed at geostationary mirrors that would be pointed in the right direction, either to aim directly at the rising missile itself or towards mirrors on other satellites on lower orbits much closer to the Russian launching sites. But none of these schemes appears practicable for many years, apart from the scale on which they would be needed. The same is true of all forms of lasers, including X-ray lasers, and particle beams.

That at least is the conclusion of the Union of Concerned Scientists, who have discussed all these problems in a report Space Based Missile Defence which appeared in March 1984. Its panel was composed of physicists up to Nobel Laureate level, defence analysts, and other members with command experience in operations and in intelligence: geostationary platforms are amazingly good for surveillance but most unpromising as sites for killer-lasers. This is not, incidentally, to decry the potential of lasers as high-speed weapons at short range: the U.S. Air Force in May 1983 demonstrated a 10.6 micron carbon dioxide laser mounted in a large jet transport which destroyed five air-launched Sidewinder AIM9-L missiles fired in rapid succession;

Laser/

Laser and Particle Beams: Accuracy of Aiming

It is worth looking at the aiming accuracy required of any device, laser or mirror or particle beam generator, in geostationary orbit. First the rising booster, some 40,000 kilometres away, has to be detected with sufficient precision for aiming the energy which is intended to destroy it. The accuracy required is of the order of 10 centimetres at 35,000 kilometres, or an angle of one in three hundred and fifty million. The Union of Concerned Scientists has stated that since the detection system would have to use mainly the infra-red radiation of 1 micron wavelength from the booster, the necessary angular discrimination would need a detecting system 100 to 150 metres in in diameter 'about the size of a football pitch' up in geostationary orbit. Here the U. C. S. is in error, through confusing what is known as resolving power with the precision with which the central maximum of a diffraction pattern can be established. I have myself, for example, performed experiments in which the precision is of the order of a million times better than the resolving power; and it would be possible to achieve the necessary angular precision in detection with a system no more than 100 centimetres in diameter, unless boosters were launched fro such adjacent sites that the detector was unable to distinguish between them.

While the detection problem is therefore not nearly so severe as the U. C. S. considers, it is otherwise regarding their main criticism: to focus the destructive energy on an area less than 1 metre diameter at 35,000 kilometres does require a big mirror; and even the proponents of lasers admit that it would have to be of at least 15 metres diameter. This presents its own problems: it has to be of very high quality, and keep its shape as its temperature changes as it constantly changes its attitude relative to the sun. Assuming that these problems are overcome, the energy has to be aimed in the direction pointed by the detection system to a precision of one in three hundred and fifty million.

Now/

Now the most precise aiming system so far contemplated in any practical development in space is that of the space telescope now nearing completion, where the specified precision is an angle of one in thirty million. So each geostationary laser, mirror or beam device will have to work to a precision at least ten times better than the space telescope. And it will be very difficult to calibrate any errors in alignment between the detecting and firing systems. It will be comparable with having to check in advance that the sights on a rifle are aligned so accurately with the barrel that the aiming error would be no more than one bullet diameter at a range of a thousand miles, without having a chance to fire a trial shot, and with the rifle more than 20,000 miles away in space.

Even this is not the end of the problem. Supposing that everything has so far gone perfectly, and the system has destroyed its first rising booster: this destruction must either be assumed or be revealed by the detector, which has then to steer the system on to another booster, for presumably the Russians are launching a salvo. If this included some hundreds of missiles, either there would have to be a comparable number of geostationary laser or other beam stations, or each station would have to destroy several boosters in succession, involving rapid slewing to the same high degree of precision.

So, while differing from the Union of Concerned Scientists on the point of the size of the detector (as opposed to the destroyer) system, and noting that it has corrected an error in its original paper on the weight of the power unit for a particle beam system, I conclude that the Union's objections to geostationary destroying systems are valid.

Orbitting/

Orbitting Missile Killers

The great merits of a geostationary platform are that it remains in one position relative to the Earth for a long time, and that it can view a large portion of the Earth's surface from that position. The only feasible way of overcoming its disadvantage of range is to mount whatever is intended to destroy the rising missile on a satellite in a much lower orbit, and typically travelling along a north-south line at a few hundred kilometres height, and with a period of around 94 minutes. Such a satellite, once it has detected a rising missile might aim a missile-killer at it, rather along the lines of the American ASAT, which currently is intended to be fired from an F-15 fighter, boosted upwards by a two stage rocket. The ASAT is a small cylinder about 30 centimetres in length and in diameter weighing about 15 kilograms, and it is steered by small auxiliary jets controlled by infra-red sensors which pick up heat radiated by the target, which is intended to be destroyed by direct impact.

One satellite in low orbit could carry many ASATs which could be fired rapidly against several rising missiles provided that it has first seen them, alerted by its own detection system or by signals from a geostationary surveyor. But such ASATs will not be able to operate much below about 50 kilometres altitude because they would themselves heat up aerodynamically, and this self-generated heat would at least partly "blind" their infra-red sensors. And they would also need some means of distinguishing the body of the missile so that they did not home instead on to its plume, through which they might pass as through the tail of a comet and probably be incinerated in the process. The aerodynamic restriction requires that they should not operate below about 100 kilometres altitude. The Concerned Scientists, taking an/

an optimistic case, assumed that an ASAT might be developed to weigh 5 kilograms instead of the present 15, and that by carrying nine times this weight of fuel for the booster, it could be accelerated to about 8 kilometres per second.

The question then arises of how far away we could afford the orbitting satellite to be for it to have a chance of hitting the rising booster with one of its killer-missiles (or hittiles). The Union of Concerned Scientists assumed that the boost phase would last 100 seconds, which gives a maximum stand-off for the orbitting satellites of 800 kilometres. If, to give the missile-killer technique its most optimistic chance of success we take the case of the Russian SS 18 missile, this is said to have a boost phase lasting 300 seconds, which would permit a stand-off range of 2400 kilometres, if we assume that the orbitting satellite detects the launch immediately, and equally immediately launches one of its hittiles.

Orbital Geometry: Killing Range 800 kilometres

The two ranges, 800 and 2400 kilometres, lead to different estimates for the number of orbitting satellites required. For a killing range of 800 kilometres, any one satellite will be within range of the Russian launching area for about 5 minutes, or one-twentieth of the ninety-four minutes round its orbit, so that to be sure of having one satellite within range, twenty or more satellites would be needed to be following it spaced at regular intervals around the orbit. Each satellite would menace a swathe 1600 kilometres wide cut through the Russian launching area from south to north or vice-versa, and so satellites would be needed in other orbits spaced laterally at not more than 1600 kilometre intervals as they cross the area, which lies at about 45° latitude, where a line of latitude right round the Earth has a circumference of about 28,000 kilometres; and satellite orbits would have to be spaced around

this/

this at no greater than 1600 kilometre intervals to ensure that at least one orbit would be within sight of any one of the possible launching points. So 28.000 ÷ 1600 or about 18 orbits would be needed to be spaced rather like the divisions between the segments of an orange, as the Earth rotates below them. Actually, the number can be halved because 18 orbits would ensure that any one point on Earth that has been covered once by a satellite, say from south to north, will be covered a second time, this time from north to south, about 12 hours later.

Number of patrolling satellites for a killing range of 800 kilometres

So we need 9 orbits, each holding about 20 satellites, to be reasonably sure that any one point in the Russian launching area has at least one American satellite within sight at any one time. So with 9 x 20, or 180, satellites we might hope at best to destroy as many ICBMs as the hittiles that can be fired from the American satellites within sight of the Russian launching area at any one time. If, as the UCS assumes, this area extends roughly from east to west (Sverdlovsk to Irkutsk) for about 2700 kilometres, there would not be more than three such satellites on the foregoing calculation - and since several hundred ICBMs might be fired in one salvo, then either each American satellite must be able to carry (and aim) at least 100 killers or, more realistically, many more satellites would be required - at least five times to reduce each satellite to carrying and aiming no more than 20 killers. So on this argument 5 x 150 or 900 satellites would be required to ensure that 300 ICBMs could be attacked out of one salvo.

Number of Patrolling Satellites for 2400 kilometres killing range.

The foregoing calculation has made some highly optimistic assumptions, such as the unerring detection of ICBM launches and immediate dispatch of hittiles. We will now stretch optimism further by supposing that the entire duration of

a/

a 300 second boost phase would be available for attack by killers. We could then afford the orbitting satellite to be 2400 kilometres away from the ICBM launch. Instead of about 20 satellites spaced around any one orbit, we would need only 7, and the orbits could be spaced laterally at 4800 kilometres instead of 1600. So we now need only about one third of the orbits we need for 1600 kilometre spacing, or 9 ÷ 3 = 3. So we now only need 21 orbitting satellites to ensure that at least one is within sight of the Russian launching area at any one time; moreover since this can oversee and menace a swathe 4800 kilometres wide, it does not matter whether the launching area stretches from Sverdlovsk to Irkutsk or from Moscow to Sakhalin (5000 kilometres). But either that one satellite within menacing range must carry enough killers to deal with an entire salvo of 300 ICBMs, or we must have many more satellites to make the task of any one satellite feasible. At 20 hittiles per satellite, we therefore need 15 x 21 or about 300 satellites - not as many as for a 800 kilometre killing range, but still a large number.

Other Factors affecting the required number of patrolling satellites.

The foregoing calculations indicate that when a very small number of ICBMs would have to be dealt with, the requirement of having one satellite within killing range results in the number of satellites needed being inversely proportional to the square of the killing range. But for hundreds of ICBMs to be countered simultaneously the number of satellites required is determined much more by the numbers of ICBMs to be countered than by the killing range.

The number of ICBMs out of a salvo that could be detected and engaged by each patrolling satellite depends in turn on two others: (1) the total number of killing devices that can be carried by any one patrolling satellite and (2) the rate at which the satellite can detect and engage rising IBCMs, which

determines/

determines how many ICBMs the one satellite could engage out of a single salvo while they are in the boost or immediate post-boost (busing) phase. With missile-killers, each one of which would be autonomous after launching from its parent satellite, the latter could immediately turn its attention to a second IBCM and launch a second killer. Even so, it seems extremely optimistic to assume that this could be accomplished in less than 3 seconds, and so no more than 30 killers could be launched if 100 seconds were available in the boost phase.

Rather similar considerations would apply if it becomes possible to replace missile-killers with a laser or particle-beam device which is aimed directly from the patrol-satellite against the rising boosters, with the additionl requirement that the aiming system of the satellite must 'dwell' on each ICBM long enough for the aimed laser or particle beam to destroy it. If the satellite's system is "intelligent" enough to recognise that the target has been destroyed, and immediately switches itself to another target, a favourable factor in killing performance can be gained. For if, say, the laser particle beam is powerful enough to destroy an ICBM at 2400 kilometres range in 5 seconds, it could probably destroy the same ICBM at 1200 kilometres range in little over 1 second, assuming the inverse square law. This would mean that the system could deal with four times as many missiles if these were to come up randomly in its survey area as it would if they had all to be engaged at extreme range. The number of satellites required could therefore be no more than a quarter of the number calculated on an extreme-range basis, provided that enough destructive energy can be carried in each satellite to destroy the required number of ICBMs.

The necessary number of satellites therefore appears to be highly dependent on the assumptionsthat are made concerning the killing range, the slewing time, the energy store that can be carried in each satellite, and on the number of missiles that the Russians are likely to launch in one salvo. We have seen that

at/

at least 900 satellites would have to be on patrol to give even a hope of attacking every one of a salvo of 300 ICBMs with a 100 second boost phase assuming that each satellite carried 20 hittiles, and this number would rise to 4000 satellites if the salvo included all 1400 of the Russian ICBMs. By contrast, if either a laser or particle beam system, intelligent enough not to dwell on any one ICBM any longer than is necessary to destroy it, and if the laser or particle beam could be fired 20 times over a period of 300 seconds (or 100 seconds, depending on the duration of the boost phase) then about 300 satellites would be needed on patrol for a salvo of 300 ICBMs.

The Cost of Continuous Patrols

Since the Russians would be aware of how many American satellites were on patrol, they would try to fire a big enough salvo to ensure that the defences were saturated. The Americans would in turn try to increase the number of patrolling satellites, and the Russians would in turn try to saturate this new number by launching, if necessary, all their 1400 ICBMs, or even by building still more of the latter. And if the SDI showed any sign of success, the Russians might revise the policy, initiated by the U.S., of multiple-warheaded missiles, since if the boost phase proves the most vulnerable, it could pay to have fewer warheads per booster, and more boosters. So it does not seem unreasonable to assume that the Russians would try to launch as many of their ICBMs in one salvo - let us say about a thousand.

For hittile-firing satellites some 2500 - 3000 might therefore be required on patrol against a boost phase lasting 100 seconds, while for laser or particle beam satellites, and a boost phase of 300 seconds, around 900 would appear necessary. Taking the hittile-carriers, the mass of hittiles to be lifted into orbit, at 50 kilograms* per hittile, would be about 2500 tons; and the mass of the satellite to carry the hittiles might be of the same order, making the mass to be lifted as about 5000 tons all told. The Union of Concerned Scientists estimates that the cost of lifting into orbit is about 3 million dollars per ton, so the cost of putting the satellites into orbit would be about 15 billion dollars.

In/

* 5 kilograms hittile + 45 kilograms booster

In comparison with some of the other costs involved, 15 billion dollars is very minor. As for the costs of the basic satellites, one of the few positive statements is that by one of the 'Star Wars' protagonists , Robert Jastrow, in Commentary for December 1984, who said 'Now, everyone acknowledges that these satellites are going to be extremely expensive. Each one will cost a billion dollars or more - as much as an aircraft carrier' . And another of the protagonists, General Daniel Graham, whose persuasion was largely responsible for President Reagan's launching of the SDI programme, was reported in Science (1st July 1983) as saying that ' more than 400' satellites would be needed. If Jastrow and Graham were referring to the same kind of satellite , this would imply a cost of more than 400 million dollars, but Jastrow points to a computation by the Livermore Laboratory that no more than 90 satellites would suffice. But it is hard to reconcile the Livermore figure with the admittedly rough estimates of the present paper, or with the revised estimates of the Union of Concerned Scientists At minimum it would imply that each satellite could kill at least 15 ICBMs if all the satellites were within sight of the ICBM launchings at the same time, but this would only be so if (i), as is most unlikely, all satellites could be over the Russian area at the same time or (2) the lasers are not on patrolling but on geostationary satellites, in which case a solution of the aiming problem appears beyond reasonable expectation.

More or less backing up Graham's estimate of at least 400 satellites are the revised calculations of the UCS (300) and of Drell, Farley and Holloway in The Reagan Strategic Defense Initiative: A Technical, Political, and Arms Control Appraisal (Stanford University, July 1984). And a valuable paper of 30 December 1984 by a leading member of the UCS, Richard L. Garwin, gives the estimate for a range of assumptions, of which the following are typical,

assuming/

assuming a launch of 1400 ICBMs :

Boost Duration (Seconds)	100	100	40	40
Slewing time between engagements (Seconds)	3	0.5	3	0.5
Number of satellites required	422	278	1056	695

For 3000 ICBMs launched simultaneously the numbers in the last row would be increased so that, for example, for 40 second boost duration and a slewing time of 0.5 seconds, the required satellite number would rise from 695 to 1488.

So apart from the very low Livermore figure there is a general consensus that at least some hundreds of satellites would be required, and Garwin's detailed calculations also suggest, as my own rough ones did, that the numbers required are approximately proportional to the number of ICBMs to be countered in any one salvo, and not to the square root of that number, as Jastrow reports los Alamos and Livermore to conclude. The point is important because it bears on the question of whether SDI defences can be saturated by the Russians building more ICBMs. From Garwin's figures this appears at least a probability. His figures also show how many more satellites would be required if the boost-phase duration were shortened from 100 to 40 seconds, as American designers would consider feasible.

Lasers or Particle Beams on Patrol

In attempting to estimate the numbers of satellites required on patrol we have made some very optimistic assumptions indeed regarding the performance of the systems. With all systems we have assumed a perfect and near-immediate detection by any one satellite of an ICBM , which could take place in any compass-direction around it. If it is to launch a hittile this has to be fired in the appropriate direction within an error that can be corrected by the homing system of the missile-killer; this done, the satellite can immediately look for another IBCM. If instead of a hittile, the satellite has to fire a particle beam, then this has to be aimed much more precisely than a killer-missile, and has to be held on the target long enough to disrupt it. The precision demanded at an average of, say, 2000 kilometres is of course at least 20 times less stringent than that which we estimated for the 35,000 kilometres range from geostationary orbit, but it is still comparable with that required for the space telescope which will be the greatest yet achieved by man.

Moreover, for a laser to produce the necessary concentration of energy, say an area 50 to 100 centimetre diameter at 2000 kilometres range, the optical system associated with the laser needs a much smaller aperture than that required for the 35,000 kilometre range from geostationary orbit; a mirror about 2 metres in diameter might suffice, if the laser operated withgreen light. If, though, it operated in the infra-red region (2.7 microns wavelength was assummed by UCS, since the most powerful laser yet devised, based on the hydrogen-fluorine reaction works at this wavelength) the mirror would need to be 10 metres in diameter. Assuming that such a laser could work at a power of 25 megawatts (more than ten times that scheduled by the Fletcher Commission for demonstration by 1987), it would need to'dwell' on a spot of just under one metre diameter on a booster at a range of 3000 kilometres for 7 seconds in order to produce sufficient disruption (assuming the Fletcher Commission's reported figure of 200 megajoules per square metre as the necessary dose).

As/

As in the case of geostationary lasers we still have the problem of knowing when the laser is aiming precisely at the booster whose rise has been detected by the visible or infra-red radiation from its plume. One way of doing this might be to use the laser as its own 'radar' system; if it can be set on an initial scan around the direction indicated by the plume-detector, some of the laser energy will be reflected back from the booster as soon as the laser beam strikes it in the course of scanning. A photoelectric detector system on the satellite might then "lock" the laser on to the booster until the latter breaks up under the cumulative effect of the beam. Unfortunately, though, some further technique would be necessary to ensure that the laser aims precisely, not merely at the booster, but at a fixed area on the booster. But an advantage of using the beam from the laser as its own scanner to find the target is that it might be possible to broaden the beam while it was in the searching mode, and then sharpen it again once it had located a target.

Such a technique might give a laser system an important advantage over a particle beam, where there would be no obvious way of ensuring that the beam was actually striking the target until the latter was disrupted.

Are Star Wars technologies feasible?

Part of the purpose of the rather laboured approach of the preceding sections has been to work out, roughly but independently, some of the figures that are feasibly calculable to see which of the two main American schools of thought - 'Star Wars' or 'Anti-Star Wars' is the more likely to prove right. The Union of Concerned Scientists, which belongs to the second school, has made its calculations and comments publicly available for criticism, and has revised them in the light of that criticism. Although one or two of the technical criticisms have been important, they have not given the Union cause to change its conclusions substantially. The same will be true of my own criticism, made earlier in this paper, of the large overestimate of the size of the detector mirror,

and/

and of a further small technical point concerning the possibility of mirrors for X-rays, which may be more feasible than the Union suggests if current developme in multi-layer mirrors succeed.

In general, the Union has considered many other factors and techniques besides those mentioned in the foregoing survey, and has in most instances stretched hope to its limits in supposing possibilities, such as a hittile with a mas of no more than 5 kilograms, or accurately bouncing a beam from a ground-based laser on to a geostationary mirror so oriented as to bounce the beam back down to another mirror on a patrolling satellite over the Russian area again so oriented as to direct the beam precisely on to a spot on a rising booster, and keeping the entire system aligned for several seconds. Even with all these highly favourable assumptions, the Concerned Scientists conclude that if the task for a ballistic missile defence is to deal effectively with a salvo of ICBMS of the order of hundreds or a thousand:

(1) A highly efficient boost phase intercept is a prerequisite of total BMD, but is doomed by the inherent limitations of the weapons, insoluble basing dilemmas, and an array of offensive counter-measures.

(2) As a result, the failure of midcourse systems is preordained. Midcourse BMD is plagued not so much by the laws of physics and geometry (as is boost phase BMD) as by the unmanageability of its task in the absence of a ruthless thinning out of the attack in the boost phase.

(3) Terminal phase BMD is fundamentally unsuitable for area defence of population centres, as opposed to hardpoint-targets.

An overstated counter-case?

We may ask whether the Concerned Scientists have overstated their case: but as regards the technologies involved in BMD they have given the pro-BMD lobby the benefits of any doubts regarding the limits of performance to which foreseeable technology may be stretched; and the same applies to the human abilities involved in taking the necessary command decisions before a defence would be activated. But have they overstated the scale of any possible attack? I recall the wild but official overestimate amounting to hundreds of thousands of casualties expected in London from German bombing in the first week of war in 1939. Again, in 1943 the Ministry of Home Security insisted on the estimate of its 'experts' that the V2 rockets would kill 108,000 people per month, and yet the average monthly rate over the seven months of the actual bombardmen was less than 400.

In both these cases there had been gross overestimates of the scale of attack: could the Concerned Scientists have fallen into the same error? The Russians would have every incentive to fire as many missiles as possible in one salvo, to saturate any possible defences; but could they, or would they, launch all 1400 at once? They might, for example, hold back half to deal with any possible threat from China, or they might be concerned about the effects of a nuclear winter or of radioactive fall out if they fired more missiles than necessary to neutralize America. So they might not fire more than, say, 200 in one salvo. This would, in effect, produce something of the "ruthless thinning out" that the Concerned Scientists find necessary for any hope of mid-course BMD; but the Russian s would be equally aware of this danger, and would probably decide to fire a salvo numerous enough, on their calculations, to ensure that enough ICBMs survived to deliver a knock-out blow to America.

A factor that might ease the Americans' problem to some extent is the difficulty that the Russians would have in concealing their preparations from the American Intelligence Services. But, this does not seem likely to help much with the problem of attacking the boost phase, where so many satellites have to be already in orbit if any salvo of, say, 50 or more ICBMs is to be dealt with.

A factor which would substantially add to the difficulty of the Americans' problem is the Russian ability to take countermeasures. We have already noted that concentration is one of these, as it has so often been in the past, for example in Bomber Command's battle with the German night defences. Another simple counter might be to make the rising boosters spin slowly, say once every second or two, which would spread the disruptive effect of a laser over the entire circumference and thus dilute its effect on any one spot; while this might be offset by making the laser emit its beam in pulses, it is likely to add a further complication. Decoys of various forms, so as to blind or deflect killer-missiles from genuine ICBMs are an obvious countermeasure; and by the time the Americans have developed killer-missiles to the sophisticated degree for anti-ICBM work, the Russians will have developed killers of a performance which, while not equalling that of ASAT might well be able to cope with American satellites. And since the BMD

concept/

concept depends on defeating any Russian initiative in starting an intercontinental nuclear war, the Russians can always delay this initiative until their technology has sufficiently caught up.

Another American problem may occur in recognition: supposing that they have a swarm of satellites each carrying a clutch of missile-killers, each satellite capable of detecting a rising IBCM and launching a killer to home on to it, and that each killer can achieve this satisfactorily, for every member of the swarm over the Russian launching area there will be another over the American launching area, if the two areas are comparable in extent. Somehow the American satellites must be prevented from initiating killer action when they detect the rise of an American ICBM launched in response to the Russian attack. If the inhibition of action depends on the receipt of some signal from the American ICBM or from its launching territory, this offers the possibility of Russian countermeasures: but it may be possible to devise some form of internal timing arrangement which would disarm the American satellites while near their own ICBM launching area.

Besides the countermeasures that the Russians might develop to defeat BMD directly, they will also have available the alternative of nuclear missiles launched from submarines either ballistically or on airborne cruise vehicles. Of course, if there were such a swarm of American defending satellites as to cover the entire globe, as a successful boost phase/attack demands, then these could also detect the firing of ballistic missiles from submarines and attack them, subject to one proviso - this is that the boost phase of such missile lasts as long as the 100 or so seconds for an ICBM. If it were, for example, only half as long, then this would roughly halve the time for a missile-killer to reach the rising missile, which would need a closer spacing of satellites requiring roughly four times as many as for the 100 second boosters. And as the Concerned Scientists point out (quoting evidence presented to the President's

own/

own Fletcher Commission, the Defensive Technologies Study Team), it may be possible to reduce the boost-time of even an ICBM to the order of 50 seconds (certainly this appears in prospect to be much easier than many of the development problems facing BMD technology), which would make their general conclusions even more plausible than they are already.

The Surprises of the Past

Notwithstanding all the argumen ts so far presented in this paper any critic must ask himself, in view of the optimism shown by the President and those who have influenced him, how often the critic has been surprised by technological developments in the past. For myself, satellites were no surprise: a few of us had forecast in 1944, against general opinion, that sooner or later the Moon would be hit. But even we would have doubted whether by 1970 men would have been landed on the Moon and safely brought back. And although surveillance, both photographic and electronic, by satellite was conceivable, I for one was surprised by the exquisite quality that has been achieved; and although I was a witness of the early development of radar, I have since been astonished by the feats of precision radar in measuring the distances of Venus and the divination of its surface features from the information contained in its radar actions, and even more by the fantastic feats of radionavigational command and control of the probes to Jupiter and Saturn. Moreover, the whole Polaris concept of ballistic missiles launched and accurately aimed from submarine seemed highly optimistic when it was suggested at Peenemünde before 1945; it would have been even more so to suggest that by 1985 each missile could carry 14 independently targeted nuclear warheads. And if any testimony is required to the American ability to react and improvise in an emergency situation, the history of the Apollo 13 ('we have a problem') mission is more than sufficient.

Why/

Why is the President enthusiastic?

The problem for a critic is therefore whether despite his doubts American ability, industry and ingenuity might successfully implement the SDI programme. The examples of Lord Cherwell in doubting the feasibility of the V2 or Henry Tizard of the atomic bomb, are disquieting precedents from the past. But my personal guess is that SDI is of an entirely different order of difficulty from anything so far within human achievement. All the fantastic achievements mentioned in the preceding paragraph were made in contention with Nature which, although a hard master, always plays fair, and not against an opponent who will be trying to trick you at every stage. And my doubt is reinforced by the fact that American technological enthusiasm has not always been well founded. An example that I have in mind concerns the detection of submarines by infra-red reconnaissance of the ocean surface, based on the idea that a submarine moving at depth would force water from its path upwards to the surface, and this water would be at a temperature different from that at the surface, and would therefore show up as a thermal wake on infra-red scans. While this could sometimes happen, it seemed to those of us concerned with military infra-red in Britain that it would be most unlikely to be reliable enough to be adopted as a reliable, or even partial, method of detecting submarines. But American opinion was so confident and enthusiastic that there were doubts in British defence circles about the competence of the British infra-red committee which I chaired: but subsequent developments entirely vindicated our doubts.

This/

This would be part of my answer to the inevitable question of why the President and his advisers are so enthusiastic about SDI - the enthusiasm of some of its proponents may have carried them too far beyond what the facts of nature and of conflict will permit. SDI and its prospect of freeing humanity from nuclear bombardments has a great emotional appeal; but all the more because of this we need to remember the words that Louis Pasteur said that he would like to see inscribed on the threshhold of all the temples of science: 'The greatest derangement of the human mind is to believe in something because one wishes it to be so'. Or, in the words of Crow's Law: 'Do not think what you want to think until you know what you ought to know'.

[useful for speeches]

The second part of my answer is that not all American authorities, and not even all of the President's advisers, are so enthusiastic. A former Secretary of Defence, Dr. James Schlesinger, and formerly a defence analyst with the Rand Corporation and Director of C.I.A., as well as a Counsellor to the President's Commission on Strategic Forces which reported in 1983, said at a conference on space and national security in 1984: 'The heart of Reagan's speech was the promise that some day American cities might indeed be safe from nuclear attack' and he went on, 'There is no serious likelihood of removing the nuclear threat from our cities in our lifetime or in the lifetime of our children'. He also ventured the cost of a 'defensive missile shield' as at least 1000 billion dollars. And it was noteworthy that at the same conference both General Abrahamson and Gerald Yonas, his chief scientific adviser on SDI, consciously downplayed any hopes of using it to defend cities. (<u>Science</u> 9th November 1984).

Why/

Why do the Russians appear to be worried?

Well if, as it seems, the President was led to over-enthusiasm in his original statement by a pressure group, and SDI does not offer prospect of a believable defence until long into the future, at best, then why are the Russians so apprehensive about it? One answer is that the sooner the Americans start on the programme, the sooner it will achieve its aims however far they may be into the future, and at that time - unless the Russians have caught up - the Americans would have a strategic advantage.

Another conceivable answer is that the Russians are not really apprehensive at all, but by appearing to be so they may raise American enthusiasm for and confidence in SDI, so that much of the trillion dollars spent in its pursuit will be diverted away from projects which would contribute more substantially to American military potential. Again, there is a precedent from World War II : the effort spent by the Germans in developing the V2, though technically brilliant, was largely wasted as far as the war was concerned - if it had gone instead into jet fighters, or even into building many more of the much cheaper V1, it would have caused the Allies far more trouble militarily.

And another answer may be that the Russian leaders are after all, just as human as those in America, or indeed those in Germany and Britain were, in the Second World War. For rocket missiles seem to have an extraordinary appeal and influence: after some initial scepticism Hitler waxed enthusiastic over the V2: 'This is the decisive weapon of the war', he told Albert Speer on 7th July 1943 (Speer, Inside the Third Reich, p. 496, Cardinal paperback). And, reciprocally, the threat was very much over-estimated in Britain - so much so that, Lord Cherwell told me in 1944, the construction of two battleships was cancelled to provide the steel estimated to be required to make enormous numbers of Morrison shelters. And the alarm caused by the prospect of ten tons of explosive delivered by rocket was much more than that of fifty tons delivered by bombing aircraft. Could the same semi-irrational

factors/

factors be at work on either side to-day? And could that be why the Russians appear so apprehensive?

Another, and less subtle, answer is to imagine ourselves in the Kremlin. We have opposing us a country with a leadership that believes, rightly or wrongly, that it can shield its homeland from our nuclear missiles while being able to launch its own at us. Although it may declare that it would never start a nuclear war, the fact that it believes that BMD would ensure that it would not lose such a war could make it less reluctant to resort to nuclear attack. The Russians might therefore conclude that the American leadership might be the more prepared to risk a nuclear war because they believed that they could win without incurring serious casualties among their population: if they were right, the Russians must lose: and if they were wrong they - the Americans - could lose, but the ensuing nuclear exchange would still have dire consequences for Russia as well as for America. True, the President has spoken of sharing BMD technology with the Russians, but such altruism is not a quality that they have given much evidence of recognising.

The possible effect of the SDI programme on the Kremlin outlook is not in itself an argument for not pursuing it if it has a good chance of successful fulfilment. Sooner or later some nation or other is likely to go for any development in military technology if it thinks that this will give it an advantage, despite the moral issues this may raise. Whatever scruples the Oppenheimers and Wieners may have, sooner or later the Tellers and von Neumanns will prevail. High principles, unhappily, tend to be overwhelmed in the face of military extremity. The German employment of gas and unrestricted U-boat warfare, and of biological warfare with anthrax, in World War I, and the Allied development of napalm and of anthrax and of the atomic bomb, and their bombing of civilian populations, are all examples. These were all

offensive/

offensive in intention: and yet, despite considerations of morality, they were nearly all employed. There is no such moral brake on a purely defensive programme such as SDI, and so it will be pursued by at least one side, and probably both, if it offers them any hope of success.

The Problems of Asymmetry

It is not easy to view the world through Russian eyes, especially because the Russian and NATO positions are so asymmetrical. Their geographical circumstances are disparate - Russia's huge territory forms one continuous land mass with its Warsaw Pact dependencies, America is separated by the ocean from its NATO partners which are in the main contiguous with countries in the Warsaw Pact, and physically nearer to Russia than to America. NATO is vitally dependent on sea lanes: Russia is not. All countries in NATO have open societies, with the opportunities these offer the Russians for intelligence gathering, both overt and covert: Russia is a closed society, far more difficult for the gathering of intelligence, which has to be obtained predominantly by photographic and electronic means. Not only are the oceanic transport links of NATO far more vulnerable than the land transport links inside Russia, but the dispersed dispositions of the NATO allies, and particularly of the American forces supporting them make the West far more dependent on radio communications, both by convential links and by satellite than the Russians, who can largely communicate by landlines.

Two problems arise from these asymmetries. The first is general: whenever the Americans and the Russians attempt to negotiate they inevitably have differing, and sometimes even opposite, views regarding the importance of particular techniques and types of weapon, for what may appear the greatest threat to one side may be of lesser importance to the other. Anything that threatens the command of the sea would, for example, be vital to NATO but

not/

not to the Warsaw Pact, while any convention of human rights might appear to the Politburo to threaten the closed structure of the Russian State, where by contrast the convention is taken for granted in the openness of America.

In any one of several specific fields, any agreement based on equality between the two sides will benefit one side more than the other: NATO, for example, requires more naval forces to protect its sea links, whereas the Russians have few such links that they need to guard. So any agreement giving the same number of naval escorts to both sides would give an advantage to the Russians. And they in turn feel that any agreement on inspection of nuclear test sites based on equal numbers of inspections on each side might give the American inspectors useful opportunities for espionage; while Russian inspectors on American soil would have similar opportunities, these might seem of relatively little value because of the large amount of information the Russians can already gather in America by virtue of its far more open society. Further, any agreement on intermediate range ballistic missiles will be viewed differently by the two sides, for while these will bring Russian centres within range of American missiles sited in Europe (and conversely NATO centres within range of Russian IRBMs) Russian IRBMs could not reach the American homeland.

So there is often little incentive for the prospectively disadvantaged side to come to agreement in any one field, and bargaining has to be extended to at least two fields simultaneously, with one side giving more in one field and taking more in another; but there then arises the question of how much chalk is equivalent to so much cheese, with the difference that the commodities to be bargained are so sophisticated that there is little prospect of reasonable agreement. Negotiation is then fraught with frustration, all the more so

because/

because a further asymmetry arises from the growing power of China on Russia's land frontier.

ASAT

We have already noted that American intelligence is much more dependent on spy-satellites than is Russian intelligence, and that American forces are far more dependent on satellite communications than are the Russian. And so any agreement that satellites should be immune from attack would appear to benefit America much more than Russia, and it is therefore not surprising that while both the Americans and the Russians started to develop anti-satellite capabilities in the 1960s, the Americans dismantled theirs and took up the position that their national security would be better served by abstaining from competition in ASAT weaponry. The Russians, though, continued with their own ASAT work, and late in the 1970s the Americans restarted. According to the Concerned Scientists, the Russian satellite-killer weighs about three tons and is launched from an SS9 booster weighing about 200 tons. It could not reach geosynchronous orbits, and can only be launched into low-altitude orbits; it is operated in such a manner as to chase its target from astern, perhaps taking one or two entire orbits to get into a killing position, and destroy the target by a shrapnel explosion using a conventional explosive.

The American ASAT which is due to be tested shortly is, by contrast, very small: its characteristics have already been mentioned in considering how its principles might be adapted to a missile-killer against Russian ICBMs in the boost phase. Apart from its small size, its other main differences are that it is designed to kill by direct impact, and to be fired to intercept its satellite target head-on after a trajectory of relatively short duration, and not to lose time in a stern chase. Its design is much more sophisticated, as it needs to be, than that of its Russian rival, but the Americans believe that their greater accuracy in detection and control systems will enable them to make it effective. In any case, in comparison with the SDI project, and difficult as it is, it is a mere stepping stone on the way to SDI.

Despite/

Despite the promise of the American ASAT, it seems that a ban on all anti-satellite weapons would benefit the Americans more than the Russians because of the greater dependence of the former on satellites for reconnaissance and communication. It was therefore noteworthy that President Andropov in August 1981 proposed a treaty banning anti-satellite weapons. Whether or not this was because he thought that the Russians had already developed a proven system, while a ban might hamstring the Americans, his concern about the future in space was repeated in his reply of 1st April 1983 to the petition that the Concerned Scientists cabled to him on 24th February 1983. Incidentally, they sent parallel petitions to the leaders of France, India, Japan, China, Britain and America, but Andropov alone answered within 3 months. Their subsequent challenge to Andropov to make a public statement that, as part of a general treaty banning space weaponry, the Russians would be willing to forego further tests of any anti-satellite system provided that the Americans would make an identical commitment, was not answered before Andropov died (as far as I am aware) and has been overtaken by more recent arms talks.

The Economics of SDI

Reverting to the Strategic Defence Initiative, what are the prospects for its deployment in the foreseeable future? Earlier we have cited opinions from authorities qualified in one way or another to comment, and these range from the expectation of some degree of deployment by 2000, through 2050 to virtually never. And as for the development of the necessary technology, some believe that it will be forthcoming, or at least can see no absolute obstacle to its ultimate success, and that it will be possible to intercept ICBMs in any one of the three phases: boost, midcourse, and terminal.

Assuming/

Assuming that, against the odds, the SDI proponents are right about the technical possibilities, the vital question then becomes the one posed by the Concerned Scientists: what scale of effort is required? One simple observation appears to me crucial: while ICBMs are already in existence, there is widespread agreement, even among the proponents of SDI, that a successful technology for intercepting ICBMs, particularly in the vital boost phase, will be very difficult and will take great effort and much time to achieve. Therefore it is going to be much more expensive to intercept and destroy an ICBM than it is to build it, a conclusion which is supported by the kind of numerical assessment made by the Concerned Scientists. This is not by itself an argument for not pursuing SDI, because the economic balance that has to be struck is not simply between the cost of destroying an ICBM and the cost to build it, but between the cost of destroying an ICBM and the cost of the damage it would cause if it reached its target. We in Britain learned this in the V1 campaign of 1944, where the cost to Britain (and the U. S. Forces) of defending against the V1s substantially exceeded the cost of the V1 campaign to the Germans, but where the cost of damage to Britain would have been very much greater if no defence had been made.

But, if as seems most likely, the cost of destroying an ICBM greatly exceeds the cost of constructing it, then all the Russians have to do is to build more ICBMs to the point where the Americans cannot stand the economic strain.* This argument would require qualifications if, say, the cost of defence against 1000 ICBMs is not as much as 10 times the cost of defending against 100 ICBMs; some factors could work in this direction - general surveillance, for example, would have to be provided irrespective of the number of ICBMs to be contained - but others would work the other way,

e specially/

* Costings are hard to estimate: President Reagan has recently (9 March 1985) asked for 1.5 billion dollars to buy a further 21 MX missiles. If this is all to be spent on missiles and their associated equipment, it implies a cost of 70 million dollars a missile, while a Trident D5 missile has been estimated to cost 25 million dollars; we therefore take a median figure of 50 million dollars per ICBM. If, say, seven satellites have to be in orbit to ensure that one is over the Russian launching area, and each costs 'a billion dollars or more' then seven billion dollars have to be expended to eliminate the number of ICBMs that can be destroyed by a single satellite. Unless this number is at least a hundred and forty, the economics are adverse: and it would be even less favourable if the Russians can build ICBMs (perhaps with fewer warheads) for less.

especially since the greater number of ICBMs must require greater defensive effort, if this is not to be saturated. So anything like the complete defence optimistically envisaged by President Reagan and Secretary Weinberger seems quite out of question on scale alone, if not on technological difficulty.

Effects on NATO

This paper has been concerned primarily with the questions of whether SDI is technologically and logistically sensible, and only secondarily with its geopolitical implications. Obviously, if SDI offered the prospect of substantially shielding America against nuclear ICBMs, the Americans would adopt it regardless -in the end - of any repercussions on other members of NATO, and who could blame them? The fear would be the withdrawal of the U.S. Forces into Fortress America, leaving the other members open to Russian attack. But this fear will exist regardless of whether or not SDI is successfully developed.

Another ground for fear might be found in contemplating the deployment phase of SDI , for the Russians might see this as a last chance for a successful first strike before the American deployment, which could not be hidden, proceeded too far. But such a risk might be worth taking.

Two further fears may be less easy to discount:

(1) American over-confidence in SDI might make some future Administration less cautious in risking a nuclear war, which would be bound to result in enormous damage to the European members, if not to America itself; and (2) if SDI does not in fact offer the prospect of an effective shield, then enormous amounts of American effort will have been wasted, much to the detriment of the whole of NATO, both as regards its military potential

and/

and its economic viability. Of these fears the first may well disappear if the reasoning in this paper is correct because, barring some unforeseen invention, long before SDI could be deployed its defects would have become evident. The second, though, given the present outlook of the Administration, could persist for some time. And although it is entirely for the Americans to determine how they spend their efforts, it would be reassuring if they could convincingly demolish the arguments in this paper and those of others more expert than I am in the field of geowarfare.

What will come out of SDI ?

In the 1986 budget, President Reagan has asked for the expenditure on SDI research to be increased from 1.3 to 3.7 billion dollars; and in December 1984 Defense Electronics stated that the programme is scheduled to receive more than 25 billion dollars over the next five years. This is a huge sum, sufficient to cover three projects each of magnitude comparable with that required to develop the atomic bomb in World War II, and presumably this will be expended whether or not SDI ultimately becomes practicable. Such an effort is bound to have many results, both in the development of existing technologies such as lasers and mirrors for X-rays, and in the birth of new technologies at present unconceived.

If the arguments in this paper are correct, then it is on such unforeseen developments in technology that a successful SDI must depend. The rational case against SDI is as strong as that against attempting to bomb Germany by day on World War II, where the logic was almost faultless. Experience has shown that bomber formations unescorted by protective fighters could not survive against fighters defending their homeland. Moreover, protective fighters, too, could be picked off by defensive fighters, because these - since they were operating at much shorter range and therefore having to carry less fuel - were always likely to have a superior combat performance, all the more so because they had the benefit of radar control from their ground stations. So both bombers and escorting fighters could not be expected to survive against the

German/

German defences, and early experiences fully justified this expectation. Then came an invention and an accident. The invention was the drop-tank, which gave an escorting fighter sufficient range to operate over Germany, but which could be jettisoned to give the fighter a better performance in combat. The accident was the Mustang fighter whose original performance was insufficient; but when fitted with the Merlin engine it became outstanding. So escorting fighters could now enjoy a period of superiority until German fighters of comparable performance could be produced, and this period proved decisive in the daylight bombing of Germany.

The main hope for SDI may well have to lie in the appearance of inventions as vital for space defence as was the drop-tank for daylight bombing.

The drop-tank precedent, though, should not be taken too seriously, for its advantage was very temporary: had the war gone on, better German fighters would have appeared. SDI aims at producing a permanent defense for all times in the foreseeable future, and since the United States are committed never to start a war, then it follows that SDI would only come into action after the Russians had started the war - and the Russians would presumably not do this until they were reasonably sure of being able to render SDI ineffective. If they could not do this, then a successful SDI might fulfil its aim of preventing nuclear war; but much faith is required to believe that SDI is feasible, and that the necessary inventions will be forthcoming.

R.V. Jones

15th March 1985

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

MO 26/7/4

15th April 1985

Prime Minister
CDP 15/4.

Dear Len,

STRATEGIC DEFENCE INITIATIVE - PARTICIPATION IN RESEARCH PROGRAMME

The Defence Secretary minuted the Foreign and Commonwealth Secretary on 27th March enclosing a letter from Mr Weinberger about participation in the SDI Research Programme. In that letter, Mr Weinberger asked his colleagues to respond within 60 days giving an indication of their interest. We have today received via the US Embassy in London the attached self-explanatory further letter from Mr Weinberger essentially dropping the 60 day deadline.

Although the formal deadline has now been lifted it is still Mr Heseltine's intention to bring forward early proposals about how we should respond to Mr Weinberger's original letter.

I am copying this letter to Charles Powell (No 10), the Private Secretaries to other members of OD and to Richard Hatfield (Cabinet Office).

Yours ever,

Richard Mottram

(R C MOTTRAM)

L Appleyard Esq
Foreign and Commonwealth Office

CONFIDENTIAL

April 13, 1985

Dear Colleague:

Since extending an invitation to your Government to join with the United States in the Strategic Defense Initiative Research Program, I have noted that some -- both in the US and elsewhere -- have chosen to interpret the reference it makes to a 60-day initial response period as an "ultimatum" for Allied participation. This is of course totally untrue and I regret any misunderstandings that may have arisen over this point.

As you know, the United States is pursuing intensively the SDI Research Program which is an on-going, large research effort, with several contracts planned for signature in the near-term. The 60-day initial response period in the letter simply reflects our desire to ensure that the United States' allies and friends have an opportunity, as early as possible, to participate in this program, and our hope is that the SDI will realize the maximum benefit from such participation.

I wanted to emphasize that you should not feel constrained to respond within any set period of time. Rather, we hope you will respond any time and, indeed, continually throughout the program. You should feel confident that an indication of your interest in participating in SDI research will be welcome whenever it is received. We view the initial indication of interest as but the first step in a process which would develop in detail subsequently, and over a long period of time.

There are numerous issues concerning the SDI and its implications that merit serious analysis and dialogue, and we want to provide any information or briefings that you think will be helpful. I hope this can put any possible misunderstandings behind us.

Sincerely,

/s/

Caspar Weinberger

CONFIDENTIAL

US : FOREIGN POLICY

Pt 2

ccPC

Foreign and Commonwealth Office

London SW1A 2AH

NBPM
4/4

4 April 1985

Dear Richard,

Strategic Defence Initiative: Participation in Research Programme

The Foreign Secretary has asked me to express his thanks for the Defence Secretary's minute of 27 March. He has read this in conjunction with Charles Powell's letter of 28 March, conveying the Prime Minister's initial reactions, and your reply of 29 March. He has also noted the Prime Minister's comments at her press conference at the end of the European Council on 30 March, when she referred implicitly to her hope, expressed to the US Congress on 20 February, that our scientists will share in the SDI research; and to the need for further study of the possibilities for joint collaboration with some of our European partners.

