Live Fire Test and Evaluation (LFT&E)

Summary

- In FY19, DOT&E executed LFT&E oversight for 86 Service acquisition programs, 3 joint programs, and 3 special interest programs.
- In support of fielding DOD technologies, DOT&E published six combined OT&E and LFT&E reports, and one LFT&E report summarizing the survivability and lethality performance of subject systems and offered recommendations to further advance their performance in emerging combat environments.
- In accordance with the National Defense Strategy, DOT&E realigned the objectives of the three joint programs chartered to:
  - Deliver and maintain credible joint weaponeering tools capable of providing weapons or mission effect estimates across all warfare domains.
  - Deliver T&E tools and joint aircraft survivability solutions to assess and mitigate U.S. aircraft losses in projected combat missions and areas of operation.
  - Innovate T&E methods to include modeling and simulation (M&S) tools to support efficient prototyping and fielding of DOD technologies.
- DOT&E provided oversight of three disparate, special interest projects focused on delivering credible evaluations of combat-induced injuries, collecting adequate combat damage data, and preparing the T&E infrastructure to evaluate directed-energy weapons and Counter-Unmanned Aerial Systems (C-UAS).

ACQUISITION PROGRAMS

In FY19, DOT&E executed LFT&E oversight for 86 acquisition programs and published 6 combined OT&E and LFT&E reports and 1 LFT&E report. These reports provided assessments of the survivability and lethality performance of subject systems and offered recommendations to further advance their performance in emerging combat environments.

- "Stryker Infantry Carrier Vehicle – Dragoon Early Fielding Report," published in October 2018, evaluated the lethality and survivability of the Stryker Infantry Carrier Vehicle – Dragoon to support the urgent materiel release decision for fielding to the 2nd Stryker Cavalry Regiment in Europe.
- "Modular Handgun System (MHS) Initial Operational and Live Fire Test and Evaluation Report," published in January 2019, reported on the MHS' operational effectiveness, suitability, and lethality against intended targets. The report supported the Army's MHS Full-Rate Production decision.
- "Javelin Spiral 2 Live Fire Test and Evaluation Report," published in February 2019, reported on Javelin Spiral 2's lethality against its intended targets and compared its lethality against legacy Javelin variants. The report supported the Army's materiel release of the Javelin Spiral 2.
- "USS *America* (LHA 6) Combined Initial Operational Test and Evaluation (IOT&E) and Live Fire Test and Evaluation (LFT&E) Report," published in April 2019, evaluated the survivability of the LHA 6 Flight 0 class of ships. The report informed the follow-on LHA Flight 1 test and evaluation strategy.
- "Stryker Double-V Hull A1 (DHV A1) Family of Vehicles Follow-on Operational Test and Evaluation Report," published in May 2019, assessed the operational effectiveness, suitability, and survivability of the A1 modification to the Stryker DVH. The findings supported the Army Program Executive Office decision to field a Stryker DVH A1-equipped Brigade Combat Team in FY20.
- "Armored Multi-Purpose Vehicle Operational and Live Fire Test and Evaluation Report," published in June 2019, supported the Army's Milestone C decision.
- "Block III Variant of the *Virginia*-Class Submarine Follow-on Operational Test and Evaluation Report," published in July 2019, included discussion of the differences in survivability between the Block I and II versions of the submarine as compared to Block III.

JOINT PROGRAM CHARTERS

LFT&E provides oversight of three programs chartered to support LFT&E Title 10 requirements and operational needs. A brief description of these programs is below. Given their common objectives, they will be referred to in this report as joint programs.

