APPENDIX A

VISUAL SYSTEM FOR THE CLOSE COMBAT TACTICAL TRAINER

A.1. SCOPE.

This appendix establishes the majority of the requirements for the image generation and display systems for the CCTT. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

A.2. APPLICABLE DOCUMENTS.

(This section is not applicable to this appendix)

A.3. REQUIREMENTS.

A.3.1 Item definition.

The image generation and display systems shall consist of the computer image generation equipment, display devices and associated software required to simulate the CCTT visual scene environment. The visual scene environment shall be seen through the vision blocks, sights, sensors and popped hatch of the CCTT modules and on the visual displays associated with selected CCTT consoles.

The following CCTT modules and consoles are covered by this appendix:

a. Modules:
   (1) M1A1/M1A2 tank.
   (2) M2A2/M3A2
   (3) M981 Fire Support Team Vehicle.
   (4) M113A3 Armored Personnel Carrier.
   (5) High Mobility Multipurpose Wheeled Vehicle (HMMWV).
   (6) Dismounted Infantry.

b. Consoles with visual displays:
   (1) After Action Review (AAR).
   (2) Tactical Air Control Party (TACP)

Throughout this appendix the term “host” shall be understood to mean the primary computer processor associated with each module or ~~/~~console.

A.3.1.1 Interface definition.

A.3.1.1.1 Mechanical interface.

The mechanical interface shall include all mechanical structures for housing the various components for the visual systems and structures to position and support the components.

A.3.1.1.2 Electronic interface.

The electronic interface shall provide all of the data, power and control interfaces required to achieve the complete performance and functionality specified for the CCTT system. A compatible data transfer and control interface interconnecting each module or console image generation system and local host computer system shall be provided. The interface shall provide

necessary control signal generation, timing, logic level shifting, signal buffering, etc. as required for proper image generator system operation. The interface between the image generation system and the local host computer shall utilize a common, standard interconnect and shall observe standard communication protocols.

A.3.1.1.3 Software interface.

The software interface shall include the software necessary to properly integrate each module's and ~~/~~console's host and image generation systems in order to provide the complete performance specified for the CCTT system. The image generation system shall interface with software as required by 3.1.1.

A.3.1.2 Major component list.

The major visual system components for each module/console shall be as specified below.

A.3.1.2.1 Image generator subsystem.

The image generation subsystem shall provide image signals for the simulation of all of the display types listed in A.3.1.2.2 as applicable to each individual module and~~/~~ console. The image generation subsystem shall provide, as a minimum, the following functions:

a. Host Processor Interface.

b. Local database storage including terrain, features and models.

c. Real time scene content management.

d. Image processing.

e. Display processing.

A.3.1.2.2 Image display subsystems.

The image display subsystems shall convert the signals from the image generator into visual images which depict the appearance of the physical environment. The image display subsystem shall include the following display types as applicable to each individual module or~~/~~ console:

a. Vision blocks.

b. Weapon sights and periscopes (with magnification).

c. Thermal imagery systems.

d. Light intensification devices.

e. Console visual displays.

f. Popped hatch, Dismounted Infantry, and HMMWV displays.

g. Binoculars.

A.3.1.2.3 Image databases.

CCTT visual systems shall utilize government furnished, stored digital representation of the training environment's physical characteristics, vehicles, military units and special effects. (see 6.2)

A.3.1.2.4 Operating and maintenance software and hardware.

All software and hardware needed to operate and maintain the system shall be provided.

A.3.2 Characteristics.

A.3.2.1 Performance.

The Image Generation and Display System for each module and ~~/~~console shall provide real-time visual and sensor displays of the training environment for all simulated viewpoint positions and attitudes. The computer image generator imagery shall change with and be dictated by real-time movement through the environment, engagement actions taken, and the actions of all modules and consoles in the battle scenario.

A.3.2.1.1 General training scene requirements.

Training scene features must be displayed with sufficient fidelity to allow 95 percent of the users to recognize them by shape, size, relationship to other objects, and texture.

A.3.2.1.1.1 Range of vision.

The range of vision shall be the same as in the corresponding real world situation except where limited by the system resolution and the specified visible range (active radius). The range of vision shall be no less than 4000 meters for surrounding terrain and objects on the terrain and 20,000 meters for prominent navigational and tactically significant landmarks.

A.3.2.1.1.2 Vehicle simulation.

The displayed images shall depict the speed, path and attitude of the simulated vehicle using vehicle dynamics calculations from the host. The movement of units shall be correctly influenced by the terrain slope, surface material (soil type), and water depth, so that the same limitations on motion exist as in the real world. The dynamics of the moving parts on vehicles, e.g., turret, tube and cupola, as appropriate, shall be depicted. The displayed images shall depict operation of weapons system stabilization and tracking systems. The simulated vehicles shall be capable of being placed anywhere in the gaming environment at initialization. The movement and function for the vehicles shall be controlled by the host.

A.3.2.1.1.3 Ground missile combat.

The CCTT visual system shall provide displayed images of the engagement of simulated vehicles by ground launched missile systems.

A.3.2.1.1.4 Ground mounted combat.

The CCTT visual system shall generate, in real-time, displayed images of the simulated battlefield which depict the movement and engagement of all stationary and moving vehicles (friendly and enemy), including dismounted infantry, whether in the open or partially concealed. The CCTT visual system shall also provide visual scenes for ground unit engagement of air targets.

A.3.2.1.1.5 Ground dismounted combat.

The CCTT visual system shall portray the movement and maneuver of dismounted infantry units. The dismounted infantry units shall appear as described in paragraph 3.7.10. The appearance of the soldier icon shall be a function of the type of cover present and the stance. Movement of the

dismounted infantry shall be controlled by a squad leader, platoon leader or forward observer from the respective station within a DI module. Capability for the infantry to dismount and remount shall be provided. Engagement (utilizing appropriate infantry weapons) with hostile vehicles and fire fights with hostile dismounted infantry shall be provided. Deployment and recovery of dismounted infantry units shall be to and from appropriate vehicles. Vehicles used by the infantry shall be simulated to the same extent as other vehicles specified herein.

30.2.1.1.2.6 Ground-to-air-combat.

The CCTT visual system shall provide visual scenes for ground unit engagement of air targets. Displayed images shall include all of the aircraft types specified in Table A-1. Weapons employment by and against aircraft shall be depicted.

A.3.2.1.2 Special real-time processing.

The image generator shall have the capability to provide high-fidelity simulation of atmospheric and meteorological effects, illumination conditions, special light characteristics and tactical smoke. The specified effects and conditions shall be realistically reflected in the simulation of all imagery.

A.3.2.1.2.1 Atmospheric and meteorological effects.

Simulation of the sky, horizon, and variable atmospheric and meteorological effects of haze, rain, fog and clouds shall be provided.

A.3.2.1.2.2 Illumination.

The illumination of the visual scene by both natural and artificial sources shall be simulated.

A.3.2.1.2.2.1 Time of day.

Automatic, gradual illumination changes to simulate continuous time of day shall be provided.

A.3.2.1.2.2.2 Artificial illumination.

A.3.2.1.2.2.2.1 Flare illumination.

Falling flares shall be simulated as an overhead illumination source at the appropriate location and altitude. Two types of flares, the illumination round for the 120mm mortar and the M485A2 illumination round for the 155mm Howitzer shall be selectable. The system shall support at least two simultaneous single or multiple flares.

A.3.2.1.2.2.2.2 Light points.

A variable intensity light points capability shall be provided.

A.3.2.1.2.2.2.3 Light point intensity control.

Each light point group intensity level shall be individually programmable by the host computer.

A.3.2.1.2.3 Tactical smoke.

The use of tactical smoke for screening, silhouetting, and blinding shall be simulated. The laser range finder shall be appropriately degraded due to smoke.

A.3.2.1.2.4 Visual simulation of motion.

Visual simulation of own-vehicle (shall be understood to include the DI, TACP, and AAR eyepoints) and visual scene element motion shall be as follows:

A.3.2.1.2.4.1 Own-vehicle dynamics.

Visual simulation shall provide own-vehicle motion equal to the complete range of motion capability of the design basis vehicle along and about all axes without any degradation in scene content or scene quality unless otherwise specified. The motion effects shall be applied to the visual simulation associated with each own-vehicle eyepoint.

A.3.2.1.2.4.2 Moving, / repositionable, and /switchable models.

The image generator shall be capable of displaying a combination of dynamic and static vehicles as modeled in the CCTT terrain databases (see 6.2), which represent a full complement of vehicles and other objects to simulate any potential scenario required as part of the CCTT trainer system. Dynamic models shall have unrestricted movement in six-degrees of freedom. Dynamic models representing vehicles with moving parts shall have articulated components, which move in the visual scene. The image generator shall provide at a minimum the following number of dynamic and static objects:

	Total Number Active	Displayed per Module/Console
Vehicles	150	100
Immobilized Vehicles	50	35
In Flight Missiles/Projectiles	35	20
Special Effects/Animations	35	20
Misc. Relocatable Objects	20	10
Tactical Smoke	15	7

A scene management process shall be provided to allow real-time reallocation of processing resources to accommodate other combinations of entities. Ground vehicles shall follow the contour of the terrain, as commanded by the local host computer. Air vehicles shall follow flight paths computed by the related vehicle consoles.

A.3.2.1.2.4.3 Animation and special effects.

A.3.2.1.2.4.3.1 Propeller/Rotor disc.

A translucent disc for all aircraft with propellers (rotors) shall be displayed in the scene.

A.3.2.1.2.4.3.2 Visible weapons effects.

All visible effects of weapons originating from friendly and hostile military units on targets, terrain and features, within the visual simulation range shall be visually depicted. These weapon effects shall include but not limited to muzzle flash, rocket plume, smoke, temporary vision obscuration, tracers, projectile flight (for guided, self propelled weapons), weapon impact, and detonation. Both transient and permanent weapons impact effects shall be depicted. Transient weapons effects shall depict bursts on terrain or target vehicle hits. Permanent weapon impact

effects shall result in the depiction of the computed result of the weapon damage to the general use models as defined in Table A-1, and buildings and bridges. The weapon effect simulation shall be such that misregistration between the effect and the associated point of origin, the coordinates for the weapon in flight and the impact point shall not be discernible by the observer.

A.3.2.1.2.4.3.2.1 Air-to-ground weapon effects.

Air-to-ground weapons employment by aircraft shall be depicted. Air-to-ground weapons flight (for guided, self propelled weapons), and weapons bursts on or near the target shall be depicted. Air-to-ground weapons effects consistent with the type of weapon and its point of impact or detonation shall be provided.

A.3.2.1.2.4.3.2.2 Weapons fire and weapons impact effect.

There shall be weapons fire effects (i.e., muzzle flash, tracer, missile launch, laser designation of target, etc.) and weapons impact effect visually depicted for all weapons (enemy and friendly) in the CCTT system.

