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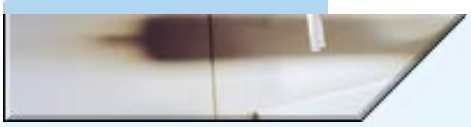

COVER STORY

KB Mashinostroeniya (KBM) has developed a new Igla-S extended-range version of the Igla (SA-18 'Grouse') shoulder-fired surface-to-air missile (SAM), writes Doug Richardson. KBM says the new variant is "highly-effective against small-sized targets like cruise missiles and UAVs [unmanned aerial vehicles]", and offers the "effectiveness of two missiles in a single round".

Full Story

AIR-TO-AIR HEADLINES

Eurofighter scores its first AMRAAM 'kill'

Eurofighter has carried out its first fully-guided firing of a Raytheon AIM-120 Advanced Medium-Range Air-to-Air

Jane's Missiles & Rockets Sponsor

Missile (AMRAAM) on 9 April. The firing was...
May 21, 2002

IRIS-T firing trials gather speed

During the joint government/industry trials at the Salto di Quirra Test Range in Sardinia, the Bodenseewerk Gerätetechnik (BGT) IRIS-T short-range air-to-air missile has...
May 21, 2002

Raytheon breeds a better AMRAAM

The next AIM-120C-5 Advanced Medium-Range Air-to-Air Missile (AMRAAM) upgrade to be fielded will be a high off-boresight (HOBS) capability, writes Doug Richardson. This is a software development and requires no changes to the missile. It was a jointly-funded development, with Raytheon paying for the software changes and the US Department of Defense paying for the flight- test programme.
April 23, 2002

S U R F A C E - T O - A I R H E A D L I N E S

BRIEFS - South Korea orders continuous-wave illuminators

May 21, 2002

BRIEFS - Follow-on Rolling Airframe Missile deals

Raytheon is being awarded a US$35.79 million contract for the production of 90 Launching Canisters; 60 Block 1 Mk 44 Mod 2 Rolling...
May 21, 2002

Raytheon delivers first DPELS launcher

Denmark has taken delivery of the first of 10 Dual-Pack Evolved SeaSparrow Missile Launching Systems (DPELS). It will be installed on the first...
May 21, 2002

A I R - T O - S U R F A C E H E A D L I N E S

Agent-Defeat ACTD to develop warheads

As part of the Agent-Defeat advanced concept technology demonstration (ACTD) programme, the US Naval Surface Warfare Center (NSWC), Indian Head, Maryland, and Lockheed...
May 21, 2002

BRIEFS - Fuze extenders ordered

May 21, 2002

BRIEFS - SAT to develop supersonic missile powerplant

May 21, 2002

A N T I - T A N K H E A D L I N E S

ATK to develop guided 105mm anti-tank round

Initial development of the US Army's new precision-guided 105mm Mid-Range Munition (MRM) is to begin under a US$5 million contract awarded to ATK...

May 21, 2002

China unveils improved Red Arrow systems

NORINCO (China North Industries Corporation) has revealed additional versions of its well-established Red Arrow 8 and 9 anti-tank guided missile (ATGM) systems, writes Christopher F Foss. These new developments are the Red Arrow 8F missile and Red Arrow 8L lightweight launcher, and the Red Arrow 9 in a new vehicle-based application called the Red Arrow 9A. These provide enhanced capabilities, and could appeal to a wider range of export customers than current variants.
May 21, 2002

Thermobaric warhead for Hellfire successfully tested

The thermobaric warhead being developed by the US Naval Surface Warfare Center, Indian Head, Maryland, for the Lockheed Martin AGM-114 Hellfire anti-tank guided...
May 21, 2002

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BRIEFS - Trident II technology-sustainment contract signed

Under a US$9 million contract from the US Navy's Strategic Systems Programs, Lockheed Martin Space Systems is to provide research and development (R&D)...
May 21, 2002

Last Titan arrives at Cape Canaveral

The first and second stages of the last Titan IV-B to be launched from Cape Canaveral have been delivered to the site by...
May 21, 2002

Trident II makes 95th successful flight

The US Navy (USN) has carried out the 95th consecutive successful launch of a Lockheed Martin Trident II (D5) fleet ballistic missile. Launched...
April 23, 2002

USAF deploys first modernised Minuteman missiles

The US Air Force (USAF) has revealed that the first 10 Minuteman III missiles equipped with remanufactured solid-propellant rocket motors were placed on...
April 23, 2002

Agni II enters production

India's 2,000km-range Agni II ballistic missile "has entered the production phase" and is "under induction" into service, writes David C Isby. The news...
April 23, 2002

BRIEFS - Trident support contracts

The US Navy's (USN's) Strategic Systems Programs has awarded Northrop Grumman Marine Systems a US$52,48 million modification to existing contract N00030-01-C-0013 to exercise...
April 23, 2002

BRIEFS - Integrated circuits for Minuteman

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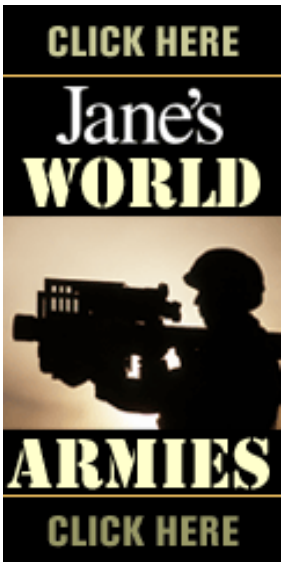

guidance
April 23, 2002

Pakistan ready to test Shaheen II
Reports in the Pakistani press say that the nation is ready to test its Shaheen II two-stage, extended-range ballistic missile, writes David C...
March 22, 2002

Minuteman III to get Peacekeeper RVs
The Lockheed Martin Mk21 re-entry vehicle (RV) with the W87 nuclear warhead, used by the MX MGM-118 Peacekeeper intercontinental ballistic missile (ICBM), will...
March 22, 2002

BRIEFS - TRW wins ICBM support contracts
TRW Intercontinental Ballistic Missile (ICBM) Systems is being awarded a contract modification worth an estimated US$169.7 million to provide for ICBM safety enhanced...
March 22, 2002

CIA sees weaknesses in Russian nuclear security
An unauthorised launch or accidental use of a Russian nuclear weapon is "highly unlikely" as long as current safeguards remain in place, says a report by the US Director of Central Intelligence (DCI). However, any breakdown of central political authority "would raise our concerns about possible circumvention of the system".
March 22, 2002

Russia to build six Topol-M ICBMs in 2002
Russian intercontinental ballistic missile (ICBM) production for 2002 is planned at six RT-2PM2 Topol-M (SS-27) missiles, writes David C Isby. This rate of...
March 22, 2002

India tests a reduced-range Agni
India has successfully tested a shorter-range variant of its nuclear-capable Agni (Fire) intermediate-range ballistic missile (IRBM), writes Rahul Bedi. Launched from the Chandipur test range on 25 January, the missile reached a range of 700km.
February 21, 2002

CIA sees no slowdown in ballistic-missile proliferation
Russia, China and North Korea are the most significant suppliers of missile technology to nations attempting to develop ballistic missiles, says the latest in a series of bi-annual reports by the US Central Intelligence Agency (CIA). The document covers activities during the first half of 2001.
February 21, 2002

BRIEFS - Trident FY02 contracts awarded
Lockheed Martin Space Systems (LMSS) is being awarded a US$12.41 million modification to previously awarded contract

N00030-01-C-0100 to exercise an option for the...
February 21, 2002

USN submarine fires four Trident missiles

Four Lockheed Martin Trident I C-4 submarine-launched ballistic missiles (SLBMs) were ripple-fired on 9 December from the US Navy ballistic missile submarine Ohio,...
January 31, 2002

US reviews its nuclear forces

The US has completed its second Nuclear Posture Review, an exercise which forms part of the effort to transform its military forces to meet the security challenges of the early 21st century, and which recognises the new relationship with Russia. (An earlier review was conducted in 1994.)
January 31, 2002

Russia plans cut-back in ICBM strength

The Russian Strategic Missile Troops (RVSN) still suffer from the limited resources that affect all of Russia's armed forces, but its high priority...
January 31, 2002

North Korea develops Taepo Dong 2 guidance software

Although North Korea has agreed to suspend flight tests of its Taepo Dong 2 long-range ballistic missile, it is continuing to develop the...
January 31, 2002

US could face North Korean and Iranian ICBM threats by 2015

Most US Intelligence Community (IC) agencies believe the US could face intercontinental ballistic missile (ICBM) threats from North Korea and Iran, and possibly from Iraq, before 2015.
January 31, 2002

BRIEFS - Trident SLBM funded for FY02

December 13, 2001

BRIEFS - Trident guidance repairs funded

December 13, 2001

BRIEFS - TRW wins extensions to Minuteman contracts

December 13, 2001

BRIEFS - Trident options exercised

December 13, 2001

Russian ICBM tests are tracked

Russia has carried out several training launches of intercontinental ballistic missiles (ICBMs) writes David C Isby. An RS-18 (SS-19 'Stiletto') ICBM was silo-launched...
December 13, 2001

Ukraine destroys last SS-24 silo

The Ukraine has destroyed its last silo for the RS-22 (SS-24 'Scalpel') intercontinental ballistic missile (ICBM). Located at Pervomaysk,

approximately 400km...
November 26, 2001

Shahab-3 enters production

According to unconfirmed reports, Iran has started serial production of the 1,300km-range Shahab-3 theatre ballistic missile (TBM), writes David C Isby....
November 26, 2001

Minuteman motors enter full-rate production

TRW is to begin full-rate production of new rocket motors for the Minuteman III intercontinental ballistic missile (ICBM). The contract is...
November 26, 2001

US and UK Trident support funded

BAE Systems Applied Technologies is to provide Fiscal Year 2002 (FY02) fleet ballistic missile (FBM) system integration and logistics support for...
November 26, 2001

Trident goes COTS

The US Department of Defense's Defense Acquisition Executive (DAE) has presented the Fleet Ballistic Missile (FBM) Trident Open System Architecture Team...
October 24, 2001

Indian Army will operate Agni II

The Indian defence ministry has announced that the 2,500km-range Agni II intermediate-range ballistic missile (IRBM) will be operated by the Indian...
September 19, 2001

German hardware may have helped launch Agni II

A recent criminal investigation has focused on the transfer of German technology to India's ballistic missile programme, writes David C Isby....
September 19, 2001

ICBM threat is growing, warns CIA

Most nations currently attempting to develop long-range ballistic missiles or even intercontinental ballistic missiles (ICBMs) are dependant on foreign assistance, says US Deputy Director of Central Intelligence, John E McLaughlin. Some states have already decided to go beyond medium-range weapons and develop ICBMs and others may decide to follow them, he told the 4th Annual Space and Missile Defense Conference at Huntsville, Alabama.
September 19, 2001

Minuteman cutbacks completed

The US has completed the conversion of 150 Minuteman III intercontinental ballistic missiles (ICBMs) to a single-warhead configuration, and the destruction...
September 19, 2001

'Rogue state' has fired shipboard ballistic missile

A nation identified only as a 'rogue state' has successfully demonstrated the shipboard launch of a ballistic missile, US Defense Secretary...
September 19, 2001

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BAT submunitions deployed from ATACMS

During a test carried out at the White Sands Missile Range, New Mexico, by the US Army Aviation and Missile Command and Northrop...
May 21, 2002

Missiles and PGMs could provide future US Army fire-support

In the wake of the decision by the US Department of Defense to cancel the 155mm Crusader self-propelled gun programme, the US Army...
May 21, 2002

Product-improved SMArt round passes first test

GIWS (Gesellschaft für Intelligente Wirksysteme) has successfully completed the first lot-acceptance test of its Product Improvement (PI) SMArt 155 gun-launched munition. This new...
May 21, 2002

Netherlands considers Tomahawk purchase

The Netherlands is considering the possible procurement of US Raytheon Tomahawk Land Attack Missiles (TLAMs), writes David C Isby. A feasibility study of...
May 21, 2002

KBM inspects Yemen's Tochkas

Russia's Kolomna Machine Building Design Bureau (KBM) has carried out an inspection of 80 Tochka (SS-21 'Scarab') short-range ballistic missiles in service with...
April 23, 2002

Excalibur may become US-Swedish programme

The US Army's Raytheon XM982 Excalibur 155mm GPS/INS guided artillery round, which successfully completed its initial testing in 2001, may incorporate technology developed...
April 23, 2002

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BRIEFS - More funding for earth-penetrating missile
April 23, 2002

BRIEFS - Team ERGM wins Vanguard Award
The US Navy/Raytheon Company Team ERGM has received the Vanguard Award from the Navy's Program Executive Office for Surface Strike for the successful...
April 23, 2002

BRIEFS - MLRS for Egypt
December 13, 2001

BRIEFS - South Korea orders ATACMS Block 1
December 13, 2001

GMLRS rocket makes successful flight test
The US Army and Lockheed Martin Missiles and Fire Control have successfully conducted the first engineering development flight test (EDT) of the Guided...
December 13, 2001

Lockheed Martin conducts second Netfires test
Lockheed Martin Missiles and Fire Control has conducted a successful Boost Test Vehicle (BTV-1) flight-test demonstration of technology related to the company's NetFires...
December 13, 2001

Taiwan pushing ahead with SRBMs
The Republic of China (ROC/Taiwan) is progressing with the development of a short-range surface-to-surface ballistic missile (SRBM) capability with a 300km range, writes Wendell Minnick. According to a report in the Taipei Times, the missile - tentatively planned to be based on Penghu Island in 2007 - will allow for limited strikes inside Fujian province on the Chinese mainland.
December 13, 2001

TLAM may be fired from a modified SLBM tube
The US Navy (USN) may conduct an underwater launch of a Tomahawk Land Attack Cruise Missile (TLAM) from a modified Trident submarine-launched ballistic...
December 13, 2001

Russia to replace Tochka with Iskander
The Russian Army will replace its 9K79 Tochka (SS-21 'Scarab') tactical ballistic missiles (TBMs) with the KB Mashinostroyenie Iskander (SS-X-26 'Stone'), writes David...
December 13, 2001

Royal Navy orders 48 TLAM Block IIIC missiles
The UK has told the US government that it wants to procure a further 48 Raytheon Tomahawk TLAM Block IIIC missiles,...
November 26, 2001

HIMARS fires MLRS and ATACMS rounds

Two Technical Demonstration (TD) test firings have demonstrated the ability of Lockheed Martin Missile and Fire Control's High Mobility Artillery Rocket...
November 26, 2001

Hard-target ATACMS to begin development

David C IsbyA hard and deeply-buried target defeat (HDBTD)...
November 26, 2001

Excalibur unguided test firings are successful

David C IsbyThe Raytheon Missile Systems XM892 Excalibur guided...
November 26, 2001

Bulgaria to scrap its 'Spiders'

David C IsbyBulgaria has finally decided to scrap its...
November 26, 2001

MBDA to join guided-MLRS consortium

MBDA will join Euro Rocket System, the joint venture set up by Lockheed Martin and Diehl to handle the international Guided...
October 24, 2001

Smart round guides, but fails to use rocket boost

ATK Tactical Systems has conducted two gun-launched tests of the Autonomous Naval Support Round (ANSR), a low-cost, precision-guided projectile for ship-to-shore...
October 24, 2001

BRIEFS - MLRS support contract awarded

October 24, 2001

BRIEFS - LRIP ATACM contract

October 24, 2001

Egypt to buy ER-MLRS

The US Defense Security and Co-operation Agency has notified the US Congress of a possible Foreign Military Sale of Extended-Range Multiple...
October 24, 2001

Smerch MLRS offered on lengthened Tatra chassis

One surprise at the MAKS 2001 defence exhibition was the appearance of the 12-round 300mm-calibre Smerch multiple launch rocket system (MLRS)...
September 19, 2001

BRIEFS - Tomahawk launch system to be modified for Astute-class

The United States Navy Tactical Tomahawk Weapons Control System is to be adapted for use on the United Kingdom Astute-class submarines...
September 19, 2001

ATACMS Block II funding trimmed due to testing problems

The US Army's Lockheed Martin ATACMS (Army Tactical Ballistic Missile System) Block II, intended to deliver the Northrop Grumman BAT (Brilliant Anti Tank) guided submunition, has suffered from funding cutbacks after it encountered problems in a test firing, writes David C Isby. However, both the Army and industry remain convinced that the problems are solvable and do not require major changes to the programme.
August 30, 2001

Royal Navy fires its fourth Tomahawk

Tomahawk will achieve Fleet Weapon Acceptance with the UK Royal Navy (RN) at the end of this year, the date originally...
August 30, 2001

Syrian Scud carried a simulated chemical warhead

Israeli sources report that the R-17E ('Scud-B') theatre ballistic missile (TBM) that Syria test-launched on 1 July carried a simulated chemical...
August 30, 2001

BRIEFS - Second Guided MLRS test successful

The US Army and Lockheed Martin Missiles and Fire Control have conducted the second successful ballistic flight test of the Guided...
August 30, 2001

PLA develops low-cost training for TBM units

The increasing importance of theatre ballistic missile (TBM) units to the People's Liberation Army - largely as a result of the...
August 30, 2001

Taiwan denies developing tactical ballistic and cruise missiles

The Taiwanese military has categorically denied it is developing long-range land attack cruise missiles (LACMs) and theatre ballistic missiles (TBMs), writes...
August 30, 2001

Boeing Harpoon Block II attacks land target

The US Navy (USN) has successfully tested the Boeing Harpoon Block II missile against a land target on San Nicolas Island...
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France plans ship and sub-launched Scalp

France has an emerging requirement for a new version of the Storm Shadow/Scalp EG. Suitable for use from next-generation frigates and...
July 18, 2001

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Moscow ABM upgrade to be completed this autumn

Russian press reports say an upgrade of the Moscow anti-ballistic missile (ABM) system will be completed by the autumn of 2002, writes David...
May 21, 2002

No replacement for Navy Area Defense ATBM programme

Following a study conducted by the US Missile Defense Agency (MDA), the US Department of Defense (DoD) has decided not to start a...
May 21, 2002

Northrop Grumman to lead a combined SBIRS Low team

TRW is to become prime contractor of a combined team tasked with developing the US Department of Defense's (DoD's) Space-Based Infrared System Low...
May 21, 2002

TRW to develop liquid-propellant booster

TRW has been selected by the US Missile Defense Agency to design a new liquid-propellant booster target under a US$29 million, five-year development...
May 21, 2002

US demonstrates another ICBM 'kill'

The US Missile Defense Agency (MDA) has successfully completed another intercept of an intercontinental ballistic missile (ICBM) target over the central Pacific Ocean. Conducted on 15 March 2002, Integrated Flight Test 8 (IFT-8) of the Ground-based Midcourse Defense (GMD) segment - formerly known as the National Missile Defense system - was the fourth successful intercept in six attempts carried out since 1999.
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Lockheed Martin to study target vehicle for ABM trials

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Lockheed Martin Space Systems is to study the development of a next-generation target system for future ballistic missile defence testing. Funded by a...
April 23, 2002

UK ABM study favours 'hit-to-kill' systems

The Technology Readiness and Risk Assessment Programme (TRRAP) ordered by the UK government in 1998 has concluded that surface-based interceptors, employing 'hit-to-kill', are a feasible counter to the tactical ballistic missile (TBM) systems and payloads expected to be in service up to 2015.
April 23, 2002

BRIEFS - Missile Defense Agency building to be modernised

April 23, 2002

BRIEFS - Naval ABM radar development contract

March 22, 2002

BRIEFS - Two companies to support missile-defence efforts

March 22, 2002

Orbital to develop ABM booster

Orbital Sciences has been selected by Boeing to develop, test and produce a second pattern of ground-based boost vehicle for the US Ground-based...
March 22, 2002

Russia plans Moscow ABM upgrade

Russia is planning to upgrade the Moscow anti-ballistic missile (ABM) system in the next three to four years, writes David C Isby. The...
March 22, 2002

BMD test hardware could provide emergency capability

Test hardware developed by the US missile defence programme could be used to provide the United States with a limited degree of anti-ballistic missile (ABM) defence capability prior to the deployment of an operation system, Missile Defense Agency (MDA) Director Gen Ronald T Kadish, US Air Force, told congressional procurement, and research and development subcommittees during a presentation on the MDA's Fiscal Year 2003 (FY03) budget.
March 22, 2002

BRIEFS - ABL risk-reduction contract

Boeing Defense and Space Group is being awarded a US$65.89 million contract modification to provide for action that definitises the effort to procure...
March 22, 2002

Standard SM-3 intercepts ballistic-missile target

A Raytheon Company Standard Missile-3 (SM-3) intercepted a ballistic-missile target in

space during a test of the US Navy's (USN's) Sea-based Missile Defense...
February 21, 2002

Raytheon to develop LADAR sensor

Under the US Army's Advanced Discriminating LADAR Technology (ADLT) programme, Raytheon is developing a range-resolved, Doppler-imaging laser radar (LADAR) sensor intended to provide...
February 21, 2002

US blocks Arrow sale to India

According to unconfirmed reports, the US has held up Israeli exports of the IAI-Boeing Arrow anti-tactical ballistic missile (ATBM) system to India, writes...
February 21, 2002

BRIEFS - BMDO orders technical support

February 21, 2002

BRIEFS - Supercomputer centre maintenance contract

February 21, 2002

US pulls out of ABM treaty

On 13 December 2001, the US government gave formal notice to Russia that the US is withdrawing from the 1972 ABM (anti-ballistic missile) Treaty. Announcing the decision, US President George Bush said, "I have concluded the ABM treaty hinders our government's ability to develop ways to protect our people from future terrorist or rogue state missile attacks.
January 31, 2002

Rising costs kill USN Area Missile Defense programme

The US Undersecretary of Defense for Acquisition, Technology and Logistics, Edward C 'Pete' Aldridge, has cancelled the Navy Area Missile Defense programme. The decision was taken due to poor performance and projected future costs and schedules. Most of the problems had been with the Raytheon Standard Block IVB missile. "There were some interface problems," said Aldridge, "but mostly with the missile."
January 31, 2002

India could procure Arrow ATBM

India hopes to be able to order the Israeli Arrow anti-theatre ballistic missile (ATBM) system, reports in the Israeli press suggest. In 2001,...
January 31, 2002

BMDO becomes the Missile Defense Agency

The US Ballistic Missile Defense Organization (BMDO) has been redesignated as the Missile Defense Agency. The current director of BMDO, Air Force Lt...
January 31, 2002

BRIEFS - Vanguard Research to support BMD research efforts

Under a modification to contract FA2524-95-D-0001, Vanguard Research will

provide advisory and assistance services, including support of research and development for ballistic-missile defence;...
December 13, 2001

BRIEFS - SBL gets stage 3 funding

Team Space Base Laser (SBL) Integrated Flight Experiment (IFX) Joint Venture, El Segundo, California, is being awarded a US$49.98 million contract modification to...
December 13, 2001

Missile interceptor scores third ICBM kill

Integrated Flight Test (IFT) 7 of the US Ground-based Midcourse Defense (GMD) Segment, formerly known as the National Missile Defense system, resulted in the successful interception of a re-entry vehicle target over the Pacific Ocean on 3 December 2001. This was the third successful trial of the system.
December 13, 2001

Orbital to develop air-launched TBM target

Orbital Sciences Corporation is to develop and launch four Short Range Air Launch Targets for the US Navy Area Wide theatre ballistic missile...
December 13, 2001

US Army selects target booster teams

TRW and Orbital Sciences have been selected by the US Army Space & Missile Defense Command to develop a liquid-propellant rocket...
November 26, 2001

Patriot PAC-3 intercepts cruise missile target

In the final Developmental Test firing, the Lockheed Martin Patriot Advanced Capability-3 (PAC-3) missile successfully engaged a BQM-74 target drone flying...
November 26, 2001

France may test Aster against a ballistic-missile target

Aerospatiale Matra Missiles is studying a possible anti-tactical ballistic missile (ATBM) trial which would use a derivative of the Aster 30 to engage a ballistic-missile target over a missile range in France, writes Doug Richardson. According to Claude Tribout, senior manager of the company's air-defence programme directorate, the trial would be conducted as part of current studies on a follow-on Aster Block 2 missile (see Jane's Missiles & Rockets August 1999, p1).
November 26, 2001

US Army selects target booster teams

TRW and Orbital Sciences have been selected by the US Army Space & Missile Defense Command to develop a liquid-propellant rocket...
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Patriot PAC-3 intercepts cruise missile target

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November 26, 2001

BRIEFS - Surveillance aircraft operation funded

October 24, 2001

MBDA studies next-generation air defences

MBDA foresees a change in surface-to-air missile (SAM) philosophy starting around 2005. Currently, SAM systems are divided into four performance classes:
October 24, 2001

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BRIEFS - Follow-on Rolling Airframe Missile deals
Raytheon is being awarded a US$35.79 million contract for the production of 90 Launching Canisters; 60 Block 1 Mk 44 Mod 2 Rolling...
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Raytheon delivers first DPELS launcher
Denmark has taken delivery of the first of 10 Dual-Pack Evolved SeaSparrow Missile Launching Systems (DPELS). It will be installed on the first...
May 21, 2002

Taiwan salvo-fires Tien Kung II and Improved HAWK
The Republic of China (Taiwan) successfully launched its locally-developed Tien Kung II (Sky Bow II) surface-to-air missile (SAM) during a live-fire exercise on 10 May 2002, writes Wendell Minnick. The 43rd 'God's Arrow' I exercise, the operation was designed to verify the engagement capability of the Tien Kung II and the country's Raytheon Improved HAWK systems.
May 21, 2002

Iraq redeploys SAM systems in 'no-fly' zones
Iraqi movements of surface-to-air missile (SAM) systems onto the northern and southern 'no-fly' zones in mid-April were at a greater level than has...
May 21, 2002

Palestinians may have used man-portable SAMs
According to unconfirmed reports, Palestinian forces used man-portable surface-to-air missile (SAM) systems for the first time on 5 April, firing two missiles against...

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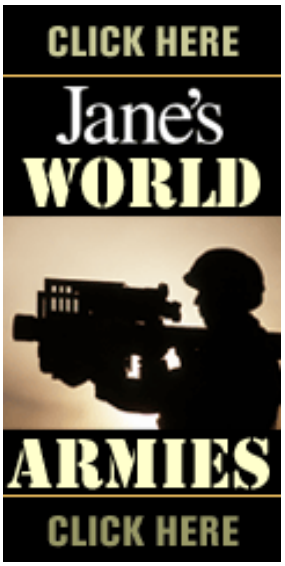

May 21, 2002

Russia approves Almaz-Antei merger

A presidential decree, signed by Vladimir Putin on 24 May, approved the formation of a new integrated air-defence company that effectively combines much...
May 21, 2002

Antelope SAM enters full-rate production

Taiwan's Chung Shan Institute of Science and Technology (CSIST) has announced that its self-propelled Antelope surface-to-air missile (SAM) system entered full-scale production in...
May 21, 2002

ESSM hits simulated anti-ship missiles

The Raytheon Evolved SeaSparrow Missile (ESSM) successfully shot down a low- altitude supersonic target simulating an anti-ship cruise missile (ASCM), writes David C...
April 23, 2002

Malaysia orders all-weather Jernas

The Malaysian government has become the first customer for the MBDA Jernas (Young Falcon) short-range air defence (SHORAD) system, the export version of the Rapier Field Standard C (FSC) system used by the UK services. At the recent Defence Services Asia 2002 exhibition, the Malaysian Ministry of Defence confirmed that Jernas will equip a new air-defence regiment of the Royal Malaysian Army.
April 23, 2002

USMC wants new Stinger night sight

The US Marine Corps (USMC) has issued a Request for Information (RFI) for 475 night sights for the Raytheon FIM-92 Stinger man-portable surface-to-air...
April 23, 2002

BRIEFS - Mk 41 launcher support contract awarded

April 23, 2002

BRIEFS - Upgrade will improve Patriot radars

April 23, 2002

BRIEFS - First Aegis Baseline 7.1 delivered

Lockheed Martin has completed equipment testing of the seventh generation of its Aegis Weapon System. The Baseline 7.1 system upgrade includes a new...
April 23, 2002

South Korea close to signing SAM-X deal

The Republic of Korea Air Force may decide on the future of its long-standing SAM-X long-range surface-to-air missile (SAM) requirement in April 2002,...
April 23, 2002

Patriot PAC-3 downs targets

The Missile Defense Agency (MDA) and the US Army have conducted the second of four

operational flight tests planned during the initial operational test and evaluation (IOT&E) for the Patriot Advanced Capability-3 (PAC-3) system. Although all test objectives were not met, preliminary data showed that the missiles hit their targets.
April 23, 2002

SEARAM launches first rounds

Four blast test vehicles (BTVs) have been launched from the Raytheon SEARAM Weapon System in a test designed to verify the system's structural...
April 23, 2002

Raytheon offers to support Standard SM-1s

Raytheon has set up an industrial team to handle future support of the Standard Missile 1 (SM-1), writes Ted Hooton. This move is...
April 23, 2002

BRIEFS - Raytheon to support CEC programme

April 23, 2002

BRIEFS - RAM modification kits ordered

April 23, 2002

India to test Danush naval TBM

India is to resume testing of the Danush ('bow') naval tactical ballistic missile (TBM) in the near future, writes David C Isby. According...
March 22, 2002

North Korea continues to test engines and export missiles

Despite the well-publicised moratorium on flight tests of the potentially intercontinental-range Taepo Dong-2 missile by North Korea, press reports from the Republic of...
March 22, 2002

BRIEFS - UK orders Tomahawk rounds

March 22, 2002

BRIEFS - MLRS vehicle support packages awarded

March 22, 2002

French Navy launches Naval Storm Shadow/Scalp programme

MBDA has been awarded a contract from the French Ministry of Defence (MoD) to begin the project-definition phase of the Naval Storm Shadow/Scalp...
March 22, 2002

New command vehicle for Smerch MLRS units

Russian Federal State Unitary Enterprise Radiozavod in co-operation with Federal State Unitary Enterprise Rosoboronoexport is offering the 9S729M1 Slepok-1 system for the command...
March 22, 2002

Three-round Patriot test scores only a single hit

During a trial conducted by the US Missile Defense Agency and the US Army at the White Sands Missile Range, New Mexico, a...
March 22, 2002

Netfires to support US Army Future Combat System

According to US Army 'Objective Force' defence planners, tactical missiles will provide a key component of the emerging 'system-of-systems' structure that will comprise...
March 22, 2002

Italy begins first SAAM/IT qualification firings

MBDA has successfully completed the first qualification firing of its Aster 15 Naval missile from an Italian ship fitted with the SAAM/IT naval-defence...
March 22, 2002

BRIEFS - Cruiser-conversion contract expanded

Lockheed Martin Naval Electronics and Surveillance Systems is being awarded a US$15.91 million modification to existing contract N00024-98-C-5197 to exercise options to provide...
March 22, 2002

BRIEFS - Raytheon to supply Aegis hardware

March 22, 2002

BRIEFS - Aegis network support contract

March 22, 2002

BRIEFS - Raytheon to support export Patriots

March 22, 2002

IDF hunts Qassam-II rocket workshops

During a series of raids mounted against Palestinian targets, following the use of Qassam unguided rockets against Israeli targets, the Israel Defence Forces (IDF) have located several of the workshops where these locally-developed missiles are being manufactured, writes Doug Richardson.
March 22, 2002

SMArt 155 munition repeats 100% reliability in tests

GIWS (Gesellschaft für Intelligente Wirksysteme) achieved 100% reliability in a series of gun-fired tests of the SMArt 155 sensor-fuzed munition system conducted in...
February 21, 2002

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Eurofighter scores its first AMRAAM 'kill'

Eurofighter has carried out its first fully-guided firing of a Raytheon AIM-120 Advanced Medium-Range Air-to-Air Missile (AMRAAM) on 9 April. The firing was...
May 21, 2002

IRIS-T firing trials gather speed

During the joint government/industry trials at the Salto di Quirra Test Range in Sardinia, the Bodenseewerk Gerätetechnik (BGT) IRIS-T short-range air-to-air missile has...
May 21, 2002

Raytheon breeds a better AMRAAM

The next AIM-120C-5 Advanced Medium-Range Air-to-Air Missile (AMRAAM) upgrade to be fielded will be a high off-boresight (HOBS) capability, writes Doug Richardson. This is a software development and requires no changes to the missile. It was a jointly-funded development, with Raytheon paying for the software changes and the US Department of Defense paying for the flight-test programme.
April 23, 2002

First seeker-guided IRIS-T firing downs target drone

The first seeker-guided firing trial of a BGT IRIS-T air-to-air missile resulted in a direct hit on the target drone. Carried out at...
April 23, 2002

Switzerland narrows its choice of dogfight missile

Switzerland has narrowed its choice of a next-generation air-to-air missile (AAM) to the Raytheon AIM-9X and Bodenseewerk Geratetechnik IRIS-T, writes Doug Richardson.Intended for...
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IRIS-T to begin seeker-guided firings

The first seeker-guided test firing of the

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Bodenseewerk Gerätetechnik IRIS-T short-range air-to-air missile (AAM) was expected to take place in mid- March, Gerhard...
March 22, 2002

France to buy self-defence missile for Mirage 2000

France plans to equip its Mirage 2000D fleet with a new short-range air-to-air missile (AAM), writes Doug Richardson. It will replace the MBDA...
March 22, 2002

Follow-on AIM-9X order

March 22, 2002

China shows its newest air-to-air missiles

The Beijing-based China National Aero Technology Import & Export Corporation (CATIC) is working on a next-generation dogfight missile, writes Robert Hewson. A CATIC engineer attending this year's Asian Aerospace exhibition, held in Singapore during February, described the new missile as being "very different to the PL-9", but "still a few years away from service yet".
March 22, 2002

IRIS-T aircraft-integration contracts signed

The German parliamentary budget committee has approved a Ministry of Defence request that it release DM120 million (US$53.4m) for the integration of the...
February 21, 2002

AIM-9X multinational buy is under consideration

Potential customers of the Raytheon AIM-9X infrared air-to-air missile (AAM) are considering placing a joint multinational buy, writes David C Isby. This approach...
February 21, 2002

BRIEFS - Meteor awaits German go-ahead

February 21, 2002

BRIEFS - Greece orders AMRAAM

February 21, 2002

ASRAAM enters service with the Royal Air Force

MBDA has delivered a first production batch of the Advanced Short-Range Air-to-Air Missile (ASRAAM) to the Royal Air Force (RAF), writes Doug Richardson. The initial batch of rounds is a mix of operational and training missiles.
February 21, 2002

BRIEFS - Raytheon to deliver spare parts

January 31, 2002

BRIEFS - Tactical telemetry units for AMRAAM

January 31, 2002

BRIEFS - Six nations order rocket motor hardware

Alliant Techsystems Allegany Ballistics Laboratory has been awarded an US$8.57 million modification to existing contract N00019-97-C-0156 to exercise an option for the procurement...
January 31, 2002

US Congress insists on Starstreak tests

The US Congress does not intend to let the US Army evade a congressionally-imposed requirement - dating from 1998 - to conduct comparative...
January 31, 2002

Taiwan's two F-16 wings operational

Taiwan's first F-16 wing was declared operational on 20 December, and is equipped with the Raytheon AIM-120 AMRAAM air-to-air and Boeing AGM-84 Harpoon...
January 31, 2002

ATK to develop propulsion for Spike

ATK (Alliant Techsystems) has been awarded a US$4 million contract from the US Naval Air Systems Command, China Lake, California, to develop the...
January 31, 2002

BRIEFS - AIM-9X LRIP funded

December 13, 2001

US Army shelves air-to-air Starstreak test

The US Army and the US Congress have taken time away from the war on terrorism to engage in their long-running dispute over...
December 13, 2001

Slim-line pylon boosts Swiss F/A-18 performance

Switzerland has been able to increase the air-combat performance of its F/A-18 fleet by developing its own low-drag launcher for the Raytheon AIM-120 Advanced Medium Range Air-to-Air Missile (AMRAAM), writes Doug Richardson. Developed by RUAG, the new SUU-84A launcher carries a single AMRAAM or AIM-9 missile.
November 26, 2001

Rafael Derby datalink: a correction

Statements made by Rafael earlier this year, that its new Derby beyond-visual-range air-to-air missile (BVRAAM) does not incorporate a datalink for...
November 26, 2001

Canada pulls out of IRIS-T project

A few days before the October meeting of the IRIS-T Steering Committee in Athens, and an associated meeting of the top management board of all IRIS-T companies, the Canadian Department of National Defence informed the IRIS-T programme management office that they had decided to withdraw from the programme.
November 26, 2001

F-22 Raptor fires a guided AMRAAM

On 21 September, the US Air Force (USAF)

conducted the first firing of a fully-guided AIM-120C advanced medium-range air-to-air missile (AMRAAM)...
October 24, 2001

MiG-31s intercept anti-ship missiles

Two Russian MiG-31 'Foxhound' interceptors are reported to have successfully engaged air-launched anti-ship missile targets during Russian Pacific Fleet exercises held...
October 24, 2001

BRIEFS - Three nations order AMRAAM hardware

September 19, 2001

Improved Archer enters production

September 19, 2001

Denel sees a future for A-Darter

Denel hopes that the future of its A-Darter short-range air-to-air missile can be resolved by the end of this year. The...
August 30, 2001

Tien Chien II offers an AMRAAM-class performance

Making its first appearance at a European air show, Taiwan's Chung Shan Institute of Science & Technology (CSIST) exhibited its Tien Chien I and Tien Chien II air-to-air missiles. These are guided by passive infrared and semi-active radar seekers respectively. While Tien Chien I is an infrared-guided Sidewinder look-alike, the larger and heavier Tien Chien II is a beyond-visual-range (BVR) weapon whose visual resemblance of the US AIM-7 Sparrow conceals a performance similar to that of the Raytheon Advanced Medium-Range Air-to-Air Missile (AMRAAM).
July 18, 2001

Denel shows definitive R-Darter

Models of the Denel R-Darter/V-4 radar-guided air-to-air missile displayed at the recent Paris air show carried the twin roll-control surfaces found on Rafael's Derby missile, writes Doug Richardson. The absence of these small moving surfaces on the first officially-released photograph of the South African missile was due to the fact that the image showed an early captive-carry round. Since the purpose of this variant was to measure the aerodynamic effect of missile carriage, the twin surfaces were omitted since they would have a negligible effect, says Denel.
July 18, 2001

Brazil may have ordered Derby for AH-64

July 18, 2001

Starstreak undergoes static testing

The long-delayed live-fire evaluation of the Thales (formerly Shorts) Starstreak missile as an air-to-air weapon for the US Army's Boeing AH-64...
July 18, 2001

IRIS-T completes fourth series of firing trials

The international Infra-Red Improved Sidewinder-TVC (IRIS-T) short-range air-to-air missile being developed by Canada, Germany, Greece, Italy, Norway and Sweden has completed...
July 18, 2001

Three nations sign Meteor go-ahead

In a ceremony held at the Paris air show, defence ministers from France, Sweden and the UK signed a Memorandum of...
July 18, 2001

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Denmark gets first Harpoon II missiles

The Danish Naval Materiel Command has taken delivery of the first Boeing Harpoon Block II missiles following installation of upgrade kits which convert...
May 21, 2002

BrahMos tests to resume this summer

India is to resume flight tests of the PJ-10 BrahMos (Brahmaputra-Moskva) supersonic anti-ship missile, writes David C Isby. The first flight test was...
March 22, 2002

ARC completes ramjet engine tests

Atlantic Research Corporation (ARC) has completed development testing of the MARC-R-282 ramjet engine for the US Navy's GQM-163A Supersonic Sea Skimming Target (SSST)....
March 22, 2002

Egypt's Harpoon 2 missiles will have no land-attack capability

The Bush administration, criticised by Israel and its supporters in Congress for plans to sell satellite-guided RGM-84L-4 Harpoon II missiles to the Egyptian...
March 22, 2002

Israel worried by Harpoon II sale to Egypt

Israel is opposing the US proposal to sell Boeing Harpoon II missiles to Egypt, writes Ed Blanche. Part of a planned US$400 million...
February 21, 2002

Ramjet missile may have an anti-ship role

A series of photographs taken by Jane's Missiles & Rockets correspondent, Miroslav Gyürösi, shows new details of a Chinese supersonic air-launched missile. Reported...
January 31, 2002

Russia forms anti-ship missile consortium

A consortium of seven design bureaus and manufacturers associated with anti-ship cruise

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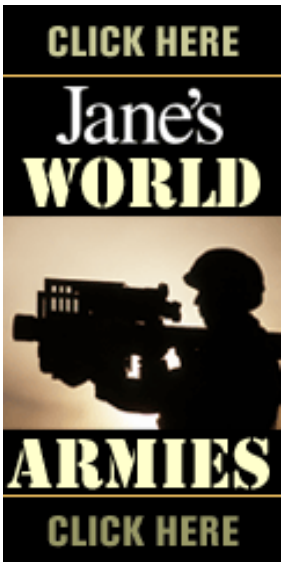

missiles (ASCM) was formed in Russia in late December, writes David...
January 31, 2002

Argentine Sea King launches Exocet

The Argentine Navy has fired an air-launched Aerospatiale Matra Missiles AM.39 Exocet anti-ship missile from one of its Agusta ASF-3H Sea King helicopters...
December 13, 2001

BRIEFS - Harpoon order for eight nations

December 13, 2001

New anti-ship missile plan for MH-60

A new anti-ship missile will arm the US Navy's (USN's) new Sikorsky MH-60R/S multirole helicopters that will replace the current Sikorsky SH-60 and...
December 13, 2001

Harpoon Block II ends developmental testing

The US Navy has completed developmental testing of the Boeing Harpoon Block II missile at the Naval Air Warfare Center-Weapons Division...
November 26, 2001

'Granit' missiles recovered from Kursk

In a dry dock at Roslyakovo near the Russian Arctic port of Murmansk, Russian missile specialists have successfully removed 16 P-700...
November 26, 2001

BRIEFS - FLH to supply RBS15 Mk3 canard actuators

FHL, a division of the Hamilton Sundstrand-owned Claverham Group, has been selected by Saab Bofors Dynamics AB to produce the fin-actuation...
October 24, 2001

BRIEFS - Software ordered for Harpoon training

October 24, 2001

NT-D goes to sea

Rafael has developed and tested a new naval mounting which combines a 30mm cannon with two of the company's NT-D anti-tank...
October 24, 2001

Indian/Russian PJ-10 missile to be vertically launched

Technical details of the PJ-10 supersonic anti-ship cruise missile being jointly developed by India and Russia were released for the first time at the MAKS 2001 defence exhibition at Zhukovskiy near Moscow, writes Miroslav Gyürösi. The weapon is ramjet-powered and exploits the experience gained by earlier Russian anti-ship missiles in the same performance class (see ''Shipwreck' surfaces after 20 years' on page 2 of this issue).
September 19, 2001

Kh-59MK intended for all-weather attacks

The FGUP GMKB Raduga design bureau from Dubna displayed a new variant of its Kh-59/-59M (AS-13 'Kingbolt'/AS-18 'Kazoo') series of air-to-surface...
September 19, 2001

PLA exercises use missiles in anti-carrier role

The Chinese People's Liberation Army (PLA) has recently used ballistic and cruise missiles in support of amphibious operations and against simulated carrier task forces, writes David C Isby. Part of a continued series of 'missile diplomacy' exercises, the firings were apparently intended as a message aimed at both Taiwan and the US. China has explicitly presented recent exercises as a counter to what it claimed was a US one-day exercise involving two carrier battle groups held in the South China Sea on 17 August.
September 19, 2001

'Shipwreck' surfaces after 20 years

Newly released information on the Russian Navy's P-700 Granit (SS-N-19 'Shipwreck') anti-ship missile suggests that the weapon's performance and technology may have been underestimated by Western navies, writes Doug Richardson. The weapon was designed in the late 1970s and entered service in the early 1980s, but for almost two decades its configuration remained classified.
September 19, 2001

Taiwan tests supersonic anti-ship missile

The first full live-fire testing of the Chung Shan Institute of Science and Technology's Hsiung Feng III (Brave Wind III) supersonic...
August 30, 2001

Improved Uran-E ASM enters serial production

The Zvezda-Strela 3M24 Uran-E (SS-N-25 'Switchblade') anti-ship missile has entered serial production, writes David C Isby. This is the latest version...
August 30, 2001

BRIEFS - Nine nations order Harpoon hardware

McDonnell Douglas is being awarded a US$27.06 million contract for the procurement of eight Harpoon Shipboard Command and Launch Control Systems...
August 30, 2001

China deploys HY-2 anti-ship missiles to Paracel islands

China recently deployed HY-2 'Seersucker' anti-ship missiles to its main base on Woody Island in the disputed Paracel islands, writes David...
July 18, 2001

China deploys HY-2 anti-ship missiles to Paracel islands

China recently deployed HY-2 'Seersucker' anti-ship missiles to its main base on Woody Island in the disputed Paracel islands, writes David C Isby. Citing intelligence sources, US press reports say that the missiles were detected following amphibious exercises on Woody Island in early June.
July 18, 2001

US Navy tests Harpoon Block II

The US Navy (USN) has conducted the first flight test of the Boeing Harpoon Block II anti-ship missile at the Naval Air Warfare Center-Weapons Division sea range off Point Mugu, California. After launch from the Arleigh Burke-class guided missile destroyer Decatur (DDG 73), the missile flew towards two targets, the navy's Mobile Sea Target and another target ship, the MK-35 SEPTAR. The trial was intended to demonstrate the missile's ability to select the proper target when used in open-ocean conditions. Harpoon II tracked and acquired the target exactly as planned, says Boeing. Flight tests later this summer will demonstrate the missile's other capabilities.
June 15, 2001

Iran may have ordered Yakhont missiles

According to unconfirmed reports, recent Russian/Iranian talks on arms transfers included an agreement for the sale of the Chelomey Design Bureau's 3K55 Yakhont (SS-N-26) supersonic surface-skimming anti-ship missiles to Iran, writes David C Isby. The sale is one of several - with a total value etimated at up to US$7 billion - that are likely to follow now Russian President Vladimir Putin has said that he will no longer follow a 1995 understanding with the US to ban new arms sales to Iran.
June 15, 2001

RPK-8 rocket-propelled ASW round for RBU-6000 enters production

The RPK-8 Zapad, an improved rocket-powered guided anti-submarine warfare (ASW) round for the standard Soviet-era RBU-6000 ahead-firing weapons system, entered production for the Russian Navy in April, writes David C Isby.
May 29, 2001

New payloads for Vertically Launched ASROC

Enhancements to Lockheed Martin's RUM-139A Vertically Launched ASROC (VLA) anti-submarine weapon system, including a proposal for a land-attack version, were announced at this year's US Navy League's Sea-Air-Space Exposition, held in Washington, writes E R Hooton.
May 29, 2001

AMS to upgrade Egyptian Navy OTOMATs

Alenia Marconi Systems (AMS) has been awarded a contract by the Armament Authority of Egypt for the upgrade of the Egyptian Navy's OTOMAT missiles. Originally supplied in the early 1980s by what were then Matra and OTO Melara, the missiles were used to arm Egypt's October and Ramadan-class fast-attack craft (FAC), plus three coast-defence batteries.
April 24, 2001

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ATK to develop guided 105mm anti-tank round

Initial development of the US Army's new precision-guided 105mm Mid-Range Munition (MRM) is to begin under a US$5 million contract awarded to ATK...
May 21, 2002

China unveils improved Red Arrow systems

NORINCO (China North Industries Corporation) has revealed additional versions of its well-established Red Arrow 8 and 9 anti-tank guided missile (ATGM) systems, writes Christopher F Foss. These new developments are the Red Arrow 8F missile and Red Arrow 8L lightweight launcher, and the Red Arrow 9 in a new vehicle-based application called the Red Arrow 9A. These provide enhanced capabilities, and could appeal to a wider range of export customers than current variants.
May 21, 2002

Thermobaric warhead for Hellfire successfully tested

The thermobaric warhead being developed by the US Naval Surface Warfare Center, Indian Head, Maryland, for the Lockheed Martin AGM-114 Hellfire anti-tank guided...
May 21, 2002

Upgrade planned for TOW night sight

DRS Technologies is to design prototype upgrade kits for the night-vision targeting sight on the Raytheon BGM-71 TOW (Tube-launched, Optically-tracked, Wire-guided) anti-tank missile...
April 23, 2002

Iran tests indigenous TOW in air-launched form

Iran has tested a locally produced version of the US TOW wire-guided, anti-tank-guided missile (ATGM) from a helicopter, writes David C Isby. According...
March 22, 2002

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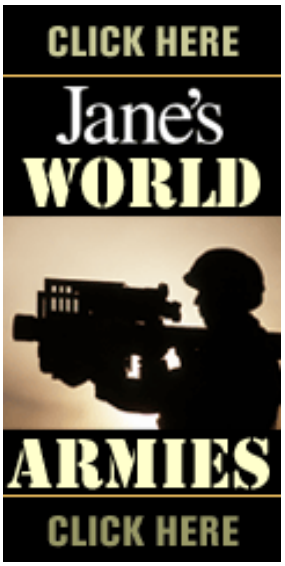

BRIEFS - Javelin support contract awarded
March 22, 2002

BRIEFS - Five-year TOW system contract for Raytheon
March 22, 2002

BRIEFS - UK orders Hellfire/Longbow support
March 22, 2002

BRIEFS - BAE Systems to build tactical trainers
March 22, 2002

MBDA details its Kestrel bid
MBDA has released further details of the Kestrel fire-and-forget anti-tank guided weapon (ATGW) writes Christopher F Foss. Kestrel is the company's entry in the British Army competition for a New Light Anti-tank Weapon (NLAW) to meet Staff Requirement (Land) 7098. Also competing for this contract, which is worth at least £250 million (US$357m), is Saab Bofors Dynamics of Sweden with the MBT-LAW.
February 21, 2002

Range boost for Spike and TOW
Rafael's Spike fibre-optic guided anti-tank missile has now been cleared for use at ranges of up to 6km, writes Doug Richardson. Up until...
February 21, 2002

Israeli CH-53s armed with Nimrod ATGMs
Israel is arming its US-built Sikorsky CH-53D Sea Stallion helicopters with Israeli-built Israel Aircraft Industries Nimrod laser-guided anti-tank missiles, writes David C Isby....
January 31, 2002

Common Missile System agreement ratified
The US-UK Memorandum of Understanding (MoU) setting out the terms of international co-operation to develop the Common Missile System (CMS) was ratified on...
January 31, 2002

Jordan, Lithuania to buy Javelin anti-tank missiles
Lithuania and Jordan have become the first European and Middle Eastern customers for the Javelin anti-tank missile, says the Raytheon-Lockheed Martin Javelin joint...
January 31, 2002

LR TRIGAT finishes helicopter-qualification firings
The MBDA LR-TRIGAT 'fire-and-forget' anti-tank missile system for the Eurocopter Tiger attack helicopter has completed the 10 guided firings in increasingly difficult scenarios required for its helicopter qualification trials. Nine of the 10 firings were successful.
January 31, 2002

ATK tests LOSAT rocket motor

ATK Tactical Systems has successfully completed two static firing tests of a developmental solid-propellant rocket motor for the US Army's Line-of-Sight Anti-tank (LOSAT)...
December 13, 2001

US Army proposes to end TERM anti-armour round

The US Army is proposing to terminate the TERM (tank extended-range munition) guided 120mm tank-round programme, writes David C Isby. Intended to produce...
December 13, 2001

US Army may kill TOW F&F

The US Army is proposing to terminate the Raytheon TOW F&F (Fire-and-Forget) anti-tank guided-missile (ATGM) upgrade programme, writes David C Isby. However, this...
December 13, 2001

IDF Hellfires wreak havoc in aerial ambushes

Ed Blanche
November 26, 2001

BRIEFS - More Hellfires ordered

November 26, 2001

SMArt 155 passes lot-acceptance tests

GIWS (Gesellschaft für Intelligente Wirksysteme) has conducted a successful series of gun-fired lot-acceptance tests of its SMArt 155 sensor-fuzed munition system....
October 24, 2001

Denel shows advanced warheads

At the recent Defence Systems & Equipment Exhibition (DSEI) in London, the Somchem division of Denel displayed several warhead developments in...
October 24, 2001

Khrizantema-S to finish state trials by 2002

The Kolomna Engineering Design Bureau has announced that its 9M123 Khrizantema-S (Chrysanthemum) anti-tank guided missile is currently undergoing state certification tests,...
October 24, 2001

Nag ATGM makes successful test flight

India's Nag (Cobra) anti-tank guided missile (ATGM) has completed a successful control and guidance flight test at the interim test range...
October 24, 2001

UK asks for Javelin and Spike bids

Invitations to tender (ITTs) have been issued by the UK Ministry of Defence (MoD) to Lockheed-Martin, Raytheon and Matra BAe Dynamics for an off-the-shelf medium-range anti-tank missile system. The US companies are offering the Javelin missile currently in service with the US forces, while Matra BAe has teamed with Rafael to offer the Spike family

of anti-tank missiles used by the Israel Defence Forces.
October 24, 2001

Hellfire motor modification needs testing and funding

The US Army has developed a fix to faulty rocket motors used on late-production Lockheed Martin AGM-114K/L Hellfire anti-tank guided missiles...
September 19, 2001

Brimstone completes ground trials

On 27 June 2001, a ground-launched Alenia Marconi Systems Brimstone missile scored a hit on a tank target at the Yuma...
August 30, 2001

Second phase of Hellfire firings from UAVs successful

The second phase of weapons testing by the US Air Force's General Atomics RQ-1A Predator unmanned air vehicles (UAVs) at Nellis...
August 30, 2001

Iran test-fires Lightning anti-tank missile

Iran has successfully test-fired a new pattern of anti-tank missile. According to the Iranian defence ministry, the Saeqeh-1 (Lightning-1) "can destroy...
August 30, 2001

BRIEFS - Netherlands selects Gill

August 30, 2001

Brimstone development near end

Brimstone will be available for service with the Royal Air Force in October of this year, says Alenia Marconi. Although the...
July 18, 2001

TOW to be modified for bunker busting role

The US Army's Aviation and Missile Command Research and Development Center is to modify the Raytheon TOW 2A anti-tank guided missile...
July 18, 2001

UK will participate in Common Missile programme

The UK Ministry of Defence has signed a statement of intent to participate in the US Common Missile programme, writes David...
July 18, 2001

BRIEFS - More TOW warheads ordered

July 18, 2001

Brimstone development near end

Brimstone will be available for service with the Royal Air Force in October of this year, says Alenia Marconi. Although the weapon will be useable as a war store, it will not have its full operating capability on the Tornado GR4 until the associated aircraft software is ready.
July 18, 2001

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Agent-Defeat ACTD to develop warheads

As part of the Agent-Defeat advanced concept technology demonstration (ACTD) programme, the US Naval Surface Warfare Center (NSWC), Indian Head, Maryland, and Lockheed...
May 21, 2002

BRIEFS - Fuze extenders ordered

May 21, 2002

BRIEFS - SAT to develop supersonic missile powerplant

May 21, 2002

BRIEFS - Popeye support for Australia

May 21, 2002

EDO to develop weapon carriage system for SDB

EDO Corporation has been awarded a contract by Lockheed Martin to develop a weapon carriage system for the Component Advance Development phase of...
May 21, 2002

USAF tests Mk 82 JDAM

The US Air Force (USAF) has successfully flight-tested the Boeing Mk 82 500 lb Joint Direct Attack Munition (JDAM) at Eglin Air Force...
May 21, 2002

LOCAAS flight tests will end with a live-fire trial

A series of flight tests of the Lockheed Martin LOCAAS (low-cost autonomous attack system), due to be completed over the next 18 months,...
May 21, 2002

MBDA would build JDAM in the UK

MBDA plans to establish its own Joint Direct Attack Munition (JDAM) production line in the UK if the Mk 82 (500 lb) version of the weapon is selected to meet the UK Precision Guided Bomb (PGB) requirement, writes Doug Richardson. Lostock, Lancashire, is being

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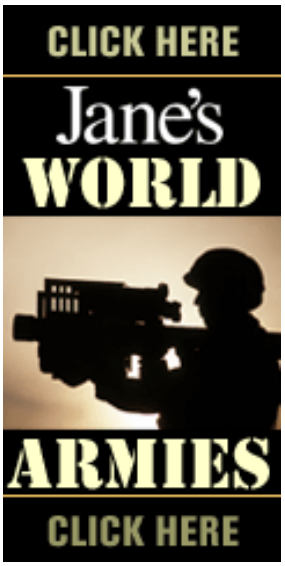

considered as a location for the facility, which would deliver weapons to meet the UK requirement, as well as delivering to some export customers.
May 21, 2002

Oman orders JDAM and Paveway II

Oman is expected to become the second export customer for the Boeing JDAM (Joint Direct Attack Munition) GPS/INS (inertial navigation system) guided bomb...
May 21, 2002

PGB teams choose TME's hard target fuze

Thales Missile Electronics (TME) has revealed all three contractors competing for the contract to supply the Precision Guided Bomb (PGB) to the UK...
May 21, 2002

USAF demonstrates multitarget strikes from single-pass attacks

On 2 May, a US Air Force (USAF) B-1B Lancer crew successfully targeted three different weapon types against three separate targets in a...
May 21, 2002

Small Diameter Bomb becomes a USAF 'Pathfinder programme'

The US Air Force (USAF) has chosen its Small Diameter Bomb (SDB) GPS/INS (inertial navigation system)-guided 250 lb bomb as one of 10...
May 21, 2002

USAF will develop extended-range WCMD

The US Air Force (USAF) Air Armament Center at Eglin Air Force Base, Florida, is to develop an extended-range version of the Lockheed...
May 21, 2002

Extra funding may not tackle US PGM shortage

Even with the supplemental appropriations intended to pay for the munitions expended in recent military operation against terrorist forces in Afghanistan, the US services still are facing a potential shortage of some munitions and missiles, writes David C Isby. Admiral Dennis Blair, commander-in-chief of US Pacific Command (CINCPAC), testified in Congress in March that "Operation 'Enduring Freedom' has significantly reduced the already limited worldwide stocks of precision munitions across all services".
April 23, 2002

JASSM-ER may become USAF's Extended Range Cruise Missile

The extended-range version of the Lockheed Martin Joint Air-to-Surface Standoff Missile (JASSM-ER) is emerging as the front-runner for the US Air Force's (USAF's)...
April 23, 2002

US ALCM could retain a nuclear role

The recently-completed US Nuclear Posture Review (NPR) has recommended that the Boeing AGM-86 air-launched cruise missile (ALCM) and the Raytheon AGM-129 advanced cruise...
April 23, 2002

US thermobaric bomb uses a single-stage explosive charge

US Department of Defense (DoD) officials have provided more details of the new BLU-118/B thermobaric bomb. Some US press reports have suggested the weapon, which was used for the first time on 5 March against Al-Qaeda fighters in a cave near Gardez in Afghanistan, is designed to detonate in two stages, so should be considered a weapon of mass destruction.
April 23, 2002

JDAM seen as a war-winner in Afghanistan

Major General Daniel P Leaf, director of operational requirements for air and space operations at the US Department of Defense credits the Boeing...
April 23, 2002

JSOW-B tests will show design fixes

A flight-test programme due to begin later in 2002 is to validate design fixes made to allow integration of the Raytheon AGM-154 JSOW...
April 23, 2002

USAF looks at new missiles for Predator

Following the success of armed versions of the General Atomics RQ-1A Predator unmanned air vehicles (UAV) in Afghanistan, the US Air Force (USAF)...
March 22, 2002

USAF delays ERCM programme

The US Air Force (USAF) has decided to delay its programme to develop and procure several hundred stealthy extended-range cruise missiles (ERCMs), writes David C Isby. No research and development funding for the programme was included in the Fiscal Year 2003 (FY03) budget request, and the USAF has re-programmed US$83 million in previous-year funds appropriated for the programme to "higher priorities".
March 22, 2002

Dual launch ends JSOW integration tests on B-52

Raytheon's AGM-158A Joint Standoff Weapon (JSOW) has successfully completed aircraft integration tests with the US Air Force's B-52 Stratofortress bomber. During a trial...
March 22, 2002

BRIEFS - Proximity fuzes ordered

March 22, 2002

BRIEFS - Export orders for Maverick

March 22, 2002

Unitary-warhead JSOW makes second flight

The US Navy (USN) and Raytheon Company have successfully completed the second free-flight demonstration of the AGM-154C unitary-warhead version of the Joint Standoff...
February 21, 2002

UAV targets laser-guided bomb attacks in Extendor trials

The UK Ministry of Defence's (MoD's) Extendor operational concept demonstrator programme has used data from a General Atomics Predator unmanned air vehicle (UAV)...
February 21, 2002

JDAM production rate could be speeded

The US Department of Defense is considering increasing the production rate of the Boeing JDAM (Joint Direct Attack Munition) GPS/INS guided bomb kit...
February 21, 2002

AARGM makes a second guided flight

The US Navy (USN) has successfully completed the second guided flight test (and fourth launch) of its Science and Applied technology (SAT) AARGM...
February 21, 2002

30,000 lb 'Big BLU' proposed for deep-buried targets

A 30,000 lb guided hard and deeply buried target defeat (HDBTD) bomb, designated 'Big BLU', has been proposed by an industry team of...
February 21, 2002

Lancer MWS punches above its weight

SEI (UK) has carried out a dynamic firing trial of its Lancer multiwarhead system (MWS) at the QinetiQ Pendine range in the UK,...
January 31, 2002

US deploys BLU-118B thermobaric bombs

The US Department of Defense has accelerated its hardened target defeat (HTD) advanced concept technology demonstration (ACTD) programme with the objective of producing...
January 31, 2002

Boeing tests small smart bombs

Late last year, the US Air Force (USAF) Research Laboratory Munitions Directorate and Boeing successfully flight-tested two Small Smart Bomb Range Extension (SSBREX)...
January 31, 2002

JASSM to enter low-rate production

US Undersecretary of Defense for Acquisition, Technology and Logistics Edward C 'Pete' Aldridge has given the go-ahead for low-rate initial production (LRIP) of...
January 31, 2002

JASSM flies simulated combat mission

In December 2001, a Lockheed Martin AGM-158 Joint Air-to-Surface Standoff Missile (JASSM) destroyed a hardened bunker target

at the Western Test Range in...
January 31, 2002

WCMD used for first time in Afghanistan

The Lockheed Martin (Orlando) Wind Corrected Munitions Dispenser (WCMD) was used in combat for the first time in Afghanistan, writes David C Isby....
January 31, 2002

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Missile destroyer Cole rejoins the fleet

Following a 14-month programme of repair and modernisation, the Aegis guided missile destroyer Cole (DDG 67) has returned to service. Thousands of Northrop...
May 21, 2002

DD(X) destroyer will have side-mounted vertical missile launchers

Vertical-launch systems installed along the sides of the US Navy's (USN's) planned DD(X) multimission destroyer, rather than in a central location, were one...
May 21, 2002

'Smart' scanning proposed for laser beam-riding missiles

Aerospatiale Matra Missiles (now part of MBDA) has developed a new form of laser-based missile guidance which significantly reduces the chance that a...
May 21, 2002

USAF proposes liquid/solid mix for rocket propellants

In its search for a rocket propulsion system that overcomes the disadvantages of conventional solid-propellant and liquid-propellant systems, the US Air Force (USAF) has devised a scheme in which the propellant takes the form of a liquid oxidiser mixed with pellets of cross-linked hydrogel polymer. Stored in a single tank, this could be expelled by a pressurisation system and fed into a separate combustion chamber.
May 21, 2002

ARC demonstrates improved propulsion technologies

Atlantic Research Corporation (ARC) has successfully conducted a ground test of an advanced high-energy variable-flow ducted rocket (VFDR). Taking place at the company's...
April 23, 2002

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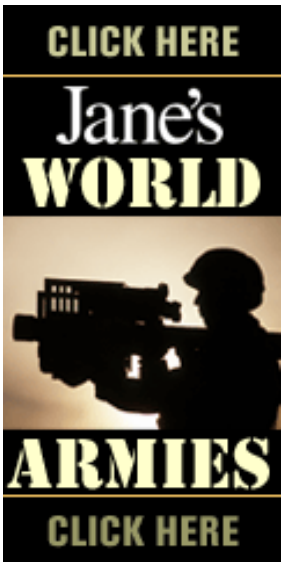

New tower to improve weapon-seeker testing

The US Air Force's 46th Test Wing at Eglin Air Force Base, Florida, is commissioning a new 91.4m test tower to be used...
April 23, 2002

Hypersonic missile reaches Mach 6+ in low-level flight

During a flight test at a German test site, an EADS/LFK experimental missile designated Hoch-Geschwindigkeits Flugkorper (HFK) EO2 reached a speed of over...
March 22, 2002

Altair offers antenna for missile applications

A new family of modular phase-array antennas, which could be used for missile-guidance applications, is being offered by Russia's Altair design bureau, writes...
March 22, 2002

INMIZE becomes Spain's missile company

In a move which forms part of the current consolidation of the European defence industry, Spain has set up INMIZE, a new company...
February 21, 2002

Luke AFB updates its training ranges

The mountainous desert terrain of the Barry M Goldwater Range at Luke Air Force Base (AFB), Arizona base was being used to simulate...
February 21, 2002

MBDA completes tri-national merger

On 18 December 2001, Fabrice Brégier, chief executive officer of MBDA, signed the documents formally establishing the international missile company as a legal...
January 31, 2002

US Army to study remotely-operated turrets

US Army planners are investigating the possibility of upgrading selected light combat vehicles with a remotely-operated missile turret subsystem, writes Scott R Gourley....
January 31, 2002

Jane's conference reviews ballistic missile proliferation

The future ballistic missile threat could be from an area extending from Casablanca to the Straits of Taiwan, Alexander Pikayev, scholar in residence at the Carnegie Moscow Centre, told the Jane's conference on Missile Proliferation held in Edinburgh, Scotland, late last year. In his view, Russian President Vladimir Putin is ready to make major concessions to the US on Anti-Ballistic Missile (ABM) systems but will be looking for benefits for Russia in return.
December 13, 2001

US low-cost guidance ready for initial test

The General Dynamics Low Cost Course Correction (LCCC) programme (not to be confused with a similar British project that uses

the same acronym)...
December 13, 2001

US PGMs target Afghan caves and bunkers

The US has used a number of hard and deeply buried target defeat (HDBTD) munitions in the air offensive against the Taliban-controlled parts of Afghanistan, writes David C Isby. These have included GBU-28 5,000 lb laser-guided bombs and 5,000 lb Northrop Grumman GBU-37s, a shorter GPS/INS-guided variant sized to fit the Northrop B-2's bomb bay.
November 26, 2001

Cruise missiles and 'smart' bombs used in Afghanistan

Approximately 50 Tomahawk missiles launched from platforms including US Navy surface ships and the UK Royal Navy (RN) submarines were used in the first phase of attacks against Taliban and Al-Qaeda targets in Afghanistan on 7 October. Aircraft participating in these initial attacks included about 15 land-based bombers and around 25 carrier-based strike aircraft.
October 24, 2001

Predators launch Hellfire ATGMs over Afghanistan

Lockheed Martin AGM-114 Hellfire anti-tank guided missiles (ATGMs) are being fired from General Atomics RQ-1A Predator unmanned air vehicles (UAVs) during...
November 26, 2001

BRIEFS - Simulations and support funded

Computer Sciences Corporation has been awarded a task order from the US Army Aviation and Missile Command (AMCOM) to support simulation...
November 26, 2001

BRIEFS - Space and Missile Systems Center joins AFSPC

November 26, 2001

BRIEFS - Tyndall drone operations funded

November 26, 2001

Anti-Taliban air offensive dominated by missiles and PGMs

The allied air offensive against the Taliban-occupied areas of Afghanistan, starting on 8 October 2001, has featured a more intensive use of guided weapons than even the 1999 operations against the former Yugoslavia, writes David C Isby. While fewer than 2,000 munitions were delivered in the first five days of the campaign - much less than either the 1991 offensive against Iraq or in 1999 - since then there has been a steady use of precision guided munitions (PGMs) and missiles. Around 8,000 munitions were delivered in the first month of the air campaign.
November 26, 2001

US speeds up weapon development, production and conversion programmes

The US Air Force (USAF) may accelerate its current procurement plans for the Boeing CALCM (conventional air-launched cruise missile) and Lockheed Martin JASSMs (joint air-surface standoff missile) to meet urgent operational requirements, writes David C Isby. With more funding now available as a result of the 11 September attacks on the USA, the USAF is also re-thinking its policy on the ERCM (extended-range cruise missile) programme, which it had wanted to end (see Jane's Missiles & Rockets, October 2001, p13).
October 24, 2001

Cruise missiles and 'smart' bombs used in Afghanistan

Approximately 50 Tomahawk missiles launched from platforms including US Navy surface ships and the UK Royal Navy (RN) submarines were used in the first phase of attacks against Taliban and Al-Qaeda targets in Afghanistan on 7 October. Aircraft participating in these initial attacks included about 15 land-based bombers and around 25 carrier-based strike aircraft.
October 24, 2001

DARPA tests a Mach 7 scramjet

The US Defense Advanced Research Projects Agency (DARPA) has carried out the first successful free flights of a hypersonic projectile powered...
September 19, 2001

Rafael moves into profit

Rafael has completed around 10 years of painful downsizing, says the organisation's president Giora Shalgi. In the late 1980s, Rafael had around 7,600 employees but only half of today's sales. Today it is almost half that size, with around 4,500 employees.
June 15, 2001

US Marines unlikely to have been exposed to chemical agents, says DoD

The US Department of Defense (DoD) has concluded that none of the 17 possible chemical warfare incidents involving the 11th Marines Artillery Regiment during the Gulf War can be verified. In 13 incidents, there was substantial information that allowed investigators to determine the presence of chemical warfare agent (CWA) as "unlikely", while two incidents were assessed as "definitely not" involving the presence of chemical warfare agent. Since very little detail was available about the remaining two incidents, investigators assessed the possibility of chemical warfare agent presence as "indeterminate".
June 15, 2001

BRIEFS - New management system for second Lockheed Martin site

TASC is to provide Product Life-Cycle Management (PLM) to Lockheed Martin Missiles and Fire Control, Orlando, Florida

under a two-year, US$7.2 million systems integration contract, one of the largest PLM contracts awarded to date in the aerospace industry. Collaborative product life-cycle management (c-PLM) is a process that digitises data and automates the procedures required to design and manufacture a product.
June 15, 2001

BRIEFS - Thiokol deal completed

The sale of Alcoa's Thiokol Propulsion business to ATK (Alliant Techsystems) has been completed. Agreement on the sale was announced in January. ATK purchased Thiokol Propulsion for US$685 million in cash.

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June 15, 2001

Israel's 'triad' could deter TBM attacks

Faced with the potential threat posed by tactical ballistic missiles (TBMs) in service with many neighbouring countries, and the continued development of even longer-ranged missiles by Iran, Israel has developed a three-stage approach to countering these, writes Doug Richardson. This combines active defensive measures such as the Arrow and Patriot missile systems; passive measures such as the provision of warning to the population to allow them to use gas masks, sealed rooms or shelters; and a 'triad' deterrent force consisting of manned strike aircraft, land-based ballistic missiles and submarine-launched cruise missiles.
May 29, 2001

New missiles for Israel Defence Forces

"Most of MBT's activity is classified", a briefer told an audience of defence journalists who visited this division of Israel Aircraft Industries last month. Much the same can be said for most of Israel's missile-development activities. It is rare for projects to be declassified until they have been in service for some time, and weapons which do not live up to expectations or which are not adopted for service are seldom declassified.
May 29, 2001

MBDA is ready for launch

BAe Systems, EADS and Finmeccanica have signed an agreement for the creation of MBDA, a company which will merge the missile and missile systems activities of Matra BAe Dynamics, Aerospatiale Matra Missiles and Alenia Marconi Systems. MBDA will become operational once the required regulatory approval has been obtained.
May 29, 2001

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SURFACE-TO-AIR

Date Posted: May 21, 2002

JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

Igla-S can engage cruise missiles and UAVs

Doug Richardson

KB Mashinostroeniya (KBM) has developed a new Igla-S extended-range version of the Igla (SA-18 'Grouse') shoulder-fired surface-to-air missile (SAM), writes Doug Richardson. KBM says the new variant is "highly- effective against small-sized targets like cruise missiles and UAVs [unmanned aerial vehicles]", and offers the "effectiveness of two missiles in a single round".

Unlike earlier versions of the Igla series - Igla (SA-18 'Grouse') and Igla-1 (SA-14 'Gimlet') - and the earlier Strela family (SA-7 'Grail' and SA-14 'Gremlin'), the new Igla-S has a warhead that can be initiated by a proximity fuze. The earlier missiles used an impact fuze, as did variants and derivatives developed by other nations such as the Chinese QW-1, Egyptian Saqr Eye and Pakistani Anza Mk I and II.

The first Igla variant known to have a proximity fuze was the Romanian Arsenalul Armatei Regie Autonoma CA94M (see JMR,

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September 1998, p1). It is not known whether the Igla-S and CA94M were parallel projects, collaborative projects, or if the Russian missile was developed once the Romanian weapon had demonstrated the feasibility of fitting a proximity fuze within the Igla fuselage.

According to KBM, Igla-S has a "considerable increase in warhead lethality against all target types", and uses "new scientific and technical solutions" to provide a substantial increase in kill probability. Compared with unspecified "existing counterparts", the new missile has twice the effectiveness when fired against jet fighters, three times the effectiveness against helicopters, and five times the effectiveness against cruise missiles. Reliability is higher than that of earlier Igla variants, and service life is longer.

The current Igla has a maximum range of 4,500m against an approaching target, and 5,200m against a receding target. The equivalent minimum firing ranges are 500m and 800m respectively. Igla-S has a maximum range of 6,000m against a receding target.

Maximum target speed for Igla-S is 400m/sec against an approaching target, the corresponding figure for the basic version being 360-400m/sec, depending on target type. Maximum engagement height is 3,500m against an unspecified target type. The basic Igla can manage 3,500m against a receding piston-engined aircraft or helicopter, 2,500m against a receding jet target, and 2,000m against a head-on jet target. Minimum engagement height of the Igla-S is 10m, unchanged from that of the earlier version. Total weight ready-for-action is not more than 19kg, slightly heavier than the 18kg of a basic Igla.

It is not clear from the above figures whether the Igla-S has an improved rocket motor, but the essentially unchanged figures for target speed and engagement height suggest that the additional range may be the result of improvements to the missile guidance system.

The nose-mounted seeker retains the aerodynamic spike fitted to the basic Igla missile. This reduces wave drag and kinetic heating of the sensor dome. The operating band of the LOMO 9E410 cooled dual-channel seeker used in the earlier missile is thought to be in the 3.0µm to 5.0µm infrared waveband regions. KBM has given no technical information on the seeker of the Igla-S, but says it has a "high resistance to background clutter and thermal countermeasures".

The control section, located immediately behind the seeker, not only contains the canard control surfaces and their associated deployment mechanism and actuators, but has been redesigned to incorporate an electro-optical proximity fuze. The latter has five pairs of optical ports distributed around the circumference of the weapon, and is probably an active laser-based system.

The warhead is probably unchanged from that of the standard Igla, which carries a fragmentation warhead with 0.405kg of explosive, whose effectiveness is increased by an explosion generator which detonates any remaining solid propellant (typically 0.6-1.3kg).

Like the basic Igla and the earlier Igla-1 (SA-16 'Gimlet'), Igla-S can be shoulder-fired by a single operator, from the Djighet twin-round pedestal mount or from the Strelets twin-round remote-controlled launch module.

This Russian test firing resulted in a successful interception. (Source: KBM)

The extended-range Igla-S missile, seen alongside its man-portable launcher. (Source: Rob Hewson)

The windows for the proximity fuze are located just aft of the control section. (Source: Rob Hewson)

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AIR-TO-AIR

Date Posted: May 21, 2002

JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

Eurofighter scores its first AMRAAM 'kill'

Eurofighter has carried out its first fully-guided firing of a Raytheon AIM-120 Advanced Medium-Range Air-to-Air Missile (AMRAAM) on 9 April. The firing was undertaken at the UK Ministry of Defence's (MoD's) Benbecula range off the coast of Scotland, and is the first in a series of guided tests that will be conducted to fully certify the missile for operational deployment on Eurofighter.

The AMRAAM was fired from Eurofighter DA4 in a nose-aspect, lookdown launch against an unmanned Mirach target drone. Although configured to carry a telemetry package in place of a warhead, the missile destroyed the target by scoring a direct hit. More detailed weapons system performance data will be available after telemetry data analysis. "The radar acquired the target at a very long range and continued to track it all the way through until after the missile actually destroyed the target," says BAE Systems test pilot Craig Penrice.

In 2000, AMRAAM was selected by the UK MoD to serve as the primary air-defence weapon for Eurofighter when the aircraft comes into service in 2004. Four AIM-120C-5 missiles can be accommodated

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in special recesses under the aircraft's fuselage and others on wing pylons. In the longer term, they will be supplanted by MBDA Meteor air-breathing missiles.

· Raytheon recently won a US$165 million contract to build 387 AMRAAM missiles for the US Navy (USN), Air Force (USAF) and foreign military customers. The contract, which is due to be completed by August 2004 also covers integrated test vehicles, AMRAAM equipment pods for the USAF, miscellaneous hardware for the USN, and spares for foreign military customers.

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AIR-TO-AIR

Date Posted: May 21, 2002

JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

IRIS-T firing trials gather speed

During the joint government/industry trials at the Salto di Quirra Test Range in Sardinia, the Bodenseewerk Gerätetechnik (BGT) IRIS-T short-range air-to-air missile has completed two more successful guided firings. The programme will involve a relatively small number of air-to-air firings, a reduction made possible by modern simulation technology, and development is due to end by December 2002.

