EXECUTIVE SUMMARY

The results of accreditation support activities documented in ASP-II provide the prospective model user with confidence that the model design, assumptions, limitations, inputs and outputs are reasonably valid representations of real world conditions and outcomes. This confidence is typically achieved via reviews by subject matter experts (SMEs) familiar with the real world phenomena simulated by the model. The end product of this review is a determination of whether the model can reasonably be expected to produce results realistic enough to be of use for the application at hand. V&V activities contributing to such reviews can be divided into two categories:

> **Logical Verification**, which ensures that the basic equations, algorithms, and design of the model are reasonable and correct, and which identifies assumptions and limitations inherent in the implementation, and;
>
> **Face Validation**, which consists of input data verification and validation, comparison of model outputs with assessments and known or best estimates, and a review of sensitivity analysis results.

This Volume II Accreditation Support Package provides software design information in the Conceptual Model Specification (Section 2.0) that supports logical verification and Sensitivity Analysis information (Section 3.0) that supports face validation activities. Results of logical verification and face validation reviews are provided in Sections 4 and 5, respectively. When coupled with ASP-I information, ASP-II provides the user with the best possible confidence in top-level model results short of detailed V&V, the results of which are addressed in ASP- III.

Conceptual Model Specification (CMS) sections for the overall model (top level design) and individual functional elements (FEs) presented in Section 2 describe inherent design assumptions and limitations as well as other significant information intended to support detailed verification efforts or logical verification reviews in support of accreditation without the benefit (or expense) of detailed verification results. Although Brawler has been in use for many years, it was developed in a piecemeal, or incremental, fashion without the benefit of a structured design phase prior to code implementation. Therefore, the design information presented here was reverse engineered from the actual code as it exists rather than from pre-development design specifications. Of primary interest to users seeking accreditation or evaluators charged with supporting accreditation decisions would be implications tied to assumptions and limitations presented in Tables i-1 and i-2 below. These may impact potential model use to the extent that they affect certain aspects of intended applications to user-specific problem areas and some limitations may be sufficient to disqualify the model for intended usage. A more comprehensive summary produced by the developer for the whole model can be found in Section 3 of ASP-I.

TABLE i-1. Brawler Model Level Assumptions.

Type	Assumption	Conditions of Applicability
Model Sequencing	Driven by events that correlate to physical processes or simulation management of execution	Always
Physical Process Events	Are self-planting; occur repeatedly	Always
	Timing of events is dynamic	When status modes change

TABLE i-1. Brawler Model Level Assumptions. (Contd.)

Type	Assumption	Conditions of Applicability
Consciousness Events	Occur repeatedly and consist of situation update, assessment, and decision making, which occur sequentially	When the pilot is conscious
Management Events	Are not related to physical processes, only to simulation execution, diagnostics, output, etc.	Always

Limitations inherent in the design can have significant implications for model use in certain types of applications and some of those documented here are summarized in Table i-2 below.

TABLE i-2. Brawler Model Level Limitations.

Type	Limitation	Conditions of Applicability
Situation Awareness	Based solely upon observations of on-board displays, radio comm, and visual detections	When pilot is conscious
Situation Assessment	Influenced by many derived factors that may or may not be valid for a particular situation	When pilot is conscious
Decision Making	Based upon relationships among factors relevant to a particular type of decision as derived from expert system inputs and tactical doctrine	When pilot is conscious
Entities Simulated	Limited only by computer system and run-time resource requirements	Always

Design assumptions and limitations derived from the functional elements documented in Section 2 are summarized in Tables i-3 and i-4 below. Additional information on FEs not yet addressed at this level of detail can be found in Section 3 of ASP-I.

TABLE i-3. Brawler Function Level Assumptions.

Functional Area	Assumption	Conditions of Applicability
Aircraft Configuration	External stores and weapons add only weight and drag	Always
Aircraft Movement	Coordinated flight is assumed. Yaw angle = 0	Always
	First order control systems with dynamically varying time constants	When Type 1 Aerodynamic models are employed
	Integration time steps are small enough for rate changes to be assumed linear over time steps	Always
Weapons, Guided	Flight simulated by 3 DOF models - no pitch, roll, or yaw	Always
Sensors, RF	Detections are generated by random draws from probability distribution based on signal-to-noise ratio	Always
Sensors, IRST	Statistical treatment of clutter based upon sensor spatial and/or temporal filtering	Always

TABLE i-3. Brawler Function Level Assumptions. (Contd.)

Functional Area	Assumption	Conditions of Applicability
Sensors, IFF/NCID	Characterized by reliability factors and range (power, gain, parametric ECM level)	Always
CM, Expendables	Free-falling or towed trajectories	Always
	Launched by pilot or missile warning devices	When under missile attack
Environment, weather	Affects only visual and IR sensors	When specified by user input
DME, Pilot	Consciousness events are repeated at regular intervals and represented by the same sequence of situation update, situation assessment, and decision making	When the pilot is conscious
	No errors in track correlation between successive observations	When TWS radars are used
DME, Pilot, Radar Mode	TWS antennas may have up to three different scanning patterns: no two will have the same number of bars and azimuth half widths	When TWS radars are used
	TWS radars may also have multi-target track (MTT) capability that us usually limited to electronically scanned array (ESA) radars	When TWS radars are used
DME, Pilot, Maneuvers	SAM sites and SOJs do not make maneuver decisions	Always
	Reflex delay is the same for all pilots in the scenario	Always
	Pilots do not consider the presence of SAM sites when making maneuver decisions	Always

Limitations inherent in the design of specific functions can have implications for model use in certain types of applications and those summarized in Table i-4 below were derived from those FE CMS sections documented in Section 2. No significant model deficiencies were reported from the compilation of the design information presented in the functions documented in this ASP volume.

