4.7.16 Return-To-Base (RTB) Ruleset

4.7.16.1 RTB Overview

The Return to Base (RTB) ruleset is a ruleset that aircraft can transition to when returning to base. While operating in the RTB ruleset, aircraft can execute drag maneuvers to avoid enemy attacks. The RTB ruleset, however, does not allow aircraft to return fire, receive commanded assignments, nor engage enemies on its own.

4.7.16.2 RTB Battle Management Phases

The RTB ruleset consists of only a few phases that may be executed while a platform is returning home.

4.7.16.2.1 RTB Phase

The return to base phase is scheduled after a flight leader evaluates its RTB trigger events and one of the events is satisfied. It is scheduled to execute when the associated RTB response delay expires. The purpose of this phase is to determine whether or not a flight is ready to return to base and if so, schedule the associated RTB response. There are two possible RTB responses: return to base and land or return home and adopt a CAP. If returning to base, the flight leader will continue to execute this phase once every scenario interval until the decision has been reached that the flight can return home. If the flight is supposed to adopt an RTB ruleset, the flight cannot return to base until all members have completed their current engagements, i.e., are operating in their target select or vector phases. When the flight is ready to return to base, the flight is marked RTB in the commander's subordinate list to prevent further assignments. After the flight is marked RTB, each flight member will transition to an RTB ruleset if one is specified. On the other hand, if the flight has been triggered to return home and adopt a CAP, the flight leader will execute this phase once to carry out the RTB response.

If the commander of the flight is a Flexible Commander ruleset and the flight was on a CAP, the commander of the flight attempts to refill the CAP from an airbase if the CAP's deactivation time has not been reached.

4.7.16.2.2 RTB React-to-Engage Phase

The react-to-engage phase is scheduled in response to an engagement against the RTB ruleset. This phase is scheduled at its start time by an attacker entering the engage mode against the RTB platform: i.e., entering an attempt to lock on the platform. The RTB ruleset does not react to being engaged.

4.7.16.2.3 RTB React-to-Lock Phase

The react-to lock phase is the reaction of the RTB ruleset to being locked on by an attacker's fire control radar. The RTB ruleset performs a drag maneuver and schedules the drag phase at the completion of the maneuver.

4.7.16.2.4 RTB Drag Maneuver Phase

The drag phase processing represents the completion of the drag phase. The RTB platform continues executing the drag phase until no more missiles are in the air to the RTB platform. If the platform has survived the encounter, it now resumes its return to base actions.

4.7.16.3 RTB Received-Message Processing

The RTB ruleset receives and sends no messages.

4.7.16.4 RTB System Configuration

Platforms are not configured initially using the RTB ruleset.

4.7.17 Escort Ruleset

4.7.17.1 Escort Overview

The Escort ruleset is designed as a fighter escort to the bomber-type rulesets: i.e., Agattacker, Bomber, Fighter-Bomber, and Wild Weasel. The escort is highly centralized to the escorted platform; therefore, the escort has no independent target-selection process. The escort engages only targets assigned by the escorted platforms or as a reaction to being engaged. The Fighter Ruleset is often a preferred ruleset for modeling of an air-to-air interaction for many "escort" missions.

4.7.17.2 Escort Battle Management Phases

The Escort ruleset uses much of the same processing as the Sweeper ruleset, the major exception being that the escort relies on the escorted platform for target assignments. Therefore, the target selection and engage phases used in the Sweeper ruleset are not used by the Escort ruleset.

4.7.17.2.1 Escort Lock Phase

The lock phase is entered once a particular target is selected and executed repeatedly until lock on target is achieved. Targets are selected through the reaction phases. These reaction phases are scheduled either by an attacker engaging the escort or the escorted platform assigning an attacker to the escort. The first checks are made to determine whether the target is in track. If the target is not in track, the lock phase is rescheduled for the repeat time. The phase repeats until track is achieved or a time-out of 10 sec has elapsed, which allows time for temporary loss of track and attempting to maneuver to regain track. If track is not held and the time-out has been reached, the escort returns to flying its escort position with no phases executing. The escort also goes back to the escort position if track is held but the target has died. The engagement on the current target stops for both cases.

If the target is in track, the target is evaluated against the available weapons to determine whether lock can be achieved. For a weapon to be evaluated, the range to the target must be less than 90% of the maximum weapon's range. The weapon must also be capable against aircraft. A fire-and-forget missile is chosen in preference to a missile with semi-active guidance. Among the weapons that fall into each category, prioritization is based on the best Pk. If both weapons have equal Pks, the weapon with the highest velocity is chosen: i.e., the shortest intercept time to the target.