On 24 April, a missile fired from a German Air Force F-4F test aircraft, from a near head-on position and a distance of slightly under 10km, scored a direct hit against a Meteor Mirach 100/5 target drone and destroyed it. The target and launch aircraft were flying at high subsonic speed and medium altitude. This trial demonstrated missile performance against low infrared (IR) signature targets under difficult head-on engagement conditions.

A third firing conducted at the Salto di Quirra range on 3 May was designed to demonstrate the hit capability of IRIS-T in the presence of IR flares and under difficult head-on engagement conditions. Conditions

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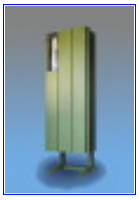
were similar to these on the 24 April firing, but on this occasion the F-4F test aircraft (from the German WTD 61 Test Centre in Manching) launched the missile from a range of slightly under 7km. The round intercepted a Mirach 100/5 drone, which was flying a maximum-g evasive manoeuvre, and dispensing flare countermeasures.

BGT has also released information on a proposed six-round IRIS-T/GL vertical launcher for the ground-based, air-defence role. The unit is modular, and can be integrated on vehicles or deployed individually as a stand-alone system. IRIS-T requires no modification for the new role. It can be supplied with target data via its MIL-STD 1760 interface, then fired in lock-on-before-launch or lock-on-after-launch mode. Ground launches of IRIS-T were performed successfully at the Salto di Quirra range in early 2000 and 2002.

Maximum intercept range against typical aircraft targets exceeds that of today's SHORAD systems, says BGT. A German Ministry of Defence-funded study, performed by the company, showed that a substantial increase in intercept range can be achieved by fitting the missile with a larger and more powerful rocket motor, plus an additional data link.

IRIS-T/GL meets all MEADS requirements for an affordable and cost-effective secondary missile able to complement Patriot PAC-3, defeating aircraft, helicopters, cruise and other tactical aerodynamic missiles flying at low and medium altitudes. BGT says that an independent assessment carried out by IABG (a consulting company to the German MoD) showed that IRIS-T/GL was superior to competing solutions in terms of technical performance and cost-effectiveness.



This mock-up shows the configuration of the proposed IRIS-T SAM system. (Source: BGT)

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AIR-TO-AIR

Date Posted: April 23, 2002

JANE'S MISSILES AND ROCKETS - MAY 01, 2002

Raytheon breeds a better AMRAAM

Doug Richardson

The next AIM-120C-5 Advanced Medium-Range Air-to-Air Missile (AMRAAM) upgrade to be fielded will be a high off-boresight (HOBS) capability, writes *Doug Richardson*. This is a software development and requires no changes to the missile. It was a jointly-funded development, with Raytheon paying for the software changes and the US Department of Defense paying for the flight- test programme.

HOBS is a modification to the autopilot functions, Raytheon director for air-to-air missile (AAM) development, William West, told the AAM conference held recently in London by SMi. It will allow the missile to fly a lock-on-after-launch trajectory in which the target is outside the gimbal limits of the seeker. This is not intended to give the weapon an improved close-range capability, but will allow the engagement of targets detected by a third party such as a second fighter. HOBS will be introduced during production Lot 14 in Fiscal Year 2002 (FY02).

Since HOBS is a software-only modification,

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it will not necessarily be provided on all missiles. Possible export approval is currently being studied.

Deliveries of the AMRAAM P3I missile will start with Lot 16 in FY04. To be known as the AIM-120C-7, this version will have a compressed guidance section, hardware for which is currently undergoing system integration testing. The existing AMRAAM data processor (a 30MHz unit with 192kbyte of memory) will be replaced by a new version which runs at the same speed but has 750kbyte of memory.

Both versions are AMRAAM-dedicated units programmed in assembly language, but the P3I missile will also have two PowerPC 755 processors running at 300MHz, each with 4Mbyte of memory (only 50% of which will be used). Based on a commercial standard, these will be programmed in the commercial C++ language and will be compatible with commercial software-development tools.

Incorporation of the compressed guidance section will free 15cm of space within the forward fuselage of the missile. This internal volume will remain unused in the C-7 missile, but could allow the use of a longer rocket motor at some stage in the future.

First captive flight of a C-7 missile is due to take place in the first quarter of 2002, and the first guided flight is expected around the end of the year. Development is due to end in the autumn of 2003, with the first production rounds being ready in the fourth quarter of 2003.

In its studies of an extended-range AMRAAM with an expanded 'no-escape' zone and better end-game kinematics, Raytheon has investigated what it terms "all reasonable candidates" for an improved propulsion section, said West. These were:

- the increased-diameter rocket motor used by the Evolved SeaSparrow Missile (ESSM);

- an improved solid-propellant rocket motor;

- an extended-length dual-pulse rocket motor;

- an extended-length gel rocket motor;

- a hybrid rocket motor;

- a variable-flow ducted rocket (VFDR); and

- a ramjet.

By eliminating proposals which would not extend the missile range by a factor of two to three, the company was able to refine this list to:

- the ESSM motor;

- an extended-length high-pressure rocket motor;

- an extended-length dual-pulse rocket motor;

- an extended-length hybrid rocket motor;

- a variable-flow ducted rocket; and

- a liquid-fuelled ramjet (LFRJ).

Raytheon refers to the extended-length motors as '+11' designs. This reflects the fact that these powerplants would use the unoccupied 15cm (6in) created within the forward fuselage of the C-7 round, whose rocket motor is 12.5cm (5in) longer than that of the original AMRAAM powerplant.

A further evaluation, which looked at factors such as cost and technological maturity, has narrowed the field still further to:

- the ESSM motor; and

- an extended-length +11 dual-pulse rocket motor.

Both would be hydroxyl-terminated polyether (HTPE) solid-propellant units; the first would be 254mm (10in) in diameter, the second 178mm (7in) in diameter to match the existing fuselage diameter.

Another potential improvement being studied for introduction, on a similar timescale as the improved propulsion system, is an enhanced datalink. Like the HOBS upgrade, this is intended to help with third-party targeting.

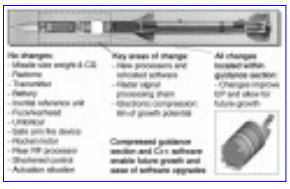
The HOBS and P3I improvements are funded, but the production lots envisaged as

having the extended-range rocket motor and enhanced datalink have not yet been funded. Raytheon envisages development of the extended-range AMRAAM running from now until FY08. A production contract in the latter year would allow deliveries to begin early in FY07 during Lot 20.

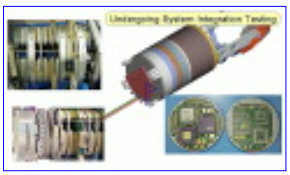
Given the existing stocks of AIM-120B missiles around the world, Raytheon is considering a possible retrofit scheme which would allow users to upgrade their missiles to the AIM-120C standard, West told the conference. Such a scheme would also allow -120B users to take advantage of the -120C-5 warhead. Australia is showing interest in upgrading its -120B missiles, and would want to tackle the modification in-country.

The -120C-5 warhead was designed for greater lethality against modern combat aircraft, which incorporate survivability features such as widely-spaced powerplants and high levels of system redundancy. Around 2% heavier than the original warhead, it generates more than five times the number of fragments. While the weight of the individual fragments is greatly reduced, their velocity is increased by 23% in the forward sector, 18% in the rear sector and 9% at intermediate angles.

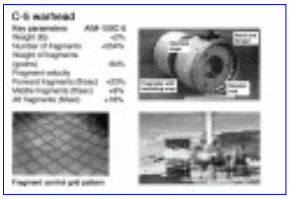
The high-off-boresight (HOBS) upgrade was a Raytheon internal research and development (IRAD) project. (Source: Raytheon)



The compressed guidance section will free 15cm of space within the forward fuselage of the missile. This internal volume could allow the use of a longer rocket motor at some stage in the future. (Source: Raytheon)



The new compressed guidance section to be used in the AIM-120C-7 will use new processors and re-hosted software. (Source: Raytheon)



The improved warhead introduced on the AIM-120C-5 missile generates five times the number of fragments as the original design. (Source: Raytheon)

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SURFACE-TO-AIR

Date Posted: May 21, 2002

JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

BRIEFS - South Korea orders continuous-wave illuminators

Raytheon Electronic Systems' Naval and Maritime Integrated Systems (N&MIS) operation is being awarded a US$23.35 million modification to existing contract N00024-99-C-5387 to cover six OT-134A continuous-wave (CW) illuminators, associated spares, technical documentation, training and engineering services in support of the Missile Fire Control Mechanism programme for the Republic of Korea Navy under the Foreign Military Sales programme. This work will take place in Sudbury, Massachusetts (48%); Waterloo, Ontario, Canada (42%); Chula Vista, California (9%) and Andover, Massachusetts (1%), and is to be completed by June 2005.

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SURFACE-TO-AIR

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

BRIEFS - Follow-on Rolling Airframe Missile deals

Raytheon is being awarded a US$35.79 million contract for the production of 90 Launching Canisters; 60 Block 1 Mk 44 Mod 2 Rolling Airframe Missile (RAM) Guided Missile Round Packs (GMRPs); 30 Mk 47 Mod 6 RAM GMRPs; 90 Mk-20 Mod 2 Active Optical Target Detectors (AOTDs); and 90 AOTD spares in support of the RAM programme for the US government. Also, three Blast Test Vehicles are being procured for the German National Government as a member of the RAM Consortium, and three Blast Test Vehicles are being procured for Korea under the Foreign Military Sales programme.

Under a US$39.76 million modification to previously-awarded contract N00024-00-C-5482, the company is also to manufacture, test and deliver 10 Mk 49 Mod 3 Guided Missile Launching Systems (GMLS) for the RAM. These are to meet German national requirements. The hardware under both contracts will be manufactured in Tucson, Arizona (50%) and Ottobrunn, Germany (50%), and is to be delivered by September 2004 and November 2006 respectively.

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

Raytheon delivers first DPELS launcher

Denmark has taken delivery of the first of 10 Dual-Pack Evolved SeaSparrow Missile Launching Systems (DPELS). It will be installed on the first of two Standard Flexible (StanFlex) frigates being built for the Royal Danish Navy.

Developed by a Raytheon-led industry team, the DPELS launcher is the first shipboard unmanned system capable of launching the new Evolved SeaSparrow Missile (ESSM) from vertically-mounted canisters. The hardware delivered to Denmark by Raytheon Naval & Maritime Integrated Systems (N&MIS) consists of a complete system including the evolved launch controller, missile canisters, exhaust systems, and the full framework and required cabling for integration into the StanFlex.

The launcher has 12 independent, re-usable, extremely lightweight and durable composite missile canisters, but the design is flexible enough to be reconfigured to accommodate any canister quantity required by other ship platforms. It is being considered by the US Navy for installation on all aircraft carriers and Wasp-class amphibious assault ships.

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

Agent-Defeat ACTD to develop warheads

David C Isby

As part of the Agent-Defeat advanced concept technology demonstration (ACTD) programme, the US Naval Surface Warfare Center (NSWC), Indian Head, Maryland, and Lockheed Martin will team up to develop new agent-defeat warheads for US guided bombs. These will be able to destroy chemical or biological weapons in hardened shelters without collateral damage or unintentional release of the target agent, writes David C Isby.

The ACTD will produce two new agent-defeat warheads, one for the BLU-109 2,000 lb penetrator used with the Boeing joint direct attack munition (JDAM) GPS/inertial navigation system guided bomb, and one for the BLU-116 2,000 lb penetrator used with the Raytheon Paveway III laser guidance system. These warheads will use the external casings of the penetrators to break open storage facilities. The warheads will contain explosively-formed copper plate penetrators that will be ejected from the warhead after penetration, and are intended to puncture any storage containers.

The warheads will then detonate, igniting an incendiary fill that will produce an extremely

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intense heat source with low overpressure (to prevent the release of the agent), and will also produce a disinfectant chlorine gas to sterilise the area as it burns.

Both warheads will be developed over 30 months by the NSWC in a co-operative programme with the US Air Force Air Armament Center at Eglin Air Force Base, Florida; the Office of Naval Research (ONR) and the Defense Threat Reduction Agency (DTRA). The NSWC has been the designer of thermobaric warheads for the BLU-118/B penetrator and the AGM-114 Hellfire anti-tank guided missile, and will apply this background to the agent-defeat warheads.

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

BRIEFS - Fuze extenders ordered

Alliant Tech Systems is being awarded a US$10 million contract for procurement of 18,959 FZU-48 and 61 fuze-extender kits for use on the Joint Direct Attack Munition (JDAM) and laser guided bombs. These will be manufactured in Janesville, Wisconsin, and are due to be delivered by May 2003.

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

BRIEFS - SAT to develop supersonic missile powerplant

Science and Applied Technologies, San Diego, is to develop and deliver a forebody vehicle section which demonstrates a new integral nozzleless rocket, variable flow ducted rocket ramjet propulsion and steering control subsystem in support of the US government's High Speed Anti-Radiation Demonstration (HSAD) project. This work will be performed in Woodland Hills, California, and is to be completed in September 2005. It is funded by a US$10 million contract funds from the US Naval Air Systems Command, Naval Air Warfare Center Weapons Division, China Lake, California.

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Date Posted: May 21, 2002

JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

ATK to develop guided 105mm anti-tank round

Initial development of the US Army's new precision-guided 105mm Mid-Range Munition (MRM) is to begin under a US$5 million contract awarded to ATK (Alliant Techsystems) by the US Army Armament Research, Development and Engineering Center (ARDEC), Picatinny Arsenal, New Jersey. This covers the first phase of a 15-month programme that will conclude with firing demonstrations.

The MRM projectile is designed to defeat main battle tanks equipped with explosive reactive armour (ERA) and active protection systems. It will incorporate technologies developed for the Tank Extended Range Munition-Kinetic Energy (TERM-KE), a gun-launched, precision-guided munition that is compatible with 105mm and 120mm gun systems. It is one of the first in a series of precision munitions being developed for the US Army's Future Combat System (FCS).

During the next 15 months, development efforts will be focused on technology demonstrations of the munition's seeker/ guidance and control system, rocket motor propulsion, airframe system, lethal

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mechanism and gun propulsion system.

ATK Ammunition Systems, Arden Hills, Minnesota, will manage the MRM programme, with the support of ATK Tactical Systems, Rocket Center, West Virginia and Clearwater, Florida, and ATK Integrated Defense, Plymouth, Minnesota. All three companies are operating units within ATK's recently-formed Precision Systems Group.

ATK Ammunition Systems is also part of an industry team headed by Lockheed Martin Missiles and Fire Control that has been selected to develop a smart ammunition suite for the US Army's Multi-Role Armament and Ammunition System (MRAAS), which is a candidate armament system for Block 2 of the FCS.

The company will develop the MRAAS precision-guided, kinetic energy projectile (MRAAS-KE) and support Lockheed Martin in the development of two other complementary rounds that comprise its MRAAS munitions suite. MRAAS-KE will be a derivative of the TERM.

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ANTI-TANK

Date Posted: May 21, 2002

JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

China unveils improved Red Arrow systems

Christopher F Foss

NORINCO (China North Industries Corporation) has revealed additional versions of its well-established Red Arrow 8 and 9 anti-tank guided missile (ATGM) systems, writes Christopher F Foss. These new developments are the Red Arrow 8F missile and Red Arrow 8L lightweight launcher, and the Red Arrow 9 in a new vehicle-based application called the Red Arrow 9A. These provide enhanced capabilities, and could appeal to a wider range of export customers than current variants.

Red Arrow 8F is the latest member of the of the Red Arrow family of missiles. According to NORINCO, it is a second-generation missile that can be launched from all current launchers including the standard infantry tripod model, armoured fighting vehicle (AFV - tracked and wheeled) and helicopter versions.

Previous versions of the Red Arrow 8 anti-tank guided weapon (ATGW) were

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optimised for use against AFVs. Red Arrow 8A had a maximum range of 3,000m and was fitted with a single HEAT (high-explosive, anti-tank) warhead. This was followed by the improved Red Arrow 8C with a similar range but fitted with a nose-mounted precursor HEAT charge with a larger follow-on HEAT charge to defeat targets with explosive reactive armour (ERA). The first nose-mounted HEAT warhead activates the ERA, clearing the way for the main and larger HEAT charge to penetrate the main armour of the vehicle and cause considerable damage.

The next version was the Red Arrow 8E, which was revealed in 1998, and has a tandem HEAT warhead and an increased range to 4,000m. The Red Arrow 8 is also manufactured in Pakistan as the 'Baktar Shikan'.

HEAT-type warheads are optimised for use against AFVs, and are less effective against other types of battlefield targets such as field fortifications, buildings and bunkers, which are now becoming increasing common targets in many conflicts. For many armies, this type of target will be more common than tanks in potential future conflicts.

The new Red Arrow 8F missile has two warheads, HEAT and HE (high-explosive). The first nose-mounted HEAT charge will penetrate 80mm of conventional steel armour at an angle of 0º. This clears the way for the main HE charge to penetrate the vehicle or structure and cause the maximum amount of damage inside the target.

The standard infantry version of the Red Arrow 8 is launched from a tripod-based fire unit - very similar to that used with the US Raytheon Systems TOW (tube-launched, optically-tracked, wire-guided missile). It incorporates a day sight, but an infrared thermal sight can be rapidly fitted to enable targets to be engaged at night or under poor weather conditions. Missile guidance is semi-automatic command to line-of-sight (SACLOS) and all the operator has to do is to keep his sight on the target until missile impact.

The existing Red Arrow launcher and guidance system are very heavy and are not easy to deploy in the field. NORINCO has now developed a new Red Arrow 8L lightweight launcher, which is compatible with all current versions of the Red Arrow 8 ATGW including the 8A, 8C, 8E and the latest 8F.

The Red Arrow 8L launcher weighs only 22.5kg and, according to NORINCO, can be carried by an infantryman. The guidance package is also much more compact and lighter, with an improved anti-jamming capability.

In the baseline Red Arrow 8 system, the operator is positioned on the left side of the launcher parallel to the missile, but with the new Red Arrow 8L launcher the operator is in the prone position just above the tripod legs. This makes the system easier to deploy and conceal, as well as increasing the survivability of the missile operator.

For several years the People's Liberation Army (PLA) has fielded the NORINCO Type 92B (4x4) tank destroyer based on a modified WZ 551 armoured personnel carrier chassis with a roof-mounted retractable launcher, and carrying four Red Arrow 9 ATGWs in the ready-to-launch position. Additional missiles were stored inside the hull, and the launcher could be reloaded under full armour protection.

Red Arrow 9 has a SACLOS guidance system, with the missile having a minimum range of 100m and a maximum range of 5,000m. The tandem HEAT warhead will penetrate 320mm of steel armour at an incidence of 68º protected by ERA.

NORINCO says there are at least two versions of the Red Arrow 9 missile, the 9A with a millimetre-wave command guidance and the 9B laser beam-riding version.

NORINCO has now developed a much lighter version of the system called Red Arrow 9A, which can be installed on a variety of light tracked and wheeled vehicles, armoured and unarmoured. When mounted on a light vehicle, such as the widely

deployed US AM General HMMWV (4x4), the complete system (platform, launcher and missiles) weighs 2,800kg. The launcher is said to weigh 150kg, and six ready-to-fire missiles are carried, three stowed on either side of the vehicle.

The launcher can be traversed through 360º, and from -10º to +10º in elevation. It has a two-man crew and a firing rate of two missiles per minute. Maximum range is quoted as 5,500m with a 90% hit probability.

The latest NORINCO Red Arrow 8L lightweight launcher, that can be used with all versions of the Red Arrow 8 ATGW. (Source: Christopher F Foss)

Close up of the latest NORINCO Red Arrow 8L lightweight launcher with missile and associated launcher tube removed. (Source: Christopher F Foss)

The latest NORINCO Red Arrow 8F ATGW with wings unfolded and HEAT nose probe extended. (Source: NORINCO)

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ANTI-TANK

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

Thermobaric warhead for Hellfire successfully tested

David C Isby

The thermobaric warhead being developed by the US Naval Surface Warfare Center, Indian Head, Maryland, for the Lockheed Martin AGM-114 Hellfire anti-tank guided missile has had its first successful static test on 2 April at the Army Test Facility at Blossom Point, Maryland, writes David C Isby.

The new warhead is being developed as part of a one-year advance technology demonstration (ATD) programme. While the US Marine Corps will not decide whether to procure the warhead until near the end of the ATD late in 2002, it has already identified the AH-1W attack helicopter as the platform with which the upgraded Hellfire will be integrated.

Recent combat operations in Afghanistan have increased US interest in thermobaric warheads. The Marines initiated the ATD because of the potential usefulness of the thermobaric Hellfire in urban warfare situations, where it could destroy reinforced building positions while minimising collateral damage. However, the anti-cave

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potential of the weapon in campaigns similar to that fought in Afghanistan have shown that it is likely to have broader applications.

Afghanistan combat lessons have also led the US Army to accelerate the retrofit of late-production Hellfire motors to avoid damage to helicopters when they are fired (see JMR, July 2001, p14). The Army had signed a US$17 million contract with Lockheed Martin for the retrofit of some 10,000 Longbow and laser-guided Hellfires, but had planned to delay funding the programme until Fiscal Year 2003. It now plans to start the programme early using US$5 million of emergency appropriations for stockpile replenishment following Afghanistan operations.

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

BRIEFS - Trident II technology-sustainment contract signed

Under a US$9 million contract from the US Navy's Strategic Systems Programs, Lockheed Martin Space Systems is to provide research and development (R&D) investigations for technology sustainment of the Trident II (D5) missile system. The company will use research findings from the previous years' Technology Sustainment Support Services (TSSS) efforts to develop a radiation hardening systems-design software programme, and provide continued R&D investigations of missile structure dynamic response to rocket-motor ignition events, as well as investigations of alternative missile drag-reduction devices. Most of this work will be done in Sunnyvale, California, but 6% will be tackled in Salt Lake City, Utah. A separate US$8.74 million contract covers long-lead material (LLM) required for the Fiscal Year 2003 (FY03) follow-on production of the Trident II (D5).

The company is also being awarded a US$12.03 million contract by the US Navy's Strategic Systems Programs for support of the UK FY03 Trident II (D5) programme. This work will be performed in Sunnyvale, California, and is expected to be completed by March 2003.

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

Last Titan arrives at Cape Canaveral

The first and second stages of the last Titan IV-B to be launched from Cape Canaveral have been delivered to the site by a C-5 Galaxy aircraft. After being unloaded, the stages were placed on large trailer trucks and transported to a facility where the rocket will be assembled. Preparations for the launch will take about six months, and the vehicle will be used to orbit a DSP (Defense Support Program) satellite some time in 2003. The launch will end Cape Canaveral's four decades of involvement in the Titan programme.

Titan IV-B is a satellite-launch vehicle based on the LGM-25C Titan 2 intercontinental ballistic missile (ICBM), a heavy liquid-propellant weapon which entered service in 1963 and was finally phased out in 1987. Like the earlier MGM-25A Titan 1 ICBM, which used cryogenic rather than storable liquid propellants, Titan 2 was flight-tested from Cape Canaveral Air Force Station.

The first Titan 1 was launched from Complex 15 on 6 February 1959, and the last from Complex 19 on 29 January 1962. Titan 1 entered service in 1961 and was retired in 1965. The first Titan II was launched from

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Complex 16 on 16 March 1962, and the final research and development launch was on 9 April 1964.

All Titans launched since then have been satellite-launch vehicles, although GT-2 - launched as part of NASA's two-man Gemini programme - had been built as an ICBM before being diverted to NASA. The more powerful Titan III and IV series were developed as satellite-launch vehicles for the US Air Force, but were used for some NASA missions such as the Viking and Voyager launches to Mars and the outer planets.

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STRATEGIC & SUB-STRATEGIC

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JANE'S MISSILES AND ROCKETS - MAY 01, 2002

Trident II makes 95th successful flight

The US Navy (USN) has carried out the 95th consecutive successful launch of a Lockheed Martin Trident II (D5) fleet ballistic missile. Launched from the Ohio-class submarine Alaska (SSBN 732) at the Eastern Range off the eastern Florida coast, the test was the final activity of a Demonstration and Shakedown Operation (DASO) exercise conducted by the vessel's 'blue crew'. DASO exercises are carried out to collect system performance data in an operational environment and to evaluate the readiness of the weapon system, crew and submarine for operational patrol.

The 95th firing was the first of four launches scheduled over the next few years as part of the USN programme to convert four Ohio-class submarines currently homeported at the Navy strategic submarine base in Bangor, Washington, to the Trident II missile. Alaska, Nevada (SSBN-733), Henry M Jackson (SSBN-730) and Alabama (SSBN-731) were commissioned in the mid-1980s, and were armed with the older Trident I (C4) missile.

Alaska entered Puget Sound Naval Shipyard in April 2000 to begin her conversion to D5 capability. Following the DASO launch, the vessel will return to the shipyard for a

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three-month Post-Shakedown Availability (PSA) period to correct problems and deficiencies discovered during the DASO. Early this summer it is expected to re-deploy in the Pacific Ocean.

Recently, the USN awarded Lockheed Martin the first of several contracts to extend the service life of the Trident II missile system from 30 to 44 years to match the extended life of the Ohio-class submarines. The D5 service-life extension programme will extend missile production through 2013, and is expected to make the system operationally viable until 2042.

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JANE'S MISSILES AND ROCKETS - MAY 01, 2002

USAF deploys first modernised Minuteman missiles

The US Air Force (USAF) has revealed that the first 10 Minuteman III missiles equipped with remanufactured solid-propellant rocket motors were placed on alert status at Malmstrom Air Force Base, Montana, on 30 January. This Initial Operational Capability was achieved six months ahead of schedule.

"This is an outstanding achievement for the Air Force and the ICBM [intercontinental ballistic missile] Prime Contractor team," says John Clay, TRW ICBM programme manager in Clearfield, Utah. "This key operational milestone was achieved six months ahead of the date set by the Air Force six years ago when the Acquisition Program Baseline schedule was approved."

The Minuteman III Propulsion Replacement Program (PRP) is designed to replace ageing rocket motors in the Minuteman III force with new remanufactured motors, allowing the missiles to remain in service until 2020.

The PRP is managed by TRW, as part of its US$5.4 billion ICBM Prime Integration contract. Under contract to TRW, ATK Thiokol Propulsion, and Pratt & Whitney Space and Missile Propulsion formed a joint-venture propulsion team to produce the

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motors. Alliant and Pratt & Whitney are remanufacturing the motors, replacing the propellant and obsolete or environmentally unsafe materials and components.

TRW is operating under a full-rate production contract valued at US$215 million to deliver the remanufactured Minuteman III first-, second- and third-stage rocket motors and ordnance items. The missiles are being reassembled by the USAF.

The rounds declared operational in January were fitted with the first of 607 PRP boosters that will be delivered over the next six years. The full-rate production contract for the PRP has a potential value of US$1.4 billion through September 2008.

l Currently, the average age of Minuteman IIIs is 26 years, so further life extension may be difficult, writes David C Isby. If the force is to be replaced around 2020, development of a follow-on ICBM will have to begin no later than 2010. This, in turn, means that an Analysis of Alternative (AoA) study on a projected Minuteman III replacement (designated 'Minuteman IV') is likely to be included in the Fiscal Year 2004 budget request that will be sent to the US Congress next February. The AoA study will be conducted in 2004-05.

The Air Force has prepared a mission-needs statement (MNS) for a follow-on ICBM. Development and deployment of the projected Minuteman IV is expected to take 15 years - five years to study and develop the system, and 10 years to deliver the operational hardware. The USAF has been looking at Minuteman IV alternatives for some years, and the planned AoA will be the most comprehensive study yet carried out.

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JANE'S MISSILES AND ROCKETS - MAY 01, 2002

Agni II enters production

David C Isby

India's 2,000km-range Agni II ballistic missile "has entered the production phase" and is "under induction" into service, writes *David C Isby*. The news was announced by Indian defence minister George Fernandes, and followed statements by his scientific advisor, Dr V K Aatre, that the weapon had been inducted into military service.

Meanwhile, press reports citing US intelligence sources state that India's January test of a reduced-range Agni missile - reported at the time to have been successful - resulted in a major sub-system failure. The single-stage missile, believed to be designated Agni III, flew its full 700km-range trajectory, but the re-entry vehicle (RV) failed to separate.

Dr Aatre has announced that another Agni III test will take place in April or May. However, the US, in an effort to prevent a spiral of retaliatory missile tests by India and Pakistan, has been asking both countries to refrain from such tests in the near future.

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STRATEGIC & SUB-STRATEGIC

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JANE'S MISSILES AND ROCKETS - MAY 01, 2002

BRIEFS - Trident support contracts

The US Navy's (USN's) Strategic Systems Programs has awarded Northrop Grumman Marine Systems a US$52,48 million modification to existing contract N00030-01-C-0013 to exercise option items 0022-0025, 0032 and 0039 for Trident II (D5) tactical backfit hardware for the upgrading of the Henry M Jackson (SSBN-730), production support, and US and UK Trident II (D5) launcher subsystem deployed systems support. This work will be carried out in Sunnyvale, California, and is to be completed by June 2005.

The USN has also decided to exercise an option under existing contract N00030-00-C-0003 for Trident II (D5) launcher closure and gas generator production. The company is being awarded US$9.27 million to fund this work, which is due to be completed by July 2003.

General Dynamics Advanced Information Systems has been awarded a US$9.1 million contract for the Launcher Subsystem Control Group (LSCG) Phase I programme, a continuation of the upgrade to existing launch control systems on the Trident fleet ballistic missile submarines. The work involves hardware and software critical

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design; LSCG hardware qualification; LSCG Systems requirements testing and independent verification and validation; and delivery of fleet documentation for the system.

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JANE'S MISSILES AND ROCKETS - MAY 01, 2002

BRIEFS - Integrated circuits for Minuteman guidance

TRW Systems and Information Technology Group, is being awarded a US$47.16 million contract modification to provide various quantities of application-specific integrated circuits in support of the Guidance Replacement programme for the Minuteman III ICBM. The components will be manufactured at the Honeywell Solid State Electronics Center, Plymouth, Minnesota (68%) and other locations, and deliveries are to be completed by September 2004.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

Pakistan ready to test Shaheen II

David C Isby

Reports in the Pakistani press say that the nation is ready to test its Shaheen II two-stage, extended-range ballistic missile, writes *David C Isby*. The reports are part of the continuing tension with India, with both sides staging - or refraining from - missile tests, both to signal to the other and to appease domestic audiences.

India's tests of an Agni I on 25 January, and two Prithvi missiles on 31 January, have led to calls for a Pakistani missile test in response, but it is uncertain whether the Shaheen II will be tested in the near future. There have been reports of the imminent testing of the Shaheen II since 1998-99. Pakistan has been asked by the US (and others) to refrain from flight tests in order to reduce tensions and prevent continued cycles of retaliatory testing.

Pakistani press reports claim that the Shaheen II (also known as the Hatf-6 or Ghaznavi) has a range of over 2,000km (Pakistani sources have reported up to 3,600km), a 1 ton payload and uses solid propellant. According to Western press reports, it is based on the Chinese M-18

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solid-propellant tactical ballistic missile.

Two examples of what were identified as Shaheen II missiles were paraded in Islamabad on 23 March 2000, one carried on a 12-wheel transporter-erector-launcher (TEL) vehicle, the other on a transporter. These vehicles use a common MAZ (Minsk Auto Zavod - Belarus) chassis significantly larger than the eight-wheel launcher used by the Shaheen I.

Until now, the longest-range Pakistani missile has been the Ghauri, believed to have been developed from North Korea's No Dong, which has a 1,100-1,300km range. The Shaheen I, another solid-propellant missile reported to use Chinese technology, has a 700km range.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

Minuteman III to get Peacekeeper RVs

David C Isby

The Lockheed Martin Mk21 re-entry vehicle (RV) with the W87 nuclear warhead, used by the MX MGM-118 Peacekeeper intercontinental ballistic missile (ICBM), will be retrofitted to LGM-30G Minuteman III ICBMs under the Safety Enhanced Re-entry Vehicle (SERV) programme, writes *David C Isby*. The upgrade will start this year as the Peacekeeper is withdrawn from service.

The scheme to retrofit the Minuteman III with the newer RV had been planned for a number of years, but the schedule was finally decided as a result of a nuclear posture review held in 2001-02 by the Bush administration.

Peacekeeper will start to leave service this year. As the missiles are withdrawn, the current multiple Mk21 RVs will be removed and integrated with Minuteman III missiles. On the Peacekeeper, the Mk21 formed part of a multiple independently-targetable RV payload, but the upgraded Minuteman III will carry a single warhead. The SERV will re-arm 350 Minuteman IIIs with single Mk21 RVs. The remaining 150 Minuteman IIIs to be retained in service will be armed

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with single Mk12A RVs with W78 warheads.

The SERV modifications will include hardware and software changes to accommodate the Mk 21 on the Minuteman III, including modifications to the RV, the missile and support equipment.

As part of the SERV programme, the W87 warhead will be refurbished and will undergo further extreme environmental testing, including transportation and handling shocks, temperature changes, and simulated missile launch and flight conditions. This refurbishment programme has been under way at Pantex's Amarillo plant, Texas, since 1999. It will allow the W87 to remain in service until beyond 2025.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

BRIEFS - TRW wins ICBM support contracts

TRW Intercontinental Ballistic Missile (ICBM) Systems is being awarded a contract modification worth an estimated US$169.7 million to provide for ICBM safety enhanced re-entry system design and demonstration. Due to be conducted by Lockheed Martin Mission Systems, Colorado Springs, Colorado (41%), TRW Space and Missile Systems, Clearfield, Utah (38%), and Boeing Space and Communications Group, Anaheim, California (21%), this work is to be completed by September 2006.

Under a separate US$32.48 million contract modification, TRW ICBM Systems, is being paid for an increase in costs of the Propulsion System Rocket Engine Life Extension Program. This increase is due to adequate government-furnished facilities not being available, extension of the development phase of the programme and delay of the production phase due to funding shortfalls.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

CIA sees weaknesses in Russian nuclear security

An unauthorised launch or accidental use of a Russian nuclear weapon is "highly unlikely" as long as current safeguards remain in place, says a report by the US Director of Central Intelligence (DCI). However, any breakdown of central political authority "would raise our concerns about possible circumvention of the system".

The document is the third of an annual series of unclassified reports to the US Congress documenting the safety and security of the nuclear facilities and military forces in Russia.

The nuclear command-and-control system used by Russia is essentially that built by the former Soviet Union, whose military and political leaders built a highly centralised system with technical and procedural safeguards intended to guard against the possibility of an unauthorised launch. The security system uses a multilayered approach that includes physical, procedural and technical measures. Designed in the Soviet era to protect weapons primarily against a threat from outside the country, it "may not be sufficient to meet today's challenge of a knowledgeable insider collaborating with a

criminal or terrorist group", the report warns.

Since the September 2001 terrorist attacks in the US, President Putin and General-Colonel Igor Valynkin, chief of the 12th Main Directorate of the Ministry of Defence (12th GUMO) - the organisation responsible for warhead storage, maintenance and logistics - have conducted a public campaign to provide assurances that terrorists have not acquired Russian nuclear weapons. On 25 October, Valynkin announced that security at Russian nuclear weapons storage sites had been stepped up since the attacks on the US.

Although Gen Col Valynkin had reported in August 2000 that there had been no incidents of attempted theft, seizure or unauthorised actions involving nuclear weapons, earlier in the year the Russian authorities had twice thwarted terrorist efforts to reconnoitre nuclear weapons storage sites. As a result of these incidents, security had been improved before the 11 September attacks, said Valynkin, and none of the terrorists had entered nuclear weapons sites.

There have been reports in recent years that a number of Russian nuclear weapons have gone missing, including several man-portable nuclear devices, but at a press conference on 27 October 2001, Valynkin described such claims as "barking mad".

"Over the last six years, Moscow has recognised the need for security improvements and, with US assistance, has taken steps to reduce the risk of theft," says the DCI report. "We judge that nuclear security would improve over time if Russia routinely implemented security upgrades and procedures under US-funded threat reduction programmes."

US-funded security upgrade programmes include:

- perimeter security upgrades around nuclear storage sites, including fences, sensors and alarms;

- computers to automate the warhead inventory management system;

- transportation upgrades to railcars, and the provision of supercontainers and Kevlar

blankets for shipment of warheads to increase their protection from small-arms fire; and

- training and equipment for Emergency Response Teams for nuclear accidents.

Implementation of these measures has been slow. The DCI report quotes an August 2000 Russian newspaper report as saying that only a third of the new equipment had been put into service due to funding shortages.

Despite the lack of funds, the chief of the Ministry of Defence's Special Construction Troops reported in December 2000 that security enhancements were being completed at dozens of nuclear facilities.

"Even with the enhancements, security problems may still exist at the nuclear weapons storage sites," says the DCI report, and the Russian authorities accept that personnel problems remain.

Moscow has acknowledged the potential vulnerability of its nuclear security personnel. Serious incidents had occurred at some 12th GUMO facilities, Valynkin stated in October 1998, saying that more stringent selection criteria for nuclear warhead personnel would be used.

Several months later he told a press conference, "The greatest problem is the person who works with nuclear warheads. He knows the secrets, he has the access, he knows the security system". Personnel are being screened for links to the crime world and for their suitability to work with warheads, said Valynkin, and the 12th GUMO would be using US polygraph equipment, and drug and alcohol tests to monitor its personnel. In May 2000, two students at the 12th GUMO's Security Assessment Training Center were expelled as a result of the drug tests.

In a move which mirrors the Soviet-era practice of using officers for tasks for which enlisted personnel were considered unreliable, Valynkin also reported in May 2000 that warhead transport security operations would be handled by officers rather than enlisted personnel.

Following the break-up of the Soviet Union, all nuclear weapons of the former Soviet stockpile have been moved to storage sites in Russia. The DCI report says that by June 1992 the last of the former Soviet tactical nuclear warheads were withdrawn to Russia, and that by the end of 1996, the last of the strategic nuclear warheads had been removed from Kazakhstan, Ukraine and Belarus. According to local press reports, by 2000 some 4,500 strategic and tactical nuclear weapons, that were once stored on the territory of Ukraine, had been dismantled at Russian facilities in a process monitored by Ukrainian officials.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

Russia to build six Topol-M ICBMs in 2002

David C Isby

Russian intercontinental ballistic missile (ICBM) production for 2002 is planned at six RT-2PM2 Topol-M (SS-27) missiles, writes *David C Isby*. This rate of missile production (the same as in 2001) remains below the 'subsistence level' of 10 missiles a year required to keep the fabrication base viable as well as the 30-40 a year production level authorised in 1999. In October 2001, Russian Deputy Prime Minister Ilya Klebanov said that Russia would deploy a minimum of six missiles annually over the next decade.

Construction of SS-27 silos continues at an appropriate rate at Tatischichevo in Saratov oblast, where the missiles will be operated. Four silos were reported to have been completed in February, and two more are under construction. It is believed that eight silos are to be constructed for every six missiles.

However, recent public statements suggest Russia may be looking to emphasise submarine-launched ballistic missiles (SLBMs) for future strategic force

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modernisation. Russia's chief arms negotiator, First Deputy Chief of the General Staff Col Gen Yuriy Baluyevskiy, stated that, as Russian strategic forces decrease in size in the future, modernisation efforts will focus on SLBM capabilities, especially those associated with the new Yuriy Dolgoruky-class ballistic missile submarines. He re-affirmed, however, that Russia will retain a 'triad' of ICBMs, SLBMs and manned bombers even if the number of strategic nuclear warheads is reduced to some 1,500.

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

India tests a reduced-range Agni

Rahul Bedi

India has successfully tested a shorter-range variant of its nuclear-capable Agni (Fire) intermediate-range ballistic missile (IRBM), writes *Rahul Bedi*. Launched from the Chandipur test range on 25 January, the missile reached a range of 700km.

The 14.3m-long IRBM, with a body diameter of 1m and a launch weight of 11,800kg, has been developed to strike high-value Pakistani nuclear targets deep inside the desert in the western Baluchistan province. It is capable of carrying 3.8m-long warhead assembly weighing 1,000kg.

During the boost phase, the missile uses inertial guidance while the re-entry vehicle uses global positioning system (GPS) guidance and four aerodynamic control surfaces to obtain greater accuracy. Officials said the operational flexibility, which results from the new variant being compatible with a road or rail launcher plus the missile's depressed trajectory, would make it difficult to detect.

Defence officials said that development of

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the shorter-ranged Agni variant was approved in October 1999, three months after India and Pakistani had fought an 11-week long border deep inside Indian-administered Kashmir's mountainous Kargil region.

The conflict had threatened to escalate. According to official sources, both sides were reportedly readying their nuclear assets, a move that prompted Washington to force Pakistan into withdrawing its troops across the line of control that divides Kashmir between the neighbours.

Defence officials said the mobile single-stage, solid-propellant missile was developed to bridge the gap in range between the 250km-range Prithvi II surface-to-surface missile, and the 2,500km-range Agni II. India is also developing the Agni III, which is expected to have a 3,500-4,000km range.

"The new IRBM urgently fills the need for a nuclear missile which could be launched from sufficiently far away from the western border [with Pakistan]", said K Santhanam, director of the Institute for Defence Studies and Analyses, and former project co-ordinator for India's nuclear weapons programme.

Military planners said that any forward deployment of Prithvi in a conventional mode could provoke Pakistan to undertake a pre-emptive nuclear strike as it may perceive the missile to have been deployed with nuclear warheads. Such a move would raise the nuclear threshold between the two rivals, officials said. Besides, Pakistan could easily track Prithvi's movement from storage depots to launch pads in the northern border region. After their 1998 tit-for-tat nuclear tests, Pakistan retained the first use option of nuclear weapons while India settled for a second strike, retaliatory alternative.

The first flight test of the new missile took place just before India's 26 January Republic Day, and at a time when almost the entire Indian army was on high alert along the common frontier with nuclear rival Pakistan. India claimed the IRBM trial was not

intended as a provocation, and was not 'country-specific', but was part of its programme to develop its nuclear deterrent.

The troop build-up, which remains in place, followed the suicide attack on India's parliament last December, for which Delhi blames Islamabad. This also led to the imposition of bilateral diplomatic sanctions and the closure of rail, road and air links between the two countries, who have fought three wars since independence in 1947.

Indian prime minister Atal Behari Vajpayee said the IRBM test was "one of several steps India is taking to ensure its national security. Foreign ministry officials said the test was planned in advance and its timing determined solely by technical factors".

Foreign ministry spokeswoman Nirpuma Rao said India had informed the permanent members of the United Nations Security Council, Pakistan, Japan, Germany and Spain, that currently heads the European Union presidency of the test, which she insisted was conducted in a "transparent and predictable way".

India has already begun series production of Agni II, which has been test-fired to a range of 2,100km and is expected to enter service later this year. Official sources said the Indian Army is raising the Strategic Rocket Command (its second missile regiment) to handle, store and operationally deploy Agni II. Each mobile launcher would have a crew of 150 soldiers. Details of the overall command-and-control structure of the Nuclear Command Authority are still being finalised.

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

CIA sees no slowdown in ballistic-missile proliferation

Russia, China and North Korea are the most significant suppliers of missile technology to nations attempting to develop ballistic missiles, says the latest in a series of bi-annual reports by the US Central Intelligence Agency (CIA). The document covers activities during the first half of 2001.

During this period, Russian entities continued to supply a variety of ballistic missile-related goods and technical know-how to countries such as Iran, India, China and Libya, says the CIA. Technology and materials supplied by Russia in the past helped accelerate Iranian development of the Shahab-3 MRBM, and continuing assistance probably supports Iran's efforts to develop new missiles and to increase its self-sufficiency in missile production.

China has on several occasions pledged not to sell Missile Technology Control Regime (MTCR) Category I systems but has not recognised the regime's key technology annex. China is not a member of the MTCR, and during the first half of 2001 continued to take "a very narrow interpretation" of its

bilateral nonproliferation commitments with the US.

An example of this is continued missile-related technical assistance that China provides to Pakistan's solid-propellant missile projects such as the Shaheen-I and Haider-I. Successful development of the two-stage Shaheen-II MRBM will require continued Chinese assistance or assistance from other potential sources, says the CIA.

Organisations in China have also provided dual-use missile-related items, raw materials and/or assistance to several other countries of concern, including Iran, North Korea and Libya.

During the period covered by the report, North Korea continued to export significant ballistic missile-related equipment, components, materials and technical expertise to unidentified countries in the Middle East, South Asia and North Africa. These exports are a major source of the hard currency which North Korea needs to maintain its own missile development and production programmes.

Although western countries continue to be a less important source of the goods and materials needed by missile and weapons of mass destruction (WMD) programmes, the CIA notes that both Iran and Libya have continued to approach entities in western Europe in search of such technologies. "Proliferators and associated networks continue to seek machine tools, spare parts for dual-use equipment, and widely available materials, scientific equipment and specialty metals", says the report.

Entities in Russia and western Europe remained the primary sources of missile-related and dual-use technology transfers to India during the first half of 2001. India relies on foreign assistance for key missile technologies where it still lacks engineering or production expertise.

The report expresses concern that private companies, scientists and engineers from countries such as Russia, China and India may be increasing their involvement in

WMD- and missile-related assistance, taking advantage of weak or unenforceable national export controls and the growing availability of technology.

The trend for nations to seek increased self-sufficiency in missile technology has continued. "In bolstering their domestic production capabilities, and thereby reducing their dependence on others, they are better able to insulate their programmes against interdiction and disruption." Although indigenous capabilities may not always be a good substitute for foreign technologies, particularly for more advanced technologies, in many cases they may prove to be adequate, warns the CIA.

As their indigenous capabilities grow, nations which currently are importers of WMD and missile technology could emerge as new suppliers of technology and expertise to other nations looking for ballistic-missile and WMD capabilities. "We are increasingly concerned about the growth of 'secondary proliferation' from maturing state-sponsored programmes, such as those in India, Iran, North Korea and Pakistan. These countries and others are not members of supplier groups such as the Nuclear Suppliers Group, Australia Group and the Missile Technology Control Regime and do not adhere to their export constraints."

Iraq continues to pursue development of short-range ballistic missile (SRBM) systems such as the liquid-propellant Al Samoud and solid-propellant Arbil-100, weapons with a range of less than 300km, a category that is not prohibited by the United Nations (UN). These projects allow Iraq to develop improved technology and infrastructure that could be used to develop longer-ranged missiles. If economic sanctions against Iraq were lifted, Baghdad probably would increase its attempts to acquire missile-related items from foreign sources, says the report.

The CIA believes development of the Al-Samoud is maturing and that a low-level operational capability could be achieved in the near term. Solid-propellant missiles may now be receiving a higher priority, and

development of the Ababil-100 SRBM "and possibly longer range systems" may be moving ahead rapidly. Four Al Samoud transporter-erector-launchers (TELs) and missiles took part in the 31 December 2000 Al Aqsa parade, along with two Ababil-100 TELs and missiles.

Libya's current capability probably remains limited to Scud B missiles, says the report, but given continued foreign assistance it may well be able to field extended-range Scuds or even medium-range ballistic missiles. "Outside assistance - particularly Serbian, Indian, North Korean and Chinese - is critical to its ballistic missile development programmes, and the suspension of UN sanctions in 1999 has allowed Tripoli to expand its procurement effort."

Syrian efforts to develop and manufacture solid-propellant rocket motors continues "with help from outside countries", while organisations in North Korea and, to a lesser degree, in Russia play an essential role in Syria's liquid-propellant missile programmes. North Korea is singled out as probably providing considerable assistance to Syria's Scud C programme, and having a long-standing relationship with Egypt on ballistic missiles.

Although Sudan is a signatory to the Chemical Weapons Convention, it has been developing the capability to produce chemical weapons for many years with the assistance of other countries, principally Iraq. "We remain concerned that Sudan may seek a ballistic missile capability in the future", says the report.

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

BRIEFS - Trident FY02 contracts awarded

Lockheed Martin Space Systems (LMSS) is being awarded a US$12.41 million modification to previously awarded contract N00030-01-C-0100 to exercise an option for the procurement of additional missile system hardware and/or requalification efforts based on the negotiated values for the hardware for the FY02 Trident II (D5) Production and Deployed Systems Support contract. This work will be carried out in Sunnyvale, California, and is expected to be completed by September 2006.

Under a separate deal, the company is being awarded an US$11.85 million modification to the same contract (N00030-01-C0100) to exercise an option to provide funding for Phase A of the requalification efforts on materials and processes used in the production of Trident II (D5) post-boost control system (PBCS) gas generators and thrust-vector control (TVC) gas generators. This work will be done in Sunnyvale (36%); Elkton, Maryland (16%); Orange County, Virginia (46%); and Albany, Oregon (2%) and will be completed by January 2005.

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JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

USN submarine fires four Trident missiles

David C Isby

Four Lockheed Martin Trident I C-4 submarine-launched ballistic missiles (SLBMs) were ripple-fired on 9 December from the US Navy ballistic missile submarine Ohio, writes *David C Isby*. The vessel was submerged off Cape Canaveral, Florida, and the SLBMs were fired on a trajectory that covered the Eastern Missile Range.

This battle exercise was the second in the last six months. In June 2001, three Trident II D-5 SLBMs were fired at the same location from the Ohio-class submarine Louisiana.

The C-4, which is to leave service in 2005 with the retirement of the older Trident submarines, is currently used only on six Pacific Fleet Ohio-class submarines. This most recent test brings the total number of Trident C-4 developmental and operational test flights to 225, with an 89% mission success rate.

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JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

US reviews its nuclear forces

The US has completed its second Nuclear Posture Review, an exercise which forms part of the effort to transform its military forces to meet the security challenges of the early 21st century, and which recognises the new relationship with Russia. (An earlier review was conducted in 1994.)

The current US strategic triad was devised for a Cold War world, in which the US could see a single, known ideological opponent in the form of the former Soviet Union, and could envisage only a limited number of potential contingencies in which the US and its strategic forces would have to be involved.

During the Cold War era, the US relied not exclusively but very heavily on its offensive nuclear forces, using a threat-based approach to nuclear planning which was focused on the Soviet Union, and considered other potential contingencies as lesser included cases.

"Today we have a very different situation", assistant US Secretary of Defense for International Security Policy J D Crouch told the press during an unclassified briefing on

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the review's findings. "We have a situation where the United States may face multiple potential opponents, but we're not sure who they might be. There are multiple sources or potential sources of conflict. We also have a new relationship with Russia, which is heading down a more positive course. "And the implications of this are that, on the one hand, while it's very hard to know the 'who' and 'when' or 'where', we might have to use our military forces broadly and even our strategic forces more narrowly, we do or ought to plan the 'how' - that is to say, what are the kinds of capabilities that we need to counter the potential adversaries or the capabilities of potential adversaries that are either extant today or that will emerge in the years to come?"

Such plans need to take into account the growing capabilities of various states in the biological, chemical, nuclear and ballistic-missile delivery area, as well as explicit concerns about certain states that are developing those capabilities.

"The Cold War approach to deterrence, which was highly dependent upon offensive nuclear weapons, is no longer appropriate, which is not to say that we think nuclear weapons don't continue to play a role in that", said Crouch. "We think they play an important role, a fundamental role. But we also believe that other kinds of capabilities will be needed in the future."

Another goal of the review was to reduce the number of operationally deployed nuclear weapons without having to wait for Cold War-style arms- control treaties, and to place greater emphasis on missile-defence capabilities, and the development of advanced conventional capabilities.

The current US strategic forces take the form of a triad consisting of ICBMs (intercontinental ballistic missiles), manned bombers and SLBMs (submarine-launched ballistic missiles). "We would like to transition to what we call a new triad, a triad of forces that includes non-nuclear and nuclear strike capabilities," Crouch told reporters. "We will continue to maintain a balanced nuclear force triad, but at a much

smaller or reduced level."

The US now plans to keep its existing nuclear weapon systems in service to 2020 and beyond. This will require current life-extension programmes, plus similar efforts to modernise other weapons.

"We are also looking at study alternatives for follow-on systems at this point, but... we are planning on going with the existing force of ICBMs, SLBMs on SSBNs [ballistic missile submarines] and bombers. We will be fully funding the Trident D-5 SLBM life-extension programme in this five-year defence plan."

The US Navy (USN) plans to maintain a fleet of 14 Trident-equipped SSBNs. At any time, two of those submarines will be in overhaul, and will not have missiles available to fire, so will not be part of the operationally deployed nuclear delivery systems.

"The DoE [Department of Energy] is planning on accelerating its [nuclear] test-readiness programme." While the US continues to oppose ratification of the comprehensive test ban treaty, it will continue to adhere to a testing moratorium.

The planned force reductions will be reviewed over the next decade. "We may decide... somewhere along the line that we have to flatten out our reductions because changes have been made in the strategic environment that require us to do that," Crouch continued. "We may decide that we would have to increase our forces. We may also decide that we could decrease our forces further, or bring our forces down much faster, depending upon the security environment, technological surprise and our ability and confidence in developing new elements or fielding new elements of the triad. So we are going to be assessing along the way, as we reach the president's goal of [reducing to] 1,700 to 2,200 operationally deployed warheads in a decade."

Under current plans, the US will download warheads from the operationally deployed ICBMs and SLBMs, a process which will be completed in phases. In addition to the 1,300

warheads that will be withdrawn as a result of the retirement of Peacekeeper ICBMs, some Trident SLBMs and other systems, the US also plans to remove additional operationally deployed warheads from existing ICBMs and SLBMs, reducing to a total of around 3,800 by FY07. Beyond that date it will make force-structure decisions on how to reduce the force to 1,700 to 2,200 operationally deployed warheads.

The US maintains nuclear weapons in what are known as the active and inactive stockpile. Many of the weapons in the latter are awaiting dismantlement and destruction.

Some of the warheads due to be retired will be earmarked for destruction and will be put in the queue for destruction, while others will remain in the inactive stockpile. Some will be retained to provide a 'responsive capability', but no final decisions have been made on what size the active stockpile, responsive capability and inactive stockpile will be. In practice, the totals will shift over time.

The responsive capability consists of weapons able to augment the operational force - additional warheads that could be uploaded back onto that force if necessary. If a US president were to make a decision to do that, the uploading would take "weeks, months, even years... depending upon the system and the character of the threat", said Crouch. It would not be something that would be done to meet a tactical threat, but in response to circumstances such as a "major change in the security environment".

John Harvey, director of the DoE's Office of Policy, Planning, Assessment and Analysis, defines the a warhead in the active stockpile as "a weapon which is available, fully ready to be deployed and used". In the case of a warhead in the inactive stockpile: "Typically the limited-life components that go into a nuclear warhead, such as tritium, neutron generators, things that live for a relatively short period of time in comparison with the weapon, are typically removed, and when the weapon is transitioned to the active stockpile from the inactive, those components are reinstalled in the weapon. So the inactive weapon consists of those weapons that are

not fielded with limited-life components."

The DoE has two main responsibilities to the Department of Defense (DoD) says Harvey: "One is we have to assure that the stockpile is safe and reliable. And two, we have to make sure that we respond to any requirements that the Department of Defense has with regard to modifications, refurbishments, etc, of nuclear warhead systems.

"We have a very aggressive stockpile stewardship programme... to be able to assess and fix problems on a time scale relevant to DoD needs... We feel confident we can do this without nuclear testing, but there are no guarantees. We need to retain an ability to; if the president decides, in response to a possible problem in the stockpile that can't be fixed without testing, that we have to be able to be prepared to carry out a test, and we maintain the readiness to do so. Currently, that readiness is 24 to 36 months.

The DoE also has the problem of ensuring it can restore some of the capabilities needed later this decade. This will enable the department to refurbish elements of the stockpile in order to sustain future force levels of systems such as the W-76 warhead for Trident, the W-80 warhead for the air-launched cruise missile and the advanced cruise missile, and also some air-dropped bombs, the B-61 in particular. "We will need to establish and recover production capabilities in order to be able to refurbish that element of the stockpile later on this decade," says Harvey. "That's one of our key challenges in the future."

The US is currently re-establishing a capability to produce tritium, he explains. "For the time being, given the dramatic reductions over the past 10 years of weapons moving from the active to the inactive stockpile - that is, weapons that don't require tritium - we've been able to free up quite a bit of tritium to be able to sustain ourselves until we can resume production. We're currently scheduled to resume production sometime later on this decade, and I believe we're in good shape with regard to being able

to support the DoD requirements... Our approach to producing tritium is to use a commercial light-water reactor... that's the capability that we'll require in the future."

The Posture Review contains no recommendations about developing new nuclear weapons, said Crouch. Faced with the possible need for earth-penetrating warheads "we are trying to look at a number of initiatives. One would be to modify an existing weapon, to give it greater capability against... hard targets and deeply-buried targets. And we're also looking at non-nuclear ways that we might be able to deal with those problems."

As the number of deployed warheads declines, the US will build up its capabilities in areas such as command and control, missile defences and improved conventional strike power. (Source: US DoD)

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JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

Russia plans cut-back in ICBM strength

David C Isby

The Russian Strategic Missile Troops (RVSN) still suffer from the limited resources that affect all of Russia's armed forces, but its high priority has allowed it to point to some successes in the past year, writes *David C Isby*. The RVSN carried out four successful intercontinental ballistic missile (ICBM) launches in 2001 and saw the establishment of the Space Forces as an independent arm.

The RVSN will be severely affected by planned strategic arms reductions. Currently it consists of a force of 13,000 personnel (with 10,000 standing alert duties) organised into four missile armies. By around 2006, it could shrink to a force of 6,000, organised in two missile armies with a total of 500 single-warhead ICBMs. RVSN Commander Col-Gen Nikolay Solovtsov announced that a plan for the build-down had been approved in late December 2001.

Modernisation of the RVSN depends on continued production of the RS-12M Topol-M (SS-27) ICBM. A total of 30 of these missiles (fully equipping three RVSN regiments) are reported to have been delivered by the end of 2001. The three

regiments had previously been under strength. The goal of having 300 RS-12M delivered by 2006 is not likely to be reached unless production is speeded up.

Older RVSN systems are to be withdrawn as their service lives expire. RS-20V (SS-18) ICBMs are to continue in service to 2006 and may be kept beyond that to around 2015. The RVSN will start retiring its rail-mobile RT-23 (SS-24) ICBMs no earlier than 2002 and possibly later. Preparations for their dismantling are nearing completion in Bryansk. A test module of an SS-24 has already been scrapped.

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North Korea develops Taepo Dong 2 guidance software

David C Isby

Although North Korea has agreed to suspend flight tests of its Taepo Dong 2 long-range ballistic missile, it is continuing to develop the guidance software for the weapon, writes *David C Isby*. Press reports from Seoul say the guidance software is being indigenously produced in North Korea, despite that nation's shortage of computers and skilled personnel.

Most North Korean computers are of the 486 class, according to press reports, but high performance work stations are available. Each year, the Kim Il Military University admits 100 students to a five-year course in information and computer technology, which would provide a cadre of competent personnel to work on such programmes.

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US could face North Korean and Iranian ICBM threats by 2015

Most US Intelligence Community (IC) agencies believe the US could face intercontinental ballistic missile (ICBM) threats from North Korea and Iran, and possibly from Iraq, before 2015.

Short- and medium-range ballistic missiles (SRBMs and MRBMs) already pose a significant threat overseas to US interests, military forces and allies, says the US National Intelligence Estimate 'Foreign Missile Developments and the Ballistic Missile Threat through 2015': "A decade ago, US and allied forces abroad faced threats from SRBMs - primarily the Scud and its variants. Today, countries have deployed or are on the verge of deploying MRBMs, placing greater numbers of targets at risk."

The report's assessments of future missile developments are often based on fragmentary information, so give both the earliest date that specific countries could test various missiles, and the more realistic likely date. These dates are based largely on engineering judgments made by experts inside and outside the IC, on the technical capabilities and resources of the countries in

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question, the level of foreign assistance being provided or seen as possible, plus potential delays due to technical, political or economic difficulties. In practice, missile tests are thought more likely to be close to the projected 'likely' date than to the 'earliest' date. In many cases, the pace of a missile programme will depend on the availability of foreign assistance.

In 1990, Russia inherited a force of approximately 10,000 warheads from the former Soviet Union. Resource problems, programme development failures, weapon system ageing, the dissolution of the Soviet Union and arms control treaties have reduced this force to around 4,000 warheads - 3,000 on a force of approximately 700 ICBMs, and around 900 on a dozen nuclear submarines equipped with 200 launchers for submarine-launched ballistic missiles (SLBMs).

Russia's Strategic Rocket Forces (SRF) is extending the service lives of its older ICBMs - the silo-based RS-20 (SS-18 'Satan') and RS-18 (SS-19 'Stiletto') and road-mobile RS-12M (SS-25 'Sickle') - in part to compensate for the slow deployment of the Topol-M (SS-27). Developed in the 1980s as a response to the US Strategic Defense Initiative, the Topol-M will probably form the basis of any credible Russian response to the US missile-defence programme. A similar life-extension will be needed to extend the operational lives of existing Russian ballistic-missile submarines (SSBNs) and SLBMs.

The future size of the Russian strategic forces will depend on the availability of resources, the level of multiple independently targetable re-entry vehicle (MIRV) deployment and the success of development programmes. The US IC has prepared various projections of Russia's strategic forces for 2015, all of which predict less than 2,000 deployed nuclear weapons.

"Russia has the most technologically evolved and best-equipped, maintained and trained theatre ballistic missile force in the world today," says the report. "The SS-21 and SS-26 SRBMs provide Russian

general-purpose ground forces with a rapid, precision-guided, theatre deep-strike capability."

China's current ICBM force consists of around 20 DF-5 (CSS-4) silo-based missiles that can reach targets in the US, plus around a dozen DF-4 (CSS-3) ICBMs that are almost certainly intended as a retaliatory deterrent against targets in Russia and Asia. Both are large, liquid-propellant missiles armed with single nuclear warheads. "Beijing is concerned about the survivability of its strategic deterrent against the United States and has a long-running modernisation programme to develop mobile, solid-propellant ICBMs. The IC projects that, by 2015, most of China's strategic missile force will be mobile."

China has three new, mobile, solid-propellant strategic missiles in development. The road-mobile DF-31 (CSS-X-10) ICBM is currently being flight-tested, and deployment may begin during the first half of the decade. During the second half of the decade, it could deploy a longer-range version of the DF-31; and the new JL-2 SLBM. China's current SLBM is the JL-1 (CSS-NX-3).

"China could develop a multiple RV [re-entry vehicle] system for the CSS-4 ICBM in a few years," says the report, but any similar capability for its mobile ICBMs and SLBMs "would encounter significant technical hurdles and would be costly".

The IC estimates the likely size of the future Chinese strategic ballistic missile force, over the next 15 years, ranges from about 75-100 warheads deployed primarily against the US. "MIRVing and missile defence counter-measures would be factors in the ultimate size of the force."

The 1,300km-range No Dong is the longest-range ballistic missile in North Korean service. Taepo Dong-2 may be ready for flight-testing, but for the moment the North Korean government has unilaterally extended its voluntary flight-test moratorium until 2003. In the meantime, North Korea

may be working on improvements to the current design.

A two-stage Taepo Dong-2 could deliver a payload of several hundred kilogrammes to ranges of up to 10,000km - sufficient to strike Alaska, Hawaii and parts of the continental US. The addition of a third stage could increase the range to up to 15,000km - sufficient to strike all of North America. The report says that "a Taepo Dong-2 flight test probably would be conducted as an SLV [satellite launch vehicle] with a third stage to place a small payload into the same orbit the North Koreans tried to achieve in 1998".

Another ballistic missile thought likely to make its debut in SLV form is the follow-on to Iran's Shahab-3, a No Dong derivative currently in the late stages of development. "Iran is likely to develop space launch vehicles to put satellites into orbit and to establish the technical base from which it could develop IRBMs/ICBMs capable of delivering payloads to western Europe and the United States. Iran is likely to test these vehicles initially as SLVs and not as ballistic missiles to demonstrate an inherent IRBM [intermediate range ballistic missile]/ICBM capability without risking the potential political and economic costs of a long-range missile test."

Iran could attempt to launch an ICBM/ SLV about mid-decade, although most US intelligence agencies believe a date in the second half of the decade is more likely. One agency thinks a successful Iranian ICBM test unlikely before 2015. "Iranian acquisition of complete systems or major subsystems - such as North Korean TD-2 or Russian engines - could accelerate its capability to flight-test an ICBM/SLV... a halt or substantial decrease in assistance would delay by years the development and flight-testing of these systems."

Iraq has retained a small, covert force of Scud-type missiles, launchers and Scud-specific production equipment and support apparatus, and has maintained the infrastructure and expertise necessary to develop missiles. For the next several years, Iraq's ballistic missile projects will probably

involve MRBM systems able to threaten regional targets.

The liquid-propellant Al-Samoud SRBM will probably be deployed in the near future, and Iraq is likely to use its experience with Scud technology to resume production of the 650km-range Al Hussein, the 900km-range Al Abbas, or other Scud variants. It could also explore clustering and staging options to reach more distant targets.

"We cannot project with confidence how long UN-related sanctions and prohibitions will remain in place," say the report's authors. "Iraq could resume Scud-variant production - with foreign assistance - quickly after UN prohibitions ended.

"With substantial foreign assistance, Baghdad could flight-test a domestic MRBM by mid-decade. This possibility presumes rapid erosion of UN prohibitions and Baghdad's willingness to risk detection of developmental steps, such as static engine testing, earlier." An MRBM could be flight-tested by 2010, but any imported MRBM could be flight-tested within months of acquisition.

Some time before 2015 Iraq could attempt to test a rudimentary long-range missile based on its earlier Al-Abid SLV, says the report, but "such a missile almost certainly would fail". Iraq is not expected to follow this development path, but to pursue an SLV or ICBM similar in concept to a three-stage Taepo Dong 2. Development and testing of such a system would take around 10 years.

Iran could develop and test a missile in the Taepo Dong 1 class within a few years, but any direct purchase of Taepo Dong 2 missiles could result in a launch capability within a year or two of purchase. "If Iraq bought TD-2 [Taepo Dong 2] engines, it could test an ICBM within about five years of the acquisition."

A much faster route to an ICBM would be to cluster and stage No Dong missiles. This could be tested within a few years of initial No Dong deliveries.

If mounted on a forward-based sea platform within a few hundred kilometres of the US coastline, an SRBM or MRBM could be launched against the US. This would not pose major technical problems. The accuracy of the missile probably would be degraded due to the movement of the ocean, but would probably be better than that of some of the ICBMs projected by the report.

"The simplest method for launching a shipborne ballistic missile would be to secure a TEL [transporter erector launcher] onboard the ship and launch the missile from the TEL. Somewhat greater accuracy could be obtained by placing the TEL on a stabilisation platform to compensate for wave movement. Another option would be to add satellite-aided (GPS or GLONASS) navigation to the missile."

By 2015, between 12 and 24 nations will probably have some form of land-attack cruise missile (LACM). These missiles could be indigenous developments, purchases or modifications of other systems such as anti-ship cruise missiles or unmanned aerial vehicles. Most will be have ranges of a few hundred kilometres and, although primarily a theatre-level threat, will have enough range to be forward-deployed on air- or sea-launch platforms.

"From a technical standpoint, cruise missiles are a better alternative than ballistic missiles in launching from forward areas," says the report. Although cruise missiles can be launched from fighter, bomber or even commercial transport aircraft, the limited range of most foreign fighter and bomber aircraft, and the US capability to detect and track approaching air threats will probably make air-launch unattractive. Modifying a commercial aircraft to become a cruise missile platform would be a significant development task, requiring significant aerodynamic, structural, electrical and possibly flight control system modifications.

"Cruise missile launches from a submarine would have the advantage of being relatively covert. The technical sophistication required to design or to modify a cruise missile for launch from torpedo or missile tubes,

however, almost certainly would require detailed assistance from the defence industry of a major naval power." The US IC believes "the most plausible alternative for a forward-based launch would be a covertly equipped commercial vessel."

The report warns that "the probability that a missile with a weapon of mass destruction will be used against US forces or interests is higher today than during most of the Cold War, and it will continue to grow as the capabilities of potential adversaries mature". However it notes "some nonstate entities are seeking chemical, biological, radiological and nuclear (CBRN) materials, and would be willing to use them without missiles. In fact, US territory is more likely to be attacked with these materials from non-missile delivery means - most likely from terrorists - than by missiles, primarily because non-missile delivery means are less costly, easier to acquire and more reliable and accurate. They also can be used without attribution".

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JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

BRIEFS - Trident SLBM funded for FY02

Lockheed Martin Missile and Space is being awarded a US$283.45 million contract to provide Fiscal Year 2002 (FY02) Trident II (D5) missile deployed-system support to the US Navy fleet, re-entry body deployed-systems support, field processing, engineering and operational support services, flight-test analysis and range support, arms-control support and strategic-capability preservations investigations. The work will be done in Sunnyvale, California (54.2%); Kings Bay, Georgia (17.3%); Clearwater, Florida (13.9%); Bangor, Washington (11.5%); Salt Lake City, Utah (1.3%); Gainesville, Virginia (0.6%); Baltimore, Maryland. (0.2%); and in other locations (1.0%), and is expected to be completed by September 2006.

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BRIEFS - Trident guidance repairs funded

Raytheon Systems is being awarded a US$12.32 million contract with incentives on performance, schedule and cost to provide for repair of Trident II Mk 6 missile guidance system electronic assemblies and related hardware. This contract contains options which, if exercised, would bring the total cumulative value to US$100.85 million. The repairs will be carried out in El Segundo, California, and are due to be completed by September 2002.

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JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

BRIEFS - TRW wins extensions to Minuteman contracts

TRW ICBM Systems is being awarded a US$139.05 million contract modification to provide for Fiscal Year 2002 sustainment of the Minuteman and Peacekeeper weapon systems. This work will be done under the ICBM Prime Integration Contract, and is due to be completed by September 2002.

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BRIEFS - Trident options exercised

Lockheed Martin Space Systems is being awarded US$25.4 million to exercise an option on previously-awarded contract N00030-01- C-0100 to cover the procurement of additional hardware and/or memorandum of requalification agreement (MORA) effort under Fiscal Year 2001 Trident II (D5) Missile Production Item 0001. This work will be carried out in Sunnyvale, California, and is expected to be completed by September 2004.

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JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

Russian ICBM tests are tracked

David C Isby

Russia has carried out several training launches of intercontinental ballistic missiles (ICBMs) writes David C Isby. An RS-18 (SS-19 'Stiletto') ICBM was silo-launched from Baikonur, Kazakhstan, by an operational crew from the Strategic Rocket Forces, and impacted on Kura test range in Kamchatka. The missile used for the test is reported to have been a 25-year-old example taken from an operational silo, and the flight was intended to verify the reliability of what is now an ageing system.

An RS-12M Topol (SS-25 'Sickle') ICBM was also launched from Plestesk, northern Russia, impacting on the Kura Test Range. This was the second successful Topol launch within a month.

Russian press coverage of the tests stressed that the missiles were tracked throughout their trajectory by terrestrial radars and space-based infrared sensors. Russia's defensive strategic sensors - inherited from the Soviet Union - have been the subject of concern that their performance may have continued to deteriorate due to lack of funding. The recent tests were apparently

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concerned with publicising the continued viability of Russia's offensive and defensive strategic forces.

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Ukraine destroys last SS-24 silo

The Ukraine has destroyed its last silo for the RS-22 (SS-24 'Scalpel') intercontinental ballistic missile (ICBM). Located at Pervomaysk, approximately 400km south of the capital, Kiev, the silo was destroyed using explosives. The area will be cleaned and converted for agricultural use.

Following the US/Ukrainian agreement to retire the strategic weaponry, which the Ukraine had inherited following the break-up of the former Soviet Union, the 46 missiles at Pervomaysk were deactivated in 1994 by the removal of their warheads. In June 1998, Bechtel National was given a contract to remove the missiles from their silos, defuel and partially neutralise them, transport the missiles to transfer stations and load them onto special railway cars. Under the contract, the company also repaired and maintained a variety of infrastructure and special handling equipment, and transported quantities of liquid rocket fuel and oxidisers.

Among the types of missile facilities destroyed at the Pervomaysk site by the US company and its Ukrainian subcontractor are hardened launch-control silos; several administration buildings; standby power, refrigeration and security installations; fuel and underground water storage tanks;

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security fences; connecting tunnels and a variety of buried utility components. In an earlier project, Bechtel dismantled 130 RS-18 (SS-19 'Stiletto') missile silos in the Ukraine.

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JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

Shahab-3 enters production

David C Isby

According to unconfirmed reports, Iran has started serial production of the 1,300km-range Shahab-3 theatre ballistic missile (TBM), writes David C Isby. Production is understood to have begun earlier this year. Recent congressional testimony by US intelligence officials that the Shahab 3 would be in service "soon" seems to confirm this.

The Shahab 3 is believed to be based on the North Korean No Dong, but is reported to also include some technology from the former Soviet Union. Component production and final assembly are being carried out in Iran, but the rocket motors are imported from North Korea.

Shahab 3 has had only three flight tests, most recently in September 2000. Only one of these - the second - was successful. If the missile has been committed to production with such a limited flight-test programme - following the example of the original No Dong 1, which entered production after a single flight test - this tends to confirm intelligence assessments that ballistic missile threats may emerge without a conventional

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lengthy test programme.

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JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

Minuteman motors enter full-rate production

TRW is to begin full-rate production of new rocket motors for the Minuteman III intercontinental ballistic missile (ICBM). The contract is worth US$215 million, and follows a Milestone III decision taken by the US Air Force (USAF) Acquisition Executive in September 2001 to proceed with full-rate production.

The contract is the first of six full-rate production options due to be exercised by the USAF ICBM Systems Project Office at Hill Air Force Base (AFB), Utah. Total value of the propulsion replacement programme (PRP) is expected to be US$1.56 billion over eight years. TRW and its associated subcontractors - Alliant Technology (ATK), Thiokol Propulsion and Pratt & Whitney's Chemical Systems Division (CSD) - will deliver 607 sets of replacement motors by 2008.

The PRP programme is designed to replace aging solid-rocket motors in the Minuteman III force with remanufactured motors, allowing the modernised missiles to remain in service until 2020. Under a PRP Technology Insertion contract, which preceded the low-rate initial production

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(LRIP) phase of the programme, two flight tests were conducted using remanufactured Minuteman III boosters. In October 1999, TRW entered an LRIP contract covering the delivery of 42 remanufactured motor sets, the first of which was deployed to Malmstrom AFB, Montana, in April 2001.

Under its ICBM prime contract, TRW is also responsible for managing the Guidance Replacement Program (GRP), a project in which it is teamed with Boeing Company. GRP entered full-rate production in December 1999, and is intended to extend the life of the Minuteman III guidance system. TRW also handles the Propulsion System Rocket Engine Life Extension Program (which will refurbish the liquid-propellant fourth stage of the Minuteman III missile) and the Minuteman Minimum Essential Emergency Communication Network programme to upgrade launch-control communication.

TRW ICBM Systems has recently been awarded a US$180.91 million option on a contract to provide for Fiscal Year 2002 full-rate GRP production. This funding will cover 80 NS-50 missile- guidance sets, 36 RS cable sets, two missile-guidance set controls, two missile-guidance computers, three gyro- stabilised platforms and three gyro compass assemblies.

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STRATEGIC & SUB-STRATEGIC

Date Posted: November 26, 2001

JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

US and UK Trident support funded

BAE Systems Applied Technologies is to provide Fiscal Year 2002 (FY02) fleet ballistic missile (FBM) system integration and logistics support for the US and UK Trident programmes. The US$58-million contract covers FBM system integration, sustainment planning and studies, systems integration for D5 backfit, D5 backfit startup support, START support, Tomahawk land attack missile and SSGN (nuclear-powered cruise missile submarine) systems integration, advanced systems studies, Kings Bay supply support, UK Trident strategic weapons system and logistics support. Work will be performed in Rockville, Maryland, and is expected to be completed by September 2002.

Charles Stark Draper is being awarded a US$13.27 million contract to develop a computer-based integrated engineering environment to support work on the Mk 6 guidance system of the Trident ballistic missile. Planned activities are the replacement of existing technologies due to ageing problems with the Mk 6 guidance system, inertial component engineering to address specific features of current instruments and alternate technologies for accelerometer and gyro technology, and

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monitoring of radiation-hardened technology (including stellar technology) which is quickly disappearing and upon which the guidance system was built. This work will be carried out in Cambridge, Massachusetts, and is expected to be completed by September 2002.

A separate contract worth US$122.68 million covers FY02 tactical engineering support for the US and UK Mk 6 guidance programme and guidance test equipment; plus tactical engineering support for other investigations, evaluations and special studies. This contract also includes requirements for the design, development and production of prototype hardware, screening of pendulous integrating gyroscopic accelerometers (PIGA), reclamation of PIGA fill fluid and life test of the Mk 6 guidance system.

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STRATEGIC & SUB-STRATEGIC

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JANE'S MISSILES AND ROCKETS - NOVEMBER 01, 2001

Trident goes COTS

The US Department of Defense's Defense Acquisition Executive (DAE) has presented the Fleet Ballistic Missile (FBM) Trident Open System Architecture Team with an award for achievement in acquisition reform. "The Trident Open System Architecture Team demonstrated a remarkable ability to draw upon a wide range of commercial technologies which ultimately reduced total ownership costs for the government", says Tom Morton, vice-president, strategic missile programmes for Lockheed Martin Space Systems Missiles & Space Operations.

In 1995, the US Navy (USN) had faced several problems with the Trident II (D5) submarine-launched ballistic missile. These included rising operation and maintenance costs, technology obsolescence, the availability of legacy parts, and the need to support the shipboard systems over their planned 44-year operating life.

At the time, the Trident shipboard systems consisted of six subsystems, each made up of contractor-developed custom printed-wiring assemblies, software and Navy Standard Electronic Modules (SEMs). To reduce life-cycle costs, the USN Strategic Systems Programs (SSP) organisation set up an Over-arching Integrated Product Team (OIPT) which consisted of Lockheed Martin; SSP; the Space & Warfare (SPAWAR)

System Center, San Diego; General Dynamics Defense Systems (GDDS); Naval Sea System Command (NAVSEA); the Defense Contract Management Agency (DCMA); Boeing North American; Dynamics Research Corporation, EG&G, the Naval Surface Warfare Center-Crane, and the Naval Surface Warfare Center-Dalhgren.