TABLE i-4. Brawler Function Level Limitations.

Functional Area	Limitation	Conditions of Applicability
Weapons, Guided	RF active & semi-active, IR, and Anti-radiation missiles only	Always
Weapons, Guided, fuzing	Simple 3D cone or CPA models	Always
	Five endgame models available	User selectable
CM/CCM Expendables	Three effects modeled: P_k degrade, track loss (ballistic), centroid track	User selectable
DME Pilot, Flight Posture	Only designated aircraft: SAM sites and SOJs are not considered	Always
DME, Pilot, Radar Mode	Only controls primary antennas; other antennas must be controlled via production rules	When secondary antennas are employed for a specific type of radar sensor
	On/off switching must controlled via production rules: On is assumed	Always

TABLE i-4. Brawler Function Level Limitations. (Contd.)

Functional Area	Limitation	Conditions of Applicability
DME, Pilot, Radar Mode (Contd.)	Switchology delay is not modeled for TWS radars	When TWS radars are used
	CIC, burst, and velocity search submodes may only be entered via use of production rules	When TWS radars are used; Burst mode for ESA only

Sensitivity analyses were performed for several FEs that were believed to be of interest to users concerned with establishing requirements for aircraft designs. It was assumed that hypothetical designs submitted for consideration would satisfy specific requirements to varying degrees and a concern as to whether sufficient model sensitivity existed in some areas was an objective.

The examination of Aircraft Movement was aimed at model capabilities to simulate flight at high angles of attack with thrust-vectoring nozzles. Even though a significant tactical advantage can be afforded in specific situations, overall model sensitivity to the two types of aerodynamic models available was low for most BVR engagements simulated, but significant for close-in gun brawls. Users must be careful that data used to model aircraft performance with non-linear control systems that afford a high angle of attack capability provide accurate representations and that adversaries are also modeled at similar levels of detail.

The Flight Posture Decision process was examined and found to be quite sensitive to user defined values for Pilot Aggressiveness. Behavior for ranges of mission value and initial separation were as expected for the cases analyzed. The Radar Mode selection decision was examined for the simple single target track (STT) type radar with only two modes. Evaluation of track while scan systems was not performed due to their absence from the unclassified model version available for use. Selection of radar modes follows tactical doctrine for employment of such systems and model sensitivity to engagement conditions and geometries was moderate, or expected.

The Pilot Maneuver Decision methodology was analyzed and found to be consistent with the value driven process described in the model documentation. As with flight posture, sensitivity to pilot aggressiveness was high and served to skew outcomes in favor of more aggressive pilots. An interesting finding was that maneuvers selected by pilots are rarely achieved due to changes in maneuver objectives that occur during subsequent decision events.

Pilot pairing of weapons and targets was also examined and found to follow the tactical doctrine used for employment of weapons given their effective ranges. Long range radar guided missile are preferred in the BVR environment, but decision scores for RF and IR guided missiles are similar at shorter ranges where target type, aspect angles, and background clutter can become important criteria affecting choices. At close range, scores favoring the decision to use guns were highest, as one would expect. No model deficiencies were identified or reported during the conduct of these analyses. Except for some of the outcomes of engagements between aircraft using the two types of aerodynamic models, findings were reasonable for the cases examined.

TABLE i-5. Functional Element Cross Reference Matrix.

FUNCTIONAL AREA	#	FUNCTIONAL ELEMENT	2.0 CMS	3.0 SAR
1.0 Platform Aircraft				
		1.0 Attributes		
	1	1.1 Configuration		
	2	1.2 Movement	2.2	3.2
		1.2.1 Aerodynamics/Propulsion		
		1.3 Signatures		
	3	1.3.1 EO	2.3	
	4	1.3.2 IRST	2.4	
	5	1.3.3 RF	2.5	
	6	1.4 Vulnerability		
		2.0 Sensors		
		2.1 Acoustic		
	7	2.2 EO		
	8	2.3 IRST		
	9	2.4 RF		
		3.0 Weapons		
	10	3.1 Guided	2.10	
	11	3.2 Ballistic		
	12	4.0 Comm Devices		
	13	5.0 CM/CCM	2.13	
	14	6.0 DME - Pilot/GCI/AWACS	2.14	
	15	6.1 Situation Update	2.15	
	16	6.2 Situation Assessment	2.16	
	17	6.3 Decision Logic	2.17	
		6.3.1 Project Situation		
	18	6.3.2 Production Rules	2.18	
		6.3.3 Set Decision Level		
		6.3.4 Make Decision		
	19	6.3.4.1 pkactn Formalism	2.19	
	20	6.3.4.2 Flight Posture	2.20	3.20
	21	6.3.4.3 Flight Tactics	2.21	
	22	6.3.4.4 Radar Mode	2.22	3.22
	23	6.3.4.5 Maneuver	2.23	3.23
	24	6.3.4.6 Weapon	2.24	3.24
	25	6.4 Degraded Capabilities	2.25	