JTLS-0055 Range Specifications As Polygons

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1.0 Summary of Model Change Request

All range specifications that are currently restricted to a radius should also be specified as polygons. This should apply to Combat Air Patrol (CAP) missions and Rules Of Engagement (ROE) setting, especially Surface-to-Air Missiles (SAM). This is especially important because some SAM sites only protect small polygonal areas.

2.0 Design Summary

The request, as written by the user, is misleading. The concept of a polygonal range area does not physically exist in the real-world. Polygonal areas refer more to different Rules Of Engagement (ROE) established to limit the range capabilities of objects that can fire on an opposing force. These polygonal areas are current represented in JTLS using the Operations Area (OPAREA) concept. An OPAREA can limit CAP missions and SAM sites.

The last sentence of the request is what is important. Specifically, “some SAM sites only protect small polygonal areas”. It is this concept of a protection area, not a range capability that is being implemented as part of this ECP.

Table 1 lists the various objects that use the concept of a circular coverage area and whether they will be affected by this ECP.

Table 1. Applicability Of Polygonal Protection Areas

Object Type	Description Of ECP Applicability
Sensor Sites	Sensor Sites do not engage or fire on other objects. They simply detect the object within their circular range capability. Under JTLS-2013-11722 Non-Circular Sensor And Air Defense Ranges, this physical circular coverage capability is being expanded to be represented as a sector. ROE does not affect whether a specific Sensor Site is or is not allowed to detect an object. This will not be changed as a result of this ECP. Thus Sensor Sites are not considered part of this ECP.
Jammer Sites	Current Jammer Sites are not included in the sector size limitation improvements planned for ECP JTLS-2013-11722 Non-Circular Sensor And Air Defense Ranges. For the same reasons mentioned for Sensor Sites, Jammer Sites are not considered part of this ECP.

Table 1. Applicability Of Polygonal Protection Areas

Object Type	Description Of ECP Applicability
Air Defense Artillery (ADA), Anti-Aircraft Artillery (AAA) or SAM Sites	This is the primary purpose of this ECP. Currently ADA Sites have a circular range capability, but this is being upgraded under JTLS-2013-11722 Non-Circular Sensor And Air Defense Ranges to be represented as a sector or portion of a circle. This sector or complete circular coverage area indicates the physical or engineering firing coverage capability of the SAM site. The user currently has the ability to provide each SAM Site owned by a unit a circular ROE which places a military decision maker's limitation on where the SAM Site is allowed to fire. This ECP will expand the ROE definition of a SAM Site to use either the circular protection area, or a polygonal protection area. Before firing on an object, the model will insure that the object is: • Within the physical firing sector capability of the ADA Site and • The user specified ROE for the site whether that is a circle or OPAREA. • In the case of firing against a Theater Ballistic Missile (TBM), the model will also determine if the predicted impact point for the TBM is within the newly added polygonal protection area given to the site. It is this additional rule that is the essence of this ECP.
CAP or DCA Missions	CAP missions already have the capability to be given a polygonal protection area, by specifying that they should protect an Operations Area (OPAREA). This can be done as part of the original Defensive Counter Air (DCA) order or by submitting a Change Air Mission Parameter Order and altering the CAP mission's protection algorithm. This ECP will not alter the manner in which CAP missions operate.
Offensive Air Support (OAS) Missions	There are two primary methods in which OAS missions operate. These are: • User Assigned Target Mode - in which the mission will attack the specifically user assigned target. Before firing the mission must be within the circular ROE distance it has been assigned or the target must be in a fire-allowed polygonal OPAREA. The design team feels that these rules meet the desired goals of this ECP; therefore, this design will not alter the manner in which OAS missions decide whether they can fire on a user specified target. • Automatic Fire Mode - in which the mission will automatically fire on an object if the object characteristics are on the mission's fire allowed list and the object is within the circular ROE distance of the mission or within a visible OPAREA with positive ROE. This mode is sometimes referred to as "SCUD alert" mode, in which the primary purpose of the OAS missions is to be ready to immediately attack an opposing force Surface-to-Surface (SSM) site during its setup phase. The design team feels that these rules meet the intent of this ECP. This ECP will not alter the manner in which the OAS missions operate.