If lock is achieved, the launch phase routine is scheduled for the platform at its start time. This start time includes the reaction time to achieving lock-on-target

and the time required for the missile to launch once the pilot pulls the trigger. The react-to-lock phase is also scheduled for the target for its start time.

If lock is not achieved, the lock phase will be rescheduled for its repeat time.

4.7.17.2.2 Escort Launch Phase

The launch phase evaluates whether the actual missile launch occurs. If the platform no longer has track on the target, the escort schedules the lock phase to attempt to regain lock on the target. If the target is dead and in track, the engagement stops and the escort returns to the flight.

If track is still held and the target is still alive, the intercept time for the engagement is computed. This intercept time is computed based on the target continuing to fly at a constant velocity along its current velocity vector. If the range from the escort to the computed intercept point is within the range of the selected weapon, the weapon is launched; otherwise, the launch phase is rescheduled for its repeat time. If the weapon is to be launched, the current position of the escort is stored: i.e. the position from which the weapon started. The intercept phase is scheduled for the computed intercept time. If the launched weapon was a fire-and-forget missile, the escort does not have to maintain track on the target. If the escort is out of weapons, it transitions to the RTB ruleset to return home. If it still has weapons, it returns to its flight and wait for its next engagement.

4.7.17.2.3 Escort Intercept Phase

The intercept phase evaluates the results of the engagement. Several straightforward criteria are evaluated at the beginning of the phase. If the intercept was canceled, the engagement attempt is logged as a failure. If the weapon has semi-active guidance and the escort is dead, the engagement attempt also is logged as a failure. In both cases, the event stream ends for the ruleset. If the target has died, the engagement is logged as a failure from death of the target and the escort returns to the flight.

The intercept phase completion is reevaluated until the range from the launch position of the missile to the target is less than the range that the missile could have flown. The current position of the target is extrapolated to current simulation time to prevent problems with the granularity of state updates from flight processing. The range that the missile could have flown is computed by multiplying the time since launch of the missile by the weapon's average velocity. Once the missile range exceeds the range to the target, the engagement is judged to be over.

If the missile's range is less than the target's range, the intercept time is re-evaluated. The missile's current position is determined to be along a vector from the launch position to the current target's position. The distance of the missile from

its launch position is the already computed maximum distance that the missile could have flown. The time required for the missile to complete the intercept is reevaluated using the same assumptions as the initial computation, except for computed current missile position and target position. If the computed intercept time is beyond the maximum lethal range of the weapon, as computed using the average velocity, the intercept phase is rescheduled for intercept at the lethal range. The intercept phase, otherwise, is rescheduled for the computed intercept time.

If the engagement is over and missile range is still not greater than the range to the target, the intercept is judged a failure from the drag maneuver of the target. If the missile range exceeds the range from launch to the target, the outcome of the engagement is evaluated, as described in Subsection 4.7.11.6.5. If it is a success, the target is logged as a success. If the weapon was a fire-and-forget weapon, the escort has no further processing to perform in this phase. The escort will have already returned to the flight and be either waiting for a new target or engaging a new target. If a semi-active weapon was fired, the escort may now be out of weapons. If it is out of weapons, the escort transitions to RTB and goes home. If it still has weapons, the escort reschedules its engage phase and goes after the target again. If the engagement was a success, the escort returns to the flight.

4.7.17.2.4 Escort React to Engage Phase

This phase, which is very similar to the engagement reaction phase for the Fighter ruleset, is scheduled at its start time by an attacker entering the engage mode against the target: i.e., entering an attempt to lock on the target. This phase is scheduled also by the escorted rulesets—i.e., Bomber, Fighter-Bomber, or Wild Weasel—when the escort is to react to an engagement against the escorted platforms. The first check is to determine whether a reaction is performed. Two user-specified probabilities affect the decision to react. The first probability is when the escort has track information on the attacker. The additional knowledge of threats in the area would lead to a higher probability of the escort pilot recognizing a need to react to an attacker entering the lock phase against him. If the escort does not have track on the attacker, a lower probability should be entered to reflect a lessened situation awareness. If recognition of a need to react is negative, the react-to-engage phase is not rescheduled and no further actions are taken. If randomness is eliminated, the escort will always react.

