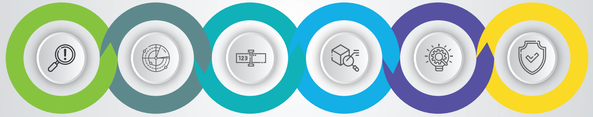
FIREPOWER

The CSIR's research effort focuses on analysing ballistic and explosive effects to devise appropriate protective technologies. This requires an understanding of conventional and unconventional threats, such as fragmentation and chemical analysis, surrogate testing of explosively formed projectiles, shaped charged explosives, or improvised explosive devices, in roadside and underbelly blasts, as well as other high explosive energetic materials.

The CSIR also conducts research aimed at designing and developing disruptor technologies and solutions. It also has the facilities and measurement technologies to do the test and evaluation of solutions that protect against IEDs.

RESEARCH INTO EXPLOSIVELY FORMED PROJECTILES, WARHEADS AND IMPROVISED EXPLOSIVE DEVICE (IED) PROTECTION:



VEHICLE AND CREW SURVIVABILITY

The major focus in vehicle design is the vehicle hull – such as its ground clearance, the V-shaped hull, widened axle length and blast deflectors (in the wheel arches). In order to increase the protection of the occupants, the choice of seats and footrests is also receiving attention.

One class of IED commonly used to defeat platforms is explosively formed projectiles. These devices consist of shallow dished liners made from high-density metal and other alloys, which are explosively formed and launched at high velocity.

Most protection solutions have a high aerial density that adds weight, reduces mobility and limits payload capacity.

The CSIR's IED protection package offers protection equal to that of 50 mm thick conventional steel armour without degradation of mobility. The package consists of two distinct and separate technologies that, when used in conjunction, create the desired protection capability. It has been used by security forces in peacekeeping deployment in Africa.

TECHNICAL CAPABILITY

To ensure that the site caters for the test needs of the SANDF and the rest of the defence and security sector, different facilities are available for different threat characterisation. Water-borne explosives are tested in dams on the site. A special minimum metal detection facility is used to research the effects of environmental influences on the aging of landmines. In addition, DBEL accommodates a test range for small arms and automatic grenade launchers, cubicles for the testing of small charges, a fenced area for research into landmine explosions – supported by the necessary explosive magazines, explosive ordnance disposal facilities and a mechanical workshop for the preparation and casting of custom explosive units. The CSIR has also designed and manufactured a human response test rig (HRTR) to enable and support in-house research on crew survivability.

EXPLOSIVE SCIENCE

The CSIR's measurement methodology is based on comparing various explosives and munitions in terms of blast wave characteristics. Elements of the research include analyses of pressure, stress, load or force, velocity, acceleration, displacement and impulse.

The acquisition of data during explosive tests is accomplished by the integration of various sensors, medium, high and ultra-high-speed cameras (capturing up to two million frames per second), various data acquisition systems and X-ray systems. However, not all research requires the detonation of explosives. For instance, a device can be inspected dynamically or non-destructively through the use of X-ray facilities.

Ultra-high-speed photography (recording speeds up to two million frames per second) and the Flash X-ray system are used for ultra-fast diagnostics of explosive events. These diagnostic tools capture events in nanoseconds.

DBEL FOR TRAINING

The SANDF, Armscor and other governmental department groups have used DBEL facilities for training and experimentation. In fact, prior to becoming a national research, development and test range, the property was used as a military training facility.

The South African Police Service and Special Forces use the site for testing and training on explosive ordinance disposal and improvised explosive device disruption, and the Department of Employment and Labour has used it for the training of explosives inspectors – particularly in the safe development and testing of experimental explosive devices.

The facilities are also used to support national skills development in the science domain of detonics, ballistics and explosives by making it available to higher education institutes, in support of under and postgraduate students. In addition, a number of technical interns are employed at DBEL, where they are trained and exposed to the unique processes and facilities at the site.