JOINT TECHNICAL COORDINATING GROUP FOR MUNITIONS EFFECTIVENESS (JTCG/ME)

JTCG/ME serves as the DOD's sole developer of joint weaponeering tools known as Joint Munition Effectiveness Manuals (JMEMs). JMEM products determine the appropriate number and types of weapons required by Combatant Commands (CCMDs) to achieve the desired lethal effect on a target. As such, JMEMs rely on authoritative data to:

- Accurately capture the performance of DOD weapons and capabilities of relevant, adversary targets
- Develop physics-based methods that predict DOD weapons effects for a range of relevant engagement conditions

- Develop user-friendly software that permits mission planners to predict and visualize weapons effects while also estimating the potential for civilian casualties

DOT&E provides oversight and strategic guidance to JTCG/ME to support the development of credible and operationally relevant JMEM products as the complexities of the operational environment emerge. The Army's Combat Capability Development Command Data and Analysis Center executes the JTCG/ME mission in accordance with DOT&E guidance, Joint Staff Military Targeting Committee requirements, and Chairman of the Joint Chiefs of Staff Instructions. Current JMEM product lines include:

1. Digital Imagery Exploitation Engine used to geographically locate and characterize the target (using National Geospatial-Intelligence Agency tools), weaponeer the target using JMEM Weaponeering Software, and estimate collateral damage effects using the Digital Precision Strike Suite Collateral Damage Estimation tool
2. Joint Anti-Air Combat Effectiveness tool used in combat mission planning, training, and weapon schools for development of air combat tactics, techniques, and procedures

To maintain relevancy in multi-domain combat environments, DOT&E initiated the development of JMEM products capable of estimating lethal effects of cyber, electromagnetic spectrum fires, and directed-energy weapons (both high-energy lasers and high-power microwave weapons). Additional resources are required to incorporate the effects of U.S. and adversary countermeasures across JMEM products.

JOINT AIRCRAFT SURVIVABILITY PROGRAM (JASP)

JASP serves as the DOD lead in enabling the development of cross-Service aircraft survivability solutions and evaluation methods needed to mitigate operational shortfalls of U.S. aircraft in combat. The Joint Logistics Commanders chartered JASP in 1971 to respond to the high aircraft loss rates experienced in the Vietnam War. Today, this program responds to the existing and emerging multi-domain operating environments to anticipate and prevent U.S. aircraft loses. JASP is the only program in the Department positioned to enable the coordination and support for:

- Development of joint M&S tools needed to evaluate aircraft survivability as required by Title 10, and for use by CCMDs and Service aviation weapons and tactics squadrons, schools, or training ranges for mission planning and combat operations.
- The Joint Combat Assessment Team (JCAT) to collect and analyze U.S. aircraft combat damage and losses. These data and combat reports have been critical in informing Title 10 aircraft survivability evaluations and in highlighting the requirements for joint aircraft survivability solutions to provide force protection and remedy operational shortfalls.

JASP is currently chartered by the aviation components of each Service: the Naval Air Systems Command, the Air Force Life Cycle Management Center, and the Assistant Secretary of the Army for Acquisition, Logistics and Technology. The Services provide the manpower while DOT&E provides stability in funding and strategic guidance for JASP to meet DOD needs.

JOINT LIVE FIRE (JLF) PROGRAM

In 1984, the then Director, Defense Test and Evaluation charted JLF to support LFT&E execution of its Title 10 responsibilities. Originally, the JLF program enabled the survivability assessment of front line air-to-ground attack aircraft and the lethality evaluation of major caliber anti-armor munitions against first-line armored vehicles during the technology development phase. Today, JLF continues to support LFT&E execution of its Title 10 responsibilities by addressing a more comprehensive spectrum of survivability and lethality issues as both the complexity of our own technologies and the operational environment advance. The JLF program is an effective vehicle used to address two overarching concerns: (1) survivability/lethality performance shortfalls of deployed DOD systems due to changes in concepts of operations, systems mission, rules of engagement, or threat changes, and (2) survivability/lethality test and evaluation capability shortfalls due to the increased complexity of DOD systems and adversary threats.

LFT&E JOINT PROGRAM ACCOMPLISHMENTS

BUILD A MORE LETHAL FORCE

In FY19, DOT&E supported the development of more lethal forces by funding the test and evaluation of several advanced, foreign body armor systems not previously assessed. This effort provided data that influenced ammunition/armor research, development, and fielding strategies of next-generation U.S. small arms munitions and weapons directly supporting the DOD lethality task force objectives.