A.3.2.1.2.4.3.2.2.1 Tracer simulation.

The CCTT visual system shall display simulated weapon system tracers consistent with the weapon being fired and shall realistically represent the rate of fire. For tracers originating from weapons attached to a given simulator module, the proper tracer trajectory and occultation shall be visually displayed for the crew stations of that module (i.e. own-vehicle tracers). A simplified tracer simulation for tracers generated by weapons external to the simulator module (i.e. crossing tracers) shall be provided for up to four weapons per firing platform model..

A.3.2.1.2.4.3.3 Dust trail.

The CCTT visual system shall display simulated dust trails on ground vehicles as modeled in the CCTT terrain databases (see 6.2) and controlled by the host computer. Activation of the dust trails shall not adversely affect other CCTT requirements such as visibility ranges, number of moving models, etc.

A.3.2.1.2.5 Special geometric computations.

The following requirements apply to computations of the location, orientation, positioning, and dynamics of own-vehicle, models (tanks, weapons, etc.) and special effects relative to, and as affected by, the terrain surface and objects on the terrain. The results of the computation are generally data for animation or data needed by the host for computations, which must be based on the image database to ensure correlation of all simulation components.

A.3.2.1.2.5.1 Simulated position.

The image generator shall generate an image that is positioned within the following computational tolerances. These tolerances are with respect to the position inputs from the local host that are supplied to the visual system for own vehicle, models and special effects.

a. Simulated angular position for all axes: +/- 0.04 degree.

b. Simulated altitude: +/- 1.0 cm.

c. Simulated North-South and East-West position: +/- 2.0 cm.

d. Moving object simulated angular position for all axes: +/- 0.05 degree.

e. Moving object simulated altitude: +/- 1.0 cm.

f. Moving object simulated North-South and East-West position: +/-2.0 cm.

g. Surface elevation: +/- 1.0 cm.

A.3.2.1.2.5.2 Laser range finder.

The visual system shall compute the range for the laser range finder simulation and return it to the host during the next update period following the request. The visual system shall support multiple simultaneous active laser range finder cursors with no change in the response time for the calculation. The system shall compute and return the laser range with no effect on system throughput.

A.3.2.1.2.5.3 Gaming area.

The visual system shall accommodate terrain databases of at least 100 km by 150 km

A.3.2.1.3 Image quality, general.

The CCTT system, when integrated with the visual system, shall provide the performance specified below. The performance specified applies to the total contributions of all parts of the complete integrated system.

There shall not be any variations or degradation in brightness, color, sharpness, position, or other visual characteristics, which are not typical of the scene being simulated except as specified.

A.3.2.1.3.1 Visual image field of view.

The true field of view for each design eyepoint and the associated sights, sensors, vision blocks and direct view displays shall be as specified in 3.2.1.6 and associated subparagraphs for each manned module/console.

A.3.2.1.3.2 Visual image sharpness.

The ratio of vertical to horizontal resolution (in arc-minutes/Optical Line Pair) shall vary no more than 0.8 to 1.2. Image motion of up to 15 degrees per second shall not degrade sharpness by more than 20 percent.

A.3.2.1.3.3 Luminance.

Luminance shall be no less than 3.5 foot Lamberts (ft-L) at the center of each display channel with the only exception being direct view CRT monitors which shall be no less than 20 ft-L. The requirement shall apply to all locations within the viewing volume specified and shall include the effect of all viewing optics, windscreens, etc.

A.3.2.1.3.3.1 Luminance variation.

Luminance drift shall not exceed +/- l0 percent over a continuous 16 hour operation period for any selected time of day simulation. The system shall maintain a minimum of 50 percent of the specified peak luminance for a minimum of 2000 hours of operation without replacement of any display component.

A.3.2.1.3.4 Contrast.

The minimum contrast ratio for all displayed images shall be 10:1 (only exception: 20:1 for direct view CRT monitors) for each display channel and throughout the viewing volume and FOV

A.3.2.1.3.5 Color.

The visual imagery shall provide an approximation of the full visible color spectrum as limited by commercial color display monitors

A.3.2.1.3.5.1 Color processing.

Luminance and chrominance information processing shall be accomplished with sufficient resolution and accuracy to ensure stable, continuous, color at the display with no discernible abrupt transitions and mach banding except as demanded by the phenomena being simulated.

A.3.2.1.3.6 Image perspective and geometric accuracy.

The CCTT visual systems shall generate and display true perspective images of the three-dimensional visual scene. The scene perspective shall be correct for all simulated eyepoint positions and viewing angles. Visual features which are obscured from view by other objects and the hidden back sides of objects shall not be visible in the display. Spurious images and object outlines shall not result from the occultation, backface elimination or any other image generation process.

Where headtracking is employed to monitor head motion, as the trainee moves his eyepoint throughout the viewing volume the image generator shall recompute the instantaneous image viewpoint for each associated active monitor. The recomputation of the image shall provide the trainee with a perception of parallax to provide enhanced distance cues and an increased sense of depth and the ability to move the instantaneous field of view in a natural manner to allow the trainee to see around nearby objects or to see objects which are in the gaps between vision blocks or otherwise immediately outside of the current viewing area.

A.3.2.1.3.6.1 Total geometric accuracy.

Total geometric distortion for each display shall minimize the error in apparent location for any point in the scene relative to the true projected position.

A.3.2.1.3.6.2 Relative geometric errors.

Geometric errors in scene points relative to nearby scene points shall not exceed six arc minutes at the center of the display(s). The relative geometric error at the edges of the display(s) shall not exceed ten arc minutes.

A.3.2.1.3.7 Vernier resolution.

Vernier resolution shall be less than 20 percent of the resolution (Optical Line Pair spacing) specified for each display.

A.3.2.1.3.8 Adjacent channel matching.

Gaps in what should be a continuous scene are only allowed in meeting the visual display requirements for the popped hatch mode, CWS (only vertical gaps are allowed), vision blocks (only vertical gaps are allowed), DI, HMMWV and the AAR console. For popped hatch, CWS,

and the vision blocks, the gap (discontinuity) in what should be a continuous scene shall be no larger than 2 degrees as measured from the design eyepoint. For the DI and HMMWV, a gap of 5 degrees is allowed. For the AAR console, a gap of 10 degrees is allowed. For displays with adjacent channels, that part of the scene which would fall within the gap in what should be a continuous scene shall be displayed by the surrounding displays. Adjacent channels shall be designed so as to minimize the appearance of discontinuity.

Where the scene presented is a combination of multiple channels, variations in color, brightness, contrast, resolution, and collimation between adjacent channels shall be minimized for the full range of simulated conditions.

A.3.2.1.3.9 Image stability.

The displayed image shall not drift in position more than one pixel per four hours of continuous operation. Peak to peak short term image deviations such as jitter and oscillation shall not exceed 0.04 percent (only exception: 0.02 percent for direct view CRT monitors) of the display diagonal measurement for the specified operating conditions. There shall not be any discernible relative motion between fixed objects in the visual scene except as demanded by the equations of motion for the operator/trainee viewpoint(s).

A.3.2.1.3.10 Video rate.

The video refresh rate shall be sufficient to prevent any noticeable display artifacts. A non-interlaced raster is preferred.

A.3.2.1.3.11 Update rate.

The position and attitude data for the viewpoint and all moving models shall be updated and a complete scene shall be computed at a rate that is sufficient to support the CCTT training tasks.

A.3.2.1.3.12 Transport delay.

The visual system transport delay shall be minimized and must be sufficient to support the CCTT training tasks and satisfaction of the overall system and manned module latency requirements (paragraph 3.2.2).

A.3.2.1.3.13 Occulting (hidden surface elimination).

The system shall provide general, all-inclusive occulting of objects, which are behind other objects without any restrictions on the orientation or real-time motion of objects. All moving models shall be properly occluded by intervening terrain and other visual features without any limitation. Occulting shall not result in any visible artifacts in the displayed image.

A.3.2.1.3.14 Smear.

Smear due to image motion shall not degrade resolution in excess of the value specified nor be noticeable in the displayed images.

A.3.2.1.3.15 Flicker.

Flicker due to image refresh rate shall not be noticeable for the image luminance as specified.

A.3.2.1.3.16 Stepping.

Stepping or other discrete image motion shall be minimized to the maximum extent practicable for all displays. If the image generator update rate produces stepping in the Commander's

Popped Hatch display a means of compensating for horizontal panning of the visual scene shall be provided (such as horizontally offsetting the displayed visual scene at a faster rate) in order to compensate for image motion between update cycles.

A.3.2.1.4 Image quality (system capacity).

The visual system shall optimize and maximize the density, distribution, and information content of visual features in the scene(s) for all conditions of image generator operation.

A.3.2.1.4.1 Continuous image density.

The visual system shall continuously maximize the density of displayed visual features, optimize the distribution of scene elements, and optimize the selection of scene elements for display, for the training tasks related to each display, and for the exercise conditions. For all conditions of operation, commensurate with maximizing scene content, maximum instantaneous polygon and object processing capacity specified shall be dedicated to the terrain, features and static models specified herein. Instantaneous polygon and object processing shall be distributed between channels (viewports) (but not between Channel Processors) based on individual channel scene content with individual channel level-of-detail provided. Level-of-detail transition range and the width of transparency band used to fade levels-of detail shall be adjustable to accommodate varying levels of scene content and to minimize operation at reduced update rate. Processing capacity used for special effects and moving models that cause high concentrations of polygons are excluded from the distribution requirement. The term feature denotes representations of separate physical entities (e.g., tree, storage tank, house, field, etc.) with color distinct from the background and sized larger than 3 X 3 pixels.

A.3.2.1.4.1.1 Feature selection.

The following lists shall be used as the criteria for the selection of features for display in each type of display channel. The relative priority of the features is indicated by the order of the list but that does not imply that all features at the top of the list should be displayed at the expense of having no features from lower items in the list. The selection shall take into account overall tactical significance, maintenance of scene continuity, and the field of view and resolution of the channel.

a. Gun sights or magnified devices:
    (1) All military equipment, troops, and activities.
    (2) Natural and cultural features of inherent military significance (e.g., roads, other lines of communication and transportation, bridges, buildings, natural features which would influence the course of action of military units).
    (3) Natural and cultural features, which obstruct vision and provide cover and concealment.
b. Driver’s vision block and HMMWV and TACP visual displays:
    (1) Foreground scene details which influence detail route selection, provide velocity and relative motion and position cues, indicate where and how fast the vehicle should be driven, indicate if an area is passable for the vehicle, indicate surface conditions such as mud, sand, etc.

(2) Items under (a) above at medium ranges based on their size, relevance to route planning and importance to scene continuity.

