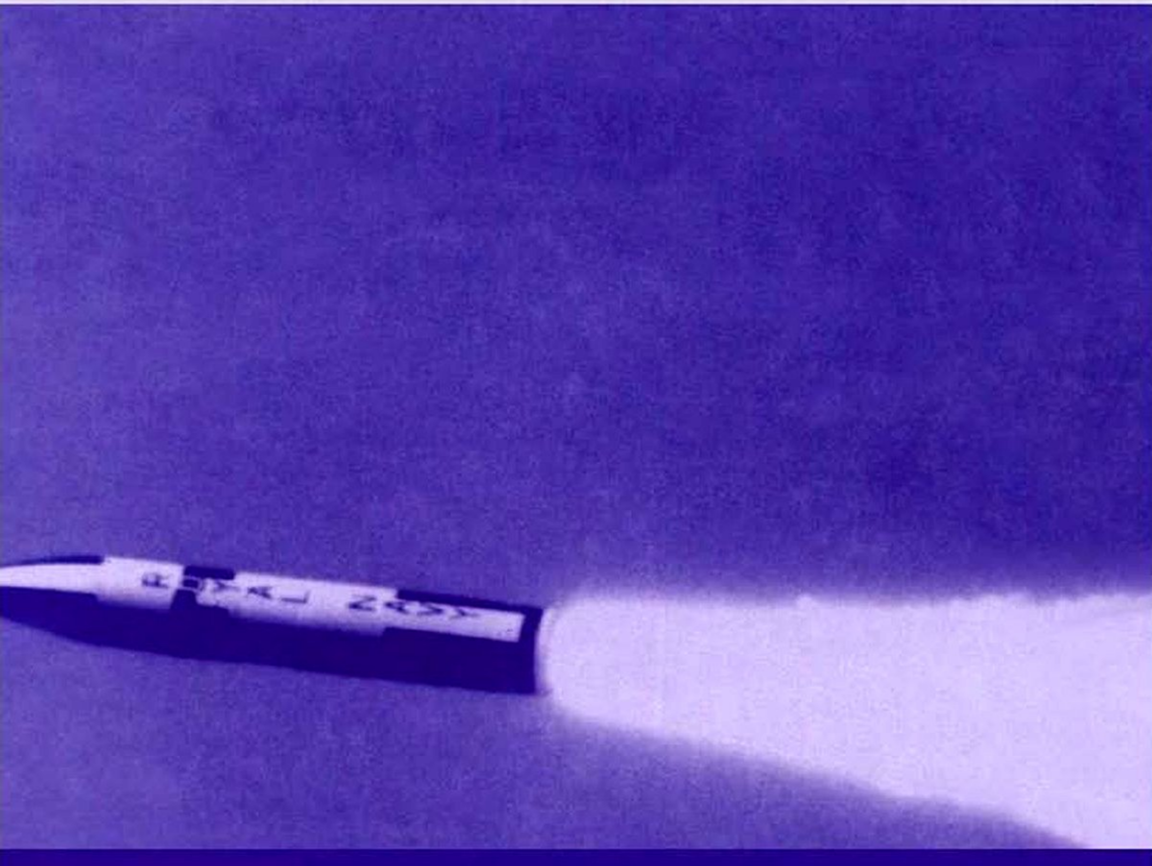
BRITAIN AND BALLISTIC MISSILE DEFENCE

1942–2002



Jeremy Stocker

BRITAIN AND BALLISTIC MISSILE DEFENCE 1942–2002

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FRANK CASS
LONDON • NEW YORK

First published 2004 by FRANK CASS 11 New Fetter Lane, London EC4P 4EE

Simultaneously published in the USA and Canada by FRANK CASS 29 West 35th Street, New York, NY 10001

FRANK CASS is an imprint of the Taylor & Francis Group
This edition published in the Taylor & Francis e-Library, 2005.

British Library Cataloguing in Publication Data A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication Data Stocker, Jeremy Britain and ballistic missile defence, 1942–2 002/Jeremy Stocker p. cm—(Cass series—strategy and history, ISSN 1473-6403; 8) Includes bibilographical references and index. 1. Ballistic missile defenses-Great Britain–History. 1. Title. II. Series

ISBN 0-203-30963-4 Master e-book ISBN

ISBN - (Adobe e-Reader Format)
ISBN 0-714-65696-8 (Print Edition)

To my Father, Group Captain John Stocker RAF,

whose career in air defence spanned most of the period considered in this book

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Series Editor's Preface

An important function of this Series is to offer analyses of episodes or themes in strategic history that have been thus far neglected. The subject of Jeremy Stocker's study of *Britain and Ballistic Missile Defence, 1942–2002*, falls four-square in the 'neglected' category. On 8 September, 1944, Britain was the first victim in history to suffer assault by a ballistic missile (Germany's V-2). From that time to the present day, the country has a continuous, if often all but inactive, record of concern about, and some involvement in, ballistic missile defence (BMD). Despite that lengthy experience, prior to the publication of Dr. Stocker's book there was no extant comprehensive examination of Britain and BMD. The author claims, without risk of contradiction, to provide the first study that traces the full history of how Britain responded to the challenge posed by the menace of ballistic missile attack over a period of no less than sixty years.

It is somewhat surprising that this should be such an innovative work. After all, since the late 1960s BMD has been by far the single most controversial topic in Western defence strategy, and arms control. Indeed, as Dr. Stocker makes abundantly clear, although his subject is 'Britain and BMD', the main issue almost always has been Britain's attitude towards the latest shift in American policy on the matter. Inhabiting a small and crowded island, the British have long elected to adopt a principally political approach to their national security in the nuclear age. In the context of a large, then very large, Soviet nuclear-missile threat, even a *fairly* competent BMD architecture did not have much to offer Britain by way of reliable physical protection. That strategic judgment is offered in addition, of course, to the all too obvious issues of military-technical feasibility and affordability. In British, indeed in NATO-European, eyes, the first line of security against the nuclear-missile menace was diplomacy. For reasons of political culture, strategic conviction, and expediency, Britain—and Europe, more generally—has always looked to arms control diplomacy to provide, or at least help shape, a context that would blunt the missile danger. Dr. Stocker makes the point with an admirable directness. He characterises the ABM Treaty of 1972 as 'the defining event in the UK's responses to both US and Soviet ABMs (p.6)'. Literally for thirty years the Treaty served as the Hindenburg Line against the periodic flurry of renewed US interest in moving BMD from research and development into a more active phase. In the Cold War years, at least, the Treaty was portrayed as the essential protector against a more heated strategic arms race (defence-offence, or offence-defence).

BMD is a deeply technical subject, as the author's narrative makes very plain. However, if anything it is even more deeply political than technical. The ABM Treaty was regarded, by its friends and foes alike, as the jewel in the crown of arms control. It was the most substantial achievement of arms control policy and diplomacy in the Cold War. A rigorous critic of the Treaty, Dr. Donald G. Brennan, observed ruefully at the time that the Treaty 'did the wrong thing well'. The Treaty denied the superpower signatories the right to deploy a missile defence of their national territory. The theology of nuclear era strategic theory was central to the argument. Allegedly, it was beneficial for strategic stability—the holy grail of the period—for each side to enjoy unrestricted military access to the other's society. More theology asserted that defensive systems must spur the deployment of more, or more sophisticated, offensive weapons: so BMD inexorably would fuel a defence-offence spiral of arms competition. For a quarter century, strategic theorists and defence analysts engaged repeatedly in the kind of 'expert' strategic debate that tends to give such debate a bad name. Theories were advanced as facts—on both sides, let it be said—and the only certainty about the subject was that BMD was a topic that would be certain to come round again in the next major review of US nation-al security policy. Although the issues could hardly be more technical, the on-off-on 'debate' was always dominated by political attitudes. BMD became an iconic subject, for all parties to the long running dispute.

From 1972 until its formal demise in June 2002, the existence of the ABM Treaty, and the vociferous arguments of its large body of, principally liberal, American admirers, allowed London to conceal its distaste for BMD. Today, however, the absence of a strategic arms race, an apparently relaxed Russian attitude towards American BMD, the demise of the Treaty, and the transformation of the threat context, makes it close to a certainty that BMD's hour is arriving at last. To understand the choices that Britain will face, and the beliefs and assumptions it will bring to the subject, it is essential to know where the country has been. Dr. Stocker's book is an outstanding contribution to the shedding of light on an unduly foggy topic. As often as not, BMD has been debated in technical, or pseudo-technical terms (could as-yet unbuilt US defences handle as-yet undemonstrated Russian countermeasures), when both sides really regarded the matter as being primarily one of political symbolism. To oppose BMD was to oppose the arms race, to 'believe in' arms control, and—ergo—to stand for peace!

Good strategic history cannot provide a truly robust defence against the repetition of folly, but it can only help. We are very pleased to add Dr Stocker's careful study to the Series.

Colin S.Gray, Series Co-Editor.

Acknowledgements

This book is a revised version of my PhD thesis, submitted to the Centre for Security Studies, University of Hull. I must therefore thank my supervisor, mentor and friend, Dr Eric Grove, whose light touch provided just the right amount of guidance and direction. I should also thank my examiners, Professor Martin Edmonds and Dr Tom Kane, whose rigorous yet sympathetic grilling caused me to question, justify and sometimes revise the judgements I have made. I am also in the debt of Dr Robin Ranger, through whom I first became interested in missile defence.

Much of my original research was done at the Public Record Office in Kew. The members of staff of that organization are a fine example of how a public service can and should operate. They made every visit to the PRO a positive pleasure.

I should also like to thank the numerous individuals, serving and retired, uniformed and civilian, who provided me with many valuable insights. Their assistance helped me to make sense of the bare documentary record, and gave me a closer understanding of how policy continues to evolve. Any errors of fact or judgement are, of course, solely mine.

For permission to reproduce photographs, diagrams and tables, I am grateful to the Public Record Office, the Imperial War Museum, the Ministry of Defence and the House of Commons.

My last and greatest thanks must be to my wife Judith, for everything.

Abbreviations

AA	Anti-Aircraft
ABL	Airborne Laser
ABM	Anti-Ballistic Missile
ABT	Air-Breathing Threat
ACAS	Assistant Chief of Air Staff
ACCS	Air Command and Control System (NATO)
ACDRU	Arms Control and Disarmament Research Unit
ADGB	Air Defence of Great Britain
ADOC	Air Defence Operations Centre
AEW	Airborne Early Warning
AGARD	Advisory Group for Aerospace Research and Development (NATO)
AHB	Air Historical Branch
AHB Vol. VI	Air Ministry Air Historical Branch, *RAF Narrative Air Defence of Great Britain, Vol. VI: The Flying Bomb and Rocket Campaign 1944–1945*
AIT	Atmospheric (or Advanced) Interceptor Technology
AMES	Air Ministry Experimental Station
AOC	Air Officer Commanding
AOC-in-C	Air Officer Commanding-in-Chief
ASR	Air Staff Requirement
AST	Air Staff Target
ATBM	Anti-Tactical Ballistic Missile
AWRE	Atomic Weapons Research Establishment
BMD	Ballistic Missile Defence
BMDO	Ballistic Missile Defense Organization (US)
BMEWS	Ballistic Missile Early Warning System
BPI	Boost Phase Intercept
CAS	Chief of the Air Staff
CDISS	Centre for Defence and International Security Studies
CEC	Cooperative Engagement Capability
CEP	Circular Error Probable
CG	Command-Guidance

CH	Chain Home
C-in-C	Commander-in-Chief
CMAS	Cheyenne Mountain Air Station
CNAD	Conference of National Armaments Directors (NATO)
CoS	Chiefs of Staff
CRDF	Cathode-Ray Direction Finding
CRS Report	Paul E.Gallis *et al.*, *The Strategic Defense Initiative and United States Alliance Strategy* (Washington, DC: Congressional Research Service, 1 February 1985)
CSA	Chief Scientific Advisor
CW	Continuous Wave
DCAS	Deputy Chief of the Air Staff
DDOR5	Deputy Director Operational Requirements
DEC(TA)	Directorate for Theatre Airspace
DERA	Defence Evaluation and Research Agency
DEW	Directed Energy Weapon
DGP	Defence Group on Proliferation (NATO)
DRPC	Defence Research Policy Committee
DSP	Defense Support Program (US)
EAD	Extended Air Defence
EDI	European Defence Initiative
ERINT	Extended Range Interceptor
FCO	Foreign and Commonwealth Office
FIS	Fundamental Issues Study
FIS	N.Brown, *The Fundamental Issues Study with the PreFeasibility Programme* (Oxford: Manfield College, 1998)
GAO	General Accounting Office
GAO Report	General Accounting Office, *Strategic Defense Initiative Program: Extent of Foreign Participation* (Washington, DC: General Accounting Office, February 1990)
GBR	Ground-Based Radar
GMDS	Ground-Based Midcourse Defense Segement
GPALS	Global Protection Against Limited Strikes (US)
HE	High Explosive
HF	High Frequency
HOE	Homing Overlay Experiment
ICBM	Inter-Continental Ballistic Missile

INF	Intermediate Nuclear Forces
IR	Infra-Red
IRBM	Intermediate Range Ballistic Missile
ISS/IISS	(International) Institute for Strategic Studies
JIC	Joint Intelligence Committee
JSWS	D.Lennox *(ed.), Jane's Strategic Weapons Systems,* Issue 34 (Coulsdon: Jane's, 2001)
JTWC	Joint Technical Warfare Committee
KEW	Kinetic Energy Weapon
KKV	Kinetic Kill Vehicle
km	Kilometres
kph	Kilometres Per Hour
kt	Kiloton
LDS	N.Brown, *Ballistic Missile Defence: A British Perspective,* London Defence Studies No. 27 (London: Centre for Defence Studies, 1995)
LEAP	Lightweight Exo-Atmospheric Projectile
MAD	Mutual Assured Destruction
MDA	Missile Defense Agency (US)
MEADS	Medium Extended Air Defense System (US/Ger/It)
MESAR	Multifunction Electronically Scanned Adaptive Radar
MIDAS	Missile Defense Alert System (US)
MIRV	Multiple Independently Targeted Re-entry Vehicle
MoD	Ministry of Defence
MOR	Military Operational Requirement
MoU	Memorandum of Understanding
MRBM	Medium Range Ballistic Missile
MSAM	Medium Surface-to-Air Missile
MT	Megaton
MTCR	Missile Technology Control Regime
NADC	NATO Air Defence Committee
NADGE	NATO Air Defence Ground Environment
NATO	North Atlantic Treaty Organization
NBC	Nuclear, Biological, Chemical
NC3A	NATO Consultation, Command and Control Agency
NIAG	National Industrial Advisory Group (NATO)
nm	Nautical Miles

NMD	National Missile Defence
NORAD	North American Air Defense (Canada/US)
NPG	Nuclear Planning Group (NATO)
NPT	Non-Proliferation Treaty
OPCON	Operational Control
OTH	Over The Horizon
PAAMS	Principal Anti-Air Missile System (Fr/It/UK)
PAC	Penetration Aid Carrier (UK) or Patriot Advanced Capability (US)
PFP	Pre-Feasibility Programme
PFS	Pre-Feasibility Study
PRO	Public Record Office (now part of the National Archives)
PSO	Peace Support Operation
PUS	Permanent Under-Secretary
R&D	Research and Development
RAE	Royal Aircraft Establishment (Farnborough)
RAF	Royal Air Force
RCM	Radio Counter-Measures
RCS	Radar Cross-Section
RF	Radio Frequency
RO	Research Objective
RRE	Royal Radar Establishment (Malvern)
RUSI	Royal United Services Institute
RV	Re-entry Vehicle
SADTC	SHAPE Air Defence Technical Centre (NATO)
SAGW	Surface-to-Air Guided Weapon
SALT	Strategic Arms Limitations Talks
SAM	Surface-to-Air Missile
SAMP/T	Sol-Air Moyenne Portee / Terre (Fr)
SBIRS	Space-Based Infra-Red System
SBL	Space-Based Laser
SCORE	Scientific Corporation Research Exchange Programme
SDI	Strategic Defense Initiative (US)
SDIO	Strategic Defense Initiative Office
SDIPO	Strategic Defence Initiative Participation Office (UK)
SDR	Strategic Defence Review (UK)

SHAEF	Supreme Headquarters Allied Expeditionary Force
SHAPE	Supreme Headquarters Allied Powers Europe (NATO)
SLBM	Submarine Launched Ballistic Missile
SofS	Secretary of State
SRBM	Short Range Ballistic Missile
SSPAR	Solid State Phased Array Radar
TA	Technical Area
TACON	Tactical Control
TBM	Theatre Ballistic Missile
TBMD	Theatre Ballistic Missile Defence
TEL	Transporter-Erector-Launcher
THAAD	Theater High Altitude Air Defense (US Army)
TMD	Theatre Missile Defence
TRRAP	Technology, Readiness and Risk Assessment Programme
TRRAP Report	Director of Strategic Technologies, MoD, *The Technology Readiness and Risk Assessment Programme: A Summary Report*, February 2002
WEU	Western European Union
WMD	Weapons of Mass Destruction

1
Introduction

The UK was the first country ever to come under sustained ballistic missile attack, in 1944–45. Defence against these weapons has been a persistent topic of policy and technical investigation for the UK ever since. It has been a contentious political issue on three main occasions, each of them in response to a planned US deployment of defences. The UK's own efforts to develop missile defences have largely gone unnoticed outside a small military and technical community. In fact, the greatest amount of work done in the UK in the field has actually been to overcome Soviet missile defences, rather than to produce them for the UK. At the end of the twentieth century, the UK was considering how to respond to an imminent US deployment of missile defences, and whether to acquire its own.

Because of its very high speed, range and altitude, defence against the ballistic missile in flight has always presented formidable technical problems. Just as problematic have been the political and strategic issues surrounding missile defence, not least because of the association between ballistic missiles and nuclear weapons.

Many of these wider issues have lain at the heart of foreign policy and national strategy since the end of World War II. A condition of stable nuclear deterrence became the basic requirement for national survival for most of the Cold War, and ballistic missile defence (BMD) has been a major factor in that equation, both for those that had, or were developing, missile defences, and those that did not. Missile defences were themselves the subject of arms control and underpinned other, more wide-ranging, agreements. BMD has often been a significant factor in transatlantic relations and specifically in NATO alliance cohesion. It has also been an item in relations between the West and Moscow, especially since the end of the Cold War.

Only four countries have had indigenous ballistic missile defence programmes: the United States, the Soviet Union, the UK and Israel, the latter with considerable US assistance. In each case, BMD development has followed a few years after a state's nuclear weapons programme, though this seems more coincidental than a direct consequence. US research into missile defence began in February 1946 as a result of a study of the V-2 campaign, and has, in one form or another, continued to the present day.[1] The Soviet Union is known to have begun considering ABM development as early as 1948, but the decision to develop a defence system was probably not taken until after Stalin's death in 1953.[2] Israeli development of its Arrow system began in 1986 with the signing of a Memorandum of Understanding (MoU) with the United States.[3] Of these three, only Russia and Israel currently have BMD systems deployed, though the operational status of the Russian system around Moscow is uncertain. The United States will deploy a range of BMD systems over the next decade.

When Britain was attacked by German V-2 rockets in 1944–45, its gun-based defence proposals were somewhat 'Heath Robinson', were never implemented, and ceased at the end of the War. The UK did not resume work on missile defence until 1954 and unlike the other three states never came close to deploying an operational system.

Defence against ballistic missiles has, however, been a persistent issue for successive British Governments except, ironically, during the one period when development of an actual system was proceeding. More important by far than Britain's own hesitant attempts to develop defences, have been UK attitudes and responses to the other countries' missile defences.

At the start of the twenty-first century, BMD was once again a subject of both technical investigation and policy debate. The UK was moving cautiously towards the procurement of some form of missile defence, while at the same time a major shift in official thinking on the subject saw many long-held axioms being overturned, a British Government, for the first time, viewing an imminent US deployment of missile defences with a degree of equanimity. Outside government circles, however, missile defence has lost none of its controversy.

A ballistic missile is a form of rocket that can be used to deliver a variety of payloads via the upper atmosphere and space back to earth, at very high speeds and over very long ranges. It is closely related to spacelaunch vehicles which are used to deploy satellites into orbit—indeed the two are largely interchangeable. It is powered only for the early part of its travel, following a ballistic trajectory thereafter, somewhat like an artillery shell.[4] The missile is propelled upwards by one or more boosters burning liquid or solid fuel. It includes a guidance and control system, a warhead, and protection against the extreme environments experienced during ascent and descent through the atmosphere. Some missiles carry one or more separating re-entry vehicles (RVs), but simpler systems like the ubiquitous 'Scud' do not, the missile returning to earth largely intact.

Ballistic missiles have, since the mid-1950s, been closely associated with nuclear warheads, but they can be used to deliver other Weapons of Mass Destruction (WMDs)—biological, chemical or radiological—or conventional high explosives.

The technicalities of intercepting and destroying a ballistic missile are related directly to the three phases of its trajectory. As it climbs up out of the earth's atmosphere with the boosters still attached and burning, the missile is large, hot and relatively slow, but accelerating. It is easily detected by radar and particularly by infra-red sensors. Interception during the boost phase, however, is more problematic, as a defensive weapon needs to be positioned within range and have a very fast speed of reaction, which is generally taken to require directed-energy weapons, such as lasers, rather than an aerodynamic missile.

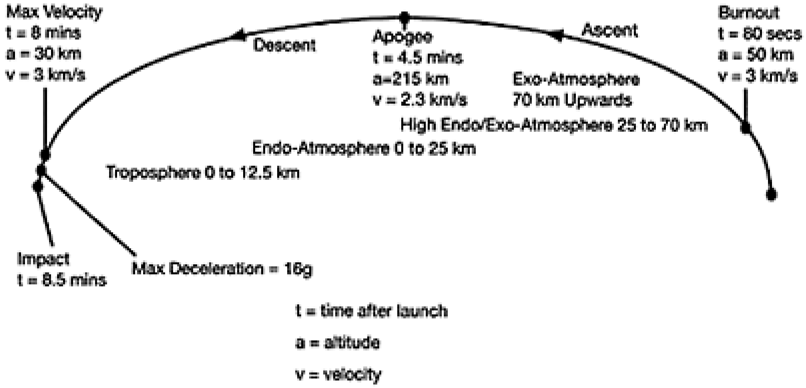
Once the booster(s) have burnt out and separated, the remaining front end of the missile carrying one or more warheads follows a ballistic trajectory through the upper atmosphere and into near space. During this mid-course phase it is much smaller and cooler than hitherto. Multiple warheads and decoys, where present, will separate. Infra-red detection becomes much more difficult, though radar tracking is still possible, made easier by the stable, predictable path that the missile follows. Interception in space requires a missile that can manoeuvre without the use of aerodynamic control surfaces.

During the final terminal phase, the one or more RVs descend towards their intended target(s). The effect of re-entering the atmosphere will be to slow (or 'retard') the missile. All but the most sophisticated decoys, being lighter, will fall behind the warheads. Interception is now possible by a conventional aerodynamic missile, which may itself be an adaptation of a weapon designed to intercept 'air-breathing' threats (ABT), such as manned aircraft and cruise missiles.

The range of a ballistic missile following an 'optimum' trajectory is directly proportional to speed, though missiles can be 'depressed' or 'lofted' with some range/payload penalty. On an optimum trajectory a missile's apogee (maximum altitude) will be roughly 20 per cent of its range, thus a missile with a range of 1,000 km will climb to a maximum height of about 200 km. Because of the curvature of the earth, ascent and descent angles will be between about 35° and 43°, longer ranges inducing shallower angles. Even a relatively short-range 'Scud' will travel at speeds of up to 2 km per second, and an intermediate-range missile travelling 3,500 km will attain a speed of 5 km per second—about 11,000 miles per hour.

The appreciable atmosphere extends upwards to about 70 km. Even a relatively short-range missile will therefore climb beyond it, and longer-range systems spend the great majority of their time outside the atmosphere altogether. Interceptions within and beyond the atmosphere are known as endo- and exo-atmospheric, respectively.

Figure 1: Typical Ballistic Missile Trajectory



Source: DERA/WX9/6/173/1/3/2/2.0. *The UK Ballistic Missile Defence Pre-Feasibility Programme Report*, June 1998, p. 2; © Crown Copyright/MOD. Reproduced with the permission of the Controller of Her Majesty's Stationery Office.

Figure 2: Summary of Ballistic Missile Interception Terminology

System Type	*Operating Region*	*Also known as*
Endo-atmospheric	up to 25 km	Point Defence
		Lower Tier
		Lower Layer
		EAD (if system has an ABT Capability)

High Endo/Exo-atmospheric	above 25 km	Area Defence
		Upper Tier
		Upper Layer
Exo-atmospheric	70 km upwards	Area Defence
		Upper Tier
		Area Defence
Ascent Phase Kill	pre apogee	BPI (boost phase only)
		PBI (post boost phase only)

Source: DERA PFP Report, p.3; © Crown Copyright/MOD. Reproduced with the permission of the Controller of Her Majesty's Stationery Office.

A successful interception requires two fundamental problems to be solved—discrimination (finding the warhead) and lethality (destroying it). This is true of any target and any weapon system, but is particularly challenging for BMD in view of the very high speeds, ranges and altitudes involved.

Active defence entails the physical interception and neutralisation of a ballistic missile after it has been launched. It is, however, only one of a number of counters to this type of threat.

The first is a diplomatic response, to prevent missiles and their associated warheads being secured by potential enemies. Export controls and arms control agreements are examples of non-proliferation. The second is deterrence, seeking to dissuade a state from employing the weapons in its possession, and is particularly associated with nuclear-armed missiles. A third approach is counter-force, the pre-emptive destruction of missiles on the ground prior to launch.[5] And finally, if all these and active defence are unsuccessful, passive defence (sometimes known as civil defence) seeks to ameliorate the effects of the missile's warhead once it reaches its target. Passive defence measures include concealment, hardening and decontamination.[6]

Ballistic missiles can, broadly, be employed to meet two kinds of objective. Particularly (but not only) when carrying nuclear warheads, they may be used for direct, strategic effect. In this role they have largely, though not entirely, supplanted the manned bomber. They can also be used in a tactical role, against targets of military importance. This distinction is not absolute, however. Bombardment of a major port, for example, may have both strategic and tactical significance. But it remains a useful categorisation, and defence against ballistic missiles may therefore also be 'strategic' or 'tactical'. Only the former has, in general, generated much political interest and dispute, the latter being little more than a technical challenge subject to operational requirements, financial constraints and competing priorities. Until recently, the US Government classified missile defences into Theater Missile Defense (TMD) and National Missile Defense (NMD), though the former included defence of regional friends and allies (strategic) as well as forces deployed overseas (tactical).

Defence against ballistic missiles was, until the early 1970s, usually referred to as Anti-Ballistic Missile (ABM) defence. Since then, the term has tended to be replaced by Ballistic Missile Defence (BMD), though the two are essentially interchangeable.

The first operational ballistic missile was the German V-2. Most missiles today can trace their origins, directly or indirectly, back to that original, revolutionary weapon. The early Soviet missiles were developed straight from the V-2, and though US missile developments featured rather more original, indigenous work, the US programme was headed for many years by the V-2's chief designer, Wernher von Braun.[7]

Despite the Cold War association between ballistic missiles and nuclear warheads, all of the 5000–6,000 ballistic missiles actually fired in anger have carried high-explosive warheads (see Table 1).

Table 1: History of Ballistic Missile Use

Conflict	*Dates*	*Missile*	*User*
World War II	1944–45	V-2	Germany
Yom Kippur	1973	Scud & FROG	Egypt & Syria
Iran-Iraq	1984–88	Scud & FROG	Iran & Iraq
US–Libya	1986	Scud	Libya
Afghan Civil War	1988–91	Scud	Afghanistan
First Gulf War	1991	Al Hussain† & FROG	Iraq
Yemen Civil War	1994	Scud & SS-21	Yemen
Taiwan Crisis*	1995–96	M-9	China
Chechnya	1999	Scud & SS-21	Russia
Iraq	2001	Scud & Mushak	Iran
Second Gulf War	2003	Al Samoud	Iraq

* Demonstration firings for coercive effect
† An Iraqi-modified Scud
Complied by the author from various open sources

There is a very substantial body of secondary literature on the subject of ABM/BMD. Most, though not all of it, is American. Much of it deals with US missile defence, especially the 1980s Strategic Defense Initiative (SDI) and post-Cold War TMD and NMD.[8] Although several works have been published in the UK, especially among the Adelphi Papers monograph series from the International Institute for Strategic Studies (IISS) in London, many of them are by US authors and deal with US defences. Some of the literature does deal with European attitudes to US programmes, often a chapter or two in a more general work.[9] So-called theatre or tactical missile defences for Europe have their own literature.[10]

The only part of the UK BMD story extensively covered in published works is the World War II V-2 experience, on which there are plenty of books, a mix of official, scholarly and more popular volumes.[11] Other than the official histories, few deal with active defence plans in any detail, which can, however, be readily traced in files now held in the Public Record Office (PRO) in Kew. Though there is an extensive literature on postwar defence policy and particularly on its nuclear dimension,[12] BMD gets hardly a mention. Such references as there are relate to US and, to a much lesser extent, Soviet ABMs.

The year 1972 marks a major watershed in Britain's BMD story, and not only because it represents the exact half-way point. Coincidentally, the 30-year point at which most, though not all, official documents are released into the public domain at the PRO falls in the same year as the signing of the Anti-Ballistic Missile (ABM) Treaty. Though Britain was not a signatory to the Treaty, it played an absolutely pivotal role in UK policy towards BMD, then and ever since. The ABM Treaty was the defining event in the UK's responses to both US and Soviet ABMs.

The period up to the signing of the Treaty is well covered by material now available at Kew, though some technical files have been retained beyond the 30-year point. Because of the ABM Treaty, the subject went very quiet for over a decade thereafter, apart from the Chevaline Polaris Improvement Programme designed to overcome the Moscow ABM system, and which had already been set in train by then anyway. It is unlikely, therefore, that many fresh revelations on UK policy towards missile defence will be forthcoming in the next decade. Indeed, one promising-looking file entitled 'Ballistic Missile Defence 1974–1978',[13] which it was possible to get released ahead of the 30-year point, contained no more than details of the routine five-yearly renewal of the BMEWS Agreement.

The British story on BMD picks up again in 1983 with President Ronald Reagan's seminal speech on missile defence. The absence of primary source material in the PRO is in part compensated for by the increasing number of public statements on the subject made in Parliament, the media and in speeches and journals. Evidence taken by the House of Commons Public Accounts, and later the Defence and Foreign Affairs Committees, provides a rich source of primary, albeit unclassified, material. The large body of contemporary secondary literature also indicates the terms of the policy debate at the time. I have been able to talk, often on a non-attributable basis, to several of the key individuals in both the policy and technical aspects of UK BMD throughout most of the period considered in this work.

This study is the first ever attempt to trace the full history of the UK's involvement with BMD. It uses a combined chronological and thematic structure. Each chapter deals with a distinct element of the story. There is, however, a general chronological progression within each chapter, and the chapters themselves fall into a natural chronological order. Some of these do, however, run in parallel for parts of their length. For example, British concerns about US and Soviet ABM developments ran largely concurrently, though the UK's response to Soviet ABMs outlasted its worries about the US ABM programme.

Despite the greatly changing technical and strategic contexts for missile defence over the last 60 years, many consistent issues are apparent. The concluding chapter seeks briefly to draw the most salient ones together.

NOTES

1. For the early history of US ABM work, see Donald Baucom, *The Origins of SDI 1944–1983* (Lawrence, KS: University Press of Kansas, 1992), Ch. 1.
2. Jennifer G.Mathers, *The Russian Nuclear Shield from Stalin to Yeltsin* (Basingstoke: Macmillan, 2000), pp. 3–4.

3. For several Israeli views on BMD, and details of the Arrow system, see Ariel Stav (ed.), *Ballistic Missiles: The Threat and The Response* (London: Brassey's, 1999).
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2
The Wartime V-2 Experience

THE V-2 PROGRAMME

The ballistic missile age began in earnest at 6.43 p.m. on 8 September 1944, when a German V-2 rocket landed in Staveley Road, Chiswick, in west London.[1] In fact, a rocket had landed in a Paris suburb earlier that day, but the Chiswick incident, in which 2 people were killed and 20 injured,[2] is generally acknowledged as the first operational use of a ballistic missile. Sixteen seconds later another V-2 landed harmlessly in Epping Forest.

The ensuing six-and-a-half month campaign remains, over half a century later, 'the leading example of the use of ballistic missiles in warfare'.[3] Most elements of subsequent ballistic missile developments, and counters to them, were present in 1944–45: an ambitious technological programme, uncertain but improving intelligence about the missiles, a strategic rather than purely tactical plan for their actual employment, efforts to locate and destroy them on the ground, development of a sophisticated (and generally successful) early warning network, and a mix of (less successful) passive and active defences. Missing from the V-2 campaign were only efforts to limit their proliferation by means of arms control, and to limit their use by deterrence. Of course, World War II as a whole stemmed in part from failures of both those approaches, though in a more general context.

Like many of the notable German weapons of World War II, development of the V-2 had begun in the early 1930s, before the Nazis came to power. Private research into rockets began in the 1920s and by 1932 the German Army was sufficiently interested to set up its own laboratory, one of whose earliest employees was Wernher von Braun.[4] The Army saw rockets as a form of artillery, one that was not proscribed by the Treaty of Versailles.[5]

The Reichswehr's rocket team, led by an artillery engineer Captain Dornberger, achieved its first success in 1934 when the *Aggregat* (prototype) *-2* (or A-2), was first launched. It was followed by a larger A-3 in 1936–37, by which time an operational version (A-4) had been designed.[6] Mass production of the still untested weapon was authorised by the Army itself in October 1939,[7] The project was not accorded a high priority, however, until more than a year later by which time it was clear that neither invasion nor conventional aerial bombardment would bring about Britain's defeat.[8] The first test launch took place at the Peenemunde research establishment on the Baltic coast on 13 June 1942. It was a failure, as was a second test in August. But on 3 October an A-4 prototype flew 118 miles along the coast and landed within 4,000 yards of its target.[9]

Though subsequent tests were not always as successful, Hitler himself authorised full-scale production in December 1942. However, a year later there were still no operational missiles in existence and it took a film-show of a launch fully to convince Hitler that development should continue.[10] The Luftwaffe was in parallel developing a pilotless flying bomb (the V-1, an early cruise missile), and together they became known as *Vergeltungswaffen* (weapons of revenge), in retaliation for Allied bombing of German cities.[11] By August 1944 the A-4 (V-2) was ready, after a total of 65,000 modifications to the original design.[12]

The V-2 (to use its more popular designation), though considered at the time a long-range weapon was, in today's terms, a short-range, single-stage, liquid-fuelled, single-warhead ballistic missile.[13] Fourteen metres long and at launch weighing almost 13,000 kg, it carried a 750 kg high-explosive warhead fitted with an impact fuze. There is some evidence that a radiological warhead was planned, but it was never deployed.[14] The V-2 was powered by a nine-ton mixture of ethyl alcohol and liquid oxygen, more than double the weight of the missile itself, including the warhead.[15] Its maximum range was about 350 km (200 miles), with a Circular Error Probable (CEP) at that range of over 15 km.[16] It travelled at up to 1.6 km/sec (about 3,500 miles per hour), reaching a maximum altitude of 85 km (50 miles). Total flight-time for a maximum-range trajectory was about five minutes.

The V-2 was gyro-stabilised and range was controlled by cutting off the fuel supply to the rocket motor so that the correct maximum velocity was achieved for the desired distance to be travelled.[17] This could be preset before launch, or executed by radio command (though the latter was rarely used). V-2s were delivered to their firing points by train. After being transferred to a road vehicle the missile was checked, erected and fuelled, a process taking at least an hour in all.[18]

The final production contract was for 12,000 missiles, of which about half were actually built.[19] Monthly production peaked at 600 in November 1944. The cost was prodigious. Precise costings vary according to what is and is not included, but Aaron Karp estimates each missile cost between $70,000 and $90,000—almost $0.5 million at today's prices. Once research and development costs are included, the total V-2 programme has been estimated by Michael Neufeld at $5 billion in early 1990s dollars.[20] The opportunity cost was also considerable. One historian has estimated that six fighters could have been produced instead of each V-2.[21] Other, potentially promising projects suffered as a result of the research and development resources devoted to the V-2, including the *Wasserfall* surface-to-air guided missile.[22]

Nonetheless, the V-2 was an engineering and manufacturing success. Though it could not and did not win the war for Germany, even in combination with the V-1 cruise missile, it did do substantial damage and countering it occupied a great deal of Allied attention and resources in late 1944 and early 1945.

BRITISH INTELLIGENCE ABOUT THE V-2

The first possible hint about a German secret weapon came from Hitler himself. At a rally in Danzig on 19 September 1939, he boasted of a secret weapon against which there was no defence.[23] The Prime Minister, Neville Chamberlain, directed that this unknown weapon be investigated, and the task was entrusted to the newly appointed Assistant Director Intelligence (Science) in the Air Ministry, Dr R.V.Jones. Jones's initial analysis of available intelligence revealed only a single source suggesting a rocket, and some historians believe Hitler was simply referring to the Luftwaffe.[24]

Soon after Jones submitted his first assessment the British naval attaché in Oslo received an anonymous report on German technical developments, thereafter known as the 'Oslo Report', which contained details of a range of weapons projects.[25] These included two types of radar and a radio-controlled anti-ship glider-bomb. The subsequent appearance of just these devices later gave credence to reports of another weapon mentioned—a gyroscopically stabilised rocket. However, the report was widely regarded at the time (though not by Jones) as far-fetched and certainly little more was heard of rockets for nearly three years, by which time the first test launches had already taken place.

In May 1942 an RAF photo-reconnaissance aircraft returning from a mission over Kiel took a few chance photographs of Peenemunde. Because interpreters on the ground were not looking for anything in particular, they aroused little interest.[26] But in December the first of three reports from a Danish chemical engineer gave some details of rocket firings off the Baltic coast. Later reports identified Peenemunde as the precise location. In April 1943 a re-examination of the previous year's aerial photographs, together with those from subsequent missions, began to reveal details of test facilities for both the V-1 (in the Luftwaffe part of the establishment), and the V-2 (in the Army section).[27]

'From that time onwards a stream of intelligence about the rocket reached this country.'[28] Early reports seemed to indicate a weapon capable of delivering a five-ton warhead over a distance of 130 miles. Corroboration was obtained from an overheard conversation between two captured Wehrmacht generals, one of whom claimed to have witnessed an early firing.[29] Whilst these reports were being analysed in the Air Ministry by Dr Jones, they were brought to the attention of the Vice Chief of the Imperial General Staff in the War Office, Lieutenant General A.E.Nye. He consulted the Scientific Advisor to the Army Council, Professor Ellis, and the Controller of Projectile Development in the Ministry of Supply, Dr Crow, the latter being Britain's leading expert on rocket technology.[30]

The result was a paper circulated to the Chiefs of Staff (CoS) in April 1943.[31] It drew attention to the intelligence so far received and went on to speculate about the form a rocket might take. The range, weight and warhead size (130 miles, 9½ tons and 1,600 lbs respectively) were all of a similar order to the real V-2 (200 miles, 13 tons and 1,650 lbs). The external dimensions were quite wrong, however, predicting a length of 95 feet and a diameter of only 30 inches. The V-2 measured 45 feet by 65 inches, a much shorter and 'fatter' object. Significantly, a 100-yard-long 'projector' was needed to launch the rocket, an assessment that led to much wasted intelligence effort searching for such an enormous mortar-like structure.[32] The paper did not speculate about the rocket's means of propulsion, but the details above suggest that a solid fuel was considered likely as British rocket development (a simple anti-aircraft weapon) had hitherto relied solely on cordite, the only known propellant with an even rate of burning.[33]

The paper went on to consider the advantages and drawbacks of such a weapon:

> The principal advantages of long range rockets compared, as an offensive weapon, with action by bomber aircraft are:

(a) The rocket attack cannot be the subject of an early warning as can aircraft.
(b) The rocket cannot be intercepted in flight by fighters or attacked with AA weapons.

(c) Bad weather conditions are no deterrent. A rocket can be used when aircraft would be grounded.
(d) There are no losses in trained personnel in the form of air crews.
(e) Heavy attack in daylight is possible.

> The principal disadvantages from which the long range rocket suffers are:–

(i) The total expenditure of much labour and material in metal and propellant with each shot fired. In the case considered it would amount to a total of nearly 10 tons, including at least 4 tons of propellant, for every 2,800 lb effective weight of bomb fired.
(ii) The relative inaccuracy as compared with bomber aircraft. At 130 miles range, the mean lateral deviation is estimated to be at least 2½ miles either side of the target, very probably more, depending on the degree of accuracy in manufacture. The lateral 50 per cent zone would probably be at least 8 miles, and the smallest profitable target for a concentrated attack would be an area of about 64 square miles.
(iii) The substantial labour involved in installing each projector, which, unless very carefully concealed, cannot be expected to remain free from attack.

The paper concluded that whilst such a rocket was tecnically feasible, its inaccuracy would limit its use to area targets (i.e. cities). It was believed that the Germans were pursuing such a development, but that it was wasteful of resources. An attack could, however, be launched without warning and there were no means of intercepting such a weason. ‘The only satisfactory counter-measure appears to be destruction or damage to the [non-existent] projectors before they can be used.’[34]

The man longest associated with investigation of long-range rockets, Jones, was not involved in the production of this study or its recommendations. It did, however, generate immediate interest on the part of the Vice Chiefs of Staff (the Chiefs were at that time abroad) and only four days later the War Cabinet Secretariat recommended ‘… that one individual…should be appointed to take charge of the investigations’.[35] The Prime Minister, Winston Churchill, was soon briefed on the rocket problem and approved the appointment of his son-in-law Duncan Sandys, Joint Parliamentary Secretary to the Ministry of Supply, to the new, and somewhat unusual post.[36] Sandys, now an MP, had previously been commanding officer of the Army’s first experimental rocket regiment using the anti-aircraft rockets developed by Dr Crow, one of the experts consulted by the War Office in drafting their paper.[37]

Almost immediately, the German rocket became the subject of a Whitehall ‘turf war’ which had a significant effect on the accuracy and timeliness of British intelligence about the threat. Dr Jones resolved to work with Sandys, and placed all his existing work at his disposal.[38] His former professor, however, was Lord Cherwell (previously Professor Lindemann), the Paymaster General and Churchill’s Scientific Advisor. He was sceptical about the technical feasibility of the rocket, and in particular how it could be controlled in the early (slow) part of its ascent. Von Braun had in fact solved this with rudders placed inside the missile’s efflux.[39] Cherwell also, and with better reason, did not believe in the possibility of a 60-ton rocket, which was mentioned in Sandys’s first progress report in May.[40]

At this stage intelligence on the V-2 was speculative and drew as much on what was believed theoretically possible as on what was actually known. The Ministry of Home Security calculated that a 60–70-ton rocket with a 10-ton warhead might kill up to 600 people and that a concerted campaign employing such weapons might kill over 100,000 Londoners a month.[41]

The new priority accorded to the rocket threat resulted in the allocation of photo-reconnaissance aircraft both to Peenemunde and to possible launch sites in France, especially the Pas de Calais region.[42] In June photographs revealed what was quite clearly a rocket at Peenemunde, though lack of knowledge of its propellant continued to cause gross overestimates of its size and weight. Jones and Cherwell discussed the rocket with Churchill himself on 29 June. Churchill sided with Jones's assessment of the reality of the rocket,[43] against Cherwell's belief that it was an elaborate hoax, noting that at this time the existence of *both* a rocket *and* a flying bomb was not yet firmly established. A tangible result of this meeting was the authorisation of a large-scale bombing raid on Peenemunde.

In August 1943 two intelligence sources provided further information on the rocket. One, a disaffected German staff officer, confirmed the existence of the A-4, parts for which were being manufactured at several locations, but assembly and testing of which was taking place only at Peenemunde. About 100 rockets had been test-fired so far. Moreover, the large concrete emplacements under construction in France were for storage only, as the rocket 'projectors' could be erected anywhere.[44] A French source provided confirmatory details, together with information on guided bombs. This latter was corroborated by other sources, lending credence to his information on the rocket.[45]

At the same time information was received from the United States about its work on liquid propellants. This 'completely altered the picture', according to one of the British scientists working on V-2 assessment.[46] A committee of scientists (the 'Bodyline' Committee) concluded that a single-stage liquid-fuelled rocket with a range of 130 miles and a warhead of up to 15 tons, or a range of 200 miles and a warhead of up to 5 tons, was technically feasible.

A paper prepared for the CoS reviewed what was known about the German rocket.[47] This study recognised that the growing body of evidence could prove the existence of a rocket, be an elaborate hoax (as Cherwell believed), or point to some other device (such as the flying bomb). The paper reviewed all the intelligence received so far, from the original Oslo Report onwards. The German designation 'A-4' was now known, and the possibility that the German Air Force was developing one weapon and the Army another was also (correctly) identified. As to the possibility of a hoax, the paper stated, 'While…there may be technical difficulties in accepting the big rocket, there are even greater difficulties in accepting the big hoax.'[48] It concluded that the evidence amounted to 'a coherent picture… The Germans have been conducting an extensive research into long range rockets at Peenemunde… Hitler would press the rockets into service at the earliest possible moment; that moment is probably still some months ahead.'[49]

Cherwell was still sceptical, famously stating that 'at the end of the war, when we know the full story, we should find that the rocket was a mare's nest'.[50] His was increasingly a minority view (though he was supported by Dr Crow) and one of diminishing influence.[51] The problem was rather one of an over-estimation of threat. A much larger weapon than the V-2 was still considered likely by the 'Bodyline'

Committee, one that would require, even with liquid propellant, either more than one stage or launch from a large mortar.[52] The UK's air defence commander later observed, 'The problem of defending the capital against so disobliging a projectile was naturally a source of some anxiety…'[53]

In November Sandys's responsibilities were transferred to the Air Ministry in order that counter measures (bombing) could more effectively be coordinated.[54] At the same time, the Joint Intelligence Committee (JIC) established a new sub-committee, codenamed 'Crossbow', to coordinate all intelligence regarding the V-1 and V-2 weapons.[55]

In December British signals intelligence intercepted a message ordering the German Experimental Signals Regiment to track an A-4 test launch, final proof of the missile's existence. But the exact details of the rocket remained unknown and many (including Cherwell) refused to believe that the Germans could produce a liquid-fuelled missile.[56] This situation endured throughout the early months of 1944, despite a continuing trickle of further evidence. As Air Chief Marshal Hill later reported:

> Although our ordnance experts continued to believe that anything other than an outsize long-range rocket was out of the question, as time went by the evidence began to point more and more clearly to a warhead of relatively modest size.
>
> Notwithstanding this evidence, the conception of a huge, earthshaking projectile persisted. Accordingly much effort was spent on a vain search for the massive launching devices which were believed to be necessary to start so large a missile on its flight.[57]

In March 1944 Polish agents reported rocket activity at Blizna, 170 miles south of Warsaw.[58] Whilst a picture was built of what was going on, from both aerial reconnaissance and partisans' reports, a complete V-2 fell into British hands. On 13 June, a week after D-Day and, coincidentally, the opening day of the V-1 offensive, a V-2 fired from Peenemunde landed near Malmö in Sweden.[59] The missile was examined on the spot by two British intelligence officers whose initial report indicated that the fuel might be liquid oxygen.[60] They also reported that the rocket was radio-controlled and would carry a warhead of not less than 10,000 lbs,[61] thus continuing the over-estimate of the V-2's destructive potential. After some delicate negotiations with the neutral Swedish Government, the parts of the crashed rocket were shipped back to Britain, and reconstruction started at the Royal Aircraft Establishment at Farnborough at the end of July.[62] A steady stream of information was also coming from Poland where partisans were often able to inspect the wreckage of test firings before the Germans got to the site. One misleading item was the reported size of craters, which Jones believed indicated a warhead of between 3 and 7 tons.[63] The Ministry of Home Security later calculated that this would cause the destruction of all houses within a 400-yard radius of the impact point.[64]

Though it proved to be an invaluable source of information, the V-2 shipped to England was deceptive in one major regard. It had been used as a test-bed for the radio-control equipment of the *Wasserfall* surface-toair missile. This seemed to confirm that the

V-2 itself was radio-controlled and much subsequent and fruitless effort was later devoted to trying to jam V-2s.[65]

With the V-1 campaign now under way, Churchill formed a 'Crossbow' sub-committee of the War Cabinet on 19 June, under Duncan Sandys' chairmanship.[66] This body, distinct from the earlier Crossbow intelligence sub-committee, took on the role of coordinating all countermeasures to the V-1 and V-2 weapons.

By early August Blizna had been captured by the Red Army. A small British team, after much difficulty, was able to inspect the site and arrange for wreckage to be sent to Britain. When it arrived crashed aircraft parts had been substituted.[67] The Russians later fully exploited what they had captured when starting their own missile programme (see Chapter 3).

By the middle of August the work at Farnborough was doing much to clarify details of the V-2, and Jones was able to state that the rocket weighed about 12 tons and carried a 1-ton warhead:[68] '…at last the A-4 rocket had been brought down to its proper size…the rocket threat had almost dissolved of its own accord.'[69]

'By the last week in August [i.e. on the eve of the first V-2 attack] all the main characteristics of the A-4 had been established…[and] we had some reason to suspect that active operations would begin during the first half of September.'[70] Only the method of control remained a mystery. The current assessment of the threat was summed up in the 14th Report of the Crossbow Committee:[71]

Target:	London only.
Warhead:	1 ton up to a range of 200 miles; possibly tons at ranges under 140 miles.
Accuracy:	One half to two thirds of rockets fired will fall in the London Region (i.e. within about 15 miles of Charing Cross. The remainder may be erratic.
Public Warning:	1–1½ minutes before the fall of the rocket.
Start of Attack:	The attack may start at any time from now onwards. It will not continue on an appreciable scale after 15 October.
Average Rate of fire:	Up to 60 rockets per day, during first month of bombardment.
Flying Bombs:	To the above should be added a probable average of about 20 flying bomb incidents per day in London Region.
Average Scale of combined Rocket and Flying Bomb Attack.	Up to 80 tons of HE per day falling in London Region. (This compares with 48 tons during the worst week of the flying bomb attacks.)

The judgement that attacks were likely to begin in early September was based on JIC assessments of the state of progress in the A-4 programme and interrogation of a captured general in Normandy.[72] Further technical details were supplied by the capture of documents.[73]

However, just when it was believed V-2 attacks were imminent, it began to appear that they might be forestalled altogether due to the rapid advance of the Allied armies as they broke out of their Normandy beach-head.[74] The last V-1 launched from the ground in France reached Britain on 1 September, though flying bombs continued to be launched from the Netherlands and from aircraft until late March the following year. Despite the misgivings of Hill and Jones, on 7 September Sandys held a press conference where he declared, 'Except possibly for a few last shots, the Battle of London is over.'[75] The first V-2s arrived the following day: The A-4 intelligence problem was over.'[76]

THE V-2 CAMPAIGN

The first 10 days of what became a 6½-month campaign disproved the more alarmist predictions about the V-2, or 'Big Ben' as it was codenamed in Britain. It proved to have the smallest warhead of any of the previous estimates—about the same size as the V-1—and arrived in only small numbers. About 35 rockets were fired at London in the first 10 days, of which 16 actually fell in the London area.[77] None caused extensive casualties-56 people were killed in all.[78]

There was then a lull of a week in which no rockets were fired, as the Allied operation at Arnhem caused a temporary withdrawal of firing units for fear of being cut off.[79] Attacks resumed on 25 September, when a rocket landed near Diss in Suffolk. V-2s continued to land near Norwich (their intended target) and then resumed attacks on London on 3 October, firing units having returned to within range of the city after the Allied setback at Arnhem.[80]

By the middle of the month over 100 V-2 strikes had been reported on the Continent and it seemed likely that the chief target in future would be the port of Antwerp,[81] captured in September but not fully open until late November. Antwerp did indeed receive several times the number of V-2 hits as London—2,419 and 517 respectively.[82] The rate of attacks on London increased sharply from late October onwards, however, with 44 missiles reaching Britain in one 10-day period. The rate of casualties also increased.[83] By 20 November 210 V-2s had reached Britain (96 in London), and 456 people had been killed. On average four people were killed by each V-2, double the rate for the V-1.[84] Perhaps of greater significance than the average kill-rate were the handful of individual rockets causing mass casualties: 'every now and again a really bad incident [was] experienced'.[85] On 25 November 160 people were killed by a single rocket which hit Woolworth's in Deptford. The worst incident occurred in Antwerp, where 567 people were killed in a cinema.[86]

Attacks continued on targets in south-east England, Belgium and northern France until 27 March, when the firing units withdrew to Germany to avoid capture by advancing Allied troops.[87] The last V-1 attack came 2 days later. In total, 1,115 V-2s fell on the UK, causing a total of 2,855 fatalities.[88] Thirty-three rocket 'incidents' were responsible for 20 or more deaths each,[89] of which only 1 (in Chelmsford) was outside London.

The V-2 attacks against Britain, like the V-1s, were retaliatory. Operations on the Continent had more specific aims. Antwerp was attacked in order to disrupt the vital Allied supply routes through the port. V-2s were also used in a strictly tactical manner when 11 were fired (unsuccessfully) at the Rhine bridge at Remagen after its capture by American troops on 7 March 1945.[90]

The 2,754 British civilians killed by V-2s represents less than 5 per cent of total fatalities in the period 1939–45. The overwhelming majority (over 51,000) died as a result of conventional bombing, and 6,184 were killed by V-1s.[91] The largest number killed by a single rocket (160) compares with 1,436 killed by a single air raid on 10 May 1941, and 9,169 deaths in road accidents in the same year.[92] A single RAF bomber raid against a German town could kill many more times the number of people than all the V-2s which reached London.[93] One should not, however, underestimate the human cost of the V-2 campaign. Antwerp alone suffered approximately 30,000 casualties (dead and injured).[94] But the impact of the V-2 campaign against Britain amounted to more than just the casualty list. Over 20,000 houses were destroyed and about 580,000 damaged.[95] In the port of Antwerp 150 ships were sunk or damaged by V-1s and V-2s.[96]

More contentious has been the effect on morale, especially in London. Some historians have claimed that the effect of the V-2 on public morale was less than that of the V-1 or the earlier Blitz. The official historian of Britain's air defences in 1939–45, Basil Collier, states, 'On the whole, the British public found [the] V.2 a less alarming weapon than [the] V.1… often unnoticed by people outside the immediate vicinity of the point of impact.'[97] Air Chief Marshall Joubert de la Ferte of Fighter Command states, 'The effects of the V2 bombardment were purely physical. Unheard and unheralded, its explosion was the first sign of trouble, and as the fall was very scattered and the numbers relatively small, the moral effect was slight.'[98]

More recently, others have described the V-2 as having a greater effect than the V-1 (whose approach could be heard, but against which an effective defence was devised). David Johnson writes that 'the V-2 was generally more feared',[99] while Robin Ranger asserts that 'UK air defences could not intercept V-2s…although these casualties were much lower than those caused by the V-1s, the adverse psychological effects of the V-2 attacks were much greater and morale dropped sharply'.[100] The evidence is inconclusive.

THE COUNTER-FORCE CAMPAIGN

A detailed examination of Allied efforts to locate and destroy V-2s on the ground is outside the scope of this study. Nevertheless, the counter-force campaign was part of an overall strategy to defeat the rocket threat, and one that had a significant effect on the wider conduct of Allied air and ground operations in late 1944 and early 1945. Some mention of these operations is necessary, therefore, to place efforts to counter the airborne V-2s in context.

'[T]he obvious and only methods of attack against it [the V-2] are attacks on its launching sites and the simple but fundamental solution of occupying the country which launches it.'[101] Prior to D-Day in June 1944, only the first of these approaches was feasible.

The bombing of German installations associated with the development and production of V-weapons began in the summer of 1943. The third report from Duncan Sandys was considered on 29 June by the full Defence Committee (Operations), chaired by Churchill.[102] The result was a decision to bomb Peenemunde at the next opportunity. This came on the night of 17/18 August. For the loss of 41 out of 600 aircraft an estimated 130 German scientists and engineers and a larger number of foreign labourers were killed. The V-2 programme was put back several months.[103]

This was followed by a somewhat speculative US attack on a so-called 'large-site' at Watten near Calais. Its exact purpose was unclear, though in fact it was intended for the storage and servicing of V-2s.[104] For the remainder of the year and well into 1944, however, the bomber offensive was directed against German war industry, targets in support of the forthcoming Normandy invasion, and a large number of V-1 'ski sites' in northern France. There was a massive photo-reconnaissance effort, of which a significant proportion went in search of both V-1 and V-2 sites.[105]

By late August 1944, with an imminent V-2 attack expected, rocket targets assumed a higher priority.[106] Attacks were made on sites believed to be associated with the manufacture and storage of V-2s, and also on rail links used for transporting the missiles.[107] Destruction of V-1 sites continued throughout this period, being accorded a priority second only to 'the urgent requirements of the battle'.[108] Just on the eve of the start of the V-2 campaign, however, attacks on 'Crossbow' targets were halted as it appeared the ground offensive had removed the threat.[109] By this time over 20,000 tons of bombs had been dropped on V-2 targets (compared with nearly 100,000 tons on the V-1).[110]

Once the V-2 campaign actually started in September, armed reconnaisance missions were flown by fighter-bombers seeking V-2 launch sites which could then be attacked immediately.[111] However, the destruc-tion of V-2 sites was not accorded the same priority that V-1 sites had been a few months before, as the scale of attacks by the former never justified such emphasis.[112] After 15 October Hill's command, Air Defence of Great Britain (ADGB), became independent of the Allied air forces operating on the Continent, and reverted to its old name, Fighter Command.[113] Most attacks were therefore carried out by aircraft from this command, operating from Britain, and not aircraft based in Europe which were tasked directly in support of ground operations.

By the early months of 1945 the rate of V-2 attacks had increased, and poor weather was hampering fighter-bomber armed reconnaissance sorties.[114] A high-level attack by medium bombers was therefore made on the Hague suburb from which many V-2s were being launched. The consequent loss of life amongst Dutch civilians meant that the exercise was not repeated.[115]

Air attacks did not halt V-2 operations (approximately 6,800 sorties), despite the loss of an estimated 450 aircraft and over 2,300 aircrew.[116] On 7 March the German rocket forces themselves reported that only 48 rockets had so far been damaged by air attack.[117] Collier assesses that 'armed reconnaissance and fighter-bomber attacks were only palliatives, although the latter achieved some good results'.[118]

In the end, it was the advance of the Allied armies that pushed the V-weapon units back beyond range of their intended targets. Anglo-American troops had already broken out of the Normandy beachhead by the time the first V-2s were launched on 8 September. The following day, Montgomery was asked by what date he could isolate the Antwerp-Utrecht-Rotterdam area from where the rockets were launched.[119] Montgomery later recalled that 'that settled the direction of the thrust of my operations to secure crossing[s] over the Meuse and the Rhine; it must be towards Arnhem'.[120] Operation Market Garden, a combined airborne and armoured attack was, however, a 'bridge too far'[121] and the Hague launch sites remained operational for another six months, though Walcheren Island was captured on 9 November, preventing its further use for V-2 launches.[122] The V-2 sites were finally cut off from Germany in early April, by which time the firings units had ceased operations and withdrawn to the east. 'The V-2 had finally been beaten by the ordinary soldier on the ground.'[123]

EARLY WARNING

> It was known early in June 1943 that plans were being made by the enemy to use some form of explosive rocket to attack this country from the Continent, and special information for early warning and firing point location purposes would be required from the Radar chain (Air Ministry report, September 1944).[124]

Accordingly, by 31 August 1943 five existing ‘Chain Home’ (CH) radar stations along the south coast, at Swingate, Rye, Pevensey, Poling and Ventnor had been tasked to watch for rocket launches from northern France, from where attacks were at that time expected. New cathode-ray direction-finding (CRDF) displays were installed so that the radars could detect rockets side-on as they were still climbing. At a range of 120 miles, the rocket would be seen once it had risen to an altitude of about 30,000 feet.[125] This would provide both early warning of attack and an approximate launch site location. Reports were to be collated at Fighter Command headquarters at Stanmore, north-west of London.