If the reaction draw is positive, some decision-making is performed. If the escort is already engaged on the attacker or has a fire-and-forget missile in the air to the attacker, no reaction is performed. If the escort is already engaged on another target but lock has not been achieved, the ruleset breaks off the engagement. If lock had been achieved on the target, this phase is rescheduled for its repeat time to allow a reaction once the current engagement is completed.

If the escort is not engaged on another target or is able to break off its current engagement, the escort immediately attacks the attacker. The lock phase is scheduled for its start time.

4.7.17.2.5 Escort React-to Lock Phase

The react-to-lock phase is the reaction of the Escort ruleset to being locked on by an attacker's fire control radar. A determination is made whether to react. The user-supplied hero time is used. If the escort has had a missile in flight to the target for at least the hero time, the escort will not react. If a reaction is taken and the escort is currently engaging another target, that engagement is terminated. If the attacker is currently being engaged, the success of the engagement is determined by the intercept phase, although the execution of the drag maneuver greatly decreases any chance of the target still being in the FOV of the escort's sensor. The drag maneuver phase then is scheduled for the fighter at its start time.

4.7.17.2.6 Escort Drag Maneuver Phase

The drag-phase processing represents the completion of the drag phase. If track is currently held on the attacker, the escort immediately goes after the threat by scheduling the lock phase for the current time. If track is currently not held, the lock phase is scheduled for the attacker at its start time. The Escort continues executing the drag phase until no more missiles are in the air to the Escort.

4.7.17.2.7 Escort User Rules Phase

The Escort ruleset utilizes the User Rules phase, which allows event-based management of the platform. The User Rules phase is described in Section 4.12.

4.7.17.3 Escort Received-Message Processing

Communications for the Escort ruleset are not explicitly modeled. The only coordination with other platforms comes through the reaction phases of the escorted platforms. A bomber, fighter-bomber, or Wild Weasel causes a non-bomber wingman or subordinate to react to an engagement against the escorted platform. This coordination is performed through the react-to-engage phases of the non-bomber wingmen and subordinates and requires no messages to be sent or received.

4.7.17.4 Escort System Configuration

The Escort ruleset can be used only on aircraft. Sensors and weapons are required. Valid weapon types are air-to-air, towed decoy and anti-weapons. Communications devices are not used. An Escort cannot be a commander or have one. An Escort can be a wingman to a bomber, fighter-bomber, or Wild Weasel. Escorts cannot be flight leaders, and they do not use the target or asset lists.

4.7.17.5 Escort Network Recommendations

There are no requirements for networks, since the Escort does not have a message-processing capability.

4.7.18 Was Bomber Ruleset

4.7.18.1 Was Bomber Overview

The Was Bomber ruleset represents the capability of the AGAttacker, Fighter-Bomber, or Wild Weasel to act as an air-to-air combatant after transitioning from a bombing mission. The AGAttacker, Fighter-Bomber, and Wild Weasel rulesets can transition to the Was Bomber ruleset during a reaction to being engaged or at the completion of a drag maneuver.

4.7.18.2 Was Bomber Battle Management Phases

The lock, launch, intercept, and reaction phases of the Was Bomber are similar to the Escort battle management phases. However, the Was Bomber ruleset uses the target-select phase of the platform's mission ruleset. This allows these platforms to transition to Was Bomber to engage an air attacker and then transition back to their original rulesets to continue on their missions. While the platform is executing the Was Bomber ruleset, they jettison ordnance specified in the react-to-lock and react-to-engage phases of their mission rulesets.

4.7.18.2.1 Was Bomber Target-Select Phase

The Was Bomber executes its mission ruleset target-select phase. The target-select phase allows the Was Bomber to transition back to the mission ruleset if the platform still has capable weapons. If the platform does not have weapons to continue its mission, the target-select phase schedules the platform to return to base.

4.7.18.2.2 Was Bomber Lock Phase

The lock phase is entered once a particular target is selected and is executed repeatedly until lock-on-target is achieved. Targets are selected through the reaction phases. These reaction phases are scheduled by the attacker engaging the platform, resulting in a transition to the Was Bomber ruleset.

If the target is not in track, the lock phase is rescheduled for the repeat time. The phase repeats until track is achieved or a timeout of 10 sec has elapsed, which allows time for temporary loss of track and attempting to maneuver to regain track. If track is not held and the timeout has been reached, the Was Bomber reschedules its target-select phase. The Was Bomber also reschedules its target-select phase if track is held but the target has died. The engagement on the current target stops for both cases, and the target-select phase is scheduled for its start time.