PRODUCT DEVELOPMENT SUPPORT FOR INDUSTRY

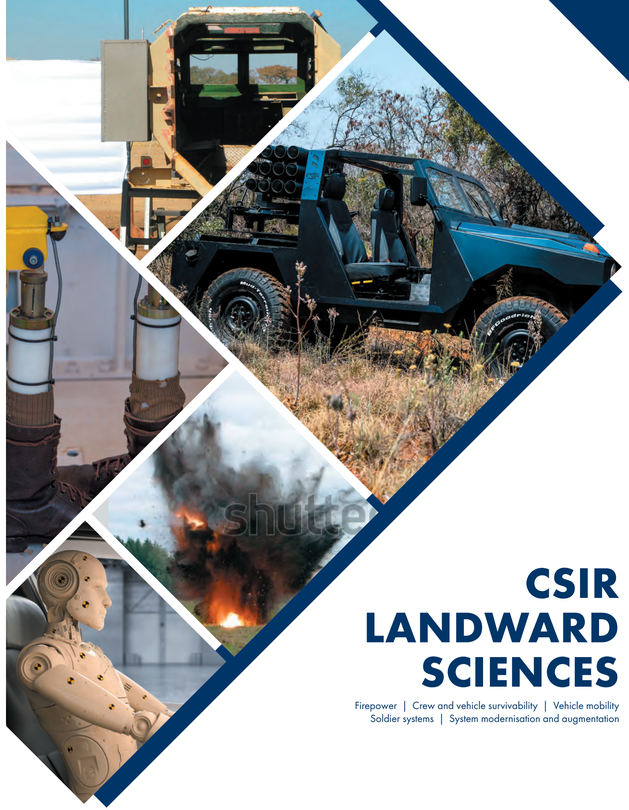
The facility supports product development for various industries through provision of test and evaluation (T&E) services. This enables the facility to support the competitiveness of the industry locally and internationally. Industries supported include mining, explosives, cash-in-transit (CIT) and banking.

Scientifically Instrumented Impulse Measurement Apparatus

Flash X-ray

Blast-enclosed Chamber

High-speed Cameras



CSIR LANDWARD SCIENCES

Firepower | Crew and vehicle survivability | Vehicle mobility
Soldier systems | System modernisation and augmentation

science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

CSIR
Touching lives through innovation

ABOUT US

The CSIR's landward sciences experts undertake research, development and innovation (RD&I) across the full spectrum of landward defence and security in the contemporary operating environment to deliver:

- Science, engineering and technology solutions;
- Test, measurement and evaluation services; and
- Advisory and decision support.

The group comprises R&D engineers (electronic, metallurgical, mechanical, biomedical) and scientists in fields such as explosives, computational modelling, physics and chemistry. The specific research areas are applied detonics, ballistics and explosives; tactical vehicle mobility; and rapid operational solutions.

LANDWARD SCIENCES FOCUS AREAS:

- Firepower
- Crew and vehicle survivability
- Vehicle mobility
- Soldier systems
- System modernisation and augmentation

- Enabled by bespoke capabilities
- Detonics, Ballistics and Explosives Laboratory (DBEL).
- Prototype fabrication workshops and
- Multi-physics modelling and simulation

Technology becomes the critical armament to shape forces for the future. The CSIR is proud of its track record in using scientific, engineering and technological tools and approaches to transform, support and sharpen the effectiveness of our defence and security forces.

Several decades of R&D and technology development puts the CSIR in a position to offer the defence and security clients access to significant expertise complemented by test, evaluation and measurement infrastructure and facilities of which many are unique in the world.

Operational insight and techno-military capability is complemented with expertise in other departments within the CSIR such as materials, food, health, manufacturing, robotics, nano-technology, smart space design and environmental management.

The CSIR is the single, National Authority for Vehicle Landmine Protection Validation Testing in accordance with either RSA-MIL- STD-37 or AEP-55 Volume 2 and 3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AEP-55

PROCEDURES FOR EVALUATING THE PROTECTION LEVEL OF ARMOURED VEHICLES - IED THREAT

Edition C Volume 3 (PART I), Version 1
Ratification Draft 1

NORTH ATLANTIC TREATY ORGANIZATION

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TITLE PAGE

TITLE : LANDMINE AND IED PROTECTED WHEELED VEHICLES: DESIGN, DEVELOPMENT AND EVALUATION OF

DOCUMENT NUMBER : RSA-MIL-STD-37

SUMMARY : THIS DOCUMENT PROVIDES MINIMUM REQUIREMENTS, TEST SPECIFICATIONS, DESIGN AND EVALUATION OF LANDMINE AND IED PROTECTED WHEELED VEHICLES