Other enhancements followed. Transmitted power was increased and additional radar displays with automatic tracking facilities installed. Photographic recording equipment, code-named ‘Willie’ and ‘Oswald’, would allow post-event analysis of firings to improve intelligence about V-2 performance and to refine site location. Installation of this equipment was complete at all five stations by the end of October.[126]

By this time, however, further intelligence indicated that the V-2 might be launched from ranges as great as 200 miles, and that it might present a weaker radar signature than previously anticipated. The greater demands this placed on radar meant that the twin tasks of early warning and site location were now considered incompatible. In view of the scale of the photo-reconnaissance efforts being devoted to V-weapon sites, it was decided in March 1944 to concentrate the radars on the early warning task. It was also decided not to extend the rocket warning chain further along the south coast, facing the Cherbourg peninsula, in view of the approach of D-Day, which would forestall rocket launches from that area.

Additional radar sites were added to the system further east instead. Two special high-looking radars (Air Ministry Experimental Station [AMES] 9) were installed at Martin’s Hill and Snap Hill,[127] and additional CRDF sets at Ramsgate and Dymchurch on the south coast and Bawdsey, Bromley and High Street on the east coast,[128] the latter three looking east towards the Low Countries rather than south and south-east towards France. These radars would provide early warning as the rockets climbed. To provide terminal-phase detection, 11 Army GL Mark II radars were deployed, 20–30 miles apart, between North Foreland and Portsmouth. All were in place by late August 1944.

A ‘Big Ben’ reporting exercise conducted by the headquarters of ADGB on 26 August proved satisfactory. Warning times of up to 205 seconds were expected from the longer-range radars and 90 seconds from the army sets.[129] The ‘point of strike’ was predicted by the Army’s existing AA Command Prediction System,[130] though as this could be achieved only 70 seconds before impact it was of limited utility.

On 6 September, however, in view of the advance of Allied armies in France, the Vice CoS agreed that V-2 attacks on London were no longer expected. The official history states that ‘the first opportunity was taken for discounting a threat which had always been an irritating diversion from the last great offensive’.[131] This did not tally with the intelligence about the V-2 held by Hill’s staff at ADGB, and radar watch was maintained in case rockets were fired at targets other than London.[132]

The radar watch for rockets was supplemented by Royal Artillery counter-battery flash-spotting and sound-ranging techniques. As early as April 1943 General Nye’s report on the long-range rocket[133] recommended the use of flash spotting to detect expected V-2 ‘ranging-shots’ (following the artillery analogy). By August 1944 11th Survey Regiment, based at Canterbury, was integrated with the various radar stations in providing rocket data to Stanmore. Sound-ranging employed a chain of microphones whilst flash-spotting sought to detect the exhaust plume of rocket launches, employing three balloons to raise the observers aloft.[134] Both had some early success in detecting actual V-2 launches.[135] Flash-spotting was effective at ranges of up to 150 km in good weather.[136]

The tasking of Bawdsey on the east coast for rocket-watching was fortuitous, for the first two V-2s launched on 8 September were fired, not from northern France as previously anticipated, but from the Netherlands. Although the rockets were not detected by radar at the time, subsequent examination of the photographic records showed the track of a projectile at a range of 135 miles.[137] Of the first 25 V-2s, only 28 per cent were detected by radar operators at the time, most of the remainder being found on subsequent examination of the film records.[138] By the end of October, 49 out of 50 incidents had been caught on the cameras, and by triangulation of these records launch site positions could be established with an accuracy of a few kilometres.[139]

A Crossbow meeting on 9 September quickly identified the need to deploy radars on the Continent in the light of these first attacks, to increase the amount of warning time. As the Official History puts it:

> The fact was that the original programme of radar…counter-measures had been based on the assumption that rocket attacks would be launched from northern France; whereas attacks from Holland required both the radar stations…and the survey unit to operate beyond the range at which reliable and efficient working would have been possible…what the situation demanded in September 1944 was that an organisation similar to what had been prepared in England should be set up on the Continent as close as possible to the area which the Germans were using.[140]

It was resolved to send three mobile GL Mark II radars, to be followed by two AMES 9 Mark III as soon as they could be made mobile as well.[141] In addition, 10th Survey Regiment would deploy with sound-ranging and flash-spotting equipment and a local command organisation, 105 Mobile Air Reporting Unit, would be located at Malines, near Brussels[142] (which by now was in Allied hands). Direct communications were to be established between the deployed radars and the RAF’s No.11 Group Filter Room where rocket reports were being collated and a composite report issued every 24 hours.[143]

Almost as soon as this new arrangement was in place, Hill’s ADGB lost control of it to Eisenhower’s Supreme Headquarters Allied Expeditionary Force (SHAEF). The CoS assessed (correctly) that the main object of future V-2 attacks would be Antwerp and possibly Brussels. Allied forces on the Continent therefore needed their own rocket-warning organisation, and anyway the early warning so far achieved for the UK had not been adequate for a general warning system,[144] though the CH radar performance was improving.[145] The Continental assets were consequently re-deployed to provide better coverage for Antwerp, though they continued to send data to Stanmore.[146]

The patchy record of V-2 early warning in Britain was illustrated by a trial conducted between 14 and 19 September. Based on information from all sensor sources, 43 warnings were issued by the 11 Group Filter Room; 33 were false alarms and 3 real rockets were missed. The CH radars provided an average of just under four minutes' warning, 11 Regiment a little less and the GL radars a minute and a half.[147]

As V-2 attacks on Antwerp escalated, the entire chain of GL radars in England was stood down and transferred to Belgium in November,[148] in response to an urgent plea by Eisenhower himself.[149] Though the short warning times obtainable were of little more use than in London, the additional radar coverage was used to further refine the location of launch sites for subsequent counter-attack. The loss of these assets from the UK was not considered serious: '…we are unable even with these sets to institute a satisfactory system of public warnings owing to the large number of false alarms…and the impossibility of deciding where the rocket will fall…'.[150]

This was not to say that the missiles were not being detected, simply that tracking was not sufficiently accurate for practical purposes. Every V-2 which reached Britain in 1945 was detected at the time on radar.[151]

Towards the end of the V-2 campaign, two additional experimental radars were deployed in the UK, both with automatic tracking.[152]A US set positioned under the usual trajectory approaching London was able to lock on to some V-2s and produce data good enough for impact-point prediction, though too late to be of practical benefit. Another set produced by the Army's AA Command tracked several rockets at ranges of up to 60 miles. A Predictor was developed for use with it, including a data-transmission link, but was never used. These experiments came to an end with the V-2 offensive itself.

ACTIVE DEFENCE

In 1949 General Sir Frederick Pile, Commander-in-Chief of Anti-Aircraft Command throughout the war, wrote that 'by far the most difficult problem we ever had to tackle was to find some means of defence against the V-2 rocket'.[153] By the time the V-2 offensive opened in early September 1944, the problem of defence against the earlier V-1 cruise missile, or flying bomb, had largely been solved. On 28 August all but 4 out of 97 V-1s which approached the British coast were shot down.[154] During the final phase of the V-1 attacks on London in March 1945 (when the V-2 campaign was also coming to an end), only 13 V-1s reached London out of 275 launched, of which 91 were actually shot down.[155]

The V-2 story was very different. In early 1945, whilst rocket attacks were still continuing, the author H.E.Bates, then serving in the RAF, wrote, 'Defence against this projectile [the V-2] that precedes the sound of itself flying through space offers none of the opportunities of the doodlebug [the V-1].'[156] Indeed, the provision of a fully effective defence against such a weapon still remained elusive half a century later. Efforts were made, however, to achieve some sort of active defence against the V-2 after it had left the ground. Two approaches were tried.

The first was Radio Counter-Measures (RCM). The rocket recovered from Sweden appeared to confirm that the missile's range was controlled by a radio command shutting off the fuel supply to the motor.[157] It was therefore resolved early in 1944 to try to intercept and then jam its control signals. By August 1944 the RAF's No. 80 Signals Wing was operating seven Y Service stations along the coast with a central control station at Beachy Head, listening for signals that might be associated with V-2s. Halifax aircraft of 192 Squadron were also equipped for signals intercept.[158]

In order to jam signals once intercepted, it was planned to have in place by 1 September a total of 54 ground-based jamming transmitters and 12 Flying Fortress aircraft of 214 Squadron for airborne jamming with a 'Jostle' Mark IV set.[159] No jammable signals were intercepted,[160] however, as the Germans were not, in fact, using radio control of the missiles.

RCM was considered by the Crossbow meeting on 9 September, immediately after the first two rocket strikes. The wreckage did not reveal any radio-control equipment, but this was not considered significant and it was decided to continue assuming radio control, and possibly radio tracking, of V-2s.[161] Forty ground-based jammers were available, including 18 naval sets. Six Fortresses and six Liberators were tasked for airborne jamming, and a further nine of the latter would be available within four days. A standing patrol of one jamming aircraft was to be maintained over the assumed launch area in the Netherlands, and Halifax signals intercept aircraft were also used.[162]

By late October a small jamming unit had been deployed to the Continent, near Blankenburg. This comprised a Y unit and four jammers. But it was noted at the time, There [is] no proof that it has been effective… The future effectiveness of this ground radio counter-measure unit is problematical…'.[163] By mid-December there was still no concrete evidence of radio control of the V-2s, and RCM efforts ceased. Listening stations were taken off rocket-watching duties and jamming aircraft were re-assigned in support of the bomber offensive.[164]

Attempts to jam the V-2 were replaced by efforts to shoot it down. 'The problems involved seemed formidable.'[165] As General Pile put it:

> Here we had a target that was travelling at over 3,500 miles an hour, or about five times the speed of sound. It was no use puncturing it if we did not detonate the war-head. It had to be blown up in the air, and the war-head was not only protected by a casing of quarter-inch steel, but was also a very small target—a fraction of the whole rocket. It made all our equipment and our methods look far more antiquated than they had done against the 200 mph bomber in the primitive days of 1940.[166]

On 24 August 1944 AA Command made a tentative proposal for the engagement of the V-2 by placing a 40 km wide barrage of gunfire in the path of an approaching rocket. An estimated 320,000 rounds of ammunition would be needed for each V-2. About 2 per cent could be expected to fall back to earth unexploded—a total weight of nearly 90 tons of explosive which was likely to cause much greater damage than the one-ton warhead of the V-2 itself.[167] The scheme was clearly impracticable, and a Crossbow meeting on 25 August decided that the project was not worth-while.[168]

Pile was not deterred, however, and set up a small scientific committee to develop the idea further. The proposals of this committee were considered at a joint Fighter/Anti-Aircraft Commands conference, chaired by Hill, at Stanmore on 19 December.[169] Pile made some significant opening remarks:

> The long range rocket was a weapon which, sooner or later, we would have to deal with, either during this war or as a post-war problem.
>
> Time was of the highest importance lest experience was not gained nor progress made before a more powerful rocket was used against us.
>
> Experience against these projectiles in this war was essential for planning our post-war defences.
>
> Experience had, throughout the war, shown:–

(a) as soon as you start operational shooting you straightaway start to improve your technique;
(b) operational shooting, as well as scientific theory, was necessary to the solution of any AA problem.

Pile went on to explain the two key problems: accurate prediction of flight and causing the rocket to explode in the air. He proposed a trial against rockets on which accurate data was available, and initially only in daylight. New specially designed fuzes would reduce the amount of unexploded ordnance falling back to earth, and only about 150 shells would be fired at any one rocket. He stressed that the proposed trial was based on an entirely different basis to his Command's earlier proposals. The revised plan relied on accurate predictions of a rocket's actual trajectory, whereas the August scheme was no more than a crude barrage. A Home Office representative emphasised the importance to public morale of being seen to do something about the V-2.

AA Command's plan[170] consisted of 2 modified GL radars at Aldeburgh and Foreness facing each other and registering when a rocket crossed the line between them. An accurate point in space could thereby be obtained. Together with the point of launch (from the CH radars) and the V-2's known trajectory (from records) an accurate prediction of a future position could therefore be made. Gunfire would be brought to bear on that position producing a curtain of shell fragments through which the V-2 would have to pass. Impact with a shell fragment would cause the missile's warhead to explode. One hundred and fifty rounds of ammunition would be fired into a 1,000-metre square at a height of 20,000 feet. Some detailed (but entirely theoretical) calculations were made about lethality, concluding that the chances of a successful warhead detonation were one in 50.

The objectives of the trial would be to establish whether a sufficiently accurate future position could be predicted, whether it could be done in time to create the cloud of gunfire fragments, and whether these fragments would cause the warhead to explode. One or two suitable targets per day were anticipated, which would require a trial of at least a month's duration before any useful conclusions could be drawn.[171]

Hill was 'satisfied that it contained the germ of a successful countermeasure, which might become important in the future, and that on purely operational grounds a practical trial was desirable'.[172] He forwarded Pile's proposals to the Crossbow Committee, with a recommendation that, subject to Home Office approval (in view of the possible damage caused by unexploded shells and the effects on public morale), a trial should proceed. The proposed experiment also had the support of Professor Ellis,[173] whom Sandys consulted directly before the plan was considered by the full Crossbow Committee on 15 January.

Despite the strong advocacy of both Hill and Ellis, the Committee decided not to recommend to the Cabinet that the trial begin.[174] Two reasons were advanced. One was the significant variation so far observed in rocket trajectories, which would prevent the required predictions being made. The second was the public disturbance that would be caused by the gunfire, which would require the institution of a public warning system. AA Command was directed to obtain further evidence of V-2 trajectories and radar performance against them.

By late March significant advances had been made in trajectory prediction, by establishing three accurate points along the path of the rocket.[175] The first of these, the point of launch, was obtained by a specially modified US-supplied SCR 584 radar positioned at Steenbergen in Holland. This type of set was already in extensive use against the V-1.[176] The latter points were established by modified GL Mark II sets at Aldeburgh, Southwold and Walmer through a complicated process of cross-referencing. The effects of atmospheric retardation after re-entry were known from previous observations.

The Greater London area was divided up into a series of 2.5 km grid squares. Each gun site in the trial, all of them east of a line running north/south through Hyde Park, would have predetermined firing data for each grid in which individual rockets were predicted to land. Between 60 and 500 rounds of ammunition were anticipated for each V-2, depending upon the predicted impact point in relation to gun sites.[177]

A radar trial had already successfully predicted 81 per cent of V-2s landing either in the predicted or adjacent grid square. This was deemed by AA Command sufficient to warrant requesting approval for a live firing trial, as it overcame the previous problem of variable trajectories. The new proposal was considered by the Crossbow Committee on 26 March.[178] Pile told the Committee that 'the method suggested offered considerable possibilities of successful engagement of Long Range Rockets and it was of the greatest importance to use the present fleeting opportunity to gain experience of possible counter-measures to this serious form of attack'. He also stated that research was going on into predicted fire against rockets (i.e. not just a barrage), but this was a long-term project. Pile clearly saw that the V-2 campaign was coming to an end and that the end of the war in Europe itself was in sight. He was looking further ahead than that.

The Committee directed Pile to convene a scientific sub-committee, including Dr Jones and Professor Ellis, to assess the chances of a successful engagement using the new scheme. This reported two days later,[179] estimating that one in every 60 rockets landing in the London area would be successfully engaged, in addition to the three that experience suggested were subject to premature air-burst. This short report was immediately forwarded to the CoS[180] and considered by them on 30 March.[181] Two thousand rounds would have to be fired to destroy a single rocket and it would take some time for the trial to establish any results. The CoS therefore decided not to approve the proposed trial as it would neither justify the scale of effort involved nor the possible adverse effect on public morale of the gunfire.

In any event, as Pile later wrote, ‘Monty beat us to it, and, before we could wring permission out of the War Cabinet to try our plan, the rocket-area of Holland was cut off by the liberation armies and V-2 attacks ceased.’[182] The last V-2 had fallen on London on 27 March.

One V-2 was, however, shot down—by a bomber. A V-2 launched from the Netherlands passed right through a formation of USAAF B-24 Liberators returning to England, and was successfully engaged by a .50-calibre machine gun.[183] Nor was this the only US action against the V-2. A similar arrangement to that for London was devised for the defence of Antwerp,[184] though also forestalled by the advance of Allied armies.

CIVIL DEFENCE

The UK maintained a comprehensive civil defence organisation throughout World War II. The V-2 was only the last, and in terms of damage done least serious, of the threats faced by the country, and London in particular. It is impossible, therefore, to identify many measures taken that were designed specifically to limit the damage inflicted by the V-2 rockets. Some examination of civil defence is necessary, though, as part of the overall story of Britain’s experience in countering the V-2.

Civil defence planning began as soon as intelligence revealed the future V-2 threat, and was based on the premise of a 10-ton warhead. Eighteen thousand fatalities were expected from the 1,000 rockets the Germans were believed to have in production;[185] 100,000 additional ‘Morrison’ shelters (named after the Minister of Home Security) were ordered, the steel coming from the cancellation of two new battleships, *Lion* and *Temeraire*, construction of which had already been suspended.[186] Plans were also made for the use of Underground stations as shelters,[187] and for the control of the expected refugee flows. The Post Office Engineering Department instituted a public warning system which included klaxons, maroons and the firing of blank ammunition by AA gun sites. Similar arrangements were made for Portsmouth and Southampton, in each case triggered by telephone warnings issued from Stanmore.[188]

During the first half of 1944 civil defence measures were aimed not against a future V-2 threat but against the manned bomber during the so-called ‘Baby Blitz’ and then the V-1 offensive.[189] The Senior London Regional Commissioner, Sir Ernest Gowers, warned, however, ‘If BIG BEN were to arrive, Local Authorities would, of course, be in still more urgent need of help.’[190]

On the eve of the V-2 offensive, two significant events had occurred. First, an estimated 1½ million people had already left London in response to the V-1,[191] a number never matched throughout the V-2 campaign. Second, air raid wardens were instructed, on 1 September, to cease lectures and training about the V-2[192] in view of the over-running of likely launch sites in northern France.[193]

The Crossbow meeting held on 9 September, immediately after the first V-2 attacks, considered one aspect of civil defence that was unique to the V-2 problem: the issuing of public warnings about a weapon that otherwise arrived unheralded. The Committee decided that ‘any announcement about the arrival of rockets in this country should be delayed for as long as possible'.[194] There were two main reasons for this. One was to avoid an adverse effect on public morale, the other so as not to give the enemy intelligence on the accuracy and effectiveness of the attacks. It was also considered that little real advantage could be gained from the very small amount of warning obtainable, and the likely number of false alarms.[195] For some time V-2 strikes were officially ascribed to gas main explosions. Government acknowledgement of what was by then an open secret only came after the Germans themselves announced the use of V-2s in November.[196]

In January 1945 the issue was re-examined in the light of the radar warning measures proposed by AA Command in connection with gun engagement of the V-2.[197] No firm decision was made by the Crossbow Committee, though it was noted that strong public pressure for such a system might emerge.[198] Arrangements were made, however, for rocket warnings to be passed to the London Passenger Transport Board so that underground flood gates could be closed in case part of the tube system near the River Thames was hit by a V-2.[199] A total of 201 such warnings were subsequently issued. The limited scale of V-2 attacks and the end of the campaign altogether in late March meant that a public warning system was never instituted.

THE AFTERMATH

The significance of the V-2 rocket for the future of warfare was being considered even before the V-2 campaign itself was over. We have already seen that the wish of General Pile and Air Chief Marshal Hill to conduct trials of a gun-based active defence system was motivated as much by postwar concerns as an immediate wish to defeat the V-2. They were not the only ones in Britain thinking further ahead. Dr Jones, in an article written in late 1944 for the US Eighth Air Force magazine, said:

> There can be no doubt that with the A-4 the rocket has come to stay for a long time…in no other way can we get free of the earth's atmosphere… Military applications are bound to be made, whatever the limits imposed by treaties, and we should do well to keep an eye on the possibilities.
>
> … With a very long range rocket…it may be easier to increase the radius of destruction by the use of new types of explosive based upon the fission of the uranium atomic nucleus [this nine months before Hiroshima]…it might be best carried in some unmanned projectile, of which the rocket would be a particularly suitable type by virtue of its relative immunity from interception…
>
> Reviewing therefore what we have seen to be reasonable extrapolation from present practice, a two-stage rocket of about 150 tons starting weight could deliver a 1 ton warhead to nearly 3,000 miles range, with a probable error of 10 miles in range and 3 miles in line. This might be a feasible weapon for delivering a uranium bomb, should such a bomb become practicable.[200]

This analysis was echoed by Duncan Sandys himself in his 17th Crossbow Report in November 1944:

> The flying-bomb and the rocket, which have been used against us in 1944, are of course only the fore-runners of other long distance bombardment weapons of this kind. Given time, there can be little doubt that the effectiveness of the existing A-4 rocket could be appreciably improved upon. Moreover, it is possible that larger rockets with longer range or heavier war-heads are already in development by the Germans…
>
> In future the possession of superiority in long distance rocket artillery may well count for nearly as much as superiority in naval or air power. The Americans have already embarked upon an ambitious programme of development and there are signs that the Russians also are impressed with the potentialities of this new technique. If Great Britain is not to risk falling behind…extensive research facilities will have to be provided and maintained as a permanent part of our peace-time military organisation.[201]

The Germans did, indeed, already have improved missiles under development. The A-9, a winged version of the A-4, was test fired in January 1945, though further work was ended when Peenemunde had to be evacuated.[202] The A-9 was designed to bounce off the atmosphere on re-entry to increase its range. A more ambitious A-10, still in the design stage, would have been a two-stage rocket with sufficient range to reach New York.[203]

As soon as the war itself was over in Europe, all three Allies moved immediately to exploit what they could of German advances. The British rebuilt eight V-2s and three of them were test-fired at Cuxhaven in October 1945. The Americans took over 100 rockets back to the United States, as well as von Braun himself. The V-2 became the boost stage of the 'Bumper' rocket of 1949.[204] The United States also initiated its first ballistic missile defence programme as a consequence of a study made of Allied countermeasures to the V-2.[205] The V-2 became the basis of the Soviet ballistic missile programme.

AN ASSESSMENT

The significance of the German V-2 campaign has been debated ever since. A recent work asserts: 'The first two rockets that fell on London had an effect on the course of the war totally out of proportion to the casualties or damage they caused in the British capital.'[206] Air Chief Marshal Hill, however, believed that 'the rocket offensive must be regarded merely as a harassing attack. In the outcome it was not particularly successful.'[207] The V-2 certainly did not save Germany from defeat, but its potential importance did cause a substantial diversion of Allied resources to countering it.[208] Hill also believed that 'the A-4 rocket cannot be dismissed as a mere freak. Practically, it was a new weapon, which brought new hazards to the lives of millions, and set new problems of defence.'[209]

The opportunity cost to Germany of the V-Weapons, as for any country at any time engaged on a substantial weapons programme, was considerable. The V-2 may have cost Germany substantial aircraft production, but in view of shortages of both aviation fuel and trained aircrew, may also have been a substitute for them. The strategic effect of the V-2 cannot be entirely separated from that of the V-1. Eisenhower certainly believed that the earlier deployment of these weapons, and against invasion ports rather than London, could have prevented the successful invasion of Normandy.[210] Aaron Karp assesses, 'As a weapon, the V-2 was neither a panacea nor a frivolity. Rather it was an opportunity that failed.'[211]

The British intelligence assessment of the V-2 was at first vague, and then misleading. It led to a wasteful expenditure of resources looking for nonexistent elements—large mortars and radio-control signals. But a fairly accurate picture had been compiled by the time the V-2 attacks on London began. If the effect of the V-2 on the UK was one of harassment, then so was the effect of bombing on the V-2. Neither was decisive.

The plan to engage V-2s in the air, though never tried, 'was a bold one to attempt to meet, in effect, tomorrow's weapons with to-day's defences'.[212] Collier believed

> …the Chiefs of Staff forfeited a unique chance of gaining valuable experience of a new technique at trifling cost. Even if no hits were scored, Britain would have won the moral advantage of being the first nation to experiment with anti-missile missiles in realistic conditions.[213]

The V-2 attacks on London, and Britain's efforts to counter them, marked the beginning, not just of the ballistic missile era itself, but of a long and varied history of British involvement in the technically demanding and politically controversial field of ballistic missile defence.

NOTES

1. Collier, *Battle of the V-Weapons*, p. 113.
2. King and Kutta, *Impact*, p. 243.
3. Aaron Karp, *Ballistic Missile Proliferation: The Politics and Technics* (Oxford: Oxford University Press for Stockholm International Peace Research Institute, 1996), p.37.
4. Richard Overy, *Why the Allies Won* (London: Pimlico, 1995), p. 238.
5. David Johnson, *V-1 V-2: Hitler's Vengeance on London* (Chelsea, MI: Scarborough House, 1981), p. 21.
6. For a fuller history of early German rocket developments, see Johnson, *V-1 V-2*, pp. 21–5. Collier, *Battle of the V-Weapons*, contains a useful and detailed chronology of the full history of the V-1 and V-2 weapons.
7. Irving, *The Mare's Nest*, p. 18.
8. Ibid.
9. Ibid., p. 21.
10. Overy, *Why the Allies Won*, p. 239.
11. Irving, *The Mare's Nest*, p. 137.
12. Johnson, *V-1 V-2*, p. 113.
13. *JSWS*, p. 541.
14. Overy, *Why the Allies Won*, pp. 240–1.
15. Collier, *Battle of the V-Weapons*, pp. 180–1. For a detailed description of the V-2, see *JSWS*, pp. 541–2, Collier, *Battle of the V-Weapons*, pp. 180–3, and King and Kutta, *Impact*, pp. 239–42. One of the best collections of illustrations of the V-2 is Joachim Engelmann's *V-2: Dawn of the Rocket Age* (West Chester, PA: Schiffer Publishing, 1990).

16. Circular Error Probable (CEP) is the radius within which 50 per cent of missiles are expected to hit. The V-2 was a very inaccurate weapon.
17. Collier, *Battle of the V-Weapons,* p. 182.
18. See King and Kutta, *Impact,* pp. 239–42, for a full description of the firing process.
19. This analysis of V-2 production costs is based on Karp, *Ballistic Missile Proliferation,* pp. 39–41.
20. Michael Neufeld, *The Rocket and the Reich: Peenemunde and the Coming of the Ballistic Missile Era* (New York: Free Press, 1995), cited in Karp, *Ballistic Missile Proliferation,* p. 40.
21. A.S. Milward, *The German Economy at War* (London: Athlone Press, 1965), cited in Karp, *Ballistic Missile Proliferation,* p. 39.
22. Irving, *The Mare's Nest,* p. 305.
23. Ibid., p. 13.
24. King and Kutta, *Impact,* p. 104.
25. Collier, *Defence of the UK,* p. 331.
26. Collier, *Battle of the V-Weapons,* pp. 26–7.
27. Collier, *Defence of the UK,* p. 340.
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29. Irving, *The Mare's Nest,* pp. 34–5.
30. Collier, *Defence of the UK,* p. 341.
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32. Irving, *The Mare's Nest,* p. 45.
33. Air Chief Marshal Sir Philip Joubert de la Ferte, *Rocket* (London: Hutchinson, 1957), p. 58.
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38. R.V.Jones, *Most Secret War: British Scientific Intelligence 1939–1945* (London: Hamish Hamilton, 1978), p. 428.
39. Irving, *The Mare's Nest,* p. 45.
40. Collier, *Battle of the V-Weapons,* p. 30.
41. COS(43) 469, cited in Collier, *Defence of the UK,* p. 343.
42. King and Kutta, *Impact,* p. 109.
43. Jones, *Most Secret War,* pp. 437–40.
44. Irving, *The Mare's Nest,* pp. 124–5.
45. Ibid., p. 125.
46. Collier, *Defence of the UK,* p. 349.
47. CAB 80/75 COS(43)592(O), 29 September 1943 *German Long Range Rockets: Report on Reliability of Evidence Collected*.
48. Ibid., p. 7.
49. Ibid., p. 9.
50. Collier, *Defence of the UK,* p. 350. This statement was the origin of the ironic title of David Irving's seminal work.
51. Irving, *The Mare's Nest,* p. 159.
52. Collier, *Defence of the UK,* p. 350.
53. Hill, *Air Operations,* p. 5603.

54. Irving, *The Mare's Nest,* p. 174.
55. King and Kutta, *Impact,* p. 124.
56. Ibid., p. 127.
57. Hill, *Air Operations,* p. 5605.
58. Jones, *Most Secret War,* p. 543.
59. King and Kutta, *Impact,* p. 225.
60. Collier, *Defence of the UK,* p. 402.
61. King and Kutta, *Impact,* p. 226.
62. Collier, *Defence of the UK,* p. 402.
63. Collier, *Battle of the V-Weapons,* p. 105.
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68. Collier, *Battle of the V-Weapons,* p. 106.
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202. Irving, *The Mare's Nest,* p. 299.
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204. *JSWS,* p. 542.
205. Baucom, *Origins of SDI,* p. 4.
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207. Hill, *Air Operations,* p. 5616.
208. Irving states that between August 1943 and August 1944, Crossbow (V-1 and V-2) targets absorbed 15.5 per cent of Allied bomb tonnage dropped.
209. Hill, Air *Operations,* p. 5614.
210. Cited in Ranger, 'The Operational Environment', p. 24.
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3
The Emerging Soviet Threat

THE TIZARD REPORT

Whilst Air Chief Marshal Hill and General Pile were attempting to deal with the V-2 offensive, the CoS had already started to look further ahead. The Joint Technical Warfare Committee (JTWC) was directed to undertake a scientific study into the future nature of warfare. An ‘Ad Hoc’ subcommittee was set up under the chairmanship of Sir Henry Tizard (the ‘Tizard Committee’). Tizard had previously chaired the Committee for the Scientific Survey of Air Defence in 1934,[1] and more recently had been head of the Department of Scientific and Industrial Research. The Tizard Committee included the scientific advisors to each of the Service Ministries, including Professor Ellis from the War Office.

One of the technical reports considered by the Tizard Committee was submitted by Dr Crow, the Controller of Projectile Development in the Ministry of Supply and another key investigator in the V-2 story. Crow concluded, just weeks after the end of the V-2 campaign, that

> Germany has given the lead in the use for military purposes of rocket type projectiles capable of a range of 100–200 miles. Such projectiles have been discussed in many countries prior to the war; it is to be expected that these countries, principally [the] USA and Russia will pursue their development energetically. [The] USA has already started work on V.2 and V.1 types. This country, the insularity of which breaks down under such conditions of warfare…must be in the forefront of technical advances likely both to enable her to reach out to attack from these shores and to counter such enemy weapons…[2]

Crow went on to speculate that within ten years liquid fuel rockets could achieve ranges of 400 miles, and that a two-stage rocket might travel 1,500–3,000 miles, employing a winged final stage—what today would be called a hybrid ballistic/cruise missile.

The Tizard Report itself[3] was submitted to the CoS on 16 June 1945. It was wide-ranging and dealt with all aspects of warfare. Information about the Manhattan Project (prior to Hiroshima) was, however, denied to Tizard in the interests of security.[4] In Part I ‘The Development of Weapons’, the Report said of rockets:

> In its most revolutionary form, that of long-range bombardment, the rocket has…appeared too late to have a decisive effect. In all its forms, we believe that its use will be of great significance in future war…it may contribute to render the ‘strategic bomber’ obsolete—or at any rate of

> much less importance thaN it has been in this war. As a method of bombarding towns it is at present more expensive and less accurate than the bombing aircraft; but it must not be assumed that this will be true in the future.
>
> The military advantages of very long-range bombardment by rocket are liable, in our view, to be grossly exaggerated. It has been calculated that ranges of 2,000 miles are possible—but only if the warhead is less than 1 percent of the starting weight of the rocket. We can imagine no method by which a sufficient accuracy could be obtained at these ranges to justify the effort…

Without knowledge of the Manhattan Project, the Report speculated that an atomic bomb might be produced within 20 years. More presciently, Tizard noted that

> the only answer that we can see to the atomic bomb is to be prepared to use it ourselves in retaliation. A knowledge that we were prepared, in the last resort, to do this might well deter an aggressive nation…[5]

Given the later association between ballistic missiles and nuclear warheads, this early and succinct statement of nuclear deterrence theory is both startling and significant.

After atomic bombs were exploded over Hiroshima and Nagasaki in August, the Tizard Report underwent a process of revision by the JTWC to correct its prior ignorance of atomic matters. Its conclusions on rockets, however, were not affected.[6] Though the appearance of the V-2 in 1944 had generated plenty of speculation about the future, after Hiroshima atomic bombs became the main focus and attention devoted to rockets faded somewhat.

EARLY COLD WAR ASSESSMENTS

The Tizard Report was one of several inputs into a process of strategic planning for the postwar world that had begun in earnest as early as 1942, and which by 1944 had identified the Soviet Union as the likely postwar threat to the security of the UK and the Empire.[7] By late 1945 atomic and rocket matters were being considered almost entirely in a Russian context. In July the following year the Prime Minister, Clement Attlee (who was also at this time Minister of Defence), observed to the CoS that

> from reading the report by the Joint Technical Warfare Committee, he gathered that attacks by modern projectile weapons were envisaged from ranges up to 400 miles away. With the Russians on the Atlantic seaboard, they would be at a considerable advantage in that their weapons would be within range of this country, whereas we should not be in a position to hit back…[8]

The War Office and the Ministry of Defence had already started outline planning to exploit rockets. A General Staff paper prepared in January examined in broad terms the use of rockets both for offence and defence,[9] and a joint General and Air Staff Requirement was drawn up later the same year for a ground-to-ground strategic rocket called MENACE with a range of up to 3,000 miles,[10] indicating an awareness of the future possibilities of long-range ballistic rockets.

In May 1947 the recently formed Defence Research Policy Committee (DRPC) submitted a report on the main scientific factors affecting defence policy,[11] as part of a major review being conducted by the Directors of Plans from each Service Ministry. An annex dealing with Weapons of Mass Destruction (WMD) identified manned aircraft as the most likely means of delivery: ‘The long range rocket is unlikely to mature within ten years.’ Another input into this process was a March 1947 report by the MoD Future Planning Section on ‘Future Defence Problems’, which considered it ‘most improbable’ that the Russians would have atomic-armed rockets in service before 1965, and then only V-2-based weapons with ranges of up to 600 miles.[12]

These conclusions were incorporated into the CoS report[13] to the Cabinet Defence Committee, chaired by Attlee himself. In a section entitled ‘Implications of New Weapons’, the report stated that by 1956–57 the Russians were expected to have some atomic bombs and biological weapons and that ‘she may have developed, probably with German advice and technical assistance, rockets… The advent of mass destruction weapons and other means of offence has greatly increased the vulnerability of the United Kingdom.’ The report went on to echo Tizard’s earlier view on deterring such a threat: ‘The only means whereby we can prevent her [Russia] using them [WMD]…is by facing her with the threat of large-scale damage from similar weapons…a most effective deterrent to war itself.’

A more detailed view of the future Russian rocket threat was provided by the JIC:

> The Russians…are certainly experimenting with V-2s with the intention of eventually producing long-range rockets… Although behind the Anglo-Americans in rocket research, they may have achieved by 1957 a rocket capable of bombarding the United Kingdom from European Russia and have accumulated stocks of subsonic flying-bombs and V-2s. Atomic warheads are unlikely, but chemical and biological warheads are possible…
>
> Although direct defence against strategic rockets is probably not economically feasible, they are unlikely to provide an economic method of attack beyond, say, 500 miles with conventional explosives, or as economic a method of attack as the subsonic manned bomber with atomic weapons.
>
> …it is unlikely that the Russians will entrust an atomic warhead to any rocket…which they may possess by 1957…[14]

A forecast of the nature of a future rocket attack followed, drawing heavily on wartime experience:

> V-2 type weapons with HE warheads (about 1 ton), on a scale of approximately 675 daily and launched from a range of 200–300 miles…we estimate the existing Russian stocks [in 1956–60] would be

> expended by about D+120. Thereafter the scale of attack would be reduced to current production, which might be about 3,500 flying bombs and 700 rockets per month.[15]

This compared to an estimated 1,450 tons of bombs deliverable daily by heavy bombers from the first day of war, and another 900 tons from medium bombers once bases were acquired within range.[16]

It should emphasised that these estimates were almost entirely speculative. Overhead imagery was a thing of the future and human intelligence almost entirely lacking from postwar Stalinist Russia. Assessments of future missile developments in the Soviet Union were based largely on what was believed possible rather than what was actually known—much as had been early wartime intelligence about the V-2. The German influence was crucial, as it was known that German rockets and scientists had been captured by the Russians in 1945,[17] and the German wartime experience was taken as a guide to the future. In July 1948 the DRPC noted:

> Intelligence on the Soviet Guided Weapons programme is rather nebulous. Such information as is available suggests that the programme is based exclusively on German weapons and projects which have been acquired in the Soviet Zone… There is no evidence that any weapon of purely Soviet origin is being developed, although the possibility cannot be excluded.[18]

The following year the Chairman of the Joint Scientific and Joint Technical Committees was still hoping that a better ‘inspired guess’ could be made about Russian missile capabilities.[19]

By 1948 the JIC had managed to identify one plant as being associated with V-2 production, and assessed that by 1951 a production rate of 700 rockets per month might be achieved, though at the cost of not having improved on the original V-2’s range. After that time an improved version might become available, reaching a similar production rate by 1956.[20] Attacks on Britain could not begin, in view of the V-2’s limited range, until suitable bases in western Europe had been captured by a Soviet ground offensive. Limited attacks could start 50 days after commencement of hostilities.[21] Current production of the V-2, however, was on a limited scale and for experimental purposes only.[22] The JIC recommended that surviving Crossbow sites on the Continent be demolished, to deny their use to the Soviets.[23]

ANGLO-AMERICAN COOPERATION

By early 1949 the Cold War was fully under way and UK-US intelligence cooperation was returning to its wartime closeness.[24] One of the earliest results of this was a conference convened in January 1949 to examine what was known of Soviet rocket programmes.[25] This meeting showed that the Americans were no better informed than the British, and in submitting their report[26] the study group expressly made several assumptions. In contrast to some earlier British assessments, the conference ‘limited its speculation to a period not more than five years ahead, since it is considered that speculations projected further than that time into the future bear little possibility of being correct', itself one of the more accurate predictions of the time.

The conference assessed that the Soviets would want to bring 'reasonably effective' missiles into service as soon as possible, whilst also pursuing a longer-term development programme. The starting-point for all rocket work was the captured elements of the German programme. A limited production facility was identified at Kaliningrad, formerly part of East Prussia, but was believed to be supporting only experimental and training programmes. Assuming lack of test facilities up to that time, a slightly improved V-2 could be produced by 1952. An A-4b (or A-9), the winged version of the V-2 first tested in January 1945, might begin trials by 1953 for operational service two years later.

The conference's findings were incorporated into a formal JIC report in May,[27] which did continue to look further ahead than the conference had deemed appropriate. It was also still assessed, on the eve of the first Russian atomic test, that 'owing to the size and weight of the atomic bomb, weapons of the V-1 and V-2 type will probably still be incapable of delivering accurately an atomic warhead…piloted bombers will remain by far the most effective means of delivering atomic bombs'.[28]

A later JIC report prepared for the DRPC[29] estimated that the V-2's range might be extended from 200 to 310 miles through improved design, but that mass production was unlikely until 1952. There were at this time differing views concerning the operational status of the Russian rocket programme. Whilst the Air Defence Committee echoed the JIC view above, the Joint Scientific and Joint Technical Intelligence Committees had submitted a report suggesting some Soviet capability to attack the UK with V-2s in 1949–50,[30] though this was based, again, on what was theoretically possible rather than any hard intelligence. The JIC emphasised that any estimates about the scale of such an attack were purely speculative as There was no evidence of quantity production, or of Soviet intentions to employ these missiles.'[31]

A revised report[32] noted that assembly of V-2s had started in 1947, using captured components, and that manufacture of some parts had subsequently commenced. It reiterated earlier views that rockets would be a secondary means of attack against the UK, after manned bombers. 'Haphazard' attacks with HE warheads could commence 90 days after Soviet armies had occupied launching sites in northern France and the Low Countries. Significant quantities of rockets could be available from 1953 onwards.

The Soviet explosion of an atomic device in August 1949 did not materially affect the rocket assessment:

> As far as is known it is impossible to produce an atomic warhead small enough for any guided missiles at present existing or believed to be under development…the accuracy of guided weapons is not likely to be sufficient to justify development for atomic warheads.[33]

Why atomic warheads needed more, not less, accurate delivery than high explosive was not explained.

About this time a major intelligence opportunity may have been missed. Over half a century later, it was reported that a junior official in the Soviet missile design bureau attempted to pass a comprehensive report on Russian programmes to both American and

British intelligence agents in Moscow, without either apparently being aware of it.[34] As the intelligence historian Nigel West put it, 'There was a blind period in the Fifties which was immensely dangerous… We knew hardly anything at all.'[35]

The JIC did note in April 1951[36] that V-2 production could have started, but there was still no information to that effect. The Committee also assessed that a larger rocket capable of carrying a four-ton warhead to a range of 400 miles was under development.[37] In the meantime, an improved V-2 with either increased range (300 miles) *or* a larger warhead, could be available in 1952.[38]

It is worthwhile at this stage to examine what was the actual state of Soviet missile developments up to this time.[39] The R-1 (NATO name SS-1A 'Scunner') was a slightly improved version of the V-2, which entered operational service in 1950. It was soon followed by the R-2 (SS-2 'Sibling') with a range of 600 km, more than double that of its predecessor on which it was based. It also introduced, for the first time, a separating warhead. At the same time, development began of the R-5 (SS-3 'Shyster'), a limited number of which entered service in 1956. It could carry a conventional or nuclear warhead to a range of 1,200 km, and with a CEP of less than 4 km. None of these capabilities was foreseen at the time by western intelligence. Development was also under way of the 2,000 km range R-12 (SS-4 'Sandal'), which was deployed from 1958 on in large numbers, and on the R-7 (SS-6 'Sapwood') intercontinental-range missile which was to carry a three MT nuclear warhead to a range of 8,500 km. This represents a development programme of far greater diversity and capability than the West was aware of at the time.

OPERATION DRAGON RETURN

By 1952 the British understanding of Soviet missile developments had begun to improve. This was entirely due to the interrogation (Operation Dragon Return) of German scientists and engineers repatriated from the Soviet Union after working on the Russian missile programme.[40] Reports from the first Germans to return were of limited value as they had been working exclusively on existing German rockets. Improvements in range and payload were clear, however,[41] whilst it was realised that atomic warheads were getting smaller. The CoS Air Defence Committee therefore noted: 'A development of the V-2 weapon capable of carrying an atomic warhead is not considered unreasonable of development.'[42]

In 1953 the JIC for the first time assessed that the Soviets might be doing more than just reconstructing and improving upon German rockets.[43] The Soviet test of an H-bomb in August was also significant, though as yet not linked by British intelligence to the missile programme.[44]

Further information was now available on rocket motor development, on which many of the Germans had been working.[45] Three versions were identified, having 25, 35 and 100 tons of thrust, which could later be equated with the SS-1A (R-1), SS-2 (R-2) and SS-3 (R-5) missiles respectively. Other engineers had been working on advanced rocket design projects. R-10 was an 800 km range weapon which was never fully developed, but the R-12 (SS-4) did enter service in the late 1950s. A separable warhead was also identified for the first time, though the Controller of Guided Weapons in the Ministry of

Supply, who compiled this report, doubted its feasibility. An even more advanced R-14 (SS-5) with a range of 3,000 km and a 3,000 kg warhead was also described, with greatly improved accuracy. Both the R-12 and R-14 were believed to be two-stage rockets, though it is now known they were single-stage.[46] This represents the first instance of the missile threat being over- rather than underestimated. The SS-5 entered service in 1961 and, with an even greater range than forecast, 4,500 km, remained in service until 1984.

Still lacking was any information as to which design projects had been authorised for full-scale development and production. The report itself noted:

> Almost all the intelligence is confined to the activities of *Germans* in Russia. Nothing is known in the ground-to-ground field about the Russians' own programme—which is the programme that matters.
>
> The conclusion, however, is apparently inescapable that there is serious Russian interest in long range ballistic rockets
>
> …it is a reasonable deduction that one major Russian staff requirement is for a rocket to carry a warhead adequate for an atomic filling to a range great enough to reach the UK from firing points deep in Russia.

Largely as a result of this study, the most comprehensive so far of Russian rocket developments, the JIC and the Air Defence Committee now accorded the 'highest priority' to obtaining further intelligence and to considering defensive measures against rockets.[47]

Another JIC report in early 1954 was more positive than hitherto about the existence of an indigenous Soviet rocket programme beyond V-2 reconstruction and improvement.[48] It still, however, believed that missile production was only that required by the research and development programme, whereas the SS-1A and SS-2 were in fact already in operational service.[49]

The year 1954 marks something of a watershed in UK appreciations of the Soviet missile capability, by now based not so much on past World War II German experience, but on Dragon Return reports and on British experience with its own missile and nuclear programmes. It was clear that the Soviets were devoting considerably more effort to missiles than previously thought,[50] and the possibilities that the Russians were ahead in missile work and that Soviet rockets might carry atomic warheads were now acknowledged.[51]

UK air defence planning now included a limited ballistic rocket threat, but not until 1965,[52] an assessment somewhat at variance with the emerging intelligence picture. The Air Defence Committee went so far as to assert that 'there would not appear to be any evidence to indicate that the Russians are putting particularly heavy effort into the ballistic missile',[53] which may reflect an ignorance of the results of Dragon Return but also a desire to maintain the RAF's fighter strength against the manned bomber threat.

In October the JIC issued the most comprehensive assessment yet of Soviet missile programmes, still based largely on Dragon Return reports and what it was believed the Soviet Government would require in the way of surface-to-surface missiles.[54] It stated that short-range missiles might be accurate enough for use against military assets, but that medium- and long-range rockets would be suitable only for use against 'large area' targets. The former were unlikely to be available before 1956 (in fact they were already in service), the latter not before late 1958 (which was a more accurate forecast). The existence of purely Russian development work in addition to that carried out by the Germans was now known, but the paper incorrectly stated that work on the R-12 (SS-4) had been halted in favour of the R-14 (SS-5). Both were later deployed, though it is possible the JIC were really referring to the R-10 programme, which had been terminated.

RENEWED UK-US COOPERATION

This report formed the basis of the UK submission to the second major UK-US intelligence conference on guided weapons, held in London in early November. UK and US intelligence appreciations proved to be very similar,[55] based as they were on the same sources,[56] but with differences of emphasis in analysis. For example, differing range estimates were based on different assumptions about where rockets might be launched from, and therefore the range they would require in order to reach their presumed targets.[57] The UK discounted a Soviet requirement for a 1,500–2,000 nm range weapon on the grounds that it did not bring into range any more significant targets than would already be covered by shorter-range weapons. The Americans did expect a small number of such missiles to appear. Neither country anticipated a 4,500-plus km range missile before the mid-1960s, though three such weapons (SS-5, SS-6 and SS-7) were all to appear in 1960–61.[58] The Americans had no more firm intelligence about Soviet missiles than did the British.[59]

The Air Defence Committee continued to downplay the prospects for a nuclear-armed ballistic missile threat, assessing in January 1955:

> There were very great technical problems associated with the design and proving of a ballistic rocket with a nuclear head. For this reason it is doubtful whether the Russians could have such weapons in full service by 1960 and possibly not before 1965.[60]

This judgement was later passed on to the CoS.[61] Medium-range (1,500 miles) ballistic rockets could start to appear from about 1960 onwards.[62]

The JIC assessed the threat more pessimistically, but still underestimated the rate of Soviet progress:[63]

> We believe that, at the present time, the USSR could have available guided missiles (ballistic rockets or unmanned aircraft) capable of being used against the United Kingdom from eastern Germany, with a warhead weight of about 1 ton. It is possible that, before the end of the period [up to 1959], a ballistic rocket attack could be mounted…from the western USSR, with an increased warhead weight. We believe that the Soviet leaders would not consider it worthwhile employing such missiles, fitted with an HE head, against the United Kingdom. If the USSR should produce guided missiles with atomic warheads in the period, the

> inaccuracies of the missiles would probably restrict their use to attacks against area targets…
>
> We have no evidence of the production of guided weapons in the USSR for operational use nor do we know the Soviets' intention in this field… It is estimated that the USSR has an extensive guided weapon programme in being and has the capacity to develop and produce the following weapons in the period under review [up to 1959]:–
>
> … A redesigned version of the V-2, having a range of 450nm, probable error of 1nm and warhead of 1 ton weight [the SS-2]… 1955 is the *earliest possible* date for start of production of this rocket [it had entered service in 1952].
>
> … A missile with range 1,500 nm, probable error of 2½ to 5 nm and a warhead weight of 3 tons…1958 is the *earliest possible* date at which this rocket could be available.[64]

The JIC also assessed that the Soviet Union would not employ nuclear weapons (however delivered) against the UK until they could simultaneously attack North America (using manned bombers), in about 1960.[65]

At the end of the year the JIC summarised all known intelligence on Soviet rockets in preparation for UK-US research and development and intelligence conferences.[66] After acknowledging that 'We do not know the present Soviet requirements for ballistic rockets, nor the policy that will govern their deployment and use in war… The amount of direct intelligence on the Soviet guided weapon programme is limited,' the paper surmised that the Russians would use missiles primarily for nuclear delivery to reduce the nuclear threat to themselves, to attack important targets in North America, the UK and Europe, and in support of the land battle. Only in the latter case might HE warheads be used.

Soviet requirements were estimated to be for three types of missile: a 4,500–6,000 nm range weapon for attacks on the United States, a 1,500–2,000 nm range weapon for attacks on the UK, western Europe and North Africa, and a 600 nm range weapon also for use in Europe. These requirements broadly equate to the SS-6, SS-4 and SS-2 missiles respectively, though the JIC were basing their estimates, as before, on what they themselves thought the Russians required rather than much hard intelligence. Dragon Return had by this time been largely exhausted as a source of fresh intelligence.[67]

The paper summarised what was known of the various missile programmes. It noted that R-1 and R-2s could have been stockpiled by then, though under-estimated ranges and initial deployment dates. The medium-range weapon was largely unknown, and the Inter-Continental Ballistic Missile (ICBM) (less than two years before Sputnik) was assessed as being available in about 1967.

By this time the gradually emerging picture of Soviet rocket developments, also informed by UK and US experiences with their own missile programmes, had generated significant research into defences. The needs of effective defence in turn caused intelligence efforts themselves to be increased.

A further dimension to the threat also emerged in early 1956—short-range missiles launched from submarines.[68] Though speculative, this assessment was reasonably accurate. An R-1 1FM (SS-1B 'Scud') had been test-fired from a submarine in September 1955, though this was not known at the time, and became operational four years later.[69]

In 1955–56 the Ministry of Defence conducted a review of long-term defence policy,[70] which led up to the 1957 Sandys Defence Review (so-called after the Minister of Defence Duncan Sandys, previously Chairman of the Crossbow Committee—see Chapter 2). In respect of ballistic missiles, the MoD noted:

> The amount of intelligence upon which to assess the ballistic missile threat is small. There is no knowledge of Russian intentions in this field…
>
> The guesses…are that they [the Russians] may have a ballistic missile in service [by 1962] with a range of 1,500 nautical miles, a nuclear head of fairly high yield and an accuracy of about 2½ to 5 nautical miles…based on very limited intelligence and Western estimates of what is technically possible…
>
> It is highly unlikely that the Russians will be able to offer a ballistic missile threat to the United States by 1962.

Soon after this assessment was made, further hard intelligence was received, some of it from a new US radar site in Turkey built for the express purpose of monitoring Soviet rocket tests.[71] In 1954–55 between 125 and 150 test firings took place at Kapustin Yar near Stalingrad, of which about a third were in the 150 nm range, a third 300 nm and a third up to 600 nm. The shorter-range firings were significant, as these indicated what is now known as the SS-1B Scud—another derivative of the V-2 but with improvements in mobility and accuracy[72] rather than range in the case of the SS-2 and SS-3s already identified. The longer-range firings were of the SS-3. These tests confirmed the scale of Russian development work in rockets, the JIC noting that it represented as many resources devoted to surface-to-surface missiles alone as the entire UK guided weapons programme.[73]

The tests also attracted the attention of the Foreign Office, who related them to statements made by Marshal Zhukov, Soviet Minister of Defence, concerning Russian 'long-range rocket weapons'.[74] The JIC were led to conclude that 'the Russians are well ahead of the Western Powers in the development of ballistic rockets'.[75] By 1958 they could have 'operational quantities' of the SS-3 with a nuclear head, though the main threat would still be from manned bombers.[76] This led the Air Defence Committee to revise its earlier optimistic assessment of when the UK itself could be subject to a ballistic attack. An initial threat from 1958 would be followed from 1960 by a 1,600 nm missile with a megaton warhead.[77] This anticipated the SS-4, which was actually deployed from 1958 though with a range of only 2,000 km (1,100 nm), but overlooked the SS-5, which appeared in 1961 with a range of 4,500 km (2,400 nm).

During the Suez crisis in November 1956, the Soviet Government warned that Britain might be attacked by missiles. This was regarded in London as a bluff, as such a capability did not exist and it was largely ignored. It did, however, highlight the importance of gaining a better picture of Soviet missile capabilities, which became a major factor in planning Britain's own future nuclear deterrent.[78] Specifically, a future Soviet Intermediate Range Ballistic Missile (IRBM) force was expected to be used not just against cities (the ‘large area targets’ of earlier assessments), but also against the existing V-bomber airfields and future Blue Streak bases.[79]

SANDYS AND SPUTNIK

The 1957 Sandys Defence Review was published in April of that year.[80] It was significant for the new stress it laid on deterrence as the only means to prevent a nuclear attack against the UK. Such a threat was still expressed in terms of the manned bomber. A JIC report issued soon after made clear why. It concluded:

> the Russians have carried out extensive and successful research and development firings of ballistic missiles at ranges up to 650 nautical miles. Accuracy is of the order of 1/200 of the range…
>
> We would expect these missiles when they become operational to have nuclear warheads. There is some evidence to connect the missile firing range with a nuclear test programme.
>
> We have no evidence on when the Russians will have operational units or what strength these will be. We estimate the first units equipped with missiles to reach the UK could be operational in 1958.
>
> Firing sites for 650 n.mile missiles against the United Kingdom would have to be in the European satellites…
>
> We have no evidence on the possible scale of production of missiles, but we believe the Russians have the industrial capacity to manufacture in quantity whatever they are likely to require.[81]

No mention whatever was made of a weapon with a longer range than 650 miles, though the 2,000 km range SS-4 was to be deployed the following year, permitting attacks to be mounted from the Soviet Union itself. Moreover, by this time several ICBM test firings had already taken place, and been detected by US radars.[82] Surprisingly, given the continued exchange of intelligence,[83] these firings do not appear in any British assessments of Soviet missile capabilities at the time. Though the ICBMs were clearly intended for attacks on North America, their existence should have had clear implications for the existence of shorter-range IRBMs (SS-4 and SS-5) that could reach the UK from inside the Soviet Union. Further ICBM tests took place between May and August 1957, to be followed by the first-ever launch of an earth satellite, Sputnik, on 4 October, using a modified R-7 (SS-6) ICBM. Though the ICBM tests had not generated much concern in Washington either, Sputnik certainly did, and caused a ‘missile gap’ scare.[84]

In London, however, it did not lead to a new perception of the threat. An intelligence digest issued in January 1958[85] drew the conclusion that Sputnik showed the Russians were ahead of the West in rocket technology, but stated that Sputnik was ‘not of direct military significance’. It contained a passing reference to the ICBM firings but no more, concentrating on the continuing series of shorter-range tests that were of more direct relevance to Britain. A separate report assessed that the SS-3 could become available that year, an IRBM (SS-4) from 1961 and the ICBM from 1962.[86] Those dates we now know should have read 1956, 1958 and 1961, respectively. Anticipated deployment dates were therefore still late, but closer to reality than in previous years. No mention was made, however, of the SS-5 IRBM with a range of 4,500 km (2,400 nm), which was also to enter service in 1961.

A further intelligence shortfall was identified at this time—information regarding missile decoys, an area in which the United States was already working.[87] The possibility of 'semi-mobile' missiles was also stated, which would obviate the requirement for permanent launching sites in eastern Europe.[88] Continuing Soviet propaganda regarding offensive missiles was noted as well, but treated with official scepticism on both sides of the Atlantic.[89] The annual military parade in Moscow was, however, a source of some intelligence, in 1957 revealing both the Scud (SS-1B) and Shyster (SS-3).[90]

The JIC also considered the implications of possible submarine-launched ballistic missiles.[91] It decided that the Soviets could have five Submarine Launched Ballistic Missile (SLBM) firing submarines in service by 1964, but that they would not be used against Britain which could be attacked by land-based missiles and bombers. In fact, a total of 31 submarines equipped with the SS-N-4 SLBM were in service by 1963.[92]

At the end of 1958 the Air Ministry conducted a study of the possible effects of a ballistic missile attack on the V-bomber deterrent bases, and the utility of a dispersal policy.[93] It concluded that 'we present a target system of about 50 airfields…[if] 100 one-megaton missiles were fired at these airfields…55% of our offensive capability can be expected to be destroyed'. Another study also examined the scale of Soviet missile attack needed to destroy the future Blue Streak IRBM-based deterrent,[94] deciding that between 1,100 and 16,000 SS-3s would be required to neutralise 100 Blue Streaks, the number required dependent upon missile accuracy. Less than 50 SS-3s were ever deployed.

By early 1959 the JIC was revising its previous neglect of ICBMs and Sputnik, noting that they were 'closely associated' and possibly controlled by a single authority. It also correctly identified the Soviet need to solve the re-entry problem.[95] Information was still lacking on production and deployment of missiles, but the SS-3 was believed operational in the Soviet Union and could be moved forward to launch sites in eastern Europe at short notice. A longer-range IRBM could threaten the UK from inside the Soviet Union from 1961 on.[96] The range quoted (1,400–1,600 nm, based on early Dragon Return reports of a stated Russian requirement) still lay in between the ranges of the SS-4 (1,100 nm) and SS-5 (2,400 nm) and overlooked the deployment of the SS-4 from 1958 onwards. The ICBM for use against the United States was believed to be a higher priority, as European targets could be attacked by shorter-range missiles and manned aircraft. Its development would, however, also hasten the IRBM programme. The ICBM itself would not be employed against the UK.[97]

The JIC started to speculate about Soviet missile transfers to other states: 'There is no information pointing to the existence [in China] of guided weapons projects, but it is possible that the USSR may supply China with guided weapons but without nuclear warheads.'[98] Short- and medium-range surface-to-surface missiles could replace existing medium bombers, but 'because of their relative inaccuracy these missiles would be of little military value unless fitted with nuclear warheads. We consider it unlikely, therefore, that the Soviet Union would supply these weapons to other countries.'[99] This early reference to what today would be called a 'Theatre' missile threat was misleading, as by the year in question, 1965, the Scud was in service with several countries in eastern Europe and the Middle East.[100] This was yet another example of an intelligence estimate that, lacking hard information, was based on an assessment of what it was thought the Soviet Union would do.