This team began the task of converting the system from a mil-spec design, to a configuration with a commercial off-the-shelf (COTS) based open-system architecture. The resulting design will allow regular system architecture enhancements using new commercial technology without requiring another major system redesign.

Over a five-year period, the COTS content of the system was increased to 60% in terms of numbers of parts, the number of parts was reduced by 75%, and development cycle time was halved, saving a total of US$1.2 billion.

The first of these redesigned systems is currently being installed aboard the Alaska (SSBN 732) as she undergoes overhaul and conversion to Trident II capability at Puget Sound Naval Shipyard. The other 13 Trident II SSBNs will also be outfitted with the redesigned system when they are overhauled.

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STRATEGIC & SUB-STRATEGIC

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JANE'S MISSILES AND ROCKETS - OCTOBER 01, 2001

Indian Army will operate Agni II

David C Isby

The Indian defence ministry has announced that the 2,500km-range Agni II intermediate-range ballistic missile (IRBM) will be operated by the Indian Army when it becomes operational in 2001-02, writes David C Isby. This followed announcements on 22 July that the Agni II had entered production, and on 2 August that India is not contemplating any exports of the Agni II.

The defence minister said the Agni II would equip the 333rd Army Missile Group. A new army formation, the Strategic Rocket Regiment, will be organised to operate the Agni II. The army's greater infrastructure, greater ability to provide local security and greater experience in carrying out rapid movement of large terrestrial systems - the Agni II is to be rail-mobile - were cited among the reasons for the defence ministry's decision.

The Prithvi short-range ballistic missile (SRBM) is also operated by the army. According to Indian press reports, this tactical weapon will not be nuclear-armed.

The Indian Air Force had argued strongly

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that they should operate the Agni II, saying this would keep all long-range nuclear delivery systems - IRBM and aircraft - as well as long-range reconnaissance assets under the same service. It also claimed the air force would be better suited to operate high-technology systems than the Indian Army.

The debate over which service should operate the Agni II has led to questions about the adequacy of India's arrangements for nuclear command and control. India has been hesitant to form joint or multi-service commands in past years. However, a joint strategic command reporting to a to-be-established Chief of Defense Staff has been proposed to control nuclear-capable forces. It is uncertain what the relationship of this command would be towards the army-operated Agni regiment. The Indian Air Force, which is highly suspicious that multi-service command arrangements would be dominated by the Indian Army, has strongly opposed this organisational move.

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JANE'S MISSILES AND ROCKETS - OCTOBER 01, 2001

German hardware may have helped launch Agni II

David C Isby

A recent criminal investigation has focused on the transfer of German technology to India's ballistic missile programme, writes David C Isby. The investigation, launched by both Federal German and Bavarian authorities, has drawn attention to German technology-transfer restrictions.

Hunger, a company in Lohr in lower Franconia is being investigated under the Foreign Trade and Payments Law by the public prosecutor's office in Würzburg. In 1997, Hunger is reported to have supplied eight heavy-lift telescopic hydraulic cylinders to India, units which are believed to have been used in the launch pad of India's Agni II intermediate-range ballistic missile (IRBM). The application for export license for the cylinders had specified they were to be used on bridge construction. The value of the contract was described as several hundred thousand German marks.

The Indian government, through an External Affairs Ministry spokesman, has officially denied that the technology in question had

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been used for India's missile programmes.

Hunger has expressed surprise that the cylinders were not used for their intended purpose and knew of no missile-technology applications for these units. The Federal Customs Crime office and the Federal Office for industry and Export Control are continuing to investigate. The BND (Foreign Secret Intelligence Service) is also believed to be involved in the investigation.

· In its latest report to the US Congress of the proliferation of missile technology, the Central Intelligence Agency says, "India continues to rely on foreign assistance for key missile technologies, where it still lacks engineering or production expertise. Entities in Russia and western Europe remained the primary conduits of missile-related and dual-use technology transfers during the latter half of 2000."

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JANE'S MISSILES AND ROCKETS - OCTOBER 01, 2001

ICBM threat is growing, warns CIA

Most nations currently attempting to develop long-range ballistic missiles or even intercontinental ballistic missiles (ICBMs) are dependant on foreign assistance, says US Deputy Director of Central Intelligence, John E McLaughlin. Some states have already decided to go beyond medium-range weapons and develop ICBMs and others may decide to follow them, he told the 4th Annual Space and Missile Defense Conference at Huntsville, Alabama.

"At the expense of other needs, governments willingly devote often-scarce resources to acquire ballistic missiles. And they actively pursue foreign technologies, materials and specialists to compensate for domestic shortfalls and to gain expertise", McLaughlin said.

"The willingness of some to make these technologies available - for a price, to be sure - has enabled emerging missile states to accelerate their current programmes and to lay the groundwork for future systems with greater capabilities and longer ranges."

Such projects will be technologically demanding. "The road to possession of ICBMs is neither short nor straight. Most of the aspiring states are highly dependent on

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foreign assistance. And the complexities of the associated technology are virtual guarantees of delay and frustration. But those obstacles are by no means permanent; we assess that aspiring missile states are likely to overcome them.

"The intelligence community continues to project that as we progress through the next 15 years, our country most likely will face ICBM threats from North Korea, probably from Iran, and possibly from Iraq -- barring significant changes in their political orientations."

The threat posed by such weapons will be very different from that of the ICBM forces of the former Soviet Union. "The emerging missile threats from countries like North Korea, Iran and Iraq will be, not only fewer in number, but lower in terms of accuracy, yield, survivability, reliability and range-payload capability", McLaughlin continued.

Missiles could be fielded with little or no testing. "Some [nations] may see little need for a full-blown test of a long-range ballistic missile. For them, it may be enough to demonstrate their capabilities in the form of a space launch vehicle - a strategy that could achieve the twin goals of deterrence and prestige without the political and economic costs that a long-range ballistic missile test might bring."

McLaughlin singled out North Korea, Iran and Iraq as being of particular concern. A two-stage version of the planned Taepo Dong-2 could reach parts of the US with a nuclear-sized payload, while a three-stage version could reach anywhere in Europe or the US.

Taepo Dong-2 has not yet been flight tested. "The North Koreans are currently observing a self-imposed flight test moratorium. They have announced, however, that they intend to end this moratorium in 2003... In the meantime, the Taepo Dong programme remains very much alive, and the North Koreans have the ability to resume tests with very little warning and deploy the missiles shortly thereafter."

Iran will soon field the 1,300km-range Shahab-3, which is based on the North Korean No Dong. It will be able to reach Israel, most of Saudi Arabia and Turkey. "Tehran's public statements indicate plans to develop longer-range systems. Most analysts believe Iran is likely sometime in the next 10-15 years to test an ICBM that could hit the United States; they further believe such a test could come as early as 2005, although that is less likely given the ground Iran must still cover."

Iran has publicly acknowledged the development of a Shahab-4. This was originally described as being a more capable ballistic missile than the Shahab-3, but later Iranian statements have said that it is a satellite launch vehicle with no military applications. Iran's defence minister has also publicly mentioned plans for a Shahab-5.

The types of missile that Iraq is allowed to develop under UN constraints can target Kuwait, but not Tehran, Riyadh or Manama. In the unclassified version of its regular report to the US Congress on the acquisition, by foreign countries, of technology relating to weapons of mass destruction and advanced conventional munitions, the CIA says, "Development of the liquid-propellant Al-Samoud SRBM [short-range ballistic missile] probably is maturing and that a low-level operational capability could be achieved in the near term - which is further suggested by the appearance of four Al Samoud transporter-erector-launchers [TELs] with airframes at the 31 December Al Aqsa Cal parade. The solid-propellant missile development programme may now be receiving a higher priority, and development of the Ababil-100 SRBM - two of such airframes and TELs were paraded on 31 December -- and possibly longer range systems may be moving ahead rapidly."

McLaughlin believes both types could easily be upgraded to reach longer ranges. "We also believe that Saddam is hiding a small force of Al Hussein SRBMs with a range of 650km, capable of targeting Israel, Iran, Saudi Arabia and Turkey," he told the Huntsville conference. Iraq has rebuilt

several critical missile production sites, and "we think that it, too, could develop an ICBM capability sometime in the next 15 years with foreign assistance".

The suspension of UN sanctions in 1999 has allowed Libya to expand its missile-procurement efforts. The latest CIA report to Congress says, "Libya's current capability probably remains limited to its Scud B missiles, but with continued foreign assistance it may achieve an MRBM [medium-range ballistic missile] capability - a long-desired goal - or extended-range Scud capability".

While Syria has no known plans to develop missiles of greater range than the Scud series, the CIA notes continued work on establishing a solid-propellant rocket motor development and production capability with help from unspecified outside countries. Assistance to Syria's liquid-propellant missile programme has come primarily from North Korea but also from organisations in Russia. "Damascus also continued its efforts to assemble - probably with considerable North Korean assistance - liquid-fueled Scud C missiles", says the CIA report.

McLaughlin recognises the threat posed by alternative delivery systems such as cruise missiles, aircraft, short-range missiles mounted on ships, and truck-delivered and man-portable weapons, noting that "some of these means are cheaper, lower in profile and perhaps more accurate".

He disagrees with those who believe that the existence of such delivery methods makes ballistic-missile defence an expensive irrelevance. "The US intelligence community does not have the luxury of viewing these two threats - ballistic missiles vs other means of delivery - as an 'either/or' proposition. They must each be monitored, deterred and defended against through different mechanisms, for the reality is that they both exist."

Russia, China and North Korea are all involved in exporting missile technology, said McLaughlin: "Last year, Russian entities continued to supply ballistic

missile-related goods and technical know-how to countries like Iran, China and Libya. The transfer of ballistic missile technology to Iran - to cite just one case - was substantial. And we believe it will permit Iran to further accelerate its missile development programmes and to move ever closer toward self-sufficiency in production."

Organisations in China have provided missile-related items, raw materials or other help to several countries of proliferation concern, including Iran, Libya and North Korea, while North Korea is still selling ballistic missile-related equipment, components, materials and technical expertise, having found customers in the Middle East, South Asia and North Africa.

Pakistan is moving toward serial production of solid-propellant SRBMs, such as the Shaheen-I and Haider-I, the CIA told Congress. "Pakistan flight-tested the Shaheen-I in 1999 and plans to flight-test the Haider-I in 2001. Successful development of the two-stage Shaheen-II MRBM will require continued Chinese assistance or assistance from other potential sources."

McLaughlin notes that keeping track of ballistic-missile development programmes is becoming more difficult. "Missile proliferation is a changing business, and the changes are making it harder to track and control, increasing the risk of unpleasant surprise. More players are proficient at the use of denial and deception. They have been aided by continued leaks and disclosures of information revealing the intelligence community's sources and methods, and helping states involved in proliferation to conceal their activities."

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STRATEGIC & SUB-STRATEGIC

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JANE'S MISSILES AND ROCKETS - OCTOBER 01, 2001

Minuteman cutbacks completed

The US has completed the conversion of 150 Minuteman III intercontinental ballistic missiles (ICBMs) to a single-warhead configuration, and the destruction of a total of 149 Minuteman III missile silos. Both measures were required by the Strategic Arms Reduction Treaty I (START 1) negotiated in the 1980s between former US President Ronald Reagan and former Soviet leader Mikhail Gorbachev.

US Air Force missile maintainers from the 90th Space Wing completed the field reconfiguration of the wing's Minuteman III missiles four months early. The missiles at FE Warren Air Force Base (AFB) were converted from the original configuration in which each carried three multiple re-entry vehicles (MRVs), and each now carries only a single warhead (single re-entry vehicle - SRV).

The conversion task started on 23 November 1998, and each missile took four to six days to reconfigure. During the three years required to modify all the missiles, Russian delegations carried out five on-site inspections.

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"Placing the final SRV into the last silo was a momentous occasion," said Col Thomas Shearer, 90th Space Wing commander. "The fact that it happened months in advance of the deadline date is due to the dedication and expertise of all the maintainers at both the weapon storage area - where they reconfigured all the missiles from a MRV to an SRV - and to the missile maintainers, who placed the SRVs back into the silos. Their hardworking efforts, along with supporting security forces teams, missile crew members and medical personnel, brought every missile back to full operational capability with minimal delay."

Under the treaty, the US and Russia will both reduce their ICBM force to 6,000 warheads. "The SRV programme is only one piece of the START I treaty puzzle, but it's a very important piece," says Rex Ellis, a treaty-compliance specialist at the 90th Space Wing. "[FE] Warren's portion of the treaty was to decommission 300 RVs. Reductions are also being made to the [US] bomber fleet and the sea-launch ballistic missile structure."

A final stage of the process of meeting the treaty requirements will be to destroy 150 MRV bulkheads, the portion of the missile that connected the MRVs to the rest of the missile. These will be smashed with sledgehammers, a task due to be completed by 5 December.

Destruction of the last Minuteman silo took place in late August when 360kg of explosive was detonated in missile silo H-22, the last but one of 150 silos that were part of Grand Forks AFB, near Petersburg in North Dakota. The final example is being converted into a museum site. The first silo implosion at the Grand Forks missile complex took place on 6 October 1999. Contractors imploded 13 more that year, then 86 silos in 2000, and 49 this year.

A total of 360kg of explosives destroyed the walls of the silo, making it unusable (Source: USAF)

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JANE'S MISSILES AND ROCKETS - OCTOBER 01, 2001

'Rogue state' has fired shipboard ballistic missile

A nation identified only as a 'rogue state' has successfully demonstrated the shipboard launch of a ballistic missile, US Defense Secretary Donald H Rumsfeld told a group of local journalists during his recent visit to Russia. "A weapon of mass destruction can be delivered over intercontinental range by a ballistic missile that has less than intercontinental range", said Rumsfeld. One technique "is to put it on a ship, peel back the cover, use a transporter-erector-launcher, and fire it from a distance shorter than ICBM range. That has been done".

He provided few details, saying in response to questions: "I'm calculating in my mind what is classified and what is not." However, he confirmed that "a rogue state has done that... They have fired a ballistic missile from a ship simply by peeling back the top, erecting it, firing it off, launching it a good distance, and covering it back up and moving the ship away".

Asked whether some potentially hostile nations were preparing to manufacture chemical or biological missile warheads, he said, "Yes, there is proof that rogue states have demonstrated the use of chemical

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weapons on ballistic missiles".

He declined to identify the specific countries involved. The term 'rogue states' was "an imperfect phrase" he told the journalists, "but certainly you would include in that category North Korea and Iraq and Iran and Libya - and North Korea".

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

BAT submunitions deployed from ATACMS

During a test carried out at the White Sands Missile Range, New Mexico, by the US Army Aviation and Missile Command and Northrop Grumman Land Combat Systems, an Army Tactical Missile System (ATACMS) successfully deployed Brilliant Anti-armor Submunitions (BATs) against a moving array of various armoured vehicles equipped with countermeasures.

After they were dispensed from the ATACMS missile, the individual BAT submunitions deployed their aerodynamic surfaces, acoustically acquired the moving targets and manoeuvred to the target area. The submunitions recorded hits on all three types of target vehicles (tanks, armoured personnel carriers and self-propelled howitzers), despite the presence of countermeasures.

Some of the BATs were fitted with warheads, while others carried flight data recorders to gather information needed to verify the results of pre-test modelling and simulations. "A preliminary evaluation indicates that the flight test was highly successful, with all submunitions appearing to operate reliably," says Emmitt Gibson,

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vice-president of Precision Munitions at Northrop Grumman's Electronic Systems sector. Although official figures are not yet available, it appears BAT's performance exceeded the Army's operational requirements.

BAT is currently in low-rate initial production at Northrop Grumman's Land Combat Systems facility in Huntsville, Alabama. The company is under contract to supply the Army with approximately 1,200 submunitions.

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TACTICAL SURFACE-TO-SURFACE

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

Missiles and PGMs could provide future US Army fire-support

In the wake of the decision by the US Department of Defense to cancel the 155mm Crusader self-propelled gun programme, the US Army is considering how missiles and precision-guided artillery projectiles could be used to provide future indirect-fire capability.

Announcing the cancellation on 26 April, US Deputy Secretary of Defense Paul Wolfowitz said: "This decision is not about killing a bad system. This decision is about cancelling a system originally designed for a different strategic context, to make room for more promising technologies that offer greater payoffs and are more consistent with the Army's overall transformation effort.

"We are working with the Army on the details of where we would propose to reallocate their Crusader funding. However, the emphasis will be on those systems and technologies that provide greater precision, more rapid deployability and the ability to integrate fires."

The need for artillery has definitely not gone away, Wolfowitz confirmed: "What we are

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hoping to do with this decision is to accelerate our ability to have very precise artillery fires and to accelerate that transformation the Army has correctly identified of a more rapidly deployable, more highly networked force...

"If resources were infinite, there's no question we'd go ahead with Crusader and we'd go ahead with these other things. Some of them are future generation; in that sense you might say we're skipping a generation. Some of them we think - like more accurate artillery rounds - are actually things that might come in even in the same time frame or possibly even earlier than Crusader." Missile developments that might provide future firepower include the Excalibur guided artillery shell, and a speeded-up Guided MLRS (multiple launch rocket system) or HIMARS (high-mobility artillery rocket system), said Wolfowitz.

The requirement for indirect-fire systems, able to operate in all weathers against point or area targets, remains, said Secretary of the Army Thomas E White: "That requirement is valid and has to be met." In the absence of Crusader, it will be met "through a different combination of programmes - and it's the details of all that that we are currently working on". ·

The Lockheed-Martin HIMARS is one of the systems which may have to fulfil the role originally planned for the Crusader self-propelled gun. (Source: Lockheed Martin)

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

Product-improved SMArt round passes first test

GIWS (Gesellschaft für Intelligente Wirksysteme) has successfully completed the first lot-acceptance test of its Product Improvement (PI) SMArt 155 gun-launched munition. This new variant incorporates a scan pattern whose increased 'footprint' more than doubles the target search area.

A total of 15 SMArt 155 PI submunitions were delivered over the target array during the test, which was conducted on 23 April by the German government. The system achieved seven hits, eight near misses and 100% reliability. This successful completion of the first PI production lot clears the way for delivery of the improved munition to the German Army.

In full-rate production for the German Army since 1998, SMArt 155 is an advanced 'fire-and-forget' artillery projectile that employs a millimetre-wave radar, radiometer and an infrared sensor to detect artillery and armoured targets in all weather and environmental conditions. It is the only gun-fired multisensor smart munition system currently in production.

GIWS is a joint-venture company owned by the German companies Diehl Munitions

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Systeme and Rheinmetall DeTec AG. It has delivered more than 3,000 SMArt projectiles to the German artillery forces under a contract that calls for total production of 9,000 projectiles over the next several years.

SMArt 155 is demonstrating reliability levels unmatched by any gun-fired system in either development or pre-production, says ATK, whose recently-formed Precision Systems Group will be the prime contractor for marketing and manufacturing the round in the US.

"The entry of the product-improved munition into service with the German Army is a significant milestone that cements the system's leading position as the only 155mm smart artillery projectile currently in full production - as well as the first extended footprint munition to move into production," says ATK director of business development, Charles Farnham.

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

Netherlands considers Tomahawk purchase

David C Isby

The Netherlands is considering the possible procurement of US Raytheon Tomahawk Land Attack Missiles (TLAMs), writes David C Isby. A feasibility study of the use of TLAMs has started, according to press reports, and is expected to end later this year.

Unlike the UK Royal Navy, which currently uses the TLAM exclusively from submarines, the Netherlands study is examining the TLAM primarily as an armament option for its new four-ship De Zeven Provincien-class destroyers. The proposed procurement would be integrated with the Netherlands' contributions to the NATO DCI (Defense Capabilities Initiative).

Smaller NATO members - such as the Netherlands - are starting to follow the lead given by larger members such as France, Germany and Italy in looking at the potential for naval cruise missiles. Norway has already looked at this option.

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KBM inspects Yemen's Tochkas

David C Isby

Russia's Kolomna Machine Building Design Bureau (KBM) has carried out an inspection of 80 Tochka (SS-21 'Scarab') short-range ballistic missiles in service with Yemen, writes *David C Isby*. Yemen inherited the missiles from the former People's Democratic Republic of Yemen (PDRY), which had procured them from the former Soviet Union.

The PDRY, along with Syria, was the only third-world customer for the SS-21, reflecting the higher cost of this sophisticated weapon compared with its liquid-propellant predecessors.

It was not reported what the condition of Yemen's SS-21s is, but that country's Soviet-built equipment is thought to largely have low serviceability. Considering the service life of Soviet-built solid-propellant rocket motors, these SS-21s are likely to require upgrading if they are to remain in service.

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TACTICAL SURFACE-TO-SURFACE

Date Posted: April 23, 2002

JANE'S MISSILES AND ROCKETS - MAY 01, 2002

Excalibur may become US-Swedish programme

David C Isby

The US Army's Raytheon XM982 Excalibur 155mm GPS/INS guided artillery round, which successfully completed its initial testing in 2001, may incorporate technology developed for the Swedish Bofors Trajectory Correctable Munition (TCM), writes *David C Isby*. Excalibur has been in the engineering and manufacturing development phase since 1998. With neither the US Army nor Congress moving to rescind the cancellation of the SADARM guided submunitions artillery shell programme, Excalibur takes on additional importance as the US Army's only guided tube-artillery programme.

In Fiscal Year 1999, the US Congress ordered a foreign co-operative programme with Bofors and its US partner, Science and Applied Technologies (SAT) of San Diego California. The US Army has looked at the TCM as an alternative to the Excalibur and provided developmental funding to Bofors for the TCM in July 2001, but claims it does not have sufficient funds for a traditional

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competition between the two designs.

The US and Swedish armies are looking at the possibility of developing a common requirement that could be met by an international programme to develop a single pattern of guided round. Alternatively, an interchange of technologies between the two programmes may be carried out between the two prime contractors.

Excalibur uses GPS-based guidance, while the TCM uses a mid-course guidance system in which a ground-based tracking radar follows the TCM round in flight, transmitting course corrections via an ECM-resistant datalink. The US weapon could, in theory, benefit from the TCM's terminal-correction guidance capability, which would provide better accuracy in the event of GPS jamming or interference, but in practice it may be difficult to reconcile the two guidance philosophies in a single design. Another problem is that the US tends to cancel international programmes and rely on domestic substitutes.

Excalibur uses a built-in GPS receiver to measure its trajectory. (Source: Raytheon)

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TACTICAL SURFACE-TO-SURFACE

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JANE'S MISSILES AND ROCKETS - MAY 01, 2002

BRIEFS - More funding for earth-penetrating missile

Lockheed Martin is to receive a US$1.94 million increment to a US$15.6 million contract for Tactical Missile System Penetrator Demonstration (TPD) Missile System Integration. This work will be performed in Dallas, Texas, and is expected to be completed by 30 November 2004. The TPD programme is intended to demonstrate the effectiveness of an Army TACMS prototype missile fitted with a US Navy non-nuclear earth penetrator warhead section.

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TACTICAL SURFACE-TO-SURFACE

Date Posted: April 23, 2002

JANE'S MISSILES AND ROCKETS - MAY 01, 2002

BRIEFS - Team ERGM wins Vanguard Award

The US Navy/Raytheon Company Team ERGM has received the Vanguard Award from the Navy's Program Executive Office for Surface Strike for the successful guided flight test of an Extended Range Guided Munition (ERGM). Controlled Flight Test-2 (CTV-2) was fired at the White Sands Missile Range, New Mexico, on 10 December 2001,

Presenting the award, Navy ERGM programme manager Captain Herb Hause, described CTV-2 as "the most advanced and complex munition ever fired from a gun". Accomplishments cited by Capt Hause and Rear Admiral C S Hamilton, programme executive officer, Surface Strike, were successful operation of the round's guidance and electronics unit; canard/tail fin deployment and operation; telemetry acquisition and data transmittal; rocket motor ignition and burn; and GPS acquisition, track, reacquisition and guided flight to a point target.

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TACTICAL SURFACE-TO-SURFACE

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JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

BRIEFS - MLRS for Egypt

Lockheed Martin Missile and Fire Control is being awarded a US$36.13 million increment as part of a US$72.26 million modification to contract DAAH01-00-C-0044 for 485 Extended Range Multiple Launch Rocket System (MLRS) rockets for Egypt. These are due to be manufactured in Camden, Arkansas (94%) and Grand Prairie, Texas (6%), and should be completed by 31 October 2003.

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TACTICAL SURFACE-TO-SURFACE

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JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

BRIEFS - South Korea orders ATACMS Block 1

Lockheed Martin Missile & Fire Control is to supply 110 Army Tactical Missile System (ATACMS) Block I Foreign Military Sales-variant guided missile and launching assemblies, one guided missile and launching assembly, and flight-test support for South Korea. These are being funded by a US$80.74 million modification to firm-fixed-price contract DAAH01-98-C-0093, and were due to be completed by the end of 2001.

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JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

GMLRS rocket makes successful flight test

The US Army and Lockheed Martin Missiles and Fire Control have successfully conducted the first engineering development flight test (EDT) of the Guided Multiple Launch Rocket System (GMLRS) rocket.

The missile was launched at White Sands Missile Range, New Mexico, on 7 November 2001, using an MLRS M270 launcher. Major test objectives included the successful launch of the missile from the canister, nominal motor performance, tail-fin deployment and rotation, as well as telemetry, guidance and control system performance. Preliminary data indicated that all test objectives were successfully achieved.

"Our international team's ability to work together and maintain programme schedule, in part, is what made this first engineering and development test a success," says Ron Abbott, vice-president of Fire Support at Lockheed Martin Missiles and Fire Control. "We are very pleased with the programme's progress." Six EDT tests are planned.

The GMLRS rocket programme is an international co-operative programme between France, Germany, Italy, the UK and the US. The new rocket incorporates a global positioning system (GPS)-aided inertial

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guidance package integrated on a product-improved rocket body. Small canards on the GMLRS rocket nose will provide the basic manoeuvrability needed to enhance the accuracy of the system. GMLRS initial operational capability (IOC) is scheduled for Fiscal Year 2004.

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JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

Lockheed Martin conducts second Netfires test

Lockheed Martin Missiles and Fire Control has conducted a successful Boost Test Vehicle (BTV-1) flight-test demonstration of technology related to the company's NetFires Loitering Attack Missile (LAM). The test was conducted at the Naval Surface Weapons Center - Dahlgren facility in Virginia. Initial data indicates all test objectives were achieved.

This is the second in a series of increasingly difficult tests resulting in a vertically-launched family of canistered missiles for wide-area search, automatic target recognition, networked/co-ordinated attack and precision strike.

The company is under contract to the US Defense Advanced Research Projects Agency (DARPA) to develop technology for the NetFires LAM missile - one of two weapons which will form part of the planned Netfires system. A joint DARPA/US Army co-operative programme, intended to demonstrate future weapons technology, Netfires will develop techniques able to deliver beyond line-of-sight fire to support the Future Combat System (FCS). The system will be networked, and will include a

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remotely-controlled, platform-independent launcher and two patterns of missile - the LAM and the Precision Attack Missile (PAM). Rival designs for both missiles are also being developed by Raytheon.

The LAM is intended to be a relatively slow-moving missile with a maximum speed of around 250mph and the ability to loiter over target areas more than 25km from the launcher. A developed version could have a 30min loiter time at ranges of up to 100km.

The BTV-1 test involved a lightweight closed-breech launch tube and solid-propellant rocket booster, and collected data to validate small tactical-missile, vertical-launch simulations and design data for launch canister and missile components. Lockheed Martin Naval Electronic Surveillance Systems-Marine Systems in Baltimore, Maryland, designed and built the canister and launcher. Additional NetFires launcher and missile testing is planned through Fiscal Year 2003.

An earlier trial conducted in mid-2001 was intended to validate the NetFires lightweight composite vertical launcher and solid-propellant rocket booster (see Jane's Missiles & Rockets, July 2001, p3).

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Date Posted: December 13, 2001

JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

Taiwan pushing ahead with SRBMs

Wendell Minnick

The Republic of China (ROC/Taiwan) is progressing with the development of a short-range surface-to-surface ballistic missile (SRBM) capability with a 300km range, writes Wendell Minnick. According to a report in the Taipei Times, the missile - tentatively planned to be based on Penghu Island in 2007 - will allow for limited strikes inside Fujian province on the Chinese mainland.

An ROC official told Jane's that the programme has been under development since 1999, and the missile is a modified Tien Kung (Sky Bow) surface-to-air missile (SAM). The official defended Taiwan's right to develop SSM capabilities, saying this is a "reasonable alternative for Taiwan's defence situation in the future, and that the range of the Tien Kung is within [the limits of the] Missile Technology Control Regime [MTCR]". The MTCR covers ranges of 300km and payloads of 500kg, but Taiwan is not a signatory.

ROC President Chen Shui-bian unveiled an offensive policy in June 2000. Dubbed the 'offshore full-scale engagement' policy, this focuses on a pro-active defence that includes

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'surgical strikes' by 'defence deterrent weapons systems'. The new weapons include an anti-radiation missile based on the Tien Chien (Sky Sword) air-to-air missile, a land attack cruise missile (LACM) based on the anti-ship Hsiung Feng (Brave Wind) missile (HF-2E), and there are now plans for the development and deployment of an SRBM (see Jane's Missiles & Rockets, October 2000, p16).

Taiwan is also reported to be developing a medium-range SSM capability. The existence of the Tiching programme to build a 1,000km-range missile was denied by the ROC military. However, an official of the Chungshan Institute of Science and Technology (CSIST) stated the difficulty was not in the development of a medium-range missile, but in finding a reliable guidance system.

Tiching is derived from 'Ti' for Tsu Ti, a national hero of the Eastern Tsin Dynasty, who was a great warrior, while 'Ching' comes from a poem in Yueh Fei's poem 'Manchianghung', which states, "First wash away humiliation and then take vengeance".

A US government official has told Jane's that there is doubt Taiwan, though not an MTCR member, would violate MTCR restrictions (300km-range and 500kg payloads). "There is a lot of smoke on a ballistic programme, but no real fire yet," the official said. However, the official did not exclude an SRBM programme.

Taiwan cancelled its first SSM Tien Ma (Sky Horse) programme due to US pressure in 1993. Tien Ma is reported to have had a range of 950km, and several examples were constructed before the cancellation. ROC military officials still express bitterness over US pressure to cancel the programme. Taiwan faces a Chinese force of about 100 Dong Feng-11 (M-11) and 300 Dong Feng-15 (M-9) tactical missiles, which are expected to increase by 50 annually to reach a total of 650 in 2005.

· Taiwan will purchase 60 locally-developed RT-2000 (Thunder 2000) MLRS systems for the ROC army. Developed by the Missile

and Rocket Systems Research Division of the CSIST, these will be deployed for coastal defence on Taiwan and Penghu Island, and will replace the earlier 117mm-calibre Kung Feng-6 (Worker Bee-6).

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TACTICAL SURFACE-TO-SURFACE

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JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

TLAM may be fired from a modified SLBM tube

David C Isby

The US Navy (USN) may conduct an underwater launch of a Tomahawk Land Attack Cruise Missile (TLAM) from a modified Trident submarine-launched ballistic missile tube as early as late 2002, writes David C Isby. The experiment is considered vital for the proposed modification of two or four Trident ballistic-missile submarines (SSBNs) to guided-missile submarines (SSGNs) armed with TLAMs.

The test is part of a proposed acceleration of the SSGN programme. The USN budget request for Fiscal Year 2002 (FY02) included US$86 million for a two-SSGN programme. The House Armed Services Committee added US$463 million to cover four SSGN conversions. How big the programme will be and how soon it will be ready depends on the level of funding which will eventually be signed into law.

Engineering work on modification of the Trident missile tube to accommodate up to eight TLAMs is currently in progress. However, the proposed 2002 test would not necessarily be of the final tube configuration,

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but rather to demonstrate the principle. It has been proposed that the SSGNs can use modified versions of the Lockheed Martin Mk 41 fire-control system and Mk 98 vertical-launch system currently used on surface warships.

The USN plans that the main armament of the SSGN will be the Raytheon Tactical Tomahawk. No problems are expected with the vertical-launch technique, since the Tactical Tomahawk was designed to be launched from the in-hull vertical-launch tubes on the later-model SSN 688-class submarines.

Unlike earlier versions, Tactical Tomahawk cannot be launched from torpedo tubes, the only launch method available to earlier attack submarines or those of the UK Royal Navy. Within the next few months, the USN is expected to launch a 30-month engineering and manufacturing development (EMD) programme, with Raytheon as prime contractor, to test and integrate a breakaway low-cost protective capsule that would be used to protect the Tactical Tomahawk if fired from a torpedo tube. The project is being carried out in co-operation with the UK and is receiving UK funding. The goal is for the capsule to cost 20% less than production Tactical Tomahawks, which will cost US$150,000 (in FY00 dollars).

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TACTICAL SURFACE-TO-SURFACE

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JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

Russia to replace Tochka with Iskander

David C Isby

The Russian Army will replace its 9K79 Tochka (SS-21 'Scarab') tactical ballistic missiles (TBMs) with the KB Mashinostroyenie Iskander (SS-X-26 'Stone'), writes David C Isby. Lieut Gen Vladimir Zaritskiy, the head of the Russian Army's Missile Troops and Artillery, told reporters that the Iskander will be phased in over the next three to four years.

Although designed as a division-level system, the Tochka currently serves in the Russian Army's army-level TBM brigades, where it has largely replaced the older SS-1c 'Scud'. Russia has made heavy use of the missile in Chechnya.

The Iskander has undergone extensive trials, and is expected to become operational within the next year (see Jane's Missiles & Rockets, April, 2001, p5). When the missile enters service, its Western designation will become SS-26.

Russia hopes to export the Iskander, which it claims is compliant with MTCR (Missile

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Technology Control Regime) guidelines on range and payload. There have been unconfirmed reports that one unidentified customer has already ordered the weapon. By introducing the system into Russian service and setting up a Russian training base, Russia hopes to increase the appeal of the system to potential export customers.

The Iskander missile is carried by a wheeled transporter-erector-launcher (TEL) vehicle.
(Source: Miroslav Gyürösi)

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JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

Royal Navy orders 48 TLAM Block IIIC missiles

The UK has told the US government that it wants to procure a further 48 Raytheon Tomahawk TLAM Block IIIC missiles, writes David C Isby. This request followed the launch of TLAMs from UK Royal Navy (RN) submarines during the opening stages of the allied air offensive against Taliban-controlled portions of Afghanistan.

The RN purchased an initial batch of 65 Block III TLAMs. A follow-on order for 30 more was announced in 1999 to replace rounds used when UK submarines took part in the air offensive against the former Yugoslavia in 1999. It is uncertain if any deliveries from this second lot have yet taken place.

As production of Block III TLAMs has halted, the British requirement will have to be met by supplying upgraded ex-US Navy early-model Tomahawks. While this places US and British re-equipment needs in conflict, Raytheon has accelerated the rate of TLAM Block IIIC conversions. This speed-up was funded by the US supplemental appropriations following the 11 September attacks on New York and Washington.

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No figures have been released for the number of British TLAMs that have been used against the Taliban. Two Triumph-class nuclear attack submarines (Trafalgar and Triumph) equipped to launch TLAMs have been in the area of operations. Splendid and Spartan are also equipped to fire TLAMs. Current planning is that at least one of these submarines will remain on station to provide TLAM support for sustained operations in Afghanistan.

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JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

HIMARS fires MLRS and ATACMS rounds

Two Technical Demonstration (TD) test firings have demonstrated the ability of Lockheed Martin Missile and Fire Control's High Mobility Artillery Rocket System (HIMARS) to fire the current Multiple Launch Rocket System (MLRS) Family of Munitions (MFOM). In early October, HIMARS successfully fired 18 MLRS Extended-Range rockets at White Sands Missile Range, New Mexico, and in mid-October, a HIMARS TD launcher successfully fired an Army Tactical Missile System (Army TACMS) Block IA missile.

Lockheed Martin Missiles and Fire Control developed and built four operational HIMARS prototypes as part of the US Army's Rapid Force Projection Initiative Advanced Concept Technology Demonstration contract, which was awarded to the company in March 1996. Three of the wheeled vehicles (a platoon) are undergoing user evaluation at the Army's XVIIIth Airborne Corps Artillery, while the company uses the fourth vehicle for testing and evaluation.

In December 1999, the programme entered engineering and manufacturing development (EMD). Six HIMARS launchers will be built

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for engineering and development testing - four for the US Army and two for the US Marine Corps.

HIMARS is based on a wheeled vehicle, but uses the same fire-control system, electronics and communications units as the tracked M270A1 launcher. It is C-130 transportable, so can be deployed by air into areas inaccessible to the larger aircraft required to transport the standard MLRS launcher.

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JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

Hard-target ATACMS to begin development

David C Isby

A hard and deeply-buried target defeat (HDBTD) version of the Lockheed Martin Army Tactical Missile System (ATACMS) is to be produced by Fiscal Year 2004 (FY04), writes David C Isby. Designated the Tactical Missile Penetrator (TACM-P), it will be developed as an advanced-concept technology demonstration (ACTD) programme, starting in FY01 and being completed in FY04.

The TACM-P ACTD will integrate an ATACMS booster with a Navy-developed HDBTD warhead to provide a high-availability, all-weather, survivable weapon with a short response time and the ability to destroy hard and deeply- buried targets within the Korean theatre. The programme has been endorsed by three Commanders-in-Chief (CINCs) to solve urgent needs within their theatres. US Pacific Command is the operational sponsor.

Lockheed Martin is to be the prime contractor, and will carry out the ACTD together with Sandia National Laboratories. As with all ACTDs, there will be, on completion of a programme, a 'leave behind'

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operational capability available to a US regional CINC. This operational capability will consist of any unexpended research and development missiles remaining from the nine being procured for the ACTD, plus any follow-on buys.

The FY01 stage of the ACTD includes definition of the interface requirements and the start of software and hardware design. Design completion and the start of missile body re-entry tests are scheduled for FY02. Funding through FY02 is US$24 million, with an undisclosed sum still being required to complete the ACTD. The final stages of the programme will include demonstrating the capability of the TACM-P missile, probably in a live fire test.

Proposals for a HDBTD version of ATACMS date to 1996-97. The proposal was originally designated ATACMS Block III, and much of the work on the new missile will draw on these earlier designs.

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TACTICAL SURFACE-TO-SURFACE

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JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

Excalibur unguided test firings are successful

David C Isby

The Raytheon Missile Systems XM892 Excalibur guided 155mm artillery projectile has successfully completed a series of unguided firing tests at the Yuma Proving Grounds, Arizona, writes David C Isby. The success of these trials has cleared the way for guided flight tests, which are considered to be the critical part of the programme. The first launches of the Excalibur's GPS/INS unit took place in 2000. Excalibur is designed to achieve a guided circular error probable (CEP) of 6m, rising to 9m in the presence of GPS jamming.

The most recent round of test firings concentrated on the Excalibur round's airframe, which was developed by General Dynamics Ordnance, with Tactical Systems Division as a subcontractor. Ballistic and sealant ring performance and structural capability were all found to meet requirements.

The projectile currently being tested is a unitary rather than a submunitions round.

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The Excalibur programme changed direction last December to emphasise unitary warhead development before that of a submunitions round, reflecting the requirements of the US Army's Initial Brigade Combat Teams, including the need for precision effects, limiting collateral damage and reducing the risk of leaving unexploded munitions in the target area. Excalibur is expected to enter service in Fiscal Year 2006-07.

Three versions of Excalibur have been proposed; all share the same guidance system.
(Source: Raytheon)

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JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

Bulgaria to scrap its 'Spiders'

David C Isby

Bulgaria has finally decided to scrap its Soviet-built 9K714 Oka (SS-23 'Spider') theatre ballistic missiles (TBMs), writes David C Isby. When these missiles are phased out, Bulgaria will no longer have TBMs and the SS-23 will no longer be in service anywhere in the world. Recent Bulgarian press reports have described Bulgaria as having eight SS-23 TELs and "two or three dozen" missiles.

The decision to scrap the SS-23s was announced at a cabinet meeting in Sofia on 24 September. Answering questions in Parliament on 19 October, Defense Minister Nikolai Svinarov said that, while scrapping the SS-23s will formally require a government proposal and a parliamentary decision, the TBMs are cold-war leftovers that do not fit in with Bulgaria's defensive national security strategy.

The US had long been pressing Bulgaria to scrap its SS-23s. The issue has been raised repeatedly since 1997, most recently in January 2001 and during US Senator Richard

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Lugar's visit to Sofia in August. A commitment by the Bulgarian government to do this has been seen as one of the conditions for Bulgarian admission to NATO. The schedule for the phase-out, and details of who will pay the costs have not yet been announced.

These disassembled Russian 9K714 Oka missiles show what appear to be active-radar slot antennas on the nosecone sections. (Source: Jane's Strategic Weapon Systems)

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TACTICAL SURFACE-TO-SURFACE

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JANE'S MISSILES AND ROCKETS - NOVEMBER 01, 2001

MBDA to join guided-MLRS consortium

MBDA will join Euro Rocket System, the joint venture set up by Lockheed Martin and Diehl to handle the international Guided Multiple Launch Rocket System (GMLRS) programme. The resulting extended Euro Rocket System GmbH will act as a single contractor to handle the European side of the planned transatlantic co-production programme.

The GMLRS programme is intended to produce a new high-accuracy rocket for use from MLRS launchers. The new round will have more than double the range of the current rocket, and carry a bomblet payload. It will replace the current unguided rocket, whose production has ended.

GMLRS will retain the current six-round launcher pack, two of which are carried by each MLRS launch vehicle. The main launcher modification will be to add a fire-control system able to handle guided rounds, and it is possible that the European partners could opt to use the M270A1 upgraded launcher developed for the US Army.

Currently in the engineering and

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manufacturing development (EMD) phase, the programme is being funded by the US, France, Germany, Italy and the UK. The US provides 50% of the funding, while each of the European partners provides 12.5%. Prime contractor is Lockheed Martin Missiles and Fire Control.

Two of the companies which will make up MBDA - Aerospatiale Matra Missiles and Matra BAe Dynamics - are already involved in the MLRS programme. Aerospatiale Matra Missiles already participates in production of MLRS rounds and in launcher manufacture. Both are involved in the Future Fire Control Study, FFOR Anti-Armour Study, and are part of the GMLRS Systems team working with Lockheed Martin on EMD.

The European share of the programme will involve around £1 billion (US$1.4bn) of procurement, and the first deliveries will be able to meet the timescale required by the UK. The extended Euro Rocket System will also be able to take part in efforts intended to exploit the growth capability of the basic GMLRS design. Possible developments include sensor-fuzed or terminally-guided submunitions, and trajectory shaping that could be used to conceal the launch point from enemy radars, preventing counter-battery fire.

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TACTICAL SURFACE-TO-SURFACE

Date Posted: October 24, 2001

JANE'S MISSILES AND ROCKETS - NOVEMBER 01, 2001

Smart round guides, but fails to use rocket boost

ATK Tactical Systems has conducted two gun-launched tests of the Autonomous Naval Support Round (ANSR), a low-cost, precision-guided projectile for ship-to-shore fire support. The test follows two successful static test firings and earlier flight-demonstration tests.

During the test firings from the Wallops Island flight facility in southeastern Virginia, on 26 September, two unguided ANSR rounds were fired from a standard US Navy 5in 54-calibre gun. Test objectives included:

· gun-launch survivability (at full operational gun propellant charge) of the tactical airframe, rocket motor, telemetry unit and inertial sensors;

· satisfactory gun-gas dynamic sealing (obturation);

· proper fin deployment;

· stable, low-drag flight; and

· confirmation of greater than 50nm range.

Gun instrumentation, video, radar and telemetry were used to record performance parameters. This data showed that all but the

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final test objective had been met.

"We are disappointed that a test-configuration rocket motor initiator did not operate, thereby preventing flight to maximum range and a clean sweep of test objectives", said Dan Murphy, president of ATK Tactical Systems. "We will fix and test the initiator within two weeks. Because the operational unit will use a different electronic initiator, no operational design change is needed.

"Looking ahead, we will return to Wallops Island in early November to fly 50nm from a standard Navy 5in/54[-calibre] gun. Next spring we will begin guided flight testing."

ATK is developing ANSR to meet the fire-support needs of ground forces using the existing 5in 54-calibre gun, more than 100 of which are currently in service. "In tandem with the round under development for the larger 5in/62[-calibre] gun being introduced in new-construction destroyers, ANSR provides the existing fleet with long- range, affordable fire-support capability," says Murphy.

As the lead contractor of the consortium developing the ANSR, ATK Tactical Systems is responsible for system integration and the solid-propellant rocket motor. Other team members are Custom Analytical Engineering Systems (airframe, warhead and control actuation) and Draper Laboratory (guidance electronics and navigation).

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Date Posted: October 24, 2001

JANE'S MISSILES AND ROCKETS - NOVEMBER 01, 2001

BRIEFS - MLRS support contract awarded

Lockheed Martin Missiles and Fire Control is being awarded a US$11 million increment as part of a US$111.02 million contract for industrial engineering services related to Multiple Launch Rocket Systems for France, Germany, Italy, and the UK. This work is not intended to produce hardware in support of any specific production contract, and will be carried out in Grand Prairie, Texas (99.1%), and Camden, Arkansas (0.09%). Completion is expected by 31 March, 2004.

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TACTICAL SURFACE-TO-SURFACE

Date Posted: October 24, 2001

JANE'S MISSILES AND ROCKETS - NOVEMBER 01, 2001

BRIEFS - LRIP ATACM contract

Lockheed Martin Missiles and Fire Control has received a US$165 million contract, with US$82.4 million of the contract initially funded, for production of the Army TACMS Block II Missiles. The Low-Rate Initial Production (LRIP-IIIA) contract from the US Army Aviation & Missile Command, Redstone Arsenal, Alabama, covers 19 Tactical Block II/BAT missile systems, three test missiles, and logistics and test support requirements. Manufacturing will be done at the company's Dallas and Horizon City, Texas, facilities and will be completed in December 2003.

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Date Posted: October 24, 2001

JANE'S MISSILES AND ROCKETS - NOVEMBER 01, 2001

Egypt to buy ER-MLRS

The US Defense Security and Co-operation Agency has notified the US Congress of a possible Foreign Military Sale of Extended-Range Multiple Launch Rocket Systems (ER-MLRS) to the Egyptian government. The proposed order would be worth US$354 million and will include:

· 26 ER-MLRS with fire-control panels;

· 485 six-round ER-MLRS rocket pods;

· 22 six-round reduced-range practice rocket pods;

· one MLRS fire-control proficiency centre;

· three M-88A2 recovery vehicles;

· 30 M577A2 command post carriers;

· 29 AN/VRC-89 E, 57 AN/VRC-90E and 60 AN/VRC-93 E Single-Channel Ground and Airborne Radio System (SINCGARS) radios;

·training, maintenance and logistic support.

The prime contractor will be Lockheed Missiles and Fire Control of Dallas, Texas.

The ER-MLRS will allow the Egyptian Army to continue developing "a defensive area-fire capability to counter hostile

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long-range artillery as well enhance its interoperability with US forces", says the formal notification sent to Congress. The SINCGARS radios will be needed to meet the Egyptian Army's "strategic commitments for complete communications interoperability and standardisation of equipment" and allow it to communicate with its various vehicles and with US forces.

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TACTICAL SURFACE-TO-SURFACE

Date Posted: September 19, 2001

JANE'S MISSILES AND ROCKETS - OCTOBER 01, 2001

Smerch MLRS offered on lengthened Tatra chassis

Miroslav Gyürösi

One surprise at the MAKS 2001 defence exhibition was the appearance of the 12-round 300mm-calibre Smerch multiple launch rocket system (MLRS) on a new chassis, writes Miroslav Gyürösi. The 9A52-2T transporter-erector-launcher (TEL) vehicle mounts a pack of twelve 300mm launch tubes plus the associated fire-control systems on a lengthened 10x10 version of the Czech-made Tatra T816 wheeled chassis.

The basic 8x8 version of the T716 was developed from the standard T815 8x8 to meet a requirement from the United Arab Emirates. It employs the traditional and proven Tatra chassis concept with a central backbone tube and independently-swinging semi-axle wheel suspension.

The original Czech-made engine and transmission has been replaced by a 400kW Deutz BF 8M 1015C engine and a US automatic six-speed twin-disc transmission. The vehicle has the unique feature that the automatic transmission is incorporated into

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the backbone structure of the chassis.

The 9A52-2T is fitted with an ABUS (Aparatura Boyevovo Upravleniya i Svyazi) system for combat-control and communication, plus an ASUNO (Avtomatizirovanaya Sistema Upravleniya Navedeniyem i Ognom) automated system for targeting and firing.

These two systems provide:

· automated fast transmission and reception of tactical information;

· display and storage of this information;

· protection of information against unauthorised access;

· automated navigation, displaying the current position and orientation of the TEL vehicle on an electronic map;

· automated aiming of the launch tubes in azimuth and elevation while the crew remain in the vehicle cabin.

The 9A52-2T weighs 39,500kg when loaded with 12 rockets. It has a crew of three, and can be brought into action in 120 seconds. Maximum firing range is 90km, and a full salvo can be fired in 40 seconds. With the help of a transporter-loader vehicle, the system can be reloaded in 16 minutes. ·

The launch tubes are aimed by remote control, allowing the crew to remain in the vehicle cabin
(Source: Miroslav Gyürösi)

The long-established 300mm Smerch MLRS could attract more customers in its new Tatra-mounted version (Source: Miroslav Gyürösi)

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TACTICAL SURFACE-TO-SURFACE

Date Posted: September 19, 2001

JANE'S MISSILES AND ROCKETS - OCTOBER 01, 2001

BRIEFS - Tomahawk launch system to be modified for Astute-class

The United States Navy Tactical Tomahawk Weapons Control System is to be adapted for use on the United Kingdom Astute-class submarines under a US$30.71 million contract awarded to Lockheed Martin, Management and Data Systems by the US Naval Air Systems Command, Patuxent River, Maryland.

The company will carry out the design, development and production work in King of Prussia, Pennsylvania (39.4%); Manassas, Virginia (23.5%); Dahlgren, Virginia (13.7%); Cherry Hill, New Jersey (1%); and the UK (22.4%). This project is being carried out under the Foreign Military Sales (FMS) programme, and is due to be completed in August 2004.

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TACTICAL SURFACE-TO-SURFACE

Date Posted: August 30, 2001

JANE'S MISSILES AND ROCKETS - SEPTEMBER 01, 2001

ATACMS Block II funding trimmed due to testing problems

David C Isby

The US Army's Lockheed Martin ATACMS (Army Tactical Ballistic Missile System) Block II, intended to deliver the Northrop Grumman BAT (Brilliant Anti Tank) guided submunition, has suffered from funding cutbacks after it encountered problems in a test firing, writes David C Isby. However, both the Army and industry remain convinced that the problems are solvable and do not require major changes to the programme.

The ATACMS Block II/BAT combination carried out its second live-fire development and operational test (DTOT) in June. The test was carried out in stressing environmental conditions and included the use of countermeasures by the targets. All five BATs carried by the ATACMS test missile deployed properly but failed to hit their targets. In the previous DTOT live fire test, in 2000, nine out of 10 BATS that deployed correctly hit their targets (another three prematurely exploded).

The failure was followed on 21 July by a successful Developmental Test-5 (DT-5). During this trial at the White Sands Missile

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Range, New Mexico, an ATACMS Block II missile was launched against an array of armoured vehicles, and successfully dispensed 13 tactical BAT submunitions. All test objectives were achieved, according to Lockheed Martin. DT-5 met the US Army Test and Evaluation Command criteria for operational testing, which will begin in August.

The ATCMS Block II/BAT is currently in low-rate initial production (LRIP). Monthly flight tests had been scheduled for the remainder of 2001. As a result of the problems in testing, the order for the third LRIP production batch, intended to be 42 missiles, has been reduced to 22 missiles. An additional developmental test was added to the programme. These actions are intended to allow the production line to continue while tests are made and allowing required modifications to be made downstream, when the additional 20 missiles from the third LRIP batch may be ordered later this year.

The decision to initiate full-rate production (FRP) had been expected in 2003 but is now likely to be delayed. Because of the hold-up with the programme, the ATACMS Block II/BAT budget request for Fiscal Year 2002 (FY02) was reduced from US$213.4 million in FY01 to US$61 million. ATACMS funding was also reduced to US$34.3 million in FY02 from US$97.1 million in FY01. BAT research and development spending will increase. US$124 million has been requested for FY02, compared to US$97.1 million in FY01.

- Lockheed Martin has delivered the 500th ATACMS Block IA missile to the US Army. The round was handed over four years after this variant initially entered production. Deliveries of ATACMS Block I and Block IA have been on time or ahead of schedule for 11 consecutive years, says Lockheed Martin. "Not only have they all been delivered ahead of schedule, but each and every one we've fired since beginning production has performed as expected", explains Col Kelley Griswold, US Army TACMS/BAT Project Manager.

"Confidence in the system is one of the

reasons we sent every available missile to Albania in support of Operation Allied Force. Although none were fired during the short conflict, the Army's willingness to deploy it and our confidence in the system surely sent a strong message to potential adversaries."

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TACTICAL SURFACE-TO-SURFACE

Date Posted: August 30, 2001

JANE'S MISSILES AND ROCKETS - SEPTEMBER 01, 2001

Royal Navy fires its fourth Tomahawk

Tomahawk will achieve Fleet Weapon Acceptance with the UK Royal Navy (RN) at the end of this year, the date originally planned when the project was approved in 1995. "This means the full operational capability will have been delivered to the Royal Navy on time and within budget", says Lord Bach, UK Minister for Defence Procurement.

The RN attack submarine Trafalgar, the third UK vessel to be fitted with the Tomahawk cruise missile, successfully launched a round on 7 August. The missile was fired while the submarine was operating in the Gulf of Mexico. It flew over a pre-planned route to the test range at the US Air Force Base, Eglin, in western Florida, where it made a simulated aerial detonation above a land target before being recovered safely by parachute. All mission-planning and targeting data for the test flight was provided to Trafalgar via satellite communications from the RN's operational headquarters at Northwood, northwest London.

"The test has also set a number of notable firsts," says Lord Bach. "It is the first firing from a submarine fitted with the new

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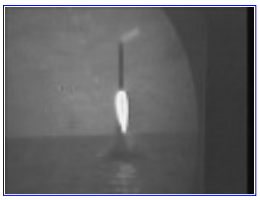
Submarine Command System [SMCS], which will be widely fitted to all Royal Navy submarines. It is also the first use of a joint US/UK version of the Advanced Tomahawk Weapon Control System software, which promotes commonality and interoperability between the Royal Navy and US Navy."

Tomahawk can be deployed on Trafalgar and Swiftsure-class nuclear-powered attack submarines, and now equips Trafalgar, Triumph and Splendid. It will be fitted to the new Astute-class when those enter service from 2005 onwards. This firing was the fourth Tomahawk operational flight test by the RN over US test ranges, the previous three being conducted in November 1998. Operational testing of the missile demonstrates the reliability of the weapon system and gives realistic training to RN submarine crews.



The periscope of Trafalgar captured this image of the launch (Source: Royal Navy)

Throughout the flight, the Tomahawk was escorted by a USAF 'chase' plane (Source: Royal Navy)

Tomahawk heads for the target area, maintaining the Royal Navy's perfect launch record with the weapon (Source: Royal Navy)

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Date Posted: August 30, 2001

JANE'S MISSILES AND ROCKETS - SEPTEMBER 01, 2001

Syrian Scud carried a simulated chemical warhead

David C Isby

Israeli sources report that the R-17E ('Scud-B') theatre ballistic missile (TBM) that Syria test-launched on 1 July carried a simulated chemical warhead, writes David C Isby. The test flight was the first Syrian Scud launch since the reported test of a 'Scud-D' in September, 2000. Launched from Haleb in northern Syria it impacted in southern Syria after travelling its full 300km range.

This launch was apparently intended to underline Syria's TBM and chemical warfare (CW) capabilities and so to deter Israeli escalation that might involve Syria following the recent Israeli Air Force attack on a Syrian radar in Lebanon's Bekaa Valley. Syrian sources denied that any such test had taken place and described Israeli claims as "trivial".

Israeli sources report that the Scud-B was tracked from launch until impact by the Oren Yaruk (Green Pine) radar associated with the Arrow theatre missile defence (TMD) system. Israeli sources did not reveal how they identified the Scud as having a CW

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warhead, as this would be unlikely to be apparent from a radar track of its trajectory. (One possibility is that Israeli radars were able to observe the warhead airbursting at altitude, a technique normally used by Scuds fitted with chemical payloads. An airburst spreads the chemical agent over a wide area.)

Recent reports from Israeli sources have claimed that Syria has 26 Scud TELs (transporter-erector-launcher vehicles) and stockpiles of up to 400 Scud-Bs, between 60 and 120 500km-range Scud-Cs and an unknown number of 700km-range Scud-Ds, the later two subtypes having been imported from North Korea. Syria is believed to have large stocks of mustard, Sarin and VX CW agents among its TBM armament options.

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JANE'S MISSILES AND ROCKETS - SEPTEMBER 01, 2001

BRIEFS - Second Guided MLRS test successful

The US Army and Lockheed Martin Missiles and Fire Control have conducted the second successful ballistic flight test of the Guided MLRS (Multiple Launch Rocket System) rocket. The missile was launched from an MLRS M270 launcher at White Sands Missile Range, New Mexico. Major test objectives included the successful launch of the missile from the canister, nominal motor performance, tail fin deployment and rotation, and telemetry performance. Preliminary data indicate all test objectives were successfully achieved.

"We evaluated several facets of the rocket performance during this test, such as determining the spin rate of the tail fin assembly as the rocket exited the tube, and a few items relating to launch and motor performance", says Ron Abbott, company vice-president - Fire Support. "The Guided MLRS rocket has met or exceeded all of our expectations during these first two flight tests, putting the programme in an excellent position for the first guided flight this fall.'"

The company has also conducted the final developmental flight test of the MLRS upgraded M270A1 launcher. A total of 12

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MLRS Reduced-Range Practice Rockets (RRPRs) were fired successfully from the M270A1 to four different aimpoints at the White Sands Missile Range. Operational testing of the M270A1 is due to begin at Fort Sill, Oklahoma, in August 2001.

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JANE'S MISSILES AND ROCKETS - SEPTEMBER 01, 2001

PLA develops low-cost training for TBM units

David C Isby

The increasing importance of theatre ballistic missile (TBM) units to the People's Liberation Army - largely as a result of the continued confrontation with Taiwan - has been underlined by the development of indigenous TBM launch simulators, writes David C Isby. These simulators have been produced for a range of TBMs by the Langfang Army Missile Academy as a result of a 300-day high priority programme.

As with most simulator systems, the goal is to reduce the cost of training and to ensure performance in live-fire training. One function offered by the simulator system is reported to be the identification of faults in TBM guidance systems, which suggests a potential hardware-in-the-loop (HWIL) capability.

A Chinese missile brigade is reported to have qualified for live-firing of an unidentified new TBM after less than two months of simulator training. In addition to the simulators, the system is understood to include a full-size missile that can be used for all types of training up to simulated

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firing. Such training missiles have long been a familiar part of all types of Soviet and Russian-designed missile systems, but this training missile design is said to be unique due to its integration with the overall simulator system.

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TACTICAL SURFACE-TO-SURFACE

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JANE'S MISSILES AND ROCKETS - SEPTEMBER 01, 2001

Taiwan denies developing tactical ballistic and cruise missiles

David C Isby

The Taiwanese military has categorically denied it is developing long-range land attack cruise missiles (LACMs) and theatre ballistic missiles (TBMs), writes David C Isby. This contradicts Taiwanese press reports that the military's Chung Shan Institute of Science and Technology [CSIST] is developing a 1,000km-range LACM, designated the Hsiung Feng IIE.

The military has stated that the Hsiung Feng IIE is an improved subsonic anti-ship missile, a version of the Hsiung Feng II that is currently in service. Not only is it not a land attack missile, it lacks the high technology of the new supersonic Hsiung Feng III anti-ship missile, which is to have its first control test later this year. The Hsiung Feng IIE version has an improved seeker head design, intended to avoid operational problems identified in recent testing.

Taiwanese press reports, however, described the Hsiung Feng IIE as instead being similar

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to the US Tomahawk LACM, 6.25m long, with a total weight of 1,440kg, a post-launch wing span of 2.67m, and a range of 873-1,249km.

The Taiwanese TBM - reported to be designated Tichin - is supposedly a continuation, also by CSIST, of the 1,000km-range Sky Horse TBM project that was officially terminated in 1982 as a result of US pressure. The Tichin TBM has been developed, say local press reports, but has not been tested to its full range. It is expected to enter production around 2005.

Other press reports suggest that Taiwan has secretly produced and deployed about 10-15 short-range TBMs, with a range variously reported as being anything from less than 100km to around 120km. Said to be deployed on the offshore islands, these missiles are surface-to-surface versions of the Tien Kung surface-to-air missile (SAM) system, and reportedly use the same launch containers.

This TBM version of the Tuen Kung was originally designated the Tien Chi, say local reports, but is now known by an unspecified numerical designation. The weapon is thought to use technology developed for the Sky Horse programme, and Taiwanese press reports suggest ultimate production numbers may reach 50-100.

These missiles are supposedly designed to permit retaliatory strikes against mainland targets as well as holding at risk long-range PLA weapons such as missile and air bases. The Taiwanese military, however, depends on the US both for support and as a source of technology, so may be reluctant to violate US proliferation policies.

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Date Posted: August 30, 2001

JANE'S MISSILES AND ROCKETS - SEPTEMBER 01, 2001

Boeing Harpoon Block II attacks land target

The US Navy (USN) has successfully tested the Boeing Harpoon Block II missile against a land target on San Nicolas Island at the Naval Air Warfare Center-Weapons Division sea range off Point Mugu, California. The mission was the first to be flown against a land target, and was intended to demonstrate the new variant's ability to attack coastal targets.

The missile was launched from the Arleigh Burke-class guided missile destroyer Decatur (DDG-73), which had been fitted with an upgraded Harpoon Ship Command and Launch Control System (HSCLCS) prior to the first launch of the Block II missile in May 2001 (see Jane's Missiles & Rockets, July 2001, p1). This improved launch system allows faster and more user-friendly engagement planning, and provides for Global Positioning System (GPS) initialisation.

Harpoon Block II is capable of executing both anti-ship and coastal target suppression missions. For conventional anti-ship missions in open ocean or near-land, the use of combined GPS and inertial navigation allows more accurate guidance to the

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target-search area. In addition, the missile is pre-loaded before launch with information about geographic areas to avoid in the search pattern when the seeker is activated. This information, coupled with the accurate navigation solution, greatly reduces target-location uncertainty and allows the Harpoon's active radar seeker to better discriminate the desired target ships from islands, other obstructions or neutral ships.

To strike targets on land and in ports, the missile uses GPS-aided inertial navigation to steer itself towards a user-defined target impact point. The 500 lb (227kg) blast warhead delivers lethal firepower against a wide variety of land-based targets, including coastal defence sites, surface-to-air missile sites, exposed aircraft, port/industrial facilities and ships in port. At the end of its land-attack mission, the missile scored a direct hit on a simulated SA-20 mobile radar van.

"Today's operation again proved the viability and capability of the Harpoon Block II through a modernisation upgrade of the missile using proven hardware components from the SLAM-ER and JDAM missile programmes," said Captain Carl Reiber, USN programme manager, Standoff Missile Systems (PMA-258).

The Block II variant is "part of our spiral development plan for Harpoon," says Jim O'Neill, Boeing general manager of Navy Missile Systems. "Harpoon has proven it is a naval precision-strike weapon that has the ability to attack surface ships and land targets at standoff ranges."

Block II missiles can be deployed from all current Harpoon platforms and they are compatible with either upgraded existing command and launch equipment or the new Advanced Harpoon Weapon Control System (AHWCS). It is also fully compatible with the earlier Block I missile and the existing HSCLCS and AHWCS.

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TACTICAL SURFACE-TO-SURFACE

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JANE'S MISSILES AND ROCKETS - AUGUST 01, 2001

France plans ship and sub-launched Scalp

France has an emerging requirement for a new version of the Storm Shadow/Scalp EG. Suitable for use from next-generation frigates and compatible with underwater launch from submarine torpedo tubes, this is currently the subject of advanced studies. MBDA expects to receive a project-definition and risk-reduction contract from the French DGA and anticipates that a programme to develop the new variant will begin in 2004, leading to initial operational capability around 2010.

The ship-launched version will be designed for use from a stretched version of the current Sylver vertical launcher. It is expected to serve on the proposed Fregate Multi-Missions, and will probably be retrofitted to the Lafayette-class frigates. The submarine-launched variant will arm the planned Barracuda-class nuclear-powered attack submarines.

Scalp Naval will be able to meet the naval land-attack requirements of European nations, says MBDA, but at a press conference held at the Paris air show, the company said that there were no plans for

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other countries to join the programme.

The basic Storm Shadow/Scalp EG series has now been sold to five nations - France, Greece, Italy and the UK, plus the United Arab Emirates, which has ordered the Black Shaheen variant.

The first flight of Storm Shadow on a Tornado GR4 took place at BAE Systems Warton in May 2001, and the missile is expected to enter service with the Royal Air Force in 2002.

Development of the Black Shaheen version is under way, and an extensive training programme for the customer is being carried out. The weapon is intended to arm the Mirage 2000-9 fighters of the UAE air force.

This artist's impression shows a Scalp Naval round being fired from a Lafayette-class frigate.
(Source: MBDA)

Scalp Naval will have a longer fuselage than the air-launched variants.
(Source: French Navy)

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ANTI-MISSILE DEFENCE

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

Moscow ABM upgrade to be completed this autumn

David C Isby

Russian press reports say an upgrade of the Moscow anti-ballistic missile (ABM) system will be completed by the autumn of 2002, writes David C Isby. According to an announcement made in February 2002, the system's mechanical equipment, computer complex, and transmitting and receiving technologies were due to be modified "in the next few years" (see JMR, April 2002, p7).

The upgrade will include making operational all of the launch facilities for A-135 (SH-11 'Gorgon') nuclear-armed interceptor missiles that were constructed around the Moscow outer ring road in 1994. While the SH-11 has been in service since the early 1980s, apparently some of the previous upgrades had not been integrated into the overall system. The original batteries were at Aleksandrov (northeast of Moscow), Klin and Novopetrovskoye (northwest of Moscow) and a fourth location at Verena (southwest of Moscow).

It is uncertain whether this upgrade will

include making ready launch silos that were built in the mid-1990s but have never been made operational, or whether new silos will be built. According to contemporary western sources, nine silos were built for each battery in the 1980s. However, an Izvestiya report, published on 24 February 1998, suggested that only 16 A-135/SH-11 missiles had been deployed to defend Moscow.

Part of the upgrade will made good some of the degradation in Russia's strategic warning systems, and improve the links between the ABM system and the Volga radar at Baranovichi in Belarus. Russia will also launch a fourth SPRN missile-warning satellite (equivalent in mission to the US Defense Support Program spacecraft) in 2002. These satellites will provide launch warning to the Moscow ABM system. The Serpukhovo-15 control system for these satellites has reportedly been restored after suffering fire damage in 2001. Poor maintenance of electrical equipment has been responsible for several fires in Russian command-and-control installations in recent years.

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ANTI-MISSILE DEFENCE

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

No replacement for Navy Area Defense ATBM programme

Following a study conducted by the US Missile Defense Agency (MDA), the US Department of Defense (DoD) has decided not to start a new Navy Terminal Defense System. When the DoD terminated the Navy Area Terminal Defense System in December 2002, US Under Secretary of Defense for Acquisition, Logistics and Technology Edward C 'Pete' Aldridge had asked the MDA to develop a replacement programme that could exploit more recent technologies.

"We found that through improvements in the Navy Midcourse System, the so-called Upper Tier, which is performing quite well, and some improvements in the existing Block 4 Standard Missile, we can achieve much of the capabilities lost as a result of the removal of Navy Area," says Aldridge. "And certainly we do not need anymore pressure on our budget resulting from a new [programme] start. So we're not going to pursue that plan."

The programme cancelled last December was designed to provide a terminal defence against shorter-ranged tactical ballistic missiles, while the Navy Midcourse System is intended to counter longer-range missiles.

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Three factors lie behind the decision not to begin a new naval terminal-defence project:

· It is unlikely the US Navy would have to defend a base or port where land-based missile defence systems could not be deployed;

· The MDA has decided the coverage of the Navy Midcourse System can be extended down to a lower intercept altitude than had originally been planned, allowing the system to engage shorter-range missiles; and

· Studies are being conducted to see if improvements to the basic Standard Block 4 missile, in areas such as fuzing, can increase its performance against some short-range ballistic-missile targets.

While the Block 4 missile does not have as good a kill probability against ballistic-missile targets as the Block 4A version, which would have formed part of the Navy Area Terminal Defense System, Aldridge says, "We think we can do some things to it to get the kill probability up. And if we can do that, it will absorb a lot of the shorter-range capability that was lost".

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Date Posted: May 21, 2002

JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

Northrop Grumman to lead a combined SBIRS Low team

TRW is to become prime contractor of a combined team tasked with developing the US Department of Defense's (DoD's) Space-Based Infrared System Low (SBIRS Low) missile-tracking programme. Until now, TRW, with Raytheon as a principal team member, and Spectrum Astro with Northrop Grumman, had led competing teams to define requirements and complete conceptual designs for an operational SBIRS Low system. In the new combined team, Spectrum Astro will develop spacecraft for TRW, while Raytheon and Northrop Grumman will develop sensor payloads under competitive subcontracts.

"TRW will act as the prime for the spacecraft design and development, and Spectrum Mastro has agreed to this arrangement," says US Under Secretary of Defense for Acquisition, Logistics and Technology Edward C 'Pete' Aldridge.

SBIRS Low is part of the US' planned missile defence system, which will provide end-to-end infrared (IR) tracking of missiles throughout their trajectories. The restructured programme will provide early development and deployment of missile

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tracking satellites, but allow the system capability to evolve as technology advances.

"We're going to implement spiral development, evolving the spacecraft capability with time," explains Aldridge. "And by doing this, starting off with a little slower pace... we can plan for the first increment to be launched in the 2006 to 2007 timeframe." These initial spacecraft will be followed by launches of upgraded satellites in subsequent blocks.

The Missile Defense Agency's budget requests for SBIRS Low total US$3.63 billion for Fiscal Years 2003 through 2007 (FY03-07), although the programme will continue beyond that five-year period. The US Congress will be asked to reprogramme an additional US$13.4 million in FY02, boosting the already-planned US$250 million to the level needed to support the restructured programme.

"This combined team offers a compelling, evolutionary approach to lowering technology risk for the programme by combining the best and the brightest from both previous teams," says Tim Hannemann, a member of TRW's Chief Executive Office. "At the same time, the team preserves competition in developing the critical sensor elements of the satellite payload, ensuring that the best technology prevails."

To avoid confusion between SBIRS Low and the SBIRS High programme, Aldridge has asked Missile Defence Agency head General Ronald Kadish to select a new designation for SBIRS Low.

The DoD has studied the SIBRS High programme to see if it could identify cheaper, better alternatives, but has decided to stay with a restructured version of the programme. "I think the contractor realised that the performance and the management approach he was taking for SBIRS High needed some serious adjustment, and he took those measures to make that happen," says Aldridge. "We redid the costs, redid the schedule. The new management scheme's in place, and I think the message to the prime contractors, which are Lockheed Martin and Northrop Grumman, is that they're in a

spotlight. And if we find that six months from now, the programme is going south, I have no hesitation to pull the plug."

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ANTI-MISSILE DEFENCE

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

TRW to develop liquid-propellant booster

TRW has been selected by the US Missile Defense Agency to design a new liquid-propellant booster target under a US$29 million, five-year development contract. The new booster will be used to test current and future US missile defence systems.

"This is a major opportunity for TRW as we continue to grow our presence in the area of defensive countermeasures for the US military," says Jerry Agee, vice president and general manager, TRW Missile Defense Division. "TRW is drawing on its broad experience in rocket engine development and missile system integration to engineer a booster that will better represent the threat.

"The liquid booster programme is the result of intense research by the DoD to provide a well-built, reliable and representative target system. This new target will effectively test the sophisticated weapon systems now being developed while making the launches safer and more environmentally friendly."

The company will manage the design and development of the booster, build and test the rocket on the ground, and build actuators for the booster. The booster design principles

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have been intentionally selected so the vehicle could grow to support the full range of missile defence programmes.

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ANTI-MISSILE DEFENCE

Date Posted: April 23, 2002

JANE'S MISSILES AND ROCKETS - MAY 01, 2002

US demonstrates another ICBM 'kill'

The US Missile Defense Agency (MDA) has successfully completed another intercept of an intercontinental ballistic missile (ICBM) target over the central Pacific Ocean. Conducted on 15 March 2002, Integrated Flight Test 8 (IFT-8) of the Ground-based Midcourse Defense (GMD) segment - formerly known as the National Missile Defense system - was the fourth successful intercept in six attempts carried out since 1999.

An Orbital Sciences' Orbital/Suborbital Target Launch Vehicle (OSP TLV) was launched from Vandenberg Air Force Base, California, at approximately 9.11pm EST. A modified Minuteman ICBM, it released a mock re-entry vehicle (RV) and three balloon decoys. IFT-8 was the first intercept attempt to use multiple decoys. During the six previous shots, the RV was accompanied by only a single decoy.

The US Department of Defense's Defense Support Program (DSP) early-warning satellites detected the target booster, and the GMD battle management, command, control and communications (BMC3) system was alerted. The BMC3 cued ground-based

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radars that tracked the target and decoys. These radars provided more-accurate target information to the BMC3, allowing command-and-control centres at the Joint National Integration Center in Colorado Springs, Colorado, and the Reagan Test Site in the Pacific Atoll to collect and fuse data from surrogate radars and the ground-based radar (GRP) prototype, then use this data to generate and send an engagement plan to the ground-based interceptor. The BMC3 system gave the commands, which led to the launch of the interceptor vehicle from the Reagan Test Site in the central Pacific Ocean.

At 9.31pm EST, a payload launch vehicle (PLV), developed by Lockheed Martin Space Systems, lifted off from the Reagan Test Site at Kwajalein Atoll, in the Republic of the Marshall Islands.

Based on a refurbished, two-stage Minuteman II ICBM with a new front section, the PLV serves as a surrogate ground-based interceptor (GBI) during this stage of the GMD flight-test programme. The company provides an Upper Stage Assembly that serves as the interface between the Raytheon-developed exoatmospheric kill vehicle (EKV) and the Minuteman booster, as well as all the PLV avionics. It is also responsible for payload and mission integration, as well as launch services.

IFT-8 was the fifth integrated flight test to use the Raytheon Pave Paws early- warning radar (EWR) and Ground-based Radar-Prototype (GBR-P) in operational modes. The participating Pave Paws radar is one of five EWRs that will be upgraded to improve track accuracy, search capability and object classification. Located at Beale Air Force Base, California, it provided early target detection and mid-course target tracking.

The GBR-P is the testbed radar for the X-Band Radar (XBR) currently under development by Raytheon for the GMDS programme. From a site at Kwajalein Atoll, it acted as the fire-control radar for IFT-8, providing real-time discrimination, target-object-mapping and the hit assessment.

After the interceptor was launched, the battle management, command and control (BMC2) system received more accurate track reports from the GBR and generated improved targeting data. The BMC2 system then tasked the IFICS Data Terminal to transmit these critical targeting updates to the interceptor as it approached the target to help acquire and identify the target, and assist in the hit-to-kill intercept. TRW develops the IFICS software, and Harris Corporation, under subcontract to TRW, develops the IFICS hardware.

While still more than 2,250km from the target warhead, the EKV separated from its booster. It then used its on-board infrared and visual sensors, augmented with the X-Band radar data provided by BMC3 via the In-flight Interceptor Communications System, to locate and track the target.

Only system-generated data was used for the intercept after the EKV separated from its booster rocket. A C-band transponder aboard the target warhead did not provide any tracking or targeting information to the interceptor after the interceptor was launched.

Sensors aboard the EKV successfully selected the target instead of three decoys. At around 9.44pm EST, the EKV intercepted and destroyed the target by hitting body-to-body at an altitude of approximately 225km and a closing speed of more than 24,000km/h.

In the weeks following the test, government and industry programme officials conducted an extensive analysis of the data received during the flight test to determine whether any anomalies or malfunctions occurred, to evaluate system performance and to determine whether or not all flight test objectives were met. "Since the system is in the developmental phase of design and testing, performance of individual elements and the overall system integration was as important as the actual intercept," said the MDA.

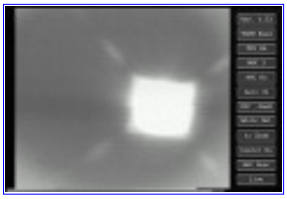
Approximately 18 more intercept trials are due to take place over the next several years.

While there has been no commitment to deploy a GMD system, tests are to be conducted under operationally realistic conditions following the creation of a new testbed in the central and northern Pacific Ocean areas. A new testbed complex is planned for Fort Greely, Alaska, beginning in 2004.

The Fort Greely portion of the testbed will consist of a scaled-down GBI site. By locating testbed components at potential future deployment locations for an operational GMD system, the MDA will be able to conduct operationally realistic testing.

Boeing is overall prime contractor and systems integrator for GMD, supported by Raytheon (kill vehicle, radars); TRW (BMC2); and Lockheed Martin Space Systems (GBI and flight test support).