(3) Medium and far range scene details based on tactical significance and resolution of the display, and to maintain scene continuity.

c. Loader's vision block:

Same as commander's vision block.

d. Commander's vision blocks and popped hatch:

(1) Items from the gun sight list above but with reduced detail consistent with display field of view and resolution.

(2) Items from the driver's list above sufficient for route planning and directing general vehicle motion.

(3) Medium and far range features to assess the general nature of the terrain and features of tactical significance and to support navigation.

e. Dismounted infantry:

(1) All gun sight items.

(2) Items from the driver vision block list with extra emphasis on cover and concealment.

(3) Military items at all ranges sufficient to detect, recognize, identify, and engage targets.

(4) Terrain and vegetation detail at close ranges sufficient to move over terrain and to select and move into cover.

f. After action review console:

Shall default to the same selection criteria as the commander's vision block, however, shall provide the capability to override the default with any one of the above lists.

A.3.2.1.4.2 Scene content management.

Scene content management shall optimize the training value of the system by ensuring a maximum of needed visual cueing information for current operating conditions, and ensuring a minimum of scene discontinuities and other distracting image processing artifacts which could inhibit user psychological acceptance of the scene. Scene content filtering shall include the effects of visibility, elevation, viewing range, object angular subtense, and object color. Scene content shall be controlled in real-time to accomplish the following:

a. Ensure that the image processing and storage capacity of the system is efficiently utilized, but not exceeded, for all the conditions, and that the requirements for continuous image density are met for all conditions.

b. Ensure optimum selection of features for each display channel according to the function of that channel.

c. Ensure continuity of the scene and prevent noticeable changes in scene elements.

d. Prevent overload conditions.

e. Minimize operation at reduced update rates.

f. Eliminate scene details when they no longer contribute to the training problem.

g. Ensure that visual features are distributed within the field of view according to crew needs for the applicable tasks.

A.3.2.1.4.2.1 Scene management mechanisms.

The scene content management mechanisms shall include the following scene control features.

a. Eliminating scene elements from processing when they are hidden from view (behind obstructions).

b. Dynamic removal of scene elements (down to the polygon level) when their projected size precludes their effective use for visual cueing. This may be accomplished in non-real time by assigning transition range values, which effectively remove the object when its projected size is too small to contribute to training.

c. Dynamic concentration of scene detail on terrain immediately surrounding own-vehicle and on targets as viewed through a sight.

d. Dynamic modification of scene content control parameters, such as level of detail switching distance.

e. Dynamic control of width of transparency band.

f. Multiple levels-of-detail shall be used in all but the simplest models and sub-models to allow widely varying changes in model complexity.

g. The ability to assign individual channel (viewport) load management.

h. Programmable priority for the above measures and system resources to ensure that the most training critical aspects of scene quality and quantity are the last to be impacted when overload measures are implemented.

A.3.2.1.4.2.2 Environment integrity.

Scene management shall maintain the integrity of the training environment to ensure that significant features (terrain, culture and moving models) are kept in the scene under all circumstances in which they are essential, e.g., concealment. Environment integrity must be maintained between visual assets within a module/console (intra-module) and modules/consoles networked together in a common exercise (inter-module). Environment integrity shall be maintained to facilitate accurate weapon impact determination. A means to implement effective and realistic concealment simulation shall be provided. Scene features which serve to conceal a unit shall be visible to all observers. The simulation shall include effects for varying degrees of concealment to provide for partially concealed vehicles and dismounted infantry.

A.3.2.1.4.2.3 Scene management dynamics.

Scene management shall operate at a rate sufficient to ensure that the requirements for image continuity and continuous image density are maintained for all conditions of motion of the vehicle simulated by the host. Scene content management shall occur in a gradual, continuous manner, masked from the viewer to the maximum extent practical. Deletion and insertion of

scene elements made by the scene content manager shall be accomplished gradually in a manner, which minimizes the objects "popping" into the scene and causing any distraction. This shall include dynamic control of visibility range, transparency, contrast etc., for both individual scene elements and the entire scene, to mask scene content transitions. Changes in the displayed scene made by the scene content manager shall be accomplished at the single object level and several polygon levels, except changes relative to perspective size which shall occur at the single polygon level.

A.3.2.1.4.2.4 Overload prevention.

The system shall detect impending overload conditions prior to the occurrence of any scene discontinuity and shall adjust system parameters to maintain scene continuity. All system resources which can limit scene processing shall be monitored for overload conditions. Adjustments to scene content shall be selected to optimize relief of the exhausted resource. Overload conditions shall not result in the system locking up. The system shall automatically recover to full performance when the overload condition is removed.

A.3.2.1.5 Display configurations.

The following provides requirements for each general type of display, which is common to more than one module or ~~/~~console.

All vision path obstructions and ~~/~~restrictions encountered on the real vehicle (includes limitations resulting from head motion and parts of own-vehicle which obstruct) shall be duplicated in the modules. If a position-attitude sensor is utilized, the sensor and emitter configuration shall not add more than 5 ounces of head supported ~~and/~~or simulated device weight and shall not interfere with the user's viewing volume nor restrict movement within the simulated vehicle during the simulation. Methods which are based on a switched or~~/~~ stepped repositioning of the IFOV in response to a position-attitude sensor input shall provide for the following: The displayed image center shall be within 25 degrees of static head pointing direction. The rotation of the displayed image area shall be performed in discrete steps of not more than 45 degrees. With all head rotation less than 60 degrees per second, the displayed image center shall not lag the head pointing direction by more than 36 degrees.

A continuous slew of the IFOV in response to a position-attitude sensor input shall provide for the following: The displayed image center shall be within 30 arc minutes of static head pointing direction. With all head rotation less than 60 degrees per second, the displayed image center shall not lag the head pointing direction by more than 6 degrees. The IFOV shall be slewed in a way that maintains the correct position of the associated imagery while preventing artificialities or~~/~~ anomalies~~,~~ (e.g., perceptible jumps, latencies, and imagery quality degradations). Additionally, the imagery shall remain stable (free from image swim or ~~/~~oscillation and other abnormal movement) with all head rotation less than 60 degrees per second and all head oscillations of less than 1 Hz. Where displays are being switched (activated or ~~/~~deactivated) the overall transport delay (from the time the trainee action triggers a display change to completion of resulting field) shall be less than 250 ms.

Turret, cupola, sight, and periscope dynamics shall provide the full range of motion available in the actual vehicle. Where simulation of a full 360 degrees of horizontal FOV is accomplished by slewing or ~~/~~switching a smaller FOV the simulation shall allow for unlimited rotations clockwise and counterclockwise.

The requirement for total FOV can be simulated by providing an active display area with a FOV that is larger, relative to the design eyepoint, than the instantaneous FOV (accomplished by the use of an aperture or ~~/~~obstruction which restricts the optical path). As an alternate approach, the total FOV can be simulated independent of head motion by having the IG recompute the imagery in a fixed instantaneous FOV in response to operator input. The specified total FOV, both vertical and horizontal, shall be provided by a means whereby operator activation is not required. The use of manual switch or ~~/~~control activations, which are not required in the actual vehicle, to control visual system functions (e.g. selection of look direction) shall be~~is~~ allowed only in the following cases:

a. Binocular and night vision devices

b. To select appropriate imagery for the simulation of Total FOV. (This shall be ~~is only~~ allowed only where a total FOV requirement is explicitly stated.)

The methods used to satisfy the display configuration requirements shall be carefully selected so as to minimize the negative impact of latencies, perceptible display switching, and control or~~/~~ switch activation not required in the actual vehicle.

A.3.2.1.5.1 Full circle vision block configurations.

For crew stations which provide a full 360 degrees of horizontal FOV via a set of vision blocks mounted in a circle around the crew members head position (e.g. tank commanders), a complete set of simulated vision blocks shall be located around the head position just as in the design basis vehicle, however, for any given time only three, adjacent vision blocks need be active. The crewmember shall have the ability to select the active vision blocks. The selection method shall provide the operator with the same freedom of movement available in the actual vehicle and shall not require control/switch activations not required in the actual vehicle. When the vision blocks are integrated with the Popped Hatch Display such that the image seen through the vision block is the image on the Popped Hatch display, then the FOV and resolution requirements of the vision blocks shall be the same as that as the Popped Hatch with the FOV truncated by the mechanical limitations of the vision blocks.

A.3.2.1.5.2 Popped hatch displays.

For crew stations with a popped hatch capability a large total FOV, 360 degrees horizontal by 38 degrees vertical, shall be accessible but only a portion (instantaneous FOV) of it shall be available at any given time. The popped hatch view shall be provided via a set of displays fully or partially surrounding the crew member's head position.

The popped hatch shall be as follows:

a. For the popped hatch, a minimum instantaneous FOV of 180 degrees by 27.4 degrees shall be active (unless binoculars or NVG are in use) as long as the hatch is in the popped position.

b. For the popped hatch, the full 360 degree horizontal FOV shall be provided in response to the crew member's horizontal head rotation. A means of having the physical location of the center of the instantaneous FOV follow the operator's horizontal look direction shall be provided. The means used to steer the FOV horizontally shall provide the operator with the same freedom of movement encountered in the actual vehicle and shall not require control/switch activations not required in the actual vehicle. A means

shall also be provided to view the remaining 10.5 degrees of vertical FOV. However, the physical location of the center of the instantaneous FOV need not be repositioned vertically. Changing the scene to represent a pitch up/down is acceptable.

c. In the popped hatch, a binocular simulation shall be provided. It is acceptable to provide this simulation by replacing the active 180 degree FOV with a smaller FOV which is consistent with 7 by~~x~~ 50 field binoculars and providing a means for the operator to steer it. This means shall be such that negative training is minimized. It is unacceptable to base the simulation on the use of actual binoculars.

d. In the popped hatch, a NVG capability shall be provided. It is acceptable to provide this simulation by replacing the active 180 degree FOV with a smaller FOV which is consistent with 40 by~~x~~ 30 NVG and providing a means for the operator to steer it.

e. In the popped hatch, if this same display resource is used to satisfy other display requirements herein, a means of compensating for the difference in eyepoints shall be provided.

A.3.2.1.5.3 Driver displays.

Driver displays shall be as follows:

For the driver, all display vision blocks shall be active at all times.

A.3.2.1.5.4 Loader displays.

Loader (hatch-mounted) displays shall be as follows:

a. The loader's vision block shall always be active.

b. For the loader, a full 360 degree horizontal FOV shall be provided by manual rotation of the vision block.

A.3.2.1.5.5 Sights (primary, backup, and extension, (optical and thermal)).

