IV. Modeling Units

VR-Forces has two, quite different, ways to model simulation objects: entity-level modeling and aggregate-level modeling. These modeling approaches affect how units are modeled.

The chapters in this section provide conceptual background about modeling units, how to create them, and how to display them.

2. Entity-Level Unit Modeling

This chapter describes how units are modeled in entity-level scenarios.

2.1. How Units Are Organized

The organization within a unit is based on the echelon ID of each member. For example, in Table 1, four unique entities (identified by name) are assigned designators in **2 Plt**.

Table 1. Example of names and echelon IDs

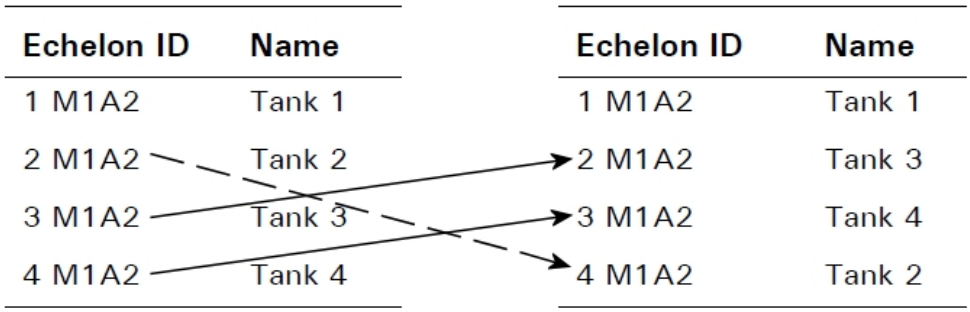
Name	Echelon ID
Tank 1	1 M1A2, 2 Plt, 1 Force
Tank 2	2 M1A2, 2 Plt, 1 Force
Tank 3	3 M1A2, 2 Plt, 1 Force
Tank 4	4 M1A2, 2 Plt, 1 Force

Assignment of echelon IDs is handled automatically by VR-Forces when you create a unit.

2.1.1 Reorganizing Units

Reorganization is the reassignment of echelon IDs to the members of a unit when a member is destroyed. If reorganization is enabled, when a member of a unit is destroyed, the destroyed member is assigned the highest numerical ID in the unit, and the surviving members' echelon IDs are moved down numerically by one. For example, assume a platoon as shown in the leftmost table in Figure 1. If **2 M1A2** (currently the entity named Tank 2) is destroyed, reorganization would result in the new echelon ID assignments illustrated in the rightmost table. The former **3 M1A2** is now **2 M1A2**, former **4 M1A2** is now **3 M1A2**, and the former **2 M1A2**, is now **4 M1A2**. Their echelon IDs have changed. Their names and object IDs have not.

Figure 1. Reorganization of Platoon 2



You can configure VR-Forces to reorganize units automatically, or you can reorganize manually. Manual reorganization does not require you to reassign each designator; you simply order the unit to reorganize with the Reorganize command.

2.2. How Units Move

When a unit receives a movement command, VR-Forces calculates the path the unit leader must follow for movement. Then it calculates parallel paths (taking into account the formation) for each member of the unit. The unit members are responsible for following these paths until the unit completes the movement task.

2.2.1 Closing Formation

VR-Forces can close up holes in formations that are created when a unit member is removed from a formation. When a unit is ordered to form up, it assigns formation positions to each of its members. Each position in the formation has an internal ID. If at some point one or more of the unit's members are destroyed, removed, or independently tasked, the unit reassigns the formation IDs for its list of members. Members that are removed, destroyed, or independently tasked are not given formation IDs. The active members are moved up in the formation to fill the vacancies. Assignment to a different formation position has no effect on echelon designator.

The process of closing formation is internal to a unit. Formation position is not reported as part of simulation object information. The only way to determine a simulation object's formation position is to observe the formation as the unit moves.

Closing formation is an inherent feature of units in the VR-Forces application. You do not need to do anything to put it into effect and you cannot turn it off.

2.2.2 Closing Formation Versus Reorganization

Closing the formation of the entities in a unit is not the same thing as reorganization. Reorganization changes the echelon designators of its members. Closing formation does not change the echelon designators of unit members, or the tasks a simulation object is assigned. It only affects the relative positioning of members within a formation.

2.3. How Units Carry Out Tasks

Like other simulation objects, each unit has a plan and you can assign independent tasks to units. When you give a task to a unit, that unit sends radio messages to its subordinates directing them to carry out their role in the task, for example, getting into formation and moving to a waypoint.

The precise way in which a unit sends out messages to its subordinates is part of the modeling of the unit that is built into the VR-Forces application.

3. How Aggregate-Level Modeling Works

This chapter describes the aggregate warfare model and how simulation objects created using the aggregate-level SMSs work (*AggregateLevelBase.sms* and *AggregateLevel.sms*).

3.1. The Aggregate Warfare Model

VR-Forces supports a warfare model for aggregate-level scenarios. The aggregate warfare model requires use of *AggregateLevel.sms* or a similar SMS and only works with HLA Evolved and the MAK FOM extensions.

The aggregate warfare model is data-driven. Simulation objects have combat power and combat vulnerability. Their overall state is expressed as their health. These are abstract values that represent relative strengths of different units.

When opposing force simulation objects come into contact, they inflict damage on each other until one of the simulation objects is destroyed or breaks off combat. A unit is considered killed when its health is 0.

Some of the features that distinguish aggregate-level scenarios from entity-level scenarios include:

- Footprint. The area occupied by the unit.
- Posture. The unit's mode of interaction with the environment.
- Logistics. Management of personnel and matériel.
- Combat engineering objects. Tactical graphics that affect simulation object movement and health.
- Reports. Some data tracked in a simulation, such as personnel levels and pacing and tracking, is not used by the sim. engine. It is sent over the network to be used by command and control systems and human participants.

> ⓘ Aggregate-level scenarios can include individual entities, such as surface vessels and aircraft. However, those entities also use the aggregate warfare model. They do not behave like they would if you were using the same entity types in entity-level modeling.

3.1.1 Unit Combat

Combat power is the ability of a simulation object to cause casualties and damage, and is a function of how many weapons it has, the size (destructive power) of their munitions, the rate of fire of the weapons, the accuracy of the weapons, and the effectiveness of the subordinate simulation objects in conducting an attack (tactics, coordination, target selection, and so on).

A simulation object's ability to engage in combat is expressed as a strength value in one or more of these domains:

- Anti-air
- Anti-tank

- High explosive
- Anti-personnel
- Anti-ship

The strength value describes the attrition rate per second imposed on the target by the attacking unit.

A combat domain has a range. When an opposing force simulation object is within the range of a combat domain for which a simulation object has strength, it attacks the simulation object.

Health is a function of the amount of equipment, personnel, or both in the simulation object, and the difficulty in destroying them. For example, a unit with 10 tanks would have twice the health of a unit with 5 of the same kind of tank. However, note that the initial health for a unit is set by the SMS designer in the Simulation Object Editor. It is independent of other parameters or resource variables. It is not computed based on the equipment in the unit. Also, health values in different domains are not usually comparable to each other. They are only meaningful relative to units in the same domain.

Simulation objects also have a vulnerability in each of these domains. Base vulnerability describes how susceptible a simulation object is to a given category of weapon. In particular, it describes how easy it is to hit and kill the equipment in the simulation object with the given category of weapon. For example, infantry is very susceptible to high explosive munitions, light armor fairly susceptible, and heavy armor not very susceptible.

Vulnerability is expressed as a modifier of the combat power (attrition rate) of the attacker. It is multiplied by the attrition rate to calculate the actual damage. For example, a Mech Inf CO US has an Anti-personnel strength of 78. A Mech Inf CO RU has an Anti-personnel vulnerability of 0.1. If the US company attacks the Russian company, the actual damage for personnel will be 78 * 0.1 = 7.8 per second.

Both combat power and vulnerability are modified by a variety of factors, including posture, MOPP level, sector, and morale. The combination of all modifiers results in the final attrition rate.

The attrition across all domains is applied to the simulation object's health. If health declines to 0, the simulation object is killed.

3.1.2 Unit Footprints

A unit footprint is an abstract representation of the area the unit occupies with vehicles, personnel, and equipment. A unit takes damage from events that occur within its physical footprint, such as explosions or other simulation objects firing into that area.

The physical footprint has four sectors: front, rear, left flank, and right flank. The interactions of the unit with other simulation objects in the scenario varies based on which sector another entity is encountered on. For example, a unit is typically much more vulnerable to attack on the rear and flank sectors.

Both the physical footprint size and the size of the sectors for a unit are configured with a base value, but can then change during the scenario depending on actions of the unit.

The footprint is always circular. The footprint parameter describes the radius.

3.1.3 Unit Posture

Posture is an abstraction of the positioning of the equipment and personnel of a unit within its physical footprint, and its state of readiness for various activities.