The interceptor was launched from the Reagan Test Site at Kwajalein Atoll.
(Source: Boeing)



The Super Radot ground-based camera at Kwajalein Atoll observed the interception.
(Source: Boeing)

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ANTI-MISSILE DEFENCE

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JANE'S MISSILES AND ROCKETS - MAY 01, 2002

Lockheed Martin to study target vehicle for ABM trials

Lockheed Martin Space Systems is to study the development of a next-generation target system for future ballistic missile defence testing. Funded by a four-month, US$600,000 contract from the US Army Space and Missile Defense Command (USASMDC), in Huntsville, Alabama, the new study will be carried out under the Missile Defense Agency (MDA) Enhanced Target Delivery System (ETDS) programme.

ETDS is a response to the MDA's requirement for larger, more massive target vehicles able to carry heavier and more complex payload suites. The new target system must be suitable for a variety of engagement scenarios, including launching from remote, unimproved land-based sites, as well as from sea- and air-based platforms. The study will also consider demands for mission flexibility, decreased launch cycle time, and realistic emulation of current and projected threat systems.

Lockheed Martin has extensive experience in launch system design and development, and in launch operations. Its Multiservice Launch System (MSLS) is a target vehicle which uses retired Minuteman II rocket boosters to

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launch a variety of ballistic experiments carrying payloads weighing up to 650kg as far as 6,750km down-range. Under the terms of the study contract, the company will assess the feasibility of launching heavy targets from various land, sea and airborne platforms, then deliver a set of flexible design approaches to USASMDC. The study project does not include a preliminary design review.

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ANTI-MISSILE DEFENCE

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JANE'S MISSILES AND ROCKETS - MAY 01, 2002

UK ABM study favours 'hit-to-kill' systems

The Technology Readiness and Risk Assessment Programme (TRRAP) ordered by the UK government in 1998 has concluded that surface-based interceptors, employing 'hit-to-kill', are a feasible counter to the tactical ballistic missile (TBM) systems and payloads expected to be in service up to 2015.

The programme was led by DERA (now QinetiQ) with extensive industry participation from Alenia Marconi Systems, BAe Systems, Hunting Engineering and Matra BAe Dynamics (now part of MBDA). The work was completed in August 2001 at a cost of £12.5 million (US$18m).

The study considered the TBM defence of deployed forces, and did not address the defence of national territory against longer-range ballistic missile threats.

A joint memorandum prepared earlier this year by the UK Ministry of Defence (MoD) and Foreign and Commonwealth Office says: "We currently assess that at present there is no significant threat to the UK from ballistic missiles. Nevertheless, it is a serious cause for concern that some states have developed, or are seeking to develop or acquire, ballistic

missile capabilities of increasing range. We continue to monitor developments closely... A particular cause for concern is the fact that North Korea appears to be willing to sell its missiles to any country prepared to pay for them. Were a country in the Middle East or North Africa to acquire a complete long-range ballistic missile system, a capability to target the UK accurately could emerge within the next few years."

The document's authors say: "We currently have no evidence that any state with ballistic missiles has the intention specifically to target the UK. But intentions can change rapidly, and the fact is that the proliferation continues of weapons of mass destruction and their means of delivery."

In the TRRAP study, six systems were considered representative of the TBM threat that could be encountered by deployed UK forces. These were the Soviet-era Scud B and Scud C, the KBM Tochka (SS-21 'Scarab'), North Korea's No Dong and Taepo Dong and Iran's Shahab 3.

Various alternative payloads were assessed, including unitary high-explosive (HE) and chemical, and chemical and biological submunitions. In each case, the mass characteristics of the warhead were estimated, allowing an assessment of the effects that different warheads would have on the trajectory profile. Investigators also looked at possible countermeasures that could be engineered by TBM designers, and selected a number of concepts for further analysis.

Current TBM threats were assessed to be of relatively low accuracy, giving unitary HE warheads only limited military utility, but it was noted that guidance improvements could give increased accuracy and greater tactical usefulness.

Work was focussed on two generic types of TBMD systems - a Low Endo-atmospheric (LENDO) system operating at low altitude within the Earth's atmosphere, and a High Endo-atmospheric (HENDO) operating at high altitudes. Some limited analysis was performed on TBM interceptors mounted on

naval and airborne platforms, but the technology of an airborne high-energy laser operating at high altitude and destroying TBMs during their boost phase was not assessed.

A generic LENDO system would be capable of intercepting and negating shorter-range BMs armed with unitary warheads such as HE and bulk chemical-warfare (CW) or bulk bacteriological-warfare (BW) carriers. Different threats would have different 'ideal' intercept altitudes, but a worthwhile defended ground area would be achievable.

A generic HENDO system would be capable of intercepting and negating longer-range missiles armed with unitary warheads. The intercept region will lie between 50km and 150km altitude and a larger defended ground area would be achievable.

Both types of system are highly dependent on the performance of sensors, particularly radars, and their ability to discriminate between the real target and other objects. In a memorandum summarising the TRRAP programme, the UK MoD notes that "threat BMs may employ a separation mechanism, by which a re-entry vehicle (RV) is separated from the spent booster before motors are fired to impart a spin to the RV for stabilisation. The separation event would probably result in debris objects being produced that could take up defensive radar resources and have an adverse effect on system discrimination performance".

While a warhead-armed interceptor is less demanding in terms of miss-distance, it may be less well-suited to destroying targets containing multiple submunitions. In the situations examined by the TRRAP, 'hit-to-kill' was seen as the preferred lethal mechanism.

The capability of BMD systems to counter submunition warheads is difficult to quantify, due to problems in estimating the number of submunitions that might survive a successful engagement. Depending on the altitude of intercept, submunition dispersal and the type of lethal agent carried, there could still be casualties on the ground. Deflecting any surviving submunitions to a

different impact location may or may not be a desirable outcome.

The final stage of an engagement makes severe demands on radio frequency seekers, the study concluded. Alternative seeker technologies need to be identified, and their integration into the interceptor guidance and control loop should be assessed.

If the incoming missiles employ countermeasures to confuse the sensors of the defending ATBM system, there would only be a limited amount of time available for target discrimination, the TRRAP concluded, and increased sensor performance could only go so far in improving the situation, given the threat missile's finite time of flight. This is particularly a problem in HENDO interceptions, but cannot be completely ignored for LENDO intercepts. Four main technical risk areas were identified:

- The threat will evolve both in terms of improvements made possible by advancing technology, but also in response to the deployment of active BMD systems. Further work on threat projection is needed, particularly on countermeasures;

- The system functionality and technical and operational requirements may alter significantly as the threat complexity increases, and a key uncertainty is in predicting what countermeasures might be used. If successful, these could delay the process of identifying the target, delay interceptor commit, and result in an inability to acquire the RV at seeker handover;

- Intercepting threats in the LENDO region requires seekers to operate "close to performance limits", the study concludes, saying that further examination of seeker characteristics is required, supported by hardware demonstrations; and

- Any realistic assessment of ATBM lethality must be influenced by the type of guidance used by an interceptor; assessment of the miss distance; closing velocity, engagement geometry and intercept altitude; and the actual rather than the currently-estimated threat payload.

The deployment strategy, lay-down pattern and tasking processes would all be key factors in the process of maximising ATBM effectiveness, says the MoD. "The management of battle management, command, control, communication, computers and intelligence (BMC4I) during the deployment process is critical, as its structure and communications topology is likely to evolve as deployment proceeds." A particular concern is the need to ensure timely distribution of intelligence information, so the deployment strategy and lay-down could be optimised.

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ANTI-MISSILE DEFENCE

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JANE'S MISSILES AND ROCKETS - MAY 01, 2002

BRIEFS - Missile Defense Agency building to be modernised

System Engineering and Management is to renovate wings 1, 2, 3, and headhouse areas of Federal Office Building #2 in Arlington, Virginia, a facility used by the Missile Defense Agency.

The work is due to be completed by October 2000, and is funded by a US$5.8 million contract from the US Department of Defense's Washington Headquarters Services Real Estate and Facilities Directorate.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

BRIEFS - Naval ABM radar development contract

Lockheed Martin Naval Electronic & Surveillance Systems is to develop the S-Band Radar component of the Sea-based Midcourse Defense (SMD) Advanced Radar Suite under a US Naval Sea Systems Command contract with a cost-ceiling of US$420 million. Development will take place in Moorestown, New Jersey, and is expected to be completed by March 2007.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

BRIEFS - Two companies to support missile-defence efforts

Boeing is being awarded a 'transaction agreement' with a not-to-exceed amount of US$23.93 million for System Engineering and Integration work in support of the Missile Defense National Team (MDNT). This work will be paid for using Fiscal Year 2002 funds, and is due to be completed by June 2002. A similar agreement with Lockheed Martin Mission Systems is worth US$23 million, and covers the development and integration of the Battle Management, Command and Control, and Communications capability in support of the MDNT.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

Orbital to develop ABM booster

Orbital Sciences has been selected by Boeing to develop, test and produce a second pattern of ground-based boost vehicle for the US Ground-based Midcourse Defense (GMD) system. A rival proposal by Lockheed Martin was rejected. The new booster will be used to carry the GMD exo-atmospheric kill vehicle (EKV), which is designed to locate, track and destroy incoming re-entry vehicles.

Under a contract worth approximately US$400 million, Orbital will develop and test a silo-launched three-stage rocket derived from its Pegasus and Taurus small satellite launch vehicles, demonstrating its performance and operational features in a series of test flights. This phase of the project will run from 2002 to 2006.

A proposed US$535 million follow-on contract will cover production, deployment and support activities to be conducted from 2003 or 2004 through 2010. According to current plans, a total of about 70 boost vehicles are to be built and delivered in the development and production phases of the baseline GMD programme over the next seven years.

"The GMD boost vehicle award is one of the largest and most important contracts in

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Orbital's 20-year history," says company chairman and chief executive officer David W Thompson. "We strongly appreciate Boeing and MDA's [Missile Defence Agency's] confidence in our company's launch system capabilities and experience."

The programme will be tackled by Orbital's Launch Systems Group (LSG), whose primary engineering and production staff are based in Chandler, Arizona. Other Orbital personnel in Dulles, Virginia; Huntsville, Alabama; and Vandenberg Air Force Base, California, will also be involved. Major subcontractors for the new booster include ATK Thiokol, Teledyne Brown Engineering, Mission Research Corporation and Electro Magnetic Applications.

ATK Thiokol Propulsion (which manufactures the propulsion systems of the Pegasus and Taurus launch vehicles) will develop and produce the solid-propellant motors for the Orbital GMD booster vehicles at its facilities in Promontory and Magna, Utah. The value of ATK's work on the programme could be approximately US$300 million.

Boeing, lead contractor on the GMD programme, will choose which of the two competitive booster designs will be used for an operational GMD system. Boeing's own design of booster was successfully tested for the first time on 31 August 2001, but a subsequent trial flown on 13 December failed around 30sec after launch.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

Russia plans Moscow ABM upgrade

David C Isby

Russia is planning to upgrade the Moscow anti-ballistic missile (ABM) system in the next three to four years, writes *David C Isby*. The system has been in service since the 1970s, and is permitted under the ABM Treaty of 1972.

Russia says the planned upgrade would be permitted under the ABM Treaty, despite the US intention to withdraw from that agreement. The Moscow ABM system has already been modernised, the most recent upgrade having been conducted in the 1990s, but it continues to rely on nuclear-armed interceptor missiles.

The scope of the upgrade has not been announced, but it is linked with restoring Russian strategic warning and command control capability, which was degraded due to post-Soviet political disruptions and lack of funding.

Power drive equipment, computer hardware, transmission equipment and communications are among the priorities for the upgrade, which will concentrate on ground-based equipment rather than the missiles themselves. The DON-2N ('Pill Box')

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battle-management radar at Pushkino has also been identified as requiring upgrading. Russia is reported to have studied Belarus-produced technology that could be incorporated in the modernisation.

Currently, the Moscow ABM System is operated by the Space and Missile Defense Forces (also responsible for space strategic warning sensors).

Moscow's air defences are also being reorganised. The Moscow Air Defense District - which dates back to the opening years of the Cold War - is to be disbanded and replaced by a 'special purpose command'. Its air assets will be re-subordinated to the 16th Air Army and other formations. The first S-400 Triumf surface-to-air missiles are due to be introduced around Moscow later in 2002.

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ANTI-MISSILE DEFENCE

Date Posted: March 22, 2002

JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

BMD test hardware could provide emergency capability

Test hardware developed by the US missile defence programme could be used to provide the United States with a limited degree of anti-ballistic missile (ABM) defence capability prior to the deployment of an operation system, Missile Defense Agency (MDA) Director Gen Ronald T Kadish, US Air Force, told congressional procurement, and research and development subcommittees during a presentation on the MDA's Fiscal Year 2003 (FY03) budget.

"As they become available, we could use prototypes and test assets to provide early capability, if so directed," Gen Kadish told the subcommittees. "A decision to employ test assets would depend upon the success of testing, the appropriate positioning of test bed components, the availability of test interceptors and other assets, and the international security environment. Our test infrastructure, in other words, will have an inherent, though rudimentary, operational capability."

Based on the results of last year's rigorous missile defence review, the Department of Defense has moved away from an independently managed, element-centric

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approach. It has established a single programme to develop an integrated ballistic missile defence (BMD) system configured into layered defences to provide autonomous and mutual support, including multiple engagement opportunities, along a threat missile's flight path.

The initial goal of the missile defence programme is to provide limited protection against long-range threats to the US and potentially its allies in the 2004-08 time period, plus more advanced capabilities against shorter-range threats.

The traditional acquisition process has not worked well for missile defence, said Gen Kadish. The normal approach is to use operational experience with existing weapons to define the system specifications for future weapons many years before the latter will be deployed, but "missile defence is a cutting-edge development effort and an area where we have very little operational experience".

As a result, a system specification could result in "a less than optimum deployed capability that does not take advantage of the most advanced technologies". Given the pace of technological development, a requirement written during a system's development phase "can quickly become irrelevant or a one-way street that leads developers into a technological cul-de-sac".

Following the US Secretary of Defense's decision to cancel the current Operational Requirements Documents (ORDs) related to missile defence, the MDA is now using these ORDs as reference documents rather than as measures of development progress. "Instead of developing a system in response to a clearly defined threat from a known adversary, we are looking at missile capabilities that any adversary could have in a given timeframe. We also continually assess missile defence technology options and availability."

This capability-based acquisition strategy requires continual assessment of technical and operational alternatives, said Kadish, and a risk-management programme is essential. "We will build what we can technologically,

and improve it as rapidly as possible. Configuration management and risk management will continue to guide the engineering processes."

The system will be engineered and tested using a two-year capability 'block' approach, with the initial introduction of elements into the expanded Test Bed starting as early as FY04. This initial Block 2004 BMD system capability will evolve as technologies mature, and are demonstrated using the BMD System Test Bed. "This capability will be increased incrementally in future blocks through the introduction of new sensor and weapon components, and by augmenting or upgrading existing capabilities," said Gen Kadish.

The BMD System Test Bed is an integrated set of components that are widely dispersed among operationally realistic locations, primarily throughout the Pacific and continental US. It will allow tests to be carried out against faster, longer-range target missiles than are currently being used, and will allow tests using different geometric, operational and element configurations.

Each BMD system block will be made up of selected element configurations integrated into the overall BM/C2 (battle management/ command-and-control) system. Each subsequent block will build on and be integrated into the capabilities provided by predecessor blocks. "There will be annual decision points at which time assessments will be made on the basis of effectiveness and synergy within the system; technical risk; deployment schedule; cost; and threat. This assessment of progress will determine whether a given developmental activity will be accelerated, modified or terminated." This approach will allow more rapid programme adjustments as required by threat projections and technological progress.

"This evolutionary strategy allows us to put the high performance technologies 'in play' sooner than would otherwise be possible," explained Kadish. "Once they have been demonstrated, elements or their components will be available for emergency use, if directed, or for transfer to the military departments for production as part of a

standard acquisition programme."

During FY02, the MDA hopes to further demonstrate hit-to-kill and discrimination capabilities of the Ground-based Midcourse Defense (GMD) system using increasingly complex and realistic test-scenarios. A Targets and Countermeasures programme will provide ballistic-missile targets, countermeasures and other payloads to support system and element-level testing across the segments. The use of standard interfaces between payloads and boosters will make it easier to introduce different targets into flight-test scenarios. "Beginning in FY02, we are establishing an inventory of target modules (boosters, re-entry-vehicles, countermeasures and instrumentation) to shorten the build-cycle and support more frequent flight tests."

Development of the 2004 BMD System Test Bed will involve an upgraded Cobra Dane radar in Alaska able to act as a temporary surrogate for Upgraded Early Warning Radars (UEWRs); an accelerated version of the In-Flight Interceptor Communications System (IFICS) and Battle Management, Command, Control and Communications (BMC3) capability; the construction of five interceptor silos and Command Launch Equipment (CLE); and software upgrades. Five Ground-Based Interceptors, using what Kadish described as "a precursor of the objective booster and an operationally representative kill vehicle", will be developed for installation and testing in FY04.

Development of the definitive ("objective") booster will continue, plus the complementary exo-atmospheric kill vehicle (EKV) development. The latter work could result in a common EKV for Ground and Sea-based midcourse defences (SMD). Incremental prototypes of BM/C2 and communications subsystems "will be integrated and demonstrated at multiple locations and assessed with user participation".

In FY03, the Prototype Manufacturing Rate Facility will continue to provide the interceptors needed to support an increased

rate of flight tests, and will also support the continued development and testing of more-capable interceptors, sensors and targets.

In the same year, the MDA hoped to complete missile and launcher designs for the THAAD (theatre high-altitude air defence); begin manufacturing of missile ground-test units; continue the construction of the first and second radars; and continue to build and test the BM/C2 hardware and software. Robust ground testing and flight-hardware testing will be carried out to clear the way for flight testing at the White Sands Missile Range, New Mexico.

During FY03, the MDA will also work towards the development, integration and testing of evolutionary block upgrades to the Patriot PAC-3. Its plans include transitioning PAC-3 to full-rate production, building up the inventory of PAC-3 missiles and fielding additional PAC-3 capabilities.

The SMD programme has three primary objectives in FY03, Gen Kadish told the subcommittees. These are:

- to continue testing and complete ALI (Aegis Lightweight Exo-Atmospheric Projectile Intercept) flight demonstration project;

- to design and develop a contingency ship-based ascent and midcourse ballistic-missile intercept capability based on ALI and associated technologies; and

- to continue work on a ship-based system able to provide an ascent midcourse phase 'hit-to-kill' technology around FY08-10.

The SMD project will continue to build upon the existing Aegis weapon system, while pursuing alternative kinetic warhead technologies.

Following successful subsystem testing and the modification of the aircraft structure, in FY03 the Airborne Laser (ABL) programme will begin major subsystem integration and testing activities. The Block 2004 phase of the ABL programme will finish with the engagement and destruction of boosting

ballistic missile threat-representative targets, and deliver one aircraft for integration and testing. "If directed, this aircraft could also provide an emergency defensive capability," said Kadish. "We plan to develop a second test aircraft, that will further develop this new technology."

In its studies of Kinetic Energy Boost defences able to engage missiles in the first minutes of powered flight, the MDA has "identified several lucrative technology candidates for immediate investment, including fast burn and flexible axial propulsion technologies, agile kill vehicles, early detection and track sensors, quick-reaction BM/C2 and affordable weapons platforms. We will assess these component technologies through rigorous ground and flight tests.

"We will evaluate prototype component and element configurations under realistic operational conditions. We will experiment using emerging component technologies and test infrastructure to resolve tough technical challenges, such as predicting the point of intercept and finding the missile tank in the presence of hot exhaust. When possible, we will exploit targets of opportunity by tracking space launch vehicles and test missions launched out of Vandenberg, Air Force Base. The test data we collect from our risk reduction work and critical experiments will help guide decisions concerning focused demonstrations in FY05."

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ANTI-MISSILE DEFENCE

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

BRIEFS - ABL risk-reduction contract

Boeing Defense and Space Group is being awarded a US$65.89 million contract modification to provide for action that definitises the effort to procure component spares and fabrication of these components into higher-level sub-assemblies to reduce integration and test risk identified in the Airborne Laser Fiscal Year 2001 supplemental funding request. Included are critical beam control, fire control and laser components, laser long-lead items, and an effort to secure the information system across airborne laser test facilities, plus the augmentation of airworthiness and safety tasks. This work will be performed at Lockheed Martin Missile and Space, Sunnyvale, California (45%), and TRW Space and Electronics Group, Redondo Beach, California (43%), and other locations, and is due to be completed by September 2004.

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ANTI-MISSILE DEFENCE

Date Posted: February 21, 2002

JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

Standard SM-3 intercepts ballistic-missile target

A Raytheon Company Standard Missile-3 (SM-3) intercepted a ballistic-missile target in space during a test of the US Navy's (USN's) Sea-based Missile Defense System (SMD) carried out off the Hawaiian coast on 25 January. The success of this test, which was sponsored by the Missile Defense Agency (formerly the Ballistic Missile Defense Organization), brings the USN a step closer to fielding a sea-based missile defence capability.

SM-3 is designed to intercept an incoming theatre ballistic missile outside the Earth's atmosphere. The fourth-stage kinetic warhead is based on technology developed during the Lightweight Exo-Atmospheric Projectile (LEAP) programme.

The test, designated Flight Mission-2 (FM-2), was designed to evaluate the guidance, navigation and control capabilities of the missile's kinetic warhead. It was the SMD programme's third successful flight and first target intercept. It was also the first using an operational Solid Divert and Attitude Control System (SDACS).

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An Aries ballistic target was launched from Kauai, and the Aegis cruiser Lake Erie (CG 70) tracked the missile as it rose above the horizon, then launched the SM-3. The missile, with guidance commands from the Aegis weapon system, flew a nominal trajectory, reaching the point in space at which the fourth-stage interceptor was ejected as planned.

The interceptor acquired and tracked the target in the exo-atmosphere above the mid-Pacific Ocean. As it approached the Aries, it used the thrusters of the SDACS to manoeuvre into the path of the target missile. This mission was the first operational SM-3 kinetic warhead with a live SDACS. The SM-3 missile provides a burnout velocity of approximately 3km/sec, and the closing velocities between the interceptor and the target missile approached 4km/sec. The missile, kinetic interceptor and the rest of the system performed as expected.

The launch was the fourth in a planned series of nine test flights for SMD, formerly known as the Navy Theater Wide ballistic-missile defence system. The SM-3 and the kinetic warhead are under development by Raytheon Electronic Systems at its Missile Systems business unit in Tucson, Arizona, with major subsystems developed by Alliant Techsystems and Boeing.

The SM-3 missile was fired from the vertical launch system on the cruiser Lake Erie (Source: Raytheon)

This view of the Aries ballistic-missile target was captured by the seeker on the SM-3 kill vehicle (Source: Raytheon)

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ANTI-MISSILE DEFENCE

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

Raytheon to develop LADAR sensor

Under the US Army's Advanced Discriminating LADAR Technology (ADLT) programme, Raytheon is developing a range-resolved, Doppler-imaging laser radar (LADAR) sensor intended to provide the Ground-based Midcourse Defense Segment (GMDS) exo-atmospheric kill vehicle (EKV) with additional discrimination capability.

The ADLT solid-state LADAR will use an ultra-stable laser transmitter to interrogate targets, and it will then receive and Doppler-process the reflected energy. This will provide range and velocity data, and allow the creation of a range-resolved Doppler image (RRDI) which reveals the target's micromotions. RRDI imagery can be made at very long ranges, long before camera-based systems can resolve the target.

ADLT will provide an increased level of discrimination capability for future ground and/or sea-based midcourse interceptors in the face of the most difficult threat countermeasures. Although designed with the GMDS EKV in mind, it could be integrated into other Ballistic Missile Defense Organization (BMDO) missile-defence systems.

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Raytheon's prior work on ADLT at the Army Missile Optical Range, Redstone Arsenal, Alabama, resulted in the successful testing of an initial prototype. That testing paved the way for current technology development, and the design, fabrication and demonstration of a more advanced, near tactically-packaged, 'brassboard' sensor.

Development will be funded by a US$38.6 million US Army Space and Missile Defense Command contract. It will be handled by Raytheon's Missile Systems business unit in Tucson, Arizona. Development of the LADAR subsystem will be done by Boeing-SVS and Goodrich's Space Flight Systems group, both in Albuquerque, New Mexico, and by Raytheon Electro-Optics Systems of El Segundo, California.

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ANTI-MISSILE DEFENCE

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

US blocks Arrow sale to India

According to unconfirmed reports, the US has held up Israeli exports of the IAI-Boeing Arrow anti-tactical ballistic missile (ATBM) system to India, writes David C Isby. The US objection is on the grounds that orders for a new military capability would destabilise the strategic balance with Pakistan in the near term.

This apparently leads the door open for eventual US approval for an Arrow sale to India when tensions with Pakistan decrease. Arrow export approval may have been one of the issues discussed during US-Israeli ministerial discussions at the Pentagon on 7 February. According to reports prior to the meeting, Israeli Defense Minister Benjamin Ben-Eliezer planned to ask his US counterpart, Defense Secretary Donald Rumsfeld, to allow joint export of the Arrow to India and Turkey.

According to Indian press reports, Defence Minister George Fernandes has pressed the US government to acknowledge that they support the Arrow sale, but the US government has reservations about its timing. There are also concerns that, despite its defensive mission, the Arrow could be seen as a Category 1 missile under the

Missile Technology Control Regime (MTCR) and thus have its export limited. However, in view of the defensive mission and limited warhead of the Arrow, it is thought that the MTCR issue will not prove a barrier to export.

According to unconfirmed Israeli press reports, the first Israeli Green Pine radars were delivered to India in 2001. The Green Pine radar is an integral part of the Arrow weapons system and can also be used to cue other radars. Reportedly, Indian Green Pine radar took part in Exercise 'Perfect Victory' in May 2001, and one is currently deployed between the towns of Uri and Punch.

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ANTI-MISSILE DEFENCE

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

BRIEFS - BMDO orders technical support

Sparta Inc is being awarded a US$39.89 million contract for scientific, engineering and technical assistance to the Ballistic Missile Defense Organization. This work will be performed primarily in Arlington, Virginia, and is expected to be completed not later than 23 November 2002.

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

BRIEFS - Supercomputer centre maintenance contract

Madison Research Corporation is being awarded a US$400,000 increment as part of a US$62.01 million contract to help maintain the supercomputer centre that supports the Ballistic Missile Defense Organization, National Missile Defense, Theater Missile Defense, and the Space and Missile Defense Command and High Performance Computing Modernization Office projects and other government agency programmes. This work will be performed in Huntsville, Alabama, and is expected to be completed by 13 December 2007.

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Date Posted: January 31, 2002

JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

US pulls out of ABM treaty

On 13 December 2001, the US government gave formal notice to Russia that the US is withdrawing from the 1972 ABM (anti-ballistic missile) Treaty. Announcing the decision, US President George Bush said, "I have concluded the ABM treaty hinders our government's ability to develop ways to protect our people from future terrorist or rogue state missile attacks.

"The 1972 ABM treaty was signed by the United States and the Soviet Union at a much different time, in a vastly different world," said President Bush. "One of the signatories, the Soviet Union, no longer exists. And neither does the hostility that once led both our countries to keep thousands of nuclear weapons on hair-trigger alert, pointed at each other. The grim theory was that neither side would launch a nuclear attack because it knew the other would respond, thereby destroying both.

"Today, as the events of 11 September made all too clear, the greatest threats to both our countries come not from each other, or other big powers in the world, but from terrorists who strike without warning, or rogue states who seek weapons of mass destruction.

"We know that the terrorists, and some of

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those who support them, seek the ability to deliver death and destruction to our doorstep via missile. And we must have the freedom and the flexibility to develop effective defences against those attacks... I cannot and will not allow the United States to remain in a treaty that prevents us from developing effective defences.

"The United States and Russia have developed a new, much more hopeful and constructive relationship. We are moving to replace mutually assured destruction with mutual co-operation. Beginning in Ljubljana, and continuing in meetings in Genoa, Shanghai, Washington and Crawford, President Putin and I developed common ground for a new strategic relationship... I look forward to visiting Moscow, to continue our discussions, as we seek a formal way to express a new strategic relationship that will last long beyond our individual administrations, providing a foundation for peace for the years to come."

Attempts to devise a formula, under which both parties would abandon the treaty, failed, explained US Defense Secretary Donald H Rumsfeld: "We worked very hard to try to find... a basis on which we could withdraw together, and spent the better part of the year working on that and were not able to quite achieve it."

During these discussions there were "sticking points on both sides. We offered any number of proposals and different ideas and papers - the president did, the national security adviser did, Secretary Powell did, I did. We've had all kinds of discussions at our level, we've had discussions at lower levels. They are going to continue".

Having announced the US plan to withdraw from the treaty, the US will now work with the Russian government to devise a new arrangement, said Rumsfeld. "I will be meeting with the defence minister of Russia next week in Brussels and we will be continuing the discussions that we've had, the president has had, Secretary Powell has had, to find a framework that can replace the treaty that has existed now for some 30 years. I think that those discussions will be

going forward just as they had been prior to the notification by President Bush to Russia."

The withdrawal will not have come as a surprise to the Russian government, said Rumsfeld. "We've had a relationship that's been going on, Secretary Powell with the foreign minister and me with the defence minister, the president with President Putin, and we've said all along, 'Look, we're bumping up against this thing, we want to set it aside, we want to get on with a new framework, a new relationship that's looking forward, not back'. I personally think that people ought to be relieved that this is behind us. It has been a sticking point that's just been sitting there for this period of time, 'When are they going to withdraw?'"

For some time, US plans for future ABM tests have seemed likely to violate the provisions of the ABM Treaty, explained Rumsfeld. "We bumped up against it in a couple of respects, and we will be doing more of that between now and the time six months expires."

With the treaty restrictions due to end this summer, Rumsfeld expects that "the basic plan that's been put in place will go forward and that we'll keep trying to explore the best, most cost-effective and easiest way for us to get a capability deployed at some point in the period ahead that will deal with relatively small numbers of these very dangerous weapons [ICBMs]".

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ANTI-MISSILE DEFENCE

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JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

Rising costs kill USN Area Missile Defense programme

The US Undersecretary of Defense for Acquisition, Technology and Logistics, Edward C 'Pete' Aldridge, has cancelled the Navy Area Missile Defense programme. The decision was taken due to poor performance and projected future costs and schedules. Most of the problems had been with the Raytheon Standard Block IVB missile. "There were some interface problems," said Aldridge, "but mostly with the missile."

The cancellation came, in part, as a result of a Nunn-McCurdy Selected Acquisition Report breach of the existing programme. Under a law introduced several years ago, a Nunn-McCurdy unit cost breach occurs when a major defence acquisition programme experiences a unit cost increase of at least 15%.

If the unit cost increase is at least 25%, the US Secretary of Defense must certify that:

- the acquisition programme is essential to national security;

- there are no alternatives to the acquisition programme which will provide equal or greater military capability at less cost; - the new estimates of the programme acquisition

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unit cost or procurement unit cost are reasonable; and,

- the management structure for the acquisition programme is adequate to manage and control the programme acquisition unit cost or procurement unit cost.

In the case of the Navy Area Missile Defense programme, the acquisition unit cost had increased by 57%, while the average procurement unit cost had increased by 65%. "When I looked at that programme with those four criteria, I could not answer yes to every one," said Aldridge. "And so, by law, we had to stop the programme."

According to Aldridge, only two of the four conditions could be met. "I did have a letter from the chairman of the Joint Chiefs that said Navy Area was essential. The second question, were there other alternatives? There were other land-based alternatives, there were no other sea-based alternatives... I could not certify that cost was under control, because it already had exceeded the 25%, and independent cost estimates said the number was closer to 60%. And that I could not certify that we had a management structure in place..."

After cancelling the programme, Aldridge asked the Ballistic Missile Defense Organis-ation (BMDO) to create "a revised programme that will look at a Navy Terminal [terminal phase] defence, but that will also take into account the new technologies which we have been seeing in the missile defence programme, such as hit-to-kill technology, which might be applicable to the new design."

Aldridge has asked his Acquisition, Technol-ogy and Logistics office to be on guard against over-optimism early in new programmes, saying many "are in trouble because of optimism about how fast, what the scheduled cost performance was going to be. And we need to do something to address that problem.

"One is introduce spiral development in the programme. Don't go for the 100% solution... it doesn't have to perform at

100%, 80% is good enough and we'll evolve it with time. So we can get rid of old stuff quicker; we can get the programme on the field sooner. It is less risk, in terms of technical risks, cost risks, scheduled risks."

He also wants to see future programmes properly funded. "I am insistent... programmes are properly priced... the Cost Analysis Improvement Group [CAIG] has been traditionally much closer to what real costs are than the programme managers or the services, so we're insisting that these programmes, when they go through a DAB [Defense Acquisition Board] process, when I have to approve them, they're priced to the CAIG estimate."

Evolutionary development and more realistic cost estimates "will slowly bring into control this risk and optimism that tends to prevail the programme managers early in the game", Aldridge believes.

The following major defence contractors are affected by the cancellation:

- Raytheon, Tucson, Arizona;

- Lockheed-Martin, Moorestown, New Jersey, and Middle River, Maryland;

- United Defense, Baltimore, Maryland, and Minneapolis, Minnesota;

- Orbital Sciences, Dulles, Virginia, and Chandler, Arizona; and

- L-3 Communications, New York.

Other establishments affected include the Naval Surface Warfare Centers at Dahlgren, Virginia and Port Hueneme, California, the Applied Physics Laboratory at Johns Hopkins University, Laurel, Maryland, and the Massachusetts Institute of Technology Lincoln Laboratories, in Lexington, Massachusetts.

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Date Posted: January 31, 2002

JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

India could procure Arrow ATBM

India hopes to be able to order the Israeli Arrow anti-theatre ballistic missile (ATBM) system, reports in the Israeli press suggest. In 2001, India was reported to have agreed to purchase two Israeli-developed Green Pine L-band radars at a cost of US$400 million. Developed by Elta Electronics, Green Pine provides the search, tracking and fire-control functions for the Arrow system.

According to the Israeli press, interest in the Arrow was expressed in ministerial level meetings in New Delhi in December 2001. Development of the Arrow was partly funded by the US, so any sale to India would require Washington's approval. Such approval is likely, say reports, as are assurances by the US that the deal will not be seen as raising issues under the Missile Technology Control Regime (MTCR).

If India does acquire the Arrow, the system would provide an 'upper tier' of anti-missile defence in an integrated defence system, which would include the multiple Antey-2500 batteries being procured for the ATBM role from Russia. However, it will further complicate the Russian task - as part of the Antey-2500 procurement - of integrating India's disparate systems into an

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integrated missile-defence architecture.

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Date Posted: January 31, 2002

JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

BMDO becomes the Missile Defense Agency

The US Ballistic Missile Defense Organization (BMDO) has been redesignated as the Missile Defense Agency. The current director of BMDO, Air Force Lt Gen Ronald T Kadish, will assume the title of director for the new agency. He will continue to report directly to Edward C 'Pete' Aldridge, Undersecretary of Defense for Acquisition, Technology and Logistics.

Giving the BMDO agency status recognises the urgency now being given in the US to missile defence. The top four priorities for the new agency are:

- to defend the US, deployed forces, allies and friends from ballistic missile attack;

- to employ a multilayer ballistic missile defence system able to intercept missiles in all phases of flight (ie, boost, midcourse and terminal) against all ranges of threats;

- to enable the services to field elements of the overall ballistic-missile defence system as soon as practicable; and

- to develop and test technologies, use prototype and test assets to provide early capability, if necessary, and improve the

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effectiveness of deployed capability by inserting new technologies as they become available or when the threat warrants an accelerated capability.

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ANTI-MISSILE DEFENCE

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JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

BRIEFS - Vanguard Research to support BMD research efforts

Under a modification to contract FA2524-95-D-0001, Vanguard Research will provide advisory and assistance services, including support of research and development for ballistic-missile defence; missile-defence analysis; modelling and simulations; test, exercise and evaluation reviews; integrated systems assessment; wargaming; concepts of operation; requirements definition and documentation; software/hardware and systems integration; risk assessment; and US and international security. This work will be carried out at the Joint National Test Facility, Schriever Air Force Base, Colorado. The value of this contract modification is US$8.07 million using Fiscal Year 2001 and 2002 funds; the total cumulative face value of the contract including this modification is US$49.89 million.

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ANTI-MISSILE DEFENCE

Date Posted: December 13, 2001

JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

BRIEFS - SBL gets stage 3 funding

Team Space Base Laser (SBL) Integrated Flight Experiment (IFX) Joint Venture, El Segundo, California, is being awarded a US$49.98 million contract modification to provide for the initial phase (December 2001 through April 2002) of the third increment of the SBL programme's IFX project. The project will mature and integrate the component technologies, as well as including a component and system-level test programme leading to a proof-of-concept-on-orbit demonstration. The third increment involves continued risk-reduction testing in the areas of laser, beam control and beam direction, long-lead procurement and first release of the payload specification. This effort will be performed by Joint Venture team members Boeing (Canoga Park, California); Lockheed Martin (Sunnyvale, California); and TRW (Redondo Beach, California), and is due to be completed in April 2002.

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ANTI-MISSILE DEFENCE

Date Posted: December 13, 2001

JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

Missile interceptor scores third ICBM kill

Integrated Flight Test (IFT) 7 of the US Ground-based Midcourse Defense (GMD) Segment, formerly known as the National Missile Defense system, resulted in the successful interception of a re-entry vehicle target over the Pacific Ocean on 3 December 2001. This was the third successful trial of the system.

Earlier attempts to launch IFT 7 on the night of 1 and 2 December had been postponed due to poor weather conditions at Vandenberg Air Force Base, California. Conditions did not meet range safety requirements.

A modified Minuteman intercontinental ballistic missile (ICBM) target vehicle was launched from Vandenberg at 9:59pm Eastern Standard Time, and a prototype interceptor was launched approximately 20min later from the Ronald Reagan Missile Site at Kwajalein Atoll in the Republic of the Marshall Islands.

The exoatmospheric kill vehicle (EKV) separated from its rocket booster while still more than 2,200km miles from the target warhead. After separation, it used its on-board infrared and visual sensors,

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augmented with the X-Band radar data provided by the ground-based Battle Management, Command Control and Communications (BMC3) system to locate and track the target. The BMC3 data was transmitted to the EKV via the In-flight Interceptor Communications System (IFICS) at Kwajalein.

The objectives of ITF 7 were the same as those for the earlier IFT 3, 4, 5 and 6, explained Ballistic Missile Defense Organization (BMDO) director Lt Gen Ronald T Kadish during a pre-flight briefing. The only significant difference in the trial was the use of a different booster for the target - an Orbital Sub-Orbital Target Program booster instead of the Multi-Launch Service Target Program booster used earlier. The target suite was unchanged - a warhead and a large balloon decoy.

"There has been some confusion over why this particular target suite has been in since IFT 3, our first intercept attempt", said Kadish. "Some people say we should have a lot more countermeasures to test against. Some people say these are not representative of the countermeasures of a warhead that we need to test against eventually for operational realism.

"The reason why we're doing this is that the large balloon as well as the warhead itself represents what I would like to call classes of threats - not necessarily the specific threat we'll eventually go after, but classes of threat that give us enough test information in order for us to proceed with the development programme.

"So these are class-representative types of decoys and warheads... The large balloon does not, and there is no intention of, actually replicating the warhead signatures that are in this particular target warhead. It's a class of warheads and a class of decoys. So it gives us valuable information... They're not operationally realistic in the sense that the balloon on this flight test is supposed to replicate the warhead on this flight test. That's not the case."

The EKV successfully selected the target instead of the balloon decoy, and scored a

'hit-to-kill'. The intercept took place approximately 10min after the interceptor was launched, at an altitude of more than 220km above the earth.

The changes made to the system since ITF 6 were relatively minor, said Kadish. "There's been an awful lot of things that have happened to software, and little tweaks of the system that we are doing to make it better as we understood the last test results. So there have been some changes, but not massive changes in any of the activities that should cause us too much concern."

As on previous tests, the Ground-based Prototype Radar is at Kwajalein, the wrong position for an operationally realistic look at the warhead. In order to overcome that problem, a test radar in Hawaii is used to track the targets at an earlier stage of the flight. To help that test radar detect the warhead at long range, the warhead carries a C-band radar transponder. The warhead also carries a global positioning system (GPS) satellite navigation hardware to measure its position and broadcast this information to the ground.

Some critics of the programme have suggested that the transponder and GPS system are used to help the kill vehicle find its target. In practice, neither of these data sources is used after the kill vehicle has separated from its booster.

"The only thing we may use that [GPS] data for is the initial tasking plan to the interceptor to tell it where to go in space the first time because these radars are out of place, and they're a surrogate for it", explained Kadish. "We are going to remove those surrogates and those artificialities as soon as we are able to do it in the upgrades of the test bed in the Pacific. And that won't be for some time yet. But we're working on ways to eliminate those artificialities."

Like all BMDO tests, IFT 7 was reviewed to ensure compliance with the 1972 ABM (Anti-Ballistic Missile) Treaty compliance. As a result of this review, three elements that could have been a part of the test were dropped. One of these was a plan to track IFT 7 activities using a ship-mounted SPY-1

Aegis radar. (Another abandoned ABM-related test would have involved an Aegis radar being used to track a Titan II space-launch vehicle due for launch in November 2000.)

Announcing the US decision to postpone controversial ABM-related tests, US Defense Secretary Donald Rumsfeld said on 25 October 2001, "We have said we will not violate the treaty while it remains in force. In recent days, to keep from having it suggested that we might not be keeping that commitment, we have voluntarily restrained our ballistic missile defence test programme.

"Specifically, the Ballistic Missile Defense Organization has refrained from conducting several test activities, each of which some lawyers could debate might have been a violation of the treaty, were we to have proceeded."

IFT 8, the next scheduled test, is expected to take place around February 2002. Asked during the pre-flight briefing when, during the planned 18-flight test programme, the system would begin operational testing, Kadish replied, "When we're ready... It depends on how rapidly we are able to prove out the different modes of the system".

He defined the current phase of testing as developmental testing - testing to learn. This would lead to a combination of testing to learn and operational-type testing, then to operational testing. "We should be entering the combination period in about two years or less."

If ITF 7 achieved an interception, "we will have increased our confidence to move on to more aggressive and complicated efforts... The first one, and obvious one, is that we would be adding more countermeasure type of activity to the testing... My supposition at this point would be that we would add more decoys, certainly of the balloon type, that are more wide-ranging in the class of threats we would go after".

The target was launched from western USA, and the target from Kwajalein Atoll in the Marshall Islands. (Source: BMDO)

The Raytheon-designed exoatmospheric kill vehicle (EKV) is a 'hit-to-kill' weapon, and carries no warhead. (Source: BMDO)

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ANTI-MISSILE DEFENCE

Date Posted: December 13, 2001

JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

Orbital to develop air-launched TBM target

Orbital Sciences Corporation is to develop and launch four Short Range Air Launch Targets for the US Navy Area Wide theatre ballistic missile (TBM) programme. It has been awarded a US$24 million development task order by the US Army Space and Missile Defense Command (USASMDC) to cover this development and manufacturing work, which will be carried out in Chandler, Arizona, by the engineering and manufacturing facility of the company's Launch Systems Group.

The Short Range Air Launch Target will re-use surplus intercontinental ballistic missile solid-propellant rocket motors. After being transported aboard a C-130 Hercules cargo aircraft to a pre-defined launch area over the ocean, the vehicle will be extracted from the aircraft using parachutes. Once its descent has been stabilised, the rocket motor will be ignited, and the target will fly a trajectory of less than 500km.

This launch method allows target missions to be carried out from locations where no ground-based launch range exists. It has already been successfully demonstrated by USASMDC.

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ANTI-MISSILE DEFENCE

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JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

US Army selects target booster teams

TRW and Orbital Sciences have been selected by the US Army Space & Missile Defense Command to develop a liquid-propellant rocket booster which will be used as a target during the tests of current and future US missile-defence systems. This hardware will be developed under Phase IIa of the Liquid Booster Development Program.

Current targets are based on solid- propellant rocket motors removed from retired intercontinental ballistic missiles. These use toxic propellants, but the planned replacement will burn hydrogen peroxide and kerosene, and produce a clean exhaust.

The new target is intended for use by theatre missile-defence programmes, but the booster's design principles have been intentionally selected so that the unit could form the basis of targets intended for use in strategic missile-defence programmes.

TRW has been awarded a Phase IIa contact worth US$24 million. This includes a US$4.69-million option. The project will be managed by the company's operation in San Bernardino, California, which will design and develop the liquid booster. Its Redondo Beach facility in California will design the engine, and build and test the rocket on the

ground, while its unit in Aurora, Ohio, will build actuators for the booster.

Orbital Sciences has been awarded a development contract worth US$22 million, and will carry out the development work at its Launch Systems Group engineering and manufacturing facility in Chandler, Arizona.

"The benefits of a liquid propulsion-based target vehicle includes a more accurate representation of today's potential hostile weapons systems", says Michael J Bender, senior manager of business development for Orbital's Launch Systems Group. Other advantages are affordability, plus greater safety during production, handling and flight-test operations.

When the Phase IIa programme is completed with static-firings of both designs, one company will be selected for Phase IIb of the programme, and will complete the detailed design of its booster under a development programme expected to end with the flight test in early 2004. If successful, this could lead to a production contract worth up to US$100 million over six years.

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ANTI-MISSILE DEFENCE

Date Posted: November 26, 2001

JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

Patriot PAC-3 intercepts cruise missile target

In the final Developmental Test firing, the Lockheed Martin Patriot Advanced Capability-3 (PAC-3) missile successfully engaged a BQM-74 target drone flying at a very low altitude in a cluttered background at the White Sands Missile Range, New Mexico. The target was intended to simulate what the company described as an "advanced cruise missile". Soldiers from the 2nd Battalion of the 43rd Air Defense Artillery Regiment, Fort Bliss, Texas, participated in the launch.

The mission was the first PAC-3 flight test to use the newest Patriot software update (Post Deployment Build 5+) in the simultaneous engagement of a surrogate cruise missile target and sub-scale MQM-107 target drone. After radar acquisition and target classification of both targets by the Patriot Engagement Control Station, a PAC-3 missile was fired at the inbound cruise missile target while a PAC-2 missile was launched at the MQM 107 drone. Both missiles destroyed their respective targets.

"The PAC-3 Missile has been tremendously successful during Developmental Testing,"

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says Jim Berry, president of Lockheed Martin Missiles and Fire Control. "We have proven conclusively through these tests that the PAC-3 Missile is fully capable of defeating the entire threat to the Patriot air-defence system: tactical ballistic missiles [TBMs], cruise missiles and aircraft. The PAC-3 Missile provides a new level of protection against these challenging targets."

During development testing, PAC-3 achieved nine intercepts in 10 attempts. These are shown in the table (right).

The earlier Extended-Range Interceptor technology-demonstration missile scored three hits during its demonstration/validation phase. Two were against TBM targets and one against a drone simulating a cruise missile or aircraft.

PAC-3 can now begin Operational Testing, and is already in low-rate production. "For the projected US Army production run on PAC-3, we've been able to achieve cost-savings that place the average unit price of the missile just above US$2 million each," says Berry. "And when we add expected foreign PAC-3 missile production, we're talking about a missile that will be well below the US$2 million mark."

Date	**Target**
15 March 1999	TBM
16 September 1999	TBM
5 February 2000	TBM
22 July 2000	low-flying cruise missile
28 July 2000	low-flying cruise missile
14 October 2000	TBM
31 March 2001	TBM (first 'Tactical Ripple Mode' firing)
9 July 2001	QF-4 remotely-piloted aircraft
19 October 2001	advanced cruise missile

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ANTI-MISSILE DEFENCE

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JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

France may test Aster against a ballistic-missile target

Doug Richardson

Aerospatiale Matra Missiles is studying a possible anti-tactical ballistic missile (ATBM) trial which would use a derivative of the Aster 30 to engage a ballistic-missile target over a missile range in France, writes Doug Richardson. According to Claude Tribout, senior manager of the company's air-defence programme directorate, the trial would be conducted as part of current studies on a follow-on Aster Block 2 missile (see Jane's Missiles & Rockets August 1999, p1).

Speaking at the recent Global Missiles Summit conference held in London by SMi, Tribout said, "We are currently under contract to study new improvements of Aster to be potentially implemented within the next 10 years in order to meet the TMDPG [Tactical Missile Defence Programme Group] Staff Target Requirements".

The task of providing Aster with an improved ATBM capability is being tackled in two phases - the Block 1 missile, which is

currently under development, and a planned Block 2 version, able to meet the NATO staff target.

Block I is intended to provide the Aster 30 with an increased capability against tactical ballistic missiles (TBMs) in the class of the Frog, SS-21, Scud B and Scud C. The missile airframe will remain unchanged, but some subassemblies of the kill vehicle will be modified. The seeker will be given a new function based on a high-resolution range mode. The duty cycle will be modified to increase the transmitted power, while the target lock-on algorithms and tracking loops will be modified. The current pattern of radome may have to be modified to match the needs of the upgraded seeker. The revised seeker will be able to cope with higher closing velocities.

The missile warhead will be replaced by a new design incorporating an "eccentric triggering device" (presumably to direct the warhead's effects in the direction of the target) and two different types of fragments. The onboard computer will be more powerful and will handle an additional guidance law, plus the computation of new warhead-triggering delays.

Block 1 missiles will be delivered with the first SAMP/T systems to enter service. Intended to provide a full ATBM Capability against a Scud C-class threat but with no downgrading of its capability against air-breathing targets, it will be tested during SAMP/T User Operational Evaluation System (UOES) trials planned for 2004.

Looking beyond the Block 1 configuration, the company is trying to identify future system configurations, including Aster derivatives, which will be able to cope with the full spectrum of ballistic-missile targets expected around 2010-2012 that have been defined by the NATO TMDPG Staff Requirement Package.

Current studies will analyse the potential threat and its likely trajectories, and identify the most difficult operation scenario that a future ATBM system will have to handle, said Tribout. This could well be the task of

using missile-armed warships to protect military forces and vital assets in the littoral region. Since the Aster philosophy is to use the same weapon for land and naval applications, a solution able to meet the most stressing naval requirement will also meet the requirements of ground forces.

Studies are intended to show whether hit-to-kill capability can be maintained against the full spectrum of TBM targets, including missiles able to manoeuvre in the final stages of flight. A conclusion is expected next year.

Under these Aster Block 2 studies, the company will assess a wide range of weapon architectures. One of the most critical trade-offs to be studied is related to seeker technology. A future Aster derivative could use infra-red (IR) seeker technology from the MICA air-to-air missile, and be able to use an IR-homing mode in the final stages of an engagement. Studies will have to assess whether an IR-homing Aster or a dual-mode IR/radar missile is best matched to the task of low endo-atmospheric interception of TBM targets. Earlier studies have suggested that both solutions are feasible and affordable, and the team will have to decide whether to propose a dedicated Block 2 ATBM missile or a multirole round for use against aircraft and missile targets.

Another important study is investigating possible developments of the Aster PIF (Pilotage en Force) system of using sideways firing thrusters for final trajectory correction. Solutions being explored include:

· Perform the sustain phase of propulsion and the PIF function with the same propellant grain (charge), designing this charge either to increase the operating time or the level of generated lateral acceleration;

· Use of a single grain to generate one, two or even three PIF pulses;

· A two-pulse PIF system based on a single auto-extinguishable grain; and

· A PIF system based on two or three grains.

The candidate configurations will be selected

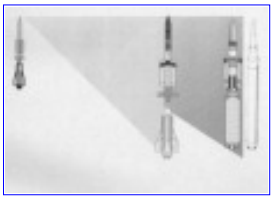
early next year.

Three potential Aster Block 2 weapon configurations, which are able to meet the NATO TMDPG Staff Requirement Target, have been identified.

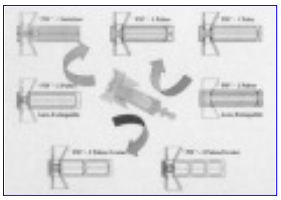
One way of exploiting the current investment in Aster technology is to retain the current kill vehicle airframe, whose performance is compatible with the requirements for a high-altitude ATBM engagement. The seeker would be changed, the proximity sensing system revised, the onboard computer adapted, and the sustainer and PIF subsystem redesigned. It is too early to say if a warhead would be carried by the kill vehicle, or if a hit-to-kill solution will be adopted.

"To extend the intercept volume and provide the possibility to intercept at higher altitude, we also are investigating various configurations of larger booster, while remaining compatible with the current Aster 30 canister," Tribout told the conference. Concepts being studied include a missile with a larger-diameter kill vehicle sized to house a dual-mode seeker and an enlarged wingless booster stage. Another teams an even larger wingless booster with a kinetic kill vehicle (KKV). The use of wingless boosters is made possible by the lack of any requirement to carry out short-range intercepts.

The company is currently refining a series of possible configurations, and plans to short-list the most promising concepts by the end of 2001.



Today's Aster 30 (left) could evolve into an improved version with or without a warhead, a larger diameter round with a wingless booster, or even a wingless design (shown in outline at the right).
(Source: Aerospatiale Matra Missiles)



Several configurations of PIF control system are being studied. (Source: Aerospatiale Matra Missiles)

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ANTI-MISSILE DEFENCE

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JANE'S MISSILES AND ROCKETS - NOVEMBER 01, 2001

BRIEFS - Surveillance aircraft operation funded

Boeing is to continue operation of the airborne surveillance testbed from 1 October 2001 until 30 September 2002 under a US$963,632 increment, that forms part of a US$15.06 million modification to existing contract DASG60-91-C-0146. The company will carry out the planning, calibration, testing, data collection and data reduction needed to provide infrared data from specific missions. These will support resolution of ballistic missile defence (BMD) issues and provide assistance for BMD and strategic-defence element developments. The work will be carried out in Seattle, Washington.

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ANTI-MISSILE DEFENCE

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JANE'S MISSILES AND ROCKETS - NOVEMBER 01, 2001

MBDA studies next-generation air defences

MBDA foresees a change in surface-to-air missile (SAM) philosophy starting around 2005. Currently, SAM systems are divided into four performance classes:

· anti-tactical ballistic missile (ATBM);

· medium-range (MSAM);

· short-range (SHORAD); and

· very short-range (VSHORAD).

By the of the decade, the ATBM and MSAM roles will merge, and in the decade which follows the SHORAD and VSHORAD roles will also merge, with the creation of short-range systems able to counter threats such as precision-guided missiles and cruise missiles.

Having made a major investment in Rapier Field Standard C and the Thales (formerly Shorts) Starstreak high-velocity missile (HVM), the UK Ministry of Defence (MoD) is looking at a two-stage programme to maintain its short-range SAM defences. MBDA hopes to play a major role in both programmes.

Two projects are being studied - Integrated

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GBAD (ground-based air defence) and Future GBAD. These will probably be integrated into a single GBAD programme divided into Phases 1 and 3.

Integrated GBAD (perhaps to become GBAD Phase 1) would update the existing Rapier and Starstreak systems, injecting new technology and ordering more missiles. The project would be worth around £1 billion (US$1.4bn).

The current standard Rapier round is the Mk 2B, and existing warstocks will last until 2010. The in-service date for the Integrated GBAD programme would be some time between 2006 and 2010, and the new rounds ordered under this programme would be in service until 2020 or later. UK Rapier and Starstreak systems would also be integrated with an overarching ADC4I (air-defence command, control, communications, computers and intelligence) system.

Future GBAD/GBAD Phase 2 would replace Rapier and Starstreak, and incorporate an evolved battle-management C4I system. Intended to provide a defence against what MBDA describes as "complex future threats", it would cost several billions of pounds, and have an in-service date of around 2020. It could involve some form of NATO collaboration; MBDA says it sees no signs of an alternative NATO programme in this performance class.

Since the fielding of the first land-based SAM systems, the UK has deployed only modest (some might say nominal) medium- or long-range SAM systems. No attempt was made to field defence systems around centres of population or to create an extension of the NATO ground-based HAWK and I-HAWK systems.

The long-range Bloodhound was originally fielded to defend UK bomber bases, but remained in service until the early 1990s. With the end of the Cold War, UK intelligence assessments concluded that the country faced no threat of air attack. The MSAM project, which was intended to meet Staff Target 1235 for a Bloodhound replacement, was cancelled and the older

missile suddenly retired not long after having completed a significant upgrading.

Although the Integrated GBAD and Future GBAD projects have no medium-range components, studies are under way at MBDA on ATBM concepts in response to UK interest and as part of the latest of a series of NATO feasibility studies.

NATO has defined the ballistic-missile threat as falling into three classes - 120-3,000km range, 1,000-5,000km, and 5,000-10,000km - which would require theatre, regional and national missile-defence systems respectively.

No one weapon system will defend against all threats and payloads, says MBDA. Evolving threats and countermeasures will require new weapon mixes and layers of defence. Multi-national role sharing will be an inevitable part of any tactical or regional ballistic missile defence (BMD) system.

The company already has significant national, NATO and multi-national BMD programme experience, having been the prime contractor in the UK Pre-Feasibility Study (PFS), the industrial lead in the three-year UK Technology Readiness and Risk Assessment Programme (TRRAP), and been involved in France's Epaminondas early-warning and anti-missile defence, Aster evolution, NATO Industrial Advisory Group (NIAG) technology studies, the Corps SAM project, which preceded MEADS, and MEADS.

Recent studies such as UK PFS, TRRAP, and Epaminondas have addressed system architectures and detailed technical issues and have provided a limited opportunity for bi-national co-operation. The NATO TBMD feasibility study started in July 2001 is now the primary effort aimed at creating a future NATO-based BMD architecture. It will investigate:

· threats and warheads;

· scenarios and missions;

· BMC3I and integration;

· systems and architectures (including growth

capability); and

· future plans and industrial strategies.

National studies, and others being conducted in parallel with NATO effort, will provide detailed information to support subsequent decision-making. These studies, funded under the UK Applied Research Programme, are due to begin at the end of this year.

Current MBDA programmes will provide a lower-tier capability with potential for further growth. SAMP/T and PAAMS will have lower-tier TBMD capability. This is being provided by the Aster Block 1 missile and the PAAMS Growth Potential Study (PAAMS GPS). Greater BMD performance will be provided by future concepts such as the Aster Block 2 missile (currently being defined) and the proposed Naval Middle Tier (NMT) programme.

NMT would be a development of the current PAAMS system and suitable for use on a Type 45-sized frigate. Within the UK, BAE Systems is running several studies looking at discrimination-technology programmes, and is studying higher-powered transmit/receive modules which could increase the capabilities of active phased-array radars. Studies of a similar naval ATBM system are under way in France, presumably for use on a Horizon-class frigate, but for the moment there is no convergence between the two efforts.

MBDA sees 'hit-to-kill' as the best kill mechanism for use against ballistic-missile warheads, says Dr Ian Errington, MBDA chief engineer advanced concepts. Any follow-on to the Aster missile should be designed to allow higher-altitude engagements. Although based on Aster technology, the resulting weapon would not at first sight look like an Aster derivative. It would retain the Pif-Paf control system of lateral-firing thrusters used for course-correction in the final stages of flight, but this concept "will need to be extended somewhat".

Some of the technology needed to counter ballistic missile targets is provided by

existing MBDA programmes. ASRAAM, Meteor and PAAMS use precision guidance, while image-processing and counter-countermeasure (CCM) techniques are applicable to the BMD task.

Future ATBM systems may not all be surface-based. Future air-launched interceptor concepts under study by MBDA could provide additional TMBD capability, the company suggests.

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Date Posted: May 21, 2002

JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

Taiwan salvo-fires Tien Kung II and Improved HAWK

Wendell Minnick

The Republic of China (Taiwan) successfully launched its locally-developed Tien Kung II (Sky Bow II) surface-to-air missile (SAM) during a live-fire exercise on 10 May 2002, writes Wendell Minnick. The 43rd 'God's Arrow' l exercise, the operation was designed to verify the engagement capability of the Tien Kung II and the country's Raytheon Improved HAWK systems.

Two firings were carried against Raytheon MQM-107E Streaker target drones. The first tested the HAWK's low-altitude interception capability. A single missile was fired, which successfully hit the target. The second scenario tested the ability of the Tien Kung II and Improved HAWK systems to engage two targets simultaneously at different ranges. During this firing, two Improved HAWKS and one Tien Kung II successfully engaged three targets.

The Air Defence Missile Command (ADMC) and the Chungshan Institute of Science and Technology (CSIST) jointly

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conducted the test at the Chiupeng Missile Testing Range on Taiwan's southeast coast.

Last year, Taiwan conducted two 'God's Arrow' exercises. The 41st was a Tien Kung II and Improved HAWK test, and the 42nd was Taiwan's first live-fire test of the Raytheon Patriot PAC-2 Plus.

In 2000, Taiwan purchased 162 Raytheon Improved HAWK missiles in a Foreign Military Sale (FMS) for US$106 million.

There have been media reports that Taiwan has decided to forego future purchases of the Patriot missile system. During the recent exercise, Chao Yao-ming, CSIST deputy director of the Tien Kung project, told Jane's Missiles & Rockets that the Tien Kung II is a better interceptor of aircraft than the PAC-2 Plus. Chao believes the Tien Kung II midcourse inertial guidance and active radar terminal homing is more advanced than those of the PAC-2. He stated the Tien Kung II has "better multi-engagement capabilities than the PAC-2", but would not comment on whether the Taiwanese missile had an ATBM (anti-tactical ballistic missile) capability similar to that of PAC-2.

According to official CSIST documents, the Tien Kung II has a speed of Mach 4.2, a combat ceiling of 25km and a range of 200km. However, Chao told JMR that those official figures are "conservative". When asked about Taiwan's reported attempts to develop the Tien Kung II into an ATBM as an alternative to further purchases of Patriot, Chao stated, "We are doing our best to move in that direction".

Taiwan has a stated policy of 'self-reliance' with regard to the development of indigenous weapon systems, and has become increasingly hostile to foreign military sales that encumber development.

There have been unconfirmed media reports that CSIST is attempting to modify the Tien Kung II into SSM (Tien Chi 'Sky Spear'), ATBM (TK-2A) and ship-based versions. According to media reports, the Republic of China Navy is considering the Tien Kung as

a possible weapon for the Knox-class frigates. However, a senior US defence official expressed doubt about Tien Kung II's potential ATBM capability. "I think there is some scepticism about the prospects it will perform on a par with the PAC-3 missile," the official stated.

Chinese intelligence-gathering ships are believed to have attempted to monitor this year's 'God's Arrow' exercise. Taiwan's navy went on alert after sighting the Chinese vessel Yuanwang 3 ('Long Look') 32km off the northern coastal city of Tamsui on 6 May. The 17,000-tonne 'space event ship' is one of four People's Liberation Army Yuanwang-class vessels assigned to monitor ballistic missile launches. The Yuanwang-class vessels have over 50 antennas, including one parabolic tracking antenna, two missile-tracking radars and two high- frequency antennas.

On 14 April, the Republic of China Navy chased off the Xiangyanghong-14 ('The East is Red'), a Chinese oceanographic research vessel. Operating 74km off Taiwan's east coast, near the Chiupeng missile range, the vessel was believed to be collecting information on the depth of the surrounding water, information which could have helped submarines to monitor the test site.

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SURFACE-TO-AIR

Date Posted: May 21, 2002

JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

Iraq redeploys SAM systems in 'no-fly' zones

Iraqi movements of surface-to-air missile (SAM) systems onto the northern and southern 'no-fly' zones in mid-April were at a greater level than has been seen for several years, according to US Secretary of Defense Donald H Rumsfeld: "He [Saddam Hussein] tends to move things around and do things that are inconsistent with the UN resolutions." Rumsfeld believes, however, that no particular significance should be attached to the redeployments.

"This is one of the things we've seen over time," said US Air Force General Richard B Myers, chairman, Joint Chiefs of Staff. "There will be surface-to-air missiles moved in, moved around, moved out. And it's just a little more activity in the last couple of days than we've seen in the last couple of years."

The moves could be intended to create 'SAM traps' said Gen Myers: "Any time they move a surface-to-air missile system into those areas, they threaten your force, so you have to be aware. We follow that very closely."

Asked if Iraq had reconstituted the fibre-optic-controlled air-defence system, which the US attacked in early 2001, and if

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there was any evidence that China had provided technical assistance or technicians, Myers would only say, "They have a very good fibre-optic system. I'll just leave it at that".

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

Palestinians may have used man-portable SAMs

According to unconfirmed reports, Palestinian forces used man-portable surface-to-air missile (SAM) systems for the first time on 5 April, firing two missiles against Israeli helicopters near Nablus. The helicopters reportedly evaded the missiles by manoeuvring and ejecting decoy flares.

Israeli helicopters have been using countermeasures against such weapons, which are known to be in Palestinian hands, for many months. Shoulder-fired SAMs available to the Palestinians include US-designed Stingers, Egyptian-produced Sakr Eye, and other versions of the basic Soviet-era SA-7 design.

Israeli forces have found it difficult to distinguish man-portable SAM launches from those of unguided RPG-7-series rocket launchers. If the Palestinians have used SAMs, it would represent a significant escalation of the conflict.

Recent Israeli incursions on the West Bank have led to the capture of extensive Palestinian weapons stockpiles. However, SAMs have been conspicuous by their absence from the well-publicised lists of

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seized weapons published by Israel. This suggests the capability remains potentially operational.

· On 11 May, the Israel Defence Forces reported that Hezbollah had directed anti-aircraft fire toward a civilian aircraft flying in the western sector of the Israel-Lebanon border. This incident seems to have involved gunfire rather than a missile attack - an Israeli civilian in the Shlomi settlement was reported to have been "lightly wounded by shrapnel".

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

Russia approves Almaz-Antei merger

David C Isby

A presidential decree, signed by Vladimir Putin on 24 May, approved the formation of a new integrated air-defence company that effectively combines much of Russia's surface-to-air missile (SAM) system expertise, most notably the Antei and Almaz organisations, writes David C Isby. In addition to these two major SAM system integrators - designers and producers of the S-300 (SA-10) and S-300V (SA-12) series respectively - up to 40 other enterprises and companies are expected to join the new organisation.

The most significant of these is the Fakel SAM manufacturer, located in Khimki, Moscow, and its Avanguard factory. One of the major objectives of the Almaz-Antei merger was to integrate Fakel with the new company. Fakel had previously been linked to the Oboronitelniye Systemy (Defense Systems) Joint Stock Company.

The new company, to be titled Air Defense Concern Almaz-Antei, has proven controversial in its formation, in part because of the different ownership of the two major organisations and their unwillingness to be subordinate to each other (see JMR, April

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2001, p10).

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Antelope SAM enters full-rate production

David C Isby

Taiwan's Chung Shan Institute of Science and Technology (CSIST) has announced that its self-propelled Antelope surface-to-air missile (SAM) system entered full-scale production in March after over seven years of research and development and low-rate production, writes David C Isby.

The Antelope system, used by Taiwan's Air Force for airfield defence, consists of a standard HMMWV (high-mobility multipurpose wheeled vehicle) light truck, which has a quadruple launcher with four ready-to-fire upgraded 9km-range Tien Chien 1 (Sky Sword 1) infrared-guidance SAMs.

The launcher includes a laser rangefinder, a 10km-range electro-optical sensor, a CSIST MPQ-78 30km-range integral search radar and a 20km-range forward-looking infrared (FLIR) sensor, allowing autonomous operations; but the Antelope is normally linked by a 70m cable to a remote battery fire-control radar and fire-control van. It can also be integrated with air-defence artillery.

At least one battalion is equipped with initial

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production Antelope systems, and it has been projected that at least one more battalion will be equipped. Antelope has been marketed internationally since 1998 but no export sales have so far been reported.

The investment in Antelope reflects Taiwan's increasing concern over the vulnerability of its airfields - both main and dispersal bases - to threats from the mainland. Targeting Taiwan's airfields could redress Taiwan's air-to-air superiority over the straits between the island and the Chinese mainland.

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JANE'S MISSILES AND ROCKETS - MAY 01, 2002

ESSM hits simulated anti-ship missiles

David C Isby

The Raytheon Evolved SeaSparrow Missile (ESSM) successfully shot down a low- altitude supersonic target simulating an anti-ship cruise missile (ASCM), writes *David C Isby*. The test, conducted from the US Navy's remotely controlled Self-Defense Testbed Ship (SDTS - the former DDG 31) off San Nicolas Island off the California coast, was the third successful live-fire ESSM test since the current series commenced in November 2001. It was the first test against this target flying a simulated ASCM profile. An MQM-8G ER Vandal was used as the target. This target is capable of Mach 2.1 at 3.6m altitude with a terminal weave end-game manoeuvre.

The Vandal was detected by the combat system carried aboard the SDTS and assigned to the ESSM system, which fired a single round using inertial midcourse guidance. At the scheduled time during its flight, the missile acquired the target, switched to terminal guidance and flew to intercept with the proximity fuze detecting the target and initiating warhead detonation.

Preliminary data indicate all test objectives were met.

This was a significant test as the ESSM is designed to intercept supersonic anti-ship missiles. It retains the semi-active radar guidance and warhead of the NATO SeaSparrow Missile (NSSM), but doubles the speed and improves manoeuvrability by adding an improved transition section with a fast digital autopilot as well as a new tail-controlled airframe and rocket motor with a booster and an integrated thrust vector control.

Three weeks later, during another test conducted from the SDTS, an ESSM missile successfully engaged and destroyed a subsonic Boeing Harpoon anti-ship missile which was flying a low-altitude trajectory. The Harpoon was detected by the SDTS combat system and assigned to ESSM. The ESSM missile was fired in HAW (home-all-the-way) guidance mode and flew to intercept with the proximity fuze detecting the target and initiating warhead detonation, destroying the Harpoon. Preliminary data indicate all test objectives were met. "This test was of particular significance for the US and consortium navies because it was a test against a representative target," says NATO SeaSparrow programme manager Captain Ken Graber.

During a firing carried out from the SDTS in February of this year, an ESSM missile successfully engaged and destroyed a manoeuvring, low-altitude BQM-74E subsonic target missile. Like the anti-Vandal firing, this was carried out with the missile flying initially under inertial control, then switching to semi-active radar homing.

ESSM had its first successful test at sea in November 2001 (see JMR, January 2002, p11). In January, an ESSM fired from a land-based Mk 41 Vertical Launching System at the White Sands Missile Range, New Mexico, passed within lethal range of a BQM-74E subsonic target, which was simulating an anti-ship missile. This test was intended to demonstrate a short-range, short-flight time engagement.

An ESSM leaves the launcher of the US Navy's unmanned Self Defense Testbed Ship. (Source: Raytheon)

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Malaysia orders all-weather Jernas

The Malaysian government has become the first customer for the MBDA Jernas (Young Falcon) short-range air defence (SHORAD) system, the export version of the Rapier Field Standard C (FSC) system used by the UK services. At the recent Defence Services Asia 2002 exhibition, the Malaysian Ministry of Defence confirmed that Jernas will equip a new air-defence regiment of the Royal Malaysian Army.

The contract covers Jernas missile launchers, surveillance radars, tracking radars and missiles, as well as a comprehensive training and support package. The procurement involves a significant and innovative technology-transfer programme, which will include the design and manufacture of Jernas sub-systems in Malaysia.

"This programme benefits both nations, and the UK is committed to a long-term partnership with Malaysia," said the UK's Minister for Defence Procurement Lord Bach. "In particular, we will be sharing our experience and operational knowledge throughout the service life of the Jernas system. This will include opportunities for Malaysian service personnel to undergo

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training in the UK with the British Armed Forces."

In its original Field Standard A (FSA) form, Rapier entered service with the UK forces in the early 1970s. This was followed in 1979-80 by Field Standard B1 (FSB1), some of which were later upgraded to FSB1(M) (Modified) version. Field Standard B2 (FSB2) followed in the mid-1980s.

These systems were intended to provide point-defence against low-flying aircraft, but FSC - also known as Rapier 2000 - was intended to counter threats such as pop-up attack helicopter attacks, anti-radar missiles, cruise missiles and unmanned aerial vehicles, and be able to operate in a severe electronic countermeasures environment.

Development of the FSC version was started in 1983 by what was than BAe Dynamics (now part of MBDA). It entered service with the British Army and Royal Air Force in 1996, and approximately 60 systems are now in service.

Work on Jernas started in 1992 as a private venture. Jernas is based on Rapier FSC but is optimised for deployment in the Middle East and other hot regions. The system can be configured to customer requirements, ranging from a passive day/night availability, obtained from the launcher operating in isolation, through to the full all-weather, dual-engagement capability of a complete system.

The version ordered by Malaysia includes the Alenia Marconi Systems (AMS) Dagger surveillance radar and Blindfire tracking and weapon control radars, so is capable of all-weather operation. The Dagger radar provides early-warning detection and target gathering, while Blindfire acquires and tracks both the target and the missile. Both radars use a narrow beam, frequency agility and have minimal sidelobes, says AMS, so are immune to jamming and air-defence suppression threats.

Like Rapier FSC, Jernas can engage two different targets at once, one with the electro-optical tracker and the other with the

radar tracker. It was designed to fire the impact fuzed Rapier Mk 2A or the crush/proximity fuzed Rapier Mk 2B missile variants, but in practice the Mk 2B is the only type of round currently being produced.

- Malaysia is also to procure Russian-made Igla (SA-18 'Grouse') man-portable surface-to-air missiles (SAMs), writes David C Isby. The agreement was negotiated as part of a larger arms package that may include upgraded Su-30 fighters. The contract, reported to be worth M$190 million (US$50m), was announced in Kuala Lumpur on 17 March by Malaysian defence minister Najib Tun Razak.

Since 2000, the Igla's manufacturer, the Kolomna Machine Building Design Bureau (KBM), has been authorised as an independent dealer, and has won several contracts for the missile. Because the missile is a 'wooden round' and the end user does not have to open its canister for routine maintenance or inspections, purchasers are not dependent on continuing support by the manufacturer. Many users see it as a stand-alone self-defence system for army units, a role that poses no integration problems. Support and integration concerns have limited the export of larger Russian air-defence systems despite their technical performance.

Jernas is based on Rapier Field Standard C, but is optimised for deployment in the Middle East and other hot regions.
(Source: MBDA)

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JANE'S MISSILES AND ROCKETS - MAY 01, 2002

USMC wants new Stinger night sight

David C Isby

The US Marine Corps (USMC) has issued a Request for Information (RFI) for 475 night sights for the Raytheon FIM-92 Stinger man-portable surface-to-air missile, writes *David C Isby*. The Marines are looking for a commercial off-the-shelf (COTS) technology replacement to the current night sight that can be funded in the near-term, and are considering a wide range of potential solutions.

The RFI was issued following Raytheon's decision to end production of the Stinger's current AN/PAS-18 Stinger Night Sight (SNS). Based on a forward-looking infrared (FLIR) system, this has been widely exported and is also used by some US Army Stinger teams, especially those assigned to SOCOM (Special Operations Command). The AN/PAS-18 can detect aircraft at 20-30km under optimal conditions (but lacks the resolution for visual identification) and has a 12x20º field-of-view. It is powered by a lithium battery with six to 12 hours of life.

Raytheon cited the lack of recent sales, and the difficulty in obtaining some of its older technology components, as reasons for withdrawing the AN/PAS-18 from

production. The company may update the device with COTS technology to respond to the RFI.

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BRIEFS - Mk 41 launcher support contract awarded

Lockheed Martin Naval Electronics & Surveillance Systems is to provide design-agent engineering efforts to support ongoing product improvements and new missile integration, as well as continued design agent engineering support for launcher electronics, systems integration and software integration portions of the Mk 41 Vertical Launching System. This work is due to be completed by October 2004, and is funded by a US$6.05 million modification to existing contract N00024-00-C-5486.

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BRIEFS - Upgrade will improve Patriot radars

Raytheon has received a US$48.7 million contract for four Patriot Radar Enhancement Phase III (REP III) kits, and four Classification, Discrimination and Identification Phase 3 (CDI-3) kits. The contract award includes spares and integration of the kits into the Patriot radars. The REP III improvements double the average power of the Patriot radar, while the CDI-3 kits add a wideband capability to the radar for generating and processing high-range and medium-range resolution waveforms for target discrimination.

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BRIEFS - First Aegis Baseline 7.1 delivered

Lockheed Martin has completed equipment testing of the seventh generation of its Aegis Weapon System. The Baseline 7.1 system upgrade includes a new AN/SPY-1D(V) radar, and the first complete commercial-off-the-shelf (COTS) Aegis computing architecture. These new capabilities will be introduced to the fleet in November when the system is installed on the Arleigh Burke-class guided missile destroyer Pinckney (DDG 91).

Aegis Baseline 7.1 production equipment has undergone acceptance testing and integration to verify system performance prior to being installed on Pinckney. After delivery to Northrop Grumman Ship Systems Ingalls Operations in Pascagoula, Mississippi - a task which required the use of 21 tractor-trailers - it will be integrated into the ship. Sea trials for Pinckney are due to begin in August 2003.

A total of 18 Arleigh Burke-class destroyers will receive the new radar, which adds the capability to operate more effectively in littoral environments, and has enhanced electronic countermeasures against advanced threats. The transition to COTS computing equipment increases the system's capability and is a major step toward an open

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architecture, which eases introduction of features and upgrades.

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South Korea close to signing SAM-X deal

David C Isby

The Republic of Korea Air Force may decide on the future of its long-standing SAM-X long-range surface-to-air missile (SAM) requirement in April 2002, writes *David C Isby*. The decision awaits the results of a cost-benefit analysis of the currently offered procurement being carried out by the Korea Institute of Defense Analyses, a government research institution.

Only the Raytheon Patriot system is being actively considered; the Russian competitors withdrew from the competition in 2000. However, negotiations between South Korea and Raytheon were stalled by Korean insistence on deferring payments for procurement of the system. In February, Raytheon agreed to receive 95% of the payment by 2010, rather than 2006 as originally asked. The agreement on deferred payment was said to be the only way SAM-X could be procured in the same timeframe as the new F-15K, which is likely to absorb most of the Air Force's procurement spending.