The sights and periscopes with magnification shall be as follows:

a. For the magnified periscopes and sights, just as in the actual vehicle, the sight extension shall duplicate the image seen by the gunner in the primary sight.

b. The magnified periscopes and sights shall have the capability to change magnification, reticles, pointing direction, image source (optical, thermal, or image intensifier) as in the actual vehicle. For the magnified periscopes and sights, all rangefinding devices, laser designators and laser rangefinders shall function as in the actual vehicle. For the magnified periscopes and sights, switching times and control response shall be comparable to the actual vehicle. For the magnified periscopes and sights, moving reticles shall be fully simulated.

c. For all magnified periscopes and sights, it is acceptable to simulate the FOV as a circle with a truncated top and bottom (this results from fitting the circular FOV to a standard display with a 4/3 aspect ratio). The FOV as viewed through the eyepiece shall be the specified computed FOV, the physical FOV shall be that provided by the eyepiece.

d. The magnified periscopes and sights shall display all reticles for all modes of operation with the correct color, content, size and resolution.

A.3.2.1.6 Module and /Console specific FOV and resolution requirements.

The module displays shall provide FOVs (including up and/ down orientation of the vertical FOV), resolutions, detection ranges, and recognition ranges as required in the subparagraphs which follow. The resolution values specified are the maximum values acceptable. The location, size and orientation of all the vision blocks, periscopes (with magnification), sights and sensors shall conform to the module physical and /dimensional characteristics and component placement requirements of paragraph 3.6 of this specification.

Target detection and recognition ranges are specified in meters and based on the standard 2.5 meter high target.. The terms detection and recognition are defined below and are equivalent to their definitions in Johnson's Criteria

a. Detection - An object is present and requires 1.5 active scan lines across the object.

b. Recognition - The class to which an object or target belongs may be discerned, e.g., a small vehicle (like a jeep), a mid-sized vehicle (like an M1) and a transport aircraft. Requires 7.5 active scan lines across the object.

FOV (instantaneous and total) is specified as degrees horizontal x degrees vertical. The FOV requirements refer to the computed FOV. The physical (measurable at the eyepoint) FOV shall be equal to the computed FOV within +/- 10 percent%. Circular sights specified as having unequal horizontal and vertical fields of view shall be understood to represent a circle with a truncated top and bottom. For magnified sights, the FOV is stated in terms of the true FOV as opposed to the apparent FOV.

Resolution is the average vertical resolution specified in arc-minutes per optical line pair. The worst case vertical resolution shall be no greater than 110 percent% of the specified average vertical resolution. For systems which magnify, the resolution is stated in terms of the acceptance/true FOV as opposed to the apparent FOV. For all static head pointing directions (azimuth only), that part of the FOV which is within plus or minus 15 horizontal degrees of the head pointing direction shall meet the respective popped hatch and DI resolution requirements specified in subsequent parts of this section. The FOV falling outside of the viewing area defined above shall have resolution no worse than 2 times the respective resolution requirements for popped hatch and DI. Where the given system must support two operators, each shall have a dedicated, independent higher resolution viewing area. In all cases, the higher resolution area shall follow the head look direction without the need for operator intervention through controls or /switches.

A.3.2.1.6.1 M1A1/M1A2 tank module.

The following requirements apply to the M1A1 AND M1A2 modules except where a subparagraph is specifically labeled as applicable only to a particular version(s) of the M1:

a. In the M1A1 the Tank Commander shall have: six vision blocks and the Commanders Weapon System Sight (CWS) in a slewable cupola just like the actual vehicle, and a popped hatch capability with three modes of operation (normal, binocular and NVG).

Commander's cupola (M1A1 only):

(1) Instantaneous FOV (short vision blocks), 1X 34.9x9.0

	Instantaneous FOV (long vision block), 1X	25.6x6.5
	Instantaneous FOV (CWS), 3X	6.7 +/- 0.5
(2)	Total FOV (each vision block), 1X	60 X 18
(3)	Resolution (vision blocks), 1X	6.1
	Resolution (CWS), 3X	3.5
(4)	Detection range (vision blocks), 1X	2400
	Detection range (CWS), 3X	4000
(5)	Recognition range (vision blocks), 1X	500
	Recognition range (CWS), 3X	900

b. In the M1A2 the Tank Commander shall have: eight vision blocks in a cupola just like the actual vehicle and a popped hatch capability with three modes of operation (normal, binocular and NVG).

Commander's cupola (M1A2 only):

(1)	Instantaneous FOV (each vision block), 1X	34.9x9.0
(2)	Total FOV (each vision block), 1X	45 X 18
(3)	Resolution (vision blocks), 1X	6.1
(4)	Detection range (vision blocks), 1X	2400
(5)	Recognition range (vision block), 1X	500

c. In the M1A1 and M1A2 module the commander's popped hatch shall be supported.

Popped hatch (M1A1/M1A2):

(1)	Instantaneous FOV, 1X	180x27.4
	Instantaneous FOV, 7X (binoculars)	5.3x4.0
	Instantaneous FOV, (NVG)	36.0x27.4
(2)	Resolution, 1X	6.1
	Resolution, 7X	1.0
	Resolution, (NVG)	6.1
(3)	Detection range, 1X	2400
	Detection range, 7X	4000
	Detection range, (NVG)	2400
(4)	Recognition range, 1X	500
	Recognition range, 7X	2400
	Recognition range, (NVG)	500

d. For the M1A2 Tank Commander the Commander's Independent Thermal Viewer (CITV) shall be provided.

CITV (M1A2 only):

(1)	CITV Instantaneous FOV, 3X	10X7.5
	CITV Instantaneous FOV, 10X	3.00x2.2

(2) Resolution, 3X 1.5
Resolution, 10X 0.5

(3) Detection range, 3X 4000
Detection range, 10X 4000

(4) Recognition range, 3X 2000
Recognition range, 10X 4000

e. In the M1A1 and M1A2 modules, three vision blocks and one installable AN/VVS-2 night viewer shall be provided for the driver.

Driver (M1A1/M1A2):

(1) Day (optical) mode:

(a) Instantaneous FOV (center vision block), 1X, 34.9x9.0

(b) Instantaneous FOV (left/right vision blocks), 1X 22.3x9.00

(c) Total FOV (center vision block), 1X 60 X 18

(d) Total FOV (left/right vision blocks), 1X 38.2x18.0

(e) Resolution (vision blocks), 1X 6.1

(f) Detection range (vision blocks), 1X 2400

(g) Recognition range (vision blocks), 1X 500

(2) Night mode (Image intensification):

(a) Instantaneous FOV, 1X 35.2x18.0

Total FOV, 1X 125X 18

(Total FOV includes mechanical selection of viewing angle)

(b) Resolution, 1X 6.1

(c) Detection, 1X 2400

(d) Recognition, 1X 500

f. In the M1A1 and M1A2 modules, one vision block shall be provided for the Loader.

Loader (M1A1/M1A2):

(1) Instantaneous FOV,1X 34.9x9.0

(2) Total FOV, 1X 360x18

(Total FOV includes mechanical rotation of vision block)

(3) Resolution, 1X 6.1

(4) Detection range, 1X 2400

(5) Recognition range, 1X 500

g. In the M1A1 and M1A2 modules, one circular sight shall be provided for the gunner's primary sight (GPS) and commander's GPS extension (GPSE).

Gunner and commander (M1A1/M1A2):

(1) Optical mode:

(a)	Instantaneous FOV, 1X (unity window)	18.0x6.0
	Instantaneous FOV, 3X	18.9x14.2
	Instantaneous FOV, 10X	5.7x4.3
(b)	Resolution, 1X	6.1
	Resolution, 3X	2.8
	Resolution, 10X	0.9
(c)	Detection range, 1X	2400
	Detection range, 3X	4000
	Detection range, 10X	4000
(d)	Recognition range, 1X	500
	Recognition range, 3X	1100
	Recognition range, 10X	3100

(2) Thermal mode:

(a)	Instantaneous FOV, 3X	15.4x8.3
	Instantaneous FOV, 10X	4.6x2.5
(b)	Resolution, 3X	2.8
	Resolution, 10X	0.8
(c)	Detection range, 3X	4000
	Detection range, 10X	4000
(d)	Recognition range, 3X	1100
	Recognition range, 10X	3100

h. In the M1A1 and M1A2 modules, one circular sight shall be provided for the gunner's auxiliary sight (GAS).

Gunner (M1A1/M1A2):

(1)	Instantaneous FOV, 8X	7.1x5.4
(2)	Resolution, 8X	1.2
(3)	Detection range, 8X	4000
(4)	Recognition range, 8X	2400

A.3.2.1.6.2 M2A2 Infantry fighting vehicle and M3A2 cavalry fighting vehicle module.

The following requirements apply to the M2A2/M3A2 Bradley fighting vehicle.

a. In the M2A2 and M3A2 module, the Tank commander shall be provided with seven vision blocks and a popped hatch capability with three modes of operation (normal, binocular and NVG).

Commander's hatch (M2A2/M3A2):

(1)	Instantaneous FOV (each vision block), 1X	24.7x6.3
(2)	Total FOV (each vision block), 1X	48 X 12
(3)	Resolution (vision blocks), 1X	6.1
(4)	Detection range (vision blocks), 1X	2400
(5)	Recognition range (vision blocks), 1X	500

b. In the M2A2 and M3A2 module, the commander's popped hatch shall be supported.

Popped hatch (M2A2/M3A2):

(1)	Instantaneous FOV, 1X	180x27.4
	Instantaneous FOV, 7X (binoculars)	5.3x4.0
	Instantaneous FOV, (NVG) 4	36.0x27.4
(2)	Resolution, 1X	6.1
	Resolution, 7X	1.0
	Resolution, (NVG)	6.1
(3)	Detection range, 1X	2400
	Detection range, 7X	4000
	Detection range, (NVG)	2400
(4)	Recognition range, 1X	500
	Recognition range, 7X	2400
	Recognition range, (NVG)	500

c. For the M2A2 and M3A2 modules, the driver shall be provided with four M17 vision blocks and one AN/VVS-2 night viewer.

Driver (M2A2/M3A2):

(1)	Day (optical) mode:		
	(a)	Instantaneous FOV(each vision block), 1X	31.2x8.0
	(b)	Total FOV (each vision block), 1X	43 X 12
	(c)	Resolution (vision blocks), 1X	6.1
	(d)	Detection range (vision blocks), 1X	2400
	(e)	Recognition range (vision blocks), 1X	500
(2)	Night mode (Image intensification):		
	(a)	Instantaneous FOV, 1X	35.2x18.0
		Total FOV, 1X	125X 18
		(Total FOV includes mechanical selection of viewing angle)	
	(b)	Resolution, 1X	6.1

(c)	Detection range, 1X	2400
(d)	Recognition range, 1X	500

d. For the M2A2 and M3A2 modules, the gunners integrated sight unit including the commanders relay assembly shall be provided.