The supported postures are:

- Deliberate-Defense. Planned, prepared. Lower mobility, lower vulnerability, moderate attack power. It is a positional defense.
- Hasty-Defense. Reactionary. Moderate mobility, moderate vulnerability, lower attack power. Happens when the unit first makes contact with the enemy. This is a positional defense, but with less time to prepare than deliberate-defense.
- Deliberate-Attack. Planned, prepared. Moderate mobility, moderate vulnerability, higher attack power. A fully planned attack executed as a deliberate advance using fire and maneuver techniques.
- Hasty-Attack. Reactionary. Higher mobility, higher vulnerability, lower attack power. Used for movement when enemy contact is expected.
- Reconnaissance. Mobile maneuver, locate and report on enemy, avoid detection, avoid engagement (if you can). Sensor signature and vulnerability are low, but so are combat power and speed.
- Travel. Very high mobility, but very vulnerable to attack and low attack power. Useful when the unit is moving from one location to another in a safe area.
- Rout. Health is less than 50% and unit is under attack. It cannot change to another posture until its health exceeds 50%.

A unit's posture affects:

- Footprint. The amount of space that the unit occupies.
- Sensing. For example, in reconnaissance posture the unit detects objects more quickly and at a greater distance than in a defensive posture.
- Sensor signature. The ability of other units to detect a unit is affected.
- Movement speed.
- Sector sizes.
- Combat power. Many weapon systems can only be used in certain postures. In particular, most cannot be used in Travel posture (which is the posture a simulation object is in when it is created).
- Vulnerability.

When a unit transitions between postures, it does so over time. Transitions may take up to several hours. The transition delay models the planning and preparation necessary to perform the task expected in the new posture. For example, deliberate defense is a well prepared defense that assumes planning fires, digging fighting positions, and so on. It significantly reduces the vulnerability of the defender. However, it may require 3 hours to transition to this posture. Hasty attack is the only posture that does not require a long transition time, as it is the posture for quick actions on contact, meeting engagements, pursuits, and so on. Transition times between each posture are configured in the Simulation Object Editor.

Because transitioning between postures can take hours of simulation time, when you set up a scenario you must decide if you want units to start in a given posture or transition to it as part of the simulation.

Defense postures assume stationary defense.

Aircraft and ships generally do not distinguish postures, except that they are not battle-ready in Travel posture.

3.1.4 Unit Movement

Units try to move at their ordered speed. The movement speed of a unit over the terrain depends on many factors, including:

- The slope of the terrain and the broad categories of the terrain underneath the unit, alter the maximum possible travel speed.
- Roads allow units to move more quickly, while restricted areas like forests or cities slow them down.
- Rivers and water bodies may stop a unit completely, although bridges allow them to cross.
- Overlapping footprints cause units to slow down.

> The movement speed modifiers for slope, terrain, footprint overlap, MOPP, posture, and so on only affect maximum speed. If ordered speed is less than the net modified maximum speed, you will not see a change in speed due to these factors.

For movement speed calculations, the center point of the unit is used to determine what type of terrain the unit is on.

If the footprints of two units overlap, their movement is slowed based on their Max Speed Modifier When Overlapping Another Unit parameter. This parameter is set on the Movement tab for a unit in the Simulation Object Editor. The lower the value, the greater the movement penalty. When unit footprints overlap, the lowest modifier among all overlapping units is applied to all of them.

> Aggregate-level scenarios do not support collision avoidance among simulation objects.

The effect of terrain features on movement is configured in a unit's movement system. For details, see "Configuring Aggregate-Level Movement Restrictions" in *Adding Content to MAK ONE Applications Reference Manual*.

VR-Forces supports a variety of combat engineering objects that affect entity movement. They may cause a unit to go more slowly or they may damage the unit. For information about combat engineering objects, see "3.2. Combat Engineering Objects" on page 13.

3.1.5 Limited Munition Attack

Most aggregate-level combat is automated and continues until a combatant is killed or combatants run out of ammunition. There are no specific fire or detonation interactions involved and combat essentially takes place in the background. The aggregate warfare

model also supports limited munition attacks, in which a limited amount of munitions are used and the attack then ends. In the case of artillery, this is a specified number of rounds from a battery, delivered over a short time. In the case of large munitions such as missiles and bombs, the attack for each munition is generally instantaneous. VR-Forces does not model the time it takes for a munition to reach its target.

> ⓘ Not all missile attacks are modeled as limited munition attacks. Anti-tank missiles in ground units, for example, are launched by multiple launchers in the unit against multiple targets in the defender, and are modeled with normal combat power.

Individual missile attacks typically make use of a hit factor from the attacker and a defense factor from the defender to determine a hit probability. The missile must hit before its combat power is applied in an attack.

3.1.6 Contamination Areas

The aggregate warfare model supports nuclear, biological, and chemical contamination areas (NBC areas) that may damage or impede a unit. You can create contamination areas as tactical graphics, or simulation objects with nuclear, biological, or chemical weapon systems can create them as a result of attacking with these weapons.

Contamination areas have parameters that are similar to other areal tactical graphics, plus these parameters:

- Agent type. The type of contamination. It determines the configuration used for damage calculations.
- Terrain type. Informational only; not used by VR-Forces.
- Topography type. Informational only; not used by VR-Forces.
- Vegetation type. Informational only; not used by VR-Forces.

The terrain, topography, and vegetation types are published by VR-Forces, but do not affect unit modeling or interaction. They may be useful to other applications that interact with VR-Forces.

By default, NBC hazard areas are placed on the Contamination Areas overlay.

Contamination (NBC) Areas and MOPP Level

When a unit is attacked by NBC weapons or enters an NBC area, it suffers attrition. It stops its current task and increases its mission oriented protective posture (MOPP) level until it stops suffering attrition. Then it resumes its task. However, any contamination that took place persists.

If a unit is moving and it detects an NBC hazard area in its path, it stops moving and increases its MOPP level to a point that will allow it to pass through the hazard area without suffering attrition.

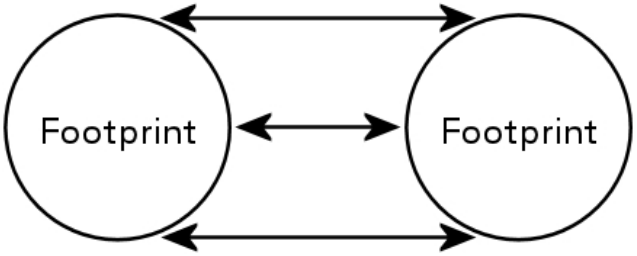
Increasing MOPP level affects a unit's speed, combat effectiveness, sensor sensitivity, posture transition time, and vulnerability.

> Some types of contamination are benign enough that they cause little, if any, damage to simulation objects. Other types, such as gamma rays, cause attrition even at the highest MOPP level.

3.1.7 Unit Sensors

Simulation objects in aggregate-level scenarios use the same sensor signature mechanism as simulation objects in entity-level scenarios. Sensor systems allow them to detect other simulation objects in various domains. Sensor signatures indicate how detectable they are by other simulation objects in the applicable domains. The main difference between simulation objects in the two types of modeling is in the detection checks. Simulation objects in entity-level scenarios do a line-of-sight check from the center of the simulation object. Simulation objects in aggregate-level scenarios do three checks: one from the center of the outer ring of the footprint and two from the edges of the circumference of the footprint, as illustrated in Figure 2.

Figure 2. Aggregate-level sensing



3.2. Combat Engineering Objects

VR-Forces supports a variety of combat engineering objects that affect unit movement. They may cause a unit to go more slowly or they may damage the unit. Combat engineering objects (CEOs), such as fortifications, can also protect a unit, in that they affect the effectiveness of opposing forces.

CEOs are displayed as tactical graphics. You can create combat engineering objects from the Create Object Palette. Also, units can create combat engineering objects in response to combat engineering object tasks.

Units can counter the presence of combat engineering objects by breaching them, bridging them, defusing them, or destroying them.

Combat engineering objects can affect units:

- Mobility. CEOs can decrease entity mobility. Mobility modifiers are configured by mobility type. For instance, an object might affect the mobility of soldiers on foot more than tanks. When a simulation object comes in contact with an engineering object, it checks the object type's mobility modifier against the entity's mobility type. The entity slows down based on the modifier value.

The modifier is scaled based on the completion percentage of the object. Modifiers only affect the maximum speed, so speed is affected only if the modified maximum speed is less than the current speed of the unit.

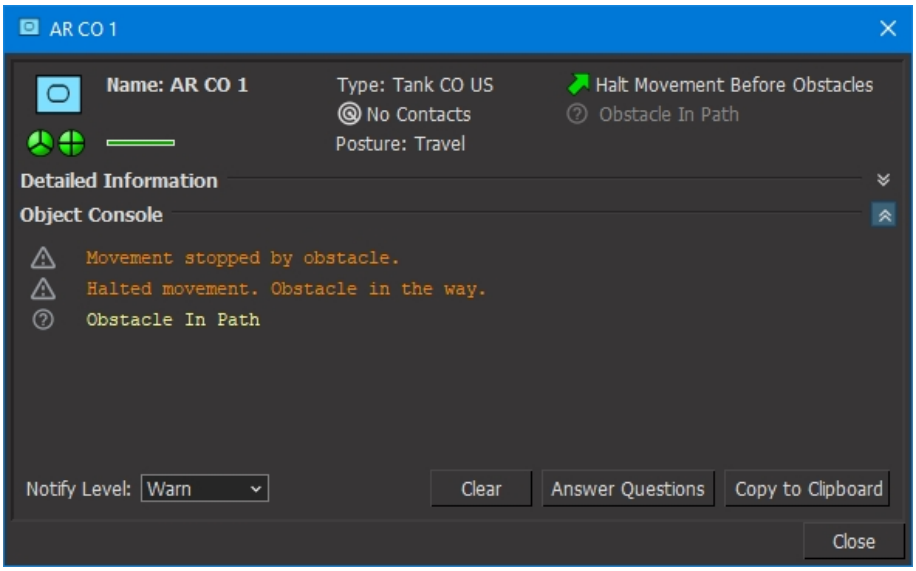
If a unit encounters an obstacle that obstructs its movement or may cause damage, it stops moving and sends a message to the console indicating that it is obstructed (Figure 3). The user must then tell it what to do. The console message may use the question and answer capability. (For information about console questions, see "Answering Questions from Scripted Tasks".)

