BALLISTIC MISSILE DEFENCE

- *What are the current threat assessments?*
- *Are countermeasures worthwhile?*

POST note 72 January 1996

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The use of SCUD missiles during the Gulf War served as a reminder that shorter-range 'Theatre' Ballistic Missiles (TBM) could pose a threat in the hands of certain states or terrorist groups. Iraq's SCUDs have been destroyed, but other states are acquiring TBM which potentially places Europe within striking range of politically unstable regions.

This note analyses the potential threat from TBM and the policy issues raised.

PROLIFERATION OF MISSILES

Strategic intercontinental and submarine launched ballistic missiles **(ICBM, SLBM)** are limited to the world's nuclear powers (USA, UK, China, Russia and France). However, there is speculation that other nations (e.g. North Korea) ultimately might acquire global 'strategic' missile capability through their own efforts. Also, there is at least a theoretical possibility that political instability or an ICBM facility being seized by terrorists, could lead to a threat from small numbers of ICBMs outside of the strategic context. Long-range ground attack **Cruise missiles** could also comprise a threat if they were to fall into the wrong hands. Current systems such as the US Tomahawk (range 3,000km or more) require sophisticated guidance and support, which makes it beyond the means of the developing nations, but civilian Global Positioning Systems (GPS) etc. may allow other states to adapt missiles (e.g. Exocets, surface-to-surface missiles, etc.) to longer range in future.

A concern today, however, is **Theatre ballistic missiles (TBM)** which have been supplied to several states world-wide. The Missile Technology Control Regime (MTCR), established in 1987, has helped to limit the spread of ballistic missiles with ranges greater than 500 km, but some countries involved in missile production have yet to join. Moreover, several developing nations are now able to develop their own missiles, and the world TBM inventory extends to about 24 countries, some of which are shown in **Figure 1**.

TBM have a range of under 5,500km and can be categorised as short, medium and long ranges (**Table 1**). Most were originally supplied by the USSR, the USA, and China. Thus, for example, the USSR sold the Scud B to Afghanistan, Egypt, Iran, Iraq, Libya, and North Korea, amongst others (reportedly at around $1M per missile). China has sold short-range TBM to Iran and possibly to Pakistan, is suspected of selling medium-range TBM to Syria and sold 40 long-range (2,700km) CSS-2 missiles to Saudi Arabia in 1988. Other countries (e.g. France and Germany), have also been 'primary sources' of BM components and systems.

