# UWTSD OME Degree apprenticeship: Final Project Challenger 3 Main Battle Tank: Secondary Natures


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**Summary:**

**OBJECTIVE:** This report assesses whether the Challenger 3 (CR3) main battle tank possesses a **sufficiently capable suite of secondary natures to meet expected operational requirements** and identifies additional natures that could **close residual gaps** or enhance platform effectiveness. Conducted in parallel with a formal Dstl study, this work uses open-source material only and is written at UK OFFICIAL.

**Method:** Capability was evaluated through a structured survey completed by UWTSD OME apprentices. Respondents compared the current CR3 ammunition set—**APFSDS**, a **baseline HE-fragmentation** nature (Point Detonating assumed), and the platform's machine guns—against a representative target set. Assessments were expressed using the UK Defence Intelligence probability yardstick, translated into a seven-point numerical scale to enable aggregation and comparison.

**Results: I**ndicate a strong baseline against most targets, particularly when engaging armoured vehicles outside their frontal arc. However, consistent shortfalls were identified against **hardened structures, entrenched infantry, and drones**. Potential mitigations include adopting **multi-mode HE-FRAG** with airburst, re-introducing a **HESH** type structural-defeat munition and exploring **NLOS** (ATGM and HE-FRAG) solutions. Continued **APFSDS** development remains important for overmatch but does not address secondary-effects gaps. Given the open-source evidence base and non-SME respondent pool, confidence levels are limited; **follow-on modelling/wargaming**, SME advice, and targeted technology demonstrations are recommended to validate findings and de-risk integration.





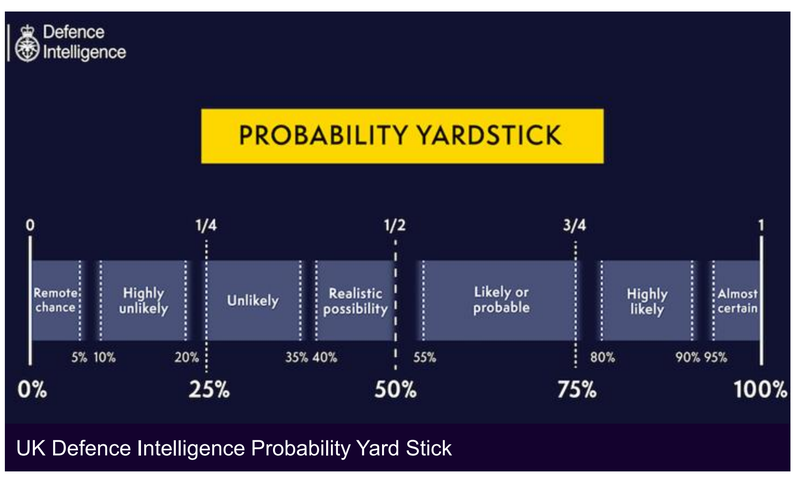
Challenger 3 Advanced Technology Demonstrator at RBSL Telford

## Background

The Challenger 2 MBT has been in service with the British army since **1998**. Since its introduction it has seen a number of upgrades including the capability sustainment programme (2005) and the CR2 Life extension Programme (LEP) (2014). The LEP programme considered the adoption of a **120mm Smoothbore gun**, in a break with previous UK MBT designs. In 2018, BAE systems developed the Challenger 'Black Knight' demonstrated with various upgrades, concurrently Rheinmetall who developed their own variant featuring a new turret and the Rheinmetall L55A1 120mm Smoothbore gun. A year later in 2019 BAE and Rheinmetall formed the joint venture company 'Rheinmetall BAE systems Land' (RBSL) and submitted the winning bid for the CR2 LEP programme. This culminated in the 2021 command Paper 'Defence in a Competitive Age' announcing the upgrade of **148** CR2 MBTs to the CR2 LEP standard, which was **renamed to become Challenger 3.**

## Methodology and Target Set

To assess the capability a **survey-based approach has been taken**. This mirrors the formal Dstl report but only contains the information available in the public domain. This included defining the missions and subsequently generating a target set for the targets challenger may face. In the Dstl formal study, SME judgement was sought to assess the capability, but to prevent classification issues, OME apprentices were approached instead. To assess the current and potential capabilities a matrix was developed, comparing munitions with a target and its position. These were scored 1-7 using a numerical interpretation of the UK Defence Intelligence probability yard stick. Results were then collated and averaged to produce the capability matrix summaries.