> The unit may not be able to move until you respond to the question.
>
> If an obstacle is concealed, the unit does not stop. For information about concealed obstacles, see "3.2.1 Concealed Obstacles" on the facing page.

- Mobility enabling. Certain types of engineering objects are treated as terrain features by a moving unit. For instance, a simulation object may determine that an engineering object represents a road or bridge, giving it additional path planning options. This capability is either on or off.
- Vulnerability. Vulnerability modifiers are configured by weapon type. For instance, a fortification might do very well at stopping anti-personnel weapons, but may do little or nothing to stop high explosives. When a simulation object under fire contacts an engineering object, it checks the object type's vulnerability modifier against the attacking weapon's category. This may reduce the amount of damage the entity takes from that weapon.

  The modifier is scaled based on the completion percentage of the object.

Figure 3. Question in entity console



- Visibility. When a simulation object contacts an engineering object with a visibility modifier, its visibility to opposing simulation objects is increased or decreased accordingly.

  The modifier is scaled based on the completion percentage of the object.

- Attrition over time. When a simulation object contacts an engineering object that causes damage (for example a minefield), that object continues taking damage over time as long as it remains in contact. The damage is configured as one of the existing damage/weapon categories, for example, high-explosive. Simulation objects with more or less vulnerability to that damage type take more or less damage accordingly.

  The attrition is scaled based on the completion percentage of the object.

- Immediate attrition. Some engineering objects cause one-time, immediate damage to any unit that comes in contact with them. For instance, a simulation object might trigger an IED. Usually the engineering object is destroyed in the process.

  The modifier is scaled based on the completion percentage of the object.

  The various modifiers are configured for each CEO in the Simulation Object Editor.

3.2.1 Concealed Obstacles

By default, minefields, booby traps and unexploded ordnance objects are concealed. (This attribute is configurable in the Simulation Object Editor, so you can set it for other objects if you want to.) The engineering object sensor does not automatically detect concealed objects within its sensing radius. The sensor has a random (configurable) chance of detecting the object each sensor cycle that the object is within range.

If a sensor detects a concealed minefield, the Mark Minefield reactive task marks it as detected. Thereafter, the minefield is always 100% detectable. (The Mark Minefield reactive task is enabled by default.)

Unit movement systems check the concealed flag for obstacles. For non-friendly obstacles that are concealed, the "stop and ask" behavior is suppressed unless the object has been specifically detected by the sensor. Therefore, if the sensor has not detected the object, the unit enters it without first stopping and alerting you to the presence of the object.

Concealed objects are always discovered if they are causing damage to a simulation object.

3.2.2 Creating Combat Engineering Objects

You can create combat engineering objects directly from the Create Object Palette or you can task simulation objects with the appropriate systems, such as combat engineering units, to create them.

Combat engineering objects are implemented as points, lines, and areas, so you can create them the same way that you would create tactical graphics. Most areal CEOs are fixed size, which is configurable in the Simulation Object Editor. You just have to specify the lower left corner of the area.

When you create a CEO from the Create Object Palette, you can give it a name, specify a layer and set all the parameters you would expect for that type of object. When you task a unit to create a CEO, it is given a default name and you can only specify its location.

Many tactical graphics have the same default names as CEOs, for example, fortified lines and minefields. They may also look the same on the map. However tactical graphics do not affect unit movement and combat the way that CEOs do. To help distinguish tactical graphics from CEOs, CEOs created by units are placed on the Combat Engineering Object layer. It is recommended that if you create CEOs from the Create Object Palette, that you place them on the CEO layer.

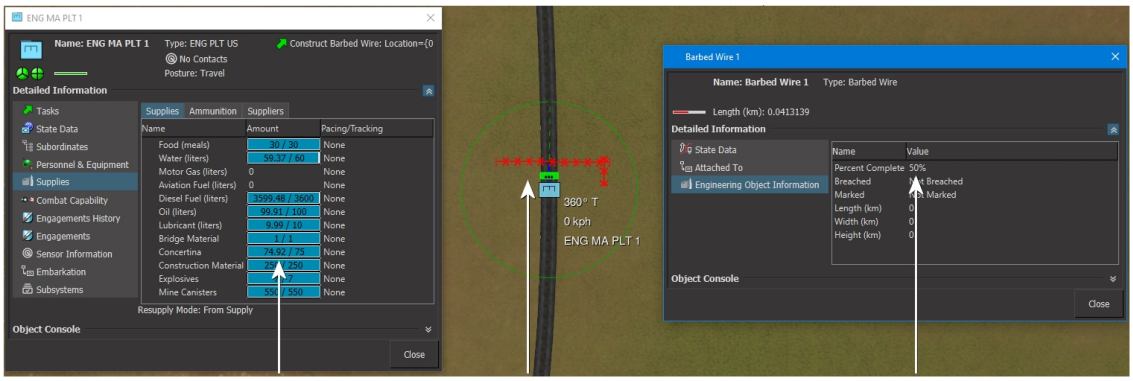
3.2.3 How Engineering Units Create Engineering Objects

When a unit with engineering capabilities creates a CEO, it expends construction material at a rate specified in the object's model (configured in the Simulation Object Editor). Depending on the type of objects, the process can take hours of simulation time.

While an object is partially complete, its effectiveness is reduced. Some effects, such as enabling mobility over previously impassable terrain (for example by using bridges), do not take effect until the object is complete.

> ⓘ You can follow the progress of object construction in two ways. You can view the engineering unit's use of construction material on the Supplies page of its Information dialog box. You can view the percent of the object's completion on the Engineering Object Information page of the Information dialog box for the object (Figure 4).

Figure 4. Barbed wire under construction



Units create combat engineering objects as follows:

1. The unit moves within range of the location to create the object.
2. The unit creates a new object that is 0% complete. The object is displayed on the terrain.
3. The unit begins constructing the object. As it does so, its supply of construction material decreases.
4. When the object is complete or the unit runs out of construction material, it ends the task.

If a creating unit is interrupted and must halt construction, it notifies that object that construction has stopped. The object stays at its current level of completion, which may or may not be useful, depending on the object type. A constructing unit might also reduce its rate of construction if it takes damage.

If the constructing unit is able to resume construction or another unit is tasked to improve the object, it moves within range of the object and construction starts again.

Multiple units with construction capability can work together. To task a second unit to assist the first, task it to improve the object under construction.

You can also set the completion percentage of a combat engineering object with the Percent Complete set data request.

3.3. Logistics

Simulation objects have resources, such as fuel, ammunition, and food. Over time, and particularly during combat, these resources are consumed. Logistics is the process by which a unit resupplies itself.

Units can resupply these resources:

- Health
- Food
- Water
- Motor gas
- Aviation fuel
- Diesel fuel
- Oil
- Lubricant
- Anti-Tank
- High-Explosive
- Anti-Personnel
- Anti-Air
- Anti-Ship
- Large-Munition
- Other

Anti-Tank, High-Explosive, Anti-Personnel, Anti-Air, and Anti-Ship refer to ammunition in that category. There is no distinction made between different ammunition names within a category. Large-munition covers all other categories of ammunition, such as indirect fire munitions, bombs, and missiles. Other supplies covers any other type of supply, including engineering materials.

The Supplies page on the Information dialog box indicates when a simulation object is receiving or providing supplies. You can display supply lines that show when a supply unit is supplying another unit (Figure 5). In Figure 6, green arrows show the supplies that the entity is receiving.