THE POWELL COMMITTEE

At the end of the 1950s there was some controversy within the MoD and the Service Ministries about the planned Blue Streak IRBM replacement for the V-bombers.[101] The British Nuclear Deterrent Study Group was therefore set up under Sir Richard Powell, the MoD's Permanent Secretary, to examine the options for future nuclear delivery systems. Threat evaluations, based on worst-case analysis, played a major role in its deliberations which were published in December 1959.[102] It concluded that Blue Streak would be subject to pre-emption by massed SS-3 attacks, of which 3½ minutes warning, could be expected (in view of their relatively short range). This estimate finally killed off Blue Streak, which was cancelled in April 1960. This decision, we now know, was based on a faulty threat assessment. The SS-3 was not the problem—the SS-4 was, but with its longer range and flight time, more warning would have been available. Neither missile was as accurate as the Powell Committee's (worst-case) assumptions.[103]

The Committee's work also played a role in UK policy towards active defence and its response to Soviet air defences (see Chapters 4 and 7 respectively).

THE THREAT RESOLVED

As the 1960s began, the Western Powers started to establish a much more accurate picture of the state of Soviet missile programmes and deployments. The breakthrough that brought this about was overhead imagery, both manned aircraft like the U-2, and satellites. Radar monitoring of test firings, missiles displayed in military parades, and Soviet public statements all added to the picture. Though the Sputnik-induced 'missile gap' played a significant role in the 1960 US Presidential election, it was soon known that such ICBM 'gap' as existed worked in the United States's, not the Soviet Union's, favour.[104]

In Britain, where the 'missile gap' had never existed, the new sources of information led to increased estimates of the missile threat. In early 1960 the JIC compared a public statement by the Soviet leader Khrushchev that he had visited a factory where 250 nuclear-armed missiles were produced in a year with what was known of Soviet rocket programmes.[105] It was believed he was referring to the plant at Dnepropetrovsk and that most such missiles would not be ICBMs, but shorter-range weapons. The Soviets were assessed to have a 1,000 nm range missile (the SS-4). An ICBM would become available in 1961, which was when the two-stage R-16 (SS-7 'Saddler') did indeed enter service although a handful of the rather crude SS-6s was deployed in 1960.[106] Test firings to a range of 4,500 nm had been identified.

The deployment of the SS-4 led to the date by which the nuclear threat to the UK would be a missile-borne one to be brought forward to 1963.[107] The JIC noted that there was no recent intelligence on the 1,400–1,600 nm missile[108] (for it did not exist), but did at last identify a 2,000nm missile (the SS-5).[109] The monitoring of test firings had identified ranges between 75 and 2,000 nm in the short- and medium-range categories, and 3,500–6,500 nm for ICBMs, with accuracies of the order of 1½–2 miles expected using inertial guidance. Though all existing missiles were liquid fuelled, the Soviets were expected to start introducing solid fuels by 1970. Decoys had not been observed, but were expected in view of US plans to deploy active defence systems.[110]

In 1961 a new JIC sub-committee was set up to keep under review all information on Sino-Soviet guided missiles.[111] More information was becoming available to be analysed, and the imminence of the ballistic threat to the UK made it more urgent. In January 1962 it assessed the Soviet ballistic missile inventory to be:[112]

	1962	1963	1966 (tentative estimate)
650 and 1,000 nm	250	450	600–700
2,000 nm		40	
ICBM	12–20	85–100	220–400

In addition, the Soviets now had 34 SLBM-firing submarines, some of them nuclear powered (the ‘Hotel’ class), between them carrying 94 300 nm range weapons (mainly the R-13/SS-N-4). By 1966 another 30 nuclear-powered submarines would have been added, some carrying a 1,000 nm range missile (the R-21/SS-N-5). These force levels are in marked contrast to the 1958 assessment[113] of five such submarines in service by 1964, and were revised upwards again three months later when, in the light of fresh intelligence, the total missile-firing submarine force was put at 42 boats as of 1 April 1962.[114]

Another report also estimated the Soviet inventory of tactical surface-to-surface missiles units.[115] Though lacking firm intelligence, the JIC, in consultation with the US Intelligence Board, believed the Soviets to have ten brigades with a mix of Scuds and an unidentified ‘300 nm’ weapon (presumably the SS-2, though these were no longer operational by then). A Scud brigade had 18 launchers, the 300 nm missile brigade only six. Two missiles were assumed for each launcher. By 1966 there were expected to be 40 such missile brigades deployed in East Germany and the western Soviet Union, plus a further 50 employing a shorter-range free-flight rocket (the R-65 ‘Frog’).[116]

In April the JIC also started to revise its earlier assessments concerning the possible use of ICBMs and SLBMs against the UK,[117] which it had previously discounted. ICBMs fired on a depressed trajectory could be used to deliver very high yield weapons (58–100 MT). SLBMs might be used to attack from sectors not covered by the new Ballistic Missile Early Warning System (BMEWS) at RAF Fylingdales (see Chapter 5), and by 1966 the Soviets were now expected to have about 60 missile-firing submarines. At least some would be tasked against the UK.

Based on the new intelligence now available, the RAF’s Bomber Command made another assessment of the missile threat to its airfields.[118] Assuming its aircraft were dispersed to 24 airfields and were launched on warning received from Fylingdales, only 10 per cent of its aircraft might survive a pre-emptive attack. Four minutes’ warning of SS-3 and nine minutes’ warning of SS-4 attacks, based on maximum-range, optimal trajectories were expected. Some aircraft would still be destroyed by the nuclear blast even after launch, and the report concluded that intelligence warning was critical as a high readiness state could not be maintained indefinitely. Only an airborne alert could ensure the survivability of some of the deterrent. The implications this had for the UK's nuclear force were overtaken by events a few months later, when the US air-launched Skybolt missile, which was to have extended the lives of the V-bombers, was cancelled, forcing the switch to the invulnerable submarine-based Polaris.[119]

At the end of 1962 the Soviet missile inventory was revised upwards once again:[120]

	Dec. 1962	1963	1967 (tentative)
MRBM (650 and 1,000 nm)	500	580	630
IRBM (2,000 nm)	50	100	200
ICBM (6,000 nm)	60–70	160–190	400–500

The total of missile-firing submarines had now gone up to 49, and was expected to nearly double by 1967, of which 36 would be nuclear powered and several would be capable of submerged launch (which the early boats were not). Though the accuracy of the MRBMs (the SS-3 and SS-4) was being realistically assessed as 1–2 nm CEP, that for the IRBMs and ICBMs was under-estimated at about 3 nm CEP. Figures of 1–3 km would have been truer,[121] and the JIC revised its own estimates of CEP downwards the following year.[122] At the same time, it anticipated the deployment of decoys on all ballistic systems except short-range army weapons in the 1975–85 timescale, 'although so far development of decoys has not been seen'.

The JIC also revised its earlier assessments of non-Soviet missile deployments, anticipating that China would have a few 1,000 nm range weapons by 1970, an accurate prediction as to date but an under-estimate of the range of the CSS-2 (Dong Feng-3), which had a range of 2,600 km (1,400 nm).[123] Egypt was known to possess missiles 'of doubtful military value'.

By late 1964 the UK intelligence picture of Soviet missile capabilities had become fairly comprehensive and accurate. The introduction of the SS-6 and SS-7 ICBMs was retrospectively dated to 1960 and 1962, with a good estimate of their actual capabilities, the former being described as 'obsolescent'. Current and projected numbers were also realistic and the new SS-8 missile was identified. Assessments of the SS-4 and SS-5 were similarly accurate, although the SS-3, while believed obsolescent, was over-estimated for numbers held (100–200).[124] A new tactical missile to supplement the Scud and Frog was expected, though the anticipated range (150 nm) was far short of the 900 km (500 nm) range of the SS-12A 'Scaleboard' which had actually entered service in 1962.[125]

For the first time since 1945, British defence planners had a sufficiently accurate picture of the missile threat on which to base current and future planning.

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4
Early Efforts at Active Defence

POSTWAR DELIBERATIONS

Tizard's 'Ad Hoc' Committee observed that 'the rocket will remain a very difficult form of bombardment to counter'. The JTWC, in considering the implications of Tizard's report in July 1946, concluded: 'It is…of importance, in view of the difficulty of intercepting rockets, that no potential enemy should possess bases within 400 miles of ours…'[1] This drew directly on recent wartime experience, V-2 attacks having ceased only when they were pushed back out of range of the UK. The JTWC's report also stated that the development of 'guided anti-aircraft projectiles' should be accorded a high priority.

A paper prepared for the Assistant Chief of the Imperial General Staff (Weapons), in considering the future implications of rockets and guided missiles, noted: 'The probable rate of progress, not only of the rocket… but of the counter-measures to [them] must be taken into account.'[2] Wartime proposals for gun-based rocket defences appear, however, to have had little immediate impact on postwar thinking. This was probably because there was no existing rocket threat to the UK. Staff Targets for 'Heathen' and 'Howler' army ground-to-air guided missiles produced at this time were intended to counter aircraft, not rockets.[3]

In 1947 the Ministry of Supply's Chief Scientist stated: 'No requirement exists for defence against weapons of the V.2 type, ie parabolic trajectory and supersonic speed. This is admittedly a very difficult problem.'[4] Tizard himself, newly appointed to chair the DRPC, expressed the view: 'There is no more likelihood of active defence against rockets of the V.2 type (once they are launched) than there is of defence against a long range shell.'[5]

The CoS in a report to the Cabinet Defence Committee, added a further dimension to the problem that would become ever-more important once the rocket threat became an atomic threat: 'Owing to the vastly greater destructive power of atomic and biological weapons, acceptable standards of defence have gone up immeasurably. Within the next ten years there is little possibility that these higher standards of defence can be reached…'[6] Rates of attrition that would make a conventional bombing campaign unsustainable were no longer enough. A worthwhile defence would have to defeat the attack at the outset, a judgement in regard to WMD that has remained valid ever since.

A DRPC report on future research policy stated

> One of the principal dangers to which we may be subjected is strategic bombardment by rockets of the V.2 type from relatively short ranges; some defence against this form of attack is a vital requirement. We do not, however, see at present any defence against this weapon once it is

> launched; nor do we believe that the limited warning that is theoretically possible would be of any real value.[7]

Tizard did seek an outside view on the problem, however. The Atomic Energy Study Group at the Royal Institute of International Affairs (Chatham House) submitted a report to him at the end of 1947:[8] '…it is often stated that against such a missile "There is no defence". It is the purpose of this paper to consider whether this is indeed the case.' The report examined the V-2 experience, and the prospects for longer-range rockets in the future, deciding that because of weight and speed requirements, and the heating of the nose of projectiles on re-entry, there was little likelihood of their development 'at any early date'. As regards active defence,

> Guns and counter rockets making use of proximity fuses might do something… But the proportion brought down could scarcely be considerable…so—if it be possible—the approaching missile must be countered with a defending radio beam…
>
> What appears to be needed is a radiant energy beam, directed like a search-light, and capable of destroying any hostile missile… automatically guided by radar when a target is found…
>
> Even if it be admitted that such a defence weapon is fairly certain to be produced some day, it will be conceded to be a hard nut to crack under the conditions of today. American facilities and American energy however did succeed in a comparatively few years in producing the atom bomb. Is this problem a harder one?
>
> …if the long range missiles can be destroyed by the means here discussed…the chief difficulty to be encountered in that case might well arise from the numbers capable of being put into action.

Lasers ('energy beams') were indeed to be later proposed for missile defence (see Chapter 8), and the most common form of counter to missile defences has been 'numbers', especially multiple warheads. Tizard replied that 'there is none [a defence] and no sign of any practicable defence being developed as yet.'[9]

By early 1950 the situation was essentially unchanged, though some advantage might be gained from an early warning system for passive defence purposes:

> No effective means of defence is in sight against long-range rockets, apart from denying to the enemy the territory from which they could be launched. However, it is unlikely that rockets large enough to carry an atomic warhead, or accurate enough to deliver them economically, will be available to the enemy by 1957, although there will be a threat from rockets with HE heads. We do not consider that any effort can be spared for this problem at present. A limited warning of the approach of rockets, together with an accurate estimate of fall of shot, is possible, and could be used to reduce casualties to personnel in the target area…
>
> We recommend…That no effort be devoted at present to this problem.[10]

THE START OF RESEARCH

The Air Ministry had, however, begun to look at the problem in a little more detail, still drawing heavily on the experience of five years before. Defence was examined in terms of three possible requirements: early warning for passive defence purposes; firing site location; and active defence.[11]

Against rockets with ranges of up to 600 miles, 2–3 minutes' warning might be obtainable using the existing CH radars. Against longer-range missiles 'it is difficult to see how we could get useful information from any UK based radars'. At this time the development of new radars for UK air defence was a low priority and efforts were concentrated on improving the existing World War II-vintage sets.[12] Further into the future, a rocket warning system would require new radars separate from those required for the aircraft control and reporting system. Its cost-effectiveness would require further study. Approximate location of firing sites would be possible by radar, as it had been in 1944–45, but 'the sites themselves are not likely to be the targets for bombardment'. Why not was not explained, but may have been because of the poor results achieved in World War II.

A gun-based engagement system as proposed in 1945 was not considered likely, except as a morale-booster, and 'the use of guided weapons is at present a rather indefinite possibility', though it was recommended that a start be made on solving the radar requirements of a future defensive missile system. At this point, introduction into service of an operational SAM for engaging even subsonic aircraft was still some years away.

At the same time, the Army Operational Research Group was investigating both the early warning problem and active defence employing either gunfire or rockets. It assumed, for an unspecified 'interim period', that the threat was a V-2 type weapon but noted that, unlike 1944–45, a warning radar might not be available within 50 miles of the launch point.[13] Early warning was worthwhile for passive defence purposes, and could lead 'in the course of development, to active method'. Detection of rockets was possible using existing radars (as in 1944–45). Airborne infra-red detection was also considered, but existing techniques would be unlikely to achieve detection ranges any greater than 20–50 miles. Radar therefore remained the best option. Tracking and prediction of V-2s required new equipment, which, located near to the target area, should be able to detect and track rockets as they ascended and during at least part of their trajectory. The design of such a radar did 'not appear difficult', and less than ten such sets would be required for an early warning system for the London area.

A gun-based defence employing a new anti-aircraft gun then planned would need to fire 1.5 million rounds per kill achieved if used in a barrage. With a new tracking radar and predicted fire, the number of rounds might be reduced to 'only' 18,000. As regards a missile-based defence, 'It is understood that the problem is being studied in the United States but little progress has been made.'

The report concluded:

(a) With existing AA equipments it would be impossible to achieve an appreciable rate of attrition.
(b) With a new design of tracking radar and the new…gun the attrition rate to be expected would not be economic.

(c) A guided missile might be designed for the purpose of destroying the V-2 in flight.
(d) The only present solution appears to be:

(i) strategic action to keep the enemy out of range of V-2 missiles;
(ii) neutralisation of launching sites, communications and production centres by air attack, or by ground to ground Guided Missiles (SSMs).[14]

The DRPC and the Air Defence Committee had also begun to investigate the use of atomic missiles for air defence,[15] in the hope that this would provide the higher standards of defence required by the nuclear threat, albeit at this stage a manned bomber threat.

In May 1952 the CoS, as part of a wider demarkation of air defence responsibilities between the Army and RAF, agreed that the Air Ministry should assume responsibility for the detection of guided missile launching sites.[16] A year later, it was decided that the RAF would also assume responsibility for future air defence guided weapons, though the Army's AA Command would continue to operate the existing guns.[17]

Another small step forward was taken in mid-1952 when the Guided Weapons Sub-Committee of the DRPC (part of the MoD) listed 'a GW for defence against V.2 type of attack' as one of several 'possible needs' in a review of future policy for research and development.[18] In the meantime, the Ministry of Supply's Guided Weapons Advisory Board had decided that the problem ought to be investigated more fully. A subcommittee set up for that purpose reported at the beginning of 1953.[19]

It assumed an atomic threat, but otherwise considered that rocket performance would be similar to the V-2. The wartime experience was reviewed, as were the recent theoretical studies and further V-2 work undertaken in the United States. Four to five minutes' warning might be obtainable for passive defence purposes, which would reduce casualties from 118,000 to 30,000 for a single airburst over London.

As regards active defence, determining the characteristics of a tracking radar was hampered by little knowledge of the radar-reflective properties of rockets. An atomic warhead was considered as vulnerable to detonation as an HE head, and any interceptor, though none had so far been proposed, would be similar to existing ground-to-air designs. It would require mid-course guidance and terminal homing. The report concluded:

> While the extreme difficulty of the problems is realised, it is agreed that there is no one technical factor which rules out the possibility of a defence system against a V.2 weapon…
>
> The problem of active defence is incomparably more difficult than that of passive defence…very little work has so far been done. The effort required to proceed with a complete G.W. project would be very large and would not be justified at this stage. Theoretical and experimental assessment of both the method of guidance… and of the warhead and fuze problem, as well as the radar reflection problem are among the necessary preliminaries to a complete assessment.

The sub-committee invited the DRPC to assess the importance of such work and to 'allocate an appropriate priority' to research. The radar experimental work was the most important as without it work on an interceptor would be of little value. The DRPC itself deferred any firm decision pending the results of Conference 'Ally' with the Americans after which the subject would be considered again. In the meantime, no operational requirement existed.[20]

CONFERENCE 'ALLY'

The UK-US Conference 'Ally' was a wide-ranging technical exchange of views on air defence subjects, held on 18–20 February 1953 at RAF Old Sarum in Wiltshire. It was part of a series of such contacts between the two countries, of which the 1949 conference on rocket intelligence had been an early example. One topic discussed was warning and defence against long-range missiles.[21]

Two detailed papers were presented, one from each country, and formed the basis for all discussions. The US paper[22] identified the three essential characteristics of the ballistic missile as a target—speed, height and radar cross-section (or reflectivity). In view of the paucity of intelligence about Soviet missiles at this time, contemporary US systems were taken as examples. Any defence against such threats would require further radar development, automatic data processing and have to employ an interceptor not having a speed advantage over its target. Additionally, 'No time is available for human decisions.'

The first requirement was the development of suitable radars for surveillance, tracking and homing. The latter was required as the short timelines precluded command guidance or beam-riding. Passive infrared homing might be possible in the future.

Defence against short-range threats like the V-2 was considered as well as missiles of intercontinental range. Countering an ICBM involved the same basic issues as the V-2, but to a more challenging degree. The paper's author concluded that no defence against an ICBM could at present be visualised, so 'as to render its consideration for the moment unprofitable'.

The British paper, as might be expected, dealt solely with the V-2-type threat.[23] Existing radars could provide early warning, but with an inaccurate prediction of point of fall. Tracking a V-2 was possible with new radars positioned ahead of the target area. The only solution to the control problem of an interceptor was seen to be mid-course guidance and semi-active terminal homing. Interception at ranges of more than about 40,000–50,000 yards (20–25 miles) was unlikely. In view of the ease with which a V-2 warhead could be protected, terminal lethality was the key problem 'to which *no solution is seen*'. The paper concluded:

> for a given level of technical development ability, it will be easier to provide a successful attacking missile than a successful defence against it.
>
> The only real solution seen is to seize, and maintain, the technical lead in strategic offensive weapons as the only effective deterrent against attack.

Two salient conclusions emerged from Conference 'Ally'. Early warning was desirable, and achievable, as five minutes' warning could reduce the casualties from an atomic strike by up to 75 per cent. Whatever the ability of an interceptor to destroy an incoming warhead, whether by fragmentation or atomic means, such a defence was likely to be impracticable as it could be saturated by weight of numbers.[24]

After the conference, the DRPC commissioned a report on its implications for UK research and development in the field. This was submitted in October 1953 by Dr R.Cockburn, the Controller of Guided Weapons and Electronics in the Ministry of Supply.[25] After reviewing in detail what was known about the Soviet programme, Cockburn outlined the technical factors which had been considered by 'Ally'. He concluded that a suitable, specialised radar could provide three minutes' warning of a V-2 type attack on London to reduce casualties. This requirement should be included in the forthcoming study of the 'Stage II' Control and Reporting system.[26] As regards active defence, it was considered that

> Guided Weapons currently under development and their associated radar system will not provide adequate active defence against ballistic rockets. As far as can be foreseen, an active defence system against rockets would be extremely expensive, highly specialised and of single purpose. Hence, effort should not be devoted to this task until a definite threat is more clearly seen.
>
> It should be stressed that in general we are pessimistic about any possibility of creating a defence against ballistic rockets which could be regarded as adequate in the context of the atomic, or still less thermo nuclear warhead where an attrition defence is of almost no value.
>
> This does not invalidate the need for continuing research on the problem, but it is particularly desired to avoid giving any impression that any solution can be seen in the light of our present knowledge.

Cockburn recommended that research into interception of ballistic rockets be included in forthcoming studies of next-generation guided weapons, though the priority should remain interception of supersonic aircraft and winged (i.e. cruise) missiles.

The Guided Weapons Sub-Committee had in the meantime estimated the costs of preliminary research into defence against V-2s, commencing in 1957, 'although at present no technical solution is seen'.[27] A budget of £0.25 million was planned for 1957/58, rising to £2.5 million in 1959/60. Two weeks later, they observed:

> We recognise the importance of providing a defence against V.2 type weapons. No project can however begin in the present state of knowledge and we consider it unlikely that any expenditure on a project could in any case begin until about 1957. Meanwhile thought and research into techniques will continue.[28]

In November the DRPC examined Cockburn's report, and heard from one of the scientists working on the problem that 'at present he could see how to track a rocket but not how to intercept it'.[29] Cockburn pointed out that 'vast sums of money' were being spent on countering the manned bomber, but 'virtually nothing on defence against rockets', a threat quite as likely to be faced. It was noted that defence against ballistic missiles would be included in a forthcoming study by the Air Defence Committee, who would have to consider the relative importance of defence against aircraft and against missiles. However, 'the only defence might be the development of similar equipment ourselves', a reference to the future Blue Streak IRBM project. It was agreed that the Ministry of Supply should continue work on radar reflectivity and on interception and lethality problems,[30] preferably in conjunction with the United States and Canada.

AN OPERATIONAL NEED

In March 1954, a major review of policy by the DRPC observed: 'Defence against the ballistic rocket is a vital requirement which is becoming progressively more urgent.'[31] It noted that as yet no complete solution could be envisaged but that certain necessary steps in a research programme were already clear. The introduction of longer-range, two-stage missiles would only exacerbate the problem, while, by contrast, 'There has been no effort at all in this country directed to the development of ballistic rockets and scarcely any to devising any means of defence.'[32] It was still the case that the only means of defence was the ability of NATO ground forces to hold territory sufficiently far to the east as to keep the UK out of missile weapon range.[33]

The Ministry of Supply placed contracts with English Electric and Marconi to study the possibility of a defensive system.[34] The Royal Radar Establishment at Malvern was by this time looking into radar and infrared detection of missiles, and Marconi had been awarded another contract to improve early warning of rocket attack.[35] As a result of this work it was estimated that up to 15 minutes' warning might be obtained against a 1,500-mile-range missile.[36]

A further review later the same year noted:[37]

> There is at present in sight no practical method of defence against ballistic rockets but there are certain possibilities which are being investigated. The successful development of any such defence would make a great change in the strategic situation. Highest priority should therefore be given to any development that appears to hold promise.

The Air Defence Committee considered the wider implications of the threat of ballistic missiles and the lack of any defence against them. 'Unstoppable retaliation' would remove the need for 'total' air defence, which in future would be required only to deal with limited or peripheral threats.[38] The planned 'Stage 2' air defence employing a mix of fighter aircraft and the new SAM would be ineffective against the ballistic threat. The possibility of a nuclear-armed missile defence was, however, mooted at the end of the year, provided an adequate early warning system could be devised.[39]

In January 1955 the Air Defence Committee published a major report into the future of the UK's air defences.[40] It opened by stating:

> The threat to this country is from nuclear attack by ballistic rocket and/or flying machines. We can conceive no direct defence which can prevent a determined and well equipped enemy from devastating this country by both these means… Our ability to retaliate will, therefore, be the major deterrent to war…

> We cannot, at present, envisage a defence against the ballistic rocket, although there are some indications that such a defence may eventually be possible…

The Committee noted that short-range nuclear-armed rockets were already available to the Soviets, and that the UK would come within direct range of longer-range missiles from about 1960.[41] It reiterated verbatim many of the earlier judgements about the feasibility of an active defence, but concluded: 'Although the nuclear deterrent is the prime means of defence, a direct defence should be developed to a significantly high level… Research into the means of providing a defence…should continue.' This judgement was relayed to the DRPC.

In February 1955 the emerging requirement for defence against ballistic rockets was formalised when the Air Ministry's Deputy Director Operational Requirements 5 (DDOR5) (responsible for air defence matters) released Air Staff Target (AST) OR/1135 (see Appendix 1) for an active defence system,[42] which was issued to the Ministry of Supply. As an AST it only outlined, in the most general terms, an operational need which was to be translated nearly three years later into a more definite Air Staff Requirement (ASR). It was notable for two characterisations of threat; missiles only over 500 miles in range (i.e. excluding shorter-range 'tactical' systems like the Scud which was shortly to enter service), and only carrying atomic or thermonuclear warheads (as rockets with other heads were not considered significant threats). This was a requirement to defend the UK itself, but not British forces overseas (especially in West Germany).

An advance draft of the British AST was reviewed by the Canadian Vice Chief of Air Staff, and a Canadian General Air Staff Target[43] was issued on similar lines. Some of the wording was almost identical, though significantly the Canadian requirement was to counter ICBMs only, which were expected in service by 1960. The UK assessment date was not until 1967. The Canadians were, however, pessimistic about the prospects for an early warning radar by 1960/61.[44]

In July the Air Defence Committee made a curious observation: 'The great difficulties which the threat poses makes it unlikely that the study [of defence against ballistic missiles] will be able to absorb much R&D effort over the next few years.'[45] Presumably what was meant was that the state of *research* would not allow much effort to be devoted to *development*. The same paper reviewed progress with surface-to-air guided weapons (SAGW). This was following an incremental pattern, with so-called Stages 1½ and 1¾ being inserted between existing Stages 1 and 2, the latter not expected in service until 1967. An improved Red Duster (Bloodhound) SAGW was proposed for Stage 1¾. A new fire control radar, mid-course guidance and an atomic head were all being considered for the new version, which would later be proposed as the basis for an interim ABM system (see below).

Soon after, the Vice Chief of Air Staff (Operational Requirements) directed a new DDOR5 to review the state of work on the BMD problem.[46] In doing so, he asked whether an AST was required, apparently unaware that one had already been issued. More presciently, he noted that existing research concentrated on intercepting missiles in the later stage of their trajectories, over the UK itself—what today would be called terminal phase intercept—and speculated about the use of satellites to achieve much earlier intercepts.

In October a report by the Air Defence Committee on the introduction of SAGW into service did not discuss their use for missile defence.[47] However, a technical report published at the same time by the Royal Aircraft Establishment at Farnborough[48] described a simulation study conducted of interceptions at altitudes of about 70,000 feet by a Mach 2 missile against a Mach 17 ballistic target, employing proportional navigation with a final homing stage.

DDOR5's review was completed in December 1955,[49] and it summarised the results of the English Electric and Marconi studies. The two companies had been directed to study the interception of ballistic missiles with ranges between 350 and 2,000 miles, for which 'a system of limited capacity would be adequate'. Intercept should be achieved early enough to avoid damage on the ground if the target's own warhead was detonated. Countermeasures should not be considered in too great a detail, but means to reduce the vulnerability of the system to counter-measures should be adopted. The studies concluded that existing radar technology could provide the early warning required, and could be improved upon. The design and control of an interceptor missile could not at present be foreseen, though both were considered solvable problems. Guidance could not be accurate enough, however, for a conventional warhead to be used; an atomic head would be required.

An outline proposal was made. An early warning radar would track the incoming missile throughout most of its trajectory, and hand over to a dedicated tracking radar at a range of about 400 miles. The defensive missile would be based on existing designs, have a range of about 55 miles and be launched from about 30 miles distance from the edge of the area to be defended. Intercept would take place at an altitude of about 70,000 feet. A miss-distance of 500–1,000 feet was expected, requiring a small atomic head, though further lethality studies were required.

DDOR5's review noted that further work was required in several areas, including the radar reflectivity of ballistic missiles, the effects of the upper atmosphere and ionosphere, the choice of warhead, fuze and control mechanism for the interceptor, and the effect of possible counter-measures. Another three to four years' work was required on these problems, for which the Ministry of Supply were seeking DRPC approval.

The Air Staff conducted a brief study of the Marconi/English Electric proposals, concentrating on coverage, capacity, cost and operability of a proposed system.[50] Outline plans covered both population centres and bomber bases. A system covering eight 'basic areas' and over 50 per cent of bomber bases would exclude Belfast and Plymouth and provide little overlap and no redundancy. Including those two cities and all bomber bases, and preventing any missile impact within 25 miles of major population centres, would require a total of 14 defence sites assuming a coverage radius of 44 miles. Even so, only Leeds and Sheffield would be protected by more than one site.

A threat of 150 missiles (185 if bomber bases were also attacked) was assumed and used as the lower capacity limit for the system. An upper limit could not be established as it depended on the weight of Soviet attack. The problems of simultaneous, coordinated attack would require sites to be able to engage multiple targets, the greatest requirement being in the Mersey/Manchester area. Each defensive site should be able to engage up to ten targets at a time.

For a minimal eight-area deployment, a 'highly speculative' cost of £70 million was estimated, being 'rounded-off' to £100 million, a figure comparable to the planned 'Stage

1’ SAGW perimeter defence against aircraft. The missile defence plan included 6 early warning radars, 15 tracking systems, 6 operations rooms, 150 tracking radars, 600 launchers, 15 launch control posts and 1,000 missiles. A salvo of four interceptors per target was assumed. Substitution of a nuclear head for HE would increase the cost per missile but reduce the overall numbers. The missile itself would use mid-course command guidance with semi-active radar or infra-red terminal homing, and different versions might be required for engagement of longer-range and shorter-range threats.

Whichever way figures were adjusted for the size and range of threat against defence configuration, with an assumed cost per 2,000-mile missile of £200,000 ‘the position of the defence tends to be economically unfavourable even in the best case’. This cost comparison was between offensive and defensive systems, but did not take into account the value of the targets being protected.

The planned system would have to be capable of going into action with no more than five minutes’ warning; it would therefore be expensive in logistics and manpower. The system would need a high degree of automation and some centralised control. A trials and training programme at the missile range at Woomera in Australia would be necessary but very expensive.

It was concluded that

> it will cost the enemy less to increase the threat than it will cost us to match this increase. However, we should not conclude from this that the system is not worth pursuing. We are looking rather for methods of injecting doubt into the minds of the enemy than for completely effective defence.

Such a scheme was not affordable at the same time as the proposed ‘Stage 1¾’ SAGW and fighter-based air defence.

THE 1956 TRIPARTITE CONFERENCE

Another Transatlantic exchange of views on defence against ballistic missiles was scheduled for January 1956. British papers prepared for the conference summarised most of the work already in hand, commissioned by the Ministry of Supply in response to AST OR1135:[51]

> ‘Effects of the Atmosphere on the Detection and Tracking of Long Range Ballistic Missiles’
> ‘Radar Echoing Properties of Missiles’
> ‘Use of Special [Atomic] Warheads’
> ‘The Defensive Weapon System’
> ‘The Marconi Proposals for Radar Detection and Tracking’
> ‘Alternative Proposals for a Radar System of Defence against Ballistic Missiles’
> ‘Technical Aspects of Ballistic Missiles as Applied to the Threat’

> ‘The Potential Vulnerability to Radio Countermeasures of Some Systems of Defence against Ballistic Missiles’
> ‘Valve Requirements’

The report on the defensive weapon submitted by the English Electric Company[52] considered the use of a two-stage interceptor capable of operation at altitudes (up to 200,000 feet) at which a second stage would require controllable jet motors to manoeuvre. Avoiding such a complication would limit interception altitude to about 70,000 feet.

The Marconi paper on radar[53] noted that the UK’s early warning requirements were more modest than those of North America as the direction of threat was more closely defined. Early warning would both providr for civil defence purposes and reduce the required readiness state of weapon launching sites and tracking radars.

A combined Royal Radar Establishment (RRE) and Royal Aircraft Establishment (RAE) report on countermeasures[54] observed:

> In planning a defence against the long range ballistic missile we must assume that countermeasures are likely to be used… The cost of such countermeasures would probably be negligible in comparison with the very considerable cost of the rocket and its warhead.

This referred, however, to *radio* countermeasures, that is, jamming of radars. The vulnerability of an early warning radar to airborne jamming was to become a recurring theme, and the destruction of enemy jamming aircraft a task for the conventional air defences. Other forms of countermeasures were considered by another study prepared in the MoD itself.[55] These might involve deliberately ‘dismembering’ the final propulsive stage of the rocket and supplementing it with other radar reflectors. Discharged in space, they would follow a similar trajectory to the warhead itself until re-entry. The paper appeared to overlook the fact that current proposals were for interception to take place after re-entry, when these simple decoys would be retarded at different rates to the warhead, allowing discrimination.

The conference with the United States and Canada took place in London between 18 and 20 January 1956, chaired by Sir Frederick Brundrett, Chief Scientific Advisor and Chairman of the Air Defence Committee, and Dr Cockburn.[56]

A lengthy discussion about the technical aspects of ballistic missiles was based largely on existing UK and US missile programmes, as relatively little was known about Soviet systems at this time (see Chapter 3). It was clear that the shorter-range missile threat already existed and presented a smaller, slower target for defences and with less warning, than would the future longer-range ICBM. Considerable attention was paid to warhead design and re-entry problems, especially intense heating. The susceptibility of hot boosters to infra-red detection as the missile was still climbing was identified. In the ‘free-flight’ phase outside the atmosphere infra-red detection was impossible as the boosters would have burnt out and separated, and radar tracking be complicated by the presence of the booster remains. Velocity discrimination between the warhead and debris would be possible once the re-entry vehicle descended to about 200,000 feet in altitude, but its trajectory would not vary greatly from that predicted by tracking it in space until it descended to about 75,000 feet.

A large part of the conference was devoted to a detailed exchange of information on radars for early detection and tracking. Differences in approach were accounted for by the very different geographical circumstances of the UK and North America. In the former case, radar sites would have to be located close to the impact-point of the threat, whereas in North America early warning radars positioned around the periphery would be significantly in advance along the missile's trajectory. The latter would also have to track much faster targets.

When the conference turned to the defensive missile, it was clear that the United States was considering a much faster interceptor—Mach 6—than was the UK. The United States also had more detailed plans with several systems under consideration or development, by both the US Army and US Air Force. Whilst the UK team were able to discuss nuclear warheads for interceptors at some length, a US delegate could only describe the warhead of the proposed Plato system as 'feasible'. The United States did consider that a re-entry vehicle was anyway so fragile that only a small hit might destroy it. The United States was therefore interested in the effects of high-speed fragments, indicating a possible HE alternative to the nuclear warhead which was in fact intended.[57]

In the final discussion the head of the US delegation confirmed that the United States was giving priority to developing its own ICBMs and the maintenance of the bomber-based deterrent. Defensive measures, both passive and active, were 'strictly geared' to the protection of the deterrent.

Dr Cockburn, in the chair, concluded that the three countries' thoughts 'were remarkably close'. They had identified that

(a) present radar techniques were capable of development for the detection of long range ballistic missiles;
(b) foreseeable improvements in techniques could give tracking of missiles adequate enough for quite small missdistances between a defensive missile and the target;
(c) the design of a defensive missile system could not be undertaken without further study but there were no insurmountable difficulties in the way of such a system;
(d) lack of knowledge of the real design and vulnerability of the target missile and of diversionary systems which might be employed made it very difficult to assess the performance of a complete defensive system.[58]

As a result of the conference, the UK now realised that existing missile designs were too slow and short-ranged, and that the defensive missile would have to be purpose-designed.[59]

AN OPERATIONAL REQUIREMENT

In February 1956 the CoS agreed:

> There is some possibility of developing a defensive system against a ballistic missile attack, but this is looking a long time ahead, and presents formidable difficulties. What is clear is that the first requirement of such a

> system will be the development of the warning system to give the maximum amount of notice.[60]

With the JIC and Air Defence Committee, and the Supply and Air Ministries all now involved in work on missile defence, the DRPC undertook the coordination of these efforts.[61] They also cited the absence of any defence against ballistic missiles as a reason to recommend to the Minister of Defence an 'Importance Grading 1' for the development of a British missile (Blue Streak).[62]

In April the Ministry of Supply summarised their work so far in meeting AST OR/1135. Missiles of ranges up to 2,000 miles could be detected and tracked, providing up to ten minutes' warning depending on range and trajectory. Mid-course guidance could be supplied to a defensive missile to intercept at about 100,000 feet with a miss-distance of a few hundred feet, which required a nuclear warhead of about 500 lbs in weight. An HE warhead was not feasible. A single defence site would cover several hundred square miles. The greatest difficulty was the speed of action required and the coordination of several firing units with a central command system, 'whose solution cannot be foreseen at present'. A defence system could be operational in about ten years (i.e. the mid-1960s), though costs had still to be estimated.[63]

The Air Ministry did a calculation of the number of defensive sites needed according to the area covered by each site:[64]

Radius of coverage	*No. of sites*	*No. of airfields*
150	2	36
100	2	33
50	6	24
30	9	16
20	14	9
10	28	2
5	75	

In September the Ministry of Supply completed another review of progress so far, and made recommendations for further work.[65] It assessed that for passive defence, an early warning radar could give 5–10 minutes' warning, and that an active defence was technically feasible using small atomic warheads. It could not yet assess whether such a defence would be operationally adequate. A further two years' investigation into the radar problem was required, but an extensive research programme of up to five years was needed before an active defence project could be considered. For the radar research, approximately £1 million was required, which would include the installation of a second radar in Australia for experimental tracking of Blue Streak firings. All these measures were put in hand.[66] Despite an earlier conclusion that a dedicated interceptor would be required, the paper recommended that the adaptation of weapons already under development (later versions of Bloodhound) should be studied.

Active defence and an offensive capability were becoming more closely linked. Both were seen as means to defeat the threat—one by deterring it, the other by countering it.

Another rationale for active defence research also emerged. It would better enable the UK to assess the prospects for the Soviets developing such a defence, and the implications that had for the country's future offensive capability (Blue Streak). Moreover, an active defence could prevent the offensive force being destroyed in a pre-emptive strike: 'At the present time, therefore, it is considered that development of the two types of counter to the threat should be treated as of equal importance.' The ten years' research and development required into active defence made the project 'no more "long-haired" than many others'. There was 'no divergence of opinion on *need* and *urgency*. The question at issue is *feasibility*.'[67]

A short paper by the Deputy Director Operations (Guided Weapons) made a contrary judgement soon to be overturned by the 1957 Defence Review. He considered pre-emptive attacks on the deterrent unlikely, as the dispersal of bombers would require a major offensive effort. When replaced by Blue Streak missiles in underground silos and 'launched on warning', the deterrent would be even less susceptible to pre-emption.[68] Therefore, 'An active defence will be required within 10 years for the protection of centres of population against attack by ballistic missiles. It is doubtful whether we should be justified in deploying this type of defence specifically for the protection of military objectives…'

As part of a major review of defence policy that led up to the Sandys Review, Sir Frederick Brundrett reported to the CoS:

> The Ministry of Supply's latest proposals leave me in no doubt that detection, interception and destruction of a ballistic missile is technically feasible and that against a limited threat, an active defence system can be conceived. But at least five years must elapse before such a defence could be specified in any detail. In the meanwhile, air defence will still be required against the threat by aircraft.[69]

In July the British Joint Service Mission in Washington was approached by the US Joint Chiefs of Staff with a view to the extension of the North American Air Defense (NORAD) early warning system to the UK. This proposal was viewed favourably within the MoD, as in exchange for the siting of a radar in the UK, Britain would receive early warning information from the entire chain.[70] This proposal rapidly overtook the UK's own national early warning requirement, and is henceforth considered separately in Chapter 5.

In January 1957 the Deputy Chief of the Air Staff reviewed all work being done on ballistic missile defence.[71] His threat assumptions, in line with JIC assessments of the time, understated the true Soviet capability. Nonetheless, he recommended that ASRs (as opposed to the earlier AST) should be stated for an early warning radar to be in service by 1960/61 and for an active defence system by 1965/66. The latter was required both for the protection of centres of population and industry, and the preservation of the deterrent. 'The Air Staff consider that development of a defence system should proceed side by side with that of development of the ballistic missile…on the same priority.' A greater level of research than that already proposed by the Ministry of Supply[72] would be required if the target date of 1965 was to be met. He concluded:

> Although there are many outstanding technical and operational problems still to be solved, development of an active defence system against a ballistic missile threat is now possible within a reasonable time scale. Although we may not be able to produce a fully effective system at the outset we should be able to cast doubts in the mind of the enemy on the effectiveness of his own ballistic missile threat.

The view that defence and deterrence should be accorded equal priority was not universally held. The Joint Planning Staff, as part of the Sandys Defence Review, stated:

> The only military threat to the United Kingdom is from Russia. This threat includes the possibility of nuclear bombardment, against which no adequate defence is foreseeable. The safety of the United Kingdom therefore depends on deterring the Russians from attacking it. This can only be achieved by the counter-threat of nuclear retaliation.[73]

The CoS endorsed this view, and made a significant decision. In future, the UK would maintain only 'sufficient active air defence to convince the Russians that they could not destroy a worthwhile proportion of the bases for the strategic offensive before the United Kingdom could retaliate. A serious calculated risk has been taken here…'.[74] Another vital factor in the forthcoming Defence Review was provided by the Treasury: 'Our recent experiences [Suez], and our grim economic prospects, require us to think again about defence…'.[75]

The 1957–58 Air Estimates which accompanied the Sandys Defence Review[76] publicised this decision: 'The air defences are being recast in order to concentrate on the defence of the nuclear bases upon which the functioning of the deterrent and the ultimate defence of the United Kingdom depend.'[77] Neither document made any specific reference to defence against ballistic missiles, probably due to the classified nature of the work being undertaken. The decision to protect only the deterrent was, however, of obvious significance.

The earlier draft by the Deputy Chief of the Air Staff (DCAS) was published in March[78] and contained Air Staff judgements at variance with the Sandys Review, as well as some notable additions to the earlier version. A defence was needed not just to protect the deterrent ('the prime requirement') and population centres ('of national importance'), but also overseas bases and the army in the field—the emergence for the first time of what today would be called a 'theatre' requirement. The paper used a modest defence radius of 30 miles to estimate a requirement of two sites to protect bomber and missile bases, and a further nine to protect population centres. The date for introduction of such a system was advanced to 1963, presumably as a result of the changing intelligence picture. Detailed costings (a 'best estimate') totalled £91.85 million.

The need to accelerate the programme was confirmed in June:

> The Air Staff believe that the programme proposed in DRP/P(56)40 dated 13 September, 1956 needs every possible acceleration in the light of the latest Intelligence estimate[79] of the Soviet Ballistic Missile threat; they consider that the research and development programme should be

> drastically revised where possible to bring it more into line with the threat as now envisaged.[80]

This prompted Duncan Sandys himself to query the relative needs for defence against manned aircraft and ballistic missiles. Brundrett replied:

> Two years ago we had absolutely no conception how any form of defence against the ballistic missile could be achieved. During the past two years that position has radically changed and we can now see quite clearly the lines of development we should follow which might lead to a reasonably effective defence of small targets…
>
> According to present thinking it is possible that reasonably easily attainable developments of Stage 1½ [Bloodhound Mark II] could form the basis of a defence of a point target…
>
> On the assumption…that we can completely ignore any need to provide a defence against manned aircraft,[81] I would say that the needs of development of the anti-ballistic rocket defence would necessitate the deployment at three or four sites of both Stage 1 and Stage 1½.
>
> …these deployments would be solely development trials…[82]

Adaptation of an existing SAGW, as opposed to a purpose-designed weapon, was therefore back on the agenda.

In September 1957 Cockburn issued an update of progress with the active defence studies.[83] A major obstacle had emerged in the form of decoys. These might be produced by the deliberate breaking up of the incoming missile after the re-entry vehicle carrying the warhead had separated. Three to five pieces could be produced having similar radar properties to the warhead, and whilst in space would follow a similar trajectory. Only on re-entry would their higher drag/weight ratios cause them to fall behind. There could be two ways to counter this. One would be to fire a large number of interceptors with a 'side-step' i.e. manoeuvre capability to engage each piece, the other to wait until re-entry when discrimination would be possible: '…until this problem is solved, it is not possible to undertake the design of a defensive missile.' RAE Farnborough was examining a range of proposals submitted by the Bristol Aircraft Company and English Electric, code-named 'Violet Friend'.[84]

At a subsequent DRPC meeting, it was agreed that the decoy problem could be over-stated. The best approach would be to tackle the threat in stages. Cockburn asked for a statement of the operational requirement, which the Air Ministry agreed to produce.[85]

Brundrett made a further submission to Sandys, in which he observed that the sole purpose of any defence was to preserve the deterrent. An early warning system was required whether or not an active defence was acquired. He observed:

> There is some doubt in the minds of many people at the present day whether even the guided weapon can provide any form of defence against the ballistic rocket… I am reasonably sure it will be possible to develop…[such a defence] but… I do not think it is likely to happen before 1965 at the earliest and it may well be later.

He recommended that 'if the need to reduce expenditure is an overriding consideration', flghter defences should be scrapped immediately and guided weapon development be intensified. Britain should 'proceed as rapidly as is scientifically justified with the research into defence against ballistic missiles'.[86] Sandys reported to the Prime Minister that he wished to abolish the fighter force and concentrate on the best form of defence against aircraft and the only defence against missiles and powered bombs—the surface-to-air guided weapon.[87]

In response to the decoy problem the Ministry of Supply decided in favour of target discrimination after re-entry. It drew up specifications for acquisition and tracking radars, the former with a range of 300 miles, the latter 100. It also identified the need for three separate computers in the system, for general tracking, decoy discrimination based on data from the acquisition radar, and command guidance to the interceptor.[88] A later study of the decoy problem judged that breaking up the booster was in fact a formidable problem. Purpose-designed 'artificial' decoys were a more likely development, but with significant penalties in terms of range and/or payload. 'Light' decoys would be susceptible to discrimination on re-entry, but 'heavy' decoys, essentially dummy warheads, would not.[89] The latter is the route that both the Americans and Soviets later followed, though with multiple real warheads rather than dummies.

In November the Air Ministry issued the ASR previously called for by the DCAS and Dr Cockburn.[90] It was not much more detailed than the earlier AST. It did state: 'The seriousness of this threat to the survival of the United Kingdom is so great that it is essential to provide defence against it at the earliest possible date…and in any event not later than 1964.' The ranges of missiles it must defend against was reduced from the 500–5,500 nm of the AST to 500–2,500 nm, as longer-range systems were not expected to be used against the UK. Eschewing previous arguments in favour of a limited or partial defence, it required that all ballistic missiles fired at the UK must be destroyed. However, the number of launching sites was to be as small possible. To that end, a coverage diameter of less than ten nm was not acceptable. Soon after, ASR OR/1157 was issued for the nuclear warhead, of which 104 were eventually planned.[91]

In February 1958 the Air Estimates presented to Parliament stated, for the first time, that SAMs were being developed for ABM defence.[92]

SUB-GROUP 'F'

A follow-up to the January 1956 tripartite conference was held in Ottawa from 25 to 28 March 1958. It was set up as one of several sub-committees of the newly established and very extensive Tripartite Technical Committee.[93] Most of the conference was devoted to radars and decoy discrimination. It was clear that the only answer to the latter problem was extensive flight-testing of missiles and decoys, which the UK was not in a position to do.[94] Little new was revealed in the way of basic defence concepts, but the advantages in terms of wider area coverage of higher-altitude intercepts was clear.[95]

A further meeting took place in Washington in October. Proposals for the siting of a US early warning radar in the UK were discussed, as were a programme of test firings of the Nike Zeus missile, which would include siting a radar on the British Caribbean island of Barbuda. Decoy discrimination was also covered at length by the British delegation. It was agreed that current arrangements for the exchange of technical information, especially between the United States and UK, were unsatisfactory and needed improvement.[96] Little else of significance emerged.

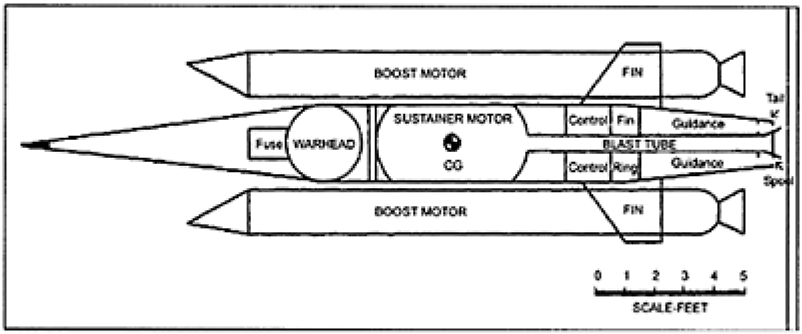
Further meetings followed at six-monthly intervals. Detailed exchanges of technical information continued, but with few revelations by any country of major significance.[97]

AN INTERIM ABM SYSTEM

During 1957–58 RRE and Bristol Aircraft Ltd devised an ABM system using existing or planned equipment to counter a simple 900-mile-range ballistic missile (which broadly equated to the SS-4). The system would use the Red Duster Series 2 Mark 2 (later Bloodhound Mark 3) missile, Type 85 'Blue Yeoman' early warning radar, Type 86 'Blue Anchor' boost tracking radar[98] and an FPS-16 warhead acquisition radar, positioned ahead of the defended area.[99] After being alerted by the early warning radar, the boost tracker would lock onto the missile booster, the warhead after separation being assumed to be within one mile of the booster. After computation of the target's future trajectory, an interceptor would be fired no more than 30 seconds after initial early warning. The missile would 'cruise' under command guidance from the ground until the acquisition radar could lock onto the incoming warhead itself. The interceptor would then be steered (using a sidestep 'jerk' procedure) to the target, achieving intercept no less than 30,000 feet above the ground. The system's coverage meant that a launcher could not defend itself, but two launchers positioned apart could defend each other.

Whilst plans for an interim system were being developed and considered, research continued into a dedicated, and therefore more capable, defensive system. Clarification of the intended basing mode for Blue Streak also served to clarify the ABM requirements for its defence, and the cost of adequate hardening of its silos made an active defence system more attractive. In order to achieve intercept altitudes of 80,000–90,000 feet, interceptor speeds in the range of Mach 5–10 were being used in aerodynamic and structural studies.[100]

Figure 3: An Early Outline Design for an ABM Interceptor



Source: PRO DSIR 23/27482 Technical Note No. 254 Structures, 1958.

A revised timescale for the deployment of a fully effective defence was based on the date by which the Russians were expected to achieve missile accuracies sufficient to threaten underground silos, which was assessed as half a mile by 1968/70.[101] This not only allowed more time for research and development, but also increased the rationale for a limited system in the interim. Brundrett also noted that if the UK deterrent went to sea in submarines, the need for active defence would be removed. For as long as the deterrent remained land-based, a defence system was most likely to be successful if developed in collaboration with the Americans, in which Brundrett recommended that the UK confine itself to radar research and use US interceptors.

When published by the DRPC, Brundrett's paper[102] dropped all reference to 1968/70 and was more forthright in its desire for cooperation with the United States: 'So far as defence against the ballistic missile is concerned, it is clear that we could not, within our own resources, carry the load involved in the development of a complete system.' Purchase of Nike Hercules would remove the requirement for a command guidance Bloodhound with a nuclear head (Bloodhound Mark 3). ABM was not, however, the only rationale for a nuclear-tipped Bloodhound, as it would also provide the lethality required against nuclear-armed manned aircraft.

The possibility of realising financial savings through a purchase of US equipment was raised by the Chancellor of the Exchequer. He also noted that

> these studies [of SAGW] will need to be related to the outcome of the review, which you [Minister of Defence] are going to undertake, on the prospects of the Russian ballistic missile, against which we have no defence, becoming a menace earlier than had been expected.[103]

The interim plan was refined by Ferranti Ltd in Manchester.[104] It was found that six of the existing sites for Bloodhound Mark 1 (then being deployed) would cover most of the 'retaliatory bases', if the proposed Mark 3 weapon was deployed there. Four tracker sites would be required, two of them in Holland, plus four Blue Yeoman early warning radars, two at each of two of the missile sites, all connected by a data link.

This plan was still further developed by RRE Malvern. Its great attraction was the minimal R&D costs involved as it used existing or already planned equipments. 'Unless decoys are used the system proposed should provide an effective defence; it might be that the enemy would decide to defeat the defence by numbers rather than by decoys,[105] in which case the low cost of the system would be a great advantage.'[106] Deployment was proposed at 16 sites, 10 of them existing Stage 1 and Stage 1½ Bloodhound sites. Remotely controlled, some sites might be unmanned. Complete or partial protection would be provided for all 9 'Class 1' airfields, 16 Thor IRBM sites[107] and 7 US airbases. The deployment plan was based on being able to deal with six threats at a time. This would require six warhead trackers in Holland and eight boost trackers in southern England, plus five Blue Yeoman early warning sets.

An initial operational date of 1963 depended on the availability of the Blue Yeoman radars. R&D costs were estimated at £1.46 million, principally for the missile, computer and early warning radar, and deployment costs totalled just £12.5 million in addition to that already planned for defence against the winged threat. Some US aid was hoped for, as defence of US airfields in Britain was included in the scheme. In view of the high degree of automation, manpower demands would be small and later additions to the plan inexpensive as the most costly item, the Blue Yeoman early warning radar, would not need to be augmented. It was considered that

> this proposal should provide a worthwhile development of presently planned defence systems and extend their useful time scale nearer to the deployment of any more sophisticated ABM system. The additional R&D and deployment costs involved would amount to only a small fraction of the total costs envisaged to deal with the manned winged threat.

Meanwhile, Bristols and RAE Farnborough were considering the use of the Skylark meteorological research rocket for ABM purposes, and were producing an outline design for a Mach 10 hypersonic interceptor.[108] RAE also cast doubt on the plan submitted by RRE, noting the optimistic assumptions about threat and defence performance, and that if the proposed system had to deal with a winged threat at the same time as ballistic missiles, a larger number of trackers and launchers would be required. It was also uncertain that the command guidance version of Red Duster would be suitable, or what coverage areas might result.[109] In view of the subsequent four decades of US experience in developing missile defences, this pessimism seems justified. However, RRE replied to these criticisms in detail, explaining the assumptions made in the proposal.[110] This exchange was reflected by Cockburn when he observed that opinions varied from those who thought it would be impossibly expensive to those who thought it so vital it must be pursued at all costs.[111]

The Ministry of Supply drew up a detailed proposal for further research,[112] in response to a request by the DRPC. It opened by stating:

> Although an adequate solution to the operational problem cannot yet be envisaged the lines along which a solution may be achieved have been defined. Further progress will only be achieved by experimental work involving the development of equipment…
>
> The proposals take account, and are complementary to, work proceeding in the United States…

It was noted that the Americans were working on ‘above atmosphere’ intercept, whilst the UK, with shorter warning times, wanted to make use of ‘atmospheric effects’ (i.e. decoy discrimination after re-entry). The requirement was assumed to be the defence of small areas (deterrent bases) against a multiple decoy threat. Research should be concentrated on a discriminating radar, electronic (as opposed to mechanical) scanning and the design of an interceptor test vehicle. A five-year programme was addition to a substantial intra-mural (RRE and RAE) effort, which could proposed, with £10 million allocated for extra-mural (industrial) work in only be at the expense of other projects.

Cockburn stated to the DRPC that ‘we were not quite sure where we wanted to go but unless we studied the problem we should not go anywhere’. He felt that in about two years’ time it might be possible to determine whether an ABM system was feasible.[113] One member of the Committee wondered whether they were not becoming obsessed with the decoy problem. The Chairman described the ABM as ‘the most important defence problem of our time’. Work on the discriminating radar was approved, and Cockburn directed to determine the minimum level of effort on electronic scanning and the test vehicle required to give the UK standing with the Americans. Sandys confirmed in Parliament that the UK was cooperating in ABM research with the United States,[114] though the aspect most often raised in the House of Commons, infra-red detection, was not actually being researched in the UK.[115]

Cockburn reported back to the DRPC in March.[116] Work on electronic scanning was required because such a radar array reduced vulnerability to nuclear over-pressure, and could track multiple targets, so reducing the number of equipments required. Work on a test vehicle was needed so that a design capable of meeting the performance requirements (Mach 5–10 and manoeuvres of up to 50 g) could be selected later in the year. The minimum useful expenditure in this area would be £2.5 million over four years. The DRPC decided to delay the electronic scanning work for a year in view of a congestion of work at RRE, but approved the test vehicle programme. Missile design work was proceeding at Bristols and RAE. Two- and three-stage configurations had been tested in wind tunnels, though performance calculations were not complete. Launcher design was being investigated.[117]

A further study of the ‘Interim’ plan by a working party set up for the purpose noted that it was dependent on the introduction of the command-guidance, nuclear-tipped Bloodhound Mark 3. At least 200 miles early warning was required in order to achieve intercept by 136 miles, to maximise defensive coverage. Earlier estimates of cost and timescale were, broadly, confirmed, as was the judgement that it was ‘comparatively’ cheap. The political implications of siting the warhead trackers in Holland were noted. The study concluded that it had a ‘reasonable’ chance against a simple ballistic missile, but that a deeper study was required before a deployment decision could be taken.[118]

An RAE report clarified the altitudes for interception. A ‘Phase 3’ system was favoured as this simplified the manoeuvres required of the interceptor. Discrimination between warhead and decoys would start to take place below 200,000 feet. However, it took only about ten seconds for a warhead to descend to 100,000 feet, so interception above that height was not feasible. Manoeuvrability of an aerodynamic interceptor was inhibited above about 70,000 feet, and safety considerations limited the minimum altitude to 30,000 feet. This therefore defined the interception bracket. As to lethality, a blast warhead was considered the most effective, though the effects of blast on re-entry vehicles was still ‘a matter of conjecture’. However, assuming a miss-distance of no more than 500 feet, a nuclear warhead of no more than a few tens of kilotons, with adequate fuzing, could induce up to 1,000 g of acceleration on the re-entry head. This was not guaranteed to be lethal, ‘but it would seem an attractive possibility’.[119]

At this point Bloodhound Mark 1 was being deployed, largely for trials and training purposes and the improved Mark 2 ‘Super-Bloodhound’ was scheduled for 1963. The Mark 3 was still under assessment, the only version with any possible ABM application.[120] The future of both versions was under review on the grounds of affordability with the likelihood that only one would be proceeded with. The DRPC discussions were based on the missile’s complementary role to the Lightning fighter in countering the manned air threat and the ABM implications of any decision were, surprisingly, not considered.[121]

The Air Ministry did consider Bloodhound’s potential role in ABM, as well as its capability against the supersonic aircraft and powered bomb. In the interests of economy, therefore, they were prepared to accept the cancellation of the Mark 2 (an extended-range, transportable, semi-active homing, conventionally armed development of the existing Mark 1) in favour of the command-guided, nuclear-tipped and even longer-range Mark 3, on which ‘effort should be concentrated as quickly as possible’.[122] The Atomic Weapons Research Establishment (AWRE) at Aldermaston were currently working on a common lightweight warhead for Bloodhound Mark 3, the Navy’s Seaslug Mark 2 and a Blue Water surface-to-surface missile.[123]

The Air Ministry also investigated possible commonality between the Interim ABM system and Plan ‘Ahead’, the future air defence control and reporting system, which was also to use a version of the Type 85 Blue Yeoman radar.[124] The report concluded that only in R&D might there be some overlap, as although the ABM system was based on existing air defence equipments, all needed adaptation. ‘Ahead’ and ABM were instead likely to be competing for funds.[125]

The report of the working party on the Interim ABM plan was examined by RAE Farnborough. It noted that if the command-guidance (CG) version of Bloodhound was not developed for the winged threat, but was retained for ABM, then its modest extra cost estimates would be invalid. It was also necessary to establish the priority accorded to ABM compared to other defence projects. The system would ‘probably’ provide some defence. The absence of any intelligence suggesting Russian development of decoys did not mean they were not doing so, and the proposed system would be ineffective in the face of such a threat. Thus any defence provided by this ABM system would be against a threat which is probably valid now and which may be valid in 3–5 years’ time, but which would cease to be valid at any time—and the UK might never know of the cessation.’[126] Any decision to deploy such a system rested on judgements about the likely development of the threat, its relationship to other projects, and its value as a contribution to the deterrent, judgements that the Ministry of Supply (of which RAE was a part) could not make.[127] This report maintained a trend of greater RAE scepticism about ABM than was evident in RRE and industry.

