M&S for OT&E - Examples

Example 1 – Aircraft OT&E Example

3.4.1. Modeling & Simulation. The F-100 fighter aircraft will use the Aerial Combat Simulation (ACS) to support evaluations of F-100 operational effectiveness in air-to-air missions. The ACS will provide data in support of the following metrics: Air-to-Air Kill Ratio, Blue-on-Blue Kills, and Blue-on-White Kills. Other secondary metrics also will be evaluated.

The ACS consists of four actual F-100 cockpits installed in visual scene domes and ten other manned interactive cockpit stations. The ACS includes high fidelity models of the F-100's cockpit and sensor suite and integrated threat models developed by MSIC, NASIC, and ONI. Scenarios will be focused around two simultaneous Major Contingency Operations threats. The ACS is intended to model a dense surface-to-air and air-to-air threat and electronic signal environment, which is impractical to create on an open-air range (OAR).

The ACS will support operational test design, test team and pilot training, and test preparation and rehearsal. In addition, ACS will be used to mitigate test limitations and to support the evaluation of F-100 effectiveness under conditions not possible on an OAR. OAR limitations that ACS can address include constraints due to flight security concerns, the lack of realistic threat assets (types and/or numbers), and limited battle space.

AFOTEC will perform Verification, Validation, and Accreditation (VV&A) of the ACS, which will include the use of F-100 DT validation data, Intelligence agency support of validated threat models, and operational test data collected on the OAR against available threats or surrogates. A model-test-model approach will be used. If intelligence shortfalls limit the ability of AFOTEC to accredit an ACS component, AFOTEC will consider the operational context of the shortfall to assess the likely outcome and impact to the evaluation. ACS limitations will be included in the F-100 IOT&E test plan. AFOTEC has defined the ACS requirements to support the F-100 IOT&E via the Integrated Test Team (ITT).

Funding and resources for ACS validation, ACS operation and AFOTEC test activities in the ACS for FY-10 through FY-15 are detailed in Part IV.

Example 2 – Missile OT&E Example

3.4.1. Modeling & Simulation. Modeling and Simulation (M&S) is an integral part of Bama Missile (BAMM) T&E. Below is a discussion of the BAMM simulation and associated tools.

3.4.1.1 Integrated Flight Simulation (IFS)

The BAMM IFS is a complete, closed-loop simulation of the BAMM system and is considered the authoritative representation of the BAMM for simulation purposes. The BAMM IFS contains five main models: (1) environment model, (2) seeker model, (3) tactical software including the missile tracker, (4) six degrees of freedom (6-DOF), and (5) launcher model. The five main models contained in the BAMM IFS are independent of any contractor's technical solution and any simulation architecture. The BAMM IFS is a contract deliverable to the

Government by the prime contractor and will be hosted by the government at the Army's Aviation and Missile Research, Development and Engineering Center at Redstone Arsenal and the Navy's Naval Air Warfare Center Weapons Division at China Lake. Independent Verification and Validation will be conducted by the government under the auspices of the BAMM Simulation Working Group.

3.4.1.2 Software Test Station (STS)

The BAMM STS contains tactical processor boards which replace the equivalent models contained in the IFS, along with the tactical software. The other models of the IFS remain the same. The STS is used to perform further checkout of missile tracker algorithms and tactical software, but its primary function is to perform the Formal Qualification Testing (FQT) of the tactical software prior to loading on tactical hardware for guided flight testing.

3.4.1.3 Performance Hardware in the Loop

Throughout the SDD acquisition phase, the prime contractor will be required to provide to the Government missile hardware and support to allow the government simulation team to complete development of the Advanced Multispectral Simulation, Test, Acceptance Resource (AMSTAR), consisting of two hardware-in-the-loop (HWIL) facilities located at Redstone Arsenal.

The first AMSTAR facility to be used will be the Performance Test Bay, which will be used by the government and prime contractor as a risk reduction tool for missile seekers by performing system and subsystem tests, and performing pre-flight test predictions and post-flight test reconstructions and analysis. Those missile components not included in the HWIL facility will be simulated by the IFS model. The second AMSTAR facility to be used will be the Production Test Bay, still under development, and will incorporate every hardware and software component of tactical missiles.

