JTLS-2006-1653 Represent Unmanned Underwater Vehicles

Ellen Roland, John Hertz, Robert Montgomery

1.0 Summary of Model Change Request

In naval operations, unmanned vehicles have become an important force multiplier in conducting maritime missions. These vehicles, operating at or below the sea surface, reduce risk to personnel by performing missions that manned vehicles often cannot. These relatively small, tactical assets are becoming more significant participants in asymmetric warfare and should be represented in JTLS-GO.

Engineering Change Proposal (ECP) JTLS-2006-1653 Represent Unmanned Underwater Vehicles specifically refers only to adding Unmanned Underwater Vehicle (UUV) representation to JTLS-GO. Unmanned Surface Vehicles (USVs) and Unmanned Land Vehicles (ULVs) are also growing in use by military forces and share at least some technological capabilities with UUVs. Consequently, this Design Plan is expanded to describe how all three assets, UUVs, USVs, and ULVs, will be represented in JTLS-GO.

2.0 Design Summary

2.1 Current Capabilities

Currently, JTLS-GO does not represent small, unmanned vehicles employed from naval vessels or ground combat units. JTLS-GO does model Unmanned Aerial Vehicles (UAVs) as individual aircraft flown from squadrons to conduct reconnaissance, SEAD, or Offensive Air Support (OAS) missions. Example UAVs in the standard database include Global Hawk, Reaper, and Predator. There is no similar modeling of unmanned vehicles that operate on or under the sea surface, or on land. Submarines, represented as naval units with crews, are the only assets in JTLS-GO that operate below the sea surface.

Table 1 provides the reader with some currently available capabilities that will be represented when this ECP is implemented.

Table 1. Unmanned Vehicle Definitions And Representation

UNMANNED VEHICLE (UV) TYPE	DEFINITION	EXAMPLES
Unmanned Underwater Vehicle (UUV)	Unmanned vehicles that can move under the surface of the water to carry out a variety of tactical missions using a variety of weapons and sensors	• US Navy Snorkeler Class (7M SS)

Table 1. Unmanned Vehicle Definitions And Representation

Unmanned Vehicle (UV) Type	Definition	Examples
Unmanned Surface Vehicle (USV)	Unmanned vehicles that can move on the surface of the water to carry out a variety of tactical missions using a variety of weapons and sensors.	• US Navy Harbor Class (7M) • US Navy Fleet Class (11M)
Unmanned Land Vehicle (ULV)	Unmanned vehicles that can have move on land or transition from water to land to carry out a variety of tactical missions using a variety of weapons and sensors.	• US Army Talon • USMC Gladiator (under development) • Improvised Explosive Device

2.2 Design Approach

UUVs, USVs, and ULVs, referred to collectively as Unmanned Vehicles (UVs) throughout the remainder of this document, are essentially small, tactical assets that perform various dedicated missions. They can operate remotely or autonomously and are deployed when required. As such, it is not practical to model UVs as full-fledged naval or ground units in JTLS-GO. To do so would populate the scenario database and WHIP display with many, ever-present, limited capability units that must be managed by players.

The most logical and expedient way to represent UVs in JTLS-GO is through High Resolution Units (HRUs). HRUs are currently used in JTLS-GO to represent lifeboats, small ground units, SOF direct action teams, and covert HUMINT teams. An HRU is defined by its HighRes Unit Prototype (HUP). The HUP specifies the types and quantities of combat systems, targets, and supplies that equip the HRU upon creation. HRUs are created by the player (or deployed) when needed from a parent unit and may rejoin the parent when no longer needed.

In this design plan, HUPs will be modified to effectively represent particular types of UVs. New HUP attributes will be necessary to properly model these capabilities:

- Control type (i.e. remote or autonomous),
- Control distance limitation,
- Submerged Flag used to indicate that the vehicle is underwater with reduced enemy detection capability.
- The most critical combat system, and
- Whether the created HRU is a one-time use weapon system.

In addition, a new HRU task is needed to fully represent the unmanned vehicles in use by worldwide military forces. After the implementation of this ECP, HRUs will be allowed to lay and clear minefields.