The Foreign Secretary agrees that we need without delay to make up our own minds on how to reply to Mr Weinberger's invitation. He has noted Sir Oliver Wright's proposals in this sense. He has therefore been pleased to hear of the arrangements already reached between MOD and FCO officials,to ensure that both the technical and political aspects of participation are subject to thorough and urgent review. He has asked me to underline the importance he attaches to full FCO participation in this work, and to the need to take account of all the wider political factors which will affect any technical considerations. He looks forward to seeing the paper which the Defence Secretary proposes to put to colleagues at an early stage, and to providing advice on the response to Sir Oliver Wright.

In order to understand the potential for UK participation in the SDI, it will be obviously important to establish as soon as possible the exact elements of the US programme, and the areas to which we might best contribute with greatest advantage to ourselves. The Foreign Secretary is aware that officials on the scientific side of the MOD are already engaged in this work. He hopes that further contacts with US officials in the near future will establish a proper basis on which detailed and specific decisions will then be possible.

/In

In reviewing these decisions we shall at the same time need to bear in mind the possible constraints on the fullest collaboration with the Americans. In addition to the US-specific problems of technology transfer and Congressional pressures for "Buy American", with which we are familiar, we should note - as Sir Antony Acland pointed out to Sir Clive Whitmore in his letter of 11 March - the line in Article IX of the ABM Treaty: "To assure the viability and effectiveness of this Treaty, each Party undertakes not to transfer to other States, and not to deploy outside its national territory, ABM systems or their components limited by this Treaty". We also need to bear in mind Agreed Statement G on the same Treaty: "The Parties understand that Article IX of the Treaty includes the obligation of the US and the USSR not to provide to other States technical descriptions or blue prints specially worked out for the construction of ABM systems and their components limited by the Treaty". I see that when the French raised this with the Americans last week, General Abrahamson admitted that the room for manoeuvre was very limited; and that under the Treaty only technology relating to fundamental research could be transferred to third parties.

As for a coordinated European response, the Foreign Secretary sees the theoretical attractions in such an approach, and has noted with interest the discussion on this aspect in Cabinet on 28 March. Recent contacts with a range of European Ministers and officials have underlined the interest in principle in engaging in this sort of response. Nonetheless, the Foreign Secretary appreciates the force in the argument that such coordination should only be pursued where it can be shown to serve our own best interests. He therefore believes that we should devote proper attention to the possibilities of a collective or coordinated response, while maintaining a watchful eye on the potential difficulties to which attention was drawn in Cabinet last week. Whatever the eventual fate of the SDI programme itself, there is little doubt in his mind that the momentum generated by the new US programme will lead to new technologies with far-reaching defence implications. Even if ballistic missile defences are not deployed as a direct result of this research, we cannot afford in the Foreign Secretary's view to take a narrow view of their potential, nor to dismiss the advantages in principle of coordinating our views on these issues with our European Allies.

In considering with our European Allies the possibilities for a joint or coordinated approach, the Foreign Secretary trusts that we shall not restrict these contacts to strictly technical issues. Meetings of the National Armaments Directors

/may

may well be the appropriate forum in which to exchange views on technical issues. Equally, the broader issues of strategy to which I referred earlier will need similar debate. This might best be conducted by Ministers and senior officials from both the FCO and the MOD.

I am copying this letter to the Private Secretaries of members of OD, and PS/Sir Robert Armstrong.

Yours Sincerely,
Colin Budd

(C R Budd)
Private Secretary

Richard Mottram Esq
PS/Secretary of State
Ministry of Defence
Whitehall
LONDON SW1

USA Pt 2

Foreign Pol.

cc NO CePL

MINISTRY OF DEFENCE
MAIN BUILDING WHITEHALL LONDON SW1
Telephone 01-~~930 7022~~ 218 2111/3

MO 26/7/4 29th March 1985

NB PM
CDP 30/3.

Dear Charles

STRATEGIC DEFENCE INITIATIVE:
PARTICIPATION IN RESEARCH PROGRAMME

The Defence Secretary has seen your letter of 28th March and noted the Prime Minister's reaction on how we should respond to the US invitation to participate in the SDI research programme. As proposed in the second paragraph of your letter, he would intend to establish how our European allies intend to proceed. He will at the same time be addressing our own best interests and intends to put an early paper to colleagues for decision.

I am copying this letter as yours.

Yours ever,

Richard Mottram

(R C MOTTRAM)

C Powell Esq
10 Downing Street

29

CONFIDENTIAL

EL3AFQ

cc ✓ 10

10 DOWNING STREET

From the Private Secretary

28 March 1985

Dear Richard,

STRATEGIC DEFENCE INITIATIVE:
PARTICIPATION IN RESEARCH PROGRAMME

The Prime Minister has seen a copy of your Secretary of State's minute of 27 March to the Foreign and Commonwealth Secretary about the form of our response to the American invitation to take part in the SDI Research programme. She is not at all attracted by the Defence Secretary's suggestion that we should try for a joint European response. She can see no good scientific or industrial reason for a joint response: indeed she suspects that we would be more likely to lose from it. She doubts whether the French would share scientific knowledge or technology with us in areas where they are ahead: and we should be net contributors of expertise in regard to other European countries. Politically she sees a risk that a joint response might place an undesirable restraint on the position which we take towards the SDI. She also thinks that we can reasonably expect to cash in with the Americans the credit we have built up by giving a lead to European support for SDI research, and can best do so bilaterally.

The Prime Minister would not object to an exchange of information by European Governments about their intentions but thinks that we must make up our own minds how to reply and do so rapidly. This would not exclude coordinated national responses if the others were ready in time.

I am copying this letter to the Private Secretaries to members of OD and to Sir Robert Armstrong.

Yours sincerely

Charles Powell

(Charles Powell)

Richard Mottram, Esq.,
Ministry of Defence.

CONFIDENTIAL

BM

PRIORITY H/C / LOUGHEAD / SPENCER + DELGN

FOEC 013/29

Full Distribution ✓

PP UKREP BRUSELS

GRS 200
UNCLASSIFIED
FM WASHINGTON 290105Z MAR 85
TO PRIORITY FCO
TELEGRAM NUMBER 1106 OF 28 MARCH
INFO PRIORITY MODUK (FOR DACU), UKREP BRUSSELS (FOR PRIVATE SECRETARY), UKDEL NATO ROUTINE MOSCOW BONN PARIS ROME UKDIS GENEVA UKDEL VIENNA UKDEL STOCKHOLM
INFO SAVING OTHER NATO POSTS

[illegible]

MY TEL NO 1052: SDI: SHULTZ SPEECH

1. SHULTZ'S SPEECH ON QUOTE ARMS CONTROL: OBJECTIVES AND PROSPECTS UNQUOTE IN AUSTIN, TEXAS, TONIGHT (FULL TEXT BY FAX TO ACDD) IS A MEASURED AND CAREFULLY DRAFTED EXPLANATION OF THE US APPROACH AT GENEVA, REAFFIRMING THE ADMINISTRATION'S COMMITMENT TO ARMS CONTROL: EXPLAINING THE RELATIONSHIP BETWEEN MAINTAINING ALLIANCE STRENGTH WHILE SEEKING BALANCED REDUCTIONS: WARNING THAT THE GENEVA ROAD IS LIKELY TO BE LONG: AND CALLING FOR ALLIANCE SOLIDARITY, AND DOMESTIC SUPPORT FOR THE PRESIDENT, DURING THE PROCESS. FOUR US AIMS AT GENEVA ARE OUTLINED: THE ENHANCEMENT OF STRATEGIC STABILITY: REDUCTIONS TO A MORE STABLE BALANCE AT LOWER LEVELS OF FORCES ON BOTH SIDES: EQUALITY, IE AN OUTCOME LEAVING BOTH SIDES WITH QUOTE EQUAL OR EQUIVALENT LEVELS UNQUOTE OF FORCES: AND ADEQUATE VERIFIABILITY.

2. THE CORE OF THE SPEECH IS HOWEVER A DEFENCE/EXPLANATION OF SDI. IT CONTAINS NO SPECIFIC REFERENCE TO THE RUSI SPEECH, BUT EVIDENCE THAT SOME OF THE RUSI POINTS HAVE BEEN HOISTED IN. MIFT CONTAINS KEY EXTRACTS.

FCO PLEASE PASS SAVING ANKARA ATHENS BRUSSELS COPENHAGEN LISBON LUXEMBOURG OTTAWA OSLO REYKJAVIK THE HAGUE

WRIGHT

PRIORITY

NNNN

KFOEC 012/29
PP UKREP BRUSSELS

HofC | LOUGHEAD | SLOCOCK

GRS 1000

+ DELEGATION

UNCLASSIFIED
FM WASHINGTON 290110Z MAR 85
TO PRIORITY FCO
TELEGRAM NUMBER 1107 OF 28 MARCH
INFO PRIORITY MODUK(FOR DACU), UKREP BRUSSELS(FOR PS), UKDEL NATO,
ROUTINE MOSCOW, BONN, PARIS, ROME, UKDIS ~~GENEVA, UKDEL VIENNA~~ AND
UKDEL STOCKHOLM
INFO SAVING OTHER NATO POSTS

MIPT: SHULTZ'S AUSTIN SPEECH: SDI

1. FOLLOWING ARE KEY PASSAGES:-

A. BEGIN SQUARE BRACKETS DETERRENCE END SQUARE BRACKETS

''FOR AT LEAST THE PAST THIRTY YEARS, DETERRENCE HAS RESTED ON THE ULTIMATE THREAT OF OFFENSIVE NUCLEAR RETALIATION: THE UNITED STATES AND THE SOVIET UNION HAVE EACH BEEN HOSTAGE TO THE NUCLEAR FORCES OF THE OTHER. OUR RETALIATORY DETERRENT HAS ENABLE US TO LIVE IN PEACE WITH FREEDOM. WE STRIVE TO DETER WAR WITH THE MINIMUM LEVEL OF MILITARY POWER CONSISTENT WITH THAT PURPOSE. IF THERE IS NO ALTERNATIVE TO THE THREAT OF OFFENSIVE NUCLEAR RETALIATION, THEN THIS IS THE NECESSARY AND MORAL COURSE. BUT IF, WITH ADEQUATE DEFENSES, WE COULD DENY THE POTENTIAL AGGRESSOR ANY HOPE OF ACHIEVING HIS OBJECTIVES THROUGH MILITARY POWER, SO THAT NEITHER SIDE'S POPULATION WAS AT RISK TO THE OTHER, THEN THAT WOULD BECOME THE PREFERABLE AND MORAL COURSE''.....

...''WE RECOGNISE THAT DETERRENCE WILL HAVE TO RELY ON THE THREAT OF OFFENSIVE NUCLEAR RETALIATION FOR MANY YEARS TO COME - THOUGH AT SHARPLY REDUCED LEVELS, IF THE GENEVA TALKS SUCCEED. WITH THIS UNDERSTANDING, WE NOW BEGIN A MAJOR RESEARCH EFFORT: THE SDI''

B. BEGIN SQUARE BRACKETS NITZE CRITERIA END SQUARE BRACKETS

''WE BELIEVE THAT IT WILL BEGIN SQUARE BRACKETS SDI END SQUARE BRACKETS PROVIDE THE BASIS FOR A CONSIDERED JUDGEMENT, SOMETIME IN THE NEXT DECADE, ON THE FEASIBILITY AND PRACTICALITY OF PROVIDING A SHIELD FOR THE UNITED STATES AND OUR ALLIES AGAINST BALLISTIC MISSILES''.....

....''FEASIBILITY MEANS, FIRST, THAT ANY NEW DEFENSIVE SYSTEMS MUST BE REASONABLY SURVIVABLE: IF NOT, THEY MIGHT THEMSELVES BE TEMPTING TARGETS FOR A FIRST STRIKE. SECOND, IT MEANS NOT JUST THAT THE SYSTEMS MUST WORK, BUT THAT THEY MUST BE CHEAPER TO PRODUCE THAN WOULD BE THE NEW OFFENSIVE SYSTEMS NEEDED TO OVERCOME THEM. IN SHORT, THEY MUST BE COST-EFFECTIVE OTHERWISE IT WOULD MAKE SENSE TO PRODUCE OFFENSIVE WEAPONS IN NUMBERS SUFFICIENT TO OVERWHELM THE DEFENSES''....

''THE FEASIBILITY CRITERIA WE HAVE ADOPTED - SURVIVABILITY AND COST- EFFECTIVENESS - ARE DESIGNED PRECISELY TO ENSURE THAT ANY TRANSITION PERIOD IS A STABLE ONE. THUS, SURVIVABILITY MEANS LESS TEMPTATION AND INCENTIVE FOR EITHER SIDE TO ATTACK THESE NEW DEFENSIVE SYSTEMS AT A MOMENT OF POLITICAL CRISIS DURING THE TRANSITION PERIOD. PHASING- IN OF TRULY COST-EFFECTIVE DEFENSIVE SYSTEMS WILL MEAN THAT OFFENSIVE COUNTERMEASURES - SUCH AS PILING UP MORE MISSILES TO SWAMP THE DEFENSES - ARE A LOSING GAME.''

C. BEGIN SQUARE BRACKETS CAMP DAVID END SQUARE BRACKETS

''SDI IS NOT A BID FOR STRATEGIC SUPERIORITY: ON THE CONTRARY, IT WOULD MAINTAIN THE BALANCE, IN LIGHT OF THE RAPID SOVIET PROGRESS IN BOTH OFFENSIVE AND DEFENSIVE SYSTEMS. NOR IS SDI AN ABROGATION OF THE ABM TREATY. PRESIDENT REAGAN HAS DIRECTED THAT THE RESEARCH /RESEARCH

PROGRAMME BE CARRIED OUT IN FULL COMPLIANCE WITH THE TREATY. HE HAS ALSO MADE CLEAR THAT ANY FUTURE DECISION TO DEPLOY DEFENSES THAT WERE NOT PERMITTED BY TREATY WOULD HAVE TO BE A MATTER OF NEGOTIATION.

THIS DOES NOT MEAN GIVING THE SOVIET A VETO OVER OUR DEFENSIVE PROGRAMMES, ANY MORE THAN THE SOVIETS HAVE A VETO OVER OUR CURRENT STRATEGIC AND INTERMEDIATE-RANGE PROGRAMS. BUT OUR COMMITMENT TO NEGOTIATIONS DOES REFLECT A RECOGNITION THAT WE SHOULD SEEK TO MOVE FORWARD IN A COOPERATIVE MANNER WITH THE SOVIETS''..

D.BEGIN SQUARE BRACKETS EUROPEAN DEFENCE END SQUARE BRACKETS

''OUR SDI PROGRAME IS DESIGNED TO ENHANCE ALLIED AS WELL AS US SECURITY. A DECISION TO MOVE FROM RESEARCH TO DEVELOPMENT AND DEPLOYMENT WOULD, OF COURSE, BE TAKEN IN CLOSE CONSULTATION WITH OUR ALLIES. AS THE US AND SOVIET STRATEGIC AND INTERMEDIATE-RANGE NUCLEAR ARSENALS DECLINED SIGNIFICANTLY, WE WOULD SEEK TO NEGOTIATE REDUCTIONS IN OTHER TYPES OF NUCLEAR WEAPONS. IF WE COULD DEVELOP THE TECHNOLOGIES TO DEFEND AGAINST BALLISTIC MISSILES, WE COULD THEN TURN OUR ENERGIES TO THE PERFECTION OF DEFENSIVE MEASURES AGAINST THESE OTHER NUCLEAR WEAPONS. OUR ULTIMATE OBJECTIVE WOULD BE THE ELIMINATION OF THEM ALL.

BY NECESSITY, THIS IS A VERY LONG-TERM GOAL. FOR YEARS TO COME, WE WILL HAVE TO CONTINUE TO BASE DETERRENCE ON THE ULTIMATE THREAT OF NUCLEAR RETALIATION. AND THAT MEANS WE WILL CONTINUE OUR MODERNIZATION PROGRAMMES TO KEEP THE PEACE''.

E. BEGIN SQUARE BRACKETS CRITICISM OF SDI END SQUARE BRACKETS

''SOME ARGUE AGAINST SDI. THEY SAY THE BALANCE OF TERROR HAS WORKED, SO WHY TAMPER WITH IT? THEY ALSO SAY SDI WILL LEAD TO AN OFFENSIVE ARMS RACE AS THE SOVIETS MOVE TO COUNTER OUR DEFENSES -- AS IF THE SOVIETS HAVE NOT BEEN ENGAGED FOR THE PAST TWENTY YEARS IN THE GREATEST OFFENSIVE BUILDUP IN HISTORY, ONE FAR BEYOND LEGITIMATE SECURITY NEEDS. THESE CRITICS OVERLOOK TWO OTHER CENTRAL POINTS THE FIRST IS THAT THE PACE OF TECHNOLOGICAL ADVANCE IN OFFENSIVE WEAPONS -- SUCH AS INCREASING MISSILE ACCURACY AND MOBILITY -- COULD OVER TIME UNDERMINE THE PRINCIPLES ON WHICH THE MUTUAL HOSTAGE RELATIONSHIP HAS RESTED. SDI IS A PRUDENT AND WISE INVESTMENT IN OUR FUTURE SAFETY. IT WOULD ENHANCE, NOT UNDERCUT, DETERRENCE.

THE SECOND POINT THE CRITICS OVERLOOK IS THAT THE SOVIETS HAVE THEIR OWN VERSION OF AN SDI PROGRAM, AND HAVE HAD IT FOR YEARS, LONG BEFOREOURS. BEHIND THE PROPAGANDA ABOUT THE ALLEGED ''MILITARIZATION OF SPACE'' YOU WILL FIND THE EXPENDITURES, THE MILITARY AND RESEARCH PERSONNEL, THE LABORATORIES, TESTING GROUNDS, AND WEAPONS OF AN AMBITIOUS SOVIET STRATEGIC DEFENSE PROGRAM''.

F. BEGIN SQUARE BRACKETS KRASNOYARSK END SQUARE BRACKETS

''THE ABM TEATY LIMITS THE DEPLOYMENT OF BALLISTIC-MISSILE EARLY-WARNING RADARS TO LOCATIONS ALONG THE PERIPHERY OF THE NATIONAL TERRITORY OF EACH PARTY AND REQUIRES THAT THEY BE ORIENTED OUTWARD. AT KRASNOYARSK, ALMOST 400 MILES INSIDE THE FRONTIERS OF THE SOVIET UNION, A NEW RADAR, ORIENTED ACROSS SOVIET TERRITORY, IS UNDER CONSTRUCTION IN VIOLATION OF THE TREATY. OTHER SOVIET ACTIVITIES SUGGEST THAT THE SOVIET UNION MAY BE RREPARING A NATIONWIDE ABM DEFENSE - AN ACTION WHICH, OF COURSE, WOULD ENTIRELY NEGATE THE ABM TREATY.''

WRIGHT

FCO PASS SAVING ANKARA ATHENS BRUSSELS COPENHAGEN LISBON LUXEMBOURG OTTAWA OSLO REYKJAVIK THE HAGUE

NNNNN

14

PRIME MINISTER

STRATEGIC DEFENCE INITIATIVE

You have asked on the attached why I circulated a note of your meeting in Moscow with Vice President Bush.

I am very careful in the notes I do:

(a) not to record particularly sensitive points. In this particular case I noted that Mr.Shultz had said that the ABM Treaty contained a provision by which either side could give notice if they were not satisfied with it; also that by continuing to abide by the Treaty, the Americans were not necessarily saying that the United States would never deploy defensive weapons unless all parties agreed to it. The fact that Weinberger spoke similarly though more explicitly shows that this is becoming a standard American line.

(b) to ensure that the distribution of such notes is rigorously limited. In this case the relevant part of the note was sent only to the Foreign Office and the Ministry of Defence for the information of their Ministers and the most senior officials most directly concerned, as well as to Bryan Cartledge in the Cabinet Office.

Particularly in areas such as SDI where you are running our policy directly, it would really be very difficult if I could not keep your most senior advisers informed of points of major importance. And in any event, the Foreign Secretary, the Ambassador in Moscow and Mr. Broomfield were present at the meeting. It is best in such circumstances to have an authorised version of what was said. But I shall continue to exercise very great discretion.

C.D.P.

28 March 1985

10 DOWNING STREET

From the Private Secretary

Prime Minister

Perhaps I am too suspicious. But it seems to me that one reason why the Defence Secretary proposes a joint European response on SDI research is that he wants build up a body of opinion sceptical of SDI. There doesn't seem any good industrial or scientific reason for a ~~a~~ joint response: so it must be political.

An alternative might be coordinated national responses, in which we each tell the other ~~other~~ how we are going to reply. But retain our national freedom of manoeuvre.

Would you like me to comment on these lines (i.e. my suggested alternative) on your behalf?

CDP 27/3.

Yes please MT

Strictly Personal

10 DOWNING STREET

Prime Minister MS

It is becoming quite widely known that Michael Heseltine and Cap Weinberger are frequently at loggerheads, & that there is no love lost between them.

C.D.P.

OTO

CC NO

MO 26/7/4

FOREIGN AND COMMONWEALTH SECRETARY

STRATEGIC DEFENCE INITIATIVE - PARTICIPATION IN RESEARCH PROGRAMME

The anticipated American initiative on participation in the SDI research programme was unveiled yesterday at the Nuclear Planning Group meeting in Luxembourg. Mr Weinberger circulated to each of his colleagues the attached letter, which is self-explanatory. Mr Weinberger is seeing M. Hernu tomorrow when French participation will no doubt arise and I understand that the Americans are also approaching the Japanese and Israeli Governments. We need to determine the form of our response.

2. Following our discussion about the possibility of a four power - British, German, French and Italian - approach to SDI research, Dr Woerner spoke to me in the margins of the NPG in favour of a concerted European effort. Subsequently, Peter Carrington also took the line that, while it was not a matter for him, he felt that the major European countries should make a joint response to Mr Weinberger's letter. Senatore Spadolini, who was somewhat put out by the Weinberger letter, is also attracted by the idea of a joint European response, which he discussed briefly with me this morning. There remains the question of the French attitude which I shall be able to address with M. Hernu when I see him in Paris next Tuesday at the meeting already arranged to discuss EFA.

3. I see two potential advantages from a joint response. First it would help the process of maintaining a shared European approach to the wider strategic issues raised by the SDI and to counter pressure on individual countries to be sucked in to support

for the SDI going beyond that in the Prime Minister's four points because of the lure of participation in the technologies of the future. Secondly, four major European countries working together could share the benefits of their collaboration so that we all stand to gain from four pieces of research rather than one. I therefore believe that the advantage lies with a concerted approach, which in any case our European partners seem likely to pursue regardless of whether we take part. In following this through, we obviously need to think carefully about those areas of SDI-related research which is is to our greatest national advantage to offer to pursue. The Germans have apparently already addressed this from their point of view. My officials will be in touch about this with other Departments concerned. I would want to co-ordinate with the Department of Trade and Industry specific proposals for any British component in particular collaborative research projects.

4. Some may argue for a European centre of excellence on the CERN model as the mechanism for a joint European contribution. I have reservations myself about an institution of this kind which would rapidly acquire a vested interest in the pursuit of the SDI which might not be helpful to our own effort to think through the issues in political and strategic terms rather than to allow technological and industrial factors to dominate.

5. As to the next step, my own initial preference is that the scope for a joint approach should be pursued through the National Armaments Directors of the four countries. But we shall obviously need to take account of the views of our prospective partners on this.

6. I am copying this minute to the Prime Minister, to the other members of OD and to Sir Robert Armstrong.

(Approved by the Defence Secretary & signed in his absence)

Ministry of Defence
27th March 1985

THE SECRETARY OF DEFENSE
WASHINGTON, THE DISTRICT OF COLUMBIA

March 26, 1985

The Honorable Michael Heseltine
Secretary of State for Defense
United Kingdom

Dear Colleague:

In the period since President Reagan introduced his vision for the Strategic Defense Initiative (SDI), many of our Allies have informally expressed an interest in participating in this research program. At the same time, some of our friends have sought clarification of our policy and attitude toward such cooperation. I am writing to you today both to make clear my Government's views on this important subject and to begin a direct dialogue with you thereon.

As you know, the purpose of the SDI is to determine whether there are cost-effective defensive technologies that could enhance deterrence and increase stability. Because our security is inextricably linked to that of our friends and Allies, we will work closely over the next several years with our Allies to ensure that, in the event of any future decision to deploy defensive systems (a decision in which consultation with our Allies would play an important part), Allied, as well as United States, security against aggression would be enhanced. Moreover, the SDI program will not confine itself solely to an exploitation of technologies with potential against ICBMs and SLBMs, but will also carefully examine technologies with potential against shorter-range ballistic missiles.

The United States will, consistent with our existing international obligations including the ABM Treaty, proceed with cooperative research with the Allies in areas of technology that could contribute to the SDI research program. Pursuant to this policy, the United States is permitted -- and is prepared -- to undertake such cooperative programs on data and technology short of ABM component level as may be mutually agreed with Allied countries.

If your nation is interested in exploring possible cooperative efforts or contributions, I would ask, as a first step, that you send me, within 60 days, an indication of your interest in participating in the SDI research program and of the areas of your country's research excellence that you deem most promising for this program. In order to provide a more comprehensive basis for your assessment of pertinent capabilities and to help expedite the process, the United States is prepared to arrange meetings in Washington so that your government's scientific/technical representatives may receive detailed briefings on the SDI program during this period.

We would expect to give your response prompt consideration with a view to initiating as appropriate bilateral discussions on specific areas and arrangements for cooperation.

Sincerely,

Caspar W. Weinberger

Prime Minister
Weinberger is now, like Shultz, canvassing the possibility of US withdrawal from the ABM Treaty.
C.D.P. 27/3

1B

SECRETARY OF STATE

MO 26/7/4

PRIME MINISTER

STRATEGIC DEFENCE INITIATIVE

I have minuted separately about the US initiative on SDI research at this week's Nuclear Planning Group meeting. I should report separately on a more restricted basis about indications of the American approach on the wider issue of the deployment of defensive systems.

2. After our arrival in Luxembourg, we were faced with American proposals that in the NPG Communique the Alliance as a whole should not only note with concern (and rightly so) the extensive Soviet effort in the field of strategic defence but should go on to "deplore" the new phased array radar under construction at Krasnoyarsk "in violation of the ABM Treaty". This placed me in a difficult position because, as the Americans know, our expert advice is that it is not possible on the current evidence to determine whether or not the radar contravenes the ABM Treaty. I pointed out to the Americans in a private bilateral meeting that I could not agree to a categorical statement in the Communique which was unsupported by my own expert advice and suggested that the right course was to pursue the exchange between experts on both sides, which had already been arranged, in order to establish a jointly agreed position. Moreover, we had to bear in mind the link with the US modernisation of BMEWs facilities at Fylingdales, on which I shall be putting proposals to you shortly, where we could face charges from the Russians of a breach by the Americans of the 1972 Treaty. It seemed sensible therefore in our joint interest to

play down the radar argument at this stage. The crucial consideration for the present was to secure Alliance support for the SDI research programme, on which the British Government's position could not be clearer. It seemed unnecessary to muddy the waters by bringing in disputed violations by the Soviet Union of the ABM Treaty itself.

3. These arguments were not at all well received by Mr Weinberger and his team. They were dismissive of our reservations about whether a violation had been established almost to the point of arguing that they were the only people capable of reaching a judgement. They were uninterested in the potential link with their own BMEWs plans. Notwithstanding their argument that essentially they were dealing with a bilateral US/USSR Treaty and that they were best able to judge whether it had been breached, they were reluctant to accept as a corollary that any statement in the Communique about violations should be expressed as their view. They were determined to obtain a statement on behalf of the Alliance as a whole deploring Soviet violations. Because we could not agree in private, the argument had to be pursued in the NPG meeting itself and agreement on a form of words was eventually reached. This was all very tiresome. The interesting question is why the Americans attached such importance to an Alliance statement on treaty violations.

4. Based upon these discussions over the wording of the Communique itself, my own suspicion was that the Americans see it as an important plank in preparing the Alliance for the deployment of defensive systems to establish clearly in public a record of Soviet violations, coupled with the risk of a Soviet "break-out" from the ABM Treaty. The ground is being prepared - and this process will continue over a series of NPG meetings - for the argument to be used at the appropriate point that the regime established by the Treaty has effectively broken down because of Soviet behaviour and that there is therefore no reason for the US Administration to feel any obligation on its own part to uphold its provisions.

5. This can only be speculation. But its general thrust is reinforced by a comment made to me by Mr Weinberger in an entirely private conversation about the importance of not misunderstanding the significance of the second point agreed at your meeting with President Reagan in December, that is that "SDI-related deployment would, in view of Treaty obligations, have to be a matter for negotiation". He said that the reference to negotiation should not be interpreted in a way which could give the Soviet Union a "veto" over US deployment of strategic defences. The Treaty itself included a provision that either side could withdraw on 6 months notice (in the words of Article XV,2 of the Treaty: "if it decides that extraordinary events related to the subject matter of the Treaty have jeopardised its supreme interests"). The Weinberger interpretation of the need to operate within the framework of the Treaty and by negotiation may therefore be that at the appropriate time notice will be given that this clause is being invoked. The extraordinary events will by then have been set out in succeeding Alliance communiques. This emphasis is not, moreover, limited to Mr Weinberger. I noted with interest that, at your meeting with Vice President Bush on 13th March, Mr Shultz is recorded as making a broadly similar point.

Charles Why was this circulated?

6. Mr Weinberger in the course of my private conversation made the point that, if there was any misunderstanding between us, it should be cleared up quickly. You will appreciate that these events have a particular impact on our judgement about the likely prospects for a successful conclusion to the Geneva talks.

7. I am copying this minute to the Foreign and Commonwealth Secretary and to Sir Robert Armstrong.

[signature]

(Approved by the Defence Secretary & signed in his absence)

Ministry of Defence
27th March 1985

27 MAR 1985

CONFIDENTIAL

FILE

cc: PC

10 DOWNING STREET

From the Private Secretary 27 March 1985

SDI:MESSAGE FROM SHULTZ

Thank you for your letter of 26 March enclosing a draft message from the Foreign Secretary to Secretary Shultz.

The Prime Minister has no objection to this.

(C D Powell)

C Budd Esq
Foreign and Commonwealth Office

OZO

cc PC

(1)

Foreign and Commonwealth Office

London SW1A 2AH

26 March, 1985

MO

Prime Minister

Agree that the Foreign Secretary may reply as he proposes?

CDP

Dear Charles,

SDI: Message from Shultz

The US Embassy delivered to us on 25 March the
/ attached message to the Foreign Secretary from Mr Shultz.

Subject to any comments the Prime Minister may have, the Foreign Secretary intends to reply as in the
/ attached draft.

Yours ever,

Colin Budd

(C R Budd)
Private Secretary

C D Powell Esq
10 Downing Street

CONFIDENTIAL

March 23, 1985

Dear Geoffrey:

I have read with interest your speech of March 15 on "Defense and Security in the Nuclear Age." It is a cogent statement of certain of the strategic issues we may face in the coming year. The questions you raise are indeed important and justify our common attention.

I appreciate your reiterated support for the SDI research program, and am distressed to see your statement widely interpreted by the media as exposing some serious differences between our two governments. I know that Charlie Price has spoken to you of our concern that, as we embark upon a broad and vital new negotiating effort to reduce nuclear arms, and while we here also face crucial congressional votes on our defense budget, any such impression can only be destructive of our common aims.

In your statement you make reference to the possibility that constraints on ASATS might be agreed at an early stage in the current Geneva talks. Having closely examined this issue, we have concluded that such limitations, which in any case raise severe verification and other problems, would not be in our interest. We are accordingly not prepared to consider such restrictions, except perhaps at some later stage in negotiations, in the context of substantial progress toward significant reductions in nuclear arms.

I am sorry we did not have an opportunity to discuss your speech during our meeting in Moscow. Only through the closest possible consultation on these issues, which we have sought to sustain, can we together arrive at the right answers to the many important questions your statement of March 15 poses.

Paul Nitze will, as you know, be in London next week. I hope he will have an opportunity to discuss further some of the issues raised in the speech with you and your colleagues.

Sincerely,

/S/

George Shultz

CONFIDENTIAL

DSR 11 (Revised)

DRAFT: minute/letter/teleletter/despatch/note

TYPE: Draft/Final 1+

FROM:
Secretary of State

Reference

DEPARTMENT: TEL. NO:

SECURITY CLASSIFICATION

Top Secret
Secret
Confidential
Restricted
Unclassified

TO: The Hon George Shultz

Your Reference

Copies to:

PRIVACY MARKING

..................In Confidence

CAVEAT......................

SUBJECT:

Thank you very much for your message of 23 March, which Charlie Price's people delivered on 25 March.

I entirely agree with you about the need to maintain alliance solidarity in relation to the Geneva negotiations and greatly appreciate your recognition that it was no part of the purpose of my speech to imply any serious differences between us. As the Prime Minister and I both made clear in Parliament last week, the speech was firmly based on the four points which she agreed with the President at Camp David. We continue to believe that these reflect a position which all members of the Alliance can endorse and uphold.

As you rightly say, this still leaves a range of important questions which justify our common attention. We shall need to go on tackling these together in a spirit of mutual confidence and understanding.

Enclosures—flag(s)..........

/That

That is why I was particularly interested to read what you had to say of your Administration's conclusions about possible ASAT constraints. I agree with you that this points to the need for the closest possible consultation on all these issues as the Geneva process develops. We are very pleased that Paul Nitze will be in London later this week. I am only sorry that I myself have to be absent when he is here, but I am sure his visit will give a good opportunity for the kind of consultations between us which we both recognise as so important.

Like you, I am sorry we could not find time to talk ~~this~~ all this through in Moscow. We may have a chance when we meet again at Bonn in early May. In any case I much look forward to seeing you again soon.

No 10 J.S.
PRESS OFFICE

IMMEDIATE

BCT VDD015 8503261401 PBD009 8503261401 AG032 ADVANCE COPY

OO FCO

GRS 500
UNCLASSIFIED
FM COM LONDON
TO IMMEDIATE FCO
TELNO RETRACT 106
OF 261342Z MAR 85
AND TO IMMEDIATE NO TEN
IMMEDIATE MOD

SENT 26 MAR 1985

FOR FCO - NEWS DEPT
NO TEN - PRESS OFFICE
MOD - PRESS OFFICE

ITEM: NATO SUPPORTS SDI RESEARCH
BY CHARLES E. SKINNER, LPS DEFENCE CORRESPONDENT

LUXEMBOURG (LPS): PRESIDENT REAGAN'S STRATEGIC DEFENCE INITIATIVE (SDI) WAS THE MAIN FOCUS OF DISCUSSION AT THE START OF NATO'S NUCLEAR PLANNING GROUP (NPG) MEETING HERE TODAY, 26 MARCH.

AS IS TRADITIONAL AT THESE TWICE-YEARLY GATHERINGS OF ALLIANCE DEFENCE MINISTERS (14 NATO NATIONS, INCLUDING THE UNITED KINGDOM, CONTRIBUTE TO THE NPG), US DEFENCE SECRETARY CASPAR WEINBERGER STARTED BY GIVING A BRIEFING ON NUCLEAR FORCES, WITH THE EMPHASIS ON STRATEGIC STOCKS.

ACCORDING TO A BRITISH OFFICIAL, THE NEWS WAS ALL ABOUT SDI. MR WEINBERGER, IT IS UNDERSTOOD, ANNOUNCED THAT HE WILL BE FORMALISING HIS INVITATION FOR ALLIANCE GOVERNMENTS AND INDUSTRIES TO PARTICIPATE IN THE RESEARCH PROGRAMME. INDEED, AN INVITATION IS EXPECTED TO BE ISSUED TODAY AND MR WEINBERGER WILL BE LOOKING FOR A FORMAL RESPONSE FROM AMERICA'S ALLIES, BUT NOT AT THIS MEETING.

AS A BRITISH OFFICIAL OBSERVED: ''THE RESEARCH PHASE IS LIKELY TO BE LONG, SO WE ARE NOT UNDER IMMEDIATE PRESSURE FOR AGREEMENTS. HE STRESSED THAT THERE HAD BEEN UNANIMOUS SUPPORT FOR THE UNITED STATES' COMMITMENT TO RESEARCH.

MR WEINBERGER REPORTEDLY DESCRIBED THE RESEARCH PROGRAMME ITSELF AS ''AGGRESSIVE.'' A BRITISH OFFICIAL SAID THIS WAS IN THE SENSE THAT WASHINGTON WANTED TO DISCOVER JUST WHAT COULD BE DONE AS SOON AS POSSIBLE UNDER THE SDI PROGRAMME. THE US WANTED TO IDENTIFY WHAT THE NATO ALLIES COULD DO - HOW THEY COULD PARTICIPATE IN THE SCHEME.

BESIDES WANTING TO INVOLVE ALLIANCE COUNTRIES, THE STATES WOULD LIKE TO INVITE SOME NON-MEMBERS TO PLAY A PART AND, QUESTIONED ON THIS, A BRITISH OFFICIAL SAID HE ASSUMED THAT JAPAN WOULD BE INVITED TO CONTRIBUTE. ON THE OVERALL QUESTION OF INVOLVING NON-ALLIANCE COUNTRIES IN RESEARCH, HE SAID THIS HAD BEEN GENERALLY WELCOMED AROUND THE TABLE

BRITAIN'S POSITION OF SUPPORT FOR RESEARCH INTO SDI IS WELL KNOWN, WITH PRIME MINISTER MARGARET THATCHER HAVING PUBLICLY SUPPORTED IT. THE GENERAL FEELING OF THIS MORNING'S MEETING WAS THAT IS WAS IMPOSSIBLE AT THIS EARLY STAGE TO JUDGE SDI DEPLOYMENT.

SOURCES MADE THE POINT THAT THERE WAS ABSOLUTELY NO INTENTION OF UNDERMINING OTHER NATO STRATEGIES AS A RESULT OF SDI RESEARCH. A BRITISH OFFICIAL SAID THAT THE NPG HAD BEEN ABLE TO GET MORE CLOSELY TO GRIPS WITH THE REAL ISSUES: ''TO AGREE RESEARCH, TO MAINTAIN ALLIANCE SOLIDARITY - BUT NATO STRATRGY THE REST IS IN THE FUTURE.'' ANOTHER BRITISH SOURCE ALSO UNDERLINED THAT ALLIANCE STRATEGY NOW IS RIGHT, ''AND THE NPG HAS PUT THIS IN PERSPECTIVE. WHAT WE HAVE TO DO NOW IS LOOK TO THE FUTURE.''

NATO SECRETARY-GENERAL LORD CARRINGTON TOLD PRESSMEN THAT THE MEETING HAD BEEN HARMONIOUS AND FRUITFUL. AGREEMENT BETWEEN THE ALLIES, INCLUDING BRITAIN, ON THE VALIDITY OF SDI RESEARCH, IS AN IMPORTANT ACHIEVEMENT. AS A BRITISH OFFICIAL OBSERVED, IT WOULD BE TOTALLY COUNTER PRODUCTIVE IF THERE WERE DISAGREEMENT ON THE PROGRAMME AS EARLY AS THE RESEARCH STAGE.

NPG MINISTERS MEET AGAIN THIS AFTERNOON AND AGAIN TOMORROW MORNING. (LPS)

ENDS

COMMENTS BY MR NEIL KINNOCK ON HIS VISIT TO NATO ON 6TH MARCH 1985

He described America as "a cherished ally - a permanent ally, I hope," (Daily Telegraph 7th March 1985). According to The Times, Mr Kinnock did not think there would ever be an alliance with the Soviet Union.

Mr Kinnock said that a Labour Government would meet any defence obligations that arose "for for our defence and for NATO obligations", but promised that cruise missiles would "go back". (Daily Telegraph 7th March 1985)

He warned against any retaliation by the United States for a future British Government did enforce such a withdrawal. It would be "fool-hardy to jeopardise the alliance" simply because one member took an action of which others disapproved. (Financial Times 7th March 1985)

Labour opposition to SDI spelt out by Kinnock

FT 7/3/85

BY QUENTIN PEEL IN BRUSSELS

MR NEIL KINNOCK, leader of the British Labour Party, yesterday spelt out his strong opposition to the U.S. Star Wars initiative, and repeated his determination to remove cruise missiles from Britain if his party wins the next election.

He put over this firm line in talks with Lord Carrington, Nato's secretary-general, and other senior officials at the alliance headquarters in Brussels.

Mr Kinnock described the U.S. move to start research into the so-called Strategic Defence Initiative as "itself an embarkation on the arms race."

"The U.S. is starting on a road whose end is not given sufficient attention," he declared. "No one has given any indication as to when research turns to production and produtcion turns to deployment. There is a quantum leap from research to deployment."

He criticised Mrs Margaret Thatcher, the British Prime Minister, for "being prepared simply to follow in the wake of the U.S." on the question of the research into nuclear weapons in space.

The SDI had been the main topic of his discussions, he said. Labour Party policy to remove cruise missiles from Britain and close U.S. nuclear bases had not been critcised specifically.

He warned against any retaliation by the U.S. if a future British government did enforce such a withdrawal. It would be "foolhardy to jeopardise the alliance" simply because one member took an action of which others disapproved.

TIMES
7/03/75.

1985 ☆ ☆ ☆

'Star Wars' condemned by Kinnock at Nato

**From Ian Murray
Brussels**

Mr Neil Kinnock went to Nato headquarters in Brussels yesterday and told Lord Carrington, the Secretary-General, that he was "extremely hostile" to the idea of research into "Star Wars" technology. The British Labour leader was on his first visit to the headquarters, aware that his party's unilateralist stance is causing grave concern among many members of the alliance.

But his "extremely amicable" hour-long meeting with the Secretary-General concentrated on the American research programme for Star Wars, officially known as the Strategic Defence Initiative. Mr Kinnock said afterwards that his party could not share Mrs Thatcher's enthusiasm for it.

He had told Lord Carrington that Nato had not understood the full implications of backing such a programme. Although research in itself was "relatively benevolent", there was no way of knowing when research turned into production and production into deployment.

Allowing research to go ahead meant starting a new kind of arms race. He was equally hostile to any similar project being undertaken by the Soviet Union. He had emphasized Labour's continuing commitment to Nato and believed it was fully understood in the alliance that the next Labour Government would meet its obligations in defence effectively.

He looked to the United States as "a cherished and permanent ally" and did not think there would ever be an alliance with the Soviet Union.

He promised that "cruise missiles are going back on the election of a Labour Government", but Nato understood.

"They recognize the importance of a decision by a sovereign government which has been duly elected.

"There is no point in Nato cutting off its nose to spite its face. If a withdrawal of cruise were to come about – as it will come about – it would be foolhardy for the others to object simply because a duly elected government was taking steps which it is perfectly entitled to take."

Cautious Craxi, page 6

Kinnock tells Nato he would kick out cruise

By ALAN OSBORN Common Market Correspondent in Brussels

MR KINNOCK, Labour leader, said yesterday at Nato headquarters in Brussels that a Labour government would immediately remove American cruise missiles from Britain and press for the adoption of a non-nuclear defence programme.

Following what he called a "cordial" meeting with Lord Carrington, Nato Secretary-General, Mr Kinnock said he also opposed President Reagan's Strategic Defence Initiative — the so-called "Star Wars" programme.

Mr Kinnock nevertheless described America as "a cherished ally—a permanent ally, I hope."

He said that a Labour government would meet any defence obligations that arose "both for our defence and for Nato obligations," but promised that cruise missiles would "go back."

Mr Kinnock, who was accompanied by Mr Denzil Davies, Labour defence spokesman, said he would be pleased if the Belgian government decides against the deployment of cruise. This would be a "useful addition" to the general campaign to bar the weapon.

TRUDEAU CALL

'Oppose space plan'

OUR TORONTO CORRESPONDENT writes: Mr Trudeau, former Canadian premier, yesterday urged Canada to strongly oppose America's space defence plan, which was "so dangerous" because it fuelled the arms race and increased the danger of nuclear war.

He was speaking to University students in Montreal. Canada's Conservative Government has taken the position that America is being prudent in researching space defence, but should not deploy it because it would violate international treaties.

D Tel
7/3/75.

CONFIDENTIAL

cPS

DA
CP3

10 DOWNING STREET

From the Private Secretary 1 March 1985

SDI Testing/ABM Treaty

Thank you for your letter of 28 February about possible American plans for testing the components of a ballistic missile defence system.

The Prime Minister has noted this.

I am sending copies of this letter to Richard Mottram (Ministry of Defence) and Richard Hatfield (Cabinet Office).

(Charles Powell)

L.V. Appleyard, Esq.,
Foreign and Commonwealth Office.

CONFIDENTIAL

0lo

CONFIDENTIAL

cc PC.

(2)

Prime Minister

I'm pretty sure that this letter is based on a report which I saw in Aviation Week. We need to establish officially exactly what the Americans intend to do, before we make any sort of protest. CDP 28/2.

Foreign and Commonwealth Office

London SW1A 2AH

28 February 1985

Dear Charles,

SDI Testing/ABM Treaty

During her press conference in Washington on 21 February the Prime Minister emphasised the "many, many years" which would have to elapse between starting research on ballistic missile defence and coming to any possibility of deployment. This has hitherto been our clear understanding of the proposed US time-scale for the SDI, on the basis of numerous briefings from the Americans themselves, most recently confirmed by Nitze's speech on 20 February to the World Affairs Council of Philadelphia ("... it will not be for many, many years, perhaps well into the next century").

You may however like to be aware of a recent development which shows the fragility of this timetable in the hands of at least one important US spokesman. US press reports last week quoted General Abrahamson, Director of the SDI programme in the Pentagon, as saying that the schedule for some aspects of testing in space of tracking and targeting systems against missiles had been brought forward by two years to 1987. As part of the new testing programme, it was also reported that the US could use "active ballistic missile targets". This would in itself appear to demonstrate an ABM intention. However, Article V(i) of the ABM Treaty specifically bans the development, testing or deployment of space-based ABM systems or components. To that extent, these reports give rise for concern about the possible impact on the Treaty of this new move.

