Missile success

After the flawless launch of the surface-to-surface missile Shourya, the DRDO is set to fire an interceptor missile. BY T.S. SUBRAMANIAN

Shourya will rank among the top 10 missiles in the world in its class, with **its high-performance navigation and** guidance systems, efficient propulsion systems, state-of-the-art control technologies, and canisterised launch.

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V.K. SARASWAT (left), Chief Controller, Research and Development, Missile and Strategic Systems, with the Shourya team led by its programme director A.K. Chakrabarti (right) and P. Venugopalan, DRDL Director. In the backdrop is the missile in a canister.

BUOYED by the successful first test of the surface-to-surface Shourya missile from the Integrated Test Range at Chandipur-on-sea near Balasore in Orissa on November 12, missile technologists of the Defence Research and Development Organisation (DRDO) are engaged in preparing for the launch of an interceptor missile. The launch, scheduled to take place in the second half of December, will feature two missiles. While the target missile, with a range of 1,500 km, will be fired from a ship in the Bay of Bengal towards Wheeler Island, located off the Orissa coast, the interceptor missile, which will be fired from the island, will engage an incoming "enemy missile" in the terminal phase of its flight at an altitude of 80 km in the exo-atmosphere and pulverise it. The enemy missile will be a modified version of Dhanush.

There is intense high-technology work going on at the Defence Research and Development Laboratory (DRDL), the Advanced Systems Laboratory (ASL), and the Research Centre, Imarat (RCI), all located on the serene DRDO campus. The scientists at the ASL are furiously working on Agni-V, which will have a range of 5,000 km. Its design has been completed and development work is under way. It will be launched in 2010. The ASL is also preparing for a flight trial of Agni-IIIA in 2009. The missile will be an advanced version of Agni-II, which has a range of more than 2,500 km.

Shourya is a hypersonic missile; it can reach a velocity of Mach 6 (six times the speed of sound) even at low altitudes. On November 12, even before this "totally new" missile crossed a distance of 300 km, it reached a velocity of Mach 5, heating up its surface to 700° Celsius. The missile performed an ingenuous manoeuvre of rolling to spread the heat uniformly on its surface. Its high manoeuvrability makes it less vulnerable to present-day anti-missile defence systems.

Shourya can reach targets 700 km away, carrying both conventional and nuclear warheads. It is 10 metres long and 74 cm in diameter and weighs 6.2 tonnes. It is a two-stage missile and both its stages are powered by solid propellants. Its flight time is 500 seconds to 700 seconds.

In the estimate of V.K. Saraswat, Chief Controller, Missiles and Strategic Systems, DRDO, Shourya "will

rank among the top 10 missiles in the world" in its class, with its high-performance navigation and guidance systems, efficient propulsion systems, state-of-the-art control technologies and canisterised launch. It can be easily transported by road. The missile, encased in a canister, is mounted on a single vehicle, which has only a driver's cabin, and the vehicle itself is the launch platform. This "single vehicle solution" reduces its signature – it cannot be easily detected by satellites – and makes its deployment easy.

Shourya was ejected from the canister by a gas generator, developed by the High Energy Materials Research Laboratory (HEMRL), Pune, and the ASL. The gas generator, located at the bottom of the canister, fires for about a second and a half. It produces high pressure gas, which expands and ejects the missile from the tube. The missile has six motors; the first one is the motor in the gas generator.The centrepiece of a host of new technologies incorporated in Shourya is its ring-laser gyroscope and accelerometer. The ring-laser gyroscope, a sophisticated navigation and guidance system made by the RCI, is highly classified technology. Advanced countries have denied this technology to India. In Shourya's flight, it functioned exceptionally well. Its job is to monitor the missile's position in space when it is flying. The missile's onboard computer will use this information on the missile's actual position to compare it with the desired position. Based on the difference between the missile's actual and desired positions, the computer will decide on the optimum path and actuators will command the missile to fly in its desired/targeted position.

If one were to strike a comparison, the missile is akin to a human body, with the gyroscope acting like the eyes, the computer like the brain and the actuators like the hands.

M. Natarajan, Scientific Adviser to the Defence Minister and Director-General of the DRDO, praised the way the ring-laser gyroscope functioned in Shourya's flight. "We flew our own navigation system in this missile. It

SHOURYA LIFTS OFF from the Integrated Test Range at Balasore on November 12.

BY SPECIAL ARRANGEMENT

worked very well. This is an important step forward for the country in the navigation of missiles, aircraft and spacecraft. No other country will provide India this navigation system," he said.