Figure 1 SOME NATIONAL THEATRE MISSILE CAPABILITIES

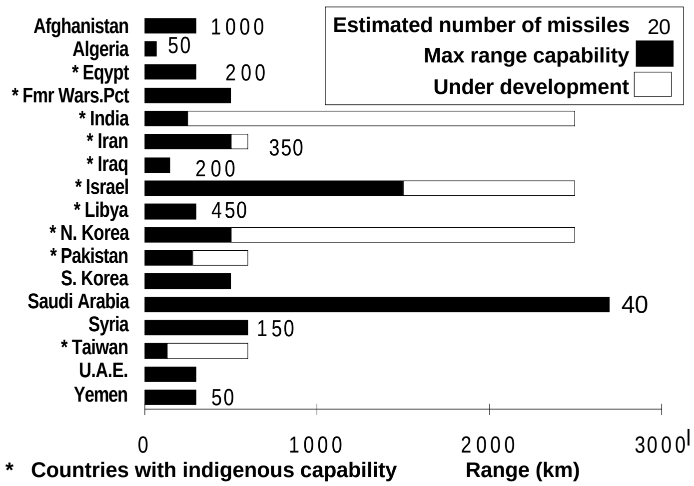


TABLE 1 EXAMPLES OF THEATRE BALLISTIC MISSILES

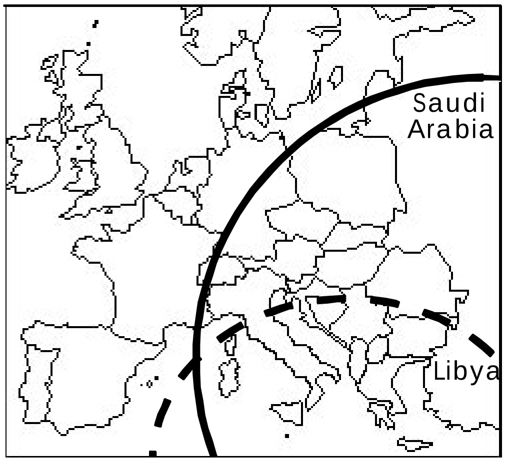
Range	Missile and Source
Short TBM (<300km)	Scud B, SS-21, Frog-7 (USSR), Lance (USA), Hatf 1/2 (Pakistan), M-11(China), Prithvi (India)
Medium TBM (<1,000km)	M-9 (China), Scud C (Iran, Egypt), No Dong 1/2 (N. Korea), Jericho 1 (Israel)
Long TBM(<5,500km)	CSS-2/3/4 (China), Agni (India)

Missiles have been sold on, sometimes in up-graded form; e.g., North Korea sold modified Scud-C (range 500km) to Iran and to Syria. Many countries with TBM have established their own missile programmes (often with help from abroad), but most relate to short range TBM only, and attempts to extend their range have been hampered by the MTCR. Despite this, Israel has Jericho 2 with a range of 1,500km and is testing Jericho 3 (range 2,500km); India and North Korea are testing their Agni and Taepo-Dong missiles respectively (both with a range of 2,500km), and other countries are expected to achieve similar ranges over the next decade.

HOW SIGNIFICANT IS THE THREAT?

Most of the TBM shown in **Figure 1** are not within range of European Nations; the exception being for some of the southern and eastern countries which are within range of missiles held by Saudi Arabia, Israel and Libya (**Figure 2**). In addition, military forces engaged in 'out-of-area' operations (e.g. NATO's force in Bosnia) would be in range, and the Defence Secretary has expressed concern that UK interests in Gibraltar and Cyprus might be vulnerable. Range enhancements of existing missiles (Iraq added an extra stage to Scud missiles to increase their range), would extend the threat boundaries, but the main concern would be if longer range missiles were to spread to other North African States bringing substantial areas of mainland Europe (and even southern parts of the UK) within range.

Figure 2 EUROPEAN RANGES OF CURRENT TBM MISSILES



The threat posed by such missiles depends very much on the warhead carried. Conventional **high explosive (HE)** ones were used most recently the 1991 Gulf War[1], when the 38 modified Scuds fired by Iraq at Israel killed two people and injured about 230 (about 6 casualties per missile). One Scud narrowly missed an Allied Coalition armoury in Saudi Arabia. At present, HE TBMs are not sufficiently accurate to be very useful militarily, but they can nevertheless strike fear into civilian populations. In the future however, cheap guidance systems such as GPS may overcome this limitation and allow them to be reliably targeted on important strategic or military assets.

Much greater threats would exist if the missiles were tipped with a nuclear, chemical or biological (NBC) warhead. A primitive ‘first generation’ **nuclear warhead** weighs about 1000Kg, which is within the payload limit of several TBM, including Scud B, Prithvi and CSS-2. Nuclear materials themselves can pose a threat -radioactive material could be dispersed using high explosive. A **Chemical Weapons** or **Biological Weapons** (BW) payload requires missiles capable of carrying about 500 kg. The key to reducing the danger from NBC warheads is seen by most as the non-proliferation regimes under the **Nuclear Non-Proliferation Treaty (NPT)**, the **Chemical Weapons Convention** (CWC) and the **Biological Weapons Convention** respectively (reviewed in 1995 by the Foreign Affairs Committee).

BALLISTIC MISSILE DEFENCE (BMD)

BMD from WWII to Date. After WWII, the USA attempted to develop anti-ballistic missile (ABM) systems that could defend the US mainland against ICBMs, but it became apparent that not only would defence against an all-out attack be impractical, but ABM systems could seriously undermine mutually assured deterrence. The USSR and the USA signed the **ABM Treaty** in 1972[2], in effect ending ABM development for the next decade, until President Reagan’s **Strategic Defense Initiative (SDI)** in 1983. Despite the substantial amounts spent on R&D, this failed to overcome all the technical obstacles, and in 1991, President Bush announced a shift of emphasis to **Theatre Missile Defence (TMD)**, perhaps extending - principally in collaboration with Russia - to Global Protection Against Limited Strike (**GPALS**). This would consist of infra-red observation satellites to detect BM launches and to track the warheads, 'Brilliant Pebble' satellites for interception in space, and ground-based missiles to engage surviving BM. Total cost was estimated at $460B, but the plans were modified in 1993, when the SDI Office was reconstituted as the Ballistic Missile Defense Organisation (BMDO), with a remit to focus more on operational TMD “to the troops”. The objective of National Missile Defence (NMD) remains on the Congressional Agenda, however, under the Republican's "Contract with America".