UV functions that were considered by the Design Team, but will not be implemented in this ECP, are submarine decoys, submarine crew rescue, illegal contraband trafficking, and the operating endurance of these vehicles. See Other Considerations, Section 3.13 for details.

3.0 Detailed Design

3.1 Background

An HRU is currently capable of performing a wide variety of missions as ordered by the player, depending on their assigned combat systems and targets. Table 2 shows the tasks currently available to HRUs. By default, HRUs that represent UVs will also be capable of executing each of these tasks.

Table 2. Currently Available HRU Tasks

HRU Tasks	Possible UV Task
Move	Move where directed
Ambush	Improvised Explosive Device (IED)
Patrol	Patrol where directed
Attack/Raid	Conduct the attack or raid
Rejoin Parent	Return to the parent when tasking is complete
Civil Military Ops	Military and civilians are supposed to be working together, and placing an unmanned capability in support of this mission seems incongruous. The HUP has an attribute indicating whether the HRU can conduct these types of operations. SVP check will be added to warn the scenario builder if an unmanned HUP is given this capability.
Coalition Support	Needed to allow the UV to move along with the owning unit. The Coalition Support task must be ended for the HRU to move and perform tasks independently.
Overwatch	Move with an object for protection. This could represent an automated robotic mine clearing capability or robotic IED detection and neutralization capability.

Table 2. Currently Available HRU Tasks

HRU TASKS	POSSIBLE UV TASK
Traffic Control	Theoretically it could represent traffic lights or some type of automated control. Still this is considered much below the level of detail needed or every desired in JTLS-GO. A new attribute will be added to the HUP, HUP TRAFFIC CONTROL CAPABLE FLAG. If set to YES, the HUP will be able to do the Traffic Control Task. If set to NO, it will not be allowed to accept the task. By adding this attribute, the HUP now consistently holds data to indicate which special operations can and cannot be accomplished. We are currently not planning on adding an SVP warning for an unmanned HUP being given this capability.

3.2 Basic UV Representation

Several new attributes will be added to the HUP data structure to accurately define the various UV type and capabilities. These attributes and their model implications are provided in Table 3.

Table 3. New HUP Attributes

ATTRIBUTE	EXPLANATION
HUP CONTROL TYPE Use of this new attribute is described in Section 3.3.	Specifies the command & control methodology for the UV type. There are three possible values for this data field: • MANNED - meaning the HUP does not represent an unmanned vehicle • REMOTE - The resulting unmanned HRU is controlled by the HRU's parent unit. • AUTONOMOUS - The resulting unmanned HRU controls itself.
HUP CONTROL DISTANCE Use of this new attribute is described in Section 3.3.	This attribute is only accessed for a HUP that has a HUP CONTROL TYPE equal to REMOTE. It represents the maximum distance from which the resulting HRU is allowed to move away from its parent unit.
HUP CRITICAL COMBAT SYS Use of this new attribute is described in Section 3.9.	Specifies the name of the HRU's critical combat system. It can be any valid combat system name or set to NONE. • If the HUP does not represent an unmanned vehicle, this attribute should be set to NONE, and the resulting HRU will die when all personnel systems have been killed. • For an unmanned HRU the attribute must be filled and the HRU is destroyed when all systems, of the HUP CRITICAL COMBAT SYSTEM type, are destroyed.

Table 3. New HUP Attributes

ATTRIBUTE	EXPLANATION
HUP LOITERING MUNITION FLAG Use of this attribute is described in Section 3.6.	JTLS-2016-12737 UAV Turns Into Weapon requires that the model handle the ability to represent a fully capable UAV that can be turned into a weapon and fired on a specific target. Given that desired capability, it is only logical that the UV be given the same capability. This attribute can have one of two values: • NO - meaning it can have multiple weapons and fire each of the available weapons and then can return to its parent to reload if needed. • YES - meaning that the HUP can only specify one weapon. When the user directs the resulting HRU to fire that single weapon, the HRU is automatically destroyed, because in fact it represents the weapon itself. This is the method with which the Design Team feels that intelligent IEDs can be represented in JTLS.

Manned HRUs, if they are given an Organic Small Boat (HUP ORGANIC SMALL BOAT) can transition from land to water and back. The model currently does not consider where the small boat is when the HRU is on land and the transition between land and water does not take time. The modeling assumption is that the personnel assigned to the HRU are properly taking care of what needs to be done to support the transition resulting in smooth movement between the two travel modes.