R&D costs for ABM were projected at this point to rise from £1.4 million in 1960/61 to £13.8 million in 1964/65, within an overall R&D budget for the Defence of the Deterrent remaining steady at about £40 million per annum.[128] At the end of 1959, Brundrett summed up the current situation:

> We see no prospect of defence against missiles except possibly of very hard and restricted targets represented by underground hardened sites… We should, however, maintain our research effort on detection, tracking and discrimination of missiles, since this must be the basis of any possible defence and if we were able to find an effective defence, it would alter the whole situation.[129]

The future of Bloodhound Mark 3, on which the ‘Interim’ plan depended, remained in doubt. Its nuclear warhead made it six times more expensive than the conventionally armed Mark 2, and its cancellation would save an estimated £9–12 million from a pressurised defence budget, though cancellation would require more expenditure on dedicated ABM work.[130] Funds were only allocated for Bloodhound Mark 3 up to 31 March 1960 for the defence of the deterrent, but not specifically for ABM purposes.[131] Importantly, and unlike the Mark 2, it was not transportable and therefore could not be deployed overseas other than on a permanent basis. The Mark 3's future was tied to the role of nuclear-armed SAGW in air defence, which as the main threat became ballistic missiles meant countering 'intruders'—reconnaissance and jamming aircraft—for which it was not suitable.[132] It was finally cancelled in March 1960 in favour of the Mark 2.[133] Though a revival was considered during the following months, the demise of active defence plans removed the one requirement for which a nuclear-tipped SAGW really was necessary.

THE END OF STRATEGIC DEFENCE

The Ministry of Supply (soon to be the Ministry of Aviation) Estimates for 1960/61 included £600,000 for ABM research (excluding the warhead). Expenditure, in addition to that planned for Bloodhound Mark 3 anyway, was forecast to rise to £7.5 million in 1964/65.[134] These plans were soon overtaken by a change in policy. The new Minister of Defence, Harold Watkinson, ordered another review of defence spending (Sandys had moved to the Ministry of Aviation). Many programmes were re-examined, including Blue Streak, which was cancelled in April 1960. The Ministry of Aviation took a fresh look at defence against ballistic missiles:[135]

> It is our considered opinion that the possibility of evolving a defence against ballistic missiles that would be both operationally feasible and effective against multiple attack is extremely small at present, and that it will remain so for a substantial number of years … Blue Streak was abandoned largely because it was adjudged vulnerable to attack by 300 rockets arriving on the UK within a period of a minute…it would appear reasonable to take that scale of attack as at least a broad indicator of what an anti ballistic missile defence would have to cope with. Judged by this standard we do not consider that an effective defence is likely to emerge within any foreseeable period.
>
> …the field is of such importance that we should not abandon it entirely. On the other hand, it appears to be a particularly suitable one in which to be largely dependent on America.

This was already the established policy in regards to early warning (see Chapter 5): '…our effort should be confined to work on techniques at the minimum level necessary to maintain access to US information and progress'. There was a precedent for this as well. The same approach had been followed in regard to electronic scanning, and was now to be applied across the board. Most research was therefore to be terminated. Some radar work would continue which would in any case have wider applications, as would use of the Black Knight experimental ballistic rocket to study re-entry problems, in conjunction with the United States. These recommendations were accepted by the DRPC.[136]

Bernard Cole has demonstrated the extent to which the decision to cancel Blue Streak, however justified it would prove to be, was based at the time on faulty intelligence (see Chapter 3). The same may also have been true of the ABM programme. The Soviets never did deploy missile decoys of the kind on which the British were themselves working, and which were the greatest stumbling block to the development of an effective defence. But it was certainly the case that Blue Streak's cancellation removed the single biggest rationale for deploying an ABM system.

Active defence continued to be considered at the policy level for several years, though without significant R&D resources being devoted to it. In January 1961 the Technical Sub-Committee of the Powell Committee took a long-range look at the issue.[137] It assessed that in future the position would be largely unchanged, as missile designers had not yet fully exploited all possible countermeasures (in the absence of ABM defences, they had not needed to):

> It is now generally accepted that if no decoys are present then the problem of intercepting and destroying the enemy warhead is solvable with existing techniques… Most of present day studies on active defence have however foundered on the problem of providing an economic system in the presence of artificial decoys accompanying the warhead.
>
> In general it would appear that the cost to the attack of increasing the number of ballistic missiles or of their sophistication is less, both in finance and technical complexity, than that thereby imposed on the defence.

The paper noted that in future adequate discrimination might be devised, or that a defence not requiring discrimination might become practicable. It also observed that an alternative to penetration aids was saturation of the defence, which was in fact to become the real issue. It concluded: 'There is nothing to indicate that in 1970–80 the BM designer will not be able to maintain the economic and technical advantage which he now possesses.' The following year a committee under Dr Penley, formerly Head of Guided Weapons at Malvern, produced a report on ABM prospects (the 'Penley Report').[138] This was effectively the final death knell for ABM research as it concluded that current radar technology, computing and phenomena prediction were all inadequate.[139]

In 1963 the MoD took almost a final look at 'anti-ICBM defence'. The previous stance was confirmed; provided decoys were not present, an effective defence at sufficient altitude could be devised, but in the face of decoys 'discrimination becomes well nigh impossible'.[140] Moreover, it would always be easier to overcome defences than to design them. Most of the report examined what the Americans and Russians were doing in the field (see Chapters 6 and 7), rather than what Britain might do, an early foretaste of the main focus of British policy for the next three decades.

A supporting paper noted that the miss-distances inherent in a CG system required a nuclear head, but that collateral damage might be caused on the ground. Fragmentation warheads could be overcome by the hardening of re-entry vehicles. Some preliminary work had been done on lasers, radio frequency beams and streams of electrons or protons. All still faced 'fundamental problems'.[141] The Black Knight experimental programme was being used to investigate the creation of an 'artificial atmosphere' at high altitude by means of an MT burst which might permit discrimination. Most other approaches had been discarded because of the ease of overcoming them with changes to decoys.

An internal loose minute from the Air Ministry soon after summed up Britain's policy:

> The overall policy of nuclear deterrence is based on the main assumption that a viable defence against ballistic missile attack is not possible now, nor can be foreseen to be possible at any given future date. Limited defences may become possible for particular vulnerable points, but worthwhile defences for vulnerable areas cannot be conceived on a military or economic basis.
>
> The solution to this defence problem is a first requirement for our research and development resources. At the moment a very limited amount of effort is devoted to it in this country, mainly for the reason that no theoretical proposal so far justifies larger expenditure on development…
>
> A pre-requisite of our research programme is therefore the maintenance of a sufficient theoretical effort in this field both to ensure continued access to American work and theories and to ensure a continuing study of the basic problem in the light of new advances in theoretical science. Although no solution is in sight the search must continue.[142]

The existing ASR 1155 was 'Under Assessment', whilst the earlier AST 1135 would be cancelled once 1155 became an approved project. However, neither was regarded as technically feasible and no work was being done to address either.[143] AST 1135 was formally cancelled in June 1965.[144]

In November 1964 Professor R.V.Jones reported on the future of air defence. He considered the problems of defence against stand-off cruise missiles, but hardly addressed the ballistic threat at all, perhaps because its distinct and unsolvable nature made it no longer a practicable air defence issue. The report did recommend that 'no special air defence to deal with nuclear threats be developed, if reliance can be placed on deterrence by the threat of nuclear retaliation'.[145]

TACTICAL DEFENCE

Defence against ballistic missiles had been considered almost exclusively in terms of strategic defence, that is, the defence of the homeland and in particular the defence of the nuclear deterrent. At the same time that such efforts were effectively abandoned, Watkinson asked the new Chief Scientific Advisor, Sir Solly Zuckerman, about defence against tactical missiles.[146] The subject was already under consideration in the Air Ministry. It was believed that a shorter-range and so smaller and slower missile developed for tactical purposes (i.e. on the battlefield) would be much easier to counter, not least because decoys were less likely. This was borne out by recent tests in the United States of Nike-Hercules and Hawk missiles against Hercules and Honest John short-range rockets.[147] Theatre Ballistic Missile Defence (TBMD) had been identified as an item of

R&D to be 'retained' in the UK under the coordination of research and development between the UK and United States,[148] notwithstanding the US Army's ongoing programme.

Defence against tactical ballistic rockets also began to be considered by NATO's Supreme Headquarter's Allied Powers (SHAPE) Air Defence Technical Centre.[149] A working party sought British views on the subject, which were, however, largely derived from the work being done by the Americans. Britain was interested in the US Army's proposed 'Mauler' system which would provide defence for the army in the field against low-level aircraft and short-range tactical ballistic missiles, and had Army, RAF and Ministry of Aviation representatives on the American project team.[150]

The Air Defence Committee Working Party also considered adapting the Navy's new CF 299 missile (which became Seadart in operational service) for a land-based role.[151] It would be in direct competition (for possible NATO deployment) with the US Hawk, which had already demonstrated a limited Anti-Tactical Ballistic Missile (ATBM) capability. CF 299 was considered superior by virtue of higher speed and range, and improved guidance and fuzing. Lethality was unlikely to be good enough, however, requiring a larger warhead and possibly a third stage ('Blue Shield').[152]

Nothing came of these proposals. By the time Labour came to power in Britain in October 1964, the prospects for a British ABM capability, whether strategic or tactical, had already faded.

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5
Ballistic Missile Early Warning

THE BMEWS AGREEMENT

The UK was initially approached by the United States in 1956, with a view to the establishment in the UK of a ballistic-missile warning radar (see Chapter 4). Thereafter this proposal rapidly overtook Britain's own early warning requirements. In the meantime, however, research continued in the UK.

Views in the UK about the amount of radar-based early warning that might be achievable were becoming more optimistic. Ranges of up to 2,000 miles, subject to the radar horizon and the missile's trajectory, might be obtainable.[1] Such a radar would, unlike the Blue Yeoman then under development, be able to detect missiles as they were still climbing rather than when they were already descending towards their target. A single site would therefore provide the necessary warning, as opposed to the several Blue Yeomans required as part of an active defence system. As much as ten minutes' warning might be achievable.[2]

This warning would permit the future missile force, and a proportion of the bomber force, to be launched and so avoid pre-emptive destruction on the ground. It could also ensure a 'substantial reduction' in civilian casualties if cities were attacked.[3] The Air Staff therefore issued ASR 2149 for a system:

(a) To provide maximum early warning on the approach of ballistic missiles, launched from Russia or satellites against the United Kingdom either on optimum or non-optimum trajectories.
(b) To compute the ground impact point to an accuracy of within ± 20 n. miles.
(c) To provide the maximum immunity to false alarms.
(d) To provide sufficient capacity to compute the ground impact points of approximately 10 missiles within the coverage at the same time.
(e) That the equipment shall be designed and installed in such a way that it can form the first stage of an active defence system if such a system is eventually authorised.[4]

The UK's early warning needs were stated to be:

(a) Provision of early warning for 'alerting' the deterrent.
(b) Provision of early warning for the civilian population.
(c) As Stage 1 of an effective ABM defence system.[5]

Marconi were awarded a contract for a design study in July 1957.[6] The total cost of such a radar was estimated by Cockburn to be around £2.5 million.[7] Two development sets were envisaged, one at Woomera in Australia tracking Blue Streak firings, the other in the UK. Continued research was considered essential despite the prospects of a US installation, not least so that US proposals could be assessed[8]—an early precursor of the

1990s 'intelligent customer' approach (see Chapter 9). An 'off-the-shelf' purchase of US equipment was also considered, quite apart from the US proposals to site one of their own radars in Britain.[9]

In the United States, RCA was awarded prime contract for the new BMEWS in January 1958. The first station planned was in Thule, in Greenland, to be followed by Clear, Alaska and then a third site in Europe.[10] A UK site was preferred for security reasons, and would be less susceptible to jamming being some distance from Soviet-controlled territory. The US Air Force wished to site the third BMEWS station in Scotland, but an RRE study determined that this would not meet the UK's own early warning requirements against shorter-range missiles on lower trajectories,[11] even if the coverage arc was extended. The ideal site for UK purposes would be in eastern Lincolnshire or north Norfolk, which might not meet US needs. This provided an additional reason for continuing with research in Britain. However, if UK and US requirements could be reconciled, a BMEWS site might meet all the UK's needs.[12]

These issues were discussed at the October 1958 meeting of SubGroup F, which provided a forum for reconciling the differing US and UK criteria for a UK-based BMEWS station.[13] The possibility of supplementing a US installation with British equipment, mainly additional trackers, was considered. It began to appear, however, that it might be possible to meet US requirements with a station in East Anglia or Yorkshire,[14] although a number of site surveys had already been carried out in Scotland,[15] at Wick, Fochabers and Ballantrae.[16]

In January 1959 the Ministry of Supply concluded that a separate British programme was no longer required, on the assumption that a US BMEWS installation would be located in the UK.[17] An agreement similar to that recently concluded for the stationing of Thor IRBMs in the UK was suggested by the United States, with the UK meeting the costs of 'works services'—about £7 million. London initially hoped that a cheaper deal might be struck, given the importance to the Americans of the third BMEWS site.[18] It might also pave the way for wider UK-US cooperation in active defence.

A UK—US survey team had found a suitable site on existing War Office land near Thetford in Norfolk. A radar located there would provide between three and seven minutes' warning, the most that could be expected. Soon after, however, a compromise site was selected at Fylingdales on the North Yorkshire moors. Its configuration would be somewhat different from those at Thule and Clear, in view of its closer proximity to possible missile launch sites in eastern Europe.[19]

The United States proposed to install three FPS-49 tracking radars, two of which would actually be used for surveillance covering an arc of between 340° and 135°. The Air Ministry conducted a detailed study to determine whether the outline plan would meet the UK's own requirements.[20] The tracking capacity of the proposed configuration, as part of a three-station chain, was considered adequate but the UK site faced conflicting priorities in tracking ICBMs aimed at North America and IRBMs aimed at Europe. An additional tracker might provide the extra capacity required. Alternatively, the UK could accept warning of attack against the West in general as being adequate. In that case, the station would not meet the early warning needs of a possible active defence system. Finally, the study noted that the Americans did not plan to install display equipment, but simply to transmit data to the US Ballistic Missile Operations Centre. The UK would itself have to install such equipment to meet its own needs.

A meeting with Dr Skifter, an assistant to the US Assistant Secretary of Defense, in May 1959 established that the total cost of the third BMEWS site would be around $90 million, of which the UK share would be $20 million, accounting for the building work. The United States would supply and fund the radar. The UK would also bear any additional cost of equipment needed to meet UK requirements. Skifter expressed some concern at the slow rate of progress, though at this stage there was no formal political commitment to the project.[21]

A further study by the Assistant Chief of Air Staff (ACAS) (Air Defence) examined whether a BMEWS installation would contribute to the defence of the deterrent, be capable of integration into a future ABM system, and be of assistance to civil defence authorities.[22] The amount of early warning provided would vary from a maximum 17 minutes against an IRBM on a high trajectory, to as little as 3½ minutes on a low trajectory. He concluded that missile warning from BMEWS would enable a proportion of the V-bomber force to get airborne if already dispersed, would not be adequate for the Thor missiles, but would provide adequate notice for Blue Streak, provided it had previously been brought to 30 seconds readiness. This latter condition could be maintained for up to ten hours.

For active defence purposes, a 3½-minute reaction time was required. This could be provided by BMEWS against medium and high trajectory threats, but was marginal against low (i.e. depressed) trajectory missiles. Tracking capacity would, however, need to be increased. The system could in most cases provide the five minutes' warning considered necessary for effective civil defence measures to be taken. There was 'little doubt that it could form an essential part of the deterrent and be of great value to Civil Defence authorities. Its installation is therefore recommended.'

A meeting of the Air Council in July, chaired by the Air Minister, George Ward, noted that the proposed configuration for the site would enable it to track ICBMs or IRBMs, but not both. Its military value to the UK might therefore be limited and would not warrant a UK financial contribution, unless Britain's needs could be adequately met.[23] A meeting with the US Air Force a month later revealed that a UK contribution was essential, as US budgetary limits did not provide sufficient funds to complete all three BMEWS sites.[24]

A paper prepared for the Air Minister in November spelt out the warning times that might be obtained from BMEWS, which were less than half those it provided for the United States. However, it observed that, as the proposed site had been moved south to accommodate Britain's needs, a financial contribution was not unreasonable. No expenditure on BMEWS had been included in the recent Defence Review Costing, but the terms on offer from the Americans were unlikely to be bettered in negotiations.[25] The Ministers of Defence and Air (Watkinson and Ward respectively) agreed that the costs—£7.7 million initially and annual running costs of £¾-1½ million—should be met, and that Fylingdales was the only suitable site. Any further north would not meet the UK's requirements, and any further south would be subject to too much radio interference. The proposal should go to the Cabinet.[26]

The Air Minister submitted the proposal on 26 November, paying attention to the politically sensitive issues of siting the station in a national park.[27] A subsequent brief prepared for the Prime Minister by the Foreign Secretary, in consultation with the other Ministers concerned, stated:

> Militarily, the project is of the highest importance to us in order to sustain the validity of the United Kingdom deterrent. With the station in operation, the Russians would have to assume that our forces could still retaliate even if they were attacked by missiles.[28]

The plan was approved by the Cabinet on 26 November.

Negotiations with the Americans quickly proceeded and were soon concluded. The resultant agreement was published in February 1960 (Appendix 2). The station was to be commanded and run by the RAF under a joint US Air Force/RAF plan. The US Government would supply the radar, data processing equipment and communications, and spare parts for the first five years. Thereafter, spares would be the subject of further agreement. Britain would provide the land, accommodation, support services and communications links with UK authorities. It would also bear the running costs, also subject to further agreement after five years. This was announced in Parliament on 17 February.[29] When further questioned a few days later, George Ward, the Air Minister, confirmed that the United States was bearing 97 per cent of the cost of the entire system, and over 80 per cent of the cost of the UK site.[30]

JODRELL BANK

The use of Manchester University's radio telescope at Jodrell Bank in Cheshire for radar research was first mooted in 1956.[31] A low-power transmitter was produced to enable the telescope to monitor the possible effects of meteors and auroral effects on long-range warning radar.[32] This work began in mid-1958, when a British early warning radar was still being developed. It was soon apparent that a satellite rocket could be detected travelling through the beam at a range of 1,400 km. It was therefore conjectured that the equipment might have an operational use in detecting ballistic missiles.[33] The existing transmitters could cover an arc of 2½° and detect a missile launch, but not predict the point of impact. If a more powerful transmitter were to be installed, the arc could be widened to 15°, though this would interfere with the telescope's research functions. When required, the telescope could be pointed to cover a likely launching area.[34]

This idea was not immediately pursued because of the perceived difficulties in distinguishing between missiles and meteorites. However, by late 1960 it was clear that a significant gap in the early warning organisation would exist until BMEWS became operational in 1963. The idea was therefore raised again of using the telescope in the interim.[35] Discussions with Professor Lovell at Jodrell Bank revealed that tracking Sputnik II had shown a radar echoing area of approximately 15 square metres, which could also be expected from a missile booster. Jodrell Bank was also being used to monitor the telemetry from Soviet space probes.[36]

The telescope was not suitable for mechanical or electronic scanning, but could be aimed at one of two most likely missile launch areas. Meteors did not occur sufficiently often to present a discrimination problem. Existing transmitters would give a limited capability, but a more powerful one was really required. Given an hour's notice, the telescope could be re-tasked away from its normal research work.[37] A transmitter currently in store was identified that would give reasonable results, because a more suitable equipment could not be produced within the required timescale.[38]

An Air Ministry working party examined the practicalities. In addition to components already held, an expenditure of about £6,000 would be required. No personnel need be permanently assigned, but periodic training would be required. Communications would need to be established with the Air Defence Operations Centre (ADOC). In view of reductions elsewhere in expenditure on ballistic missile defence projects, Treasury approval might be required even for the modest sums involved.[39] The urgency of the project reflected the latest intelligence estimates about the missile threat to the UK.

The Vice Chief of the Air Staff recommended the proposal to the Air Minister ('I regard this as very well worth having'), which could be implemented by mid-1961.[40] This was referred to Watkinson, the Minister of Defence. Project 'Verify', as it became known, was approved but proceeded at a relatively leisurely pace, despite the apparent urgency. By November the additional equipment needed was ready for installation.[41] In the meantime, warning times of between 3½ and 9¼ minutes had been calculated depending on the range and trajectory of the threat.[42]

It was agreed that the telescope would be handed over for RAF operational use once the alert state 'Military Vigilance' was declared, and peacetime training would be possible for a period of 48 hours every 3–4 weeks. Controllers drawn from Fighter Command would train the equipment on a bearing ordered by the ADOC, and a warning procedure was established in case missiles were detected.[43] The RAF's equipment was installed by March 1962. Tracking of the American Echo I satellite and Canberra aircraft demonstrated its potential,[44] and the installation was accordingly handed over from RAF Signals Command to Fighter Command.[45]

Jodrell Bank's 'genuine, even if limited, ballistic warning capability' meant that, despite 'administrative and technical difficulties', it was maintained in this role until September 1963 when BMEWS was scheduled to become operational.[46]

'ZINNIA'

Trials began in 1952 with an experimental High Frequency (HF) ionospheric radar called 'Orange Poodle' to detect aircraft flying beyond the radar horizon, at ranges of up to 120 miles.[47] A later Zinnia I set was used against subsonic aircraft, but was further developed to detect high velocity targets, such as missiles (Zinnia III). Zinnia II was a UK-produced, continuous-wave (CW) version of an American pulse radar called 'Chaplain', used for monitoring their own nuclear tests and missile firings.[48] Trials of both Zinnia II and Chaplain took place in the UK between May and July 1959, and one observation was correlated with the Soviet missile test range at Kapustin Yar. Further trials of Zinnia II and III were carried out in the United States (Project 'Bart') between October 1959 and January 1960, using American Atlas, Jupiter, Thor, Polaris and Titan ballistic missile tests as targets, as well as Snark and Mace cruise missiles. Detections were achieved at ranges of up to 1,800 km by means of doppler shifts between transmitted and received frequencies.

To begin with, interest in these theoretical experiments was for an intelligence-gathering application, but as work progressed their potential for early warning became clear.[49] Following the successful experiments in the United States, it was decided to produce an 'engineered version', codenamed 'Sandra', for intelligence purposes (ASR 2209).[50] This was to be located in Cyprus from where the three main Soviet test ranges could best be monitored. Capital expenditure was under £½ million with annual running costs of £205000–£35,000. In view of increased awareness of the scale of the Russian missile development programme, 'urgency for the deployment of the equipment is already high and is mounting rapidly'. Its performance was assessed as greatly superior to the American Chaplain system.

Cyprus was not, however, the best location from which to detect operational IRBM launches from the Baltic States, for which a UK site would be better suited.[51] RAE Zinnia II trials were still continuing in Britain. This experimental equipment was less accurate than the developed Sandra version, but subject to fewer false alarms.[52] Like Jodrell Bank, it could only cover a limited sector, making the two interim early warning proposals complementary rather than alternatives.[53]

Project Sandra became operational in Cyprus in July 1962, and was used for early warning as well as intelligence gathering until BMEWS became operational in early 1964.[54] Budgetary constraints as well as the short period for which it was required meant that the UK-based interim proposal was not proceeded with, though HF over-the-horizon (OTH) radar trials continued at Orfordness in Suffolk until the mid-1970s.[55] American OTH radars known as System 440L and 441A, were scheduled for service in 1969 and 1971/72 respectively,[56] following agreement in 1966,[57] but never actually saw operational service.[58] OTH radars could not track missiles or provide impact point prediction.[59] The experimental set detected the first Chinese nuclear test in 1964, though this was initially assessed as a missile launch—which indicates the ambiguity of much of the information derived from such systems.[60]

MIDAS

Preliminary research into infra-red detection of ballistic missiles during their ascent phase was carried out at RRE in the mid-1950s. This work assumed an airborne sensor, from which detection ranges of 600 miles for liquid fuel rockets and 2,000 miles from the hotter solid fuel missiles might be achieved.[61] No plans were made, however, to develop an operational system. The idea was examined again in 1961, but it was concluded that an airborne system offered no additional warning to that which was expected from the US Missile Defense Alert System (MIDAS) satellite-based system, an agreement on which had just been reached.[62]

In June 1959 the US Air Force made an 'informal' approach to the Air Ministry about the possibility of siting one of three ground stations for the projected MIDAS in the UK.[63] MIDAS was to be a system of 8–12 satellites in polar orbit with infra-red sensors that could detect the heat from Soviet missile launches with an accuracy of about 50 miles at a range of 4,500 miles. It would provide earlier, but less precise, warning of missile attack than the radar-based BMEWS.[64] Ground stations were planned in Alaska, Greenland and the UK, each about 150 miles from the respective BMEWS sites and utilising common communications links to NORAD.[65]

The initial British reaction was that the system was of little direct military benefit, as the threat to the UK was from shorter-range, ‘cooler’ IRBMs, but that by reducing the chances of the West in general being taken by surprise, the retaliatory policy was enhanced. A station in the UK would be funded by the United States and, unlike BMEWS, manned by Americans as well. Other than providing land, no British contribution was initially being asked for.

The Air Ministry made a detailed study of the relative characteristics and performance of BMEWS, MIDAS and HF systems such as Zinnia and Chaplain.[66] It raised the possibility of not spending any money on a contribution to BMEWS if MIDAS warning could be obtained at no cost. However, BMEWS, given the tracking capability which the others lacked, was clearly the primary means of early warning. The other systems were complementary to BMEWS but could not supplant it. The study also observed that the positioning of assets in space might have international repercussions, going so far as to suggest they might be used by the United Nations ‘for monitoring aggressive ballistic missile action by any nation’. It also, without any explanation, stated that ‘MIDAS might never come into being for various reasons and the HF systems are doubtful starters’, which, whatever its foundation, showed some foresight. The other two MIDAS stations were scheduled to be operating in 1961, and the UK station in January 1963.

The proposed station would comprise three 60-foot dish aerial receivers in radomes plus support buildings in an area of low radio noise. It would have looked like a smaller version of the BMEWS site at Fylingdales. The US Air Force had identified a suitable site, currently surplus to requirements, at RAF Kirkbride near Carlisle.[67]

The United States also approached the government of Southern Rhodesia (present-day Zimbabwe) with a view to establishing an additional ground station there. The Chief of the Air Staff (CAS) of the Royal Rhodesian Air Force sought British views on the scientific and military basis of the system, and whether it could monitor aircraft movements. His concerns were assuaged, and he was told of the similar request for a station in the UK, which had not yet been approved.[68]

The ability of MIDAS to detect the shorter-range missiles that would in future be the main threat to the UK became bound up with the whole credibility of the V-bomber force. A top secret Air Ministry internal paper stated that with BMEWS and MIDAS warning combined (assuming the latter could detect MRBMs), enough bombers could get airborne to accomplish 36 per cent of their approved task of destroying 50 per cent of 40 major Soviet cities. Without MIDAS, the figure of 36 per cent dropped to 1 per cent—in other words the UK had no credible deterrent. Advocates of a submarine-based deterrent (presumably the Admiralty) might argue that without MIDAS the validity of the deterrent rested on the Russians making a simultaneous attack on the United States, in which case the 20 minutes-plus warning available would enable the V-bombers to get airborne. MIDAS, even if only able to detect ICBMs, would therefore add to that warning and so to the credibility of the UK deterrent. It was being argued that a possible financial contribution to MIDAS now being mooted should not be made until it gained an anti-MRBM capability. In addressing this issue, the Air Staff admitted (if only to themselves) that the existing deterrent was not credible unless the United States was attacked at the same time.[69]

The Americans were now proposing that the UK contribute to the costs of MIDAS in exchange for access to the information provided, following the Fylingdales precedent.

Britain would be responsible for providing the land and existing buildings, additional accommodation, station support services and the communications link with UK authorities. It would also pay the full running costs after the first year of operation. Capital costs would be between £1.5 and £2 million, and running costs £1.4 million per annum. The satellite chain was expected to be operational by March 1964, and by mid-1965 should be capable of detecting MRBMs.[70]

This proposal was put to the Cabinet Defence Committee in June 1961,[71] with the recommendation that building work and running costs should be placed on the same basis as the BMEWS agreement. The value of MIDAS was that it would corroborate information from BMEWS, and provide between one and two minutes' extra warning, enabling the bombers to fly up to 15 miles further from their bases.[72] The Air Minister and CAS were advised to stress the value of up to half an hour's warning in the event of a simultaneous attack on the United States, and not to raise the vulnerability, with or without MIDAS, of the V-bomber force if only the UK was attacked.

A paper prepared at the same time for the Chief Scientific Advisor (CSA) listed the improved warning times that MIDAS would offer:[73]

	BMEWS BMEWS	MIDAS
1,000 nm missile on low angle trajectory	3½ mins	4½ mins
1,500 nm missile on optimum trajectory	11½ mins	14 mins
ICBM	25 mins	40 mins

It observed:

> With the precedent set by BMEWS, it would be impolitic to refuse; indeed there are no grounds for doing so… Until such time that we discontinue operating our deterrent, or obtain one which is not dependent on a warning system, we ought to have the best possible warning of attack—providing it does not cost too much.

Following Cabinet approval,[74] a detailed draft agreement was negotiated with the Americans in July. The financial arrangements were brought into line with the BMEWS agreement, as a result of which the costs to the UK were estimated at £2¼–£3 million, with annual costs thereafter of £0.7 million.[75] It was noted that the detection of MRBMs was also needed for the protection of US forces in Europe, so 'it is reasonable to suppose that neither money nor effort will be spared to achieve it… [although] [t]he problems involved [higher sensitivity] in developing MIDAS to deal with these threats are very great'. The agreement was published on 18 July 1961[76] though without the secret technical agreement on the operation of the site, and debated in Parliament the following day.[77] It was stressed that the special terms of the agreement meant that the UK would not incur any expense until the system became operational, when a limited repayment would be made to the United States.

As development continued, though at a slower rate than previously forecast, in March 1963 an Air Ministry review of ABM systems said of MIDAS that 'performance to date has been disappointing'.[78] Outright cancellation by Washington was becoming a possibility. This had already prompted renewed concerns about the validity of the V-bomber deterrent without the extra early warning. Even assuming a more modest scale of Soviet attack than hitherto, only 19 per cent of the V-bombers' mission might be accomplished without MIDAS.[79] The previous concealment of the vulnerability of the bombers to missile attack was confirmed: 'What we have said in public is rather different.'

If MIDAS were to be cancelled, some public explanation would be required as it had previously been stated that the system would provide additional early warning to the deterrent. Therefore,

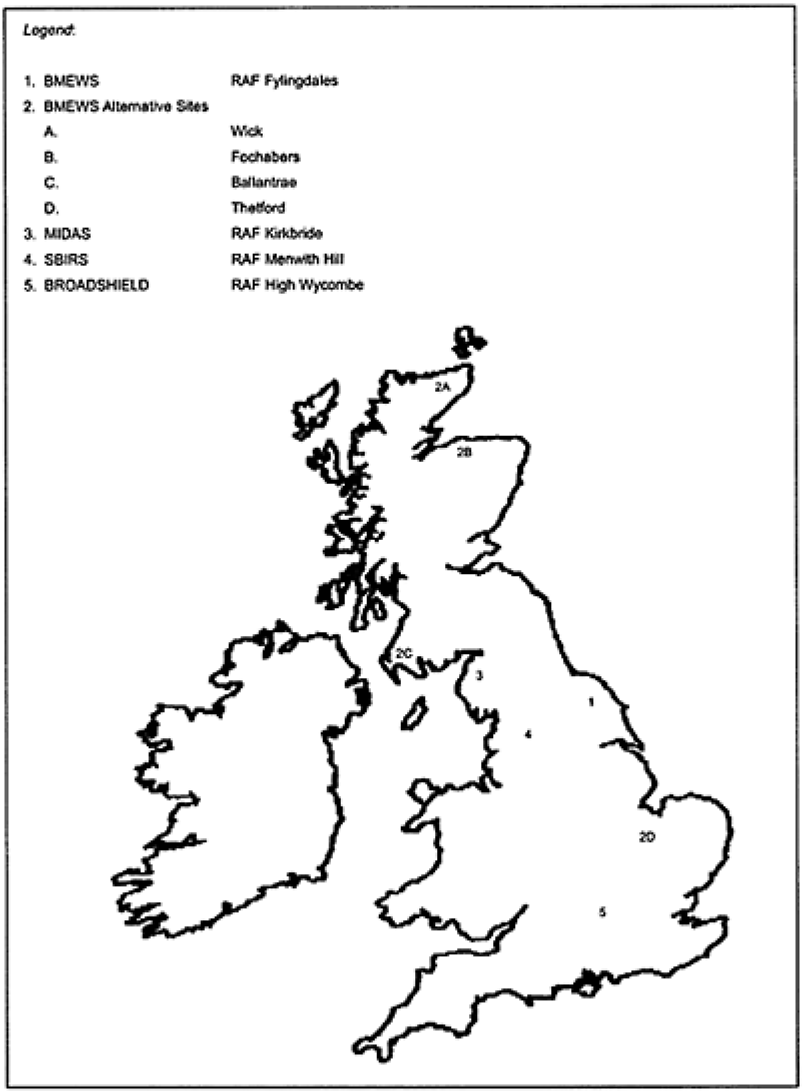
> the only possible line to take in public is that MIDAS would have been…a valuable complementary system to BMEWS, but the V-bombers have repeatedly demonstrated their ability to achieve extraordinarily quick reaction times within the reputed 4 minutes minimum warning available from BMEWS by itself…
>
> To fudge the implications of the cancellation of MIDAS should present a relatively minor problem by comparison with the problem of explaining how the V-force will continue to pose a valid deterrent even though without Skybolt[80] no airborne alert will any longer be practicable.

The distribution of this paper makes it clear that the entire hierarchy of the Air Ministry, uniformed and civilian, was party to the cover-up. The extent of the deception is shown by a letter from Peter Thorneycroft, by now Minister of Defence, to the Prime Minister in May, stating, 'From the operational point of view the consequences of the failure of MIDAS are not too serious.'[81] R.C.Kent, Assistant Under Secretary (Air), AUS(A) in the Air Ministry (author of the internal report cited above) was copied on this letter, so was clearly well aware that the Prime Minister was, in effect, being lied to. Whether Thorneycroft was aware of the deception he was party to is not clear.

Two days later, a telegram from Washington made it clear that MIDAS was about to be reduced to the status of an R&D programme, and that RAF Kirkbride was no longer required. In the wake of the Skybolt cancellation,[82] both governments were 'anxious not to exacerbate the already difficult situation'.[83] The Air Ministry agreed that Kirkbride should be disposed of, and though this implied outright abrogation of the MIDAS agreement, 'we should simply let it become a dead letter'[84] in order not to raise the public profile of MIDAS's demise. Thorneycroft reported: 'We have purposely avoided saying anything about the failure of MIDAS while the SKYBOLT episode was still fresh in mind…'.[85] As a further twist, the Americans now classified the word 'MIDAS', despite it being the subject of a public treaty between the two governments. Later histories of US BMD make no reference whatever to the subject.[86]

By the time of cancellation the wisdom of the special terms of the 1961 agreement became clear. Britain had spent no money on MIDAS, though the disposal of the Kirkbride site had been delayed.[87]

Figure 4: Early Warning Sites in Britain



BMEWS OPERATIONAL

The limited value of just four minutes' warning in the event of a 'bolt from the blue' attack was acknowledged by the Air Minister in a briefing prepared for the Prime Minister at the same time that the BMEWS agreement was signed. However, it was agreed policy that such an attack was unlikely, because 24 hours' 'strategic' warning of Russian intentions was expected, the United States would be attacked at the same time providing 25 minutes' warning, and only missiles fired from the eastern European satellite countries, on depressed trajectories, would provide only four minutes warning. Missiles launched from the Soviet Union itself would be detected much earlier.[88] Nonetheless, measures were being taken at the bomber bases to shorten their reaction times to match the worst-case analysis.[89] A later study by Bomber Command (BMEWS came under Fighter Command) further refined warning times:[90]

Warning Times for Missiles Impacting at BMEWS Radar

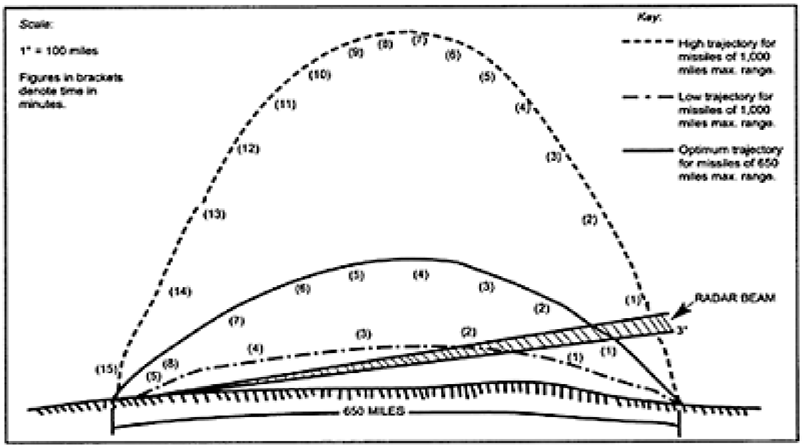
Maximum range of missile[91] (miles)	Firing range of missile (miles)	Warning time for theoretical trajectory (minutes)	Warning time for real trajectory (minutes)
1,500	1,500	10.5	10.7
1,500	1,000(L)*	3.8	4.6
1,000	1,000	8.9	9.2
1,000	650(L)	3.3	4.2
1,000	650(H)†	15.2	15.4
650	650	7.3	7.6
650	540(L)	4.3	5.2
450	450	6.2	6.6

* Low (i.e. depressed trajectory) † High (i.e. lofted trajectory)

In March 1960 BMEWS was the subject of extensive parliamentary debate. On the 2nd of the month Ward, the Air Minister, publically confirmed that the amount of warning Fylingdales would provide ranged between 4 and 15 minutes, depending on missile range and trajectory.[92] Two weeks later the subject of concern was BMEWS's role in civil defence, rather than in alerting the deterrent.[93] On 25 March it was the subject of a full debate,[94] indicating the level of political and public interest aroused by the announcement of the BMEWS agreement the previous month. Most of the debate was actually about nuclear deterrence as a whole, and the BMEWS agreement merely a catalyst for it. Interestingly, Professor Lovell was quoted (how accurately is not clear) as opposing BMEWS on technical grounds.

Having reached agreement with the United States on Site 3 at Fylingdales, the next issue to be tackled was securing early warning information from the BMEWS chain as a whole. A teletype circuit was established between NORAD and the ADOC in Britain to pass information derived from Site 1 at Thule.[95] This was supplemented by a voice circuit with agreed formatted messages, and both were operational by October 1960.

Figure 5: BMEWS Vertical Coverage Diagram



Source: PRO AIR 14/4305 Bomber Command Operational Research Branch Memorandum No. 222, April 1961.

The Americans also proposed to use BMEWS as part of a space surveillance system for monitoring satellite activity. This could be done with minimal interruption to its prime early warning function. The Air Ministry and RRE examined the proposal, and concluded that it would be 'of great advantage' to the UK to participate. It would give the UK access to US satellite records and assist with the country's own satellite research.[96] The plan was approved at Ministerial level, and satellite tracking has remained a secondary task of RAF Fylingdales to this day.[97] It was announced in Parliament in 1966.[98]

The February 1960 agreement stipulated that the UK was responsible for the provision of communications and displays needed for British early warning purposes. The result was ASR 2208—Project 'Legate'. One million pounds was allowed for this in the 1962 Defence Review Costing, which was to provide computers, data links and displays at a total of five operations centres, including the ADOC.[99] Provision was made for this equipment to pass IRBM warnings to NORAD, and to receive NORAD information in turn. Legate was approved by the DRPC in July 1962, noting that the 'Treasury had not entirely abandoned hope of getting the Americans to pay'.[100] The station was finally handed over to the RAF in January 1964.

BMEWS RENEWED

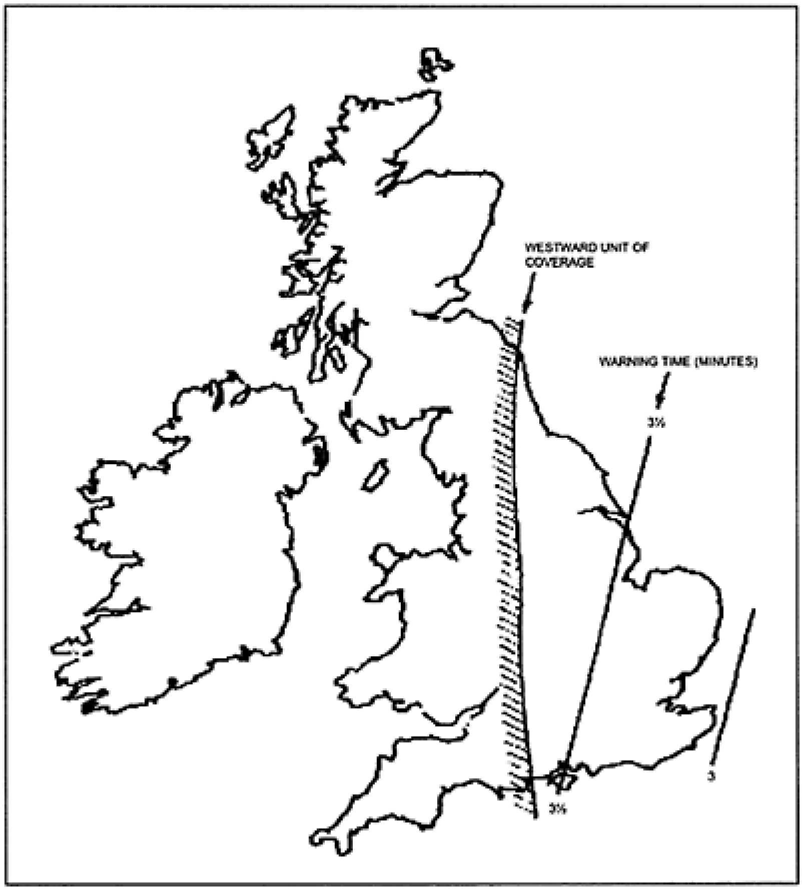
Once in service, the BMEWS agreement was subject to five-yearly renewal. This prompted the head of F.6 (Air) in the now-unified Ministry of Defence to question the continued basis for BMEWS being a call upon the Air Vote. This was on the grounds that Polaris, soon to become the strategic deterrent, did not rely on early warning in the way the V-bombers did, and anyway were not operated by the RAF: 'Whoever may derive benefit from BMEWS after 1969, it looks as though it will not be the Royal Air Force.'[101] He speculated that the future OTH radar might better meet the future early warning needs of RAF offensive and defensive aircraft. The inability of Fylingdales to detect submarine-launched missiles (because of its arc of coverage) was a further limitation on its usefulness. This prompted a review of the cost-sharing agreement with the Americans.[102]

These early musings within the Air Staff were followed by a formal review conducted by the Air and Naval Staffs.[103] It decided that warning from OTH systems would be of 'an indicative nature only'. Even after Polaris assumed the strategic deterrence role, specific early warning would still be required, and BMEWS displays were being provided to the primary and alternative Polaris headquarters. The RAF would retain a residual nuclear role which would therefore still have the same early warning requirements as before. Early warning would therefore remain part of the responsibility

Figure 6: BMEWS Warning Times v. 1,500-mile missiles (optimum trajectory)

Source: PRO AIR 14/4305 Bomber Command Operational Research Branch Memorandum No. 222, April 1961.

Figure 7: BMEWS Warning Times v. 650-mile missiles (depressed trajectory)



Source: PRO AIR 14/4305 Bomber Command Operational Research Branch Memorandum No. 222, April 1961.

of the Air Defence Commander (AOC-in-C Fighter Command). Moreover, the Home Office's civil defence warning system relied upon BMEWS, as did the gathering of 'space intelligence'. BMEWS would continue to be 'essential'.

The BMEWS agreement was therefore renewed for a further five years from January 1969. Annual running costs incurred by the UK were now £2.3 million.[104] It was further renewed in 1974 and thereafter until the present day. By 1974 the annual cost had risen to £2.9 million, which was 'good value especially given the Fylingdales warning function for the Polaris force'.[105] In 1978, the CAS minuted:

> The balance of operational interest in the site remains with the UK … Fylingdales is useful to the Americans, providing as it does warning of missile attacks on ACE[106] and space intelligence data, but it may not be essential. It is possible that the US could assemble sufficient BMEWS data from their stations in Greenland and Alaska…
>
> Fylingdales is the only system capable of providing the required high confidence of warning of missiles in flight that will impact within the UK.[107]

BMEWS UPGRADED

In 1985 US Space Command in Colorado (the US controlling authority for BMEWS) announced that all three stations were to be upgraded. A contract was awarded to Raytheon, and work began at Thule in 1987.[108] Fylingdales itself was rebuilt between August 1989 and October 1992. There were several reasons for the installation of wholly new equipment.[109] By the late 1980s the threat had evolved considerably since BMEWS was first designed in the late 1950s, in that it had become both more numerous and more sophisticated. For Fylingdales at least (though not for the other two sites), 360° coverage was required—the inability to detect Submarine-Launched Ballistic Missiles (SLBMs) was a major shortcoming of the original configuration. The technology was obsolescent, becoming increasingly unreliable and spares more difficult to obtain. And finally, ground-based sensors such as BMEWS were expected to play a significant role in any future Strategic Defense Initiative (SDI) architecture (see Chapter 8).

The three old FPS-49 radars were replaced by a single three-faced Solid State Phased Array Radar (SSPAR) in a pyramid-like structure.[110] It employs electronic scanning, which had long been identified as the future basis for early warning. The improvement in performance over the old system was dramatic:

	1964	1992
Track handling	10/minute	800 simultaneously
Range resolution	240 nm	1,000 ft
Maximum range	2,650 nm	3,000 nm
Minimum target at 1,650 nm	2.8 m^2	0.5 m^2
Azimuth coverage	180°	360°
Impact accuracy		
North America	135 nm	5–30 nm
Europe	35 nm	3–10 nm

The cost of modernisation was £170 million, of which the US Government paid for the new radar, and Britain the buildings and facilities, about 30 per cent of the total.[111]

The command and control arrangements for Fylingdales are complex, reflecting its role in both NORAD and the defence of the UK. To the former it is BMEWS Site 3, to the latter, RAF Fylingdales. OPCON (Operational Control) is therefore, most unusually, split between C-in-C NORAD at the Cheyenne Mountain Air Station (CMAS) in Colorado, and AOC-in-C Strike Command at High Wycombe. More detailed TACON (Tactical Control) is exercised through 'Broadshield', the Missile Warning Cell, also at High Wycombe. Missile warning data is passed to Broadshield and CMAS, though all the BMEWS chain is tasked by the US 14th Air Force.

Since entering service in 1992, the new BMEWS equipment at Fylingdales has been proposed as an element in both a future UK active missile defence architecture, and as part of an NMD system for the United States. Both these proposals are examined in later chapters.

NOTES

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5. AIR 2/14971 Sub-Group F presentation, March 1958.
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27. AIR 20/10715, *The Ballistic Missile Warning System: Note by Secretary of State for Air*, November 1959.
28. AIR 20/10048 CMS.3253/58/Part II enclosure, 11 December 1959.
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30. *Hansard,* 24 February 1960, cols 48–9W.
31. DRP/P(56) 40.
32. DRP/P(57)33.
33. AIR 2/13380 Science 2 Memo No. 287, 11 August 1958.
34. AIR 2/13380 Truest to Lovell, 16 October 1958.
35. AIR 2/13380 VCAS.4294, 10 October 1960.
36. DEFE 7/1389 Young-Kendrew, 31 July 1961.
37. AIR 20/9982 D/SAAM/3043, 19 October 1960.
38. AIR 2/13380 F.2224/Ops, 27 October 1960.
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44. AIR 2/13381 SC/S.660/113/RE/SASO, 4 April 1962.
45. AIR 20/11427 SC/S.6600/113/RE/C-in-C, 4 April 1962.
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52. AIR 2/15326, Tyndall to VCAS, 18 October 1960.
53. AIR 20/11427, VCAS to SofS, 16 January 1961.
54. AIR 2/15326 111/026/01, 21 July 1962.
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6
US ABM Deployment

EARLY INTEREST

UK interest in US views about, and work on, defence against ballistic missiles began even before Britain's own postwar research programme. The 1949 intelligence conference and the 1953 Conference 'Ally'[1] were early manifestations of that interest and the start of a diverse and developing pattern of cooperation throughout the 1950s. By 1956 the Americans were describing their own ABM developments to the British,[2] within the context of an exchange of views on active defence techniques. These exchanges continued, largely through the medium of Sub-Group F. In October 1958 the Chief Scientist reported to the Defence Board that the Americans were planning to deploy a system for the defence of North America by 1963, but that as their problem was different, the system might not be effective for the UK.[3] It was recognised that the United States was 'a good further along the road',[4] and as the technological and financial scale of the problem became ever-more clear, the need to combine efforts with the Americans became pressing.[5] The US Nike-Zeus[6] system was of interest to Britain as a possible ABM alternative to Red Duster (Bloodhound), and to inform British work on a dedicated ABM interceptor.

In 1960 the British contribution to the ABM problem was acknowledged by the new Ministry of Aviation as 'small and probably of little significance to the US, [but]…the same uncertainties which we have experienced have, in fact, been met by the Americans'.[7] After a SubGroup F meeting in October, the UK Chairman reported that 'ballistic missile defence continues to be an intractable subject, but US *[sic]* are prepared to continue pouring a lot of money into it'.[8]

In 1961 the Powell Committee (see Chapter 3) noted that the Nike-Zeus programme was stalled because of the decoy discrimination problem, but that work was also proceeding on satellite-based, launch-phase defences, such as BAMBI,[9] to solve the discrimination problem. An idealistic note was sounded with the hope that 'such a system could, ideally, be run as an international undertaking preventing all ballistic missiles and satellite launchings excepting those authorised for scientific purposes'. The Technical Sub-Committee reported that 'Death Rays' were also being investigated using a proton or electron high-energy beam.[10]

Britain received detailed reports on Project 'Hyvia', a US Air Force research programme conducted by the Massachusetts Institute of Technology.[11] Hyvia investigated basic technologies and techniques involved in interception of high-altitude, hyper-velocity vehicles, such as ICBMs and satellites. Much of this research laid the foundations for the 'exotic' technologies that were the basis of the 1980s Strategic Defensive Initiative (SDI) (Chapter 8).

In August 1962 a UK delegation to the United States was briefed on the US Army's Field Army Ballistic Missile Defense System, an operational requirement for a mobile system to replace the existing Hawk and Nike-Hercules surface-to-air missiles. It would be capable of engaging missiles with ranges of up to 2,000 km.[12]

By late 1963 13 ICBM intercept tests of Nike-Zeus had taken place, all but one being claimed as total or partial successes.[13] However, because of the persistent discrimination shortcomings of the system, the US Defense Secretary Robert McNamara decided against deployment and efforts were re-directed towards an improved version, Nike-X.[14] This employed a new phased-array radar and an additional low-altitude interceptor 'Sprint', whilst retaining Zeus (later 'Spartan') for high-altitude intercepts in a layered defence. In Britain the Ministry of Aviation noted that the nuclear heads made them most suitable for the defence of hardened targets (such as ICBM silos), and assessed that 'it is much too early to say whether a system will emerge which will justify the cost of its operational deployment'.[15]

The MoD's Long-Term Study Group's report on missile defence[16] indicated a continuing interest in the subject, even if research had largely been abandoned in Britain. The report identified what had become two distinct US requirements: 'hard point' defence (such as missile silos and command centres), and urban defence. As regards the former, The successful development of such a system would be an important element in providing a stable second-strike force.' But for defence of cities, 'there is notably less enthusiasm for and confidence in a terminal intercept system'. Soon after, a 'hardening' of the United States's approach to release of information on BMD was reported.[17] This was especially so in the area of defence penetration. If exchanges were to continue, the UK needed to adopt a 'quid pro quo' approach, with something to offer. Such was the position when the Wilson Labour Government came to power in October 1964.

FROM COOPERATION TO CONCERN

Starting in about 1958, doubts had begun to arise in the United States about the technical feasibility and strategic desirability of an ABM deployment.[18] By 1963 McNamara had become concerned about the implications for stable nuclear deterrence of ABM systems. His cost-effectiveness approach to defence led him to conclude that ABM systems could not be worthwhile.[19] A possible reason *for* deployment arose in October 1964, however, with the first Chinese atomic test. Thereafter ABM issues were considered not just in the light of the US-Soviet nuclear balance, but also with regard to a future more limited threat from 'third parties'—initially China.

By early 1965, McNamara was considering whether the US Army's Nike-X system should be deployed.[20] ABM deployment was the subject of Congressional hearings[21] and came to the attention of the Foreign Office in London. An immediate reaction was that 'the American decision could have a profound effect on British national security and on the future of the Atlantic Alliance…we ought to make our views known to the Americans at the highest level in good time'.[22] The initial Foreign Office analysis proceeded in complete ignorance of the earlier work done on the ABM problem in the UK, and the extensive consultations that had already taken place, albeit largely at a technical level, with the Americans: '… I am fairly confident that the Americans have never seriously consulted us… Nor am I aware that we have ever raised the subject with them.'[23]

The Foreign Office's Arms Control and Disarmament Research Unit (ACDRU) examined the ABM issue, coming to an early conclusion that because of the technical and financial impediments to a complete defence against ballistic missiles, the effects of ABM on the strategic balance might be overdrawn.[24] Another official observed that it was 'in our interest, and in that of peace, that no third country, particularly China, should be in a position to threaten effectively the homeland of the US, or even of the USSR'. He presumably did not include Britain in the category of a 'third country', but explicitly *did* include France.[25]

The result of these early deliberations was a comprehensive report prepared for the Permanent Under-Secretary's Steering Committee, a sort of internal 'think-tank'. Its lengthy conclusions are worth repeating verbatim:

(a) some form of ABM defence is a practical proposition; the Russians are working hard at it and the Americans may take a decision to proceed with it as early as this autumn;
(b) such a decision could project the world into uncharted and dangerous waters. The effect of ABM deployment is difficult to gauge because so much depends firstly on the degree to which vulnerability is thereby reduced and secondly upon the judgement made on this point by potential adversaries;
(c) it seems unlikely that the deployment of ABMs by one side or the other would overthrow the balance of deterrence. Nevertheless, it might tilt it and thus increase tension and instability.
(d) in any event it would intensify the arms race and make nuclear disarmament harder;
(e) the degree to which Europe would be adversely affected would depend upon the scale and effectiveness of the Russian and American deployment, but in any event the disparity between Europe and the two super-powers would be increased to the disadvantage of Europe;
(f) the introduction of an American ABM system without adequate allied consultation would strengthen the hand of the Gaullists and would be unhealthy for the Atlantic Alliance. ABMs create an additional need for practical measures of Atlantic cooperation, such as more closely integrated Atlantic forces;
(g) the best argument for the deployment of ABMs is the great effect it would have in limiting damage in a nuclear war with China; but such a war is not at present on the cards and in the long run China will seek to match whatever America and Russia do;
(h) in these circumstances the balance of advantage for Britain seems to be in 120 deployment of ABMs; logically this is also in the interest of the United States and Russia and although it may be very difficult to achieve we should on the basis of present information aim to bring about a Russian-American understanding not to deploy ABMs;
(i) the next step should be exploratory talks with the Americans; in the light of this we can take a decision on whether, and if so how, to try to influence their policy.[26]

The Steering Committee, chaired by the Permanent Under-Secretary (PUS) Gore-Booth, agreed that the issue was both important and urgent, and that early discussions with the Americans were required.[27] The Ministries of Defence and Aviation were both approached at PUS level in order to coordinate an approach to the Americans.[28] This revealed to the Foreign Office for the first time the extent of British technical research into ABM, and cooperation with the United States. The Foreign Office concluded that there was ‘a gap in our liaison’ and that in future they should be more closely involved in a matter with obvious political implications.[29]

On 12 August the British Ambassador in Washington had a preliminary meeting with Dean Rusk, the US Secretary of State, indicating just how important the matter was regarded in London. Rusk appeared to be no more aware of technical exchanges than had been the Foreign Office. He emphasised that US thinking on the subject was still inconclusive.[30]

A brief prepared by the Planning Staff queried how large a so-called ‘thin’ defence would need to be to counter about 20 Chinese ICBMs, a remarkably accurate guess as 35 years later the Chinese strategic arsenal was just such a size.[31] The paper stated:

> The general point to stress to the Americans is that on the face of it we think that a decision on the operational deployment of ABMs could have a big influence on our future well-being and security and that accordingly we should like to explore the whole question with them objectively and without commitment.[32]

Sir Solly Zuckerman, the MoD’s Chief Scientific Advisor (CSA) advised Gore-Booth that ABMs had been a continuing topic of conversation with the Pentagon for many years. He also observed: ‘I do not rate our chances of being able to influence the Americans too highly.’[33] The MoD Deputy Under-Secretary, Leitch, confirmed these links and stressed that they should not be prejudiced by discussions on ‘a delicate subject’.[34] The MoD was concerned that a probably futile attempt by the Foreign Office to influence US policy might disrupt their own close working relationships with the Americans. The Foreign Office seemed to accept this argument and decided to pursue a more informal approach through the Washington Embassy: ‘Even small scraps of information will be welcome to us.’[35]

Rusk for his part made it clear that the Americans would talk when they were ready.[36] In the meantime, McNamara deferred a deployment decision for another year, citing offence/defence cost-effectiveness comparisons. Research and development funding continued, but was a third priority after Vietnam and assured penetration (i.e. offence).[37]

An aide-memoire prepared for the Prime Minister’s forthcoming visit to Washington spelled out the agreed views of the MoD and Foreign Office:

1. The Government of the United Kingdom has considered the problems that would arise for the stability of the present strategic balance between the NATO and Warsaw Pacts from the deployment of anti-ballistic missile systems by the Soviet Union and the United States of America.
2. It has concluded that no such deployment can be in the interests of either nation or either alliance. The general consensus of informed military and scientific opinion is that to complete defence against in-coming ballistic missile can be mounted in the foreseeable future. No deployment could for long increase the security of either the United States or the Soviet Union, either with respect to one another or with respect to an emergent nuclear power. It could at best preserve present security at the cost of greatly increased use of resources which could be better employed elsewhere; at worst,

it is quite likely that, by introducing a further incalculable element of uncertainty in the present strategic balance, it would diminish the security of both.