The first combat use of BMD was the **Patriot Advanced Capability-2 (PAC-2)**[3] missile in the Gulf War. Open sources indicate that ca 40% of Scuds engaged over Israel and Saudi Arabia were intercepted and "high confidence" has been expressed officially that 40% of the intercepted missiles were destroyed "successfully". This overall "success" rate of 16% is questioned by some however, with doubts expressed whether any warhead was destroyed as a results of PAC-2. Failure to intercept could have been caused by errors in the radar and guidance systems and insufficient manoeuvrability; failure to destroy the warhead was most likely caused by the Scuds breaking up, generating a ‘threat cloud’ of debris which ‘decoyed’ the interceptors (see **Box 1**).

The first of about 350 upgraded **PAC-2** missiles are now entering service with the US Army. Russia also has a point defence capability based on its S-300P family of weapons, which gives a similar performance to Patriot. Russia exports this system to Bulgaria, China, Croatia, the Czech Republic and Iran.

Systems under development. As far as ‘**point defence**’ is concerned, the US Department of Defense (DoD) selected the Extended Range Interceptor (**ERINT)** in 1994 to meet the Army’s **PAC-3** requirement, in preference to a further upgrade of Patriot. ERINT has a range of 15km and an intercept altitude of 10km, and uses the standard Patriot launcher. The US Navy is developing its own version for the Aegis battle management system on destroyers and cruisers, scheduled for demonstration in 1998.

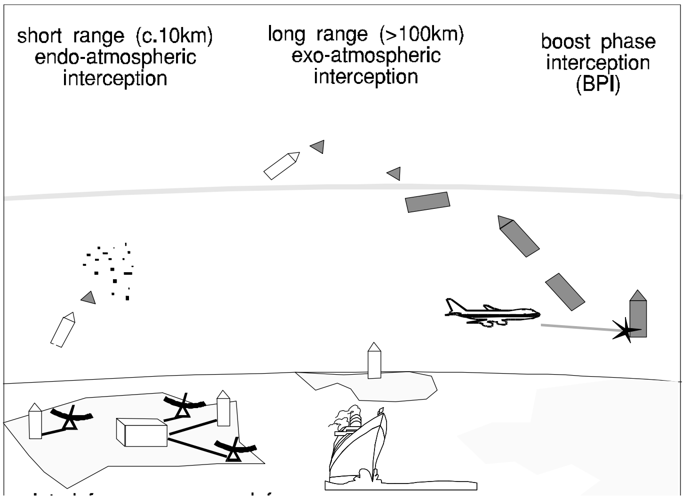
Extending the area defended to ‘**medium range**’, France, Germany, Italy and the USA signed a statement of intent in February 1995, to collaborate on the **Medium**

1. On another occasion (in 1986), Libya launched a SCUD at a US base on Lampedusa (Italy) following the US attack on Tripoli. The missile fell into the sea about 1km short of its target.

2. The Treaty allows the USA to match Moscow's one area defence ABM and permits point defence ABM to protect "second strike" capability.

3 This system was originally designed to intercept aircraft. Its PAC-2 variant is an interim solution to the additional requirement for BMD.

Box 1 BMD - THE TASK



Point defence e.g. Patriot | Area defence e.g.THAAD | Naval defence e.g. Aegis Destroyer

A worthwhile BMD system must be capable of performing a sequence of complex tasks; in about 6 minutes for a Scud-type missile, about 15 minutes for a long range TBM. First of all, the incoming threat must be detected: **intelligence sources** might provide forewarning that a missile attack is likely, and **satellite** or **aerial surveillance** can detect the characteristic infra-red 'signature' from a rocket launch. **Radar** on the ground would then focus in the direction of the threat and try to isolate the very weak reflection from a BM. Even a re-entry vehicle (RV) without 'stealth' technology has a radar image similar to a small dustbin and travels at speeds up to several kilometres a second.