Another important feature of the missile is that it has a trajectory that is non-ballistic. This gives Shourya a big advantage in a combat environment of interception by a ballistic missile defence shield. Saraswat said: "There are many features in this missile that reduce its radar cross-section to very low values, ensuring that under no phase of its trajectory, Shourya can be detected by state-of-the-art radars. In strategic defence scenario, this missile will find an important place after it completes its development trials."

What has focussed attention on Shourya is that it is a land variant of the DRDO's K-15 missile launched from under water. There have been several launches of the K-15 missile, coming under the Sagarika project. The last of these took place in February 2008 from a submerged pontoon. The launch simulated the conditions of a submarine. W. Selvamurthy, Chief Controller (R&D), DRDO, asserted that the missile provided India with a second strike capability. Selvamurthy called Shourya's flight a significant milestone in building capability for the nation in the field of missiles for both strategic and tactical applications.

A.K. Chakrabarti, programme director of the Shourya project, said the missile had several "safety interlocks" preventing it from being fired inadvertently. He said strategic missiles (that is, missiles that can carry nuclear warheads, which are used only for a show of threat) had redundancy and reliability built into them so that they were not fired accidentally. Safety interlocks provided such redundancy.

Although hypersonic missiles fly at high altitudes, what makes Shourya different is that it can fly at low altitudes. For instance, Agni variants flew at 100 km, 200 km or 500 km altitudes, reaching even Mach 15. "But Shourya flies at a relatively low altitude, even reaching Mach 6. This is the crux of the matter in terms of technology development," Saraswat said.

Chakrabarti added: "Hypersonic missile is a new field of activity even in advanced countries. However, we have established our expertise in this field."

CANISTERISED FORM

Shourya's launch was in a canisterised form but from a silo. Half of the missile's length was inside a pit, that is, a silo. Chakrabarti said: "You can easily put the entire missile inside the pit. Normally, the depth of the silo depends on the operation. So the depth can be 10 metres or 20 metres, depending on the place where you are going to launch it from, the condition of the ground, or safety requirements."

Whether the missile was launched from a depth of 20 m or 40 m did not make a difference, P. Venugopalan, Director, DRDL, said. The silo had to be built accordingly. "The missile comes out of it as part of its trajectory. You must fire the main booster only after it comes out of the silo." A tremendous amount of effort went into the design, quality assurance, and the manufacture and testing of hardware. "For a large system, you cannot afford to conduct many tests. In a few trials, you have to prove the system. Shourya has a high order of reliability," he said.

What lends mobility to Shourya is that it can be launched from a canister mounted on a trailer. This trailer, or launcher, as it is called, was built by the Research and Development Establishment (Engineers), Pune. It has several features to absorb shocks in order to make the transport of the missile by road safe.

Chakrabarti said the canister was made of locally available high-strength, special-glass composite. The DRDO has set up a facility in the missile complex to manufacture the tube.

Dr. A. Subhananda Rao, Director, HEMRL, said: "This gas generator system should have a very high reliability of 99.997 per cent. If it fails, a lot of things will burst." The gas generator's propellants have a special requirement. Their burn rate should be very high, that is, three to four times more than that of the rocket's propellants. The responsibility of the generator is to produce the gases at the required pressure so that the missile comes out of the canister within a certain velocity band. "The basic requirement is that the missile should come out of the canister within a few seconds. This is to meet the required canister-exit velocity," Subhananda Rao said.

The first stage is fired by a motor powered by solid propellants, which has a complex grain configuration. The second stage is fired by another motor, which will take the missile to the required velocity. There are retro-motors as well. "When the first stage is separated from the second stage, it has to be decelerated to maintain the gap between the first and second stages. For separating the first stage and jettisoning it, we have pitch-and-yaw motors," he added.

The HEMRL provides the solid propellants for powering Shourya's various motors and the pyro devices for jettisoning the first stage. There are elaborate facilities at the 850-acre (one acre is 0.4 hectare) HEMRL complex to design and produce the solid propellants required for various missiles.

The secret of Shourya's success, in the estimate of M.S.R. Prasad, project director, lies in its optimum configuration. The smaller the size of the missile, the lower its drag and resistance. So its packing density would be high. "Shourya has minimum weight and minimum cross-section. That gives it a high performance," Prasad explained. If the missile's diameter were to be large, it could be comfortable internally. But such a diameter would increase the air resistance and decrease the overall performance.

It was a young DRDO team, under the leadership of A. Joseph, project director, that built the missile. While the project team was from the DRDL, which designed Shourya, important contributions came from the ASL, the RCI, the HEMRL and the RDE (Engineers). The missile is under production by Bharat Dynamics Limited, Hyderabad. □