Figure 5. Supply information and supply lines

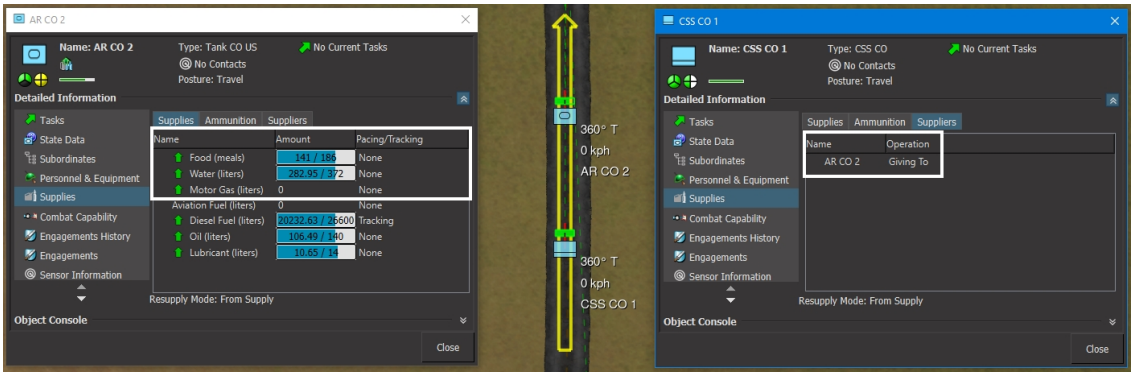
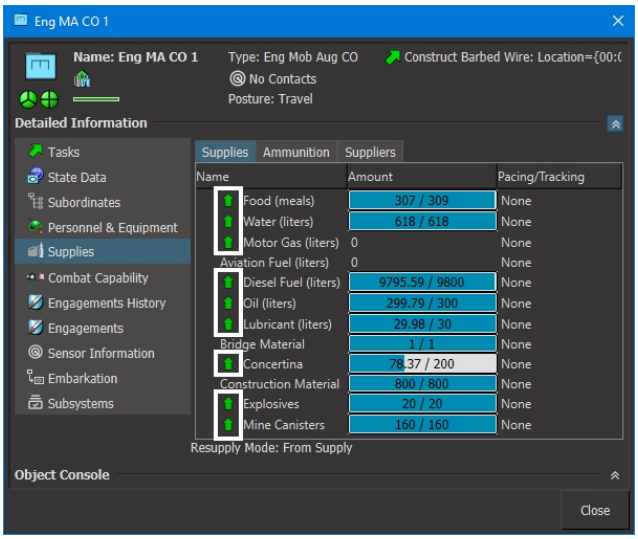


Figure 6. Supplies being received



3.3.1 Receiving Supplies

To receive supplies, units can:

- Take supplies from a supply unit. Units take supplies from a friendly supply unit that is within range and has notified them that it can provide supplies. The resupply range is specified in the Simulation Object Editor as part of a supply system.
- Auto Resupply Continuously. Supplies increase continuously at a configurable rate.
- Auto Resupply Periodically. Simulation objects refill all supplies at specified intervals. The interval is configurable.
- Refueling. Air units can refuel from tanker units. For details, see "3.7. Fuel Use and Aerial Refueling" on page 23.

The ability to resupply can be restricted if a simulation object is moving, attacking, or defending. This is configured in the Simulation Object Editor on the Supplies tab. You can change how a simulation object receives supplies using the Set Resupply Mode task. If they are configured for airborne refueling (Can Receive Fuel While Airborne parameter), airplanes can receive fuel while they are flying, but must be on the ground to receive any other type of supply.

3.3.2 Providing Supplies

Simulation objects can provide supplies to other simulation objects if they have a resupply system (*resupplier.sysdef*). A supply unit can be configured to provide any of the supplies that are supported. A supply unit can provide supplies to any number of other simulation objects. It is assumed to have its own supply source, so it never runs out. You can change a supply unit's status with the Change Supplying Command task.

A supply unit runs a background process that tests for friendly simulation objects in its area and notifies them that it is available to provide supplies. It checks for conditions that might prevent a simulation object from receiving supplies. It stops providing supplies to simulation objects that move out of range.

Aircraft units that have a refueling capacity can refuel other air units that request refueling.

3.4. Electronic Warfare

The aggregate warfare model supports three types of electronic warfare: communications jamming, radar jamming, and sensing electronic emissions.

3.4.1 Jamming Communications

Each unit has an EW-Comms-Dependence and an EW-Defense-Strength property. The dependence property indicates how much it can be affected if its communications are jammed. The defense factor indicates how well its technology and practices protect it from communications jamming. Units also have, in their state properties, a list of jamming attacks being made against them (type and strength) and a net EW-Comms-Degradation-Percentage.

When a simulation object attacks another entity with jamming, it sends EW attack information to the target.

> Simulation objects jam all enemy simulation objects in range; there is no target selection. Friendly simulation objects are not affected.

When a simulation object suffers communications jamming attacks, the strengths of all attacks are added together and compared to the defensive strength. The ratio determines a modifier between 0 and 1, which is multiplied by the EW-Comms-Dependence. The result is a degradation percentage. This degradation percentage is applied to reduce combat power, and increase vulnerability and posture change time (by a maximum factor of 2.0).

Units can have a system called an aggregate-comms-jammer. This system has parameters for strength, maximum range, and a set of allowed postures. Strength falls off with $1/r^2$ (r is range in kilometers). This system can trigger EW attacks using the Make EW Attack background scripted task. It has a jammer controller that can publish an emitter.

You can enable or disable the emitter using the Emitter set data request. Turning it on activates jamming, and turning it off deactivates jamming. If the emitter is turned on while the simulation object is not in an allowed posture for jamming, a warning is printed to the console. In this case the emitter is on, but it is not used for jamming attacks.

When jamming is enabled the Make EW Attack script determines which jamming systems on the simulation object are on, and then uses them to attack all targets within range. It updates (new) EW-Attacks and Jamming-Strength-On state properties on the simulation object. The Jamming-Strength-On property summarizes the strength from all jammers the simulation object has turned on, and is used for emissions sensing. The Update_EW_ Degradation background script computes the effects of EW attacks on a simulation object.

The MI PLT (military intelligence platoon) unit is configured to have an aggregate-comms-jammer.

3.4.2 Jamming Radar

Each unit has a state property Radar-Jamming-Strength-Receiving, which is updated by the Update_EW_Degradation background script. This is the total radar jamming strength being received.

Radar jamming can:

- Reduce the sensitivity of radar sensors so they cannot detect targets.
- Reduce the hit factor of radar-homing missiles so they have a smaller hit probability.

The active-radar-sensor system has a parameter called **jamming-defense-factor**. This factor reflects the technology of the radar (not power) and is used with the jamming strength received to compute a sensitivity modifier for the sensor. The modifier varies from 0 to 1.

The weapon systems that use a controller that uses an aggregateReleaseBombControllerDescriptor have parameters **can-be-radar-jammed** and **jamming-defense-factor**. This includes these weapon systems:

- aggregate-antiair-missile
- aggregate-antiship-missile
- aggregate-land-attack-missile
- aggregate-release-bomb
- aggregate-unguided-bomb

If **can-be-radar-jammed** is true, then **jamming-defense-factor** is used with jamming strength received to calculate a modifier for the hit factor of the weapon.

Weapon systems are configured with either a constant or variable for **can-be-radar-jammed**, to provide examples of different guidance systems:

- Anti-air missiles use a variable, to allow modeling of IR or radar-homing missiles.
- Anti-ship missiles set **can-be-radar-jammed** true, thus assuming radar guidance.
- Land attack missiles use a variable.
- Release-bomb omits the parameter (default is false), to simulate optical guidance.
- Unguided bomb omits the parameter (default is false).

The aggregate-radar-jammer system can publish an emitter and can be turned on and off using Emitter set data request. It enables the EW_Attack script.

The radar jammer strength falls off with $1/r^2$ (r is range in kilometers).

The EA-18G entity is configured with a radar jamming system.

3.4.3 Sensing Electronic Emissions

The emission sensor domain allows simulation objects to sense RF electromagnetic emissions from simulation objects. Each simulation object has an emissions signature, which is a parameter for each object type. This can be detected by the SIGINT sensor. This is the "normal background signature".

There is a sensor signature modifier for emissions. VR-Forces determines if specific emitters are turned on, thus adding to the normal background signature for the simulation object .

The emissions signature modifier has a parameter, **jam-strength-factor**, that converts jamming strength to a signature value. It is set in the platform files.

There is a sensor system emissions-sensor for emissions. It is called a SIGINT (signals intelligence) sensor. The MI PLT unit is configured with a SIGINT Sensor.

3.5. Air Combat

All air-to-air and air-to-ground engagements are executed using the limited munitions attack capability in the aggregate model. The core of this model is that a single munition is fired at a time, and then a hit calculation is performed. The hit calculation uses the hit-factor of the shooter and compares it to the defense factor of the target to determine a hit chance. A random draw is done and compared to the hit chance to determine if an actual hit takes place. If the hit occurs, then the attack power of the munition is applied to the target.

Aircraft units can represent one or more aircraft. Each aircraft has a primary equipment attribute, which is usually the airframe. When aircraft units engage in combat, damage is calculated against the primary equipment. For example, if an F-16 aircraft has the F-16 airframe as its primary equipment, a unit that represents four F-16s has a primary equipment count of four. When that unit takes damage, no more than one F-16 can be damaged by each hit.

Each aircraft type has a loadout that is defined in the Simulation Object Editor. A loadout specifies the equipment and weapons for the aircraft. At runtime, you can set the loadout for an aircraft unit. The loadout for a unit determines how effective it is when it attacks another simulation object.

The results of air-to-air engagements are determined by these rules:

- Sensor capabilities. The sensor range and sensitivity, and the sensor signature of the target determine the maximum range for detection, and therefore the maximum range for engagement of a target.
- Weapon type. The weapon types on the aircraft determine the maximum engagement range when engaging with a weapon. The weapon type also determines the hit factor that affects the chance of a weapon hitting, and the total damage done if the weapon does hit.
- Tactical Data Link. If the aircraft unit is equipped with a Tactical Data Link combat system, the unit receives a bonus to its defense factor.

