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BMD Ground-Based Radars - Archived 10/96

Outlook

- Demonstration/validation engineering and development are underway
- One GBR-X has been produced, various unspecified testing units in existence
- The project will continue to receive funding
- Due to its enormous size and classified nature, the project will keep it difficult to break into, for new companies

Orientation

Description. A family of fixed, ground-based tracking and imaging radars for midcourse/terminal defense against re-entering nuclear warheads designed to support the Upper Tier Theater Missile Defense System as part of the Ballistic Missile Defense (BMD) program (formerly know as the Strategic Defense Initiative or SDI prior to May 1993).

Sponsor

Ballistic Missile Defense Organization

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USA

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Contractors

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(Midcourse GBR concept)

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(GBR Phase 3 prime contractor)

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(Raytheon subcontractor - software development)

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(Phase 1 design contractor)

Status. Demonstration/validation engineering and development under way.

Total Produced. One GBR-X produced. Various unspecified testing units.

Application. This program provides a late midcourse and high endoatmospheric active sensor to track and discriminate surviving re-entry objects as part of the overall BMD capability.

Price Range. Indeterminate due to conceptual nature of program.

Technical Data

Design Features. The original concept called for the development of a single Ground Based Radar only. The concept has since expanded to include a modular family of X-band radars that will be built upon the work done with the GBR, now called the GBR-X. A common Phased Array Antenna Module (PAAM) will serve as the basic building block, with the Theater Missile Defense-Ground Based Radar using one PAAM and the Ground Based Radar-Terminal (GBR- T) and the Ground Based Radar-Midcourse (GBR-M) stemming from the TMD-GBR.

The original GBR is a single-faced, X-band phased- array radar. The two basing concepts under consideration for it were fixed-site and rail-mobile. Due to the higher level of survivability associated with rail mobility, it has been the GBR baseline approach. The GBR was to be the US's first X-band ballistic missile defense radar. Real-time imaging is a key technical characteristic.

The first requirement for the BMD program was to develop and DEM/VAL a more capable TMD-GBR, derived from the GBR-X. This version necessitates C-130 roll-on/roll-off compatibility, road mobility, and the capacity to acquire and track theater missile threat targets at ranges of 500 or more kilometers, using a 90-degree sector hemispherical volume search. Required functions include attack early warning, threat type classification, interceptor fire-control sensor queuing, launch/impact point estimation, and threat classification against theater/tactical ballistic missiles. Also included are fire support capabilities against tactical ballistic missiles, cruise missiles, and other air-breathing threats.

Operational Characteristics. The exoatmospheric-capable GBR-T was designed to provide the following capabilities: a limited exoatmospheric search, interceptor precommit against short-time-of-flight ballistic missiles, initialization and kill assessment for shoot-look-shoot and adaptive firing doctrines, and additional phenomenology as a hedge against reactive response to optics elements; an early deployment option against limited attacks, including accidental, unauthorized, or deliberate launch of a small number of ballistic missiles; and performance of late midcourse exoatmospheric discrimination as an

independent underlay to space-based elements in addition to acquisition, interceptor support, and kill assessment functions. The GBR-T offers increased survivability (over the GBR) through greater mobility, rapid deployability, and lower weight and power requirements.

The GBR works in conjunction with Brilliant Eyes (BE) satellites, tracking a hostile missile's trajectory. BE would cue GBR to acquire and track threat clusters containing decoys and re-entry vehicles. The two would track the threat cluster, and furnish tracking information to a BM/C3 center.

While the desire is for solid-state technology, the use of existing TWT technology and matching transmit/ receive elements during the DEM/VAL portion of both the TMD-GBR and the GBR-T are permissible.

The GBR-T will, in turn, be modularly growable to a more capable GBR-M as a sensor element in possible SDS Phase I defenses (post-GPALS) against large-scale ballistic missile attacks.