Gunner and Commander (M2A2/M3A2):

(1) Optical mode:

(a)	Instantaneous FOV, 1X (Unity window)	11.0x5.5
	Instantaneous FOV, 4X	14.2x10.7
	Instantaneous FOV, 12X	4.8x3.6
(b)	Resolution, 1X	6.1
	Resolution, 4X	2.3
	Resolution, 12X	0.8
(c)	Detection range, 1X	2400
	Detection range, 4X	4000
	Detection range, 12X	4000
(d)	Recognition range, 1X	500
	Recognition range, 4X	1300
	Recognition range, 12X	4000

(2) Thermal mode:

(a)	Instantaneous FOV, 4X	7.1x5.4
	Instantaneous FOV, 12X	2.4x1.8
(b)	Resolution, 4X	2.3
	Resolution, 12X	0.8
(c)	Detection range, 4X	4000
	Detection range, 12X	4000
(d)	Recognition range, 4X	1300
	Recognition range, 12X	4000

e. For the M2A2 and M3A2 modules, the gunner’s hatch shall have two vision blocks.

Gunner (M2A2/M3A2):

(1)	Instantaneous FOV (each vision block), 1X	11.0x5.5
(2)	Total FOV (each vision block), 1X	11.0x5.5
(3)	Resolution (vision blocks), 1X	6.1
(4)	Detection range (vision blocks), 1X	2400
(5)	Recognition range (vision blocks), 1X	500

f. For the M2A2 and M3A2 modules, the gunner shall be provided with one circular sight. Backup sight: One circular sight.

Gunner BUS (M2A2/M3A2):

(1) Instantaneous FOV, 5X	11.4x8.6
(2) Resolution, 5X	1.7
(3) Detection range, 5X	4000
(4) Recognition range, 5X	2000

A.3.2.1.6.3 M981 fire support team vehicle module (FIST-V).

The following requirements apply to the M981 FIST-V module.

a. In the M981 FIST-V module, the Commander's hatch/targeting station shall have Seven M17 vision blocks in a slewable hatch just like the actual vehicle.

Commander (M981 FIST-V):

(1) Instantaneous FOV (each vision block), 1X	31.2x8.0
(2) Total FOV (each vision block), 1X	31.2x8.0
(3) Resolution (vision block), 1X	6.1
(4) Detection range (vision blocks), 1X	2400
(5) Recognition range (vision blocks),	500

b. For the M981 FIST-V driver, Four M17 vision blocks and one M19 night vision device shall be provided.

Driver (M981 FIST-V):

(1) Day (optical) mode:

(a) Instantaneous FOV (each vision block), 1X	31.2x8.0
(b) Total FOV (each vision block), 1X	34 degrees X 12 degrees
(c) Resolution (vision blocks), 1X	6.1
(d) Detection range (vision blocks) , 1X	2400
(e) Recognition range (vision blocks) , 1X	500

(2) Night mode:

(a) Instantaneous FOV, 1X	31.2x8.0
(b) Resolution, 1X	6.1
(c) Detection range, 1X	2400
(d) Recognition range, 1X	500

c. For the M981 FIST-V gunner's sights, the simulated gunner's sights shall have the capability of selecting an optical acquisition sight, a thermal night sight, and a ground vehicle laser locator designator/range finder. The circular sight, in optical and thermal modes of operation, shall have two different magnification levels.

Gunner (M981 FIST-V):

(1) Optical mode:

(a) Instantaneous FOV, 3X	22.6x17.1
(b) Instantaneous FOV, 13X	5.3x4.0
(c) Resolution, 3X	3.7
(d) Resolution, 13X	0.8
(e) Detection range, 3X	4000
(f) Detection range, 13X	4000
(g) Recognition range, 3X	800
(h) Recognition range, 13	4000

(2) Thermal mode:

(a) Instantaneous FOV, 3X	6.8X 5.1
Instantaneous FOV, 13X	6.0x3.8
(b) Resolution, 3X	3.7
Resolution, 13X	0.8
(c) Detection range, 3X	4000
Detection range, 13X	4000
(d) Recognition range, 3X	800
Recognition range, 13X	4000

d. In the M981 FIST-V module, the Observation station panoramic telescope shall be provided. The simulated observation station panoramic telescope shall rotate throughout 360 degrees, providing the observation station full horizontal field of view coverage.

Observer (M981 FIST-V):

(1) Instantaneous FOV, 4X	17.1x12.8
(2) Resolution, 4X	2.1
(3) Detection range, 4X	4000
(4) Recognition range, 4X	1600

A.3.2.1.6.4 M113A3 armored personnel carrier (APC).

The following requirements apply to the M113A3 full tracked armored personnel carrier module:

a. For the M113A3 APC, the driver shall have four M17 vision blocks and one M19 night vision device.

Driver (M113A3 APC):

(1) Day (optical) mode:

(a) Instantaneous FOV (each vision block), 1X 31.2x8.0

(b) Total FOV (each vision block), 1X 34 degrees X 12 degrees

(c) Resolution (vision blocks), 1X 6.1

(d) Detection range (vision blocks), 1X 2400

(e) Recognition range (vision blocks),1X 500

(2) Night mode:

(a) Instantaneous FOV, 1X 2 31.2x8.0

(b) Resolution, 1X 6.1

(c) Detection range, 1X 2400

(d) Recognition range, 1X 500

b. For the M113A3 APC, the commander's cupola shall be comprised of five vision blocks in a slewable hatch just like the actual vehicle.

Commander (M113A3 APC):

(1) Instantaneous FOV (each vision block),1X 31.2x8.0

(2) Total FOV (each vision block), 1X 31.2x8.0

(3) Resolution (vision blocks), 1X 6.1

(4) Detection range (vision blocks), 1X 2400

(5) Recognition range (vision blocks), 1X 500

c. For the M113A3 APC commander's hatch, no visual displays are required.

A.3.2.1.6.5 High mobility multipurpose wheeled vehicle (HMMWV) module.

Each HMMWV module shall have a visual display system, which serves both the driver and observer. The HMMWV module shall have three user selectable modes: unaided eye, binocular, and image intensifier. The driver and forward observer display systems for the HMMWV shall have multiple direct view displays which together present an instantaneous FOV of 108 by 27.4 degrees.

For the HMMWV module, a display system serving both the driver and forward observer shall be provided.

a. Instantaneous FOV, 1X 108X 27.4

Instantaneous FOV, 7X (binoculars) 5.3x4.0

Instantaneous FOV, (NVG) 36x27.4

b. Resolution, 1X 6.1

Resolution, 7X 0.9

Resolution, (NVG) 6.1

c. Detection range, 1X 2400

	Detection range, 7X	4000
	Detection range, (NVG)	2400
d.	Recognition range, 1X	500
	Recognition range, 7X	2400
	Recognition range, (NVG)	500

A.3.2.1.6.6 Dismounted infantry (DI) module.

Each DI module shall have three visual display systems. In the DI module, two of the systems shall each serve a single operator, squad leader, and the third shall be shared by the forward observer (FO) and a platoon leader (PL), i.e., the same visual scene shall serve both the FO and PL. The DI module shall have three user selectable modes: unaided eye, binocular, and image intensifier. For the DI display system there shall be multiple direct view displays which together present an instantaneous FOV of 180 by 27.4 degrees.

a.	Instantaneous FOV, 1X	180 X 27.4
	Instantaneous FOV, 7X (binoculars)	5.3 x 4.0
	Instantaneous FOV, (NVG)	36 x 27.4
	Dragon FOV (Day)	6.0
	Dragon FOV (IR)	3.4 x 6.8
	Javelin FOV (Day)	5.4 x 6.8
	Javelin FOV (IR)	4.58 x 6.11
b.	Javelin FOV (IR)	2.0 x 3.0
	Resolution, 1X	6.1
	Resolution, 7X	0.9
	Resolution, (NVG)	6.1
	Resolution, Dragon Day, 6x	1.3
	Resolution, Dragon IR,	4x 0.8
	Resolution, Javelin Day, 4x	1.2
	Resolution, Javelin IR, 4.2x	1.0
	Resolution, Javelin IR, 9x	0.4
c.	Detection range, 1X	2400
	Detection range, 7X	4000
	Detection range, (NVG)	4000
	Detection range, Dragon Day 6x	4000
	Detection range, Dragon IR 4x	4000
	Detection range, Javelin Day 4x	4000
	Detection range, Javelin IR 4.2x	4000

	Detection range, Javelin IR 9x	4000
d.	Recognition range, 1X	500
	Recognition range, 7X	2400
	Recognition range, (NVG)	500
	Recognition range, Dragon Day	2400
	Recognition range, Dragon IR	2400
	Recognition range, Javelin Day	2400
	Recognition range, Javelin IR	2400

A.3.2.1.6.7 After action review console - visual display.

For the AAR console, there shall be a minimum of three direct view displays which together provide an instantaneous FOV of 120 by 30.5 degrees. The AAR visual display system shall have three modes of operation: independent, tethered and slaved as described in paragraph 3.7.2.2.3. The AAR visual display shall be available during real-time and playback modes. For the AAR console, the displayed scene shall be operator selectable as unaided, thermal, and light intensifier. The displayed image shall repeat the associated characteristics of the selected displayed image including magnification, reticle and displayed data. The AAR visual display shall provide the capability to display magnified images equivalent to the selected crew member position when operating in the slaved mode and shall be capable of providing 3X and 10X magnification when operating in the tethered mode.

For the AAR console, a 3-channel display system with the following characteristics shall be provided:

a.	Instantaneous FOV per channel (normal)	40X30.5
	Instantaneous FOV, (thermal)	40X30.5
	Instantaneous FOV (NVG)	40X30.5
b.	Resolution, 1X (normal)	6.8
	Resolution, (thermal)	6.8
	Resolution, (NVG)	6.8
c.	Detection range, 1X (normal)	2400
	Detection range, (thermal)	2400
	Detection range, (NVG)	2400
d.	Recognition range, 1X (normal)	500
	Recognition range, (thermal)	500
	Recognition range, (NVG)	500

A.3.2.1.6.8 After Action Review - debrief display.

The AAR debrief display shall be at least a 68 inch by 92 inch color display system. The AAR debrief display system shall provide a single channel large screen display with the raster format (number of lines and pixels) being the same as the AAR plan view display. The display shall be able to display any channel of the AAR visual display as described in paragraph A.3.2.1.7.8 or

the AAR plan view display as described in paragraph 3.7.2.2.1.1. The AAR debrief display shall be synchronized with the source AAR console to eliminate screen roll during source select.

A.3.2.1.6.9 Tactical Air Control Party console - visual display.

For the TACP console, there shall be a minimum of one direct view display with a computed FOV of 40 by 30.5 degrees.

For the TACP console, a 1-channel display system with the following characteristics shall be provided:

a.	Instantaneous FOV per channel (normal)	40X30.5
	Instantaneous FOV, 7X (binoculars)	5.8x4.4
	Instantaneous FOV (NVG)	40 X 30.5
b.	Resolution, 1X	6.8
	Resolution, 7X	0.9
	Resolution, (NVG)	6.8
c.	Detection range, 1X	2400
	Detection range, 7X	4000
	Detection range, (NVG)	2400
d.	Recognition range, 1X	500
	Recognition range, 7X	2400
	Recognition range, (NVG)	500

A.3.2.1.7 Electro-optics sensor image simulation.