3.4.1.4 Production Hardware in the Loop

The Production Test Bay will be used primarily as a safe, non-destructive production acceptance test capability with the objective of cost savings from performing less destructive testing of production missiles. The Production Test Bay will use IFS models to stimulate the missiles under test. Both the Performance Test Bay and Production Test Bay are a combined development effort of the AMRDEC and the Redstone Technical Test Center (RTTC), a subordinate command of the Army Test and Evaluation Command (ATEC) that was the primary financial sponsor during development. The Production HWIL will support AUR testing in a non-destructive environment prior to GFT. The Production HWIL will be on line prior to the end of SDD and utilization will continue during the production phase of the program. The Production HWIL will use IFS drivers to stimulate the tactical hardware and will use equivalent scene generators to those developed for the Performance HWIL. VV&A of the Production HWIL will be completed prior to FRP.

3.4.1.5 Simulation Based Performance Assessment

The simulation based performance assessment (PA) will address the BAMM key performance parameters; probability of hit, probability of kill, and probability of incapacitation. While the flight test program will demonstrate a limited number of scenarios, the simulation will be used to assess the performance for a broad range of scenarios under a broad range of conditions. This approach will not only assess performance for the broad range of scenarios but also BAMM performance robustness to various conditions within those scenarios. The PA will use the IFS all digital capability, with subsets being conducted using the IFS in the STS and the performance HWIL. Various levels of preliminary assessments will be conducted throughout SDD. The results of these initial assessments will be provided to the prime contractor to support design and algorithm enhancements. The milestone C PA, which will calculate the probability of hit and probability of kill against the BAMM-specified targets, will occur during the latter portion of SDD, after the system design is solidified and after the simulation has been validated against flight tests. The PA will consist of a large number of simulation executions for the different launch platforms, all modes of operation, stationary and moving targets, and target aspect. The BAMM Simulation IPT will develop the exact structure of the PA. The PA will be conducted for benign atmospheric conditions, selected countermeasures, APS/DAS, obscurants, and different weather conditions. The magnitude and structure of the countermeasures, APS/DAS, obscurant, and weather matrices will also be defined during the SDD contract.

The PA will include a Monte Carlo analysis of the missile seeker parameters, 6-DOF variables, different geographic locations, and different target locations within a geographic location. Target conditions will include moving and stationary, solar loaded, and non-solar loaded. Geographical locations will include temperate, arid, and cold weather areas.

3.4.1.6 Verification, Validation, and Accreditation

The most important activities to be performed in M&S on BAMM are Verification, Validation, and Accreditation (VV&A). As such, the VV&A strategy will be aggressive and rigorous for the prime contractor as well as for the Government. The BAMM System Simulation Working Group (SWG) will be the overseeing organization for VV&A. A VV&A subgroup will be formed within the SWG and will be required to report regularly to the SWG and will document their efforts to the T&E Integrated Product Team (IPT). The VV&A subgroup will contain members from the JAMS PO, the prime contractor, AMRDEC and NAWC subject matter experts (SMEs), ATEC, OPTEVFOR, and other interested organizations.

SMEs from the Army, Navy, and the prime contractor will be used in the model verification effort. To assist the SMEs in their effort, the Common Simulation Evaluator (CSE) will be used and tailored for the particular model being verified. This provides a method of quantifying and documenting the models. The compilation of the CSEs for the models will constitute a major portion of the verification documentation contained in the BAMM System Verification Report. This report will be augmented by the prime contractor's contractually required deliverable "IFS Model and System Level V&V Report," which will include test data from various tests conducted. The initial delivery of the prime contractor's report is due at the Preliminary Design Review. The next required update will be at the Critical Design Review with additional updates as required.