3. The most likely result of any ABM deployment by one side, however modest, is an increase in the number of nuclear delivery vehicles by the other, and thus a further exacerbation of the arms race. Thus the impact on the prospect of substantial measures of nuclear disarmament is also likely to be severe…[38]

At the same time, however, a report by the ACDRU on Arms Control and Minimum Stable Deterrence[39] did not consider the implications of ABMs at all. Another brief for the Prime Minister introduced additional factors in British thinking. ABM developments would require further nuclear testing, making a comprehensive test ban more unlikely. Deployment of a ‘thin’ system against China could strengthen arguments for a ‘thick’ system against the Soviet Union, with all the destabilising consequences that would follow. McNamara himself was opposed to ABM deployment, except perhaps against China, but ‘should there be an anti-ballistic missile race, we recognise that domestic political pressure may make it very difficult for the US Government not to follow suit’.[40]

A seminar held at the Institute for Strategic Studies,[41] which was extensively reported on within the Foreign Office, introduced yet more elements to the debate. ABMs might be used for the protection of ‘hardened’ sites, an echo of the 1950s preoccupation in Britain with defence of the deterrent, and a fear that a United States that felt invulnerable could be ‘insufferable in the world’. It might also increase doubts about the US commitment to Europe.[42] The ACDRU reported that 75 per cent of Americans believed that the United States already had an effective ABM system.[43]

In January 1966 Thomson, the Foreign Office official who did much of the early work on the ABM question, visited Washington. He reported that ‘in the ABM question the Americans are drifting’. They were confident that they could out-build the Soviets in offensive and defensive weapons, but ‘had done no serious thinking beyond this point…the Americans had as much difficulty in speaking to themselves about ABMs as they did in speaking to us’. China had replaced Russia as the focus of ABM, but the possible implications of deployment for Russia were acknowledged. ‘McNamara personally does not want to buy them.’[44]

So far most thinking about the consequences of a US ABM deployment had been done in the Foreign Office, albeit in consultation with the MoD. The Defence Secretariat now produced a major study themselves.[45] It reviewed what was known of US and Soviet programmes, their strategic implications, and what position the UK should take in the bilateral discussions with the Americans which were still being sought. It reiterated most of the factors already identified, noting the cost advantages of means to overcome defences compared to the defences themselves, and the adverse effect on disarmament measures. It raised the possibility of a demand for an ABM system in Europe to counter Medium Range Ballistic Missiles (MRBMs) and discussed at length the implications for the UK of a Soviet ABM deployment. The study echoed the Foreign Office view that the Americans should be persuaded against deployment, and suggested that the UK might play an intermediary role between Russia and the United States.

This paper was examined in detail by the Defence Planning Staff, who were broadly in agreement with its conclusions and recommendations. They did not, however, believe that the arguments advanced against ABM deployment were likely to persuade the Americans, and that anyway nothing should be proposed that would inhibit their research and development in the field.[46] Future discussions should take care not to prejudice existing intelligence and scientific relationships, a view reiterated by the CoS.[47]

At the same time as continuing to press for talks with the Americans, both the Foreign Office and the MoD were considering raising the issue with the Soviets[48] and within NATO's Nuclear Planning Group (NPG).[49] The Americans were consulted about both, in order not to prejudice the chances of getting bilateral talks going. The US response was that any restriction on ABMs would have to be linked to a nuclear 'freeze', and that they would not foreclose the possibility of an ABM deployment to counter the limited Chinese capability expected in the 1970s. An approach to the Soviets might be 'premature', but the United States would not seek to dissuade the Prime Minister from raising the subject with the Soviet Prime Minister, Kosygin, during a forthcoming visit to London.[50] The UK was also given an advance copy of a presentation on the damage-limiting effects of ABMs to be given to the NPG by McNamara,[51] who on 18 April further deferred a deployment decision.

Another routine visit to Washington by Thomson in July led him to conclude that the position had not changed and that disagreement about deployment within the Administration remained.[52] Formal bilateral talks seemed no closer.[53] The United States did, however, present a detailed ABM plan based on Nike-X to a meeting of NATO's Committee of Political Advisors in Paris in September. The ensuing lengthy discussion revealed widespread European concern about possible ABM deployment, but little that was not already being considered in Washington and London.[54]

FORMAL CONSULTATION

By the summer of 1966 the Foreign Office felt that consideration of ABM issues could go no further without proper consultation with the Americans. Another approach was therefore made to the US State Department.[55] A provisional list of topics for discussion was drawn up, which included the technical feasibility and financial cost of ABM deployment; its effects on the 'balance of deterrence' and arms control prospects; and the effect on NATO, China and 'non-aligned' nations, including potential nuclear powers. By now discussions in the NPG had demonstrated the concerns of many of America's allies about ABM, and the State Department agreed to talks with the British in October. British preparations stressed that the aim should be to ask questions rather then express views, with the focus on the broad political, strategic and economic aspects rather than a 'technical fishing expedition'.[56]

The long-awaited meeting took place in Washington on 6–7 October. The British delegation was drawn primarily from the Foreign Office, but included Defence and Aviation Ministry representatives, the latter having worked on missile defence in the 1950s. The British got what they wanted—'The Americans took us into their confidence in considerable detail.'[57] The US delegation presented a series of papers, each of which was further discussed enabling UK views to be put across. The leader of the US team made the following overall observations:

(a) the United States Government had not decided to deploy an ABM system;
(b) it had not, however, ruled out the possibility of deployment;

(c) the effects of deployment on the strategic balance, the arms race and the political situation would be complex and contingent upon particular circumstances;
(d) this was the first full discussion of the political aspects of deployment with any of the United States' allies, but it would not be the only one.[58]

A paper on system effectiveness stated that an exo-atmospheric, area defence system was difficult for an offensive missile to bypass, but easy to beat (e.g. by the use of decoys), whilst an endo-atmospheric point defence system was easy to bypass but difficult to beat. Soviet missiles of the future were assumed to carry multiple warheads and decoys. The ratio of defending to attacking missiles for successful defence varied between 5:1 and 1:1, according to circumstances. US calculations of warhead/casualty ratios were lower than UK estimates, perhaps because the UK was more densely populated. As regards cost ratios, adding decoys was cheaper than countering them, but adding multiple warheads cost about as much as defeating them.[59]

The Americans were unequivocal in their view that there was no prospect of a large-scale, 'perfect' defence. The strategic balance was a dynamic one, constantly changing, in which ABMs and penetration aids would both become factors. Though missile defences would not increase the attractiveness of a first strike, they might increase the chances of miscalculation in a crisis. They would increase stability in the face of 'nth country' (i.e. Chinese) threats. The British observed that ABM deployment could be de-stabilising, particularly if it prompted an intensified arms race in offensive missiles. There were no logical arguments in favour of a 'thin' defence that could not also be advanced later in favour of a 'thick' defence.

The question of an ABM defence for western Europe was discussed, noting that a different system would be required against the shorter-range threats it faced. Against China the United States could deploy a light defence costing $5–10 billion, though the British suggested that the United States' overwhelming nuclear superiority would be an effective deterrent in itself. Inconclusive discussions followed on the effect of ABM deployment in Asia, on other potential nuclear powers like Japan and India and on the 'non-aligned' world in general.

One of the critical issues was the effect of ABMs on arms control, specifically the prospects for a non-proliferation treaty, a comprehensive test ban, a cut-off of fissionable materials and a freeze and reduction of nuclear delivery vehicles.[60] The United States could already produce nuclear warheads for an ABM system, but would want to test them. Any agreement on offensive weapons would have to include ABM systems as well, as otherwise defensive deployments could reach the stage where the existing 'balance of deterrence' would be upset. The UK view was that, in general, ABM deployment would reduce the prospects of further arms control agreements, though by raising the costs of 'going nuclear' proliferation might be retarded. However, as the US team pointed out, the motives for other powers acquiring nuclear capabilities were generally local and not driven by a desire to compete with the superpowers.

The British came away clear that though no deployment decision had yet been taken, there were considerable domestic pressures on the Johnson Administration to do so, and indeed there was a divergence of opinion within the Administration itself. Chinese nuclear and missile tests, and significant technological advances in the United States (particularly in phased-array radars), made the issue more pressing than hitherto.[61] Lord Chalfont, Minister of State at the Foreign Office, was subsequently told: 'The

Administration could hold the line for the next six months but after that anything could happen…'.[62] One State Department official expected a 'dirty campaign' to be waged by the proponents of missile defence within the military and research communities, and wanted Britain to stimulate discussion within NATO to strengthen the Administration's hand.[63] The British Ambassador in Washington assessed that, given McNamara's known opposition to ABMs, and the existing pressures on the US defence budget, President Johnson would not request funds to move from R&D to deployment.[64]

Regular contacts between US and UK officials continued, as the latter strove to assess the future likelihood of US deployment and its consequences.[65] In January 1967 the British Ambassador reported that McNamara was still opposed to ABM deployment, but had to consider 'appeasing' Congress,[66] especially having announced the previous November that the Soviets were deploying the 'Galosh' ABM system.[67]

Later the same month the Washington Embassy was told by the State Department that the President was about to inform Congress that he was not going to begin deployment; that he would seek negotiations with the Russians;[68] and would include a small sum for 'pre-deployment' items in the 1968 budget. This was 'as satisfactory as we could have hoped in the light of the pressures now being brought to bear on the Administration'.[69] The Foreign Secretary George Brown telegrammed Dean Rusk, the Secretary of State, that he 'welcome[d] the way in which the US Government have resisted the many pressures on them to proceed to deployment'.[70] McNamara indicated that the only deployment worthy of consideration was one to protect ICBM silos, and so enhance deterrence.[71]

The ABM issue was by now considered so important that the Prime Minister was given a detailed brief. There was 'very little prospect of either the Soviet Union or the United States of America achieving a ballistic missile defence that would negate the deterrent forces of the other',[72] though either power could deploy a 'nearly complete' defence against China. Such defences 'raise doubts about the credibility of the French and United Kingdom strategic nuclear forces'. McNamara's grounds for opposing missile defences were outlined, though he had

> shown himself less averse from *[sic]* providing a ballistic missile defence for the American deterrent than for American cities… ABMs might enhance the credibility of the American deterrent in the same way as the hardening of missile sites, whereas the defence of cities is an attempt to negate or reduce the effectiveness of the Russian deterrent…there is little risk of the strategic balance being overthrown. But…a new and highly expensive dimension would have been added to the arms race.

The aim of British policy should therefore be to convince the Russians of the dangers of ABM deployment, to strengthen the elements in the United States opposing deployment and, if it should occur, to reduce the dangerous consequences that could flow from it. The subject of ABMs would be raised during Kosygin's forthcoming visit to London.

The concerns of the British Government were stated several times in Parliament by George Brown:

> the best prospect of progress in this vital field lies in the direct exchanges which the two governments [US and Soviet] have decided to initiate… One must recognize that the development of anti-ballistic missile defensive systems would give a new impetus to the nuclear race…[73]

At the first meeting of the NPG in Washington in April, McNamara was forthcoming in outlining the differing views about ABMs within the US defence establishment, in particular the disagreements between himself and the Joint Chiefs of Staff who were in favour of deployment. The UK Defence Secretary Denis Healey led the subsequent discussion, thanking McNamara for being so frank ‘on a vital issue affecting the security of the United States, which could legitimately be considered as being for decision by the United States alone’.[74]

In May Sir Solly Zuckerman, by now Chief Scientific Advisor to the government as a whole and not just the Ministry of Defence, reported that in conversation with Henry Kissinger (then an advisor to the US Government), he had learnt that McNamara had finally yielded to pressure and decided to deploy a ‘thin’ ABM defence,[75] some four months before the formal announcement was made. The Foreign Office observed that ‘it looks as though we may have to learn to live with some ABM deployment by both sides’.[76]

THE DECISION TO DEPLOY

McNamara publicly announced the US decision to deploy a limited ABM system (now known as Sentinel)[77] on 18 September 1967. He discussed at length the basis for mutual deterrence between the United States and the Soviet Union, and stated that in the absence of an arms control agree-ment with the Russians, the US response to Soviet ABM deployment would be to increase its offensive forces. However, the emerging Chinese threat did warrant a defensive deployment which had the added advantage of protecting Minuteman ICBM silos, and so enhancing the deterrence relationship with the Soviets.[78]

The British Government had been given advance warning of this announcement,[79] as had NATO’s North Atlantic Council.[80] The Foreign Office intended to ‘try to play this down when the news breaks’. The US decision was regretted because of its likely impact on the arms race and the prospects for arms control. ‘Speculation’ would, however, not help either the Americans or the British Government. The British delegation to NATO set out the Alliance’s basic approach:

> NATO’s deterrent strategy is founded on the ability of NATO forces, in conjunction with the external nuclear strike force, to cause unacceptable damage to the Soviet Bloc even if the latter should strike first. The United States decision to embark on a limited deployment of ABMs will have no effect on this basic strategy since the fundamental balance of East/West deterrence will remain unchanged: Indeed ABM protection of the United States land-based missiles is designed to preserve in the future the present assured destruction capability and thus the balance of deterrence.[81]

Denis Healey wrote to McNamara:

> I know with what regret you have been compelled to take this decision…we cannot help but feel that the decision is unfortunate because of its implications worldwide. I hope that you will be able to keep us in touch with developments, so that we can help to mitigate these adverse effects in the future…[82]

The Foreign Secretary told the Prime Minister:

> …it really does put us and our European friends into the position of always being asked to rubber-stamp what the Americans do; or otherwise disassociating ourselves from what they do. I therefore think they should be told very clearly that if they go ahead in this way it will make a nonsense of all the discussions about consultations.[83]

This amounted to a claim on a power of veto over US decisions about the defence of North America, which perhaps fortunately was not relayed to them. The contrast with Healey's attitude at the Washington NPG meeting is stark. After McNamara's speech was delivered Brown added:

> Seldom can any statesman have announced with such obvious distaste…a major new development in the defence of his country …there is no justification deployed in this speech for this decision …the American decision is a logic-chopping mess and the first to realise it is Mr McNamara.[84]

Ernest Yanarella observes: 'An ABM system was deployed because McNamara's options had simply run out.'[85]

ABMS FOR EUROPE?

Until the first NPG meeting in Washington, ABMs had received little attention in Europe. The controversy over the issue in the United States now put them on the agenda.[86] The Defence Ministers decided to study the problem from the European point of view, and it was agreed that the UK should take the lead.[87] The resultant paper was circulated to the NPG permanent delegations in July.[88] It examined the military, financial and political consequences of three possible scenarios: (1) deployment by the Soviet Union only; (2) by the Soviets and Americans; and (3) by both superpowers and Europe.

The threat to Europe was from MRBMs and IRBMs, of which the Soviets deployed about 1,000. These were expected to improve in quality but remain at similar numbers. There were also large numbers of shorter-range missiles for tactical use on the battlefield. Submarine-launched missiles were mainly for use against North America. The threat to Europe was therefore more diverse and numerous than that to the United States.[89]

A Europe-wide defence could be provided by ten defensive missile sites using the Nike-X system, the majority of which could expect between five and nine minutes' warning of attack. Such a defence would protect both major population centres and military installations, but would need to be supplemented by an expanded civil defence programme. It could also be nullified by aircraft and missile attacks on the ABM sites themselves.

As regards the wider implications of ABMs, a Soviet-only deployment would be matched by improvements in the American strike capability in order to maintain 'assured destruction'. 'Short of an all-out strategic nuclear exchange the implications of Soviet deployment of ABM systems are at present slight.' If the United States was also to deploy ABMs, 'the fundamental balance of East/West deterrence would not be changed'. Such would remain true if defences were deployed in Europe as well, though Soviet force planning would be further complicated. A European ABM system would cost about $10.3 billion and a further $0.6 billion annually, at the expense of other military capabilities. Politically, the greatest dangers would arise if the United States deployed ABM defences but Europe did not, leading to strains within the Alliance.

McNamara's deployment announcement just days before the next NPG meeting caused considerable resentment, though the British at least recognised the domestic reasons for it.[90] The Americans for their part wanted to discuss ABMs within the NPG in Ankara on 28 September, but were anxious not to tell the Europeans what was good for them in regard to a possible European deployment.[91] McNamara did, however, express his concern at the way the deployment decision had been portrayed in Europe. Healey, despite the frequent meetings that had taken place and the advance notice given of the announcement, countered by accusing the Americans of a lack of consultation. He also made clear his own opposition to any European ABM system,[92] and wrote in the *New York Herald Tribune* on 3 October that there was 'no evidence that an ABM system now conceivable could produce meaningful defence against a major nuclear attack'.

Healey explained his reasoning to the German Bundestag Defence Committee a month later. Whatever the US position on ABMs, 'In Europe the situation is very different. All the work done so far suggests that to deploy a European system would make no sense at all. It could not prevent tens of millions of European deaths in a strategic nuclear exchange.' The cost would be immense, and a further problem was the command and control issue. The speed of reaction needed would require the authority to release (nuclear-armed) ABMs to be pre-delegated to a military commander. The necessary multinational approach to ABMs was evident in suggestions that a European system might be constructed along the lines of the Multi-Lateral Force or later Atlantic Nuclear Force proposals.[93] There was, however, no urgency to make a final decision and the matter would continue to be studied.[94]

Parliamentary questions on the subject ranged from the usual concerns about the arms race and prospects for arms control, through the public Transatlantic disagreement over prior consultation, to the prospects for a European defence system. The costs of the latter would be 'prohibitive' according to a junior defence minister, Roy Mason, who went on to deny that the ABM defence of the UK had ever been studied.[95]

A brief prepared for Healey in advance of the third NPG meeting in the Hague in April 1968 commended the Permanent Representatives' view that 'in the light of current and foreseeable technological circumstances, the deployment of ABMs in NATO Europe is not at present politically, militarily or financially warranted, though it would be necessary to keep developments in the ABM field under constant review'.[96] The meeting accordingly decided that 'the deployment of ABMs in Europe is not at present warranted'. Review and consultations should continue,[97] though it was by now clear that there was no political will in Europe for an ABM deployment.[98]

FROM SENTINEL TO SAFEGUARD

In November 1967, Thomson made another 'Planners' routine visit to Washington. He reported that the Americans were still disappointed by the British reaction to McNamara's announcement in September and judged that in time a 'thin' system would, because of domestic pressures, be developed into a 'thick' one. President Johnson, however, would try to get an agreement with the Russians on ABM limitation.[99] Several people in his Administration would not be disappointed if such negotiations led to a Sentinel deferral, but in the meantime the US Army was starting to establish the missile and radar sites.[100]

In January 1969 the Republican Richard Nixon entered the White House. His Defense Secretary appeared to favour deployment of Sentinel,[101] although he ordered a halt to further work pending a review of the programme.[102] At the same time, increasing opposition to ABM in the United States was reported, and the new US Secretary of State made clear his hopes for arms limitations—both offensive and defensive.[103] A shift from protection of cities against the Chinese to protection of ICBM silos, so strengthening deterrence, was also possible.[104]

On 27 February Wilson confirmed that he had already discussed arms control and ABM matters with Nixon during the latter's tour of Europe.[105] Two weeks later, the Washington Embassy reported the essential points in an announcement to be made by Nixon the following day. The Sentinel programme needed substantial revision and would now follow a phased pattern which would take into account the diplomatic situation (i.e. arms control negotiations with the Soviet Union). Protection of the land-based element of the retaliatory forces was now the prime objective, with defence against China and 'accidental' launches secondary.[106] The new system would be called 'Safeguard'.[107]

Britain was the only country informed in advance of this re-orientation.[108] The Foreign Office continued to be concerned mainly about the effect of ABM deployment on arms control prospects, and was relieved that the Russians appeared unconcerned that the new system was oriented mainly against them. The unmistakable defensive nature of Safeguard was welcomed,[109] while the continuing prevalence of domestic politics in US ABM policy was reported by the ambassador in Washington.[110] Michael Quinlan, Director of Defence Policy in the MoD, took a slightly different line to the Foreign Office, stating that Britain's primary concern was with the security of the West, not reaching an agreement with the Russians. He was also more hostile to the very idea of ABMs, in view of their implications for other states, (i.e. British) nuclear capabilities.[111]

The Washington NATO Ministerial Meeting in April 1969 included a lengthy 'private and restricted' discussion on ABMs, the two principal participants being Nixon and Healey. No official record was circulated by NATO, though the MoD kept a detailed transcript.[112] Nixon, conscious of Alliance anxieties on the subject, explained at length the domestic political dimension to his Safeguard decision. It was also important for the United States to maintain its defensive posture in anticipation of talks with the Russians—in effect keeping a bargaining counter. Healey explained that his outspoken criticism of Sentinel had been in part prompted by what he perceived as a lack of consultation. He was not disposed to criticise Safeguard because he felt he had been consulted and its rationale was more persuasive. He added that he hoped the Americans would not exaggerate the significance of ABMs as this could undermine the credibility of the (UK) deterrent.

The Foreign Secretary was briefed that ‘it is generally accepted that a major aim of strategic arms limitations talks [SALT] between the United States and the Soviet Union will be to find a way to limit ABM systems’.[113] Though Britain remained concerned about any ABM deployment, the Safeguard system seemed unlikely to be an obstacle to Strategic Arms Limitation Talks (SALT). Britain’s ‘particularly sharp’ reaction to the previous Sentinel announcement, ‘whilst having no practical effect on the [Johnson] Administration, nevertheless caused a good deal of annoyance in Washington’. Nixon’s ABM review was welcomed and the Foreign and Commonwealth Office (FCO) was encouraged by the reasoning and presentation of the Safeguard decision. The Labour Government was therefore much more ‘content’ with Nixon’s ABM policy than it had been with Johnson’s, a view confirmed in Parliament on 7 May.[114]

The continuing political controversy in Washington continued to be closely monitored by the British Embassy, and Britain was kept fully informed by the Americans as negotiations with the Soviets progressed.[115] A decision in January 1970 to proceed to ‘phase 2’—a full 12-site deployment[116]—was never authorised by Congress, and looked like being overtaken by a SALT agreement.[117]

US ABM deployment had become a serious policy issue for the British Government soon after Labour came to power in 1964. By the time they were replaced by Edward Heath’s Conservative Party in June 1970, the subject had largely subsided again. It was by then clear that ABMs were to be the subject of limitation. The United States did deploy a single ABM system in 1975 at Mickelson, North Dakota, to protect Minuteman ICBM silos, which was all they were allowed under the 1974 Protocol to the ABM Treaty.[118] It was de-activated soon after, though the Russians’ equivalent system around Moscow remained operational. It was the latter which henceforth was the source of British concern.

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7
Soviet ABM Deployment

THE CREDIBILITY OF THE DETERRENT

Defence against ballistic missiles has always been closely associated with the credibility of a nuclear retaliatory capability. This is especially so for a modest nuclear power like Britain, whose ‘minimum’ deterrent has at the same time been both relatively small and reliant upon a single means of delivery. Any such system is potentially vulnerable in two ways. It may be susceptible to pre-emption before it can be launched, and it can be countered in the air before it reaches its target.

As soon as Britain’s V-bombers began to enter service in late 1956,[1] their protection became the sole function of Britain’s existing and future air defences, and the essential function of BMEWS was to enable the bombers to get airborne before being destroyed on the ground. The perceived vulnerability of Blue Streak to a pre-emptive strike was a determining factor in its cancellation in 1960.[2] When Blue Streak’s successor, the American Skybolt, was in turn cancelled in 1962 the submarine-launched Polaris missile was selected instead. Only when Polaris entered service in 1968 did Britain acquire a deterrent system that was fully secure prior to launch.[3]

Ensuring the ability of the deterrent to hit its targets once launched has been equally problematic. By the late 1950s improvements in Soviet air defences were starting to call into question the ability of the new V-bombers to get through.[4] Robert Paterson only partly over-states the case when he asserts: ‘In 1957 Britain embraced massive retaliation with a nuclear force of doubtful credibility.’[5] The initial response to this problem was the Blue Steel stand-off powered bomb with a range of 100 miles, which obviated the requirement for the aircraft to over-fly their targets, and which was in service by 1963.[6]

An improved Mark 2 version with a range of 900 miles, was cancelled because ‘it would not long remain invulnerable to the Russian defences’.[7] The American Skybolt was preferred because, although also air-launched and with a similar range, being a ballistic weapon it was not itself vulnerable to Soviet air defences.[8] Skybolt appeared to offer the twin attractions of being able to overcome Russian defences without the (recently acquired) V-bomber force having to be retired. It was selected to replace Blue Streak once the latter was cancelled, though the V-bombers themselves were, if anything, even more susceptible to preemption, the very reason for Blue Streak’s cancellation. A supersonic replacement for the V-bomber, the Avro 530, had previously been discarded in favour of Blue Streak.[9]

Once it was clear that the future deterrent would be delivered by a ballistic missile, however launched, attention moved from Soviet conventional air defence to their ABM defences.

BLUE STREAK

Ironically, though Soviet offensive capabilities were the principal reason for Blue Streak's eventual demise, Soviet *defensive* capabilities were the initial spur to its development.[10] Over two years before the first V-bombers even entered service, the DRPC staff wondered 'whether we should develop long range ballistic rockets (against which no defence can be foreseen) at the expense of other strategic air effort'.[11] In 1955 the Air Ministry issued its operational requirement for what became Blue Streak:

> Future enemy defensive systems are likely to include ground launched guided weapons of increasing range, speed and lethality, with the result that it may be impossible to reach major target areas by either subsonic or supersonic bomber aircraft without prohibitive losses. If we are to maintain a medium range strategic bombardment threat, the ballistic missile offers the best chance of delivery of nuclear weapons since no effective defence against such a missile is now known.
>
> It is essential that the weapon system should have the maximum freedom from interference by enemy countermeasures and defences.[12]

By early 1958 studies had already been undertaken at Farnborough of decoys for a ballistic missile that could either be ejected from the warhead, or created by the break-up of the missile booster.[13] Such decoys could confuse ABM radars and force the enemy to use additional defensive missiles.[14] Later the same year, the first review of Blue Streak's future identified its twin survivability requirements: '…as invulnerable as possible to attack at base; and with spare capacity for devices for countering defences…' This is noteworthy, as at the time nothing was known of future Soviet missile defences. The Defence Board decided to continue Blue Streak's development as 'it would have the right combination of range…and capacity to carry counter counter measures'.[15]

Work on decoys for Blue Streak was also used to inform assessments of what countermeasures the Russians might incorporate into their own offensive missiles, and British ABM studies were used in turn to assess the threat to Blue Streak posed by Russian defences.[16] UK work showed that such defences were unlikely to be effective for some time.[17] The British Nuclear Deterrent Study Group assessed that '…once launched the Blue Streak missiles would be completely invulnerable so long as the Soviet Union had no effective defence against ballistic missiles'.[18]

Measures were taken, however, to overcome defences. The design of the Blue Streak re-entry vehicle minimised its radar reflectivity, whilst the booster was to carry 20–30 re-entry decoys. These would have similar drag/mass ratios and radar 'fingerprints' to the re-entry body itself, and would accompany it throughout its trajectory. The decoys would be carried externally on the booster, and be ejected shortly after re-entry body separation into a cloud of about 30 miles in diameter. They would be of radar transparent glass-fibre construction with a radar-reflecting metal nose cone and rear sphere, together producing similar ballistic and reflective properties to the warhead itself. Some decoys might also carry low-power radar jammers.[19]

This work came to end with the cancellation of Blue Streak in April 1960 on the grounds of its vulnerability to pre-emption, a separate problem altogether.

SOVIET DEFENCES

A former CIA analyst observed in 1984:

> There are and always have been many uncertainties about the Soviet BMD program, its achievements, technical objectives, and overall intent. As a result, our judgements about Soviet activities and the threat that they embody are far more often a matter of conjecture than of established fact.[20]

Soviet interest in defensive missiles began at the same time as their own offensive missile programme, in the years immediately after World War II.[21] Virtually nothing was known in the West of Soviet air defences until the mid-1950s, when Dragon Return reports provided the first clues about Russian work on surface-to-air missiles.[22] Soon after, there was evidence of an SAGW deployment around Mosow,[23] though its efficacy against the jet bombers then entering RAF service is doubtful.

Nothing was known of Soviet defences against ballistic missiles, but as work in UK indicated such a defence might eventually be possible: '…the enemy must, in his own interest, have considered or be considering this possibility. If he has evolved or does evolve a satisfactory active defence then the value of the threat of reprisals is seriously affected.'[24] A detailed study for the CoS using mathematical modelling of air attacks on the Soviet Union, with and without effective defences, concluded a little awkwardly that 'the inference should not be drawn that the USSR ought to neglect anti-BM defence'.[25] At the same time, a major US intelligence report suggested that a Russian ABM defence was still ten years away.[26] In early 1959 the JIC echoed this assessment, stating that though Soviet air defences, especially SAGW, were improving, they were 'not expected to provide adequate protection against large-scale nuclear air and missile raids',[27] at least until 1963 by which time Blue Steel would be in service and development of Blue Streak well advanced.

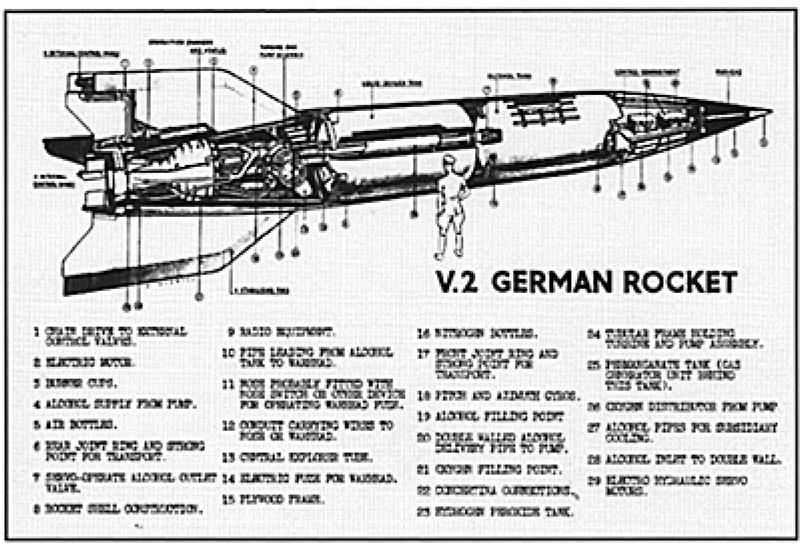
The JIC did believe that the new SA-2 'Guideline' SAGW might be operational around Moscow,[28] and it was now known that investigations had started in 1953 into the adaptation of existing SAGW guidance systems for ABM purposes.[29] The United States had observed radar installations possibly connected with ABM, one of which was located at Sary Shagan by a U-2 flight.[30] The JIC relayed this information, assessing that a limited BMEWS capability might be operational by the end of 1960.[31] At the same time that research into active defence was being largely terminated in Britain (see Chapter 4), the JIC summed up what little was known of Soviet efforts in the field:

> It is believed that the USSR will have placed anti-ballistic missile defence on top priority, foreseeing that a successful solution to this in advance of a developed solution by the West will offer distinctive advantages to its strategy. It is known that the problem was under consideration some years ago and evidence suggests that development is now underway. It is not yet possible to indicate any specific design feature of this development and estimates of its characteristics and time scale are only possible by analogy with western ideas.[32]

The potential shortcoming of this approach was identified by Air Vice Marshal Bateson, ACAS(OR): '…arguments based on our own limited progress in this field are not necessarily a valid extrapolation of possible advances made by the USSR…'.[33] A little later the JIC's annual report on Soviet air defences (which indicates the importance attached to the subject) assessed that 'after 1964 a limited active system of defence against simple ballistic missiles could be deployed for a very small number of important targets, but it would be effective only against missiles arriving from certain directions'.[34] This judgement was derived from assessments, based on US ABM work and further evidence of Soviet progress.[35]

At the beginning of 1963 it was reported that the Soviets had developed, and possibly begun to deploy around Leningrad, a limited terminalphase ABM system, but that it would be unable to discriminate between warheads and decoys.[36] The Russians could be ahead of the Americans, with a system roughly comparable to Nike-Zeus,[37] but, 'There is no evidence that the Soviets have made any significant advances in solving the problem of discriminating between targets and decoys or for that matter, that they have been concerned with it.'

The Leningrad system was based on the 'Griffon' missile, which the JIC assessed to be a high-altitude defence against bombers and cruise missiles, with a limited ABM potential.[38] However, deployment was halted soon after, probably due to performance limitations, and the issue of whether it was intended to have an ABM role was never fully resolved.[39] Further sites for SA-5 'Gammon' systems were detected in what became known as the 'Tallinn Line' and were the subject of intense intelligence investigation by the United States.[40] They were also, in fact, intended to counter supersonic bombers and cruise missiles, rather than IRBMs and ICBMs.[41]

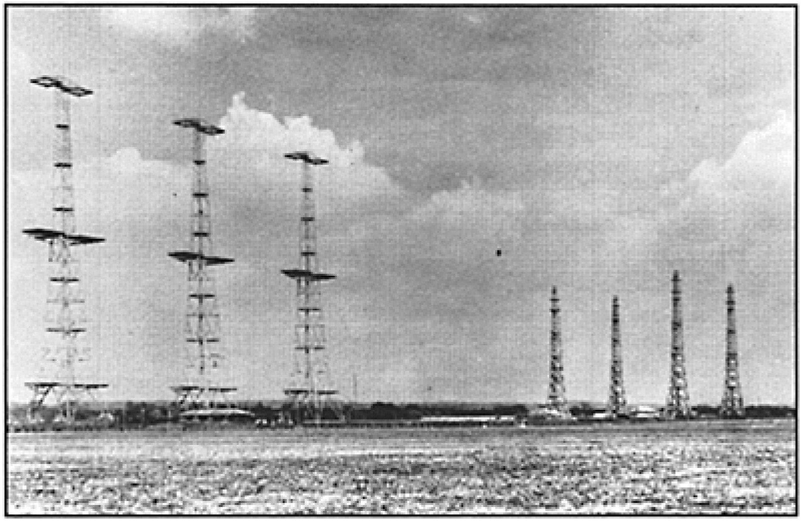


1. A post-war British diagrammatic representation of the world's first

operational ballistic missile (Imperial War Museum C4832)

2. Duncan Sandys, Chairman of the ‘Crossbow’ Committee, addressing a press conference, 7 September 1944. He declared the Battle of London to be over: the first V-2 arrived the following day. Seated to his right is General Sir Frederick Pile, Commander-in-Chief of the Army’s AntiAircraft Command throughout the War. On his far left, facing the camera, is Air Chief Marshal Sir Roderic Hill, Commander-in-Chief of Air Defence of Great Britain (later Fighter Command). (Imperial War Museum CH 13827)

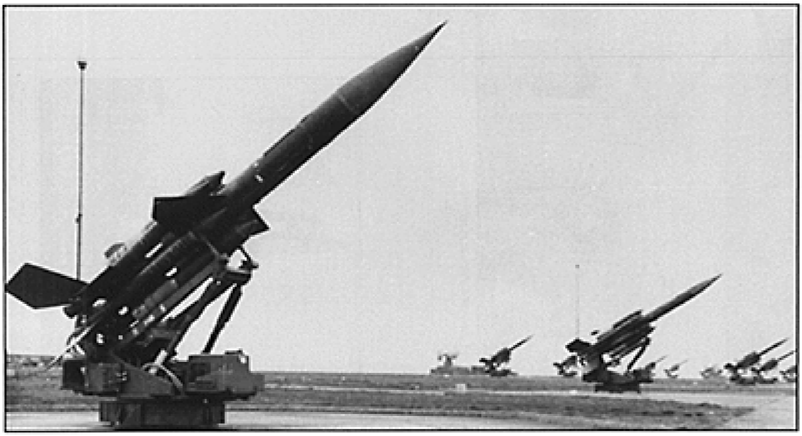
3. Site of a V-2 strike in Islington, North London, pictured some six months later. (Imperial War Museum CH 15111)



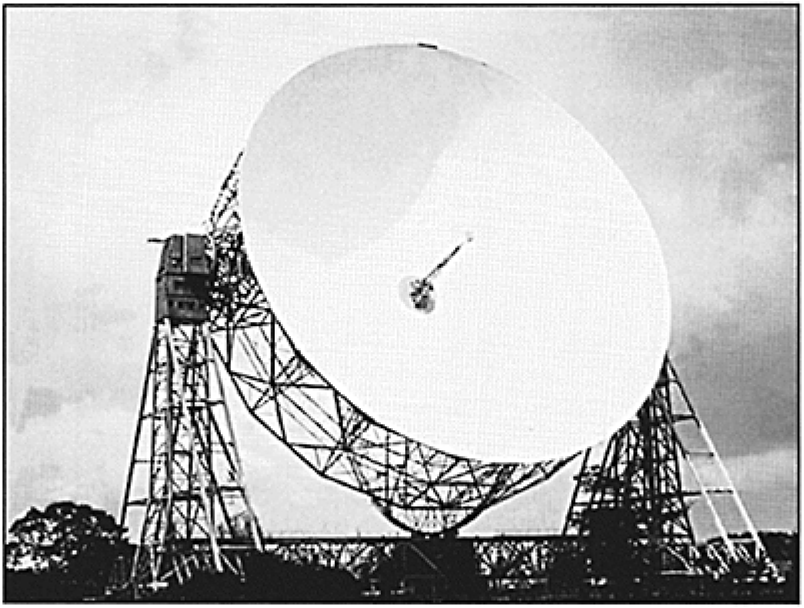
4. Chain Home radars, which formed part of the improvised V-2 early-warning network (Imperial War Museum CH 15173)

5. MPs inspect 3.7” AA guns, 1944.
(IWM) H 34290

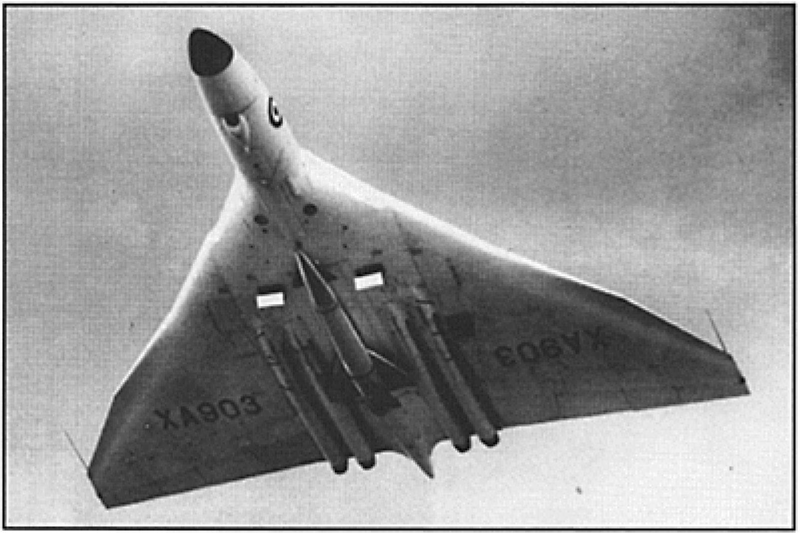
6. German V-2 rocket being prepared for test-firing under British supervision, late 1945. (Imperial War Museum BU 10770)



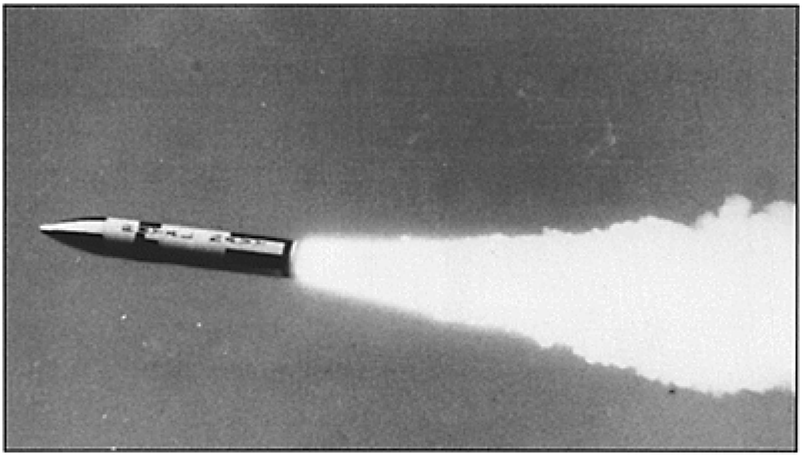
7. Bloodhound surface-to-air missiles, which formed the basis of the so-called ‘Interim’ ABM system proposed in the late 1950s



8. Jodrell Bank Radio telescope, which provided a limited, interim ballistic-missile early-warning capability in the early 1960s. (Jodrell Bank)



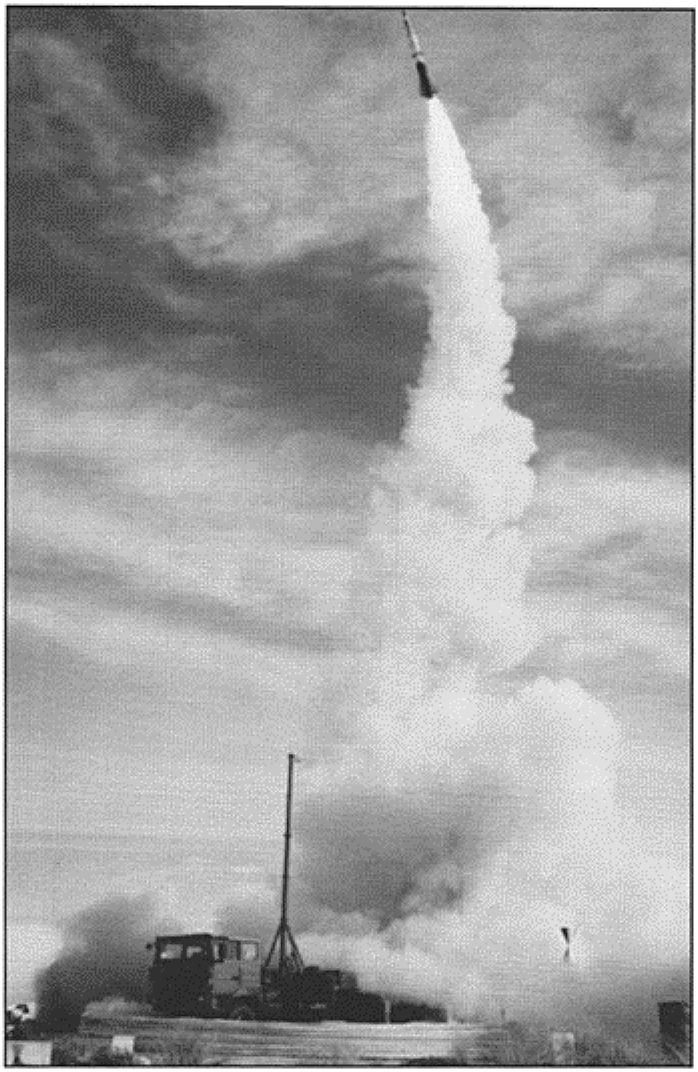
9. Vulcan bomber with Blue Steel stand-off powered bomb. This was the first attempt to counter Soviet air defences but was vulnerable to pre-emptive strike on the ground by Soviet ballistic missiles. (Imperial War Museum MH 27874)



10. Polaris missile being fired from a British submarine, 1970. Polaris was

assessed as being vulnerable to Soviet missile defences even before it entered service with the Royal Navy. The Chevaline Polaris Improvement programme was specifically designed to overcome the 'Galosh' ABM system around Moscow. (Imperial War Museum MH 30564)

11. RAF Fylingdales, 1992. The new Solid State Phased Array Radar (SSPAR) 'pyramid' has been completed, but the old 'golfballs' containing the FPS-49 radars have yet to be dismantled. (RAF Fylingdales)



12. Aster 30 missile which will equip the Royal Navy’s new Type 45 destroyers. A land-based Block I version being developed for France and Italy will have a lower-tier capability against shorterrange ballistic missiles, and could form the basis of a UK system for the defence of deployed forces. (DGA/CEL)

By the middle of 1965 there was some evidence of a different ABM being deployed around Moscow. This was the ‘Galosh’ system, first seen on parade in Moscow the previous November. Because it was displayed inside a canister, the intelligence assessment made was somewhat speculative, but it was believed to be a two-stage, nuclear-tipped ABM system designed for exo-atmospheric interception. Its range could be as much as 450 miles, but no assessment could be made of its manoeuvrability.[42] It was expected that the defence of Moscow would be given priority, and it was possible that existing SAGW sites were being modified to take the new system. In addition, large ‘Hen House’ radars were under construction as part of a BMEWS system though as yet the Soviets lacked a comprehensive early warning capability[43] (RAF Fylingdales was by this time in operation).

By now Soviet ABMs were the subject of interest beyond the intelligence community. The MoD prepared a detailed summary for the Foreign Office as part of preparations for the UK-US ABM discussions in October 1966:

> We believe that the Soviet defensive policy includes an active defence against ballistic missiles of all types. This has been demonstrated by the continuance since 1956, of an extensive R and D programme based on the Sary Shagan Anti-Missile Test Centre (SSATC) and certain deployment activities taking place at Moscow and in European USSR. We have insufficient knowledge on which to base an estimate of the exact characteristics of any ABM systems which have been developed but we have been able to make preliminary assessments of missile and radar equipment almost certainly associated with the programme and to examine the developing pattern.[44]

The report went on to summarise what was known of the Griffon and Galosh systems, and provided more detail than hitherto of Soviet ABM radars, including some seen in a propaganda film ‘Rockets for Peace’. The Hen House early warning radar was an electronically scanned array assessed to have range of about 2,000 miles and some tracking capability. The ‘Dog House’ radar under construction south-west of Moscow was believed to be another phased array, this one for acquisition, tracking and possibly target discrimination. Several ‘Triad Buildings’ under construction at existing SA-1 sites were surmounted by domes believed to house target- and missile-tracking radars. These assessments were all based on photographs and intercepted radar emissions.[45] Hen House sites on the Kola peninsula and the Baltic coast were of particular interest as they could provide up to 15 minutes’ warning of a Polaris attack. The study concluded:

> …construction representing the initial deployment of an ABM system is taking place at Moscow. It is not possible to determine whether the system will be long range exo-atmospheric, endoatmospheric or both as no missiles have been sighted. Deployment activity at other areas (Tallinn etc) is for a different system which may be ABM but…is more likely to be long range SAM.
>
> We are not able to estimate the effectiveness…of any ABM system deployed by the Russians nor have we identified any specific experiments

> designed to examine the problems associated with penetration aids. It is possible that the first ABM system may not have a capability against such devices.

The ABM conference with the Americans in October showed that the US assessment was much the same: '…this system could provide a limited defense of the Moscow area but…it could be seriously degraded by sophisticated penetration aids, precursor bursts and the vulnerability of the radars to nuclear explosions.'[46]

The early warning radars being built covered the planned deployment areas for the UK's Polaris submarines, but the Russian ABM system was vulnerable to saturation, 'though it might engage simultaneously (but not necessarily destroy) the smaller number of UK missiles'.[47] The Moscow system might provide a partial defence of about a third of Soviet cities.[48] An MoD official also observed that for several 'influential Americans', a side benefit of Soviet ABMs would be to exclude the UK and France from the 'nuclear club'.[49]

In February 1967 the JIC reported that the Soviets had been developing back-scatter HF radar, which may have been used to detect Western nuclear and missile tests. These radars had not been detected in a surveillance role.[50] A study was also made of the vulnerability of the Moscow ABM system. The number of Triad sites indicated that the system could deal with 16 incoming missiles at a time (coincidentally the number to be carried by a Polaris submarine). Galosh was believed to be committed to a predicted intercept point after sustainer burn-out (about 66 seconds). It could therefore be defeated by manoeuvring warheads in the remaining time before intercept (about three minutes), though the high lethality of a nuclear burst in space might in part compensate for this. It appeared that little if any work had been done on overcoming penetration aids. Finally, the associated radars (Hen House and Dog House) provided limited arcs of coverage and might be vulnerable to precursor nuclear bursts. Polaris effectiveness in the face of this defence varied, depending on whether it was fired from within the early warning coverage area, and to a lesser extent on the range from which it was launched.[51]

The most comprehensive assessment yet of Soviet BMDs was produced by the JIC in October 1967.[52] By now a substantial programme of improvements to the Polaris system was being considered (see below), with Moscow the critical target. The intelligence estimate needs to be viewed in that light. The JIC's forecast of future Soviet BMD developments was inferred from:

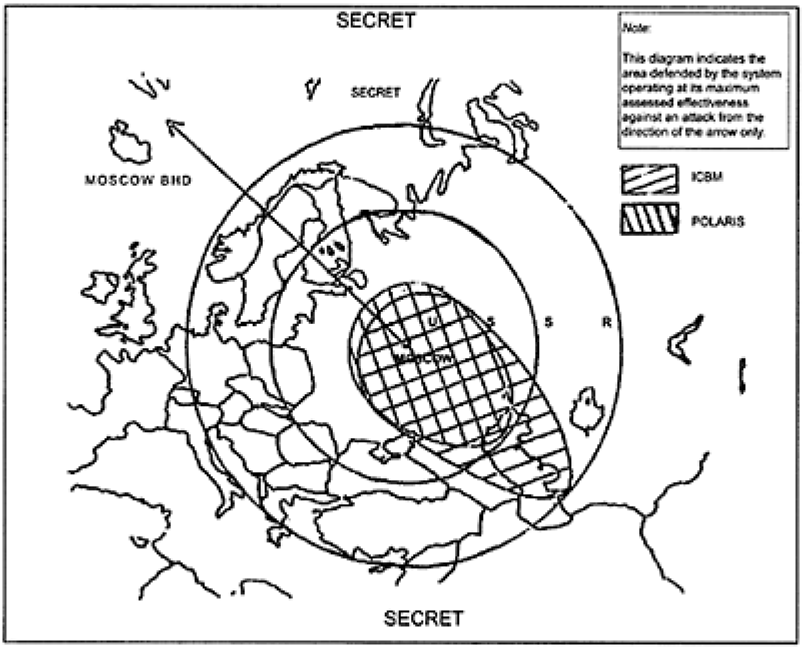
(a) the defence which the Russian are deploying and the possible reasons for this deployment; and
(b) the military, technical, economic and political factors which we consider are likely to affect the decisions of Soviet policy makers.

It concluded:

(a) The Moscow BMD system, which is expected to be operational by 1970, will provide a degree of protection against attack from the north-west and possibly the south-east. It will probably be extended to cover attack from all directions.
(b) The Moscow system as now known could be saturated by mass attack. The performance of the system would be reduced by manoeuvrable re-entry vehicles, by

decoys, and particularly by hardened warheads. Further development of penetration aids will render the system even less effective.

Figure 8: Anticipated Coverage of the Moscow BMD System



Source: PRO CAB 158/66 JIC(67)32(Final) Appendix A to Annex 31 (October 1967)

(c) The Russians must now realise that, barring an unforeseen technical breakthrough, a defence capable of destroying the credibility of the Western deterrent will not be feasible, but that defence against a small-scale attack may be…

The Soviets were considered unlikely to come to an agreement on ABMs with the United States, in view of their long-standing policy of defence by all possible means. Additionally, China provided another long-term need for missile defence for the Soviets as well as the Americans. It was still not possible to make an accurate assessment of the Galosh system's performance, but a defended area extending up to 300 miles in the direction of attack, and up to 700 miles on the far side of Moscow against Polaris was predicted.

High-altitude nuclear tests conducted by the Russians in 1961–62 indicated that they believed 'killing' missiles at long ranges outside the atmosphere was feasible, but a change in public pronouncements on BMD suggested that they were becoming less optimistic about the effectiveness of defences: '… Soviet BMD deployment will not destroy the credibility of the Western deterrent. Most Soviet military strategists must appreciate this…development of penetration aids will render the system even less effective.' They did not appear to be developing an endo-atmospheric terminal phase interceptor comparable to the American 'Sprint'; why not was not understood. Significantly,

> the Russians may expect that an extensive BMD deployment would so reduce the effectiveness of the British and French missile forces that they would not serve as the basis for an independent European deterrent… In Soviet eyes bi-polarity thus strengthened would make it easier for the United States and Russia to control political crises…

As to future developments, 'No hard conclusions can be reached…[but] the Russians attach special importance to Moscow and have already devoted considerable effort to provision of the existing system. We believe that for both political and military reasons they will extend it…' A 'sanitised' version of this report formed the basis of the UK's submission to the NPG on Soviet BMD.[53]

A year later Zuckerman reported that the Americans had noted slow progress with the Moscow ABM system, indicating that the Soviets had 'little faith in the usefulness of the work they are doing'. This accorded with UK observations on the rate of progress,[54] but Western analysts assessed that the system acquired 'some' operational capability in 1968.[55]

In April 1969 the MoD's Director-General of Intelligence noted that Britain had good intelligence on what the Soviets were actually doing, but not on their intentions for the future. It was still clear that the United States could easily saturate it, but 'the Moscow ABM system looks rather more formidable in terms of the British or French Polaris-type deterrent'. R&D was continuing and 'its future effectiveness, especially versus the UK deterrent, may be of greater consequence'.[56] The Russians had by now established a 'thin' system around Moscow comprising four sites with a total of 64 launchers, which was the subject of a 'massive' survey as part of the Polaris Improvement Study,[57] which unfortunately has not yet been declassified.

In March 1970 Zuckerman opined that 'what we know about present levels of Russian ABM deployment need cause us no concern',[58] though this view was clearly at variance with intelligence assessments. In July he obtained further information from Harold Brown, a future US Defense Secretary but then part of the SALT negotiating team.[59] The ability of the Galosh system to defeat an *American* (i.e. far more numerous) Polaris attack was doubtful, especially as the SALT negotiations had established that the Soviets were now willing to limit ABM systems to the respective national capitals. Zuckerman and Brown also discussed the ability of the US 'Antelope' penetration system to defeat Galosh.

Later the same month a meeting was held between representatives of the MoD, AWRE, RRE and the Directorate of Scientific and Technical Intelligence to discuss the effectiveness of the Moscow BMD system. Depending on the operating mode of the system, the defended 'footprint' extended up to 450 nm in front of Moscow and 950 miles beyond it against a Polaris threat. Significantly, 'in the case of the present day Polaris A-3 warhead, the lethal range of an exo-atmospheric ABM warhead detonation is so great that there is no chance of a Polaris A-3 payload surviving a successful intercept'. The effectiveness of a future Soviet BMD system against an improved Polaris warhead was dependent upon ‘the outcome of the large and vigorous R&D programme on missile defences which the Russians are now carrying out’. Intelligence suggested that the Soviets were working on a re-ignitable rocket motor which would give Galosh, or a successor interceptor, a terminal propulsive phase which would increase flexibility in managing intercepts, though not a larger defended area. They were also doing major work on control radars. It was concluded that ‘the next generation system will have a coverage no less than that estimated for the current system and… it will be effective against the Polaris A-3’.[60]

If SALT were to eliminate ABMs altogether, the UK did not have a problem with the credibility of its deterrent. However, limitation rather than abolition seemed more likely. Moreover, in the absence of any agreement at all, the Russians were assessed as being capable of deploying up to 500 ABM launchers, and ‘no one knew how far the Russians might actually go’.[61] Even the existing 64 launchers around Moscow could not be saturated or exhausted by a UK Polaris force able to fire a maximum of 32 missiles.

In view of the Soviets’ lack of a terminal interceptor comparable to the US Sprint, a technical study group formed from AWRE, RAE and RRE looked at the possibility of the long-range SA-2 Guideline being adapted for the purpose. They concluded this was unlikely, and that if the Russians wanted such a capability they would do better to start again.[62]

By 1970 the full four-site, 64-launcher complex was operational, though work had stopped on two further sites. It appeared that the Russians, conscious of the technological limitations of the existing system, were waiting for further improvements and the outcome of the SALT process before proceeding further.[63] The ABM Treaty (part of the SALT process) signed in May 1972 by the United States and the Soviet Union limited each side to two ABM systems of 100 launchers each, one to protect the national capital, the other an ICBM ‘field’. A 1974 Protocol reduced this to one system each—in the Russian case, the existing Moscow sites. This, then, was the system the small British Polaris force had to deal with. As Stanley Orman later put it, ‘The deployment of the Russian ABM system was not a minor irritant to a country with such a limited deterrent force; it necessitated a major reconsideration of strategic thinking.’[64]

DISCUSSIONS WITH THE SOVIETS

From a comparatively early date, the British Government paid heed to Soviet public statements about missile defences. Most famous was Khruschev’s statement in July 1962 that ‘our rockets can hit a fly in space’.[65] This was not, however, the Soviets’ first public pronouncement. The previous year, Marshal Malinovskiy had informed the Communist Party Congress that the problem of destroying rockets in flight had been solved.[66] These and similar statements were correlated by the MoD with what the Americans had observed being installed around Leningrad, with the inference that the Russians believed their defences to be as effective as their own offensive missiles.[67] Khruschev later confirmed that he had, in part, been bluffing.[68]

The Foreign Office recognised that there might be no more they could do to influence the Russians[69] than they could the Americans. As even a limited system for the defence of Moscow ‘would have a serious de-stabilising effect on the present East/West balance',[70] this was a matter of concern. It was known that the Russians and Americans had exchanged views on ABMs informally in 1964,[71] and the Foreign Office Minister Lord Chalfont had similar discussions with a Soviet diplomat in November 1965. These revealed

> a fine example of the ostrich-like attitude of the Russians. They seem to take the attitude that if a weapon is defensive it is automatically good and useful. In fact…both sides are likely to feel under the compulsion to meet the uncertain ABM threat…by increasing the number of missiles in their deterrent and thus giving another upwards twist to the arms race.[72]

The Foreign Office therefore began to consider whether the Soviet Government should be approached formally with a view to achieving some ABM limitation.[73] This idea was welcomed by the Americans, if only as a way of finding out what the Soviets really thought on the subject.[74] Wilson raised the subject with Kosygin during the former's visit to Moscow in February 1966 and again when the latter visited London a year later. By this time President Johnson had proposed talks with the Soviet Union covering offensive and defensive missiles, but so far without response.[75] It was 'very important to get the Russians to understand the real arguments about ABMs'.[76] When the issue was raised with Kosygin by Wilson and the Foreign Secretary, George Brown, his response was a traditional Russian one, stressing the importance of the defence. Wilson himself reported Kosygin's view that the UK had

> posed the question in a very odd way, as had President Johnson and Mr McNamara, when they approached the subject. Their attitude seemed to be one of asking why they should start making antimissile systems when it was cheaper to make offensive weapons. He was surprised that we should support this attitude…what kind of philosophy was it that concerned itself with killing people in the cheapest possible way?…
>
> He must express his criticism of the Labour Government for taking the line that it was cheaper and better to go with offensive systems.[77]

Wilson, anxious to be an effective go-between in superpower negotiations, persisted. A 'piece of paper' was accordingly delivered to the Soviet Government by the British Ambassador the following month. It reiterated the British view that an ABM deployment would amount to a further twist in the arms race and put paid to prospects for arms control, specifically a comprehensive test ban.[78] Kosygin promised to study it, subsequently making clear that the Soviets would not discuss defences in isolation, but only in the context of all strategic nuclear weapons.[79]

The major report on Soviet ABMs compiled by the JIC later that year examined Soviet public statements on the subject,[80] noting that claims made since 1965 had been more cautious. This was ascribed to greater realism about the effectiveness of ABMs in the face of improvements in the US offensive capability. In June 1968 the Soviet Government agreed to the American proposal of 18 months before that both offensive and defensive weapons should be discussed—what became SALT.[81] The JIC assessed that this was the result of a fundamental reappraisal of the cost-effectiveness of ABMs and the prospects of their providing a 'net increase' in their level of security.[82] Thereafter the UK took a back seat as secret bilateral negotiations progressed towards the signing of the ABM Treaty,[83] though Britain was kept fully informed by the Americans.[84]

THE MOSCOW CRITERION

One issue, so far only alluded to, has dominated Britain's response to Soviet missile defences: the so-called 'Moscow Criterion'. For Britain, as a last resort, to be able to deter a larger and much more heavily (nuclear) armed country like the Soviet Union, it must be able to inflict 'unacceptable damage'.[85] This meant a targeting policy of 'counter-value' (i.e. cities) rather than a hopelessly one-sided competition in 'counter-force' (military targets).[86] As a memorandum submitted to the House of Commons Defence Committee in 1981 put it, 'This in turn raises the issue of how imperative it is to threaten Moscow.'[87]

Moscow was regarded as the key target by the Soviet leadership itself: '…the area…essential to the continuation of the Soviet political regime …the heart of the motherland and an economic, military, industrial and political center'.[88] Its destruction 'might well be more than the Soviet leadership could contemplate'.[89] Though other targeting strategies have been considered against undefended cities,[90] Moscow has always been regarded by Britain as *the* significant target in maximising the deterrent effectiveness of its small strategic nuclear force. Michael Quinlan, then Deputy Under-Secretary of State at the MoD, confirmed this view in 1974: '… Governments did not want to have a situation where the adversary could have a sanctuary for his capital and a large area around it.'[91] Sir Hermann Bondi, Chief Scientific Advisor for much of the 1970s, told a BBC interviewer in 1985 that 'abandoning "the Moscow criterion" would be a very severe reduction in what one might call "the quality of the deterrent"'.[92]

The fact that the British threat does not seem to have influenced Soviet BMD policy to any significant degree[93] does not invalidate Lawrence Freedman's judgement that, 'in a society as centralised as that of the Soviet Union the disruption caused by the loss of Moscow would far outweigh the loss of any other centre'.[94]

In 1985, John Roper observed that

> Soviet Ballistic-missile defence has been a major factor in British decision-making on nuclear weapons for some 20 years. Indeed, because of the relative size of the British force and the political requirement to strike Moscow, the one target in the Soviet Union which has until now enjoyed some ABM protection, more attention had probably been given to Soviet BMD in London than elsewhere.[95]

Though Britain was not a signatory to it, the ABM Treaty played a crucial role in this equation. David Owen, Labour's Navy Minister, later wrote:

> The lack of any agreement to halt further ABM deployment could have a serious effect on the viabi lity of the French and British deterrents. Their

> effectiveness to penetrate Soviet territory *[sic]* would be seriously weakened by thick ABM deployment.[96]

As Lawrence Freedman observed to the House of Commons Expenditure Committee in 1979, 'The May 1972 ABM Treaty worked to the advantage of the British and French nuclear deterrents by making it easier for them to reach Soviet targets.'[97] Soviet missile defences would not become so widespread and numerous as to negate Britain's deterrent altogether, but at the same time it did allow a limited defence of the key target, Moscow, that Polaris must, and with improvement could, overcome.