The CCTT shall have sensor simulation capability. The sensor simulation capability shall include thermal imaging and low light amplification in the form of Night Vision Goggles (NVG) and appropriate installable/switchable devices (those available in the actual vehicles). Sensor simulation modes shall be available at all times, where appropriate, during a simulation session. The selection time to and from sensor modes shall not exceed selection times in the actual vehicle.

The initial conditions shall be controllable from the MCC during exercise generation. The viewed sensor image magnifications (where magnification is selectable on installed equipment), fields of view, and viewing pupils shall at all times be the same as in the operational equipment, except where deviation is allowed. Simulation of corresponding sensor viewer overlay information, e.g., range, bearing, crosshairs, etc., is required.

A.3.2.1.7.1 Sensor image database.

The electro-optic sensors simulation shall utilize the visual database with additional descriptors and object data necessary to generate images with the fundamental characteristics of the sensor being simulated. Use of the visual database for sensor image generation shall not result in degradation of the capabilities of either the standard visual or sensor image generation.

A.3.2.1.7.2 EO simulation optics.

All optics shall be in accordance with A.3.3.2.2.

A.3.2.1.7.3 Thermal sight image simulation.

The thermal images shall be generated about the instantaneous optical line-of-sight of the thermal receiver optics. Under MCC operator control, four environmental thermal conditions: wet hot day, dry hot day, wet cold day, and dry cold day for the database shall be selectable.

The thermal conditions shall provide a generally correct appearance for all objects for a given time of day, temperature and atmospheric condition. Thermal signature simulation may be absolute in thermal representation and simplified by creating generic thermal signatures by type of model e.g., tank, armored personnel carrier, wheeled armored, truck, etc. Simulation of thermal signatures emitted through tactical smoke, fog, and vegetation is required. The effect of atmospheric attenuation shall utilize a fading function appropriate to infrared. The simulated thermal image shall simulate thermal noise to the thermal imagery video to produce a realistic appearance. The thermal image simulation shall exhibit the response to operator manipulation of sensitivity, gain, contrast and other controls applicable to each vehicle to approximate the relationship between control settings, environmental conditions, and the displayed imagery. Both white-hot and black-hot modes shall be simulated.

A.3.2.1.7.4 Night vision image intensifier.

The CCTT shall provide a realistic simulation of the use of low light level vision intensification equipment. For vehicle drivers the intensification simulation shall utilize a simulated NVV having the look and feel of operational equipment. When simulating instruments of the operational intensification equipment, operational mechanical adjustment features and electrical controls shall be simulated. When existing display assets are used, all electrical controls and fields of view restrictions shall be simulated. As part of simulation initial condition setup performed at the MCC, the intensifier simulation shall provide selectable natural illumination. The options shall include an overcast condition and three phases of lunar illumination (0 (starlight only), half~~1/2,~~ and full moon). The lunar phase and illumination levels shall correspond to real world conditions.

A.3.2.1.7.5 Laser range finder.

The system shall simulate the laser range finder for units, which have that capability. Range finder information shall be provided in the same manner as in the operational equipment for targets that are within the line of sight of the reticle center. When the laser range finder mode is activated, proper fire control symbology shall be generated in the appropriate sights. The range finder shall also simulate false/doubled echoes and natural obscurants (i.e. haze, fog, etc.). The effectiveness of the range finder shall be affected by the use of tactical smoke.

A.3.3 Major component characteristics.

A.3.3.1 Image generator subsystem.

The CCTT image generator subsystem shall consist of real-time computer image generation and image processing equipment. The computer image generation is considered to include that class of system, which provides true perspective two-dimensional displays of stored three-dimensional environment database. Image processing refers to operations performed on pixel image data. It is applicable to the visual scene as seen through the periscopes, sights sensors and popped hatch of the vehicle modules and the CCTT console visual displays, which depict the geometry, and

appearance of their environment. The system shall provide imagery for each module/console for all of the following that are applicable.

a. Vision blocks.

b. Weapon system sights and periscopes (those that magnify).

c. Thermal sensors.

d. Image intensifier night vision devices.

e. CCTT consoles, including binocular and NVG view.

f. After action review station, including a single large screen video projection system shared by the AAR consoles.

g. Popped hatch capability.

A.3.3.1.1 Image generation system throughput.

In each channel no less than 1130 polygons per 40 degrees of true horizontal FOV shall be available for the display of the medium and high resolution terrain skins. Potentially visible polygons are defined as the front facing, four sided surfaces that are either directly visible or would be visible if not occulted by an intervening scene element.

Potentially visible polygons (Minimum acceptable) = 1000 + [(Channel's true horizontal FOV) / 40] x 2500

The above values assume a highly effective scene content management system. If the image generator light point capacity is stated separately from (in addition to) polygon capacity then three light points are assumed equivalent to one polygon for up to ten percent of the required capacity if the lights can have reflectance characteristics and serve as point objects. The system shall have the capability to compute both light points and surfaces. If the number of pixel writes can limit system output, then a depth complexity of no less than 2.7 (ability to write each pixel 2.7 times per field and frame) shall be provided. System and channel capacity throughout the image generator shall be adequate to support the specified polygon capacity for all operating conditions. There shall be no computational, memory, data transfer, or other limitations anywhere in the image generator or the database design which would limit the ability of the system to display the specified quantity of potentially visible polygons. The polygon and pixel performance shall be independent of the number of channels generated by a single image generator. The polygon and pixel capacity shall be met regardless of the displayed image geometrical arrangement, distribution of polygons within the displayed image, number and distribution of moving models and the worst case combination of special processing and display features invoked. The polygon and pixel capacity shall not be restricted by polygon complexity attributes (i.e., texture, antialiasing and shading).

A.3.3.1.2 Displayed image artifacts.

Distracting artifacts caused by digital processing errors shall be minimized. Anomalies shall in every case be eliminated or reduced to the extent that they shall not degrade the effectiveness of exercise execution.

A.3.3.1.2.1 Anti-aliasing.

Undesirable artifacts of digital image processing shall be eliminated or reduced to a negligible level for both surfaces and light points.

A.3.3.1.3 Special image generator processing.

The system shall have sufficient special processing features such as shading, transparency, etc. to meet the functional and performance requirements herein. Shading shall be used on all polygons and objects in the database. Flat, fixed, and smooth surface shading shall be provided. Shading shall not result in any Mach band or other color discontinuities in smooth surfaces.

A.3.3.1.4 Texture.

The system shall be capable of mapping image data onto all environment polygons. In this specification image data refers to stored pixel (texel) data generated by both photographic means and numerical algorithms. The image data is referred to as photo-maps, cells, texture maps, texture patterns, etc. The effect of transparency, shading, illumination, and all other simulated characteristics specified for polygons shall be reflected in the mapped polygons. The image data shall provide intensity contour and modulation, color contour and modulation, transparency contour and modulation and full color texture. Contour mapping allows a pattern to depict a shape (silhouette) on a single polygon. Image data parameters shall be capable of being modulated independently, simultaneously, and as a function of range.

The system shall be capable of storing no less than 4 million texels of texture map data in online memory. Texture map sizes of at least 512 by~~X~~ 512 shall be available. Retrieval (paging) of image data in real time shall be provided to permit geo-typical and geo-specific photographic data to be used throughout the visual environment.

A.3.3.1.4.1 Mapping.

The image data shall be spatially fixed on the surfaces and shall display correct perspective and orientation as the viewpoint and mapped surface move in the environment. The texture shall remain fixed relative to the underlying polygons and shall be valid for all orientations of objects and polygons in the environment.

A.3.3.1.4.2 Anti-aliasing and blending.

The image data shall be blended at boundaries between repetitions and at boundaries between polygons, where appropriate, to prevent the boundaries and repetitions from being obvious. Resolution and dynamic range of texture shall be adequate to provide stable imagery throughout the operating range. The imagery shall be free of aliasing.

A.3.3.1.4.3 Dynamic texture.

Dynamic texture patterns shall be provided which have the capability to move in any direction on the surface to which it is applied to simulate moving ocean waves, clouds, blowing sand/snow, and similar effects.

A.3.3.1.5 Database storage capacity.

Although only one database shall be in use (selected) at any given time on any given module or~~/~~ console, each module and~~/~~ console shall have enough mass storage capacity to simultaneously accommodate three complete databases of 100 km by~~X~~ 150 km. For the CCTT system, the time to activate any one of the three that are available shall be less than 5 minutes. At each module and ~~/~~console a means to replace one of the available databases with a new one in less than 3 hours shall be provided. For the CCTT system, there shall be a means provided for replacing databases on modules and ~~/~~consoles, by removable media (~~ie.~~i.e. magnetic tape, at each module and~~/~~ console).

A.3.3.1.6 Improved IG performance.

The image generator designs shall provide for straightforward upgrade by modular expansion of the system. Spare card slots shall be provided in the image generator for expansion flexibility. The image generator expansion capability shall allow for a higher processing and storage capacity to provide coverage of larger areas with higher resolution data and increased density.

A.3.3.2 Image display subsystem.

The CCTT image display subsystems shall convert the signals from the image generator into visual images representing the simulated environment for each of the module/console displays as specified. For each module, light-tight shrouds or similar means shall be provided so that extraneous dust and light from outside the module doesn't degrade visual display system performance.

All optics used in the sights and optical paths shall be readily accessible to facilitate cleaning and adjustments.

A.3.3.2.1 Optics.

All reflective optics used in the CCTT display subsystem shall be front surface reflective coated. The transmission and reflection of any beam-splitter utilized shall be maximized for signal to ghosting ratio both on and off axis. No chromatic or spherical aberration shall be discernible. Physical configuration of the display unit shall be optimized to the crew members compartment with a minimum of compartment modifications. A dust proof enclosure shall be provided for the optical subsystem. There shall be no major spurious images or reflections, including light leaks, mirror imperfections, and reflections, or from any other source.

A.3.3.2.2 Magnified displays.

Except where deviation is authorized, the magnified sight displays shall duplicate the magnification, real FOV and apparent FOV of the corresponding operational equipment for each module. The external appearance (from within the vehicle module) of the simulated sights shall have the form, fit and feel of the operational equipment. Displayed images which simulate selectable modes (optical and ~~/~~thermal) and magnification shall, when in optical mode, utilize the full horizontal and vertical resolution capability of the raster format regardless of the magnification selected (except where a portion of the field of view is masked to provide resolution representative of the device being simulated). For thermal mode operation an appropriate portion of the full raster format may be masked but the remaining unmasked part of

the raster shall be used for all magnification options. As appropriate, based on the actual vehicle, sights and periscopes with magnification shall have eyepieces with the following characteristics:

a. Erfle design.

b. Diopter adjustment - +/- 2.5 Diopters.

c. Reticle focus (when appropriate, but not needed if reticle is generated by the CIG).

d. Eye relief - 25mm.

e. Exit pupil - 6mm.

f. Apparent field of view (AFOV) available - Shall be the same as that in the corresponding operational equipment. The part of the available AFOV which is actually filled with imagery (AFOV used) shall vary from sight to sight and from mode to mode (thermal versus optical) just as it does in the operational equipment.