UK Defence Intelligence Probability Yard Stick

| Available to CR3 (Publically | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Platform | Capability | TRL | Dismounted Troops (Pax x4) | | | | Low Silhouette Vehicle | | | Soft Skin Vehicle (Logistics Vehicle/ Trucks) | | | Armour Personnel Carrier (Protected Mobility) | | | Light Infantry Fighting Vehicle | | |
| | | | O | PMed | PHard | E | S | F | R | S | F | R | S | F | R | S | F | R |
| CR3 | APFSDS | | 2 | 2 | 2 | 1 | 5 | 5 | 5 | 5 | 5 | 5 | 6 | 5 | 6 | 6 | 5 | 6 |
| | HE FRAG PD | | 6 | 5 | 3 | 3 | 4 | 4 | 4 | 6 | 6 | 6 | 4 | 3 | 4 | 4 | 3 | 4 |
| | Chain Gun | | 6 | 5 | 4 | 3 | 4 | 4 | 4 | 5 | 5 | 4 | 2 | 2 | 2 | 2 | 2 | 2 |
| | GPMG Pintle | | 6 | 4 | 3 | 2 | 4 | 3 | 3 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 2 |
| | Highest SCORE | | 6 | 5 | 4 | 3 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 5 | 6 | 6 | 5 | 6 |
| | Average / Flexibility | | 5 | 4 | 3 | 2.25 | 4.25 | 4 | 4 | 5 | 5 | 4.75 | 3.5 | 3 | 3.5 | 3.5 | 3 | 3.5 |
| | Average (rounded) | | 5 | 4 | 3 | 2 | 4 | 4 | 4 | 5 | 5 | 5 | 4 | 3 | 4 | 4 | 3 | 4 |

Section of the CR3 Current Capability Matrix

## Current Capabilities

There is limited public information surrounding the current ammunition natures available to the Challenger 3 MBT, however Defence Equipment & Support (DE&S) have previously confirmed that the 120mm **Enhanced Kinetic Energy** (EKE / KE2020NEO) has been supplied to the British army and is currently **undergoing qualification**. Whilst the has been **no publicly announced High Explosive nature**, the project has assumed that a basic type with a point detonating fuze (PD) similar to the General Dynamics 'IM-HE-T', Rheinmetall 'DM11 (with RH31Fuze)' or KNDS 'F1 HE'. Whilst the extant munitions are **effective against the majority of the target set**, some areas were identified as requiring improvement. **Structures**: this was the single largest weakness of the current suite, the HE Frag (PD) munition was assessed to have relatively poor effect against this target type; additional investigation is recommended within the potential capabilities. **Drones**: engaging these targets are extremely difficult not only to target but to detect in the first instance. It was recommended that this also be investigated within the Potential capabilities.

## Platform Considerations

As well as the capability of the ammunition it is important to remember it must be integrated onto a platform. These have limitations including items such **as turret traverse speeds, munition programming limitations and gun elevations and depressions**. It is also essential to ensure that ammunition will match the pressure requirements of the gun system; **not all 1200x570mm NATO ammunition can be fired out of every gun of that calibre.**

