



# VRSG™ Visuals in Aerial Refueling Simulation



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Inside the boom pod of the KC-135R Air National Guard (ANG) Boom Operator Simulator System (BOSS) with MetaVR visuals. Photo courtesy of FAAC, Inc.



KC-135R ANG Boom Operator Simulator System (BOSS). Photo courtesy of FAAC Inc.



Micro Boom Operator Simulation System (MicroBOSS). Photo courtesy of QuantaDyn Corp.

MetaVR is delivering multiple Virtual Reality Scene Generator™ (VRSG™) real-time licenses to FAAC, Inc. for its production order of the KC-135R Air National Guard (ANG) Boom Operator Simulator System (BOSS). The total BOSS production run consists of 17 simulators, each with 7 MetaVR software licenses for a total of 119 licenses over the two-year production period of the aerial refueling simulator.

In the last few years, MetaVR has also delivered multiple VRSG licenses and visual systems to other ANG aerial refueling training programs: QuantaDyn's MicroBOSS, an F-16 Distributed Mission Operations Aerial Refueling Trainer, and Randolph AFB's KC-135R and C-130 Multi-Mission Crew Trainer.

In addition, AVT Simulation uses VRSG in its F/A-18 Refueling Part-Task Trainer (PPT) Small Business Innovative Research (SBIR) Training Device.

### ANG BOSS refueling simulator

The fully immersive Distributed Mission Operations (DMO)-capable refueling boom operator trainer is a high-fidelity replica of a KC-135R Block 40 boom pod. The immersive simulation environment emulates the actual aircraft boom controls, and includes associated operating systems, 4-channel image generation and projection systems, instructor operator station, physics-based tanker and receiver models, threat environment generation station, and ARCNet Gateway. Other technologies include head-tracking, voice recognition and synthetic response, and a recording/debriefing capability. The compact size of the BOSS (22' x 21') allows it to fit within a 27' x 30' room with 12' ceilings.

The BOSS is intended for squadron-level training to be co-located with operational KC-135 air refueling wings. The ANG will field the 17 BOSS systems at locations across the US where qualified boom operators at the ANG KC-135R flying units will use the BOSS for a complete training

**Image on the cover:** Real-time MetaVR VRSG screen capture of a simulated KC-135R aircraft refueling an A-10C on the 400 NS aerial refueling track area of MetaVR's CONUS++ virtual terrain.

curriculum: initial qualification, difference qualification, certification, requalification, mission certification, and instructor upgrade training to meet Aerial Refueling Airplane Simulator Qualification (ARASQ) standards. Mission-rehearsal DMO training will be through the ANG Distributed Training Operations Center (DTC).

As part of the delivery, MetaVR is providing 4 meter-per-pixel Metadesic terrain tiles of CONUS++ 3D terrain enhanced with cultural lighting for all of the CONUS area. The terrain features cultural lights points that are geospecific to actual road networks.

### MicroBOSS desktop refueling simulator

QuantaDyn purchased 25 MetaVR visual systems (game-level ruggedized rackmount PCs loaded with VRSG licenses) for its production Micro Boom Operator Simulation System (MicroBOSS) for training KC-135R boom operators at 17 Air National Guard (ANG) sites.

The MicroBOSS is a desktop training system which uses a computer-generated receiver aircraft to train boom operators. The VRSG systems replaced Quantum3D visual systems that were used in the boom operator trainer prototype. The MicroBOSS incorporates software features and capabilities of the ANG Boom Operator Simulation System (BOSS) as well as the Air Education Training Command (AETC) Boom Operator Weapon System Trainer (BOWST). This desktop system uses selective-fidelity concepts in the hardware design to provide a realistic and cost-effective training environment. Through the use of photo-realistic graphical displays, touch screens, an aural cueing system, a high-definition out-the-window display, and representative joystick controls, the MicroBOSS provides the functional equivalent of a complete KC-135R boom pod station.

Using highly detailed visual models, the MicroBOSS can provide training on Air Force, Navy, and NATO receiver aircraft.



Training personnel can adapt MicroBOSS scenarios to support each unit's unique mission profiles, or concentrate on high-interest training times from operational lessons learned. Mission preparation for air refueling profiles, including the Boom Drogue Adapter (BDA), enables the aircrew to be mission ready.

The initial sale was for 17 MicroBOSS systems, with an option for additional systems to be purchased later so each ANG unit will have a MicroBOSS.

QuantaDyn is also under contract to develop for the ANG an F-16 Distributed Mission Operations Aerial Refueling Trainer (DART). The DART, which uses MetaVR visuals, will incorporate DMO Level 5 aerial refueling requirements. The DART will be used as the receiver aircraft for the BOSS DMO testing and demonstration.