Given that this design is based on the premise that the UV representation will use the HRU construct, this same multi-mode travel capability will be afforded to the UV HRUs. This is not as logical as is for the manned HRU representation and special effort must be allocated to properly configure the Small Boat to represent the true capabilities of the UV. A transition between land and water can only take place if the HRU's HUP has a HUP ORGANIC SMALL BOAT and that Small Boat Type has an agility type (SB AGILITY TYPE) indicating that it can cross shore barriers.

Table 4 summarizes the rules that a database builder should use to configure their desired UVs.

Table 4. Differentiating Between UUV, USV, and ULV

HUP ORGANIC SMALL BOAT	SB OPERATIONAL DEPTH	SB AGILITY TYPE CROSSING SHORE CAPABLE	RESULT HRU CAPABILITY
Specified	Greater Than Zero	Yes	Transitions Between UUV and ULV
		No	Always UUV
Specified	Equal To Zero	Yes	Transitions Between UUV and ULV
		No	Always USV

Table 4. Differentiating Between UUV, USV, and ULV

HUP ORGANIC SMALL BOAT	SB OPERATIONAL DEPTH	SB AGILITY TYPE CROSSING SHORE CAPABLE	RESULT HRU CAPABILITY
Not specified	Not Applicable (N/A)	N/A	Always ULV

3.3 Controlling UVs

If the HUP is an unmanned prototype, it is important to specify how the unmanned vehicle is controlled. As mentioned above this is indicated by the database parameter HUP CONTROL TYPE which can have the following values:

- MANNED - There are no control limitations for this Control Type
- AUTONOMOUS - There are no control limitations for this Control Type
- REMOTE - indicates that the UV is under positive control by its parent unit. The maximum distance that it can be from its parent unit is specified in the database parameter HUP CONTROL DISTANCE

Each time an HRU is about to move, the HUP CONTROL TYPE attribute will be checked. If the value is REMOTE, the rules described in Table 5 will be used to determine if the move can take place. For this algorithm, the following data or computations are referenced:

- D_N - the distance between the HRU's parent unit and the next move location
- D_C - the current distance between the HRU's parent unit and the HRU.
- C_D - the database parameter HUP DISTANCE for the HRU's HUP.

Table 5. HRU Movement Rules For REMOTE Control Type

DISTANCE COMPARISON	RULE RESULT
$D_N \le C_D$	Move is allowed to occur
$(D_N > C_D)$ And $(D_N < D_C)$	Move is allowed to occur. In other words, if this move brings the vehicle closer to home the move is allowed. This rule is needed so the vehicle will attempt to stay within range of its parent when the parent is moving.

Table 5. HRU Movement Rules For REMOTE Control Type

DISTANCE COMPARISON	RULE RESULT
$(D_N > C_D)$ And $(D_N \geq D_C)$	Move is not allowed. There are two possible outcomes when this happens: • If the HRU is executing a Patrol Task within an OPAREA or a Polygon, a new patrol location is computed and the next move is scheduled. • Under all other circumstances, the HRU's current task is postponed and a Ground Wait task is placed on the task list. An Alert is generated for the HRU to quickly warn the user of the problem. The user can alter the HRU's task or the Parent Unit's tasks to solve the problem.

3.4 Submerged UV Representation

To accurately model the movement capability of the UV on or under the sea surface, new attributes will be added to the Small Boat entity. These new attributes are shown in Table 6.

Table 6. New Small Boat Attributes

SB ATTRIBUTE	DEFINITION
SB OPERATIONAL DEPTH	• A value of zero indicates that the Small Boat is a surface boat and can only move on the sea surface. • A value greater than zero feet indicates that the Small Boat can only move beneath the surface and it will do so at the specified depth. Note unlike Naval Units, Small Boats will not be given any capability to surface or snorkel. An HRU on the ocean with a Small Boat is either submerged or on the surface
SB NOISE	The noise generated by the Small Boat. The HRUs will only travel at a constant speed and this is the noise level in decibels that are generated when the HRU and thus this small boat is deployed.