In FY19, DOT&E updated currently fielded JMEM products and weaponeering processes designed to estimate lethal and collateral damage effects for kinetic weapons. The following updates improved mission planning efficiency, credibility, and analytical support to CCMDs responsible for targeting high-value assets:

- New software features that enable more rapid characterization of the adversary target and improved connectivity to targeting and mission planning systems.
- New weapon/target data sets to include additional weapons in the U.S. inventory.
- New, data-based Collateral Effects Radii Reference Tables (within the context of Theater Rules of Engagement and the Laws of Armed Conflict) that kinetic strike planners use to mitigate risk to non-combatants during weapons employment.
- Improved collection and use of Battle Damage Assessment data after a strike to support validation and increased accuracy of existing weaponeering tools. More credible weapons effects

estimates enable efficient munition expenditure rates that will mitigate stockpile stress.

To enable delivery of standardized tools and interoperability across the Department, on October 1, 2019, the Combatant Command Action Group facilitated a fly-off of two competing products and designated the Digital Imagery Exploitation Engine tool (JMEM product) as the primary DOD solution for advanced target development. However, additional resources are necessary to update JMEM products to more accurately represent the operational environment. For example, current JMEM tools do not account for the effects of existing and emerging countermeasures, the contested electromagnetic spectrum, or emerging non-kinetic threats, such as cyber and directed-energy weapons. Current JMEM tools also have not been validated against adversary ships and submarines, a capability that the CCMDs have identified as an urgent need.

In FY19, DOT&E supported the development of new JMEM products that will increase the scope and relevance of fielded JMEM products in a multi-domain environment. These weaponeering tools include:

- **Cyber Operation Lethality and Effectiveness (COLE) tool.** The COLE tool provides a capability that enables easy access to a number of weapon/target characterization and cyber effectiveness data sources. The tool provides a means to develop and characterize the target (network) and its environment presenting visual options to cyber operations currently not available. Lastly, the COLE tool includes fundamental analytical tools that need to be further developed to automate access and ingestion of all available data and to automate the development of the network. These analytical tools need to be further refined to enable calculation of the probability of an effect for a sequence of cyber-attacks in the absence of empirical data. These follow-on capabilities are scheduled to be delivered in FY20 and FY21. DOT&E requires additional resources to operationalize COLE using a DevOps approach.
- **Joint Laser Weaponeering Software tool.** The tool is founded on test data collected during eight field tests designed to verify and validate available M&S tools needed to characterize the vulnerability of a subset of operationally relevant targets to high-energy lasers. The tool includes a Probabilistic Risk Assessment tool, which provides collateral damage effect estimates unique to directed-energy weapons. DOT&E has a well-supported plan to continue to update this tool with additional data that will accurately capture existing and emerging U.S. high-energy laser performance as a function of system power, dwell time, jitter, and other factors needed to validate and operationalize this tool.
- **High-Power Microwave Weaponeering tool.** FY19 efforts focused on identifying available models and methods needed to estimate the effects of such weapons and the associated collateral risk effects, as well as the data standards to validate the tool. This initiative starts in FY20.
- **Electromagnetic Spectrum Fires tools.** FY19 efforts focused on benchmarking requirements and data sources. Such a tool will allow mission planners to consider the effects of electronic attack and electronic protection as a standalone effect or in conjunction with kinetic weapons and/or cyber effects estimates. This initiative starts in FY20.

In FY19, DOT&E executed several efforts that improved air combat lethality and survivability:

- Updated the Joint Air Combat Effectiveness tools with new data for a limited number of near-peer threats to increase the fidelity of the tool against those threats. DOT&E requires additional resources to update this tool to adequately represent the operational environment to include a more comprehensive spectrum of relevant threats and the consideration of available and emerging countermeasures.
- Supported the development of new techniques and technologies to remedy operational capability shortfalls against advanced radio frequency (RF)- and infrared (IR)-guided threats. For example, DOT&E demonstrated the ability of a new RF-countermeasure (RFCM) technique to degrade the ability of a near-peer threat radar system to acquire and/or track U.S. aircraft. This effort also illuminated shortfalls in the representation of these threat systems that initiated further efforts by the intelligence community. Similarly, DOT&E demonstrated the ability of new IR-countermeasures to increase the survivability against more stressing, near-peer IR-guided threats.
- Supported the development of new technologies to increase the tolerance/hardness of U.S. aircraft in combat. For example, DOT&E supported the: (1) collection of data to inform requirements for systems intended to protect the U.S. rotorcraft against rocket-propelled grenades, (2) development of armor solutions at about 50 percent of the weight of currently fielded solutions, (3) development and demonstration of a cross-platform compatible helicopter armored seating system that improves ballistic protection coverage by over 20 percent and increases occupant crash survivability within the weight and space constraints of the UH-60 BLACK HAWK cockpit seat, (4) demonstration of a novel self-sealing fuel bladder technology that successfully sealed against small arms rounds mitigating fire-induced helicopter crashes, and (5) development of the formulation for a fire-mitigating mist additive to prevent ignition of avionics coolants mitigating fire-induced aircraft losses.

STRENGTHEN ALLIANCES AND NEW PARTNERS

In FY19, DOT&E:

- Facilitated the delivery of weaponeering tools and training to coalition partners in support of current operations under Foreign Military Sales agreements. This included the release of Collateral Effects Radii tables to key coalition partners to minimize collateral damage/reduce civilian casualties.
- Supported standardization of weapon characteristics and interoperability by providing coalition partners with the updated JTCG/ME Weapon Test Procedures Manual, which will augment international test operation procedures.

- Continued the partnership with Canadian counterparts to enable credible evaluation of torpedo and mine effects on Navy platforms. DOT&E collected test data using a decommissioned Canadian ship to validate critical M&S tools for capturing underwater explosion effects on ships. This effort, in coordination with other Joint Live Fire M&S efforts, will enable an accurate survivability assessment of ships and submarines against torpedo and mine engagements, as well as an accurate lethality assessment and optimization of U.S. weapons against enemy ships and submarines.

REFORM THE DEPARTMENT FOR GREATER PERFORMANCE AND AFFORDABILITY

In FY19, DOT&E used the joint programs to support Department reforms by advancing the state of the art M&S tools and other innovative T&E methods. These efforts introduce efficiencies in LFT&E to support rapid prototyping and rapid fielding while minimizing risk to the warfighter.

New Weaponeering Tool Software Architecture to Enable Targeting Solutions across Warfare Domains

DOT&E investigated the use of a new software architecture for JMEM products. The new software will support modular capabilities and improved interface with all new data or methods, which will be stored in various Joint Effects Libraries. The development of these libraries will include the use of neural network tools, data compression algorithms, such as XGBoost and machine learning to manage access and credibility of the available information. Use of these advanced analytical techniques will improve the quality of existing solutions, decrease computation time of applications, and answer questions previously not possible.

Credible Modeling and Simulation (M&S) Tools to Increase Efficiency and Reduce Risk

DOT&E supported the development of three M&S tools needed for the advancement of JMEM products and Title 10 evaluations. DOT&E reprioritized the joint programs to focus on increasing the accuracy, credibility, and capability of these M&S tools. The efforts focused on baselining M&S tool capabilities and limitations, completing sensitivity studies to identify M&S factors that may drive the output errors, and formulating strategic roadmaps to increase the credibility and/or capability of these tools.

The three major M&S tools used to predict either system survivability or conversely the weapon lethality include: the Army-managed Advanced Joint Effectiveness Model (AJEM), the Air Force-managed Computation of Vulnerable Area Tool (COVART), and the Navy-managed Advanced Survivability Assessment Program (ASAP). All three rely on two additional M&S tools: Fast Air Target Encounter Penetration (FATEPEN) model used for estimating penetration of warhead-generated fragments and Projectile Penetration (ProjPEN) used for estimating penetration of small- and medium-caliber projectiles. Two additional M&S tools are used to evaluate the engagement kill chain of adversary surface-to-air and air-to-air weapons against our aircraft: Enhanced Surface-to-Air Missile Simulation (ESAMS) and Brawler.