POLARIS IMPROVEMENT

Polaris was selected as the future UK strategic deterrent after the cancellation of the US air-launched Skybolt missile in November 1962. A few months later the MoD's Long-Term Study Group stated that though high-altitude missile intercepts were achievable, the use of decoys could overcome the defence. The Americans were known to be carrying out a programme to ensure that their missiles, including Polaris, could penetrate any defences.[98]

In Britain the Ministry of Aviation had continued to investigate defence penetration using the Black Knight experimental rocket firings in Australia after it was no longer required for Blue Streak development. The aim of this work (Project 'Dazzle') was to enable the UK to retain the capacity to design and build re-entry vehicles and decoy systems,[99] and part of the re-entry system for the UK's Polaris missiles was to be a British design.[100] Moreover, a classified annex attached to the Polaris Sales Agreement specifically excluded penetration aids from the information to be supplied by the United States.[101] Zuckerman believed that this left the UK more dependent on American goodwill in this area than the rest of the Polaris project, but Black Knight studies (in which the United States was involved anyway) meant the UK had something to offer in return.[102]

At the same time, the appreciation of the threat to re-entry vehicles posed by nuclear-armed defences was changing. During the design of Blue Streak it had been assumed that the problem was the blast from a nuclear explosion in the upper reaches of the atmosphere. But by 1963 it was clear that a much bigger threat was from high-yield X-rays outside the atmosphere, and low-yield neutrons inside it.[103] The US Spartan/ Sprint combination stemmed directly from that perception, though the Soviets were much slower to produce a Sprint-like component. For the United States and the UK, it meant warheads would have to become resistant to exo-atmospheric X-ray attack.

By September 1965 the UK Polaris project was well advanced.[104] Information was still not forthcoming on the penetration aids planned for US missiles, and a debate about whether the UK should follow a similar path was 'in abeyance'.[105] It was believed, however, that it was more cost-effective to deploy penetration aids than to try to overcome them,[106] though at this stage there were mixed views on the subject. In the absence of 'penaids' a Russian ABM deployment would 'bring into question the effectiveness of our Polaris',[107] according to a brief prepared for Wilson. The CoS, however, did not agree: '…a limited deployment of Russian ABMs would not detract from the effectiveness of our Polaris force as a contribution to NATO. Furthermore, in our view, even a widespread deployment of systems based on present techniques would not invalidate it.'[108]

The Americans, meanwhile, had decided to go ahead with the 'MIRV'd' (Multiple Independently Targeted Re-entry Vehicle) Poseidon missile to overcome Soviet defences.[109] The Soviets might deploy ABMs in sufficient numbers to counter a US-scale attack, in which case the much smaller number of UK Polaris missiles could face up to 40 ABMs each.[110] There was therefore a growing interest in 'hardening' Polaris warheads to withstand the effects of a nuclear explosion and developing penetration aids to go with them,[111] and a preliminary study was undertaken. A purely national programme would cost about £5½ million to develop and a further £27 million for full flight trials. A joint programme with the Americans would be much cheaper, though requiring an amendment to the Confidential Annex to the Sales Agreement.[112]

One reason for improving Polaris would be not its effect on Russian perceptions of the UK deterrent, but on American.[113] The Deputy UnderSecretary (Policy) in the MoD, Leitch, advised Healey that

> if we are going to stay in the nuclear business we must make some effort to keep our weapon system credible, as much to impress our allies as our potential enemies…having committed ourselves to Polaris and spent large sums of money it seem sensible to me in principle that we should be prepared to spend a little more now. How much more we should spend—ie whether we should go for penetration aids as well as hardening—depends crucially on the assessments of the relative effectiveness of the various measures and of the degree of probability of a further breakthrough in the ABM field.[114]

At a meeting of the Ministerial Committee on Nuclear Policy in May 1967, it was decided to send a team to Lockheeds in the United States (the Polaris manufacturers) to determine whether the UK could manufacture US-designed penaids, and at what cost. The Pentagon's Director of Defense Research and Engineering, Dr Foster, had already agreed to this. Failing this approach, Healey did not rule out a purely UK programme.[115] The British Government had, however, already decided against the purchase of Poseidon missiles[116] which would have obviated the need to improve Polaris. A Labour backbencher over-stated the case when he said that 'the Polaris missile is already virtually obsolete…if there is a decision to go ahead with the development of anti-ballistic missile systems our Polaris missiles will become virtually useless'.[117] Nonetheless, the future credibility of Polaris in the face of ABMs was certainly a potential problem.

The most pressing issue, for purely programmatic reasons, was whether to purchase hardened or unhardened missiles (as opposed to reentry vehicles). The United States was about to place its final orders and it was actually cheaper to buy hardened.[118] On Healey's recommendation, this decision was quickly taken. This did not address the real problem, however. The existing three Polaris re-entry bodies would disperse by about ten miles, well within the lethal radius of a single well-placed ABM megaton burst (up to 100 miles). It was pessimistically assessed that even if two submarines could be maintained on station (which was not always possible with a four-boat force), 50 ABMs could neutralise the entire UK deterrent. 'This scale of defence could be almost within Russia's capability now.'[119] The unmodified re-entry system was so vulnerable that even a relatively simple Chinese ABM system (which never materialised) could negate it.[120]

Neither a hardened re-entry body nor decoys would, on their own, significantly improve Polaris's ability to penetrate an ABM system. However, US hardened re-entry bodies in conjunction with UK or US decoys could increase the ABMs required to defeat them ten-fold. A more advanced British re-entry body which could be developed would pose an even greater problem for the defence—up to 2,000 interceptors. For design reasons, this was only compatible with British decoys. The cost of developing British re-entry bodies and decoys was estimated at £50 million. A less advanced US package now appeared to be actually more expensive, especially in scarce dollars.[121]

Polaris improvement was considered by the Ministerial Committee on Nuclear Policy in December 1967, as part of a major review of UK nuclear weapons policy.[122] Healey was clearly convinced of the need for penaids though others like Zuckerman and Anthony Wedgwood Benn, Minister of Technology, were not. The cost of improvements did not 'seem large by comparison with the costs of other defence projects and the investment already made in Polaris'. All options would require some degree of US cooperation. The review stated unequivocally:

> The advent of ABM defences in Russia…will reduce the amount of damage that our Polaris force can expect to inflict. If, therefore, nothing is done to improve Polaris… This will inevitably cast doubts on the credibility of our deterrent.

It was too soon to make a definitive decision to improve Polaris,[123] so it was decided to undertake further studies of the various options, with particular reference to the work that would be required at the AWRE. Healey was to find out from McNamara what further information might be forthcoming from the United States.[124] This proved to be substantial, provided the UK committed itself in advance actually to use information supplied to improve the British Polaris.

Work in 1968 established that there were really two options. One was to adopt the US project ('Antelope'), the other to develop that work further with an improved hardened re-entry body and British decoys ('Super Antelope'). The new US Administration of Richard Nixon did not materially alter the degree of US cooperation available, but the UK's own technical studies were still under way in early 1970. By then, the SALT negotiations indicated that ABM limitation was likely, with obvious implications for Polaris improvement. Re-deploying Polaris submarines to the Mediterranean in order to attack Moscow from a direction not covered by the Galosh system was rejected on logistical grounds and the possibility that the Moscow ABM system might be extended anyway.[125]

A brief prepared for the Prime Minister stated that the Technical Study Group had demonstrated 'serious shortcomings' in the US Antelope plan. On the other hand, it seemed that improved decoys and further hardening could achieve a satisfactory defence penetration without requiring either a new generation weapon system (Poseidon) or 'intolerable' costs. A two-year feasibility and project definition study would cost about

£4 million. This would maintain the good working relationship with the Americans which had by now been established, without committing the government to final development.[126]

A General Election was looming, but in the meantime it was necessary for Healey to get (Wedgwood) Benn 'under control' in view of his opposition, as Minister of Technology, to any further work on Polaris. The timetable for Polaris improvement was now 'very tight' in view of expected Soviet progress with ABMs.[127]

Labour lost power to the Conservatives under Edward Heath in June. Zuckerman wasted no time in seeking to dissuade Heath from authorising the new studies.[128] He argued that Polaris was a contribution to the overall Western deterrent, for which Soviet ABMs were no match. An independent use of nuclear weapons by Britain was not credible and anyway Russian ABMs were designed to match the American threat, which Britain could not equal. He accurately predicted significant cost escalation of any improvement programme. In conversation with Harold Brown, Zuckerman was told: 'It is technically possible to elaborate the Antelope system, but the cost would be enormous, open-ended, and for very little strategic gain. The Americans are not considering this move.'[129]

Others were not convinced, as it was clear that SALT would not result in zero ABMs. Lord Carrington, the new Defence Secretary, wrote to Heath in October 1970 that 'nothing…would justify a decision now to abandon the option of improving our Polaris system', provision for which had already been made in the 1970 Long-Term Costings.[130] Heath agreed that the AWRE should make an immediate start on a Super Antelope feasibility study,[131] which was followed two years later by a project definition study.[132] The final decision to undertake a five-year Polaris Improvement Programme was taken in April 1973 after the initial studies had completed.[133] This was confirmed by Labour following their return to power in 1974,[134] consistent with their earlier approach that it was a modification of an existing system rather than a new capability.[135] As Lawrence Freedman puts it, The virtues of Chevaline…[lay] in the fact that it appeared to be the minimum required to keep Polaris up to date and postpone a more difficult and visible decision on the matter of wholescale replacement,'[136] which meant either Poseidon or an early commitment to Trident.

The Americans had completed trials of their Antelope system before deciding, instead, to deploy Poseidon. The ideas behind Antelope were, with one exception, taken over by the UK and further developed. The exception was a decoy called Impala, which would accompany the warheads right into the atmosphere, after the other, lighter decoys had burnt up or been left behind on re-entry. Initially the Soviets only deployed an exo-atmospheric interceptor, so Impala was not required.

Another possibility was to scrap Super Antelope altogether and instead increase the separation of all three warheads, as well as hardening them. 'Hardening and Tilt-Out' was investigated but rejected in favour of Chevaline's hardening and decoys, amidst substantial controversy inside the MoD. The aim was to field a 'practical solution which was adequate, not too much and not too little',[137] possibly references to Poseidon and Tilt-Out respectively.

Super Antelope, which was re-named 'Chevaline' in 1974 (possibly to obscure its US origins) entailed substituting a Penetration Aid Carrier (PAC) for one of the three existing warheads. The remaining two warheads were themselves totally new, disguised and hardened against the effects of an exo-atmospheric ABM detonation.[138] The PAC was a ‘sophisticated space craft’,[139] which after separation from the Polaris second stage manoeuvred to deploy its payload of over 40 ‘hard’ (dummy warheads) and ‘soft’ (chaff) decoys. The AWRE produced the new warheads, and the RAE with industry the PAC. The resultant increase in weight significantly reduced the range of the UK Polaris missiles (designated A3TK) and therefore the size of the submarines’ operating area.

Escalating costs were a notable feature of the Chevaline programme, exacerbated by ‘trickle funding’.[140] When the project definition study began in late 1970, costs were estimated at £85 million. By the time full development was approved three years later, this had risen to £235 million. The final cost was around £1 billion, a three-fold increase over the original estimate, allowing for inflation. Much of this was due to under-estimation of the scientific and technical complexities involved and alleged poor project management in the early years.[141]

Until the Polaris Improvement Programme was completed, later than originally forecast, there were significant doubts within the MoD about Polaris’s ability to penetrate the Moscow ABM system. These doubts were understandably not made public, and nor were the efforts being made to rectify the shortcoming.[142] The relationship between offensive and defensive systems was often debated in public, however, in Britain as well as the United States.[143] In fact, it was known to some observers early on that the UK was upgrading Polaris, including the development of decoys.[144] Others were less well informed. A persistent belief has been that Chevaline replaced the three 200 kt warheads by six 40 kt MIRVs,[145] a view apparently taken by the Russians after observing flight tests (space and weight constraints only allowed for six telemetry decoys during test flights).[146] According to one of the principal defence scientists involved, the UK did have the technology to develop MIRVs, but could not have miniaturised warheads sufficiently to fit six onto Polaris.[147]

Chevaline was declared operational in 1982, following successful test firings by HMS *Renown* off Cape Canaveral.[148] This was 17 years after the original requirement had first been identified.[149] Use of the US instrumentation range to monitor the effectiveness of the new system was critical.[150] The following year the MoD stated that, although not a MIRV system, Chevaline ‘has provided warheads which are remarkably resistant to ABMs and have penetration aids of high complexity…this will ensure the continued effectiveness of our present strategic deterrent until Trident enters service in the 1990s’.[151] This remained the official view, probably well founded, after the Moscow system was upgraded in the mid-1980s with a new two-tier architecture[152] which would otherwise, if it could not already, have defeated Polaris.

As early as 1969 D.G.Brennan stated that ‘a good defense can be overcome, but it is difficult’,[153] a judgement that Britain’s experience with Polaris Improvement would seem to validate.

POLARIS REPLACEMENT

The story of the 1980 decision to replace Polaris with the Trident SLBM is outside the scope of this study, except in one important respect. The Moscow Criterion dictated that, as Ian Smart foresaw in 1978, ‘an unusually high priority must be attached, in the British case, to the choice of a deterrent which can be expected to penetrate foreseeable Soviet defences'.[154]

In 1982 the Defence Secretary, John Nott, told the House of Commons Defence Committee that possible future ABM developments were a factor in the Trident decision.[155] The 1985 Statement on the Defence Estimates spelt this out:

> To provide an effective deterrent, Britain's strategic nuclear force must be certain of inflicting on the Soviet Union an unacceptable level of damage; It must therefore be capable of posing a credible threat to key aspects of Soviet state power; and of posing such a threat at all times… It must be capable of meeting these requirements throughout its service life, in the face of technical changes and advances in the defensive systems that it would have to penetrate…
>
> … The [Trident] D5 offers the best prospects of being able to penetrate Soviet anti-ballistic missile defences in the face of possible improvements during the lifetime of the system.[156]

Another factor was that the 'present policy of buying off the shelf wherever possible reflected a major lesson learned from Chevaline'.[157] Though Chevaline was a unique technical success, it came at a substantial price. Britain did not want again to have to undertake a national mid-life upgrade. Polaris demonstrated the advantages of commonality with the United States, Chevaline the disadvantages of independent development.[158]

In opting for Trident's MIRVs the UK adopted the alternative solution to the penetration problem earlier pursued by both the United States and the Soviet Union: swamping the defences by weight of numbers, rather than deceiving them with decoys. Until the post-Cold War reductions in the number of nuclear warheads held by the UK,[159] British Trident missiles were planned to carry eight warheads each (128 per submarine) as opposed to Polaris/Chevaline's two warheads per missile plus 'penaids' (32 warheads per boat).[160]

In 1980 the Director of AWRE echoed earlier judgements that 'in cost effective terms the emphasis would probably lie with the ballistic missile as distinct from an ABM system'.[161] David Yost summarised the British position: 'Precautionary steps have been taken in case Soviet BMD improves, while preservation of the ABM Treaty's constraints is emphatically preferred.'[162] By 1982 Chevaline was operational and its replacement, Trident, decided upon. The following year, the main focus of attention switched back to US missile defence.

SOVIET BMD IMPROVEMENTS

The ABM Treaty did not mean that the Soviets halted further research and development into ballistic missile defence. Work at Sary Shagan continued much as before, including numerous ABM test launches.[163] The original Galosh system around Moscow was replaced in the mid-1980s by a new two-tiered, or 'layered' defence comprising the SH-08 endo-atmospheric interceptor and SH-11 exo-atmospheric system.[164]

Concern about a possible Soviet ‘breakout’ from the ABM Treaty’s limitations was one rationale for the renewed interest in missile defences in the United States in the early 1980s (see Chapter 8). These worries were in the main not shared in Europe, which remained largely sceptical about the prospects for a technological ‘breakthrough’ which would permit such a ‘breakout’.[165] There was nonetheless awareness in political and academic circles of continuing Soviet BMD activity.[166] The possibility that these activities might constitute a breach of the ABM Treaty was raised in Parliament in March 1985,[167] though the Defence Secretary Michael Heseltine stated: ‘Our view is that within the lifetime foreseen for the Trident missile the defences of the Soviet Union will not be adequate to remove its deterrent capability.’[168]

By this time the United States’ SDI was under way (see Chapter 8), and equivalent Soviet efforts were a natural subject of interest. The British analysis of the Russian BMD programme was summarised in an unclassified report released to Parliament in November 1985.[169] It detailed the modernisation of the Moscow system, as well as a ‘mature research programme’ which included lasers, particle beam and radio frequency weapons, kinetic energy weapons, surveillance and detection, pointing and tracking, space capability and command and control. It concluded:

> Despite its criticism of the United States SDI programme the Soviet Union has long standing research programmes examining new technologies with weapons potential which are generally relevant to ballistic missile defence. The future size and shape of Soviet ballistic missile defence is impossible to predict but current research and development programmes provide capabilities to develop SDI type systems if required.

The possibility that the Soviets were breaching the ABM Treaty continued to be debated in Britain for some years, though the government’s position remained that both the US and Soviet Governments remained committed to the Treaty, but differed in some of their interpretations of it.[170]

Soon after Gorbachev became Soviet leader, the Soviets offered to halt work on the controversial radar in exchange for abandonment of BMEWS modernisation at Thule and Fylingdales (Chapter 5 above). This having failed to win such a concession by the Americans, work was suspended anyway and in October 1989 the Soviet Foreign Minister Shevardnadze admitted that Krasnoyarsk did indeed violate the ABM Treaty.[171] It was subsequently dismantled.

By the end of the 1980s, with the Cold War ending, the Warsaw Pact disintegrating (soon to be followed by the Soviet Union itself) and the Trident programme well advanced, Russian BMD ceased to be of any real concern to Britain.

NOTES

1. Paterson, *Britain’s Strategic Nuclear Deterrent,* p. 11.
2. Cole, ‘British Technical Intelligence’, p. 89.
3. Pierre, *Nuclear Politics*, p. 324.
4. Peter Nailor, *The Nassau Connection* (London: Her Majesty’s Stationery Office, 1988), p. 2.
5. Paterson, *Britain’s Strategic Nuclear Deterrent,* p. 23.

6. Cmnd 120, *Ministry of Defence Estimate 1963–64,* 12 February 1963, p. 69.
7. DEFE 25/13 minute by Minister of Defence, February 1960.
8. DEFE 7/1328 BND(SG)(59)19(Final), 31 December 1959, p. 4.
9. Space precludes a full description of the evolution of the UK nuclear deterrent. For good accounts see Pierre, *Nuclear Politics,* Freedman, *Britain and Nuclear Weapons,* and Paterson, *Britain's Strategic Nuclear Deterrent*. There is at yet no comprehensive account based on the primary sources now becoming available in the PRO, though many files remain closed beyond the usual 30-year point.
10. Cole, 'British Technical Intelligence', p. 76.
11. AVIA 54/1749 'running commentary' on DRPC Review, undated but early 1954.
12. AIR 2/13206 CMS.2174/52/O.R.14 OR1139 MRBM System 8, August 1955.
13. Known as 'artificial' and 'natural' decoys, respectively.
14. AVIA 6/19876 Technical Note GW.481, February 1958.
15. DEFE 30/3 DB/C(58) 3rd meeting, 20 October 1958.
16. DEFE 7/699 DRP/P(59)1.
17. DEFE 7/1389 DRP/P(60)62, *Defence against Ballistic Missiles,* 20 July 1960.
18. BND(SG)(59)19(Final).
19. AVIA 65/1869 W/S.1235/WRBH, 29 September 1959.
20. Sayre Stevens, 'The Soviet BMD Program', in Carter and Schwartz (eds), *Ballistic Missile Defense,* p. 183.
21. Mathers, *The Russian Nuclear Shield,* pp. 3–4.
22. CAB 158/20 JIC(55)20(Final), *Russian Research and Development,* 26 April 1955, p. 27.
23. CAB 158/24 JIC(56)22(Final), *Russian Research and Development up to the End of 1955,* p. 25.
24. AIR 2/17897, ASA(O) to DDOR.5, 14 September 1956.
25. DEFE 5/79 COS(57)237, *Report on the Nature, Course and Duration of a Global War,* 21 November 1957.
26. Freedman, *US Intelligence,* p. 86.
27. CAB 158/35 JIC(59)4(Final)(Revise), *Soviet Strategy in Global War up to the End of 1963,* 20 January 1959, p. 2.
28. In fact, it was first deployed that year around Sverdiovsk, and was responsible for shooting down Gary Powers' U-2 reconnaissance aircraft in May 1960. *JSWS,* p. 288. A contemporary assessment is contained in CAB 158/42 JIC(61)8(Final), *The Air Defence of the Soviet Union up to 1965,* p. 29.
29. CAB 158/35 JIC(59)3(Final), *Sino-Soviet Bloc War Potential 1959–63,* 11 February 1959, p. 21.
30. Freedman, *US Intelligence,* p. 87.
31. CAB 158/39 JIC(60)8(Final), *The Air Defence of the Soviet Union up to 1964,* 24 February 1960, pp. 9–10.
32. CAB 158/41 JIC(60)85, *Trends in Soviet Research and Development for the Next 7–10 Years,* 19 December 1960, p. 22.
33. AIR 2/14560 CMS.2499/54/447, 6 February 1961.
34. JIC(60)8, p. 11.
35. CAB 159/36 JIC(61) 64th meeting, 30 November 1961, item 1.
36. CAB 158/48 JIC(63)6, *Intelligence Digest for Technical Departments, 1962,* 15 January 1963, p. 18.
37. DEFE 7/1390, Vowell to Andrews, 22 February 1963.
38. CAB 158/51 JIC(64)6, *Intelligence Digest for Technical Departments, 1963,* 7 January 1964, p. 18.
39. Stevens, 'The Soviet BMD Program', p. 196, and Baucom, *Origins of SDI,* p. 30.
40. Freedman, *US Intelligence,* pp. 90–4.

41. *JSWS,* p. 296, and DEFE 6/99 DP 16/66(Final), *Anti-Ballistic Missiles,* 13 April 1966, p. A-4.
42. DEFE 44/115, *DSTI Report No. 261,* August 1965.
43. CAB 158/61 JIC(66)3(Final), *Soviet Bloc War Potential 1966–70,* January 1966, p. 96.
44. FO 371/187534 DS1 1/13/1/6, 10 June 1966, Appendix B.
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46. McNamara cited in Freedman, *US Intelligence,* p. 90.
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48. FCO 10/174, Street to Rennie, 19 January 1967.
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51. CAB 168/129, *Soviet Ballistic Missile Defence: Vulnerability of the 'Moscow' System,* 24 April 1967.
52. CAB 158/66 JIC(67)32(Final), *Soviet Intentions on Ballistic Missile Defence,* 31 October 1967.
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57. DEFE 19/107, Cook to SofS, 2 July 1969.
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61. CAB 168/27 RP/D/01078, 21 September 1970, p. 5.
62. DEFE 19/107 FHP/584/70, 13 May 1970.
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91. Cited in Paterson, *Britain's Strategic Nuclear Deterrent,* p. 74.
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133. Baylis, *Anglo-American Defence Relations,* p. 109.
134. HC 269, p. 20.
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136. Freedman, *Britain and Nuclear Weapons,* p. 53.
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138. The details of the Chevaline system outlined here draw heavily on private conversations with several former MoD officials, scientists and naval officers. Other than Zuckerman’s own files, many files relating to Polaris Improvement have been retained beyond the usual 30 years, and those relating to the final development and deployment decisions would not be scheduled for normal release until 2004 at the earliest. Secondary sources on the detailed history of Chevaline development, which is outside the scope of this work, are G.M.Dillon, *Dependence and Deterrence: Success and Civility in the Anglo-American Special Nuclear Relationship, 1962–1982* (Aldershot: Gower Publishing, 1983), Ch. 6, McInnes, *Trident: The Only Option?,* pp. 4–10, and Freedman, *Britain and Nuclear Weapons,* Ch. 5.
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163. For a good account of Soviet BMD activity after 1972, see David Yost, *Soviet Ballistic Missile Defense,* pp. 29–39. See also Edward L.Warner, *Soviet Interests, Concerns and Activities with Regard to Ballistic Missile Defense* (Santa Monica, CA: RAND Corporation, September 1987).
164. For details, see *JSWS,* pp. 336–8.
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166. *Strategic Survey 1984–85,* p. 15.
167. *Hansard,* 5 March 1983, col. 434W.
168. *Hansard,* 2 July 1985, col. 170.
169. The full text is repeated in *Hansard,* 26 November 1985, cols 562–4. This report is remarkably similar to a US document issued at the same time, a joint Departments of Defence and State, *Soviet Strategic Defense Systems,* October 1985. The British assessment relied heavily on the same (mainly US) intelligence.
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8
Britain and the Strategic Defense Initiative

MISSILE DEFENCE FROM THE ABM TREATY TO SDI

The 1972 ABM Treaty meant that the ABM issue disappeared from public and political view in Europe. Even the expensive Chevaline response to the Moscow ABM system proceeded in almost complete secrecy (Chapter 7). The credibility of the British and French deterrents seemed assured[1] and the SALT process offered the prospect of progressive nuclear arms reductions by both superpowers. The Americans even decommissioned their sole ABM site almost as soon as it was completed.[2]

None of this meant, however, that missile defence was a dead issue in either the United States or the Soviet Union. Modernisation of the Moscow system went ahead and it became increasingly clear that Soviet agreement to limit ABMs by no means implied a coincidence of views on the desirability of Mutual Assured Destruction (MAD).[3] The SALT process actually accompanied an *increase* in Soviet and US offensive nuclear forces.[4] Soviet research into defensive technologies continued unabated,[5] leading to concerns in Washington that a future Soviet 'break-out' from the ABM Treaty's restraints might become possible.[6] This particular fear was shared by the British intelligence community, and aroused concerns that Chevaline might not be adequate.[7]

As a result, US ABM research continued with funding of between $100 and $200 million per annum.[8] By the late 1970s, interest in BMD was reviving in US military circles as part of a wider strategic debate about the deployment mode of the new generation of ICBMs. Missile silos were increasingly vulnerable to the latest Soviet, highly accurate, ICBMs. Defences, if more technically effective than the old Safeguard system, could therefore enhance deterrence by assuring the survivability of the land-based element of the US retaliatory capability.[9]

Several technical developments appeared to make such a defence a realistic prospect, and in particular the possibility of a non-nuclear defence. This might be by means of so-called hit-to-kill technologies, or Directed-Energy Weapons (DEW) such as lasers.[10]

To the changing strategic and technical scene was added a new political context. Ronald Reagan was instinctively unpersuaded that US security was best achieved through mutual vulnerability with the Soviets.[11] During his presidential election campaign in 1980 he expressed the hope that US technology could solve the problem of defending the country against ballistic missiles.[12] Once in office, however, Reagan and his officials were initially cautious about missile defences, though the subject was clearly back on the political agenda.[13] The Scowcroft Commission's report on strategic forces concluded in early 1983:

> Applications of current technology offer no real promise of being able to defend the United States against massive nuclear attack in this

> century…no ABM technologies appear to combine practicality, survivability, low cost and technical effectiveness sufficiently to justify proceeding beyond the stage of technology development.[14]

This analysis was in line with the view of the Conservative government in Britain, which in 1980 had stated:

> Over the last two decades the effort devoted to the Air Defence of Great Britain has been sharply reduced. This derived from strategic concepts which reasoned that we could not realistically hope to defend ourselves against a strategic nuclear missile strike…[15]

Though there was little official interest in missile defence in the decade after the ABM Treaty, a body of open-source literature did appear in Britain.[16] Lawrence Freedman observed at the time, however, that missile defence remained an American issue, and that Europeans remained almost universally sceptical about the technical prospects for effective defences.[17]

By the beginning of 1983, missile defence was 'coming out of the cold after more than ten years of neglect'.[18] A report compiled for the US Congress identified the several conditions that prevailed on the eve of Reagan's launch of what became the SDI:

- the competition in strategic offensive nuclear weapons continued;
- there was considerable scepticism in the Administration and in Congress that arms control could do much to contain the Soviet military threat to the United States;
- the near-term potential for mutually beneficial negotiations with the Soviets seemed slim;
- there was deep suspicion toward the Soviet Union inside the Administration and widely shared by the US public;
- advocates of ballistic missile defense for the United States were arguing that new technologies had put effective defenses within sight;
- the Department of Defense was concerned about Soviet BMD developments; and
- there was strong public feeling that something should be done to curb the nuclear arms race.[19]

When the US Joint Chiefs of Staff recommended a new strategic approach with a greater emphasis on defence,[20] the stage was set for the next phase of the missile defence story and Britain's part in it.

THE STRATEGIC DEFENSE INITIATIVE

The SDI was launched by President Reagan in a seminal speech delivered on television on 23 March, 1983.[21] Reagan committed his Administration to the arms control process and the stabilisation of the nuclear balance. Whilst acknowledging that mutual deterrence had kept the peace for over three decades, he identified a need to 'break out of a future that relies solely on offensive retaliation for our security'. The continued reliance on deterrence was ‘a sad commentary on the human condition. Wouldn’t it be better to save lives than to avenge them?’ Instead, Reagan proposed

> that we embark on a program to counter the awesome Soviet missile threat with measures that are defensive…
>
> …current technology has attained a level of sophistication where it’s reasonable for us to begin this effort. It will take years, probably decades of effort on many fronts. There will be failures and setbacks, just as there will be successes and breakthroughs. And as we proceed, we must remain constant in preserving the nuclear deterrent and maintaining a solid capability for flexible response. But isn’t it worth every investment necessary to free the world from the threat of nuclear war?…
>
> Tonight, consistent with our obligations of the ABM treaty and recognizing the need for closer consultation with our allies, I’m taking an important first step. I am directing a comprehensive and intensive effort to define a long-term research and development program to begin to achieve out ultimate goal of eliminating the threat posed by strategic nuclear missiles.

SDI was simply a research programme, albeit a highly ambitious one. It drew extensively on a number of disparate R&D efforts already under way, and brought them together under a single management structure (the Strategic Defense Initiative Office [SDIO]) and with greatly increased funding—$2.7 billion per annum by the mid-1980s.[22]

Reagan’s highly personal vision went far beyond the views of almost all his advisors, military and civilian. Steven Miller, in reviewing Frances Fitzgerald’s book on the subject,[23] states that SDI

> was condemned as unfeasible and unwise by most of the expert community, was dramatically unconnected to existing technological realities, was criticised internationally by friend and foe alike, was doubted by many in Reagan’s own administration, and was forbidden by international treaty.

Though Miller is wrong to assert that the military had not been consulted and that no prior studies had been done, he is right to identify that the point of departure between Reagan and almost everyone else was whether SDI would reinforce, or replace, deterrence. This issue became the crux of Allied concerns, especially for the British.[24] Though Reagan himself retained his vision his Administration effectively proceeded on the basis that, for the foreseeable future at least, SDI would seek to enhance existing deterrence.[25]

There were therefore at least two different SDIs.[26] One was Reagan’s vision of a near-perfect shield in space that would make nuclear weapons obsolete. The other much more modest aim was a protection for US ICBM silos that would reinforce the deterrent role of nuclear weapons. This was the view of most Administration officials. There were other views as well. Some argued it would reduce first-strike options and provide a partial population defence.[27] Alternatively, SDI might be used as a bargaining chip with the

Soviets to secure offensive force reductions. It could deal with small-scale attacks (such as a Chinese strike), or, in the worst case, achieve some damage limitation.[28]

Following his March 1983 speech, Reagan commissioned a series of studies to examine potential technologies and their policy implications. These were followed by a national security directive in January 1984 which established SDI itself and the Office which was to run it.[29] An early technical success, largely due to pre-SDI work, was the Homing Overlay Experiment (HOE) which in June 1984 saw a Minuteman ICBM warhead destroyed by a kinetic energy 'kill vehicle' over the Pacific.[30]

By late 1986 sufficient progress had been made for a 'Phase One' SDI architecture to be devised. This comprised a computer-based battle management system, surface- and space-based surveillance and tracking systems and space- and ground-based Kinetic Energy Weapon (KEW) interceptors. Later phases would include DEWs. By the late 1980s Phase One included a new lightweight, space-based interceptor called 'Brilliant Pebbles'.[31]

The nature and ultimate aim of SDI continued to generate controversy. But in early 1985 Paul Nitze, the President's Special Advisor on Arms Reductions, set out a strategic concept which became highly influential and formed the basis for the Reagan Administration's SDI policy:[32]

> For the immediate future—at least the next 10 years—we will continue to base deterrence on the ultimate threat of nuclear retaliation. We have little choice; today's technology provides no alternative…
>
> Should new defensive technologies prove feasible, we would want at some future date to begin…a transition, during which we would place greater reliance on defensive systems for our protection and that of our allies…
>
> Given the right technical and political conditions, we would hope to be able to continue the reduction of nuclear weapons down to zero…accompanied by widespread deployments of effective nonnuclear defenses.[33]

This was the programme to which the British Government, like others in Europe, had to respond.

THE BRITISH REACTION

Reagan's speech in March 1983 came as much of a surprise to other governments, including the British, as it did to most of his own Administration.[34] Possibly in order to increase the dramatic impact of the speech, no advance consultations had taken place.[35] The potential ramifications of Reagan's vision were self-evident, but for over a year the official British reaction was muted.[36] As Lawrence Freedman observed, 'The basic hope was that as the announcement had so obviously slipped through the policy filter, the machine would now correct the mistake and the plan would soon die without a trace.'[37] Moreover, there were more pressing strategic issues: the replacement of Polaris by Trident, the deployment of US cruise missiles in Britain (both in the face of substantial domestic opposition), and the stalled arms control negotiations with the Soviets. Until it was clear just what would be the practical manifestations of the President's approach, it was better to keep quiet. What was evident, was that neither British money nor territory were immediately involved.[38]

The despatch of briefing teams to European capitals did little to shed any further light on the idea,[39] which as the United States had not yet formulated a coherent policy was hardly surprising. From the beginning, whilst the technological possibilities of defence dominated the American debate, in Europe it was the strategic implications that most concerned governments and outside commentators alike.[40] Any proposal that might undermine stable deterrence was viewed with deep suspicion, especially in Britain.[41] There was some irritation that, as in 1967,[42] Washington appeared to have broken one of NATO's cardinal rules—'no surprises'.[43]

By the end of 1984, the SDIO had been established and a budget set. Reagan had been re-elected for a second term and SDI, as it was now known, was here to stay. The British Government therefore sought to apply the 'special relationship' to the SDI issue. It would avoid overt disagreements, whilst seeking to influence US policy behind the scenes.[44]

By now the Prime Minister, Margaret Thatcher, had formulated her own views on SDI. As she later wrote,

> Although… I differed sharply from the President's view that SDI was a major step towards a nuclear weapon-free world—something which I believed was neither attainable nor even desirable—I had no doubt about the rightness of his commitment to press ahead with the programme.[45]

She was also fascinated by the technology.[46] The British approach to SDI was, according to Thatcher's memoirs, governed by four principles: first, the scientific possibilities; second, existing arms control agreements, especially the ABM Treaty which precluded deployment but not research; third, Soviet progress in the field; and fourth, SDI's implications for deterrence.[47] Thatcher was 'horrified' by Reagan's talk of abolishing nuclear weapons and even sharing SDI technology with the Soviets. Also implicit in the British approach was the long-held belief that Alliance solidarity ultimately rested on 'shared vulnerability', which SDI might undermine.[48]

In December 1984, Mrs Thatcher visited Washington and 'lectured' Reagan at Camp David on the requirements of nuclear deterrence.[49] She then publically announced four agreed specific points:

(1) the US, and Western, aim is not to achieve superiority, but to maintain balance, taking account of Soviet developments;
(2) SDI-related deployment would, in view of treaty obligations, have to be a matter for negotiation;
(3) the overall aim is to enhance, not to undercut, deterrence;
(4) East-West negotiation should aim to achieve security with reduced levels of offensive systems on both sides. This will be the purpose of the resumed US-Soviet negotiations on arms control, which I warmly welcome.[50]

This accord was subsequently subject to varying interpretations, but it remained the basis of the UK's policy towards SDI,[51] and indeed came to be viewed as the basic European statement on the subject. US acknowledgement of the need for negotiations with the Soviets was particularly welcomed.[52] Though this verbal agreement pre-dates any formal invitation to participate in SDI research, the prospect of allied countries, especially Britain, gaining lucrative contracts may have been a powerful factor moderating Thatcher's opposition to what could undermine the whole basis of NATO's deterrence strategy towards the Soviet Union. Both Thatcher and Reagan were also extremely reluctant to openly disagree in public with each other's closest political ally.

In February 1985 Thatcher was back in the United States to address a joint meeting of Congress. Her speech re-emphasised the importance and continuing relevance of nuclear deterrence, but in view of Soviet activities in the field expressed strong support for SDI research. Deployment would, however, have to be a subject for negotiation under the ABM Treaty.[53] In subsequent discussions with Reagan, Thatcher was at pains to point out the dangers of exaggerated rhetoric about SDI's potential and the future of nuclear weapons.[54]

The government's stance was reiterated in the House of Commons six days later:

> It is absolutely vital for the United States to engage in research in order to catch up with the Soviet Union, to ensure that nuclear deterrence remains balanced, and to make absolutely sure that the Soviet Union does not leap ahead of us in research on anti-ballistic missile weapons when the United States is not doing any.[55]

On 15 March Howe delivered a major speech at the Royal United Services Institute.[56] He set out the classic case for ABM limitation:

> The ABM Treaty reflected the agreement that there could be no winner in a nuclear conflict and that it was a dangerous illusion to believe that we could get round this reality…
>
> The net effect was to eliminate the option of full-scale deployment of defensive systems, perceived in 1972 to be destabilising, costly and in any case ineffective; and to enhance the strategy of nuclear deterrence through the clear recognition of mutual vulnerability.

He went on to point out that in the intervening period the Soviet Union had not shown the hoped-for restraint in developing offensive systems. The West's response should be to maintain its deterrent whilst seeking negotiated force reductions on both sides. Reagan's SDI had introduced a new element, but his vision was 'subject to uncertainty'. At the same time, not enough attention had been paid to Soviet research efforts and their development of anti-satellite capabilities. He emphasised that 'at all times we must keep in mind the key question: will new developments enhance or undercut deterrence?'

Howe acknowledged that the SDI research programme was 'in full conformity' with the ABM Treaty and that any operational deployment was many years away. He reiterated Nitze's requirements that defences should not only work, but should also be survivable and cost effective: '…there would be no advantage in creating a new Maginot Line of the twenty-first century, liable to be outflanked by relatively simpler and demonstrably cheaper counter-measures'. He outlined a range of concerns that amounted to deep scepticism about both the feasibility and desirability of strategic defences. Principal amongst these were the effect on others' perceptions, the likelihood of alternative means being used for nuclear delivery, cost and its effect on other defence capabilities, and the implications for arms control. He concluded:

> The attractions of moving towards a more defensive strategy for the prevention of war are as apparent as are the risks…
>
> Deterrence has worked: and it will continue to work. It may be enhanced by active defences. Or their development may set us on a road that diminishes security…
>
> …we must be especially on our guard against raising hopes that it may be impossible to fulfill. We would all like to think of nuclear deterrence as a distasteful but temporary expedient. Unfortunately we have to face the harsh realities of a world in which nuclear weapons exist and cannot be disinvented.

This remained the definitive British Government statement of policy towards SDI. Though it was perceived by many (including US officials) to be more hostile to SDI than the Prime Minister's four-point accord, Howe was at pains to point out that the two statements were fully compatible.[57] Britain supported research to match Soviet efforts,[58] but remained committed to nuclear deterrence and the arms control process (which had just re-started in Geneva). Outright opposition was likely to be counter-productive but Britain did not share Reagan's nuclear-free vision. A further disagreement lay unexpressed: 'Whereas Britain viewed the SDI programme as research to help decide *whether* to proceed with BMD, the Reagan Administration tended to see it as research on *how* to proceed.'[59] Taylor observes that 'SDI had few friends in Whitehall'.[60]

A communiqué issued after the March 1985 NPG meeting combined the essence of the Thatcher/Reagan Accord with the ABM Treaty:

> We support the United States research programme into these technologies, the aim of which is to enhance stability and deterrence at reduced levels of offensive nuclear forces. This research, conducted within the terms of the ABM Treaty, is in NATO's security interest and should continue.[61]

By now SDI was the subject of public debate in Britain, generally under the pejorative term 'Star Wars'. *The Times* reacted to Howe's equivocal speech by describing it as 'mealy-mouthed, muddled in conception, negative, Luddite, ill-informed'.[62] *The Economist* also came out in support of SDI.[63] Others were as forthright in their opposition to SDI as *The Times* was in support. Opposition stemmed both from Conservatives who remained attached to NATO's deterrent policy and from the Left, including the 'peace movement', who opposed both nuclear weapons and means of countering them. Neil Kinnock, Leader of the Opposition, asserted that SDI would create a new arms race.[64] The smaller Liberal-Social Democrat Alliance adopted a more moderate tone, but opposed SDI mainly on strategic stability grounds.[65] The former Conservative Prime Minister Edward Heath called SDI 'decoupling, destabilising and a diversion of resources'.[66] Similar views were expressed in Parliament during repeated debates on the subject.[67] Political supporters of SDI included Lord Chalfont, the former Labour Foreign Office Minister and several Conservative backbenchers. The government's position was largely endorsed by the Commons Defence Committee.[68]

The continuing uncertainty about where SDI might lead was emphasised in November 1985 by the MoD's Director of Defence Policy.[69] He stressed the significance of existing Soviet research, and the Russians' response to the US programme, whilst dismissing the idea of intentionally bankrupting the Soviet Union in an SDI arms race as 'a sort of enforced arms control'. He acknowledged that 'the world has moved on dramatically since 1972', and also the problems that might be posed for the UK nuclear deterrent if the Russians were in the future to deploy a large-scale active defence. Overall, the attention paid to Soviet, as opposed to American, defences was notable. He concluded:

> SDI research is a prudent hedge against Soviet activity in the ballistic missile defence field and contributes to the maintenance of balance. As such it should proceed…[but] we must recognise the difference in perspective between the United States, upon whose nuclear guarantee the ultimate security of the Alliance rests, and that of the Europeans… European concerns are that activity in the field of strategic defence should not make the world safe for conventional war in Europe…

Of immediate concern was whether a 'broad' or 'narrow' interpretation of the ABM Treaty would be applied in determining the permitted extent of system testing.[70] Following another intervention by Thatcher, the US Government confirmed to the North Atlantic Assembly in October 1985[71] that, as Howe put it, 'The President has endorsed the *legal* view in favour of the "broader" interpretation. But he has wisely decided, in a step which bears the hallmark of statesmanship, to *conduct* the SDI within the restrictive interpretation.'[72] The FCO continued to view the ABM Treaty as 'the foundation of our present structure of deterrence'.[73]

Allied participation in SDI research was also by now being agreed. Thereafter official criticism of SDI was harder to justify when British universities and companies, and indeed the MoD itself, were in receipt of SDIO contracts.[74]

In early 1986 the Labour Party used an opposition day motion to debate SDI for three hours in a full House of Commons. Familiar positions were re-stated at length with the former Defence Secretary Denis Healey asserting that SDI was the major obstacle to progress on arms control. The current Defence Secretary outlined government policy without adding anything new, and the government majority ensured that the debate concluded:

> That this House takes note of the extensive Soviet research effort in ballistic missile defence; agrees that the Strategic Defence Initiative research programme is prudent in the light of this effort; and welcomes the participation of United Kingdom industry and research institutions in that programme.[75]

The 1986 Defence White Paper confirmed that the Camp David four-point accord remained the basis of British policy, and pointedly stated that 'SDI would in the *US view* provide the opportunity for both super-powers to shift the relative balance between offensive and defensive forces'.[76]

In October superpower relations took a new turn when Reagan and Gorbachev met at Reykjavik.[77] A deal to eliminate all ballistic missiles within ten years eluded them, mainly due to Reagan's insistence that SDI testing would not be confined to the laboratory alone.[78] For European governments, this was deeply ironic. SDI, especially the President's version of it, was regarded, at best, with scepticism and at worst with outright hostility (especially in France).[79] It had, however, prevented an even worse situation—a de-nuclearised Europe that might thereby become 'safe' for conventional war. SDI had averted the nuclear-free world that, for Reagan at least, was its ultimate objective.

So alarmed by what had almost happened was the British Government that Thatcher quickly made another visit to the United States, and 'descended like a thundercloud upon Washington'.[80] After meeting the Vice-President, Secretary of State and Defense Secretary, she obtained the agreement of Reagan himself that SDI research would remain within the constraints of the ABM Treaty, and that NATO's flexible response strategy would continue to require a mix of nuclear systems. The supply of Trident was also confirmed. Thatcher left well pleased.[81] Once again, Britain had acted as a moderating influence in Washington, a fact apparently welcomed by many US officials.[82]

By 1987 much of the heat had gone out of the SDI debate. SDI's chief sponsor, President Reagan, was in his final year of office. Cold War tensions were easing noticeably, especially in view of internal developments in the Soviet Union and the progress of arms control negotiations. It was clear that whatever promise SDI technologies might hold, operational deployment was still many years away. In 1988 it remained the MoD's view: 'The UK supports SDI less as a means of transforming the nuclear relationship between the superpowers, than as a means of preventing the Soviet Union achieving such a transformation on its own terms.'[83]

As Robert Hughes wrote just as the Cold War was coming to an end, 'Europeans…by the end of 1988 were…confident…that SDI was not to be the frightening initiative that it had been pledged to be at the outset'.[84] Margaret Thatcher herself later wrote: 'I do not know of any greater historical irony [than] the fact that ideas embodied in SDI have not been applied, while the old ABM Treaty is still revered as the cornerstone of stability.'[85]

SDI PARTICIPATION

At a meeting of the NPG on 18 March 1985, the US Defense Secretary Caspar Weinberger raised the possibility of Allied nations participating in SDI research. This was followed a week later by a formal invitation, which specified a 60-day deadline, subsequently dropped, for governments to reply.[86] The possibility of UK involvement in research had already been discussed by Thatcher the previous month during her visit to Washington,[87] and a number of British companies were already working in related fields.[88]

US motives for this approach were mixed. In a few highly specialised areas European companies and research institutions had particular skills and knowledge to offer not available in the United States. Many people also suspected that the promise of research contracts was being offered to 'buy' political support for SDI,[89] including the impact that foreign support would have on the US domestic debate. The Americans also hoped that other governments, once they got involved, could be induced to commit some of their own money.

For Allied governments, SDI participation posed a dilemma. There were political and diplomatic implications to be considered, but also the prospect of work shares and a means of gaining insight into where the technology might lead. For Britain, where the Chevaline project had only recently been completed, involvement in SDI work would give a better appreciation of what strategic defences the UK deterrent might face in the future.[90] There might also be important technological 'spin-offs' into other areas.[91] Conversely, if Britain did not take part many leading scientists might follow the money to where it was being spent—a new 'brain drain'.[92] A joint study by the AWRE and RAE set up to advise on SDI feasibility reported that much of the basic physics was sound, but that due to insufficient attention being paid to system engineering, the Americans' projected timescales were not possible.[93]

The Defence Secretary Michael Heseltine concluded that 'participation will enhance our ability to sustain an effective British research capability in areas of high technology relevant to both defence and civil programmes'.[94] A refusal to cooperate would also have been at odds with Thatcher's already expressed support for SDI research.

US negotiations with its allies were carried out on a bilateral basis. During these talks Heseltine sought a guarantee of $1.5 billion-worth of work for the UK.[95] This would have represented over 5 per cent of all SDI research over a five-year period.[96] However, US law required that all government contracts be awarded on the basis of technical merit and cost, and no work could be given to foreign firms if a US company could undertake it at a lower cost.[97] There were also doubts about the readiness of the Americans to permit real technology transfers.[98]

Negotiations on the terms under which British participation would take place were complete by November 1985. Heseltine, having recognised that no guarantee of work was going to be given, sought assurances on two issues:

> First, that there should be a proper reflection of this country's technological capability and recognition of the dangers of a one-way flow of technology across the Atlantic; and, secondly, that it should be recognised that, for Britain to play a part, it has to be significant.[99]

A Memorandum of Understanding (MoU) between the two governments was accordingly signed on 6 December.[100] Similar agreements were later signed between the United States and Germany, Israel, Italy and Japan. These MoUs were, in the words of the UK's SDI Participation Office (SDIPO) Director-General, 'merely an enabling device which would aid offshore organisations to participate on a more equal basis with Americans bidders for SDI work'.[101] It also meant that these governments had now made a political commitment to SDI.[102] The British MoU itself remains classified, but its German equivalent was 'leaked' soon after it was signed in 1986. It is likely that the two agreements are very similar. The MoU provided for several means by which companies, academic institutions and the government itself could conclude agreements with the SDIO, and with US firms involved in SDI work. It also covered such issues as intellectual property rights, security and visits. The MoU was more a statement of agreed principles than a contract. The latter would be drawn up directly with individual institutions' particular research projects.

To implement the MoU, the UK MoD set up the SDPI. Its Director-General, Dr Stanley Orman, answered directly to the CSA, then Sir Richard Norman. The SDIPO acted mainly as an intermediary, assisting UK institutions to win SDIO contracts.[103] Such was the pre-existing pattern of Anglo-American cooperation in research and intelligence, that British nationals were generally granted freer access to the SDIO and US firms than other nationalities.[104]

Detailed discussions with the Americans identified seven areas of technology in which exchanges were envisaged:

1. Command, Control and Communications, and Battle Management Research
2. Lasers and Optics
3. Advanced Computing
4. Surveillance, Target Acquisition, Identification and Tracking
5. Non-Nuclear Electro-Magnetic Pulse Radio Frequency Weapon Technology
6. Space Technology
7. Special Materials[105]

Eighteen areas were identified in which British companies and universities had expertise that might contribute to SDI:

1. European Architecture Study
2. Laser/Particle Beam/Radio Frequency Lethality Vulnerability/ Hardening
3. Electro-Magnetic Guns and Effects Research
4. Ion Sources
5. Optical Computers, Switches and Limiters
6. Advanced Thyratrons
7. Non-electronic Materials
8. Sensors
9. Terminal Radar Research
10. Terminal Interceptor Research
11. Laser Radar/Vibrometry/Imaging
12. Countermeasures
13. Software Security
14. Electronic Materials
15. Phase Conjunction
16. Battle Management/Command, Control, and Communications
17. Signal Processing
18. Space Research[106]

The British Government would not spend any funds on SDI research, but a proportion of the existing research budgets of the MoD and the Department of Trade and Industry would be devoted to SDI-*related* research which would have been undertaken even without SDI itself.[107]

The MoD stated:

> Participation in the SDI research programme will enhance the United Kingdom's ability to sustain an effective British research capability in areas of high technology relevant to both defence and civil programmes. It opens the way for research possibilities that we could not afford on our own, in technologies that will be at the forefront of tomorrow's world.[108]

Others took the opposite view. Healey described it as 'the grubby conspiracy of the British Government to encourage British scientists to leave vital British programmes of civilian research…and work instead on SDI research for the American Government'.[109]

By early 1990, about 3 per cent of all SDIO contracts by value had been awarded to foreign companies, research bodies and government agencies—a total of $297 million. British organisations received 36 direct contracts totalling $56.7 million, 19 per cent of the total by value. A further $48 million-worth of work had been awarded to foreign subcontractors (British firms securing two-thirds by value) of US companies.[110]

Most contracts were awarded to civilian firms and universities, and others to MoD research agencies. The MoD itself was contracted to undertake a European Architecture Study, later followed by an Extended Air Defence (EAD) Test Bed contract to evaluate air defence research against air-breathing as well as ballistic threats.[111] A total of 28 UK companies received sub-contracts from the MoD for SDI work,[112] in addition to those receiving contracts from SDIO itself and US prime contractors. In all, 69 per cent of SDI foreign contracts by value were devoted to TMD aspects of missile defence, indicating where foreign expertise and requirements lay.

The value of British SDI contracts clearly fell far short of early hopes and expectations, though these were purely speculative.[113] The head of SDIPO had hoped to secure $100 million-worth of contracts by the end of 1987,[114] and this figure was barely reached by the time the Cold War ended. This was often ascribed to the traditional difficulty foreign firms had in securing US defence contracts, which had been identified as a potential problem long before the SDI MoU was signed.[115]

UK participation did achieve one of its objectives, however, in that Britain was better able to assess the progress and potential of SDI. It remained the consistent view of SDIPO officials that there was no chance, in the foreseeable future, of being able to counter a full-scale raid.[116] This advice did much to assuage concerns about SDI's threat to stable deterrence.

ANTI-TACTICAL BALLISTIC MISSILES

SDI itself was concerned with a future global missile defence, or, in the shorter term, a partial defence of North America. Most European SDI-funded research, however, was related to European missile defence issues. The question of defence against shorter-range ballistic missiles also arose independently of SDI, though the two subjects often became intertwined.

During the early 1980s the Soviet Union deployed a new generation of short-range ballistic missiles in Europe, in addition to the existing FROG, Scud and SS-12A Scaleboard. These were the 70–120 km range SS-21 'Scarab', the 500 km range SS-23 'Spider' and the 900 km range SS-12B, an improved version of the earlier Scaleboard and for a time known as the SS-22.[117] There was also the 5,000 km ‘theatre’ range SS-20, which was later the subject of the 1987 Intermediate Nuclear Forces (INF) arms control treaty.[118] The Soviets were estimated to be producing over 300 SS-21, -23 and -12Bs, which were considerably more accurate than their predecessors and could carry either nuclear or conventional payloads.[119]

These systems meant that Europe faced a more numerous, and shorter-notice, nuclear threat than did the United States, and also that there was a significant ballistic element to the non-nuclear air threat. Moreover, not being ‘strategic’ weapons, defence against them was not prohibited by the ABM Treaty.[120] The Russians were known to be developing the SA-X-12 surface-to-air system with an anti-tactical ballistic missile (ATBM) capability which could be used against the West’s own shorter-range missiles, such as Lance and Pershing.[121]

Soviet missiles were expected to be used in the opening phase of an offensive, when their invulnerability to conventional air defences and improved accuracy would be exploited to attack NATO air defences, airfields and reinforcement ports.[122] This concern was first publicly raised by the West German Defence Minister, Manfred Woerner, at the NPG meeting in March 1985.[123] ATBMs rapidly became a significant NATO issue for the scale of the problem was self-evident,[124] and given its conventional non-nuclear dimension could not be countered simply by NATO’s nuclear deterrence posture.

In May 1986 the NATO Air Defence Committee began to examine ATBMs in the context of EAD, and a separate study looked at system concepts for ATBMs to ‘address defensive systems architectures capable of countering the tactical missile threat to NATO-Europe (emphasising primarily the precision non-nuclear threat)’.[125] The most immediate requirement was perhaps for surface-to-air missile batteries to defend themselves against ballistic missiles,[126] which could be TBM targets in order to degrade NATO air defences in advance of aircraft strikes against other targets.[127]

Two possible approaches were suggested. One was for an EDI in parallel with SDI, the other that ATBM should be part of an EAD which would also counter air-breathing threats like cruise missiles and manned aircraft. The latter approach was favoured by US and European governments alike, not least because it was politically less controversial.[128] The MoD saw ‘a clear conceptual difference between ATBM defence and SDI …there might be a requirement to provide an ATBM system irrespective of any decisions made on SDI’.[129]

The ATBM debate in Europe was led by the Germans, especially Woerner. As most TBM targets were in West Germany, this was not surprising. Woerner identified five requirements for a NATO ATBM system:

1. The system must be nonnuclear.
2. The defense objective must be, in the first instance, a point-defense of priority targets on NATO territory.
3. The overall defense does not have to be impenetrable, nor does it have to cover all of Western Europe.
4. The system must have high survivability.
5. The system must be invulnerable to saturation.[130]

By mid-1986 the SDIPO was negotiating a contract with SDIO for a $12.7 million US-funded European Architecture Study.[131] This was to

> provide a British perspective on a European strategic global nuclear defense, in contrast to the NATO Europe studies, which are from the perspective of an independent European defense system. The study is to look at the defenses of independent strategic retaliatory forces of the United Kingdom and France.[132]

The study initially completed a paper design of an active theatre defence system, but was then expanded to examine the synergy between European TMD and the SDI of the United States.[133] Though the ATBM requirement was politically separated from SDI, each had clear technological implications for the other.[134]

The results of the study remain classified, but several conclusions are known. First, active defence in the short to medium term would have to be based on a modified US Patriot missile system, which was being acquired by Germany and the Netherlands.[135] A British purchase of Patriot was considered to satisfy a future medium-range SAM requirement, including ATBM.[136] A definite UK need for such a capability was not established, however, and an AST for a Medium Surface-to-Air Missile (MSAM) Bloodhound replacement was later allowed to lapse (see Chapter 9).