Note that these new attributes are not limited for use with the UV capability. As a result of this design, it is possible to have a manned HUP with a submersible Small Boat.

Currently the rules for determining when an HRU is traveling on water and when it is traveling on land are not well documented or necessarily consistently implemented. The visibility of an HRU, as well as the speed at which it travels are both linked to the mode of movement, Thus, it is more important than ever to ensure the concept of being on land or on water is implemented consistently.

In JTLS, the model indicates that an HRU has “Feet Wet” when it is traveling in the water. If the HRU is in a land grid, it is obviously labeled as “Feet Dry”. While traveling though an ocean grid or on a river, the HRU is labeled as “Feet Wet”. The rules when moving through a dual-capable grid are more complicated and depends on which side of the shoreline the HRU is assumed to be moving.

Figure 1 shows five examples. In this figure a “Green” line indicates that the HRU is “Feet Dry” and a “Blue” line indicates that the HRU is using “Feet Wet” rules. The solid green grids are land, the white grids with the green lines are dual-capable grids, and the blue grids are considered ocean. The “Pink” line represents a shoreline barrier and the “Orange” dots indicate when the model will have the HRU move. Table 7 explains each of the situations

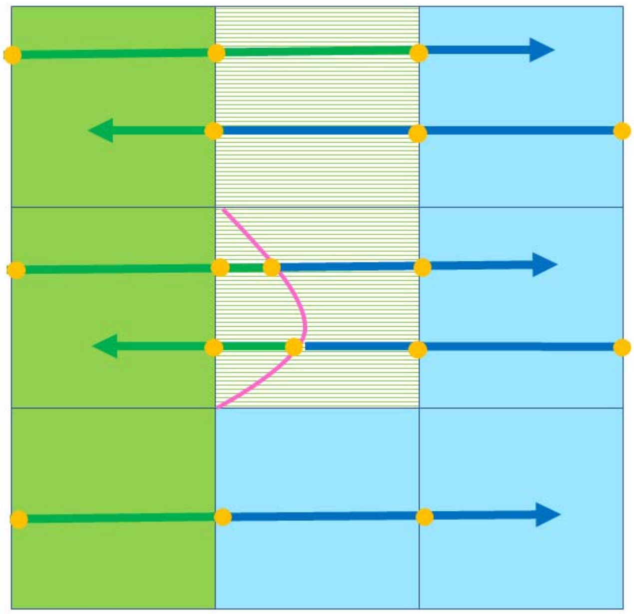

Figure 1. Example Feet Wet / Dry Situations

Table 7. Explanation Of Feet Wet / Dry Situations From Figure 1

SITUATION	EXPLANATION
Situation 1	The HRU is starting on land, as it moves into the dual-capable grid, it has not encountered a modeled barrier; therefore, the HRU considers itself on land. When it moves into the third grid, an ocean grid, the model considers this an “Implied” shoreline, and the HRU transitions to Feet Wet.
Situation 2	The HRU is starting on the ocean, as it moves into the dual-capable grid, it has not encountered a modeled barrier; therefore, the HRU does not transition and considers itself on water. When it moves into the third grid, an land grid, the model considers this an “Implied” shoreline, and the HRU transitions to Feet Dry.
Situation 3	The HRU is starting on land, as it moves into the dual-capable grid, it does encountered a modeled barrier. The HRU moves up to and just beyond the barrier. After that move is complete, the HRU transitions to “Feet Wet” and completes the remainder of the move in that mode.

Table 7. Explanation Of Feet Wet / Dry Situations From Figure 1

SITUATION	EXPLANATION
Situation 4	The HRU is starting on the ocean, as it moves into the dual-capable grid, it does encountered a modeled barrier. The HRU moves up to and just beyond the barrier. After that move is complete, the HRU transitions to "Feet Dry" and completes the remainder of the move in that mode.
Situation 5	The HRU is starting on land, after the move through the first grid is complete, the HRU is moving in an Ocean Grid and it transitions to "Feet Wet".

The inconsistency between Situation 1 and Situation 2 is well understood, but the Design Team feels is acceptable given the fact that JTLS is not a tactical model, and the difference in travel distance may well be under 1 Kilometer given a properly constructed terrain database.