Table 1. Applicability Of Polygonal Protection Areas

Object Type	Description Of ECP Applicability
Anti-Submarine Warfare ASW) Patrol Missions	Patrol missions are constantly searching for and attempting to detect submarines. As they do so, they can also detect and report surface vessels. The sensors on board the missions can detect over an circular area only because airborne sensors are not allowed to have sectors under ECP JTLS-2013-11722 Non-Circular Sensor And Air Defense Ranges. Once a submarine or surface ship is found, it can be fired on, if the user specified an allowable Target Allowed List. This is all done in a manner similar to the OAS mission, The design team feels that these rules also meet the intent of this ECP. This ECP will not alter the manner in which the OAS missions operate.

3.0 Detailed Design

Currently there is no way to pictorially display the ROE coverage area for any of the objects listed in Table 1. This will not be changed as a result of this ECP. If there is a desire to have this capability, the end user needs to submit an Model Change Request (MCR) and funding would need to be identified to implement this capability.

3.1 Current Air Defense Site Checks

Before an Air Defense Site can be considered as a viable firing site, the following checks must be passed.

- The SAM Site must not be dead
- The SAM Site must not be owned by an external model such as JCATS or GESI
- The detected object must have crossed the SAM Site's range sector since the last move. See JTLS-2013-11722 Non-Circular Sensor And Air Defense Ranges.
- There must be no terrain masking between the SAM Site and the detected objects current location.
- The SAM site must have some shots currently available to fire.
- The SAM Site must have permission to fire on the detected object's Aircraft Target Class. See JTLS-2009-10414 Create Aircraft Target Class ROE For SAM Sites

- The SAM Site must have ROE to fire on the detected object's Force Side. If the detected object is in an OPAREA visible to the SAM Site's Force Side and the ROE is set for the detected object's current altitude, then the OPAREA ROE has precedence. If there is no such OPAREA, then the SAM Site's circular ROE has precedence.

- If the SAM Site has a "jammable" Fire Control Sensor and it cannot be jammed. Refer to the analyst guide for details on this portion of the existing model. No changes will be made to this algorithm.

- If the SAM Site is not on a IADS network, it must be prepared to engage the detected object. If after a random draw, the Site must be determined to be prepared to fire.

- The SAM site must have some available ammunition with a positive Probability of Kill (PK) against the detected object.

After a site is eligible to fire, there is a much larger check that determines whether it will fire based on whether the site is or is not a member of an Integrated Air Defense Site (IADS) Network. This final logic stream is unaffected by this ECP or design. Refer to the Analyst Guide if interested in this current aspect of the JTLS-Go Air Defense logic.

3.2 Proposed Air Defense Site Protection Polygon

Only one additional check will be added to the SAM eligibility list specified in Section 3.1. This additional check only applies to a SAM Site that is firing on a Theater Ballistic Missile (TBM). The rule is stated as follows:

- If the SAM site has not been given a TBM Protection Polygon, then the eligibility list specified in Section 3.1 is the complete list used to determine whether a SAM site can be considered to fire.

- If the SAM site has been given a TBM Protection Polygon, using the ROE Order, then the predicted impact location of the TBM must fall within the specified protection polygon. Note that the SAM site range does not need to cover the protection polygon nor does the missile need to currently be in the protection polygon for the SAM site to fire. The check simply determines of the predicted TBM impact point is within the polygon. Naturally all of the other checks specified in Section 3.1 must be met for the SAM site to be on the eligible fire list.

  Figure 1 shows an example of a SAM Protection Polygon that results in the Air Defense Site firing on the detected TBM. Figure 2 shows an example of a SAM Protection Polygon that results in restricting the Air Defense Site from firing on the TBM even if it enters its engagement sector. Note in both Figure 1and Figure 2, the SAM Site would be allowed to fire, if no Polygonal Protection Polygon has been specified.