Second, in view of the short flight times of TBMs, early warning would be critical to any active defence system. This would require space-based as well as surface-based sensors, and provided the most obvious area of commonality between SDI and ATBM. Third, passive defences, such as dispersal, concealment and hardening, would continue to play an important role, whatever form of active defence might be developed.[137]

Both UK national and NATO studies were to complete in 1988–89,[138] by which time the beginning of the end of the Cold War overtook the need to consider active defences against Soviet missiles.

GLOBAL PROTECTION AGAINST LIMITED STRIKES

By 1990 the Cold War was effectively over. One consequence of that momentous development was a re-examination by the Bush Administration of the SDI programme. This review included technological progress as well as the changed strategic environment. Instability in the Soviet Union might lead to accidental or unauthorised missile launches, and proliferation of ballistic missiles outside the traditional Cold War foe was now receiving serious attention, particularly after Iraq's use of Scud missiles against Israel and Saudi Arabia in January 1991.[139] Bush's State of the Union address the same month announced a re-focusing of SDI to include 'theatre' defence of allies and US forces deployed overseas, and a limited defence of North America against up to 200 warheads.[140]

Allied consultation and cooperation on the Global Protection Against Limited Strikes (GPALS) continued along the lines established for SDI. Allied nations, including Britain, were given detailed briefings and technical participation continued under the terms of the 1985 MoU.[141] There was little public reaction in Britain to the new programme,[142] but its more limited aims and scope clearly assuaged many of the earlier concerns about SDI. GPALS, especially its space-based components, was short-lived, however, again being overtaken by events when Bill Clinton entered the White House in January 1993.

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9
After the Cold War

MISSILE PROLIFERATION

Until the early 1980s interest in ballistic missile threats extended only to the enormous, and nuclear-armed, Soviet inventory. Even when the possibility of a conventionally armed ballistic missile threat emerged, it was still within a Cold War, Soviet context. But as Cold War tensions eased in the late 1980s, a new dimension to the missile problem was revealed when, during the Iran—Iraq 'War of the Cities' in 1987–88, approximately 650 shorter-range ballistic missiles were fired.[1]

However, it was the 1991 Gulf War that really brought ballistic missile proliferation into prominence. Iraq's use of 82 Scud derivatives against targets in Israel and Saudi Arabia featured on daily news broadcasts, and raised the possibility that Israel might be drawn into the war, thereby splitting the Allied coalition.[2] The tactical problem posed by missiles was equally evident when one Scud killed 28 US servicemen in a barracks in Dhahran, and another narrowly missed the USS *Tarawa* alongside in Al Jubayl. From that time onwards, provision of a TMD for deployed forces has been a high American priority.[3]

The drama of the Patriot versus Scud battles in 1991 also aroused interest in missile proliferation in Britain. Soon after the conflict, Archie Hamilton, a junior defence minister, identified nine countries, other than the Soviet Union and China, having missiles with sufficient range to reach NATO territory. He stressed, however, that 'the possession of such a capability does not necessarily imply that any particular country constitutes a threat to NATO',[4] an early expression of what was to become a consistent government view. The role of nuclear forces in deterring non-Soviet, non-nuclear, missile threats also became widely debated. The Defence Secretary, Malcolm Rifkind, observed in 1994 that deterrence might not be a 'panacea' to biological, chemical and conventional weapons proliferation.[5]

Post-Cold War missile proliferation has spawned a voluminous open-source literature, a proportion of it in Britain.[6] By the mid-1990s most sources were citing up to 37 countries as having ballistic missiles of one type or another,[7] despite the 1987 Missile Technology Control Regime (MTCR), which sought to prevent the spread of such weapons. Parliamentary researchers responded to increasing interest in the subject in both Houses when they produced their own summation of the threat (Figures 11 and 12).

As Western armed forces were re-modelled (and reduced) to meet the new, post-Cold War security environment, considerable emphasis was placed on countering so-called 'asymmetric' threats, of which ballistic missiles are an example.[8] The Commons Foreign Affairs Committee was advised: 'In a future regional crisis, Western coalition forces are likely to confront a regional opponent capable of effectively employing nuclear, chemical and/or biological weapons.'[9]

Figure 9: Missile Proliferation

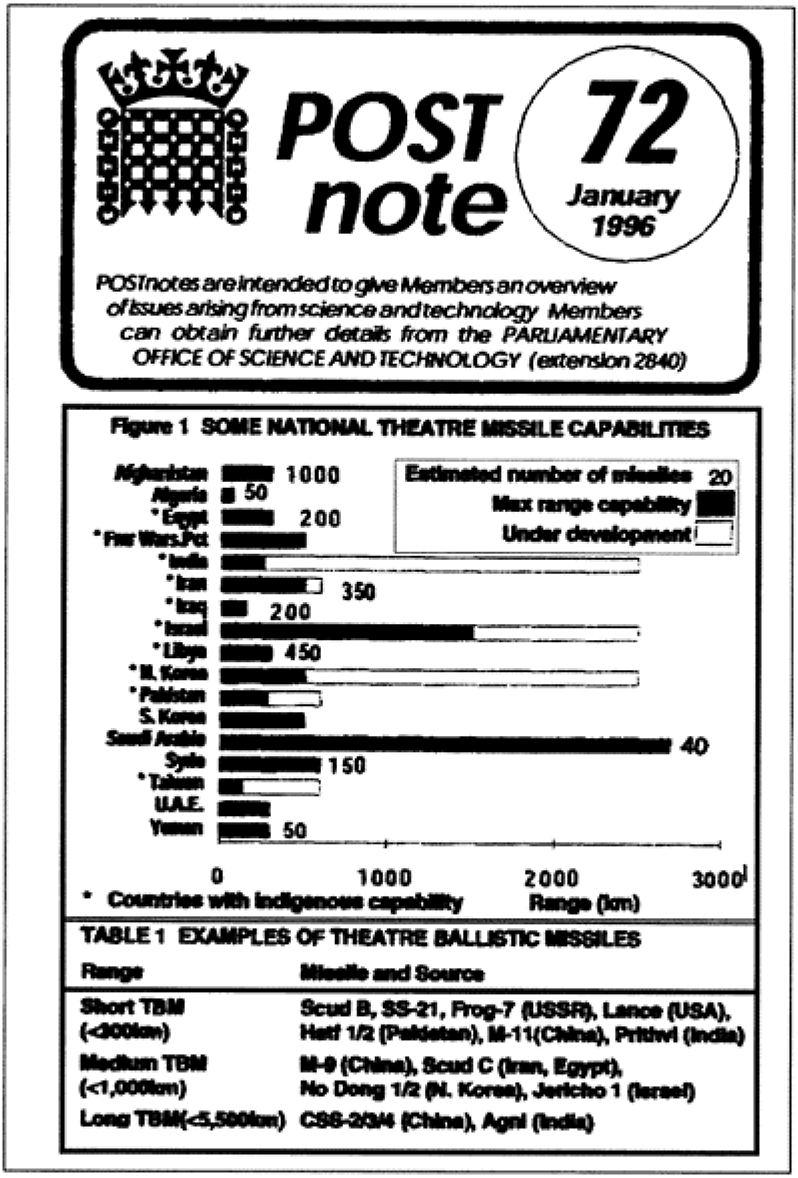
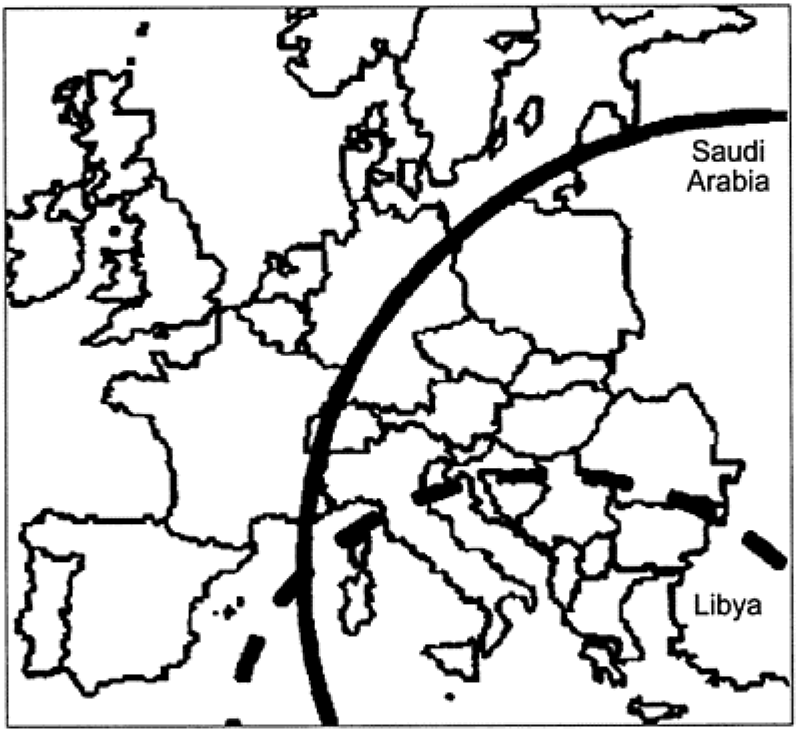


TABLE 1 EXAMPLES OF THEATRE BALLISTIC MISSILES

Range	Missile and Source
Short TBM (<300km)	Scud B, SS-21, Frog-7 (USSR), Lance (USA), Hatf 1/2 (Pakistan), M-11(China), Prithvi (India)
Medium TBM (<1,000km)	M-9 (China), Scud C (Iran, Egypt), No Dong 1/2 (N. Korea), Jericho 1 (Israel)
Long TBM(<5,500km)	CSS-2/3/4 (China), Agni (India)

Source: POST Note 72, January 1996; © Parliamentary Office of Science and Technology

Figure 10: European Ranges of TBMs



Source: POST Note 72, January 1996; © Parliamentary Office of Science and Technology

In 1994 the Chief of the Defence Staff noted: 'The positioning of long range ballistic missiles in some areas creates a direct threat to Europe and may well do to our own country within the next decade or so.'[10] For the moment, the government's view was that only former republics of the Soviet Union and China could threaten the UK. Moreover:

> Of the Third World countries currently possessing or seeking a ballistic missile capability, none is considered likely to develop the means or intent to pose a direct threat to the UK during the foreseeable future but we can be less certain about our interests elsewhere (eg NATO's Southern Region, Cyprus and Gibraltar and UK forces deployed overseas).[11]

This equivocal, and consistent, position regarding ballistic threats to deployed forces was and remains somewhat surprising in view of the Gulf War experience and that the Iraqi Scud targets could just as easily been British as American. The resource implications of a more robust statement of the threat at a time of a reducing defence budget may explain this reticence. Nonetheless, the Foreign Office did acknowledge that chemical weapons delivered by ballistic means could constitute a 'poor man's nuclear weapon'.[12] The MoD's first post-Cold War statement of military doctrine set out the problem in 1996:

> International efforts to ban chemical and biological weapons and to counter the proliferation of nuclear weapons and missile technology have had a measure of success, but many nations around the world are armed with highly destructive military equipment. This includes…long range weapons, such as tactical ballistic missiles, and weapons of mass destruction (some of which may be relatively low technology). Much of this weaponry is in unstable regions of the world, where there are many unresolved issues and potential causes of conflict…[13]

EARLY POLICY

The renewed interest in ballistic missiles and defence against them did not start with a clean slate. Technical collaboration with the United States was continuing under the terms of the 1985 MoU (see Chapter 8). By mid-1992 government-to-government contracts awarded so far totalled $107.3 million, most then sub-contracted to UK companies,[14] in addition to work contracted directly between SDIO and British companies and research institutions.

The venerable Bloodhound SAM system was finally withdrawn from service in 1991, but the Ministry of Defence issued Staff Target ST1235 for a replacement MSAM system, which could be revised to incorporate a limited ATBM capability.[15] Also under development was a new-generation radar, the Multi-function Electronically Scanned Adaptive Array (MESAR), a version of which would later be selected for the Royal Navy's new air defence ships and which had obvious BMD potential.[16] The Chemical and Biological Defence Establishment at Porton Down was working on an $11.2 million research contract for the Americans on the defeat of attacks by ballistic missiles with chemical or biological warheads.[17]

The MoD itself began to consider, in the light of the Gulf War experience, what approach to take to defence against TBMs.[18] It was clear, however, that no dramatic change in policy was to occur immediately:

> HMG's overall policy is, whilst maintaining adequate defences for the United Kingdom, to prevent the proliferation of weapons of mass destruction; to promote responsibility in the transfer of conventional weapons, and to seek to prevent destabilising buildups of weapons in regions of tension.[19]

In 1993 Malcolm Rifkind decided that the question of active BMD should be studied.[20] He spelled out the questions to be addressed in February the following year:

> We are considering whether there might be a need for a Ballistic Missile Defence system in future. There is a danger in adopting a narrow view of hard-kill defensive systems as the only response to the proliferation of ballistic missiles. We do not accept this to be self-evidently true. So we are looking with our allies at potential risks both to the UK and to our forces deployed overseas, and all possible means of countering

> them…Which states are likely to acquire effective ballistic missile systems? What targets might be within their reach? What warheads might they have—nuclear, chemical, biological or conventional? Would they create a potential threat to the UK itself?… Will defensive systems be effective and reliable? Finally, would they be affordable?[21]

All of this was fairly tentative and in contrast with the large and relatively well-funded TMD programmes being pursued by the SDIO (now renamed Ballistic Missile Defence Organisation [BMDO]) in the United States.[22] Despite the long-standing and close relationship between the two countries, Britain's cautious approach to BMD sometimes occasioned frustration in Washington for whom the need for active BMD was obvious and immediate.[23] Similar frustration was expressed by the Commons Defence Committee in 1994, which stated that 'we would be dismayed were there no prospect of such defence [BMD] being available by the turn of the century'.[24]

Though periodic distinctions were made between threats to the UK and to deployed forces,[25] it was generally the former that drove UK policy towards BMD in the 1990s, and despite the latter being acknowledged as more urgent. A new type of 'ten-year rule' emerged with frequent assertions that a threat to the UK was unlikely to emerge within ten years.[26] Humphrey Crum Ewing points out that this led to two possible conclusions: that either the problem was therefore not pressing and decisions could wait, or, alternatively, ten years' lead time would be required in order to have defences in place when they became needed.[27] Both approaches neglected the existing, and in the Gulf amply demonstrated, threat to deployed forces.

Nonetheless, it was decided in 1994 that future BMD options would be studied under an industrial contract.[28] This was to be a 'Pre-Feasibility' Study (PFS) 'to identify practical defensive architectures against a range of scenarios, taking account of costs, risks and timescales as well as technical and industrial considerations…[and] to take account of current and past American and British research in this area'.[29] A junior Defence Minister confirmed in Parliament that 'the Government take ballistic missile defence extremely seriously'.[30]

THE PRE-FEASIBILITY PROGRAMME

The Pre-Feasibility Programme (PFP) initiated by the government in 1994 consisted of the main industry-led study (the PFS) and six smaller associated studies which examined certain topics in greater detail.[31] Whilst the PFS itself was wholly UK-funded (£5 million), the associated studies were jointly financed by the UK and United States.[32] Industrial bids were received in July 1994 and a PFS contract awarded to a consortium led by British Aerospace in November.

The PFP as a whole addressed only active defence, excluding other responses, such as passive defence and counter-force operations. Nuclear-tipped and space-based weapons were also specifically excluded from consideration at the outset, but otherwise it examined a range of possible system architectures for missile defence. The requirements document called for the following to be undertaken:

(a) The provision of technical advice regarding future UK BMD options considering likely budgetary costs, risks and timescales, with emphasis on the emerging Third World threat.
(b) The development of practical architectures with the widest range of BMD applications.
(c) The provision of broad estimates of effectiveness, Life Cycle Costs (LCC), risk, timescales and an estimated Long Term Costings (LTC) profile for each architecture against an agreed range of generic scenarios and potential threats.[33]

Generic threats were to be considered with ranges of between 300 and 5,500 km with various warheads and in salvoes of up to ten missiles. The MoD supplied 16 generic scenarios within six ‘cases’. Only two of the latter, which addressed threats to the UK itself, used real-world geography, perhaps indicating political sensitivity about examining specific regional contingencies (such as the Persian Gulf) which might in themselves generate an operational requirement. The two UK cases examined an accidental or unauthorised attack from the former Soviet Union (a leading rationale for the US GPALS programme—see Chapter 8), and an attack from the Middle East or North Africa. The four generic overseas cases examined short- and longer-range threats with and without adjacent sea areas. Parallel studies examined the Air-Breathing Threat (ABT) to identify the ability of each architecture to counter other than ballistic threats.

That the PFS devised a number of missile defence architectures based on existing or projected components (such as the Patriot PAC-3 missile system in conjunction with the British MESAR radar) is striking. No operational requirement for a BMD capability had been issued and the need for any active defence had not been confirmed. To some extent this represented a reversal of the usual order of things, whereby an identified operational need would be followed by an examination of how that need was to be met. The PFP therefore resembles to some degree the SDI approach from the previous decade, which was often criticised for being technology- rather than policy-led.[34]

The more detailed associated studies were:

(a) Command, Control, Communications and Interoperability Study
(b) Ascent Phase Kill of Ballistic Missiles Study
(c) Fundamental Issues Study
(d) Discrimination Study
(e) Measures of Effectiveness Study
(f) Lethality Study

The Fundamental Issues Study (FIS) by Professor Neville Brown of Oxford University is considered separately in the next section. In addition to the PFP studies, a BMD Sensors Technology Demonstrator Programme examined the BMD applications of MESAR and BMEWS as part of ongoing joint UK/US activities. MESAR also featured in a study of the still-extant MSAM requirement.[35]

The PFS concluded that each of the six ‘cases’ could be countered by a suitable defence architecture. The overseas mission could be met by a lower-tier system in 2003 with an upper tier to follow in 2006 at the earliest. Though the exact components selected remain classified, it is clear from their repeated use as examples that the US Patriot PAC-3 and Theater High Altitude Air Defense (THAAD) systems were the basis of most architectures. A ‘marinised’ version of THAAD for shipborne use was included,[36] although this option has never been seriously considered by the US Navy. Other systems examined were the US Air Force's Airborne Laser (ABL), an air-launched Atmospheric Interceptor, the Russian SA-12 SAM and the French-built Aster missile already planned for the Royal Navy's new air defence ships.[37]

Depending on the systems selected, a two-tier TMD capability could be acquired for between £1.4 and £2.6 billion. A two-tier architecture for the defence of the UK could not be in service before 2010, costing between £2.3 and £2.6 billion. 'No weapon systems were identified that had the capability to defend the UK and deployed forces simultaneously,'[38] but THAAD featured prominently for both TMD and NMD. Purely endo-atmospheric systems like Patriot had no effective role to play in the defence of the UK, as they could only counter short-range (i.e. slower) missiles.

Many of the general conclusions were unsurprising. Purely exo-atmospheric systems were BMD-specific and could only engage the longer-range threats. Purely endo-atmospheric systems might have some capability against other threats (ABT) but defended much smaller areas. A 'layered' architecture was in all cases considered essential in the longer term. US-derived satellite warning would be 'valuable' but in-theatre surface-based sensors and airborne radars (such as the E-3 AWACS) were suitable alternatives. The PFP showed that the UK's understanding of BMD issues was 'not complete',[39] which unsurprisingly required further studies to be undertaken, in particular in the areas of threat characteristics, integration into wider air defence, development risk (i.e. proving the technology) and future threat growth. The use of naval platforms also required further study.

One would expect an industry-led study to produce technical and procurement conclusions rather than policy recommendations. Nonetheless, the PFP work did clearly inform the policy-making process. A senior participant identified six possible options for the UK: rely on the Americans, procure 'off the shelf' in the event of a crisis, procure off the shelf in advance, join a collaborative programme, develop a new UK system, or build a UK system based on existing assets (such as MESAR).[40]

In June 1995 another junior Defence Minister, Roger Freeman, said in an interview with *The Times* that 'there is a *prima facie* case for having a ballistic missile defence system… We have a ten-year window before the UK effectively could be targeted from the Mediterranean.'[41] This was followed by the strongest official case yet for missile defence. In a speech to the Belgian Royal Institute of International Affairs in October 1996 (just after the PFP was completed), the Defence Secretary, Michael Portillo (Rifkind had moved to the Foreign Office), outlined the scale of missile and WMD proliferation, and went on to say:

> The threat for our NATO allies may grow. And none of us will want to deploy forces within range of hostile ballistic missiles without affording them the best possible protection…we need ballistic missile defence, and we need to develop it jointly in NATO, with Europeans and Americans deciding together how best to respond to threats to our security interests.[42]

The PFP, which was completed in June 1996, had itself identified that Britain needed to study several aspects of BMD further before any policy and procurement decisions could be taken. The PFS prime contractor was pressing for a feasibility study as the logical next step.[43] By now, however, a General Election was less than a year away and the prospects for the Conservatives being re-elected seemed poor. Further progress on BMD would have to await the outcome of that election and the major review of defence being promised by the Labour Party.

THE FUNDAMENTAL ISSUES STUDY

When the PFP was being considered in early 1994, it was decided to commission an outside, academic review of the broader issues involved in BMD. The FIS was to include geo-politics, threat development, the technological environment, the operational context, arms control, ecological impact, industrial collaboration and participation in space-based systems, looking up to 25 years ahead.[44] As Professor Brown's work continued it became clear that it 'would most appropriately inform MoD policy'. It was therefore treated separately from the rest of the PFP, though formally being a part of it.

Unlike the rest of the PFP, the FIS was published in full, after only slight alterations to protect US-derived information.[45] An interim summary was also published in 1995.[46] Brown concluded that 'popular awareness of BMD throughout the West (but especially this side of the Atlantic) still lags far behind the subject's intrinsic importance… One thing Britain cannot do at this juncture is stand aside from the BMD debate.'[47]

Brown acknowledged the scale of missile proliferation (a 'poor man's remedy'), but provided few details, and placed it in the wider geopolitical context, paying particular attention to other means by which the West could be attacked or coerced. BMD for its part, needed to be seen within a wider EAD context. Brown's previous interest in SDI and space was evident in his focus on relations with Moscow and tendency to favour boost-phase interception over mid- and terminal-phase employing surface-based weapons.

When considering the latter, he appears to have examined the same systems as the PFS—PAC-3 and THAAD. Brown also favoured UK participation in the US/German/Italian Medium Extended Air Defence System (MEADS).[48]

The FIS reaffirmed existing views that impenetrable defences were unlikely, and that cost-exchange ratios remained important. Lethality was a critical issue, and would require the same multi-layered approach favoured by the PFS.

Brown makes a critical point, not always understood elsewhere, that the emergence of a ballistic threat to Europe could inhibit European participation in future regional conflicts, such as a new Gulf War. This links the otherwise distinct requirements of TMD and NMD. He believed that

> Britain would be all-advised to commit herself to procure forthwith surface-based BMD. She would be well-advised to resume her traditional 'intelligent customer' role…[49] and play a 'waiting game… Discuss and make ready… But do not rush into BMD acquisition.[50]

The degree of influence over policy-making exercised by the FIS is difficult to determine with confidence. Its impact may have been inhibited by its somewhat idiosyncratic style. Nonetheless, Brown's view that 'such precautions [BMD] should only be taken through the application of proven technologies, as and when there are indications of an emergent threat'[51] both reflects the earlier tendency to predicate BMD requirements on a threat to the UK itself, and the cautious 'wait and see' approach to be adopted by the new Labour Government.

THE STRATEGIC DEFENCE REVIEW

Soon after coming to power in May 1997, the Labour Government embarked on a Strategic Defence Review (SDR). In view of the work recently completed it might be expected that missile defence would feature prominently in a thorough-going review of Britain's security needs and the means to address them. In fact, the opposite proved to be the case. This was foreshadowed whilst the SDR process itself was still going on. One 'defence source' said in November 1997: 'Even if this [BMD] has not been abandoned completely, it has been kicked into the long grass.'[52] The International Institute for Strategic Studies (IISS) reported that 'MoD and Foreign and Commonwealth Office officials agree that the Review will not recommend any significant new expenditure on satellite intelligence-gathering hardware or ballistic-missile-defence systems', on the grounds that the UK was unlikely to conduct major operations alone.[53] Dr John Reid, a junior Defence Minister, stated, however, that BMD *was* being examined in the SDR, but that no decisions had yet been taken:

> It is as well to remind ourselves of the risks to not only regional but global security posed by the proliferation of missiles and the development of weapons of mass destruction…
>
> In considering the missile threats faced by the United Kingdom, it is probably helpful to distinguish between three areas: the United Kingdom itself, the territory of our NATO allies, and the territory outside the NATO area…
>
> In the immediate future, the risks lie mainly outside the NATO area, particularly the middle east, the near east and north Africa…
>
> …the protection of deployed forces is a more immediate concern than the protection of the United Kingdom itself.[54]

Once published in July 1998, the Report on the SDR[55] confirmed that the subject had, notwithstanding Reid's earlier comments, indeed been sidelined. References to missile proliferation and BMD were sparse. Scattered phrases outlined the potential security problem:

> There is an increasing danger from the proliferation of nuclear, biological and chemical technologies…(p. 5)
>
> …today's security environment is not benign…(p. 8)
>
> …the presence and potential spread of ballistic missiles, chemical and biological weapons and even nuclear weapons add to the risks. (p. 11)

A 'Supporting Essay' on *Deterrence, Arms Control and Proliferation* stated:

> …we need military capabilities to address the risks to British forces deployed overseas posed by nuclear, biological and chemical weapons and their means of delivery. To do otherwise would be an unacceptable constraint on our political freedom of action and could put our people at undue risk. (p. 5–15)

However, Britain would not, for the moment, acquire active defences:

> A number of systems intended to destroy ballistic missiles are under development, notably in the United States. These may play a role within a balanced spectrum of capabilities to counter the risks posed by chemical and biological weapons and their means of delivery. But technologies in this area are changing rapidly and it would, at this stage, be premature to decide on acquiring such a capability. We will, however, monitor developments in the risks posed by ballistic missiles and in the technology available to counter them, participate in NATO studies and work closely with our allies to inform future decisions. (p. 5–15)

The Review concluded that

> we do not need to procure a new ground launched medium or long-range air defence missile. We…have established a technology development programme to keep this option open…if a new ballistic missile threat to this country were to emerge. (p. 38)

The SDR was therefore consistent with earlier policy under the Conservatives in tying BMD acquisition to a threat to the UK itself, notwithstanding that the protection of deployed forces was acknowledged as being more urgent and SDR's commitment to an 'expeditionary' strategy. The PFS's identification of several possible missile defence architectures now looked rather premature.

The reasoning behind SDR's BMD policy was set out in public by the MoD's Director of Defence Policy in September 1998.[56] The PFS had, indeed, outlined a range of technical options, but a policy view had at that stage still not been taken as to whether *any* BMD capability should be acquired. What mattered was not so much the missiles themselves, but their payload:

> Notwithstanding the damage that individual ballistic missiles armed with conventional warheads can cause, our assessment is that they do not in themselves pose a sufficiently serious threat to justify specific countermeasures. Put bluntly, there are better ways of delivering high explosive. Or main concern is therefore with ballistic missiles armed with weapons of mass destruction.

Active defence did not feature in countering nuclear threats, for which deterrence, arms control and non-proliferation would suffice. That meant ballistic missiles were a problem only in terms of chemical and biological threats, for which anyway they are not ideal delivery vehicles (there was no mention of radiological warheads). A threat to the UK was unlikely to develop 'in the near to medium term'. Ballistic missiles were only one of many means by which chemical and biological weapons could be delivered against deployed forces, who would certainly require passive protection. But as both the threat and defensive technologies were changing rapidly, committing funds now to BMD might preclude the opportunity to exploit later developments. BMD had 'significant resource implications', which was perhaps the nub of the matter. '[I]t would clearly be important for Britain to have an intelligent customer capability' in case it was decided in the future to acquire active BMD, so the subject would continue to be studied.

The Labour Defence Secretary, George Robertson, summed it up to an American audience:

> Proliferation of nuclear, biological and chemical weapons is a growing problem in its own right… Ballistic missile defence may have a part to play… But much of the technology is still immature, and in Britain we cannot build defences against all potential forms of delivery. Nor is a fortress mentality the best way to address the problem at the political level.[57]

This policy was widely criticised, including by several people previously involved in missile defence.[58] Lord Chalfont accused the government of 'a tendency, indeed almost a desire, to stand aside from the debate'.[59] Stanley Orman drew attention to 'the dramatically different interpretations of the threat growth by international experts, compared with the staff of the policy branches within the Defence Ministry'.[60]

A *Daily Telegraph* editorial opined 'that there is no excuse for dismissing the Americans as "Star War" scaremongers and brushing the whole issue under the carpet'.[61] Even a House of Commons Library Research Paper thought: 'The Government's position on the threat from ballistic missile development overseas could…be regarded as unduly complacent.'[62] Several commentators pointed out that the SDR was a *defence*, rather than a wider-ranging, *security* review, which might have better highlighted unconventional or 'asymmetric' threats, including ballistic missiles.[63]

A memorandum submitted to the Commons Defence Committee encapsulated many of the perceived shortcomings of the SDR's treatment of BMD:

> The SDR, as a document intended to provide long term planning guidance, is rather silent on anti-ballistic missile systems. It ignores the need to give defensive as well as deterrent cover to our expeditionary forces…The non-provision of such a flexible and deployable ATBM capability seems something of a missed opportunity.
>
> …the Whitehall debate on the whole ABM question is still affected by the negative dynamics of the old, almost theological, controversies of the 1980s… The ABM question is now rather different and its current subtleties deserved fuller treatment…[64]

The Defence Committee agreed that the SDR's 'reticence on the subject does indeed represent a missed opportunity… Policy in this area needs to be clear, kept under constant review…and the research needs to be adequately funded.'[65]

THE TECHNOLOGY, READINESS AND RISK ASSESSMENT PROGRAMME

The continuing programme of research instituted by the SDR, and commended by the Commons Defence Committee, was a three-year Technology, Readiness and Risk Assessment Programme (TRRAP), part of the MoD's Corporate Research Programme, which aims to maintain and develop the defence science and technology base.[66] TRRAP was run by the Director Science (BMD), Dr Michael Rance, the aim of which was

(i) to monitor developments in the potential threat and the technologies available to counter it and
(ii) to establish a position from which a national requirement for fielding an active ballistic missile defence system could be developed, should one become necessary.

> The programme focuses on the characteristics of ballistic missiles, the performance of radar and other sensors, the guidance of interceptors, and their potential to defeat ballistic missile warheads including those containing biological or chemical agents.[67]

TRRAP addressed the protection of UK forces deployed overseas, which could in the longer term be extended to the protection of UK forces deployed on NATO territory. It expressly did not examine the defence of the UK itself.[68] This was fully in line with the prior identification of TMD as the more pressing need, but was starkly at variance with the SDR's linking a future BMD acquisition to the emergence of a (non-Russian) ballistic threat to the UK itself.

The TRRAP was undertaken by a combined industry[69] and Defence Evaluation and Research Agency (DERA) team, and was broken down into four main areas: Threat Analysis, Technical Risks, Systems and Operational Analysis.[70] TRRAP was an expression of the MoD's 'intelligent customer' approach. The PFS had shown what the UK did *not* know, some of it systems-specific knowledge which the United States would not always readily share.[71] There was also some scepticism about the veracity of some of the test results being claimed by the Americans,[72] and an awareness that for all the money spent since Reagan began the SDI, no operational systems had been fielded.[73]

TRRAP was not a lavishly funded programme—£12.5 million in all in addition to the £4.5 million cost of the PFS[74] and approximately £500,000 per annum since 1991 spent on continuing collaborative studies with the United States.[75] The TRRAP studies were completed in late 2001, and an unclassified summary published in February 2002 detailing its 'Research Objectives' (ROs) and 'Technical Areas' (TAs).

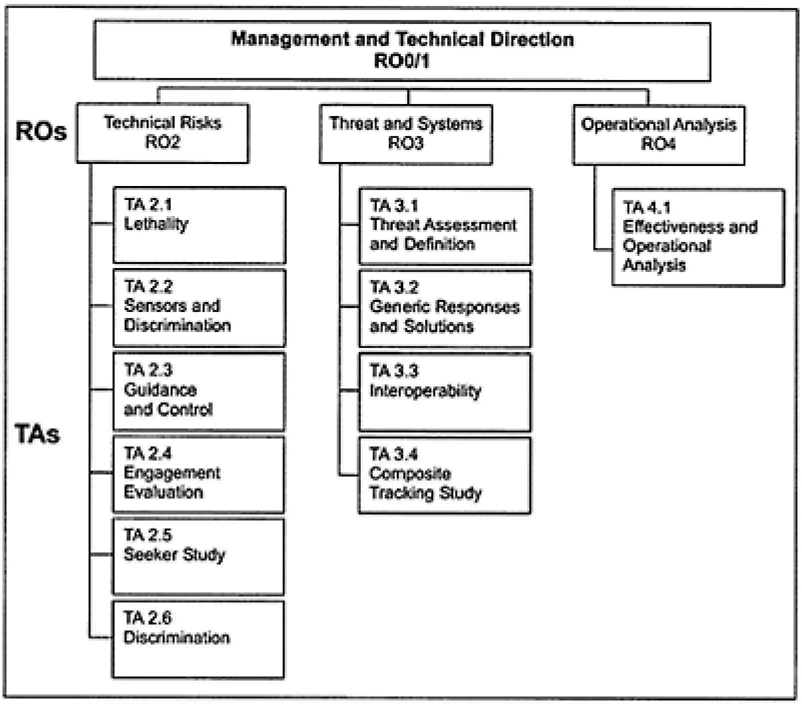
The analysis of threat development up to the year 2015 included possible defence countermeasures, informed by the UK's own experience with Chevaline. The conclusion was that 'it is not a trivial matter to deploy decoys in a credible manner and with credible signatures to increasingly sophisticated sensors. We found it a struggle in the 1970s, and sensors today are significantly better.'[76] Future improvements in missile accuracy would increase the military utility of conventionally armed ballistic missiles.

TRRAP examined in detail 'generic' low- and high-altitude endo-atmospheric TBMD systems, citing Patriot PAC-3 and the Franco-Italian (Aster-based) SAMP/T as examples of the former, and THAAD the latter. Some limited analysis of sea-based and airborne interceptors was done, but not of the ABL.

The overall conclusions of the TRRAP were:

> …ground-based interceptors employing hit-to-kill are a feasible mechanism to counter Theatre Ballistic Missile systems. The key technical risks are the possible evolution in the sophistication of TBM systems, especially if countermeasures are introduced; and the lethality against sub-munitions.
>
> The UK is…in a much stronger position to assess the operation and performance of active BMD systems, when required…
>
> TRRAP has greatly improved the techniques and methodologies available within the UK to evaluate Ballistic Missile Defence options…

Figure 11: TRRAP Report



Source: Director of Strategic Technologies, Ministry of Defence, *The Technology Readiness and Risk Assessment Programme: A Summary*

> *Paper*, February 2002; © Crown Copyright/MOD. Reproduced with the permission of the Controller of Her Majesty's Stationery Office.
>
> MOD is continuing to monitor developments both in the potential threat and in the rapidly evolving technology available to counter it.[77]

The Director of Strategic Technologies (who had by now subsumed the previous responsibilities of Director Science [BMD]), later amplified the conclusion:

> If you want to defend a military operation, you will probably want to defend an area of 100 or so kilometres at the minimum. The TRRAP studies reveal that the optimum way of doing that would be via a layered defence comprising a very short range, low altitude defence akin to PAC-3, accompanied by a slightly longer range but still intercepting within the atmosphere system… THAAD.[78]

Figure 12: Countries Operating Ballistic Missiles

Ballistic missiles were used against the UK during the Second World War and have been used in several conflicts over the last 20 years, most notably the Iraqi SCUD-type weapons during the Gulf War in 1991. Many countries now possess ballistic missile capabilities, including those shown below.

Afghanistan	SCUD-B	South Korea	NHK-1
Belarus	SCUD-B, SS-23	Libya	SCUD-B
Bulgaria	SCUD-B, SS-23	Pakistan	HATF-I, HATF-II
China	CSS-2, CSS-3,		CSS-7, SHAHEEN,
	CSS-4, CSS-5,		GHAURI
	CSS-6, CSS-7	Poland	SCUD-B
Czech Republic	SS-21	Russia	Various
Egypt	SCUD-B	Saudi Arabia	CSS-2
France	M-45	Slovakia	SS-21, SS-23
India	PRITHVI I,	Syria	SCUD-B, SCUD-C,
	PRITHVI II,		SS-21
	DHANUSH, AGNI II	Turkmenistan	SCUD-B
Iran	SCUD-B, SCUD-C,	UAE	SCUD-B
	CSS-8, SHAHAB-3	Ukraine	SCUD-B, SS-21
Iraq	AL SAMOUD,	UK	TRIDENT D-5
	AL HUSSEIN	USA	Various

Israel	JERICHO 1,	Vietnam	SCUD-B
	JERICHO 2	Yemen	SCUD-B, SS-21
Kazakhstan	SCUD-B, SS-21		
North Korea	SCUD-B, SCUD-C, NO-DONG, TAEPO-DONG 1		

Source: Director of Strategic Technologies, Ministry of Defence, *The Technology Readiness and Risk Assessment Programme: A Summary Paper*, February 2002; © Crown Copyright/MOD. Reproduced with the permission of the Controller of Her Majesty's Stationery Office.

THEATRE MISSILE DEFENCE

The publication of the Strategic Defence Review in July 1998 with its rejection of active BMD acquisition did not end the public debate in Britain, nor even the attention paid to it in official statements. Somewhat awkwardly for the government, the Report of the Rumsfeld Commission[79] was published the same month in the United States. This concluded:

> A new strategic environment now gives emerging ballistic missile powers the capacity, through a combination of domestic development and foreign assistance, to acquire the means to strike the US within about five years of a decision to acquire such a capability (10 years in the case of Iraq). During several of those years, the US might not be aware that such a decision had been made.[80]

This Congressional report addressed threats to the United States. However, the implications for countries even closer to ballistic missilearmed countries in the Middle East were obvious, even if the Rumsfeld Commission's assessment was regarded in Europe as somewhat alarmist and politically inspired. The Commission's report did not alter the British Government's own assessment of the threat,[81] but it did add weight to criticism of UK policy.[82]

Indian and Pakistani missile tests in 1999 further highlighted the continuing rate of proliferation. In August the Labour Chairman of the Commons Defence Committee, Bruce George MP, said, 'Sooner or later—hopefully sooner—we're going to have to get off the fence and cooperate with the Americans in developing such a [BMD] system.'[83]

The MoD's identification of the ballistic threat with chemical and biological warheads was reflected in its Summer 1999 report *Defending against the Threat from Biological and Chemical Weapons*. This concentrated on passive and civil defence measures, non-proliferation and research at Porton Down, but did state:

> No country of concern currently has ballistic missiles which, launched from its own territory, could threaten the UK with biological or chemical agents…

> The ballistic missiles which are now being developed could pose a threat to British forces deployed overseas. Some parts of NATO's southern flank are already vulnerable; and the risks facing Europe are likely to increase in the next decade.[84]

The new Defence Secretary, Geoff Hoon, confirmed, however: 'The Strategic Defence Review concluded that the technologies related to ballistic missile defence are changing rapidly and it would be premature to decide on acquiring such a capability. This remains our policy.'[85]

Missile defence was becoming more of a party political issue, partly in connection with US plans for an NMD of North America (see Chapter 10). But the Conservative opposition also came out strongly in favour of European defences, describing the Government's cautious approach as

> wishy-washy… It is perhaps not surprising, however, given the left-wing credentials of those Ministers currently in residence at the Foreign Office, to whom any notion of missile defence is anathema.
>
> … Europe still remains bereft of any anti-ballistic missile defences… As a result we find Western Europe cruelly exposed to the threat—or promised threat—of ballistic missile strike.[86]

In the Labour Party, missile defence was a subject of internal dispute, which to some extent reflected institutional differences of opinion between the MoD and FCO.[87] The former, with its close links to the Pentagon and a natural focus on military issues, was sympathetic towards active defence, whilst the latter has a cultural predisposition towards diplomatic responses to proliferation.

Whilst the defence of Britain itself remained highly controversial, with all its implications for deterrence, arms control and relations with Russia, the case for a tactical defence of forces deployed overseas was becoming more widely accepted.[88] The Defence Secretary himself confirmed that government thinking was evolving.[89] There was certainly a subtle shift in official statements of policy. In May 2000 Hoon issued one of many reiterations of government policy, whilst holding out the possibility of future change:

> For the moment, we consider it premature to decide on acquiring a ballistic missile defence capability either for UK forces deployed overseas or for the defence of the UK itself. That position is based on both our current assessment of the threat and of the technologies available to counter it. But our national programme of work [TRRAP], and feasibility studies shortly to be started at NATO, will enable us to continue to make informed judgements on whether to invest in such capabilities in the future.[90]

The MoD's *The Future Strategic Context for Defence* examined the security environment as far ahead as 2030. In respect of proliferation, it stated:

> We can expect some states to continue to pursue programmes to develop nuclear, biological and chemical (NBC) weapons, and associated delivery systems, particularly missile delivery systems… Where states develop such weapons, this is likely to be primarily with a view to limited regional or internal use…
>
> At present the UK remains out of range of missiles and aircraft from proliferating states. At current rates of progress, it seems likely that, well before 2030, one or more of these states will have ballistic missiles capable of reaching the UK carrying chemical or biological payloads and, potentially, nuclear weapons… There are already capabilities in the hands of proliferators which could be used to threaten British forces deployed overseas and parts of NATO's southern flank…
>
> Deterrence policies may not prove effective against small scale use of CW or BW, especially attacks on deployed troops… We should also be aware that some states may not respond to deterrence as we might expect, and that technological developments will affect both offensive capabilities and the active and passive counter measures available…
>
> UK policy on BMD will need to develop in response to changes in the nature of the threat and the defensive capabilities available.[91]

Contrary trends were at work within the MoD, however. On the one hand, TMD was coming to be seen as uncontroversial and merely part of the wider air defence problem. On the other, after 1999 there was some shift in emphasis towards Peace Support Operations (PSOs), influenced by the Kosovo campaign of that year, in which any form of air defence assumed a lower priority.[92]

Whilst TRRAP was still going on, an internal working group examined what work should follow. TMD was passed to the Equipment Capability Directorate for Theatre Airspace (DEC[TA]) as a potential procurement item, competing for funding with other projects in the equipment budget. As a result of TRRAP, the MoD view of missile defence was increasingly not 'will it work?', but 'how well will it work?',[93] and, by implication, 'will it work well enough, to be worthwhile?'

Several equipment programmes with BMD potential were quietly proceeding whilst the policy debate still went on. The Royal Navy had already examined the limited role its existing Type 42 air defence destroyers armed with Seadart could play (whilst still in development it had been suggested for an ABM role—see Chapter 4).[94] A particular area of UK expertise is in radars, largely through the experimental MESAR. A MESAR II was specifically developed by DERA and Plessey Siemens (now part of BAE Systems) for BMD trials purposes, and tested in conjunction with the US BMDO.[95] The radar has proved capable of the necessary discrimination for BMD purposes.[96] An operational derivative called Sampson is to be carried by the Type 45 replacement for the Type 42, the contract for which includes a 'BMD Growth Study'.[97] The Type 45 will carry the French Aster missile, a land-based variant of which is being acquired by France and Italy for TBMD.[98] The Royal Navy is also to acquire the US Navy's Cooperative Engagement Capability (CEC),[99] an essential part of the 'sensor-netting' necessary for extended air defence, including BMD.[100]

A draft UK doctrine for TBMD was produced in 2000 by the RAF's Air Warfare Centre, but its future status remained uncertain in the absence of an active defence capability.[101]

DEFENCE OF THE UK

In advance of the 2001 General Election, Hoon stated: 'We will work closely with the new [Bush] US Administration to consider the options for and implications of improved missile defence.'[102] For the Opposition, Duncan Smith said 'The proliferation of ballistic missiles and the weapons of mass destruction with which they are armed is the most daunting threat…of modern times… Britain should have led the European debate on missile defence…'. He lamented the lack of a more positive policy.[103]

Labour's re-election in June 2001 ensured that there would be no dramatic shift in policy. The Chief of the Defence Staff, Admiral Sir Michael Boyce, continued the cautious line, linking missile defence to threats to the UK itself: 'There is the possibility, probability, of countries being able to achieve a ballistic missile system that could be fired at us. It would be irresponsible for us not to explore what is the art of the possible…'.[104] He made clear the significant financial consequences of a missile defence programme when the defence budget continued to decline as a proportion of GDP.

Soon after, a new twist was added to the debate by the terrorist attacks on New York and Washington. These could be taken to illustrate either the vulnerability of Western societies to all forms of attack, which could include ballistic missiles, or that the real threat was not from missiles, but other forms of attack. The events of 11 September prompted a minor defence review in Britain, the 'SDR New Chapter'. BMD was not itself part of that process, but the MoD acknowledged its potential implications: 'The events of 11 September show that there are those who will seek to threaten with whatever means are available… In the future this might include ballistic missiles.'[105] One immediate consequence with implications for missile defence was a renewed emphasis on air defence.[106]

In February 2002 the MoD and FCO set out a comprehensive joint memorandum on missile defence. It repeated the familiar refrain that there was no direct threat to the UK, but that longer-range systems were in development by some states, such as Iraq. A threat depends on capability and intention, but the latter can change at short notice. 'We believe it is still premature to decide on acquiring an active ballistic missile defence capability for either deployed forces, for whom we already have considerable capabilities for passive force protection…or for the defence of the UK.' Further work was under way on countering longer-range missiles (presumably those that could one day reach the UK), and the role of active defences within a 'balanced defence posture' (the work now being done by the DEC[TA]):

> For most European nations (including the UK), the focus is on looking at the protection of deployed forces, who can already face a missile threat in certain parts of the world… Above all, we need to recognise…the reality of the proliferation of weapons of mass destruction and their means of

> delivery…and the role that missile defences might play as one part of this.[107]

MoD officials went on to confirm that British bases in Cyprus were already within range of Syrian and Iranian missiles. Moreover, the development of longer-range missiles by several states indicated capabilities beyond those required for purely regional deterrence purposes.[108] A national defence system for the UK might cost between £5 billion and £10 billion (a sum comparable to the cost of Trident). As regards protection of deployed forces, ‘There is passive defence, there is counter force, there is deterrence and there are active defences. We do not currently have active defences, but we have the other three in some quality.’ Hoon later confirmed that there was no objection, in principle, to accepting any offer the United States might make to defend allies with the systems currently under development.[109] The following month, he stated that a programme was in hand to examine ways of protecting deployed forces.[110]

During the summer of 2002, US officials visited several European capitals, including London, and explained at length the various options for missile defence, stressing the willingness of the US Administration to extend protection to its allies.[111] As a consequence, the protection of the UK itself, hitherto regarded as a largely separate subject from the defence of North America (Chapter 10), became closely bound up in debate with the latter.

The MoD initiated further work, concentrating on the wider implications of missile defence and a public discussion paper was published in December.[112] This is the most comprehensive statement yet of the British Government’s views on the subject, and stands in marked contrast to the SDR’s almost complete neglect of the topic four years earlier. The paper opens with the observation that

> missile defence is a subject of growing global importance. The potential threat of most concern both to national populations and to deployed forces is…from the increasing proliferation of ballistic missiles, not least owing to the potential for their combination with chemical, biological and nuclear weapons of mass destruction.[113]

It notes the continuing uncertainties regarding the pace of proliferation, the development of defensive technologies, and the presence of other, non-ballistic, threats such as terrorism. The UK already has a range of arms control and deterrence policies in place to counter proliferation, but may need to join in active defence efforts. A detailed examination of the current state of missile proliferation is accompanied by the following statement:

> We assess that there is no immediate significant ballistic missile threat to the UK… However, the continuing proliferation of ballistic missile technology and expertise between countries of concern makes it more rather than less likely that the UK will in due course be within range of missiles in the hands of those who may have the intent to impose their will by threat of ballistic missile attack.[114]

Work within NATO (see below) and bilaterally with the United States will continue, and, perhaps significantly, the MoD is to examine how an emergency initial operational capability might be acquired at short notice, if required. There may also be a missile defence technology centre jointly funded by government and industry. Just as important, is the explicit acknowledgement that 'the concept of active missile defence has changed fundamentally since its Cold War origins',[115] even if the paper then does go on to stress the importance of that Cold War concept, 'Strategic Stability'. This was not, however, and as widely predicted, undermined by the American withdrawal from the ABM Treaty in June 2002.

An overriding need is to assess the cost and operational effectiveness of missile defence. The UK might also consider some role specialisation—in other words accept some degree of reliance on others (i.e. the United States), which might be used to justify not meeting the full costs of an active defence capability.

The British Government has therefore not, at the end of 2002, made any positive decision to acquire missile defences, but has moved a long way in terms of recognising the threat and the role that active defence could play in countering it. Most important, perhaps, is that in the new strategic environment most of the traditional policy concerns about missile defence have finally been laid to rest.

NATO

A detailed examination of NATO's work on ballistic missile defence since the end of the Cold War is outside the scope of this study. Nonetheless, Britain has consistently taken a leading role in this work, which has proceeded in parallel with the UK's own national studies and statements of policy.

Missile proliferation attracted the interest of the Alliance just as it did in Britain. NATO's new strategic concept, published in November 1991, noted 'the proliferation of weapons technologies…including weapons of mass destruction and ballistic missiles capable of reaching the territory of some member states of the Alliance'.[116]

The NATO Air Defence Committee (NADC) began work to investigate TBM defences the following year. The NADC is only one of several NATO bodies that have examined Alliance BMD. The Nuclear Planning Group (NPG), the Conference of National Armaments Directors (CNAD), Supreme Headquarters Allied Powers Europe (SHAPE), the NATO Consultation, Command and Control Agency (NC3A), the National Industrial Advisory Group (NIAG), the Advisory Group for Aerospace Research and Development (AGARD) and a new Defence Group on Proliferation (DGP) have all been involved, with an Extended Air Defence/Theatre Missile Defence Ad Hoc Working Group doing a lot of the detailed coordination.[117]

Early work identified four pillars for EAD: Counter-Force, Lower Tier, Upper Tier and Boost-Phase.[118] In 1993 the North Atlantic Council approved a policy that TMD should not be treated separately, but as part of EAD, and that TBMs should be defined as those having ranges of up to 3,500 km.[119] This blurred the distinction between 'strategic' and 'tactical' threats, as a WMD-armed missile threat to NATO Europe is strategic in effect, but avoided ABM Treaty complications by focusing only on the 'theatre'-range threats which could still reach much of Europe. Defence was to be oriented south towards the Middle East and North Africa, and not towards the former Soviet Union in the east.[120]

Roger Freeman, Minister of State for Defence Procurement, confirmed in June 1995 what seemed the obvious, indeed only, sensible approach towards the defence of the UK: 'We are likely to look to combine our national defence requirements within a NATO-wide theatre defence strategy.'[121] NATO studies in which the UK had participated were also used to inform Britain's own PFS.

In June 1994 the *Alliance Policy Framework on Proliferation of Weapons of Mass Destruction* decided to 'improve the defence capabilities of NATO and its members to protect NATO territory, populations and forces against WMD use'. In October SHAPE completed a draft Military Operational Requirement (MOR) for Active Theatre Ballistic Missile Defence, which suggested an evolutionary, layered approach, which was, however, regarded in the political headquarters in Brussels as 'too ambitious' and was watered down to better match financial reali-ties.[122] NATO's infrastructure Security Investment Programme had already been reduced by 50 per cent since the end of the Cold War. The revised MOR led to the formal issue of a NATO Staff Target in 1999,[123] though the British Government was at pains to point out: 'Agreeing the NATO Staff Target is…not equivalent to a national Staff Target, and does not imply a decision in principle by the UK to acquire a system to provide the capability specified.'[124]

BMD was also extensively investigated by the rejuventated Western European Union (WEU), initially as the expression of the European arm of NATO and latterly as the embryonic security identity of the European Union. A large symposium on the subject of anti-missile defence for Europe was held in Rome in April 1993. A subsequent report by the Technological and Aerospace Committee recommended, in the first instance, a European early warning system.[125] Little progress was made on this idea, despite a judgement that 'the United States would not make its early-warning satellites available to NATO'.[126] In fact, agreement had already been reached whereby the US would provide satellite-derived early warning information to the Joint Analysis Centre in Britain, thence to NATO.[127] In November 1998, recognising the work going on in NATO and wishing to avoid duplication, the WEU Council decided to take BMD no further.[128] WEU deliberations, both in Council and the Assembly, had, however, served to raise the profile of missile defence as a European issue.

Because BMD was to be addressed as part of wider EAD, a TMD requirement was written in to NATO's air defence modernisation, the Air Command and Control System (ACCS). The initial level of operational capability included provision for later inclusion of BMD command and control.[129] Though ACCS replaces NATO's existing Air Defence Ground Environment (NADGE), it will have two deployable command and control sets for overseas operations.

In 1998 NATO instigated a TBMD feasibility study to investigate the technical, financial and procurement issues of an Alliance missile defence programme. In the same year, the NATO Parliamentary Assembly recommended: 'The Alliance should give urgent attention to missile defence, in particular to protect their forces when they are engaged in military operations.'[130] A revised strategic concept issued in April 1999 affirmed: 'The Alliance's defence posture against the risks and potential threats of the proliferation of NBC weapons and their means of delivery must continue to be improved, including through work on missile defences.'[131] At the same, NATO launched a defence capabilities initiative which identified WMD and missiles as likely threats to be faced. The DGP had already identified extended air defences, with a TBMD capability for deployed forces, as a current capability gap to be addressed.[132] Two industrial contracts for the feasibility studies were awarded in July 2001, and were due to complete in January 2003. These could lead to a NATO staff requirement in 2004 for an initial deployment by 2010.[133] One estimate of the scale of expenditure required is $8–10 billion, recognising that a ‘feasible architecture will have to be an affordable architecture’.[134]

None of this means, however, that NATO is any more committed to acquiring an active BMD capability than is the British Government:

> The Allies need to decide for themselves whether they require a missile defense system and are willing to pay for it. Absent a catastrophic event that shocks European governments into action …a consensus is likely to evolve slowly in most countries…
>
> Most Europeans still feel safer today than at any time in fifty years.[135]

Nonetheless, at the Prague Summit in November 2002 a new feasibility study was initiated, in advance of completion of the existing work and this time expressly to examine the protection of ‘Alliance territory, forces and population centres against the full range of missile threats, which we will continue to assess. Our efforts in this regard will be consistent with the indivisibility of Allied security.’[136]

It is likely that any future NATO BMD architecture will see TBMD sensors and command-and-control built into the Alliance-wide ACCS, whilst active defences themselves, such as German and Dutch Patriot PAC-3s, are ‘plugged into’ the NATO infrastructure.[137] An initial requirement would concentrate on the protection of deployed forces, but could soon expand to include the defence of European territory closest to the Middle East and North Africa. An added dimension is the invitation by the United States for NATO European countries to participate in, and be protected by, the Bush Administration’s plans for missile defence.[138]

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10
Britain and US National Missile Defense

THE CLINTON NMD PLAN[1]

President Bush's re-orientation of the SDI programme to face more limited threats, GPALS (Chapter 8), was short-lived. Bill Clinton entered the White House in January 1993 unconvinced that a missile defence of North America was required. As a result of the Gulf War, Theater Missile Defence (TMD) for deployed forces and regional allies was supported by most shades of political opinion. But the new Administration saw no threat to the United States itself other than the long-standing missile capabilities of Russia and China, for whom a mix of deterrence, arms control and political engagement seemed an appropriate response.[2] Accordingly, the SDIO now became the Ballistic Missile Defence Organisation (BMDO), focused on the shorter-range, 'theatre' threats and with only a 'hedge' programme of basic research relevant to a limited National Missile Defense (NMD).

There remained, however, many advocates of missile defences for the continental United States, especially in the Republican Party. During the 1994 Congressional elections, missile defence was a prominent part of their 'Contract with America' manifesto. Subsequent efforts by the now Republican-controlled Congress to force the Administration to develop a limited defence system were nonetheless defeated in the House of Representatives and by Presidential veto.[3] Clinton remained under pressure on the subject, however, which became the principal defence issue in the 1996 Presidential campaign.[4]

In consequence, his Administration devised the '3+3' programme: Three years of research and development to be followed, if such a decision were taken in 2000, by three years of deployment effort leading to an operational capability in 2003. For technical reasons this latter date was later put back to 2005.[5] This cautious (and many critics alleged inadequate) approach was justified by the 1995 National Intelligence Estimate which concluded that the United States was unlikely to face a direct missile threat for the next 15 years.[6]

This intelligence assessment was questioned in Congress and a bipartisan Commission to Assess the Ballistic Missile Threat to the United States was established. The report of the Rumsfeld Commission in July 1998 has already been cited in Chapter 9. It was followed weeks later by a North Korean test of a three-stage missile that passed over Japan. Missile defence was firmly back on the political agenda.

The year 1999 was critical for NMD. First, a budget of $10.5 billion was set. Second, the Defense Secretary, William Cohen, announced that modifications to the ABM Treaty might be necessary, to be negotiated with the Russians. Third, and separately, a National Missile Defense Act was introduced in Congress by two Republican Senators and one Democrat. The Act was signed by Clinton in July, hoping to avoid accusations in the forthcoming election campaign that the Democrats were soft on defence.[7] He nonetheless noted that no deployment decision had been made, and set out the criteria for such a decision: 'Any NMD system we deploy must be operationally effective, cost-effective and enhance our security.'[8]

A new national intelligence estimate assessed that 'during the next 15 years the United States most likely will face ICBM threats from Russia, China, and North Korea, probably from Iran, and possibly from Iraq'.[9] Finally, in October, a test of the proposed system achieved a successful intercept over the Pacific, though a subsequent trial in January 2000 failed. The issue was no longer whether, but how, NMD would be deployed.[10]

The Clinton Administration's NMD plan was predicated on a near-term threat from North Korea, and, further into the future, from the Middle East.[11] A phased deployment plan would have seen 20 interceptors (Capability 1 [C1]) deployed at a single site (probably in Alaska) by 2005, rising to 100 (C2) by the end of 2007. Other elements of the system were a single X-Band ground-based radar (GBR), a command-and-control system and upgraded early warning from satellites and BMEWS sites. A later C3 would incorporate a second interceptor site in North Dakota and up to five additional X-Band GBRs, optimised for threats originating in the Middle East.