- Number of aircraft. Defending aircraft units receive a combat maneuvers bonus to their defense factor. Attacking aircraft have a smaller attack interval when the number of aircraft is larger, causing them to fire more missiles in a shorter period of time. This bonus is based on the current number of aircraft in the unit. It is reduced if some of the aircraft are destroyed during combat.
- Battle management support. If the attacking unit has active spot-report data on the target aircraft from other units in the scenario, it receives a hit-factor bonus when engaging the target. A defending unit also receives a defense-factor bonus if it has active spot reports on the attacking entity.

The details of an engagement are displayed in the Information dialog box.

The AWACS unit is configured with long range radar. It can provide spot report tactical data to other aircraft units, which allows them to engage units that are beyond the sensor range of their aircraft.

3.5.1 Loadouts

Aircraft loadouts are defined in the Simulation Object Editor for each aircraft type, in the Combat tab. Each defined loadout specifies the quantity of weapons and equipment in the loadout. One loadout can be marked as the default. At scenario runtime, you can set the loadout for an aircraft unit and the unit will be equipped with the predefined loadout items.

The weapons and equipment determine the effectiveness of the attacks a unit can make. Additional fuel tanks can increase the range of aircraft. Jammer pods increase defense against radar guided weapons.

3.6. Air Missions

Missions are abstract command objects that link together aircraft that will be launched as a flight. A mission has these attributes:

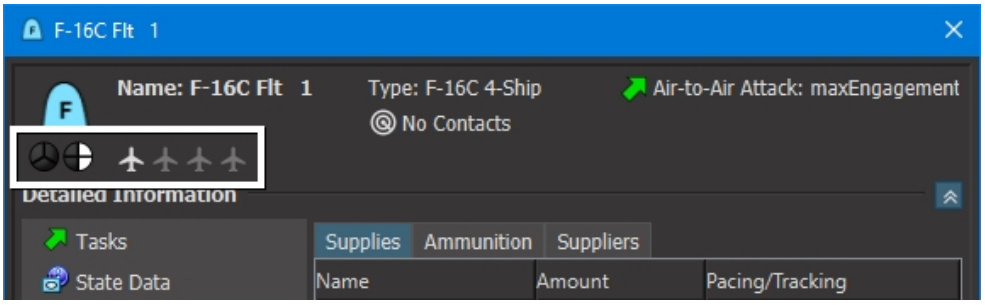
- Name (call sign).
- List of base aircraft in mission.
- Aircraft loadout.
- Target launch time.
- Time to start preparing for launch. This is computed from the target launch time and an estimate of the aircraft preparation time.
- Simulation object type for the air unit that will be created for this flight.

Air missions are carried out by aircraft units. A mission can be carried out by a single unit (which can represent multiple aircraft) or by multiple units. A multiple unit mission consists of multiple single units and a single "Mission Superior" object that is the superior of all the single units that are part of the mission.

The icons for air units have graphics that indicate the number of aircraft in the unit (Figure 7). Information dialog boxes also show the number of aircraft. If a unit suffers attrition, the number of graphics is reduced (Figure 8).

Figure 7. Aircraft unit icon

Figure 8. Aggregate information after attrition



The units that execute a mission can be created as part of the initial scenario laydown, they can be created during runtime by plans, players, or instructors, or they can be launched by an air base.

For single unit missions, the mission orders are issued directly to the unit. For multi-unit missions, the mission orders are issued to the mission superior.

Mission orders may include a task to land at an air base at the end of the mission. The units executing the mission are deleted when they land, so the mission ceases to exist. Any report of mission status should be made by the mission plan before this occurs.

> VR-Forces does not have any specific mission management features. Users can manage missions with the global and unit plans, through player interaction, or through externally developed applications that use the remote control API.

3.7. Fuel Use and Aerial Refueling

Fuel is a supply that is configured in the SOE (on the Supplies tab) and consumed based on aircraft activity. Air units use fuel based on their altitude and speed. When an aircraft unit is in a holding pattern, fuel use is calculated based on the default speed. VR-Forces interpolates values for altitudes and speeds that fall between the configured values.

For tankers, the fuel available for refueling other aircraft is assumed to be the same fuel that the tanker itself uses to fly. When refueling is complete, aviation fuel supplies are transferred from the tanker to the receiving aircraft.

3.7.1 Aerial Refueling Systems

An aircraft unit can refuel other aircraft if it is configured with an aerial refueling system. The fueling system can be a flying boom type, a drogue-and-probe type, or a combination. The configuration cannot be changed during a simulation run.

The boom system specifies a maximum fuel transfer rate. It can also be configured to have drogue lines on it, with a different transfer rate for the drogues.

Drogue systems define the number of drogues and the fuel flow rate for each fuel line.

Aircraft that are to receive fuel must be configured with an aerial refueling receiver system. The aerial refueling receiving system specifies whether the system is a boom or drogue system and what the maximum fuel transfer rate is. Air units may only refuel from tankers that have compatible refueling equipment.

Refueling systems and fuel receiving systems are assigned on the Additional Systems tab in the SOE. *AggregateLevel.sms* has two tanker units, a KC-135A with a boom system, and a KC-130J with two drogues.

3.7.2 Refueling Missions

Air units can be tasked to refuel from a tanker unit with the Refuel from Tanker task. Tanker units provide fuel in response to a Refueling Mission task. When a tanker unit receives a Refueling Mission task, it flies to the designated location, flies a race track pattern, and services aircraft that need fuel. It can continue to refuel aircraft until its fuel level falls below a configurable threshold. (For details about the Refueling Mission task, see "Refueling Mission". For details about the Refuel from Tanker task, see "Refuel from Tanker".)

The tanker coordinates with the refueling aircraft by exchanging text radio messages. The aircraft unit initiates a refueling request and says what type of system it is using and how much fuel is required. The tanker then either rejects the request (based on refueling system type and amount of fuel available) or accepts it. The aircraft unit is expected to move close to the tanker and report in with a message. When the tanker has a refuel line available, it tells the unit to move to the tanker and begins fueling it. The transfer rate is dependent on the transfer rates of the tanker and the aircraft, and the number of aircraft and drogue lines available. Supply transfer messages are sent to the refueling aircraft periodically, and corresponding aviation fuel resources in the tanker are reduced.

When refueling is complete, the tanker notifies the refueling unit.

If multiple aircraft units request refueling, the tanker coordinates with each of them and refuels them each in turn.

3.8. Air Bases and Air Missions

An air base is a special type of entity that is placed on the ground. Air bases have a variety of resources that they can use to prepare, launch, and recover air missions. They do this using a background process (Manage Air Base) and several tasks and set data requests.

An air base represents these physical features:

- Apron. The aircraft that are assigned to an air base wait on the apron to be assigned to missions, prepared for launch, or sent to a hangar to be repaired. The apron has a maximum capacity of aircraft.
- Hangar. When a damaged aircraft is actively undergoing repair, it is moved to a hangar. Hangars have a maximum capacity of aircraft.

- Runway. Aircraft that are prepared for a mission taxi on the runway area for a few minutes before taking off.
- Operational Readiness Platform (ORP). The location at the end of a runway where aircraft on Quick Reaction Alert (QRA) are stationed. The ORP has a maximum capacity of aircraft.

Air bases have these resources:

- Aircraft. All of the aircraft at an air base are on the ground. Air bases do not track the aircraft that are executing missions. When an aircraft takes off, it is deleted from the air base records. Aircraft have these attributes:
  - Type (equipment name).
  - Health. Health is expressed as a percentage and represents the status of the air frame and the amount of fuel on board.
  - Number of munitions loaded.
  - Location on the air base.

  An aircraft can be in one of the following states:
  - Available. The aircraft is at 100% health and is available to be assigned to a mission.
  - Assigned. The aircraft has been assigned to a mission. Some time before the mission launches, an assigned aircraft begins fueling and arming and its air crew prepares.
  - In Repair. The aircraft is in this state if its health is less than 100%. It can only be actively repaired (have its health improved) if it is in a hangar and has ground crew assigned to it.
  - QRA. The aircraft has been assigned and prepared, and is waiting at the ORP.
- Air crews. Each aircraft must be manned by one air crew. An air crew can man any type of aircraft. Air crews can be available or assigned. Air crews are assigned (to missions) when the air base is tasked to launch aircraft.
- Ground crew personnel. Ground crew personnel are used to repair, fuel, and arm aircraft. They may be in one of the following states and locations:
  - Available. Not assigned to any activity.
  - In-Hangar. Repairing aircraft.
  - On-Apron. Fueling and arming aircraft.
- Fuel. A single type of fuel is used to fill all aircraft prior to launching them on a mission.
- Munitions. Large munitions (bombs, missiles, and rockets) are aggregated into one count of munitions for the air base. When an aircraft is assigned a mission and given a loadout, the quantity of munitions in the loadout is deducted from the base munition count.
- Runways. An air base can have one or more runways. Runways have a length and a heading. The length of a runway determines whether aircraft can land at the air base.

You can specify the resources of an air base with these set data requests:

- "Assign Aircraft"
- "Facilities"
- "Personnel and Supplies"

3.8.1 Preparing Missions

When an air base has pending missions, the Manage Air Base process handles the preparation of the aircraft as follows:

1. It estimates the preparation time and sets a time to begin preparation so that the flight can launch at the desired time.
2. When the preparation time arrives, the process assigns ground crew to the aircraft and computes the time at which fueling, arming, and preparing the air crew will complete. These tasks occur in parallel.
   - Fueling time requires a setup time and depends on how much fuel is taken on board.
   - Arming time is constant. It is independent of the loadout.
   - Crew preparation time is constant. It is independent of the type of aircraft.
3. When all preparation tasks are complete, the ground crew is made available to the air base.
4. When all aircraft in the flight are ready, they taxi onto the runway.
5. An air unit is created and the aircraft counts in the air base are decremented to remove the flight from the air base.