Official US statements to Congress at the time of the Treaty's ratification in 1972 support the view that field testing beyond the laboratory stage is prohibited. In the words of the major White House statement on the SDI of 3 January, the Treaty "does permit research short of field testing of a prototype ABM system or component. This is the type of research that will be conducted under the SDI program". General Abrahamson assured the NATO Allies in Brussels on 14 February that all testing under the SDI research programme had been independently examined to ensure conformity with the Treaty. On the other hand, some US officials have begun to argue that field testing of SDI-related technologies is permissible under the Treaty, on the grounds that these are not solely applicable to BMD purposes and do not constitute stand-alone substitutes for an existing or deployable ABM system.

/There

CONFIDENTIAL

There is a clear possibility that such arguments will increasingly be used to justify steps along the BMD road that appear to run counter to President Reagan's repeated assertion that the SDI involved only research, as permitted under the ABM Treaty; to Mr McFarlane's statement to the Prime Minister on 9 January that "the US wanted to restore the integrity (of the Treaty)"; and to the assertion in the President's Report of 5 February to Congress on Soviet compliance that one of the US objectives in the Geneva negotiations is "to reverse the erosion of the ABM Treaty". Piecemeal activities relevant to the grey areas of the Treaty could risk undoing its central provisions much sooner than would otherwise be expected. (This might not be regretted by some in the Pentagon such as Mr Richard Perle, who has said that the Treaty "was a mistake in 1972 and the sooner we face up to the implications of recognising that mistake the better".) In any case, increased public interest can be expected in these aspects of Treaty compliance, which have already evoked some predictable criticism from the Russians. The latter will inevitably seek to capitalise on the contrast between SDI activities and US accusations (which at this stage we are not in a position entirely to endorse) of Soviet violations of the ABM Treaty.

Sir Geoffrey Howe therefore proposes that officials should engage the Americans in further discussion of General Abrahamson's latest remarks, at the next convenient opportunity. (The topic is also likely to arise in the course of discussion with our major European Allies.) Our aim would be to reach, if possible, a common and publicly defensible position on how the potential ambiguities in the Treaty should be interpreted.

I am sending copies of this letter to Richard Mottram (Ministry of Defence), and to Richard Hatfield and Bryan Cartledge (Cabinet Office).

Yours ever,

Len Appleyard

(L V Appleyard)
Private Secretary

C D Powell Esq
10 Downing Street

OFFICIAL TEXT

February 21, 1985

UNITED STATES INFORMATION SERVICE, U.S. EMBASSY, 55/56 UPPER BROOK STREET, LONDON W1A 2LH

NITZE OUTLINES U.S. STRATEGIC CONCEPT FOR NEXT TEN YEARS

(Text: Speech to Philadelphia World Affairs Council)

Philadelphia -- Paul Nitze, special adviser on arms control to the President and the Secretary of State, says the U.S. objective during the next 10 years is a "radical reduction in the power of existing and planned offensive nuclear arms."

In a speech to the World Affairs Council in Philadelphia February 20, Nitze said the concept also includes the "stabilization of the relationship between offensive and defensive nuclear arms, whether on earth or in space."

"We are even now looking forward to a period of transition to a more stable world," he said, "with greatly reduced levels of nuclear arms and an enhanced ability to deter war based upon an increasing contribution of non-nuclear defenses against offensive nuclear arms."

Nitze said the period of transition could lead to the eventual elimination of all nuclear arms, both offensive and defensive.

"A world free of nuclear arms is an ultimate objective to which we, the Soviet Union, and all other nations can agree," he said.

He said the United States envisages the transition period as "a cooperative effort" with the Soviet Union, hopefully leading to "effective non-nuclear defenses" which could make possible the eventual elimination of nuclear weapons in the arsenals of the Soviet Union and the United States.

Following is the text of Nitze's remarks:

INTRODUCTION

Since the dawn of the nuclear age forty years ago, there have been countless proposals to eliminate nuclear weapons from the face of the earth. That has been the professed objective of both the Soviet Union and the United States. But until recently it has not been a practical goal.

The President is determined to do more, to look even now toward a world in which nuclear weapons have in fact been eliminated. The present situation -- in which the threat of massive nuclear retaliation is the ultimate sanction, the key element of deterrence, and thus the basis for security and peace -- is unsatisfactory. It has kept the peace for forty years, but the potential costs of a breakdown are immense and, because of continuing massive Soviet deployments of both offensive and defensive weaponry, are not becoming less. If we can, we must find a more reliable basis for security and for peace.

This concern prompted the President's decision to proceed with the Strategic Defense Initiative. He has directed the scientific community to determine if new cost-effective defensive technologies are feasible that could be introduced into force structures so as to produce a more stable strategic relationship. We envisage, if that search is successful, a cooperative effort with the Soviet Union, hopefully leading to an agreed transition toward effective non-nuclear defenses that might make possible the eventual elimination of nuclear weapons.

THE STRATEGIC CONCEPT

In preparing for Secretary Shultz's January meeting with Foreign Minister Gromyko, we developed a strategic concept encompassing our view of how we would like to see the U.S.-Soviet strategic relationship evolve in the future. That concept provides the basis for our approach to next month's talks in Geneva. It can be summarized in four sentences:

During the next ten years, the U.S. objective is a radical reduction in the power of existing and planned offensive nuclear arms, as well as the stabilization of the relationship between offensive and defensive nuclear arms, whether on earth or in space. We are even now looking forward to a period of transition to a more stable world, with greatly reduced levels of nuclear arms and an enhanced ability to deter war based upon an increasing contribution of non-nuclear defenses against offensive nuclear arms. This period of transition could lead to the eventual elimination of all nuclear arms, both offensive and defensive. A world free of nuclear arms is an ultimate objective to which we, the Soviet Union, and all other nations can agree.

It would be worthwhile to dwell on this concept in some detail. To begin with, it entails three time phases: the near term, a transition phase, and an ultimate phase.

THE NEAR TERM

For the immediate future, at least the next ten years, we will continue to base deterrence on the ultimate threat of nuclear retaliation. We have little choice; today's technology provides no alternative.

That being said, we will press for radical reductions in the number and power of strategic and intermediate-range nuclear arms. Offensive nuclear arsenals on both sides are entirely too high and potentially destructive, particularly in the more destabilizing categories such as the large MIRVed Soviet ICBM and SS-20 forces.

At the same time, we will seek to reverse the erosion that has occurred in the Anti-Ballistic Missile Treaty regime, erosion that has resulted from Soviet actions over the last ten years. These include the construction of a large phased-array radar near Krasnoyarsk in central Siberia, in violation of the ABM Treaty's provisions regarding the location and orientation of ballistic missile early warning radars.

For the near term, we will be pursuing the SDI research program -- in full compliance with the ABM Treaty, which permits such research. Likewise, we expect the Soviets will continue their investigation of the possibilities of new defensive technologies, as they have for many years.

We have offered to begin discussions in the upcoming Geneva talks with the Soviets as to how we might together make a transition to a more stable and reliable relationship based on an increasing mix of defensive systems.

THE TRANSITION PERIOD

Should new defensive technologies prove feasible, we would want at some future date to begin such a transition, during which we would place greater reliance on defensive systems for our protection and that of our allies.

The criteria by which we will judge the feasibility of such technologies will be demanding. The technologies must produce defensive systems that are survivable; if not, the defenses would themselves be tempting targets for a first strike. This would decrease, rather than enhance, stability.

New defensive systems must also be cost-effective at the margin, that is, it must be cheap enough to add additional defensive capability so that the other side has no incentive to add additional offensive capability to overcome the defense. If this criterion is not met, the defensive systems could encourage a proliferation of countermeasures and additional offensive weapons to overcome deployed defenses, instead of a redirection of effort from offense to defense.

As I said, these criteria are demanding. If the new technologies cannot meet these standards, we are not about to deploy them. In that event, we would have to continue to base deterrence on the ultimate threat of nuclear retaliation. However, we hope and have expectations that the scientific community can respond to the challenge.

We would see the transition period as a cooperative endeavor with the Soviets. Arms control would play a critical role. We would, for example, envisage continued reductions in offensive nuclear arms.

Concurrently, we would envisage the sides beginning to test, develop, and deploy survivable and cost-effective defenses at a measured pace, with particular emphasis on non-nuclear defenses. Deterrence would thus begin to rely more on a mix of offensive nuclear and defensive systems, instead of on offensive nuclear arms alone.

The transition would continue for some time, perhaps for decades. As the U.S. and Soviet strategic and intermediate-range nuclear arsenals declined significantly, we would need to negotiate reductions in other types of nuclear weapons and involve, in some manner, the other nuclear powers.

THE ULTIMATE PERIOD

Given the right technical and political conditions, we would hope to be able to continue the reduction of nuclear weapons down to zero.

The global elimination of nuclear weapons would be accompanied by wide-spread deployments of effective non-nuclear defenses. These defenses would provide assurance that were one country to cheat, for example, by clandestinely building ICBMs or shorter range systems, such as SS-20s, it would not be able to achieve any exploitable military advantage. To overcome the deployed defenses, cheating would have to be on such a large scale that there would be sufficient notice so that counter-measures could be taken.

Were we to reach the ultimate phase, deterrence would be based on the ability of the defense to deny success to a potential aggressor's attack. The strategic relationship could then be characterized as one of mutual assured security.

COMMENTS

Having thus outlined our strategic concept, let me offer some comments, and perhaps anticipate some of your questions.

First, the concept is wholly consistent with deterrence. In both the transition and ultimate phases, deterrence would continue to provide the basis for the U.S.-Soviet strategic relationship.

Deterrence requires that a potential opponent be convinced that the risks and costs of aggression far outweigh the gains he might hope to achieve. The popular discussion of deterrence has focused almost entirely on one element, that is, posing to an aggressor high potential costs through the ultimate threat of nuclear retaliation.

But deterrence can also function if one has the ability, through defense and other military means, to deny the attacker the gains he might otherwise have hoped to realize. Our intent is to shift the deterrent balance from one which is based primarily on the ultimate threat of devastating nuclear retaliation to one in which non-nuclear defenses play a greater and greater role. We believe the latter provides a far sounder basis for a stable and reliable strategic relationship.

My second comment is that we recognize that the transition period -- if defensive technologies prove feasible and we decide to move in that direction -- could be tricky. We would have to avoid a mix of offensive and defensive systems that, in a crisis, would give one side or the other incentives to strike first. That is precisely why we would seek to make the transition a cooperative endeavor with the Soviets, and have offered even now to begin talking with them about the issues that would have to be dealt with in such a transition.

My third comment is that we realize that a world from which nuclear weapons have been eliminated would still present major risks. The technique of making nuclear weapons is well known; that knowledge cannot be excised. The danger of break-out or cheating would continue. Moreover, there would also be the potential problem of suitcase nuclear bombs and the like.

But even if all risks cannot be eliminated, they can be greatly reduced. Nothing is wholly risk-free; one must compare the alternatives. It seems to me that the risks posed by cheating or suitcase bombs in a world from which nuclear arms had been eliminated from military arsenals would be orders of magnitude less than the risks and potential costs posed by a possible breakdown in the present deterrence regime based upon the ultimate threat of massive nuclear retaliation.

THE GENEVA TALKS

U.S. and Soviet delegations will meet in Geneva in roughly three weeks time to begin negotiations on nuclear and space arms. In those talks, we will advance positions consistent with and designed to further the concept I have outlined.

At the end of January, I was asked by the press whether I was confident about the outcome of the upcoming talks. I replied that I was more confident than previously -- that is before the Geneva meeting between Mr. Shultz and Mr. Gromyko -- but I still wasn't very confident; we must bear in mind that there are profound differences of approach between the two sides.

In Geneva, Mr. Gromyko stated the Soviet position clearly and unambiguously. It has since then been repeated by many Soviet commentators.

The Soviets insist on the "non-militarization" of space; by that they mean a ban on all arms in space that are designed to attack objects in space or on earth, and all systems on earth that are designed to attack objects in space. They have expressed opposition to research efforts into such systems, in spite of their own sizeable efforts in this field, which include the only currently operational ABM and anti-satellite systems.

As to offensive arms reductions, the Soviets have yet to acknowledge legitimacy to our concern about the threat we see in their large highly MIRVed ICBM force. They continue to demand compensation for British and French nuclear forces, and assert that U.S. Pershing II and ground-launched cruise missiles somehow represent a more odious threat than that posed to NATO Europe by the hundreds of SS-20 missiles now deployed.

In addition, the Soviets maintain that the three subject areas -- strategic nuclear, intermediate-range nuclear, and defense and space arms -- must not only be discussed in their interrelationship, but that it is not possible to implement an agreement in one area without agreement in the others. We believe otherwise; if the sides come to agreement in one area, we see no sense in a self-denying rule that would prevent the sides from implementing an agreement that would serve the interests of both.

There are obvious differences. We will present our views and listen carefully to Soviet proposals.

We do not expect the Soviets to accept immediately our viewpoint or our concept as to how the future strategic relationship should evolve. The negotiators have their work cut out for them; the process will be complex and could well be lengthy. But with persistence, patience and constructive ideas, we hope the Soviets will come to see the merits of our position -- that it will serve their national interests as well as ours.

CONCLUSION

At the beginning of my remarks, I noted that the elimination of nuclear weapons has often seemed an impractical goal, one which has received little more than lip service. As you can see, the United States is going beyond that; the president has initiated a serious effort to see how it can be accomplished.

We do not underestimate the difficulties in reaching that objective. Quite frankly, it may prove impossible to obtain, and, even if we do eventually reach it, it will not be for many, many years, perhaps well into the next century.

But we cannot be anything but uneasy about the current situation, in which the nuclear arsenals of the world total tens of thousands of nuclear weapons. We owe it to our children, our grandchildren, to hold out for and to work toward some brighter vision for the future.

----

covering SECRET AND PERSONAL

(12)

From the Secretary of the Cabinet

Prime Minister

Two very interesting minutes

CDP 18/2

Mr Powell

The Prime Minister may find it interesting to glance at the attached note by Dr F. H. Panton, who has taken Dr Press's place as our (Cabinet Office) consultant on the scientific aspects of defence nuclear matters.

RTA

18. ii. 85

Mr Powell

I attach a supplementary note from Dr Panton, which Sir Robert Armstrong has not yet seen. I would be grateful if both notes could be returned in due course

[illegible] 18.2.85.

SIR ROBERT ARMSTRONG

SDI RESEARCH PROGRAMME

It is not necessary to have faith in the ultimate success of SDI in fielding in space an effective ballistic missile defence system in order to identify advantages to the UK and to the West in general in taking up current American invitations to cooperate actively with the US in the SDI research programme.

Even if we believe that cooperation, for lack of success or other reasons, will not lead to "turnkey" sharing of systems (if any) ultimately deployed, more immediate possible benefits may be argued in favour of cooperation now. First, active cooperation might enable the UK to gain a better insight than would otherwise have been possible into the progress or otherwise of the SDI programme. Second, and perhaps as important, the SDI programme may produce, as "spin off", concepts which may be applicable to the present nuclear strategic confrontation, and may therefore have to be taken into account in our strategic defence plans on a more immediate timescale than the 21st century. Third, standing aside from SDI is not likely to increase the weight of whatever advice the UK may wish to offer to the US in future on the progress of arms control talks.

Fourth, while the prospects for UK firms gaining contracts within the SDI programme will always be small, they are likely to be that much smaller in the absence of active research cooperation.

A major disadvantage to cooperation is obvious. Active cooperation in the SDI research programme is likely to lend credence and life to the "Star Wars" concept, which is highly controversial even in the US, and which, at best, is very doubtful of realistic achievement of its objectives in whole or in part, and at worst is held to be destablising. Active cooperation in SDI research could be held to be consistent with the agreed Camp David press statement of 22 December 1984, but it would be difficult to maintain a distinction between cooperation in SDI research on the one hand, and support for "Star Wars"on the other. However, refusal of research cooperation will not make the SDI programme go away. The President has invested sufficient political capital in the "Star Wars" concept to make it likely that a substantial SDI programme of some type will be around for the next four years.

It would be idle to try to weigh up these advantages and disadvantages if the UK cannot in any event make a useful contribution to SDI research. An across the board in depth contribution, or anything approaching to it, is for a variety of reasons, impossible for the UK. It is, however, possible that the MOD may have research capabilities on a few selected topics such as sensors, lasers, data reduction and handling, and damage mechanisms, which could be made relevant to SDI objectives. To do so would probably entail reassessment of existing priorities, and some high priority topics already under way might have to suffer. At the most, no more than a dozen or so scientists might be involved. Such a contribution would obviously be very modest when seen against the broad sweep of the US SDI programme. Nevertheless, as in other fields, the US may welcome even this degree of support in specific areas and be quite generous in information exchanges resulting from the cooperation.

If the inclination is to consider this matter further I suggest the next step is to get the MOD to say what cooperation in SDI research on what selected topics from among its present capabilities and resources might be usefully offered to the US, at what damage to other programmes. It might then be possible to take an overall view on how to proceed.

Frank Panton.

F.H. PANTON

12 February 1985
D/06

SECRET AND PERSONAL

CABINET OFFICE
A 1365
18 FEB 1985
FILING INSTRUCTIONS
FILE No. ....

SIR ROBERT ARMSTRONG

SDI RESEARCH PROGRAMME

Further to my minute of 12th February (D/06).

2. In the continuing discussion of the SDI research programme and "Star Wars", there is an important point which tends to get buried.

3. The programme clearly envisages staged timescales on which technological issues may be demonstrated by research as feasible and therefore candidates for development and deployment. Technological problems connected with the boost, post boost and mid course phases, with survivability of space based components and with overall battle management (particularly software design), may be in the research phase from 10 to 20 years, while logistics problems such as a launch vehicle to lift 100 metric tons in space and a multimegawatt power source for space applications, may be in research for 5-10 years. However, on a shorter time scale, within this decade, feasibility demonstrations may have been for instance made of a high power ground based laser, an airborne optical platform to assist in discrimination in the time just before re-entry, and of an endoatmospheric non-nuclear interceptor.

4. In other words, feasibility of difficult and new technologies in the boost phase, post boost phase, midcourse phase, and concerned with overall battle management is unlikely to be demonstrated until the mid to late 1990s, and, allowing for the study's optimism, somewhat later than that. On the other hand technologies associated essentially with ground based terminal defence may be proved by the end of this decade, and be available for deployment in the 1990s. Ground based terminal defence technology research has of course formed part of the US research programme before SDI came along and has been subsumed in the SDI programme.

5. In effect the SDI programme may lead to the possible development by the early 1990s of a ground based ABM system, up dated, but of a type generically similar to that permitted under the ABM treaty, but not so far deployed by the US. It could be argued perhaps that the ground based laser and an airborne optical adjunct are additions not specified as ABM components in the Treaty. In addition, of course, limitation to one site and 100 launchers would apply. Whether the US would want to deploy an ABM system of this type on its own, and if so where, must be a matter for conjecture, but it might for instance, be seen to give some protection to one of the US ICBM complexes. The rest of the objectives of the SDI research programme in the mid course, post boost and boost phases, whose deployment would contravene

/the

the ABM Treaty, will still be in research well into the late 1990s.

6. There are two conclusions I would draw from this. First, it will be well into the late 1990s before the SDI programme begins to run foul of the ABM Treaty in any substantial fashion. Second, the early products of SDI research, within the next five or so years, will largely concern ground based ABM systems in the terminal phase, and hence may have a bearing on the present strategic confrontation within the timescale of the UK Trident procurement programme. This underlines the argument for some UK participation in SDI research, in order to keep abreast of developments possibly having a bearing on the UK's own programme.

pp. F.H. PANTON

15 February 1985
D/08

Dictated by Dr. Panton, but signed in his absence.

O10

cc BTA CDP

MO 26/7/4

Prime Minister
You say this in your Congress speech.
CDP 10/2

PRIME MINISTER

STRATEGIC DEFENCE INITIATIVE: MR WEINBERGER'S VIEWS

Cap Weinberger and I attended last weekend's conference at Ditchley Park on "The US/UK Relationship in the Field of Defence and Security". The Strategic Defence Initiative (SDI) was a major talking point, and I thought you might find it useful to have an account of his remarks on the subject.

2. Weinberger made strong claims for the SDI. The aim of the initiative was clear: to achieve an absolutely reliable defensive system which allowed missiles to be destroyed by non-nuclear means outside the atmosphere. Each side would be rendered absolutely invulnerable. Both the US and the Russians were roughly equal in offensive weapons. The Russians for their part were also "very defensive minded"; they were spending a lot on defence endeavours. He had "rather complete" confidence that the SDI would work. Indeed he took encouragement from the consensus among scientists that the goal was not achievable; Einstein himself had been a lone voice. The US would not want to stop at research. They would share the technology. Allies must not worry that the SDI would turn the US into "fortress America". The cost would be much less than that of carrying on indefinitely with the improvement of offensive systems. As long as the present administration was in office, it would press ahead, and he hoped that America's friends would join in the effort.

3. Weinberger seemed little concerned, if at all, with the significance of the SDI for the forthcoming arms control negotiations. He took no account of the prospect that if the goal of a complete defence proves unattainable, the SDI will provide an incentive towards the multiplication of offensive systems and a further spiral in the arms race. I see

little hope for securing reductions in offensive systems at Geneva if, as he appeared to imply, the intention to proceed with the SDI, beyond the research phase if research proves fruitful, is inflexible. His remarks strongly reinforce what should, I believe, be our main objective next week in Washington of persuading President Reagan that while research on the SDI is a prudent hedge against Soviet efforts and must continue, anything beyond that must, in the spirit of the four points agreed between you and the President last month, be a matter for negotiation.

4. I am copying this to the Foreign and Commonwealth Secretary and to Sir Robert Armstrong.

Ministry of Defence
15th February 1985

18 FEB 1985

RESTRICTED

GRS 440
RESTRICTED
FM BONN 121145Z FEB 85
TO PRIORITY FCO
TELEGRAM NUMBER 116 OF 12 FEBRUARY
INFO PRIORITY MODUK, WASHINGTON, PARIS, UKDEL NATO (FOR WESTON)

GERMAN VIEWS ON SDI

SUMMARY
1. GERMAN LINE ON SDI BECOMING MORE FAVOURABLE. KOHL AND WOERNER SPEAKING PUBLICLY OF EUROPEAN PARTICIPATION IN SDI RESEARCH PROGRAMME, ON CERTAIN CONDITIONS.

DETAIL
2. SPEAKING AT THE WEHRKUNDE CONFERENCE IN MUNICH AT THE WEEKEND, KOHL SAID THE ''MORAL/PHILOSOPHIC'' ORIGINS OF SDI MUST BE TAKEN SERIOUSLY. HE CHALLENGED THE UNITED STATES TO ISSUE FORMAL INVITATIONS FOR EUROPEAN PARTICIPATION IN THE RESEARCH PROGRAMME. HE SUPPORTED GERMAN PARTICIPATION ON CERTAIN CONDITIONS:

A) THE FRG WOULD WATCH THE ARMS CONTROL AND STRATEGIC ASPECTS CAREFULLY: STRATEGIC INSTABILITY, PARTICULARLY DURING THE TRANSITIONAL PHASE, MUST BE AVOIDED:
B) ALLIANCE UNITY MUST BE MAINTAINED, AND ZONES OF DIFFERENTIAL SECURITY AVOIDED:
C) THE PROGRAMME WOULD GIVE THE US A SIGNIFICANT TECHNOLOGICAL LEAP FORWARD AND THE EUROPEAN ALLIES SHOULD NOT BECOME TECHNOLOGICALLY DEPENDENT. THE TECHNICAL/SCIENTIFIC COOPERATION SHOULD NOT BE A ONE-WAY STREET.

3. WEINBERGER AND WOERNER MET IN THE FRG YESTERDAY. THE FORMER TOLD THE PRESS AFTERWARDS THAT THE AMERICANS WOULD NOW SEND A FORMAL INTER-GOVERNMENTAL NOTE INVITING ALLIES TO PARTICIPATE IN SDI RESEARCH. WEINBERGER REPORTEDLY DISTINGUISHED IN THIS CONNEXION BETWEEN RESEARCH INTO THE QUESTION WHETHER STRATEGIC DEFENCE WAS POSSIBLE AND ACTUAL DEVELOPMENT OF SDI SYSTEMS.

4. WOERNER SAID THAT GERMAN AND EUROPEAN COOPERATION IN THE PROGRAMME WOULD ONLY ARISE IF THE US LIFTED ALL TECHNOLOGICAL RESTRICTIONS, AND IF THEREFORE THERE WERE ''NO SECRETS''. THE FRG WOULD ONLY TAKE PART IF PARTICIPATION WERE GENUINE. THE GERMAN DECISION WOULD BE TAKEN AFTER FURTHER DETAILED US BRIEFINGS (A TOP LEVEL TEAM IS TO VISIT THE FRG SOON). WOERNER STRESSED THAT THE RESULTS OF THE RESEARCH SHOULD BE AVAILABLE TO ALL PARTICIPANTS. THIS WAS NOT THE SAME AS TRANSFER OF TECHNOLOGY, IE THE SUPPLY OF TECHNOLOGICAL CAPABILITY FROM ONE PARTNER TO ANOTHER.

5. PRESS COMMENT TODAY AND YESTERDAY IS WIDESPREAD. THEMES INCLUDE:

RESTRICTED /(A)

?? A) DIFFERING ALLIED VIEWS: FRG READY FOR COOPERATION, FRANCE AND BRITAIN AT WEHRKUNDE CRITICAL OR SCEPTICAL. POSSIBLE ALLIANCE FRICTION AHEAD.

B) RISK OF EUROPE MISSING OUT ON TECHNOLOGICAL LEAP FORWARD: POTENTIAL EUROPEAN INDUSTRIAL INTEREST.

6. RUEHE, THE TOP FOREIGN AFFAIRS DEFENCE SPOKESMAN OF THE CDU PARLIAMENTARY PARTY, TELLS ME THAT NITZE REASSURED HIM YESTERDAY THAT THE AMERICANS WOULD GIVE PRIORITY TO INF IN THE GENEVA NEGOTIATIONS. RUEHE SEEMED CONVINCED. ON SDI HE RECOGNISED THAT US OFFERS OF RESEARCH COLLABORATION WERE DESIGNED IN PART TO CREATE PRO-SDI LOBBIES IN EUROPE. BUT HE ARGUED THAT THE EUROPEANS SHOULD BE ABLE TO CONTINUE TO ADVOCATE THEIR VIEWS ON NON-INDUSTRIAL, EG STRATEGIC AND ARMS CONTROL, ASPECTS OF SDI TO THE AMERICANS WHILE PARTICIPATING IN RESEARCH.

MALLABY

(REPEATED AS REQUESTED)

US/SOVIET ARMS CONTROL TALKS
LIMITED

DEFENCE D	PS	ADDITIONAL DISTRIBUTION
ACDD	PS/LADY YOUNG	ARMS CONTROL TALKS
SOVIET D	PS/MR RIFKIND	
NEWS D	PS/MR LUCE	
NAD	PS/PUS	
EED	MR DEREK THOMAS	
WED	MR GOODALL	
PLANNING STAFF	MR JENKINS	
RESEARCH D	MR WESTON	
INFO D	MR DAVID THOMAS	
PUSD		

10 DOWNING STREET

From the Private Secretary

11 February, 1985

The Prime Minister was grateful for your two notes about your breakfast with Henry Kissinger and about Enoch Powell's speech.

(C.D. Powell)

The Lord Thomas of Swynnerton.

Addressed to C.R.

With Compliments

I'd be v. glad if you'd game these two papers to the PM. The first is not a surprise to you

Hugh

HOUSE OF LORDS
LONDON SW1A 0PW

MO

Prime Minister
CDP
7/2.

Prime Minister

At breakfast this morning, Dr Henry Kissinger told me that he thought the S.D.I. was the only way out of our nuclear dilemma. In the long run he believes we will not be able to sustain a defence based on the idea of launching a nuclear attack in response to a conventional war. Even now he doubts if anyone around President Reagan would advise, say, a nuclear attack on Kiev in response to a Russian takeover of Berlin: particularly not Nancy Reagan who, in his opinion, would be the determining voice if she were around at the time when the President had to take a decision of this nature (and she would make it her business to be around). In the long run, he thought that Western public opinion would be certain to move towards unilateral nuclear disarmament. Not, of course, with you as Prime Minister and with Reagan as President, but in the long run. Strategic defence was a way of avoiding this.

Dr Kissinger thought that the most likely outcome from a successful series of negotiations at Geneva over arms control would consist of some version of SALT II which would differ from that old negotiation enough for Reagan to claim that it would be a new departure, but perhaps merely at best limit warheads to something like three-quarters of their present level. On I.N.F., in which the Russians have lost interest because of S.D.I., there would be some token withdrawals. As part of the package there would be a moratorium on both testing and deployment of S.D.I. which he personally thought would be a great mistake since, he argued, the West has never reneged on a moratorium or anything. (After the discussion it occured to me that the new American bomber might be an exception to this).

The benefits of S.D.I.,as Dr Kissinger saw them,were not only the above but that although, of course, the Russians would always be able to penetrate a shield of the sort envisaged, they

.../ would

would not know which ~~ones they were~~ (missiles would get through). He did not accept that the Russians were more dangerous when they were worried, as the European conventional wisdom seems to suggest. On the contrary, he thought that it was only when they were worried that they came to the negotiating table. He had heard, of course, of the hesitations caused by S.D.I. in the minds of Europeans on the grounds that it might threaten the "balance" between West and East, but had there ever been a time before when statemen were worried about such an imbalance when it was in their own favour?

Dr Kissinger wanted to congratulate you on what he took to be the outcome of the miners' strike, and thought this was a great victory not only for sanity but for the principle of resolution in these matters.

The principal occasion of this breakfast, you might like to know, was that Henry Kissinger is hoping to be able to put at my disposal all his collected papers, now in the Library of Congress, for a study which I am envisaging on US foreign policy in relation to the Soviet Union. He has, however, not found a way of giving me, a foreigner, access to these papers without making them available to all his enemies!

Hugh Thomas

Note: he thought Jean Kirkpatrick was a real possibility for Secretary of State if & when George Schultz steps down (in the summer of 1986); & for the Vice Presidency in 1988.

LORD THOMAS

February 6, 1985

RESTRICTED file

10 DOWNING STREET

From the Private Secretary

2 February 1985

STRATEGIC DEFENCE INITIATIVE

Thank you for your letter of 31 January enclosing a summary of published knowledge of the technical aspects of the Strategic Defence Initiative. The Prime Minister was grateful for this.

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

(C.D. Powell)

Denis Brennan, Esq.,
Ministry of Defence

RESTRICTED

SECRET UK EYES A

10 DOWNING STREET

From the Private Secretary 1 February 1985

Strategic Defence Initiative:
Effectiveness against Cruise Missiles

Thank you for your letter of 31 January giving an assessment of the effectiveness of the various components of a ballistic missile defence system against Cruise missiles.

The Prime Minister was grateful for this.

I am sending a copy of this letter to Peter Ricketts (Foreign and Commonwealth Office) and Richard Hatfield (Cabinet Office).

(C.D. Powell)

Denis Brennan, Esq.,
Ministry of Defence

SECRET UK EYES A

cc FCO

13 10

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

SECRETARY OF STATE

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

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

Charles Powell Esq
No 10 Downing Street

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.

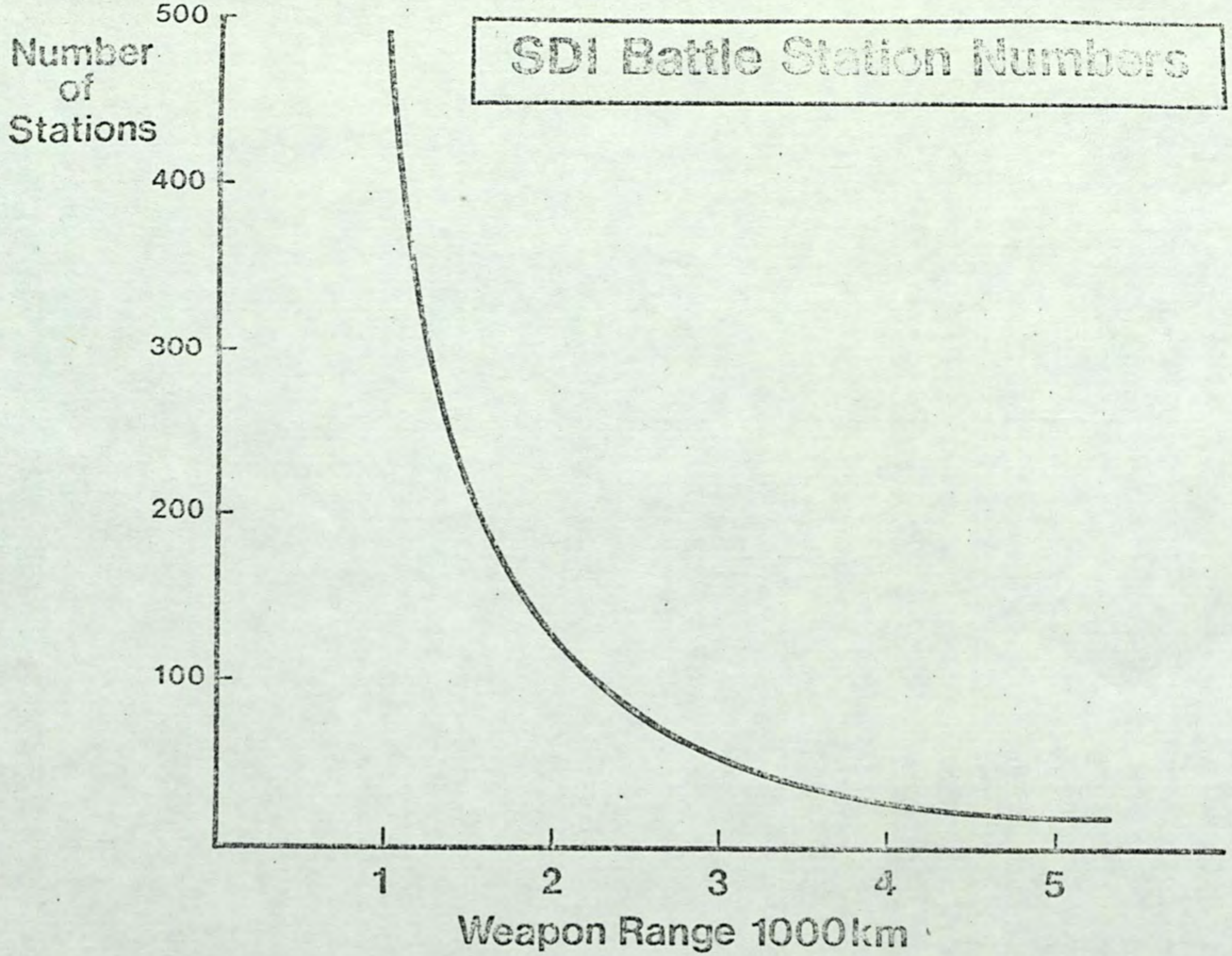
4) Terminal phase, lasting one minute or less, when the individual RVs enter the atmosphere. This is the area of current ABM defences the capabilities of which are widely known. It is not included in the proper SDI programme as such, but is funded under other headings.

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.

ANNEX B

Established 1845 SCIENTIFIC AMERICAN October 1984 Volume 251 Number 4

Space-based Ballistic-Missile Defense

President Reagan's "Star Wars" program seems unlikely ever to protect the entire nation against a nuclear attack. It would nonetheless trigger a major expansion of the arms race

by Hans A. Bethe, Richard L. Garwin, Kurt Gottfried and Henry W. Kendall

For two decades both the U.S. and the U.S.S.R. have been vulnerable to a devastating nuclear attack, inflicted by one side on the other in the form of either a first strike or a retaliatory second strike. This situation did not come about as the result of careful military planning. "Mutual assured destruction" is not a policy or a doctrine but rather a fact of life. It simply descended like a medieval plague—a seemingly inevitable consequence of the enormous destructive power of nuclear weapons, of rockets that could hurl them across almost half of the globe in 30 minutes and of the impotence of political institutions in the face of such momentous technological innovations.

This grim development holds different lessons for different people. Virtually everyone agrees that the world must eventually escape from the shadow of mutual assured destruction, since few are confident that deterrence by threat of retaliation can avert a holocaust indefinitely. Beyond this point, however, the consensus dissolves. Powerful groups in the governments of both superpowers apparently believe that unremitting competition, albeit short of war, is the only realistic future one can plan for. In the face of much evidence to the contrary they act as if the aggressive exploitation for military purposes of anything technology has to offer is critical to the security of the nation they serve. Others seek partial measures that could at least curb the arms race, arguing that this approach has usually been sidetracked by short-term (and shortsighted) military and political goals. Still others have placed varying degrees of faith in radical solutions: novel political moves, revolutionary technological advances or some combination of the two.

President Reagan's Strategic Defense Initiative belongs in this last category. In his televised speech last year calling on the nation's scientific community "to give us the means of rendering these nuclear weapons impotent and obsolete" the president expressed the hope that a technological revolution would enable the U.S. to "intercept and destroy strategic ballistic missiles before they reached our own soil or that of our allies." If such a breakthrough could be achieved, he said, "free people could live secure in the knowledge that their security did not rest upon the threat of instant U.S. retaliation."

Can this vision of the future ever become reality? Can any system for ballistic-missile defense eliminate the threat of nuclear annihilation? Would the quest for such a defense put an end to the strategic-arms race, as the president and his supporters have suggested, or is it more likely to accelerate that race? Does the president's program hold the promise of a secure and peaceful world or is it perhaps the most grandiose manifestation of the illusion that science can re-create the world that disappeared when the first nuclear bomb was exploded in 1945?

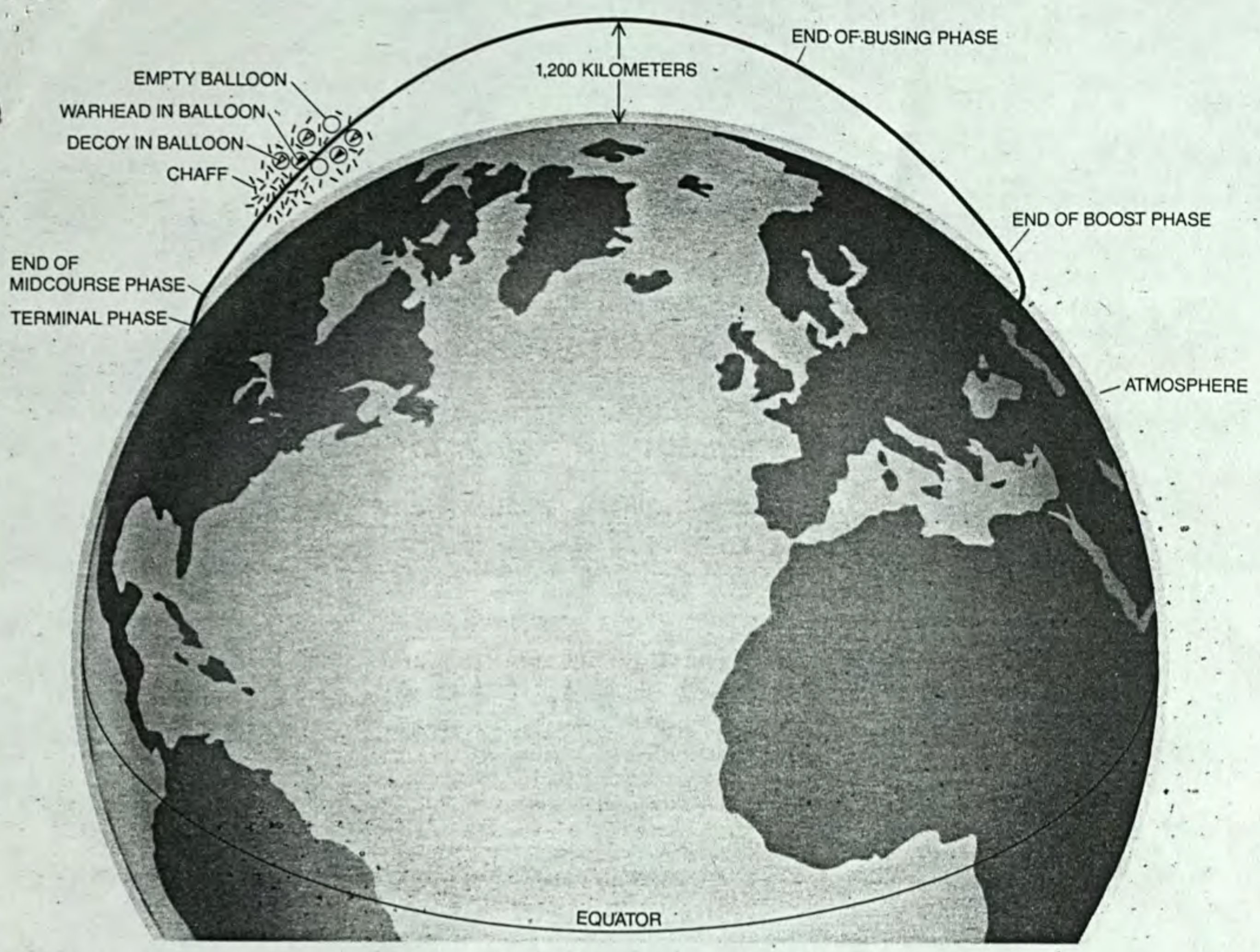
These are complex questions, with intertwined technical and political strands. They must be examined carefully before the U.S. commits itself to the quest for such a defense, because if the president's dream is to be pursued, space will become a potential field of confrontation and battle. It is partly for this reason the Strategic Defense Initiative is commonly known as the "Star Wars" program.

This article, which is based on a forthcoming book by a group of us associated with the Union for Concerned Scientists, focuses on the technical aspects of the issue of space-based ballistic-missile defense. Our discussion of the political implications of the president's Strategic Defense Initiative will draw on the work of two of our colleagues, Peter A. Clausen of the Union for Concerned Scientists and Richard Ned Lebow of Cornell University.

The search for a defense against nuclear-armed ballistic missiles began three decades ago. In the 1960's both superpowers developed anti-ballistic-missile (ABM) systems based on the use of interceptor missiles armed with nuclear warheads. In 1968 the U.S.S.R. began to operate an ABM system around Moscow based on the Galosh interceptor, and in 1974 the U.S. completed a similar system to protect Minuteman missiles near Grand Forks Air Force Base in North Dakota. (The U.S. system was dismantled in 1975.)

Although these early efforts did not provide an effective defense against a major nuclear attack, they did stimulate two developments that have been dominant features of the strategic landscape ever since: the ABM Treaty of 1972 and the subsequent deployment of multiple independently targetable reentry vehicles (MIRV's), first by the U.S. and later by the U.S.S.R.

In the late 1960's a number of scientists who had been involved in investi-



FOUR DISTINCT PHASES are evident in the flight of an intercontinental ballistic missile (ICBM). In boost phase the missile is carried above the atmosphere by a multistage booster rocket. Most modern strategic missiles carry multiple independently targetable reentry vehicles (MIRV's), which are released sequentially by a maneuverable "bus" during the busing, or postboost, phase. If the country under attack had a ballistic-missile-defense system, the bus would also dispense a variety of "penetration aids," such as decoys, balloons enclosing MIRV's and decoys, empty balloons, radar-reflecting wires called chaff and infrared-emitting aerosols. During the midcourse phase the heavy MIRV's and the light penetration aids would follow essentially identical trajectories. In the terminal phase this "threat cloud" would reenter the atmosphere, and friction with the air would retard the penetration aids much more than the MIRV's. For ICBM's the flight would last between 25 and 30 minutes; for submarine-launched ballistic missiles (SLBM's) it could be as short as eight to 10 minutes.

MISSILE	GROSS WEIGHT (KILOGRAMS)	END OF BOOST PHASE: TIME (SECONDS)	END OF BOOST PHASE: ALTITUDE (KILOMETERS)	END OF BUSING: TIME (SECONDS)	END OF BUSING: ALTITUDE (KILOMETERS)	USUAL PAYLOAD
SS-18	220,000	300	400	?	?	10 MIRV'S ON ONE BUS
MX	89,000	180	200	650	1,100	10 MIRV'S ON ONE BUS
MX WITH FAST-BURNING BOOSTER	87,000	50	90	60	110	SEVERAL MICROBUSES WITH MIRV'S AND PENETRATION AIDS
MIDGETMAN	19,000	220	340	—	—	SINGLE WARHEAD
MIDGETMAN WITH FAST-BURNING BOOSTER	22,000	50	80	—	—	SINGLE WARHEAD WITH PENETRATION AIDS

CHARACTERISTICS OF FIRST TWO PHASES in the flight of an ICBM are given for five missiles: the SS-18, a very large, multiple-warhead ICBM already deployed by the U.S.S.R.; the MX, a large, multiple-warhead ICBM currently under development by the U.S.; the Midgetman, a smaller, single-warhead ICBM now in the early planning stages in the U.S., and two hypothetical missiles comparable to the MX and the Midgetman that have been specifically designed to counter a boost-phase ballistic-missile-defense system. In this case the assumption is that both missiles would be equipped not only with suitable penetration aids but also with fast-burning boosters, thereby reducing the time available for the defense to detect their infrared emission. The SS-18 is constrained under the terms of the SALT II Treaty to carry no more than 10 MIRV's; it is actually capable of carrying 30 or more smaller warheads. A single-warhead missile such as Midgetman need have no bus and hence there would be no distinction in its case between the postboost phase and the midcourse phase. The table is adapted from a report prepared by Ashton B. Carter for the Congressional Office of Technology Assessment.

gating the possibility of ballistic-missile defense in their capacity as high-level advisers to the U.S. Government took the unusual step of airing their criticism of the proposed ABM systems both in congressional testimony and in the press [see "Anti-Ballistic-Missile Systems," by Richard L. Garwin and Hans A. Bethe; SCIENTIFIC AMERICAN, March, 1968]. Many scientists participated in the ensuing debate, and eventually a consensus emerged in the scientific community regarding the flaws in the proposed systems.