If the target is in track, the target is evaluated against the available weapons to determine whether lock can be achieved. For a weapon to be evaluated, the range to the target must be less than 90% of the maximum weapon's range. The weapon must also be capable against aircraft. A fire-and-forget missile is chosen in

preference to a missile with semi-active guidance. Among the weapons that fall into each category, prioritization is based on best Pk. If both weapons have equal Pk's, the weapon with the highest velocity: i.e., the shortest intercept time to the target, is chosen.

If lock is achieved, the launch phase is scheduled for the platform at its start time. This start time includes the reaction time to achieving lock-on-target and the time required for the missile to launch once the pilot pulls the trigger. The react-to-lock phase is scheduled for the target at its start time. If lock is not achieved, the lock phase is rescheduled at its repeat time.

4.7.18.2.3 Was Bomber Launch Phase

The launch phase evaluates whether the actual missile launch occurs. If the platform no longer has track on the target, the Was Bomber schedules the lock phase to attempt to regain lock on the target. If the target is dead and in track, the engagement stops; and the target-select phase is rescheduled at its start time.

If track is still held and the target is still alive, the intercept time for the engagement is computed. This intercept time is computed based on the target continuing to fly at a constant velocity along its current velocity vector. If the range from the platform to the computed intercept point is within the range of the selected weapon, the weapon is launched; otherwise, the launch phase is rescheduled for its repeat time.

If the weapon is to be launched, the current position of the platform is stored: i.e., the position from which the weapon started. The intercept phase is scheduled for the computed intercept time. If the launched weapon is a fire-and-forget missile, the platform does not have to maintain track on the target. If it is out of weapons, it transitions to the RTB ruleset. If it still has weapons, it reschedules its target-select phase.

4.7.18.2.4 Was Bomber Intercept Phase

The intercept phase evaluates the results of the engagement. If the intercept was canceled, the engagement is logged as a failure. If the weapon has semi-active guidance and the Was Bomber is dead, the engagement is also logged as a failure. In both cases, the event stream ends for the ruleset. If the target has died, the engagement is logged as a failure from death of the target and the target-select phase is rescheduled for the Was Bomber.

The completion of the intercept phase is reevaluated until the range from the launch position of the missile to the target is less than the range that the missile could have flown. The current position of the target is extrapolated to current simulation time to prevent problems with the granularity of state updates from flight processing. The range that the missile could have flown is computed by

multiplying the time since launch of the missile by the weapon's average velocity. Once the missile range exceeds the range to the target, the engagement is judged to be over.

If the missile's range is less than the target's range, the intercept time is re-evaluated. The missile's current position is determined to be along a vector from the launch position to the current target's position. The distance of the missile from its launch position is the already computed maximum distance that the missile could have flown. The time required for the missile to complete the intercept is reevaluated using the same assumptions as the initial computation, except for computed current missile position and target position. If the computed intercept time is beyond the maximum lethal range of the weapon, as computed using the average velocity, the intercept phase is rescheduled for intercept at the lethal range. The intercept phase otherwise is rescheduled for the computed intercept time.

If the engagement is over and missile range is still not greater than the range to the target, the intercept is judged a failure from the drag maneuver of the target. If the missile range exceeds the range from launch to the target, the outcome of the engagement is evaluated as described in Subsection 4.7.11.6.5. If the engagement is a success, the target is logged as a success.

If the weapon launched is a fire-and-forget weapon, the Was Bomber has no further processing in this phase. The target-select phase has already been scheduled for the ruleset.

If a semi-active weapon is fired, the platform may now be out of weapons. If it is out of weapons, the Was Bomber transitions to RTB. If it still has air-to-air weapons and the target is still alive, the Was Bomber reschedules its lock phase to engage the target again. If the platform does not have air-to-air weapons, its target-select phase is scheduled. The target select phase determines whether the platform has weapons to continue its mission or if it must return to base. If the engagement is a success, the ruleset schedules its target-select phase to continue its mission.

4.7.18.2.5 Was Bomber React-to-Engage Phase

The react-to-engage phase is scheduled at its start time by an attacker entering the engage mode against the Was Bomber. The Was Bomber first determines whether it will react to the engagement. Two user-specified probabilities affect the decision to react. The first probability is when the platform has track information on the attacker. The additional knowledge of threats in the area leads to a higher probability of the Was Bomber pilot recognizing a need to react to an attacker entering the lock phase against him. If the platform does not have track on the attacker, a lower probability should be entered to reflect a lessened situation awareness. If recognition of a need to react is negative, the react-to-engage phase is not rescheduled and no further actions are taken.