Next, the 'target' must be confirmed (i.e. it really is there and is not an airliner, legitimate space launch, etc.) and the risk evaluated (from its heading, nature and where debris might fall if the BM is destroyed). A **command decision** is required, to sanction the launch of a counter-attack in the light of all the known circumstances before handing over all of the tactical information to the **fire control system**, which must calculate an intercept point, choose, arm and fire the appropriate interceptor rounds.

The task of **interception** itself is no mean feat - with closing speeds of up to 10km/s - it has been described as equivalent to trying to shoot a high velocity bullet out of the sky with a second high power rifle. In fact, it can be even more difficult, because the RV can deploy 'decoys' to confuse the interceptor, or debris from the booster or RV casing may have the same effect - forming a **'threat cloud'** within which the RV must be targetted. Thus the success of any one interceptor is far from certain, and a **'probability of kill' (PK)** of 50-80% typically is claimed. In order to improve the chances of success, interceptors must be fired off in volleys, while using a 'layered' defence can reduce the total number of rounds required by ending the sequence as soon as the RV has been destroyed.

Extended Air Defence System (MEADS), planned to enter service in 2005. MEADS is intended to defend mobile forces against both TBM and cruise missiles and would replace Europe's Hawk missile and Patriot. The USA would fund 50%, France and Germany 20% each, and Italy 10%, and an MOU was signed to launch the programme in early 1996. Contracts for MEADs will be awarded on *juste retour* basis, and initially four research projects worth $100M each will be funded lasting 3 to 5 years, leading to one being pursued for design and development, expected to cost a further $3B. France and Italy are also developing the land-based SAMP/T and naval SAAM systems, planned for deployment in 1999, with the **Eurosam** consortium (Aerospatiale, Alenia and Thomson-CSF). The interceptor will be the Aster 30 missile, capable of engaging targets at slant ranges of up to 70km.

While the above systems offer some degree of 'lower tier' protection against incoming missiles, this only allows a small area (e.g. a small town, a battleship or a command centre) to be defended by each installation. In order to defend a city or an entire military force, a large number of such installations would be required. The BMDO's answer is a '**wide area**' defence system called **Theatre High Altitude Area Defence (THAAD)**, which will be capable of intercepting BM in the 3,000km class, outside the atmosphere i.e. at altitudes above 100km. Trials of THAAD began in April 1995; the US Army will receive a demonstration system in 1997, and expects to order 15 systems initially, at a cost of over $17B. The US Government has also indicated that it will actively export the technology to its allies. The expected price tag is about $1B for the radar and control system, and about $800M per 120 interceptors.

Israel has also been developing its own area defence system (90 km range), with considerable US assistance. The **Arrow** programme will provide an 'umbrella' defence for the whole of Israel after 2000, with a Patriot-based system providing a second tier of point defence. About 1200 Arrow missiles will be required, costing ~ $1B for the missiles, with a further $1.25B for the radar and control systems. Russia is also offering an area defence system, the Antey S-300V, which it claims has "significant performance" against TBM.

Advanced concepts. Many of the problems associated with destroying TBM could be eliminated by targeting in the boost phase (see Box 1). A booster stage is a big and 'soft' target, and any unpleasant payload would fall back on the country that launched the BM.

However, the BMDO concludes that **boost phase interception (BPI)**, would be impractical using interceptor missiles: this phase is only 1-3 minutes, so the interceptor would have to be launched close by - in many cases within the borders of the aggressor. The US Air Force has proposed using a directed energy weapon - a high power laser, or its microwave equivalent - and has a research programme to develop chemical laser weapons (2 megawatts) to be carried on modified Boeing 747s. More exotic weapons are under consideration, e.g. in Russia, a high power microwave source that generates an ionised region in the atmosphere intended to incapacitate anything that flies into it at high velocity. Research in the UK and elsewhere suggests that such sources might possibly be employed to counter missiles by disrupting guidance systems.

UK activity. The UK has no formal involvement in any of the programmes above, but in 1994, the MOD commissioned two studies to clarify UK options. These will inform a review for the autumn of 1996. The first contract is for a **"Fundamental Issues Study" (FIS)**, being prepared by Professor Neville Brown (Mansfield College Oxford). The remit is to think laterally about every aspect of the question: geopolitical, threat development, the operational context, comparative costings, arms control, environmental impact, industrial collaboration, participation in space, and so on.