The *AirBase.ope* platform file includes parameters for the Manage Air Base script that determine:

- The size of the ground crew needed to fuel an aircraft.
- The size of the ground crew needed to arm an aircraft.
- The time required to arm an aircraft.
- The time required to set up refueling.
- The rate at which fuel can be transferred to the aircraft.
- The time required for the air crew to prepare.
- The time required for the flight to taxi and take off.

3.8.2 Landing Air Units

When an air unit wants to land at an air base (Land at Air Base task), it sends a message to the air base requesting to land. It tells the air base the number of aircraft in the unit and how long the runway needs to be for it to land. The Manage Air Base background process handles this request.

If the air base has room for the aircraft and its runway is long enough, it tells that air unit that it can land. The air unit flies to the air base and then requests final permission to land.

The air base determines the properties of the air unit:

- The aircraft type.
- Number of aircraft.
- Air frame health percent.
- Fuel in the tanks.
- Number of munitions.

When the air unit lands, the unit is removed from the scenario. The air base adds the aircraft to its list, and makes them either available or in-repair (if they are damaged). An air crew is added to the available air crews for each aircraft. Fuel and munitions are added to the air base's fuel and munition counts. The count of aircraft on the apron is incremented for each aircraft.

3.8.3 Repairing Aircraft

The Manage Air Base background process manages aircraft repair. When an air base has damaged aircraft, it moves them into the hangar and assigns ground crew personnel to them. The process can only start this repair if there is space in the hangar and ground crew available. Aircraft in the hangar are repaired at a rate that is proportional to the number of ground crew assigned. When the aircraft is at 100% health, the ground crew are made available again, and the aircraft is moved back to the apron and becomes available.

The *AirBase.ope* platform file includes parameters for the Manage Air Base script that determine:

- The repair rate (% repair / ground crew / second).
- The maximum number of ground crew that can be assigned to an aircraft.

3.8.4 Quick Reaction Alert Status

When aircraft are assigned Quick Reaction Alert (QRA) status, they prepare to take off and taxi to the Operational Readiness Platform (ORP), which is a set of parking spaces at the end of the runway. When events require it, one or more aircraft are ordered to take off and intercept a target. Aircraft and crews cannot remain prepared indefinitely, so after some time they must be returned to unprepared status at the base.

You can specify a level of quick reaction capability. For example, some QRA aircraft might keep their engines running, while others are fueled and armed on the apron with the crew in a ready room. In general the faster the reaction capability, the less time the aircraft can be on QRA.

Aircraft in QRA status remain part of the air base inventory rather than being formed into a unit.

You assign aircraft to the QRA status with the Prepare QRA task. You launch them with the Launch QRA Aircraft task. For details, see "Prepare QRA" and "Launch QRA Aircraft".

4. Creating and Controlling Units

This chapter explains how to create and manage units.

4.1. Creating Units

You can create a unit by selecting simulation objects (which can be individual entities or units) and combining them to form a unit, or by placing a preconfigured unit from the Create Object Palette.

When you create a unit, it is created as a subordinate to the force level. You cannot create units that are subordinates of an existing unit. Once you create a unit, you can subordinate it to another unit. (For details, see "4.3. Adding Simulation Objects to a Unit" on page 32).

> ⓘ Except where noted, the procedures for creating and editing units apply to entity-level scenarios and aggregate-level scenarios.

4.1.1 Creating a Unit by Combining Existing Simulation Objects

When you create a unit by combining simulation objects, you can specify the order of subordinates in the unit. This determines which subordinate is considered the unit leader and affects the assignment of echelon IDs. (It also affects the icon used to represent the unit.) You cannot change the subordinate order after you create the unit.

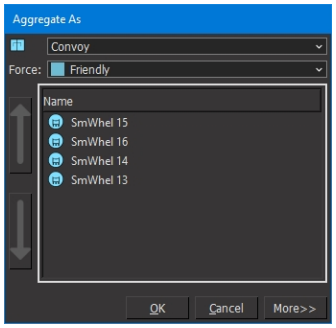
VR-Forces has many unit types configured in the Simulation Object Editor that are not available to create from the Create Object Palette, but are available as options on the Aggregate As dialog box.

> ⓘ
> - When you create a unit, the members of the unit get new echelon IDs to reflect the new entity hierarchy.
> - When you aggregate individual entities into a unit, you can include non-VR-Forces entities. These entities will be included for the purposes of calculating the bounding volume of the unit and for expanding and collapsing the display of unit members. However, VR-Forces actions that would not typically apply to non-VR-Forces entities, such as tasks and set data requests, will not affect the non-VR-Forces entities.

➤ **To create a unit by combining existing simulation objects:**

1. Select the simulation objects that you want to become part of a unit.
2. Choose **Objects > Unit > Aggregate As**. The Aggregate As dialog box opens (Figure 9).

Figure 9. Aggregate As dialog box

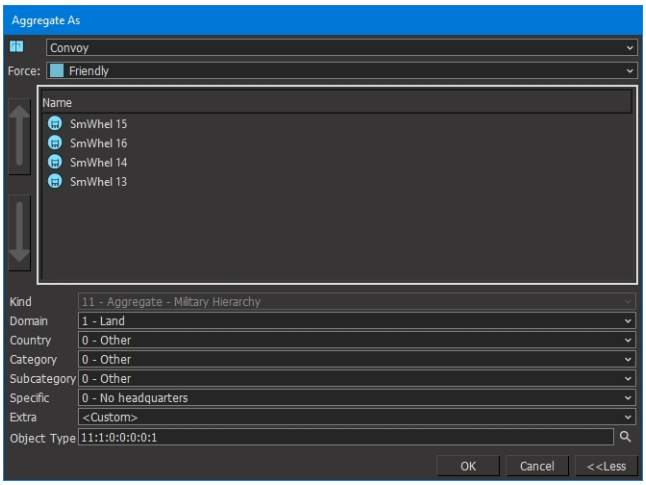


3. Select a unit type from the list.

> - The Convoy unit can only be assigned convoy tasks. Its only purpose is to allow you to quickly aggregate miscellaneous ground vehicles into a convoy.
> - The default list of unit types is limited and is different for entity-level scenarios and aggregate-level scenarios. You can specify the unit types that are on the list in the Simulation Object Editor. For details, see "Specifying an Aggregate As Option".

4. Optionally, customize the entity type enumeration for the unit:
   a. Click More. The dialog box expands to show the entity type enumeration for the unit type selected (Figure 10).

Figure 10. Aggregate As dialog box



   b. Edit the enumeration by selecting values from the lists, or by typing an enumeration.

> If an edit to the enumeration results in an entity type that does not match the unit type selected in the list, the list entry does not change. However, the unit will be created with the entity type specified by the custom enumeration.

5. Optionally, change the order of subordinates:
   a. Select the subordinate whose order you want to change.
   b. Click the up or down arrow to move it to a new position in the list of subordinates.
6. Click OK.

Creating Higher Echelon Units in Aggregate-Level Scenarios

In aggregate-level scenarios, you can combine entities and units to create higher echelon units just as you can in entity-level scenarios.

4.1.2 Creating a Preconfigured Unit

EntityLevel.sms and *AggregateLevel.sms* include preconfigured units at several hierarchical levels. You can configure them and add additional units in the Simulation Object Editor. (For details, see "Editing Unit Composition".)

You create preconfigured units by selecting them on the Create Object Palette and follow the standard procedures for creating simulation objects. The abbreviations in the unit names have the following meanings:

- ADA. Air defense artillery.
- COLT. Combat observation lasing team.
- CSS. Combat service support.
- FA. Field artillery.
- MI. Mechanized infantry.

4.2. Selecting a Unit

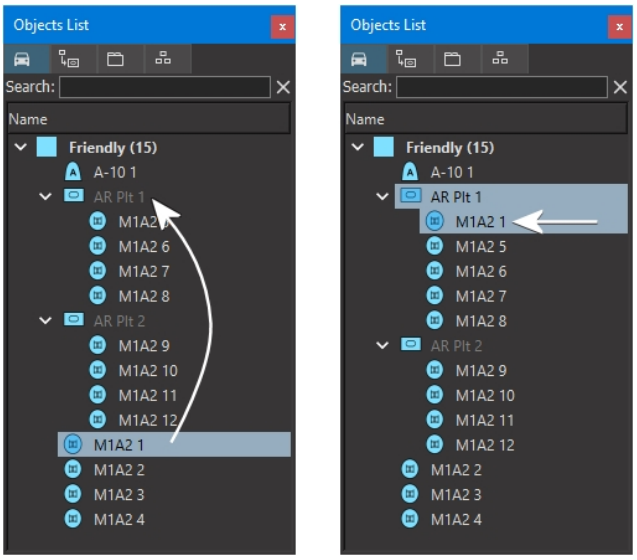
➤ To select a unit, select its icon on the terrain, or select it in one of the views on the Objects List Panel.