Once the HRU is labeled as "Feet Wet" or "Feet Dry", the visibility of the HRU and the speed at which it can move are easy to establish.

Table 8. Summary Of Visibility And Speed Rules

ATTRIBUTE	FEET DRY	FEET WET
Submerged Status	Not Submerged	• Submerged if Grid Depth greater than or equal to SB OPERATIONAL DEPTH • Not Submerged if Grid Depth less than SB OPERATIONAL DEPTH
Visibility	Visible using Covert / Non-Covert Detection Rules	• If submerged, not visible. • If not submerged, visible using Small Boat Probability of Detection Rules
Speed	Current HRU Land Speed Algorithm	Use SB SPEED Attribute

3.5 Detection of UVs

The detection of a manned HRU will not change as a result of this design, Table 9 summarizes the detection algorithms that will be used for each of the new UV capabilities.

Table 9. Detection Algorithms For Various UV Types

TYPE UV	DETECTION ALGORITHM
Unmanned Underwater Vehicle (UUV)	Passive Sonar Detection - possible under two circumstances: • Each time the UUV moves • Each time an active or passive sonar moves and starts to cover the UUV. • During the Hourly Unit Processing event. The passive detection algorithm that will be used is the same as the current naval passive detection algorithm. The SB NOISE data parameter will contribute to all Ambient Noise computations and will be used to determine of the opposing force can detect the UUV. If the noise the UUV is generating is greater than the computer Ambient Noise, a detection will be immediate. Unlike the detection algorithm for Naval Units, no coverage time is required. As soon as their is a positive passive collection asset in the area, the detection will occur.
	Active Sonar Detection. Can detect a UUV based on the following computed Probability Of Detection: $\text{Prob}_{\text{Detect}} = \text{ST BASELINE PD}_{\text{Sensor}} \times \text{IIP TGC DETECT MULT}_{\text{IIP SB}}$ Detection is possible each time UUV moves or sensor moves over the UUV.
	Surface Search Sensor: Not allowed to detect a UUV. There will be no capability to tell the UUV to surface.
Unmanned Surface Vehicle (USV)	Passive Sonar Detection - same algorithm as UUV.
	Active Sonar Detection - same algorithm as UUV
	Surface Search Sensor - same algorithm as Active Sonar Detection
Unmanned Land Vehicle (ULV)	Passive Sonar Detection - Not possible
	Active Sonar Detection - Not possible.
	Surface Search Sensor - same algorithm as Active Sonar Detection.

3.6 Smart Weapon Representation

As an HRU, this JTLS entity has two types of combat in which it can participate.

- The HRU has the ability to own a Surface-to-Surface Missile (SSM) launcher and accept Fire Missile orders from the user.

- The HRU owns Combat Systems which have the ability to fight within HRU Combat against other HRUs and other Aggregate Resolution Units.

Although extensive changes are not expected, each of these combat situations need to be reviewed as part of this UV design.

3.6.1 HRU Firing SSM

There is little that must be done for this combat interaction. If an HRU is given an order to fire missile, it will do so as it does in the current version of JTLS. There is no difference between the firing methodology used for a manned and unmanned HRU.

What is being added for the unmanned HRU is the concept of a loitering weapon capability. If the HUP LOITERING MUNITION FLAG is set to YES, the unmanned HRU will fire one missile and then automatically be “killed” and removed from the game. This is a similar concept to the manner in which the AC LOITERING MUNITION FLAG is implemented as part of JTLS-2016-12737 UAV Turns Into Weapon.

ARU Naval Units have a special Automatic Firing capability within JTLS. Feet Wet HRUs will not participate in this Automatic Fire algorithm nor will they be recipients of other ARU Naval Unit Automatic Fire.

3.6.2 HRU Assess Combat

If an HRU is given a Raid task, the HRU moves to the object being raided and if it is not detected as part of the Special Operation Force (SOF) Alert algorithm, the HRU initiates the HRU Assess Combat algorithm. If the HRU is given an Ambush task, the HRU lies in wait for the proper opposing force capability to come within its combat range, and once found the HRU will also initiate the HRU Assess Combat algorithm.