Clinton himself remained unenthusiastic, however. Just as during the ABM controversy in the 1960s, a Democrat President was being pushed towards deployment by domestic political pressures rather than any substantive belief that it was either necessary or wise. In particular, he did not want to be the US President that killed off the ABM Treaty.[12] A third intercept attempt in July 2000 also failed and provided a catalyst for Clinton to announce on 1 September that a deployment decision was being deferred for his successor to take. He cited technological problems and the implications for relations with Russia, China and US allies as the reasons.[13]

THE BRITISH REACTION (I)

For much of the time Bill Clinton occupied the White House, NMD aroused relatively little interest on the other side of the Atlantic.[14] The controversy that arose in the United States in 1998 following the Rumsfeld Commission's report and the rapid pace of developments the following year took most European governments largely by surprise, and unprepared to deal with NMD's wider implications.[15] In particular, there was little realisation of the extent to which there was a growing consensus in the United States in favour of missile defence:[16] '…the US has never fully accepted one core element of the Cold War thinking in which the vulnerability of its own territory is an inevitable precondition for global security.'[17]

At first there was little US consultation with European NATO governments, partly because the Americans knew the reaction would be largely negative, and anyway the immediate focus of NMD was Asia, not Europe. It was also perhaps because the Clinton Administration was itself embarking on NMD reluctantly.[18] In Europe it was widely expected (and hoped) that like ABM, SDI and GPALS before it, NMD might never actually be deployed.[19]

In February 1999 Baroness Symons, a junior Defence Minister, confirmed: 'Her Majesty's Government take a close interest in the debate in the United States on the possible deployment of a national missile defence system, and its wider implications.'[20] Formal presentations by the United States followed in the autumn which made it clear that NMD was a serious proposition.[21] The debate in Britain and elsewhere in Europe really started thereafter. Many of the concerns voiced reflected those aroused by ABMs and SDI: differing views on the severity of the threat, implications for stable deterrence, the effects on arms control, relations with Moscow, de-coupling of US and European security, and Alliance consultations. There was also a good deal of scepticism about the technical feasibility and financial cost of tactical, never mind strategic, missile defence. The official UK view was reported to be that 'we understand the strength of momentum in Washington', and wished to 'understand and manage any US decision, rather than take a black or white view of it'.[22]

Little more was heard of the subject until early 2000. The Foreign Secretary, on a visit to Washington, was equivocal about NMD: 'there are new threats in the world…there are specific and challenging threats to the United States from some individual countries. In these circumstances we understand that the United States would wish to respond to it.'[23] Peter Hain, the junior Foreign Office Minister responsible for non-proliferation, was more forthright: 'I don't like the idea of a Star Wars programme, limited or unlimited. Unilateral moves by Washington would be very damaging.'[24] The (perhaps belated) awareness of the need to win allied support was evident in an article written for *The Times* by the US Defence Secretary, Cohen, who concluded that

> our limited missile defence system would enhance deterrence and improve stability. An America that is confident of its own defence will be best positioned to defend its allies. A cooperative approach on national missile defence and the ABM Treaty will provide lasting benefits for global security.[25]

At the Non-Proliferation Treaty (NPT) Review Conference in New York in April, Hain was more diplomatic, but made clear British reservations about some of NMD's implications:

> Consideration of NMD by the United States has been prompted by growing concerns about the acquisition of long-range ballistic missile capabilities by some countries that do not form part of established deterrence relationships. We understand these concerns. They need to be addressed. But active missile defence raises complex and difficult issues. The United States has made clear that in taking decisions on NMD, it needs to take a number of important considerations into account, including the need to preserve strategic stability. We welcome that.[26]

He went on to stress the importance of maintaining the ABM Treaty. Despite repeated reports of FCO/MoD splits on the subject,[27] Hoon used almost identical language in Parliament to outline the government's position, noting that any US decision needed to take into account the views of NATO allies, the preservation of strategic stability, and the viability of international treaties.[28]

Political views outside the government were in some cases highly polarised. A Commons Early Day Motion was ‘concerned that the United States is considering abandoning the strategy of mutual deterrence in favour of combining offensive and defensive missiles, thereby creating a recipe for a new arms race’.[29] Lord Chalfont, by contrast, was by now a leading advocate of missile defence and stated: ‘If we resist the need to develop ballistic missile [defence] systems we shall do grave damage to the alliance.’[30] The then Shadow Defence Secretary, later Leader of the Opposition, Iain Duncan Smith, made missile defence something of a personal crusade, publishing two monographs devoted to the subject.[31]

NMD was considered by the Commons Foreign Affairs Committee as part of a wider investigation of WMD.[32] The evidence taken by the Committee was overwhelmingly from organisations and individuals hostile to missile defence, though government testimony itself was equivocal and at pains not to criticise directly the US Government. The Committee also identified some difference of view as between the MoD and FCO.[33] The Report recommended

> that the Government articulate the very strong concerns that have been expressed about NMD within the UK. We are not convinced that the US plans to deploy NMD represent an appropriate response to the proliferation problems faced by the international community. We recommend that the Government encourage the USA to seek other ways of reducing the threats it perceives.[34]

Russia and China featured prominently in British concerns about NMD. In Russia’s case this had much to do with the ABM Treaty. There were also more general worries about relations generally with Moscow, whether NMD would halt and even reverse strategic arms reductions and even prompt a Russian investment in BMD that might undermine the UK’s Trident force.[35] Early US discussions with Moscow did much to assuage these fears. It became apparent that the Russians might, in fact, trade acquiescence to NMD for the further offensive reductions it might itself have to make anyway for economic reasons.

Chinese opposition to NMD was more forthright. Like Britain, China benefited from the ABM Treaty’s limitations on strategic defences,[36] and suspected (with good reason, many observers thought) that the North Korean threat was only a cover for a system really aimed at China’s modest force of ICBMs: ‘…you don’t spend that kind of cash for one or two North Korean missiles’.[37]

NMD posed a real dilemma for the British Government. The nature of its close defence and intelligence ties made Britain more sensitive to American security concerns, and more reluctant to openly criticise US policy, than many other European states, especially France.[38] On the other hand, Britain had real concerns about NMD and wanted to be seen, in security terms, as a ‘good European’.[39] The result was ‘an official policy to have no policy’.[40]

Clinton’s decision to defer a deployment decision was greeted outside the United States with general relief and approval. The Foreign Secretary, Robin Cook, commended the ‘measured approach [of] President Clinton …which has taken careful account of the views of the United States’ allies’.[41] Clinton’s decision appeared to vindicate Britain’s cautious wait-and-see policy which had avoided paying the political costs inherent in any overt support for, or rejection of, NMD. The breathing space would only be temporary, however, as Clinton's successor, whether Democrat or Republican, would have to make an NMD decision once in office.[42]

FYLINGDALES

For the British Government, NMD was not only a subject of general concern to do with strategic stability, transatlantic relations, arms control and relations with Moscow. The existing BMEWS radars, though performing an early warning role independent of any active missile defences, nonetheless had an obvious role in NMD. BMEWS Site 3 at RAF Fylingdales had been comprehensively modernised—effectively rebuilt—as recently as 1992 (see Chapter 5). The integration of Fylingdales into an active defence system would not only require the permission of the UK Government (remembering also that it is actually operated by RAF personnel), but would be in contravention of the ABM Treaty.[43]

This meant that, as the Foreign Affairs Committee put it, 'The UK is not simply a bystander with regards to NMD.'[44] Fylingdales gave Britain some leverage in the NMD debate with the United States, but might also force the government, at some stage, to make an unequivocal decision which it might prefer not to. The Foreign Affairs Committee urged the government 'to impress upon the US Administration that it cannot necessarily assume unqualified UK cooperation with US plans to deploy NMD', whilst also noting: 'A UK refusal to allow the upgrading of facilities at Fylingdales would be unprecedented and prove very testing for the alliance.'[45] The Defence Secretary agreed: The history of our close friendship with the US is such that we are sympathetic to such requests.'[46]

The necessary upgrading would, in fact, be modest: changes to the software which governs the operation of the radar and some related hardware changes.[47] This would allow the radar to track missiles, which in its early warning role it does not need to do.[48] There was widespread concern that this would breach the ABM Treaty. However, the MoD reported that if Fylingdales were to be upgraded for NMD purposes, either a suitable amendment to the Treaty would have been negotiated with Russia, or, failing that, the United States would have given the required six months' notice of withdrawal from the Treaty. 'Either way, the question of any possible breach of the treaty through the upgrading of the Fylingdales radar or its integration into any NMD system would not appear to arise.'[49]

ABM Treaty compliance was not the only issue connected with an NMD role for BMEWS, however. Agreement to the use of Fylingdales would at least imply British support for NMD, though it was pointed out that the UK would not itself be protected by the new system.[50] 'If you want to overwhelm your enemy, you must overwhelm his defences. Only in this case America's defences will be on the Yorkshire Moors.'[51] It might even make the UK a target itself, though this objection tacitly acknowledged that there was indeed a threat.[52]

NMD and the role of RAF Fylingdales were discussed with the Americans on repeated occasions. The government, however, maintained in public that as no formal request to use the station had been made, no formal decision was required:

> We have not received a request from the US regarding the use of facilities in the UK as part of the proposed US National Missile Defence system, nor would we expect any until after a US decision on whether or not to proceed with deployment of such a system. We would consider such a request carefully, taking account of any implications for UK defence.[53]

This 'fig leaf'[54] remained the consistent public stance of the government right up to the end of 2002.[55] It was regarded by others as disingenuous, on the grounds that the issue had certainly been discussed with the Americans,[56] and the US Government would be unlikely to make a formal request without having first established what the answer would be. The RUSI observed: 'Patently the Government wishes to avoid public discussion of a complex but important issue of national security earlier than absolutely necessary.'[57]

The significance of Fylingdales for NMD, especially the C1 configuration which was all that Clinton might have authorised, was often over-stated. A former Labour Defence Minister, Peter Kilfoyle, wrote that 'without the station being upgraded the American SDI cannot work'.[58] In fact, an NMD system located in Alaska to meet a North Korean threat would have little need for a radar situated in Europe, though the C1 and C2 configurations did have some residual capability against missiles launched from the Middle East.[59] Site 3 would only become essential to NMD in a later C3 configuration in about 2010, when Fylingdales might also become the location for one of the additional X-Band GBRs. It was certainly not the case that, as Professor Rogers told the Foreign Affairs Committee, 'the NMD programme cannot actually go ahead without direct British support',[60] or that as Robin Cook stated, a software upgrade was required at Fylingdales for NMD to become effective.[61] This was later made clear in a written memorandum submitted to the Committee by the FCO:

> Without the involvement of the Upgraded Early Warning Radar at RAF Fylingdales, the ability of the proposed system to meet threats to the United States from North Korea would be unaffected. But its effectiveness in meeting threats to the United States from the Middle East would be likely to be significantly impaired.[62]

Nonetheless, the use of Fylingdales in active defence has been studied by the MoD (see Chapter 9), though the results remain classified. This was acknowledged by Paul Roper to the Defence Committee, though subsequently the phrase 'Fylingdales Study' was corrected to 'potential Fylingdales requirements',[63] which may demonstrate the political sensitivity of the subject. It may also be significant that the old Air Ministry file[64] dealing with the original agreement with the United States was again being consulted by the MoD in late 2000.

When Bill Clinton announced the deferral of an NMD deployment decision on 1 September 2000, the issue of Fylingdales's role had not been resolved. It would have to await the plans of Clinton's successor.

MENWITH HILL

RAF Fylingdales was not the only US installation in Britain potentially involved in NMD. After the failure of the MIDAS satellite system in the 1960s research into infra-red detection of ballistic missiles continued in the United States. Out of that work came the Defense Support Program (DSP) satellite warning system. The DSP ‘constellation’ of four satellites was designed to detect ICBM launches and to alert BMEWS radars. Like MIDAS would have done, it provides earlier but less precise warning than BMEWS. During the Gulf War in 1991 two satellites were re-tasked to provide warning of Iraqi Scud launches,[65] which could not be seen by BMEWS as they did not climb sufficiently high to appear above the radar horizon.[66]

In the early 1990s the United States initiated a programme to replace DSP, partly because the satellites are ageing, but also because they can only detect missiles in their ‘hot’ boost phase and cannot track them. The replacement system is known as the Space-Based Infra-Red System (SBIRS). It will comprise two elements. SBIRS (High), the first elements of which are due for launch in 2004, will comprise four geo-stationary satellites and a further two in a highly elliptical orbit. It will replace the existing DSP system and provide initial warning of missile launch. SBIRS (Low) will comprise up to 24 satellites in low-earth orbit and be capable of tracking the residual heat of a missile against the cold space background, after the boosters have burnt out and separated. The first satellites, after several delays, are due for launch in 2006–07.[67]

The SBIRS (High) system requires a European Ground Relay Station, essentially a communications link.[68] Following a UK/US agreement in March 1997, this is located at RAF Menwith Hill, also in Yorkshire, a National Security Agency signals intelligence site.[69] As this was well before NMD became an issue in Europe, it was probably regarded as uncontroversial, especially as SBIRS (High) simply replaces an existing capability. Unlike BMEWS and MIDAS there is no specific MoU governing SBIRS, its operation being covered by the very general 1951 NATO status of forces agreement and additional confidential arrangements.[70] Like BMEWS,

> SBIRS was conceived separately from NMD, and is regarded as being necessary irrespective of whether or not the United States also decides to proceed with NMD deployment. It is being pursued as a separate project…[But the] United States may…wish to make use of data relayed by SBIRS satellites via the European Ground Relay Station at RAF Menwith Hill for NMD purposes.[71]

Though operated mainly by US personnel (unlike Fylingdales), the use of Menwith Hill for NMD would also require British Government permission. The official position therefore remained the same as for Fylingdales: ‘…the Government has received no such request from the United States Administration—nor would we expect to receive such a request until and unless the United States Administration had decided to proceed with the deployment of such a system’.[72]

THE ABM TREATY

The relationship between Fylingdales, Menwith Hill and the ABM Treaty was not the only interest the British Government and others had in the Treaty. Article I unequivocally prohibits any ABM defence of national territory other than the national capital and an ICBM field, as allowed under Article III (in 1974 amended to one *or* the other). From the outset, therefore, it was evident to all concerned that any *national* missile defence would be in breach of the ABM Treaty, requiring either its amendment to permit a 'thin' national defence, or withdrawal altogether as provided for in Article XV.[73]

Britain was not a party to the Treaty, but was vitally affected by it. Its role in assuaging earlier concerns about US and Soviet ABM deployments, and thereby maintaining the credibility of the UK's own strategic deterrent, has already been noted. A consistent British view was that 'we continue to value the strategic stability that the treaty provides. We want to see it preserved,'[74] though just what constitutes 'strategic stability' after the end of Cold War bi-polarity has never been defined.

It was always the intention of the Clinton Administration that any NMD deployment would only take place in the context of an agreed Treaty amendment, and the C1/C2 100 interceptor configuration was designed to be as closely Treaty-compliant as possible.

Britain welcomed the announcement in June 1999 of discussions between the Americans and Russians on Treaty amendment and further offensive arms reductions (START III).[75] The British Government, whatever its own concerns, always maintained: 'The question of any amendment to the anti-ballistic missile treaty to accommodate NMD is strictly a matter for the US and Russia, as parties to the treaty';[76] 'The anti-ballistic missile treaty remains, in general terms, the foundation and basis of arms control';[77] but, 'As with any international treaty, the interpretation of the ABMT is a matter for the parties. It is not for nonparties, such as the United Kingdom, to offer their own interpretations of its provisions.'[78] Nonetheless, the government shared the view that 'a thin NMD system within the context of amended ABM Treaty is unequivocally preferable to unilateral withdrawal from the Treaty'.[79] That amendment had taken place before was noted, and Baroness Symons stated that a Treaty amended to allow NMD would still be worth having.[80]

Other politicians expressed themselves less attached to the Treaty. Lord Chalfont pleaded: 'Let us not place too much reliance upon, or be too affectionate about, the ABM Treaty. It was a useless treaty from the moment it was signed, and it continues to be so.'[81] Margaret Thatcher told the RUSI that 'I do not share the widespread nostalgia for the Anti-Ballistic Missile Treaty of 1972. Far from regarding it as a cornerstone of stability—to use the well-worn cliché—I view it as an outmoded relic'.[82]

A noted missile defence sceptic, Sir Michael Quinlan, a former MoD Permanent Secretary and a leading architect of Britain's nuclear weapons policy'[83] acknowledged that the end of the ABM Treaty was unlikely either to undermine all arms control, or cause the Russians to re-invest in missile defences of their own.[84] An editorial in *The Economist* observed that 'the ABM Treaty was designed for a bipolar world—not for today'.[85]

By mid-2001 George W.Bush had replaced Bill Clinton in the White House. NMD development was undergoing a thorough review, but it was clear that a much larger-scale deployment than that ever contemplated by Clinton would go ahead. The possibility that the Americans would not secure the required Treaty amendments from Russia was growing, and therefore it was becoming more likely that the United States would withdraw from the Treaty altogether. This was acknowledged by the British Government, who nonetheless continued to hold out hope that agreement would still be reached.[86] Negotiations with the Soviets did not achieve Bush's objectives, and on 13 December the US Government gave the required six months' notice of withdrawal.

The official British reaction was muted:

> …we have consistently made it clear that we understand the role that missile defences can play. We welcome the US continuing commitment to consult with NATO allies, Russia, China and others on this important issue. That shows that the US is not proceeding in a unilateral manner…
>
> …the US announced in December that it had given Russia six month's notice of its intention to withdraw from that treaty, as it was entitled to do… The ABM Treaty is essentially a bilateral issue for the US and Russia, and its future is a matter for them.[87]

The government also acknowledged that, contrary to earlier and frequently expressed fears, the US withdrawal was being accompanied, not by a renewed arms race, but by further reductions in offensive missiles.[88] The Foreign Secretary opined that 'the response of the Russian Federation has been measured, in my judgement, because of the measured proposals from the US'.[89] He went on to say that the ABM Treaty 'was a product of its time. In 1972, global security was underpinned by the grim logic of mutually assured destruction (MAD)… But the world has changed.'[90]

There was therefore something in common between the British and Russian responses[91] to US withdrawal from the Treaty. Both preferred to see it remain in place, but both realised that once the Americans were resolved to free themselves from its constraints little was to be gained by continuing to argue for its retention. Both recognised that many of the dire predictions made about the consequences of withdrawal had always been over-stated. There was to be no new arms race, nor a breakdown in relations, nor an end to other arms control agreements.[92] In fact, once the six-month period of notice of withdrawal had passed on 13 June 2002 and the ABM Treaty was no more, one could wonder what all the fuss had been about.

THE BUSH PLAN

George W.Bush indicated early on that his approach to missile defence was very different to that of Bill Clinton:

> Our mutual security need no longer depend on a nuclear balance of terror…

> It is time to leave the Cold War behind, and defend against the new threats of the 21st century.
>
> First, America must build effective missile defenses, based on the best available options, at the earliest possible date. Our missile defense must be designed to protect all 50 states—and our friends and allies and deployed forces overseas—from missile attacks by rogue nations or accidental launches…
>
> My second principle is that America should rethink the requirements for nuclear deterrence in a new security environment.[93]

In the meantime, the out-going Clinton Administration awarded an additional $6 billion contract for further development of the existing NMD system, to preserve deployment options for the new Administration based on a more thorough test programme.[94] On entering the White House, Bush emphasised his commitment to missile defence by appointing Donald Rumsfeld as Secretary of Defense, the same man who had chaired the Rumsfeld Commission in 1998.[95] This did not, however, lead to an immediate decision to deploy NMD, not least because there was nothing yet available to deploy. Having made clear that their options were a lot wider than the Clinton plan,[96] the new Administration embarked on a comprehensive review of all BMD programmes. Sea-based and airborne boost-phase options for NMD (specifically prohibited by the ABM Treaty) were now considered, though the original land-based NMD system remained the most mature and probably the first to be ready for deployment.[97]

By the middle of his first year in office, Bush had secured Russian agreement to the linking of NMD with further offensive arms reductions. The latter were desired by both sides anyway, and the pragmatic Russian President Putin recognised that opposition to NMD had run its course as a negotiating ploy. In particular, as the RUSI noted, 'Putin's threat that scrapping the ABM Treaty would trigger an arms race was essentially hollow.'[98] A further agreement in November 2001 produced mutual reductions in strategic nuclear arsenals, but failed, however, to secure a final solution to the ABM Treaty question.[99] Bush's BMD options seemed by now to require outright scrapping, not just amendment, of the Treaty.

Rumsfeld sought to prevent NMD remaining a divisive issue in relations with allies by scrapping the TMD/NMD distinction, in order to make clear that all BMD systems could protect other nations as much as the United States: 'What's "national" depends on where you live, and what's "theater" depends on where you live.'[100] Though this made some sense in diplomatic terms, it did blur the distinction between homeland defence and protection of deployed forces just when this was being understood and accepted in Europe. This always runs the risk of an otherwise uncontroversial TMD requirement being 'tarred by the same brush' as the still highly controversial national requirement. What had previously been known as the NMD *system* (as opposed to the NMD *requirement*) was now re-titled the Ground-Based Midcourse Defense Segment (GMDS). Missile defence was to be defined in terms of the phases of a missile's trajectory—boost, mid-course, and terminal—rather than the nature of its target—national or theatre.

Bush re-iterated his commitment to BMD in May 2001:

> We need a new framework that allows us to build missile defences to counter the different threats of today's world. To do so, we must move beyond the constraints of the 30-year-old ABM Treaty. This treaty does not recognise the present or point us to the future. It enshrines the past.
>
> No treaty that prevents us from addressing today's threats, that prohibits us from pursuing promising technology to defend ourselves, our friends and our allies is in our interests or in the interests of world peace.[101]

While the exact configuration of North American missile defence continues to evolve, the earliest possible date for a limited operational deployment has been put back to at least 2006.[102] It will eventually include both land- and sea-based components, the latter based on the US Navy's Standard SM3 missile. Whilst an airborne laser carried in converted Boeing 747 aircraft continues in development, a long-term programme for a space-based laser has been heavily curtailed. None of these were possible whilst the ABM Treaty remained in force.[103] In the second year of Bush's Presidency, therefore, missile defence seemed less imminent than before, but also more certain and more diverse.

THE BRITISH REACTION (II)

Bush's unequivocal commitment to missile defence and his election to the White House put further pressure on the British Government in its desire not to offend either its American or its European allies, or its own hostile backbenchers.[104] The Prime Minister, Tony Blair, described the issue as 'handle with care'.[105] There were certainly no longer grounds for hoping that the problem would simply go away. At the same time, as missile defence was studied more closely, and as relations with Russia improved rather than deteriorated, the issue came to seem less worrisome.

Just before Bush took office, the then Foreign Secretary, Robin Cook (widely regarded as an opponent of missile defence), acknowledged that 'there is a legitimate concern about rogue states firing off nuclear missiles which are outside…the old nuclear balance between Moscow and Washington'.[106] He later observed that NMD 'is not in any way a threat to Russia'.[107] However, the Labour Chairman of the Foreign Affairs Committee remained strongly attached to existing deterrence norms:

> It [missile defence] will destroy the whole system of strategic stability and international security…based exactly on this ABM Treaty … If you take this piece from under the whole foundation it will just collapse, and we'll find ourselves in a situation of strategic chaos.[108]

The Conservative Opposition leader, William Hague, came out strongly in favour of cooperation with the new US Administration as a means of embarrassing the Labour Government over its potential splits on the subject.[109] Differences of opinion between Britain and France on NMD were evident, as the UK became more reconciled and sympathetic to the subject, the French more forthright in their opposition.[110] At the same time, there was speculation that Blair was seeking to trade acquiescence in NMD for US acceptance of British assurances that the new European Rapid Reaction Force would not undermine NATO.[111]

Hoon indicated in February 2001 that the government was moving closer to the US position:

> …we are talking essentially about a defensive system… Clearly there is a role both for offensive and defensive systems…the problem [proliferation] is recognised by both Russia and the United States, and certainly by the United Kingdom…
>
> It [missile defence] is designed only to be operated in the event of an attack on the United States, and in those circumstances it is difficult to see how that directly threatens any country…[112]

Reactions throughout Europe to Bush's missile defence speech in May 2001 (see above) were more muted than would have been the case a year or two earlier.[113] There were several reasons for this. The Bush Administration seemed much more prepared to engage in real consultations than had Clinton, and talked of extending defensive cover to others. His espousal of further reductions in offensive weapons, which he linked to missile defence, also sounded a positive note. As relations between Russia and the United States improved, the prospect of a renewed arms race receded. There was also a recognition that despite his willingness to talk, Bush was not going to be dissuaded from pursuing missile defence, and that efforts to do so would be counter-productive. As Colin Gray puts it, in the wake of the terrorist attacks in September 2001, '…that homeland defence is now a hardy perennial among American strategic desiderata, virtually regardless of wider considerations, has come to be accepted in Europe as a fact of transAtlantic political life'.[114] The scale of the proliferation problem was also becoming more apparent because of Indian, Pakistani and North Korean missile and nuclear weapons programmes.[115]

Britain, as so often in the past, tried to act as go-between, seeking to moderate US language, and reassure the Europeans about the consequences of US policy.[116] Public reporting of the issue in Britain became more considered, and less inclined to 'Star Wars' hyperbole.[117] This was not true everywhere, one Labour backbencher enquiring in Parliament about the 'first strike' potential of NMD.[118] On the other side of the debate, Duncan Smith sought to exploit Labour differences, describing the government as 'no longer sitting on the fence, they are impaled on it'.[119]

Following the terrorist attacks on the United States, Hoon confirmed that British policy towards missile defence was unchanged.[120] It was still premature for the UK itself to acquire a BMD capability (Chapter 9), NATO feasibility studies were ongoing, and though Bush had expressed a wish that the United States' allies also be protected, as yet no specific proposals had been received. He later agreed, however, that the events of 11 September strengthened, not weakened, the case for missile defence, and that future reductions in US offensive missiles was 'a direct consequence of the extra security that it [the US] anticipates having once missile defence is fully deployed'.[121]

The FCO told the Foreign Affairs Committee that one of its objectives in the United States was to ensure 'that Missile Defence is pursued in a way which protects UK interests and minimises divisions within NATO'.[122] Just two months before the US announced its withdrawal from the ABM Treaty, the IISS observed that if Europeans continued to argue that the Treaty was ‘a cornerstone of strategic stability’, ‘the present US Administration will wonder if they were on a different planet on 11 September’.[123]

The new Foreign Secretary, Jack Straw, later went on to state, a little disingenuously, that ‘we in this country have long recognised the case, in appropriate circumstances, for measures of missile defence’.[124] He also observed: ‘we have to be open to new thinking. And this spirit informs our approach to Missile Defence…it is possible that Missile Defence may pave the way for greater progress on disarmament, not an arms race.’[125] Elsewhere, it was noted that missile defence could also enhance, rather than undermine, deterrence.[126] Indeed, Straw went so far as to tell the Foreign Affairs Committee: ‘There is an overwhelming case for missile defence in principle… Our view is that the United States is fully entitled to want to develop systems of missile defence.’[127] He confirmed that opinion had moved on, and observed: ‘Do the proposals threaten the safety of the world? No, they do not, not remotely. They are designed to make the world safer.’ This represents a dramatic, if little noticed, sea-change in official British thinking, which since the mid-1960s had consistently viewed deployment of missile defences as destabilising.

It was clear by late 2002, therefore, that the British Government, if not all its supporters, had become fully reconciled to the prospects of a North American missile defence. What remained to be determined, was the extent, if any, of British participation. The government’s public discussion paper issued in December (Chapter 9) stated that they would ‘agree to a US request for the use of UK facilities for missile defence only if we believe that doing so enhances the security of the UK and the NATO alliance’.[128] It went on to acknowledge US missile proliferation concerns, but also fears that the use of Fylingdales for missile defence could itself make Britain more of a target. This latter concern was dismissed: ‘RAF Fylingdales is…not a plausible target,’ because it would require an extensive and sophisticated threat to ‘blind’ the West in that manner. Nor would a more general association with US policy further endanger Britain, because of the already close security association between the two states: ‘Keeping a low profile and hoping for the best is not an option. Safety lies through recognising threats as they arise, and taking proactive steps to address them.’[129]

Only a week later, the long-awaited formal US request was received, accompanied by an offer to extend missile defence coverage to the UK ‘subject to agreement on appropriate political and financial arrangements’.[130] The Americans also proposed a new bilateral MoU covering missile defence research, development, test and evaluation. The Fylingdales upgrade would consist of the installation of new computers and software, and an additional communications link.

Such is the nature of formal diplomacy that the US Government would not make such a request without first being confident of the answer it would receive. Though no formal announcement had been made by the end of the year 2002, a British refusal to cooperate seemed unthinkable.

POSTSCRIPT

At the beginning of 2003, Geoff Hoon announced that he had ‘come to the preliminary conclusion that the answer to the US request must be yes, and that we should agree to the upgrade as proposed’.[131] He went on to emphasise that upgrading Flyingdales did not commit the UK to any further involvement in missile defence, whilst giving Britain that option for the future. There would be no 'significant variation' in the running costs met by Britain. Hoon's statement also gave a comprehensive statement on the UK Government's view of missile defence more broadly, indicating that it was fully reconciled to US plans:

> Missile defence is a defensive system that threatens no one. We see no reason to believe fears that the development of missile defences will be strategically destabilising. Reactions from Russia and China have been measured. Missile defence would need to be used only if a ballistic missile has actually been fired… Once the missile is in the air, it is unthinkable that anyone could not want us to be in a position to shoot it down.[132]

In contrast to the earlier view taken by the Foreign Affairs Committee,[133] the Defence Committee concurred with Hoon's stance:

> …the UK should agree to the upgrade. The factors in favour of that agreement—the importance of the UK-US relationship, the improvement to the early warning capability, the opportunity to keep open the prospect of future missile defence for the UK and the potential for UK industrial participation in the programme's further development—outweighs the arguments against.[134]

Formal assent to the US Government's request was given on 5 February.[135]

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11
Conclusions and Prospects

CONCLUSIONS

The UK's experience as the first country to be attacked by ballistic missiles contained many elements, in the compressed timescale of 1942–45, which were to become consistent features of BMD in succeeding decades: intelligence, early warning, counter-force operations and active and passive defence. Air Chief Marshal Hill observed in 1948 that 'the A-4 [V-2] was a notable advance on anything that had gone before, and a source of problems with which the nations are still grappling'.[1] That was true just four years after the first attacks. It remains true nearly 60 years later. One does not have to agree with his historical analysis to realise that the British Foreign Secretary was identifying the enduring legacy of the V-2 when, in late 2001, he said:

> If we had had a form of missile defence against the V1 s and, above all, against the V2s, I would suggest the war would have ended earlier because the terror which the V2s were able to inflict enhanced the confidence of the Nazi regime at a point when it was otherwise failing.[2]

Britain and its allies have had three distinct ballistic threats first to identify, and then respond to. The first was the V-2 itself. Early intelligence about the rocket was patchy and inaccurate, but by the time the V-2 campaign opened the British had a fairly accurate picture of the threat they were about to face. It was certainly good enough for the limited measures that could be taken against it, though radio-control was a minor red herring.

During the early years of the Cold War the intelligence picture of Soviet missile developments was as poor as the initial assessments of the V-2. The latter continued to exert an influence on Western appreciations until well into the 1950s, causing a severe and persistent under-estimate of the pace at which the Russians would make technological progress.[3] Dragon Return human intelligence and then Sputnik only partially improved the picture, and a realistic assessment of Soviet capabilities was not achieved until American overhead imagery became available in the early 1960s. Even then, the understanding of Soviet missile performance remained incomplete, especially in regard to accuracy and defence penetration.

As the Soviet threat faded at the end of the Cold War, attention shifted to the burgeoning proliferation of ballistic missiles to many Third World states, a phenomenon previously discounted. The overall scale of proliferation has now been well recognised for over a decade,[4] though the future pace of developments remains contested. In particular, defence penetration has been the subject of much speculation and disagreement and has a direct bearing on the subject of active defences. Though many commentators, especially those hostile to active defence, play down the future extent, and even more so the future intentions, of proliferating states, they over-state the possibilities of relatively basic, but nonetheless potentially effective, missiles also having sophisticated penaids. Britain's own experience with Chevaline gives the country a special insight into this aspect of the problem.[5] Another source of difference, especially between Americans and Europeans, has been not the extent of proliferation but its implications. Europeans are historically and geographically accustomed to living with security threats, but Americans are not,[6] despite nearly half a century of Cold War nuclear vulnerability. Much of the transatlantic missile defence debate over several decades stems from these differing perspectives on the threat.

In one sense, the ballistic missile threat has come full circle. The V-2 carried only conventional high-explosive warheads. Early assessments of the Soviet missile threat discounted atomic warheads on technical grounds. By the mid-1950s, however, the ballistic threat was exclusively a nuclear threat, mainly because of high cost and poor accuracy. But all actual use of ballistic missiles has been non-nuclear and only a minority of states today having ballistic missiles are also nuclear weapon states. With improving accuracy, relatively indiscriminate use and a perception that missiles may actually be cheaper than an airforce of sophisticated manned aircraft, there is once again, and at the very least, a significant non-nuclear dimension to the problem. As a further twist, though the missiles of the long-standing nuclear powers are several generations on from the original V-2s, the majority of Third World missiles are the ubiquitous Scud and its derivatives, itself a direct descendant of the V-2.

Because of its association with strategic nuclear bombardment the ballistic missile, and defence against it, have been intimately bound up with nuclear deterrence. Winston Churchill outlined a new dimension to warfare:

> If anything can be discovered that will put the earth on better terms against this novel form of attack, this lamentable and hateful form of attack—attack by spreading terror throughout civil populations—anything that can give us relief or aid in this matter will be a blessing to us all…[but the] fact remains that pending some new discovery, the only direct measure of defence upon a great scale is the certainty of being able to inflict simultaneously upon the enemy as great damage as he can inflict upon ourselves.[7]

That, however, was in 1934 before either ballistic missiles or nuclear weapons had been invented. He was addressing Stanley Baldwin's famous proposition that 'the bomber will always get through'. Though the development of effective air defences employing new technologies (especially radar) demonstrated in 1940 that the bomber would *not* always get through, it has remained the case much more consistently that 'the ballistic missile *will* always get through', as the 1986 Defence White Paper noted:

> Ballistic missiles came to dominate strategic thinking and the force disposition of the nuclear powers, by virtue of the certainty with which they could penetrate defensive systems and strike their intended target, combined with the appalling power of the nuclear warheads they carried.[8]

Accordingly, the subject of BMD became intimately associated with the credibility of Britain's small, 'minimal' nuclear deterrent and which was regarded as the ultimate guarantor of national independence and survival. This was so because, from the 1960s on, ballistic missiles were the chosen means of delivery for the deterrent (not least because of their perceived invulnerability to defences), and because the principal preemptive threat to the deterrent was Soviet ballistic missiles. From the mid-1950s on it was accepted that in the face of a nuclear bombardment threat, a widescale air defence of the UK was neither feasible nor worthwhile, as even a few 'leakers', whether manned bombers or, later, ballistic missiles, would still inflict unacceptable damage. Active defence, whether of bomber bases or missile silos (for Blue Streak), and whether designed to counter bombers or missiles, were therefore tasked only to defence of the retaliatory force, thereby enhancing the basic deterrent posture. For a country in Britain's fragile economic position, the deterrent had to be 'economically feasible, politically effective and strategically realistic'.[9] The same was equally true of the defence of the deterrent.

Wartime efforts to establish a gun-based defence against the V-2 can be seen now as little more than an historical curiosity. The extensive but little-known[10] R&D programme into active defence in the 1950s, though it never came to fruition, did show the way forward given the technology then available. Not only was the threat nuclear, but defence against it also had to be nuclear. The smallest miss-distances achievable were so great that no other approach was then feasible. Even so, the technological and financial demands of active defence were considered to be beyond Britain's means, though it is worth noting in passing that as the threat to the UK was a shorter-range, and so slower, threat than the ICBMs that the Americans and Soviets faced, an active defence based on existing SAMs was a more technologically realistic prospect.

The wartime establishment of an early warning network demonstrated that this aspect of the ballistic missile problem was solvable, though it was not until the late 1950s that very long-range radars provided enough warning to be of real practical benefit. Like active defence would have done, the warning obtainable was used to maintain the deterrent's survivability. Early warning calculations at the time showed just how fragile might be the actual, if not necessarily the perceived, viability of Britain's bomber-based deterrent in the face of a missile-armed Soviet Union.

Britain did not consider developing an active defence again until the 1990s. Though a non-nuclear defence against a (largely) non-nuclear threat was by then becoming possible, Britain retained many of the earlier doubts about the technical and financial feasibility of active defence. The research programmes of the 1990s examined many of the issues previously studied in the late 1950s, such as infra-red detection, decoy discrimination and re-entry body behaviour. Though the prospects of Britain deciding to develop its own defence systems are small, such research will enable the UK better to understand systems that it might acquire from elsewhere, or jointly develop with others.

As Colin Gray observes, 'Europeans have been an interested audience for the succession of debates over missile defense that Americans have conducted among themselves for forty years.'[11] US missile defences have been a subject of interest and concern to Britain on three principal occasions. The first arose soon after Britain abandoned its own attempts to develop active defences. The issues surrounding US ABM deployment raised during the Labour Government of 1964–70 were those that continued to be of concern to the Conservative Government of Margaret Thatcher in regard to SDI in the mid-1980s, and another Labour Government in the late 1990s in relation to US NMD.

A worry that the security of an invulnerable United States would thereby become 'de-coupled' from that of Europe has been tempered by scepticism as to whether such a condition was technically achievable. An American argument that a safer United States would be more likely to come to the aid of its allies has never convinced others, who have always preferred to rely on 'shared vulnerability'. Moreover, a protected United States might lead to Europe becoming even more of a Soviet target.[12]

Arms control has been a persistent European enthusiasm since the 1960s. As a diplomatic instrument of security, it has found particular favour in the British Foreign Office. Development of missile defences by either side in the Cold War would in turn demand larger offensive forces in order to overcome them, so reducing the prospects for arms control. Two qualifications have to be applied to this judgement, however. First, the scale of defences proposed in the 1960s and again in the 1990s need not have required large increases in the superpowers' offensive forces to overcome them, and, second, the largest increases in US and Soviet offensive arsenals took place in the 1970s, *after* the limitation of defences and the first agreement on offensive systems (SALT I). The greatest threat to balanced reductions was SDI in the brief period (about 1983–86) when Reagan's grand vision preceded the deterioration of the Soviet economy and the improvement in East-West relations which made increases in Soviet offensive forces progressively more unlikely. This perhaps is the key to British concerns about US BMD—not US deployment itself, but the effect of that deployment on the Russians, both their offensive and defensive capabilities.

A particular irony in the history of British attitudes to BMD is the role of the ABM Treaty. Though the UK was not a signatory to the Treaty, it played a pivotal role in British policy towards its own nuclear deterrent and the ABM systems of others. The Treaty signed in 1972 put to rest the earlier concerns about the implications of prospective US ABM deployment. It also ensured the limitation of Soviet defences to a scale that Britain *could* work to overcome, but also that Britain *had* to overcome, as they defended the all-important target—Moscow. During the SDI controversy in the 1980s, Britain's qualified support for 'Star Wars' research was always predicated on the maintenance of the ABM Treaty—which, in terms of Reagan's hopes for SDI, was quite impossible in the long term. The ABM Treaty was seen not just as a limitation on defensive systems, but the instrument that underpinned all the agreements on limitation of offensive systems. Yet it was the US withdrawal from the ABM Treaty in June 2002 (having given notice the previous December) that quelled many of the resurgent fears about a new form of US BMD deployment. These concerns had rested on the effect of US policies on the future of the Treaty itself. Once the Treaty was no more, however, the anticipated fall-out did not occur. There was no breakdown in relations with Moscow. Nor was there a renewed arms race; indeed, US withdrawal accompanied an agreement to reduce American and Russian offensive nuclear weapons still further.

A principal concern has been Soviet missile defences and their acute implications for the credibility of Britain's small nuclear deterrent. The ability of the V-bomber force first to survive a Soviet attack, and then to penentrate Soviet air defences, was a real worry not widely understood at the time outside a small official circle. Even the switch to Polaris only solved half the problem. Though now secure prior to launch, the ability of Polaris to penetrate even the limited defences around Moscow was questionable. The Chevaline solution to this problem was a unique technical success, at a cost estimated to have been about 10 per cent of that of the defence it had to overcome.[13] Despite all the controversy about penetration aids and defence countermeasures in the current US Missile Defense debate, Britain remains the only country to have deployed a full operational system of countermeasures. It did so at considerable cost and some technical reliance on the United States. In replacing Polaris/Chevaline with Trident, the UK has reverted to the solution favoured by all other nuclear powers—weight of numbers through multiple warheads.

At the start of a new century in which some aspects of missile defence may be coming of age, the subject still carries with it a huge legacy of history, technical research and political attitudes deriving from the Cold War:

> …it is slightly ironic that the implication, as in the past, of people saying that they refuse to discuss missile defence is that they fall back on the old doctrine of mutually assured destruction, which was exactly the doctrine that many of us opposed when it was proposed. Had there been missile defence then, we would have been in favour of it.[14]

At the policy level, attitudes towards missile defence and its implications for deterrence, ‘strategic stability’, arms control, transatlantic relations, East-West relations and defence budgets have an ‘established pedigree’.[15] They have remained remarkably consistent since the time, in the 1960s, when political concern about the consequences of US and Soviet missile defences replaced detailed technical investigation into British defences.

Given this consistency, one might agree with Richard Moore’s assertion that ‘we should perhaps begin to question the value of conventional historical and documentary accounts of “commanding heights” defence decision making. A more holistic view of working-level policy implementation…may be more useful’[16] Nowhere was that more true than Britain’s only postwar attempt, in the late 1950s, to develop active BMDs without any discernable higher-level policy direction, or even awareness of the issue.

It may be that, for perhaps the first time in Britain’s long history of involvement in BMD, policy debate and technical research are becoming fully aligned, each supporting and informing the other. The debate is far from over, however, and British attitudes and policies towards BMD continue to evolve.

PROSPECTS

At the beginning of the twenty-first century, 60 years after the first experimental V-2 ballistic missile was launched at Peenemunde, active defences against such projectiles seem finally to be an operational reality. The Patriot PAC-3 missile is entering service in the United States and elsewhere.[17] The Israeli Arrow-2 system is operational. A range of other active defence systems are in various stages of development in the United States.[18] The United States is also developing the MEADS system with Germany and Italy. Russia is marketing its own range of TMD systems, such as the S-300, though the operational status of its original, but updated, Moscow system is questionable. France and Italy are developing a TMD version of the new Aster missile.

Britain is not planning to acquire any of these systems. Indeed, it remains the only significant military power without any land-based medium-range SAM system.[19] Nonetheless, the UK is actively involved in the subject of BMD at both the policy and technical levels. Neville Brown posed many of the right questions in 1996:

> So where do America and the rest of us stand at this stage in the emergence of missile-centred warfare? Is the alliance getting its priorities right? Or are we still paying too much attention to missiles as opposed to other innovations in ordnance? Too much attention to ballistic missiles as opposed to cruise? Too much to missile defence as opposed to offence? Too much to active defence rather than to passive? Too much to the protection of civil society rather than of war-fighting capability? Too much to land warfare as opposed to naval? Too much to regular military threats as opposed to that of terrorist infiltrators bearing suitcase bombs? How well-founded are our geopolitical assumptions? Conclusions about Britain's BMD policy cannot simply be derived from these general issues. But they do have a bearing on it.[20]

The strategic environment within which missile defence decisions must be made has changed completely from the Cold War context within which many current attitudes were formed. Britain faces three distinct, but related, areas of policy in respect of BMD, all of them the product of the new security situation:

(1) Theatre (or perhaps tactical) defence of deployed forces against shorter-range, possibly conventionally armed, ballistic missiles, as part of the wider provision of air defence for expeditionary operations.
(2) The national (or perhaps strategic) defence of the UK itself against future longer-range missile threats, probably from the Middle East and probably armed with WMD warheads.
(3) British attitudes towards, and participation in, the missile defence of North America.

In all three areas British policy has moved on significantly in the last few years, despite the almost ritual re-affirmation that 'it is currently premature for the United Kingdom to make decisions on acquiring active missile defences'.[21]

The need for some measure of defence for deployed forces is in fact generally accepted and uncontroversial. This already includes passive defence and some counter-force capability and is likely in the future to see some form of active defence, within a wider re-appraisal of expeditionary force air defence needs. Patriot PAC-3 and THAAD continue to be of interest to the MoD. But the Block I variant of Aster, and perhaps a later, BMD-specific Block II, must also be a leading contender, given the Royal Navy's existing commitment to Aster for the Type 45 destroyer, and the already established BMD credentials of the associated British MESAR radar and its operational derivatives.

That Britain will in a few years' time be subject to a non-Russian ballistic threat is now generally recognised. Exactly when is less certain, and the political circumstances under which a substantive threat would exist (i.e. one that combines actual intent with physical capability) is less agreed. It is clear that any future threat will originate to the south-east, and that therefore much of NATO Europe will be within range of ballistic threats before the UK. European allies such as France and Italy will have to address defence of the homeland before the UK does. Indeed, most of the Mediterranean rim has been within reach of Middle East ballistic missiles for some years. Threats to the UK will have to pass over at least one other European country, and intercepts may well occur over their territory.

For reasons of timing, geography, cost and politics, therefore, a missile defence of the UK itself makes sense only in an Alliance-wide context. Though NATO's work in the field, in which the UK is playing a leading role, is focused initially on defence of deployed forces, defence of NATO territory is being considered. Britain itself has recognised:

> The overall case for new forms of missile defence has been strengthened since 11 September, not least because the world is much more aware than it was of the extreme nature of the threats that we can face … There is an overwhelming case for missile defence in principle.[22]

This echoes an earlier (perhaps over-stated) judgement made by a leading (British) analyst of post-Cold War conflict and military operations: '… limited forms of Ballistic Missile Defence will…form the principal guarantee of national security in the future'.[23]

Though it will be many years before an active defence of NATO, and with it the UK, might be in place, it is an aspect of the BMD problem where Britain can perhaps afford to wait for the Alliance as a whole to act, whilst taking a positive lead in that process.

Britain, unlike some other European countries, appears to have become reconciled, at the official level at least, to US plans for a limited missile defence of North America. Ironically, given earlier fears, the end of the ABM Treaty appears to have been something of a catalyst for this, as has the (non-ballistic) attacks on the United States in September 2001. As one RUSI analyst put it, 'Ballistic missile defence is neither a panacea for all security problems of the US and its allies, nor a catastrophe for international stability. Thus, NMD is neither a substitute for deterrence nor a surrogate for arms control.'[24] US missile defence will neither produce an invulnerable, unilateralist hegemon, nor an end to arms control, 'strategic stability' (however defined) and sensible relations with Moscow.

The exact role of Fylingdales and Menwith Hill remains to be fully resolved, but it is clear that their prime function will continue to be early warning. Both are likely, at some point, to provide elements of active defence, certainly for North America and possibly also for Europe. The British Government gave formal assent to the use of Fylingdales in missile defence in early 2003.[25] At the same time, negotiations began on a new technical memorandum of understanding to allow British participation in the US programme.

The positioning of an X-Band radar in Britain, at Fylingdales or anywhere else, would be a more overt and definitive contribution. It may be that, politically at least, this will only be possible once the need for a European system of missile defence has become accepted, in which case such an installation will play a role in European as well as US defence.

Technical investigation and policy deliberation of missile defence therefore appear to be becoming better aligned than at any time since the 1940s, despite the relative neglect of the subject just a few years ago. Britain's political and military leaderships appear to be increasingly persuaded of the need for some measure of missile defence capability, and at the same time sanguine about the consequences of US defences.

NOTES

1. Hill, *Air Operation*, p. 5617.
2. Jack Straw in HC 327 Minutes of Evidence Question 61.
3. Hennessy, *The Secret State,* p. 19.
4. For a good, succinct summary see Andrew Brookes (IISS Air Analyst), ‘Bolts from the Blue’, *Defence Review,* Spring 2000, pp. 42–3.
5. Roper, ‘Technical Factors and Issues’, in Ranger *et al., International Missile Defence,* P. 97.
6. See Gray, *European Perspectives,* for a convincing explanation of this cultural difference and its consequences.
7. House of Commons debate 28 November 1934 cited in Brzezinski (ed.), *Promise or Peril?,* pp. 5–6.
8. Cmnd 9763-I, *Statement on the Defence Estimates 1986.*
9. Paterson, *Britain’s Strategic Nuclear Deterrent,* p. 37.
10. In 2001, the MoD’s Director of Strategic Technologies asserted that though the UK had a long history of BMD research, the early work dealt only with defence penetration. Roper, ‘Technical Factors and Issues’, p. 97.
11. Gray, *European Perspectives,* p. 14.
12. Dean A.Wilkening, *Ballistic-Missile Defence and Strategic Stability,* Adelphi Paper No. 34 (London: International Institute for Strategic Studies, 2000), p. 17.
13. Orman, *Faith in G.O.D.S.,* p. 39.
14. Jack Straw, Foreign Secretary, in *Hansard,* 5 February 2002, col. 718.
15. Missile Proliferation Study Group report, *Coming into Range,* p. 66.
16. Richard Moore, *The Royal Navy and Nuclear Weapons* (London: Frank Cass, 2001), p. 194.
17. Germany, the Netherlands, Greece, Israel, Saudi Arabia, Kuwait and Japan.
18. THAAD, the Airborne Laser, Standard SM-3 and the Ground-Based Midcourse (GMD) system.
19. See J.Stocker, ‘All at Sea: UK Land-Based Air Defence’, *Defence Review,* Winter 1999.
20. *FIS,* p. 6.
21. *Hansard,* 29 April 2002, col. 654.
22. Jack Straw, evidence to Foreign Affairs Committee in HC 327 Questions 61–2.
23. Bellamy, *Knights in White Armour,* p. 68.
24. Kamp, ‘The Transatlantic NMD Debate’, p. 116.
25. *Hansard,* 5 February 2003, col. 12WS.

Appendix I

TOP SECRET

CMS.2499/54/0.R.15

AIR STAFF TARGET NO. O.R./1135 FOR A DEFENCE SYSTEM AGAINST BALLISTIC ROCKETS

INTRODUCTION

1. Short range ballistic rockets of the V.2 type are now available to the Russians. The present estimate of the longer range ballistic rocket threat is that the Russians could develop ballistic rockets with ranges of 1,500 to 2,000 n.m. by 1959 and that by 1967 rockets with ranges of 4,500 to 6,000 miles might be developed. The seriousness of this threat to the survival of the United Kingdom is so great that it is essential to investigate means of defence against it without delay. A new approach to the problem with the development of new techniques will be necessary if an effective defence is to be attained.

2. The functions of an air defence system can be classified under five main headings:–

(a) Early warning
(b) Identification, acquisition and tracking
(c) Weapon assignment
(d) Interception
(e) Destruction of the target and/or warhead

There is a need for the design of an integrated system for effective defence against ballistic missiles, capable of all operations from initial detection to final destruction.

AIM

3. The Air Staff require the development of an effective defence system against surface-to-surface ballistic missiles fitted with atomic or thermonuclear warheads.

MILITARY CHARACTERISTICS

Targets

4. The system is required for defence against ballistic missiles of 500 to 5,500 n.m. range carrying atomic of thermo-nuclear warheads.

Early Warning

5. An early warning system giving the maximum possible range on a ballistic missile at all heights is required. The possibility of detecting the launch of a ballistic missile should be investigated.

Acquisition and Tracking

6. An acquisition and tracking system is required with a high order of accuracy and capable of acquiring the target as early as possible in its trajectory. The system should take account or variance in elevation approach angle.

Weapon Performance

7. The range, speed operating altitude and lethality of the defensive weapon should be such as to ensure destruction of the target and/or warhead at heights of not less than 80,000ft.

DEFENCE SYSTEM EVALUATION

8. The Air Staff appreciate that there may be several approaches to the problem of defence against ballistic missiles and several solutions arising therefrom. Possible solutions which may offer certain desirable attributes may not meet the precise requirements in all respects but before any solution is discarded for such a reason the Air Staff wish to be fully informed. The Air Staff therefore require evaluation to be made of the possible solutions to this Air Staff Target before drafting an Operational Requirement for a weapon project.

Air Ministry, D.D.O.R.5
7th February. 1955.
G.00820(a)/EF/2/55/90

TOP SECRET

Source: PRO AIR 2/13206.

Appendix II

BALLISTIC MISSILE EARLY WARNING STATION IN THE UNITED KINGDOM

Presented to Parliament by the Secretary of State for Air
by Command of Her Majesty
February 1960

LONDON
HER MAJESTY'S STATIONERY OFFICE
FOURPENCE NET

Cmnd. 946

BALLISTIC MISSILE EARLY WARNING STATION IN THE UNITED KINGDOM

London, February 15, 1960

No. 1

The United States Ambassador at London to the Secretary of State for Foreign Affairs

Embassy of the United States of America,
London.

February 15, 1960.

Sir:

I have the honor to refer to discussions which have taken place between representatives of the Government of the United Kingdom of Great Britain and Northern Ireland and of the Government of the United States of America on the subject of co-operation between the two Governments in setting up and operating a ballistic missile early warning station at Fylingdales Moor, Yorkshire.

I also have the honor to record that, in support of the purposes of the North Atlantic Treaty and of the obligations of the parties thereto, the representatives of the two Governments have agreed to the terms set out in the memorandum annexed hereto regarding the proposed co-operation in setting up and operating a ballistic missile early warning station.

Accordingly, I have the honor to propose that this Note and your reply to that effect shall be regarded as constituting an Agreement between the two Governments in the terms set out in the annexed memorandum and that such Agreement shall have effect from the date of your reply.

Accept, etc.

JOHN HAY WHITNEY.

Enclosure:

Memorandum.

MEMORANDUM

1. The Government of the United States and the Government of the United Kingdom shall co-operate in setting up and operating a ballistic missile early warning (BMEW) station at Fylingdales Moor, Yorkshire.

2. The station shall be commanded by the Royal Air Force. The technical facilities shall be operated by the Royal Air Force in accordance with a joint plan which will be developed and agreed by the Royal Air Force and the United States Air Force.

3. The Government of the United States shall at their expense make available for the station the following types of special equipment:—

(*a*) long range radar equipment;

(*b*) data processing equipment;

(*c*) electronic, internal communications and other related specialised equipment peculiar to (*a*) and (*b*);

(*d*) spare parts peculiar to (*a*), (*b*) and (*c*) in amounts and kinds appropriate to the first five years of operation; responsibility for the cost of the subsequent provision of such spare parts shall be the subject of further agreement between the Government of the United States and the Government of the United Kingdom.

4. The Government of the United States shall at their expense be responsible for the installation of the special equipment described in paragraph 3 above and for preparing this equipment for operation as an integral part of both the United Kingdom and United States BMEW Systems.

5. The Government of the United Kingdom shall at their expense make available for the station:—

(*a*) land, appropriately prepared sites, buildings, utilities including power plant, and other fixed installations;

(*b*) all supporting equipment, except as provided in paragraph 3 above;

(*c*) domestic accommodation (including the necessary equipment, utilities and services) for the United Kingdom and United States personnel concerned to Royal Air Force scales and standards;

(*d*) support services.

6. The Government of the United Kingdom shall at their expense be responsible for providing communications facilities (including terminal facilities) and services required:—

(*a*) for use within the station, other than communications equipment supplied under paragraph 3 (*c*);

(*b*) to connect the station with commercial communications circuits;

(*c*) to provide links between the station and the appropriate authorities in the United Kingdom.

The Government of the United States shall at their expense be responsible for procuring such further communications services as may be necessary for their own purposes and to meet the requirements of the Government of the United Kingdom for information obtained from other stations of the BMEW System.

7. The cost of operation and maintenance of the special equipment at the station shall be borne by the Government of the United Kingdom for the first five years of operation. Responsibility for this cost thereafter shall be the subject of further agreement between the Government of the United States and the Government of the United Kingdom.

8. Except as otherwise provided in this Agreement, the cost of operation and maintenance of the station shall be borne by the Government of the United Kingdom.

9. The Government of the United States and the Government of the United Kingdom, as appropriate, shall take such measures relating to the

establishment and operation of the station as are required to ensure the safety of persons and property.

10. Ownership of all movable property furnished by the Government of the United States for use in the station shall remain with the Government of the United States. The Government of the United States may remove or dispose of this property following the termination of this Agreement.

11. This Agreement shall be subject to revision by agreement between the two Governments and shall, unless previously terminated by agreement between the two Governments, remain in force while the North Atlantic Treaty remains in force.

London,
February 15, 1960.

No. 2

The Secretary of State for Foreign Affairs to the United States Ambassador at London

Foreign Office, S.W.1,
February 15, 1960.

Your Excellency,

I have the honour to acknowledge receipt of your Note of to-day's date with reference to discussions which have taken place between representatives of the Government of the United States of America and of the Government of the United Kingdom of Great Britain and Northern Ireland on the subject of co-operation in setting up and operating a ballistic missile early warning station at Fylingdales Moor, Yorkshire, which Note reads as follows:

[as in No. 1]

I have the honour to inform you that the proposal made in your Note is acceptable to the Government of the United Kingdom and to confirm that your Note, together with this reply, shall constitute an Agreement between the two Governments in the terms set out in the memorandum annexed to your Note, a copy of which memorandum is enclosed, such Agreement to have effect from the date of this Note.

I have, etc.
SELWYN LLOYD.

Printed in England and published by
HER MAJESTY'S STATIONERY OFFICE
56471 Wt. 1276/BN 3795 K26 2/60 F.O.P.

Source: PRO AIR 20/10715.

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64 Research Division: Registered Files

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131 Defence Committee: Minutes and Papers

134 Cabinet: Miscellaneous Committees: Minutes and Papers

137 Cabinet: Joint Technical Warfare Committee

148 Defence and Overseas Policy Committees: Minutes and Papers

158 Joint Intelligence Committee: Memoranda

159 Joint Intelligence Committee: Minutes

168 Chief Scientific Advisor: Solly Zuckerman: Registered Files

Ministry of Defence

DEFE 2 Combined Operations Headquarters: Records

4 Chiefs of Staff Committee: Minutes

5 Chiefs of Staff Committee: Memoranda

6 Chiefs of Staff Committee: Joint Planning Staff Reports

7 Registered Files (General Series)

8 Chiefs of Staff Committee and Sub-Committees: Minutes and Memoranda

9 Papers of Sir Henry Tizard

10 Major Committees and Working Parties: Minutes and Papers

11 Chiefs of Staff Committee: Registered Files

13 Private Office: Registered Files

18 Army Department, Industrial Council: Minutes

19 Central Defence Scientific Staff: Registered Files

21 Directorate of Scientific and Technical Intelligence: Registered Files

25 Chief of Defence Staff: Registered Files

30 Defence Board: Minutes and Memoranda

40 Ministry of Defence: Papers of R.V.Jones

41 Scientific and Technical Intelligence Branch and Overseas Liaison Committee: Registered Files

44 Directorate of Scientific and Technical Intelligence: Reports and Memoranda

Dept of Scientific and Industrial Research

DSIR 23 Aeronautical Research Council: Reports and Papers

Foreign Office

FCO 10 Atomic Energy and Disarmament Department: Registered Files

41 Foreign and Commonwealth Office, Western Organisations Department

46 Defence Department: Registered Files

FO 93 Protocols of Treaties

371 Political Department: General Correspondence

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