Variants/Upgrades

With the 1991 Report to Congress, the GBR program was revised to encompass a family of X-band radars using a modular common element called the Phased Array Antenna Module. There would be three family members: the Theater Missile Defenses-Ground Based Radar (TMD-GBR), the Ground Based Radar-Terminal (GBR-T), and the GBR-Midcourse (GBR-M), although the last variant seems to have gone by the wayside, possibly replaced by the following variant.

In early 1992 the Army added another radar to the family, the National Missile Defense (NMD)-GBR, two of which would operate at the Congressionally-mandated NMD site. These versions apparently will be considerably larger than the versions that will be C-130 transportable. The NMD-GBR is required to detect, acquire, and track RVs from accidental or unauthorized limited strikes from ICBMs, SLBMs, or MRBMs. Additionally, it inputs data to the command and control element, which combines data from all available sensors, to the Ground-Based Intercepter (GBI) in exoatmospheric engagements.

Program Review

Background. This program has gone through a tremendous amount of reorganizational activity since its inception in the 1980s. Its several name changes reflect the many changes in mission and objective the project has undergone. The earliest root we can trace in the ancestry of the Ground Based Radar was originally called the Terminal Imaging Radar (TIR) which was born as part of the US Army Ballistic Missile Defense Advanced Technology program in FY82. Hughes, Westinghouse, and Raytheon each received a half million dollars to compile competitive design studies for an X-band, solid-state radar. This activity was severed in FY85 when the SDI program was first financed as an independent entity.

Raytheon and Westinghouse stayed involved in larger contracts through the mid-1980s dealing with preliminary SDI designs. TRW was Raytheon's major subcontractor; Westinghouse enlisted the help of Computer Sciences, Delta Research, Nichols Research, and Xontech.

Despite scattered opposition and substantial funding cuts, the program moved forward into Phase 3 of the GBR Functional Technology Validation Experiment, a performance check at Kwajalein Atoll performed by Raytheon with subcontractor help from Hughes, TRW, Control Data Corp, M/A-COM Microwave Circuits, and Wright Schuchart Harbor Company.

Under Clinton. With the election of President Bill Clinton and a Democratic Administration, interest in the space-based aspects of the Strategic Defense Initiative have collapsed in favor of the ground-based programs. In May 1993, Secretary of Defense Les Aspin announced the retitling of SDI to the Ballistic Missile Defense program to better emphasize the shift in focus to one of ground-based interceptors defending the country from a limited nuclear strike. Then, and especially now, much effort has been expended to utilize these facilities and the related products for expanded purposes.

The BMD ground-based radar is being designed to work not only with THAAD, but also to cue Patriot missiles to help create a layered defense. The US Army said that the ground-based radar, including both the theater and national-defense versions, will be fully compliant with the Anti-Ballistic Missile Treaty. However, the ground-based radar will not be designed to be compatible with the Arrow missile being developed by Israel with funding from the BMDO. The Israelis are interested in designing and building their own radar for use with Arrow.

The GBR family continues to undergo changes as the focus shifts to NMD and other variations such as GPALS, THAADS, TMD. The original family concept as revealed in 1991 consisted of three members: the Theater Missile Defenses-Ground Based Radar (TMD- GBR), the Ground Based Radar-Terminal (GBR-T), and the GBR-Midcourse (GBR-M). However, since then it would appear that the GBR-M has gone by the wayside, possibly replaced with the NMD-GBR, which was added to the GBR RFP in March 1992. Costs are also becoming an issue. The GBR configuration based on the TMD-GBR and the GBR-T was estimated to cost close to US$600 million. The addition of the NMD-GBR is estimated to increase total cost by another several hundred million dollars.