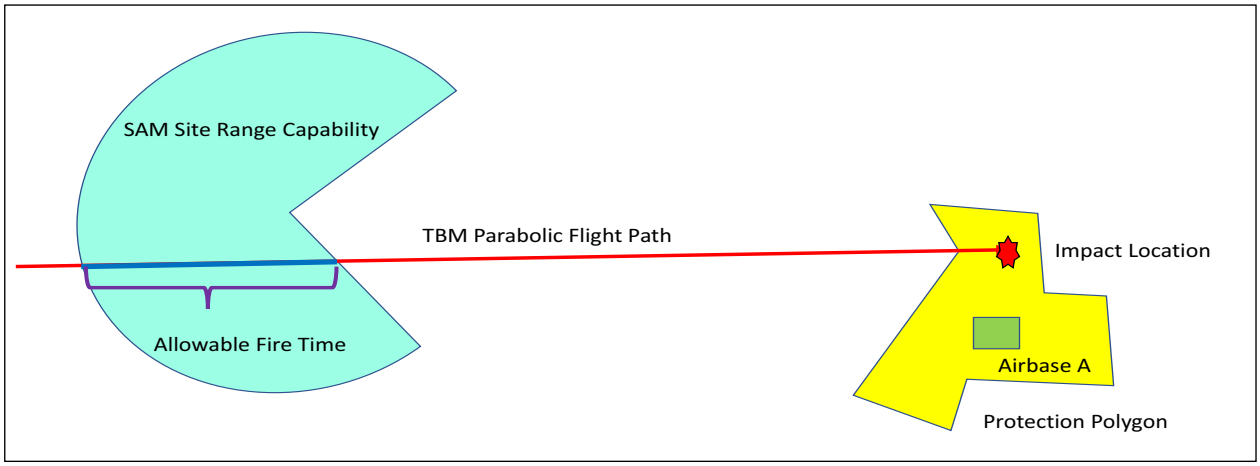

Figure 1. Example SAM Site Polygonal Protection Area Against TBMs

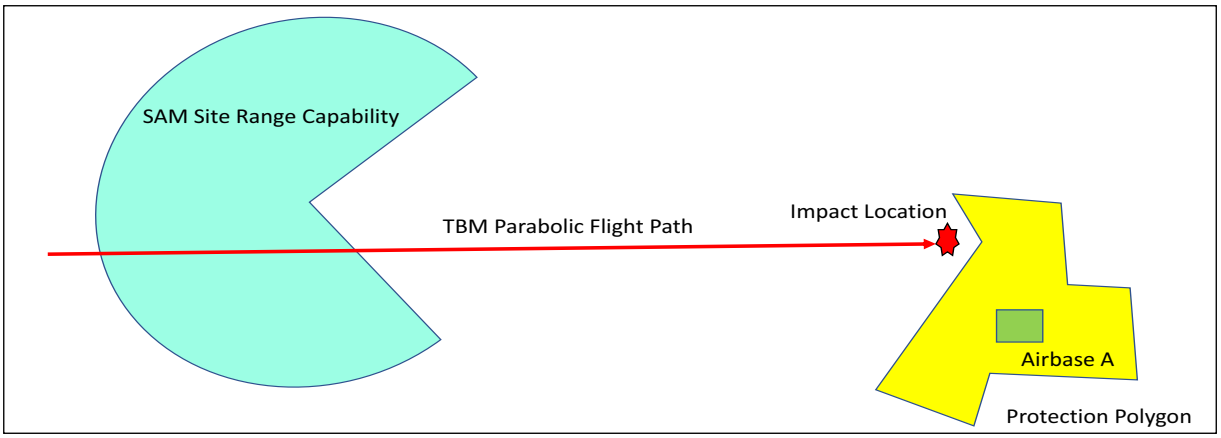

Figure 2. Example SAM Site Polygonal Area Restricts Firing Against TBM

3.3 How To Specify A Polygonal Protection Polygon

Each SAM/AAA Site in JTLS holds an attribute indicating its assigned protection polygon. There is no way to specify this polygon as part of the initialization database. The user must submit a RULES OF ENGAGMENT (ROE) Order to provide the SAM/AAA site with an assigned protection polygon, alter the protection polygon, or remove the protection polygon.

On the ROE Order, the user should select the Target ROE Option which is used to set many of the special ROE rules for Air Defense Targets. Table 2. outlines the fields available under this portion of the ROE Order. The cells highlighted in Green as specific to this ECP. All other cells are simply provided for completeness purposes.