DOT&E facilitated a tri-Service model review summit to re-baseline the verification, validation, and accreditation process that will be used in re-accrediting these M&S tools. The intent is to characterize the error bounds and understand their root-cause so DOT&E can identify and address shortfalls in upcoming joint program builds. These efforts will ultimately accelerate the overall analysis process and enable the prioritization of test parameters during a T&E program.

- **Advanced Joint Effectiveness Model (AJEM)** estimates the lethality/vulnerability of ground combat vehicles, small boats, and aircraft to kinetic threats. FY19 enhancements included an addition of features that can support three-dimensional threat encounters to more accurately capture the effects of the threat on the intended target. Enhancement also included the capability to assess the effects of explosive reactive armor, as well as effects of an active protection system. AJEM is now also able to accept a broader spectrum of complex target geometries enhancing its accuracy while saving time (estimated 30 percent reduction) and resources.
- **Computation of Vulnerable Area Tool (COVART)** estimates aircraft vulnerabilities to kinetic threats. DOT&E supported the development of a new feature to enable accurate evaluations of structural damage of aircraft caused by threat engagements to a fuel tank. DOT&E also supported the development of a capability to model the lethality effects of high-explosive threats, to include the effects of fuze timing. Lastly, DOT&E initiated the development of the Next Generation Fire Model, to enable credible prediction of threat-induced fires on board an aircraft. The team is on track to release the first version of the model in March 2020 with the goal of predicting ignition and fire sustainment with 80 percent confidence.
- **Advanced Survivability Assessment Program (ASAP)** estimates ship vulnerabilities to kinetic threat engagements. DOT&E supported a data-based evaluation of shipboard equipment fragility to improve the damage predictions for mission critical equipment. These data will also be applied within the Integrated Recoverability Model used in evaluation of the crew's ability to recover certain missions after a combat engagement. DOT&E also supported the development of an updated database of typical combustible fuel loads in shipboard compartments. These new features will be used in Title 10 assessments to estimate the fire growth rate, peak fire size, and burn duration for surface ship platforms.
- **Fast Air Target Encounter Penetration (FATEPEN)** estimates warhead-generated fragment penetration against an array of operationally representative targets. The joint programs supported updates to FATEPEN to estimate fragment penetration against concrete masonry unit blocks commonly observed in ongoing areas of operation. The joint programs supported updates to FATEPEN processing algorithms reducing calculation run time by 50 percent. They also supported a sensitivity analysis, which demonstrated that

variations in empirical data used in the model could alter the final aircraft vulnerability results up to 13.5 percent. Efforts were completed to improve the FATEPEN accuracy in modeling lethal effects of irregular fragments and highly yawed long rods formed by many contemporary munitions. Lastly, FATEPEN algorithms were updated and now have the ability to output the mean penetration with one standard deviation.

- **Projectile Penetration (ProjPEN)** estimates projectile penetration against an array of operationally representative targets. The joint programs supported a parametric study to evaluate the estimate errors and to identify their root cause.
- **Enhanced Surface-to-Air Missile Simulation (ESAMS)** estimates the probability of engagement of U.S. aircraft by radar-directed surface-to-air missile systems. DOT&E supported upgrades that will enable modeling of a representative jamming environment, clutter, and the signal environment for advanced threats. DOT&E also funded efforts to provide ESAMS with a capability to assess rotorcraft susceptibility to RF threats. Lastly, DOT&E initiated enhancements to ESAMS to enable assessment of rotorcraft susceptibility in a low-altitude electronic attack environment.
- **Brawler** is an air-to-air engagement analysis tool. DOT&E addressed 62 user requested code enhancements including the ability to generate specific missile envelopes, advanced IR signature plotting, commander-in-the-loop capabilities, and enhancements that allow the user to model IR search and track sensors and fuse them with other aircraft sensor information. Brawler supports technology development, analysis of alternatives, and Title 10 evaluations.