Under current planning, the SAM-X system will include eight Patriot fire units, each with

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six launchers capable of firing both PAC-2 and PAC-3 missiles. It will replace South Korea's elderly Nike-Hercules SAM systems and supplement the US Army's Patriot-equipped units in Korea in carrying out anti-tactical ballistic missile missions, plus the long-range SAM missions handled by the older missile.

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Patriot PAC-3 downs targets

The Missile Defense Agency (MDA) and the US Army have conducted the second of four operational flight tests planned during the initial operational test and evaluation (IOT&E) for the Patriot Advanced Capability-3 (PAC-3) system. Although all test objectives were not met, preliminary data showed that the missiles hit their targets.

Soldiers from the 2nd of the 43rd Air Defense Artillery Battalion of Fort Bliss, Texas, conducted this firing mission at the White Sands Missile Range, New Mexico. The tactical scenario used for the test required the simultaneous engagement of a Hera ballistic missile target and a tactical 'shoot-look-shoot' engagement against an MQM-107 subscale drone aircraft. This represented an aircraft raid taking place during an engagement of a tactical ballistic missile (TBM), conditions in which the TBM was the primary target.

Hera is a theatre ballistic missile target typically used for test and evaluation of Ballistic Missile Defense System (BMDS) systems. The version used in this test was the Block IIB non-separating (unitary) configuration with a Modified Ballistic

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Re-entry Vehicle 3 (MBRV-3) front end carrying a ballast payload. Launched from Launch Complex 96 at Fort Wingate, New Mexico, it flew a northwest to southeast trajectory to White Sands Missile Range reaching an altitude of 114km and flying 318km down-range in 361 seconds.

Patriot's system logic selected the most efficient missile for each engagement - the Hera target was engaged and destroyed by a PAC-3 missile, while a PAC-2 engaged and destroyed the MQM-107 drone target.

An earlier operational flight test (OT-3), conducted on 16 February 2002, had been only partially successful. It involved one PAC-3 missile fired against a subscale drone configured to represent a cruise-missile threat, and PAC-2 missiles fired against a full-scale QF-4 Phantom jet drone and a subscale drone aircraft. One PAC-2 missile intercepted and destroyed the QF-4, but the other two missiles missed their targets (see JMR, April 2002, p8).

The PAC-3 missile engaged but failed to intercept its intended target due to an inaccurate cue from the missile's ground system computer, says the US Army. This anomaly is under investigation. The PAC-2 missile engaged but failed to intercept the subscale drone aircraft due to a ground system radar fault that occurred during the last critical second of the engagement. The radar was able to recover and enabled the other PAC-2 missile engagement against the QF-4 to be successful.

The PAC-3 Missile entered low-rate initial production in late 1999, and the first production rounds were delivered to the Army in September 2001. Lockheed Martin Missiles and Fire Control officially opened the new PAC-3 Missile All-Up Round production facility in Camden, Arkansas, on 8 March 2002. PAC-3 IOT&E is due to be completed in May 2002.

l The US Department of Defense has decided not to publish the full text of this year's annual report by the Director of Operational Test and Evaluation (DOT&E), and has withdrawn the full text of earlier annual

reports from the Internet. The DOT&E website now bears a message that "due to national security considerations, portions of this website have been removed".

Danielle Brian, executive director of the pressure group, Project On Government Oversight, has written to US Defense Secretary Donald H Rumsfeld, saying: "The DOT&E's Annual Report is the most important publication communicating the findings of its programmes' testing and evaluation.... I urge you to reconsider this decision and allow the DOT&E to post its Annual Report on the web so that members of Congress and their staff, as well as US citizens can learn of your agency's important findings. The information contained in DOT&E reports is neither classified nor beneficial to potential terrorists."

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SEARAM launches first rounds

Four blast test vehicles (BTVs) have been launched from the Raytheon SEARAM Weapon System in a test designed to verify the system's structural integrity and the effects of launch forces on SEARAM sensors. The trial, conducted by the company and the US Navy (USN), was also intended to measure launch forces and to confirm there were no rocket motor effects on SEARAM's forward-looking infrared sensor. Three of the BTVs were fired in rapid succession, demonstrating the salvo capability of the system.

In 2001, Raytheon provided a SEARAM system to the UK for trials aboard the UK Royal Navy destroyer York, but the two-week trials programme did not involve missile firings (see JMR, November 2001, p10).

SEARAM is an adaptation of the Phalanx Block 1B Close-In Weapon System (CIWS), which fits the mounting with an 11-round launcher for Raytheon/RAMSYS Rolling Airframe Missiles (RAMs) in place of the normal 20mm rotary cannon.

Phalanx is a computer-controlled radar and 20mm gun system that automatically

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acquires, tracks and destroys threats that have penetrated all other ship defence systems. More than 850 systems have been built for 21 nations. Most recently, Phalanx Block 1B was installed aboard the USN's newest Arleigh Burke-class Aegis destroyers Howard (DDG 83) and Bulkeley (DDG-84).

"The firings are another indication that SEARAM is a low-risk development and will make a significant impact on the future of ship self-defence systems worldwide", says Troy Oberg, SEARAM programme manager at Raytheon's Tucson facility.

During another trial, Raytheon and the USN successfully fired a Phalanx Block 1B CIWS in an engagement against a supersonic sea-skimming missile. Phalanx was mounted on the Navy's Self-Defense Test Ship (SDTS) in a configuration that integrated the weapon with Raytheon's Ship Self-Defense System (SSDS) Mk 1 combat suite.

During the test, the Phalanx search radar passed missile detection data to the SSDS, which, in turn, ordered the Phalanx to engage the incoming missile. Post-test analysis reveals the target missile was hit by one of the first projectiles fired by the weapon's 20mm cannon, with subsequent target destruction occurring at a range double that of previous testing.

"This success further demonstrates the improvements provided by the Block 1B upgrade," says Hank Bautzmann, Phalanx chief engineer, at the company's Tucson facility. "To destroy a supersonic missile travelling at Mach 2-plus at this distance dramatically increases the keep-out range and provides our US Navy customer far greater protection." Captain Michael S Frick, Phalanx programme manager for the USN described the results of the anti-missile firing as "great news for our sailors... A proven increase in the keep-out range such as this provides irreplaceable security, especially in the littorals."

An unguided RAM missile leaves the SEARAM launcher in one of a series of firings intended to demonstrate the launcher's structural integrity.
(Source: Raytheon)

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Date Posted: April 23, 2002

JANE'S MISSILES AND ROCKETS - MAY 01, 2002

Raytheon offers to support Standard SM-1s

Raytheon has set up an industrial team to handle future support of the Standard Missile 1 (SM-1), writes Ted Hooton. This move is intended to address concern among the foreign users of the SM-1, a weapon being slowly phased out of US Navy (USN) service.

Eight countries (Australia, Bahrain, Egypt, Italy, Japan, Spain, Taiwan and Turkey) operating 53 Standard-armed cruisers, destroyers and frigates, anticipate using SM-1 Block V and Block VI as their prime area-defence weapon well into the next decade. The USN has 35 Oliver Hazard Perry-class (FFG-7) frigates equipped with SM-1 missiles whose Mk 56 dual-thrust booster/sustainer rocket motors (DTRM) are reaching the end of their practical lives (nine or 21 years depending upon the version). These solid-propellant motors will need to be replaced in order to maintain the missile's operational life, but production of Mk 56 was completed more than five years ago.

Many customers had anticipated benefiting from plans by the USN to extend the lives of

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the SM-1 family. However, with the Perry class now being gradually phased out of service, the USN decided to abandon the planned upgrade.

The matter was raised when the International Standard Missile Users Group (ISMUG) held its annual conference at the Naval Surface Warfare Center-Port Hueneme Division just before the USN League's annual sea-air-space exposition.

The Standard Missile Program Office (PMS 422) of the Theater Surface Combatant Program Executive Office (PEO-TSC), which sponsors the conference, had earlier requested Raytheon Missile Systems develop a plan to take over the responsibility for SM-1 support from Fiscal Year 2003 for both domestic and foreign users. At the Navy League event, Raytheon revealed it is assembling an industry team (that includes Aerojet of Sacramento, which developed and produced the Mk 56 DTRM), to tackle this task. Aerojet produced more than 10,000 Mk 56 motors, and has remanufactured nearly 1,500.

Aerojet still makes the M112 booster-sustainer for the MIM-14 HAWK surface-to-air missile, which is still in service with many overseas customers. The M112 and Mk 56 are similar in most characteristics and manufacturing processes, and the Raytheon-led team believes Aerojet could remanufacture the Mk 56 at a reasonable cost provided there is sufficient demand.

A plan will be placed before customers later this year, together with costings involved in dismantling and re-assembling the weapons in order to extend their lives by some 15 years. It might also be possible to upgrade missiles to the USN Block VIB standard, with an improved radar seeker and Mk 115 warhead.

At the Navy League show, Raytheon representatives said a Memorandum of Understanding is being prepared for signing between Washington and European countries covering the newer SM-2 missiles. Signing is anticipated during the next quarter, and it is expected that the SM-2 Block IIIB will be

released for export in 2004.

Commissioned in 1980, the Royal Australian Navy frigate Adelaide is equipped with a Mk 13 Mod 4 trainable launcher for the Standard SM-1MR. (Source: RAN)

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JANE'S MISSILES AND ROCKETS - MAY 01, 2002

BRIEFS - Raytheon to support CEC programme

The US Naval Sea Systems Command has awarded Raytheon a US$6.07 million modification to existing contract N00024-99-C-5110 to exercise an option for Design Agent support for the Co-operative Engagement Capability (CEC) programme. This work will be performed in St Petersburg, Florida, and is to be completed by September 2002.

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JANE'S MISSILES AND ROCKETS - MAY 01, 2002

BRIEFS - RAM modification kits ordered

Raytheon is being awarded an US$11.61 million Naval Sea Systems Command contract for production of 18 Mk 49 guided missile launching system modification kits for the Rolling Airframe Missile (RAM) programme. Work will be performed in Tucson (50%) and Ottobrunn, Germany (50%), and is to be completed by December 2005.

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TACTICAL SURFACE-TO-SURFACE

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

India to test Danush naval TBM

David C Isby

India is to resume testing of the Danush ('bow') naval tactical ballistic missile (TBM) in the near future, writes *David C Isby*. According to local press reports, India's Defence Research and Development Organisation (DRDO) will start a new series of Danush tests in April or May.

The Danush, publicly displayed at India's recent Defexpo 2002 arms exhibition, is a naval version of the Prithvi TBM, and is intended to be fired from stabilised vertical launchers on surface warships. Like Prithvi, it is designed to be nuclear-capable. Danush is reported to have a range of 250-500km, a circular error probable (CEP) of 50m and be able to carry a 300kg warhead.

The first shipboard launch of the current series was carried out in September 2001 from the test ship Subhadra. Testing of this missile was to have started in December 1998, but this has been delayed by the research and development problems that have been widespread among DRDO's missile programmes.

The first flight test of the Danush was on 11

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April 2000, when the missile flew for only four seconds and broke into two pieces, barely managing to clear the Subhadra. The current test missiles are reported to incorporate upgrades intended to prevent a repetition of the earlier failure.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

North Korea continues to test engines and export missiles

David C Isby

Despite the well-publicised moratorium on flight tests of the potentially intercontinental-range Taepo Dong-2 missile by North Korea, press reports from the Republic of Korea say ground tests of missile engines have continued, writes *David C Isby*.

Tests of engines that may be associated with the Taepo Dong-2 design have been reported at a test facility at Musudan-ri, Hwadae-gun in North Hamgyong province. At least one such test of a long-range missile engine was reported last year. Engine tests at this facility increased from one to two a year in 1998-2000, to three or four in 2001.

US intelligence assessments are that, as of 2002, North Korea remains the world's leading exporter of ballistic missiles. While these efforts have been countered by US and multilateral policies, North Korea has reportedly made strong marketing proposals to Egypt, Iran, Iraq, Libya and Syria. North Korea is reported to have sold 250 missiles

worth US$580 million to these countries since the 1980s.

Israeli sources reportedly believe they will be facing a considerable threat by 2004 from No Dong 1,300km missiles. Israeli defence minister Binyamin Ben-Eliezer has told reporters that the current Israeli Arrow 2 tactical ballistic missile defence system is not capable of intercepting missiles in this class until it is upgraded.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

BRIEFS - UK orders Tomahawk rounds

Raytheon Systems has been awarded a US$29.73 million modification to previously-awarded US Naval Air Systems Command contract N00019-00-D-0275 for the remanufacture of 22 Tomahawk missiles to the Block IIIC configuration. These missiles will be supplied to the UK under the US Foreign Military Sales (FMS) programme. The conversion work will be performed in Tucson, Arizona (52%); Salt Lake City, Utah (23%); Akron, Ohio (10%); Walled Lake, Michigan (6%); Camden, Arkansas (4%); Cedar Rapids, Iowa (3%); and Minneapolis, Minnesota (2%), and is expected to be completed by September 2004.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

BRIEFS - MLRS vehicle support packages awarded

United Defense, LP, Ground Systems Division, is being awarded a series of contracts and contract modifications by the US Army to supply systems technical support and logistics services in support of in-production and out-of-production Bradley Fighting Vehicle Systems (BFVS), Multiple Launch Rocket System (MLRS), Foreign Military Sales, and BFVS and MLRS Derivative Vehicles. Recent agreements are a contract worth US$5.45 million, and contract modifications worth US$9.37 million, US$6.88 million and US$5.46 million.

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Date Posted: March 22, 2002

JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

French Navy launches Naval Storm Shadow/Scalp programme

MBDA has been awarded a contract from the French Ministry of Defence (MoD) to begin the project-definition phase of the Naval Storm Shadow/Scalp land-attack cruise missile programme. The new missile is intended to arm the French Navy's future multimission frigates (with 17 vessels planned), and its six new Barracuda-class submarines.

A derivative of the air-launched Storm Shadow/Scalp EG cruise missile, under development for the UK Royal Air Force, French and Italian Air Forces, the naval variant will utilise many of the subsystems already developed for the air-launched weapon, ensuring cost-efficiency for the production phase and shorter delivery times than would normally be feasible for a new missile development project.

The Naval Storm Shadow/Scalp Project Definition Risk Reduction phase approved by the French MoD involves feasibility studies into methods of reducing the technical risks associated with installation of

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the missile into vertical launchers or torpedo racks and tubes.

Design of a common missile to meet the requirement for both vertical launch from surface ships and ejection from the torpedo tubes of submarines will involve a review of the aerodynamics of the baseline Storm Shadow/Scalp EG airframe. "The Naval Storm Shadow/Scalp is a project that puts together a whole range of skills which have been acquired independently within the sphere of airborne cruise missiles on the one hand and vertical launch, with the Aster family, on the other," says MBDA Engineering Director Jean-Paul Genest. "It also draws upon MBDA's experience acquired in the development of missiles such as the submarine-launched Exocet missile... The French MoD's decision should now make it possible to meet emerging requirements within other European navies for surface ship-launched deep land attack from the sea."

According to Pierre Dubois, director of MBDA France, and general manager of the Storm Shadow/Scalp family, "MBDA is today the world's largest cruise missile producer with orders now totalling 2,000 cruise missiles for the armed forces of the three launch European countries: the UK, France and Italy."

Artist's impression of SCALP Naval. The new system will use components from the existing SCALP-EG/Storm Shadow air-launched weapon in a new airframe. (Source: French Navy)

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

New command vehicle for Smerch MLRS units

Miroslav Gyürösi

Russian Federal State Unitary Enterprise Radiozavod in co-operation with Federal State Unitary Enterprise Rosoboronoexport is offering the 9S729M1 Slepok-1 system for the command of 9K52 Smerch heavy multiple-launch rocket systems (MLRS) at battery, battalion and brigade level, writes *Miroslav Gyürösi*.

A single Smerch battery equipped with the new automated command system consists of six 9A52 transport-erector-launcher (TEL) vehicles and one MP32M1 unified command-staff vehicle (UKShM = Unifitsirovanaya Komandno-Shtabnaya Mashina). Three batteries make up a battalion, which is commanded by one MP32M1 vehicle, while four battalions make up a brigade, which is commanded by two MP32M1 vehicles. A brigade thus has a total of 18 MP32M1 vehicles (12 with the individual batteries, four at battalion level and two at brigade level) which make up the overall 9S729M1 system.

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The MP32M1 unified command-staff vehicle is designed to provide automated command-and-control capability for heavy MLRS artillery units (9K52 Smerch brigades, battalions and batteries), and to provide secure data and voice communications with higher level command posts both when in static positions and on the road. It can be used for fire-preparation planning, including the effective distribution of targets to individual MLRS batteries, and data gathering to monitor mission progress.

Based on the KamAZ-43114 three-axle truck chassis with the K4.5350 shelter, it is 8.17m long, 2.55m wide and 7.71m high (including the height of the whip antennas). The vehicle weighs 14,300kg, has a maximum road speed of 85km/h, and a range of 800km without refuelling.

The MP32M1 can operate temperatures ranging from -40º to +50ºC, at a humidity of up to 98% at +35ºC, and at altitudes of up to 3,000m above sea level. It can be transported by air, sea and rail.

Within the vehicle are:

- three operations officers' workstations integrated via an Ethernet local area network;

- one workstation for the communications operator;

- one workstation which can be set up in the driver's cabin (equivalent in function to an operations officer's workstation, used when the vehicle is on the move);

- HF/VHF/UHF communication sets providing communications on six channels and at data rates of 0.1, 1.2, 2.4 and 16kbit/s, data/voice crypto systems and channel switching equipment; and

- Uragan/GLONASS and GPS/NAVSTAR satellite navigation system receivers.

This hardware is based on IBM AT-compatible computers equipped, not with the Pentium processor, but with the older and much slower 486 processor. Super VGA video monitors are used to display digitised maps, liquid-crystal displays for

alphanumeric data, and a printer is available for information logging.

Conditions for the crew of seven are controlled by an NBC system, an air filtering and ventilating unit, an air conditioner and a heater. The electric power system includes two 8kW diesel generators and 24V 190Ah batteries, able to supply emergency power for not less than 30 minutes.

Continuous operation time is at least 48 hours, while time into and out of action is 15 minutes.

The array of whip antennas raises the total height of the vehicle to more than 7m (Source: Miroslav Gyürösi)

The new MP32M1 command vehicle (rear) will improve the combat-effectiveness of the 122mm unguided artillery rocket (front) (Source: Miroslav Gyürösi)

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

Three-round Patriot test scores only a single hit

During a trial conducted by the US Missile Defense Agency and the US Army at the White Sands Missile Range, New Mexico, a Patriot Advanced Capability-3 (PAC-3) missile, launched as part of a three-missile engagement, missed its cruise missile target. The other two missiles fired during the test were both Patriot PAC-2 rounds. One successfully intercepted and destroyed a QF-4 full-scale drone aircraft, but the second missed its target - a sub-scale aircraft. The causes of the two intercept failures are currently under investigation.

This was an operational test in which one PAC-3 missile was to engage and intercept a cruise missile target, while two PAC-2 missiles were to engage and intercept a full-scale aircraft emitting radar-jamming signals and a sub-scale aircraft. The mission was designed to replicate, as closely as possible, an actual battlefield scenario, with three targets and three missiles in the air at one time. Patriot's system logic selects the most efficient missile for each engagement.

Other test objectives included demonstrating successful operation and interaction of all system elements, including radar,

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command-and-control equipment and target identification systems. Soldiers of the 2nd of the 43rd Air Defense Artillery Battalion, Fort Bliss, Texas, demonstrated their ability to conduct a tactical firing mission.

This trial completes the first of four operational flight tests planned during Initial Operational Test and Evaluation (IOT&E) for the PAC-3 system. IOT&E is due to end in May 2002. The IOT&E is being conducted by the Army Test and Evaluation Command (ATEC). Formed in 1999, when the Army consolidated developmental and operational testing and evaluation into a single command, ATEC has been deeply involved in the PAC-3 programme. ATEC's Developmental Test Command conducted extensive developmental tests on the PAC-3 system, and its Operational Test Command is conducting the user field tests.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

Netfires to support US Army Future Combat System

Scott R Gourley

According to US Army 'Objective Force' defence planners, tactical missiles will provide a key component of the emerging 'system-of-systems' structure that will comprise the pivotal Future Combat System (FCS), writes *Scott R Gourley*.

"We will have a network of sensors and we will also have a network of fires," explained Dr Allen Adler, director of the Defense Advanced Research Projects Agency (DARPA). Speaking at a technology symposium sponsored by the Association of the United States Army (AUSA) in Fort Lauderdale, Florida, Adler went on to describe a key concept within the network of fires that would feature "a vertically-launched missile system that could be brought in close in the theatre [of operations] to engage targets very quickly".

Netfires, which was formerly known as the Advanced Fire Support System (and even earlier as 'Fire Support in a Box'), is a DARPA-managed network-of-fires programme supported through a combination of DARPA and US Army Science & Technology (S&T) funding (see Jane's

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Missiles & Rockets, January 2002, p8).

Government programme descriptions note that Netfires will develop and test a containerised, platform-independent multimission weapon concept. Netfires will allow FCS to defeat all known threats, providing rapid response and lethality in packages requiring fewer personnel, decreased logistical support, lower life-cycle costs, and will have a higher survivability than current direct-fire gun and missile artillery.

The system will be air-deployable in C-130 (and smaller) aircraft, and will enhance the situational awareness and survivability of FCS by providing standoff target acquisition and extended-range, non-line-of-sight engagements. "The Netfires systems we're developing in this programme include a precision attack munition [PAM], basically a vertically-launched munition that heads right for the target, closes in very quickly and passes target updates," said Adler. "The other missile we're developing is the loiter attack munition [LAM]." Both types will have a self-locating launcher and a command-and-control system compatible with FCS.

DARPA Fiscal Year 2001 (FY01) programme accomplishments included: system hardware and software development for missiles, container/launchers and command/control units; completion of critical sub-component demonstrations; and initiation of preparations for flight-test demonstrations. Projected FY02 activities will include the initiation of ballistic test vehicle and controlled test vehicle demonstrations as well as the completion of pintle motor development and testing. Proof-of-principle flight tests are scheduled to begin in FY03.

Complimenting the work to-date performed by the two participating contractors - Raytheon Company and Lockheed Martin Missiles and Fire Control - Adler said: "As we move forward into the FCS this is the type of programme that we want to accelerate...We have networks of sensors and we have networks of fires but none of this

works if the communications system breaks down."

He told the symposium that DARPA is also managing parallel communications systems efforts that will have direct applicability to Netfires. Specific FCS tactical communications characteristics targeted for investigation and demonstration include low probability of detection and jam-resistance technologies.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

Italy begins first SAAM/IT qualification firings

MBDA has successfully completed the first qualification firing of its Aster 15 Naval missile from an Italian ship fitted with the SAAM/IT naval-defence system. The trial took place at the French DGA's Centre d'Essais de la Méditerranée (CEM) at Toulon, in southwest France, and the missile was launched from the Italian trials ship Carabiniere, which was positioned off the coast.

The firing resulted in a direct hit against the target from a distance of 7km and at an altitude of 1,000m. It follows the earlier qualification of the French SAAM/FR configuration in October of last year.

SAAM/IT shares many subsystems with the French SAAM/FR system, including the Sylver vertical launcher and Aster 15 Naval missiles, but the MBDA-designed fire-control system is integrated with an Italian multifunction EMPAR radar rather than the Arabel multifunction radar used in SAAM/FR. The SAAM/FR and SAAM/IT programmes are run by EUROSAM, a joint venture by MBDA and Thales.

In early December 2001, the French Navy took delivery of the first series-production Aster 15 Naval missiles. These were used to arm the SAAM/FR system aboard the French Navy's aircraft carrier Charles de Gaulle before the vessel's departure for the Indian Ocean to join the naval component of the international coalition led by the US.

A total of 200 Aster 15 Naval missiles have been ordered to equip 11 naval-defence systems intended for the Charles de Gaulle, the three F 1300S frigates Al Riyadh, Makkah and Al Dammal ordered by the Saudi Arabian Royal Navy, the second Italian aircraft carrier Andrea Doria, and six modified La Fayette-class frigates ordered by Singapore. The Aster 15 Naval missile and the longer-ranged Aster 30 Naval will also be used by the trilateral PAAMS (Principal Anti-Air Missile System) for the mid- to long-range naval defence of new-generation British, French and Italian warships.

Three PAAMS systems were ordered in 2000, with 200 Aster 15 and 30 Naval missiles, to equip the first-of-class air-defence vessels for each of the three countries: a British Daring-class Type 45 destroyer, a French Forbin-class Horizon frigate and an Italian Orizzonte frigate. Seven other PAAMS systems, and between 400 and 500 Aster 15 and 30 Naval missiles, will be ordered in 2002 to arm five Type 45 destroyers, a French Horizon and an Italian Orrizonte. Qualification of PAAMS is expected between 2004 and 2006.

During the test, the Italian trials ship Carabiniere was positioned off the coast of Centre d'Essais de la Méditerranée (CEM)at Toulon (Source: MBDA)

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

BRIEFS - Cruiser-conversion contract expanded

Lockheed Martin Naval Electronics and Surveillance Systems is being awarded a US$15.91 million modification to existing contract N00024-98-C-5197 to exercise options to provide for material and 161,967 hours to support cruiser-conversion efforts. Services include providing the material, equipment, supplies and technical engineering required to define, design, develop, integrate, test and deliver Aegis combat system upgrades for Aegis baselines (seven Phase I, six Phase III, cruiser-conversion, and Theater-Wide ballistic missile defence upgrades), which may be further clarified by written technical instructions. The contractor will provide system engineering support to evaluate all problems for their effect on the Aegis weapons system; propose solutions to each problem; and identify changes required to all specifications. This work will be carried out in Moorestown, New Jersey, and is to be completed by September 2004.

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BRIEFS - Raytheon to supply Aegis hardware

Raytheon Systems is being awarded a US$21.88 million modification to previously awarded contract N00024-02-C-5100 for ancillary equipment associated with Aegis Weapon System (AWS) OT-188 and SPY-1D (V) transmitter groups, and fire-control system (FCS) Mk99 Mod 3 supporting the AWS facilities at Surface Combat Service Center, Wallops Island, Virginia, and Naval Surface Warfare Center, Crane Division, Crane, Indiana.

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BRIEFS - Aegis network support contract

Cable and Computer Technology is being awarded a US$9.95 million contract for engineering services in support of the Aegis Sites Switching and Data Switching System (DTS). This work will be performed in Anaheim, California, and is due to be completed by March 2007.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

BRIEFS - Raytheon to support export Patriots

Raytheon Electronic Systems is being awarded US$12.08 million as part of a US$44.95 million contract for 2002-2004 support services for Patriot Missile Support Centers (PMSC) for NATO Maintenance Support Activities, Israel, Saudi Arabia, Kuwait, Taiwan, Japan and Greece. This work will be carried out in Bedford, Massachusetts, and is due to be completed by 31 January 2005.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

IDF hunts Qassam-II rocket workshops

Doug Richardson

During a series of raids mounted against Palestinian targets, following the use of Qassam unguided rockets against Israeli targets, the Israel Defence Forces (IDF) have located several of the workshops where these locally-developed missiles are being manufactured, writes *Doug Richardson*.

"We are in the process of searching out missile factories and destroying them," said Col Gal Hirsch, operations officer of the IDF Central Command, on 12 March. "We have so far found over 20 Qassam missiles during our searches in Gaza and the West Bank."

(The designation 'Qassam' is a transliteration from Arabic. The Palestinian Islamic Resistance Movement [Hamas] - the organisation which developed these rockets - uses the spelling 'Qassam' while the IDF favours 'Kassam'.)

During a military operation, which started on 27 February and ended on 2 March, the IDF found a laboratory for the production of Qassam-II rockets at the Balata refugee camp in Nablus. This contained six

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uncompleted rockets, and one rocket ready for launching. A factory producing materials used in the manufacture of Qassam rockets was also located.

During an 11 March raid on the Jabalya camp located north of the city of Gaza, the IDF demolished 25 weapon workshops, some of which were involved in the manufacture of Qassam rockets. Qassam-II rockets have also been found inside a garage in Tul-Karem, along with sacks of explosives, spray cans to paint the missiles, trigger wires and warheads.

The shorter-ranged 60mm Qassam rocket (originally known as the 'Izzadin Qassam') was first used in November of last year, when examples were fired at IDF posts near the Erez crossing and a Gush Katif settlement (locations in the vicinity of Gaza). Earlier this year, the IDF became aware of increasing attempts by the Palestinian Islamic Resistance Movement (Hamas) and other groups to move the longer-ranged 120mm Qassam-II rockets and launchers to border areas from which Israeli cities could be targeted.

Evidence that the new rockets were being prepared for use came on 6 February, when a truck stopped at a road-block southeast of Nablus was found to contain eight Qassam-II rockets. The vehicle had been on its way to Jenin.

On the afternoon of 10 February, two Qassam-II rockets were launched from a Palestinian-controlled area in Gaza, just south of Beit Hanoun. One of the rockets landed at Kibbutz Saad, at a distance of just under 6km from the launch site, and another at Moshav Shuva, about 7km away. Three rocket launchers were subsequently found south of Beit Hanoun by Israeli forces, all of them with timing devices for launching the rocket. The third rocket was apparently disabled when an IDF tank fired at the launchers after the first rockets were fired.

In a communiqué issued following another Qassam-II attack on 16 February, Hamas said: "The Qassam-II missile is a deterrent weapon and it is Palestinian- made. We are proud of it and it is not mere fireworks."

On 5 March, two Qassam-II rockets were fired at the city of Sderot. One of the rockets hit a residential building, the first time that a Qassam rocket had hit an Israeli city, while the other fell in an open field.

The IDF believes that Hamas has completed development of the Qassam-III rocket, a longer-ranged weapon thought to be able to reach targets up to 10km from the launch point (some sources suggest 20km). Since no Qassam-III hardware is reported to have been seized in the recent raids, development of this weapon is probably being tackled at an as-yet unknown location.

Our sister title Jane's Defence Weekly reports that Rafael has manufactured a model of the Qassam rocket in order to determine the weapon's effectiveness. This project showed that the Qassam-I has a maximum range of 1.5-2km, rather than the expected 4.5km, and that Qassam-II has a range of 5.8-8km.

According to the IDF, the Qassam-II is easy and quick to produce and, although currently armed with an explosive warhead, could be modified to carry an 'unconventional' payload. Its accuracy is poor, but good enough to hit a metropolitan target.

The comparatively unsophisticated design of the Qassam series makes them relatively easy to manufacture in improvised facilities, but their simple construction poses a heavy penalty in terms of performance.

For example, the 60mm rocket used by the Croatian Army has a maximum range of 7.2km, while the Russian 122mm SPAV rockets manage ranges of 20-40km while carrying warheads containing 18-25kg of explosives.

This still-unpainted Qassam-II was one of a batch found inside a garage in Tul-Karem. (Source: IDF)

This primitive facility, found in the Balata refugee camp was being used to support Qassam manufacturing (Source: IDF)

This batch of Qassam-II missiles was found during a search operation in the Balata refugee camp. (Source: IDF)

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

SMArt 155 munition repeats 100% reliability in tests

GIWS (Gesellschaft für Intelligente Wirksysteme) achieved 100% reliability in a series of gun-fired tests of the SMArt 155 sensor-fuzed munition system conducted in December 2001 by the German government, says ATK (Alliant Techsystems). A total of 14 SMArt 155 submunitions were delivered over the target array during these lot-acceptance tests. The system achieved eight target hits, six near misses, and demonstrated 100% submunition reliability.

The tests, which were held at government-owned proving grounds in Meppen, Germany, were part of the SMArt 155 production programme for the German Army, and follow similar tests held in April, September and November 2001. SMArt has been in full-rate production for the German Army since 1998. GIWS has delivered more than 2,500 projectiles to the German artillery forces under a contract that calls for total production of 9,000 rounds over the next several years.

GIWS is a joint venture company owned by two German companies - Diehl Munitions of Nuremberg, and Rheinmetall DeTec AG in Ratingen.

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The only gun-fired multisensor smart munition system currently in production, SMArt 155 uses a millimetre-wave radar, radiometer, and an infrared sensor to detect artillery and armoured targets in all weather and environmental conditions.

In November 2000, ATK and GIWS entered into an exclusive agreement under which GIWS will transfer the technology for SMArt 155 to ATK Ammunition Systems Company, which will manufacture the SMArt 155 system and offer it for sale in the US. "We believe the SMArt 155 and the SMArt submunition are the best and most affordable systems available to meet the US Army's requirement for gun-fired smart munitions," says Charles Farnham, director - business development at ATK Ammunition Systems Company. SMArt 155 is demonstrating reliability levels unmatched by any gun-fired system in either development or pre-production, according to ATK.

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COVER FEATURE

Date Posted: April 23, 2002

JANE'S MISSILES AND ROCKETS - MAY 01, 2002

First seeker-guided IRIS-T firing downs target drone

The first seeker-guided firing trial of a BGT IRIS-T air-to-air missile resulted in a direct hit on the target drone. Carried out at the Salto di Quirra over-water test range in Sardinia on 14 March, the firing was made from an F-4F Phantom of the German WTD 61 Test Center at Manching. The round was fired with a high off-boresight angle against a Mirach 100/5 jet-powered target drone at a range of several kilometres.

Telemetry data recorded from the missile exactly matched the results of previous simulations, says BGT, and the missile struck and destroyed the drone. Around 2.3m in wingspan, the Mirach 100/5 can fly at speeds of up to Mach 0.9.

This shot was preceded by a pre-programmed firing on 1 March 2002. This checked safe separation from the aircraft and the control response of the autopilot-guided missile under high g-loads and angles of attack.

In addition to demonstrating the weapon's performance against a small target, the trial also confirmed that problems with the

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insulation of the rocket motor blast tube, which occurred during last year's firing campaign, had been fixed. During tests last year, a workmanship problem had been experienced with an insulated lining of the blast tube. Hot efflux was able to work its way between the insulation and the tube wall, burning through the wall and damaging the missile's control actuators, which are mounted around the blast tube.

Debris from the actuation system entered the air intake of the launch aircraft, causing the declaration of an in-flight emergency. This was precautionary, said BGT at the time, and in practice no damage was found (see JMR, August 2001, p3). The liner has since been redesigned and an improved manufacturing process developed.

The IRIS-T programme is led by BGT, but is a joint development by Germany, Greece, Italy, Norway and Sweden. Canada was a partner through much of the development programme, but withdrew last year. The reasons given were higher-than-anticipated costs for integrating the missile onto the CF-18, and timescale problems which would have prevented the weapon being incorporated into the next standard of CF-18 avionics software.

Further guided firings are expected in June or July, followed by another series in the autumn. Development is due to be completed by the end of 2002, allowing low-rate series production to begin. BGT is working on the task of integrating the missile with German and Italian EF 2000 Eurofighter aircraft and on Greek F-16s, and full digital integration and certification on the F-16 is expected by the end of 2003.

First production deliveries will start in 2004, and the missile will gradually replace ageing AIM-9L/M Sidewinders in the inventories of the consortium nations and other potential customers. IRIS-T is one of the two missiles currently being considered by the Swiss Air Force as a future short-range weapon for it F/A-18 Hornet fleet.

IRIS-T incorporates aim-point selection, and in this trial scored a direct hit on the rear fuselage of the target drone.
(Source: BGT)

A long-range camera captures the moment of impact as the missile shatters the rear fuselage of the drone.
(Source: BGT)

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Date Posted: March 22, 2002

JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

Switzerland narrows its choice of dogfight missile

Doug Richardson

Switzerland has narrowed its choice of a next-generation air-to-air missile (AAM) to the Raytheon AIM-9X and Bodenseewerk Geratetechnik IRIS-T, writes *Doug Richardson*.

Intended for use on the F/A-18 as a short-range complement of the AIM-120B Advanced Medium-Range Air-to-Air Missile (AMRAAM), the weapon must have a high agility and high off-boresight capability, and be fully integrated with the Joint Helmet-Mounted Cueing System (JHMCS) which is being retrofitted to the Swiss Hornet fleet under phase 2 of the current upgrade programme.

Speaking at the recent AAM conference held in London by SMi, Juerg Weber, Chief of the Swiss Defence Procurement Agency's Air Material Division, explained the reasons why the other two candidates, from the original shortlist of four, had been rejected following the initial evaluation phase of the project to select a new short-range missile.

The MBDA Advanced Short-Range

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Air-to-Air Missile (ASRAAM) had a maximum range that partly overlapped with the beyond-visual-range capabilities of AMRAAM, but the Swiss evaluators had concluded that the weapon lacked performance at short ranges.

Rafael's Python 4 weighs 105kg, so is about 20% heavier than the AM-9X (85kg) or IRIS-T (87kg), a characteristic which would have posed problems when using the wingtip launchers of the F/A-18. (The normal armament for Swiss Hornets is either four AMRAAMs on underwing pylons and two AIM-9P-5 on the wingtip launchers, or two AMRAAMs and two AIM-9P-5 on underwing pylons plus two AIM-9P-5 on the wingtip launchers.) Another factor, which counted against the Israeli missile, was that it is not in service with any F/A-18 user - Switzerland wanted a solution which would not be 'Swiss-only' but in service with other Hornet users.

The main evaluation stage of the Swiss analysis is due to end this year. The process involves more detailed studies, plus captive flight trials to confirm the performance characteristics determined by simulations. Firings of unguided rounds will be used to test missile/aircraft separation and assess the tradeoff between high manoeuvrability immediately post-launch and the safety of the launch aircraft.

It is hoped a final selection can be made before the end of 2002, Weber told the conference, but there is a risk that this could slip, affecting the plan to begin procurement in 2003.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

IRIS-T to begin seeker-guided firings

The first seeker-guided test firing of the Bodenseewerk Gerätetechnik IRIS-T short-range air-to-air missile (AAM) was expected to take place in mid- March, Gerhard Dussler, BGT marketing manager for the missile told the recent conference on AAMs held in London by SMi. Development of the missile is due to end late in 2002, allowing first production deliveries by the end of 2003.

The missile is almost identical in dimensions to the AIM-9, and its centre of gravity is within millimetres of that of the older missile. As a result, it should be easy to integrate with aircraft cleared for Sidewinder, says BGT. There are cooling gas bottles in the missile and the launcher.

The seeker has a field-of-view twice that of the AIM-9L, and a look angle of up to 90º. It creates a 128x128 pixel image of the target, but this is achieved by scanning rather than the use of a staring array. The latter was the solution favoured by the Raytheon AIM-9X and MBDA Advanced Short-Range Air-to-Air Missile (ASRAAM).

Scanning is better than a staring array for air-to-air applications, Dussler told the conference, since at long range the target

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image may occupy only a few pixels, or even a single pixel. In an image built up by scanning there are no gaps between pixels, therefore no target loss or signal modulation at long ranges. The guidance system is intended to steer the round to a direct hit on the target.

The weapon has a lock-on-after-launch (LOAL) mode which incorporates predictive tracking. After launch, the missile can turn through 180º in an area the size of two large soccer fields, and within around 0.5sec of leaving the launcher, the seeker will be able to use its 90º look angle to see a target located directly behind the launch aircraft. The rocket motor is steel-cased, and optimised for close combat.

IRIS-T is designed to cope with directed infrared jammers, which would have to match the scan rate of the seeker mirror in order to be effective, said Dussler. If necessary, the missile would be able to home onto the energy from a jammer of this type. When the seeker was tested during carry trials on a Gripen, the Swedes released flares in order to assess its resistance to countermeasures. The flares used included a new type, Dussler told the conference, but this did not create problems for the seeker.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

France to buy self-defence missile for Mirage 2000

Doug Richardson

France plans to equip its Mirage 2000D fleet with a new short-range air-to-air missile (AAM), writes *Doug Richardson*. It will replace the MBDA Magic 2, and will provide these two-seat strike aircraft with an improved self-defence against enemy fighters. Possible use on the Mirage 2000C is also being studied.

The Missile d'Autoprotection et de Combat Rapproché (MACR) will be an off-the-shelf purchase; candidates are understood to be the Bodenseewerk Gerätetechnik IRIS-T, the infrared variant of the MBDA MICA, and a version of the AIM-9 Sidewinder (not necessarily the AIM-9X).

Requests for information for MACR have been issued, Col Guillaume Gelée of the French Air Force Plans and Studies department told the recent AAM conference held in London by SMi. A request for proposals is due to be released this summer. MACR is expected to enter service in 2007, and to have replaced the Magic 2 by 2012.

There are no plans to fit MACR to Rafale, he

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said; the newer fighter will rely on the MICA and the MBDA Meteor, which was selected to meet the French Missile d'Interception à Domaine Elargi (MIDE) requirement.

Key elements of the MIDE requirement were that the missile must have a large 'no-escape' zone and good manoeuvring capability in the final stages of flight, he explained. Having a large 'no-escape' zone would mean an enemy pilot - who realised that he was under attack (either by detecting RF transmissions from the MIDE-equipped aircraft or observing the missile launch) - has no chance of out-running the missile; while a high level of end-of- flight agility would counter any last-minute enemy manoeuvres attempted, should the pilot see the missile approaching or detect the RF transmissions from the weapon's seeker. The MIDE specification requires the missile to have a maximum manoeuvrability during the end game around three times that of the target aircraft.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

Follow-on AIM-9X order

Raytheon Systems is being awarded an US$11.46 million modification to previously- awarded contract N00019-97-C-0027 to exercise an option for low-rate initial production of the Sidewinder AIM-9X to include 35 all-up round missiles, 36 captive air-training missiles, 14 dummy air-training missiles, and four common munitions bit/reprogramming equipment adapter kits. These will be manufactured in Tucson, Arizona, and are to be completed by April 2004.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

China shows its newest air-to-air missiles

Robert Hewson

The Beijing-based China National Aero Technology Import & Export Corporation (CATIC) is working on a next-generation dogfight missile, writes *Robert Hewson*. A CATIC engineer attending this year's Asian Aerospace exhibition, held in Singapore during February, described the new missile as being "very different to the PL-9", but "still a few years away from service yet".

The new missile will use an all-new airframe design, coupled with an imaging infrared (IR) seeker - CATIC is known to be working on 64x64- and 128x128-pixel IR seeker arrays, using both linear scanning and staring array techniques. These seekers have been developed for both the 3-5µm and 8-12µm wavelengths. According to CATIC, the new missile is intended to equip the J-10 fighter.

Another future J-10 weapon is a new series of Chinese laser-guided bombs, which CATIC has confirmed is currently under development.

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China's PL-7 short-range air-to-air missile (AAM) and the PL-10 medium-range SARH missile programmes have been dropped, with no more development work ongoing. All efforts have instead been redirected to the SD-10 missile programme - an active radar AAM with an 80km range according to CATIC. A company engineer confirmed several SD-10 test firings have already taken place, and that most of the SD-10's subsystem testing has also been completed, but that the missile is not yet ready for service. CATIC is known to be developing X-band and Ku-band active radar seekers, which are certain to be applied to the SD-10.

At the Singapore exhibition, CATIC displayed the current versions of the PL-5 and PL-9 short-range AAMs (plus a PL-9-based surface-to-air missile [SAM] system), as well as the little-seen TY-90 helicopter-launched AAM.

CATIC describes the PL-9C as a 'third-generation combat AAM'. Key changes over earlier versions include the missile's new multi- element seeker (functioning in the 3-5µm band) with digital signal processing. According to CATIC, the PL-9C has significantly improved IRCCM (infrared counter countermeasure) capabilities, putting it in a class above the PL-8 (China's Python III copy).

The PL-9C has twice the head-on detection range of the basic PL-9 - now 8km - with a seeker lock-on time of >0.3 seconds. Maximum firing range (in the front hemisphere) is quoted as 22km. Off-boresight capability of ±30º, while maximum angular tracking rate is 28º/sec. According to CATIC, the PL-9C is intended for use on People's Liberation Army Air Force (PLAAF) J-8 and J-10 fighters.

Shown in parallel with the PL-9C was the DK-9C air-defence system - a ground-based SAM system using the PL-9C missile. The DK-9C uses a wheeled, four-shot launcher, with the capability to integrate an air-defence radar - or rely on the missiles' own seekers for a passive engagement capability. The

system is claimed to have an effective range of 8-10km.

The improved PL-5E is the latest iteration of an earlier class of Chinese AAM design, based on Soviet-era R-13 (AA-2 'Atoll') technology - albeit much developed over the years. Existing PL-5s have a rear-aspect 'tail-chase' engagement capability only, but the improved seeker head and laser proximity fuze of the PL-5E gives the missile an all-aspect capability for the first time.

The PL-5E and the PL-9C both use an indium antimonide (InSb) gas-cooled seeker, and may share the same basic design of proximity fuze. According to CATIC, the PL-5E is now in PLAAF service on the J-7 and J-8.

Also shown in model form was the TY-90 helicopter-launched AAM. The result of a development programme launched in the 1990s, the weapon is still in its test and trials phase. It is an all-aspect missile with a maximum head-on engagement range of 6km. CATIC claims that, like the PL-9C, the TY-90 uses 'computer-aided systems' for guidance and flight control.

It is fitted with a four-element gas-cooled seeker (with the elements arranged in two horizontal pairs), of the same type fitted to the PL-9C, and the warhead is understood to be an expanding-rod type. The TY-90 is designed to be carried in multiples of four, six and eight missiles on a single helicopter. CATIC claims airborne firing trials have been conducted, though no details were given. The missile is likely to enter service on China's armed Z-9 helicopters (a Z-9 is believed to have been used as a testbed aircraft), but is certain to be earmarked for the new Z-11 attack helicopter, currently in the advanced stages of development.

Above: While the warhead and proximity fuze of the PL-5E, shown at Singapore, are both marked with serial numbers beginning 'P5E', the seeker number begins with 'P5DK'. The job of updating the display round to the PL-5E standard, therefore, may not have been completed (Source: Robert Hewson)

Left: The seeker of the PL-9C is an indium antimonide (InSb) gas-cooled unit (Source: Robert Hewson)

The clean aerodynamic configuration of the new TY-90 air-to-air missile raised speculation at the Asian Aerospace exhibition that this was a Chinese equivalent to the AIM-9X. In practice, the weapon is for use on helicopters, not fighters, says CATIC (Source: Robert Hewson)

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

IRIS-T aircraft-integration contracts signed

The German parliamentary budget committee has approved a Ministry of Defence request that it release DM120 million (US$53.4m) for the integration of the multinational IRIS-T short-range air-to-air missile on the German and Italian EF 2000 Eurofighter aircraft.

The contract between NETMA and Eurofighter GmbH, Halbergmoos, became effective in late December 2001. Eurofighter will place a subcontract with the missile's prime contractor BGT for integration support.

The Hellenic Air Force has signed a contract worth several million Euros under which BGT will support the Greek programme to integrate IRIS-T on the F-16. This new contract is in addition to an existing agreement between the HAF and Lockheed-Martin for the integration of IRIS-T on Greek F-16s. The combined effort of HAF, Lockheed-Martin and BGT should lead to full digital integration and certification of IRIS-T on the F-16 by the end of 2003.

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

AIM-9X multinational buy is under consideration

David C Isby

Potential customers of the Raytheon AIM-9X infrared air-to-air missile (AAM) are considering placing a joint multinational buy, writes *David C Isby*. This approach would reduce unit cost, and has already been used in recent years for the purchase of US-built precision-guided munitions.

Nations that have been authorised by the US government to procure the missile include Belgium, Canada, Denmark, Finland, the Republic of Korea, the Netherlands, Norway and Switzerland. Some of these countries are reported to be looking into the possibility of placing a single multinational order if they select the AIM-9X as their next-generation air-to-air missile (AAM).

One potential problem in planning such a multinational procurement is the varying age and size of potential participant's existing stockpile of AAMs. Some countries urgently need additional AAMs, but this is a lower priority for others. The AIM-9X is competing with the BGT IRIS-T, the Rafael/Lockheed Martin Python 4, and the

MBDA ASRAAM.

The first low-rate initial production (LRIP) missiles are due to be delivered to the US Air Force and Navy in May 2002. The two services will split the first three lots of LRIP AIM-9Xs - the first for 103 missiles - when deliveries begin.

AIM-9X will initially be integrated with the F/A-18C and F-15C, then with the F/A-18E and F/A-18F. Integration with the F-22 is due to begin in Fiscal Year 2004 (FY04). While integration with the AV-8B may take place in FY04 or after, it is not currently funded.

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

BRIEFS - Meteor awaits German go-ahead

Germany is now the only partner in the Meteor agreement which has yet to sign the memorandum of understanding committing it to the UK-led Meteor beyond-visual-range air-to-air missile (BVRAAM) programme. MBDA hopes that the contract for full-scale development of the missile will be signed in the first half of 2002, but accepts that this could slip to the second half of the year. The current goal is for the missile to achieve initial operational capability in 2008.

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

BRIEFS - Greece orders AMRAAM

Raytheon Systems is being awarded a US$41.60 million contract modification to supply 100 AIM-120C5 Advanced Medium Range Air-to-Air Missiles (AMRAAMs), one lot of spares, and foreign military sales offset administration for Greece. Deliveries are to be completed in August 2003.

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

ASRAAM enters service with the Royal Air Force

Doug Richardson

MBDA has delivered a first production batch of the Advanced Short-Range Air-to-Air Missile (ASRAAM) to the Royal Air Force (RAF), writes *Doug Richardson*. The initial batch of rounds is a mix of operational and training missiles.

UK Defence Procurement Minister Lord Bach said that ASRAAM "will provide a major advance in our short-range air-to-air combat capability, giving our pilots the decisive edge in air superiority well into the future".

Earlier infrared (IR)-homing weapons, such as Sidewinder, home onto a 'hot spot' on the target, so can be decoyed by the release of pyrotechnic flares, but ASRAAM homes onto the IR signature of the target, using software-based image processing techniques to track the target and guide the missile towards a selected aim point. The use of imaging IR guidance was considered essential in order to meet the customer's clutter-rejection and electronic

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counter-countermeasures (ECCM) requirements.

"The RAF now has an extremely agile missile capable of engaging targets at high off-boresight angles and in heavy cloud clutter and countermeasures environments", says Alan Garwood, chief operating officer for MBDA.

ASRAAM imposes no launch limitations of the aircraft, says MBDA, so can be fired from any tactical situation at any altitude. Before launch, the missile is given the target's co-ordinates, which will have been obtained from the launch aircraft's sensors or the pilot's helmet-mounted sight.

ASRAAM may be fired using a lock-before-launch mode in lock-after-launch mode. The latter mode enables the missile to be fired against targets that have been located by radar or other sensors but which are not yet visible to the missile seeker. It also allows 'over-the-shoulder' launches against rear-hemisphere targets.

The missile flies at high speed. The low-drag fuselage is wingless, and steered by four moving tail surfaces. In practice, a good portion of the drag is created by the mounting points on the missile fuselage which permit the weapon to be carried on a standard Sidewinder launch rail.

There is space in the nose section of ASRAAM for a coolant bottle, but this is not needed by the UK, which uses a gas supply in the launcher to cool the seeker prior to launch. On UK ASRAAM rounds, an inert ballast device is installed in place of the gas bottle.

The first aircraft to be equipped with ASRAAM will be the Tornado F3, an aircraft originally designed as an interceptor, and which lacks the agility of fighters such as the F-15 and F-16. The range, manoeuvring and seeker capability of ASRAAM will increase the aircraft's effectiveness and survivability.

A series of clearance shots carried out last year used unguided rounds launched at

various points in the aircraft's performance envelope. These have cleared ASRAAM for launch in subsonic and supersonic conditions.

With deliveries under way, the RAF is now tackling the task of clearing the weapon for service use - a process which typically takes three to four months. Once aircrew have been trained to use the missile, it will be declared operational, probably in August 2002. The UK Ministry of Defence (MoD) is understood to be looking at deploying the missile on Tornado F3 fighters taking part in Operation 'Northern Watch' over the northern part of Iraq.

"The delivery of the first batch of ASRAAM missiles marks the successful resolution of a contractual dispute between the Ministry of Defence and the missile manufacturer MBDA", said an MoD statement which announced the delivery of the initial batch of rounds. It quoted Lord Bach as saying, "We now have a robust and clear route map to get to the level of missile performance we need".

When a contract for full development and production of ASRAAM was placed with what was then British Aerospace Defence Division in March 1992, deliveries were due to begin from 1998. Following an Equipment Approvals Committee (EAC) decision in August 1999 the programme was rescheduled. The revised programme continued to slip and the MoD began to question the missile's capabilities.

Guided firings F-7 and F-8 had been observed by members of the RAF operational evaluation team, who subsequently expressed concern that the ASRAAM trials did not reflect the operational concepts of the user. Captive trials conducted in the UK also showed performance deficiencies not identified earlier by trials conducted in the relatively good weather conditions typical at Eglin Air Force Base (AFB).

In April 2001, Baroness Symons (then the Defence Procurement Minister) called for the customer and contractor to work together to draw up a 'route map', which would lead to

ASRAAM meeting its full operational capability and allow a realistic in-service date (ISD*) to be planned. Matra BAe Dynamics paid compensation worth around £19 million (US$27m) for the delay in delivering the first operational-standard missiles.

In its November 2001 annual report on MoD programmes, the National Audit Office (NOA) stated that "shortfalls in the missile's performance have been identified which make ASRAAM unacceptable to the department's customer at present. The department and MBD are working together to achieve a way forward and a revised in-service date".

At that time, the anticipated ISD was mid-2001, a slip of 30 months from the original date. Unspecified 'technical factors' have accounted for 24 months of that slippage, said the NAO, while technical difficulties with missile hardware and software caused a delay of a further 18 months; and failure of the missile to meet contracted performance had resulted in a further six months of slippage. The official requirement had also been modified "to align missile production deliveries with candidate aircraft availability", causing six months of delay, said the NAO.

The NAO report listed four key requirements as being unlikely to be met due to classified "technical factors". These were

- All Aspect Acquisition and Track;

- Probability of Kill;

- Countermeasures Resistance; and

- Off boresight Acquisition and Launch.

While the problems with ASRAAM were tackled, the RAF continued to use the Sidewinder AIM-9L, but the NOA noted that although the existing missile has a lesser capability, "this is partially mitigated in the short term by the upgrade of a significant proportion of the Sidewinder stockpile to AIM-9Li standard which has improved capability in stressing engagements".

Discussions between the MoD and what was

then Matra BAe Dynamics continued through the second half of 2001, with the customer insisting the required performance standards had not been fully achieved, and the company stating its belief that the published specification (which dated back to the early 1990s) had been met.

Commenting on a recently-published report that the disagreement between the company and its customer was partly due to the customer requiring the missile lethality be assessed against a different threat model than that originally used, MBDA says that different threat models make different assumptions as to the effect of warheads on the aircraft. The vulnerability of fast jets, whose structure contains a growing proportion of composite materials, is under study, and each nation working in this field tends to make its own assumptions on damage phenomena which are understood largely from the results of a limited amount of warhead testing such as arena trials.

Guided firings F-9 and F-10 conducted in May and December of last year were intended to address the concerns listed in the NAO report, being made against QF-4 targets seen against a cluttered cloud background and protected by releasing a series of flares at regular intervals. Firings F11-F14 are due to take place by the early summer.

This first batch of missiles is to an interim standard and offers "a significant improvement over the current Sidewinder", says the MoD. The next batch of missiles to be delivered by MDBA (described by the MoD as being "to a higher interim standard") will incorporate a more powerful processor -- a change which has been planned for some time. Deliveries will begin in May of this year.

Further improvements will be provided by upgrades to the missile software. "There will be a continued development programme with further software upgrades that will lead to a full operational capability." This final milestone is expected by the end of 2003.

ASRAAM is intended to equip RAF

Tornado F3, Harrier GR9 and, eventually, Eurofighter combat aircraft, and the Sea Harrier FA.2 fighters of the Royal Navy. The first firing from Eurofighter was conducted on 1 June 2001 (see Jane's Missiles & Rockets, August 2001, p4). This initial launch was made under high-g conditions.

Work has begun on integrating ASRAAM with the Harrier GR9 and Sea Harrier. It is also being integrated onto the F/A-18 of the Royal Australian Air Force, which takes delivery of its first batch later this year. The F-35 Joint Strike Fighter (JSF) integration programme is expected to begin this year. On the F-35, ASRAAM would be carried in the internal weapons bays, and launched in lock-after-launch mode.

As part of the 'route map' agreed between MBDA and the MoD, a series of software upgrades to the missile will ensure that ASRAAM's performance will be maintained as it continues its service life.

ASRAAM is intended to defeat today's Vympel R-73 (AA-11 'Archer') but needs the growth potential to deal with future threats. MBDA believes that Vympel will improve the R-73 by moves such as upgrading the seeker, increasing the off-boresight capability and reducing the drag.

Not all the likely future developments are funded by the current contract. As the threat evolves, the point may be reached when further development of ASRAAM may have to be funded. The missile's designers have tried to allow for this in the current design. The EPU (electronics power unit) contains six slots for printed circuit cards - complex sub-assemblies that consist of two cards (each up to 12 layers thick) mounted on either side of a metal plate which acts as a heat-sink. Currently, only four slots are used, leaving two free for use in future upgrades. The airframe itself has been stress tested to a level of 180g.

Production of ASRAAM is being undertaken at MBDA's Lostock facility in northwest England, with missile development led from the Stevenage site, north of London.

Under the original NATO memorandum of understanding signed in 1980, ASRAAM would have become the NATO-standard Sidewinder replacement and been adopted by the US services as the AIM-132. In 1988 the prime contractorship, for what was to become a UK programme, was transferred to what was then British Aerospace.

There are no plans to give the missile a name in place of the current acronym ASRAAM, but MBDA confirms that the missile is no longer referred to as the AIM-132.

* ISD definition: Acceptance of the Certificate of Design and the performance Statement with the subsequent delivery of 60 missiles that are fit for purpose.

Test installation of an ASRAAM round on a Harrier GR7. Integration work started with the GR7 standard, but is now focused on the planned GR9 configuration (Source: MBDA)

ASRAAM will enter service on Royal Australian Air Force F-18s later this year (Source: RAAF)

An ASRAAM round is loaded onto Eurofighter DA7 (Source: MBDA)

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AIR TO AIR

Date Posted: January 31, 2002

JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

BRIEFS - Raytheon to deliver spare parts

Raytheon Technical Services Co, Norfolk, Virginia, is being awarded an estimated US$11.39 million order for repair parts for the Sidewinder missile, SPS-49 radar system, NATO Sea-Sparrow and other weapon systems. These parts will be manufactured in Chula Vista, California (63%); Norfolk, Virginia (26%); and Goleta, California (11%), and are due to be completed by December 2002.

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AIR TO AIR

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JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

BRIEFS - Tactical telemetry units for AMRAAM

Harris is to provide 94 warhead-replacement tactical telemetry units for use on the AIM-120 advanced medium-range air-to-air missile (AMRAAM). Due to be manufactured by November 2003, these units are funded by a US$10.12 million contract modification awarded by the Warner Robins Air Logistics Center, Robins Air Force Base, Georgia.

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JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

BRIEFS - Six nations order rocket motor hardware

Alliant Techsystems Allegany Ballistics Laboratory has been awarded an US$8.57 million modification to existing contract N00019-97-C-0156 to exercise an option for the procurement under the Foreign Military Sales Program of:

- 178 Mk 58 Mod 5 AIM-7P Sparrow missile rocket motors;

- 509 Mk 58 Mod 4 RIM-7P surface-to-air Sparrow missile rocket motors; and

- four Mk 58 Mod 4 igniters.

This hardware is required by the governments of Australia (73 Mk 58 Mod 5), Singapore (25 Mk 58 Mod 5), Jordan (80 Mk 58 Mod 4), Egypt (424 Mk 58 Mod 4), Turkey (85 Mk 58 Mod 4) and Germany (4 Mk 58 Mod 4 igniters).

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JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

US Congress insists on Starstreak tests

David C Isby

The US Congress does not intend to let the US Army evade a congressionally-imposed requirement - dating from 1998 - to conduct comparative live-fire testing of the Thales Air Defense (formerly Shorts) Starstreak, writes *David C Isby*.

Thales (which has Lockheed Martin as its US partner) is offering its missile in competition with the Raytheon Stinger as a potential air-to-air missile to arm the Boeing AH-64D Apache attack helicopter. Despite previous appropriations of funds and legislative language requiring Starstreak tests, the Army has recently indicated that it does not believe such trials are necessary (see Jane's Missiles & Rockets, January 2002, p13).

Following action by the US Senate, US$13.6 million was added to the Fiscal Year 2002 defence appropriations bill to cover testing. US$12 million is to fund live-fire testing of the Starstreak against air-to-air targets, while an additional US$1.6 million covers Starstreak tests against ground targets such as light armoured fighting vehicles. This money provides funding that the Army said

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was necessary to address the problem of potential Starstreak blast damage to the helicopter at launch. Congressional observers have identified the Starstreak testing issue as an example of the 'low cost, high irritation' issues that have hurt the US Army's case in Congress in recent years.

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JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

Taiwan's two F-16 wings operational

David C Isby

Taiwan's first F-16 wing was declared operational on 20 December, and is equipped with the Raytheon AIM-120 AMRAAM air-to-air and Boeing AGM-84 Harpoon anti-ship missiles, plus other weapons, writes *David C Isby*. The second F-16 wing, to be declared operational on 13 January, will have the same capabilities.

Both types of missile have been available to Taiwan's F-16s since 2001. The first Harpoon live-fire test from an F-16D in April 2001 hit a destroyer target at a range of 30nm off Chiupeng. The first batch of AMRAAM Taiwan took place in July 2001, with a shipment to Hualien in eastern Taiwan.

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JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

ATK to develop propulsion for Spike

ATK (Alliant Techsystems) has been awarded a US$4 million contract from the US Naval Air Systems Command, China Lake, California, to develop the propulsion system and warhead for the Spike shoulder-fired missile. Under the three-year programme, ATK Thiokol Propulsion Company in Promontory, Utah, will develop and test the Spike propulsion system, demonstrate safe handling and firing, continue development to maturity, and deliver quantities of hardware to the US Navy for flight testing.

The new missile should not be confused with the Rafael anti-tank missile of the same name.

Under development by the US Naval Air Warfare Center Weapons Division (NAWCWPNS) at China Lake, Spike is a low-cost, fire-and-forget guided missile and launcher system designed to defeat targets such as unarmoured or lightly armoured vehicles, infantry fighting positions, mobile anti-aircraft systems and slow-moving helicopters.

The missile weighs 2kg and the launcher

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12.3kg, making the system easily carried in a backpack. Other potential applications include use as a tactical armament for unmanned aerial vehicles. Maximum range is expected to be 3,200m.

The first ballistic firing took place successfully at China Lake in September 1999, leading the US Special Operations Command to request funding to begin an applied research/ exploratory development.

Guidance will be by a nose-mounted, strapdown electro-optical seeker, plus a simple inertial-guidance unit. Alternate modes are reported to include semi-active laser homing onto remotely-designated targets, and a quick-reaction, inertial-only mode for use against targets that unmask at ranges out to about 300m.

Model showing the various elements of Spike: the launch/sighting unit (top), two rounds (center) and the launch tube (bottom).
(Source: Jane's/IDR)

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AIR-TO-AIR

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JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

BRIEFS - AIM-9X LRIP funded

The US Naval Air Systems Command has awarded Raytheon Systems two modifications to existing contract N00019-97-C-0027 to cover low-rate initial production (LRIP) of the Sidewinder AIM-9X. The first is worth US$17.24 million, and exercises an option for the LRIP of 67 all-up round missiles, three captive air-training missiles and other associated components. The second is worth US$19.27 million and covers the LRIP of 82 all-up-round missiles and other associated components. All hardware ordered by both awards will be built in Tucson, Arizona, and is due to be completed by April 2004.

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JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

US Army shelves air-to-air Starstreak test

David C Isby

The US Army and the US Congress have taken time away from the war on terrorism to engage in their long-running dispute over the Army's refusal to undertake live-fire testing of the Thales (formerly Shorts) Starstreak missile as a potential air-to-air weapon option for the Boeing AH-64D Apache helicopter, writes David C Isby.

The Secretary of the Army is reported to have sent a letter to Robert Byrd, chairman of the Senate Appropriations Committee, on its latest position regarding live-fire Starstreak testing. Despite a section in the Fiscal Year 2000 (FY00) defence appropriation bill requiring the Army to carry out comparative live-fire tests of the Starstreak and the Raytheon (formerly General Dynamics) Stinger as an air-to-air weapon for the AH-64D, the service now considers the problem of launch damage from the Starstreak to be unsolvable, so the tests will not be held. As a result, the Army has not included the additional US$14.4 million it claimed would be required to

conduct the live-fire tests in its FY02 budget request.

This new position is a backward step in the process of arranging the required test, which was due to take place in June. Thales has worked on a modification of the missile, and had been able to demonstrate that launch overpressure - originally the Army's main concern - would be held within acceptable limits and would not lead to airframe damage. Thales, at its own expense, has conducted extensive overpressure tests and put in place a number of modifications to the Starstreak to reduce overpressure, including replacing the propellant and adding a blast diffuser.

However, the recent incident of debris damage to the AH-64D caused by firing late-production AGM-114 Hellfire anti-tank guided missiles (ATGMs) has made the Army more aware of this potential problem. The service is reluctant to test the Starstreak for fear of debris damage, although the contractor reports that this problem has been solved.

The Army has never wanted to test the Starstreak and, with many of its higher priority programmes facing cancellation due to lack of funding, is reluctant to follow congressional requirements. It remains to be seen whether Congress, its attention elsewhere as a result of recent events, will continue to insist that the Army conducts the comparative live-fire test.

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JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

Slim-line pylon boosts Swiss F/A-18 performance

Doug Richardson

Switzerland has been able to increase the air-combat performance of its F/A-18 fleet by developing its own low-drag launcher for the Raytheon AIM-120 Advanced Medium Range Air-to-Air Missile (AMRAAM), writes Doug Richardson. Developed by RUAG, the new SUU-84A launcher carries a single AMRAAM or AIM-9 missile.

Development of an alternative pylon was begun by, what was then, the Swiss Federal Aircraft Factory, with support from McDonnell Douglas and from the US Navy (which helped with software development).

The existing pylon offered by the US was designed to handle heavy loads including external fuel tanks. By limiting the new design to the carriage of only a single AIM-120B or AIM-9P-5, Swiss engineers were able to devise a configuration which was lighter than the US pylon and much less deep.

Speaking at the recent Global Missile Summit held in London by SMi, Juerg Weber, chief of the Swiss Defence

Procurement Agency's Air Materiel Division, said that the lower drag of the SUU-84A had reduced the time taken to reach Mach 1.4 at 47,000ft by 25%. The most commonly used weapon loads carried by Swiss Hornets are either four AIM-9P-5s and two AIM-120Bs, or two AIM-9P-5s and two AIM-120Bs.

A series of 97 flight tests carried out in the US in 1996-97 qualified the Swiss configuration. These trials included air launches of the AIM-9P-5 and AIM-120B.

Switzerland is currently in the process of selecting a high off-boresight 'dogfight' missile to replace the AIM-9P-5, Weber told the conference. Four missiles have been evaluated, he said, and the shortlist narrowed to two. Although he did not specifically list the candidates, these are known to be the Raytheon AIM-9X, Matra BAe Dynamics ASRAAM, the Bodenseewerk Gerätetechnik IRIS-T and the Rafael Python 4.

During an initial evaluation conducted in 2000, all four teams had been given test scenarios and asked to detail their weapon's performance under such conditions. Following studies and simulations, and the receipt of proposals, two missiles were rejected on performance grounds. Weber did not identify these.

Switzerland plans to conduct a main evaluation of the two shortlisted designs in late 2001 and early 2002. This will include detailed studies and flight tests. Although the intention is to select the winner in mid-2002, Weber said the evaluation could be delayed "due to the current situation".

Switzerland is looking for commonality and co-operation with other air forces, and hopes to adopt a missile which was already in service with another F/A-18 customer, he noted.

A strong emphasis is being placed on performance-to-cost ratio, he explained. This might mean buying a missile that has a greater capability than Switzerland requires, if this were to give a better cost-to-performance ratio.

The chosen design will be fully integrated

with the F/A-18 weapon system, including the new helmet-mounted cueing system. The latter is due to be added to the aircraft under a planned upgrade, also including a MIDS datalink, a digital moving map and a combined interrogator/ transponder.

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JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

Rafael Derby datalink: a correction

Statements made by Rafael earlier this year, that its new Derby beyond-visual-range air-to-air missile (BVRAAM) does not incorporate a datalink for in-flight updating, were untrue, Jane's Missiles & Rockets has learned. A briefing on the rationale behind the lack of a datalink, given to Jane's at the June 2001 Paris air show, must therefore be considered misleading.

Speaking at the recent Global Missiles Summit conference held in London by SMi, Eitan Barzilai, marketing manager at Rafael's Air-to-Air Directorate described the tactical advantages in air-to-air combat of what he called the Derby 'Up Link'. This link provides target data to the missile, increases the 'no-escape' envelope, and improves the kill probability of missiles fired against long-range targets. It also maintains the fire-and-forget capability of the missile without requiring the launch aircraft to keep its radar locked onto the target, said Barzilai, and allows the engagement to be aborted either automatically or manually.

The uplink requires the installation of a transmitter connected to the muxbus of the launch aircraft, said Barzilai. The missile-mounted receiver can accept information from the launch aircraft, or from

a similar transmitter in another aircraft.

Such datalinks are present in most long-range air-to-air missiles, and the original Rafael claim that Derby lacked a datalink had been questioned by some observers. Reminded of his company's earlier statements, and asked if the uplink had been a recent addition to the missile, Barzilai said that at the time the Derby was announced in May 2001, its datalink capability was still classified. This had recently been declassified, he said, so could be discussed at the conference.

· During his presentation, Barzilai hinted that the earlier and shorter-ranged Python 3 missile has been successfully used in combat by at least one export customer. Displaying a slide which credited the missile with more than 35 'kills' during Israeli combat operations in 1982, he remarked that "most" of the missile's 'kills' had been scored in the Middle East. Export users of Python 3 are understood to be Brazil, Chile, China, Ecuador, Romania, South Africa and Thailand. South Africa is known to have deployed an off-the-shelf short-range 'dogfight' missile on its Mirage F1CZ fleet from 1989 onwards, and this weapon (given the cover designation 'V3S') may have been the Python 3.

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JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

Canada pulls out of IRIS-T project

A few days before the October meeting of the IRIS-T Steering Committee in Athens, and an associated meeting of the top management board of all IRIS-T companies, the Canadian Department of National Defence informed the IRIS-T programme management office that they had decided to withdraw from the programme.

Canada was one member of the six-nation team which has been developing the IRIS-T agile short-range air-to-air missile as replacement for the AIM-9 Sidewinder. The other partners are Germany, Greece, Italy, Norway and Sweden.

Maj Jean-Marc Brzezinski, deputy project director for Canada's Advanced Air-to-Air Weapon (Short Range) told our sister publication Jane's Defence Weekly that the costs of integrating IRIS-T onto the CF-18 had increased drastically over the last year. Until recently there had not been enough data available to allow accurate cost estimates. However, the data now available showed that the likely cost was much higher than had been expected.

A second problem was that the missile could not have been incorporated into the next

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standard of CF-18 avionics software due to be released around 2005-06, so full IRIS-T functionality would have been delayed until the following release, some time around 2009-10.

Brzezinski also cited "some capability deficiencies", but said these were of less concern than the integration issues.

Bodenseewerk Gerätetechnik, prime contractor of the IRIS-T programme has taken the required steps - in agreement with all involved industrial partners - to ensure that the Canadian withdrawal will not have any impact on the overall programme. "Honeywell, as our Canadian programme partner, is still committed to the programme and will do its utmost to finalise its nearly completed development work," says the company. Honeywell is responsible for the actuator systems and thrust-vector controls.

"As the Canadian decision was announced a few days before these meetings, the governments and industry have been in the position to discuss and analyse the impact of the Canadian withdrawal," says Joerg Sorg of the Strategic Marketing & Business Development department of Bodenseewerk Gerätetechnik.

"Canada has about 4% share, thus a very small package in the programme. Fortunately, technologically we can compensate their share without any problem. Both government and industry came to the conclusion that the withdrawal of Canada will have no major impact on the programme. The development phase will end as planned in November 2002, and the first operational missiles will be delivered to the services in 2003."

Canada is now reconsidering the Raytheon AIM-9X, Matra BAe Dynamics ASRAAM and an improved version of the Rafael Python 4. It hopes to order the chosen missile in mid-2002, and to take delivery of the first missiles in late 2003 or early 2004.

AIM-9X or ASRAAM could be seen as low-risk solutions, since both have already been integrated on the F/A-18. Python 4 has not, so the integration task could pose extra

cost and technological risk.

The Israeli missile had originally been rejected as failing to meet the requirement, but Canada is now being given information on an upgraded version. No details of this new variant are available, but it may incorporate an improved seeker. The current seeker is a 'pseudo-imaging' infrared (IR) seeker (essentially a low-resolution imaging device), and a true imaging IR seeker may be one of the future developments being explored by Rafael in conjunction with Lockheed Martin. In 1998, the two companies teamed to co-operate on the international marketing and future development of Python.

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JANE'S MISSILES AND ROCKETS - NOVEMBER 01, 2001

F-22 Raptor fires a guided AMRAAM

On 21 September, the US Air Force (USAF) conducted the first firing of a fully-guided AIM-120C advanced medium-range air-to-air missile (AMRAAM) from a Lockheed Martin F-22 Raptor. USAF test pilot Maj Brian Ernisse launched the missile from Raptor 4005 flying at subsonic airspeed at a height of about 40,000ft over the Pacific Missile Test Range at Point Mugu, California. The missile flew within lethal range of the unmanned target aircraft and, from preliminary data analysis, was assessed to have scored a kill.

The aircraft used Block 3.0 avionics software. Developed by Boeing, this handles avionics integration including sensor fusion - the use of targeting, detection and tracking information from multiple sensors to create a single input to the pilot. Boeing has been testing F-22 avionics software packages in its Avionics Integration Lab since 1998, on its 757 Flying Test Bed since March 1999, and on F-22 flight test aircraft since January 2001.

"This first guided missile launch shows that the avionics system is well on the way to supporting the F-22's ability to find and identify an adversary, shoot before the

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adversary and obtain the kill," says F-22 combined test director Col Chris Seat. "We call this 'first look, first shoot, first kill', and this capability will ensure the United States has the overwhelming advantage in any future potential conflicts.

"We hope an adversary's knowledge of the awesome capabilities of the F-22 would be enough to deter any threatening actions, but if engaged we don't want a fair fight, we want to win decisively."

The launch was the last of three flight-test milestones due to be completed this fiscal year. Earlier milestones demonstrated the F-22's radar detection capabilities and the aircraft's ability to release AIM-9 Sidewinder and AIM-120 missiles at high angles of attack.

The firing took place a month after the US Defense Acquisition Board approved production of 10 F-22 aircraft, allowing the programme to enter low-rate initial production. The combined test force at Edwards Air Force Base, California, is currently testing five F-22s. Since the start of testing nearly three years ago, the F-22 test programme has completed more than 1,375 flying hours and more than 610 flight-test sorties.

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AIR-TO-AIR

Date Posted: October 24, 2001

JANE'S MISSILES AND ROCKETS - NOVEMBER 01, 2001

MiG-31s intercept anti-ship missiles

David C Isby

Two Russian MiG-31 'Foxhound' interceptors are reported to have successfully engaged air-launched anti-ship missile targets during Russian Pacific Fleet exercises held in the Sea of Okhotsk, Avati Bay, and the Kamchatka peninsula, writes David C Isby. The overall operation was primarily a command-post exercise and had a limited live-fire component. It was significant because it was the first time MiG-31 interceptors had operated under Pacific Fleet command in that organisation's joint-service role.

The types of anti-ship missiles used as targets were not reported. Presumably they were launched from Tu-22M3 'Backfire' bombers that also took part in the live-fire part of this exercise, which included launching a co-ordinated missile attack with the 'Oscar-class' SSGN Tomsk.

The interception of anti-ship missiles suggests this exercise was intended to show the ability of the Russian Air Force to provide shore-based air cover for the nation's Pacific Fleet. Although Russian press reports did not identify the MiG-31 unit which shot

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down the missiles, it was announced that interceptor units had deployed from the Moscow Military District for the exercise.

Recent Russian press reports have expressed concern that the ability of Russian interceptors to deal with any threats entering Russian airspace was highly limited. A Chinese aircraft was reported to have entered Russian airspace near Altai on 3 September without authorisation and to have left unchallenged. The Russian interceptor force in the Far East is reported to be limited to regiments at Kupino (Novosibirsk Oblast) and Kansk (Krasnoyarsk Kray). The annual flying hours of pilots is reported as averaging about 11 hours in recent years.

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Date Posted: September 19, 2001

JANE'S MISSILES AND ROCKETS - OCTOBER 01, 2001

BRIEFS - Three nations order AMRAAM hardware

Raytheon is to provide 48 AIM-120C-5 advanced medium-range air-to-air missiles (AMRAAMs), 47 AMRAAM air vehicles (AAVs), one AMRAAM air vehicle instrumented, one AMRAAM instrumentation unit kit and one set of spares for Israel; eight AIM-120C-5 AAVs for Thailand; and one set of spares for Taiwan. These deliveries are funded by a US$22.47 million modification contract from the US Air Force Air Armament Center, Eglin Air Force Base, Florida, and are due to be completed by July 2003.

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AIR-TO-AIR

Date Posted: September 19, 2001

JANE'S MISSILES AND ROCKETS - OCTOBER 01, 2001

Improved Archer enters production

David C Isby

The Russian Academy of Military Sciences has announced that a new version of the R-73 (AA-11 'Archer') air-to-air missile has entered production, writes David C Isby. Like the original R-73, which first became operational in 1984, the new variant was developed by the Vympel state machine building design bureau. Descriptions of the improvements associated with the new version were not detailed, but they include greater compatibility with both Russian and foreign combat aircraft.