If the reaction draw is positive, the status of the Was Bomber is checked. If randomness is eliminated, the Was Bomber will always react. If the Was Bomber is already engaged on the attacker or has a fire-and-forget missile in the air to the attacker, no reaction is performed. If the Was Bomber is already engaged on another target but lock has not been achieved, the Was Bomber breaks off the engagement. If lock has been achieved on the target, this phase is rescheduled for its repeat time to allow the Was Bomber to react when the current engagement is completed.

If the Was Bomber is not engaged on another target or was able to break off the current engagement, the Was Bomber jettisons any ordnance specified in either its original mission ruleset. The Was Bomber lock phase is scheduled at its start time.

4.7.18.2.6 Was Bomber React-to-Lock Phase

The react-to-lock phase is the reaction of the ruleset to being locked on by an attacker's fire control radar. A determination is made whether a reaction will occur. The user-specified hero time is used. If the platform has had a missile in flight to the target for at least the hero time, the Was Bomber does not react.

If the Was Bomber decides to react and it is currently engaging another target, that engagement is terminated. If the attacker is currently being engaged, the success of the engagement is determined by the intercept phase; however, the execution of the drag maneuver greatly decreases any chance of the target still being in the FOV of the platform's sensor. The Was Bomber jettisons ordnance specified by its Fighter-Bomber or Wild Weasel ruleset and schedules the drag phase at its start time. The Was Bomber continues executing the drag phase until no more missiles are in the air to the Was Bomber.

4.7.18.2.7 Was Bomber Drag Maneuver Phase

The drag-phase processing represents the completion of the drag phase. If track is currently held on the attacker and the Was Bomber still has air-to-air weapons, the Was Bomber immediately goes after the threat by scheduling the lock phase for the current time. If track is currently not held, the lock phase is scheduled for the attacker at its start time. If the Was Bomber has no air-to-air weapons, its target-select phase is scheduled to determine whether the platform can continue its mission or if it must return to base.

4.7.18.3 Was Bomber Received-Message Processing

Communications for the Was Bomber ruleset are not explicitly modeled.

4.7.18.4 Was Bomber System Configuration

Platforms are not configured initially using the Was Bomber ruleset; however, the user can specify the timing for each of the Was Bomber phases.

4.7.19 Air Warning and Control System (AWACS)

4.7.19.1 AWACS Overview

The function of a platform using the Air Warning and Control System (AWACS) ruleset is to use its sensor to gather track information. This information is then forwarded to other platforms. The AWACS ruleset does not represent any C2 capabilities; therefore, it is simply a source of track data.

4.7.19.2 AWACS Battle Management Phases

The AWACS has no battle management phases. The track information gathered by AWACS is forwarded as discussed in Subsection 4.6.

4.7.19.3 AWACS Received-Message Processing

Platforms using the AWACS ruleset have no message-processing routines.

4.7.19.4 AWACS Systems Configuration

The AWACS ruleset can be used on either a ground or air platform. A sensor and a communications device are required. Weapons are not used. AWACS platforms can neither have commanders nor be commanders. They do not use targets or assets and they cannot be flight leaders or wingmen.

4.7.19.5 AWACS Network Recommendations

The recommended network type for AWACS platforms is simplex or broadcast network types, which support outgoing track messages only. Track recipients should be on the net with the AWACS.

4.7.20 Ground Support Module (GSM)

4.7.20.1 GSM Overview

The Ground Support Module (GSM) ruleset is currently set up to receive and delay track messages being forwarded.

4.7.20.2 GSM Battle Management Phases

The GSM ruleset utilizes no battle management phases. It delays the forwarded messages within its message-processing routine.

4.7.20.3 GSM Received-Message Processing

The GSM message-processing routine receives and delays track messages. All other messages are ignored.

4.7.20.4 GSM System Configuration

The GSM ruleset can be used only for ground platforms. A communications device is required; sensors and weapons are not used. Platforms using the GSM ruleset cannot be commanders, flight leaders, or wingmen, and they cannot be commanded. Targets and assets are not used.

4.7.20.5 GSM Network Recommendations

The GSM platform requires a link from the platform sending the message to be delayed and a link to the platform receiving the delayed message.