4.3. Adding Simulation Objects to a Unit

➤ To add a simulation object to a unit, in the Objects List View, select the simulation object you want to add and drag it onto the unit as illustrated in Figure 11. The name of the simulation object stays the same, but its echelon ID changes. (You can see the echelon ID in the object's Information dialog box.)

> You can add simulation objects to a unit with the Superior set data request. For details, see "Superior".

Figure 11. Adding a simulation object to a unit

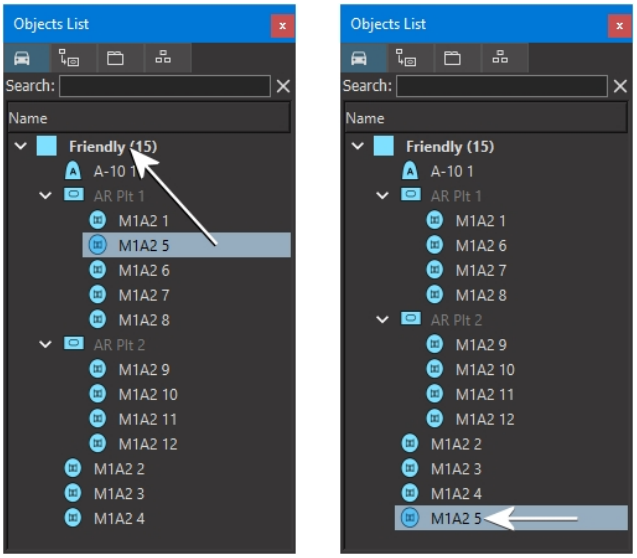


4.4. Removing a Simulation Object from a Unit

➤ To remove a simulation object from a unit, in the Objects List View, drag the simulation object from the unit to the force level in the window, as illustrated in Figure 12, or into another unit. The name of the simulation object stays the same, but its echelon ID changes. (You can see the echelon ID in the object's Information dialog box.)

> ⓘ You can remove simulation objects from a unit with the Superior set data request. For details, see "Superior".

Figure 12. Removing a simulation object from a unit



4.5. Deleting a Unit

> ⚠ If you delete a unit, all of its members are deleted.

➤ **To delete a unit:**

1. Select the unit.
2. Choose **Objects > Delete**.

5. Displaying Units

Many aspects of managing units are the same as for individual entities. This chapter focuses on features that are unique to units.

5.1. Selecting Units

You can select units in the same ways that you can select entities. (For details about selecting entities, see "Selecting Simulation Objects, Tactical Graphics, and Props".) However, to select a unit, you must select the unit icon, not individual members of the unit. If a unit is expanded, the unit icon might not be visible. To select the unit, you can collapse it, or you can select the unit in the Objects List View.

5.2. Expanding and Collapsing Units

You can display units in expanded or collapsed mode. The expanded or collapsed state is saved as part of a scenario.

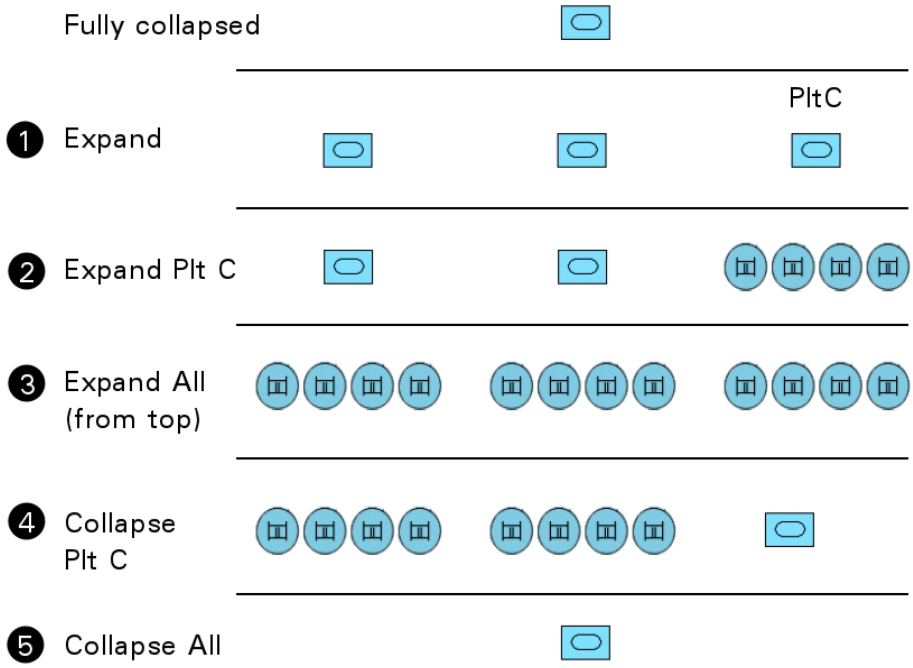
When a unit is collapsed, it displays as one icon. When a unit is expanded, all the members of the unit are visible as individual entities or subordinate units and the unit icon is hidden. Multi-level units can expand and collapse at each level of aggregation. For example, a company could be collapsed to the company level (one icon), the platoon level (an icon for each platoon), or fully expanded.

When you Expand or Collapse a unit, you can expand or collapse one level of aggregation or all levels. When you Expand or Expand All, expansion is downward from the current unit and does not affect any sibling units. When you Collapse, contraction is upward in the hierarchy. Collapse All collapses all members of the unit to the topmost level.

Figure 13 illustrates these relationships. Assume a company with three platoons, each of which has four vehicles.

- If you Expand the top level unit, it expands to the platoon level. (1)
- If you select Plt C and choose Expand or Expand All, it expands just Plt C. (2)
- If you select the top level unit and expand all, it expands to the leaf level – 12 individual vehicles. (3)
- If the unit is fully expanded and you select one member of Plt C and choose Collapse, just Plt C collapses. (4)
- If you select any member of an expanded unit and select Collapse All, the entire unit collapses. (5)

Figure 13. Unit expand and collapse



5.2.1 Expanding or Collapsing a Single Unit

➤ **To expand a unit:**

1. Select the unit icon or its entry in the Objects List View of the Objects List Panel.
2. Choose **Objects > Unit > Expand**.

➤ **To expand a unit and all its subordinate units:**

1. Select the unit icon or its entry in the Objects List View of the Objects List Panel.
2. Choose **Objects > Unit > Expand All**.

➤ **To collapse a unit one level:**

1. Select any member of the unit.
2. Choose **Objects > Unit > Collapse**.

➤ **To collapse a unit to its root level:**

1. Select any member of the unit.
2. Choose **Objects > Unit > Collapse All**.

5.2.2 Expanding or Collapsing All Units

Using the Aggregate Display Toolbar, you can expand or collapse all units in the scenario.

➤ To collapse all units to their root levels, click the Collapse All button ( ).

➤ To expand all units and their subordinates, click the Expand All button ( ).

> The Collapse All and Expand All buttons apply only to units that are known at the time you click the button. Any units added to the scenario after you click the button display in their default state.

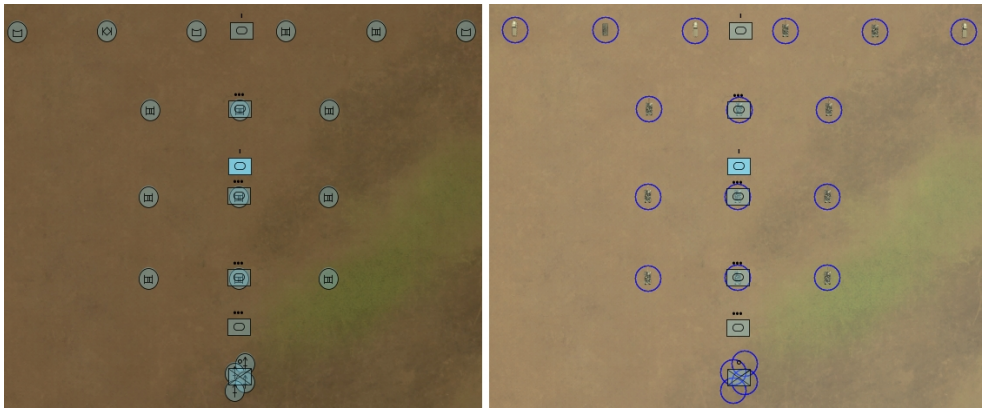
5.3. Displaying Ghosted Icons

If you want to select units, you need to collapse them so that you can select the unit icon. However, when you do this, you can no longer see where individual subordinate simulation objects are located and if subordinates are destroyed, you cannot see which ones are destroyed and which are functional. VR-Forces provides the following options for displaying unit icons to allow you to work with them in a way that best meets your visualization and simulation object management needs:

- Display ghosted icons for hidden simulation objects.
- Allow ghosted icons to be selected.
- Display all unit members.
- Manually expand and collapse the display.
- Display leaf-level unit members.

In the Plan View observer mode, when you display ghosted units, the unit icon displays normally, and the subordinate members are displayed using semi-transparent icons. In 3D observer modes, units that are subordinate to the top level unit are displayed using semi-transparent icons. Leaf-level entities are displayed using the appropriate model for the observer mode (Figure 14).