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AIR-TO-AIR

Date Posted: August 30, 2001

JANE'S MISSILES AND ROCKETS - SEPTEMBER 01, 2001

Denel sees a future for A-Darter

Denel hopes that the future of its A-Darter short-range air-to-air missile can be resolved by the end of this year. The South African government was expected to release a request for information (RFI) on weapons of this class soon after the recent Paris air show, and Denel believes it will be asked to respond. The company also expects to be included when a request for proposals (RFP) is issued. Any slip in the schedule of the South African Air Force's plan to field a next-generation 'dogfight' missile could help the chances of A-Darter.

Currently the A-Darter programme is still active, says Denel, but is moving at a speed slower than that of a normal full-scale development programme. Since no formal requirement exists, the programme carries a smaller administrative overhead than would otherwise be the case.

The imaging infrared seeker has now been through three design iterations, and as been tested on the ground and in an aircraft-mounted test pod. The company would like to begin guided flight tests within the next 12 months, if funding becomes available.

The missile recently made two

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ground-launched flights in which it flew a pre-programmed flight path. This ground-launch test programme uses rounds which are boosted to flying speed by a solid-propellant booster. The booster used for initial flights was a time-expired motor from the Matra R550 Magic missile, but supplies of these are now exhausted. More recent launches used the motor from Denel's U-Darter.

South Africa wants to retain an indigenous capability in seeker and system design capabilities. At the worst, Denel expects to see A-Darter continued as a technology-demonstration programme, but hopes that the weapon may form the basis for an international joint programme.

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Date Posted: July 18, 2001

JANE'S MISSILES AND ROCKETS - AUGUST 01, 2001

Tien Chien II offers an AMRAAM-class performance

Making its first appearance at a European air show, Taiwan's Chung Shan Institute of Science & Technology (CSIST) exhibited its Tien Chien I and Tien Chien II air-to-air missiles. These are guided by passive infrared and semi-active radar seekers respectively. While Tien Chien I is an infrared-guided Sidewinder look-alike, the larger and heavier Tien Chien II is a beyond-visual-range (BVR) weapon whose visual resemblance of the US AIM-7 Sparrow conceals a performance similar to that of the Raytheon Advanced Medium-Range Air-to-Air Missile (AMRAAM).

Until recently, most analysts had assumed that Tien Chien II was a development of the AIM-7 Sparrow, and probably using some sub-systems from the US missile. It was assumed to have the same 203mm diameter as Sparrow, and to be based on Sparrow-style semi-active radar homing. In practice, Tien Chien II is 3.6m long (marginally shorter than the 3.66m Sparrow) but has a diameter of only 190mm, and a wing span of 0.62m.

The missile is guided by moving cruciform tail surfaces, the arrangement used by AMRAAM - (Sparrow is guided by moving cruciform wings). These provide a high degree of manoeuvrability, says CSIST. It is guided by an active radar seeker, plus an inertial guidance unit, and carries a 22kg blast/fragmentation

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warhead fitted with an active-radar proximity fuze.

Two Tien Chien II missiles can be carried under the central fuselage of Taiwan's indigenous Ching-Kuo fighter, allowing the aircraft to conduct simultaneous all-weather, all-aspect, shoot-up and shoot-down attacks against two BVR targets. Maximum range is 60km.

Development started in the 1980s, and the missile was first seen publicly at the roll-out ceremony of the Ching-Kuo in December 1988. The air-launch test programme was successfully completed in July 1994. The missile has also completed 800 hours of carry flight tests and successfully passed the first and second phases of initial operational test and evaluation (IOT&E). Prod-uction started in 1994, and the weapon entered service in 1996.

CSIST is already looking at alternative roles for the Tien Chien II. These include ground and shipboard SAM applications, and what the institute describes as an "anti-ship weapon system". The latter could be a reference to the recently-reported anti-radiation version (see Jane's Missiles & Rockets, July 2001, p10).

BVR missiles compared					
Missile	Length	Diameter	Weight	Range	Warhead
Tien Chien II	3.6m	190mm	183kg	60km	22kg
AMRAAM	3.65m	178mm	157kg	50km	22kg
Derby	3.62m	160mm	118kg	?	?
R-77 (AA-12)	3.6m	200mm	175kg	75km	22kg
MICA	3.1m	165mm	112kg	60km	12kg

This Ching-Kuo fighter is armed with two fuselage-mounted Tien Chien II radar-guided missiles plus a total of four Tien Chien I heat-seeking missiles on wingtip and underwing stations. (Source: CSIST)

Tien Chien II is fitted with a nose-mounted active-radar seeker. (Source: CSIST)

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Date Posted: July 18, 2001

JANE'S MISSILES AND ROCKETS - AUGUST 01, 2001

Denel shows definitive R-Darter

Doug Richardson

Models of the Denel R-Darter/V-4 radar-guided air-to-air missile displayed at the recent Paris air show carried the twin roll-control surfaces found on Rafael's Derby missile, writes Doug Richardson. The absence of these small moving surfaces on the first officially-released photograph of the South African missile was due to the fact that the image showed an early captive-carry round. Since the purpose of this variant was to measure the aerodynamic effect of missile carriage, the twin surfaces were omitted since they would have a negligible effect, says Denel.

R-Darter entered service with the South African Air Force in March 2000 as the V-4. Its Israeli equivalent has yet to be ordered by the Israeli Air Force, but IAF officials and Rafael both say it is in service with an unidentified export customer. This claim was dismissed by Raytheon during a press conference at the Paris air show, with one company official saying that it was unsupported by evidence.

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In practice, the unidentified customer is Chile, and Jane's Missiles & Rockets understands that rounds have been delivered to the first user squadron, but are not yet in operational service.

The design, of what are now R-Darter and Derby, was jointly funded by Israel and South Africa, but the current relationship between the two programmes remains unclear. According to Rafael, collaboration between the two nations ended six years ago, resulting in two parallel weapons projects based on a common design but evolving independently. This view is not shared by Denel; it would be "crazy" to allow the common design to split into two variants, Jane's Missiles & Rockets was told by an official of the South African company. He insisted that collaboration between the two companies was continuing and has included some exchange of development information.

Told of the South African claim, a Rafael official reiterated that the collaborative venture had ended. Current discussions with Denel are informal, he suggested, and should be seen as part of the normal relationship which Rafael maintains with other missile companies. Derby was now an Israeli project, and is entirely manufactured in Israel.

South Africa seems to have started with a plan to manufacture R-Darter entirely in South Africa, but this has been complicated by a marketing agreement that exists between the two projects. Both partners have a marketing region in which they are the lead contractor. This agreement also covers manufacturing of the missile, but allows payments to be made from one company to the other if the agreed workshare on individual orders cannot be achieved.

Like its Israeli counterpart, the South African Air Force wants to be in complete control of the electronic counter-countermeasures (ECCM) features of its beyond-visual-range (BVR) missile.

Denel expressed surprise to Jane's Missiles & Rockets when told that Rafael had revealed that, unlike other recent BVR

missiles, Derby did not have a datalink which allowed the launch aircraft to provide mid-course updates. The company would not say whether or not such a datalink exists in R-Darter or is planned as an upgrade.

Rafael takes the view that targets which move beyond their expected location during the time-of-flight of a Derby fired at long-range will, in most cases, be acquired when the missile executes a pre-planned seeker-search procedure which is invoked if the target is not found when the seeker first activates. If the target has managed to fly a manoeuvre that carries it beyond the limits of this 'lost-target' search procedure, it has almost certainly moved beyond the kinematic limits of the missile, the company argues.

During live-fire tests, Derby has been launched against targets programmed to fly sharp turns, which would take them out of the airspace that the seeker would search on first acquisition. These flights showed that the weapon could autonomously search for and acquire the target.

The R-Darter (known to the South African Air Force as the V-4) has two roll-control surfaces mounted just aft of the canards. (Source: Doug Richardson)

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JANE'S MISSILES AND ROCKETS - AUGUST 01, 2001

Brazil may have ordered Derby for AH-64

David C Isby

According to unconfirmed Israeli press reports, Derby has been sold to Brazil, writes David C Isby. The potential sale is associated with the recently awarded upgrade of the Brazilian F-5 fleet by Israel's Elbit Industries, which will enable these aircraft to use both the Derby and the short-range Rafael Python 4, along with their associated helmet-mounted sight. Derby is reported to have been integrated with Mirage-series fighters, and this may also have made the weapon attractive to Brazil.

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Date Posted: July 18, 2001

JANE'S MISSILES AND ROCKETS - AUGUST 01, 2001

Starstreak undergoes static testing

for AH-64

David C Isby

The long-delayed live-fire evaluation of the Thales (formerly Shorts) Starstreak missile as an air-to-air weapon for the US Army's Boeing AH-64 Apache helicopters has come closer with the completion of a series of static launch tests, writes David C Isby. Conducted using an AH-64 mock-up, these were intended to test the performance of Starstreak with a blast diffuser and new propellant.

These changes to Starstreak were intended to meet US Army concerns, that the launch of the unmodified Starstreak generated excessive overpressure that could damage an AH-64. Once the overpressure issue is addressed, the programme will progress towards comparative live-fire tests against the Raytheon Stinger, currently scheduled for 2002. The US Army had been reluctant to carry out live-fire testing of the Starstreak, but has been compelled to do so by the US Congress (see Jane's Missiles & Rockets, June 1999, p1).

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AIR-TO-AIR

Date Posted: July 18, 2001

JANE'S MISSILES AND ROCKETS - AUGUST 01, 2001

IRIS-T completes fourth series of firing trials

The international Infra-Red Improved Sidewinder-TVC (IRIS-T) short-range air-to-air missile being developed by Canada, Germany, Greece, Italy, Norway and Sweden has completed its fourth series of free-flight development test firings, says Bodenseewerk Gerätetechnik (BGT).

A specially instrumented F-4F Phantom II of the WTD 61 Flight Test Centre, Manching, Germany, served as launch aircraft for missiles which flew under pre-programmed autopilot control to demonstrate the response of the missile's control loops under severe conditions up to the g- and angle-of-attack limits. The test firings took place over the Salto di Quirra Test Range in Sardinia, using various launch altitudes, Mach numbers and aircraft manoeuvres representative of short-range air-to-air missile engagements.

BGT dismisses suggestions that several of the firings were failures that resulted in damage to the launch aircraft. Problems were experienced with the ejection of material from the rocket motor as the missile was

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fired, but the declaration of an emergency by the trials aircraft reflected pre-defined operating procedures to be followed in the event of aircrew suspecting possible damage to the aircraft. This was precautionary, says BGT, and in practice no damage was found.

The first guided flight test is now expected to take place late this year or early next year. The imaging infrared seeker has already been flight-tested. Two test firings conducted in 1996 under what was then the German national IRIS-T programme used BGT seekers mated to AIM-9 Sidewinder bodies. These firings were made against targets more than 50s#186; off-boresight and resulted in direct hits on 26cm-diameter towed targets.

The six-nation IRIS-T development programme began in January 1998, and the programme is within budget and overall schedule, says BGT. Negotiations over a Memorandum of Understanding (MoU) covering series production is now in the final phase, and signature by the partner nations is expected in early 2002.The first series production missiles are due for delivery in 2003.

Work to integrate IRIS-T on the Eurofighter, Tornado, AMX, Gripen, F-16 and F-18 has been under way for some time, and the missile has been offered to a number of potential customers including Finland, South Africa, Spain and Switzerland.

This sequence shows a test round separating from the F-4F trials aircraft. (Source: BGT)

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Date Posted: July 18, 2001

JANE'S MISSILES AND ROCKETS - AUGUST 01, 2001

Three nations sign Meteor go-ahead

In a ceremony held at the Paris air show, defence ministers from France, Sweden and the UK signed a Memorandum of Understanding (MoU) committing their nations to the UK-led Meteor beyond-visual-range air-to-air missile (BVRAAM) programme. Germany, Italy and Spain were expected to sign within a few weeks. Negotiations on concluding a smart procurement contract with MBDA for Meteor are contin-uing, and are expected to result in a contract later this year.

The delays by the other partners are procedural, and the result of national procurement processes. Rather than have these nations sign tentative agreements covered by individual caveats, it was agreed that the ceremony would go ahead with signatures from the nations that had approved the planned procurement. As a result of the MoU, Meteor will be available as a long-range missile armament for the Eurofighter, Rafale and Gripen.

There should be no technical problems in integrating Meteor with Rafale, though the

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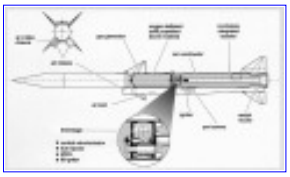
process will take time and money. Discussions are currently under way with the aircraft prime contractor.

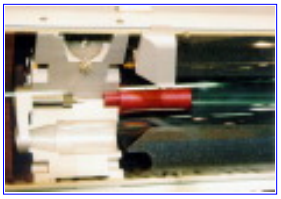
Bayern Chemie and Protac displayed a sectioned version of the Meteor powerplant at the show. This is a throttleable ducted rocket (TDR) with a nozzleless integrated booster. The booster uses low-smoke propellant that meets class BC, STANAG 6016 requirements, while the gas generator burns a high-energy boron-filled composite propellant. Both sections have steel cases.

The component technology needed for the Meteor motor was developed in the early 1980s. This work explored air intakes, gas generator propellant and control, ram combustor design and insulation. The first demonstration firing of a ducted rocket with a boron-based gas generator was conducted in 1981, while a lightweight TDR suitable for use on the planned Franco/German ANS supersonic anti-ship missile was tested in 1986. Research and development on TDRs for BVRAAM applications began in 1990, exploring the problems of asymmetrical intake configurations. A lightweight BVRAAM motor demonstrated the critical boost-to-sustain transition in 1998.

The Meteor powerplant will provide three times the kinematic performance of a conventional solid-propellant rocket motor, says the team, while the flow of gas from the gas generator will be controllable over a range of more then 10:1, tailoring the thrust level to match the mission.



This cutaway diagram shows the main components of the throttleable ducted rocket motor for Meteor. (Source: Bayern Chemie/Protac)



The interstage section contains the controls needed to vary motor thrust (Source: Doug Richardson)

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Date Posted: May 21, 2002

JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

Denmark gets first Harpoon II missiles

The Danish Naval Materiel Command has taken delivery of the first Boeing Harpoon Block II missiles following installation of upgrade kits which convert existing missiles to the new standard. Denmark, an existing Harpoon customer, was the first country to order the upgraded missile, signing a US$10 million contract for 50 upgrade kits in 1997.

The kits will be installed by the Royal Netherlands Navy for the Royal Danish Navy at their joint missile maintenance facility in Den Helder, Netherlands. This modification upgrades about half of the Royal Danish Navy inventory, providing greater accuracy against ship targets and providing the missile with a land strike capability.

The Harpoon Block II kit provides a new Guidance Control Unit flight computer, a new guidance section shell and a Global Positioning System (GPS) antenna. With these subsystems installed, the accuracy of the Harpoon missile is improved, and the weapon can be used to attack coastal, in-harbour and land targets such as shore defence sites, surface-to-air missile sites, exposed aircraft, port/industrial facilities and

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ships in port.

The Block II missile incorporates guidance technologies from two other Boeing weapons programmes - the low-cost, inertial measuring unit from the Joint Direct Attack Munition; and the software, mission computer, integrated GPS/inertial navigation system, and GPS antenna and receiver from the Standoff Land Attack Missile Expanded-Response. The US Navy completed flight-testing of the Harpoon Block II in November 2001.

Harpoon II (seen here on its first test flight) retains the existing airframe, powerplant, warhead and guidance, but adds a JDAM inertial measuring unit, and the software, mission computer, integrated GPS/INS, and the GPS antenna and receiver from the AGM-84H Standoff Land Attack Missile Expanded Response (SLAM-ER). (Source: Boeing)

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Date Posted: March 22, 2002

JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

BrahMos tests to resume this summer

David C Isby

India is to resume flight tests of the PJ-10 BrahMos (Brahmaputra-Moskva) supersonic anti-ship missile, writes *David C Isby*. The first flight test was held on 12 June 2001, and the missile was reported to have reached Mach 2. BrahMos is understood to have a maximum speed of Mach 2.5-2.8, a maximum range of up to 300km, and to carry a 200-300kg warhead.

Another test is currently scheduled for May 2002, to be followed by several others. According to Dr VK Aatre, science advisor to India's defence minister, if this series of test flights is successful the BrahMos will be considered mature and be given the go-ahead for production.

The result of a collaborative programme between India's Defense Research and Development Organization (DRDO) and Russia's NPO Masinostroynia which started in 1998, BrahMos is a version of the Russian 3M55 Oniks/Yakhont SS-N-26. It incorporates an Indian-developed guidance system and a Russian ramjet propulsion system. The BrahMos programme has received extensive publicity in Russia and

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India, and has been identified as a model for future collaboration in weapons development.

India has been heavily marketing the new missile to Asian and African countries even before the well-publicised Defexpo in February 2002. The UAE and Malaysia have been offered deliveries starting in 2004.

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Date Posted: March 22, 2002

JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

ARC completes ramjet engine tests

Atlantic Research Corporation (ARC) has completed development testing of the MARC-R-282 ramjet engine for the US Navy's GQM-163A Supersonic Sea Skimming Target (SSST). Under development by Orbital Sciences (supported by Raytheon for missile avionics, and ARC for propulsion), the GQM-163A is being developed to provide an affordable target able to simulate anti-ship cruise missiles.

The MARC-R-282 engine is based on a Variable Flow Ducted Rocket (VFDR) ramjet engine cycle. ARC has conducted technology programmes over the last 20 years to develop the required component design approaches, and is now transitioning VFDR technology to a level of maturity required for use in a missile system.

Initial testing of the MARC-R-282 ramjet engine has been completed to define the ramcombustor geometry, the solid fuel formulation, the fuel valve and injector design, and to verify the assumed levels of engine performance. The newly expanded ARC ramjet test facility was used to simulate sea-level flight at over 2.5 times the speed of sound. By drawing upon past engine design and test data, ARC was able to achieve levels of performance that exceeded programme

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goals.

Flight-rated hardware will now be built, and flight-testing is due to begin late next year. These are expected to be the first-ever flights of a VFDR engine, which is being seen as a likely candidate to meet the propulsion requirements of future US missiles. The contract, under which ARC is working, covers a three-year development and flight-test programme, and includes options for two years of production.

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Date Posted: March 22, 2002

JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

Egypt's Harpoon 2 missiles will have no land-attack capability

Ed Blanche

The Bush administration, criticised by Israel and its supporters in Congress for plans to sell satellite-guided RGM-84L-4 Harpoon II missiles to the Egyptian Navy, has agreed to modify the weapons so they cannot be used for land-attack missions, writes *Ed Blanche*. Israel had argued that this capability posed a potential threat to that nation and, ultimately, to US forces in the region as well.

US Secretary of State Colin Powell disclosed on 13 February that the sale would go through, although the Harpoons would be modified so they could not hit land targets. "I'm assured... it would be a non-land attack version that would not have the capability of being reconfigured," he told a House of Representatives subcommittee.

The 53 RGM-84L-4s are part of an arms package, worth up to US$1 billion, under which Egypt would also take delivery of four fast missile craft - with an option for four more - armed with Harpoon launch systems, Phalanx close-in weapons systems and 50,000 rounds of tungsten ammunition.

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In their original configuration, the Harpoons would have boosted the Egyptian Navy's anti-ship capability, but given it a vastly enhanced land-attack capability as well. This latter feature alarmed Israel, which has long been concerned about the growing capabilities of Egypt's armed forces, particularly its air force, in recent years under an ambitious modernisation programme that involved the conversion from Soviet-era equipment and doctrine to US systems and training. Israeli concerns have shifted to Egypt's navy since it began undergoing across-the-board modernisation a few years ago, largely with US equipment.

The administration notified Congress about the proposed sale to Cairo in early November, and in the weeks that followed held an unprecedented 15 briefings for legislators on its strategic importance. David Des Roches of the Defence Security Co-operation Agency argued that Egypt needed the Harpoon II to maintain its defensive capabilities by replacing the Block I anti-ship missiles already deployed aboard its warships. Boeing no longer produces Harpoon I systems and the US is running low on spares. He also argued that Harpoon II would help Egypt protect the Suez Canal, essential for the rapid deployment of US forces in the Gulf and Arabian Sea.

Israel maintained that introducing Harpoon II into the Egyptian Navy would, along with the Standard SM-1MR surface-to-air missiles aboard Egypt's US-supplied Perry-class frigates, threaten Israeli freedom of movement in the eastern Mediterranean and give Egypt a naval land-attack capability which would threaten strategic installations in Israel.

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

Israel worried by Harpoon II sale to Egypt

Ed Blanche

Israel is opposing the US proposal to sell Boeing Harpoon II missiles to Egypt, writes *Ed Blanche*. Part of a planned US$400 million package of arms sales to Egypt, which also includes four Ambassador III-class fast attack missile warships ordered in November 2000, the deal was notified to the US Congress on 2 November 2001 in a classified memorandum from the US State Department. On 27 November, after the mandatory 20-day period during which Congress can present its position on foreign arms sales, State Department spokesman Richard Boucher confirmed that the administration intended to go ahead with the Harpoon II deal.

Bipartisan congressional opposition to the deal is mounting. Some key legislators echo Israeli defence officials' claims that providing such sophisticated technology to Egypt would erode Israel's qualitative edge. According to Israel's Haaretz daily, until 11 September 2001, the pro-Israeli lobby in the US had effectively blocked moves to sell Harpoon II to Egypt, but with President Bush

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trying to maintain Arab support for his international anti-terrorism coalition new imperatives are in play and the sale is expected to go through despite congressional misgivings.

The Bush administration has insisted that the sale of the 53 multimission RGM-84L Harpoon Block II missiles is "part of an ongoing and long-standing co-operation we've had with the Egyptian military and will enhance protection of the Suez Canal, which would be of value to shipping generally and to US warships that use this channel."

Harpoon Block II carries a 500 lb warhead and has a range of 130nm. It can be directed against land targets as well as ships, and is said to have a circular error probable (CEP) of less than 9m. This land-attack capability is of concern to Israel, for although the Harpoon II is intended to attack land targets close to the shore, the geographic shape of Israel puts many sensitive potential targets within the missile's reach.

Israel's opposition to the proposed Harpoon sale underlines the extent of fears that country has of an Egyptian military resurgence, much of it due to US military support for a 10-year programme to convert Egypt's armed forces from obsolete Soviet-era equipment and doctrine to US weapons systems and, probably more importantly, US war-fighting doctrine. Egypt has received US$2 billion in US aid every year since it signed its landmark peace treaty with Israel in 1979, which makes it the second largest recipient after Israel.

Egypt's navy is now bigger than Israel's, and the Harpoons would provide it with a significant increase in firepower and destructive reach. While the possibility of another war between the two states seems highly unlikely, the Palestinian intifada has raised tensions alarmingly and Tel Aviv has been concerned at recent Egyptian military exercises that it has concluded were planned with Israel as the projected 'enemy'.

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ANTI-SHIP & ASW

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JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

Ramjet missile may have an anti-ship role

A series of photographs taken by Jane's Missiles & Rockets correspondent, Miroslav Gyürösi, shows new details of a Chinese supersonic air-launched missile. Reported to have the designation Ying-Ji 12 (Eagle Strike 12), this weapon has been shown in model form at several recent defence exhibitions, including the third Zhuhai Airshow held in China on 6-12 November 2000, and the MAK 2001 air show held in Moscow last summer. However, the Chinese authorities have released no detailed information on the new missile.

The most obvious features shown by this scale model of the missile are side-mounted air intakes and four aerodynamic surfaces around the rear. The powerplant is probably a liquid-propellant ramjet with an integral solid-propellant rocket booster.

Earlier air-launched weapons powered by ramjets such as the Hai Ying-3 (Sea Eagle-3) rely on jettisonable solid-propellant boosters to bring the missile up to speed. This solution is simpler to engineer, but increases the overall bulk of the round.

In general configuration, the weapon

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resembles France's Vesta technology demonstrator for the ASMP-A (Air-Sol Moyenne Portee-Amelioree) supersonic cruise missile. Scaling of the photographs suggests that the Chinese missile is around 5m long, with a forward-fuselage diameter of 30-35cm. It is similar in size to the ASMP-A and to the Matra BAe Dynamics Apache/Storm Shadow/Scalp EG family of missiles.

Maximum speed of the Chinese missile is likely to be between Mach 2.0 and 2.5, and the maximum range of 100-120km. Its primary role is likely to be anti-ship (France's projected ANF anti-ship missile was expected to use the same airframe and powerplant as the ASMP-A), but anti-radiation or even land-attack versions could be developed.

The designation YJ-12 also suggests an anti-ship role, but cannot be confirmed. Until recently, the YJ-12 was thought to be an improved longer-ranged version of the rocket-powered YJ-1 (C-801) or turbofan-powered YJ-2 (C-802) anti-ship missiles. Both are subsonic weapons. The designation YJ-22 has been associated with a reported land-attack variant, while the designation YJ-83 (C-803) has been reported as being for either a torpedo-tube launched subsonic missile or for a new supersonic design.

A photograph published in January 2001 by Jane's Missiles & Rockets showing what appeared to be a new Chinese air-launched missile is now thought to have been a hoax, writes Seymour Johnson. It seems to have been created by retouching a photograph showing an underwing-mounted CATIC PL-8 copy of the Rafael Python 3 air-to-air missile.

Above: China's new missile has the same general configuration as France's ASMP-A (Air-Sol Moyenne Portee-Amelioree) supersonic cruise missile. (Source: Miroslav Gyürösi)

Right: This rear view shows the exhaust nozzle and the four control surfaces. (Source: Miroslav Gyürösi)

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ANTI-SHIP & ASW

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JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

Russia forms anti-ship missile consortium

David C Isby

A consortium of seven design bureaus and manufacturers associated with anti-ship cruise missiles (ASCM) was formed in Russia in late December, writes *David C Isby*.

Put together at short notice, the new consortium was intended to pre-empt attempts by the Russian government to restructure the missile industry, or attempts to put the different organisations under 'kholdingizatsiya' (holding companies). The consortium will be able to market its products independently worldwide over the next six years under a presidential authorisation.

The Moscow-based Reutov NPO Machine Works 'Mashinostroyeniye' will be the leader of the consortium with its general director, Gerbert Yefremov, as chairman of the consortiums' board of directors. The other members of the consortium will include Strela PO (Production Association, Orenburg), Granit TsNII (Central Research and Development Institute, St Petersburg), Avangard PO (Safonovo), Mashinostroitel Plant (Perm), Vympel OKB (Special Design

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Bureau, Moscow) as well as Electro-mechanics NPO (Scientific and Production Association, Miass).

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JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

Argentine Sea King launches Exocet

David C Isby

The Argentine Navy has fired an air-launched Aerospatiale Matra Missiles AM.39 Exocet anti-ship missile from one of its Agusta ASF-3H Sea King helicopters for the first time, writes David C Isby. Conducted offshore of the Esposa naval air base, the trial was named Operation 'South Pole' after the name of the fishing boat hulk used as target. The successful live-fire test was the final stage of an indigenous development programme to provide Argentina's naval Sea Kings with an anti-ship missile capability they had previously lacked.

Argentina originally ordered the AM.39 to arm its Dassault Breguet Super Etendard fighters, and used the weapon to sink two UK Royal Navy vessels during combat operations in the South Atlantic in 1982. Development of the upgrade is reported to have taken five years and was launched with a target-cost-per-aircraft budget of 120,000 pesos (US$120,000), much less than the official factory-provided modification.

It is uncertain how many of the Argentine Navy's five Sea Kings will receive an Exocet-launch capability. The service

planned to brief British Admiral Sir Alan West on the programme during his visit to Argentina late last year.

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JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

BRIEFS - Harpoon order for eight nations

A US$98.27 million contract awarded to McDonnell Douglas for 77 Harpoon missiles, 25 Harpoon exercise sections, 103 Harpoon shipping containers and associated spares combines purchases for the governments of Taiwan (87%), Canada (9.5%), Germany (1.8%), Netherlands (0.5%), Singapore (0.4%), Korea (0.3%), Japan (0.25%) and Greece (0.25%) under the Foreign Military Sales programme.

The equipment will be manufactured in St Louis, Missouri (59%); Clearwater, Florida (16.6%); Melbourne, Florida (7.9%); Middletown, Connecticut (5.2%); and various other US locations (11.3%) and is expected to be completed by April 2003.

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JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

New anti-ship missile plan for MH-60

David C Isby

A new anti-ship missile will arm the US Navy's (USN's) new Sikorsky MH-60R/S multirole helicopters that will replace the current Sikorsky SH-60 and HH-60 helicopters, writes David C Isby. An official Request for Information (RFI) for the new missile, designated the Standoff Anti-Surface Warfare Missile (SASWM), was issued by the Naval Air Systems Command in November 2001, with responses due by late January 2002.

Acquisition of the SASWM and integration with the MH-60 helicopter is scheduled to begin in Fiscal Year 2004 (FY04). Procurement will continue until FY12.

SAWSM will be required to destroy warships as large as a frigate, although its main target is seen as smaller craft, operating in littoral waters and in adverse conditions, and with target speeds from 40kt. Range must be sufficient to allow the helicopter to stay out of the coverage of point-defence weapons carried by this class of vessel.

SAWSM will have to be able to engage targets in a countermeasures environment. The chosen guidance technique (which could be electro-optical) will have to include a

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man-in-the-loop capability, and impose minimal restrictions on post-launch helicopter manoeuvres.

Currently, USN SH-60 helicopters use a limited number of Kongsberg/Northrop Grumman AGM-119 Penguin and Lockheed Martin AGM-114 Hellfire missiles for anti-surface missions. While not specified in the RFI, the USN is apparently looking for an existing programme that would fit its requirements. Norway's NSM, intended to replace the Penguin, would appear to be a potential strong contender.

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ANTI-SHIP & ASW

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JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

Harpoon Block II ends developmental testing

The US Navy has completed developmental testing of the Boeing Harpoon Block II missile at the Naval Air Warfare Center-Weapons Division sea range off Point Mugu, California. In the final test flight, a missile launched from the Arleigh Burke-class guided missile destroyer Decatur (DDG-73) attacked a mobile ship target close to land.

"The Harpoon Block II missile has successfully demonstrated its effectiveness against sea, land and littoral targets," says Jim O'Neill, Boeing general manager of Navy Missile Systems. "We can now provide our customers with a low-cost, low-risk approach to protecting waterways and littoral regions."

Harpoon Block II incorporates the low-cost inertial measuring unit from the Boeing Joint Direct Attack Munition programme, and the mission computer and GPS receiver/antenna from the Boeing Standoff Land Attack Missile Expanded Response (SLAM-ER). Existing SLAM-ER navigation and land-strike software, and proven Harpoon ship-attack software provided the foundation for major portions of the Block II mission software.

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For conventional anti-ship missions, such as open-ocean or near-land, the inclusion of GPS/INS improves guidance accuracy during missile flight to the target area, allowing the seeker to discriminate ship targets from islands, other obstructions or neutral ships. This helps maintain a high hit probability even against ships very close to land and in congested waterways.

When fired against land targets or ships in port, the missile uses GPS-aided inertial navigation to hit a designated target aimpoint. The 500 lb blast warhead is suitable for use against a wide variety of land-based targets, including coastal-defence sites, surface-to-air missile sites, exposed aircraft, port/industrial facilities and ships in port.

Harpoon Block II missile can be deployed on all Harpoon platforms with either existing command-and-launch equipment or the new Advanced Harpoon Weapon Control System. A number of foreign countries are considering the Harpoon Block II missile under US foreign military sales agreements, says Boeing. Deliveries could begin in January 2002.

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JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

'Granit' missiles recovered from Kursk

In a dry dock at Roslyakovo near the Russian Arctic port of Murmansk, Russian missile specialists have successfully removed 16 P-700 Granit (SS-N-19 'Shipwreck') missiles from the submarine Kursk, which was brought to the shipyard after being raised from the seabed on 8 October. According to reports in the Russian press, the recovered missiles are unlikely to be returned to service, but will be cannibalised for spares.

It is unclear how many missiles were aboard the submarine, and how many are still to be recovered. According to Russian statements following the loss of the vessel in August of last year, Kursk had carried 22 standard rounds with live warheads, and two training rounds with dummy warheads. One of these training rounds was fired just before the vessel was lost, leaving 23 still on the vessel. Recent Russian press reports say that the wreck contained 22 missiles.

On Project 949A 'Oscar II'-class submarines, the missiles are carried in storage tubes, 12 on either side of the hull. The hull of the Kursk is distorted towards the bow section as a result of the explosions which are believed to have sunk the vessel. This makes recovery of missiles from the front three tubes on either side difficult. Five of these tubes are

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reported to contain missiles with live warheads, while the sixth holds a training round.

For the moment, these remaining missiles will be left in the hull, and once the submarine has been moved to the facility where it is due to be broken up, they will be cut free of the distorted structure.

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JANE'S MISSILES AND ROCKETS - NOVEMBER 01, 2001

BRIEFS - FLH to supply RBS15 Mk3 canard actuators

FHL, a division of the Hamilton Sundstrand-owned Claverham Group, has been selected by Saab Bofors Dynamics AB to produce the fin-actuation system for the RBS 15 Mk3 anti-ship missile. When production orders have been secured, manufacturing will commence at the company's new cellular guided weapons facility, alongside other programmes such as Brimstone and Marté Mk2S.

The company takes a modular approach to the development of actuator systems. Wherever possible, it takes mechanisms and electronics from existing actuator systems, and modifies these for the new application. The system that it has developed for the Swedish missile is based on electromechanical actuators, and will be used on the weapon's canard control surfaces.

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JANE'S MISSILES AND ROCKETS - NOVEMBER 01, 2001

BRIEFS - Software ordered for Harpoon training

Delex Systems is being awarded a US$24 million contract to develop, design, modify and produce training-system computer programs for AN/SWG-1A(V) Harpoon Ship Command-Launch Control System Embedded Trainer, including documentation, installation and training for the Japanese government and various other foreign governments under the Foreign Military Sales Program. The work will be carried out in Vienna, Virginia (95%) and Virginia Beach, Virginia (5%), and is expected to be completed in October 2006.

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JANE'S MISSILES AND ROCKETS - NOVEMBER 01, 2001

NT-D goes to sea

Doug Richardson

Rafael has developed and tested a new naval mounting which combines a 30mm cannon with two of the company's NT-D anti-tank missiles, writes Doug Richardson. First shown at the recent Defence Systems & Equipment Exhibition (DSEI) in London, the Typhoon GS is based on a mounting already in service with the US and Israeli navies. It is intended to provide what Rafael describes as a "dramatic upgrade" for small craft such as the Dvora-class 23m patrol boat, increasing their firepower against surface targets.

Typhoon GS is one member of a family of mounts which uses common hardware including a trainable mounting suitable for local and remote operation, and a built-in fire-control computer. Other members of the Typhoon family include Typhoon G (single cannon), Typhoon GSA (cannon plus two man-portable surface-to-air missiles [SAMs]), and Typhoon DSA (four three-tube decoy dispensers plus four man-portable SAMs).

A single operator controls both the gun and

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missile systems of the Typhoon GS, and the mount can be operated autonomously, or slaved to an external director. Since the mount is stabilised, the missiles are also stabilised, providing good conditions for obtaining lock-on via the missile's seeker, which is fielded in both charge-coupled device (CCD) and infrared forms.

NT-D has a range of up to 6km, and like the smaller Spike member of the same missile family, incorporates a fibre-optic datalink between the missile and the launcher. This allows the operator to monitor the image seen by the missile seeker throughout the flight, correcting and refining the aim point as necessary for maximum lethal effect, or breaking off the engagement if the target turns out to be 'friendly', or the risk of collateral damage is too high (see story 'UK asks for Javelin and Spike bids' on p15 of this issue).

The programme was started last year, and a successful land-based test firing was carried out in the summer of 2001. The test was conducted by the Israeli Navy, but the weapon is attracted interest from several potential customers, to whom Rafael has already submitted proposals.

The mount has a 30mm cannon plus two ready-to-fire NT-D missiles (Source: Doug Richardson)

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ANTI-SHIP & ASW

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JANE'S MISSILES AND ROCKETS - OCTOBER 01, 2001

Indian/Russian PJ-10 missile to be vertically launched

Miroslav Gyürösi

Technical details of the PJ-10 supersonic anti-ship cruise missile being jointly developed by India and Russia were released for the first time at the MAKS 2001 defence exhibition at Zhukovskiy near Moscow, writes Miroslav Gyürösi. The weapon is ramjet-powered and exploits the experience gained by earlier Russian anti-ship missiles in the same performance class (see ''Shipwreck' surfaces after 20 years' on page 2 of this issue).

A collaborative project by India's Defense Research and Development Organisation (DRDO) and the Russian design and production company NPO Mashinostroyenia (formerly OKB-52) from Reutov, the BrahMos Joint-Venture was set up in February 1998 and is registered in India. The name BrahMos is derived from the name of the Indian god Brahma and the Russian capital Moscow.

Design work on the PJ-10 missile started in July 1999, and the programme will involve

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the participation of multiple Indian and Russian institutions in addition to the DRDO and Mashinostroyenia.

The new weapon is based on the design and technology of the Yakhont anti-ship cruise missile (Yakhont is the export designation for the Oniks missile). Development of the 3M55 Oniks started in 1983. It forms part of the Alfa anti-ship weapon complex (which has an industrial designation 3K55). Since 1993 Yakhont/Oniks has been promoted at defence exhibitions and offered for export. There are no reports of Oniks having entered service with the Russian Navy.

The PJ-10 is a supersonic cruise missile suitable for launch from land, sea or air platforms. At sea, the PJ-10 can be launched from submarines and ships, while air-launch would be from multirole combat aircraft such as the Su-30MKI. The ground launcher uses a self-propelled wheeled vehicle based in a lengthened Tatra T816 chassis similar to the new 9A52-2T launcher for the Smerch MLRS (see 'Smerch MLRS offered on lengthened Tatra chassis' on page 7 of this issue). A stationary silo-based coastal defence version is also being studied.

The missile will fly supersonically throughout its mission, descending to low level for the final attack. Several types of flight trajectory can be used. In all cases, the relatively short flight time will minimise both the time to target destruction, and the amount by which the target will have moved since missile launch.

The PJ-10 has an identical configuration for land, sea and sub-sea launching platforms. It will be vertically launched from a TPK (Transportno-Puskovoy Konteyner) transport-launching container. The system uses cold-launch and offers full 360º coverage.

Once the missile has reached a height of around 25-30m above the launcher, a turnover system is activated. Located in a barrel-like unit that covers the air intake of the missile, this combines a series of small rocket thrusters and a computer-based command unit. Thrusters are fired to turn the

missile to the correct azimuth and bring it to the optimal angle for propulsion start-up.

The turnover system is then jettisoned, uncovering the missile's air intake, then an integral solid-propellant rocket booster is ignited to raise the missile speed to the point where the main ramjet engine can be started.

Guidance is fire-and-forget, a combination of an inertial mid-course guidance system and a radar seeker for terminal homing. The seeker is dual-mode, normally operating in passive homing mode during its approach to the target and switching to active mode only if needed.

PJ-10 will be more effective at penetrating ship defences than earlier missiles, say its developers. Like all supersonic anti-ship missiles, it will have its destructive effects boosted by the kinetic energy of high-speed impact.

India will use its new Kamov Ka-31 helicopters to acquire targets for the PJ-10. These helicopters are fitted with the Yastreb decimeter-wavelength search radar. (Yastreb is the export designation of the Oko radar.)

The first test launch of the PJ-10 was a trial designated BrahMos D 01 and was carried out on 12 July at the Chandipur Interim Test Range in Orissa, India. Serial production will be split 50:50 between the Russian and Indian industries, and the first production round is due to be built in India during 2003. In Russia, production will be at NPO Strela in Orenburg, with the half-completed missiles being delivered to NPO Mashinostroyenia for final assembly. Total production capacity will be up to 200 missiles per year.

Missile specifications	
Length	8.1m
Length of transport/launch container	9.0m
Diameter	67cm
Launch weight	3,000kg
Range	50-300km

Propulsion	ramjet with integral rocket booster
Maximum speed	Mach 2.5-2.8
Maximum cruise height	14,000-15,000m
Height above the sea during final attack	10-15m
Guidance	inertial + passive or active radar homing
Warhead	200kg

The wider-diameter nose fairing contains the turnover mechanism which is activated shortly after vertical launch
(Source: Miroslav Gyürösi)

This first view of the PL-10 missile shows a layout which owes much to the earlier Granit and Yakhont/Oniks
(Source: Miroslav Gyürösi)

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JANE'S MISSILES AND ROCKETS - OCTOBER 01, 2001

Kh-59MK intended for all-weather attacks

Miroslav Gyürösi

The FGUP GMKB Raduga design bureau from Dubna displayed a new variant of its Kh-59/-59M (AS-13 'Kingbolt'/AS-18 'Kazoo') series of air-to-surface missiles at the MAKS 2001 defence exhibition, writes Miroslav Gyürösi. The new Kh-59MK has all-weather guidance and a much longer range.

The original Kh-59 is powered by a rocket motor, while the Kh-59M uses an R-95-300 turbojet which provides three times the range. Both use TV-based command guidance via an APK-9 datalink pod carried by the launch aircraft.

In the Kh-59MK, the TV camera guidance system is replaced by an active-radar seeker, an improved model of the ARGS-35 seeker developed by Radar-MMS of St Petersburg for use on the Kh-35 anti-ship missile. The basic ARGS seeker can scan ±45º in azimuth and from -20º to +10º in elevation, and has a maximum range of up to 20km. The new version fitted to the Kh-59MK has a range of up to **25km** against a target with a radar cross-section (RCS) of 5,000m^2, or **15km**

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against a 300m^2 target such as a patrol craft. According to the manufacturer, the Kh-59MK can be used against warships from the size of small fast craft to cruisers operating in open sea or in the littoral, by day or by night, and in any weather.

It does not have the solid-propellant booster used to launch the Kh-59 and -59M. It is powered by a new 36MT turbofan engine with a thrust of 450kg and a lower specific fuel consumption than that of the R-95-300, while the rocket booster is replaced by an additional fuel tank. It probably uses the same AKU-58 airborne launcher as the earlier variants.

The new missile is being offered to arm the Su-30MKK. It was probably developed to meet a specific Chinese requirement, but would be available for other users of the Su-30MK family of aircraft. It is not known whether the Russian Navy Aviation is showing interest in the weapon.

KH-59MK specifications	
Length	5.7m
Wingspan	130cm
Fuselage diameter	38cm
Nose diameter	42cm
Launch weight	not more than 930kg
Launch speed	600-1,100km/h
Launch height	200-11,000m
Missile speed	900-1,050km/h
Maximum range (against a 5,000m^2 RCS cruiser)	**285km ?? [m?]**
Maximum range (against a 300m^2 RCS patrol craft)	**145km?? [m?]**
Minimum range from target at launch	5-25km
Cruise height over the sea surface	10-15 m
Final attack height over the sea surface	4-7m
Warhead	320kg penetrating

The nose section of the Kh-59MK has been widened to house a radar seeker (Source: Miroslav Gyürösi)

The new 36MT turbofan engine has a lower specific fuel consumption that that of the R-95-300 turbojet used on the earlier air-breathing Kh-59M missiles (Source: Miroslav Gyürösi)

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ANTI-SHIP & ASW

Date Posted: September 19, 2001

JANE'S MISSILES AND ROCKETS - OCTOBER 01, 2001

PLA exercises use missiles in anti-carrier role

David C Isby

The Chinese People's Liberation Army (PLA) has recently used ballistic and cruise missiles in support of amphibious operations and against simulated carrier task forces, writes David C Isby. Part of a continued series of 'missile diplomacy' exercises, the firings were apparently intended as a message aimed at both Taiwan and the US. China has explicitly presented recent exercises as a counter to what it claimed was a US one-day exercise involving two carrier battle groups held in the South China Sea on 17 August.

The main 'Dong Hai 6' exercises were held in August, mainly off Dong Shan Island in the Taiwan Straits and the southeast coast, especially in Fuijian province. Other parts of this exercise were spread throughout littoral China. The exercise included a number of live-fire missile demonstrations.

Three submarine-launched ballistic missiles (SLBMs) with the previously-unknown designation 'JL-21A' are reported to have been launched from ballistic missile submarines (SSBNs) in the South China Sea,

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the East China Sea and the Yellow Sea. They were fired against an impact area 5,000km away as a simultaneous time-on-target (TOT) exercise. The Hong Kong press reported that these missiles demonstrated a circular error probable (CEP) of 50m. A similar trial reported in December 2000 is said to have involved two JL-2 Ju Lang/Tidal Wave (CSS-N-X-4) SLBMs.

It seems unlikely that China could have conducted three near-simultaneous SLBM firings from widely-spaced locations. The PLAN has only two ballistic-missile submarines - a single Xia-class (Type 092) SSBN, which some reports say has been non-operational since 1998, and a single trials submarine based on the Russian 'Golf'-class. In the mid-1980s, China was reported to have two Xia-class vessels, but one was reported lost in 1988. Currently, Jane's Fighting Ships lists only a single Xia-class submarine, and notes that although a refit ended in 1998, the vessel was not expected to become fully operational until some time in 2001.

The Xia-class was originally armed with 12 JL-1 (CSS-N-3) SLBMs, and the upgrade may have equipped the vessel with longer-ranged JL-1A missiles. JL-1A is thought to be similar to the land-based DF-21A (CSS-5 Mod 2), so it is possible the reported designation 'JL-21A' could indicate a renaming of the naval weapon. The only platform able to launch the JL-2 is the trials submarine, which has only a single launch tube. The JL-2 is expected to enter service in the middle of this decade aboard the first of four Type 094 SSBNs, each of which will carry 16 missiles. Construction of the lead boat was expected to begin this year.

The PLA Navy is reported to have air-launched an HN-2 (Hong Ngaio, Red Bird) cruise missile in the exercise. This was announced as the first flight test of the weapon. Few details are available, but it is believed to be a development of the jet-powered C-802 anti-ship missile, with a range extended to more than 1,000km.

The exercises concluded with the live fire

launch by the 2nd Artillery (which operates the PLA's ballistic missiles) of a DF-2A (CSS-2) intermediate-range ballistic missile (IRBM) launched from a test site in northern China to an impact area need the Mongolian border. According to US press reports, M-series theatre ballistic missiles (TBMs) were moved by rail from a brigade headquarters at Leping in Jiangxi province to the exercise area in Fujian province. The Hong Kong press reported that these TBMs were exercised in the anti-carrier role, but that all launches were simulated - live firings did not take place.

Other missiles reported by the Hong Kong press as being used in the exercise include the 'Rizhi' - PLA nickname of the Raduga 3K80/3K82 Moskit (SS-N-22 'Sunburn'). The PLAN's two Sovremmeny-class destroyers, Fuzhous and Hangzhou, took part in their first live-fire exercise in co-operation with other PLAN units.

Other missiles fired during the exercise include the C-802 anti-ship missile, and S-300 (SA-10) SAM. Naval SAMs were also used to shoot down targets simulating incoming anti-ship missiles. This broad range of PLA missiles was operated in a co-ordinated manner, reports suggest, exploiting long-range target acquisition methods (including unspecified space assets) and electronic countermeasures. B-6 'Badger' bombers armed with air-to-surface missiles were used to demonstrate the PLA's new air-refuelling capabilities.

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JANE'S MISSILES AND ROCKETS - OCTOBER 01, 2001

'Shipwreck' surfaces after 20 years

Doug Richardson

Newly released information on the Russian Navy's P-700 Granit (SS-N-19 'Shipwreck') anti-ship missile suggests that the weapon's performance and technology may have been underestimated by Western navies, writes Doug Richardson. The weapon was designed in the late 1970s and entered service in the early 1980s, but for almost two decades its configuration remained classified.

Until now, Granit was thought to be an improved model of the P-500 Bazal't (SS-N-12 'Sandbox'). It was reported to be launched by two solid-propellant rocket boosters and to cruise at around Mach 1.6 under the power of a built-in turbojet. The aerodynamic configuration was said to be aircraft-like, with two sharply swept-back wings and two swept-back tail fins.

This view of the Granit was strongly conditioned by artist's impressions released by the US Department of Defense. These showed a missile which simply could not have fitted into a narrow launch container, and were obvious disinformation, perhaps intended to downplay the threat which the Granit would pose to US carrier groups.

In practice, the configuration adopted by the Reutovo branch of Mashinostroyenia under chief designer Academician Vladimir Chelomeyev is based on a supersonic ramjet with a nose-mounted inlet. This gives the weapon a top speed of Mach 2.5, and allows the use of relatively small high-mounted wings whose span is not much greater than that of the cruciform tail surfaces.

The configuration is a familiar one, having been used in the more recent Yakhont anti-ship missile. The latter is slightly smaller than Granit and about half the weight, and shows how more recent technology can shrink a basic design which has been proven by almost two decades of service. Yakhont is the export designation for the weapon. The Russian version is known as 3M55 Oniks (SS-NX-26) in its ship-launched form, and Bastion (SSC-X-5) in its coast-defence variant.

No information has been released on the Granit powerplant, but this is probably a liquid-propellant ramjet. Like all ramjets, this needs to be boosted to high speed before ignition. A tandem-mounted solid-propellant rocket booster would add undesirable additional length to the missile, so it is likely that an integral booster is used.

According to Russian sources, the guidance system used by the Granit makes extensive use of artificial intelligence technology. The missile's onboard computer is loaded with data on modern classes of warship, likely tactical formations, possible enemy electronic countermeasures (ECM) techniques, and methods of avoiding air defences.

The missile is able to select and classify targets, then select the best attack tactics. A series of missiles launched in a salvo attack will make autonomous decisions as to which target in a formation each will attack, and the best tactical manoeuvres to be made against each target. Once the main target in a formation of ships has been destroyed, the remaining missiles will attack the other ships in the formation.

Such a degree of autonomy would require an impressive degree of artificial intelligence and extensive inter-missile datalinks. It would be a

major undertaking even with today's technology, but the Granit was designed in the late 1970s and thus contemporary with the first generation of personal computers such as the Apple II and the original IBM PC. As a result, its onboard computing power would be a fraction of that found in today's desktop computers. It is possible that the onboard computer has been updated since the weapon first entered service, but the claimed degree of artificial intelligence still seems ambitious.

In practice, one missile of the attacking salvo is preprogrammed to fly a high-altitude approach, while the others fly at low level. The high fligher would be the first to detect the target formation, allowing it to pass individual assignments to the low-flying missiles, updating these as the attack proceeded. The success of such a tactic would depend on the ability of the high-altitude missile to survive attack by long-range surface-to-air missiles, and the jam-resistance of the datalinks to the other missiles.

The type of guidance used for terminal homing is unknown. Inertial with command update, active radar/infrared and anti-radar homing have all been postulated.

There is no reliable information on the type of warhead carried. Reports have mentioned 750kg conventional high explosive or 500kT nuclear payloads.

Granit is 10m in length and weighs 7,000kg at launch. Today's technology would allow Mach 2.5 performance to be obtained from a much smaller and lighter missile. France's suspended Anti-Navire Futur (ANF) would have been only 5.8m long and less than 1,000kg in weight.

The Russian missile is clearly a weapon which follows the 'large and heavy' philosophy favoured by the Russian Navy and by the Mashinostroyenia bureau (formerly OKB-52) which was also responsible for some earlier anti-ship missiles such as the P-5 (SS-N-3a 'Shaddock'). First-generation anti-ship missiles such as the Vought Regulus 1 and the Beriev P-10 (a late 1950s Russian design never adopted for service) had required some pre-launch assembly, but the first P-5 launch

from a submarine on 22 November 1957 showed the practicality of a missile which could be fired directly from its container.

Even if successfully engaged by close-in air-defence systems, Granit may still cause massive damage to the target vessel, say its designers. Due to the missile's high speed and heavy weight, the impact of a warheadless training round could snap a destroyer-class vessel in half, so a round hit at short range could still create severe effects on impact.

Granit was first deployed on the battle cruiser Kirov (later renamed Admiral Ushakov), and now serves on a total of three surface ships - the aircraft carrier Admiral Kuznetsov (12 launchers) and the Kirov-class nuclear powered cruisers Admiral Nakhimov and Pyotr Velikiy (each with 20 launchers). Two other Kirov-class vessels, Admiral Ushakov and Admiral Lazarev have been inactive for some years and are likely to be scrapped, and the operational status of the Admiral Nakhimov is questionable.

Granit has been more successful as a submarine-launched missile. It is also deployed on seven surviving Antyey/Type 949A ('Oscar II') submarines of the Russian Navy. Each carries 24 missiles, which can be launched while the vessel is submerged. When the Kursk made its final sortie in the Barents Sea in August 2000, it was equipped with 24 Granit missiles - 22 standard rounds and two training rounds with dummy warheads. One of these training rounds was fired just before the vessel was lost. The remaining 23 are due to be recovered when the submarine is raised later in September.

Mashinostroyenia is working on improvements to the Granit which are intended to maintain its combat effectiveness. These changes will modify the weapon's flight characteristics and guidance system.

China was recently reported to be negotiating the purchase of Granit missiles and Antyey-class submarines. Granit has never been exported, but Mashinostroyenia is vigorously promoting the Yakhont. Three vessels of the Antyey class are laid up awaiting disposal. Although the final example was launched in August 1999, it may not be wanted

by the Russian Navy, so could be completed for export at relatively low cost to the Russian industry.

	Granit	Yakhont
Length	10m	Less than 9m
Diameter	?	Less than 70cm
Weight	c.7,000kg	c.3,000kg
Booster	Solid-propellant rocket?	Solid propellant rocket
Main propulsion	Liquid-ramjet ramjet?	Liquid-propellant ramjet
Speed	Mach 2.5	Mach 2.0-2.5
Range	more than 500km	300km hi-lo/150km lo-lo
Guidance	?	inertial + active/passive radar homing
Warhead	several types	c.200kg

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ANTI-SHIP & ASW

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JANE'S MISSILES AND ROCKETS - SEPTEMBER 01, 2001

Taiwan tests supersonic anti-ship missile

David C Isby

The first full live-fire testing of the Chung Shan Institute of Science and Technology's Hsiung Feng III (Brave Wind III) supersonic anti-ship missile has taken place in Taiwan, writes David C Isby. According to unconfirmed reports from Taiwan, the first trial was carried out in mid-July against a target offshore from the firing range at Jeoupeng. Testing was originally scheduled to take place in April.

If the trials are successful, a production decision is expected later this year, allowing the missile to enter production next year. Production funding is reported to be included in the current defence budget.

Flight tests of Hsiung Feng III prototypes have reported to have taken place since 1998, under the cover of tests of earlier Hsiung Feng I and II subsonic anti-ship missiles. According to unconfirmed reports, Hsiung Feng III uses a rocket booster and a ramjet sustainer engine. Some sources say significant problems were encountered during previous tests.

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Hsiung Feng III is thought to have a range of hundreds of kilometres, a speed of Mach 2 and a weight of 1,500kg. It is reported to be able to distinguish ships against a cluttered background and to hit ships in harbour. It is expected to be deployed for coast defence and to be retrofitted to Taiwan's Perry and Lafayette-class frigates in vertical-launch system mountings.

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JANE'S MISSILES AND ROCKETS - SEPTEMBER 01, 2001

Improved Uran-E ASM enters serial production

David C Isby

The Zvezda-Strela 3M24 Uran-E (SS-N-25 'Switchblade') anti-ship missile has entered serial production, writes David C Isby. This is the latest version offered for export of the Russian anti-ship missile, known as the 'Harpoonski' from its resemblance to its US equivalent.

Improvements incorporated in the new version are reported to include an upgraded radar altimeter allowing surface-skimming attacks at altitudes as low as 0.5m in the terminal stages of flight. Russian sources report its range (130km), warhead (145kg) and cruise-flight altitude (10m) are the same as in previous versions that are understood to have been operational since the mid-1990s. Export customers for the SS-N-25 include Algeria, India and Vietnam.

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JANE'S MISSILES AND ROCKETS - SEPTEMBER 01, 2001

BRIEFS - Nine nations order Harpoon hardware

McDonnell Douglas is being awarded a US$27.06 million contract for the procurement of eight Harpoon Shipboard Command and Launch Control Systems for the governments of Turkey (4) and Egypt (4); Ordnance Alteration kits with support for Japan (4) and Greece (4); and spare parts for Taiwan, the Netherlands, Germany, the United Arab Emirates, and the UK.

This contract combines purchase for the governments of Egypt (40.91%); Turkey (46.87%); Greece (7.71%); Japan (2.73%); the Netherlands (0.32%); Taiwan (0.32%); Germany (0.32%); the United Arab Emirates (0.32%); and UK (0.50%) under the Foreign Military Sales (FMS) programme. Work will be performed St Charles, Missouri (55%); Lititz, Pennsylvania (13%); Baltimore, Maryland (12%); San Diego, California (12%); Kellyville, Oklahoma (3%) and at various locations worldwide (5%), and is due to be completed in March 2003.

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JANE'S MISSILES AND ROCKETS - AUGUST 01, 2001

China deploys HY-2 anti-ship missiles to Paracel islands

David C Isby

China recently deployed HY-2 'Seersucker' anti-ship missiles to its main base on Woody Island in the disputed Paracel islands, writes David C Isby. Citing intelligence sources, US press reports say that the missiles were detected following amphibious exercises on Woody Island in early June.

This represents a major increase of the permanent Chinese military presence in its South China Sea outposts. The missile deployment was part of a pattern of increased Chinese presence in and around the islands of the South China Sea. This has included deploying warships to Scarborough Reef and moving large numbers of ships through the disputed areas.

HY-2 carries a 454kg warhead and is powered by a liquid-propellant rocket motor. It is available with either a radar or infrared seeker, and has a maximum range of 95km. The Woody Island missiles are within striking distance of a considerable portion of Asia's seaborne trade.

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ANTI-SHIP & ASW

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JANE'S MISSILES AND ROCKETS - JULY 01, 2001

US Navy tests Harpoon Block II

The US Navy (USN) has conducted the first flight test of the Boeing Harpoon Block II anti-ship missile at the Naval Air Warfare Center-Weapons Division sea range off Point Mugu, California. After launch from the Arleigh Burke-class guided missile destroyer Decatur (DDG 73), the missile flew towards two targets, the navy's Mobile Sea Target and another target ship, the MK-35 SEPTAR. The trial was intended to demonstrate the missile's ability to select the proper target when used in open-ocean conditions. Harpoon II tracked and acquired the target exactly as planned, says Boeing. Flight tests later this summer will demonstrate the missile's other capabilities.

Harpoon Block II is an upgraded version of a missile which is now in service with the armed forces of 26 countries. The Block II variant improves strike capabilities in congested littoral environments and adds the ability to attack land-based coastal targets. It retains the airframe and turbojet propulsion of the current Block 1C/1G round, but adds the low-cost inertial measuring unit from the Boeing Joint Direct Attack Munition; and the software, mission computer, integrated

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Global Positioning System/Inertial Navigation System (INS) and the GPS antenna and receiver from the AGM-84H Standoff Land Attack Missile Expanded Response (SLAM-ER).

The accurate navigation solution provided by these new components allows the Block II missile to discriminate target ships from islands, other obstructions or neutral ships. "The Block II missile clearly provides a significant improvement over the existing Block 1C version currently in the US Navy's inventory", says Capt Carl Reiber, USN programme manager, Standoff Missile Systems (PMA-258).

For conventional anti-ship missions, such as open ocean or near-land, the GPS/INS improves midcourse guidance to the target area. The accurate navigation solution allows users to discriminate target ships from islands or other nearby land masses or ships.

To strike targets on land and ships in port, the missile uses GPS-aided inertial navigation to hit a designated target aimpoint. Boeing claims a circular error of probability of about 10m against targets up to 50km inland.

The 500lb blast warhead delivers lethal firepower against a wide variety of land-based targets, including coastal defence sites, surface-to-air missile sites, exposed aircraft, port/industrial facilities and ships in port.

Block II missiles can be delivered as new-production rounds, or created by upgrading existing missiles. Boeing says that the Block II upgrade would cost only 10% of the price of a new-construction missile. The new variant can be deployed from all current Harpoon missile system platforms with either existing command and launch equipment or the new Advanced Harpoon Weapon Control System (AHWCS).

In 1999 the Danish Naval Materiel Command (NMC) contracted to purchase the AHWCS for its Flyvefisken-class STANFLEX corvettes, and became the first nation to adopt the Harpoon Block II missile, committing itself to a scheme to upgrade its

existing Harpoon Block IC missiles to the Block II configuration.

The first Harpoon Block II missile was fired from the Arleigh Burke-class destroyer Decatur (Source: Boeing)

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JANE'S MISSILES AND ROCKETS - JULY 01, 2001

Iran may have ordered Yakhont missiles

David C Isby

According to unconfirmed reports, recent Russian/Iranian talks on arms transfers included an agreement for the sale of the Chelomey Design Bureau's 3K55 Yakhont (SS-N-26) supersonic surface-skimming anti-ship missiles to Iran, writes David C Isby. The sale is one of several - with a total value etimated at up to US$7 billion - that are likely to follow now Russian President Vladimir Putin has said that he will no longer follow a 1995 understanding with the US to ban new arms sales to Iran.

While there have been reports that the Yakhont will be used to arm Iranian warships, it appears more likely that air-launched versions would be exported. Iran currently has no warships whose fire-control systems appear to be compatible with the Russian missile.

These reports followed announcements that an improved version of Yakhont is being made available for export. This is reported to be optimised for attacks against carrier task forces, and to have a guidance system able to distinguish an aircraft carrier from its

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escorts.

The Russian defence industry sees anti-ship missiles as one area where they are competitive in international commerce. Yakhont has strong Russian competition in export sales, most notably from missiles from the Novator Design Bureau.

The surface-launched version of Yakhont is canister-mounted. It is 8.9m long, weighs 3,000kg and has a range of 300km. Its ramjet sustainer is reported to provide speeds of Mach 2.0-3.5.

At the 1999 Moscow Air Show, an air-launched version of the Yakhont was displayed for the first time. Lighter than the ship- and ground-launched versions with folding wings and fins, this 2,550kg has an air intake and nozzle that are covered by shrouds discarded after launch. A MiG-29 can carry two Yakhonts.

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ANTI TANK

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JANE'S MISSILES AND ROCKETS - MAY 01, 2002

Upgrade planned for TOW night sight

DRS Technologies is to design prototype upgrade kits for the night-vision targeting sight on the Raytheon BGM-71 TOW (Tube-launched, Optically-tracked, Wire-guided) anti-tank missile system. The new AN/TAS-4(X) configuration will be a low-cost upgrade to the existing AN/TAS-4 first-generation infrared weapon sight.

It will integrate and retain the existing optics, weapons systems interfaces and operator interfaces, but will offer larger fields-of-view and increased operating range. New hardware added by the upgrade will include advanced focal plane array components and a quiet, highly reliable cryogenic cooler assembly.

Development is to be funded by a US$1.5 million contract from the Center for Electro-Optics Research, at the Applied Research Laboratory of Pennsylvania State University. The kit will be developed by the company's DRS Infrared Technologies unit in Dallas, Texas, and prototype deliveries are expected to begin in January 2003.

The selection of DRS to provide prototype AN/TAS-4(X) upgrade kits puts the company in a good position to win orders to upgrade many of the thousands of TOW

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systems currently in operational service, says DRS Technologies chief executive officer Mark S Newman. TOW is widely used by the US Army, US Marine Corps and the military forces of more than 40 nations.

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ANTI-TANK

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

Iran tests indigenous TOW in air-launched form

David C Isby

Iran has tested a locally produced version of the US TOW wire-guided, anti-tank-guided missile (ATGM) from a helicopter, writes *David C Isby*. According to Tehran press reports, the firing was made by an operational helicopter unit, and was the first time the Toophan missile had been operationally tested from a helicopter.

Toophan is manufactured by the Iranian Ministry of Defense and Logistics, and is based on US-supplied TOW missiles, which have been in Iranian service since the 1970s. Iranian military officials have claimed that the locally produced missile is superior in performance to TOW, and has a longer range. It has been in service since the 1990s and has been exported to Hezbollah forces in south Lebanon.

The air launches were conducted by a helicopter unit based at Nasrabad, Ishfahan, presumably equipped with Bell AH-1J Sea Cobras. Recent reports indicate that the weapon is operational with at least some of Iran's attack helicopter fleet.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

BRIEFS - Javelin support contract awarded

The US Army Aviation and Missile Command, Redstone Arsenal, Alabama, has awarded Raytheon Lockheed Martin Javelin Joint Venture a US$7.58 million modification to existing contract DAAH01-01-C-0095 for interim contract support for Javelin missile systems. This work will be carried out in Tucson, Arizona, (65%), and Orlando, Florida (35%), and is expected to be completed by 30 June 2003.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

BRIEFS - Five-year TOW system contract for Raytheon

Raytheon Systems has been awarded US$4.36 million of an estimated US$65.36 million contract with options from Fiscal Year 2002 (FY02) to FY06 for contractor logistics support of the TOW Improved Target Acquisition System. This is intended to maintain operational readiness at, or above, 90%. The work will be done at Raytheon's McKinney, Texas, facility between now and 15 December 2006.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

BRIEFS - UK orders Hellfire/Longbow support

Hellfire Limited Liability has been awarded a US$7.94 million US Army Aviation and Missile Command contract with options for engineering services for Laser Hellfire and Longbow missiles for the United Kingdom. Work will be performed in Orlando, Florida, (50%), and Baltimore, Maryland (50%), and is expected to be completed by 30 November 2004.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

BRIEFS - BAE Systems to build tactical trainers

British Aerospace Engineering (BAE) Systems is to supply 122 anti-tank guided missile field tactical trainer systems under a US$7.69 million contract from the US Naval Air Systems Command, Naval Air Warfare Center, Training Systems Division, Orlando, Florida. These will be built in Syosset, New York, and are due to be completed by March 2003.

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

MBDA details its Kestrel bid

Christopher F Foss

MBDA has released further details of the Kestrel fire-and-forget anti-tank guided weapon (ATGW) writes *Christopher F Foss*. Kestrel is the company's entry in the British Army competition for a New Light Anti-tank Weapon (NLAW) to meet Staff Requirement (Land) 7098. Also competing for this contract, which is worth at least £250 million (US$357m), is Saab Bofors Dynamics of Sweden with the MBT-LAW.

For the NLAW competition MBDA is partnered with Lockheed Martin, Missiles & Fire Control to offer Kestrel, an enhanced version of the Lockheed Martin Predator. The main difference between Predator and Kestrel is that the latter has been optimised to meet the operational requirements of the UK and has a number of improvements, the most important of which is a direct-attack mode to defeat bunkers and soft-skinned vehicles.

Predator has been under development by Lockheed Martin for some years to meet the requirements of the US Marine Corps, and late in January this year the company was

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finally awarded a US$39 million low-rate initial production (LRIP) contract.

Kestrel is a fire-and-forget weapon, and can engage and neutralise static and moving targets out to a maximum range of 600m, with further growth potential. It is claimed that the missile has a low signature at launch and a minimum-smoke motor to further reduce operator detection. Kestrel can also be fired from an enclosed space and comes with a day sight with the option of an add-on night sight.

Minimum range is 20m, and time to engage a target is less than 10 seconds. This includes battery initiation, tracking target and firing. Once the system has been fired, the launcher is disposed of and the operator is free to move. The inertial guidance in the Kestrel missile compensates for cross winds and target movements without requiring the operator to lead or super-elevate the target.

MBDA has bid a complete system to meet the NLAW requirement including the weapon system (missile and launcher), integrated logistic support and a complete training package. If selected by the UK, Kestrel would be manufactured at MBDA facilities at Henlow where over 65,000 Milan missiles for the British Army and Royal Marines have already been assembled. MBDA would also have access to some export markets for the Kestrel.

INSYS would manufacture the launcher, with the MBDA Lostock facility assembling the Target Detection Device (TDD). This includes an impact sensor developed using Javelin independent research and development funding. Saab Training of Sweden would also be a member of the team.

The EFP (Explosively Formed Penetrator) top attack warhead is an enhanced version of that fitted to the Raytheon Systems Company TOW-2B. This features an improved warhead liner, and would be supplied by Aerojet. Extensive trials have shown that this will penetrate main battle tanks fitted with explosive reactive armour (ERA) on the roof.

According to the Kestrel team, the EFP gives lethal spall and pyrophoric effects inside the

vehicle and ensures the target is neutralised. In addition, the EFP design is claimed to reduce sensitivity to velocity and stand-off. According to MBDA, the EFP warhead of Kestrel exceeds the specified penetration requirements.

The top attack/direct attack switch is from the US MPIM/SRAW (Multi-Purpose Individual Munition/Short Range Attack Weapon) also under development by Lockheed Martin.

As required by the UK Ministry of Defence, a complete training package will be provided for Kestrel and this will include characteristics familiarisation material, drill round, indoor aim and track trainer, outdoor trainer and weapons effect simulator, and ammunition technical officer training equipment. There will also be an integrated logistic support package.

A total of 13 Kestrel missiles have been fired in the UK and US against stationary and moving targets. These included a number of manned firings out to 600m at stationary and moving targets. The missile has also been demonstrated as being safe in flight through brushwood.

As a result of inputs from the potential user a number of changes have already been made to the launcher to make the weapon easier to carry and handle in the field. For example, the original integrated handle has been replaced by a web handle.

Kestrel NLAW contender being unloaded from a Warrior infantry combat vehicle during British Army trials at the Infantry Trials and Development Unit (ITDU) Warminister (Source: MoD)

One of the key features of the Kestrel NLAW is that it can be fired from within a confined space (Source: MoD)

The Kestrel NLAW being put through its paces by a British Army infantryman wearing NBC equipment (Source: MoD)

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

Range boost for Spike and TOW

Doug Richardson

Rafael's Spike fibre-optic guided anti-tank missile has now been cleared for use at ranges of up to 6km, writes *Doug Richardson*. Up until now the missile has had a maximum range of 4km, although the heavier NT-D variant - originally developed for helicopter use - has always had a 6km range.

Spike carries a bobbin of optical fibre which is used to maintain a datalink back to the launcher. This allows engagements at longer range, and gives the gunner the ability to refine the aim point, or to break off the attack if the image from the seeker shows that the target is 'friendly' or that the attack will cause unacceptable collateral damage. (Rafael also offers the 2.5km range Gill variant, which does not have a datalink.)

This extended range could make Spike more attractive to the British Army, which is evaluating Spike/Gill and the Raytheon/Lockheed Martin Javelin, and will select one as a Light Forces Anti-Tank Guided Weapon System (LFATGWS) to replace the Euromissile Milan. Although the UK requirement calls for a maximum range of only 2.5km, the British Army is also

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planning to procure a new longer-range guided weapon for use by its armoured infantry battalions. The latter requirement was expected to be met by Hellfire or Brimstone - weapons with a range of around 10km - but the increased range now being offered by Spike could make the Israeli missile a cost-effective compromise.

Raytheon is now offering an extended-range version of its Tube-launched, Optically-tracked, Wire-guided (TOW) 2B wire-guided anti-tank missile to current TOW 2B customers via the US Department of Defense's Foreign Military Sales office. In its current form the missile has a maximum range of 3.75km, but the improved variant has a range of over 4km.

The revised design was successfully demonstrated in December 2001 by a joint Raytheon and US Army initial test conducted at the Army's Redstone Arsenal, Huntsville, Alabama. "This demonstration proved that the existing TOW missile propulsion system, coupled with minor airframe modifications, has the capability to deliver the TOW missile to extended ranges, with no decrease in terminal lethality," says Paul Walker, vice-president, Land Combat at Raytheon Missile Systems.

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ANTI-TANK

Date Posted: January 31, 2002

JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

Israeli CH-53s armed with Nimrod ATGMs

David C Isby

Israel is arming its US-built Sikorsky CH-53D Sea Stallion helicopters with Israeli-built Israel Aircraft Industries Nimrod laser-guided anti-tank missiles, writes *David C Isby*. Four of the 26km-range missiles can be mounted on each side of the helicopter in place of the aircraft's long-range fuel tanks. According to a report in the Israel Air Force magazine Israel Air Force Journal, the system has completed flight tests.

While the long range of the Nimrod gives the helicopter a stand-off attack capability, the installation is reported to be intended for self protection. The modification which adds the missile launchers to the CH-53D is believed to have been designed in the 1980s, but was not implemented at the time due to a lack of resources. Israel currently has 38 CH-53s, 30 of which have been upgraded to the Yas'ur 2000 configuration.

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Launchers for the Nimrod laser-guided missile can be fitted to the CH-53 in place of the side-mounted external fuel tanks. (Source: Jane's)

Launchers for the Nimrod laser-guided missile can be fitted to the CH-53 in place of the side-mounted external fuel tanks. (Source: Israel Air Force)

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JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

Common Missile System agreement ratified

David C Isby

The US-UK Memorandum of Understanding (MoU) setting out the terms of international co-operation to develop the Common Missile System (CMS) was ratified on 10 December, writes *David C Isby*. The CMS is intended to replace existing Raytheon BGM-71 TOW and Lockheed Martin AGM-114 Hellfire ATGMs (anti-tank guided missiles).

Currently in the concept and technology demonstration phase that is to run through 2003, the CMS has received about US$58 million in funding, about 15% of which has come from the UK Ministry of Defense. The US/UK MoU on co-operation was announced in July 2000, and the UK will decide whether to fully commit to the CMS programme at the end of the current phase. The CMS missile could enter production in 2008-10 - there have even been proposals to accelerate its deployment to 2006 - but it is likely to be fielded in 2011 or later.

In Washington, the future of the CMS is being questioned. The US Congress, which

has long been unhappy with what it perceives as a lack of direction in Army ATGM programmes, has reduced CMS funding in the Fiscal Year 2002 defence appropriations bill. Only around US$300,000 of the US$17 million requested for the programme was finally deleted; earlier proposed congressional cuts had ranged up to US$8.4 million. Congress was particularly concerned at the lack of a requirements document for the programme.

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JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

Jordan, Lithuania to buy Javelin anti-tank missiles

Lithuania and Jordan have become the first European and Middle Eastern customers for the Javelin anti-tank missile, says the Raytheon-Lockheed Martin Javelin joint venture. The agreement with the government of Lithuania is expected to result in an award to the joint venture of a contract worth US$10 million. The Lithuanian sale will include more than 75 missiles and 18 command launch units (CLUs), training devices, logistics support, associated equipment and training.

The agreement with is Jordan is expected to lead to a US$12 million contract, which could pave the way for additional Javelin foreign military sales in the region. The deal is expected to include more than 110 missiles and 30 CLUs, training devices, logistics support, associated equipment and training.

"Javelin ensures the Lithuanian and Jordanian armed forces have the world's best light infantry anti-tank weapon suitable for worldwide employment, with highest soldier survivability and system lethality, at the lowest support and life-cycle cost," says US Army Close Combat Missile Systems

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(CCMS) project manager Col John Weinzettle.

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JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

LR TRIGAT finishes helicopter-qualification firings

The MBDA LR-TRIGAT 'fire-and-forget' anti-tank missile system for the Eurocopter Tiger attack helicopter has completed the 10 guided firings in increasingly difficult scenarios required for its helicopter qualification trials. Nine of the 10 firings were successful.

The launches were carried out by an integrated team, comprising both industry representatives and DGA staff, at the DGA firing range at Captieux in south- western France.

A series of five qualification firings carried out between March 2000 and June 2001, tested the missile:

- at ranges of 500 to 4,200m;

- at targets that were either fixed or moving at their maximum speed;

- in different attack trajectories, ie, nap-of-the-earth flight or terminal dive attack;

against different types of tank including the AMX 30B2 tank and Leopard tank; and in the presence of smoke dispensers.

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Four of these five firings achieved a hit. The last missile was destroyed by the range safety officer while it was heading to the target, because the firing range's radars had lost track of it.

The final series of firings began on 27 September 2001, with a 2,600m firing at an accelerating tank. Although the helicopter was in motion at the time of firing and was aiming at an accelerating mobile target, it scored a hit in the centre of the target.

During a 4,500m firing at a head-on target on 19 October, a second tank was moving in the background under remote control to act as a decoy while the missile was in flight. The round stuck the base of the target tank's turret. This test confirmed that when the two tanks cross in the field-of-view, the missile's infrared (IR) seeker keeps tracking the assigned target. Analysis of the telemetry data showed that the missile seeker had detected the decoy tank, but rejected it as not being the designated target.

A test on 23 October offered the system a more complex discrimination task. During a 4,500m firing at a tank in motion, a T-72 decoying tank stationed just in front of the target released a pyrotechnic decoy as the LR-TRIGAT missile approached. The missile scored a hit in the lower section of the designated target's turret.

During a 4,500m firing from a helicopter in forward flight at 180km/h on 27 November, the missile hit the turret of a stationary tank protected by a pyrotechnic decoy. A second missile on board the helicopter completed its target lock-on before launch and tracking sequence correctly just after the first missile had been fired.

The final test was carried out from the hovering helicopter on 5 December against a tank at a range of 4,000m, which was making a turn in the immediate vicinity of a fuel fire. The target was hit in the turret.

Qualification of the LR-TRIGAT missile and the helicopter-borne firing post is due to take place during 2002.The deliveries of the first qualified missiles, including combat-ready missiles, are due to start in the second quarter

of 2002. This will allow the operational testing and evaluation (OT&E) trials to begin in the second half of 2002.

The development of the LR-TRIGAT system was carried out by EMDG, a joint venture combining the skills of Matra BAe Dynamics and Aerospatiale Matra Missiles (two of the companies which now form part of MBDA) and EADS/LFK in Germany.

LR Trigat is guided by a node-mounted imaging infrared seeker operating at around 10µm. This uses automatic image correlation tracking to steer the round to impact.
(Source: MBDA)

This Panther trials helicopter was used for many of the early flight tests of the LR TRIGAT.
(Source: MBDA)

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JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

ATK tests LOSAT rocket motor

ATK Tactical Systems has successfully completed two static firing tests of a developmental solid-propellant rocket motor for the US Army's Line-of-Sight Anti-tank (LOSAT) Weapon System. This clears the way for qualification tests of the motor later this year and production of 42 motors for missile flight-qualification tests in 2002.