In September 1992, a team lead by Raytheon Equipment Division was awarded a US Army contract worth US$491.2 million to develop and produce the ground-based radars for national missile defense. Under the 60-month contract, Raytheon was to build three radars for theater missile defense and one other radar to be used to guide missile interceptors, which is planned as part of the BMD. Preparations are now under way to begin testing the first of the three theater missile defense radars, with SCUD-busting interceptors. The three radars are being designed to provide fire support for THAAD and early warning target information to lower-tiered defensive systems such as Patriot, Extended Range Interceptor, and Corps SAMs. They will also incorporate lightweight miniaturized solid-state modules for quick transport aboard C-130 aircraft.

Subcontractors on the Raytheon team include: TRW, for software; Texas Instruments for solid-state transmit-receive modules; Digital Equipment for signal and data processors; EBCO for turrets for National Missile Defense radars; Datatape for data recorders, and Hughes Aircraft for traveling wave tubes.

Contracts for DEM/VAL for the family of radars have been inked, the preliminary design review (PDR) and critical design review (CDR) are completed, and engineering and unit fabrication have begun. Tests have prompted other developments: the GBR-T at USAKA was changed from a 24-square meter antenna, with a full field view, to an 89.4-square meter antenna with a medium field of view. The LDS FY92/FY93 funding was reduced by US$15.4 million to US$38.0 million due to budget reprogramming, a trend that continued through the first half of the 1990s. TMD FY92/FY93 funding was reduced by US$2.0 million/US$10.0 million due to budget reprogramming. FY94 funding of US$43.8 million for the Solid-State Demonstration Array project was transferred from Limited Defense Systems to Theater Missile Defense to directly support risk reduction for TMD-GBR EMD and production.

More recently, the TMD-GBR DEM/VAL radar was changed from a six-square meter antenna to a 4.6- square meter antenna and the TMD-GBR UOE radar was changed from a 12-square meter antenna to a 9.2- square meter antenna. The TMD-GBR DEM/VAL and TMD-GBR UOES delivery schedules were adjusted to reduce risk and align the contract award dates.

Test facilities are being constructed now, and various increment I and II software is scheduled for completion.

Investment in the program was sizeable throughout the 1980s, and commitment to the program has expanded rather than diminished. In 1993, the GAO expressed concern regarding the production of large quantities of GBR-related components, and has dispersed the re-sponsibility among a number of other contractors. The integration of all radar components has been and still is a huge problem, as has been the development of a discrimination and kill assessment capability with a phased array, X-band radar. Efforts to develop algorithms to determine not only hit-or-miss, but the probability of kill for interceptors have led BMDO officials to solicit assistance from unrelated contractors and universities. Of all areas of BMD, GBR is certainly one of the most active.

Because of its volitile nature, defined program plans are elusive. A history of revisions have altered the program's focus almost annually, and technical uncertainties in various NMD elements will no doubt ensure further changes to the architecture throughout DEM/ VAL. Since each element of the plan relies on the perfection of another (for example, Brilliant Eyes is needed to extend the reach of Ground Based Interceptors to cue the GBR), the program will likely continue behind schedule, drawing further attention to its sizeable cost and raising the ire of its increasingly vocal opponents. Recently, equally vocal support has surfaced, including groups who see future threat uncertainty as a reason to speed up the inauguration of a national missile defense system.

Funding

US FUNDING

	FY94		FY95		FY96		FY97	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
RDT&E (BMDO)								
PE#0604861C								
THAAD System								
Project 2154								
TMD-GBR	-	-	-	-	-	-	-	204.0
Procurement (BMDO)								
PE#0604861C								
Project 2154								
TMD-GBR	-	-	-	-	-	-	-	-
RDT&E(BMDO)								
PE#0603872C[a]								
Other Theater Missile Defense								
GBR	-	-	-	-	-	-	-	-

	FY94		FY95		FY96		FY97	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
RDT&E(BMDO)								
PE#0604216C[b]								
Theater Missile Defense								
Project #2104								
GBR	-	42.0	-	112.1	-	234.0	-	173.2
RDT&E(BDMO)								
PE#0603217C[c]								
Ballistic Missile Defense								
Project #2104								
GBR	-	-	-	82.5	-	24.8	-	8.0
Procurement								
PE#0208060C								
GBR	-	-	-	-	-	-	-	-