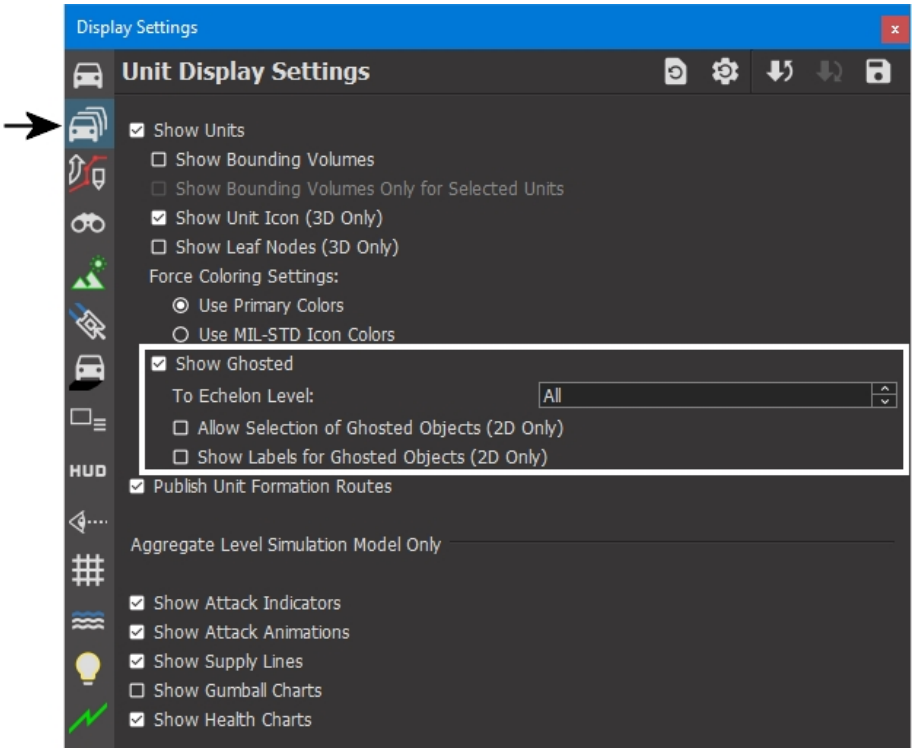
Figure 14. Ghosted icons - 2D and 3D



➤ **To configure the display of unit icons in Unit Display Settings:**

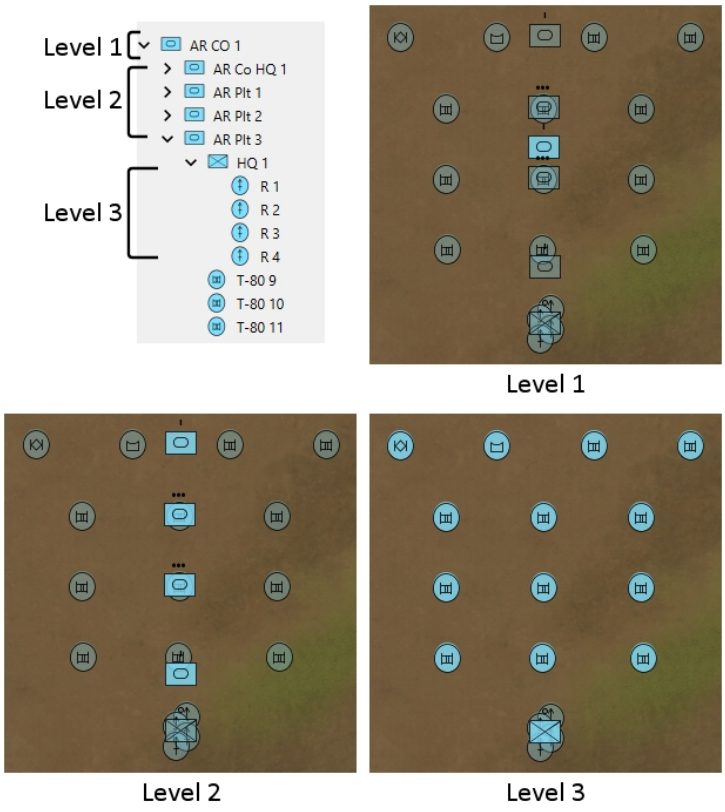
1. Choose **Settings > Display**. The Display Settings dialog box opens.
2. Select the Unit Display Settings page (Figure 15).

Figure 15. Unit Display Settings page



3. To display unit members based on the current level of aggregation only, clear Show Ghosted.
4. To display ghosted icons:
    a. Select Show Ghosted.
    b. In the To Echelon Level box, select the level of aggregation to show ghosted icons for. To show all levels without needing to consider how many levels there are, select All. Figure 16 illustrates the effect of changing the echelon level for displaying ghosted icons for the VR-Forces unit hierarchy shown.
    c. To allow selection of ghosted icons (2D view only), select Allow Selection of Ghosted Icons. (In 3D views, you can always select entities at the leaf level.)
    d. To display symbol decorations for ghosted icons (2D view only), select Show Labels for Ghosted Objects.

Figure 16. Displaying ghosted icons by echelon level



➤ **To display ghosted icons using the Aggregate Display Toolbar:**

1. Enable the Show/Hide Ghosted icon to display ghosted icons ( ).
2. Use the arrow to access the slider and adjust the level of aggregation to show ghosted icons for.

5.4. Displaying Unit Icons and Bounding Volumes

VR-Forces lets you configure when to display unit icons and bounding volumes. Bounding volumes are translucent polygons that show the extents of the unit. This is useful when the individual entity icons or models are not displayed. You can configure icons and bounding volumes:

- Enable and disable the display of units. When disabled, only the 2D icons or 3D models for leaf level unit members are displayed.
- Enable and disable the display of bounding volumes. Bounding volumes are displayed only for collapsed units. You can restrict the display of bounding volumes to the selected units.
- In 3D observer modes, enable or disable the display of unit icons.

Figure 17 shows a unit bounding volume in Stealth observer mode, with leaf nodes displayed.

Figure 17. 3D bounding volume

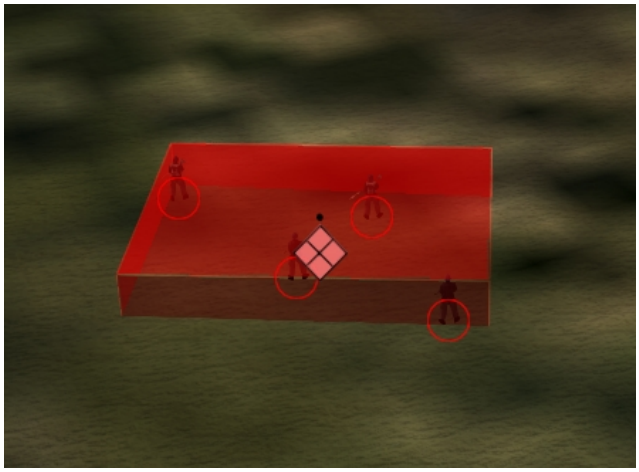
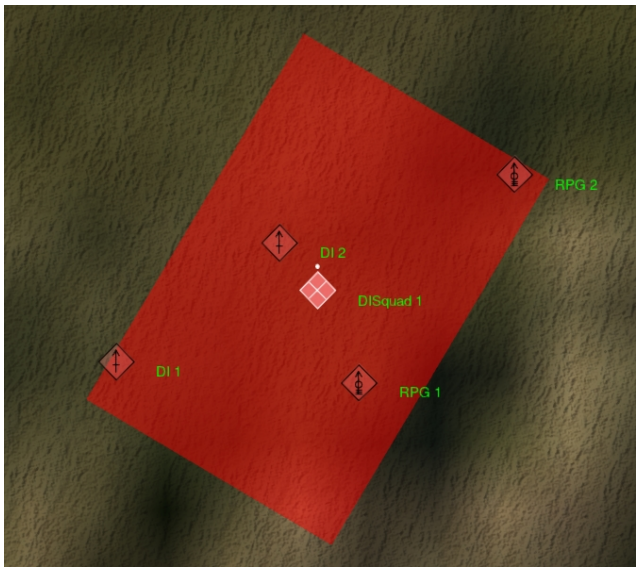


Figure 18 shows a unit bounding volume in Plan View observer mode, with ghosting enabled.

Figure 18. 2D bounding volume



You can display unit icons without showing bounding volumes and vice versa.

➤ **To configure the display of unit icons and bounding volumes:**

1. Choose **Settings > Display**. The Display Settings dialog box opens.
2. Select the Unit Display Settings page (Figure 15 on page 39).
3. To enable the display of unit icons, bounding volumes, or both, select Show Units.
4. To display bounding volumes for collapsed units, select Show Bounding Volumes.
5. To restrict the display of bounding volumes to the selected units, select Show Bounding Volumes Only for Selected Units.
6. To display unit icons in 3D observer modes, select Show Aggregate Icon (3D Only).

> ⓘ You can also enable and disable units by choosing **Settings > Units**.

5.4.1 Specifying the Color Scheme for Unit Bounding Volumes

Unit bounding volumes can be displayed using primary colors or MIL-STD colors.

➤ **To specify the color scheme to use for unit bounding volumes:**

1. Choose **Settings > Display**. The Display Settings dialog box opens.
2. Select the Unit Display Settings page (Figure 15 on page 39).
3. Select the Force Coloring Settings option that you want (Use Primary Colors or Use MIL-STD Icon Colors).