The LOSAT Weapon System consists of the Kinetic Energy Missile (KEM) and its fire-control system mounted on an air-mobile, heavy High-Mobility Multi-Purpose Wheeled Vehicle (HMMWV) chassis. Designed to support early- entry force missions, LOSAT is intended to defeat all current and predicted future armoured fighting vehicles at distances beyond the range of a tank main gun.

ATK Tactical Systems is developing the motor for the KEM missile under a contract from Lockheed Martin Missiles and Fire Control, the prime contractor on the LOSAT programme. Low-rate initial production of the motor is expected to begin in 2003.

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JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

US Army proposes to end TERM anti-armour round

The US Army is proposing to terminate the TERM (tank extended-range munition) guided 120mm tank-round programme, writes David C Isby. Intended to produce a dual-mode laser/millimeter wave radar-guided tank rocket-assisted projectile (RAP) shell, TERM currently exists in two competing 120mm versions.

Alliant Techsystems (with a round that uses kinetic energy as a kill mechanism) and Raytheon (with a design that uses a chemical-energy warhead) have both been funded to carry out research and development on the TERM programme until one is selected for production, in a competition that had been due to take place in 2001.

The project succeeded the cancelled X-Rod and STAFF (Smart Top Attack Fire-and-Forget) ammunition, which were seen as too expensive, but would have been ended by the Army in Fiscal Year 2000 (FY00) if the US Congress had not provided extra money for the programme. Cancellation of the TERM programme, which was intended to provide a long-range, beyond line-of-sight, indirect-fire capability

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using onboard sensors, is expected to save US$142.4 million already budgeted over FY03-07. By attempting to end the programme, the Army is basically telling Congress that, if it wants to continue with TERM, it will have to provide further funding.

Although the US Army's Armor Center at Fort Knox had identified TERM as a core requirement for the Mechanized Force Modernization Plan and one of the Army's top needs, outside the Armor Branch there was not much support for TERM in the Army as a whole or in the Office of the Secretary of Defense. Without a competitive armour threat, there is less interest in long-range tank duels and in making sure US tanks have capabilities to match Russian guided tank projectiles whose basic design dates back to the 1970s.

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JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

US Army may kill TOW F&F

David C Isby

The US Army is proposing to terminate the Raytheon TOW F&F (Fire-and-Forget) anti-tank guided-missile (ATGM) upgrade programme, writes David C Isby. However, this move is controversial and may be reversed by the Department of Defense or the US Congress. TOW F&F is also supported by a number of major commands within the Army.

The Army is proposing to cancel 19 major systems - including the TOW F&F - either in procurement or in research and development to save money for high-priority 'transformational' spending. Ending the programme would, according to press reports, make available about US$610 million between Fiscal Years 2003-07, and prevent the Army having to invest further funding in TOW F&F.

TOW F&F is itself a replacement for a cancelled programme, the FOTT (Follow-on To TOW). It was intended to upgrade current TOW missiles and launchers to provide a low-cost, interim, fire-and-forget anti-tank capability pending the introduction of the Common Missile System (CMS) ATGM

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after 2010. TOW F&F is also intended to provide greater range, missile speed and tactical flexibility.

To reduce cost, the Army did not intend to upgrade all its current TOW II missiles and launch platforms to TOW F&F standards, but previously had intended to concentrate these upgraded systems in high-readiness rapid-deployment formations. These included the new Interim Brigade Combat Teams (IBCTs), which lack heavy armour and so are dependent on ATGMs for use against both tanks and bunkers.

According to press reports, a number of major US Army commands have objected to the proposed termination of TOW F&F. This includes US Army TRADOC (Training and Doctrine Command) and FORSCOM (Forces Command) and the senior army commanders of USFK (US Forces Korea) and PACOM (Pacific Command). Only USAREUR (US Army Europe) was in favour of going directly to the CMS, bypassing TOW F&F.

In recent years, Congress has been concerned over what it perceived as a lack of direction in US Army anti-tank weapons investment, and is likely to get involved in the decision-making process. It may object to the Army view that TOW F&F is "not essential" and continue to fund the programme.

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JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

IDF Hellfires wreak havoc in aerial ambushes

Ed Blanche

As US and UK forces plan the hunt for Osama bin Laden and his associates in the mountains of Afghanistan, Israel is continuing its controversial policy of targeted killings of individuals it believes to be playing key roles in the Al Aqsa intifada (uprising) which began on 28 September 2000, writes Ed Blanche.

In the first 13 months of the uprising, Israeli Defence Forces (IDF) helicopter gunships, mainly AH-64 Apaches armed with laser-guided AGM-114 Hellfire surface-to-air missiles, have attacked and killed more than a dozen senior Palestinian figures. These have included political leaders as well as militia chieftains and those alleged to have masterminded suicide bombings.

Between November 2000, when the policy of targeted killings began, and the end of October 2001, at least 16 gunship ambushes resulted in the deaths of the targeted men, while at least four times the target survived the missile strikes. On at least one occasion, the Israelis wrongly identified their target. In this instance, a missile attack on a car in the

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West Bank resulted in the wounding of five farm workers.

The combination of the Apache and Hellfire missile has proved to be extremely deadly, particularly when employed in conjunction with real-time intelligence, which has apparently been supplied in most cases by Palestinian informers. These individuals provided the information needed to identify the targets - mostly vehicles but sometimes specific rooms in buildings.

The first time the IDF used gunships to attack specific Palestinians in the West Bank and the Gaza Strip was on 9 November 2000. The target was 37-year-old Hussein Abayat, commander of the armed militias run by Yasser Arafat's mainstream Fatah movement in the southern West Bank region. His pick-up truck was hit by a volley of missiles fired by three gunships that had been stalking his vehicle outside the West Bank village of Beit Sahour, near Bethlehem. Five minutes earlier, Abayat had been drinking coffee with friends and had mocked the helicopters clattering overhead.

Abayat and two women bystanders were killed. Reporters at the scene found a football-sized missile fragment marked AGM-114 near the burned-out wreckage of the vehicle. Later an individual was executed by the Palestinian Authority for informing Israeli intelligence of Abayat's movements on that day.

The IDF often uses two, or as many as four, gunships to carry out these aerial ambushes, a technique the Israelis developed in the early 1990s to attack leading figures in Hizbullah, the Lebanese resistance movement supported by Iran and Syria that fought the Israelis in south Lebanon. The first known victim of this tactic was Sheikh Abbas Musawi, Hizbullah's secretary-general, who was killed on 16 February 1992 when his motorcade was ambushed as it drove through the region's hill country.

In another gunship strike, which failed to kill two top activists of the Islamic fundamentalist group Hamas, two Apaches

fired four missiles into two civilian cars outside the Bureij refugee camp in the central Gaza Strip on 23 August 2001. Their apparent targets were Hamas' key field commander, Mohammed Deif, who has been on Israel's 'most wanted' list since 1989 and has survived several assassination attempts, and one of his top bombmakers, Adnan al-Ghoul.

Both men were in the leading car, while al-Ghoul's son, Bilal, was in the second. He spotted the gunships and zigzagged on the dirt road to draw their fire, according to witnesses. He crashed into a wall and his vehicle was hit by two missiles. He was killed instantly. The other car raced into an olive grove for cover and the two Hamas chiefs fled on foot before two more missiles wrecked their car. They escaped unharmed.

Among the most spectacular of the gunship attacks were the assassination of West Bank Hamas leaders Jamal Mansour and Jamal Salim, in an apartment block in the West Bank town of Nablus on 31 July 2001, and that of Mustafa Zibri, leader of the radical Popular Front for the Liberation of Palestine (PFLP), in a building in Ramallah on 27 August 2001.

Mansour was the primary target in the 31 July strike, which marked a significant shift by the Israelis towards killing radical Palestinian political leaders following a series of suicide bombings against targets in Israel. He and Salim were killed when two gunships fired two missiles through the windows of the third-floor room in a seven-storey building in downtown Nablus where they were meeting. Four other men in the room were killed with them.

In the attack on Zibri, two gunships, which had been hovering some distance away, swooped in and each loosed off a missile directed at two windows of his corner office on the second floor of an apartment block as he sat at his desk. The missiles were so accurate that the arched window frames were left intact when the room was devastated. In both these attacks, Mansour and Zibri had received telephone calls moments before the gunships struck. These apparently had been

intended to make sure the men were at their desks moments before the gunships attacked.

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JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

BRIEFS - More Hellfires ordered

Hellfire Systems LLC has been given a US$9.6 million modification to contract DAAH01-00-C-0179 to cover Fiscal Year 2001 options for AGM-114K Hellfire II laser guided missiles and AGM-114M blast fragmentation warhead missiles. These will be built in Orlando, Florida, and should be completed by October 2003.

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JANE'S MISSILES AND ROCKETS - NOVEMBER 01, 2001

SMArt 155 passes lot-acceptance tests

GIWS (Gesellschaft für Intelligente Wirksysteme) has conducted a successful series of gun-fired lot-acceptance tests of its SMArt 155 sensor-fuzed munition system. The 14 submunitions delivered over the target array at the government-owned proving grounds in Meppen, Germany, during the lot acceptance tests held earlier this month, achieved seven target hits and seven near misses, despite adverse weather conditions that included high winds, low cloud ceilings and heavy precipitation. GIWS is under contract to produce 9,000 SMArt 155 projectiles over the next several years for the German Army, and the recent tests were part of this production programme.

In November 2000, ATK and GIWS entered into an agreement under which the German company will transfer the technology for SMArt 155 to ATK Ammunition Systems, which will market the product in the US, and be the prime contractor for local manufacture of the projectiles, submunitions and other components. "The successful lot-acceptance test conducted this month demonstrates again the superior performance of the SMArt 155 system against any other 155mm 'smart'

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artillery projectile," said Michael McCann, president of ATK Ammunition Systems, following the German tests.

A SMArt 155 submunition detonates over the range, firing its explosively-forged penetrator at a ground target
(Source: GIWS)

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ANTI-TANK

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JANE'S MISSILES AND ROCKETS - NOVEMBER 01, 2001

Denel shows advanced warheads

Doug Richardson

At the recent Defence Systems & Equipment Exhibition (DSEI) in London, the Somchem division of Denel displayed several warhead developments in order to promote a technology area in which it hopes to attract more business, writes Doug Richardson.

The tandem warhead of the Ingwe anti-tank missile is currently in production for an unspecified overseas customer. It has a fixed nose probe containing a 60mm diameter precursor charge, and a main charge able to penetrate 1,000mm of armour. An inductive sensor is used to detect the presence of metal, and to activate the active IR ranging fuze. This arrangement prevents the IR fuze being triggered by non-metallic objects such as twigs.

A cut-away version of an alternative warhead for the FT-5 shoulder-fired rocket was also shown. This employs a sub-calibre penetrator which is intended to detonate approximately 1m behind the protective layer it was fired through, and has roughly the explosive power of two hand-grenades. It

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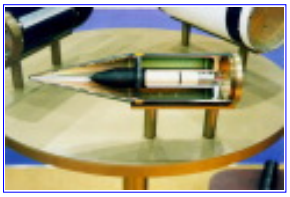
can penetrate 20mm of armour (15mm had been demanded by the specification), 300mm of steel-reinforced concrete or a 1.5m layer of sandbags.

The FT-5 warhead was developed with government and company funding to meet a South African requirement. It has been demonstrated, but is not yet in production. It is attracting interest from a European country which is considering it "to arm their own weapon", says Somchem.

The warhead of the Ingwe anti-tank missile combines a probe-mounted precursor charge and a full-diameter main charge (Source: Doug Richardson)



This cut-away model shows the sub-calibre penetrator within the new warhead for the FT-5 rocket (Source: Doug Richardson)

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Date Posted: October 24, 2001

JANE'S MISSILES AND ROCKETS - NOVEMBER 01, 2001

Khrizantema-S to finish state trials by 2002

David C Isby

The Kolomna Engineering Design Bureau has announced that its 9M123 Khrizantema-S (Chrysanthemum) anti-tank guided missile is currently undergoing state certification tests, writes David C Isby. It is likely to be accepted for possible production in 2002, according to first deputy chief designer Valeriy Kashin.

The Khrizantema-S (AT-15) has been exhibited at defence exhibitions through the 1990s. It had been announced that production would begin in 1998, but this statement apparently referred to the test missiles. The latest announcement shows it has not yet been adopted for service with the Russian Army.

A twin Khrizantema-S launcher is mounted on the 9M157-2 tank destroyer, which uses the BMP-3 chassis and can carry 15 rounds. Khrizantema-S uses automatic fire-and-forget radar guidance or semi-automatic laser beam-riding, and can be fired against two targets simultaneously. It has a range of about 6km.

In addition to the normal anti-tank role, it is

said to be able to carry out all-weather attacks against low-altitude aircraft and helicopters. Two versions of the missile have been reported; these are fitted with HEAT (9M123-2) or HE (9M123F-2) warheads.

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ANTI-TANK

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JANE'S MISSILES AND ROCKETS - NOVEMBER 01, 2001

Nag ATGM makes successful test flight

David C Isby

India's Nag (Cobra) anti-tank guided missile (ATGM) has completed a successful control and guidance flight test at the interim test range at Chandipur in Orissa state, writes David C Isby. The test missile was fired from a mobile launcher, presumably the Namica tank destroyer (a modified BMP-2) that has been used for previous Nag test firings.

The Nag, being developed by India's Defence Research and Development Organization (DRDO), is one of five missiles comprising that organization's controversial and troubled Integrated Guided Missile Development Programme. Nag testing started in November 1990 and has included both the helicopter and ground launched versions. The latest test was seen as a step towards the Nag's long-delayed operational capability and a welcome success after a number of recent setbacks.

A further order for 25 Nag missiles for testing was placed with Bharat Electronics in 2000. A follow on-order for 200 missiles is expected later in 2001 or in 2002. This would allow a limited operational capability. Total requirements are 500 missiles for the

Indian Army and 100 for helicopter use by the Indian Air Force.

Nag weighs 42kg and is designed to have imaging infrared terminal homing (with a millimeter wave option under development) and a range of 4-6km. It uses a tandem HEAT (high explosive anti-tank) warhead with top and front-attack modes. Nag makes extensive use of glass fibre structure and uses a smokeless nitramine-based propellant.

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Date Posted: October 24, 2001

JANE'S MISSILES AND ROCKETS - NOVEMBER 01, 2001

UK asks for Javelin and Spike bids

Invitations to tender (ITTs) have been issued by the UK Ministry of Defence (MoD) to Lockheed-Martin, Raytheon and Matra BAe Dynamics for an off-the-shelf medium-range anti-tank missile system. The US companies are offering the Javelin missile currently in service with the US forces, while Matra BAe has teamed with Rafael to offer the Spike family of anti-tank missiles used by the Israel Defence Forces.

Key features of the requirement are:

· the system must be man-portable;

· maximum range should be 2.5km;

· all weather, day and night capability;

· a tandem warhead able to penetrate main battle tanks and secondary targets;

· high survivability;

· able to be fired from an enclosed space firing;

· minimal live firings in training; and

· training linked to other systems.

The British Army plans to buy up to 300

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firing posts and 5,000 missiles. The new missile is primarily intended to replace the Euromissile Milan in the light forces, but will also serve with the mechanised forces.

A hint that these figures could increase came in October, when the US Defense Security Co-operation Agency formally notified Congress of the possible Foreign Military Sale of Javelin hardware to the UK, saying, "The government of United Kingdom has requested a possible sale of 550 Javelin anti-tank missile command launch units..."

Both teams are currently working under Assessment Phase contracts. Assessment trials of both weapons started in April 2001, and was expected to last for 12 months. The recently-released Manufacturing & Support ITT will be followed by a Main Gate procurement milestone in September 2002 and contract award in the first quarter of 2003. The subsequent schedule calls for readiness to begin training in the fourth quarter of 2004, and an in-service date in the second quarter of 2005.

Under the agreement drawn up between Rafael and MBDA, the two companies will co-operate in marketing the Spike family of anti-tank weapons in the UK, certain European countries and Commonwealth markets. Rafael is lead contractor for the current UK assessment phase, while MBDA would lead the manufacturing and support main contracts, with Rafael as a subcontractor. The team is evaluating the possible involvement of Eurospike, the joint venture set up in 1998 by Rafael, STN Atlas Elektronik, Diehl and Rheinmetall Weapons and Munitions to manufacture and market the NT family of anti-tank guided weapons (ATGWs) in Europe, but nothing has been agreed yet.

The UK MoD trials are providing useful feedback in areas such as handling and ways of strapping the missile to vehicles, says MBDA, and the team is considering modifications such as cold-weather grips devised as a result of trials held in Finland.

The firing post's thermal imager and x10 daylight optics would be used by the British Army as surveillance sensors, so the system

will have a standby mode so that it does not need to be powered up all the time. It requires no gas bottles. Detection and recognition are possible at ranges of more than 3km, says MBDA.

Gill or Spike missiles can be fired from a firing post which consists of a command launch unit (CLU), thermal sight and tripod. The latter allows the operator to be prone, sitting or kneeling, and is damped to assist tracking.

The individual rounds are sealed and have a 10-year service life before requiring refurbishment. All the missile software is stored in the CLU, and injected into the missile before launch. The individual missile containers will have to be navalised so that the weapon can be used by the Royal Marines.

At present, power is provided by a lithium battery which allows 120min of operation and more than 30 firings. However the British Army wants to use a common rechargeable battery compatible with that of Bowman combat radios.

The Spike family has three members - the 2.5km range Gill, the 4km range Spike (which incorporates a fibre-optic data link between the missile and firing post) and the 6km range NT-D (originally developed for helicopter use, but now offered in vehicle-mounted and shipboard forms - see 'NT-D goes to sea' on p13 of this issue).

The Gill and Spike missiles are near-identical; the only difference being the presence of the fibre-optic bobbin in the Spike. Having the missile datalinked to the fire unit allows engagements at longer range, aim-point refinement for better lethal effect or reduced collateral damage, the ability to break off an attack if the image from the seeker shows that the target is 'friendly', and a measure of battle-damage assessment.

Gill and Spike are fire-and-forget missiles with a minimum range of 400m, and can fly lofted attacks or low trajectories better suited to urban and forest combat. Gill has the range needed to met the UK requirement, but the Rafael/MDBA team intends to offer both

Gill and Spike, leaving the British Army to decide if the additional range and operational flexibility offered by Spike is worth the extra cost.

No figure has been released for the number of Spike and Gill missiles currently in service. Raytheon estimates the total to be around 400, and compares this with the Javelin programme, which delivered its 5,000th round in February of this year. Around 200 Javelins have been fired over the last two years.

Raytheon sees seeker technology as being an area where Javelin scores over its Israeli opponent. Javelin uses third-generation technology in the form of a 64x64 pixel staring array, says the company, while Spike/Gill uses second-generation technology based on scanning.

Operational availability of Javelin should be high, says Raytheon. MBTF is four to five times the value originally specified, and the CLU has a sophisticated built-in test (BIT) facility which can diagnose 99% of faults at front-line level. Commonality with the US forces will guarantee the UK not only interoperability with the US, but also a potential supply of additional rounds in an emergency. If the UK adopts Javelin, it would be able to participate in the planned Javelin pre-planned product improvement (P3I) programme.

Rafael's Spike is already being tested by the British Army (Source: MBDA)

The sheer destructive power of the Javelin warhead is shown by the minimal remains of a T-72 tank used as a target during trials. The tank had been loaded with 44 propellant charges for the main gun, and a small amount of fuel
(Source: Raytheon)

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JANE'S MISSILES AND ROCKETS - OCTOBER 01, 2001

Hellfire motor modification needs testing and funding

David C Isby

The US Army has developed a fix to faulty rocket motors used on late-production Lockheed Martin AGM-114K/L Hellfire anti-tank guided missiles (ATGMs), writes David C Isby. The army, working with Lockheed Martin, is preparing to conduct tests before this upgrade can be incorporated into current production missiles and retrofitted to existing stocks.

These motor tests are due to begin later in 2001 and run for about six months. If the modification proves successful, the upgrade would initially be incorporated in new production missiles, but the timing depends on available funding.

The fault was first identified following US Army live-fire training in Poland in September 2000. AH-64D Longbow Apache helicopter horizontal stabilisers were damaged by the propellant ring grain spacer, which is ejected from the Hellfire as it is fired from the helicopter. The US Army immediately suspended all live-fire training with late-production laser-guided AGM-144K and millimetre-wave guided

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AGM-114L missiles, which are powered by an improved motor produced by Alliant Techsystems. Although this order has since been modified, allowing live firing of these Hellfire versions from the right outboard weapons station, the US Army has used earlier AGM-114A/C/F models for its live-fire training since then.

The UK and the Netherlands have stocks of only the affected version of the missile, so their ability to carry out live-fire training with their Boeing AH-64D helicopters has been curtailed (see Jane's Missiles & Rockets, July 2001, p14).

Some 60% of the US Army's Hellfire inventory - reported in published sources to be around 12,000 missiles - will require modification, as will all new production rounds. A further 2,200 Hellfires were requested as part of the Fiscal Year 2002 (FY02) budget request.

The proposed retrofit of existing Hellfires may be delayed by a shortage of funding. The FY02 budget request included US$10.7 million for the Hellfire retrofit programme, which the US Army later reported was under-funded by US$35.7 million. Requests for follow-on years are also reported to be under-funded.

The army is apparently hoping that the US Congress will provide additional funding for the upgrades. At the current level of funding, it is unlikely the upgrade work will be able to start in 2001 and it will probably require four years to upgrade the entire inventory.

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JANE'S MISSILES AND ROCKETS - SEPTEMBER 01, 2001

Brimstone completes ground trials

On 27 June 2001, a ground-launched Alenia Marconi Systems Brimstone missile scored a hit on a tank target at the Yuma Proving Ground, Arizona. The test was intended to demonstrate the short-range performance of the missile, and the missile hit the tank on the rear of the turret.

This was the 16th ground-launched firing trial, and ends a series of firings which began in August 1999. A total of 16 missiles were fired during the ground-launch phase, which included autopilot development (unguided) and data gathering trials. The earliest firings were conducted using development hardware and software, but later firings used a full pre-production version of the Brimstone weapon. All pre-production weapon trials were successful and demonstrated Brimstone's full performance envelope.

Brimstone programme is currently continuing its air-launched flight-evaluation phase. A number of aircraft release trials have been carried out from a Tornado aircraft in the UK, and further air launched guided firings against tank targets will take place at the China Lake Naval Air Weapons Station in California later this year (see Jane's Missiles & Rockets, August 2001,

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p16).

"We are obviously delighted with the success achieved in the ground firing trials which was an important proving programme for the Brimstone weapon", says Brimstone project director Keith Lewindon. "The fact that the weapon performance was demonstrated successfully in a wide range of launch conditions has shown Brimstone will be a significant addition to the RAF anti-armour capability."

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JANE'S MISSILES AND ROCKETS - SEPTEMBER 01, 2001

Second phase of Hellfire firings from UAVs successful

The second phase of weapons testing by the US Air Force's General Atomics RQ-1A Predator unmanned air vehicles (UAVs) at Nellis Air Force Base, Nevada, has proven successful. As with the first phase of the testing, which took place earlier this year (see Jane's Missiles & Rockets, April 2001, p16), the second phase used laser-guided Lockheed Martin AGM-114 Hellfire anti-tank guided missiles (ATGMs) mounted under the wings of the Predator.

The second phase is intended, not to develop an operational capability, but to examine the feasibility of weapons delivery by UAVs. It differs from the first phase in that the altitudes used in the weapons tests are more representative of the 15-20,000ft altitude at which Predator UAVs normally operate. All missile firings in the second-phase weapons testing are reported to be from above 10,000ft, with at least some of the shots being guided by the firing UAV. The second-phase testing also incorporates a number of changes made in the Predator software and control system as a result of the

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first phase of weapons trials.

The USAF believes the Predator tests show that a near-term unmanned combat air vehicle (UCAV) capability could be feasible, possibly as soon as around 2007.

If the high-altitude Predator tests are successful, they could clear the way for an armed UAV to be in service before the end of the decade (Source: USAF)

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JANE'S MISSILES AND ROCKETS - SEPTEMBER 01, 2001

Iran test-fires Lightning anti-tank missile

Iran has successfully test-fired a new pattern of anti-tank missile. According to the Iranian defence ministry, the Saeqeh-1 (Lightning-1) "can destroy the most sophisticated armoured equipment in the world". The missile had been tested in two phases, and was "very precise in hitting targets". Development of the missile was credited to "experts of the Iranian aerospace industry".

Currently Iran manufactures three families of anti-tank missile, all of which are derivatives of existing weapons. The Iranian Defense Industries Organization Raad and I-Raad are based on the Russian Malyutka 9M14 and Malyutka 2 variants of the AT-3 'Sagger'; the Aerospace Industries Organization Toophan and Toophan 2 are derivatives of the BGM-71 TOW; while the Towsan-1 is an Iranian-manufactured version of the Russian 9M113 Konkurs-M (AT-5b 'Spandrel').

Saeqeh-1 has almost certainly been reverse-engineered from the McDonnell Douglas FGM-77 Dragon man-portable surface-to-air missile system, a system which was sold to Iran before the Iranian Revolution. In its basic form, Dragon has a

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single HEAT (high-explosive anti-tank) shaped charge warhead which is of limited effectiveness against modern armour.

In the US, rights to the Dragon have passed to CMS. This company has improved the design, adding an improved warhead, which provides an 85% increase in armour penetration performance (Dragon II), a precursor warhead able to defeat explosive reactive armour and giving a 98% increase in armour penetration over the original Dragon I (SuperDragon), and a tandem warhead with an extended standoff probe (Dragon ITT). SuperDragon also introduced a sustainer rocket motor which increased missile range from 1km to 1.5km, then later to 2km.

Saeqeh-1 seems to have followed a similar development path, and is reported to have a tandem warhead and a range of 1.5km. Another improvement is reported to be a semi-automatic command to line-of-sight (SACLOS) guidance system which has replaced the command to line-of-sight (CLOS) system used by all US members of the Dragon family.

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JANE'S MISSILES AND ROCKETS - SEPTEMBER 01, 2001

BRIEFS - Netherlands selects Gill

The Netherlands has selected the Rafael Gill as its next infantry anti-tank missile system. It is expected to buy around 300 launch systems and 2,400 rounds. Like the UK, the Netherlands had been evaluating Gill and the Lockheed Martin Javelin.

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JANE'S MISSILES AND ROCKETS - AUGUST 01, 2001

Brimstone development near end

Brimstone will be available for service with the Royal Air Force in October of this year, says Alenia Marconi. Although the weapon will be useable as a war store, it will not have its full operating capability on the Tornado GR4 until the associated aircraft software is ready.

The latest test firing took place in early June. Missile M11 was fired from a launcher, which also carried a second round instrumented with thermocouples to check the effects of missile efflux on unfired rounds on the same launcher. Only one more ground firing remains to be carried out.

Three rounds have been successfully fired from Tornado aircraft at the Aberporth test range in Wales. These were not guided, but flew a pre-programmed flight path under autopilot control. A Tornado trials aircraft from BAE Systems' Warton facility was due to be deployed to China Lake, California in late July to begin a series of around 10 flight trials using guided rounds.

Air tests from the Harrier GR8 are due to begin later this year. Since the missile will have been proven by the Tornado trials, the Harrier programme will require only a small

number of launches. The number has yet to be defined - one proposal would limit the programme to pre-programmed autopilot-guided rounds.

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JANE'S MISSILES AND ROCKETS - AUGUST 01, 2001

TOW to be modified for bunker busting role

David C Isby

The US Army's Aviation and Missile Command Research and Development Center is to modify the Raytheon TOW 2A anti-tank guided missile (ATGM) warhead to make it more suitable to defeat bunker and building targets, writes David C Isby. Designated the TOW Bunker Buster, the new missile is intended to be used by a TOW-armed version of the US Army's wheeled Interim Armored Vehicle (IAV). Because the gun-armed version of the IAV will not be operational until 2005, the TOW Bunker Buster is needed as an interim support weapon.

TOW Bunker Buster will carry a 2.85kg (6 lb) high-explosive blast warhead in place of the TOW 2A's current shaped charge. The new warhead was developed by the Army Aviation and Missile Command at Redstone Arsenal, and is designed to be capable of defeating a standard Russian earth and timber bunker and of putting a 60cm hole in a double reinforced 20cm concrete wall.

The TOW Bunker Buster programme faces an accelerated schedule. The engineering and

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manufacturing development (EMD) phase of the program is funded at US$14 million and is due to start in July 2001 and run through April 2002. This will include testing and production of test missiles. A further US$6 million is budgeted for conversion of 500 TOW 2As following the completion of testing. Raytheon will carry out the conversions as depot-level upgrades at the US Army's Anniston, Alabama facility, and the conversion program is expected to be complete by September 2002.

While the TOW Bunker Buster conversion is currently a US Army project, the US Marine Corps is reported to be showing considerable interest and is expected to join in the programme. Several foreign TOW users are also studying the new variant.

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JANE'S MISSILES AND ROCKETS - AUGUST 01, 2001

UK will participate in Common Missile programme

David C Isby

The UK Ministry of Defence has signed a statement of intent to participate in the US Common Missile programme, writes David C Isby. In the words of Lieutenant General Paul J Kern, Deputy Assistant Secretary of the US Army for Acquisition, Logistics, and Technology, "The US and UK have started down the path of establishing a co-operative programme on our next-generation tactical missile, the Common Missile. This programme has been structured using the lessons learned from past co-operative endeavours."

Currently BAE Systems, a Boeing-Northrop Grumman team, Lockheed Martin and Raytheon have been cleared as participants in the current project-definition and risk-reduction (PD&RR) phase, which will run until Fiscal Year 2004 (FY04), when the US Army will down-select two designs for engineering and manufacturing development (EMD). The winning design is expected to enter production around FY07 or FY08, with two contractors being certified to produce the missile in order to maintain competition.

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Increased UK interest is linked to the goal of deploying Future Rapid Effects Systems light armoured vehicles some time after 2007. These will require an improved anti-tank guided missile such as the Common Missile to provide long-range firepower. The Common Missile is intended to replace both air- and surface-launched Hellfire and TOW anti-tank missiles. It will have fire-and-forget guidance with multi-mode adverse weather-capable sensors. Range will be 50-100% greater than that of current Hellfire missiles.

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JANE'S MISSILES AND ROCKETS - AUGUST 01, 2001

BRIEFS - More TOW warheads ordered

Aerojet has received a US$5.9 million contract from Raytheon to produce 2,251 additional warhead sections for the Tube-Launched, Optically Tracked, Wire-Guided (TOW) 2A missile. Aerojet is nearing delivery of the last of 1,113 TOW 2A warhead sections ordered by Raytheon in January 2000.

Aerojet builds the missile's main and precursor charges and assembles them into warhead sections at its Socorro, New Mexico, facility. In the past decade, it has delivered more than 16,000 TOW 2A and 41,000 TOW 2B warhead sections.

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

BRIEFS - Popeye support for Australia

PGSUS Limited Liability, Orlando, Florida, is being awarded a US$5.91 million contract modification to provide for five common munitions and reprogramming equipment, one flight termination system, 100 test set, missile test set and pod test set spares, one ground support hardware, missile mission planning system, one captive air test missile, two flash memory decoding capability, four telemetry monitor stations, aircraft integration engineering support, contractor logistics support, missile acceptance support, telemetry trays and live launch support. This contract is in support of foreign military sales to Australia, and is due to be completed in December 2004.

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AIR-TO-SURFACE

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

EDO to develop weapon carriage system for SDB

EDO Corporation has been awarded a contract by Lockheed Martin to develop a weapon carriage system for the Component Advance Development phase of the Small Diameter Bomb (SDB) project. It will be capable of carrying and safely ejecting multiple weapons at up to, and including, supersonic speeds and from various aircraft platforms.

EDO's Marine and Aircraft Systems division in Amityville, New York, will design and develop the mechanical subsystem, while EDO M Tech, Huntingdon Valley, Pennsylvania, will provide the electronics. The contract will run for approximately two years. "Weapons carriage and release systems for the next generation of small smart bombs establishes a new area for expansion," says James M Smith, president and chief executive officer of EDO. He sees the SDB contract as an example of how the company is securing its future through, what he terms, "the focused application of its internal research and development funding".

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AIR-TO-SURFACE

Date Posted: May 21, 2002

JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

USAF tests Mk 82 JDAM

The US Air Force (USAF) has successfully flight-tested the Boeing Mk 82 500 lb Joint Direct Attack Munition (JDAM) at Eglin Air Force Base (AFB), Florida. The weapon was released from an F-16, which was flying at 20,000ft (6,000m) and 10km from the aim point. The JDAM flew its planned flight path, and made a direct hit on the target.

The USAF awarded US$45 million to Boeing in September 2000 for engineering, manufacturing and development (EMD) of the 500 lb version of JDAM. The flight-test programme began in December 2000 with captive-carry flights and fit checks from a number of different aircraft. Controlled (guided) launches and separation flight tests have been conducted at Eglin AFB since the beginning of 2002. Separation flights began in April 2002 at Patuxent River, Maryland, from a US Navy F/A- 18C/D Hornet.

"The EMD flight-test programme is being conducted on the F-16 with follow-on integration on the US Air Force's B-2 and the US Navy's F/A-18 aircraft," says Kim Michel, Boeing JDAM programme manager. "This smaller version of JDAM improves mission capability by allowing more JDAMs to be loaded on an aircraft, and reduces

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damage around the intended target due to the smaller warhead."

David Martin, Boeing Mk 82 JDAM programme manager says, "The Mk 82 JDAM EMD programme is very healthy; exceeding requirements, on schedule and within cost".

Originally designed for 2,000 lb (Mk 84 and BLU-109) warheads, JDAM kits have also been developed for 1,000 lb (Mk 83 and BLU-110) warheads. All JDAM kit variants use the same mission computer, navigation unit and GPS receiver.

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

LOCAAS flight tests will end with a live-fire trial

David C Isby

A series of flight tests of the Lockheed Martin LOCAAS (low-cost autonomous attack system), due to be completed over the next 18 months, will end with an integrated live-fire test, writes David C Isby.

In the first test, successfully carried out at Eglin Air Force Base, Florida, on 4 February (see JMR, April 2002, p11), the LOCAAS flew a pre-programmed flight test, including steep banks. The flight tests will increase in complexity, with the last of the series being a full autonomous combat profile, with an active seeker and warhead that will be used for a live-fire target attack.

While the LOCAAS' LADAR guidance has been successfully tested since 2000, it will have to be integrated with automatic target recognition (ATR) algorithms and fuzing for the LOCAAS warhead - which can defeat soft targets with a blast-fragmentation effect, and hard targets with an explosively-formed penetrator. Successful demonstration of these capabilities during the live-fire test is considered a significant developmental

milestone towards the long-term goal of obtaining an autonomous stand-off weapons capability.

The US Air Force (USAF) continues to support LOCAAS, which was close to cancellation in the mid-1990s, but was funded as an advanced technology demonstration (ATD) in 1998-2001. However, the limited resources for miniature munitions are being prioritised towards the Small Diameter Bomb (SDB) programme. This is seen as a higher priority because it can be ready earlier, and because its technology is seen as less likely than LOCAAS to encounter developmental problems. The SDB is also identified as a weapon for the Lockheed Martin F-22, which remains the USAF's top near-term procurement priority. Current programme goals are for the LOCAAS to be operational by 2010, and have a unit cost of US$33,000 in production quantities.

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Date Posted: May 21, 2002

JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

MBDA would build JDAM in the UK

Doug Richardson

MBDA plans to establish its own Joint Direct Attack Munition (JDAM) production line in the UK if the Mk 82 (500 lb) version of the weapon is selected to meet the UK Precision Guided Bomb (PGB) requirement, writes Doug Richardson. Lostock, Lancashire, is being considered as a location for the facility, which would deliver weapons to meet the UK requirement, as well as delivering to some export customers.

Since the Royal Air Force (RAF) first showed interest around 1994 in procuring a day/night all-weather weapon, six teams have expressed interest in meeting the requirement - Elbit, Frazer Nash, MBDA, Northrop Grumman, Raytheon and SAGEM. MBDA, Raytheon and SAGEM are the three companies now under consideration to supply the PGB.

Down-selection to two contractors was due to take place on 17 May, with the results being publicly announced on 20 May. Selection of the winner is expected at the end of 2002, leading to contract award by the end

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of 2003. The chosen weapon is expected to enter service in mid-2003.

The PGB is expected to serve on the Tornado GR.4, Harrier GR.9, Eurofighter, Jaguar and Joint Combat Aircraft (JCA). Tornado and Harrier will be the first platforms equipped, although Harrier will need to be fitted with a MIL-STD 1760 databus, an upgrade currently anticipated in 2005 or 2006.

The development and initial production contract for PGB will be awarded to the weapon supplier. Separate integration contracts will be placed with the aircraft manufacturers, who will act as subcontractors to the weapon manufacturer.

MBDA has teamed with Boeing and INSYS (formerly Hunting Engineering) to offer the Mk 82 version of JDAM. More than 30,000 1,000 lb and 2,000 lb JDAMs are already under contract for the US forces and export users. Around half of this total have already been delivered, and more than 12,000 have been used in Afghanistan. As the US Department of Defense places more emphasis on precision-guided weapons, larger buys are being contemplated, with total US procurement of up to 236,000 being considered. Unit cost of a JDAM kit is around US$22,000, a figure that excludes the bomb and fuze with which the kit will eventually be mated.

Unlike the 1,000 lb and 2,000 lb variant, the Mk 82 variant does not require the addition of body strakes to the sides of the bomb. Instead it has two small nose-mounted surfaces. The absence of body strakes allows weapons to be packed more tightly into an internal weapons bay. The B-2 Spirit will be able to carry a total of 80 mounted on four Smart Bomb Rack Assemblies (SBRAs). Each SBRA holds 20 Mk 82s, and each of the aircraft's weapons bays can accommodate two SBRAs.

As with all versions of JDAM, only three of the four tail fins move - a cost-saving measure. The JDAM guidance system integrates horizontal and vertical guidance into a single optimal control law, allowing

the user to programme each round with an individual impact point, impact velocity, elevation and azimuth of final approach. If the demands of the mission exceed the weapon's full ability, the guidance system will gracefully degrade the preset impact velocity, then elevation and azimuth.

Around 500 JDAM development rounds have been dropped during trials, the latest 40 weapons being fitted with 12-channel GPS. The circular error probable (CEP) was 4.9m, but the 12-channel version has demonstrated 3m, a figure which is already being improved. The UK had originally considered a 1,000 lb PGB, but these demonstrated accuracy levels persuaded planners that a 500 lb weapon would have the required lethal effects.

The UK requirement specifies that accuracy must remain high, even if GPS is not available. The US services had asked for an inertial navigation system-only CEP of 30m, but in practice the weapon has demonstrated 6.8m.

The US version of the Mk 82 JDAM kit is due to enter service in 2003 (see 'USAF tests Mk 82 JDAM' on p8 of this issue). While this configuration already meets the UK requirement, the version being proposed by MBDA would have minor hardware changes in the GPS area, and in guidance software.

The PGB would consist of a Mk 82 bomb procured from an existing production line - and fitted with a nosecone or nose-mounted proximity sensor as required - nose strakes and the tail kit. A 1760 connector would be located at the top front of the tail kit, and an FZU pocket would be incorporated in the side of the Mk 82 should this be required.

The PGB is intended to have a 20-year storage life without maintenance. When taken from storage for use, the weapon will undergo a test routine, and the test set will update the JDAM software if the version already in the weapon is not the latest standard. The process of testing and software updating will take around 10 minutes.

The Thomson-Thorn Missile Electronics (TME) electronic Multifunction Bomb Fuze

(MFBF) currently used by the RAF entered service in 1989 as the No 960 fuze, and is now near the end of its life, says MBDA. The PGB needs a modern adaptable bomb fuze, and the choice has been left to the individual bidders (see 'PGB teams choose TME's hard target fuze' on p6 of this issue).

The UK currently plans to order around 3,000 PGBs, but is looking to place possible follow-on orders. It has yet to decide whether weapons should be procured as all-up rounds of bombs or as bombs plus add-on kits.

With stocks of existing free-falling bombs dwindling, further orders for these are not expected. The UK services are unlikely to buy any unguided Mk 82 bombs, or other members of the US 'Mk' series, so will switch to becoming an 'all-PGM' force with the arrival of the PGB and the gradual retirement of the older unguided bombs.

US production of the Mk 82 JDAM will run around three years ahead of the schedule planned by the UK, so British procurement could be speeded up should this become necessary due to operational demands. UK aircraft could use the UK Mk 82 JDAM (the unguided Mk 82 is already cleared for use on Tornado GR.4), and so could be equipped with the US version if a PGM was to be required ahead of the planned schedule, or in the event of in-theatre shortages during combat operations.

The UK would have an indigenous capability to upgrade the Mk 82 JDAM, says MBDA. The UK invitation to tender (ITT) specified eight to 10 areas of future growth capability, including alternative warheads, and the addition of seekers or subsystems for BDI.

By around 2006, the US Navy's US$120 million Precision JDAM programme is expected to give the F/A-18 the ability to use JDAM against time-critical targets, based on target data obtained from the aircraft's forward-looking infrared (FLIR) system.

An add-on wing kit has been tested during seven releases of JDAM and SSB (Small Smart Bomb) from F-16s. The extended

range gives an expanded delivery footprint, allowing more targets to be attacked from a single release point, but does degrade JDAM's ability to attack the target from chosen elevation and azimuth angles. A winged JDAM fitted with improved guidance could address the lower range of the UK's SPEAR requirement, studies of which are now being funded.

Mk 82 JDAM rounds under the wing of a USMC AV-8B. (Source: US DoD)

Like the US version, the JDAM variant being proposed to the UK MoD does not have body-mounted strakes. (Source: MBDA)

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

Oman orders JDAM and Paveway II

David C Isby

Oman is expected to become the second export customer for the Boeing JDAM (Joint Direct Attack Munition) GPS/INS (inertial navigation system) guided bomb kit, writes David C Isby. These would be used to arm 12 Lockheed Martin F-16s, whose sale was covered by a package announced in October 2001. This deal included 50 AIM-120 Advanced Medium-Range Air-to-Air Missiles and 10 training missiles, 100 AIM-9M Sidewinders and 10 training missiles, 80 AGM-65D/G Maverick air-to-surface missiles and 10 training missiles, and 20 AGM-84D Harpoon anti-ship missiles.

A follow-on sale, announced in Washington on 10 April, will include the 50 JDAMS, 100 Raytheon GBU-12 Paveway II series laser guided bombs (LGBs) and 50 Textron Systems CBU-97 cluster bomb units including Sensor Fused Weapon (SFW) terminally-guided submunitions. In addition, Oman is requesting 500 unguided 500 lb and 1,000 lb bombs and 20mm cannon ammunition. The total munition package cost is US$42 million.

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The US Congress is considered unlikely to block the sale, which reflects the close co-operation offered by Oman in recent military operations against Afghanistan. The potential for further military action against Iraq is likely to make the relationship even more important in the future, especially if Omani bases have to substitute for those in Saudi Arabia.

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

PGB teams choose TME's hard target fuze

Thales Missile Electronics (TME) has revealed all three contractors competing for the contract to supply the Precision Guided Bomb (PGB) to the UK Ministry of Defence have selected the company's Multi-Event Hard Target Fuze (MEHTF). The MEHTF solution proposed by TME and Alliant Techsystems (ATK) is derived from advanced fuzing work being undertaken by both companies in support of joint UK/US government research programmes.

The origins of MEHTF can be traced back to the early 1990s when the UK company conducted research into the use of accelerometers in bomb fuzes. ATK and TME formed a team to bid for and win a US Advanced Concept Technical Demonstrator (ACTD) programme being competed by the US Air Force Research Laboratories (AFRL) at Eglin Air Force Base (AFB), Florida. ATK is the prime contractor and TME the subcontractor on a programme that is now in its fourth successful year, during which the fuzes have undergone a significant amount of impact and flight trials.

The UK MoD established a similar technology demonstrator programme to

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MEHTF called PSFT (Penetrator Smart Fuze Technology), with TME as prime contractor and ATK as subcontractor.

TME is also teamed with ATK for the Hard Target Smart Fuze (HTSF) programme being run by the US Air Force Precision Strike System Program Office at Eglin AFB. It is also a member of Team BROACH in a programme to supply multiwarhead systems for the Anglo-French Storm Shadow/ SCALP EG programme, and for the US Joint Stand-Off Weapon (JSOW) AGM-154C unitary variant.

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

USAF demonstrates multitarget strikes from single-pass attacks

On 2 May, a US Air Force (USAF) B-1B Lancer crew successfully targeted three different weapon types against three separate targets in a single, 20-second bombing run at Edwards Air Force Base (AFB), California. Part of a computer-upgrade test programme, the Global Power Bomber Combined Test Force (CTF) crew released one Mk 84 2,000 lb bomb, three Mk 82 500 lb bombs and four CBU-89 1,000 lb cluster munitions. They struck targets about 3,000m apart.

This is the first time that an aircraft's on-board weapon system used multiple weapon types against multiple, separated targets, automatically releasing munitions at the proper time and position in a single bomb run, said Lieutenant Colonel Arnie Bunch, Global Power Bomber CTF director: "This release accomplished what would typically require three aircraft passes or co-ordinated strike of three aircraft. Using this new capability, the Air Force will be able to dramatically decrease the number of assets put in harm's way during future aircraft

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attacks."

This first trial used unguided 'iron' bombs, but cleared the way for further trials using both precision and unguided weapons in a single run. In 2003, testing will begin to integrate the Joint Standoff Weapon (JSOW) and Joint Air-to-Surface Standoff Missile (JASSM). Modified to the Block E standard, each B-1B will be able to carry four JSOWs in each weapons bay giving a total of 12 per bomber, or eight JASSM in each weapons bay giving a total of 24 per bomber.

In a trial conducted three days earlier, over the US Navy's China Lake test range near Edwards AFB, a two-seat F-15 flown by test pilot Lt Col Troy Fontaine and weapons system officer Major Kevin Steffenson released five Mk 84 2,000 lb Joint Direct Attack Munitions (JDAMs) against five separate, preplanned targets. The exercise was successful, with each GPS-guided weapon attacking its individual target, whose co-ordinates had been programmed into the bomb prior to launch.

Five Mk 84 JDAMs begin their independent flights to attack five separate targets on the ground. (Source: USAF)

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

Small Diameter Bomb becomes a USAF 'Pathfinder programme'

David C Isby

The US Air Force (USAF) has chosen its Small Diameter Bomb (SDB) GPS/INS (inertial navigation system)-guided 250 lb bomb as one of 10 high-priority 'Pathfinder programmes', which will use incremental 'spiral development' approaches to avoid cost and schedule problems, writes David C Isby. The Pathfinder programme designation gives the programme manager flexibility in achieving the required results.

Pathfinder programmes will be co-ordinated through the newly organised Acquisition Center of Excellence (ACE). Individual programmes are likely to be re-organised into two to three year 'spirals' each producing an additional capability. It has also been suggested that developmental and operational testing many be carried out concurrently rather than sequentially.

The USAF is keeping the competition between Boeing and Lockheed Martin for a final SDB design on schedule for a

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September 2003 decision. Development contracts were awarded in the last quarter of Fiscal Year 2001 (FY01), brought forward from FY02. Once a winner is selected, a two-year development programme will begin.

The first SDBs (capable of attacking non-moving targets) are due to become operational in FY05 rather than FY06, as had been previously planned. The 'spiral development' process will be expected to deliver an upgraded version of the SDB in FY10, a weapon which will be effective against mobile targets. The USAF had considered trying to accelerate the programme by awarding the development contract to a joint team of the two competitors, but this approach was not adopted.

One of the basic requirements of the SDB is that it can be dropped from the F-22's internal weapons bay while the aircraft is supercruising at a speed of Mach 1.7. The weapon is also being designed to be suitable for use by unmanned aerial vehicles. Current planning is for a total initial procurement of about 25,000 SDBs, divided equally between non-moving and moving target capable versions.

Combat lessons from Afghanistan have increased US Navy interest in the SDB. Senior naval aviators have reported that greater tactical flexibility would have been possible had the service been equipped with more guided weapons light enough to be carried back aboard a carrier if unexpended.

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JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

USAF will develop extended-range WCMD

David C Isby

The US Air Force (USAF) Air Armament Center at Eglin Air Force Base, Florida, is to develop an extended-range version of the Lockheed Martin Wind Corrected Munitions Dispenser (WCMD) inertial-navigation guidance kit for submunitions dispensers, writes David C Isby. The WCMD-ER (extended-range) programme will integrate the basic WCMD with the improved guidance (with anti-jam GPS capabilities) and extendable wings that have been developed for the Boeing JDAM-ER (joint direct attack munition - extended-range). Like the standard WCMD, WCMD-ER will be able to be used with a wide range of current US submunitions dispensers.

WCMD-ER would supplant the Raytheon AGM-154B JSOW-B (joint standoff weapon) in providing a standoff submunitions delivery capability for the USAF. All current USAF JSOW procurement has been of the JSOW-A model (which carries the BLU-97 combined effects bomblet), but current thinking is that the USAF would terminate its planned

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3,114-unit JSOW-B procurement and use the funding for WCMD-ER.

However, the US Navy (USN), concerned that this would make their planned 1,200-unit JSOW-B buy unaffordable, may ask the Department of Defense or the Joint Chiefs of Staff Joint Requirements Oversight Council (JROC) to continue the USAF JSOW-B programme. These groups would have to approve the USAF proposal to drop its planned purchase of the B variant, which carries a payload of six BLU-108/B dispensers, each with four terminally guided Skeet anti-armour warheads. Unlike the USN, the USAF has not used the JSOW in combat, and is concerned about structural and guidance fixes that the weapon has required during the past year.

WCMD-ER would have a range of up to 65km depending on release altitude, a level of standoff capability, which would allow it to be used as a low-cost follow-on to the JDAM-ER. Because of the WCMD's different aerodynamics and weight compared to the JDAM, it will require additional testing.

The development of the WCMD-ER had been identified as a US$16.2 million unfunded requirement by the USAF. The House Armed Services Committee provided this funding in its version of the Fiscal Year 2003 authorisation bill.

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JANE'S MISSILES AND ROCKETS - MAY 01, 2002

Extra funding may not tackle US PGM shortage

David C Isby

Even with the supplemental appropriations intended to pay for the munitions expended in recent military operation against terrorist forces in Afghanistan, the US services still are facing a potential shortage of some munitions and missiles, writes *David C Isby*. Admiral Dennis Blair, commander-in-chief of US Pacific Command (CINCPAC), testified in Congress in March that "Operation 'Enduring Freedom' has significantly reduced the already limited worldwide stocks of precision munitions across all services".

(The accuracy of Adm Blair's statement was subsequently questioned by US Defense Secretary Donald H Rumsfeld, who told reporters that the admiral may not have known all the facts about the total stocks. "The level of munitions is not everybody in the world's business, to be perfectly honest, and he should have known better. But he may have been talking about what he did know about in a narrower area, but not a worldwide area.")

The US$9.4 billion Defense Emergency Response Fund (DERF) was set up last year and has already been used to fund many munition procurements. However, the potential for future military operations, most notably against Iraq, has raised questions about the sufficiency of this funding.

The most significant increase in the Fiscal Year 2003 (FY03) budget request was in the US Air Force (USAF) procurement of the Boeing JDAM (joint direct attack munition) guided bomb kit. This increased to US$502 million to buy 22,700 JDAMs from US$461 million to buy 14,300 JDAMs the previous year.

Between October 2001 and February 2002, the USAF used about 4,600 JDAMs in action, while the US Navy (USN) used an unspecified smaller amount, probably 300 to 900. This represented a considerable percentage of the USN JDAM stockpile, and it is likely that Navy munitions requirements will emphasise JDAM re-supply.

The maximum production rate of the JDAM will be increased to about 3,000 a month from the current level of some 2,000 a month. As part of this capacity upgrade programme, prime contractor Boeing will provide resources to suppliers - most notably Honeywell, producer of the internal measurement unit (IMU) - that will allow them to keep up with such an increase.

As well as additional production, the JDAM is to be integrated with a number of extra platforms. It will be integrated with F-14Ds this year; it is already integrated with F-14Bs. Flight tests of the F-22 with the Mk 83 1,000 lb version of the JDAM will begin this year. Integration with the F-117 is currently in progress, although a capability was put in place as an emergency upgrade last year. Integration with the A-10 will be funded in the FY04 budget request that will be sent to Congress next February. According to press reports, an updated JDAM operational requirements document (ORD) also requires that it be compatible with a future unmanned combat air vehicle.

In addition to JDAMs, laser guided bomb (LGB) kits could also be in short supply in the immediate future. Operations in Afghanistan are reported to have consumed an average of 1,700 LGB kits a month.

- Pete Aldridge, US undersecretary of Defense for Acquisition, Technology and Logistics says the DoD is re-examining the increased production rates for JDAM and other guided-bomb kits to see if the revised production rate is sufficient to ensure the stockpile will be able to meet the demands of any future contingency that can be anticipated. Production is now running in multiple shifts, but is constrained by the fact that some components can only be produced at a certain rate. There are no plans to increase the number of facilities being used in the production programme, but the DoD plans to make the best use of the existing facilities.

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JANE'S MISSILES AND ROCKETS - MAY 01, 2002

JASSM-ER may become USAF's Extended Range Cruise Missile

David C Isby

The extended-range version of the Lockheed Martin Joint Air-to-Surface Standoff Missile (JASSM-ER) is emerging as the front-runner for the US Air Force's (USAF's) Extended Range Cruise Missile (ERCM) requirement, writes *David C Isby*. One of the advantages associated with the JASSM-ER design has been that it can be integrated with the B-1B bomber (see JMR, April 2002, p10).

The USAF is currently committed to procure at least 3,700 JASSMs, and it now appears likely that at least some of these will be JASSM-ER versions. Extending the missile's range from the 370km of the current design to about 1,100-1,300km in the JASSM-ER version involves increasing the on-board fuel by over 45kg and replacing the current Teledyne J402-100 turbojet engine with a higher-cost, but more fuel-efficient, turbofan.

Both Teledyne Technologies and Williams International have proposed turbofan engine designs. These will be evaluated by Lockheed Martin, and the engine for the

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JASSM-ER will be selected within the next year. The new engine and additional fuel are expected to increase the total weight of the missile by less than 5%, allowing the use of the airframe external mouldings of the baseline JASSM.

A formal decision on which design will be produced as the ERCM is unlikely to be announced before the Fiscal Year 2004 (FY04) budget request is announced in February 2003. Under current planning, that budget request will include funds for the first year JASSM full-rate production. The first lot of 76 low-rate initial production (LRIP) baseline JASSMs is now being produced.

In April, the US Navy (USN) announced it will buy 450 JASSMs from production lot 6 for delivery in FY08 as an initial order. The USN is starting work on the integration and testing of the JASSM with the Boeing F/A-18E/F, and plans to make the aircraft JASSM-capable by FY07.

Until now, the USAF had been reluctant to modify the basic JASSM design until Lockheed Martin had completed the initial production lot at a fixed price. However, the Air Force is now examining the feasibility of producing JASSM-ERs alongside basic JASSMs at Lockheed Martin's Alabama plant around FY04-07.

The JASSM-ER would have the benefit of being integrated with all combat aircraft able to use the baseline JASSM. The UK Royal Air Force is believed to be interested in examining a combination of JASSM-ER delivered from Joint Strike Fighters as potentially meeting its Future Offensive Air System requirement for a Tornado GR.4 replacement.

JASSM completed its initial phase of development testing with a successful direct hit on 4 April on a simulated bunker target at White Sands Missile range following a 324km flight, which included eight way points. The JASSM struck the target in a steep terminal dive to maximise penetration.

A new 10-shot series of live-fire tests will start in May. Independent operational testing and evaluation is scheduled to run through

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JANE'S MISSILES AND ROCKETS - MAY 01, 2002

US thermobaric bomb uses a single-stage explosive charge

US Department of Defense (DoD) officials have provided more details of the new BLU-118/B thermobaric bomb. Some US press reports have suggested the weapon, which was used for the first time on 5 March against Al-Qaeda fighters in a cave near Gardez in Afghanistan, is designed to detonate in two stages, so should be considered a weapon of mass destruction.

"As with all new weapon acquisitions and modifications, use of the BLU-118 was reviewed and found consistent with all international legal obligations of the United States, including the law of armed conflict," says Lieutenant Commander Donald Sewell of the office of the Secretary of Defense for public affairs.

An initial batch of 10 BLU-118/B weapons was produced under a crash 90-day development programme. These use the same penetrating warhead as the 2,000 lb BLU-109, but with a different chemical explosive filling.

"The blast pressure from a traditional bomb explosive material starts strong but dissipates rapidly, which can result in relatively limited base effects deep within tunnels," Lt Cdr

Sewell explains. "The blast pressure of a thermobaric weapon, which combines a smaller amount of traditional explosive material with fuel-enriched compounds (mostly aluminum), begins less strongly but builds within a confined space and extends over longer duration," he said. This increased blast pressure produces destructive effects over much greater distances within a tunnel or cave.

The design of the BLU-118 allows for greater internal blast effectiveness, says Lieutentant Colonel Thomas Ward, programme manager of the hard target defeat branch of the Defense Threat Reduction Agency. "This is done with a single-stage detonation, not in two stages as hypothesised by the [press] articles."

Many types of explosive fill try to balance the required amount of fuel and oxidizer within the charge, but "the general principle behind the new weapon is to carry a higher percentage of fuel, and attempt to use available oxygen from the target area to add to the reaction, resulting in a higher overpressure".

Other reported inaccuracies were caused, in part, by wrongly comparing the BLU-118 to a dissimilar Russian weapon, says Lt Col Ward. Russian weapons used during its occupation of Afghanistan and, more recently, in Chechnya are similar to a fuel-air explosive, relying on a mist of liquid explosives to provide a secondary detonation.

The US used the BLU-82 two-stage, fuel-air explosive weapon during the Vietnam War. During the first stage, the fuel was spread and combined with oxygen in the atmosphere. A second stage detonator then ignited the fuel-air mixture.

Unlike the BLU-82 or the Russian weapons, the BLU-118 uses a solid explosive that is detonated without previously having been dispersed and mixed with air, says the DoD, so is a single-stage weapon. The BLU-118 uses its fuel-rich composition to release energy over a longer period than traditional explosives, creating a longer-duration blast effect when detonated in a confined area.

An improved thermobaric bomb could be created by a Fiscal Year 2002 advanced concept technology demonstration (ACTD) announced in March. The thermobaric ACTD will look at optimising the bomb's chemical filling and developing the weapon's concept of operations.

Under another new ACTD, the DoD is continuing to develop an 'agent defeat' warhead designed to destroy chemical and biological agents in situ without causing their dispersal. "Bioagents are best attacked with heat, and we want to avoid over-pressure", explains Lieutenant Colonel John Wilcox, US Air Force, military assistant to Sue Payton, Deputy Undersecretary of Defense for Advanced Systems and Concepts. "We don't want to just blow up a bunker and let this [lethal agent] escape out into the atmosphere. So we try to do it with low over-pressure and a boutique of different types of chemical fills that will apply to that [specific] chemical or bioagent."

According to Payton's military deputy Captain Mike Knollmann, US Navy: "What we'd like to do in the agent-defeat warhead is try to develop an air-deliverable weapon that can host a variety of different kinds of kill mechanisms or neutralisation agents. And that would probably be developed in conjunction with NAVSEA [Naval Sea Systems Command] and Eglin [Air Force Base] Air Armament Control Center."

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JANE'S MISSILES AND ROCKETS - MAY 01, 2002

JDAM seen as a war-winner in Afghanistan

Major General Daniel P Leaf, director of operational requirements for air and space operations at the US Department of Defense credits the Boeing Joint Direct Attack Munition (JDAM) as having played a major role in the defeat of the Taliban and Al-Qaeda.

He recalls the scene of a string of GBU-31 (Mk 83) and -32 (Mk 84 or BLU-109/B) versions of JDAM impacting along an enemy trench line. "I would venture to say, at some point in the conflict the massed JDAM employment by the B-1s is when the Taliban and Al-Qaeda leadership thought to themselves 'we're not fighting the Soviet Union. This is a different, extraordinarily more capable enemy'. That's played a very big part in the rout of the Taliban and Al-Qaeda."

In Operation 'Enduring Freedom', the B-1B Lancer delivered nearly 40% of the ordnance, while flying only 5% of the strike sorties. It can carry up to 24 JDAMs.

Maj Gen Leaf says the B-1B proved itself in combat during Operation 'Allied Force' in Kosovo, but in Afghanistan it has

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demonstrated the value of massed precision attacks using JDAM. "If you offered the B-1 with JDAMs in direct support of ground forces as a solution 10 years ago, I would have laughed heartily because it's not what we envisioned. However, faced with a shift in paradigms and a shift in what we have to do, we adjusted and used the airplane in an extraordinarily flexible manner over Afghanistan. It's part of the intellectual shift that's occurring in the Air Force."

Turning an aircraft originally developed as a nuclear bomber into a delivery system for conventional weapons involved modifying it for missions and weapons that its designers had never considered. The US Air Force plans to arm the B-1B with the Lockheed Martin AGM-158 Joint Air-to-Surface Standoff Missile (JASSM). When the missile is deployed in about two years from now, each Lancer will be able carry 24, launching them from positions almost 310km away from the target.

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JANE'S MISSILES AND ROCKETS - MAY 01, 2002

JSOW-B tests will show design fixes

David C Isby

A flight-test programme due to begin later in 2002 is to validate design fixes made to allow integration of the Raytheon AGM-154 JSOW (joint standoff weapon) GPS/INS guided glide bomb with the Lockheed Martin F-16C/D Block 50, writes *David C Isby*. JSOW had encountered vibration problems when carried on the F-16 under-wing pylons (see JMR, August 2001, p14). Subsequently, the same problem was identified as affecting JSOWs carried by F/A-18s as well.

This problem did not affect the ability to use JSOWs operationally against targets in Afghanistan during Operation 'Enduring Freedom'. An undisclosed number of JSOWs - believed to be a handful - were used, all delivered by F/A-18s.

The upgrades will be implemented in all production JSOWs, starting with the third full-rate production lots, and will be retrofitted to existing weapons. It is not expected to produce a significant increase in unit cost.

The flight test programme will test a primary

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and a back-up upgrade design, which includes structural modifications to the JSOW control surfaces. The tests will be integrated with the operational test programme for the AGM-154B JSOW-B, which carries a payload of six Textron BLU-108 Sensor Fused Weapon (SFW) guided submunitions.

In addition to the under-wing carriage upgrade, a separate upgrade has been designed to address weapon release problems. This smaller upgrade is currently being retrofitted to the JSOW inventory and is already incorporated in production JSOWs.

All previous JSOW deliveries have been of the AGM-154A JSOW-A version, armed with 145 BLU-97 Combined Effects Munitions (CEM) unguided submunitions. Total JSOW deliveries to the US Navy are expected to eventually total 8,800 JSOW-As and 1,200 JSOW-Bs, with the US Air Force taking 3,000 JSOW-As and 23,114 JSOW-Bs.

Development of the AGM-154C JSOW-C hard and deeply-buried target defeat version is continuing. Following successful ground tests of BAE Systems' BROACH warhead in Wales in February, ground testing will shift to NAS China Lake later this year, culminating in a series of three sled tests there.

Operational testing will take place next year. If successful, low-rate initial production for the JSOW-C will start in December 2002, with an order for 75 to be delivered within 27 months. The Navy is planning to procure 3,000 JSOW-Cs while the Air Force has not so far planned to procure any, relying instead on laser-guided bombs delivered from B-2s, F-117s and F-15Es for this mission.

l Canada is reported likely to become the first export customer for JSOW. It is already in the process of upgrading its operational CF-18 fighters, which will allow them to use GPS/INS guided weapons (like JSOW) that use the MIL-STD-1760 interface. The JSOW version Canada would procure has not been

announced.

Australia is also considering JSOW procurement. Previously, a powered version of the weapon had been proposed to meet Australian requirements for a standoff missile. Other potential customers are reported to include several NATO countries.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

USAF looks at new missiles for Predator

David C Isby

Following the success of armed versions of the General Atomics RQ-1A Predator unmanned air vehicles (UAV) in Afghanistan, the US Air Force (USAF) is looking at improved armament options that will increase Predator's combat capability, writes *David C Isby*.

During combat operations in Afghanistan, Predator carried Lockheed Martin AGM-114 Hellfire anti-tank guided missiles, but armament options now being studied include the Lockheed Martin LOCAAS (low-cost autonomous attack system) for use against ground targets, and modified Raytheon Stinger missiles for air-to-air use.

The use of the LOCAAS would remove the need to laser designate targets, a technique necessary with Hellfire. It would also give the UAV additional standoff capability - the Hellfire has a maximum ceiling around 10,000ft (3,000m).

Lockheed Martin believes that the turbojet-powered Predator-B version could carry up to 10 LOCAAS at altitudes of up to 50,000ft. To demonstrate this capability, the

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company has requested US$11 million from the USAF for an advanced concept technology integration effort to integrate the LOCAAS on the Predator-B by Fiscal Year 2004.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

USAF delays ERCM programme

David C Isby

The US Air Force (USAF) has decided to delay its programme to develop and procure several hundred stealthy extended-range cruise missiles (ERCMs), writes *David C Isby*. No research and development funding for the programme was included in the Fiscal Year 2003 (FY03) budget request, and the USAF has re-programmed US$83 million in previous-year funds appropriated for the programme to "higher priorities".

ERCM was conceived as a result of the extensive use of B-52s as a standoff missile platform against Iraq and Yugoslavia in 1998-99, operations which reduced the stockpile of Boeing AGM-86C conventional air-launched cruise missiles (CALCMs) to under 100. In practice, the status of the ERCM programme has varied between high priority and a candidate for cancellation.

Proposals to meet the ERCM requirement included extended-range versions of the Boeing AGM-86C CALCM, the Raytheon AGM-129 advanced cruise missile (ACM), a turbofan-powered version of the AGM-158 Lockheed Martin joint air-surface standoff missile (JASSM) and an unspecified 'black'

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weapon developed through a classified programme. According to reports, the competition has been narrowed to new production CALCMs and the JASSM-ER.

At first, the extended-range CALCM was thought to be the most likely candidate, a follow-on to the expanded conversion project now in progress at Boeing St Charles, Missouri, facility to convert surplus nuclear-armed ALCMs to the conventional role. However, adoption of the CALCM concept would have limited the ERCM to use on the B-52H.

The JASSM programme has progressed, overcoming earlier research and development problems, and this missile has now entered low-rate initial production (LRIP). An ERCM based on the JASSM would have the advantage of economies of scale in production and could potentially be carried by a broad range of platforms, including the Lockheed Martin F-35 Joint Strike Fighter (JSF).

A JASSM-ER could also be exported. In the UK, the Royal Air Force is reported to be looking at a JSF/JASSM-ER combination among the options for its FOAS (future offensive air system) Tornado GR.4 replacement.

Currently, the US Air Staff is studying ERCM options. This could lead to a programme start in the next budget request. One of the issues being studied is whether the recent Nuclear Posture Review makes further nuclear-armed ALCMs and AGMs available for conversion.

Another launch platform that has been associated with these proposed cruise missiles is the B-1B. The extended-range version of the JASSM, that was originally proposed as an ERCM in 1998-99, has been proposed as a potential weapons option for upgraded B-1Bs because the current policy is to make the B-1B force a purely conventional one for arms control purposes. The other proposed ERCMs are externally similar to nuclear-capable cruise missiles, so the use of JASSM and an ERCM would remove a potential arms-control verification

issue.

JASSM-ER would be relatively easy to integrate with the B-1B. Upgraded bombers have already received MIL-STD-1760 umbilicals in the weapons bay, and appropriate upgrades to the bombing and navigation systems. The JASSM-ER would retain the same external dimensions as the baseline missile, reports have suggested, a feature that would help integration with the B-1B internal weapons bays.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

Dual launch ends JSOW integration tests on B-52

Raytheon's AGM-158A Joint Standoff Weapon (JSOW) has successfully completed aircraft integration tests with the US Air Force's B-52 Stratofortress bomber. During a trial conducted over the Naval Air Systems Command western test range complex, two JSOWs were successfully launched from a B-52. Both weapons safely separated from the aircraft, navigated approximately 50km to the target area, and dispensed live BLU-97 Combined Effect Munitions (CEM) near-simultaneously over their respective target areas.

"This dual free-flight test demonstrated the multiple launch capability of JSOW weapons from the B-52 platform, and safe separation from the aircraft," says Jon Jones, vice president of strike product line, at Raytheon Missile Systems. "The test successfully utilised the Air Force mission support system (AFMSS), which included a JSOW mission planning component developed by Raytheon."

The AGM-154A and AGM-154B (which carries BLU-108 Sensor Fused Weapon submunitions) have completed engineering

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and manufacturing development (EMD) and are in production. The AGM-154C, which carries a unitary warhead, is currently in EMD.

JSOW is presently flying on the F/A-18, F-16 and B-2, and is being integrated onto the B-1B and the F-15E. More than 100 rounds have been used in combat since 1999.

"This is a significant milestone leading to the JSOW-A variant initial operating capability for the B-52," said Col Kenneth Merchant, programme director for Area Attack Systems Program Office, at Eglin Air Force Base, Florida. "The full-rate production weapons used in this test are identical to the ones that will be used on both Air Force and Navy aircraft."

In a ground trial conducted at the QinetiQ run test range at Pendine in Wales, an AGM-154C JSOW fitted with a UK-developed BROACH (Bomb Royal Ordnance Augmented Charge) penetration warhead successfully completed a dynamic sled test, completely perforating a steel-reinforced concrete target.

Developed by BAE Systems RO Defence, BROACH is a multistage warhead consisting of a penetrating shaped charge mounted in front of a conventional follow-through bomb. The warhead used in the test included an augmenting charge and an inert follow-through bomb integrated with a JSOW airframe. The test simulated the speed at which a tactical weapon would impact a target.

"The success of this test indicates that the BROACH warhead can achieve the required performance on the JSOW-C weapon," said the US Navy (USN) programme manager. The USN will conduct independent dynamic sled testing of the BROACH system later this year.

Operational testing of JSOW-C rounds fitted with BROACH warheads is expected to take place against hardened targets in early- to mid-2003. JSOW-C has already completed two successful free-flight tests, demonstrating the weapon's autonomous

targeting acquisition and terminal homing ability, but these rounds did not carry a warhead.

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BRIEFS - Proximity fuzes ordered

Alliant Precision Fuze is to supply 72,000 nose-mounted radio frequency proximity sensors for use on M-117 and Mk80 series general-purpose bombs and the Joint Direct Attack Munitions (JDAM). These are due to be delivered by February 2003, and are funded by a US$7.33 million contract from the Air Armament Center, Eglin Air Force Base, Florida.

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JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

BRIEFS - Export orders for Maverick

Raytheon Systems is being awarded a US$34.26 million contract to provide 206 AGM-65G Maverick missiles, 31 TGM-65G Maverick missiles and six TGM-65D Maverick missiles. These are required to support foreign military sales to South Korea, Spain and United Arab Emirates. The missiles are due to be completed by November 2003.

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

Unitary-warhead JSOW makes second flight

The US Navy (USN) and Raytheon Company have successfully completed the second free-flight demonstration of the AGM-154C unitary-warhead version of the Joint Standoff Weapon (JSOW). Conducted at the Naval Air Systems Command western test range, the flight tested the waypoint navigation and autonomous target-acquisition (ATA) capability of the AGM-154C.

After release from an F/A-18 flying at 29,000ft at a speed of Mach 0.9, the missile navigated autonomously through several enroute waypoints, and began searching for the target approximately 50km from the launch point. The mission had been intended to demonstrate the ATA capability of the Raytheon-developed uncooled, long-wave infrared seeker against a dual height, multiple-level target, and target acquisition and subsequent impact were completed as predicted.

The AGM-154C is intended to provide the USN with a launch-and-leave standoff weapon able to strike targets with high accuracy. It is the first US weapon to

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incorporate the UK-developed BROACH penetration multiple warhead, and tests using rounds fitted with this payload will be conducted later in 2002.

The AGM-154A is in production and delivers the BLU-97 Combined Effects Bomblets for area targets. It has been used successfully in Iraq and Kosovo. The AGM-145B variant carries the BLU-108 Sensor Fused Weapon anti-armour bomblets, and is in low-rate production.

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

UAV targets laser-guided bomb attacks in Extendor trials

The UK Ministry of Defence's (MoD's) Extendor operational concept demonstrator programme has used data from a General Atomics Predator unmanned air vehicle (UAV) to provide target information to Royal Air Force Jaguar strike aircraft, which were able to use this data to deliver laser-guided bombs. The tests, organised by QinetiQ, ended the Extendor Phase 2 trials.

Part of an MoD applied research programme, Extendor envisages using UAVs as communications relay platforms for tactical aircraft and military units, allowing them to share data while engaged in an air campaign. The aim of the programme is to reduce sensor-to-shooter times dramatically, allowing mobile targets to be attacked more effectively.

As in the earlier Phase 1, the trial was conducted in conjunction with the US Air Force's UAV Battlelab. It used a Predator UAV equipped as a communications relay fitted with two UHF radios, an Improved

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Data Modem and payload-control processor. The UAV was flown at altitudes of up to 21,000ft over China Lake Naval Air Warfare Center, California, and was controlled via a satellite link by the General Atomics test facility at El Mirage.

During the exercise, the UAV payload passed target information in a TACFIRE (Standard Army Tactical Fire) digital message format, from a forward air controller (FAC) via the UAV into the cockpit of two RAF Jaguars. These aircraft were holding at low level and out of direct line-of-sight with the FAC.

The Jaguars and ground control kept track of each other via the newly implemented station reporting messages, which used the AFAPD (Air Force Application Program Development) protocol to give interoperability with the UK Apache.

Other functionality tested included network management of the communications traffic via the UAV's on-board processor. By remote selection of the pre-scripted forwarding rules, the incoming message was automatically re-routed to the specified strike assets.

Upon pilot acceptance of the tasking message, the target information was digitally transferred into the navigation/attack system of the Jaguar, presenting a target diamond on the aircraft's head-up display (HUD). The pilot manoeuvred the aircraft to the target, visually confirmed the accuracy of the HUD target marker against the ground target and released either a practice bomb or a Paveway II laser guided bomb. This was repeated a number of times against various targets.

Target laser designation was provided by a US Cobra AH-1W attack helicopter. The attacks were imaged by the Predator's Skyball sensor system, which supplied live video images of weapon impact and target damage via satellite datalink.

During the exercise, Predator-derived target imagery was transmitted into the cockpit of an F-16 in near-real-time via TacSat radios. Ground-controlled capture, review and

transmission of Predator target video as still images directly from the UAV into the cockpit of an F-14 Tomcat was also demonstrated.

The final Extendor trial is set for autumn 2002. This will take place in the UK, with the communications relay payload being flown to show interoperability between UK assets.

The experimental payload carried by the UAV consisted of UHF radios, a data modem and a payload-control processor (Source: QinetiQ)

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

JDAM production rate could be speeded

David C Isby

The US Department of Defense is considering increasing the production rate of the Boeing JDAM (Joint Direct Attack Munition) GPS/INS guided bomb kit to replenish stocks expended in Afghanistan and to build up for further operations, writes *David C Isby*.

Before recent combat operations, the target rate for JDAM production was to be about 1,000 per month, and this was to be achieved by February 2003. However, under recent contracts, this rate will be achieved sooner. A US$480 million contract for 11,333 JDAMs was awarded to Boeing on 27 December 2001. Deliveries will be completed by 1 October 2002.

The currently planned JDAM production capability is 2,000 per month. There are proposals to increase that figure, but this capability would require additional investment in capital equipment. The key bottleneck in any speed-up plan is in the ability of component suppliers to support an increased production rate.

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

AARGM makes a second guided flight

David C Isby

The US Navy (USN) has successfully completed the second guided flight test (and fourth launch) of its Science and Applied technology (SAT) AARGM (Advanced Anti Radiation Guided Missile) at China Lake, California, writes *David C Isby*. The missile was successfully guided to a simulated warhead kill of an air-defence radar target, using its passive radar-homing seeker to acquire the target and its active millimeter wave radar for final homing.

The test is reported to have shown an accuracy higher than that expected from a standard Raytheon AGM-88 HARM (Highspeed Anti Radiation Missile), and demonstrated the capability of destroying radars that use emission-control tactics. AARGM uses a multimode active-passive seeker as well as GPS/INS guidance.

The USN did not request any AARGM funding in the Fiscal Year 2002 (FY02) budget request but the US Congress added US$10 million to continue the risk reduction and producibility (formerly research and development) stage of the programme.

Congress has been a strong supporter of AARGM, a programme that was congressionally mandated, starting in FY93, as a reflection of Congress' concerns that US anti-radiation missiles lacked effectiveness against threat radars which used minimal-radiation tactics. In previous years, Congress has increased the funding for AARGM and the related QuickBolt programme from US$10 to US$25 million in FY00 and from US$12 to 27 million in FY01.

The FY03 budget request will be critical for AARGM. It will take an estimated US$300 million to bring the programme through system development and demonstration (formerly engineering and manufacturing development) and bring it to the stage where it would be ready for low-rate initial production. Current planning is that a 1,800-unit production run of AARGM will not cost more than a similar batch of HARM.

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

30,000 lb 'Big BLU' proposed for deep-buried targets

David C Isby

A 30,000 lb guided hard and deeply buried target defeat (HDBTD) bomb, designated 'Big BLU', has been proposed by an industry team of Boeing, Northrop Grumman and National Forge to meet urgent US Department of Defense requirements, writes *David C Isby*. The proposed weapon, which if built would be the largest-ever conventional bomb to enter production, is a response to the problems encountered in Afghanistan of defeating terrorist targets in deep caves.