KEY WORDS : LANDMINE, IED, WHEELED VEHICLE, PROTECTION, SURVIVABILITY, RELIABILITY

DATE OF ORIGINAL ISSUE: OCTOBER 2020

CREW SAFETY AND SURVIVABILITY

There are several international standards for the specific injury criteria for protective vehicles, based on measured forces and accelerations. With a research focus on impact on lower limbs and seat design, the CSIR conducts blast experiments with anthropomorphic test devices (ATDs) – or dummies as they are commonly referred to – with sensor instrumentation, combined with tools such as computational modelling, simulation and infrared or high-speed photography to capture and analyse the dynamic response of crew during explosive events.

HUMAN INJURY CRITERIA RESEARCH

The CSIR has specialised equipment and facilities to test human response to explosive events – particularly for vertical loading events, landmine detonations and IED penetrations. ATDs or dummies are used to measure the human response to blast incidents.

Human vulnerability research is undertaken into:

- Blunt trauma;
- Effects of explosive events; and
- Terminal ballistics.

RESEARCH INTO DIFFERENT BODY REGIONS

Where the seats of a landmine-protected vehicle are integrated into the vehicle floor and the occupant's feet are in contact with the floor and toe pan, serious injury to lower legs, lumbar, pelvis and cervical spine can occur due to the direct structural load path of the shock and stress wave propagation.

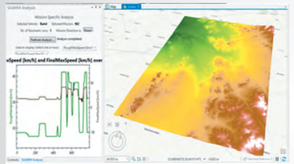
VEHICLE MOBILITY

Key to the design of mobility solutions is an understanding of the operational requirement, terrain, environment to be covered, and the performance of best-suited vehicle options. In many cases, economical factors require that existing mobility platforms be adapted for new uses. In such cases, a standard vehicle becomes a mobile command centre, a troop carrier, and ambulance or a logistics platform.

Mobility is a form of protection. A vehicle that has become immobilised compromises the mission and safety of the occupants.

PROTOTYPE AND TECHNOLOGY DEMONSTRATOR DEVELOPMENT

The CSIR has a testbed vehicle that can be used to accurately test different mobility technology applications. On this platform, weaponry, troop mobility, autonomous technologies and terrain handling can be tested.



Independent research into vehicle mobility, includes the following:

- Operational area vehicle mobility test and evaluation;
- Vehicle subsystem parameterisation and characterisation for model development;
- Multibody vehicle dynamics and mobility modelling;
- Roll-over stability evaluation of protected military vehicles;
- Tyre characterisation and modelling;
- Terrain profile measurement and modelling;
- Controllable suspension research;
- Ride comfort vs handling compromise;
- Dynamic control of autonomous vehicles; and
- Remote sensing and vehicle telemetry.

SOLDIER SYSTEMS

PROJECT EXAMPLE: TESTING THE CONCEPT OF "GREEN" DEPLOYMENT

The Joint Operations Division of the South African National Defence Force (SANDF) and the CSIR have a long-standing partnership in operational border deployment. South Africa's border line has a number of unique challenges brought about by its size, porousness, ecological sensitivities, etc.

The objective is to improve the deployment conditions, capabilities and effectiveness of the soldier, deployed on mission-specific tasks, where combat systems are not suitable for these unique deployment scenarios.

Specific projects include the following:

- Custom mobility package development;
- Protection of soldiers against dangerous animals;
- Power supply for deployed soldiers in remote locations;
- Waste management for deployed soldiers;
- Identification of friend or foe;
- Non-lethal/less than lethal requirements;
- Operational command and control capability; and
- Sustainment systems.

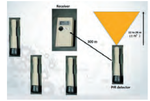
These pilot projects provided important operational insight into remote deployments in aspects such as managing the environmental footprint of troops, waste management (including water purification), food management, and protection of soldiers (non-lethal). It is of particular value to remote deployments, such as peace support operations in Africa.