	FY98		FY99		FY00		FY01	
	QTY	AMT	QTY	AMT	QTY	AMT	QTY	AMT
RDT&E								
PE#0604861C								
Project 2154								
TMD-GBR	-	173.0	-	134.0	-	79.0	-	33.0
Procurement								
PE#0604861C								
TMD-GBR	-	11.9	-	156.2	-	289.6	-	433.9
PE#0604216C								
GBR	-	157.5	-	49.2	-	11.4	-	-
PE#0603217C								
GBR	-	11.0	-	20.0	-	20.0	-	26.0
Procurement								
PE#0208060C								
GBR	-	-	-	-	-	15.4	-	189.3

All US$ are in millions.

Analysis. BMDO has risen in popularity this past year. This year, nearly US$3 billion was requested and granted for the continuation of its many programs, a badly needed sign of commitment toward completing this huge project. Some could argue that the US is in too deep to withdraw now anyway, but the current climate in Washington hints at a strong backing among the Republican majority on Capitol Hill.

The enormous funding and classified nature of the program makes many of its facets almost immune to scrutiny; huge sums of money are begin invested (and this is likely to continue), yet it is difficult to tell exactly where and for what.

Recent Contracts

Contractor	Award ($ millions)	Date/Description
Raytheon	491.2	Sep 1992 - Contract award to design, develop, demonstrate, and validate the hardware/software for the GBR Family of Strategic and Theater DEM/VAL Radars. To be completed in September 1997 (DASG60-92-C-0184)

Timetable

	1983	Army awarded contracts to Hughes, Raytheon, Westinghouse for competitive design studies of an X-band solid-state radar related to ABMD system
	1985	Army awarded GBR preliminary design contracts
	1986	GBR Phase 2. Completion of system design review.
	1987	Raytheon selected as Phase 3 prime contractor
Jan	1988	Design goal redefined to include midcourse correction capability
	FY90/91	Requirements Definitions Study
Jan	1992	Milestone I approved by DSARC
Sep	1992	DEM/VAL contract awarded to Raytheon
Mar	FY92	Army added NMD version of GBR to requirement
	FY94	DEM/VAL
	1995	Engineering and manufacturing development

Worldwide Distribution

This is a **US** program only, although Allied participation is authorized at the subcontract level provided any such subcontracts can be performed within the scope of information authorized for release to Allied nation companies by the USASDC Foreign Disclosure Guidelines for Release of Sensors Data to the Allies.

Forecast Rationale

In mid-1994, the BMDO selected 94 US businesses for 116 Phase I research awards, averaging about US$61,000 each. Research funded by these awards aimed to channel several new related technologies into related government and commercial applications.

GBR remains one of the most active elements of BMD, yet it is also one of the most susceptible, being reliant upon the success and timely completion of the many links that comprise the defense chain. It cannot progress any more rapidly than the THAAD program will allow, nor can testing be completed without the steady funding of the several programs from which it draws technology development funding.

We do believe the program will go forward. We also believe that future contracts will continue to be small piecemeal projects to construct tiny bits of this enormous

puzzle. Its classified nature will continue to make it difficult to break into, and the DoD is also wary of going too far in the other direction; that is, spreading the projects too thinly among too many players.

Ten-Year Outlook

ESTIMATED CALENDAR YEAR FUNDING ($ in millions)

			High Confidence Level				Good Confidence Level			Speculative				
Designation	Application	thru 94	95	96	97	98	99	00	01	02	03	04	Total 95-04
SDI GROUND BASED RADARS	STRATEGIC DEFENSE (DOD)	739.00	194.60	249.00	360.00	342.00	324.00	404.00	651.00	458.00	330.00	385.00	3697.60