The scientists' case rested on a technical assessment and a strategic prognosis. On the technical side they pointed out that the systems then under consideration were inherently vulnerable to deception by various countermeasures and to preemptive attack on their exposed components, particularly their radars. On the strategic side the scientists argued that the U.S.S.R. could add enough missiles to its attacking force to ensure penetration of any such defense. These arguments eventually carried the day, and they are still germane. They were the basis for the ABM Treaty, which was signed by President Nixon and General Secretary Brezhnev in Moscow in May, 1972. The ABM Treaty formally recognized that not only the deployment but also the development of such defensive systems would have to be strictly controlled if the race in offensive missiles was to be contained.

MIRV's were originally conceived as the ideal countermeasure to ballistic-missile defense, and in a logical world they would have been abandoned with the signing of the ABM Treaty. Nevertheless, the U.S. did not try to negotiate a ban on MIRV's. Instead it led the way to their deployment in spite of repeated warnings by scientific advisers and the Arms Control and Disarmament Agency to senior Government officials that MIRV's would undermine the strategic balance and ultimately be to the advantage of the U.S.S.R. because of its larger ICBM's. The massive increase in the number of nuclear warheads in both strategic arsenals during the 1970's is largely attributable to the introduction of MIRV's. The result, almost everyone now agrees, is a more precarious strategic balance.

The president's Strategic Defense Initiative is much more ambitious than the ABM proposals of the 1960's. To protect an entire society a nationwide defense of "soft" targets such as cities would be necessary; in contrast, the last previous U.S. ABM plan—the Safeguard system proposed by the Nixon Administration in 1969—was intended to provide only a "point" defense of "hard" targets such as missile silos and command bunkers. The latter mission could be accomplished by a quite permeable terminal-defense system that intercepted warheads very close to their targets, since a formidable retaliatory capability would remain even if most of the missile silos were destroyed. A large metropolitan area, on the other hand, could be devastated by a handful of weapons detonated at high altitude; if necessary, the warheads could be designed to explode on interception.

To be useful a nationwide defense would have to intercept and eliminate virtually all the 10,000 or so nuclear warheads that each side is currently capable of committing to a major strategic attack. For a city attack it could not wait until the atmosphere allowed the defense to discriminate between warheads and decoys. Such a high rate of attrition would be conceivable only if there were several layers of defense, each of which could reliably intercept a large percentage of the attacking force. In particular, the first defensive layer would have to destroy most of the attacking warheads soon after they left their silos or submerged submarines, while the booster rockets were still firing. Accordingly boost-phase interception would be an indispensable part of any defense of the nation as a whole.

Booster rockets rising through the atmosphere thousands of miles from U.S. territory could be attacked only from space. That is why the Strategic Defense Initiative is regarded primarily as a space-weapons program. If the president's plan is actually pursued, it will mark a turning point in the arms race perhaps as significant as the introduction of ICBM's.

Several quite different outcomes of the introduction of space weapons have been envisioned. One view (apparently widely held in the Reagan Administration) has been expressed most succinctly by Robert S. Cooper, director of the Defense Advanced Research Projects Agency. Testifying last year before the Armed Services Committee of the House of Representatives, Cooper declared: "The policy for the first time recognizes the need to control space as a military environment." Indeed, given the intrinsic vulnerability of space-based systems, the domination of space by the U.S. would be a prerequisite to a reliable ballistic-missile defense of the entire nation. For that reason, among others, the current policy also calls for the acquisition by the U.S. of antisatellite weapons [see "Antisatellite Weapons," by Richard L. Garwin, Kurt Gottfried and Donald L. Hafner; SCIENTIFIC AMERICAN, June].

The notion that the U.S. could establish and maintain supremacy in space ignores a key lesson of the post-Hiroshima era: a technological breakthrough of even the most dramatic and unexpected nature can provide only a temporary advantage. Indeed, the only outcome one can reasonably expect is that both superpowers would eventually develop space-based ballistic-missile-defense systems. The effectiveness of these systems would be uncertain and would make the strategic balance more precarious than it is today. Both sides will have expanded their offensive forces to guarantee full confidence in their ability to penetrate defenses of unknown reliability, and the incentive to cut one's own losses by striking first in a crisis will be even greater than it is now. Whether or not weapons deployed in space could ever provide a reliable defense against ballistic missiles, they would be potent antisatellite weapons. As such they could be used to promptly destroy an opponent's early-warning and communications satellites, thereby creating a need for critical decisions at a tempo ill suited to the speed of human judgment.

Our analysis of the prospects for a space-based defensive system against ballistic-missile attack will focus on the problem of boost-phase interception. It is not only an indispensable part of the currently proposed systems but also what distinguishes the current concept from all previous ABM plans. On the basis of our technical analysis and our assessment of the most likely response of the U.S.S.R. we conclude that the pursuit of the president's program would inevitably stimulate a large increase in the Russian strategic offensive forces, further reduce the chances of controlling events in a crisis and possibly provoke the nuclear attack it was designed to prevent. In addition the reliability of the proposed defense would remain a mystery until the fateful moment at which it was attacked.

Before assessing the task of any defense one must first examine the likely nature of the attack. In this case we shall concentrate on the technical and military attributes of the land-based ICBM and on how a large number of such missiles could be used in combination to mount a major strategic attack.

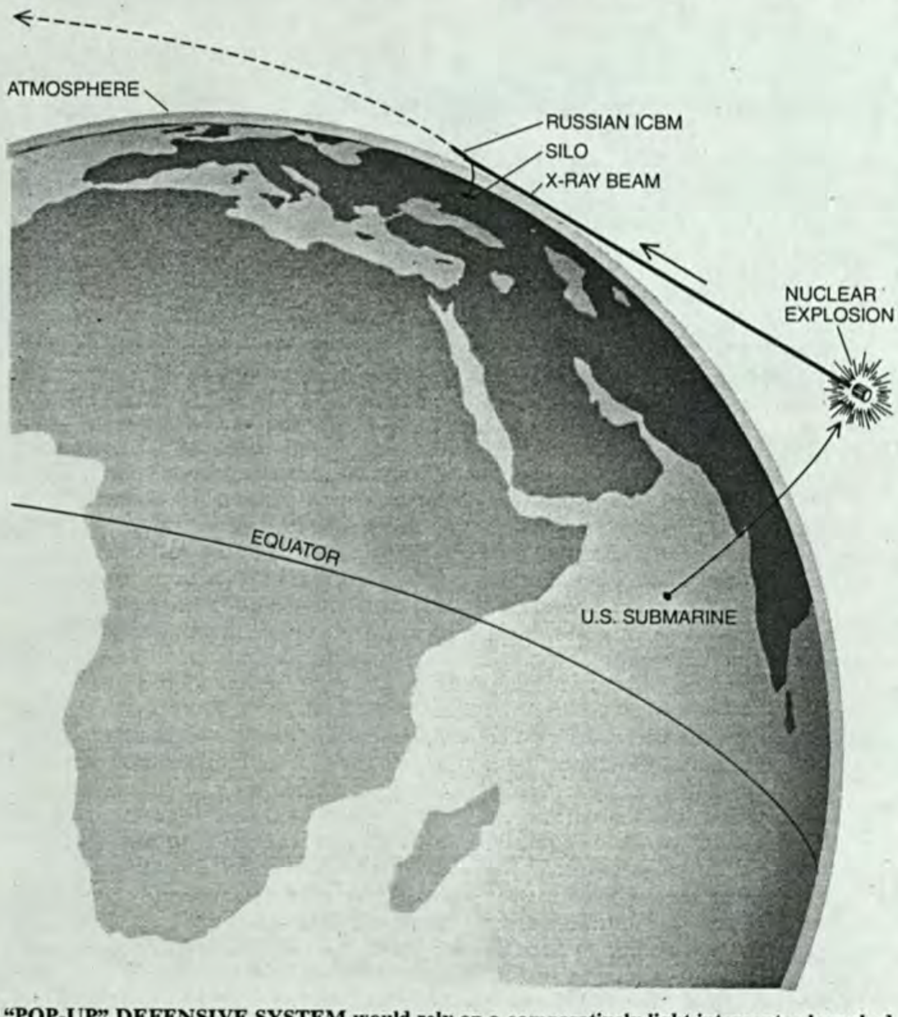
The flight of an ICBM begins when the silo door opens and hot gases eject the missile. The first-stage booster then ignites. After exhausting its fuel the first stage falls away as the second stage takes over; this sequence is usually repeated at least one more time. The journey from the launch point to where the main rockets stop burning is the boost phase. For the present generation of ICBM's the boost phase lasts for three to five minutes and ends at an altitude of 300 to 400 kilometers, above the atmosphere.

A typical ICBM in the strategic arsenal of the U.S. or the U.S.S.R. is equipped with MIRV's, which are dispensed by a maneuverable carrier vehicle called a bus after the boost phase ends. The bus releases the MIRV's one at a time along slightly different trajectories toward their separate targets. If there were defenses, the bus could also release a variety of penetration aids, such as lightweight decoys, reentry vehicles camouflaged to resemble decoys, radar-reflecting wires called chaff and infrared-emitting aerosols. Once the bus had completed its task the missile would be in midcourse. At that point the ICBM would have proliferated into a swarm of objects, each of which, no matter how light, would move along a ballistic trajectory indistinguishable from those of its accompanying objects. Only after the swarm reentered the atmosphere would the heavy, specially shaped reentry vehicles be exposed as friction with the air tore away the screen of lightweight decoys and chaff.

This brief account reveals why boost-phase interception would be crucial: every missile that survived boost phase would become a complex "threat cloud" by the time it reached midcourse. Other factors also amplify the importance of boost-phase interception. For one thing, the booster rocket is a much larger and more fragile target than the individual reentry vehicles are. For another, its flame is an abundant source of infrared radiation, enabling the defense to get an accurate fix on the missile. It is only during boost phase that a missile reveals itself by emitting an intense signal that can be detected at a large distance. In midcourse it must first be found by illuminating it with microwaves (or possibly laser light) and then sensing the reflected radiation, or by observing its weak infrared signal, which is due mostly to reflection of the earth's infrared radiation.

Because a nationwide defense must be capable of withstanding any kind of strategic attack, the exact nature of the existing offensive forces is immaterial to the evaluation of the defense. At present a full-scale attack by the U.S.S.R. on the U.S. could involve as many as 1,400 land-based ICBM's. The attack might well begin with submarine-launched ballistic missiles (SLBM's), since their unpredictable launch points and short flight times (10 minutes or less) would lend the attack an element of surprise that would be critical if the national leadership and the ground-based bomber force were high-priority targets.

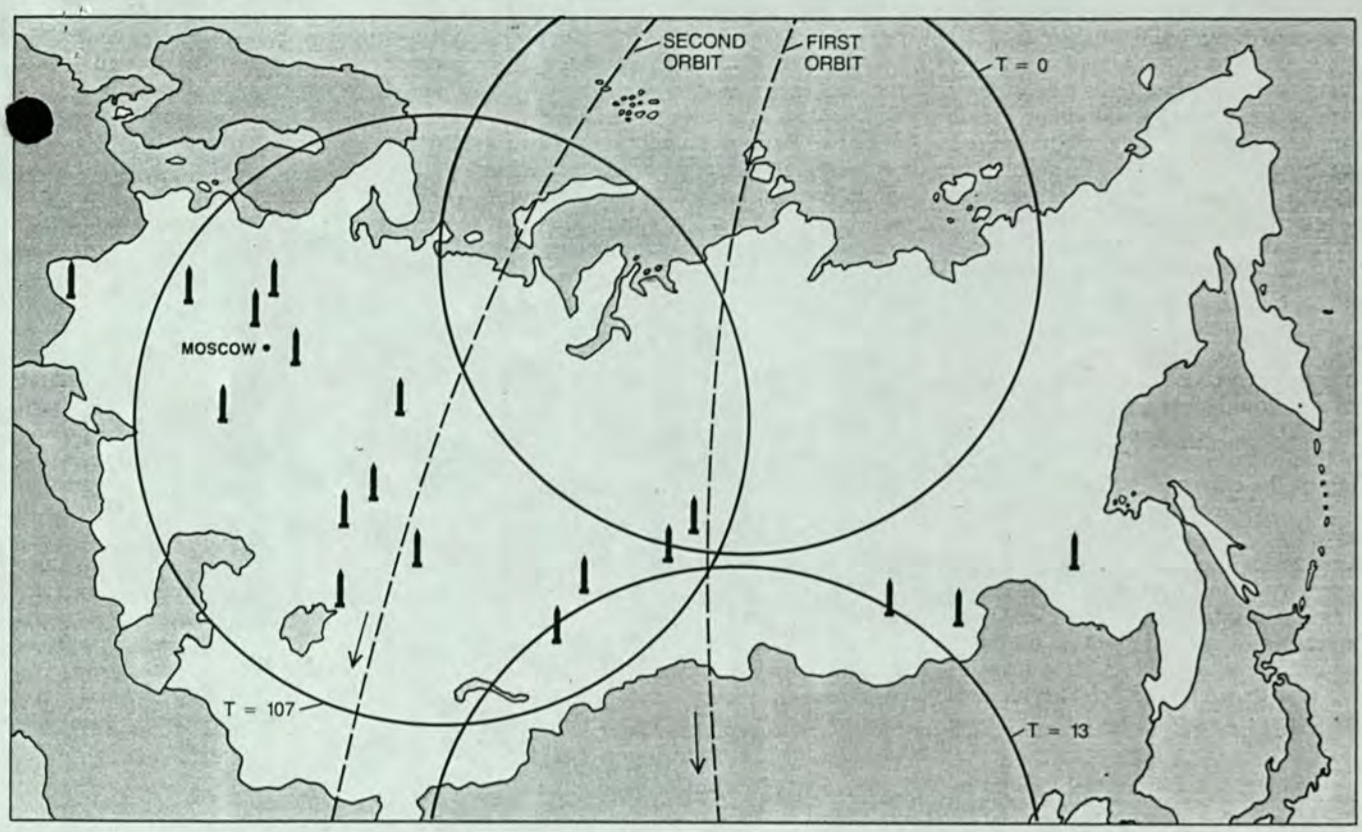
SLBM's would be harder to intercept than ICBM's, which spend 30 minutes or so on trajectories whose launch points are precisely known. Moreover, a space-based defense system would be unable to intercept ground-hugging cruise missiles, which can deliver nuclear warheads to distant targets with an accuracy that is independent of range. Both superpowers are developing sea-launched cruise missiles, and these weapons are certain to become a major part of their strategic forces once space-based ballistic-missile-defense systems appear on the horizon.



"POP-UP" DEFENSIVE SYSTEM would rely on a comparatively light interceptor launched from a submarine stationed in waters as close to the Russian ICBM fields as possible (in this case in the northern Indian Ocean). At present the leading candidate for this mission is the X-ray laser, a device consisting of a nuclear explosive surrounded by a cylindrical array of thin metallic fibers. Thermal X rays from the nuclear explosion would stimulate the emission of a highly directed beam of X-radiation from the fibers in the microsecond before the device was destroyed. In order to engage ICBM's similar to the MX rising out of the closest missile silos in the U.S.S.R. while they were still in their boost phase, the interceptor would have to travel at least 940 kilometers from the submarine to the point where the device would be detonated.

The boost-phase layer of the defense would require many components that are not weapons in themselves. They would provide early warning of an attack by sensing the boosters' exhaust plumes; ascertain the precise number of the attacking missiles and, if possible, their identities; determine the trajectories of the missiles and get a fix on them; assign, aim and fire the defensive weapons; assess whether or not interception was successful, and, if time allowed, fire additional rounds. This intricate sequence of operations would have to be automated, because the total duration of the boost phase, now a few minutes, is likely to be less than 100 seconds by the time the proposed defensive systems are ready for deployment.

If a sizable fraction of the missiles were to survive boost-phase interception, the midcourse defensive layer would have to deal with a threat cloud consisting of hundreds of thousands of objects. For example, each bus could dispense as many as 100 empty aluminized Mylar balloons weighing only 100 grams each. The bus would dispense reentry vehicles (and possibly some decoy reentry vehicles of moderate weight) enclosed in identical balloons. The balloons and the decoys would have the same optical and microwave "signature" as the camouflaged warheads, and therefore the defensive system's sensors would not be able to distinguish between them. The defense would have to disturb the threat cloud in some way in order to find the heavy reentry vehicles, perhaps by detonating a nuclear explosive in the path of the cloud. To counteract such a measure, however, the reentry vehicles could be designed to release more balloons. Alternatively, the midcourse defense could be designed to tar-



COVERAGE OF THE U.S.S.R. by an antimissile weapon with a range of 3,000 kilometers deployed in a polar orbit at an altitude of 1,000 kilometers is indicated by the three circles on this map. The circles show the extent of the weapon's effect at two times separated by 13 minutes on one circuit of the earth and at another time 94 minutes later, on the next circuit. The orbiting weapon could be either a laser or a "fighting mirror" designed to reflect the light sent to it by a mirror stationed at an altitude of 36,000 kilometers above the Equator.

get everything in the threat cloud, a prodigious task that might be beyond the supercomputers expected a decade from now. In short, the midcourse defense would be overwhelmed unless the attacking force was drastically thinned out in the boost phase.

Because the boosters would have to be attacked while they could not yet be seen from any point on the earth's surface accessible to the defense, the defensive system would have to initiate boost-phase interception from a point in space, at a range measured in thousands of kilometers. Two types of "directed energy" weapon are currently under investigation for this purpose: one type based on the use of laser beams, which travel at the speed of light (300,000 kilometers per second), and the other based on the use of particle beams, which are almost as fast. Nonexplosive projectiles that home on the booster's infrared signal have also been proposed.

There are two alternatives for basing such weapons in space. They could be in orbit all the time or they could be "popped up" at the time of the attack. There are complementary advantages and disadvantages to each approach. With enough weapons in orbit some would be "on station" whenever they were needed, and they could provide global coverage; on the other hand, they would be inefficient because of the number of weapons that would have to be actively deployed, and they would be extremely vulnerable. Pop-up weapons would be more efficient and less vulnerable, but they would suffer from formidable time constraints and would offer poor protection against a widely dispersed fleet of strategic submarines.

Pop-up interceptors of ICBM's would have to be launched from submarines, since the only accessible points close enough to the Russian ICBM silos are in the Arabian Sea and the Norwegian Sea, at a distance of more than 4,000 kilometers. An interceptor of this type would have to travel at least 940 kilometers before it could "see" an ICBM just burning out at an altitude of 200 kilometers. If the interceptor were lofted by an ideal instant-burn booster with a total weight-to-payload ratio of 14 to one, it could reach the target-sighting point in about 120 seconds. For comparison, the boost phase of the new U.S. MX missile (which has a weight-to-payload ratio of 25 to one) is between 150 and 180 seconds. In principle, therefore, it should just barely be possible by this method to intercept a Russian missile comparable to the MX, provided the interception technique employed a beam that moves at the speed of light. On the other hand, it would be impossible to intercept a large number of missiles, since many silos would be more than 4,000 kilometers away, submarines cannot launch all their missiles simultaneously and 30 seconds would leave virtually no time for the complex sequence of operations the battle-management system would have to perform.

A report prepared for the Fletcher panel, the study team set up last year by the Department of Defense under the chairmanship of James C. Fletcher of the University of Pittsburgh to evaluate the Strategic Defense Initiative for the president, bears on this question. According to the report, it is possible to build ICBM's that could complete the boost phase and disperse their MIRV's in only 60 seconds, at a sacrifice of no more than 20 percent of payload. Even with zero decision time a hypothetical instant-burn rocket that could pop up an interceptor system in time for a speed-of-light attack on such an ICBM would need an impossible weight-to-payload ratio in excess of 800 to one! Accordingly all pop-up interception schemes, no matter what kind of antimissile weapon they employ, depend on the assumption that the U.S.S.R. will not build ICBM's with a boost phase so short that no pop-up system could view the burning booster.

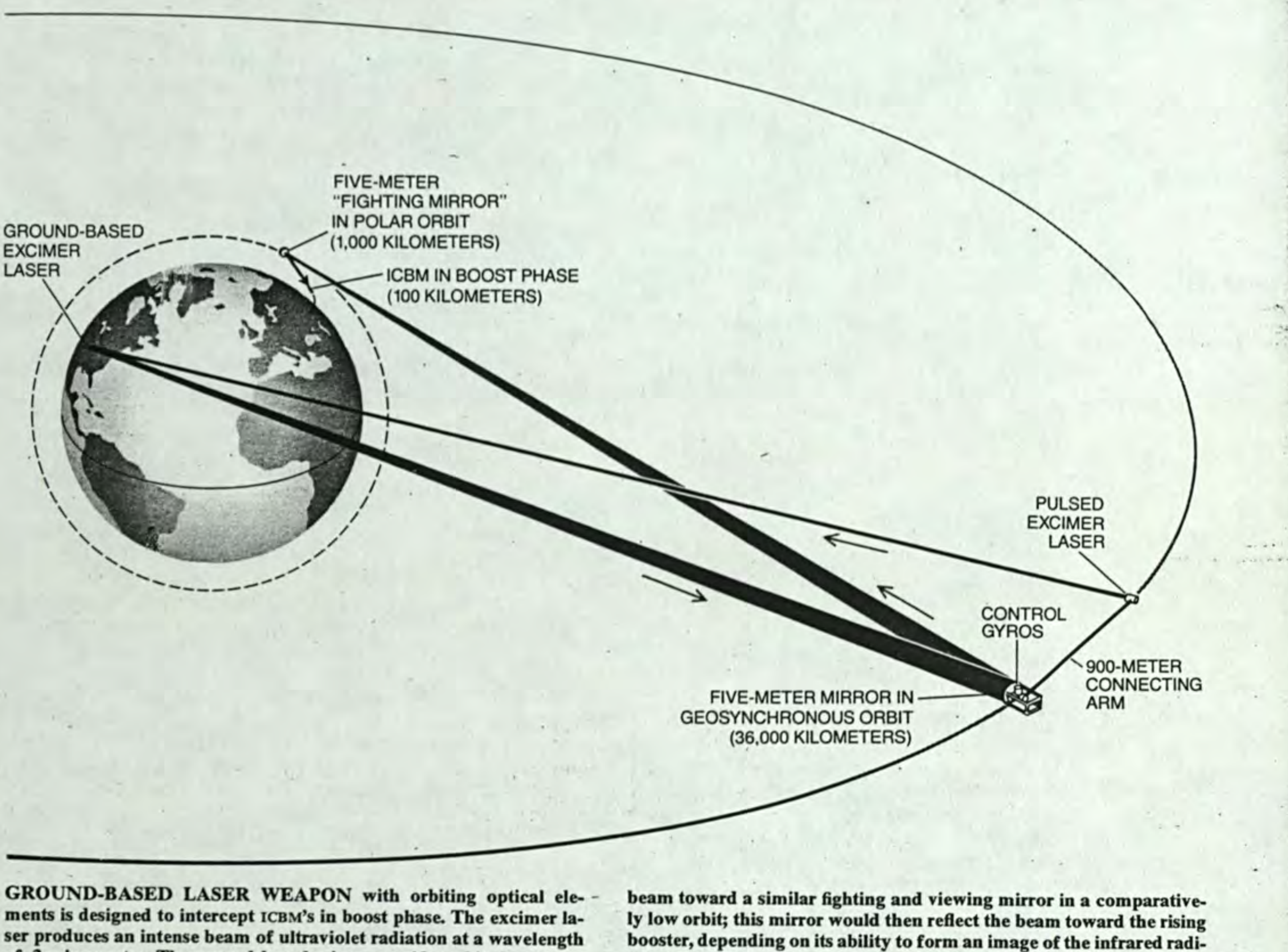
The time constraint faced by pop-up schemes could be avoided by putting at least some parts of the system into orbit. An antimissile satellite in a low orbit would have the advantage of having the weapon close to its targets, but it would suffer from the "absentee" handicap: because of its own orbital motion, combined with the earth's rotation, the ground track of such a satellite would pass close to a fixed point on the earth's surface only twice a day. Hence for every low-orbit weapon that was within range of the ICBM silos many others would be "absentees": they would be below the horizon and unable to take part in the defense. This unavoidable replication would depend on the range of the defensive weapon, the altitude and inclination of its orbit and the distribution of the enemy silos.

The absentee problem could be solved by mounting at least some components of the defensive system on a geosynchronous satellite, which remains at an altitude of some 36,000 kilometers above a fixed point on the Equator, or approximately 39,000 kilometers from the Russian ICBM fields. Whichever weapon were used, however, this enormous range would make it virtually impossible to exploit the radiation from the booster's flame to accurately fix an aim point on the target. The resolution of any optical instrument, whether it is an observing telescope or a beam-focusing mirror, is limited by the phenomenon of diffraction. The smallest spot on which a mirror can focus a beam has a diameter that depends on the wavelength of the radiation, the aperture of the instrument and the distance to the spot. For infrared radiation from the booster's flame the wavelength would typically be one micrometer, so that targeting on a spot 50 centimeters across at a range of 39,000 kilometers would require a precisely shaped mirror 100 meters across—roughly the length of a football field. (For comparison, the largest telescope mirrors in the world today are on the order of five meters in diameter.)

The feasibility of orbiting a high-quality optical instrument of this stupendous size seems remote. The wavelengths used must be shortened, or the viewing must be reduced, or both. Accordingly it has been suggested that a geosynchronous defensive system might be augmented by other optical elements deployed in low orbits.

One such scheme that has been proposed calls for an array of ground-based excimer lasers designed to work in conjunction with orbiting optical elements. The excimer laser incorporates a pulsed electron beam to excite a mixture of gases such as xenon and chlorine into a metastable molecular state, which spontaneously reverts to the molecular ground state; the latter in turn immediately dissociates into two atoms, emitting the excess energy in the form of ultraviolet radiation at a wavelength of .3 micrometer.

Each ground-based excimer laser would send its beam to a geosynchronous mirror with a diameter of five meters, and the geosynchronous mirror would in turn reflect the beam toward an appropriate "fighting mirror" in low orbit. The fighting mirror would then redi-



GROUND-BASED LASER WEAPON with orbiting optical elements is designed to intercept ICBM's in boost phase. The excimer laser produces an intense beam of ultraviolet radiation at a wavelength of .3 micrometer. The ground-based mirror would send its beam to a five-meter geosynchronous mirror, which would in turn reflect the beam toward a similar fighting and viewing mirror in a comparatively low orbit; this mirror would then reflect the beam toward the rising booster, depending on its ability to form an image of the infrared radiation from the booster's exhaust plume to get a fix on the target (*diagram at left*). In order to compensate for fluctuations in the density

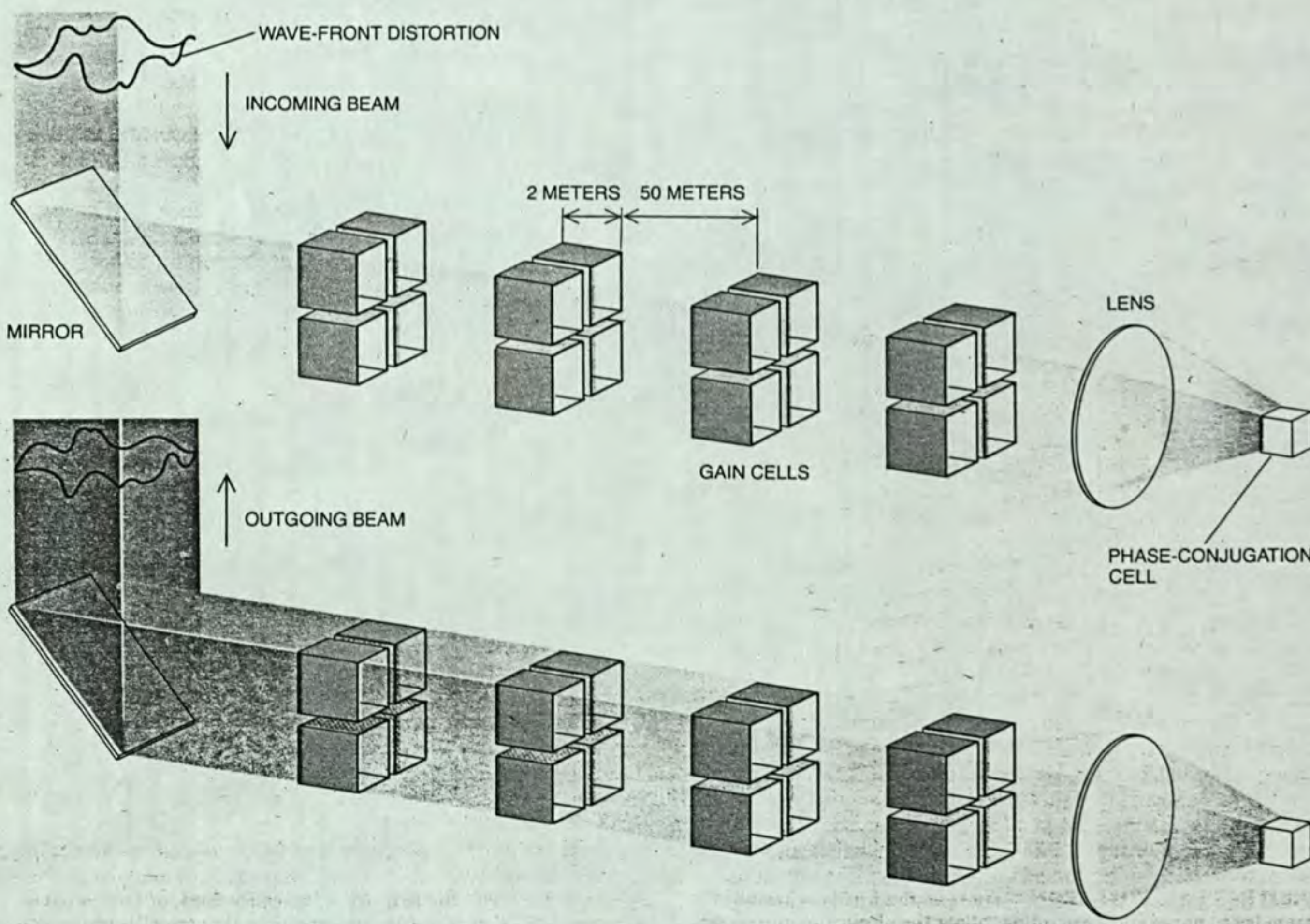
rect and concentrate the beam onto the rising booster rockets, depending on an accompanying infrared telescope to get an accurate fix on the boosters.

The main advantage of this scheme is that the intricate and heavy lasers, together with their substantial power supplies, would be on the ground rather than in orbit. The beam of any ground-based laser, however, would be greatly disturbed in an unpredictable way by ever present fluctuations in the density of the atmosphere, causing the beam to diverge and lose its effectiveness as a weapon. One of us (Garwin) has described a technique to compensate for these disturbances, making it possible, at least in principle, to intercept boosters by this scheme [*see illustration on these two pages*].

Assuming that such a system could be made to work perfectly, its power requirement can be estimated. Such an exercise is illuminating because it gives an impression of the staggering total cost of the system. Again information from the Fletcher panel provides the basis for our estimate. Apparently the "skin" of a booster can be "hardened" to withstand an energy deposition of 200 megajoules per square meter, which is roughly what is required to evaporate a layer of carbon three millimeters thick. With the aid of a geosynchronous mirror five meters in diameter and a fighting and viewing mirror of the same size, the beam of the excimer laser described above would easily be able to make a spot one meter across on the skin of a booster at a range of 3,000 kilometers from the fighting mirror; the resulting lethal dose would be about 160 megajoules.

A successful defense against an attack by the 1,400 ICBM's in the current Russian force would require a total energy deposition of 225,000 megajoules. (A factor of about 10 is necessary to compensate for atmospheric absorption, reflection losses at the mirrors and overcast skies.) If the time available for interception were 100 seconds and the lasers had an electrical efficiency of 6 percent, the power requirement would be more than the output of 300 1,000-megawatt power plants, or more than 60 percent of the current electrical generating capacity of the entire U.S. Moreover, this energy could not be extracted instantaneously from the national power grid, and it could not be stored by any known technology for instantaneous discharge. Special power plants would have to be built; even though they would need to operate only for minutes, an investment of $300 per kilowatt is a reasonable estimate, and so the outlay for the power supply alone would exceed $100 billion.

This partial cost estimate is highly optimistic. It assumes that all the boosters could be destroyed on the first shot, that the Russians would not have shortened the boost phase of their ICBM's, enlarged their total strategic-missile force or installed enough countermeasures to degrade the defense significantly by the time this particular defensive system was ready for deployment at the end of the century. Of course the cost of the entire system of lasers, mirrors, sensors



of the atmosphere the geosynchronous satellite would be equipped with a smaller excimer laser mounted on a 900-meter connecting arm ahead of the main mirror. A pulse of ultraviolet radiation from this laser would be directed at the ground-based laser, which would reverse the phase of the incoming beam and would emit a much more intense outgoing beam that would exactly precompensate for the atmospheric disturbance encountered by the incoming beam (*diagram at right*). The gain cells would be powered by pulsed electron beams synchronized with the outgoing beam. Such difficulties as mirror vulnerability must be resolved if such a device is ever to be effective.

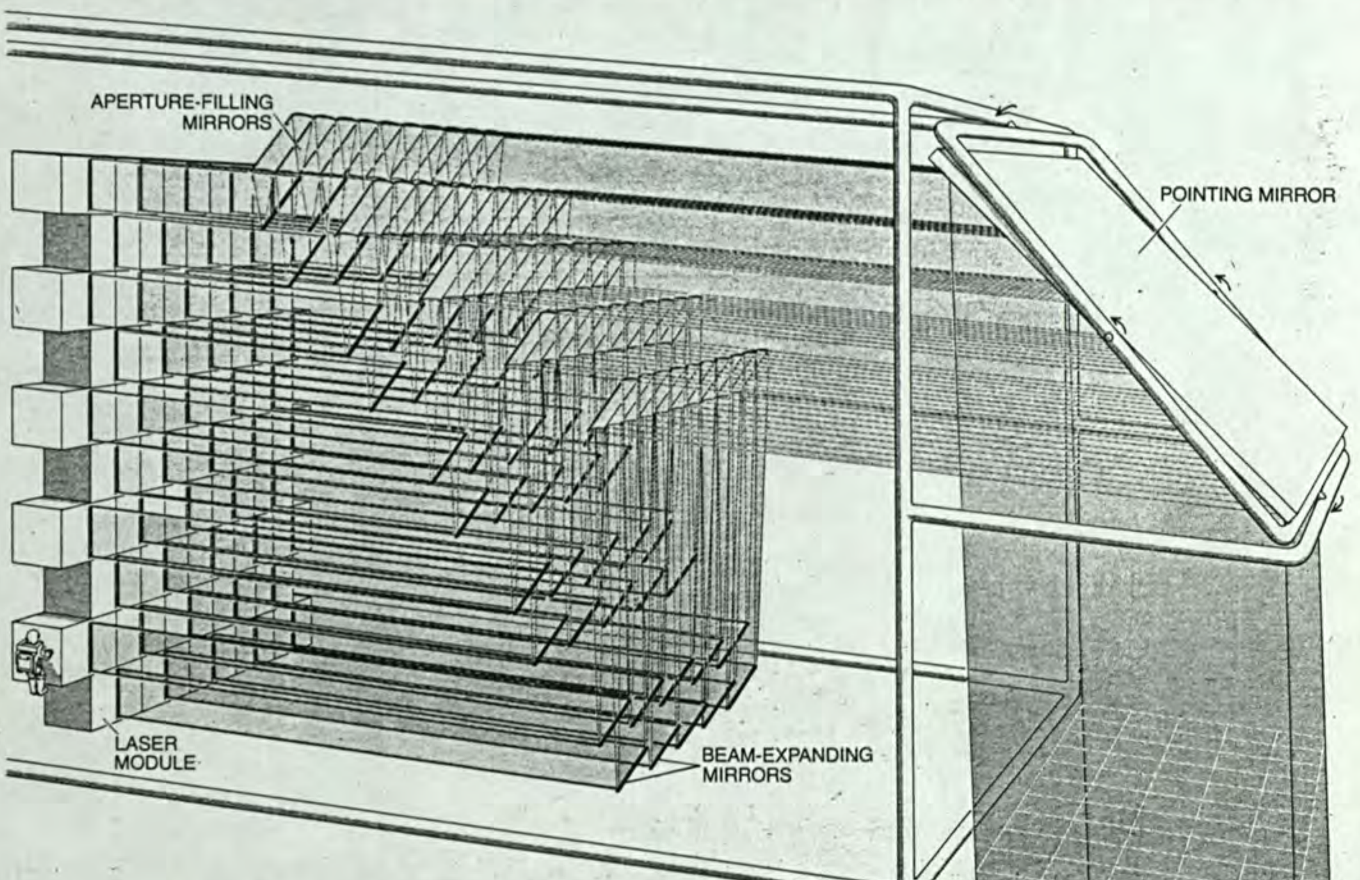
and computers would far exceed the cost of the power plant, but at this stage virtually all the required technologies are too immature to allow a fair estimate of their cost.

The exact number of mirrors in the excimer scheme depends on the intensity of the laser beams. For example, if the lasers could deliver a lethal dose of heat in just five seconds, one low-orbit fighting mirror could destroy 20 boosters in the assumed time of 100 seconds. It follows that 70 mirrors would have to be within range of the Russian silos to handle the entire attack, and each mirror would need to have a corresponding mirror in a geosynchronous orbit. If the distance at which a fighting mirror could focus a small enough spot of light was on the order of 3,000 kilometers, there would have to be about six mirrors in orbit elsewhere for every one "on station" at the time of the attack, for a total of about 400 fighting mirrors. This allowance for absenteeism is also optimistic, in that it assumes the time needed for targeting would be negligible, there would be no misses, the Russian countermeasures would be ineffective and excimer lasers far beyond the present state of the art could be built.

The second boost-phase interception scheme we shall consider is a pop-up system based on the X-ray laser, the only known device light enough to be a candidate for this role. As explained above, shortening the boost phase of the attacking missiles would negate any pop-up scheme. In this case a shortened boost phase would be doubly crippling, since the booster would stop burning within the atmosphere, where X rays cannot penetrate. Nevertheless, the X-ray laser has generated a good deal of interest, and we shall consider it here even though it would be feasible only if the Russians were to refrain from adapting their ICBM's to thwart this threat.

The X-ray laser consists of a cylindrical array of thin fibers surrounding a nuclear explosive. The thermal X rays generated by the nuclear explosion stimulate the emission of X-radiation from the atoms in the fibers. The light produced by an ordinary optical laser can be highly collimated, or directed, because it is reflected back and forth many times between the mirrors at the ends of the laser. An intense X-ray beam, however, cannot be reflected in this way, and so the proposed X-ray laser would emit a rather divergent beam; for example, at a distance of 4,000 kilometers it would make a spot about 200 meters across.

The U.S. research program on X-ray lasers is highly classified. According to a Russian technical publication, however, such a device can be expected to operate at an energy of about 1,000 electron volts. Such a "soft" X-ray pulse would be absorbed in the outermost fraction of a micrometer of a booster's skin, "blowing off" a thin surface layer. This would have two effects. First, the booster as a whole would recoil. The inertial-guidance system would presumably sense the blow, however, and it could still di-



ORBITING LASER WEAPON is shown in this highly schematic diagram based on several assumptions about the physical requirements of such a system. The weapon, which is designed to intercept ICBM's in boost phase from a comparatively low earth orbit, is scaled to generate a total of 25 megawatts of laser light at a wavelength of 2.7 micrometers from a bank of 50 chemical lasers, utilizing hydrogen fluoride as the lasing medium. The lasers, each of which occupies a cubic volume approximately two meters on a side, are arranged to produce an output beam with a square cross section 10 meters on a side. Assuming that the light from the entire bank of laser modules is in phase and that all the mirrors are optically perfect, it can be calculated that a weapon of this type could deliver a lethal dose of heat in seven seconds to a booster at a "kill radius" of some 3,000 kilometers. Some 300 such lasers would be needed in orbit to destroy the 1,400 ICBM's in the current Russian arsenal, assuming no countermeasures were taken other than "hardening" the missiles. Only the front of the weapon is shown; the fuel supply and other components would presumably be mounted behind the laser modules, to the left.

rect the warheads to their targets. Second, the skin would be subjected to an abrupt pressure wave that, in a careless design, could cause the skin to shear at its supports and damage the booster's interior. A crushable layer installed under the skin could prolong and weaken the pressure wave, however, thereby protecting both the skin and its contents.

Other interception schemes proposed for ballistic-missile defense include chemical-laser weapons, neutral-particle-beam weapons and nonexplosive homing vehicles, all of which would have to be stationed in low orbits.

The brightest laser beam attained so far is an infrared beam produced by a chemical laser that utilizes hydrogen fluoride. The U.S. Department of Defense plans to demonstrate a two-megawatt version of this laser by 1987. Assuming that 25-megawatt hydrogen-fluoride lasers and optically perfect 10-meter mirrors eventually become available, a weapon with a "kill radius" of 3,000 kilometers would be at hand. A total of 300 such lasers in low orbits could destroy 1,400 ICBM boosters in the absence of countermeasures if every component worked to its theoretical limit.

A particle-beam weapon could fire a stream of energetic charged particles, such as protons, that could penetrate deep into a missile and disrupt the semiconductors in its guidance system. A charged-particle beam, however, would be bent by the earth's magnetic field and therefore could not be aimed accurately at distant targets. Hence any plausible particle-beam weapon would have to produce a neutral beam, perhaps one consisting of hydrogen atoms (protons paired with oppositely charged electrons). This could be done, although aiming the beam would still present formidable problems. Interception would be possible only above the atmosphere at an altitude of 150 kilometers or more, since collisions with air molecules would disintegrate the atoms and the geomagnetic field would then fan out the beam. Furthermore, by using gallium arsenide semiconductors, which are about 1,000 times more resistant to radiation damage than silicon semiconductors, it would be possible to protect the missile's guidance computer from such a weapon.

Projectiles that home on the booster's flame are also under discussion. They have the advantage that impact would virtually guarantee destruction, whereas a beam weapon would have to dwell on the fast-moving booster for some time. Homing weapons, however, have two drawbacks that preclude their use as boost-phase interceptors. First, they move at less than .01 percent of the speed of light, and therefore they would have to be deployed in uneconomically large numbers. Second, a booster that burned out within the atmosphere would be immune to them, since friction with the air would blind their homing sensors.

That such a homing vehicle can indeed destroy an object in space was demonstrated by the U.S. Army in its current Homing Overlay test series. On June 10 a projectile launched from Kwajalein Atoll in the Pacific intercepted a dummy Minuteman warhead at an altitude of more than 100 miles. The interceptor relied on a homing technique similar to that of the Air Force's aircraft-launched antisatellite weapon. The debris from the collision was scattered over many tens of kilometers and was photographed by tracking telescopes [*see illustration on next two pages*]. The photographs show, among other things, the difficulty of evading a treaty that banned tests of weapons in space.

In an actual ballistic-missile-defense system such an interceptor might have a role in midcourse defense. It would have to be guided to a disguised reentry vehicle hidden in a swarm of decoys and other objects designed to confuse its infrared sensors. The potential of this technique for midcourse interception remains to be demonstrated, whereas its potential for boost-phase interception is questionable in view of the considerations mentioned above. On the other hand, a satellite is a larger and more fragile target than a reentry vehicle, and so the recent test shows the U.S. has a low-altitude antisatellite capability at least equivalent to the U.S.S.R.'s.

The importance of countermeasures in any consideration of ballistic-missile defense was emphasized recently by Richard D. DeLauer, Under Secretary of Defense for Research and Engineering. Testifying on this subject before the House Armed Services Committee, DeLauer stated that "any defensive system can be overcome with proliferation and decoys, decoys, decoys, decoys."

One extremely potent countermeasure has already been mentioned, namely that shortening the boost phase of the offensive missiles would nullify any boost-phase interception scheme based on X-ray lasers, neutral-particle beams or homing vehicles. Many other potent countermeasures that exploit existing technologies can also be envisioned. All of them rely on generic weaknesses of the defense. Among these weaknesses four stand out: (1) Unless the defensive weapons were cheaper than the offensive ones, any defense could simply be overwhelmed by a missile buildup; (2) the defense would have to attack every object that behaves like a booster; (3) any space-based defensive component would be far more vulnerable than the ICBM's it was designed to destroy; (4) since the booster, not the flame, would be the target, schemes based on infrared detection could be easily deceived.

Countermeasures can be divided into three categories: those that are threatening, in the sense of manifestly increasing the risk to the nation deploying the defensive system; those that are active, in the sense of attacking the defensive system itself, and those that are passive, in the sense of frustrating the system's weapons. These distinctions are politically and psychologically significant.

The most threatening response to a ballistic-missile-defense system is also the cheapest and surest: a massive buildup of real and fake ICBM's. The deployment of such a defensive system would violate the ABM Treaty, almost certainly resulting in the removal of all negotiated constraints on offensive missiles. Therefore many new missile silos could be constructed. Most of them could be comparatively inexpensive fakes arrayed in clusters about 1,000 kilometers across to exacerbate the satellites' absentee problem. The fake silos could house decoy ICBM's—boosters without expensive warheads or guidance packages—that would be indistinguishable from real ICBM's during boost phase. An attack could begin with a large proportion of decoys and shift to real ICBM's as the defense exhausted its weapons.