Validation of the IFS will be a multi-faceted approach. Validation will be accomplished based upon component level tests as well as vendor test data. The test data will be compared to the applicable IFS model. The validation of the component model will be made by the SMEs, presented to the VV&A subgroup of the SWG, and presented to the T&E IPT

The accreditation of the IFS for the BAMM System will be a joint accreditation by the Army and the Navy evaluation and development communities. The accreditation approach will be for the VV&A subgroup to develop the IFS Accreditation Plan, then present the plan through the SWG to the T&E IPT for concurrence. The VV&A subgroup will also develop the Accreditation Support Package and the Accreditation Report. It is currently intended for the IFS accreditation methodologies to be tailored from existing Army and Navy accreditation methodologies.

The IFS system level validation will be based upon a Model-Test-Model approach. The prime contractor, as well as the Government, will perform pre-flight predictions using the IFS of the scenario to be used in an upcoming flight test. The scenario will include the test range to be used, range from missile at trigger pull to the target, target aspect angle relative to the missile at trigger pull, and target motion at trigger pull. During the flight tests, telemetry data will be collected on the missile, either with the mini-telemetry section that is a part of the missile or with the warhead replacement telemetry that will only be on pre-determined missiles. Other data to be gathered include range and target metrology data, and the infrared target signature measurements that will be collected pre-flight test and post-flight test as allowed by range control/safety. The data gathered for the flight test is then used in the post-flight reconstruction in the IFS. Key missile parameters are analyzed for the flight test and for IFS Monte-Carlo runs. The comparison of the flight test results and the IFS results will show the validity of the IFS. The VV&A subgroup will oversee this effort and present results to the SWG and the T&E IPT as required.

3.4.1.7 IOT&E Scenarios

IOT test scenarios will be prepared to maximize the operational realism of the test. These scenarios will be generated using the AH-64D and AH-1Z Concept of Operations (CONOPS) and TTPs and be centered on successful completion of the unit's assigned missions.

AH-1Z scenarios will include Close Air Support (CAS), Deep Air Support (DAS), armed and visual reconnaissance, Forward Air Control Airborne (FACA), escort, and interdiction/ emergency defense of the expeditionary strike group. Forward Arming and Refueling Point (FARP) and CBRN operations will be conducted as needed in support of these scenarios.

AH-64D scenarios will include both short and maximum range engagements normally associated with Close Combat with Ground Forces, Interdiction Attack, and Vertical Maneuver missions. A/C acquisition sources matched with BAMM multiple seeker-mode capabilities will be used to test BAMM integrated seeker-mode performance based on established TTPs. The engagements will include moving and stationary targets and targets within MOUT-type environments. FARP and CBRN operations will be conducted as needed in support of these scenarios. Six AH-64D A/C will be required to support operational testing, four with FCR and

two without the FCR. Engagements will be fired using the desert type terrain at China Lake/YPG.

As a minimum, the target list will include Tanks, Air Defense Artillery (ADA) weapons, MOUT targets, Armored Vehicles, maritime targets, and both stationary and moving targets. The test will be conducted in the natural environment of the operational test range. The test officer will collect measurements of temperature, pressure, humidity, precipitation, clouds, winds, blowing sand, or other conditions that may influence system performance. BAMM capabilities and limitations in various SAL/EO/IR/RF CM environments will be assessed to determine effects on operational performance and possible BAMM tactics and improvements. Acquisition denial and tracking interference susceptibility testing will be conducted in both captive-carry and live-fire missions/scenarios against known battlefield obscurants, such as APS/DAS, host platform expendable CM, support jamming operations, and any additional CM determined to affect operations of the BAMM as specified in the STAR and Threat TSP.

Data will be captured on target acquisition performance, engagement/download timelines, missile diagnostic checks, human factors feedback, onboard A/C video, and other measures. To the degree possible, engagements/missions will be flown in simulation prior to the test to verify that each meets test performance requirements in terms of launch conditions, flight profiles, and target conditions.

Collected data will include measurements of missile-hit performance, target acquisition and transfer performance, engagement timelines, flight profiles, reliability, and other measures. Questionnaire information will also be collected from pilots on A/C/missile interface performance and from support personnel on support issues. Data on suitability and survivability will be collected where possible during the test.