Innovative T&E Methods

DOT&E leveraged the joint programs to research and adapt best practices in industry, academia, and across government laboratories to identify new LFT&E tools that could introduce efficiencies in DOT&E processes and increase the credibility of DOT&E evaluations. In FY19, DOT&E focused on developing new means to collect live fire test data, to develop new surrogate adversary threats and targets for Title 10 evaluation, and new M&S tools to predict effects currently not possible.

- **Data Analytics.** DOT&E partnered with Sandia National Laboratories to advance modeling and tracking of three-dimensional fragmentation frequently seen during lethality tests. Application of proposed artificial intelligence techniques, high-speed stereoscopic optical, and x-ray development could reduce the number of weapon test articles and labor-intensive activities in future weapon lethality T&E. DOT&E also supported the development of the Countermeasure Effectiveness Analysis Tool to automate the processing of countermeasure test data frequently used with the Modeling System for Advanced Investigation of Countermeasures tool in Title 10 evaluations.
- **Scalable Test Methods.** DOT&E partnered with the Air Force Research Laboratory (AFRL), Munitions Directorate to research the ability to use scalable experimentation methods in LFT&E. AFRL designed a building at 1/9th-scale and fabricated it from steel plates to more efficiently test and predict blast effects from detonations inside buildings. As new weapons and target sets materialize, JMEM developers will have a tailorable scale model they can use to validate blast effects models at a fraction of the cost of full-scale testing.
- **Advanced Sensors.** DOT&E supported the development of a new metrology tool that has the ability to accurately measure high-frequency, high-amplitude motion produced during ballistic blast and shock tests. To date, the team has conducted 150 laboratory tests and is working the with Advanced Combat Vehicle test director to incorporate these advanced sensors into its full-up system-level live fire test program.
- **Threat Model Development.** DOT&E sponsored the development of high-fidelity physics-based models for two widely proliferated (classified) shaped-charge warheads for use in LFT&E survivability assessments of ships and ground combat vehicles. DOT&E also funded development of an all-digital threat model that will allow evaluation of IR countermeasures techniques before actual threat exploitation data are available. Similarly, updates to RF-guided threat radar models and the ESAMS signal environment will allow development and evaluation of advanced electronic techniques and rotorcraft RFCM. Lastly, DOT&E funded an effort with the National Ground Intelligence Center to develop a model of rocket-propelled grenades to enable accurate fly out of these threats.
- **Advanced Teaming Analysis Capability** is a new methodology intended to provide a survivability and lethality evaluation of a system of systems or teams, as seen in operationally representative scenarios. This effort is coordinated with the Massachusetts Institute of Technology and uses System Theoretic Process Analysis to assess mission capability of systems and teams, from hardware, software, and network related loss of functions.
- **Full Spectrum Crash Survivability Physics-Based Modeling** integrates various rotorcraft components with various biomechanics models to represent the aircrew into a full-system rotorcraft model for investigation of full spectrum crash survivability. DOT&E also supported a development of modeling methods, which will provide a means to evaluate and model the next generation of energy absorbing technology.
- **Engagement Model of Low Altitude Rotorcraft** in an Electromagnetic Spectrum Contested Environment is an engagement simulation capability for rotorcraft that combines rotorcraft flight dynamics, maneuvers, and RFCM techniques for the purposes of evaluating rotorcraft survivability. DOT&E supported updates to threat radars in ESAMS, collected applicable radar cross section data for validation, integrated clutter tools, and began building a pseudo rotorcraft 6 degrees of freedom flight model with reactive maneuvers. This capability is a requirement identified by the Army's Future Attack Reconnaissance Aircraft and Future Long-Range Assault Aircraft, as well as the Marine's Aviation Weapons and Tactics Squadron.