The second is an 18-month contract, started in October 1994, for a **Pre-Feasibility Study (PFS)** by a consortium led by British Aerospace, with support from French and US firms. The objective of the PFS is "*to identify practical architectures with the widest possible range of UK BMD applications*", and so far 164 component systems (early warning and weapons control sensors, interceptors, launchers, etc.) have been selected. These components are currently being evaluated against (secret) 'Basic Criteria' set out by the MOD, and will then be used to generate 'architectures' for evaluation. The PFS will produce 6-9 architectures, covering homeland and out-of-area applications, drawing on 20-30 BMD systems, and will present a range of considered, costed options.

ISSUES

Although any early UK decision on BMD is unlikely, the recent MOU on MEADS may add to early pressure on the UK to clarify its views on future participation. The issue may attract parliamentary interest in 1996.

The main questions to be answered are whether the threat posed by TBM is significant enough to warrant the substantial costs of a defensive system, and if so, how extensive should that system be and how should it be deployed. Sceptics reject a military response entirely and attribute much of the pressure for such systems to the after-effects of the SDI intitative whereby the large scientific and industrial interests funded by that programme are seeking continued support. Thus the threat to the UK is seen as theoretical, the countermeasures costly and of questionable effectiveness, and some of the more interventionist measures potentially destabilising in their need to infringe national sovereignty (e.g. boost phase interception or 'counter-proliferation' pre-emptive strikes). It is argued that effort should be focused on non-proliferation policy, a view shared by the Foreign Affairs Committee which concluded in March 1995 that "*.. the likelihood of developing a credible anti-ballistic missile system for territorial defence, within the resources currently available, is remote. We therefore conclude that it would be imprudent to pursue such a policy in the light of the potential adverse effects for the consensus-backed regime approach to non-proliferation*".

On the other hand, protagonists believe that the technical difficulties of BMD will be overcome within ten years, at least as far as TBM are concerned, and that such systems, while not cheap, will be affordable. They see Patriot-like point defences to defend troops in the field etc. as within the cost regime of standard military procurement. A **British NMD** system, presumably based on THAAD might cost over a billion pounds to deploy, but international collaboration might establish a **regional BMD** system, perhaps based on MEADS. UK defence companies are concerned that by missing the early definitional stages of such projects, the opportunity is being lost to develop and apply UK skills in related technologies (e.g. radar and guidance systems).

A regional BMD system would, however, still have to resolve important questions - for instance, at which country was the attack aimed? Who makes the decision to fire, and what are the safeguards against attacking an innocent aircraft by mistake? Would France be happy for a missile heading for the UK to be shot down over its territory[4]? Such questions suggest a NATO or WEU role, and both are considering options to reduce the motive to proliferate and for BMD technologies.

With such uncertainties, many favour a cautious approach relying more on **political means** of missile and warhead control, through initiatives like the MTCR, CWC and NPT. As already described, the MTCR in its present form has limited the spread of missile technologies, but has not prevented proliferation in some of the world's less stable regions. Thus a political solution to missile proliferation might require a more stringent and stronger MTCR, with international political and economic sanctions.

But an important consequence of the work on BMD systems is the pressure it generates to **reinterprete the ABM Treaty**. Historically, the USA and Russia have used the 'Foster' Limit of 2 km/s as the definition of a strategic missile under the Treaty, but THAAD and MEADS etc. theoretically exceed this performance. Thus the USA is arguing to increase the limit to 5 km/s, allowing their TMD to be tested to maximum performance. Russia currently opposes such a change and has indicated that abrogation of the Treaty could prompt a withdrawal from START, raising the ICBM threat.

The UK is affected by this issue in two ways. Firstly many of our existing systems that could potentially form part of a BMD (e.g. the radar station at Fylingdales) are enmeshed with the USA and thus affected by the ABM Treaty. Secondly, reinterpreting the ABM treaty could allow deployment of systems capable of intercepting SLBMs, thus potentially compromising the UK's Trident deterrence.

4. Current assumptions are that if missiles are destroyed at their peak height, their payloads will not fall back on underlying countries.