All space systems would be highly vulnerable to active countermeasures. Few targets could be more fragile than a large, exquisitely made mirror whose performance would be ruined by the slightest disturbance. If an adversary were to put a satellite into the same orbit as that of the antimissile weapon but moving in the opposite direction, the relative velocity of the two objects would be about 16 kilometers per second, which is eight times faster than that of a modern armor-piercing antitank projectile. If the satellite were to release a swarm of one-ounce pellets, each pellet could penetrate 15 centimeters of steel (and much farther if it were suitably shaped). Neither side could afford to launch antimissile satellites strong enough to withstand such projectiles. Furthermore, a large number of defensive satellites in low or geosynchronous orbits could be attacked simultaneously by "space mines": satellites parked in orbit near their potential victims and set to explode by remote control or when tampered with.

Passive countermeasures could be used to hinder targeting or to protect the booster. The actual target would be several meters above the flame, and the defensive weapon would have to determine the correct aim point by means of an algorithm stored in its computer. The aim point could not be allowed to drift by more than a fraction of a meter, because the beam weapon would have to dwell on one spot for at least several seconds as the booster moved several tens of kilometers. Aiming could therefore be impeded if the booster flame were made to fluctuate in an unpredictable way. This effect could be achieved by causing additives in the propellant to be emitted at random from different nozzles or by surrounding the booster with a hollow cylindrical "skirt" that could hide various fractions of the flame or even move up and down during boost phase.

Booster protection could take different forms. A highly reflective coating kept clean during boost phase by a strippable foil wrapping would greatly reduce the damaging effect of an incident laser beam. A hydraulic cooling system or a movable heat-absorbing ring could protect the attacked region at the command of heat sensors. Aside from shortening the boost phase the attacking nation could also equip each booster with a thin metallic sheet that could be unfurled at a high altitude to absorb and deflect an X-ray pulse.

Finally, as DeLauer has emphasized, all the proposed space weapons face formidable systemic problems. Realistic testing of the system as a whole is obviously impossible and would have to depend largely on computer simulation. According to DeLauer, the battle-management system would face a task of prodigious complexity that is "expected to stress software-development technology"; in addition it would have to "operate reliably even in the presence of disturbances caused by nuclear-weapons effects or direct-energy attack." The Fletcher panel's report states that the "*survivability of the system components is a critical issue whose resolution requires a combination of technologies and tactics that remain to be worked out.*" Moreover, nuclear attacks need not be confined to the battle-management system. For example, airbursts from a precursor salvo of SLBM's could produce atmospheric disturbances that would cripple an entire defensive system that relied on the ground-based laser scheme.

Spokesmen for the Reagan Administration have stated that the Strategic Defense Initiative will produce a shift to a "defense-dominated" world. Unless the move toward ballistic-missile defense is coupled with deep cuts in both sides' offensive forces, however, there will be no such shift. Such a coupling would require one or both of the following conditions: a defensive technology that was so robust and cheap that countermeasures or an offensive buildup would be futile, or a political climate that would engender arms-control agreements of unprecedented scope. Unfortunately neither of these conditions is in sight.

What shape, then, is the future likely to take if attempts are made by the U.S. and the U.S.S.R. to implement a space-based system aimed at thwarting a nuclear attack? Several factors will have a significant impact. First, the new technologies will at best take many years to develop, and, as we have argued, they will remain vulnerable to known countermeasures. Second, both sides are currently engaged in "strategic modernization" programs that will further enhance their already awesome offensive forces. Third, in pursuing ballistic-missile defense both sides will greatly increase their currently modest antisatellite capabilities. Fourth, the ABM Treaty, which is already under attack, will fall by the wayside.

These factors, acting in concert, will accelerate the strategic-arms race and simultaneously diminish the stability of the deterrent balance in a crisis. Both superpowers have always been inordinately sensitive to real and perceived shifts in the strategic balance. A defense that could not fend off a full-scale strategic attack but might be quite effective against a weak retaliatory blow following an all-out preemptive strike would be particularly provocative. Indeed, the leaders of the U.S.S.R. have often stated that any U.S. move toward a comprehensive ballistic-missile-defense system would be viewed as an attempt to gain strategic superiority, and that no effort would be spared to prevent such an outcome. It would be foolhardy to ignore these statements.

The most likely Russian response to a U.S. decision to pursue the president's Strategic Defense Initiative should be expected to rely on traditional military "worst case" analysis; in this mode of reasoning one assigns a higher value to the other side's capabilities than an unbiased examination of the evidence would indicate, while correspondingly undervaluing one's own capabilities. In this instance the Russians will surely overestimate the effectiveness of the U.S. ballistic-missile defense and arm accordingly. Many near-term options would then be open to them. They could equip their large SS-18 ICBM's with decoys and many more warheads; they could retrofit their deployed ICBM's with protective countermeasures; they could introduce fast-burn boosters; they could deploy more of their current-model ICBM's and sea-launched cruise missiles. The latter developments would be perceived as unwarranted threats by U.S. military planners, who would be quite aware of the fragility of the nascent U.S. defensive system. A compensating U.S. buildup in offensive missiles would then be inevitable. Indeed, even if both sides bought identical defensive systems from a third party, conservative military analysis would guarantee an accelerated offensive-arms race.

Once one side began to deploy space-based antimissile beam weapons the level of risk would rise sharply. Even if the other side did not overrate the system's antimissile capability, it could properly view such a system as an immediate threat to its strategic satellites. A strategy of "launch on warning" might then seem unavoidable, and attempts might also be made to position space mines alongside the antimissile weapons. The last measure might in itself trigger a conflict since the antimissile system should be able to destroy a space mine at a considerable distance if it has any capability for its primary mission. In short, in a hostile political climate even a well-intentioned attempt to create a strategic defense could provoke war, just as the mobilizations of 1914 precipitated World War I.

Even if the space-based ballistic-missile defense did not have a cataclysmic birth, the successful deployment of such a defense would create a highly unstable strategic balance. It is difficult to imagine a system more likely to induce catastrophe than one that requires critical decisions by the second, is itself untested and fragile and yet is threatening to the other side's retaliatory capability.

In the face of mounting criticism Administration spokesmen have in recent months offered less ambitious rationales for the Strategic Defense Initiative than the president's original formulation.

SUCCESSFUL INTERCEPTION of a ballistic-missile warhead was achieved on June 10 in the course of the U.S. Army's Homing Overlay Experiment. The target was a dummy warhead mounted on a Minuteman ICBM that was launched from Vandenberg Air Force Base in California. The interceptor was a nonexplosive infrared-homing vehicle that was

One theme is that the program is just a research effort and that no decision to deploy will be made for many years. Military research programs are not normally announced from the Oval Office, however, and there is no precedent for a $26-billion, five-year military-research program without any commitment to deployment. A program of this magnitude, launched under such auspices, is likely to be treated as an essential military policy by the U.S.S.R. no matter how it is described in public.

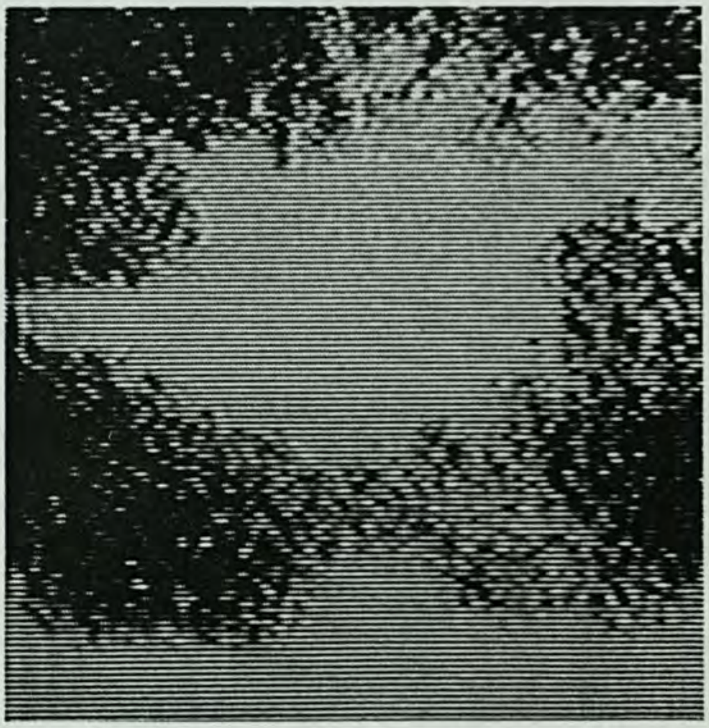
Another more modest rationale of the Strategic Defense Initiative is that it is intended to enhance nuclear deterrence. That role, however, would require only a terminal defense of hard targets, not weapons in space. Finally, it is contended that even an imperfect antimissile system would limit damage to the U.S.; the more likely consequence is exactly the opposite, since it would tend to focus the attack on cities, which could be destroyed even in the face of a highly proficient defense.

In a background report titled *Directed Energy Missile Defense in Space*, released earlier this year by the Congressional Office of Technology Assessment, the author, Ashton B. Carter of the Massachusetts Institute of Technology, a former Defense Department analyst with full access to classified data on such matters, concluded that "the prospect that emerging 'Star Wars' technologies, when further developed, will provide a perfect or near-perfect defense system ... is so remote that it should not serve as the basis of public expectation or national policy." Based on our assessment of the technical issues, we are in complete agreement with this conclusion.

In our view the questionable performance of the proposed defense, the ease with which it could be overwhelmed or circumvented and its potential as an antisatellite system would cause grievous damage to the security of the U.S. if the Strategic Defense Initiative were to be pursued. The path toward greater security lies in quite another direction. Although research on ballistic-missile defense should continue at the traditional level of expenditure and within the constraints of the ABM Treaty, every effort should be made to negotiate a bilateral ban on the testing and use of space weapons.

It is essential that such an agreement cover all altitudes, because a ban on high-altitude antisatellite weapons alone would not be viable if directed-energy weapons were developed for ballistic-missile defense. Once such weapons were tested against dummy boosters or reentry vehicles at low altitude, they would already have the capability of attacking geosynchronous satellites without testing at high altitude. The maximum energy density of any such beam in a vacuum is inversely proportional to the square of the distance. Once it is demonstrated that such a weapon can deliver a certain energy dose in one second at a range of 4,000 kilometers, it is established that the beam can deliver the same dose at a range of 36,000 kilometers in approximately 100 seconds. Since the beam could dwell on a satellite indefinitely, such a device could be a potent weapon against satellites in geosynchronous orbits even if it failed in its ballistic-missile-defense mode.

As mentioned above, the U.S. interception of a Minuteman warhead over the Pacific shows that both sides now have a ground-based antisatellite weapon of roughly equal capability. Hence there is no longer an asymmetry in such antisatellite weapons. Only a lack of political foresight and determination blocks the path to agreement. Such a pact would not permanently close the door on a defense-dominated future. If unforeseen technological developments were to take place in a receptive international political climate in which they could be exploited to provide greater security than the current condition of deterrence by threat of retaliation provides, the renegotiation of existing treaties could be readily achieved.

launched 20 minutes later from Kwajalein Atoll in the western Pacific. This sequence of photographs was made from a video display of the interception recorded through a 24-inch tracking telescope on Kwajalein. The first frame shows the rocket plume from the homing vehicle a fraction of a second before its collision with the target above the atmosphere. The short horizontal bar above the image of the plume is a tracking marker. The smaller point of light at the lower left is a star. The second and third frames show the spreading clouds of debris from the two vehicles moments after the collision. Within seconds more than a million fragments were strewn over an area of 40 square kilometers. Just before the collision the homing vehicle had deployed a weighted steel "net" 15 feet across to increase the chances of interception; as it happened, the vehicle's infrared sensor guided it to a direct, body-to-body collision with the target. According to the authors, the test demonstrates that the U.S. now has a low-altitude antisatellite capability at least equivalent to that of the U.S.S.R.

SOVIET VIEW OF A BMD SYSTEM IN SPACE BASED ON A CHEMICAL LASER

	A system for protection from 1000 missiles in 100 seconds
Number of stations	18
Orbit	polar
Weight of 1 station	800 tonnes
Supply of chemical components	700 tonnes
Laser output	60 MW
Time taken to intercept 1 missile	0.1 second
Mirror diameter	15 m
Number of launches needed to deploy the system	1440
Estimate of cost	400 billion dollars

Source - Committee of Soviet Scientists in defence of peace 1983.

Note
Calculations of the total effort needed to deploy a full SDI system depend very much on assumptions about the vulnerability of the target, the power level and range of the weapons used, their speed of response and efficiency in converting fuel to usable energy. Quite small changes may profoundly change the feasibility of the SDI proposals. The calculations above are no better or worse in that respect than any other published estimates.

SOVIET SDI SYSTEMS

All information relating to specific Soviet programmes is Secret or above and information on Soviet research laboratories and missile test centres is Secret WNINTEL. A brief summary of the primary features of these is given below:

1. There are five large (~ 5000 staff) research establishments, three concerned with specific applications of each service and two controlled by the Central Academy of Science. These are in the Leningrad and Moscow areas.

2. There are three laser-rèlated development areas at the PVO Strany (defence of the homeland) test centre, Sary Shagan. All of the areas at this Centre are defence related and include a replica of the Moscow ABM layout, prototype radars, and test sites, for new defensive missiles. Ballistic missile tests are conducted from the centre at the rate of 30 per year, mostly for exercising the new missiles and radars. The purpose and capabilities of the directed energy systems on the range are difficult to assess, largely because the energies and types cannot be directly determined.

3. Some directed-energy related work is also carried out at Turacovo, which is a nuclear effects test centre and at Sarova, the nuclear weapons research centre. This work is probably either phenomenology or equipment-development related. Prestigious Academicians are associated with this side of the work.

4. At least one research centre (PNUTS - possible nuclear underground test site) and one of the five nuclear weapon test sites, Azgir, appear at times to carry out work which is interpreted as directed-energy related.

SCIENCE AND TECHNOLOGY BRIEF

Star wars

WASHINGTON, DC

Deterrence has worked to date. But suppose it should fail? At present, neither west nor east could avoid massive destruction in a nuclear war. President Reagan wants to change that. He wants America to develop means to destroy Russian missiles in flight, before they can reach the United States. His fiscal 1985 budget includes nearly $2 billion for futuristic, anti-ballistic-missile weapons.

The idea has split the American technical community. Some scientists doubt whether it is feasible at all. By contrast, an administration study, conducted by a former head of Nasa last year, argued that recent advances in data processing, precision sensors and the generation of high-energy laser and particle beams make it possible to conceive of an effective defence.

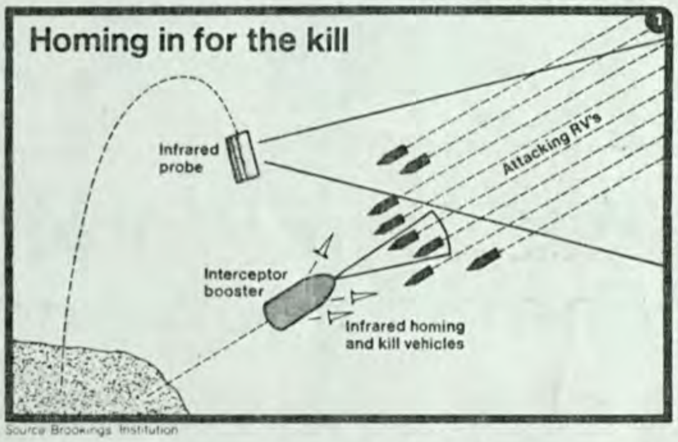
Conceive of, mind, not build. The practical problems are formidable. To understand, consider the potency of atomic weapons and the sheer size of the Russian arsenal. President Reagan's vision embraces the defence not only of America's military installations and control centres but its cities. To destroy a city requires relatively few weapons and little accuracy: four or five one-megaton bombs are ample to flatten buildings over 100 square miles.

The Soviet Union has deployed roughly 2,400 intercontinental ballistic missiles (ICBMs) and submarine-launched ballistic missiles with some 7,500 warheads. The ICBMs alone could deliver between 4,000 and 10,000 megatons—say, half a million Hiroshimas. By the time an American defence system were built, the Soviet arsenal would probably be still bigger. Even optimists concede that an American system will not be built before the end of the century, if then.

No single defence can ever be assumed to be 100% effective. And a single layer of defence, even if 95% effective, would not be good enough. So American planners are thinking of several. Simple arithmetic shows that, if enemy missiles had to pass through four separate layers of defence, and each one was 90% effective, only one out of 10,000 warheads would get through.

ICBMs fly to their targets in four distinct phases:

- In the **boost phase**, which lasts about five minutes, the missile blasts off to an altitude of about 200 kilometres.
- This is followed by the **deployment phase**, lasting several minutes, during which a "bus" manoeuvres in space to launch on their way 10 or more warheads, so-called independent re-entry vehicles (RVs).
- Next comes the **midcourse phase**, lasting up to a quarter of an hour, during which the RVs follow a predictable ballistic trajectory that may take them as high as 1,000 kilometres before they turn towards the earth.
- Finally comes the **re-entry phase**, lasting a mere 30 to 100 seconds, during which the RVs penetrate the atmosphere (at a height of roughly 100 kilometres) and hit the earth.



Source: Brookings Institution

Layer by layer

Obviously, by the time enemy RVs reach re-entry, there is precious little time left to do anything about them. There are some advantages for the defence. Ranges are comparatively short. The drag of the earth's atmosphere would strip away from the RVs lightweight decoys and other radar-confusing objects.

None the less, most options for re-entry defence are designed to protect hardened missile silos from a first strike rather than to shield cities. For example, high-yield nuclear explosives can be buried near silos and detonated just before the arrival of enemy RVs. The explosives could throw an estimated 300,000 tons of dust per megaton up to high altitudes. As the RVs hit the dust clouds, the friction would erode their heat shields, destroying them or deflecting them off course.

Countering an attack in the midcourse phase confers the advantage of time: a (comparatively) luxurious 15 minutes. There are disadvantages, too, however. For a start, there could be a huge number of apparent targets. Suppose the Russians unleashed 1,000 ICBMs, each missile had 10 RVs and each RV was accompanied by 10 decoys (high above the earth's atmosphere, lightweight decoys and other bits of debris would travel along at the same speed as real RVs). That would add up to 100,000 objects.

Discriminating between a decoy and a real RV would depend heavily on: infrared sensors that could pick out tell-tale differences in the heat emitted by the two (unlike missile boosters, RVs have no convenient exhaust flame to look for); and a lot of data-processing power. Champions of midcourse defence argue that these are now within grasp.

The idea is to use thousands of tiny, non-nuclear projectiles. After warning that enemy ICBMs had been fired, the defence would launch rockets carrying relatively wide-ranging infrared probes to spot the approaching RVs. Separate missiles, disgorging hundreds of "kill vehicles" equipped with their own homing infrared sensors, would go to the actual attack (see diagram 1).

Even so, countering an attack at the midcourse and re-entry phases is rather like shutting the stable door after the horse has bolted. Ideally, you want to catch enemy ICBMs before they spawn their multiple warheads: you want to zap them in the boost phase. Indeed, re-entry and midcourse defences are unlikely to be of much use unless that can be done, and the number of RVs left to be intercepted substantially reduced.

Hence the emphasis on "star-war" weapons—lasers and particle-beam devices. To strike an enemy ICBM in the boost phase requires a weapon that can reach it within five minutes of blast-off: ie, a weapon kept in space. If the weapon were some sort of conventional projectile, it would have to be parked on a satellite in a relatively low orbit over the earth in order to reach its target quickly enough.

Snag: a satellite in a low orbit travels faster than the speed of rotation of the earth. That means that it can be over its potential target area only during a fraction of its orbit. So, to maintain constant cover over ICBM targets, you would need a lot of (expensive) satellites. Supposing your projectile weapon had a range of 1,000 kilometres and a maximum speed of five kilometres a second, you would need 200 satellites (see diagram 2).

Far better to use satellites in geosynchronous orbits: travelling at the speed of the earth's rotation at a height of 40,000 kilometres, a satellite "hovers" over one area of the earth. The only weapons that could conceivably reach Soviet ICBMs from an altitude of 40,000 kilometres fast enough are ones that could direct beams of energy travelling at close to the speed of light, 300m metres per second.

But could such weapons actually work? Could they pack a big enough punch with pinpoint accuracy? Unlike an explosive projectile, which can wreak havoc even if it detonates some distance from its intended target, a beam weapon would have to score a direct hit on an ICBM booster. Destruction would be caused by melting the ICBM's skin, detonating its explosives or by injuring its electronic controls. Doing these things requires depositing a substantial amount of energy on one area of the booster.

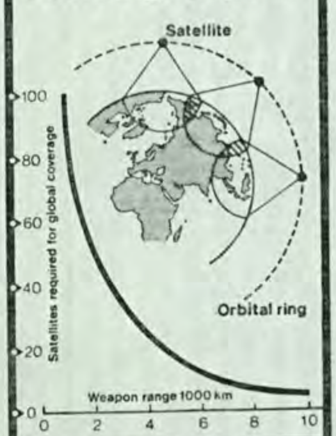
Since a booster is only about 10 metres long, hitting it at all, even from a low orbit, would require a daunting accuracy of one part in 100,000. And a booster is a moving target, travelling at five to seven kilometres a second. A beam weapon would probably have to track it for hundreds of metres before firing.

Moreover, all the equipment needed to generate the energy, focus it into a tight beam and aim it at its target would have to be got up into space in the first place. Preferably, it should be reasonably compact. As yet, anyway, the Americans are not talking about building a military manned space station on which component parts of star-war weapons could be assembled and then launched into higher orbits.

Broadly, there are two options. One is weapons generating tight beams of subatomic particles. There are a number of problems. In the first place, you need a particle accelerator to generate the beams. Even today's accelerators are huge, earthbound machines and studies by the Massachusetts Institute of Technology (MIT) suggest that accelerators suitable for particle-beam weapons would have to produce currents a thousandfold greater.

Covering targets

2



Source: Brookings Institution

Second, most particles carry an electric charge. Particles carrying the same electric charge repel one another; as it travelled along, a charged-particle beam would spread rapidly, dissipating its ability to deliver a tightly-targeted punch. Worse, a stream of charged particles could be bent by (unpredictable) distortions in the earth's own magnetic field (see diagram 3).

Admittedly, uncharged particles, such as neutrons, would not have these troublesome properties. Unfortunately, as it happens, it is much harder to generate beams of neutral particles. Charged particles can be pushed to high energies in an accelerator by subjecting them to a drop in their electric potential—something that cannot happen with electrically neutral particles.

To produce a neutron beam, you could accelerate protons (positively charged particles) and use them to bombard a material and dislodge neutrons from it. The trouble with that approach is that the neutron beam generated might not be very accurate, although the neutrons would follow the same general direction as the original proton stream.

A more promising approach might be to neutralise a charged-particle beam just before it leaves the accelerator. A hydrogen atom is electrically neutral, having a proton and an electron. In theory, you could add an extra electron to atoms of hydrogen, form the atoms into a beam and then strip the extra electron away just before the beam emerged into space. Most ways of stripping away the extra electron, such as passing the beam through a gas, would cause the beam to spread somewhat—but sophisticated engineering might minimise this.

Light options

Particle-beam weapons are only just within the bounds of the possible. What about laser weapons? Instead of particles, a laser generates a beam of light: a beam of energy packaged into photons which have neither mass nor electric charge. Even ordinary light can deliver a punch if focused: eg, burn a hole in paper. The light produced by a laser packs much more power because, instead of consisting of a mishmash of frequencies like ordinary light, it is "coherent": it consists of an intense stream of electromagnetic waves all with the same frequency, phase and direction of motion.

One key to the power a laser packs is the frequency of the light it produces: the higher the frequency, the greater the energy. Usually, the frequency is governed by the nature of the lasing material. High-energy lasers generally use a gas to generate their light. Energy is imparted to the molecules of the gas, causing some of the molecules to "jump" from their normal ground state into a higher energy state.

Such an "excited" molecule can return to its ground state, emitting a photon of energy as it does so. The amount of energy the photon has (its frequency) is determined by the energy gap between the ground and excited states of the molecules in the gas, and the size of that gap will be different in different gases.

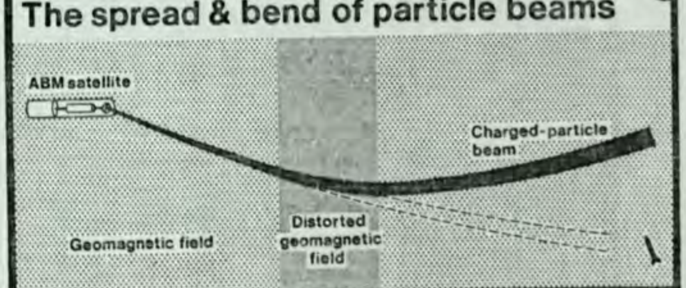
If the photon hits another molecule which is still in an excited state, it can stimulate the second molecule to emit an additional photon of precisely the same frequency. Both photons can then stimulate similar emissions from other excited molecules, setting up a chain reaction in which the number of identical photons emitted grows exponentially, resulting in a laser beam.

The only laser remotely near to becoming a weapon is the so-called chemical laser, in which two gases (usually hydrogen and fluorine) are mixed to form excited molecules of hydrogen fluoride which radiates energy. Star-war enthusiasts have high hopes of exotic new kinds of laser—excimer and free-electron lasers—capable of producing beams of much higher frequencies. In theory, a free-electron laser could be tuned to produce beams of any frequency, right up to enormously powerful X-ray frequencies (*The Economist*, October 15, 1983). But, so far, these are little more than fascinating laboratory playthings.

Generating a powerful laser beam is only the first step. The beam has to be kept in tight focus and aimed. Because photons do not have an electric charge, they will not repel each other (or be deflected by the earth's magnetic field). Even so, they will tend to spread out thanks to light diffraction. Keeping the beams tightly focused requires highly accurate mirrors. No problem, if the mirror can be small. Unfortunately, mirrors several metres in diameter may be needed. To date, the biggest mirror with the necessary precision is 1.4 metres across.

The spread & bend of particle beams

3



Source: Scientific American

Given the present state of the technology, a chemical laser weapon would have to be confined to low earth orbits—and so require a fleet of satellite battlestations, each capable of dealing with a full-scale attack on its own. Dr Kosta Tsipis, a physicist at MIT, reckons a chemical-laser defence would need at least 50 battlestations, 3m tons of chemicals and 100,000 shuttle flights to transport it all into space.

While in space, a tightly focused laser beam would lose little of its punch. To reach an ICBM in the boost phase, however, it would have to penetrate and travel through the earth's atmosphere. There its power would be attenuated: absorbed by particulate matter; scattered by dust, smoke and water molecules and the air itself; deflected and diffused by turbulence and heat. A sufficiently intense laser beam could even ionise the air in its path, stripping the molecules of electrons and creating a plasma that would absorb the beam.

Assume, for argument's sake, that all these hurdles associated with directed-energy weapons could be overcome. Assume, further, that superpowerful micros were developed that could handle the extraordinary data-processing problems involved in aiming and firing such weapons. Would Soviet ICBMs then never get farther than blast-off? Do not bet on it. Even star-war weapons are open to countermeasures.

The Russians could put small explosive satellites, or "space mines", in orbit next to each American weapons satellite and detonate them just before an attack. They could fire a cloud of chaff (thin wires) above their ICBMs to muddle American aim. Or detonate a nuclear bomb at the upper edge of the atomsphere to create a swoosh of air that would disperse a neutral-particle-beam weapon. Or clad boosters in reflective coatings to deflect a laser beam—and spin each booster so that the beam would smear round it instead of focusing energy on one spot. For that matter, the Russians are believed to be working on anti-ballistic-missile defences of their own.

It is impossible to say that star-war weapons could never work. What does seem clear is that a defensive system which could assure the survival of cities in a nuclear war, as opposed to one which could blunt a first strike against ICBM silos, is well beyond existing technical means.

010

12 9.

SECRETARY OF STATE

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

MO 26/7/4

31st January 1985

Prime Minister.
The MOD remain sceptical.
CDP
31/1

Dear Charles,

STRATEGIC DEFENCE INITIATIVE: EFFECTIVENESS AGAINST CRUISE MISSILES

At the December meeting between the Prime Minister and President Reagan in Washington, the Prime Minister asked whether the SDI would possess a capability against Cruise missiles (CM). Mr McFarlane, the President's National Security Advisor, replied that the short answer was that it would.

This claim is surprising at first sight. Whilst the SDI is only in the research phase and it is unclear which particular components will become part of an eventual system, it seems inherently unlikely that a system optimised to counter a ballistic missile (BM) threat could also deal with small, low-flying, subsonic cruise missiles, given the very different characteristics of the two types of missile in terms of both physical properties and flight patterns.

The principal challenge of CM is one of detection. Of the two detection methods proposed for the SDI, space-borne radar might be able to pick up aircraft as small as current CM, but identification would be difficult, infra-red systems would be defeated by cloud cover - a greater problem over Northern Europe than the Continental USA. CM are highly manoeuvrable and their launchers are mobile, making it difficult to acquire them at an early stage of their flight or retain continuous contact. The slower speed of CM compared to BM would allow a longer period for detection, perhaps even hours rather than minutes, but it is unlikely that this would wholly compensate for the problems of detection and tracking. The scope for cost effective counter-measures is considerable; in particular the development of stealth technologies is likely to increase the problems of detection in the future.

C D Powell Esq
No 10 Downing Street

SECRETARY OF STATE

Professor Norman has been able to obtain some clarification of the US position following a brief discussion with the President's Scientific Advisor, Dr George Keyworth, during the latter's recent visit to the United Kingdom. It appears that the Soviet Union is developing a new generation of cruise missiles which are several times the size of existing CM and would operate at high level (15,000m) at speeds of over Mach 2. It is the SDI capability against this segment of the CM threat which appears to be the basis for the American optimism. Existing systems for detecting the launch of BM have been known to detect current tactical Soviet CM (such as the AS-4 KITCHEN) as well as manned aircraft, such as BACKFIRE, on reheat. The tracking and surveillance components of the SDI are likely to be even more effective in this respect. Once detected, interception could then be carried out by conventional weapons though the use of space-borne directed energy weapons may also be possible if the means the United States have proposed for countering atmospheric dispersion and distortion of the beam prove successful. Again, countermeasures could significantly reduce the performance of an SDI system.

On balance however it still seems unlikely that more than a partial CM defence is possible. Even this would require additional system components dedicated to CM interception, particularly in the European context. Partial defence may still be a desirable objective in itself though the SDI may not necessarily be the best means of providing it. Conventional defences using airborne detection and tracking could be just as effective against CM and the United States appear to be planning a major investment in their air defence radars and interceptors for this reason.

In conclusion therefore, whilst the current American research effort may alter the balance of judgement on certain aspects, it is improbable that a comprehensive defence against all classes of CM will emerge from the SDI programme. That is not to say it could not be achieved as a specific goal, if no expense were spared.

I am sending a copy of this letter to Peter Ricketts (Foreign and Commonwealth Office) and Richard Hatfield (Cabinet Office).

Yours sincerely,

Denis Brennan

(D BRENNAN)

CABWTE ØØ1/31

O 31Ø945Z JAN 84
FM CABINET OFFICE LONDON
TO THE WHITE HOUSE
BT
C O N F I D E N T I A L
MESSAGE FROM THE PRIME MINISTER TO MR. ROBERT C. MC FARLANE, NATIONAL SECURITY ADVISER, WHITE HOUSE.

THANK YOU FOR YOUR LETTER OF 29 JANUARY ATTACHING THE VERY USEFUL CLARIFICATION FROM GENERAL ABRAHAMSON. I FOUND HIS BRIEFING EXTREMELY VALUABLE AND HOPE THAT YOU CAN ARRANGE FOR HIM TO KEEP ME PERSONALLY POSTED OF TECHNICAL DEVELOPMENTS ON THE STRATEGIC DEFENCE INITIATIVE.

I ANNEX REPLIES TO CAP WEINBERGER AND TO GENERAL ABRAHAMSON. I LOOK FORWARD TO SEEING YOU ON 2Ø FEBRUARY.

WITH BEST WISHES.

MARGARET THATCHER

MESSAGE FROM THE PRIME MINISTER TO SECRETARY WEINBERGER

MANY THANKS FOR YOUR LETTER AND FOR SENDING GENERAL ABRAHAMSON TO BRIEF ME ON PROGRESS ON THE STRATEGIC DEFENCE INITIATIVE. I WAS AND REMAIN VERY IMPRESSED BY THE VIGOUR AND INGENUITY WHICH IS GOING INTO TACKLING THE IMMENSE TECHNICAL PROBLEMS IN THE BEST AMERICAN +CAN-DO+ MANNER. I AM GRATEFUL FOR YOUR OFFER TO KEEP OUR EXPERTS INFORMED : THIS WILL BE VERY USEFUL.

I HOPE THAT WE SHALL HAVE A CHANCE TO MEET DURING MY BRIEF VISIT TO WASHINGTON ON 2Ø FEBRUARY.

WITH BEST WISHES,

MARGARET THATCHER

MESSAGE FROM THE PRIME MINISTER TO LIEUTENANT-GENERAL JAMES A. ABRAHAMSON.

THANK YOU VERY MUCH FOR YOUR LETTER - AND LET ME SAY AGAIN HOW GRATEFUL I WAS FOR THE VERY FULL AND CLEAR BRIEFING WHICH YOU GAVE ME ON THE TECHNICAL PROGRESS OF THE STRATEGIC DEFENCE INITIATIVE. I HOPE THAT YOU WILL BE ABLE TO BRING ME UP TO DATE REGULARLY WITH THE WORK.

THE EXPANSION OF YOUR ANSWER TO MY QUESTION AT THE BRIEFING ABOUT +AUTOMATIC RESPONSE+ IS HELPFUL. I NOTE WHAT YOU SAY ABOUT THE LIMITED CONSEQUENCES OF A MISTAKEN LAUNCH OF DEFENSIVE SYSTEMS. BUT WOULD NOT AN INTEGRATED DEFENCE PLAN NEED TO BE PROGRAMMED TO CONDUCT PRE-EMPTIVE ATTACKS AT LEAST ON OTHER ENEMY SPACE SYSTEMS? AND WITH A PREDICTABLE ENEMY RESPONSE TO THIS THREAT, MIGHT NOT THE SEQUENCE OF AUTOMATICALLY-DRIVEN REACTIONS QUICKLY WIDEN, RISKING A GENERAL CONFLICT? PERHAPS THIS IS A POINT WHICH WE CAN DISCUSS FURTHER WHEN WE NEXT MEET.

WITH BEST WISHES,

MARGARET THATCHER

NNNN

SENT 31/1Ø53Z RM

RECD 31/1Ø53Z BH

Prime Minister

CDP 1/2

Prime Minister

MT

DINNER WITH DR KEYWIRTH

As Charles Powell may have told you, a week or so ago Alun Chalfont gave a dinner for Dr Keywirth, the President's Scientific Adviser. Present were the Secretary of State for Defence, Field Marshal Bramall, Colonel Alford (of the Institute for Strategic Studies), Anthony Buck, Lord Beloff, Lord Gladwyn and the Chief Scientific Adviser to the Ministry of Defence. Dr Keywirth was accompanied by Mr Herbert Meyer of the CIA.

The purpose of Dr Keywirth's visit was to talk about the Strategic Defence Initiative and that he did very convincingly and interestingly. The main points that he made were:

(1) Even were the research to go ahead now at full steam, there would be no chance that the system envisaged could be effective and in place before the year 2000 (if then);

(2) Support in the U.S. scientific community for anything which would bring an end to the present system of deterents, based on the idea that in certain circumstances the nuclear button would be pressed, would in his opinion grow for moral reasons. The moral case for the Strategic Defence Initiative was the one he was stressing in his conversations throughout Western Europe;

(3) It was Soviet anxiety about the Strategic Defence Initiative which had taken them to the conference table at Geneva.

Most of those round the table seemed to be sceptical, particularly Lord Gladwyn and Colonel Alford, though, of course, our officials sustained your position of support for the research programme.

Hugh Thomas

January 30, 1985

U.S. For. Pol.

11 8.

PRIME MINISTER

SDI

I attach messages received over the hot line last night from Bob McFarlane, Cap Weinberger and General Abrahamson.

I also attach draft replies which might be sent by the same route. I assume that the White House are deliberately using this channel so as not to involve officials and I am therefore not copying the messages elsewhere.

I imagine that you will want to develop the habit of secret briefings by General Abrahamson. The draft reply to him is intended to provide points for further discussion.

Agree replies?

C.D.P.

Yes [illegible]

CHARLES POWELL

30 January 1985

CONFIDENTIAL VIA CABINET
OFFICE CHANNELS

MESSAGE FROM THE PRIME MINISTER TO MR. ROBERT C. McFARLANE,
National Security Adviser, White House.

Thank you for your letter of 29 January ~~containing~~ attaching the very useful clarification from General Abrahamson. I found his briefing extremely valuable and hope that you can arrange for him to keep me personally posted of technical developments on the Strategic Defence Initiative.

I ~~enclose~~ annex replies to Cap Weinberger and to General Abrahamson. I look forward to seeing you on 20 February.

With best wishes.

MARGARET THATCHER

Margaret Thatcher

/Message

2

MESSAGE FROM THE PRIME MINISTER TO SECRETARY WEINBERGER

Many thanks for your letter and for sending General Abrahamson to brief me on progress on the Strategic Defence Initiative. I was and remain very impressed by the vigour and ingenuity which is going into tackling the immense technical problems in the best American 'can-do' manner. I am grateful for your offer to keep our experts informed: this will be very useful.

I hope that we shall have a chance to meet during my brief visit to Washington on 20 February.

With best wishes,

MARGARET THATCHER

Margaret Thatcher

Message.

3

MESSAGE FROM THE PRIME MINISTER TO LIEUTENANT-GENERAL JAMES A. ABRAHAMSON

Thank you very much for your letter - and let me say again how grateful I was for the very full and clear briefing which you gave me on the technical progress of the Strategic Defence Initiative. I hope that you will be able to bring me up to date regularly with the work.

The expansion of your answer to my question at the briefing about 'automatic response' is helpful. I note what you say about the limited consequences of a mistaken launch of defensive systems. But would not an integrated defence plan need to be programmed to conduct pre-emptive attacks at least on other enemy space systems? And with a predictable enemy response to this threat, might not the sequence of automatically-driven reactions quickly widen, risking a general conflict? Perhaps this is a point which we can discuss further when we next meet.

With best wishes,

MARGARET THATCHER

MT

(2)

10 DOWNING STREET

Prime Minister

You might glance at this before Saturday's meeting if you have the time. It builds on the earlier article by Jastrow, which you have. I have underlined key passages.

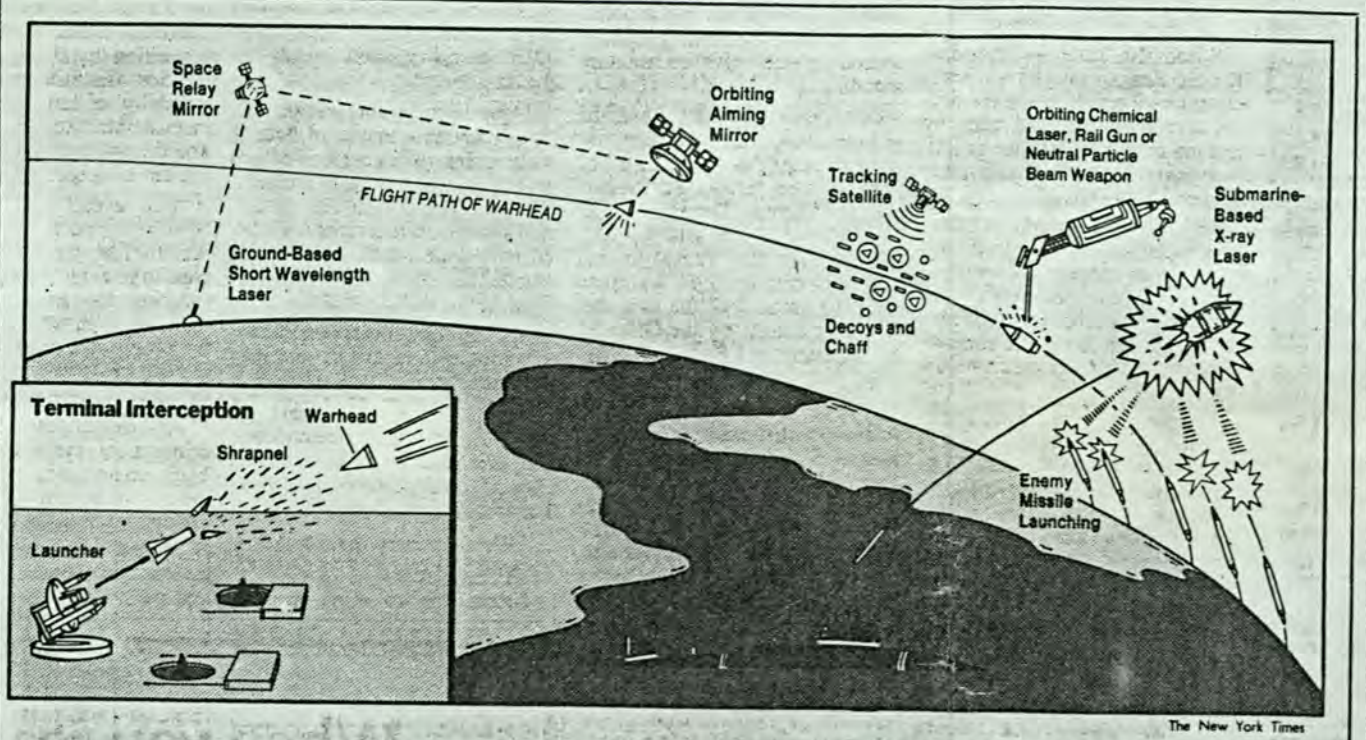
CDP
29/1

Search for Security: The Case for the Strategic Defense Initiative

Zbigniew Brzezinski, professor of government at Columbia University and senior adviser at the Center for Strategic and International Studies at Georgetown University, was national security adviser under President Jimmy Carter. Robert Jastrow, a physicist and professor of earth sciences at Dartmouth, is the founder of the Goddard Institute for Space Studies. Max M. Kampelman, a Washington lawyer, was ambassador to the Conference on Security and Cooperation in Europe under Presidents Carter and Ronald Reagan and has been named to head the U.S. delegation to the new arms control talks with the Soviet Union. In a reaction to this article in The New York Times Magazine, Tass, the Soviet press agency, characterized Mr. Kampelman as a hard-liner on U.S.-Soviet relations who would treat the negotiations "skeptically." Each author contributed individual sections to this article, which they edited and rewrote jointly.

By Zbigniew Brzezinski, Robert Jastrow, and Max M. Kampelman

New York Times Service



The New York Times

A Space-Based Defense System: How It Would Work

Proposals for a space-based missile-defense system are in an early phase of research. Several possibilities are illustrated above. Ground-based lasers, probably the easiest system to maintain and defend, would rely on satellite-mounted relay mirrors to guide their beams over the horizon. But the tracking of warheads by satellite could be complicated by such countermeasures as the deployment of decoys and radar-confusing chaff. Such nonnuclear weapons as chemical lasers, rail guns or neutral particle beams would be placed in orbit to respond to enemy attack. They would have to be deployed in large numbers, but highly polished coatings on enemy warheads might deflect much of their power. X-ray lasers would be triggered by nuclear explosion after being launched from submarines, for example; each laser could damage dozens of missiles. Terminal interceptions would be designed to block whatever warheads made their way through the screen. A projectile or cloud of shrapnel would be guided to destroy the incoming warhead.

NEW YORK — Faith moves mountains. When it is in eternal religious values, faith is an indispensable strength of the human spirit. When it is directed toward political choices, it is often an excuse for an analytic paralysis.

Regrettably, our national debate over President Ronald Reagan's suggestion that the country develop a strategic defense against a Soviet nuclear attack is taking on a theological dimension that has no place in a realistic search for a path out of the world's dilemma. The idea of basing our security on the ability to defend ourselves deserves serious consideration. Certainly, the role of strategic defense was a major issue in the recent dialogue in Geneva between Secretary of State George P. Shultz and Foreign Minister Andrei A. Gromyko of Russia on new arms control negotiations.

For many years, our search for security has been restricted to designing offensive weapons to deter aggression through fear of reprisals. We must not abandon nuclear deterrence until we are convinced that a better means is at hand. But we cannot deny that, for both the Soviet Union and the United States, the costs, insecurities and tensions surrounding this search for newer, more effective and more accurate nuclear missiles produce a profound unease that in itself undermines stability.

The conventional view is that stability in the nuclear age is based on two contradictory pursuits: the acquisition of increasingly efficient nuclear weapons and the negotiation of limits and reductions in such weapons. The United States is diligently pursuing both objectives, but the complexity of arriving at effectual arms control agreements is becoming apparent as more precise and mobile weapons, with multiple warheads, appear on both sides. Unlike ours, moreover, many Soviet missile silos are reloadable, and thus the number of silos does not indicate the number of missiles, further complicating verification.

WE must never ignore the reality that the overwhelming majority of the Soviet strategic forces is composed of primarily first-strike weaponry. And given the large numbers of first-strike Soviet SS-17, -18 and -19 land-based missiles, no responsible American leader can make decisions about security needs without acknowledging that a Soviet first strike can become a practical option.

The Russians could strike us first by firing the reloadable portion of their nuclear arsenal at our missiles, the Strategic Air Command and nuclear submarine bases, and if the surviving U.S. forces, essentially nuclear submarines, were to respond, the Russians could immediately counter by attacking our cities with missiles from nonreloadable silos and, a few hours later, with whatever of their first-strike reloadable weapons had survived our counterattack. They are set up for launching three salvos to our one.