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Table A-I. General Use Models					
Platforms	**Type**	**Category**	**DMGD 1**	**DMGD 2**	**Notes**
US Vehicle/Equip Models					
Bridge, 60 AVLB Launched	3D	Moveable	Yes		
LNCHR AVLB M60A1 Series	3D	CBT Vehicle	Yes		
M1A1, 120mm	3D	CBT Vehicle	Turret	Hull	
M1A2, 120mm	3D	CBT Vehicle	Turret	Hull	
M1043 HMMWV ARMT CARR w/MK 19	3D	CBT Vehicle	Turret	Hull	
M1044 HMMWV ARMT CARR w/M2 (.50 cal)	3D	CBT Vehicle	Turret	Hull	
M1064, CARR Mort W BMS 120	3D	CBT Vehicle	Yes		
M113A3, CARR Pers	3D	CBT Vehicle	Yes		
M2A2/M3A2/BSFV/IVF/CFV, 25mm & TOW	3D	CBT Vehicle	Turret	Hull	
M577A2 Carr CP (With and w/o tent ext.)	3D	CBT Vehicle	Yes		
M58 A3 MCLIC	3D	CBT Vehicle	Turret	Hull	
M728 CEV	3D	CBT Vehicle	Turret	Hull	
M9 ACE	3D	CBT Vehicle	Yes		
M93 NBC Recon Vehicle	3D	CBT Vehicle	Yes		No NBC tasks
M981 FISTV	3D	CBT Vehicle	Turret	Hull	
M992 FAASV	3D	TAC Vehicle	Yes		

Table A-I. General Use Models					
Platforms	**Type**	**Category**	**DMGD 1**	**DMGD 2**	**Notes**
M998, HMMWV (Stinger Tms, 1SG, UMCP)	3D	CBT Vehicle	Yes		
Mine Plows (back of HEMTT for transport)	3D	CBT Vehicle	Yes		
Mine Plows (on M1A1 Tank)	3D	CBT Vehicle	Yes		
Mine Rollers (back of HEMTT for Transport)	3D	CBT Vehicle	Yes		
Mine Rollers (on M1A1 Tank)	3D	CBT Vehicle	Yes		
M1025 HMMWV w/M2 (.50 cal)	3D	TAC Vehicle	Yes		
M1078 LMTV (2.5T)	3D	TAC Vehicle	Yes		
M1079 LMTV Van	3D	TAC Vehicle	Yes		
M1083 MTV (5T)	3D	TAC Vehicle	Yes		
M1089 MTV Wrecker	3D	TAC Vehicle	Yes		
M109A5 SP HOW	3D	CBT Vehicle	Turret	Hull	
M109A6 SP HOW	3D	CBT Vehicle	Turret	Hull	Model
M1091 MTV (5T) POL Tanker	3D	TAC Vehicle	Yes		
M270 MLRS	3D	CBT Vehicle	Turret	Hull	
M88 A2 Recvy Veh.	3D	CBT Vehicle	Yes		
M966 TRK Util HMMWV w/TOW	3D	CBT Vehicle	Turret	Hull	
M977 HEMTT, Cargo	3D	TAC Vehicle	Yes		

Table A-I. General Use Models					
Platforms	**Type**	**Category**	**DMGD 1**	**DMGD 2**	**Notes**
M978, HEMTT, FS	3D	TAC Vehicle	Yes		
M984 A1, HEMTT Wrecker	3D	TAC Vehicle	Yes		
M985 HEMTT, Cargo	3D	TAC Vehicle	Yes		
VOLCANO (mounted on an M1083)	3D	TAC Vehicle	M1083 only		
US Personnel Models					
US ATGM, 2 Pers, JAVELIN, DRAGON & M16	3D	Personnel	Attrited		Use Javelin Visual model for Dragon
US DSMT ENGR Pers, 8 Pers	3D	Personnel	Attrited		
US INF Fire Team, 4 Pers	3D	Personnel	Attrited		
US Scouts, 2 pers, SAW and COMMO	3D	Personnel	Attrited		
US Stinger TM, 2 Pers	3D	Personnel	Attrited		
US Inf, 1 Pers, Weapons (DIM only)	3D	Personnel	Attrited		Non-SAF
US Rotary Wing Models					
AH1S Cobra	3D	Attack	Yes		
AH64 Apache	3D	Attack	Yes		
OH 58D	3D	Scout	Yes		
UH60A Blackhawk	3D	Utility	Yes		
US Fixed Wing					

Table A-I. General Use Models					
Platforms	**Type**	**Category**	**DMGD 1**	**DMGD 2**	**Notes**
A10 Warthog	3D	Combat	Yes		
F16 Falcon	3D	Combat	Yes		
OPFOR Combat Vehicles					
ACRV, 1V12	3D	CBT Vehicle	Yes		
2S1, 122mm SP Howitzer	3D	CBT Vehicle	Turret	Hull	
2S19, 152mm SP Howitzer	3D	CBT Vehicle	Turret	Hull	
2S3, 152mm SP Howitzer	3D	CBT Vehicle	Turret	Hull	
2S31, Combination Gun mtd in BMP	3D	CBT Vehicle	Turret	Hull	
2S6, Quad 30mm, 8 SA 19	3D	CBT Vehicle	Turret	Hull	
BRDM 2, ATGM, w/5 AT5 (9P148)	3D	CBT Vehicle	Yes		
BMP II, 30mm & AT5	3D	CBT Vehicle	Turret	Hull	
BMP IKsh, Cmd & Comm Veh	3D	CBT Vehicle	Yes		
BMP IP, 73 mm & AT5	3D	CBT Vehicle	Turret	Hull	
BRDM 2, RECON, 14.5mm & 7.62mm MG	3D	CBT Vehicle	Turret	Hull	
GMZ Tracked Mine Layer	3D	TAC Vehicle	Yes		
MTU-20 AVLB	3D	CBT Vehicle	Yes		
Bridge, MTU-20 AVLB	3D	Moveable	Yes		
KMT-5M Roller/Plow, mounted on an OPFOR tank	3D	CBT Vehicle	Yes		

Table A-I. General Use Models					
Platforms	**Type**	**Category**	**DMGD 1**	**DMGD 2**	**Notes**
MT12	3D	CBT Vehicle	Yes		
SA-13, AD Missile Artillery	3D	CBT Vehicle	Yes		
T72B w/Reactive AR	3D	CBT Vehicle	Turret	Hull	
T72 w/o Reactive AR	3D	CBT Vehicle	Turret	Hull	
T80U w/Reactive AR	3D	CBT Vehicle	Turret	Hull	
2S23, Combination Gun mtd in BTR 80	3D	CBT Vehicle	Turret	Hull	
BMP III, 100mm, 30mm, & AT-10	3D	CBT Vehicle	Turret	Hull	
BTR 60P, 14.5mm	3D	CBT Vehicle	Turret	Hull	
BTR 80, 14.5mm	3D	CBT Vehicle	Turret	Hull	
D30, 122mm Howitzer, Towed	3D	CBT Vehicle	Yes		
SA-15, AD Missile Artillery, 2S6 Chassis	3D	CBT Vehicle	Yes		
T62 w/o Reactive AR	3D	CBT Vehicle	Turret	Hull	
T64/T64B both w/Reactive AR	3D	CBT Vehicle	Turret	Hull	
T80 w/o Reactive AR	3D	CBT Vehicle	Turret	Hull	
ZSU 23-4, Quad 23mm	3D	CBT Vehicle	Turret	Hull	
2S12 120mm Mortar	3D	Mortar	Yes		
BREM1 Recovery Vehicle	3D	TAC Vehicle	Yes		
Trk, GAZ-66 (Cargo, Medium)	3D	TAC Vehicle	Yes		
Trk, UAZ 469 (Cargo, Light/Personnel)	3D	TAC Vehicle	Yes		
Trk, KrAZ-255B (Fuel Service)	3D	TAC Vehicle	Yes		

Table A-I. General Use Models					
Platforms	**Type**	**Category**	**DMGD 1**	**DMGD 2**	**Notes**
Trk, KrAZ-255B (Cargo, Heavy)	3D	TAC Vehicle	Yes		
BAT-2 Route Clearing Vehicle	3D	CBT Vehicle	Yes		
OPFOR Dismounted Forces					
OPFOR AGL Team, 2 Pers	3D	Personnel	Attrited		
OPFOR ATGM Team, 2 Pers	3D	Personnel	Attrited		
OPFOR ATGM Team, 3 Pers	3D	Personnel	Attrited		
OPFOR Dismt Eng Element, 10 Pers	3D	Personnel	Attrited		
OPFOR Dismt Inf Ele, 6 Pers RPG-7V	3D	Personnel	Attrited		
OPFOR Dismt Scouts, 3 Pers, Wpn	3D	Personnel	Attrited		
OPFOR SA 16/18 Dismt Inf AD Weapon, 2 Pers	3D	Personnel	Attrited		
OPFOR Rotary Wing					
MI-24P Hind	3D	Attack	Yes		
MI-28 Havoc A	3D	Attack	Yes		
MI-8T Hip	3D	Assault	Yes		
KA-50 Hokum A	3D	Attack	Yes		
OPFOR Fixed Wing					
SU25 Frogfoot	3D	Combat	Yes		
MIG27 Flogger	3D	Combat	Yes		

Table A-I. General Use Models					
Platforms	**Type**	**Category**	**DMGD 1**	**DMGD 2**	**Notes**
SU17 Fitter	3D	Combat	Yes		
SU24 Fencer	3D	Combat	Yes		
Misc. Combat Vehicles					
British Challenger, 120mm	3D	CBT Vehicle	Turret	Hull	
British Chieftan, 120mm	3D	CBT Vehicle	Turret	Hull	
French AMX 10 ARC, 105mm	3D	CBT Vehicle	Turret	Hull	
French AMX 10P	3D	CBT Vehicle	Turret	Hull	
French AMX 30 MBT, 105mm	3D	CBT Vehicle	Turret	Hull	
French AMX 40 LeClerc MBT, 120mm	3D	CBT Vehicle	Turret	Hull	
German LEO IA4 MBT, 105mm	3D	CBT Vehicle	Turret	Hull	
German LEO II MBT, 120mm	3D	CBT Vehicle	Turret	Hull	
Marder 2 (GE)	3D	CBT Vehicle	Turret	Hull	
Warrior (UK)	3D	CBT Vehicle	Yes		
Obstacles/Positions					
Abatis, 8 tree	2D	Obstacle	Yes		
Building, Indirect Fire Damage	2D	Rubbled Bldg	Yes		
Covered Machine Gun Bunker	2D	Prepared Position	Yes		
Fence, Concertina, 3 Roll	3D	Obstacle	Yes		
Combined/Hull Defilade Position,	2D	Prepared Position	Yes		