| Platform | Capability | Arty - SPG | | | Arty - Towed | Mini Uninhabit | Small Uninhabit | Structures | | | Bridges | | Helicopter | | Train |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | S | F | R | In action | Micro | Mini | Hard | Med | Soft | Hard | Pont | Ground | Low Alt | |
| CR3 | FUTURE APFSDS | 6 | 6 | 6 | 5 | 1 | 1 | 3 | 3 | 3 | 2 | 3 | 5 | 4 | 4 |
| | HE FRAG PD | 5 | 5 | 5 | 5 | 2 | 2 | 3 | 3 | 4 | 2 | 4 | 6 | 3 | 4 |
| | HE FRAG PDD | 5 | 4 | 5 | 6 | 2 | 2 | 3 | 4 | 5 | 3 | 5 | 6 | 3 | 4 |
| | HE FRAG AB | 4 | 4 | 5 | 5 | 4 | 4 | 2 | 3 | 4 | 2 | 4 | 6 | 5 | 3 |
| | CANNISTER | 4 | 3 | 3 | 5 | 4 | 4 | 2 | 3 | 4 | 2 | 3 | 5 | 4 | 3 |
| | SMOKE | 3 | 3 | 3 | 4 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 2 |
| | ILLUMINATION | 4 | 4 | 4 | 4 | 2 | 2 | 4 | 4 | 4 | 3 | 3 | 4 | 3 | 3 |
| | HESH | 6 | 5 | 5 | 5 | 1 | 1 | 5 | 6 | 6 | 6 | 5 | 6 | 4 | 5 |
| | OFTA | 6 | 5 | 5 | 5 | 1 | 2 | 3 | 4 | 4 | 3 | 4 | 6 | 4 | 4 |
| | TA ATGM | 6 | 6 | 6 | 6 | 2 | 2 | 3 | 4 | 4 | 3 | 3 | 6 | 4 | 4 |
| | DF ATGM | 7 | 6 | 7 | 6 | 2 | 2 | 4 | 4 | 4 | 3 | 4 | 6 | 5 | 5 |
| | NLOS ATGM | 6 | 6 | 6 | 6 | 2 | 2 | 3 | 4 | 4 | 3 | 4 | 6 | 4 | 4 |
| | NLOS HE FRAG | 5 | 4 | 5 | 5 | 4 | 4 | 3 | 4 | 5 | 2 | 4 | 6 | 5 | 4 |
| | Highest SCORE | 7 | 6 | 7 | 6 | 4 | 4 | 5 | 6 | 6 | 6 | 5 | 6 | 5 | 5 |
| | Average / Flexibility | 5.15385 | 4.69231 | 5 | 5.15385 | 2.30769 | 2.38462 | 3.07692 | 3.69231 | 4.15385 | 2.76923 | 3.76923 | 5.46154 | 3.84615 | 3.76923 |
| | Average (rounded) | 5 | 5 | 5 | 5 | 2 | 2 | 3 | 4 | 4 | 3 | 4 | 5 | 4 | 4 |

Section of the CR3 Potential Capability Matrix

## Recommendations

Based upon the information available within the report the following munitions warrant further investigation

**Future APFSDS:**

Presents significant upgrade to existing capability. Increases lethality against many of the core target set. Should be examined by Primary Natures Project

**HE Frag (Multimode fuzing):**

Offers significant increase if flexibility and lethality including against airborne threats. Should be investigated further through wargaming models.

**HESH:**

Offers substantial effectiveness against structures as well as against light armoured vehicles. Will allow increased flexibility for the platform. Should be progressed to wargaming models.

**NLOS (ATGM and HE FRAG):**

Offer new type of capability (indirect fires). Allows increased standoff and lethality whilst not exposing platforms. Should be progressed to wargaming models.

## Potential Capabilities

The potential capability matrix covered many types of novel and preexisting munitions as can be seen in the matrix above. Many of these offered increases in capability but a few munitions stood out. The **HESH** shell had significant lethality against structures, as well as offering effectiveness across multiple other targets. **HE Frag (Multimode fuzing)** offered increased lethality against airborne targets and entrenched infantry. **Non-Line-Of-Sight Weapons** could offer an entirely new capability to CR3, there performed well; additional standoff would increase lethality whilst reducing platform losses. **Future APFSDS** will not offer additional flexibility, but will enable continued lethality against hostile armour.

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