FCS SDD-449 Close Combat Armament System (CCAS) Trade Study – Performance Assessment

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• Budget pressures on both the FCS CCAS weapon and weapon station programs necessitated looking for either Non-Development Item (NDI) or nearly NDI solutions for both the weapon and weapon station – SDD-449 Trade Study was Conducted

• AMSAA used the FBAR model to conduct a performance assessment of select weapon and ammunition systems in support of the SDD-449 Trade Study

• IWARS used to replicate a subset of the CCAS study in order to verify IWARS results consistent with established methodology
Study Scenario

- **OPFOR Targets**
  - Personnel: 8 man squad
    - Initial posture standing
    - All OPFOR go prone after first round fired (regardless of targeted OPFOR)
    - OPFOR does not return fire (FBAR only plays one sided engagement)
  - Materiel: BTR (Soviet Light Armored Vehicle)
- **Terrain**: Tabletop
- **Candidate Weapon/Munitions mounted on Combat Vehicle**
- **Engagement Process**
  - Aimpoint for bursting munition is 1 meter above target
  - Aimpoint for kinetic rounds center of mass
  - Targets OPFOR on far left first
  - Fires one burst per target
  - Subsequent burst fired at target to right of current target (personnel only)
**CCAS Weapon Alternatives and Characteristics**

**Weapon & Fire Control Basis**
- Remote weapon station
- Single or dual feed
- Stabilized gun & sight
- 360 deg traverse
- -20/+60 deg gun elevation
- Powered Optic w/thermal
- Laser range finder (LRF)
- Fire control w/lead

**Alternatives / Ammo Types / Loads**

<table>
<thead>
<tr>
<th>Weapon</th>
<th>Anti -Personnel</th>
<th>Anti - Materiel</th>
<th>Total Load</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Round</td>
<td>Count</td>
<td>Round</td>
</tr>
<tr>
<td>M240</td>
<td>M80</td>
<td>1252</td>
<td>M80</td>
</tr>
<tr>
<td>L94</td>
<td>M80</td>
<td>1252</td>
<td>M80</td>
</tr>
<tr>
<td>M134*</td>
<td>M80</td>
<td>1252</td>
<td>M80</td>
</tr>
<tr>
<td>M2HB</td>
<td>M8</td>
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<td>M8</td>
</tr>
<tr>
<td>XM312</td>
<td>M8</td>
<td>297</td>
<td>M8</td>
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<tr>
<td>ATK .50</td>
<td>M8</td>
<td>297</td>
<td>M8</td>
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<tr>
<td>XM307</td>
<td>XM1019</td>
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<td>XM1049</td>
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<tr>
<td>ATK LW 25</td>
<td>XM1019</td>
<td>205</td>
<td>XM1049</td>
</tr>
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<td>XM301*</td>
<td>XM1019</td>
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<tr>
<td>MK47</td>
<td>PPHE</td>
<td>106</td>
<td>M430</td>
</tr>
<tr>
<td>M129</td>
<td>PPHE</td>
<td>106</td>
<td>M430</td>
</tr>
</tbody>
</table>

Ammo count based on 50kg allotment and 3:1 mix

* multi-barrel gatling gun

Unclassified
AMSAA Analysis Approach

AMSAA Models
- CASRED - Lethality Effects
  - PK grids, lethal areas
- FBar - Anti-personnel Effects
  - Pi, FractCas, Rds/kill etc.
- PVTM - Anti-materiel Effects
  - Phit, Pkill, Engagement Timeline, Rds/kill etc.

AMSAA Models Inputs
- Delivery Accuracy Data
  - Gunner - Aim/wobble, lasin accy and range determination
  - Weapon - boresight, parallax, launch angle, recoil
  - Ammunition - Muzzle velocity, drag, spin, fuze timing, disp
  - Environment - Temp, wind, air den
- Engagement Conditions
  - Target set, burst fire meth, tgt exposure, ammo load, etc.

AMSAA Models Outputs
- Phit / Pkill / Pincap / Fractional Casualty
- Established ORD Targets
- Calculate
  - ORD Compliance
  - Stowed Kills
  - Time to Kill

PM / Contractor / ARDEC / ALR / ATC / AMSAA
- Anti-personnel Data
  - Frag mass/ velocity, penetration equations, etc

ARL / AMSAA
- Anti-Materiel Data
  - damage state
  - cell-by-cell vuln. data
  - Pkill / hit

Contractor / ARDEC / AMSAA
- Delivery Accuracy Data
  - Gunner - Aim/wobble, lasin accy and range determination
  - Weapon - boresight, parallax, launch angle, recoil
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UAMBL / USAIC / AMSAA
- Engagement Conditions
  - Phit, Pkill, Engagement Timeline, Rds/kill etc.
ORD Compliance Scoring Methodology

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Score</th>
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<tbody>
<tr>
<td>Exceed Objective</td>
<td>10</td>
</tr>
<tr>
<td>Midpoint of Objective to Objective</td>
<td>8</td>
</tr>
<tr>
<td>Threshold to midpoint of Objective</td>
<td>6</td>
</tr>
<tr>
<td>2/3rd of Threshold to Threshold</td>
<td>4</td>
</tr>
<tr>
<td>1/3rd-2/3rd of Threshold</td>
<td>2</td>
</tr>
<tr>
<td>0-1/3rd of Threshold</td>
<td>0</td>
</tr>
</tbody>
</table>

Score of 6 or greater indicates that ORD KPP is met or exceeded
Scores under 6 indicates that ORD KPP is not being met

ORD compliance scoring is performed for each performance KPP

**STOWED Kills** – Rounds “on board” / Number of rounds required to achieve levels of $P_k / F_c = X$. Normalized to system with most stowed kills, multiplied by 10, and rounded to nearest whole number.

