Helping to manufacture rocket motors on Australian soil

The acquisition of a dozen new families of long-range missiles and the establishment of Defence's Guided Weapons and Explosive Ordnance (GWEO) Enterprise have placed added emphasis on Defence Science and Technology Group's (DSTG's) ability to support the growth in Australian rocket motor production. **By Gregor Ferguson**

The National Defence Strategy (NDS) and associated Integrated Investment Program (IIP), published this year, state that Defence "plan investments in new weapons "of $28 – $35 billion over the next decade "to enhance their strike capabilities". During this time it will also invest another $21 billion on its GWEO Enterprise to "complement the targeting and long-range strike investments", build GWEO stocks, "strengthen supply chains and support the establishment of a domestic manufacturing capability."

DEFENCE SCIENCE AND TECHNOLOGY
OUTLOOK

The National Advanced Surface to Air Missile System fires an AIM-120 Advanced Medium Range Air to Air Missile during its first ever Australian live-fire at Woomera Test Range in South Australia on 14 November 2023.

DSTG is supporting Defence in delivery of these objectives across a broad range of areas—one such area being solid rocket motors (SRMs). DSTG has had an Advanced Rocket Motor Technology Demonstrator, or ARMTD, Program since 2021 as part of its Rapid Prototyping Initiative, says Andrew Hart. The program leverages DSTG's decades of science and technology (S&T) expertise in energetics and propulsion, and its outputs are being transitioned to Australian industry across all areas to help them manufacture advanced, military-relevant SRMs.

Hart sits at the heart of this activity as Group Leader Missile and Space Propulsion in DSTG's Sensors and Effectors Division. He is Program Director of the ARMTD Program.

"Australia's 2024 NDS and IIP explicitly reference the importance of surety of supply and adequate stockpiles of relevant munitions, and how an Australian domestic missile manufacturing capability is critical in enhancing Australia's self-reliance," he says. "Australia's defence industry is a key contributor to the ability to realise this vision."

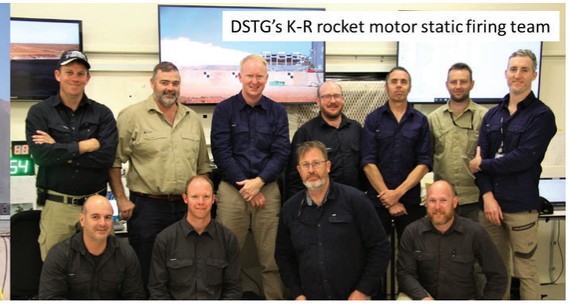
The aim of the ARMTD Program is not to build a specific type of rocket motor but to establish, upskill and demonstrate an exemplar sovereign supply chain that can be leveraged to manufacture whatever advanced, military-relevant SRMs Defence chooses to build in this country. That supply chain must be able to build SRMs to the same standard and specification as those we would normally buy from overseas and be able also to design and manufacture SRMs for future weapons, whether designed overseas or locally.

We will see the first flight test of an Australian-designed SRM delivered through ARMTD in about November this year, he says. The ARMTD Program has already seen live-fire static demonstrations of a series of wholly Australian-designed and manufactured

IMAGE: PTE Nicholas Marquis from Defence database

IMAGES: Supplied


K-R rocket motor loading at the LA5 test site


DSTG's K-R rocket motor static firing team

rocket motors, including the 10-inch (254mm) diameter Koonibba-Rising (K-R) class rocket motor. K-R was demonstrated in September 2023 at Woomera and it represents the largest advanced, military-relevant SRM designed and produced in-country to date.

That test program spawned some incremental improvements in things like design practices, material selection and industrialised manufacturing methods resulting in a version 2 of the K-R Class SRM.

"K-R version 2 is scheduled to be demonstrated through integrated live static firing and then flight tests in October and November of 2024, respectively," Hart tells *DSTG OUTLOOK*.

The next phase of the ARMTD Program will see live firing trials of a significantly larger advanced rocket motor in the second half of 2025. These rocket motors are deliberately focused on advanced propulsion technologies and military relevant design and manufacturing practices. Use of advanced SRM technologies, underpinned by appropriate design expertise, is critical, says Hart. "Maximising the energy-density of the system; minimising the mass of inert components; optimising energy management to maximise mission performance; ensuring that the rocket motor has the necessary structural strength to operate safely and reliably across its intended operating environment are the key enablers for achieving high performance missions such as long-range strike and high-speed weapons, deployed from volume and mass-constrained tactical launch platforms."

Transitioning these technologies into industry and then coupling them with DSTG's mission-specific rocket motor design capabilities—which have been independently assessed by Australia's allies as world-class—in turn pre-positions Australia to design and manufacture complete rocket motors for either 'build-to-specification' or 'wholly domestic' development and construction. It also helps future-proof Australian industry capabilities relating to advanced rocket motors.

Building and testing SRMs of an increasing unit scale and with an expanding range of technologies and functionality as the Program progresses upskills and demonstrates the ongoing maturation of the industry network, that itself also continues to expand in support of the Program. This is critical given that increasing unit scale and rocket motor functionality imposes additional technical, manufacturing and logistics challenges.

"As the ARMTD Program's milestones are met," says Hart, "the proficiency and capabilities of Australia's nascent SRM manufacturing capability are being enhanced. This maturation is being verified and validated through extensive component and integrated system level characterisation, inspection and live fire testing. As a consequence, as the ARMTD Program proceeds, the industry network is demonstrating its ability to contribute to an increasing range of Defence capability options, whether under a 'build to print', 'build to specification' or 'wholly sovereign' construct."