Table 2. Target ROE Option To Set Protection Polygon

Field	Field Alternatives	Explanation
Order Recipient	Specific ADA Target	Enter the Configuration Control Facility (CCF) Number of a specific target for which an ROE change is desired.
	All Targets Of Specific Type	Enter the desired Air Defense Class (AD) Name. All Surface to Air Missile targets on the WHIP's side from the specific AD Class will have the ROE change implemented.
	All Targets Owned or Associated with a unit. • Unit Name • Include Subordinate Flag	Enter the short name of a unit. Also indicate if only that unit or that unit and all of its subordinates should be affected. Ever Air Defense target that is either owed or associated with the specified units will have the ROE change implemented.
Impact Polygon		The user will enter a polygon area. All recipients AD Targets will start to use the impact polygon as described in Section 3.2. If the recipient of the order already has an impact polygon, the old impact polygon is automatically removed and this polygon is assigned for use.
Remove Impact Polygon		If this flag is set to "Yes", then all recipient AD Targets will delete their assigned impact polygon and will no longer be concerned about the predicted impact location of a detected TBM. The site fire on the TBM as long as all of the other firing rules outlined in Section 3.1 are met.
Restricted Aircraft Target Class (ATC) • List Of Restricted ATCs • Force Side for which the ATC list applies.		These fields were added to the ROE order in support of JTLS-2009-10414 Create Aircraft Target Class ROE For SAM Sites. If no Force Side is specified, either the ATC restrictions or allowance records in the list apply to all sides in the scenario.

4.0 Data Changes

No data changes are required for this ECP.

5.0 Order Changes

The ROE order will be changed to support this ECP. The fields highlighted in Green in Table 2 will be added to the order.

6.0 JODA Changes

No JODA Data System parameter, structure, or protocol changes are required to implement this design.

7.0 Test Plan

7.1 Test Specific Target ROE

Purpose: The purpose of this test is to verify that a specific target can be given an Impact Polygon.

Step 1: Select an Air Defense Target that has the ability to fire on TBMs. Call this Target A

Step 2: Using the ROE order give Target A an impact protection polygon that covers an airbase. Make sure that this target is the only Air Defense Target that has an ROE.

Step 3: Fire a TBM from an opposing side for which Target A has a positive ROE. Have the impact point in the protection polygon.

Expected Results: Target A should fire on the TBM.

Step 4: Fire a TBM from an opposing side for which Target A has a positive ROE. Have the impact point be outside the protection polygon.

Expected Results: Target A should NOT fire on the TBM.

Step 5: Give a positive ROE to another Air Defense Target that is on the same side as Target A. Call this Target B. Target B should not have any impact polygon specified.

Step 6: Fire a TBM from the same opposing side. Have the impact point be outside the protection polygon.

Expected Results: Target A should NOT fire on the TBM, but Target B should.

Step 7: Turn off the ROE for Target B.

Step 8: Using the ROE order remove the impact polygon from Target A.

Step 9: Fire a TBM from the same opposing side. Have the impact point be outside the protection polygon.

Expected Results: Target A should fire on the TBM.

7.2 Test Air Defense Class ROE Assignment

Purpose: The purpose of this test is to verify that the impact polygon can be given to several Air Defense targets based on their Air Defense Class.

Step 1: Select five Air Defense Targets. Targets 1 and 2 should be Air Defense Class A targets, Targets 3 and 4 should be Air Defense Class B targets. These targets should be all within the flight path of an opposing force TBM fired at a selected airbase.

Step 2: Using the ROE order given all Air Defense A targets an Impact Polygon that is positioned around the airbase.

Step 3: Using the ROE order given all Air Defense B targets an Impact Polygon that is not positioned around the airbase.

Step 4: Fire a TBM from an opposing side for which all four targets have a positive ROE. Have the impact point be outside both of the protection polygon.

Expected Results: No target should fire on the TBM

Step 5: Fire a TBM from an opposing side for which all four targets have a positive ROE. Have the impact point be inside the airbase protection polygon.

Expected Results: Targets 1 and 2 should fire on the TBM. Depending on the random numbers drawn, it is possible only one target or the other will only shoot.