The weapon would use a modified version of the GPS/INS guidance from the Boeing JDAM plus an unspecified form of terminal homing. It would initially be integrated with B-52 bombers and, eventually, with B-2s. The weapon would require new mountings and a suspension system. Fuze options have not been specified, but the US has been working on specialised HDBTD fuzes for several years.

So far, the proposal has not yet received the go-ahead for development. However, HDBTD weapons and their associated

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sensors have been identified as receiving funding increases in the upcoming Fiscal Year 2003 (FY03) defence budget request. If 'Big BLU' proceeds, it will be considered a rush development item to provide a capability against other targets that may be encountered in operations against terrorists.

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JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

Lancer MWS punches above its weight

Richard Scott

SEI (UK) has carried out a dynamic firing trial of its Lancer multiwarhead system (MWS) at the QinetiQ Pendine range in the UK, writes *Richard Scott*. The company is claiming a world first for the 500kg-class MWS, which proved its penetration capability against a hardened target that, according to SEI (UK) managing director Stephen Cardy, "was the largest ever assembled in the UK in terms of size, mass and depth of concrete".

The dynamic firing on the rocket-sled track at the QinetiQ Pendine on 5 December 2001 was jointly funded by SEI (UK), Raytheon Missile Systems and the Directorate Equipment Capability (DEC - Deep Strike) within the UK Ministry of Defence (MoD).

DEC (Deep Strike) involvement in the Lancer MWS concept is tied into studies for the Future Offensive Air System and associated interest in a penetrator variant of the Raytheon Tactical Toma-hawk cruise missile, and possible future enhancements to the Storm Shadow air-launched stand-off

missile. A representative Tactical Tomahawk nose cone and body section, manufactured by Portsmouth Aviation, was used for the dynamic test. Pains-Wessex was responsible for loading the warhead initiation system, while SEI (UK) took responsibility for the MWS and fuzing.

"The shaped charge jet provided the necessary crater profile in the target to allow the penetrator to perforate, not only the 6m reinforced concrete target, but also a 10m sand capture butt, two further concrete walls and then travel a further 800m down range," said Cardy. "This is the first time a 500kg-class warhead of any design or type has demonstrated the ability to defeat such a target."

SEI (UK) has been developing the Lancer MWS concept over the last six years with support from Raytheon Missile Systems. Lancer technology was originally developed to support the Hughes (now part of Raytheon) AirHawk bid into the UK Conventionally Armed Stand Off Munition (CASOM) programme in 1995. A four-month programme, from design to three full-scale firings, demonstrated that the combination of a Lancer shaped charge with a follow-through penetrator (250kg-class weapon system) could defeat 2m reinforced concrete with a 1m soil overburden.

"This success led to a further SEI/ Raytheon activity to identify and test a Lancer MWS as a potential warhead for the Tactical Tomahawk programme, for which Raytheon is prime contractor," said Cardy. "The MWS design process has drawn on our extensive numerical and analytical modelling capability. The result was a 500kg-class warhead system, capable of defeating more than 6m of reinforced concrete."

A full-scale jet characterisation test of the Lancer shaped charge at QinetiQ Pendine provided validation of the shaped charge liner collapse/jet formation modelling. This was followed by a successful static firing at NAWC China Lake in California, validating the target response simulations. The recent dynamic firing at QinetiQ Pendine ended the development effort.

Top: Festooned with logos, the Tactical Tomahawk nose cone and body section is ready to be propelled down the rocket-sled track at the Pendine test range.
(Source: QinetiQ)

Bottom: The warhead inflicted massive damage to this reinforced concrete target.
(Source: QinetiQ)

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AIR TO SURFACE

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JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

US deploys BLU-118B thermobaric bombs

David C Isby

The US Department of Defense has accelerated its hardened target defeat (HTD) advanced concept technology demonstration (ACTD) programme with the objective of producing a limited number of deployable weapons that could be used in action in Afghanistan, writes *David C Isby*.

The BLU-118B uses the same hard-target penetrator as the 2,000 lb BLU-109. It can be delivered with the standard Raytheon Paveway laser guided bomb (LGB) kit used with the GBU-24 2,000 lb bomb, or it can be fitted as the warhead for a Boeing AGM-130 air-to-surface missile or GBU-15 glide bomb.

The first live-fire testing of the BLU- 118B was carried out against a tunnel target on 14 December. The test, using LGB guidance, proved to be "extremely successful" according to a US Air Force spokesman.

A limited number of BLU-118B thermobaric weapons have been hurriedly assembled and around 10 have been deployed for possible use in Afghanistan. There have so far been no reports of the these being used

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operationally. Asked on 7 January if the weapon had been used in action, Rear Adm John D Stufflebeem, deputy director for operations, current readiness and capabilities, Joint Staff, confirmed that none had been dropped in combat by that date.

The lessons of the campaign in Afghanistan have increased US interest in the use of thermobaric warheads by precision-guided munitions as a counter to hardened targets such as caves. The weapons also have applications for the destruction of hardened WMD facilities in other hostile countries. The thermobaric approach also has potential for destroying stockpiles of chemical or biological weapons without spreading contamination.

The weapons technologies are being developed through the ACTD, managed by the Defense Threat Reduction Agency (DTRA, the former Defense Nuclear Agency). The DTRA had been developing a range of HTD capabilities under the programme, for which US$60 million (US$40 million of which was for thermobaric weapons) was requested in the Fiscal Year 2002 (FY02) budget.

The HTD ATD, which was to end in FY03 with unspecified residual operational capabilities, will use a 'new concept' in thermobarics for part of its HTD mechanism. While fuel-air explosives date to the Vietnam War, the new generation weapons use a fuel-enriched explosive. This allows a longer burn time and greater overpressure for a given weapon weight than was possible with earlier technologies.

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JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

Boeing tests small smart bombs

Late last year, the US Air Force (USAF) Research Laboratory Munitions Directorate and Boeing successfully flight-tested two Small Smart Bomb Range Extension (SSBREX) weapons at White Sands Missile Range in New Mexico. Both weapons were launched at an altitude of 25,000ft by an Air Armament Center F-16 aircraft operating out of Holloman Air Force Base, New Mexico.

"The general mission objectives were to demonstrate performance of the successful Miniature Munition Technol-ogy weapon with lattice fins and the Alenia Marconi Systems DiamondBack wing," says Lt John Mehrman, the USAF programme manager. "The weapons performed well and impacted their targets." Part of a co-operative miniature- munitions demonstration programmed, the tests were jointly funded by Boeing and the USAF.

The SSBREX project has demonstrated the technical concepts that led to the current Small Diameter Bomb programme. "I am very proud of the performance of the Air Force-Boeing SSBREX team that resulted in two successful launches in one day," says Boeing programme manager Robert Zbylut. "These tests validated the SSBREX concept of a winged small bomb."

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The SSBREX uses the same type of INS/GPS guidance as the Joint Direct Attack Munition (JDAM). It uses a 250 lb-class warhead that has demonstrated penetration of more than 1.8m of reinforced concrete.

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AIR TO SURFACE

Date Posted: January 31, 2002

JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

JASSM to enter low-rate production

US Undersecretary of Defense for Acquisition, Technology and Logistics Edward C 'Pete' Aldridge has given the go-ahead for low-rate initial production (LRIP) of the Lockheed Martin AGM-158 Joint Air-to-Surface Standoff Missile (JASSM). The weapon will become operational on the F-16 and B-52 by 2003, and the US Air Force (USAF) plans to make the decision for full-rate production late that year.

JASSM is a joint Air Force-Navy programme to create a missile with a range of more than 200 miles, the stealth technology needed to penetrate enemy air defences, and a guidance system which teams GPS with a terminal seeker able precisely to attack high-value targets. Unlike current cruise missiles, JASSM can be launched off most types of aircraft in the USAF inventory. The 2,000lb-class weapon is planned for use on the B-1, B-2, B-52, F-16 and the US Navy's F/A-18 E/F.

"We have a low-cost, high performance programme and we came in below the objective of US$400,000 in FY95 [Fiscal Year 1995] dollars," says USAF JASSM programme director Terry Little. As a result,

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the Air Force has increased its buy from 2,400 to 3,700 missiles.

According to Secretary of the Air Force Dr Roche, "JASSM is a flagship programme for acquisition excellence. Not only do our combat forces get an unprecedented precision-attack capability, but they get it at an affordable price never before achieved on a cruise missile programme".

Aldridge recently described JASSM as a "great programme in good shape". He also drew attention to the need to replace air-to-ground weapons used in Afghanistan. "The value of precision-guided munitions is clearly demonstrated in Afghanistan. We need to get our production base back up to produce those weapons, to replenish them".

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AIR TO SURFACE

Date Posted: January 31, 2002

JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

JASSM flies simulated combat mission

In December 2001, a Lockheed Martin AGM-158 Joint Air-to-Surface Standoff Missile (JASSM) destroyed a hardened bunker target at the Western Test Range in Nevada during the missile's seventh development test. The missile was launched from a B-52 Stratofortress at an altitude of 24,000ft and autonomously flew to the planned target. It used its seeker to provide precision guidance in the final stages of flight.

The test was designed to replicate a typical US Air Force mission against a high-value target. "We understand how critical JASSM's capabilities are to the Air Force", said Larry Lawson, vice president of Strike Weapons at Lockheed Martin. "Being able to destroy hardened targets from long range is important to the Air Force."

This was the missile's final development test of 2001. There will be one more development test in early 2002, then the programme will begin Independent Operational Test and Evaluation (IOT&E) trials.

"With the success of this test, the baseline

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JASSM development programme will be complete following our final test early next year," said Col Tim Moore, JASSM Joint Program Office programme manager, shortly after the December launch. "We have clearly demonstrated that the missile exceeds the operational requirements. Completion of development testing positions JASSM for success during the operational testing phase."

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AIR TO SURFACE

Date Posted: January 31, 2002

JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

WCMD used for first time in Afghanistan

David C Isby

The Lockheed Martin (Orlando) Wind Corrected Munitions Dispenser (WCMD) was used in combat for the first time in Afghanistan, writes *David C Isby*. WCMD is a GPS/INS guided tailkit with movable fins that serve as control surfaces and can be fitted to a range of US submunitions containers. In Afghanistan, it was reportedly used to guide CBU-87/103 Combined Effects Munitions (CEM) dispensers, each of which releases 202 BLU-97/B cluster bombs. These were delivered from high altitude by B-52s.

The WCMD has been operational on B-52s and F-16s since 2001. The first full-rate production lot of 6,000 WCMDs is currently being delivered, and a second production lot of the same size has been ordered. The US Air Force plans to eventually procure a stockpile of 40,000 WCMDs. The unit cost for production WCMDs has been reduced to less than US$10,000.

In addition to the CEM, WCMD can also be used to deliver Gator-series mines and Sensor Fuzed Weapons (SFW)

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submunitions. All are operational.

According to unconfirmed press reports the CBU-89/104 Gator system has been used in Afghanistan. In addition, according to other unconfirmed US press reports, WCMD is being adapted to two unconventional patterns of submunitions containers. One releases reels of carbon-fibre material for shorting out ground-based electrical power systems. Another, developed by the Air Force Research Laboratories, contains flechette submunitions designed to puncture and drain stored chemical weapons without resorting to an explosion, which would scatter the weapons' contents.

An F-16 Fighting Falcon from Eglin Air Force Base, Florida, drops a wind corrected munitions dispenser during testing. (Source: USAF)

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SPECIAL REPORT

Date Posted: May 21, 2002

JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

Missile destroyer Cole rejoins the fleet

Following a 14-month programme of repair and modernisation, the Aegis guided missile destroyer Cole (DDG 67) has returned to service. Thousands of Northrop Grumman employees and local residents gathered pier-side at the company's Ingalls Operations and along nearby beaches as the ship sailed for its homeport in Norfolk, Virginia, on 19 April.

Badly damaged by a terrorist attack in Aden, Yemen, in October 2000, Cole was transported to Northrop Grumman Ship Systems on the heavy lift ship Blue Marlin, and arrived in Pascagoula on 13 December 2000, after a six-week journey.

The ship was originally built in Pascagoula by the company's Ingalls Operations, and was delivered to the US Navy (USN) in 1996. The company has delivered a total of 16 Aegis guided missile destroyers, with nine more ships under contract.

When the ship arrived in Pascagoula, integrated product teams - made up of all shipyard crafts - assessed the damaged areas of the ship, and determined what areas needed to be removed and replaced. All

damaged structure, cables, pipes, ventilation and equipment were removed, and 550 tons of steel removed and replaced. The 1A and 1B main engine and modules were replaced, along with the starboard main reduction gear and three gas-turbine generators. The repair work also involved replacing 106,700m of electrical cable, and the upgrading of some combat systems. During peak periods, up to 700 of the shipyard's employees were assigned to the repair task.

The crew moved aboard on 10 March 2002 and sea trials were completed on 13 April, allowing the ship to be redelivered to the USN on 18 April 2002. "Teamwork has made this happen," said Commander Kevin Sweeney, Cole's commanding officer. "The Navy made the right decision to bring the ship here... Our goal is not to leave Pascagoula nor is our goal to get back to Norfolk. Our goal is to take Cole to sea and to start the training operations with our battle group."

> Cole leaves the Pascagoula yard to begin its voyage back to its home port.
(Source: Northrop Grumman)

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SPECIAL REPORT

Date Posted: May 21, 2002

JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

DD(X) destroyer will have side-mounted vertical missile launchers

Vertical-launch systems installed along the sides of the US Navy's (USN's) planned DD(X) multimission destroyer, rather than in a central location, were one of the key features identified by Assistant Secretary of the Navy for Research, Development and Acquisition John Young, which favoured selection of the Gold Team (made up of Ingalls Ship Systems and Raytheon) to develop the ship.

Peripheral vertical-launch system (PVLS) cells will be able to launch Tomahawk, Standard SM-2 and Evolved SeaSparrow missiles, and will be installed in blocks of four along the sides of the ship. They will be designed in such a way that, if the ship was damaged by an enemy round and this caused sympathetic detonation of one of the missiles, much of the resulting blast energy would be expended away from the hull. "This is a damage-mitigating factor for the ship," Young told reporters. "It also voids the risk of having a single round go into a magazine of, say, 48, 64 VLS cells and you

lose all the missiles at one time. Here you'd potentially lose four or eight missiles, depending on where a round came in."

Each DD(X) will also carry a single United Defense Advanced Gun System, an unmanned mounting whose 155mm weapon will be able to fire Land Attack Projectiles with a range of up to 100 miles (185km).

The dual-band radar proposed for the ship will consist of a three-face X-band radar and a three-face L-band radar. These will be "integrated at the wave-form level" says Young, offering long-term resistance to jamming. Other features that influenced the USN decision to award the contract to the Gold team rather than the rival Blue team (Bath Iron Works and Lockheed) were a two-helicopter spot flight deck and a stern boat-launching system.

A three-year US$2.9 billion design agent contract awarded to the Gold team covers the design, building and test of engineering development models for the major transformational systems, such as the integrated power system, the advance vertical-launch system and the integrated radar suite.

According to USN DD(X) Program executive officer, Rear Admiral Charlie Hamilton, the service hopes to complete a review of the requirements for the new destroyer by the end of the current Fiscal Year (FY), or if necessary by the end of 2002.

Bath Iron Works, which led the losing team, will now become part of the Northrop Grumman team, and will compete with Northrop Grumman Ship Systems for the task of building the ships. In FY05, the USN will award the contract to build the first DD(X) destroyer, and intends to use the experience gained to build further ships in the class and to develop and build a 'future cruiser' and littoral combat ship, both based on the same hull design. The DD(X) will replace current destroyers, while the future cruiser will ultimately replace the Aegis-class cruisers.

The armament of the DD(X) will consist of a series of peripheral vertical-launch systems and a single 155mm Advanced Gun System. (Source: US DoD)

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Date Posted: May 21, 2002

JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

'Smart' scanning proposed for laser beam-riding missiles

Aerospatiale Matra Missiles (now part of MBDA) has developed a new form of laser-based missile guidance which significantly reduces the chance that a target equipped with a laser-warning receiver (LWR) will detect the guidance beam. In the traditional form of laser beam-riding guidance, a laser beam projector emits a radial scanning pattern intended to cover the whole of the angular field (as seen from the launcher) within which the missile will fly. Since the laser beam is scanning a field that includes the target, it can be detected by an LWR, allowing the enemy to initiate countermeasures or to fire at the launcher. A round from the main armament of an armoured fighting vehicle (AFV) will cover the distance from the target to the missile launcher in less time than a newly-launched missile will take to travel a similar distance.

Reducing the chances that an LWR will detect the laser beam while the missile is in flight can be achieved by observing the location of the missile and laser-scanning only a small angular zone around this point.

The addition of a semi-transparent plate within the optical path of the

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target-observation system in the missile firing post will allow a video sensor to detect the position of the missile within the guidance field. In theory, this information could be used to modify the scan pattern to cover only the region around the missile, while excluding the remainder of the field. The company believes it will be more practical (particularly if the new guidance technique is applied as an upgrade to existing systems) to use full scan pattern, but to turn the laser on only while it is pointed close to the missile.

Should the missile leave the small zone of the scan pattern in which the laser is activated, energising the laser for the entire scan pattern will allow the missile to be brought backunder control.

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SPECIAL REPORT

Date Posted: May 21, 2002

JANE'S MISSILES AND ROCKETS - JUNE 01, 2002

USAF proposes liquid/solid mix for rocket propellants

In its search for a rocket propulsion system that overcomes the disadvantages of conventional solid-propellant and liquid-propellant systems, the US Air Force (USAF) has devised a scheme in which the propellant takes the form of a liquid oxidiser mixed with pellets of cross-linked hydrogel polymer. Stored in a single tank, this could be expelled by a pressurisation system and fed into a separate combustion chamber.

The pellets would be made from a material such as polyvinyl alcohol (PVA) or polyacrylamide (PAM). Other potential pellet materials include celluosic hydroxy functional, celluosic methoxy functional, polysaccharides, polyvinyl amines, polyvinyl ethers, polyethylene glycol (PEG), polypropylene glycol and polytetrahydrofuran (PTHF).

The degree of cross-linking determines the amount of oxidiser absorbed by the polymer, and this will be selected to provide the best oxidiser-to-fuel (O/F) ratio and specific impulse (ISP). If increased performance is required, metals from the aluminium, beryllium, magnesium and lithium group can be added in powder form to the polymer

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before it is cross-linked.

The size of the pellets will vary according to the application and could be as small as 20 microns and as large as 2cm thick. Larger powerplants will have larger combustion chambers, so can use larger pellets. The chosen size will be small enough to ensure that combustion is complete (or nearly so) before the hot gases enter the nozzle throat.

Suitable liquid oxidisers include hydrogen peroxide, hydroxyl ammonium nitrate (HAN) and hydroxyl ammonium dinitromide (HADN), hydroxyl ammonium (HA) salts, nitrates including ammonium nitrate, dinitromide including ammonium dinitramide, nitroformates including hydroxyl ammonium nitroformate and perchlorates. If the system is intended for tactical applications, a storable oxidiser such as HAN will be required. If a long shelf life is not needed, a low-cost oxidiser such as hydrogen peroxide could be used.

The mixture of liquid oxidiser and pellets can fill up the entire storage tank, giving the rocket motor a high propellant loading, and allowing more total impulse to be packaged into the same volume.

The scheme has advantages over liquid-propellant rockets, since it requires one propellant tank instead of two and hence only a single tank-pressurisation system. The injector that feeds the combustion chamber does not have to mix two separate liquids, so can be relatively simple. Fuel and oxidiser are already intimately mixed, giving good combustion efficiency.

Opening and closing a single valve can change the mass flow rate of propellant entering the combustion chamber, making the motor easy to throttle.

The charge within a solid-propellant motor must be bonded to the motor casing, and bondliner failures are a major source of reliability problems. A pellet-based system does not require bonding, and the propellant does not need strong mechanical properties such as modulus, tensile strength and elongation. Since the combustion process is confined to a relatively small combustion

chamber, another potential source of failure is reduced.

Solid rocket motors sometime require very extensive range-safety equipment to terminate thrust in the case of system failure. In a pellet-based propulsion system, thrust can be terminated by closing a valve and at worst by depressurising the propellant tank.

With traditional solid propellants, when the powerplant is scrapped at the end of its useful life, it is difficult to remove the solid propellant from the case and then dispose of it in a safe and environmentally acceptable manner. Pellet-based propellant can be poured out of the case and rendered harmless with a simple dehydration process.

One possible configuration for a pellet-based system would be to line the combustion chamber with solid propellant. The latter could help ignite the hydro- gel propellant, provide higher thrust for boost and increase the mass fraction of the motor.

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SPECIAL REPORT

Date Posted: April 23, 2002

JANE'S MISSILES AND ROCKETS - MAY 01, 2002

ARC demonstrates improved propulsion technologies

Atlantic Research Corporation (ARC) has successfully conducted a ground test of an advanced high-energy variable-flow ducted rocket (VFDR). Taking place at the company's Airbreathing Propulsion Test facility in Gainesville, Virginia, the trial is part of a project to reduce the technological risk for future US development programmes aimed at producing higher-speed, longer-range missiles to counter time-critical enemy targets.

The VFDR engine test used a company-developed high-energy, reduced-smoke propellant in a two-inlet, air-launched ducted rocket configuration. A flight condition of Mach 3.25 at 30,000ft (9,000m) was simulated, and the combustion efficiency obtained exceeded past results using less energetic propellants. This performance was achieved without any increase in pyrotechnic sensitivity, preserving the relatively benign Insensitive Munitions characteristics of VFDR gas generator subsystems. These results should allow future VFDR engine designs to be lighter and of higher performance than those based on earlier technology.

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Over the last 20 years ARC has conducted over 1,500 air-breathing propulsion tests (including boost-to-ramjet- sustain transition tests) using its three dedicated air-breathing test cells. The company was the lead contractor, system integrator and booster/combustor developer for the US Air Force's (USAF's) AMRAAM (advanced medium-range air-to-air missile)-VFDR programme that took VFDR propulsion technology to the point of being ready for flight-testing. It was also the US industry leader for co-operative ducted rocket ramjet development programmes with France and Germany.

ARC recently completed development testing of the MARC-R-282 VFDR ramjet engine for the US Navy's (USN's) GQM-163A Supersonic Sea Skimming Target (SSST). It is also involved in the USN's Solid Fuel Ramjet and the USAF's Advanced Rocket Combined Cycle technology programmes.

In another propulsion-development project, the company has successfully static tested a full-scale 10in (25.5cm)-diameter flightweight rocket motor which contained a low-cost hydroxy-terminated polyether (HTPE) propellant based on commercially available materials. This test demonstrated that the new propellant can match or exceed the capabilities of standard HTPE propellants, which use a more costly limited-supply polymer. The recent firing is the first of a series of planned motor tests using the new polymer.

HTPE propellants were first developed under USN Insensitive Munitions Advanced Development (IMAD) funds, but the resulting propellants were based on an expensive proprietary polymer only available from one manufacturer. The new propellant uses pre-polymer ingredients that are commercially available in large quantities and at relatively low cost. Its mechanical properties, ballistics and performance are reported to be equal or superior to those of the more expensive HTPE polymer.

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SPECIAL REPORT

Date Posted: April 23, 2002

JANE'S MISSILES AND ROCKETS - MAY 01, 2002

New tower to improve weapon-seeker testing

The US Air Force's 46th Test Wing at Eglin Air Force Base, Florida, is commissioning a new 91.4m test tower to be used for the testing of weapons seekers. It will provide a stationary platform from which testers can evaluate the performance of weapons seekers against real targets in an open-air environment.

"The tower is the first of its kind in the Department of Defense," says 46th Test Wing technical adviser Bob Arnold. A mobile flight-motion simulator on top of the tower will be used to test seekers against a variety of land and aerial targets. "This tower lets our engineers check the seeker's ability to see and track its target without actually flying the weapon.... It gives us the capability to evaluate the seeker's performance against threats it might see in a combat environment."

Before the arrival of the tower, Eglin engineers evaluated the performance of seekers against synthetic targets recreated in a laboratory setting, and then moved on to open air captive-carry or free-flight tests. Now, instead of artificially simulating targets, real aircraft can be flown against the

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seeker to evaluate its performance.

"This gives us real targets instead of computer-generated ones," says Arnold. "It adds one more step in realism so when the seeker goes into production, it will work the way it is intended."

Construction of the US$13 million tower began in October 2000 as part of a programme to repair the damage done to many of the existing test facilities at Eglin by Hurricane Opal in 1995, and to upgrade the existing test capabilities.

The tower's structure is based on similar designs used in communication towers, but has been strengthened to provide a stable test platform and to withstand coastal hurricanes. "The key was to make this an extremely rigid structure, not only to be able to resist hurricanes, but also because of the sensitivity of the sensor systems the tower will test," explains Jerry Griffith, tower project manager. Cement pylons under the three tower legs are buried 20m into the ground, giving it the capability to withstand hurricane force winds in excess of 210km/h.

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SPECIAL REPORT

Date Posted: March 22, 2002

JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

Hypersonic missile reaches Mach 6+ in low-level flight

During a flight test at a German test site, an EADS/LFK experimental missile designated Hoch-Geschwindigkeits Flugkorper (HFK) EO2 reached a speed of over Mach 6.5 - more than 2.1km/sec - in low-level flight. The successful test was carried out as part of the three-year hypersonic missile research and technology project commissioned by the Federal Office for Defence Technology and Procurement in October 2000, and was conducted with the support of the Bundeswehr Technical Centres WTD 71 and WTD 91.

The aim of the test was to investigate the performance of a new conically-shaped, high-thrust engine, which was designed by the EADS subsidiary Bayern-Chemie motor, and an aerodynamic control system based on lattice fins.

"Through attaining speeds which have never before been reached, our engineers have given an impressive demonstration of the technological capabilities of our company," says EADS/LFK chief executive officer Werner Kaltenegger. "Using the hypersonic

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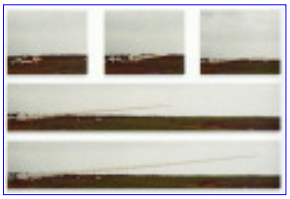
test bed, we are able to investigate a broad variety of technical and physical phenomena in the high-speed range which will be of advantage to future applications."

Evaluation of the test results have, up to now, shown that the prescribed roll-rate of the missile was achieved. To measure this, a magnetic field sensor from the Franco-German research institute, ISL, was used for the first time.

A further flight test is due to take place in Germany before 2003.



The HFK missile was surface-launched - the project was originally started with a possible surface-to-air role in mind (Source: EADS/LFK)

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SPECIAL REPORT

Date Posted: March 22, 2002

JANE'S MISSILES AND ROCKETS - APRIL 01, 2002

Altair offers antenna for missile applications

Miroslav Gyürösi

A new family of modular phase-array antennas, which could be used for missile-guidance applications, is being offered by Russia's Altair design bureau, writes *Miroslav Gyürösi*. The organisation has designed antennas for use at millimetric, centimetric and decametric wavelengths.

Three example designs (one for each operating band) publicly displayed by Altair use circular antennas that are approximately 11 wavelengths in diameter. These have a beam width of 5.8º at the half-power points (5.3º in the case of the millimetric design), and a gain of approximately 26dB. Bandwidth is 8% and the maximum sidelobe level is 17.6dB. The centimetric and decametric antennas can scan a sector of ±53º (defined by the half-power point), or ±45º in the case of the millimetric unit.

Each version consists of 192 phase shifters packed in a non-equidistant array. The millimetric and centimetric designs use ferrite phase shifters, while the decametric

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design relies on semi-conductor phase shifters.

The units incorporate integrated control and computing facilities, and could be used either as individual (stand-alone) units or as part of a larger antenna. These are designed to detect and track high-flying aerial targets and low-flying manoeuvring aerial targets, while coping with active electronic countermeasures and movements by the platform on which the antennas are mounted.

Altair specialises in the designing of naval air-defence and weapon-control systems. It sees potential applications of the new technology as including:

- a new guidance system antenna for the 3M80/3M82 family of supersonic anti-ship missiles;

- a new guidance antenna set for 9K331 Tor-M1 family short-range air- defence systems;

- a new antenna for upgrades of the radar carried by MiG-29 fighters; and

- a new antenna unit for long-range missile air-defence systems of the Project 1144 Orlan heavy nuclear cruiser.

The new search and fire-control antenna unit for the modernised Project 1144 Orlan-class nuclear cruisers (two of which are currently in service, and two more which are inactive) will consist totally of 36 new phase-array antenna modules and two large antenna sets probably intended to cover all the upper hemisphere.

A small phased-array antenna could be used to modernise the 3M80/3M82 supersonic anti- ship missile (Source: Miroslav Gyürösi)

A larger array, probably working at lower frequencies, could form part of a 9K331 Tor-M1 modernisation scheme (Source: Miroslav Gyürösi)

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SPECIAL REPORTS

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JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

INMIZE becomes Spain's missile company

In a move which forms part of the current consolidation of the European defence industry, Spain has set up INMIZE, a new company dedicated to missile technology. The creation of a missile company integrating the activities of all Spanish defence companies has long been a goal of the Spanish Ministry of Defence, and the February announcement followed several months of negotiations between MBDA, INDRA, IZAR and EADS-CASA.

The main shareholders in INMIZE are: the Spanish information-technology company INDRA (40%); MBDA (40%); the Spanish shipbuilder and naval combat system provider IZAR (10%), and EADS-CASA. The operational headquarters of INMIZE are located at INDRA's facilities in Madrid. INDRA was involved in the RIM-162 Evolved Seasparrow Missile, and is participating in the European marketing of the Raytheon Standard Block IIIA.

The new company's main activity will be to handle the Spanish share in the design and development of the Meteor AAM. Around 10% of the expected orders to be placed by the Meteor partner nations will be for rounds

to arm Spanish aircraft. However, INMIZE also hopes to participate in other European missile projects, becoming a national source of missile sub-systems and missile parts. It will also be responsible for promoting, marketing and selling MBDA products in Spain.

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SPECIAL REPORTS

Date Posted: February 21, 2002

JANE'S MISSILES AND ROCKETS - MARCH 01, 2002

Luke AFB updates its training ranges

The mountainous desert terrain of the Barry M Goldwater Range at Luke Air Force Base (AFB), Arizona base was being used to simulate Southwest Asia and the Afghan landscape well before the unforeseen war in Afghanistan started, says the US Air Force.

With the demand for improved threat replication and target arrays that provide training for military operations in urban terrain, the range - the second largest military range in the US and covering a total of 2.7 million acres - is being continually upgraded and enhanced to provide realistic training.

"The improvements made on the range help prepare our student pilots for the combat air forces", says Brig Gen Steve Sargeant, commander of the 56th Fighter Wing at Luke AFB. "For the pilots flying on the range, it's imperative the training scenarios are as realistic as possible."

Targets have evolved from Cold War- and Vietnam War-era configurations. While a simulated airfield is still a viable target, its composition and surroundings have changed. Target sets are being reconfigured to replicate enemy surface-to-air missile (SAM) sites, airfields and other targets pilots may encounter in today's air-to-ground combat

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operations.

"We are being set up against diverse targets", says Lt Col Scott Lardner, chief of wing tactical programmes at the 56th Fighter Wing range management office. "A pilot may be called upon to drop a bomb on a building or on a corner of a building in a built-up area, so we have incorporated more vertically-developed target arrays."

About 150 sea-land transport containers have been added on three tactical ranges to create new target arrays. The containers are used to make relatively full-scale mock-ups of built-up areas. The containers are inexpensive, durable structures that can be stacked like blocks and used to create three dimensional targets representing airfield hangars, airfield control towers and industrial complexes. They are spot welded so one container will not slide off the other easily, even if hit directly. The durability of the containers allows pilots to strafe them, or drop inert bombs and other practice ordnance other than live ordnance.

Joint modular ground targets have also been added. These are full-scale mock-ups of enemy weapons systems such as SAMs, tanks, anti-aircraft artillery and Scuds that add realism to the whole scenario because they are replicas of specific threats. These modular targets snap together like giant building blocks.

The modular targets are easy to place and remove, and weather better than plywood targets. The lighter metals from which they are made are easily recycled, and do not require the process of fluid purging which is required when using retired vehicles as targets.

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SPECIAL REPORT

Date Posted: January 31, 2002

JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

MBDA completes tri-national merger

On 18 December 2001, Fabrice Brégier, chief executive officer of MBDA, signed the documents formally establishing the international missile company as a legal operating entity. The result of a merger of Aerospatiale Matra Missiles, Alenia Marconi Systems (Missile Division) and Matra BAe Dynamics, the MBDA is jointly owned by BAE Systems (37.5%), EADS (37.5%) and Finmeccanica (25%), with equal rights.

"MBDA exists as from today", said Brégier. "Three national Operating Companies (OPCOs), for France, Italy and the UK, will start operating from 1 January 2002". Each of these is to be run by a managing director and all three entities are accountable for their performance to the group chief operating officer, Alan Garwood.

The three OPCOs will be operationally responsible for delivering and acquiring national programmes, for maintaining national customer interfaces, and for managing the national infrastructure in terms of facilities, people and capability. The French OPCO will be managed by Pierre Dubois, the UK OPCO by Guy Griffiths and the Italian OPCO by Sandro Pazzini.

Major multinational programmes will be

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managed by multinational teams under the authority of one of the OPCO managing directors: Pierre Dubois for the Storm Shadow/ Scalp EG air-to-surface cruise missile; Guy Griffiths for the Meteor beyond-visual-range air-to-air missile; and Sandro Pazzini for the Aster-PAAMS surface-to-air anti-missile family.

A single organisation will manage corporate functions of sales and marketing, business development, human resources and quality, and finance, for the whole group. Technical functions will also be centralised at a corporate level under the authority of the second group chief operating officer, Mario di Donato; four directorates will be created: Tech-nical, Industrial, Procurement, and Strategy and Planning.

Two holding companies (MBDAH and AMSH) have been created, which hold equally the shares in MBDA on behalf of the shareholders, who exercise their control through the MBDA management board. The trading entity, MBDA SAS, is registered in France.

With an annual turnover of EUR2 billion (US$1.7bn), a forward order book of EUR13 billion and 70 customers across the world, MBDA sees itself as the second-largest missile systems company in the world. The group employs 10,000 people across 12 main sites in Europe and the US. The company currently has 45 missile, missile system and countermeasure programmes in operational service and a further 30 in development.

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SPECIAL REPORT

Date Posted: January 31, 2002

JANE'S MISSILES AND ROCKETS - FEBRUARY 01, 2002

US Army to study remotely-operated turrets

Scott R Gourley

US Army planners are investigating the possibility of upgrading selected light combat vehicles with a remotely-operated missile turret subsystem, writes *Scott R Gourley*. The project, identified in a recent issue of the US Commerce Business Daily, is being conducted by the US Army Aviation and Missile Command (AMCOM) Research, Development, and Engineering Center (RDEC) at Redstone Arsenal, Alabama.

The 'potential sources sought' announcement notes that AMCOM RDEC "is seeking domestic sources of information on current or near-term technology that can be applied in the design, fabrication, and proof-of-concept testing of a remote turret system for US Army ground vehicles used in urban operations. The objective of this proof-of-concept demonstration is to assess the technical capability to provide an experimental item that can acquire and engage targets remotely with a variety of lethal weapons."

Baseline requirements for the remote turret include the ability to "transport in fighting/

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firing position a variety of tactical missiles having the following characteristics: length: 60in (+/-5in); diameter: 8in (+/-2in); weight: 80 lb (+/-20 lb). The remote launcher shall not impart on the missile a force in excess of the following values: longitudinal: 250g for 30m/sec; lateral: 25g for 1.4sec; vertical: 25g for 1.4sec".

Physical packaging constraints for the remote turret include the ability to operate as a subsystem of an overall 'light combat system' which can be airlifted in a C-130 Hercules.

AMCOM engineers have identified a number of technological challenges for the subsystem design, including: remote operation of turret; remote operation of target-acquisition system (sights/ cameras); remote operation of fire-control system; stabilisation for shoot-on-the-move capabilities; and missile-reload capability.

Contractors interested in responding to the announcement have until 31 January 2002 to provide AMCOM with a white paper containing a description of the technologies - already possessed or under development - that have potential application to the remote turret demonstration project.

As with all similar announcements, responding vendors are cautioned that the 'potential sources sought' notice "does not constitute an invitation for bids or a request for proposal, and it is not a commitment by the US Army to procure products or services. The government does not intend to award a contract on the basis of this request for information or otherwise pay for the information solicited. However, respondents to this request for information will not be excluded from consideration for separate contract services ancillary to this demonstration programme or for contract participation in any potential follow-on hardware development activity."

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SPECIAL REPORT

Date Posted: December 13, 2001

JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

Jane's conference reviews ballistic missile proliferation

The future ballistic missile threat could be from an area extending from Casablanca to the Straits of Taiwan, Alexander Pikayev, scholar in residence at the Carnegie Moscow Centre, told the Jane's conference on Missile Proliferation held in Edinburgh, Scotland, late last year. In his view, Russian President Vladimir Putin is ready to make major concessions to the US on Anti-Ballistic Missile (ABM) systems but will be looking for benefits for Russia in return.

Pikayev also suggested a force of 15 ABM interceptors in Alaska could be considered a test facility, and could be authorised by an amendment to the 1972 ABM treaty; a force of this size being probably the largest that China would accept.

Dr Li Bin, director of arms control programme, and associate professor at the Institute of International Studies, Tsinghua University, described what he considered the basic unstable nature of ABM defences. Assume one side has three missiles while the other has three missiles plus two interceptors, he told the conference. One side thinks: "He has three missiles while I have only two interceptors. So my defence is

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limited." The other takes the view: "He has two interceptors while I have only one missile which would survive a first strike. So his defence is too large."

Uzi Rubin, special assistant for research and development (R&D) programmes in the office of Israel's minister of defence, pointed out that Middle Eastern nations are usually one-city countries, with a high portion of the population living in an over-sized capital. For example, 20% of the population of Iraq lives in Baghdad, and 27% of the population of Jordan lives in Amman. In most west European countries, the capital accounts for no more than 10% of the population, typically around 5%.

The mass killing that would result from a Weapons of Mass Destruction (WMD) strike could effectively end the nation's power of self-defence. Enough WMD capability to do this could be carried by a single aircraft or missile.

Missile defences are destined to be a key element of deterrence in the Middle East, he said, adding that Arab Ballistic Missile Defence (BMD) capability would be "a good thing".

Professor Anoush Ehteshami, director of the Centre for Middle Eastern and Islamic Studies at the University of Durham, gave an insight into Iranian strategic thinking. Iran's missile programmes are driven by realpolitik - the need for national security - he reported. Iran wants to deter the US and its allies, and nearby countries in what it considers to be a dangerous neighbourhood. Iran sees Iraq, Taliban, Azerbaijan and the Gulf Co-operation Council member states as sub-regional threats, while India, Pakistan, Israel and Israeli/Turkish military co-operation are seen as regional threats.

'Over-the-horizon' challenges come from the US and Russia, the latter being a rival to Iran in the Caspian region and in central Asia. Iran sees Israel as a US client state - not an independent player.

Iran will become a producer of ballistic missiles and an exporter of ballistic missile

technology, Professor Ehteshami suggested, but for the moment it lacks some of the underlying technologies, and is therefore technologically dependent on other missile suppliers. Teheran needs technical equipment and training, as well as certain technologies and materials (including coated graphites, propellant technology, gyros, engines and lasers). Iran is "flirting" with nuclear technology, says Ehteshami, not nuclear weapons.

One factor which may be driving Iranian missile programmes is what Ehteshami terms "R&D and modification for the sake of it". Iran has the technology needed to develop and build missiles, and it is hard to switch off the technological drive to do whatever becomes economically feasible.

According to Brigadier Naeem Ahmad Salik, director of arms control and disarmament affairs at the Joint Staff Headquarters, Pakistan, his nation's ballistic missile programme is aimed at achieving a credible, reliable and survivable deterrence capability, not a power-projection capability beyond its immediate security arena.

"At the moment Pakistan is simultaneously pursuing both liquid-propellant and solid-propellant systems and apparently this is going to be the likely pattern in the near- to mid-term" he reported. "It will be imprudent for any country, and more so for a country with limited resources, to abandon a programme which has yielded successful results, and thereby waste the funds already expended towards Research and Development."

Pakistan has put in place a very elaborate command-and-control mechanism for its strategic assets, he told the conference. "The system [has functioned] efficiently for the last two years now, and its various components have taken firm roots... various procedures have been institutionalised and positive controls over the strategic systems have been put in place."

The original requirement which gave birth to Israel's Arrow Anti-Tactical Ballistic Missile (ATBM) programme postulated a 1,300km

range threat given the generic designation NLRM (New Long-Range Missile), said Dr Dan Peretz, Arrow programme manager at Israel Aircraft Industries (IAI). The current system needs to cope with 1,500km range threats, and 2,500km threats in the future.

Eight of the nine Arrow 2 missions were kills, but the real test of the system would be in time of war.

Douglas Graham, vice-president of defensive systems, Lockheed Martin Space Systems Company, describes several possible ways in which a mid-course ATBM system could discriminate between re-entry vehicles and decoys. One would be to have multiple-kill vehicles per interceptor - a tactic forbidden by the 1972 ABM Treaty. Given enough lightweight and inexpensive kill vehicles, the defender would be able to target decoys and warheads. Another technique could be to use clouds of pellets or even dust to disturb the approaching array of decoys and warheads. By observing the relative movement of all the affected objects, an ATBM system would be able to discriminate between real and false targets.

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SPECIAL REPORT

Date Posted: December 13, 2001

JANE'S MISSILES AND ROCKETS - JANUARY 01, 2002

US low-cost guidance ready for initial test

David C Isby

The General Dynamics Low Cost Course Correction (LCCC) programme (not to be confused with a similar British project that uses the same acronym) is currently in the initial stages of research and development, writes David C Isby. The LCCC programme is intended to provide a range of US Army munitions with an add-on guidance capability.

First funded in January 2001 by the US Army Armament, Research, Development and Engineering Center (ARDEC) at Pictatinny Arsenal, New Jersey, the LCCC programme is being handled by the General Dynamics Ordnance Tactical Systems Aerospace Division in Redmond, Washington. LCCC was due to undergo initial hardware testing in December 2001, to determine the feasibility of proceeding to demonstrations in 2002. Hardware-in-the-loop (HWIL) simulations have already been carried out to verify the sensor function.

The LCCC programme is intended to produce a low-cost (under US$1,000) guidance system adaptable to a broad range of munitions and able to be produced in large

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quantities. It will use a laser receiver for guidance - homing in on reflected light from a target 'painted' by a laser designator - and use explosive side-thrusters for course correction. Modelling has suggested that the LCCC could reduce the circular error probable (CEP) of the 2.75in unguided rocket from 200m to less than 10m.

While the initial testing will be carried out with 40mm rounds, the LCCC is also being designed to be applicable to 120mm tank guns or mortars, and 2.75in rockets. Development of the 40mm round guidance is being stressed because this projectile does not experience the high blast and acceleration of the tank shell, which has proven a limitation in previous guided-round programmes. The LCCC could be made ready for production in three to four years.

One of the key technologies seen as making other low-cost guided-munition designs possible is the development of an inertial measurement unit (IMU) using micro electromechanical system (MEMS) technology. This draws on the results of previous DARPA (Defense Advanced Research Projects Administration) research. The House Appropriations Committee added US$10 million in its Fiscal Year 2002 bill for Army development of MEMS technology.

To provide guidance to a projectile, IMUs would be linked to GPS satellite-guidance receivers. The British LCCC programme examined such GPS-based guidance techniques in the late 1990s. If they are to be used to guide artillery projectiles, such guidance technologies will have to be adapted to withstand high-g acceleration.

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SPECIAL REPORT

Date Posted: November 26, 2001

JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

US PGMs target Afghan caves and bunkers

David C Isby

The US has used a number of hard and deeply buried target defeat (HDBTD) munitions in the air offensive against the Taliban-controlled parts of Afghanistan, writes David C Isby. These have included GBU-28 5,000 lb laser-guided bombs and 5,000 lb Northrop Grumman GBU-37s, a shorter GPS/INS-guided variant sized to fit the Northrop B-2's bomb bay.

Two GBU-37s are reported to have been dropped by a single B-2 on the opening night of the air offensive, and the weapon has been used in limited numbers since then. GBU-28s have been dropped by US Air Force (USAF) F-15Es, and the US Department of Defense stated on 12 October that a "limited number" of GBU-28s were being used against underground facilities and caves.

These HDBTD weapons have become highly important to the air offensive because of the extensive network of caves in many of the mountainous areas of Afghanistan. Al-Qaeda leader Osama Bin Ladin is believed to be using these to shelter from the air attacks.

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The US is also looking at the problems of targeting a number of tunnel complexes, which were constructed by the Afghans with foreign support during the war against the former Soviet Union. Most notable are those at Zhawar in Paktika province, near the Pakistani border, which resisted Soviet air-to-surface missile and fuel-air explosive attacks in 1986.

Arab sources claim that there are 30 to 50 tunnels in Afghanistan. Current US weapons are designed to defeat targets buried some 20m, and the tunnels may be deeper than this.

US Secretary of Defense Donald Rumsfeld also made reference to these missions when visiting the B-2 bomber base at Whiteman Air Force Base, Missouri. "I know the folks here know a little about these caves. They have addressed a few of those caves with 5,000 lb bombs", a reference to some of the six HDBTD sorties flown by B-2s in the offensive so far.

Because current HDBTD munitions require precise placement for effectiveness, the lack of on-the-ground intelligence in Afghanistan is limiting their effectiveness. Despite this, Rumsfeld has confirmed reports of the GBU-28's success: "I have seen several examples where there were enormous secondary explosions. In some cases they went on for hours after targeting underground facilities."

F-15Es are thought likely to use Boeing AGM-130 ASMs against cave mouths. These have been practicing tactics in co-ordination with unmanned air vehicles equipped with thermal imaging sensors.

F-15Es have used the highly precise AGM-130 to engage Iraqi air-defences located in populated areas to protect allied aircraft engaged in Operation Southern Watch. These missions over Iraq continue, making these F-15Es the first fighters ever to fly in two different conflicts at the same time.

On 29 October, F-14A 'Bombcats' from the carrier Carl Vinson were reported as using

2,000 lb BLU-109 penetrating bombs with laser guided bomb (LGB) guidance units against cave entrances.

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SPECIAL REPORT

Date Posted: October 24, 2001

JANE'S MISSILES AND ROCKETS - NOVEMBER 01, 2001

Cruise missiles and 'smart' bombs used in Afghanistan

Approximately 50 Tomahawk missiles launched from platforms including US Navy surface ships and the UK Royal Navy (RN) submarines were used in the first phase of attacks against Taliban and Al-Qaeda targets in Afghanistan on 7 October. Aircraft participating in these initial attacks included about 15 land-based bombers and around 25 carrier-based strike aircraft.

Speaking at a 7 October press conference, US Secretary of Defense Donald H Rumsfeld confirmed that one early goal of the strikes conducted under 'Operation Enduring Freedom' was to suppress the air-defence systems available to the Taliban, to "create conditions for sustained anti-terrorist and humanitarian relief operations in Afghanistan. That requires that among other things we first remove the threat from air defences and from Taliban aircraft...We need the freedom to operate on the ground and in the air and the targets selected, if successfully destroyed, should permit an increasing degree of freedom over time.

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"We have also targeted command facilities for those forces that we know support terrorist elements within Afghanistan and critical terrorist sites."

The bomber force was made up of B-1, B-2 and B-52 aircraft. The B-2s made the attack from their base in the USA, while the B-52s were based at Diego Garcia in the Indian Ocean. No details of their armament has been released as we closed for press some 24 hours after the initial strikes, but it is likely to have involved significant numbers of JDAM and JSOW guided bombs.

"We are using, or essentially have at hand, all our conventional munitions", explained Gen Richard B Myers, chairman of the US Joint Chiefs of Staff. "A majority of them are precision weapons, but not exclusively, because we try to match targets and weapons and their effects."

A total of 30 targets were attacked on the first night as part of Britain's 'Operation Veritas', said the UK Ministry of Defence (MoD). (The US Department of Defense gave the number as 31). Three were in Kabul, four were close to other large settlements, and the others were in what the UK MoD described as "remote areas deep in the countryside". One of these targets - described by the UK MoD as a "Taliban terrorist site" was attacked by Tomahawk missiles fired from the RN submarines Trafalgar and Triumph; the remainder were attacked by US forces.

Rumsfeld described the problems of targeting what are essentially irregular forces. "There are not a lot of high value targets [in Afghanistan]...the Taliban and the Al-Qaeda do not have armies, navies and air forces...And to the extent we can use overt as well as covert activities to improve target information, to gather intelligence that will enable us to be more precise in what we do, and to force people to move and change what they're doing, to raise the cost of what they're doing, to attempt to reduce the number of people around the globe who support them and finance them, all of that helps.

"The fact is in this battle against terrorism

there is no silver bullet. There is no single thing that is going to suddenly make that threat disappear. Ultimately they're going to collapse from within and they're going to collapse from within because of the full combination of all the resources from all of the countries that are brought to bear on these networks. That is what will constitute victory."

Osama bin Laden was not specifically targeted in the first strikes, said Rumsfeld. "This is not about a single individual. It's about an entire terrorist network and multiple terrorist networks across the globe."

Another goal of the air strikes was to help anti-Taliban factions within Afghanistan, he said. "Certainly our interest is to strengthen those forces that are opposed to Al-Qaeda and opposed to the Taliban leadership that is so intimately connected to them, and to strengthen all of those forces so that they will have better opportunities to prevail."

Asked if the US would be providing arms and air cover to the opposition forces, Rumsfeld would only say, "Our goal is to make them more successful. Getting into exactly how we'll do that, I think I'll defer."

On the same night as these early combat operations, and about an hour after the attacks began, two USAF C-17 transports began dropping food supplies to refugees within Afghanistan. The intention was to deliver around 37,000 individual rations plus some medicines and other supplies during that first night.

Days before the air strikes started, Rumsfeld had confirmed the existence of the plan to air-drop humanitarian aid to refugees, but said, "The food drops will be done only in the event that it's very clear that the SAM sites - the limited number [of medium-range] surface-to-air missiles and the rather larger number of Stinger missiles - that are still in the country would not pose a problem." The absence of a SAM threat would be verified by "people on the ground we talk to, who have knowledge of what's going on".

The problems of air-dropping supplies in the face of a possible SAM threat were described

by a US DoD spokesman. "We know the Taliban have anti-air capabilities. It's not at all clear what the specific capability of their systems is. But as best we could ascertain that through a variety of means, we would plan accordingly and help to plan the altitudes, flight profiles and things of that sort to try to accomplish both objectives: be able to provide food in meaningful ways to the people of Afghanistan and allow the aircraft to get in and get out in a safe manner."

Transports would be escorted, and in the event of hostility from Taliban or Al-Qaeda air defences, "we would take appropriate action". The spokesman could recall no precedent for proving armed escorts for humanitarian aid flights, saying, "I certainly wouldn't rule it out. It's not something we would discuss publicly."

On the night of 7/8 October, the supplies were dropped from high altitude. The effectiveness of earlier air drops over Kosovo and Bosnia had been "less than desired", said Myers. As a result, the USAF had developed and tested more effective methods of delivering stores from high-altitude without the use of parachutes. "We think we can be fairly effective from high altitudes, and we're targeting remote locations where it's difficult to get trucks in. This has all been co-ordinated very well with USAID [US Agency for International Development]."

Speaking at a press conference on 8 October, Rumsfeld said, "Based on our early assessment, we believe we have made progress toward eliminating the air-defence sites that have been located around the country. We also believe we've made an impact on the military airfields that were targeted. We cannot yet state with certainty that we destroyed the dozens of military command-and-control and leadership targets we selected."

Gen Myers summarised the Taliban air-defence activities on the first night as "a lot of the anti-aircraft fire and some manned, portable surface-to-air missiles being shot. Obviously, the aircraft were at heights above

both the anti-aircraft fire and the manned, portable surface-to- air missiles that they weren't affected by it."

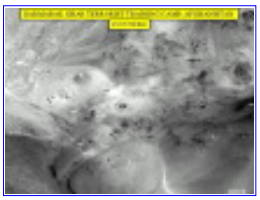
Asked if the lack of SA-2 or SA-3 fire was as a result of US targeting rather than the Taliban husbanding the few systems which might still be operational, Myers said, "Hopefully, we'll be able to provide you with some of that bomb damage assessment as we continue our analysis. We think it's the former." He said he was unaware of any air-to-air engagements.

As we closed for press, air strikes with US aircraft and cruise missiles had been mounted for a second night, with the first daylight attacks taking place during 9 October. Later that day, Gen Myers stated that "essentially we have air supremacy over Afghanistan. There will always be the anti-aircraft fire.

"There's always the possibility of these manned portable surface-to-air missiles. But the tactics that we'll utilise will keep us out of their range".

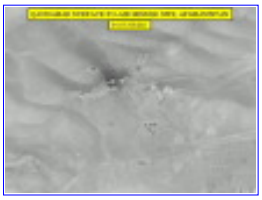
A Tomahawk cruise missile is launched from the cruiser Philippine Sea(CG 58) during the opening strike against Al-Qaeda training camps and Taliban military installations (Source: US DoD)

The two above photographs show pre- and post-strike images of a training camp at Garmabak Ghar (Source: US DoD)



The two above photographs show pre- and post-strike images of a training camp at Garmabak Ghar (Source: US DoD)

Six bombs have made the runways and taxiways at Shindand airfield temporarily unusable (Source: US DoD)



A PGM destroyed the fire-control radar of this SAM site at Kandahar (Source: US DoD)

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SPECIAL REPORT

Date Posted: November 26, 2001

JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

Predators launch Hellfire ATGMs over Afghanistan

David C Isby

Lockheed Martin AGM-114 Hellfire anti-tank guided missiles (ATGMs) are being fired from General Atomics RQ-1A Predator unmanned air vehicles (UAVs) during the ongoing allied air offensive against Taliban-occupied portions of Afghanistan, writes David C Isby.

This new Hellfire capability was tested in the US, starting last February (see Jane's Missiles & Rockets, April 2001, p16, and September 2001, p16), and the system has now been rushed into operational service. The Air Force Material Command team, responsible for the earlier tests, has been attached to operational Predator units to conduct missile-armed UAV missions. The deployment is reported to have been made after an unarmed Predator located Taliban leader Mullah Omar in the opening hours of the air offensive but the US forces were unable to engage the fleeting target.

According to reports, each of the US Air Force's (USAF's) 11th and 15th Reconnaissance Squadrons - the two Predator-equipped squadrons operating over

Afghanistan - have modified a handful of Predators for Hellfire-armed operations. This has included reinforcing their wings and adding hardpoints for the Hellfire missiles.

The USAF is thought to have 55 Predators available, having already lost 19. Two Predators have been lost during the first four weeks of the air offensive, but it is uncertain whether these were carrying out armed operations.

The Hellfire-Predator is believed to have begun combat operations around 17 October, and is said to have been successful in action. Hellfire-armed Predators are intended to be able to strike targets within five minutes of them being located. Publicity was given to armed Predator operations in the media after the US was believed to have diverted one to come to the assistance of anti-Taliban Afghan leader Hadji Abdul Haq before his capture and subsequent execution by the Taliban on 25 October.

Operationally, the Hellfires have been fired from 15,000ft or lower, with the USAF relying on the Predator's low infrared (IR) signature to minimise vulnerability to man-portable surface-to-air missiles. Hellfires fired from Predators have also been used to mark targets for attack by US Navy tactical aircraft armed with laser guided bombs. They have also been used against vehicles and smaller targets in instances where collateral damage concerns prevented the use of larger weapons.

Despite the emphasis the USAF is placing on enhancing the Predator's operational capability in combat, a recent report by the US Department of Defense's Director of Operational Test & Evaluation (DOT&E) pointed out that the system has continued to fail to meet the required performance. The report pointed out that the Predator's all-weather performance in some mission areas is limited - the UAV cannot detect targets at high altitude at night or in bad weather. However, in Afghanistan, the Hellfire's low IR signature and the limited enemy air-defences allow UAV operations at medium altitude.

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SPECIAL REPORT

Date Posted: November 26, 2001

JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

BRIEFS - Simulations and support funded

Computer Sciences Corporation has been awarded a task order from the US Army Aviation and Missile Command (AMCOM) to support simulation and development of missile and aviation systems at Redstone Arsenal, Alabama. The task order has a ceiling value of US$145.8 million if all options are exercised over a five-year period.

CSC will provide a broad range of simulations, modelling and associated engineering support services for both missile and aviation systems. Work will involve live, virtual and constructive simulations for real-time and non real-time applications, including virtual prototyping and highly immersive, virtual battlefield environments. The task order also calls for vulnerability and lethality analyses of aviation systems and associated hardware.

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SPECIAL REPORT

Date Posted: November 26, 2001

JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

BRIEFS - Space and Missile Systems Center joins AFSPC

The Space and Missile Systems Center at Los Angeles Air Force Base, California, has become part of Air Force Space Command (AFSPC). The centre's realignment from Air Force Materiel Command to AFSPC consolidates space procurement and operation functions in one organisation under one commander.

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SPECIAL REPORT

Date Posted: November 26, 2001

JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

BRIEFS - Tyndall drone operations funded

Lockheed Martin Services is being awarded a US$5.93-million contract to provide for the operation and maintenance (O&M) of full-scale aerial targets at Tyndall Air Force Base (AFB), Florida, and Holloman AFB, New Mexico, and O&M of subscale aerial targets, drone control, the Communications and Scoring System, Gulf Range Drone Control System and the airborne platform/telemetry relay at Tyndall AFB.

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SPECIAL REPORT

Date Posted: November 26, 2001

JANE'S MISSILES AND ROCKETS - DECEMBER 01, 2001

Anti-Taliban air offensive dominated by missiles and PGMs

David C Isby

The allied air offensive against the Taliban-occupied areas of Afghanistan, starting on 8 October 2001, has featured a more intensive use of guided weapons than even the 1999 operations against the former Yugoslavia, writes David C Isby. While fewer than 2,000 munitions were delivered in the first five days of the campaign - much less than either the 1991 offensive against Iraq or in 1999 - since then there has been a steady use of precision guided munitions (PGMs) and missiles. Around 8,000 munitions were delivered in the first month of the air campaign.

The most significant change from earlier air offensives is that the GPS/INS guided Boeing Joint Direct Attack Munition (JDAM) has been the most widely-used gravity munition. B-52H bombers began delivering 2,000 lb JDAMs on the first night of the conflict. Since then, they are reported to have dropped 500 lb JDAMs even though this weapon is not considered fully

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operational. This use of the smaller version reflects the need to reduce collateral damage in populated areas.

It is thought that some instances of collateral damage resulted from JDAMs losing GPS signals through atmospheric conditions, electronic interference or malfunction, forcing them to rely on INS-guidance alone. This degrades the weapon's circular error probable (CEP) from 13m or less to about 30m.

JDAM targeting tactics have been improved since 1999, allowing the weapons to be re-targeted in flight to hit movable targets. Many of the B-2 sorties from Whiteman Air Force Base (AFB), Missouri, in the continental US have carried loads of 16 independently targeted 2,000 lb JDAMs. B-1Bs have also delivered JDAMs, a weapon they did not use in 1999.

Extensive use has also been made of a wide range of laser-guided bombs (LGBs), ranging from the 1,000 lb GBU-16s to the 5,000 lb GBU-28s. Static tank targets have been a frequent LGB target in attacks similar to the 'tank plinking' missions carried out in 1991 by PAVE TACK-equipped F-111Fs. By the third week of the offensive, special operations forces on the ground were using laser designators to support LGB attacks, a capability which was available in 1999.

US carrier-based aircraft have used the Raytheon AGM-154 Joint Stand Off Weapon (JSOW) glide bomb and Boeing AGM-84H SLAM-ER air-to-surface missile. Imaging Infrared (IIR) versions of the Raytheon AGM-65 Maverick have also been used in combat, and will probably play a more important role as the air offensive tries to defeat Taliban forces deployed in the field.

Another weapon familiar from 1999 and now being used against the Taliban is the US and British Tomahawk Land Attack Missiles (TLAMs). Over 50 TLAMs were launched in the first three airstrikes of the offensive. Depleted inventories and a permissive air-defence environment have led the US Air Force (USAF) not to use its B-52H-launched Boeing AGM-86C/D Conventional Air

Launched Attack Missiles (CALCMs).

One weapon not used in 1999, but now being fired in combat, has been the Lockheed Martin AGM-114 Hellfire anti-tank guided missile (ATGM), launched from both US Army AH-64 Apache attack helicopters and USAF RQ-1A Predator unmanned air vehicles. The suppression of Taliban air-defences allowed early use of the AH-64, whose exclusion from the 1999 combat operations was politically embarrassing to the Army.

Unguided unitary and cluster munitions have been dropped by B-52 and B-1 bombers. A common weapons load for B-52s operating from Diego Garcia is reported to be 27 Mk82 500 lb bombs and 12 2,000 lb JDAMs. One specific structure target near Kabul is thought to have been attacked by a single B-52-load of gravity munitions. B-1s carry 55 Mk82s and 24 2,000 lb JDAM or 10 CBU-87 cluster bomb units. As in 1999, B-1Bs have used their Northrop Grumman APQ-164 Synthetic Aperture Radar (SAR) for highly accurate all-weather bomb delivery.

In 1999, the forces targeted in the former Yugoslavia were unused to air attacks, but the Taliban's military leaders and veteran fighting men were used to frequent air attacks by Soviet-built aircraft in 1979-92. These tended to feature larger numbers of aircraft than the US is currently using, and many unguided munitions. They generated more 'sound and fury' and had no concern for collateral damage.

To the Taliban, the intention of the US air attacks to place a relatively small number of precision munitions precisely on target seems to compare unfavourably with the Soviet attacks that threw a large high explosive tonnage at the general area of a target. Hence, the allied air strikes have had less psychological impact than they might have otherwise had. In an attempt to rectify this, from 31 October onwards, B-52s were sent to bomb Taliban positions on high ground overlooking potential axes of advance of the anti-Taliban forces.

The extensive use of guided weapons has reduced collateral damage, but has limited the scale of the air offensive. Reliance on these weapons and the limited stockpiles available have led to a lower tempo of air strikes, especially from the US Navy's carrier air wings, as they have had to be resupplied with additional munitions rushed through the pipeline. In one underway replenishment on 16 October, for example, the carrier Carl Vinson received no less than 140 pallets of laser-guided bomb components. US strike aircraft have been instructed to bring back their weapons whenever possible if they are unable to hit their primary targets.

One of the reasons for the well-publicised commitment of Lockheed AC-130H Spectre gunships has been that they are capable of high-accuracy strikes (with their 105mm cannon) without using up the limited stock of PGMs.

The most significant limitation faced by the US forces is the current stock levels of weapons such as the Boeing JDAM bomb kit, the Boeing CALCM and the Northrop Grumman GBU-37 5,000 lb penetrator bomb. The GBU-37 and JDAM are both of undoubted tactical utility but funding limitations in recent years have forced reliance on low-rate initial production (LRIP) quantities, 'pushing to the right' the total cost of full-rate production.

As a result of these shortages, efforts are being made to accelerate production of these and other munitions. On 31 October, the US Department of Defense announced that it was placing an order worth US$9.29 million for 434 JDAM kits for use on existing 1,000 lb and 2,000 lb bombs. These are to be delivered by March 2002.

A B-52 leaves Diego Garcia to begin a long flight to its targets in Afghanistan, over 8,000km away. Individual sorties can last from 12-15 hours, and may involve extended loitering in Afghan airspace. (Source: USAF)

The northern section of this combined vehicle and ordnance repair facility has been accurately targeted. (Source: US DoD)

The northern section of this combined vehicle and ordnance repair facility has been accurately targeted. (Source: US DoD)

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SPECIAL REPORT

Date Posted: October 24, 2001

JANE'S MISSILES AND ROCKETS - NOVEMBER 01, 2001

US speeds up weapon development, production and conversion programmes

David C Isby

The US Air Force (USAF) may accelerate its current procurement plans for the Boeing CALCM (conventional air-launched cruise missile) and Lockheed Martin JASSMs (joint air-surface standoff missile) to meet urgent operational requirements, writes David C Isby. With more funding now available as a result of the 11 September attacks on the USA, the USAF is also re-thinking its policy on the ERCM (extended-range cruise missile) programme, which it had wanted to end (see Jane's Missiles & Rockets, October 2001, p13).

Boeing is currently converting additional CALCMs from nuclear-armed AGM-86A ALCMs (air-launched cruise missiles) at its facility at St Charles, Missouri. Funded after heavy CALCM expenditure against Iraq and the former Yugoslavia, this programme is producing CALCMs with both high-explosive and hard and deeply buried target defeat (HDBTD) warheads.

JASSM was to be considered for low-rate initial production (LRIP) around October-November 2001, following additional testing. Consideration is now being given to assigning an operational capability to the limited number of developmental missiles - 10 has been mention in press reports - and accelerating the move to LRIP. The first production JASSM had not been expected to be delivered until October 2002, and it is uncertain how much this date could be accelerated.

The ERCM programme had benefited from its endorsement by the chairman of the defence transformation panel, established by US Secretary of Defense Donald Rumsfeld. Retired Air Force General Jim McCarthy, advocated continuing the programme, citing the likelihood of high rates of cruise missile use in the near future.

In addition, the money from the US$20 billion emergency supplemental funds, appropriated after the 11 September attacks, included US$138 million for an unspecified extension of the CALCM programme, US$57 million for Boeing JDAMs, and US$10 million for addition laser-guided bomb kits. US Department of Defense (DoD) comptroller Dr Dov Zakheim has said that the Raytheon Joint Stand-Off Weapon (JSOW) and the Tomahawk Land Attack Missile (TLAM) will also receive some of this supplemental funding.

The Raytheon EGBU-15 HDBTD upgrade of the GBU-15 glide bomb may also be accelerated with post-attack funding. About 1,000 GBU-15s are reported to have been upgraded to the EGBU-15 standard by early September. The modified missile includes a GPS/INS guidance capability and an improved Lockheed Martin BLU-109 penetration warhead.

The US Navy (USN) is reported to have asked Raytheon to accelerate testing of the Tactical Tomahawk, which is currently scheduled to enter production in Fiscal Year 2003, with the goal of making it available for operations in the near future.

The USN also wants Raytheon to expand its current programme of re-manufacturing earlier production versions (Block III, Tomahawk Anti-Ship Missiles and nuclear-capable versions) to the TLAM Block IIIC standard. A further US$420 million from the post-attack emergency appropriation funding is likely to be used to increase the scope and pace of the TLAM conversion programme.

According to press reports, the USN TLAM stockpile at the start of the current conflict was less than 2,000 missiles, and the service is re-assessing its decision not to re-open the TLAM Block IIIC production line (which it had been urged to do by many in Congress in 1999). In addition, the USN is re-assessing which of its existing Tomahawks could be upgraded to Block IIIC standard, and may increase the total to be reworked to 800 missiles.

A TLAM was launched on 18 September from the second Seawolf-class submarine, Connecticut (SSN-22), while submerged in the Atlantic Missile test Range off the Florida coast. This was the first TLAM launch from a Seawolf-class submarine. The TLAM mission was a success; the missile flew to a target on the Elgin Air Force Base ranges and was then recovered by parachute. Connecticut and Seawolf (SSN-21) are now able to be armed with TLAMs.

This test followed an earlier trial on 8 August against the same target. In this case, a TLAM, launched from the destroyer Mahan in the Gulf of Mexico, used GPS and the improved DSMAC (Digital Scene Matching Area Correlation) guidance technologies. That flight was also successful and the TLAM was recovered by parachute.

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SPECIAL REPORT

Date Posted: September 19, 2001

JANE'S MISSILES AND ROCKETS - OCTOBER 01, 2001

DARPA tests a Mach 7 scramjet

The US Defense Advanced Research Projects Agency (DARPA) has carried out the first successful free flights of a hypersonic projectile powered by a supersonic combustion ramjet (scramjet) engine burning hydrocarbon fuel. The projectile is a 100mm diameter, 20% scale model of a conceptual missile.

Scramjet engines provide propulsion at speeds above Mach 5 by capturing atmospheric air to burn on-board fuel. Since they are air-breathing engines, scramjets are more efficient than rocket motors for hypersonic propulsion. Possible weapon applications include long-range hypersonic missiles and gun-launched kinetic energy weapons.

In order to operate, scramjet engines must be boosted to hypersonic speed. This can be done by fitting them with a rocket booster as a first stage. In the DARPA tests, which were carried out in June and July, but have only just been announced, GASL Inc of Ronkonkoma, New York, fired the scramjet projectile out of a large gun at the US Air Force's Arnold Engineering Development Center (AEDC) at Arnold Air Force Base,

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Tennessee.

Arnold's G-Range was the only US facility able to launch the projectile. The two-stage light gas gun accelerated the titanium projectile to flight speed condition through a 40m-long gun barrel. The projectile experienced peak acceleration of approximately 10,000g, and was launched from the gun at Mach 7.1. It then used its scramjet engine to cover a distance of 80m in slightly over 30 milliseconds. Additional launches are planned, with higher performance scramjet engines and longer flight durations.

One goal of the trial was to show that gun launch is a viable low-cost method of testing scramjets. "Before the flight here, the only way to test a scramjet engine was to test it statically in a wind tunnel or put it on a rocket and launch it", says AEDC hypersonic test manager Rick Rushing. "By doing the testing in our ground test facility, customers save the cost of flying an aircraft, using up a missile and potentially damaging an expensive scramjet engine." A rocket-launched test would cost millions of dollars, but a gun-launched trial costs around US$100,000.

During the test, this gun-launched projectile would fly under scramjet power for only 30 milliseconds (Source: GASL)

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SPECIAL REPORTS

Date Posted: June 15, 2001

JANE'S MISSILES AND ROCKETS - JULY 01, 2001

Rafael moves into profit

Rafael has completed around 10 years of painful downsizing, says the organisation's president Giora Shalgi. In the late 1980s, Rafael had around 7,600 employees but only half of today's sales. Today it is almost half that size, with around 4,500 employees.

In 2000, Rafael made a small profit of +0.2%. This marked a turn-around from its -6.4% loss in 1999 and -17% loss in 1998. This move into profitability was the result of aggressive marketing which resulted in significant contracts and a heavy backlog of work.

Manufacture of the Gill/Spike family of anti-tank missiles is currently at a rate of 70-80 per month. More than 200 Popeye long-range air-to-surface missiles have now been built on Rafael's production line, but current production is for export. More than 50% of the workload is now outsourced.

The process of privatisation is now in the final stages, and will be finished legally in "a couple of months", says Shagli. However, no change of ownership is likely in next five years. Rafael still incorporates national laboratories, and the Israeli government is worried that Rafael could move its best technical talent from Government research

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work to business-related activities. Currently Rafael spends around US$70 million a year on research.

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SPECIAL REPORTS

Date Posted: June 15, 2001

JANE'S MISSILES AND ROCKETS - JULY 01, 2001

US Marines unlikely to have been exposed to chemical agents, says DoD

The US Department of Defense (DoD) has concluded that none of the 17 possible chemical warfare incidents involving the 11th Marines Artillery Regiment during the Gulf War can be verified. In 13 incidents, there was substantial information that allowed investigators to determine the presence of chemical warfare agent (CWA) as "unlikely", while two incidents were assessed as "definitely not" involving the presence of chemical warfare agent. Since very little detail was available about the remaining two incidents, investigators assessed the possibility of chemical warfare agent presence as "indeterminate".

Investigators say, "While we cannot discount unco-ordinated small-scale chemical warfare attacks by Iraq's forces, what we know about Iraq's chemical employment doctrine does not support piecemeal use. Their doctrine became clear during their effective use of chemical weapons during the 1980-88 Gulf War. Against Iran, Iraq used massed attacks on selected targets. Such heavy attacks were

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easy to identify".

Five of the incidents involved missiles or rockets, and are listed below:

17 January

At 10.15pm on the day the Coalition began offensive air operations, the 3d Marine Regiment received incoming artillery rocket fire. The 1st Marine Division went to Condition Red, and the units donning protective gear included the 3d Marines and the 1st Battalion, 12th Marines (1/12). Although one of the NBC NCOs (nuclear, biological and chemical non-commissioned officer) in the 1/12 recalled this as being a Scud ballistic missile attack, the unit commanding officer's notes recorded the incident as an artillery attack. The CO recalled no positive CWA detections, unusual detonation characteristics or peculiar smells. "Not a single item of evidence points to a chemical warfare attack other than the alerts, which we believe were precautionary", says the report.

18 January

Unconfirmed accounts reported a Scud launch in the direction of Al Mishab.The 3d Marines instructed the 1/3 and 3/3 to send out monitor/survey teams in their areas. The 3d Marines log reflects negative survey results from the 1/3, the 1/12, and an unidentified NBC Det (detachment). The logs report no positive detections.

20/21 January

A field radio operator told investigators that during a night-time artillery raid by 11th Marines elements firing against targets across the border in Kuwait, M8A1 chemical-warfare detectors gave alarm signals, and tests using the M256 Chemical Agent Detector Kit were positive for nerve agent two or three times. Other personnel reported a strong sulphur odour, or the smell of CS gas.

"The senior operations officer with the CP (command post) recalls standing near the back of a HMMWV when suddenly he could not breathe. He recalled a choking sensation

that did not taste like CS or smell like rotten eggs. He called CS 'kids' play' compared to the sensation he experienced. He said he gagged and coughed, but the symptoms slowly subsided after he masked. When the CP element unmasked, he said the irritant was gone."

The battery commander told investigators that he did not order the battery to increase protective posture and did not know of anyone with symptoms. He stated he did not find out the CP, almost four miles away, had gone to MOPP Level 4 until the day after the raid.

There was some incoming artillery fire that evening, "Despite getting a whiff of something strong, none of the witnesses reported experiencing the kind of serious symptoms expected from exposure to a chemical warfare agent", the report concludes. "If its concentration caused it to smell strongly, casualties would ensue promptly."

Although two Scud missiles directed toward Dhahran overflew the general area of the raid about 40 minutes before the strong smell, these missiles were still ascending on an unpowered ballistic trajectory and close to their maximum altitude, making it unlikely that the smell was due to the missiles' inhibited red fuming nitric acid oxidizer.

"On balance, we assess the likelihood of chemical warfare or riot control agent presence in the command post area as unlikely."

25 February

Battery H, 3/14, (a reserve unit attached to the 1/11) fired its cannons directly at two of Iraq's BM-21 122mm multiple rocket launcher vehicles, destroying one and putting the other out of action. The operations officer recalls, "Someone from the unit reportedly went back to the site and determined two or three chemical warfare rounds were among the conventional rounds in at least one launcher".

The 11th Marines NBC officer had quickly reconnoitered the scene within half-an-hour

of the engagement. The Marines with him performed an M256 test and got a positive result, but the officer determined they had taken shortcuts in the test. A second test gave negative results. The NBC officer noted the Iraqi site contained no special chemical protective equipment as he would have expected if the enemy unit possessed an offensive chemical capability.

Investigators found no logs or chronologies noting chemical rocket rounds in connection with this engagement or any subsequent visit to the site, and notes that although UNSCOM investigators had found Iraqi 122mm chemical warfare rockets, these had no identifying markings to distinguish them from conventional rockets.

"We believe it unlikely the multiple rocket launcher contained chemical rockets. We considered particularly significant the information of the NBC officer who led a team that investigated the site shortly after the engagement and believed they found no CWA. Also, Iraq's practice of not specially marking CWA rounds would have made identification of them in place very difficult. Our assessment cannot be more unequivocal as we could not identify and interview the Marine who allegedly discovered chemical rockets at the site and therefore could not directly investigate the second-hand report."

26 February

On three occasions (2.13am, 3.27am and 4.10am) chemical-warfare tests conducted by Battery A, 1/11, registered positively for blister agent. On the first and second occasions, the unit went to MOPP Level 4.

Two enemy rocket launchers had been damaged by artillery fire approximately 14 hours before Battery A first had positive blister agent tests. These were located about 1.5 miles northeast of Battery A's gun line. Since the evidence collected by UNSCOM inspectors after the war indicated that Iraq had no blister agent-filled 122mm warheads, investigators "strongly doubt the disabled rocket launcher caused Battery A's positive M256 blister agent readings".

They concluded that the presence of blister

agent during this series of incidents was unlikely, and noted, "We believe it is much more likely oil well contamination - rather than blister agent - caused the several positive readings".

Battery H, 3/14 knocked out this Iraqi BM-21 122mm multiple rocket launcher vehicle, and first reports suggested that it contained several chemical-warfare rounds.
(Source: US DoD)

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Date Posted: June 15, 2001

JANE'S MISSILES AND ROCKETS - JULY 01, 2001

BRIEFS - New management system for second Lockheed Martin site

TASC is to provide Product Life-Cycle Management (PLM) to Lockheed Martin Missiles and Fire Control, Orlando, Florida under a two-year, US$7.2 million systems integration contract, one of the largest PLM contracts awarded to date in the aerospace industry. Collaborative product life-cycle management (c-PLM) is a process that digitises data and automates the procedures required to design and manufacture a product.

The new contract follows an earlier award from Lockheed Martin Missiles and Fire Control unit in Dallas, Texas, and brings TASC's total PLM work for Lockheed Martin to more than US$11 million. The system in Orlando will enable Missiles and Fire Control to consolidate its engineering practice standards across the two operating locations. This will provide greater efficiency, and make it easier for employees to move from one production line to another, or even one plant to another, if necessary.

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Date Posted: June 15, 2001

JANE'S MISSILES AND ROCKETS - JULY 01, 2001

BRIEFS - Thiokol deal completed

The sale of Alcoa's Thiokol Propulsion business to ATK (Alliant Techsystems) has been completed. Agreement on the sale was announced in January. ATK purchased Thiokol Propulsion for US$685 million in cash.

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