**Time to Kill** - Average Exposure time to kill (achieve $P_k / F_c = X$) both the Materiel and 8-Man Infantry targets at the Threshold range (time from first round fired to target is dead based on number of bursts needed to kill – incorporates aim/lay time, rate of fire, and 3 sec BDA). Normalized to system with shortest time to kill, multiplied by 10, and rounded to nearest whole number.
## Summary Rankings

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>M240</th>
<th>L94</th>
<th>M134</th>
<th>M2HB</th>
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<th>ATK.50</th>
<th>XM307</th>
<th>XM30FTE</th>
<th>XM301</th>
<th>LW25</th>
<th>MK47</th>
<th>M129</th>
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<tbody>
<tr>
<td>7.62mm</td>
<td>9.04</td>
<td>6.88</td>
<td>6.90</td>
<td>5.29</td>
<td>7.33</td>
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<td>3.25</td>
<td>1.41</td>
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<td>3.00</td>
<td>2.00</td>
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<td>1.41</td>
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<td>7.39</td>
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<td>8.87</td>
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<td>40mm</td>
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<td>10.00</td>
<td>6.00</td>
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<td>4.35</td>
<td>7.17</td>
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</table>

### Alternatives

- **MK47**
  - 40mm

### Weighted Average Score

\[
\text{Weighted Average Score} = 0.50 \times \text{ORD Compliance Score} + 0.25 \times \text{Stowed Kills Score} + 0.25 \times \text{Time to Kill Score}
\]

### Weighted Average Scores

- **ORD Compliance Scores**
  - 0.67
  - 0.67
  - 0.00

- **Stowed Kills Scores**
  - 4.57
  - 4.57
  - 1.13

- **Time to Kill Scores**
  - 3.30
  - 2.91
  - 1.24

- **Weighted Average Score**
  - 7.50
  - 7.89
  - 7.39

### Unclassified

**Technology to the Warfighter Quicker**
CCAS Study Summary

• Results
  – .50 cal (bullet) weapons had the highest ORD compliance and weighted average performance scores versus materiel target
  – 25 & 40mm (grenade) weapons with programmable air burst ammunition had by far the highest ORD compliance and weighted average performance scores versus personnel target
  – Averaged over all target scenarios, 25mm (grenade) weapon alternatives had the highest weighted performance score

• Study results presented to Future Combat Systems IPT and PM FCS

Results used in decision for selection of Close Combat Armament System
IWARS is:

- Analysis driven
- Entity-based
- Multi-sided simulation
- Focused on individual and small-unit dismounted combatants and their equipment
- Used to assess operational effectiveness across the spectrum of missions, environments and threats

IWARS v1.0 Approved For:

- Soldier Sensor Performance Analyses
- Soldier Small-Arms Lethality Analyses
- Soldier Survivability Analysis
- Limited Situational Awareness / Battle Command Analysis

Army Requires Small Unit Combat Simulation Capabilities to Address Integrated “Soldier-as-a-System” Issues
### Alternatives / Ammo Types / Loads

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<td>PPHE</td>
<td>106</td>
<td></td>
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</table>

- 7.62mm machine guns firing bullets
- .50 cal machine guns firing bullets
- 25mm machine guns firing grenades
- 40mm machine guns firing grenades

* multi-barrel gatling gun
## Medium Range

<table>
<thead>
<tr>
<th>Weapon System</th>
<th>FBAR</th>
<th>IWARS</th>
</tr>
</thead>
<tbody>
<tr>
<td>M240</td>
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<tr>
<td>M134</td>
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<td>M2HB</td>
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<td>MK47</td>
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## Long Range

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<th>IWARS</th>
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</thead>
<tbody>
<tr>
<td>M240</td>
<td>4</td>
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<td>M2HB</td>
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<tr>
<td>XM307</td>
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<td>2</td>
</tr>
<tr>
<td>MK47</td>
<td>1</td>
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</tr>
</tbody>
</table>

The results for the M240 and M2HB are not statistically different.

IWARS Rankings matched well with FBAR
Summary

- Grenades are most effective
- IWARS consistent with CCAS Study
- Ongoing effort using IWARS to investigate effects on weapons effectiveness due to:
  - Two sided engagement
  - Rate of fire contributions
  - Target acquisition (ACQUIRE methodology) and target prioritization