Step 6: Fire a TBM from an opposing side for which all four targets have a positive ROE. Have the impact point be inside the protection polygon assigned to the AD Class B targets.

Expected Results: Targets 3 and 4 should fire on the TBM. Depending on the random numbers drawn, it is possible only one target or the other will only shoot.

Step 7: Using the ROE Order remove the impact polygon from the AD Class B targets.

Step 8: Fire a TBM from an opposing side for which all four targets have a positive ROE. Have the impact point be inside the protection polygon formerly assigned to the AD Class B targets.

Expected Results: Targets 3 and 4 should still fire on the TBM because they do not have any impact polygon restrictions. Depending on the random numbers drawn, it is possible only one target or the other will only shoot.

Step 9: Turn the ROE for Targets 3 and 4 off.

Step 10:Turn the ROE for Target 2 off.

Step 11:Fire a TBM from an opposing side for which Target 1 has a positive ROE. Have the impact point be inside the airbase protection polygon.

Expected Results: Target 1 should fire on the TBM.

Step 12:Take a stop checkpoint.

Step 13:Restart from the stop checkpoint

Step 14:Repeat Step 11.

Expected Results: Target 1 should fire on the TBM.

Step 15:Fire a TBM from an opposing side for which Target 1 has a positive ROE. Have the impact point be outside the protection polygon.

Expected Results: Target 1 should not fire on the TBM.

7.3 Test Unit and Subordinate ROE Assignment

Purpose: The purpose of this test is to verify that the impact polygon can be given to several Air Defense targets based on their owning or associated unit.

Step 1: Create a Unit hierarchy as described in Table 3.

Table 3. Unit and Subordinate Polygon Test Setup

<table>
<tr><th>UNIT</th><th>HIERARCHY 1</th><th>HIERARCHY 2</th></tr>
<tr><td rowspan="5">Unit A
• Owns AD Target
• Associated With AD Target</td><td colspan="2">Unit A.1
• Owns AD Target</td></tr>
<tr><td rowspan="3">Unit A.2
• Associated With AD Target</td><td>Unit A.2.1
• Owns AD Target
• Associated With AD Target</td></tr>
<tr><td>Unit A.2.2
• Owns AD Target</td></tr>
<tr><td>Unit A.2.3</td></tr>
<tr><td>Unit A.3</td><td>Unit A.3.1
• Associated With AD Target</td></tr>
<tr><td colspan="3">Unit B - No Targets</td></tr>
</table>

Step 2: Submit an ROE order for Unit A and No for subordinates to assign an impact polygon.

Step 3: Submit an order for an Air Defense report that covers all of the unit and targets specified in Table 3.

Expected Results: The report should indicate that both the owned and associated AD targets from Unit A have an impact polygon specified.

Step 4: Submit an ROE order for Unit A and Yes for subordinates to remove the impact polygon.

Expected Results: The ROE order should be accepted and processed.

Step 5: Repeat Step 3.

Expected Results: The report should indicate that none of the AD targets have an impact polygon specified.

Step 6: Submit an ROE order for Unit A.2 and all subordinates to be given an impact protection polygon.

Step 7: Repeat Step 3.

Expected Results: The report should indicate that A.2's, A.2.1's, and A.2.2's owned and associated targets each have the same impact protection polygon.

Step 8: Submit an specific target ROE order for A.2.1's Owned Target. Have the targets impact polygon be removed.

Step 9: Repeat Step 3.

Expected Results: The report should indicate that A.2's associated target, A.2.1's associated target, and A.2.2's owned target each have the same impact protection polygon. A.2.1's owned target should not have an impact protection polygon.

Step 10:Submit an ROE order for Unit A and all subordinates to be given a different impact protection polygon.

Step 11:Repeat Step 3.

Expected Results: All of the targets referenced in Table 3 should be listed in the ADA Report as having the same impact protection polygon.

Step 12:Submit an ROE order for Unit B and all subordinates to be given a completely different impact protection polygon.

Expected Results: The order should be accepted and processed normally, even though there are no changes that result from the order.

Step 13:Repeat Step 3.

Expected Results: The air defense report should be identical to the last report generated prior to executing Step 12.