LFT&E SPECIAL INTEREST PROGRAMS

WARRIOR INJURY ASSESSMENT MANIKIN (WIAMAN)

WIAMan is a military-specific anthropomorphic test device (ATD) intended to enable an assessment of crew injuries to military vehicle occupants. WIAMan is designed specifically to assess injuries due to vertical accelerative loading typically observed in IED/mine engagements. The WIAMan program consists of three main efforts:

- Development of the ATD and the integrated data acquisition system
- Biomechanics research to accurately characterize and assess the injury
- Finite element model of the WIAMan to support future M&S assessments

In FY19, the Army continued the biomechanics research to support development of human injury probability curves and injury assessment reference curves. These curves will be the basis for the crew casualty assessments given the data collected using the WIAMan ATD during LFT&E. The WIAMan biomechanics team completed the initial set of 15 injury assessment reference curves covering the spine, pelvis, and lower extremities. The Army conducted and analyzed a series of nine whole body Post-Mortem Human Surrogates and ATD matched-pair experimental tests, to support the validation effort of these curves. The Army expects to complete the development of all curves in 4QFY20.

The Army continues to develop a model of the Generation 1 ATD and expects to complete it in FY20. Verification and validation planning is underway for all three WIAMan products (ATD, biomechanics research, and the model). After WIAMan has been accredited for use in LFT&E, the Army plans to use it for the Armored Multi-Purpose Vehicle full-up system-level testing in FY21.

At the initiation of the WIAMan program, the Army identified it would need 40 WIAMan ATDs to adequately replace the existing fleet of Hybrid-III ATD. In FY19, the Army awarded a production contract and is on track to acquire five WIAMan ATDs by January 2020 and another five by July 2020. There is currently no funding in the Army budget allocated to purchase the additional 30 WIAMan ATDs.

COMBAT DAMAGE ASSESSMENT

DOT&E continued sponsoring aircraft combat damage incident reporting and aviation combat injury analyses through the Joint Combat Analysis Team (JCAT) and the U.S. Army Aeromedical Research Laboratory. The JCAT consists of Tri-Service personnel who investigate aircraft combat damage in theater. The Aeromedical Research Laboratory supports the analysis and documentation of aircraft combat injuries. Most recently, it documented the UH-60 BLACK HAWK combat injuries in Operation Iraqi Freedom and Operation Enduring Freedom while the AH-64 Apache and the CH-47 Chinook studies are ongoing.

To facilitate sustainable and credible combat damage incident reporting, capability was added to the Joint Force Air Component Commander Air Tasking Process Responsibilities, which includes consideration of the Aircraft Combat Damage Reporting Doctrine in the joint forces operational planning process. To enable combat incident data access across the DOD, Services, and CCMDs, DOT&E transitioned the Combat Damage Incident Reporting System from an Air Force SIPRNET server to National Ground Intelligence Center hosting. DOT&E is also working with the Naval Air Systems Command to determine the feasibility of automatically collecting time-sensitive threat incident and engagement data to support aircraft combat incident reporting.

TEST AND EVALUATION OF EMERGING TECHNOLOGIES

Directed-Energy Weapon T&E

In FY19, in addition to developing JMEM for directed-energy weapons, DOT&E worked with the Services to support the development of T&E plans for a number of high-energy laser prototypes or demonstrators that will be deployed in FY20 on operational assets. DOT&E focused on developing plans to quantify lethality of the systems and on providing the right information to future operational users so that the warfighter can incorporate directed-energy weapons into the weaponeering planning cycle just like other kinetic weapons. In conjunction with system developers within the Navy, a combination of land- and sea-based tests have been developed to support transition of factory units to operational employment.

Counter-Unmanned Aerial Systems (C-UAS)

In FY19, at the request of the Office of the Under Secretary of Defense for Acquisition and Sustainment, DOT&E developed an independent assessment plan to characterize capabilities and limitations of a subset of currently fielded C-UAS. DOT&E worked with the Services and CCMDs to develop an assessment plan to characterize the performance of the C-UAS as currently employed in the U.S. Central Command. The Joint Staff J6 Joint Deployable Analyses team is leading the execution of the DOT&E outside of the continental United States assessment from November 2019 through February 2020. This assessment is intended to serve several over-arching objectives: (1) characterize the capabilities and limitations of currently fielded C-UAS to establish baseline C-UAS performance, (2) provide data to inform future requirements and acquisition decisions, (3) inform and standardize test protocols needed to adequately characterize the performance of C-UAS prior to fielding, and (4) provide data to support C-UAS operator training requirements.