From a boom operator's perspective, according to QuantaDyn, MetaVR VRSG was chosen for these programs for several reasons. VRSG's high-fidelity graphical environment, atmospheric conditions, cultural lighting, and realistic precise shadow and lighting are very important components for providing realistic refueling training. The detailed ground representation of high-resolution terrain (such as MetaVR's Afghanistan virtual terrain) is important for identifying location; in daytime from the imagery on the ground, and at night, from the cultural lighting. The variety of sky models and cloud models and the ability to modify cloud effects and other environmental characteristics are all critical for maintaining situational awareness in the refueling operations, and provide the opportunity to train under

adverse conditions. The high-resolution receiver models contain details useful in training. The shadowing of the boom on the receptor aircraft is fast and very precise, which is important for replicating exactly what a boom operator sees while refueling the receiver aircraft. The external light profile, which enables one to adjust the lighting as a rheostat rather than having to use a step illumination, is a distinctive benefit.

#### **Multi-Mission Crew Trainer**

Randolph Air Force Base (AFB), home of the 902d Force Support Squadron and the AETC, acquired 6 new MetaVR VRSG licenses for the ANG's C-130 Multi-Mission Crew Trainer (MMCT) program. The MMCT will provide enhanced capabilities to support pilot and co-pilot training in a full range of flight modes, incorporating multiple navigation systems and the ability to conduct in-flight air refueling missions via Distributed Mission Operations (DMO) training profiles. The initial aircraft platforms are the KC-135R and C-130H2.

VRSG already powers the visual channels for the initial MMCT simulator prototype. The AETC at Randolph AFB purchased the additional VRSG licenses for the full production run of six C-130 MMCT devices, which will be built by the Trainer Development team and delivered to the Air National Guard. The project includes an initiative to add a refueling simulation component to the trainer. Aircrew trainees will then be able to participate in DMO aerial refueling exercises using the C-130 MMCT and an F-16 DTT as receiver aircraft, and the MicroBOSS in the KC-135R tanker role through the Distributed Training Operations Center (DTC) for multi-operator "person-in-the-loop"



*Real-time MetaVR VRSG screen captures of three different refueling aircraft scenarios over geospecific 3D terrain. The daytime scenes show refueling operations of an F-16C (left) and F-15 (right) over the Barry M. Goldwater Range (BMGR) area of MetaVR's CONUS++ virtual terrain. The night scene shows the refueling of an A-10C during night operations on the 400 NS aerial refueling track area of MetaVR's virtual North America terrain. The scene features the shadows cast by the KC-135R's tail-mounted flood light illuminating the A-10C, and the cultural lights of Amarillio, TX.*

training. Future KC-135R versions of the MMCT will allow aircrew to operate the front end of the tanker so all these devices can operate in the same virtual airspace.

### **VRSG's support of refueling simulation**

The primary requirement of an image generator used in boom operator training is to provide accurate and high quality representation of shadows cast by potentially several light sources. VRSG includes advanced object-on-object shadowing features and can support up to four concurrent, independent, occulted, and shadowed light sources. These multiple shadowed light sources can be allocated to the sun or moon, the tanker tail flood light, the receiver nacelle lights, or any other light source requiring shadowing. Shadowed light sources can be attached to either the tanker or receiver aircraft.

Self-shadowing of the receiver aircraft is supported. For optimal performance, VRSG generates ultra high-resolution shadow maps of varying resolutions for each active light source to support shadows projected by tanker and receiver aircraft geometry.

To minimize perceived aliasing, VRSG multi-samples each shadow map, using a per-pixel-unique randomly oriented sampling kernel resulting in softened and anti-aliased shadow boundaries. With generating the varying resolution shadow maps, VRSG can use the highest resolution shadow

map for the highest contrast light source, which is the light source most likely to cause aliasing artifacts.

During day operations when local light sources are not utilized, VRSG allocates more computing resources to the production of the sun shadow, as the sun shadow is of higher contrast and requires more anti-aliasing to achieve a quality result. During night operations, VRSG can reallocate these resources among multiple lower-contrast shadow casting light sources. Lower contrast light sources can use lower resolution shadow maps for better performance.

For light sources that do not require shadowing, VRSG supports a feature called "addressable light maps". Addressable light maps are built into models using multi-texture. Up to 16 addressable light maps are supported per model, and an unlimited number of models per-scene. Addressable light maps are useful for applications such as illuminating refueling receptacles, the F-16 tail flood light, or illumination of culture from local light sources. For any addressable light map on any model, the host software is able to specify an intensity level of the light map using a floating point continuum of 0 to 1.0.

VRSG's addressable light maps offer a full continuum of intensity control rather than requiring a finite number of discrete illumination levels baked into a switch node of a model.

*For more product information, pricing, and ordering, see MetaVR's website at [www.metavr.com](http://www.metavr.com) or contact [sales@metavr.com](mailto:sales@metavr.com).*

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