Modern day forces face increasingly complex and lethal battlefields with new and different threat types – remotely detonated explosive devices, advanced anti-tank missiles, unmanned remotely directed air and land platforms, sophisticated detection systems and chemical weapon agents. To counter this new battlefield domain the soldier needs to be better equipped and prepared

KEY AREAS OF RESEARCH INTO SOLDIER SAFETY:

- Technology effectiveness studies
- Situational awareness technologies (day/night)
- Equipment interfaces
- Solder performance enhancement tools
- Solutions for equipment weight
- Border safeguarding technologies
- Detection systems – including explosive remnants of war – detection, clearance and disposal
- Training systems

Situational awareness systems



Effectiveness studies

Training and simulation

Since science and technology drives innovative and new solutions, it improves the capability and survivability of the soldier in the mounted and dismounted role. Science and technology studies the baseline to understand threads and evaluate possible solutions that lead to better decision-making and soldier modernisation programmes.

ENABLING CAPABILITIES

Agencies rely on the CSIR for the scientific component of 'smart' defence, acquisition, capability management and mission success. The CSIR, therefore, develops and maintains the tools, systems and infrastructure required to yield that scientific contribution. This ranges from experimental research, computation studies, modelling and simulation to sensor systems, ultra-high-speed photography, X-ray capabilities and chemical analysis.

TEST, MEASUREMENT AND EVALUATION

- Detonics, Ballistics and Explosives Laboratory (DBEL);
- Prototype fabrication workshop – Mechanical and Electronic;
- Chemical Facility;
- Soldier Systems, Mobility and Protection Laboratories; and
- Field trials at a secure site representative of the deployment scenario.

COMPUTATIONAL MODELING

- Multibody Dynamic Modelling;
- Multiphysics modelling;
- Human response modelling;
- Numerical and Finite Element Analysis; and
- CAD Support.

MODELLING AND SIMULATION AS SMART, SCIENTIFIC WEAPONS OF CHOICE

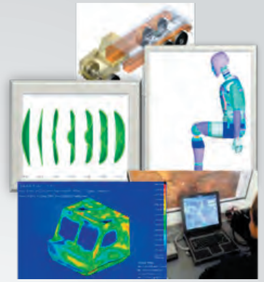
Safe, cost-effective and time efficient modelling and simulation tools provide the means to simulate threats and create and test technology concepts. For example, data from explosives testing reveal the blast loading and all the physics and mechanics to be used in designing countermeasures.

RAPID PROTOTYPING WORKSHOP

The rapid prototyping workshop is where concepts are tested, experimented with and refined to product design phase. Having a prototype for field testing takes guesswork out of coming up with solutions to operational needs.

The facility has been pivotal in a number of successful projects. It was also used in customisation of a suite of border patrol vehicles: commercially-available vehicles that were turned into field ambulances, mobile command and control stations, logistical modules and troop carriers. The facility also enables rapid integration of weapon systems tailored for specific vehicles.

More recently, the workshop produced a test-bed tactical vehicle, to demonstrate enhancements and adaptations such as increased situational awareness to unmanned, autonomous vehicle applications. The workshop is equipped with capabilities such as advanced prototype manufacturing, metal cutting and fabrication machinery, welding bays, abrasive water-jet cutting and sophisticated vertical and horizontal computer numerical controlled machining centres.



DETONICS, BALLISTICS AND EXPLOSIVES LABORATORY (DBEL)

The CSIR's DBEL is a uniquely equipped, multi-million rand facility that is used in the development of protective technologies for people and infrastructure, and to support astute procurement of defence and security operational requirements.

The facility is situated near Pretoria in South Africa's Gauteng province. Testing types range from small arms testing, small scale tests up to 200 g and explosive events up to 50 kg net explosive content. A number of shelters ensure the safety of operators in compliance with health and safety regulations.

CSIR researchers make use of specialised equipment and techniques extensively to do experiments, measure the outcome of the experiment and correlate findings with the theoretical base in the research field. Many of these techniques were developed by the CSIR and refined over many years.

DBEL is the only national test facility for the validation of vehicle protection against landmines and IEDs. Through this facility, the CSIR has developed and contributed to both international and local protection standards.

In order to support acquisition decision-making, the DBEL facility is used to develop specifications – and check delivered goods against specifications. This avoids the intake of inferior, inefficient – even dangerous or defective – products and prevents loss of lives and millions of invested rand.

The facility is used by various teams within the CSIR's defence research capability to inform the design, engineering and development of suitable and effective personnel, vehicle and infrastructure safety solutions.