Through its involvement with Australia's allies, DSTG is also confident that the SRM technologies being transferred into Australian industry through ARMTD are the 'right technologies'. In addition, the ARMTD Program is focused on ensuring that these technologies are compatible with industrialised manufacture, as opposed to something that can be produced in the laboratory but is impractical in an industrial setting. "Transferring the 'right materials/technologies' and the 'right methods' into Australian industry through ARMTD helps accelerate and pre-position local companies to be able to contribute into an allied industry base in the area of advanced SRMs," states Hart.

The industry lead for ARMTD is Thales Australia which provides the industrial-scale propellant manufacturing and filling expertise, utilising the Government-owned, contractor-operated explosive ordnance production and non-destructive testing facilities at Mulwala and Benalla. The company also provides and enacts the overarching systems engineering framework and supply chain management for a growing list of Australian small to medium enterprises (SMEs) who manufacture the advanced inert rocket motor components for the Program.

DSTG works closely with Thales Australia and the SMEs, says Hart, to develop and de-risk the underpinning SRM technologies to a level of maturity where they are ready to be industrialised.

"We then assist the industry network through this S&T-to-industrialisation transition process, until they are able to reliably manufacture the rocket motors at the subsystem component and integrated systems level," he adds.

The ARMTD Program was initially a DSTG-funded program but its progress against the initial program milestones, coupled with the increased strategic relevance of its objectives, means the Royal Australian Air Force and, more recently, GWEO Group have subsequently provided considerable additional investment, says Hart.

"This program up-funding has allowed us to invest in critical infrastructure in industry, and also expand the industry network with whom we are engaging, to allow us to demonstrate rocket motors at a larger scale and with increased functionality than would have otherwise been the case."

Of course, Defence or a prime systems integrator may simply want to leverage the expertise generated through the ARMTD Program to deliver a specific rocket motor component such as rocket motor insulation, a rocket motor casing, or the relevant industrial practices to produce military-grade rocket propellant with the required quality assurances and quality controls.

Its activities with allied partners also sees DSTG maturing advanced propulsion technologies that are at a lower technology readiness level. As these lines of effort are matured, DSTG can then leverage the growing, non-exclusive ARMTD network to transition these advances more rapidly into Australian industry and then into candidate Defence capability options.

There is another challenge too if Australia was to be used as a second-source supplier to either the Pentagon or a foreign contractor for overseas designed SRMs. In these instances, the Australian supply chain must build those missiles to the same specification and standards as the people we might otherwise buy them from. In other words, Australian missiles, or components thereof, must have the same performance and durability and be interchangeable with the foreign ones.

Qualification of an industry supply chain is generally the responsibility of the prime systems integrator who is delivering the missile. However, points out Hart, as Australia embarks on domestic manufacture of complex guided weapon components, "DSTG has a lot of unique capabilities and expertise that can be leveraged to support the assessments of components and/or to work with industry so that they can establish their own characterisation and assessment capabilities in areas where they may have gaps."

Actually, through the ARMTD and its work, DSTG is aiming to satisfy not one but two long-term strategic goals. Defence wants to build a robust and sustainable industry sector that can provide support whenever necessary, and the Government wants a strong industry sector to become a pillar of a much stronger national economy. DSTG, says Hart, is a critical contributor in supporting the achievement of both goals.

DSTG also plays an important role in supporting Defence in making informed decisions regarding acquisition of capabilities, including for guided weapons, through the conduct of technology risk assessments (TRAs). The TRAs help inform Defence as to the technical pros, cons and limitations of the various options in the context of Australia's own operating environment.

Once a specific capability has been down-selected for acquisition, says Hart, DSTG's role shifts to supporting the introduction into service of those capabilities.

"For example, the Australian operating environment, with regards to usage rates and the type and extent of transport and storage requirements, often differs from that of the allied partners from whom we acquire many of these capabilities," he says. "In these instances, DSTG will work with Defence's acquisition community and the relevant ADF [Australian Defence Force] services to determine whether additional characterisation of the system in question may be required, and then support Defence in prosecuting and interpreting the outcomes of these efforts."

Once a system is introduced into service, DSTG is often the first port of call to support Defence if there are any unexpected issues with safety and suitability for service across the weapons lifecycle. For example, if non-destructive testing identifies hidden defects, or if there is a need to either extend the life of a rocket motor or to verify or increase the operational carriage hours of in-service assets.

Hart has his own list of FAQs, including, "*This asset has been [mishandled/exposed to an unintended event or circumstance, etc.] can it safely be returned back into the ADF inventory and, if so, will it still perform as designed?" and "This asset has reached the end of its originally nominated life. Are we able to extend this service life and, if so, by how much?*"

In addition, DSTG also has a long history of helping industry to resolve issues with munitions manufacture where changes in processes, materials or personnel may result in changes in article characteristics. Historically this has included, and in the near future almost certainly will include, the manufacture of Australianised munitions, or munitions that contain Australian-produced materials, Hart says.

To support all of these areas, DSTG has decades-worth of unique, in-country end-to-end design, development, integration and test expertise for rocket motors, warheads and key guided weapon subsystem components.

DSTG work has always been critical to Defence for averting capability gaps and minimising the risk to both crews and platforms from exposure to potentially unsafe ordnance. With the planned increase in the breadth and depth of the ADF's guided weapons inventory, coupled with the planned increase of in-country manufacture of selected guided weapons, the amount of work that will be required across the propulsion and energetics areas will increase substantially, says Hart.

This will represent an ongoing workforce challenge for Australia's entire SRM ecosystem of which DSTG, owing to its support to manufacture with industry, through to support to the ADF across the weapons lifecycle, is a central part. ●


Range Operations Centre at Woomera Test Range