To us, this catastrophic exchange is unthinkable. But, with the strong probability that the U.S. response would be badly crippled at the outset by a Soviet strike, some Russian leader could someday well consider such a potential cost bearable in the light of the resulting "victory." Furthermore, such an analysis might well anticipate that an American president, knowing that a strike against our cities would inevitably follow our response to a Soviet first strike, might choose to avoid such a catastrophe by making important political concessions. No responsible U.S. president can permit this country to have to live under such a threat, not to speak of the hypothetical danger of having to choose either annihilation or submission to nuclear blackmail. Hence the understandable and continual drive for more effective offensive missiles to provide greater deterrence.

The result is that weapons technology is shaping an increasingly precarious U.S.-Soviet strategic relationship. For this reason, we urge serious consideration be given to whether some form of Strategic Defense Initiative (SDI) might not be stabilizing, enhancing to deterrence and even helpful to arms control. To that end, we address the major issues in strategic defense from three points of view:

(1) The technical: Is a defense against missiles technically and budgetarily feasible?

(2) The strategic: Is a defense against missiles strategically desirable? Does it enhance or diminish stability? Does it enhance or diminish the prospects for arms control and a nuclear-weapons build-down?

(3) The political: What are the political implications of strategic defense for our own country and for our relations with our allies? What are the implications for the larger dimensions of our relationship with the Soviet Union? How do we seek the needed domestic consensus on a viable strategy?

A great deal has been written about the state of missile-defense technology. Some experts say the technology sought is unattainable, others that it is merely unattainable in this generation. Yet the promise of the Strategic Defense Initiative is real. Some of the technologies are mature and unexotic. Their deployment around the end of this decade would involve mainly engineering development. Technically, these vital defenses could be in place at this moment were it not for the constraints accepted by the United States in its adherence to the anti-ballistic missile treaty of 1972.

With development and some additional research, we can now construct and deploy a two-layer or double-screen defense, which can be in place by the early 1990s at a cost we estimate to be somewhere in the neighborhood of $60 billion. A conservative estimate of the effectiveness of each layer would be 70 percent. The combined effectiveness of the two layers would be over 90 percent: Less than one Soviet warhead in 10 would reach its target — more than sufficient to discourage Soviet leaders from any thought of achieving a successful first strike.

The first layer in the two-layer defense system — the "boost-phase" defense — would go into effect as a Soviet first-strike missile, or "booster," carrying multiple warheads rises above the atmosphere at the beginning of its trajectory. This boost-phase defense, based on interception and destruction by nonnuclear projectiles, would depend on satellites for the surveillance of the Soviet missile field and the tracking of missiles as they rose from their silos. These operations could only be carried out from space platforms orbiting over the Soviet Union. Because they are weightless in orbit, such platforms could be protected against attack by heavy armor, onboard weapons and maneuverability.

After the booster has burned out and fallen away, the warheads arc through space on their way to the United States. The second layer of the defense — the terminal defense — comes into play as the warheads descend. Interception would be at considerable altitude, above the atmosphere if possible. This second phase requires further engineering, already under way, because interception above the atmosphere makes it difficult to discriminate between real warheads and decoys. In the interim, interception can take place in the atmosphere, where differences in air drag separate warheads from decoys. In either event, destruction of the warheads would take place at sufficiently high altitudes, above 100,000 feet (30,500 meters), so that there would be no ground damage from warheads designed to explode when approached by an intercepting missile.

Of the two layers in the defense, the boost phase is by far the most important. It would prevent the Russians from concentrating their warheads on such high priority targets as the national-command authority (the chain of command, beginning with the president, for ordering a nuclear strike), key intercontinental ballistic missile silos or the Trident submarine pens, because they could not predict which booster and which warheads would escape destruction and get through.

THIS fact is important. Simply a so-called "point defense" of our missile silos, it has been suggested, would be sufficient to restore much of the credibility of our land-based deterrent, now compromised by 6,000 Soviet ICBM warheads. It is particularly necessary to protect the 550 silos containing our Minuteman-3 ICBMs, of which 300 have the highly precise Mark-12A warheads. These are the only missiles in the possession of the United States with the combination of yield and accuracy required to destroy hardened Soviet military sites and the 1,500 hardened bunkers that would shelter the Soviet leadership. But their very importance to us illustrates the difficulty of a point defense, because the value of the silos to us means they will be among the highest priority targets in any Soviet first strike. The Russians can overwhelm any point defense we place around those silos, if they wish to do so, by allocating large numbers of warheads to these critical targets. But if we include a boost-phase defense to destroy their warheads at the time of firing, their objective becomes enormously more difficult to accomplish.

The boost-phase defense has still another advantage. It could effectively contend with the menace of the Soviet SS-18s, monster missiles twice the size of the 97.5-ton MX. Each SS-18 carries 10 warheads, but probably could be loaded with up to 30. The Russians could thus add thousands of ICBM warheads to their arsenal at relatively modest cost. With numbers like that, the costs favor the Russians. But a boost-phase defense can eliminate all a missile's warheads at one time — an effective response to the SS-18 problem.

The likely technology for an early use of the boost-phase defense would use "smart" nonnuclear projectiles that home in on the target, using radar or heat waves, and destroy it on impact. The technology is close at hand and need not wait for the availability of the more devastating but less mature technologies of the laser, the neutral particle beam or the electromagnetic rail gun. The interceptor rocket for this early boost-phase defense could be derived from air-defense interceptors that will soon be available, or the technology of anti-satellite missiles (ASAT) launched from F-15 aircraft. These rockets could weigh about 500 pounds (226 kilograms), the nonnuclear supersonic projectiles about 10 pounds.

INTERCEPTOR rockets would be stored in pods on satellites and fired from space. The tracking information needed to aim the rockets would also be acquired from satellites orbiting over the Soviet missile fields. The so-called space weapons of strategic defense are indispensable for the crucial boost-phase defense. To eliminate them would destroy the usefulness of the defense.

We estimate that the cost of establishing such a boost-phase defense by the early 1990s would be roughly $45 billion. That price tag includes 100 satellites, each holding 150 interceptors, sufficient to counter a mass Soviet attack from their 1,400 silos, plus four geosynchronous satellites and 10 low-altitude satellites dedicated to surveillance and tracking, plus the cost of facilities for ground-control communications and battle management.

The technology used for the terminal defense could be a small, nonnuclear homing interceptor with a heat-seeking sensor, which would be launched by a rocket weighing one to two tons and costing a few million dollars each. Interception would take place above the atmosphere, if possible, to give wider "area" protection to the terrain below. These heat-seeking interceptors can be available for deployment in about five years if a decision is reached to follow that course. One concept for this technology was tested successfully in June by the Defense Department, when an intercepting missile zeroed in on an oncoming warhead at an altitude of 100 miles (160 kilometers) and destroyed it.

The technology for a terminal defense within the atmosphere would be somewhat different, but would probably also depend on heat-seeking missiles. The cost of this terminal layer of defense would be about $15 billion and include $10 billion for 5,000 interceptors, plus $5 billion for 10 aircraft carrying instruments for tracking of the Soviet warheads.

The estimated $60 billion for this two-layer defense is a ball-park figure, of course. However, even with its uncertainties, it is surely an affordable outlay for protecting our country from a nuclear first strike.

TO be sure, the above is not an attractive option to those who place all their eggs in the arms control basket and underestimate the immense difficulty of attaining an effective and truly verifiable pact. It is also not appealing to those wedded to the idea that it is best to assure survival by simply maintaining the perilous balance of terror between the United States and the Soviet Union. We favor energetically pursuing arms control negotiations and seeking to achieve credible deterrence, but these options by themselves are unfortunately not as likely to provide a more secure future as the alternative strategy of mutual security combining defense against missiles with retaliatory offense.

The simplest and most appealing option, quite naturally, is comprehensive arms control. Large reductions in both launchers and warheads, as well as effective restrictions on surreptitious deployment or qualitative improvements, would enhance nuclear stability and produce greater mutual confidence. It would, if properly negotiated and effectively monitored, enhance mutual survival.

How likely is such a future? Some progress in arms control is probably possible, but genuinely effective arms control would require that: (1) there be a restraint imposed on qualitative weapons enhancement; (2) mobile systems, relatively easy to deploy secretly, be subject to some form of direct verification; (3) a method be devised for distinguishing nuclear-armed and nonnuclear cruise missiles; and (4) monitoring arrangements be devised for preventing surreptitious development, testing and deployment of new systems. So far, the Soviet record of compliance with the SALT-1 and SALT-2 accords is sufficiently troubling to warrant skepticism regarding the likelihood of implementing any such complex and far-reaching agreement.

Moreover, such an agreement would have to recognize that it is no longer possible to limit space-based systems without imposing a simultaneous limit, along the above lines, on terrestrially deployed systems, which present the greater threat to survival. After all, the space-based defenses include no weapons of mass destruction and no nuclear weapons. And it should be some cause for concern to note the Soviet insistence on prohibiting space-based defensive systems, the only method now available to inhibit the first-strike use of land-based Soviet offensive systems.

Finally, a comprehensive and genuinely verifiable agreement, limiting both qualitatively and quantitatively the respective strategic forces, on earth and in space, will require a much more felicitous political climate than currently exists. Negotiations may lead to such improvement, but in the setting of intense and profound geopolitical rivalry, how realistic is it to expect in the near future accommodation sufficient to generate the political will essential for a genuine breakthrough in arms control negotiations? The mere mentions of Afghanistan, Nicaragua, Sakharov and Soviet violations of the humanitarian provisions of the Helsinki Final Act dramatize the depths of the problem. There may be no direct negotiating linkage between these acts of Soviet misconduct and arms control, but their political interaction is evident.

This is why there is currently such an emphasis on maintaining peace via the doctrine of deterrence based on mutual assured destruction, called MAD. But what does this mean in an age when weapons are becoming incredibly precise, mobile and difficult to count? In the absence of a miraculous breakthrough in arms control, the only possible protection within the framework of the deterrence approach is to stockpile more offensive systems. This is in part what we are doing. But how many of such systems will be needed in the likely conditions of the next decade? If Soviet strategic forces continue to grow both quantitatively and qualitatively, our country will have to deploy, at enormous cost, probably no fewer than 1,500 to 2,000 mobile Midgetmen to preserve deterrence. How will they be deployed? Where? And at what cost? And will the Soviet Union and the United States be more or less secure with the deployment of such precise weaponry capable of effective pre-emption? The Soviet answer is clear: The Russians are busy enhancing the survivability of their leadership and of their key facilities by hardening, dispersal and deception.

This second traditional alternative, mutual assured destruction, cannot be an acceptable, long-run option, although it is a necessary policy in the absence of an alternative, given the dynamics of weapons technology. Thus, a new third option, the Strategy of Mutual Security, must be explored as preferable. The combination of defense against space missiles with retaliatory offense in reserve enhances deterrence.

And it does not compromise stability, even if only the United States were initially to have such a strategic defense. The deployment of the systems described above would not give us absolute protection from Soviet retaliation against a possible first strike by us, a reasonable though misplaced Soviet concern. Furthermore, the Russians know we are not deploying first-strike counterforce systems in sufficient numbers to make a first strike by us feasible. In any case, one can be quite certain that the Russians will also be moving to acquire an enhanced strategic defense, even if they do not accept President Reagan's offer to share ours. Indeed, they are doing so now and have been for some time.

AS our strategic space-defense initiative expands incrementally, it should be realistically possible to scale down our offensive forces. Such a transition, first of the United States and eventually of the Soviet Union, into a genuinely defensive posture, with neither side posing a first-strike threat to the other, would not only be stabilizing but it would also be most helpful to the pursuit of more far-reaching arms control agreements. Strategic defense would compensate for the inevitable difficulties of verification and for the absence of genuine trust by permitting some risk-taking in such agreements. This is another reason why strategic defense should not be traded in the forthcoming negotiations in return for promises that can be broken at any time.

No significant public policy can be carried out in a democracy without being fully discussed and accepted by the broad polity. Nor can an interested public be expected to resolve disputes among experts as to questions of technical feasibility. The current debate over President Reagan's initiative for a strategic defense program suffers from that conflict among scientists. It is important to clarify this issue.

We can begin a two-tiered strategic defense that would protect command structure as well as our missiles and silos and thus discourage any thoughts by the Soviet military that a first-strike effort would be effective. Some within the scientific community minimize the importance of this technical feasibility and emphasize instead the view that it is scientifically impossible today to provide a strategic defense that will protect our cities. Such a broad defense of populations is today not feasible, but it is prudent for our society to keep in mind the rising tide of technical and scientific advances so rapidly overwhelming the 20th century.

The "impossible" is a concept we should use with great hesitation. It is foolhardy to predict the timing of innovations. We are persuaded that the laws of physics do not in any way prevent the technical requirements of a defensive shield that would protect populations as well as weapons. A total shield should remain our ultimate objective, but there is every reason for us to explore transitional defenses, particularly because the one we have discussed would serve to deter the dangers of a first strike. Defenses against ballistic missiles can be effective without being "perfect," and the technology for this is nearly in hand.

SOCIETY must also not forget that ever since the beginning of the scientific age, the organized scientific community has not had a particularly good record of predicting developments that were not part of the common wisdom of the day. In 1926, for example, A. W. Bickerton, a British scientist, said it was scientifically impossible to send a rocket to the moon. In the weapons field, a U.S. admiral, William D. Leahy, told President Harry S. Truman in 1945: "That [atomic] bomb will never go off, and I speak as an expert in explosives." And Dr. Vannevar Bush, who directed the government's World War II science effort, said after the war that he rejected the talk "about a 3,000-mile rocket shot from one continent to the other carrying an atomic bomb ... and we can leave that out of our thinking." In the strategic area, as late as 1965, the capable Secretary of Defense Robert S. McNamara wrote: "There is no indication that the Soviets are seeking to develop a strategic force as large as our own."

Our debate and our discussion, furthermore, must not ignore what the Russians, who have always understood the need for defenses, are doing in space. They have spent more on strategic defensive forces since the anti-ballistic missile (ABM) treaty was signed in 1972 than on strategic offensive forces. Their anti-satellite program began nearly two decades ago. The Soviet military is now working aggressively on a nationwide missile-defense system; and it now appears ready to deploy a system capable of defending the country not only against aircraft, but also many types of ballistic missiles. Clearly, the Soviet work in strategic defense has taken place in spite of ABM treaty provisions. The large radar installation in central Siberia already violates that treaty with us. Yet the planning for it must have begun many years ago.

The recent Geneva meeting must be considered a major productive result of President Reagan's March 1983 speech announcing that we would begin developing a strategic defense initiative. We are reminded that in 1967 President Lyndon B. Johnson proposed to Prime Minister Alexei N. Kosygin a ban on ABMs, which was flatly rejected. In 1969, President Richard M. Nixon proposed to the Congress that our country begin such an ABM program, because the Russians showed little desire to join us in prohibiting such weapons. Shortly after Congress approved that program, the Russians embraced the idea of an ABM treaty. Had our government not announced its SDI program, we might still be in the cold storage of the Soviet freeze precipitated by their walking out of the Geneva negotiations.

Arms control has been said to be at a dead end, and the stalemate has reflected an impasse in thought and in conception. Our present policy requires both us and the Soviet Union to rely on a theory of mutual annihilation based on a strategic balance of offensive weapons. The U.S. approach has been to depend on deterrence alone and not on defending ourselves from Soviet offensive weapons, while the Russians have made it clear by their actions that they intend to defend themselves against our missiles. In any event, what is clear is that mankind must find ways of lifting itself out of this balance of terror. Mutual assured destruction must be replaced by mutual assured survival. Our safety cannot depend on our having no defense against missiles. The proper role of government is to protect the country from aggression, not merely avenge it. It is astounding that a president should be faulted for seeking a formula and an approach that will protect us from the continual threats and terrors coming from the volatile vagaries of adventurism and miscalculation.

EVEN if a perfect defense of our population should be impossible to achieve — and none of us can be certain of that — the leaders of our government have a responsibility to seek defense alternatives designed to complicate and frustrate aggression by our adversaries. The very injection of doubt into their calculations strengthens the prospect of hesitation and deterrence. It may not be possible to destroy the world's ballistic missiles, but if we can return them to the status of a retaliatory deterrent rather than a pre-emptive strike we will have reduced the need for the existing large arsenal and thereby the threat of war.

The argument has been made that the SDI is politically harmful because our North Atlantic Treaty Organization allies have not received the initiative with enthusiasm. Their skepticism is an understandable initial reaction. First of all, our allies were taken by surprise by the president's March proposal of a Strategic Defense Initiative. At times, secret discussions are necessary, but doubtless allied cooperation will be forthcoming in direct proportion to timely and honest consultation. Furthermore, European political leaders feel under great pressure from an activist peace movement that emphasizes traditional arms control negotiations as a major objective. A new approach, which the Russians criticize as hostile, is, therefore, looked upon as troubling, regardless of its merit.

As to the substance of the initiative, coupling our national security interest with that of our allies is a foundation of NATO defense. Any tendency toward decoupling produces great concern on their part. Western European leaders look upon all security proposals with that criterion in mind. Should America technically succeed in providing a shield against missiles, Europeans wonder whether they would then not be left in an exposed position, facing a superior Soviet conventional military force.

The concerns may be understandable, but will diminish with time and discussion. First of all, President Reagan's call for strategic defense brought the Russians back to the Geneva negotiating table. More important, however, it will become increasingly evident to our friends, as some of the confusion about the technology dissipates, that the ability of the United States to protect its missiles immeasurably strengthens our power to deter and thereby serves to protect our allies. Indeed, such a system is expected to be at least as effective against the SS-20s aimed at Western Europe as it is against ICBMs. Finally, a development pulling the world away from the precipice of nuclear terror goes far to help create an encouraging atmosphere for dialogue and agreement, a vital prerequisite for peace.

In light of the above, we reach two basic conclusions:

(1) Developing a stabilizing, limited two-tier strategic defense capability is desirable and called for by the likely strategic conditions immediately ahead. Such a deployment would be helpful both in the military and in the political dimensions. It is a proper response to the challenge posed by political uncertainties and the dynamics of weapons development. The two-layered defense described here can be deployed by the early 1990s. Americans will rest easier when that limited defense is in place, for it will mean that the prospect of a Soviet first strike is almost nil.

(2) A three- or four-layer defense, using such advanced technologies as the laser now under investigation in the research phase of the Strategic Defense Initiative, may become a reality by the end of the century. If this research shows an advanced system to be practical, its deployment may well boost the efficiency of our defense to a level so close to perfection as to signal a final end to the era of nuclear ballistic missiles. A research program offering such enormous potential gains in our security must be pursued, in spite of the fact that a successful outcome cannot be assured at this juncture.

The current debate is necessary. There are many questions, technical and political, ahead of us. For the debate to be constructive, however, we must overcome the tendency to politicize it on a partisan basis. Our objectives should be to find a way out of the current maze of world terror. The president's initiative toward that end is a major contribution to arms control and stability. The aim of making nuclear weapons impotent and obsolete should be encouraged and not savaged.

The Associated Press

President Reagan and Vice President George Bush, seated, met Tuesday at the White House with U.S. arms negotiators. From left are Max M. Kampelman, who heads the delegation, John G. Tower and Maynard W. Glitman.

SW8UQUNBL
OO WTE24
DE WTE £Ø691 Ø292238
O 3ØØØ55Z JAN 85
FM THE WHITE HOUSE
TO CABINET OFFICE
ZEM
C O N F I D E N T I A L VIA CABINET OFFICE CHANNELS WHØØ691

JANUARY 29, 1985

DEAR MRS. THATCHER:
I AM FORWARDING LETTERS FROM SECRETARY WEINBERGER AND GENERAL ABRAHAMSON ALONG WITH MY OWN BEST WISHES AND DEEP APPRECIATION FOR THE OPPORTUNITY TO MEET WITH YOU EARLIER IN THE MONTH. GENERAL ABRAHAMSON'S CLARIFICATION IS MOST TIMELY AND CONTRIBUTES TO A BETTER UNDERSTANDING OF A TECHNICALLY COMPLEX POLICY ISSUE. WE WILL CONTINUE TO REFINE OUR VIEWS ON THESE AND OTHER IMPORTANT POLICY ISSUES AND VALUE THE CHANCE TO DISCUSS THEM WITH YOU AND YOUR ADVISORS.

WITH BEST WISHES,

SINCERELY,
ROBERT C. MCFARLANE

ATTACHMENT ONE: LETTER FROM SECRETARY WEINBERGER

PRIME MINISTER
THE RIGHT HONORABLE MARGARET THATCHER, M.P.
10 DOWNING STREET
LONDON SW1, ENGLAND

DEAR MRS. THATCHER:

I WANTED TO ESPECIALLY THANK YOU FOR THE OPPORTUNITY TO PRESENT THE TECHNICAL SIDE OF THE PRESIDENT'S STRATEGIC DEFENSE INITIATIVE. WE FEEL THAT VERY SUBSTANTIAL PROGRESS IS BEING MADE, ALTHOUGH THERE IS A LONG WAY TO GO.

THE KEY TO THAT PROGRESS IS THE THOUSANDS OF PEOPLE IN GOVERNMENT AND IN INDUSTRY WHO ARE ALREADY WORKING ON THE PROJECT. OUR CONFIDENCE IS ENHANCED BECAUSE THEY REPRESENT MANY OF OUR BEST MINDS. OVER THE NEXT YEAR, WE HOPE TO CREATE ADDITIONAL OPPORTUNITIES FOR YOUR PEOPLE TO MEET WITH OUR EXPERTS SO THEY WILL GAIN AN INFORMED, FIRST-HAND IMPRESSION OF THE ISSUES AND THE PROGRAM.

I HAVE ALSO ATTACHED A LETTER FROM GENERAL ABRAHAMSON

END OF PAGE 01

EXPRESSING HIS APPRECIATION FOR THE OPPORTUNITY TO MEET WITH YOU. HE PROVIDES SOME ADDITIONAL POINTS IN ANSWER TO YOUR CONCERN ABOUT +AUTOMATIC RESPONSE.+

MY VERY BEST WISHES TO YOU. I AM LOOKING FORWARD TO OUR NEXT OPPORTUNITY TO DISCUSS THE STRATEGIC DEFENSE INITIATIVE FURTHER, AS WELL AS THE MANY PROJECTS WE HAVE UNDERWAY THAT ARE SO SATISFACTORILY IMPROVING OUR JOINT SECURITY.

SINCERELY,
CASPAR WEINBERGER

ATTACHMENT TWO: LETTER FROM GENERAL ABRAHAMSON

PRIME MINISTER
THE RIGHT HONORABLE MARGARET THATCHER, M.P.
10 DOWNING STREET
LONDON SW1, ENGLAND

DEAR MRS. THATCHER:

IT WAS A GREAT PRIVILEGE FOR ME TO BE ABLE TO PRESENT TO YOU THE TECHNICAL PROGRESS THAT IS BEING MADE ON PRESIDENT REAGAN'S STRATEGIC DEFENSE INITIATIVE. WE ALL PARTICULARLY APPRECIATE THAT YOU WERE WILLING TO DEVOTE SO MUCH TIME TO THE SUBJECT.

I REALIZED AFTER THE MEETING THAT I ANSWERED ONE OF YOUR KEY CONCERNS--THE REQUIREMENT FOR +AUTOMATIC RESPONSE+--IN A NARROWER TECHNICAL SENSE THAN YOU INTENDED BY YOUR QUESTION. THE KEY +AUTHORIZATION-TO-FIRE+ FEATURES ARE NOT YET DEFINED. HOWEVER, PRINCIPLES ARE NOW AT HAND WHICH COULD CLEARLY BE BUILT INTO A FUTURE SYSTEM. FOR EXAMPLE, IF ONE OR TWO MISSILES WERE TO BE DETECTED RISING FROM THE SOVIET UNION, EXTRA DELAY TIME COULD BE ACCEPTED TO ESTABLISH WHETHER THEY WERE A THREAT OR MERELY PEACEFUL SPACE LAUNCHES. THAT EXTRA MEASURE OF CAUTION WOULD BE QUITE ACCEPTABLE BECAUSE A SMALL NUMBER OF THREATENING OBJECTS COULD BE EASILY DESTROYED LATE IN THEIR TRAJECTORY BY A MULTI-TIERED DEFENSE SYSTEM. AGREEMENT ON PRIOR NOTIFICATION OF PEACEFUL SPACE LAUNCHES COULD ALSO REDUCE RISKS OF MISCALCULATION EVEN FURTHER.

ON THE OTHER HAND, IF INDEPENDENT SURVEILLANCE SYSTEMS REPORTED A LARGE ATTACK, A RAPID RESPONSE WOULD BE REQUIRED. HUMAN INTERVENTION FOR ANY DEFENSIVE RESPONSE OF VARIOUS POINTS WILL PROVIDE FURTHER ASSURANCE. THE MOST IMPORTANT POINT TO KEEP IN MIND IS THAT EVEN IN THE UNLIKELY EVENT OF A MISTAKEN LAUNCH OF DEFENSIVE SYSTEMS, SUCH ACTION WOULD ONLY ENTAIL THE EMISSION OF

SMALL, PRECISE LEVELS OF ENERGY DIRECTED RANDOMLY AT EMPTY POINTS IN SPACE. THIS CONTRASTS MOST DRAMATICALLY WITH THE RISK SOME PEOPLE SOMETIMES REFER TO IN CONNECTION WITH LAUNCHING OFFENSIVE MISSILES RAPIDLY FOR SECOND STRIKE RETALIATION.

WE REALIZE THAT THIS AREA, AS OTHER AREAS OF STRATEGIC DEFENSE INITIATIVE RESEARCH, REQUIRES A GREAT DEAL OF ADDITIONAL STUDY AND ATTENTION. AS THE PRESIDENT HAS DIRECTED, WE WILL CONTINUE TO KEEP MEMBERS OF YOUR GOVERNMENT FULLY APPRISED OF OUR PROGRESS. THANK YOU AGAIN FOR THE OPPORTUNITY TO MEET WITH YOU. MY BEST WISHES AND PRAYERS FOR YOU AND THE EXTRAORDINARY LEADERSHIP YOU ARE PROVIDING YOUR NATION.

RESPECTFULLY,

JAMES A. ABRAHAMSON
LIEUTENANT GENERAL, USAF
DIRECTOR, STRATEGIC DEFENSE
INITIATIVE ORGANIZATION

END TEXT
Ø846
£Ø691

NNNN

QSL YOUR WTE Ø24 AT 3ØØ134+Z DMH

SECRET

ECL

10

bc PC

7

10 DOWNING STREET

From the Private Secretary

30 January 1985

STRATEGIC DEFENCE INITIATIVE

I have seen a copy of Sir Oliver Wright's letter of 29 January to the Foreign Secretary urging the case for participation by British industry in the SDI research programme.

The Prime Minister's inclination will be to respond favourably to Sir Oliver Wright's suggestions. But before putting them to her it would be helpful to have the Defence Secretary's advice. I am copying this letter to Peter Ricketts (Foreign and Commonwealth Office).

BF

(C.D. Powell)

R.F. Mottram, Esq.,
Ministry of Defence.

SECRET

OCO

BRITISH EMBASSY,
WASHINGTON, D.C. 20008
TELEPHONE: (202) 462-1340

CPC 6

FROM THE AMBASSADOR

29 January 1985

The Right Honourable
Sir Geoffrey Howe QC MP
Secretary of State for
Foreign & Commonwealth Affairs
London SW1

Await Defence Secretary's views. 30/1

My dear Secretary of State,

STRATEGIC DEFENCE INITIATIVE

1. Like yourself, I have been wondering where we go from here over the President's Strategic Defence Initiative research programme. I listened to the President telling the Prime Minister on 22 December why he thought the programme a good idea, and to the Prime Minister telling the President why she accepted the need for it. The clear distinction drawn by the Prime Minister between research and deployment was, in my view, very helpful, not least in political terms. It made possible the armistice of Camp David. It has also, I see, attracted a good deal of support from other European governments. It ensured that we were not on the side of the Russians in opposing SDI.

2. So far so good. Except on one point. This concerns our unwillingness to involve ourselves in the research programmes now picking up steam under the SDI rubric. My Defence Staff and my Chancery have received repeated overtures from General Abrahamson, the energetic Air Force General running the SDI programme, about the possibility of his visiting the UK to brief British industry. So far the decision has been not to pick up the offer.

3. I think this is wrong. It is also inconsistent with our policy of approving research. The SDI under the President's inspiration has fired the American imagination. It is very popular: according to the polls, 60% of Americans think it a good thing. It therefore rates about the same level of popularity as the President himself, who won 59% of the popular vote on 6 November 1984. Its popularity now extends widely throughout the relevant branches of the Administration, the US armed services, and Congress, who will in my judgement vote at least the funds to see whether it will work.

/...

4. There has thus been a significant sea change since the "Star Wars" idea was first unveiled to a fairly sceptical Washington on 23 March 1983. I think it is fair to say that there is now a national consensus behind SDI research and a national determination to get results. And the SDI is one of the things, perhaps the most important, that Ronald Reagan wants to be remembered by, like Jack Kennedy and putting a man on the moon. It gives the American "can-do" spirit something to aim at. He is not going to be deflected from it, and his call for a new conquest at the frontiers of knowledge appeals to the national mood.

5. The question therefore is: are we going to exclude ourselves from the revolution in defence technology that the SDI research programme is likely to ignite? If we continue to spurn US interest in involving us, I see a real danger of our missing the bus. If we indeed miss this bus, as we missed the space bus, we shall only have to instigate, in 10-20 years time, another Alvey catch-up operation in order to stay in the field of nations competent in the most advanced technologies. Isn't it better to get in on the ground floor? Isn't there high grade employment here for a lot of British brains? Isn't there work for eg Plessey, British Aerospace, Racal, GEC? And shouldn't our defence scientists be given a chance to remain up with the US front-runners?

6. I see at least three compelling reasons for giving positive answers. First, the programme will have spin-off in many areas of defence, and no doubt civilian, technology also. It may result, for example, in the transformation of thinking about conventional warfare. We need to make sure that we benefit from this; but in this, as in other fields, without input, we shall get no product. Secondly, there may well be business for enterprising British companies. Perhaps not all that much. But who knows, and why should we deny them the opportunity of competing for what there is, if their commercial judgement inclines them to have a go? Thirdly, we can only hope to have a real influence on US policy decisions on testing and deployment issues if we know what we are talking about. Which means keeping alongside the programme.

7. I am not suggesting that we need ante-up from the defence budget: I fully understand the constraints on defence resources. What I am suggesting is that we should 1) pick up the Abrahamson offer to brief British business, make some political mileage of it here, and see if we can, by so doing, get British firms on the inside track; and 2) task the appropriate MOD research establishments to explore the opportunities for associating themselves with the US research effort (not least because of the likely spin-off for developments in conventional and other areas of defence), and make some political mileage with the US out of that too.

8. I suggest therefore that when you and Mr Heseltine come to Washington with the Prime Minister, she should be advised to tell the President of our interest in the research programme and our wish to take up the US offer of a piece of the technological action. Such a request would in fact be consistent with our support for the research programme and a natural development of the agreement of Camp David. There would be no need for her to say that she had come round to the President's point of view on deployment. But a clear statement by her of British interest in the research enterprise would at once engage the President's interest and make it much more likely that a Presidential directive would issue to ensure that we were involved where it matters at the governmental level, and that British companies were well positioned to involve themselves if they wished.

9. I raise this now because 20 February seems to me likely to provide the best occasion to make our pitch. But if for whatever reason that tactical question were seen differently in London, I believe that the case for our making such a pitch rather soon would still stand.

10. I am sending copies of this letter to the Secretary of State for Defence and to the Private Secretary at No 10 Downing Street.

Yours sincerely

Oliver Wright

Oliver Wright

MR POWELL 29 January 1985

This is the article on SDI I mentioned yesterday.

I think the Prime Minister should see it.

PERCY CRADOCK

THE STRATEGIC DEFENSE INITIATIVE

Defensive Technologies Study

Department of Defense

April 1984

For sale by the Superintendent of Documents, U.S. Government Printing Office

THE UNDER SECRETARY OF DEFENSE

WASHINGTON, D.C. 20301

RESEARCH AND ENGINEERING

On March 23, 1983, President Reagan challenged the scientific community of the United States to investigate whether new technologies could provide the means for countering the awesome threat of nuclear ballistic missiles.

Following his historic speech, the President directed an intensive study to define the technologies necessary for defending the United States and our allies from ballistic missile attack. We collected over 50 of our nation's top scientists and engineers and asked them to assess the feasibility of achieving this goal and to structure a research program to develop the technologies that could provide an effective defense against ballistic missiles. This report summarizes the results of their effort, the Defensive Technologies Study.

The principal finding of the Defensive Technologies Study Team was that, despite the uncertainties, new technologies hold great promise for achieving the President's goal of eliminating the threat of ballistic missiles to ourselves and our allies. Based on the technical recommendations of this study the United States has structured a focused research and technology program of the highest priority to pursue these new technologies. This Strategic Defense Initiative will provide future Presidents with an option to enhance our deterrence capability by basing it on a mix of offensive and defensive forces. The Strategic Defense Initiative will have three aspects as its hallmark: innovation, focused technology programs, and technical demonstration milestones.

Our scientists and engineers are aware, like the President, that we face significant technical challenges and uncertainties. Yet, as we move into the next decade, I am confident that our greatest asset, our people's ingenuity and creativity, will make the President's vision a reality. We will pursue the Strategic Defense Initiative with utmost vigor. I believe that within the technologies reviewed by the Defensive Technologies Study are the seeds of a safer world. We owe it to ourselves, our allies, and most of all to our children to meet the President's challenge.

R. D. DeLauer

CONTENTS

PREFACE

In March 1983 President Reagan established as a long-term national goal an end to the threat of ballistic missiles. He said that "we must thoroughly examine every opportunity for reducing tensions and for introducing stability into the strategic calculus on both sides." He asked the scientific community to give the United States "the means of rendering" the ballistic missile threat "impotent and obsolete."

Shortly after his address to the Nation, the President directed that an intensive analysis be conducted, to include a Defensive Technologies Study to identify the most promising approaches to effective defense against ballistic missiles and to describe a technically feasible research and development program. A study team was formed and worked under the leadership of Dr. James C. Fletcher. The team's report is summarized here.

SUMMARY AND CONCLUSIONS OF THE DEFENSIVE TECHNOLOGIES STUDY

The Defensive Technologies Study analyzed the technological feasibility of developing an effective defense against ballistic missiles and proposed programs in the areas of

- surveillance, acquisition, and tracking;
- directed energy weapons;
- conventional weapons;
- battle management, communications, and data processing;
- systems concepts;
- countermeasures and tactics.

Classified reports for each area and a *Summary, Defense Technology Plan* have been issued. Presented here is an unclassified overview of the summary report, with its principal findings.

The Study Team identified a long-term, technically feasible research and development plan. The goal of the study was to provide the basis for selecting the technology paths to follow when a specific defensive strategy is chosen. At the same time, near-term demonstrations of some system components were identified that could provide options for early deployment and meaningful levels of effectiveness against constrained threats. The plan also incorporates ideas for enhancing the defense of NATO and other allies.

The study reviewed, evaluated, and placed priorities on the technological issues underlying the ballistic missile defense of the United States and its allies. Also reviewed was a set of strategic defense system concepts and supporting technologies in various states of development. In addition, the study considered system concepts where technological attributes were not preeminent, for example, concepts constrained by fiscal considerations. The study did not consider defenses against threats other than ballistic missiles, such as bombers and cruise missiles or conventional forces; these issues are dealt with in other Department of Defense studies.

The Defensive Technologies Study Team identified a research and development program to allow knowledgeable decisions on whether, several years from now, to begin an engineering validation phase that, in turn, could lead to an effective defensive capability in the 21st century. Similarly, intermediate deployments could be feasible that would provide meaningful levels of defense, especially against constrained threats.

The Defensive Technologies Study concluded that

- powerful new technologies are becoming available that justify a major technology development effort offering future technical options to implement a defensive strategy;
- focused development of technologies for a comprehensive ballistic missile defense will require strong central management;
- the most effective systems have multiple layers, or tiers;
- survivability of the system components is a critical issue whose resolution requires a combination of technologies and tactics that remain to be worked out;
- significant demonstrations of developing technologies for critical ballistic missile defense functions can be performed over the next ten years that will provide visible evidence of progress in developing the technical capabilities required of an effective in-depth defense system.

ADVANCES IN DEFENSIVE TECHNOLOGIES

The ballistic missile threat has increased significantly over the past twenty years, so an appropriate question is: "What has happened to justify another evaluation of ballistic missile defense as a basis for a major change in strategy?" Advances in defensive technologies warrant such a reevaluation.

Two decades ago there were no reliable approaches to the problem of boost-phase intercept; however, multiple approaches now exist based on directed energy concepts such as particle beams and lasers and kinetic-energy target destruction mechanisms.

Intercept in midcourse was difficult twenty years ago because of no credible concepts for decoy discrimination, the intercept cost, and the collateral effects of nuclear weapons used for the interceptor warheads. Today, multispectral sensing of discriminants with laser

imaging and millimeter-wave radar, birth-to-death tracking, and direct-impact projectiles that have promise as inexpensive interceptors appear to eliminate the difficulties of midcourse intercept.

In the 1960s an inability to discriminate penetration aids at high altitudes and limited interceptor performance resulted in very small defended areas for each terminal site and required an unacceptably high number of interceptors for effective defense. Now, technological advances may offer ways to discriminate among incoming objects and to allow intercepts at high altitudes. When these improvements are coupled with the potential for boost-phase and midcourse intercepts to disrupt pattern attacks, the effectiveness of terminal defenses is significantly increased.

Likewise, 1960s technology in computer hardware and software and signal processing was incapable of supporting battle management of the multitiered defense. Because of technological advances, the needed command, control, and communications facilities in all likelihood will be realized.

Several new technologies and concepts emerged from the work of the Defensive Technologies Study Team that, considered with those already well known, illustrate how far defensive technology has progressed over the past two decades. For example, throughout the phases of a ballistic missile trajectory, there are many observables, and by using both active and passive sensors, a selection of them can be measured. That is, it is likely that discrimination can be done between a warhead and a decoy or debris as threatening objects proceed toward their targets. An active sensor works on the same principle as radar; a passive sensor relies on radiation emanating from the target. Some possible technologies the study identified for surveillance, acquisition, and tracking were active techniques such as thermal response of a target to a continuous-wave laser and passive techniques such as imaging with infrared sensors. Although any one sensor can be defeated, it is very difficult to defeat several operating simultaneously.

The study also identified several concepts for the intercept and destruction of targets. Kinetic-energy, or impact, devices include exoatmospheric and high endoatmospheric, nonnuclear, rocket-propelled projectiles and hypervelocity guns. Directed energy concepts with significant potential include ground- or space-based particle beams. Also identified were potential concepts for enhanced battle management and command, control, and communications as well as several different ways to ensure space systems survivability.

THE THREAT

Various potential threats were considered, ranging from an attack with fewer than 100 ballistic missiles and a few hundred warheads to a simultaneous launch attack with more than 3,000 missiles and over 30,000 warheads. The Study Team selected a defense-in-depth approach because of the stress imposed by a maximum, unconstrained ballistic missile offense. The critical technologies highlighted later are best understood in the context of this threat.

PROGRAM MANAGEMENT

The study concluded that a high priority should be placed on central management of the research and development program and there should be streamlined budgeting and contracting and effective security.

THE BALLISTIC MISSILE DEFENSE ENVIRONMENT

The four phases of a typical ballistic missile trajectory are shown in Figure 1. First, there is a boost phase when the first- and second-stage engines are burning and offering intense, highly specific observables. A post-boost, or bus deployment, phase occurs next, during which multiple warheads and penetration aids are released from a post-boost vehicle. Then, there is a midcourse phase when warheads and penetration aids travel on ballistic trajectories above the atmosphere. Finally, there is a terminal phase in which the warheads and penetration aids reenter the atmosphere and are affected by atmospheric drag.

A ballistic missile defense capable of engaging the target all along its flight path must perform certain key functions:

- *Rapid and reliable warning of an attack and initiation of the engagement.* This requires global, full-time surveillance of

ballistic missile launch areas to detect an attack and define its destination and intensity, determine likely targeted areas, and provide data for hand-off to boost-phase intercept and post-boost vehicle tracking systems.
- *Efficient intercept and destruction of the booster and post-boost vehicle.* The defense must be capable of dealing with attacks ranging from a few tens of missiles to a massive, simultaneous launch. In attacking post-boost vehicles, the defense prefers to attack as early as possible to minimize the number of penetration aids deployed.
- *Efficient discrimination through bulk filtering of lightweight penetration aids.* The price to the offense in mass, volume, and investment for credible decoys should be high.
- *Enduring birth-to-death tracking of all threatening objects.* This enables unambiguous hand-over, with few errors, of reentry vehicles to designated interceptors.
- *Low-cost target intercept and destruction in midcourse.* There should be recognition of the assigned target in the midst of a large array of penetration aids and debris. The cost to the defense for interceptors should be less than the cost to the offense for warheads.
- *High endoatmospheric terminal intercept and destruction.* This involves relatively short-range intercept of each reentering warhead.
- *Battle management, communications, and data processing.* These elements coordinate the system components for effectiveness and economy of force.

It is generally accepted, on the basis of many years of ballistic missile defense studies and associated experiments, that an efficient defense against a high-level threat would be a multitiered defense-in-depth requiring all the capabilities listed above. For each tier there will be leakage, that is, threatening objects that have not been intercepted and hence move on to the next phase. For example, three tiers, each of which allows 10 percent leakage, yielding an overall leakage of 0.1 percent, are likely to be less costly than a single layer that is 99.9 percent effective. In addition, a multitiered defense is the optimum counter to structured attacks; any given offense response affects only one phase.

The defended area of a terminal-defense interceptor is determined, working backward in a ballistic missile trajectory, by how fast the interceptor can fly and how early it can be launched. Terminal-defense interceptors fly within the atmosphere, and their velocity is limited. How early they can be launched depends on the requirements for discrimination of the target from penetration aids and accompanying debris. Because the terminal defense of a large area requires many interceptor launch sites, the defense is vulnerable to saturation tactics.

It is desirable, therefore, to complement the terminal defense with area defenses that intercept at long ranges. Such a complement is found in a system for exoatmospheric intercepts in the midcourse phase.

Intercept outside the atmosphere requires the defense to cope with decoys designed to attract interceptors and exhaust the defending force prematurely. Fortunately, available engagement times in midcourse are longer than in other phases. The midcourse defensive system must provide both early filtering, or discrimination, of nonthreatening objects and continuing attrition of threatening objects if the defense is to minimize the pressure on the terminal system. Intercept before midcourse is attractive because starting the defense at midcourse accepts the potential of a large increase in targets from multiple independently targeted reentry vehicle and decoy deployment.

The ability to respond effectively to an unconstrained threat is strongly dependent on the viability of a boost-phase intercept system. For every booster destroyed, the number of objects to be identified and sorted out by the remaining elements of a layered ballistic missile defense system is reduced significantly. Because each future booster could be capable of deploying tens of reentry vehicles and hundreds of decoys, the leverage, or the advantage gained by the defense, may be 100 to 1 or more. A boost-phase system is itself constrained by the relatively short engagement times and the potentially large number of targets. Because of these constraints, an efficient surveillance and battle-management system is needed.

That phase of flight in which post-boost vehicle operations occur is a transition from boost phase to midcourse. In this phase the leverage gained by the defense decreases with time as decoys and reentry vehicles are deployed. On the other hand, the post-boost phase offers additional time for intercept by boost-phase weapons, and above all an opportunity to discriminate between warheads and deception objects as they are deployed.

The phenomenology and required technology for each of these phases of a ballistic missile trajectory are quite different. In each phase of a ballistic missile flight, a defensive system must perform the basic functions of (1) surveillance, acquisition, and tracking and (2) intercept and target destruction.

SURVEILLANCE, ACQUISITION, AND TRACKING

Just as there are many tiers to the overall ballistic missile defense system, there can be more than one tier in each of the phases. These space-based surveillance, acquisition, and tracking components perform different tasks because the nature of a structured attack changes as the threatening objects proceed along their trajectories. To illustrate this point and also to indicate how the components of one phase may interact with those of another phase, two potential technologies will be described—(1) infrared sensors and laser designators for the midcourse phase and (2) infrared sensors and laser trackers for the terminal phase.

The surveillance, acquisition, and tracking function includes sensing information for battle management and processing signals and data for discrimination of threatening reentry vehicles from other objects. As each potential reentry vehicle is released from its post-boost vehicle, it begins ballistic midcourse flight accompanied by deployment hardware and possibly by decoys. Each credible object must be accounted for in a birth-to-death track, even if the price is many decoy false alarms. Interceptor vehicles of the defense must also be tracked.

The midcourse sensors must be able to discriminate between the threatening reentry vehicles that have survived through the post-boost deployment phase and nonthreatening objects such as decoys and debris. They must also provide reentry vehicle position and trajectory data for firing interceptors and assessing target destruction. Most reentry vehicles must be recognized, even if again there are many false alarms. Requirements are to track all objects designated as reentry vehicles and other objects that may be confusing to later tiers.

Space-based, passive, infrared sensors could provide a way to meet these requirements. They could permit long-range detection of cold bodies against the space background, rejection of simple lightweight objects, and birth-to-death tracking of designated objects. Laser trackers could provide imaging to determine if targets had been destroyed and precision tracking of objects as they continue through midcourse. As the objects proceed along their trajectories, data on them are handed off from sensor to sensor and track files on threatening objects are progressively improved.

The terminal phase is the final line of defense. The tasks of surveillance are to acquire and sort all objects that have leaked through early defense layers and to identify the remaining reentry vehicles. Such actions will, where possible, be based on hand-overs from the midcourse engagement. Objects include reentry vehicles shot at but not destroyed, reentry vehicles never detected, and decoys and other objects that were neither discriminated nor destroyed. These credible objects must be handed off to terminal-phase interceptors.