Table A-I. General Use Models					
Platforms	**Type**	**Category**	**DMGD 1**	**DMGD 2**	**Notes**
Armored Vehicle					
Combined/Hull Defilade Position, Fighting Vehicle	2D	Prepared Position	Yes		
Combined/Hull Defilade Position, Mort Carrier	2D	Prepared Position	Yes		
Combined/Hull Defilade Position, Tank	2D	Prepared Position	Yes		
Infantry Fighting Position	2D	Prepared Position	Yes		
Log Crib, Rectangle	3D	Obstacle	Yes		
Machine Gun Prepared Position	2D	Prepared Position	Yes		
Minefield, Hasty, 0-300 meters	2D	Obstacle	No		No Visual model
Minefield, Prepared, 0-500 meters	2D	Obstacle	No		No Visual model
Minefield, Scatterable, Oval	2D	Obstacle	No		No Visual model
Overhead Covered Infantry Position	2D	Prepared Position	Yes		
Prestock Entity (Ammo)	2D	Obstacle	Yes		
Prestock Entity (Fuel)	2D	Obstacle	Yes		
Tank Ditch, 100 x 4 meters	2D	Obstacle	Yes		
Tank Ditch, 200 x 4 meters	2D	Obstacle	Yes		
Tank Ditch, 300 x 4 meters	2D	Obstacle	Yes		
Cleared Mine Lane Markers	2D	Obstacle	No		
Bridge, Ribbon, 14 Sections	2D	Bridge	No		Variable size in increments of

Table A-I. General Use Models					
Platforms	**Type**	**Category**	**DMGD 1**	**DMGD 2**	**Notes**
					sections

Table A-I. General Use Models	
Ammunition Effects	**Platforms**
40mm Grenade (M430 linked grenades)	M1043 w/MK-19; M1025 w/MK-19
40mm Grenade (M433 single grenades)	M203 Grenade Launcher (BLUFOR DI); M113A3 and M2A2/M3A2 (BLUFOR DI)
.50 Caliber Machine Gun (A534 API-T)	M1025; M1A1; M1A2; M1044 w/M2; M113A3; AMX40
100mm HEAT-FS, FRAG-HE, HVAPFSDS-T	MT-12; BMP III
105mm APFSDS-T (M833)	M1; LEO 1A4 MBT; AMX 10; AMX30
105mm HEAT-T (M456A2)	M1; LEO 1A4 MBT; AMX 10; AMX30
115mm HVAPFSDS, HEAT-FS, HE FRAG	T-62
12.7mm API, API-T Machine Gun	1V12; T-62; T-64; T-72; T-80; MI-8T
120mm APFSDS-T (M829)	M1A1; M1A2; Challenger; Chieftain; AMX40; LEO II
120mm HEAT-MP-T (M830)	M1A1; M1A2; Challenger; Chieftain; AMX40; LEO II
120mm Mortar Ammo, Fuzed Smoke (WP) (M68), FRAG-HE (M57, M933, M934), Illum (M91)	M1064
120mm Mortar, FRAG-HE, Smoke, Illum, Incen	2S12(SP)
120mm/Gun/Mortar FRAG-HE, HEAT-FS, WP, Illum, Incen	2S23; 2S31
122mm FRAG-HE, HEAT-FS, Illum, Flechette	D30; 2S1
125mm HVAPFSDS, HEAT-FS, HE FRAG	T-64; T-72; T-80
14.5mm Machine Gun	BRDM 2 Recon; BTR60; BTR80
152mm Howitzer, HE (PD & VT)	2S3; 2S19
155mm Howitzer, M825WP/Smoke (MT)	M109A5; M109A6

Table A-I. General Use Models	
155mm Howitzer, M712 LGM Copperhead (BD)	M109A5; M109A6
155mm Howitzer, M107 Ser HE (MT, PD & VT)	M109A5; M109A6
155mm Howitzer, M449A1 APICM (MT)	M109A5; M109A6
155mm Howitzer, M485A2 Illum (MT)	M109A5; M109A6
155mm Howitzer, M483A1, DPICM (MT)	M109A5; M109A6
155mm Howitzer, M731, FASCAM ADAM (MT)	M109A5; M109A6
155mm Howitzer, M741, FASCAM RAAMS (MT)	M109A5; M109A6
165mm HEP	M728 CEV
2.75 inch Rockets (M261)	AH-64; AH1S Cobra
20mm Auto Cannon, AP & HE	AH1S Cobra; Marder 2; AMX10P; AMX30
23mm HEI, HEI-T, API-T	ZSU 23-4; SU 24; MIG-27
25mm Ammo, APFSDS-T (M919)	M2A2; M3A2
25mm Ammo, HE I-T (M792)	M2A2; M3A2
30mm AP-T HEI, FRAG HE Grenade (low velocity)	AH-64
30mm AP-T FRAG HE Grenade (low velocity)	AGL-17 (OPFOR DI)
30mm Auto Cannon AP-T & HE (high velocity)	MI-24; MI-28; KA-50; SU-25; SU-17; 2S6; BMP-II; BMP-III; Warrior
5.45mm Ball, Tracer	AK74 Rifle (OPFOR DI)
5.45mm Ball & linked Tracer	RPK-74 (OPFOR DI)
5.56mm ball & linked Tracer (A064)	M1025 w/M249; M249 SAW (BLUFOR DI); M113A3 and M2A2/M3A2 (BLUFOR DI)

Table A-I. General Use Models	
5.56mm ball (M855), Tracer (M856)	M16A2 (BLUFOR DI); M113A3 and M2A2/M3A2 (BLUFOR DI)
7.62mm Ball, API, API-T Machine Gun	BMP-2; T-62; T-64; T-72; T-80; BREM-1; 2S31; BMP-IP; BRDM 2 Recon; 2S23; BMP III; BTR-60; BTR-80
7.62mm Machine Gun A141, Ball & linked Tracer	M1A1; M1A2; M1025 w/M60; M2A2; M3A2; M981 FIST-V; Challenger; Chieftain; AMX 10ARC; AMX 10P; AMX 40; LEO IA4; LEO II, Marder 2: Warrior; M60 (BLUFOR DI); M113A3 and M2A2/M3A2 (BLUFOR DI)
73mm HEAT-FS, FRAG-HE	BMP-1P
ADM Stinger	ADM Stinger Missile Launcher (BLUFOR DI)
AGM 65 Maverick	A10; F16
AGM Hellfire	AH-64; OH-58D
AT-4	AT-4 (BLUFOR DI); M113A3 and M2A2/M3A3 (BLUFOR DI)
ATGM AT-10	BMP III; MT-12
ATGM AT-11	T-80; T-72B
ATGM AT-4	BMP/BTR Dismounts (AT-4 OPFOR DI)
ATGM AT-5	BRDM 2 w/AT5; BMP 2; BMP IP
ATGM AT-6	MI-24; MI-28; KA-50
ATGM AT-7 HEAT	BMP Dismounts (AT-7 OPFOR DI)
ATGM AT-8	T-80; T64B
ATGM TOW 2 BGM71D	M2A2; M3A2; M966 w/TOW; AH1S Cobra
Bomb(s), General Purpose MK82 LD low-drag	Fixed Wing A10, F16

Table A-I. General Use Models	
MK82 AIR, air inflatable retarder	A10, F16
MK82 HD (Snakeye I), high-drag	A10, F16
MK84 LD low-drag	A10, F16
MK84 AIR, air inflatable retarder	A10, F16
BLU-109/B	A10
BLU-107/B (Durandal), parachute/rocket-boosted	F16
Bomb(s), Laser Guided	Fixed Wing
GBU-10 (MK84 LGB) laser guided, low-drag	A10, F16
GBU-12 (MK82 LGB) laser guided, low-drag	A10, F16
Bomb, Cluster Unit(s)	Fixed Wing
CBU52B/B (delivers 220 BLU-61A/B bomblets)	A10, F16
CBU58A/B (delivers 650 BLU-63A/B bomblets)	A10, F16
CBU71A/B (delivers 650 BLU-86A/B bomblets) w/random fuze	A10, F16
CBU87, air inflatable decelerator (delivers 202 BLU-97 bomblets)	A10, F16
CBU89/B (GATOR) (delivers 72 BLU-91/B AT and 22 BLU-92/B AP mines)	A10, F16
Bomb(s), General Purpose	SU-25, MIG-27, SU-17, SU-24
Bomb(s), Laser Guided	SU-25, MIG-27, SU-17, SU-24
Bomb, Cluster Unit(s)	SU-25, MIG-27, SU-17, SU-24
Dragon Anti-Tank Missile (Use Javelin visual model)	M47 Dragon BLUFOR DI; M113A3 and M2A2/M3A2 (BLUFOR DI)
GPU-5A Cannon (30mm)	F16
GAU-8 Avenger (30mm API)	A10

Table A-I. General Use Models	
Javelin Anti-Tank Missile	AAWS-M BLUFOR DI; M113A3 and M2A2/M3A2 (BLUFOR DI)
M26 Tact 270mm Rocket w/M77 Warhead	M270/MLRS; M993
M26 Tact 270mm Rocket w/TGW Warhead	M270/MLRS; M993
Mine Clearing Line Charge	M58A3 MCLIC
Mine, Anti-Personnel (M16A1)	Engineers; BLUFOR Dismounts; M113A3 and M2A2/M3A2 (BLUFOR DI)
Mine, Anti-Tank (M21)	Engineers; BLUFOR Dismounts; M113A3 and M2A2/M3A2 (BLUFOR DI)
Mine, Anti-Personnel	OPFOR DI; GMZ
Mine, Anti-Tank	OPFOR DI; GMZ
Explosive Demolition	Engineers
RPG-7V HEAT	RPG-7V, OPFOR DI
SA-13	SA-13
SA-15	SA-15
SA-16/18	Dismount ADA (MANPADS), SA-16/18 OPFOR DI
SA-19	2S6 Quad 30MM
Mine, Claymore Anti-Personnel (M18)	BLUFOR Dismounts; M113A3 and M2A2/M3A2 (BLUFOR DI)
L8A3 RP Smoke Grenade	M1A1; M1A2; M2A2/M3A2; M113A3; M981 FISTV
81mm, RP-Type Smoke Grenade	T-64; T-72; T-80; BMP-II; BMP-III; BTR-80
M87 Mine Cannister (BLU-92/B and BLU-91/B gator mines)	Volcano

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