An innovative concept for the terminal phase is the airborne optical adjunct—a long-endurance platform that would be put into position on warning of attack—that would detect arriving reentry vehicles using infrared sensors, as those space-based sensors had done in midcourse, tracking those that were not previously selected. The airborne sensors would also provide the data necessary for additional discrimination. They could acquire and track objects in late exoatmospheric flight and observe interactions with the atmosphere from the beginning of reentry. Then, a laser or radar would precisely measure the position of each object and refine its track just before committing the interceptors.

INTERCEPT AND TARGET DESTRUCTION

A variety of mechanisms, including directed energy, can destroy a target at any point along its trajectory. The study identified several promising ones. An excimer laser, for example, can be configured to produce a single giant pulse that delivers a resulting shock wave to a target. The shock causes structural collapse. A continuous-wave or repetitively pulsed laser delivers radiant thermal energy to the target. Contact is maintained until a hole is burned through the target or the

temperature of the entire target is raised to a damaging level. Examples included in this category are free-electron lasers, chemical lasers (hydrogen fluoride or deuterium fluoride), and repetitively pulsed excimer lasers. Another way to destroy a target is with a neutral-particle beam, which deposits sufficient energy within a target to destroy its internal components. Guns and missiles destroy their targets through kinetic-energy impact. Here, homing projectiles are propelled by chemical rockets or by hypervelocity guns, such as the electromagnetic gun based on the idea of an open solenoid.

Figures 2, 3, and 4 show ballistic missile defense during boost, midcourse, and terminal phases.

BATTLE MANAGEMENT

The purpose of battle management is to optimize the use of defense resources—it is a data-processing and communication system that includes the command, control, and communication facilities. Its tasks are situation monitoring, resource accounting, resource allocation, and reporting.

A layered battle-management system would correspond to the different layers of the ballistic missile defense system, with each layer being semiautonomous with its own processing resources, rules of engagement, sensor inputs, and weapons. During an engagement, data would be handed over from one phase to the next. Its exact architecture would be highly dependent on the mix of sensors and weapons and the geographical scope of the defensive system that it manages.

Sensors survey the field of battle, and their raw data are filtered to reduce the volume. Later processes organize these data according to the size of the object; information specific enough to determine its orbital parameters and positions as a function of time; and a listing of other data that bear on the identity, classification, and threat status of the object being tracked. In principle, all objects in the field of view of the sensors are candidates, and all objects that cannot readily be rejected as nonthreatening will appear in the file, which is the representation of the total battle situation.

The resources of the defense system include the sensors and weapons, the data-processing and communication gear, and the platforms or stations on which these and other components reside.

The allocation of defense system resources, both sensor and weapon, is a dynamic process that must be repeated with each significant change in the situation. Sensors must be assigned to sectors or to targets of interest at appropriate times to acquire necessary data, and weapons must be assigned to targets within a framework implemented by rules of engagement. An optimum allocation of resources involves extrapolating the present situation into the future and selecting a course of action that optimizes some quantity, for example, the number of targets destroyed. In each phase there are options available to the commander depending on the nature of the threat. The options also differ because events happen within different time frames.

Ultimately, data must be distributed to authorities external to the defense system to infer or sense the development of hostilities, determine a defense condition level and take appropriate actions with respect to weapons release, assist in inferring the attacker's intent, and evaluate the effectiveness of the defense and anticipate damage.

Developing hardware will not be as difficult as developing appropriate software. Very large (order of 10 million lines of code) software that operates reliably, safely, and predictably will have to be deployed. Fault-tolerant, high-performance computing will be necessary. It must be maintenance-free for ten years, radiation-hardened, able to withstand single-event upset, and designed to degrade gracefully. The main problem of network communication is managing networks of space-, air-, and ground-based resources. Other problems are real-time protocols and dynamic reconfiguration. In addition, specific ballistic missile defense algorithms, for example, target assignment, as well as a simulation environment for evaluating architectures will have to be developed.

SURVIVABILITY

Survivability is potentially a serious problem for the space-based components. The most likely threats to the components of a defense system are direct-ascent anti-satellite weapons; ground- or air-based lasers; orbital anti-satellites, both conventional and directed energy; space mines; and fragment clouds.

The approaches to enhancing survivability against a determined attacker are the classic ones that have been used to enhance the survivability of aircraft and surface ships: hardening, evasion, proliferation, deception, and active defense. Applying these functions in combinations will be necessary to counter the spectrum of potential attacks.

Ideally, the defense system should be designed to withstand an attack meant to saturate the system, that is, to survive an attack requiring the commitment of all defense system resources.

OFFENSIVE RESPONSES

In all considerations of offense versus defense, there is a continuing dynamic interaction. Each action can stimulate a countermeasure. In response to the development of a ballistic missile defense system, history indicates that a potential opponent will, in general, proceed in a straightforward manner with the lowest level of countering technology judged adequate. There would be continual work on possible technical responses, and it should be noted that each projected response involves a trade-off; for example, hardening of booster rockets means a reduced payload or range.

CRITICAL TECHNOLOGIES

The Defensive Technologies Study Team concentrated on critical technologies, that is, the technologies basic to the longest lead-time items in a multitiered, four-phase ballistic missile defense system capable of defending against a massive and responsive threat. The concern was primarily with the technologies that are paramount—the concepts whose feasibility will determine whether an effective defense is possible.

There are several critical technological issues that will probably require research programs of ten to twenty years:

- *Boost and post-boost phases.* As mentioned earlier, the ability to effectively respond to an unconstrained threat is strongly dependent on meeting it appropriately during the boost and bus deployment, or post-boost, phases. This is especially important for a responsive threat.

- *Threat clouds.* Large threat clouds—that is, dense concentrations of reentry vehicles, decoys, and debris in great numbers—must be identified and sorted out during the midcourse phase and high reentry.
- *Survivability.* It will be necessary to develop a combination of tactics and mechanisms ensuring the survival of the system's space-based components.
- *Interceptors.* By having inexpensive interceptors in the mid-course phase and in early reentry, intercept can be economical enough to permit attacks on threatening objects that cannot be discriminated.
- *Battle Management.* Tools are needed for developing battle-management software.

The study also identified five- to ten-year research programs dealing with other issues. One category is space logistics. In order of priority within this category, it is desirable to have

(1) a heavy-lift launch vehicle for space-based platforms of up to 100 metric tons;
(2) a capability to service the space components;
(3) a capability to make available, on orbit, sufficient materials for space-component shielding against attack;
(4) an ability to transfer items from one orbit to another.

In addition to these items, multimegawatt power sources for space applications would be required.

NEAR-TERM DEMONSTRATIONS AND DEPLOYMENTS

An informed decision on system development cannot be made before the end of the decade, but there may be reasons for near-term feasibility demonstrations that could be developed into elements of a total ballistic missile defense system. Unlike the boost and post-boost phases, the trade-offs between competing technological approaches for the midcourse and terminal phases are relatively well understood. Although we cannot yet pick detailed designs for the major components of the midcourse and terminal-phase defenses, the best generic approaches are known and the set of competing technologies is narrow. A number of near-term demonstrations could be done before

the end of the decade that typify technological milestones. Such demonstrations could include, among others,

- a space-based acquisition, tracking, and pointing experiment;
- a megawatt-class, visible-light, ground-based laser demonstration;
- an airborne optical adjunct demonstration;
- a high-speed, endoatmospheric, nonnuclear interceptor missile demonstration.

In the next five years, there are decision points that will affect the technologies available by 1990. Between 1990 and 2000 the United States may decide to provide increasing protection for its allies and itself by deploying portions of the complete four-phase system. Such deployments might be evolutionary, leading to the final, low-leakage system.

The members of the Defensive Technologies Study Team finished their work with a sense of optimism. The technological challenges of a strategic defense initiative are great but not insurmountable. By pursuing the long-term, technically feasible research and development plan identified by the Study Team and presented in this report, the United States will reach that point where knowledgeable decisions concerning an engineering validation phase can be made with confidence. The scientific community may indeed give the United States "the means of rendering" the ballistic missile threat "impotent and obsolete."

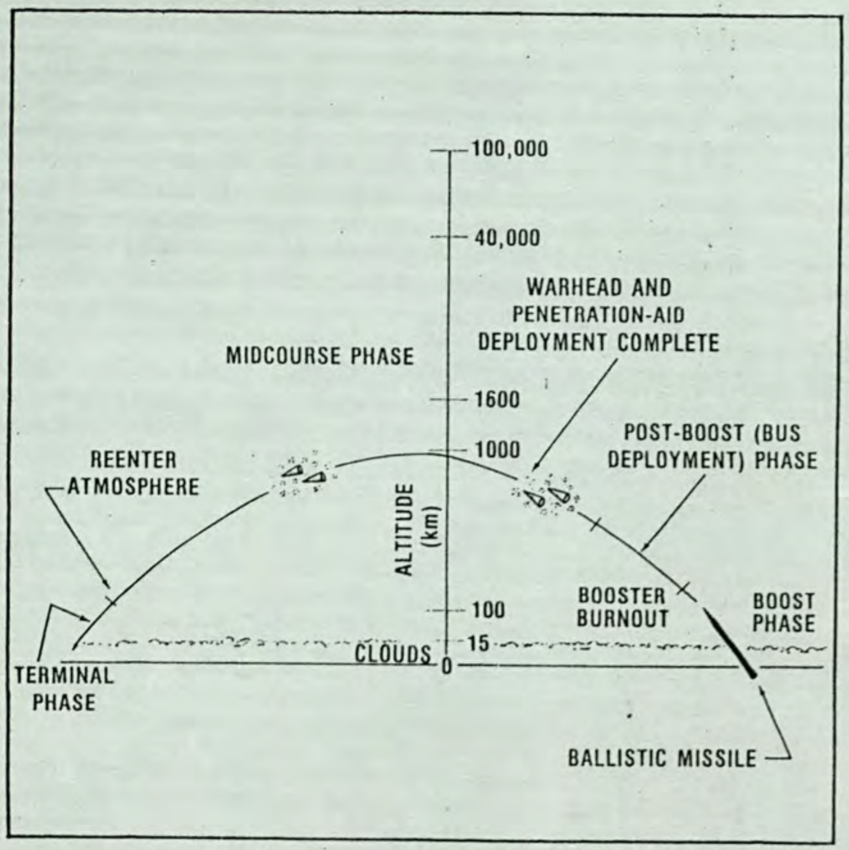


Figure 1. Phases of a typical ballistic missile trajectory. During the boost phase, the rocket engines accelerate the missile payload through and out of the atmosphere and provide intense, highly specific observables. A post-boost, or bus deployment, phase occurs next, during which multiple warheads and penetration aids are released from a post-boost vehicle. In the midcourse phase, the warheads and penetration aids travel on trajectories above the atmosphere, and they reenter it in the terminal phase, where they are affected by atmospheric drag.

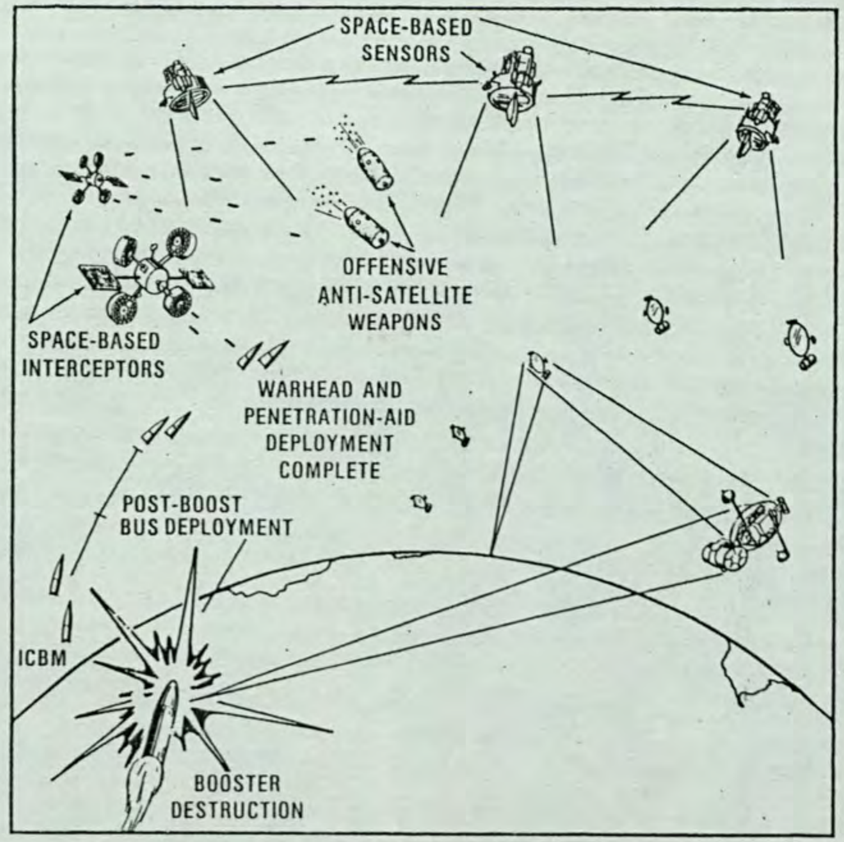


Figure 2. Strawman concept for ballistic missile defense during the boost phase. An essential requirement is a global, full-time surveillance capability to detect an attack and define its destination and intensity, determine targeted areas, and provide data to guide boost-phase intercept and post-boost vehicle tracking systems. Attacks may range from a few missiles to a massive, simultaneous launch. For every booster destroyed, the number of objects to be identified and sorted out by the remaining elements of a multitiered defense system will be reduced significantly. An early defensive response will minimize the numbers of deployed penetration aids. The transition (post-boost phase) from boost phase to midcourse allows additional time for intercept by boost-phase weapons and for discrimination between warheads and deception objects. Space-based sensors detect and define the attack. Space-based interceptors protect the sensors from offensive anti-satellite weapons and, as a secondary mission, attack the missiles. In this depiction nonnuclear, direct-impact projectiles are used against the offensive weapons.

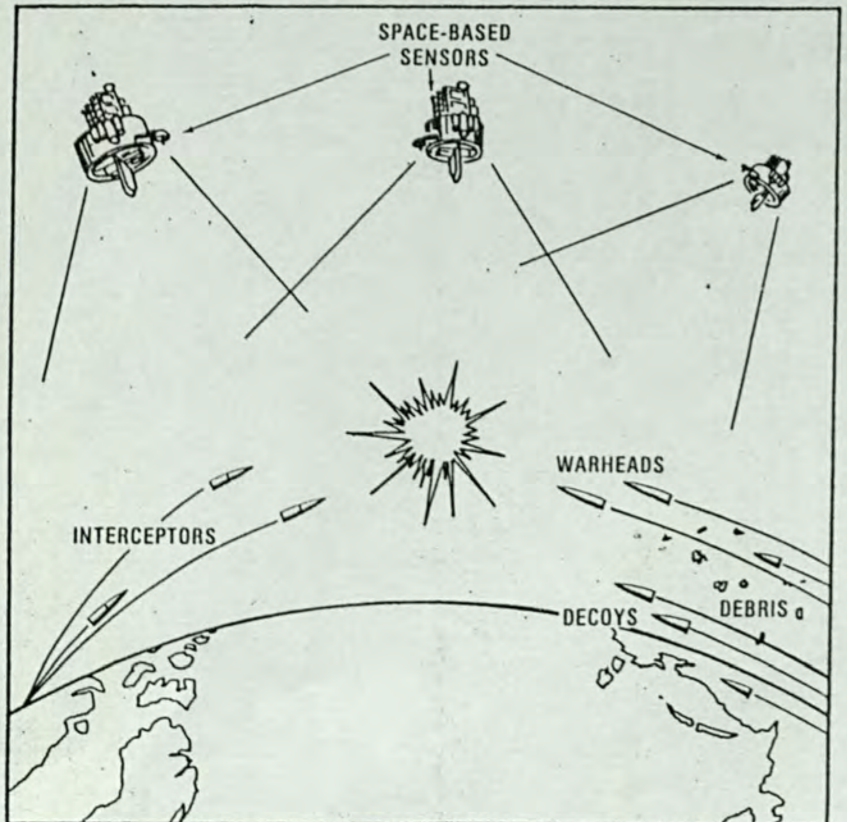


Figure 3. Strawman concept for ballistic missile defense during the midcourse phase. Intercept outside the atmosphere during the midcourse phase requires the defense to cope with decoys designed to attract interceptors and exhaust the defending force. Continuing discrimination of nonthreatening objects and continuing attrition of reentry vehicles will reduce the pressure on the terminal-phase system. Engagement times are longer here than in other phases. The figure shows space-based sensors that discriminate among the warheads, decoys, and debris and the interceptors that the defense has committed. The nonnuclear, direct-impact projectiles speed toward warheads that the sensors have identified.

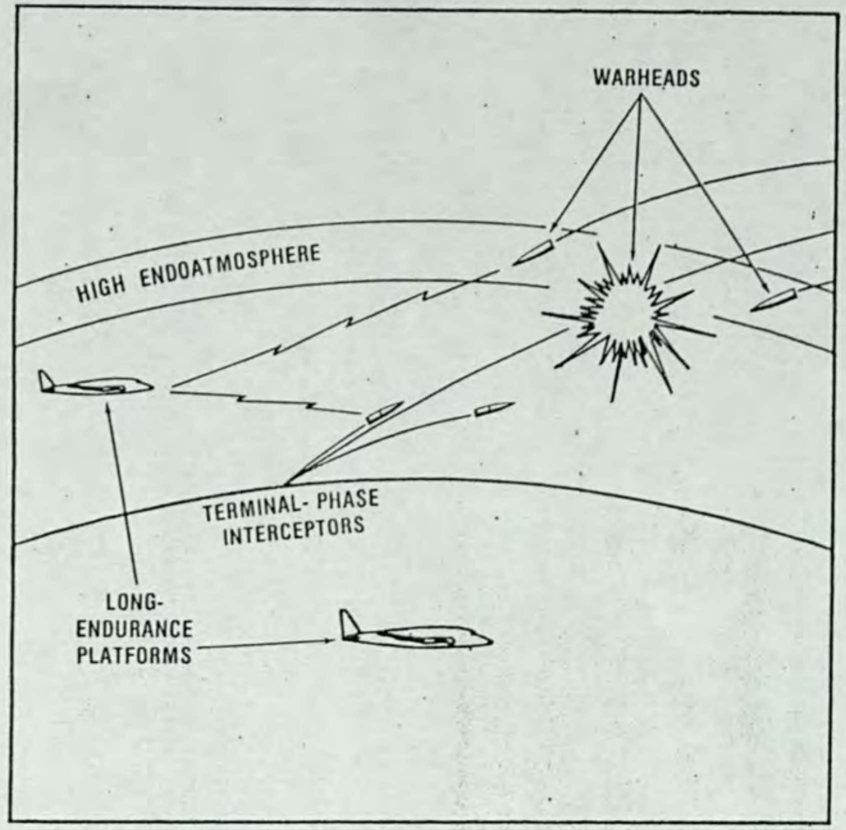


Figure 4. Strawman concept for ballistic missile defense during the terminal phase. This phase is the final line of defense. Threatening objects include warheads shot at but not destroyed, objects never detected, and decoys neither discriminated nor destroyed. These objects must be dealt with by terminal-phase interceptors. An airborne optical adjunct is shown here. Reentry vehicles are detected in late exoatmospheric flight with sensors on these long-endurance platforms. The interceptors—nonnuclear, direct-impact projectiles—are guided to the warheads that survived the engagements in previous phases.

ORGANIZATION

Caspar W. Weinberger
Secretary of Defense

Paul Thayer
Deputy Secretary of Defense
Chairman, Senior Interagency Group,
Defense Policy

Fred C. Ikle
Under Secretary of Defense for Policy
Chairman, Interagency Group,
Defense Policy

Maj. Gen. Donald L. Lamberson
Assistant for Directed Energy Weapons
Executive Secretary, Senior Interagency Group,
Defense Policy

Brig. Gen. Robert R. Rankine
Assistant for Directed Energy Weapons
Executive Secretary, Senior Interagency Group,
Defense Policy

Richard D. DeLauer
Under Secretary of Defense for Research
and Engineering
Chairman, Interagency Group,
Defensive Technologies

Franklin C. Miller
Director, Strategic Forces Policy
Study Director, Interagency Group,
Future Security Strategy Study

Fred S. Hoffman
Chairman, Future Security Strategy Study
Contractor Support Team

John L. Gardner
Director of Defensive Systems
Executive Secretary, Interagency Group,
Defensive Technologies

James C. Fletcher
Chairman, Defensive Technologies Study Team

DEFENSIVE TECHNOLOGIES STUDY TEAM MEMBERSHIP

Study Team Leadership

Dr. James C. Fletcher, Study Chairman	The University of Pittsburgh
Dr. Harold M. Agnew, Vice Chairman	General Atomic Technologies, Inc.
Major General John C. Toomay, Deputy Chairman	United States Air Force (Retired)
Dr. Alexander H. Flax, Deputy Chairman	Institute for Defense Analyses
Mr. John L. Gardner, Executive Secretary	Office of the Secretary of Defense
Major Simon P. Worden, Executive Military Assistant	Office of the Secretary of Defense

Conventional Weapons Panel

Dr. Julian Davidson, Panel Chairman	Science Applications, Inc.
Dr. Delmar Bergen	Los Alamos National Laboratory
Mr. T. Jeff Coleman	Coleman Research, Inc.
Dr. Clarke DeJonge	Science Applications, Inc.
Dr. Harry D. Fair	Defense Advanced Research Projects Agency
Dr. James Katechis	U.S. Army Ballistic Missile Defense System Command
Dr. Joseph R. Mayersak	USAF Armament Division
Lt Col Miles Clements, Military Assistant	Headquarters, Department of the Army
Lt Col Peter E. Gleszer, Military Assistant.	Headquarters, Department of the Army

Systems Concepts Panel

Dr. Edward T. Gerry, Panel Chairman (Boost-Phase Systems)	W. J. Schafer Associates, Inc.
Dr. Wayne R. Winton, Panel Chairman (Midcourse Systems)	Sparta, Inc.
Mr. Charles R. Wieser, Panel Chairman (Terminal-Pl[illegible]Systems)	Physical Dynamics, Inc.
Dr. [illegible] Lowder	Sparta, Inc.

Dr. James R. Fisher	U.S. Army Ballistic Missile Defense Systems Command
Dr. Louis C. Marquet	Defense Advanced Research Projects Agency

Directed Energy Weapons Panel

Dr. Gerold Yonas, Panel Chairman	Sandia National Laboratories
Dr. J. Richard Airey	Science Applications, Inc.
Dr. Robert T. Andrews	Lawrence Livermore National Laboratory
Dr. Richard J. Briggs	Lawrence Livermore National Laboratory
Dr. Gregory H. Canavan	Los Alamos National Laboratory
Dr. Robert W. Selden	Los Alamos National Laboratory
Dr. Petras Avizonis	USAF Weapons Laboratory
Captain Richard J. Joseph	Defense Nuclear Agency
Dr. Joseph A. Mangano	Defense Advanced Research Projects Agency
Dr. Robert C. Sepucha	Defense Advanced Research Projects Agency
Captain Alan Evans, Military Assistant	USAF Systems Command

Systems Integration Panel

Lieutenant General Kenneth B. Cooper, Panel Chairman	United States Army (Retired) Systems Planning Corporation
Mr. Wallace D. Henderson	Braddock, Dunn and McDonald
Mr. Robert T. Poppe	General Research Corporation
Mr. John M. Bachkosky	Office of the Secretary of Defense

Surveillance, Acquisition, Tracking, and Kill Assessment Panel

Dr. John L. Allen, Panel Chairman	John Allen Associates, Inc.
Dr. George F. Aroyan	Hughes Aircraft Company
Dr. John A. Jamieson	John Jamieson, Inc.
Mr. William Z. Lemnios	Massachusetts Institute of Technology
Mr. Dennis P. Murray	Research and Development Associates
Mr. Robert G. Richards	Aerojet Electronics Systems
Mr. Fritz Steudel	Raytheon Corporation
Lt (jg) Patricia A. O'Rourke, Military Assistant	Office of the Chief of Naval Operations

Countermeasures and Tactics Panel

Dr. Alexander H. Flax, Panel Chairman	Institute for Defense Analyses
Dr. Robert B. Barker	Lawrence Livermore National Laboratory
Dr. Robert G. Clem	Sandia National Laboratories
Dr. Walter R. Sooy	Lawrence Livermore National Laboratory
Dr. James W. Somers	Defense Nuclear Agency

Battle Management, C^3, and Data Processing Panel

Dr. Brockway McMillan, Panel Chairman	Private Consultant
Dr. Duane A. Adams	Private Consultant
Dr. Harry I. Davis	Private Consultant
Mr. J. R. Logie	Private Consultant
Dr. Robert E. Nicholls	Massachusetts Institute of Technology/Lincoln Laboratory
Mr. Robert Yost	Science Applications, Inc.

Executive Scientific Review Group

Dr. Edward Frieman, Group Chairman	Science Applications, Inc.
Lt Col Michael Havey	Office of Science and Technology Policy
Dr. Solomon J. Buchsbaum	Bell Laboratories
Mr. Daniel Fink	Private Consultant
Mr. Bert Fowler	Mitre Corporation
Dr. Eugene Fubini	Private Consultant
Admiral Bobby R. Inman	United States Navy (Retired) Microelectronics and Computer Technology Corporation
Dr. Michael May	Lawrence Livermore National Laboratory
General E. C. Meyer	United States Army (Retired)
Professor William A. Nierenberg	Scripps Institute of Oceanography
Dr. David Packard	Hewlett Packard Company

GLOSSARY

active sensor — A system that includes both a detector and a source of illumination. A camera with a flash attachment is an active sensor.

airborne optical adjunct — A set of sensors designed to detect, track, and discriminate an incoming warhead. The sensors are typically optical or infrared devices flown in an aircraft stationed above clouds.

algorithm — Rules for solving a problem using computer language.

architecture — The physical structure of a computer system, which can include both hardware and software (programs).

birth-to-death tracking — The ability to track a missile and its payload from launch until it is intercepted or reaches its target.

boost phase — The portion of a missile flight during which the payload is accelerated by the large rocket motors. For a multiple-stage rocket, boost phase involves all motor stages.

booster — The rocket that "boosts" the payload to accelerate it from the earth's surface into a ballistic trajectory, during which no additional force is applied to the payload.

bus deployment phase — The portion of a missile flight during which multiple warheads are deployed on different paths to different targets (also referred to as the post-boost phase). The warheads on a single missile are carried on a platform, or "bus" (also referred to as a post-boost vehicle), which has small rocket motors to move the bus slightly from its original path.

chemical laser — A laser in which chemical action is used to produce the pulses of coherent light.

coherent light The state in which light waves are in phase over the time scale of interest. Light travels in discrete bundles of energy called photons. Each photon may be treated like an ocean wave. If all the waves are in phase, they are said to be coherent. When light is coherent, the effects of each photon build on top of the others. A laser produces coherent light and therefore can concentrate energy.

cold bodies Objects at or near low ambient temperature, which radiate infrared radiation. All objects radiate electromagnetic energy, and if the object is hot enough, this energy is visible light.

constrained threat A situation where opponents are limited in the number of warheads or types of missiles, for example, by arms control agreement.

continuous-wave laser A laser in which the coherent light is generated continuously rather than at fixed time intervals.

decoy A device that is constructed to look and behave like a nuclear-weapon-carrying warhead, but which is far less costly, much less massive, and can be deployed in large numbers to complicate defenses.

directed energy Energy in the form of particle or laser beams that can be sent long distances at nearly the speed of light.

discriminate The process of observing a set of attacking objects and determining which are the real warheads and which are decoys and other nonthreatening objects.

dynamic reconfiguration A means whereby a battle-management system can change its condition during a battle to respond to changing circumstances, such as the destruction of some defensive components.

electromagnetic gun A gun based on the idea of an open solenoid. The projectile is accelerated by electromagnetic forces rather than by an explosion, as in a conventional gun.

endoatmospheric When all activities take place within the earth's atmosphere, generally considered as occurring at altitudes below 100 kilometers.

excimer laser A chemical laser that uses noble gases.

exoatmospheric When all activities take place outside the earth's atmosphere, generally considered as occurring at altitudes above 100 kilometers.

fragment clouds Clusters of small objects placed in front of a target in space. This is a simple way to destroy the target.

free-electron laser A laser in which electrons are converted to coherent light. The electrons are supplied by an accelerator and power for the laser by electrical energy.

hypervelocity gun A gun that can accelerate projectiles to 5 kilometers per second or more, for example, an electromagnetic, or rail, gun.

imaging The process of identifying an object by obtaining a high-quality image of it.

infrared sensor A sensor to detect the infrared radiation from a cold body such as a missile reentry vehicle.

Interagency Groups Two groups, one for Defensive Technologies and one for Defense Policy, set up to monitor the work of each study team.

intercept The act of destroying a target.

kinetic energy The energy from the momentum of an object.

laser A device for generating coherent visible or infrared light.

laser designator The use of a low-power laser to illuminate a target so that a weapon equipped with a special tracker can home in on the designated target.

laser imaging A new technology where a laser beam can be used in a way similar to a radar beam to produce a high-quality image of an object.

laser tracker The process of using a laser to illuminate a target so that specialized sensors can detect the reflected laser light and track the target.

leakage The percentage of warheads that get through a defensive system intact and operational.

midcourse phase The long period of a warhead's flight to its target after it has been dispensed from the post-boost vehicle until it reenters the atmosphere over its target.

multispectral sensing A method of using many different bands of the spectrum to sense a target, for example, visible and infrared light. If several bands are used, deceptive measures become much more difficult.

neutral-particle beam An energetic beam of neutral atoms (no net electric charge). A particle accelerator moves the particle to nearly the speed of light.

particle beam A stream of atoms or subatomic particles (electrons, protons, or neutrons) accelerated to nearly the speed of light.

passive sensor A sensor that only detects radiation naturally emitted (infrared radiation) or reflected (sunlight) from a target.

penetration aids Methods to defeat defenses by camouflage, deception, decoys, and countermeasures.

post-boost vehicle The portion of a rocket payload that carries the multiple warheads and has maneuvering capability to place each warhead on its final trajectory to a target (also referred to as a "bus").

radiant energy The energy from radiation such as electrons, protons, or alpha particles.

real-time protocols Computer programs capable of making decisions as rapidly as input information is received.

repetitively pulsed laser A laser that fires its beam in sequential short bursts, as opposed to a continuous beam or a single pulse.

responsive threat Offensive forces that have been modified to defeat a defensive system.

Senior Interagency Group Set up in response to the President's directive to study the ballistic missile defense problem. The group reported to the National Security Council and consisted of senior representatives from the Department of Defense, the Department of State, the Arms Control and Disarmament Agency, the Central Intelligence Agency, the National Aeronautics and Space Administration, the National Security Council, and the Office of Science and Technology Policy.

signal processing A computer system's capability to organize the raw data received from many different sources.

single-event upset Electronic components of a battle-management system performing abnormally because of radiation.

structured attack Timing the arrival of a sequence of warheads at their targets to create maximum destructive effects.

terminal phase The final phase of a ballistic missile trajectory, during which warheads and penetration aids reenter the atmosphere.

threat clouds Dense concentrations of both threatening and nonthreatening objects. The defense must distinguish between them.

Foreign Policy : USA Pt 2.

10 DOWNING STREET

From the Private Secretary

8 January 1985

Strategic Defence Initiative

The Prime Minister mentioned to Professor Norman this evening her concern not to say anything in the House of Commons or publicly elsewhere about the technical aspects of the Strategic Defence Initiative which had been gleaned from confidential US briefings. She would therefore find it helpful to have a summary of published knowledge on this upon which she could draw in answering questions. I should be grateful if you could prepare this.

I am copying this letter to Peter Ricketts (Foreign and Commonwealth Office) and Richard Hatfield (Cabinet Office).

Charles Powell

Richard Mottram Esq
Ministry of Defence.

8 5

NOTE FOR THE RECORD

Strategic Defence Initiative

The Prime Minister had a discussion of the progress of US work on the Strategic Defence Initiative with Professor Norman (Chief Scientist, MOD) this evening.

Professor Norman said that a review of all recent available evidence showed that the US conception was that of a layered system. Surveillance and identification would be performed by 8 satellites in geosynchronous orbit at a height of 36,000 km. Tracking would be carried out by 20 satellites placed at a height of about 10,000 km. Each would be armed with 3 sensors: 2 infra-red and 1 radar, the last operating on a very long wave length of 10/20 microns. Battle Station satellites would be a good deal lower, probably at 1,000 km height. At least 100 and probably more would be required. They would need to be able to operate over a range of up to 4,000 km.

The most favourable moment to mount an attack against hostile ICBMs would be during their boost phase when the missle and all its warheads and decoys were together. But this would last some 3-5 minutes only. There would be a further period of 7-10 minutes during which warheads and decoys were deployed, followed by another 10-15 minutes of flight by those outside the earth's atmosphere. The re-entry phase would be very brief, perhaps only one minute. The Americans were concentrating on destroying ICBMs during the first two phases. They did not seem to have given much attention to terminal defence.

Three types of weapon were under research for disabling ICBMs: Kinetic Energy weapons, Directed Energy weapons and Particle Beam weapons. The last category did not appear at all promising.

There were in turn three types of Kinetic Energy weapons, all of which would be satellite launched:

(i) a small projectile weighing about 5 kg which would be rocket-launched and propelled, travelling at 6 km a second. This was already in the proving phase (the Homing Overlay Experiment). It would have infra-red guidance.

(ii) an electric rail-gun launched missile. This would be smaller, probably about 1 kg, but would travel at about 30 km per second.

(iii) a missile driven by a laser. This would be tiny, about 10 grams, but could be accelerated up to 200 km a second.

Laser weapons fell into four categories:

(i) a hydrogen fluoride laser. Great difficulties had been experienced with focussing this.

(ii) a nuclear-powered X-ray laser. The Americans appeared to be paying particular attention to this option, which in essence involved generating a small nuclear explosion to drive a laser beam.

Both these two alternatives would be space-based. The other two options would be ground based and involved firing lasers at mirrors in geosynchronous orbit at 36,000 kilometres. These would in turn reflect the laser beam on to fighting mirrors and from them to the target. There were immense problems with the technology and particularly the high altitude mirrors which would need to be some 25 metres in diameter.

Professor Norman summed up US progress by saying that they were very advanced on individual components, but not on the management of the system as a whole. The software which would be needed was far beyond anything conceivable in the present state of the art. There were also major technical problems in the fields of optics and vast amounts of energy needed for laser weapons.

C.D.P.

C.D. Powell

8 January 1985

4

PRIME MINISTER

Meeting with Mr. McFarlane: Strategic Defence Initiative

The questions which you might put to him (or to General Abrahamson) are:

(i) What technical advances have the Americans made on the survivability of satellite systems?

(ii) What are the recent technical advances which Mr. McFarlane mentioned in December enabling them to deal with Cruise missiles?

(iii) What are the prospects for perfecting the software necessary for a battle management system? The risks of an autonomous/automatic system?

(iv) How would BMD cope with the threat from Submarine Launched Ballistic Missiles?

(v) What role do the Americans see for terminal defence?

(vi) How would BMD cope with short and intermediate range missiles such as SS20s?

(vii) How can problems of discrimination e.g. between armed and unarmed missiles, test firings be dealt with?

(viii) Are there particular areas of research where the US would welcome an input from the UK, such as weapons effect testing?

C.D.P.

8 January 1985

PRIME MINISTER

Meeting with Mr. McFarlane

For the first meeting, on SDI, Mr. McFarlane will be accompanied by General Abrahamson. Since he wants to show slides and tapes, we are setting the equipment up in the Cabinet Room. Robin and I will be present.

For the 1115 meeting on the outcome of the Geneva negotiations Mr. McFarlane will be joined by Mr. Lehman (Deputy to Mr. McFarlane), Charlie Price and Ray Seitz (Minister at the US Embassy: Ed Streator's successor).

On our side there will be Mr. Stanley, Mr. Rifkind, Sir A. Acland, Clive Whitmore, Bryan Cartledge and Percy Cradock.

C.D.P.

8 January 1985

Prime Minister
This is additional technical briefing for your meeting with Professor Norman (MOD's Chief Scientific Adviser) tomorrow. It is well worth reading.

2. Mr. McFarlane has asked whether he can bring General Abrahamson, Head of the SDI Programme, on Wednesday. I have agreed.
CDP 7/i

63

CABINET OFFICE
70 Whitehall, London SWIA 2AS Telephone 01-233 8378.

SECRET UK EYES A

B.06925

7 January 1985

Dear Charles,

Briefing for the Prime Minister on BMD/SDI

With my letter of 4 January I sent you three papers which might be useful to the Prime Minister in preparing for the private briefing which she is to receive from Mr McFarlane on 9 January on the US research effort into Ballistic Missile Defence. I promised to let you have, today, a short commentary on these papers and any updating of them which might be necessary. I now enclose a note, prepared by the Ministry of Defence, which brings the BMD/SDI papers up-to-date and puts our current knowledge of the US and USSR BMD programmes in perspective. You may wish to draw the Prime Minister's attention, in particular, to those sections of the note which deal with the comments made during her meeting with President Reagan on 22 December on the survivability of non-nuclear space based assets (paragraph 10) and the ability of a developed BMD system to counter Cruise missiles (paragraph 8).

Although I understand that Mr McFarlane's briefing of the Prime Minister is likely to be mainly factual, he may take the opportunity of developing the two basic arguments which he has previously advanced in favour of the SDI: these are that it is a necessary response to a shift in the strategic balance to the disadvantage of the West and that a Ballistic Missile Defence can enhance deterrence by altering the strategic calculus. If Mr McFarlane does revert to these concepts, I suggest that the Prime Minister might simply say that we are giving the most thorough consideration both to the points which were advanced by the US side at the Camp David meeting and to those embodied in the White House statement of 3 January on the SDI; that we still have some reservations about the US approach; but that she looks forward to resuming the discussion of these issues when she meets President Reagan again on 20 February. (FCO and MoD officials are preparing an analysis of the US case which will be ready for discussion at the Prime Minister's briefing meeting on 2 February.)

C D Powell Esq
10 Downing Street
S W 1

I also take this opportunity to repair an omission from the set of Treaty texts which I sent to you with my letter of 4 January: this is the text of the Protocol, signed in 1974, to the 1972 ABM Treaty, limiting each side to only one ABM deployment area.

I am sending copies of this letter, with the first enclosure only, to John Weston and Robert Alston (FCO) and Nigel Nicholls (MoD).

Yours ever,

Bryan.

B G Cartledge

US AND USSR BMD PROGRAMMES

1. A summary comparison between US and Soviet attainments and capabilities in BMD R&D was contained in Annex C of the joint MOD/FCO paper on the SDI. This remains valid. As far as Soviet ABM R&D is concerned, there is little to add to the assessment in JIC(84)(N)30.

2. For twenty years or so the Soviet Union has been pursuing an R&D programme which could give it the capability to mount some kind of ballistic missile defences in space. This includes the development of high-powered lasers, heavy lift space vehicles and reusable spacecraft. At the same time it has been upgrading its existing ground-based ABM system located around MOSCOW, with improved interceptor missiles and a new range of ABM radars. The developments which are seen are a logical extension of technological advances and the Soviet pre-occupation with Defence of the Homeland, but there is no conclusive evidence of any Soviet intention to abrogate the ABM treaty at least within the foreseeable future.

3. There is very little to add by way of developments since the JIC assessment was made. There is further evidence to support the statements made in para 12 of the Note as regards the effort the Soviets are dedicating to operating space-based lasers. The

possibility that they may also be developing a high-power ground-based laser for use with space-based deflecting mirrors has also gained some credence. However, at the moment we can go no further than this. The role and purpose of the Abalakovo radar is still not resolved. The Russians have persistently claimed that it is space-related, but it may well be a long-lead item in some kind of BMD activity. However we cannot claim this with any certainty at the moment.

4. An assessment of US attainments and capabilities is, in some ways, more difficult to make. We have received a number of US briefings on the SDI programme, but most of these have concentrated on strategic and political issues and aims, rather than technical achievements. There is a considerable amount of material appearing in the technical journals, but it is not clear how much reliance can be placed on it.

5. In a study commissioned by CSA, AWRE and RAE attempted a best assessment of US progress as a starting point for a judgement of the longer term potential of the SDI. A historical perspective of US work produced in June 1984 for this report is given in Annex 'A'. Work on laser damage weapons started in 1966 and most progress since has been in this area. However, the demonstrations of satellite sensor damage and short range missile intercept from ground and aircraft based lasers were at relatively low power. Although considerable effort has gone into particle beams and microwaves these

are still at a comparatively early stage of research. The published list of technology areas being considered in the SDI programme is consistent with this in that the topics include DEWs and kinetic energy weapons, precision sensors, tracking and pointing, millimetre and laser imaging, high velocity projectiles, hypervelocity guns and electroncis/computers for battle management.

6. In August, 1984 NATO was invited to send representatives to observe a 3-day conference at which a briefing on the US SDI programme was presented by Lt Gen Abrahamson's staff. Only the UK and France accepted this invitation. The prime purpose of this meeting was to seek proposals to explore SDI related technology from US contractors. The UK was allowed to attend all the briefings at Secret level but was excluded from a session involving nuclear driven devices, eg. X-ray lasers, and high endoatmospheric discrimination. Although some detailed points differed from earlier UK scientific assessments, and the general tone of the presentations was distinctly optimistic, the UK technical views reported in the AWRE/RAE study and used in the MOD/FCO joint paper remain valid.

7. The US presentations indicated that the current preferred systems are space and ground based kinetic energy weapons, space based lasers, ground based lasers with space based relay optics, space based neutral particle beams and nuclear driven devices. The emphasis on the role of kinetic energy weapons in the SDI programme was stronger than had been appreciated previously in the UK. In particular, it was

claimed that a concept involving kinetic energy intercept of the ballistic missile post boost phase by a space based system would be potentially cost effective. Such a system called PORCUPINE might include a large number of individual chemically driven projectiles (numbers from 5 to 150 have been quoted), each projectile capable of terminal guidance to kill a post boost vehicle. (The issues of saturation, target acquisition, guidance in a hostile environment and overall practicality were not discussed).

8. The US presentations stressed that the SDI programme did not include low level terminal defence in its Terms of Reference ie. funding comes from alternative defence budget target headings. The reference during the Prime Minister's meeting with President Reagan on an SDI role to counter cruise missiles may relate to the application of SDI components or technology to short range point defence systems using either lasers or electron beams. Effective terminal defence of area targets against cruise missiles would be much more difficult. Alternatively the reference may have indicated a concept to intercept cruise missiles in mid course by space based lasers but this was certainly not raised as a system objective at the August SDI conference.

9. It is clear that the US SDI Programme Office does not believe that they have all the technical answers. Breakthroughs will be needed before the technology is available for a system. In particular writing reliable and verifiable software for overall system

integration is a major problem area. The Americans have produced no evidence so far to support the assertion that a fundamental shift in technical advantage from offence to defence is likely to occur.

10. The only technical area where an exchange has been initiated with the US specifically on SDI aspects is that of target damage effects. Collaboration so far has been confined to establishing damage levels for the various potential weapon types. During the Prime Minister's meeting with President Reagan there was a reference to recent work which indicated a potential for improving the surviv-ability of non-nuclear space based assets. We are not aware of any progress in the effects area but it may be relevant that during the US presentations in August, the PORCUPINE system referred to in para 7 was also identified as a concept which could be applied to the defence of other space battle stations.

11. Inevitably since the US has not yet completed the necessary work to establish component feasibility it seems unlikely that more detailed technical information would alter UK scientific assessment. The US presentations in August were helpful and our first objective in any further technical interchange would be to request the US to release copies of the briefing material used then as this was very detailed and note taking was specifically forbidden.

[Mr. Keyworth was mentioned by DH]

12. A meeting in November 1983 between CSA and Dr Keyworth, the President's scientific adviser, included SDI aspects and it may be useful to exploit this link further to improve the UK's technical understanding of the SDI.

APPENDIX A

"HISTORICAL PERSPECTIVE"

A.1 Lasers

The concept of a High Energy (HE) laser beam weapon was first taken seriously in about 1966 with the breakthrough (in the US) in the development of high gas-throughput, gas dynamic lasers (GDL's) at CO_2, 10.6 µ wavelength giving 100's of kW continuous wave (CW) output.

A.2 1966-1980

In the early 1970's, most R&D was aimed at establishing thermal target damage thresholds, validating damage mechanism models, and studying atmospheric propagation difficulties encountered with thermal blooming, scattering, absorption and turbulence. Much of this early materials damage work was uninterpretable due to inadequate characterisation of the spatial and temporal profiles of the laser beams. The development of other types of HE lasers (electric but especially chemical such as Deuterium Fluoride (DF), 3.8 µ) with higher outputs, both pulsed and CW, and at differing wavelengths, led to serious consideration being given to such applications as ship-borne DF laser defence against sea-skimming missiles.

In the late 1970's, there were 3 significant areas of technological and engineering advances which started to address the practical problems associated with integration into weaponised systems:

1. The efficiency of coupling in pulsed laser energy to a target in air was found to be enhanced by a mechanism called thermo-mechanical coupling, whereby the thermally-produced target surface plasma interacts with the target structure to produce impulsive mechancial damage (as well as thermal). Although this damage mechanism has little relevance to exoatmospheric BMD, it nevertheless did (during the late 1970's) tend to alleviate the pointing/tracking requirements for aim-point maintenance on tactical targets, ie one could afford to illuminate the whole target at lower incident power density.

2. Exploitation of the sophisticated (NASA) space programme pointing/tracking technologies had resulted in accuracies in the region of tens of µ-radians being achieved with HE CW lasers. The development of precision output mirrors of about 1 m diameter contributed to this, and the large Hughes Navy Pointer Tracker (NPT) achieved 2 µR jitter in static tests in 1974.

3. Remarkable advances were made in the packaging of HE chemical lasers, especially in compact design of high power lasing modules (eg 3 ft long, 200 kW, CW modules for the 2MW DF MIRACL laser).

Several laser weapon lethality demonstrations were successfully fielded in the US, the most noteworthy being:

1976	Disablement of low-orbit satellite sensor systems by a ground-based laser.
1978	Shooting down of TOW missiles in transverse flight at 1 - 2 km range by a ground-based 230 kW DF CW laser with accurate (~20 μR) aim-point maintenance using the NPT.
1981/82	Shooting down, head-on, of SIDEWINDER missiles from an airborne 150 kW, CO_2, CW laser in a KC135, and later of Polaris booster missiles.

A.3 1980 ONWARDS

In more recent years, the US programme on development of laser systems for stategic BMD has tended to concentrate more on lower wavelength (submicron) lasers by means of which the achievement of several thousand km range in space is controlled more by source platform jitter rather than by diffraction limitation and optics diameter. The resultant damage mechanism of interest now includes single pulse structural impulse as well as thermal burn-through. This tendency is being driven by the emergence of high output EXCIMER lasers (~0.5 μ) such as Krypton Fluoride (KrF) (for which there is no extensive damage data base), and more recently by the possibility of nuclear-powered pulsed X-ray lasers.

But also in recent years, beam weapons (other than lasers) for BMD are being energetically researched, with very large funding in the US.

A.4 PARTICLE BEAM

With these, target damage is far more penetrating than with lasers and, moreover, with protons the damage peaks at the end of the penetration (Bragg peak). But more significantly, it has been established that sensitive microchip electronics can be damaged, or upset, by the associated γ and Bremmstrahlung (similar to source region Electron Magnetic Pulse (EMP)). There is an effective "radiation cone" extending ~1 m transversely beyond the primary beam so that the primary particle beam does not need to hit the electronics directly. This reduces the pointing/tracking aim-point maintenance requirements, and furthermore, 2 to 3 orders of magnitude less power density is required on target than would be necessary to produce structural or thermal damage.

In the source generation area, technological breakthroughs have occurred in ion source development (Soviet), in new techniques of "collective acceleration", in development of compact light-weight samarium cobolt magnets, and (for neutral beams) the significant attainment of 60% stripping efficiency while maintaining of order 1 μR emerging neutral beam divergence.

A.5 MICROWAVES

In some US opinion, this is now replacing lasers as the most imminent of strategic beam threats, since there has been recent significant development (especially by the Soviets) of high power, pulsed microwave (eg magnetrons giving almost 10^4 MW peak power), and there has been increasing dependence in missiles on computers and micro-chips, and credible countermeasures could (if possible to retrofit) be expensive and difficult. Very recently the microwave pulse rise time (~0.5 ns) has been recognised in the US as being critical in inducing powered systems to destroy themselves via transient changes in component parameters. Extraction of this power from diffraction limited antennas could limit the achievement of the full potential of microwaves as a beam weapon. However, at present there appears to be no US microwave weapon development programme, research being concentrated in the effects area.

A.6 POWER SOURCES

Technological and engineering steps yet to be made before successful weaponisation could be achieved for strategic scenarios are many and varied (depending on the type of beam weapon and its envisaged application). But to take an example of current concern, for a satellite-borne pulsed laser the fuel and electrical power requirements for multiple sustained engagements will not be an easy engineering problem. Not least is the difficult task of heat dissipation and returning the lasing medium quickly to a workable low temperature following each pulse. Recent advances in light-weight, high voltage capacitive discharge generators, in magnetic switching, or in magneto-hydrodynamic (MHD) generator techniques, may provide the raw power, but possibly only reactors (steady or pulsed) will be able to provide the compact, high temperature, heat-rejection capability. Pulsed reactor-driven X-ray lasers are conceptually possible in space.

A.7 THE US STRATEGIC DEFENCE INITIATIVE (SDI) PROGRAMME

The recently expanded US R&D programme on directed energy weapons for BMD is called the SDI and is headed by Gen. J Abrahamson. It has been created as a result of President Reagan's policy directive (NSSD 6-83) which determines that the US and its allies should have an effective defence against first strike ICBMs. The philosophy behind the directive is that the USSR already have a ballistic missile defence system which they are presently upgrading. The rationale behind the possible success of the SDI programme was the technical advances which had taken place over the last few years. The key technology areas were: the development of DEWs, the availability of precision sensors, tracking and pointing, the existence of millimetre imaging, the developing of high velocity projectiles and hypervelocity guns for use in the terminal phase, and the development of electronics and computers to allow for better battle management. Congress is being asked for about $30B to fund the programme over the next five years with $1.75 billion required for 1985. On the directed energy part of the programme the spend is $369.1m in 1984 and $322.5m and $489m in 1985 and 1986 respectively. Although this is an enormous sum of money to spend on R & D, it would appear that a very similar sum of money would have been spent on BMD R & D irrespective of the Strategic Defence Initiative.

SDI proponents in the US consider that no fully effective directed energy BMD will be possible until after year 2000, but partial solutions could be deployed before that time.

Prime Minister
This should be helpful background for your briefing by Mr. McFarlane. The document at X – not sent to No. 10 before – is a particularly full account of American thinking.
CDP 4/1

5 2

CABINET OFFICE

70 Whitehall, London SWIA 2AS Telephone 01-233 8378

SECRET

B.06923

4 January 1985

Dear Charles,

Briefing for the Prime Minister on BMD/SDI

We agreed on the telephone this afternoon that as Robert McFarlane's visit to give the Prime Minister a special briefing on BMD/SDI is to take place as early as 9 January, it would make sense to let you have straightaway the main components of the material which you had requested earlier, concerning Soviet and US capabilities and research in the BMD field.

I therefore enclose, so that the Prime Minister can have (if she wishes) a look at them during the coming weekend, the following papers:

(i) the JIC paper of 1 March 1984 on the Soviet BMD;

X (ii) a record of substantial briefing which senior US officials gave to UK and other Allied representatives at the Pentagon on 17 July 1984 (covering both Soviet and US activities); and

(iii) Annex C, covering US and Soviet BMD attainments and capabilities, to the MoD/FCO paper of October 1984 on BMD/SDI, which the Prime Minister has already seen but which was deliberately omitted from the composite paper on space which she had with her for her meeting with President Reagan on 22 December but did not in the event hand over.

In the time available, it has not been possible to make a thorough check on the extent to which this material needs to be updated; nor to prepare the short commentary on the papers which, as I mentioned to you, the Prime Minister might find it helpful to see before her meeting with Mr McFarlane. Work is proceeding urgently on both counts and I shall endeavour to let you have the results by the evening of Monday, 7 January.

I am sending copies of this letter (without enclosures) to Nigel Nicholls (MoD) and John Weston (FCO).

Yours ever,

Bryan

B G Cartledge

C D Powell Esq
No 10 Downing Street
S W 1

SECRET

SECRET

-3 AUG 1984

FILE 8/20/4

BOOK NO. 30

Copy 1 of 4

16

5(1

RECORD OF DISCUSSIONS AT THE PENTAGON ON SDI: 17 JULY, 1984

Annex A contains a summary list of participants.

1. Mr Hanmer (OSD/DOD) welcomed all the visitors to the briefing. The primary purpose would be to dispel misconceptions and to begin a long-term multilateral dialogue on a subject important to everyone. As a background to understanding the US SDI it was however essential to consider it in context with Soviet efforts in the Ballistic Missile Defence (BMD) field. He accordingly introduced Col. Hagar (DIA) who gave a presentation on Soviet attainments and projected capabilities.

2. The Soviets were determined that even, in a full scale nuclear war, their system would prevail and for this reason put a heavy emphasis on defensive preparations, since offensive systems alone could not guarantee them victory. Their priorities for protection were assessed as: the Wartime Leadership, the Military (and these first two categories had some 1500 hardened underground bunkers available for them), the Economy, and finally the Population, although this last meant, in practice, only key workers. Apart from huge Air Defence, ASW and Civil Defence programmes, the Soviets also had the world's only operational ABM system round Moscow. Its limited size was solely due to the constraints of the ABM Treaty which they had signed in 1972, when the kinds of ABM systems thereby relinquished where enormously less capable than those which they could deploy today by breaking out of the Treaty.

3. Signs of their recently intensified interest in widespread BMD included the Pushkino Radar, a huge structure NE of Moscow with a 360° view and believed to be capable of tracking 3000 targets when it became operational in 1987/8. It would carry out battle management functions for the 100 ABM launchers round Moscow, which were themselves now being modernised, with only 16 of the 74 launchers operational in 1979 functioning today. The new system when installed would have an outer ring of exoatmospheric and an inner ring of endoatmospheric missile interceptors. The SA-X-12 was being developed as an anti tactical missile but also had more general ABM potential. It had recently achieved 2 tactical intercepts without using explosive warheads: a feat similar to, but perhaps less difficult, than the US HOE midcourse interception in June. It was possible that there would be over 800 SA-X-12s deployed within the Soviet Union by the 1990s. Another major indication of Soviet intentions was provided by the 6 modern phased array radar sites at Pechora, Abalakovo etc. These were claimed to be filling gaps in the Soviet BMEWS network, but their location and configuration, looking back over Soviet territory rather than scanning the periphery, indicated that they might also have a major function in connection with ABM battle management.

SECRET

4. By the early 1990s current Soviet developments and programmes would put them in a very good position to abandon the ABM Treaty. But there were some constraints on any early Soviet decision for Treaty break-out: construction of launcher sites would take 18-24 months, and a shortage of sophisticated components, such as phase shifters needed for big radars like Pushkino, would cause bottlenecks in the building of further radar sites necessary for nationwide ABM defence. The US would eventually discover any programme to break out of the 1972 Treaty but probably not before 2-3 years had elapsed from the decision to commence it.

5. In new and non-conventional BMD the Soviets had been making a large effort, especially in laser research, but also into Radio Frequency damage and Particle Beam Weapons. They had put some of their best scientific resources into this. At Troitsk, a Science City south west of Moscow, they had been working on linear acceleration, and the large fabrication facility recently completed showed they were moving out of the R&D phase. As long ago as 1978 the Soviets had destroyed a tethered helicopter with a laser, and developments of this system would probably become operational for battlefield air defence in 1985. Laser turrets on aircraft had also been tested at the Shchelkovo laser R&D facility. At Sary Shagan intensive work was being carried out on ground based lasers - a large beam director had been observed beneath the sliding metal cover at Complex D, and there were also indications that an explosively pumped laser was being developed which would destroy by shock pulses rather than heat. The US believed that the near-term goal of the Soviet programme was to create a laser ASAT capability: and that there was a 50% probability of an ASAT test against satellite targets in low earth orbit (100-1000 km) before 1990. It was unclear whether the Soviets would seek to put lasers quickly into space or to perfect them for the ASAT role first on the ground. For BMD the technical problems were much more difficult, and would require hundreds of ancillary satellite systems. It was assumed that the Soviet development work could not be completed until the 1990s, and operational applications would take until the next century. Since crucial BMD components would have to be space-based, a major Soviet precondition would be creation of a heavy space lift capability. This was now underway with the Soviet copy of the US shuttle which they were developing to be carried on the Bison bomber, and their Heavy Lift Launch Vehicle (HLLV) rocket system.

6. General Abrahamson (Director, DOD SDI Task Force) then gave his standard briefing on the SDI, virtually identical to the presentation to the North Atlantic Council on 4 July. He said that he saw himself as trying to overcome what must be seen as a major communications problem about the implications of the President's speech of 23 March 1983. He emphasised that the technical approach being taken was structured by the President's goal of total effectiveness against BMs. By deploying kinetic energy interception systems of the sort proposed by General Graham and the High Frontier group, 30% effectiveness could be achieved now; but instead the US was going for major R&D programme which would take a relatively long time to mature. The goal would be a multi-layered defensive system with boost phase intercept as a key component. But no final percentage of effectiveness such as 99.5% was being sought. Some preliminary

studies were also being carried out into defence against Air Breathing systems. But this gap would have to wait to be plugged until the feasibility of defending against the much more difficult and destabilising BM threat had been assessed - and years would have to pass before this stage would be reached.

7. Work was proceeding on all identified BMD relevant technologies. The HOE intercept of 10 June (of which a video film was shown) had demonstrated Long Wave Infra Red (LWIR) sensing, and tracking technology. The White Sands laser facility was working on orbiting laser systems which had been strongly endorsed by Dr Keyworth as the most promising BMD weapons. The White Horse Neutron Particle Beam Accelerator Test Stand at Los Alamos was now operating (though, soberingly, many of its components were based on ideas derived from open Soviet scientific literature of the mid-1970s). An electromagnetic rail gun firing a small projectile would be fired this summer in test laboratories. A multi-megawatt nuclear power source reactor project was being considered between DOD, NASA and the Department of Energy.

8. On strategic and arms control aspects, crucial decisions were a long way off. The US did not know at this stage what an effective SDI would have to defend, nor how much it would cost, nor what it would comprise. But he was convinced that an effective system could be developed so long as the technical will existed to pursue it with determination. The probable anwer would be a "System of systems". For Terminal Defensive Radar (the US equivalent of Pushkino) and several other key BMD component systems, the development periods involved meant that the ABM Treaty-critical year was around 1994, when decisions would have to be taken on testing and deployment. Admittedly, with other systems and technologies, the US would have to build demonstrations very cleverly, in order to remain in compliance with the ABM Treaty until that date.

9. He did not accept that if it were decided to proceed with a BMD system, the period of transition before it was fully functioning would necessarily be destabilizing - indeed, even if not fully deployed by 2000 it could still start then to provide leverage for achieving progress in arms control. Introduction of defensive technology would, moreover, be done incrementally, with a decision being taken before each stage was introduced on whether it was technically feasible, whether it was affordable, and whether it was likely to lower the overall level of risk in the world and safeguard the US and its allies. In this context it was as well to remember that, because of commercial satellite launch programmes, ballistic missile, as well as nuclear, technology was becoming widely diffused throughout the world.

DISCUSSION

10. Madame Renouard (France) asked what was being done to ensure enhanced security and stability through the SDI rather than the undermining of the credibility of nuclear deterrence, which was the basis of the West's present security. Given the importance of agreed Treaty limitations for this, the Europeans would be very interested in the outcome of US/Soviet discussions on space in the weeks to come. In reply Mr Hanmer stressed that the US was well aware of the implications for the combined security of the Free World. Not all these implications could be assessed at the present - but they never would be without the continuation of the SDI R&D programme.

11. Mr Weston (UK) spoke as reported at Annex B.

12. Herr Ruth (FRG) agreed with both preceeding speakers, especially on the need for continued consultations. He wished to make 4 points:

a. the technical and political timeframes for SDI were very different: there was an important task of political management to be faced now by each NATO nation, which could not be handled separately. Great efforts in cooperation would have to be made to avoid being split in the face of the fierce accusations which would be made against SD1;

b. while technical questions could not yet be answered, clear positions could and would have to be worked out on political and strategic questions such as the consequences for conventional defence, SR/INF ballistic missiles, cruise missiles and aircraft;

c. there would be particular need for careful presentation of the apparent volte face over BMD, which in 1972 was portrayed to Western publics as destabilizing but now was being represented as a virtuous goal to strive for;

d. it appeared that the US development and deployment of a successfully functioning BMD would need Soviet cooperation. What was the US view of this?

Overall, the day's presentation had shown how difficult were the questions surrounding the subject. It had also given a heartening display of Alliance cooperation.

13. Sig. Danovi (Italy) agreed with Herr Ruth, especially on his first point. There were enormous opportunities for opposition parties in NATO countries to misrepresent and vilify the SDI, portraying it as just a new lap in the Arms Race, especially now that the INF crisis was over. The need for close consultations could not be overstressed. He also had 3 points arising from General Abrahamson's presentation:

a. during the transition phase SDI sub-systems would become effective at different stages, giving initially a low probability of effectiveness, like the 30% which the US had rejected as a worthwhile system goal. This could be destabilising;

b. what was to prevent the Russians countering a US BMD deployment by deploying more offensive missiles of their own?

c. the information given on Soviet research indicated that it could be a close race with them to deploy BMD systems first, and the outcome might be perhaps 20% due to chance. Given the uncertainty of outcome, might it not be better to emphasise mutual constraints rather than competition?

14. Mr Hanmer took note of the last point, but felt that it fell within the category of questions to which the answers would have to emerge later. Gen. Abrahamson pointed out that R&D work would assist stability because, even if it were decided not to deploy BMD, the US would get a better idea of what to look for in monitoring an incipient Soviet breakout. During the transitional period mutual US/Soviet communication would be important. Mr Miller (OSD/DOD) said that, although there were still large areas of uncertainty, it was possible to set out bounding cases (0% and 99%) of effectiveness and to consider the implications of situations tending towards either. Mr Dean (State Dept.) argued that it was not possible even to formulate the right questions at this stage. For example, what effect would 30%-effective BMD have? It would be too simple to imagine that it would lead only to a 30% increase in Soviet offensive numbers. The uncertainty effect on Soviet targetting would be vital in removing the guarantee that particular BMs could be set against particular targets.

15. Sig. Danovi asked why, in that case, the US had decided not to proceed with a High Frontier-type crash programme. Gen. Abrahamson said that it was a question of cost rations. It would be too easy for the Soviets to overcome such a limited BMD system. It was an important not to overestimate defensive effectiveness as offensive capability. Mr Miller emphasised that by the time, probably the end of the decade, the US could complete a crash programme the Soviets could make it obsolete. The Fletcher Defensive Technologies study had indicated that a full BMD system ought to be capable of defeating Soviet offensive forces 3-4 times greater than their present size, even if they were fully reactive. This would be a quite different proposition which could not be overcome simply by adding a few more ICBMs.

16. Sig. Danovi suggested that these replies indicated that the transition period could indeed be as destabilizing as he had suggested. Mr Weston agreed, and suggested that technical uncertainties need not prevent strategic and political implications being analysed. There was certainly an argument that the SDI would deter a first strike by increasing the uncertainty of its success (although it should be remembered that the Scowcroft Commission had found that sufficient uncertainty existed already to maintain deterrence). But could the SDI increase the overall risk of war, including conventional war, assuming the Russians deployed a similar system, by removing the top rungs of the escalatory ladder, and perhaps making lower level risk-taking more likely? It was not satisfactory to say that these

questions could not yet be answered. If this were true, then no assertions should perhaps be made about the SDI's politico-strategic implications, either positive or negative.

17. Mr Hanmer replied that NATO would be able to continue to rely on its airbreathers to carry out the function of strategic retaliation, even if there were a Soviet BMD system. Similarly, as well as counteracting Soviet ICBMs, it would inhibit SS14 and 20s within Europe and thus force the East also to rely on aircraft strikes for strategic deterrence. Mr Weston asked what, in that case, would have been gained if the SDI led only to intense pressures to proliferate and multiply air-breathers in order to maintain deterrence. Mr Weston also noted that even if the existence of effective BMD systems removed the Soviet nuclear threat against NATO, a conventional Soviet superiority would remain. Mr Miller suggested that NATO's conventional capability would be adequate to deal with this.

18. Gen. Abrahamson said that this was largely a psychological question: SDI could at the very least exert pressure for offensive ballistic missile inventories to be halved, which arms controllers had always asserted would be desirable in its own right. Both sides would have an incentive to agree that defensive systems were desirable and would then want to control their own destiny. This in turn could then lead to a better climate for negotiating reductions in less useful offensive forces. Herr Ruth agreed that this would in principle be desirable (especially if it produced cuts in INF systems which would make SDI more credible for Europe). But how could such reductions be achieved? Negotiation so far had led only to overall Soviet increases and Western reductions: the climate would have to improve markedly to allow for optimism on this. Mr Weston pointed out that a common East-West interest in negotiations would be needed and that the US had not been able to explain why SDI would create that. The risk therefore remained of the Soviets seeking to overcome any strategic disadvantage in the transition phase by sheer ICBM numbers. There seemed no reassuring signs of past Soviet reactions or present perceptions which would indicate otherwise.

19. Gen. Abrahamson referred to the experience gained in an Interactive Simulation Game at the US Naval War College with 2 teams representing the US and USSR. US Senators had been involved as the US President and Soviet First Secretary; Abrahamson himself had played Marshal Ustinov. The first 3-year move consisted of the Soviets, with clear strategic offensive superiority and an R&D lead in BMD, trying to talk and propagandize the US out of the idea of SDI. Their next move was to rush resources into counter-measures. By the 6-year point US progress - inevitably fully reported in Aviation Week - was such, although still within the ABM Treaty limits that the Soviet players had to pull back 5% of their forces from Europe because they could not afford to equip them and because of the Chinese threat. Eventually Soviet resources had to become highly concentrated on BMD. But the US side 'lost' the simulation by failing ever to abrogate the 1972 Treaty.

20. Herr Ruth said that he had been struck by the strong symmetry between US and Soviet BMD research coverage and timescales. Were there any indications that the same similarity would apply in the systems actually chosen for development? Furthermore, within Europe the Report on SDI by the Union of Concerned Scientists had established itself as one or the basic sources in the debate. Had any work been done within the US Government to analyse and refute it? If so, it would be very helpful if this could be made available to allies. Finally, could anything be said about interconnections between SDI and ASATs?

21. On the last point Gen. Abrahamson said that the timings were very different, nor were the two sets of systems interchangeable. The US ASAT was a separate USAF programme which was well on course to correct a current asymmetry. There were some technical similarities: both the MHV ASAT and the HOE interceptor used LWIR sensors; the computing problems were similar, but were being handled by different contractors, and the systems were, naturally, optimised for different tasks. It would take considerable time to adapt HOE to an ASAT if this were ever envisaged. Sig. Danovi suggested that there was perhaps another ASAT-SDI interconnection, in that unrestrained Soviet ASAT R&D would complicate the environment threat for the SDI. Gen. Abrahamson said that this was technically true. Limits on ASATs could help BMD by protecting satellite assets essential to the defence. Verification problems meant that any ban would be difficult to police. Certainly ground-based laser ASATs, which might in future become high orbit-capable, could easily be concealed. President Reagan had nonetheless made clear that he was prepared to discuss a ban on space weapons with the Soviets.

22. Herr Kellein (FRG) said that, while many questions remained unclear, all NATO governments would have to do their best to answer them, or else their opponents would fill in the missing answers. For this reason he would be interested in US responses to the following questions:

a. would SDI in effect create 2 classes of NATO membership with different assurances of security?

b. would SDI equate in practice to NOFUN, thus decoupling nuclear from non-nuclear defence?

c. if an attacker could count on only a few warheads getting through, might this dictate a return to counter-city targetting?

d. what would be the effect on crisis management stability?

Gen. Abrahamson said on (a) that the US had repeated ever since President Reagan's March 1983 speech that US Allies would be fully protected by any BMD which the US might deploy.

23. Mr Weston suggested that it might be productive to start to focus on details, rather than the very wide issues being now discussed today. Perhaps each team present might contribute brief statements of their views on questions such as automaticity, survivability, transitional problems, the role of air breathers, US/Soviet synergism, likelihood of offensive system proliferation etc. Mr. Hanmer welcomed this proposal. He felt there would be a need to organise work into smaller groups in order to carry the work forward, and he asked for

written suggestions on how the material might best be grouped for this. (At this point the Heads of Delegation left to see Dr Ikle.)

24. Gen. Abrahamson said that he wished to comment on the alleged problem of the automaticity of a BMD system. His experience on the Space Shuttle project convinced him that this was unreal. The last stages of a shuttle launch were totally under computer control, but the human controller could always intervene and overrule the automatic systems. With a BMD system, if there were only one, possibly accidental, missile launch detected, the controlling humans could decide to wait to intercept it in mid-course when its purpose and direction were clear. If at the other extreme there were a mass launch of thousands of ICMBs no deliberation would be needed to begin intercepting them. It had always to be remembered that a decision to activate the BMD system would only unleash weapons against weapons, rather than the horrifying decision which now confronted US Presidents under the MAD strategy. There would also be new options for crisis management: the President could for example warn unfriendly states in particularly tense situations that he was switching the BMD system on to automatic intercept of any offensive systems launched from their territory. This could tend to inhibit aggression. Admiral Oswald (UK) said that he found this explanation of how humans could retain control of a BMD system convincing, and wondered why the issue had aroused so much apprehension. Mr Hanmer suggested that it might be because many SDI critics had not been able to change to thinking in terms of strategic defence from concepts of strategic retaliation.

25. Herr Kellein (FRG) said that, with the recent problems in defending the INF decision in everyone's mind, it would be very desirable to have a firm public statement that there would be no change in the strategic framework of the Alliance, and making it clear that the SDI only consisted of preliminary R&D work so far. President's Reagan's very positive response to the Soviet overtures to space weapon negotiations had been helpful; the basis of an effective public position existed but needed to be further developed. Mr Hanmer agreed that the various points which should be made had not been sufficiently well gathered together for full public presentation, and that work would need to be done on this.

26. M. D'Aboville (France) wondered whether, although he was convinced that the problem of automatic BMD reaction could be overcome, the system might be decoyed by flares giving false IR signatures. Gen. Abrahamson said that this was an entirely logical and understandabl concern but an answer would have to await completion of the technical studies. Obviously the US would not intend to build a system which would disarm itself against a decoy launch in one spasm.

27. M. D'Aboville also noted that the grouping of the Soviet ABM silos shown in the CIA presentation seemed so close as to make several vulnerable to a single enemy warhead. The effectiveness of the ABM radars, too, seemed limited, since they were themselves undefended. Col. Hagar agreed that the design of the ABM sites was puzzling, especially since the Soviet strategic Defence Forces exercised reloading of silos, so that they must expect them to survive the first round of an attack. One explanation might be that there was limited land available to them for ABM dispersal but this seemed unconvincing. As far as the ABM radars was concerned, they could only be destroyed in a major strike which would also allow the Soviet ICMBs to be launched under warning. However the radars might be defensible if the Soviets abandoned the 1972 Treaty limits

and went for nationwide ABM defence.

28. Admiral Oswald asked about the resource implications of BMD, which would affect the US as well as the Soviets. Gen. Abrahamson admitted that the Soviet victory in the NWC Interactive Simulation Game had been due to the US players' difficulty in affording BMD deployment beyond the 1972 Treaty limits. Affordability problems would be greatest in the transition phase when it would also be necessary to maintain substantial offensive forces. Brigadier Rankin (DOD) commented that already 14% of the US Defence Budget was committed to strategic systems with a force modernisation programmes underway. If the Soviets further modernised their ballistic missile forces, it might be more cost-effective to respond by spending money on ballistic missile defence rather than new offensive systems.

29. A member of the Italian delegation suggested that a US and Soviet deployment of BMD systems would amount to nuclear neutralisation, thus calling into question Flexible Response and putting more emphasis on conventional forces. A member of the FRG delegation supported this, and pointed out that increased risk of conventional war would be a direct threat to European population centres. Gen. Abrahamson doubted whether conventional war would in fact be more likely. The Alliance deterred by its total capability and as the Soviet ability to gain any military advantage decreased, security would be improved. The US was not in any case going for an 'Astrodome' concept of BMD: nuclear offensive systems might be reduced in importance but some residual capacity would remain. The risk of nuclear attacks on population centres could probably never be entirely eliminated. It was thus not obvious that Flexible Response would be invalidated. The US guarantee to Europe would be strengthened because the risk of devastating nuclear retaliation against American cities would be lowered by BMD. Mr Hanmer added that the history of NATO was one of reliance upon nuclear forces to make up for a conventional disparity which Western nations had, for economic reasons, declined to match. There was now increasing public unwillingness NATO-wide to live with the drawback of this arrangement: the near-automatic resort to nuclear retaliation in any conflict. Governments had to look for ways of overcoming this attitude. SDI seemed the only new answer.

30. Brigadier Rankin argued that too much had been made in the discussion of the transitional dangers of BMD deployment. It would be a long, slow incremental process with little opportunity for either the US or USSR to move far beyond the other unless one side dropped out. Mr Hanmer added that the BMD race had already begun, largely due to Soviet efforts. The outcome would be clear, swift and destabilizing if the US were to refuse to compete. Col. Hagar emphasised that the Soviets already had a head-start in the race. If they became capable of deploying a nationwide BMD system, and not necessarily a highly effective one, they would do so. Mr Pakenham (UK) asked if this were likely at the price of unilaterally abrogating the 1972 ABM Treaty. Gen. Abrahamson said that this would depend upon the balance of advantage which they would perceive from doing so - and this would be lessened if the US were well advanced on the SDI. Mr Pakenham observed that it remained unclear whether the driving force for the SDI lay in what the Soviets were already doing, or what the US believed that it would be intrinsically desirable to do in terms of BMD.

31. Herr Kellein asked whether the US had been considering European participation in the SDI. Gen. Abrahamson said that he had had a very positive experience of industrial collaboration as Director of the F16 project. Joint programmes between NASA and ESA also provided encouraging precedents. But there would be no question of the US attempting to compel European involvement. If there were an interest in participation from all or part of NATO the US would look at ways of satisfying it. But this would have to follow a European approach.

32. Mr Hanmer closed the meeting soliciting written comments on the issues addressed during the discussion, with the aim of keeping the dialogue as active and frequent as possible.

Arms Control and Disarmament Department, Foreign and Commonwealth Office.

1 August 1984

1a

ANNEX C

COMPARATIVE US AND SOVIET BMD ATTAINMENTS AND CAPABILITIES

A THE USA

ABM

1. The 1972 ABM Treaty allowed both the US and USSR to deploy up to 100 ABM interceptors either round the national capital or one of its ICBM fields. The Americans chose to defend the ICBMs at Grand Forks, North Dakota and built up an ABM complex there based upon the SAFEGUARD system. This was, however, deactivated on grounds of cost effectiveness, soon after becoming operational in 1975, with the perimeter acquisition radar remaining in use as an early warning system. Research nevertheless continued throughout the 1970s and early 1980s on ABM-related technologies. By early 1983 before the Presidential launching of the SDI, Department of Defence and Department of Energy (DOE) expenditure of $1.75 billion was already being proposed for FY 1985 in areas such as:

a Infrared (IR) sensors for improved tactical warning of ICBM attack under the USAF's advanced warning system programme.

b Space-based IR sensor developments under the USAF's space-based surveillance system programme.

c The Defence Advanced Research Projects Agency (DARPA)'s Talon Gold programme: a space-based experiment to demonstrate pointing and tracking for space-based DEW concepts.

d Airborne optical system development as part of the US Army's BMD programme.

e The Army's Homing Overlay Experiment (HOE) for homing non-nuclear mid-course interceptors.

f The White Horse neutral particle beam test bed at Los Alamos.

g DARPA's ALPHA programme to demonstrate, initially on the ground, a megawatt-class chemical IR laser.

h DOE analyses of x-ray laser feasibility.

SDI

WORK TO DATE

2. President Reagan's speech of March 1983 led a further impetus to this work, which was brought together in the integrated Strategic Defence Initiative. Two studies on Strategy and Policy (the Hoffman Report) and Defensive Technologies (the Fletcher Report), were submitted to the President in October 1983. The Defensive Technologies study identified critical technical issues which would have to be resolved before a decision to move to full-scale development could be made. These were:

a Boost-Phase and Post-Boost-Phase Vehicle Intercept. (DEWs were identified as the most promising technology for this crucial task and the determination of their lethality against 'responsive' targets, which had been specifically designed to counter them, was given the highest priority of all.)

b Discrimination and tracking of numerous re-entry vehicles, decoys, and other material during midcourse and high re-entry.

c Survivability of space-based defensive assets when threatened with nuclear or "mirror-image" weapons.

d Inexpensive interceptors for non-nuclear midcourse and early re-entry kill.

e Automated preparation and testing of battle management software.

The study also emphasised that to discourage proliferation of offensive systems as a 'cheap' counter, the cost of destroying a warhead would have to be lower than corresponding offensive system costs, and that this problem was closely tied to the ability to discriminate between targets and decoys in all phases.

FUTURE WORK AND TIMESCALE

3. The US Government suggests that the implementation of the SDI should be seen in terms of a progressive evolution away from today's sole dependence for deterrence on nuclear retaliation, in the following notional stages, for which the timescales, due to the huge technical uncertanties involved, are necessarily vague:

a The research phase: The period from the President's March 23, 1983 speech to the early 1990s when a decision on whether to enter systems development could be made.

b The systems development (or full-scale engineering development) phase: assuming a decision to go ahead beginning in the early 1990s when prototypes of actual defensive system components are designed, built, and tested. It would be at this point (early to mid 1990s) that the US would have finally to abrogate the 1972 ABM Treaty (provided it had not already collapsed) if they were to begin testing the new technologies.

c The transition phase: of incremental, sequential deployment of defensive systems. The US intend that each added increment, in conjunction with effective and survivable offensive systems, should increase deterrence, and reduce the risk of nuclear war. During this period, as the US and USSR deploy defences against ballistic missiles that progressively reduce the value of such missiles, significant reductions in nuclear ballistic missiles might be negotiated and implemented.

d The final phase: during which deployments of highly effective multi-phased defensive systems are completed and during which ballistic missile force levels reach their negotiated nadir. This is the goal proposed in the President's March 23, 1983 speech, but seems unlikely to be reached before the first decade of the next century, if ever.

B THE SOVIET UNION

CURRENT ABM SYSTEM

4. The ABM treaty permits each side to deploy up to 100 launchers in defence of an ICBM field or the national capital. The Soviet Union currently possesses 16 above-ground launchers and 16 silo launchers as part of the GALOSH ABM system around Moscow. Of these only the above-ground launchers are assessed to be operational. The GALOSH system, now 20 years old, was designed to counter only simple threats (ie those without penetration aids such as chaff or decoys) and, in response to the development of more sophisticated weapons, the Soviet Union is developing and deploying the High Acceleration Vehicle (HAV) designed to counter missiles well inside the atmosphere. 66 HAV launchers are under construction and preparation is in hand to start another 2. Deployment of the HAV will thus give the Soviet Union a total of 100 HAV and GALOSH launchers by 1989 thus giving a limited two-layer defence system around Moscow. These developments remain within the confines of the 1972 ABM Treaty and there is no hard evidence of a Soviet intention to abrogate this Treaty.

OVERALL R & D EFFORT

5. The Soviet Union appears to be following an extensive research and development programme which covers many of the elements required for more advanced multi-layered BMD systems, including possible space-based elements. However, there is no evidence of an intention to deploy an SDI system as such, nor of work on further ground-based BMD using existing technology. But the United States estimates that the Soviet Union is spending in the order of $1 billion a year on BMD-related directed-energy research alone. In addition, R & D on space continues at a very high level and essential developments such as large space booster and a re-usable orbiter are well advanced. R & D on the systems required to produce a new generation of BMD is, however, in general at such an early stage so highly vulnerable to the development of countermeasures, and so subject to unforeseeable technological development, that it is impossible to predict its outcome.

SPACE-BASED BMD DEVELOPMENTS

6. The Soviet Union has tested three types of laser considered suitable for space-borne BMD i.e. gas dynamic, chemical and iodine lasers. Research programmes exist on megawatt chemical lasers and power systems for electrically-driven gas lasers. Work on an x-ray laser based on the radiation from a nuclear explosion is probably at a much earlier stage. The Soviet Union is well advanced in particle beam research; work on an accelerator began in the 1960s. But while there is some evidence of testing an evaluation of a particle beam weapon concept, there is no indication that the problems of beam steering and control have been solved. The Soviets have also been working for many years on producing the very high powers needed for radio frequency (RF) weapons, as a natural extension of the development of powerful radars and jamming equipment. There is however only limited knowledge of Soviet progress in this field and the importance they attach to the development of such weapons.

7. The effective use of DEWs as BMD weapons depends on very high accuracy target tracking and precision pointing of the beam. The required accuracy of at least 1 microradian (i.e. within a metre at a range of 1000 kms) is at least 10 times better than the best thought to be achieved by current Soviet ground-based systems. At present the Soviet Union makes use of research in the German Democratic Republic on target tracking in space where the performance achieved is comparable to that in the West. Soviet research has concentrated on laser design and mirror technology (for the beam directing mirror). The pointing and tracking experiments carried out so far in the SALYUT 7 spacecraft are, however, far too crude for the requirements of lasers. Together with the problems of compact power supplies and the miniaturization of command and control systems we believe it will take 20-30 years to produce an operational system, using existing technologies.

8. The Soviet Union has several operational space launch vehicles but none large enough to put a DEW system in space. However new large space boosters are under development with the payload capacity adequate to support a laser weapon programme. One of these is assessed to have the ability to lift possibly up to 200 tonnes into low Earth orbit. A re-usable manned orbiter similar to the US Shuttle is also under development and should be operational by the late 1980s while a re-usable small space plane has been tested. The large dimensions and mass of space based BMD weapons imply fabrication in space. The Soviet Union has considerable experience from its manned space programme, but a vast amount of additional work would be required to reach a level of expertise adequate for assembling and maintaining space-based BMD.

GROUND-BASED BMD DEVELOPMENTS

9. The Soviets may be working on ground-based lasers for BMD. A project which started in the mid 1960's involves an iodine laser believed to be intended for use against re-entry vehicles in the terminal phase. Trials on the laser are carried out regularly at the weapons development centre at Sary Shagan. Particle Beam Weapons would not be effective as ground-based BMD weapons because of atmospheric absorption.

C. COMPARISON OF US AND SOVIET BMD CAPABILITIES AND POTENTIAL

TECHNICAL PROGRESS

10. It is impossible to be precise about the relative status of the Soviet and United States directed energy weapons programmes because of the wide range of potential weapons, the long lead times associated with the larger systems, the early stages reached in research for space-based BMD applications and, not least, the different approach to the problem taken by the two sides. In broad terms, the Soviet Union appears to be ahead in the development of high-power lasers, with the notable exception of chemical lasers, while the US is more advanced in the development of pointing and tracking and mirror technologies. In space-based systems neither country is advanced beyond R&D, but at this early stage the US has probably progressed further.

C CAPACITY TO AFFORD DEPLOYMENT

11. American ability to afford deployment of a comprehensive BMD system is discussed in Paras 25-30 of the main paper.

12. For the Soviets, their BMD R&D programme must already be extremely expensive in both human and financial resources. Two leading research establishments are believed to be involved in the development of space-based lasers and their heavy lift launch vehicles, both received massive investment during the late 1970's and early 1980's. R&D accounts for 20 per cent of Soviet military expenditure and was increasing at an average annual rate of 5 per cent between 1970 and 1982, making it the fastest growing category of military expenditure; it is not, however, possible to isolate the cost of individual programmes within the overall R&D budget.

13. The Soviet Union is unlikely to allow cost to restrain its development of SDI if it perceives the need to match the US programme. Such a decision would be based on strategic rather than financial considerations and the Soviets, by their construction of an unparalleled air defence and ABM system have already proved their willingness to divert very considerable resources to limit the damage which might be inflicted on their homeland, and have consistently demonstrated the ability and willingness to match US developments in other fields.

14. A greater restraint than cost alone is likely to be the demands that a BMD system would place on certain key industries such as electronics where the United States still enjoys a considerable advantage over the USSR. There is no doubt, however, that the Soviet Union is placing great emphasis on advanced technology and in developing its industrial base, particularly in the electronics industry.

15. While the pace and degree of success in these directions will be critical to the development of Soviet BMD, there are already indications that considerable resources are being allocated to space systems development, particularly large launch vehicles

and large orbital platforms, and associated infrastructure. In parallel with this effort work has begun on development of DEW components. Thus the indications are that technical and industrial resources for a BMD system would be found, although it is unclear what long-term effect the concentration of resources on this area may have on other parts of the defence sector. There is no doubt about the damaging effects that having to devote an even larger slice of the national economy to defence will have but equally no doubt that the leadership would consider this the lesser of the two evils if the choice were between disappointing consumer expectations and keeping up in an arms race in space with the US. Once begun, however, Soviet work on a full-scale counterpart to the American SDI would probably be much less subject to internal political change and turbulence than in the US.

SECRET

-FCE

4

10 DOWNING STREET

From the Private Secretary

4 January, 1985

Strategic Defence Initiative

I have written to you separately about Mr. McFarlane's briefing on the outcome of the US/Soviet discussions on arms control in Geneva, which will be held at 10 Downing Street at 1115 on 9 January.

BF 11

Strictly for your own information and that of other recipients of this letter, Mr. McFarlane will beforehand give the Prime Minister a strictly personal briefing on the strategic defence initiative. No announcement of this will be made and knowledge of it should be kept as restricted as possible.

I am sending copies of this letter to Dennis Brennan (Ministry of Defence) and Bryan Cartledge (Cabinet Office).

C. D. POWELL

CST

P. F. Ricketts, Esq.,
Foreign and Commonwealth Office

SECRET

7i6
bcPC

PRIME MINISTER

STRATEGIC DEFENCE INITIATIVE

I enclose a note on this which has been sent in by David Hart. You will certainly wish to read it. I think it contains some interesting points but:

(i) Mr. Hart's Washington friends, whom he quotes, are the strongest opponents of any arms control negotiations and fervent supporters of the SDI. I do not doubt that their views are as he represents them but they are only part of the picture.

(ii) His fear that there remains a potential serious problem between Washington and London on the SDI ignores the fact that agreement was reached between you and the President on the four points.

(iii) I think it would be wrong for you to see Dr. Keyworth at least until after you have seen Mr. Macfarlane. The President's offer to provide you with briefing was specific to Mr. Macfarlane. I think it would be a mistake for you to see individual lobbyists for different points of view within the US Administration except at the President's specific suggestion.

(iv) The idea of somehow associating the UK with research into SDI is imaginative and might be discussed with Mr. Macfarlane when he comes. It might buy us some influence over, or of at least knowledge of, the way in which the project develops. But it seems inconceivable to me however that this would qualify us for joint operational control.

CDP

2 January 1985

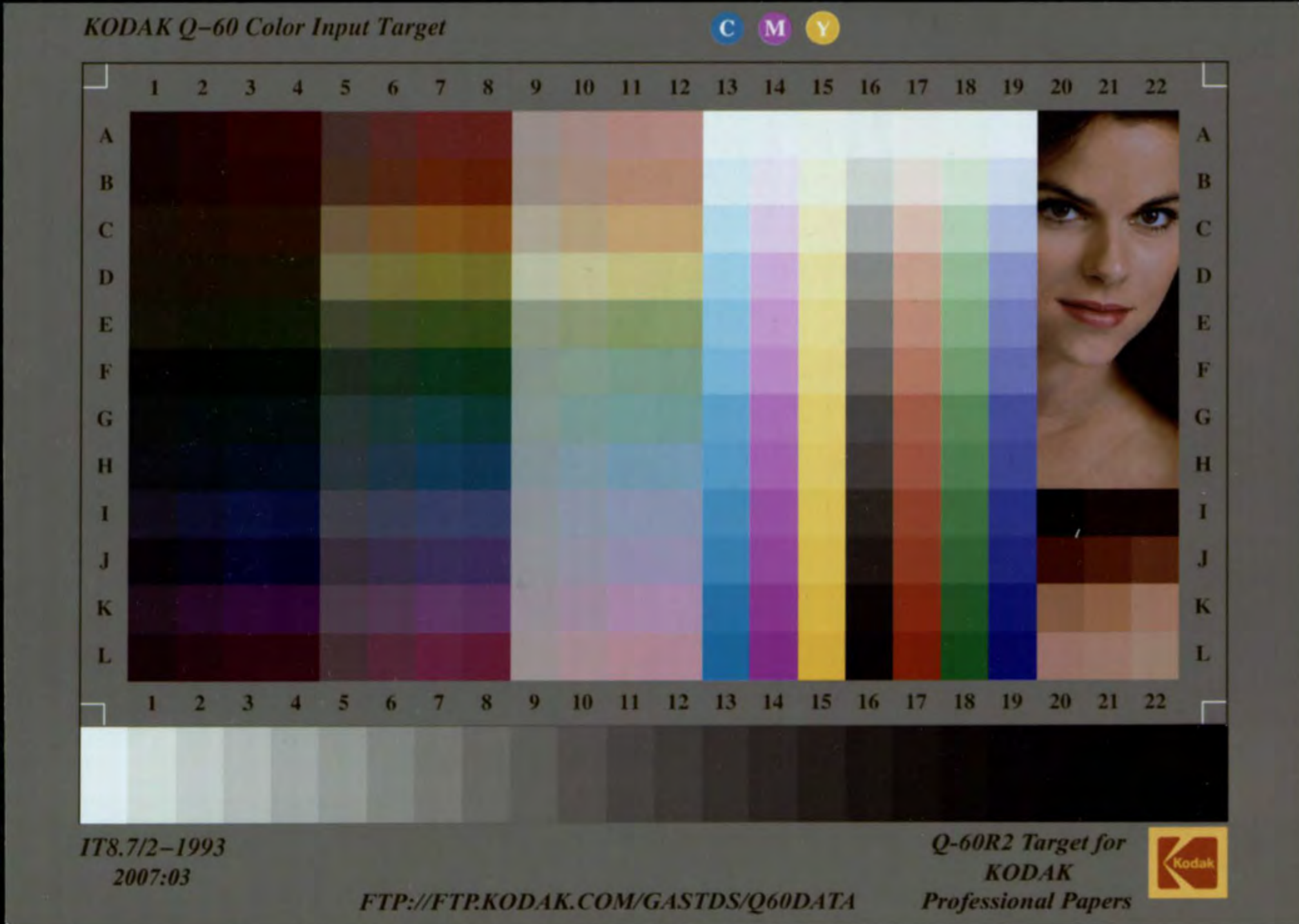
VC3AAD

PART 1 ends:-

PM Press Statement 22/12/84

PART 2 begins:-

CDP to PM 2/1/85


KODAK Q-60 Color Input Target
C M Y
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
A B C D E F G H I J K L
IT8.7/2-1993
2007:03
FTP://FTP.KODAK.COM/GASTDS/Q60DATA
Q-60R2 Target for KODAK Professional Papers
Kodak