This algorithm will also not change drastically as a result of this design. The three phases of HRU Assess Combat: “Ambush”, “Fire Fight”, and “Disengage” will all be represented. The only difference is that if the HRU is an unmanned asset and the HUP LOITERING MUNITIONS FLAG is set to Yes, the HRU will only be allowed to participate in the one phase of the HRU Assessment. Specifically:

- If the Unmanned HRU starts the fight, it will execute the Ambush phase of the assessment and then be removed from the game.
- If the unmanned HRU is detected as part of the SOF Alert algorithm, normally the HRU goes directly to the Fire Fight phase in which it gets to fire on the victim and the victim gets to fire back. The order in which these assessments are accomplished must be changed for a more proper representation of the conflict. For the Fire Fight phase, the victim under these circumstances will get to fire first. If the result is that the unmanned

HRU is killed, the HRU is not allowed to fire back. If it did then being in SOF Alert against a HUP LOITERING MUNITION is of no use. If the HRU is not killed, then the HRU gets to “Fire” back and then it will be removed from the game.

- Under no circumstances will the “Disengage” phase of HRU Assess Combat ever take place with an HRU that represents a loitering munition.

3.7 New HRU Mining Operations

Originally this design did not expand the HRU tasks to include mining operations, both the clearing of mines and laying of mines. The Government indicates that this was unacceptable because one of the primary missions of USVs is to covertly lay mines. The purpose of this section is to outline how an HRU Mine Laying Task and HRU Mine Clearing Task will be implemented.

3.7.1 Mine Laying Task

A new task will be added to the HRU Task Order. All of the standard task fields, such as start time, will be active. The Mine Laying Task Group will include the following special fields:

- Location at which the mines should be placed - this is a mandatory field
- Number of mines that should be empaneled - this is a mandatory field
- Type of Targetable Weapon that should be used - this is a mandatory field
- The deactivation time - this is an optional field. If not specified, the mines will not deactivate.

Implementing this task is fairly straight forward. When the task starts execution:

- The model determines if the HRU has the needed supplies for at least one mine. If not, the task is canceled.
- The model then determine if the HRU radius covers the emplacement location. If not, a movement task is automatically added to the HRUs task list.

Once the HRU is at the proper location, it starts to emplace the mines. Each mine is emplaced in sequence. The time it takes to lay each mine will follow these rules:

- If an submerged HRU is emplacing naval mines, then the time to lay each mine is obtained from the attribute TW TIME PER ROUND.
- If a surface HRU is emplacing naval mines, then the time to lay each mine is obtained using the following formula:

$$\text{Time Per Mine (TM)} = \text{TW TIME PER ROUND} \times \text{TW DZ EMPLACE MODIFIER}$$

- If a land HRU is emplacing land mines, then the time to lay each mine is obtained using the following formula which is also used for land-based ARUs.

$$\text{TM} = (\text{MCP MFT TIME TO LAY MINEFIELD} / \text{MFT NUMBER OF MINES}) \times \text{TW NUMBER MUNITIONS}$$

The HRU Mine Laying task can be canceled and postponed using the existing Manage HRU Task order.

3.7.2 Mine Clearing Task

Another new task will be added to the HRU Task Order. All of the standard task fields, such as start time, will be active. The Mine Clearing Task Group needs only one field, the location at which the clearing task should take place.

Implementing this task is also fairly straight forward. When the task starts execution, the model will determine if the HRU radius covers the clear mine location. If it does not, a move task is added to the HRU task list.

Once the HRU is at the proper location, the model will determine if there is an enemy minefield in the area. The minefield radius must cover the specified location of the clearing task. If no such minefield is found, the task is canceled.

- If a minefield is found, the clear task will begin and each mine will be cleared sequentially. Unlike laying mines, the time to clear each mine is computed in the same way for all objects whether the mine is a water mine or a land mine. This same algorithm will be used to computed the time to clear a mine by an HRU. This algorithm can be summarized by the following equation:.

$$\text{TM} = (\text{MCP MFT TIME TO CLEAR MINEFIELD} / \text{MFT NUMBER OF MINES}) \times \text{TW NUMBER MUNITIONS}$$

The HRU Mine Laying task can be canceled and postponed using the existing Manage HRU Task order.

3.8 HRU Weighted Strength Computation

A new algorithm is needed to provide a weighted strength of an HRU. If the HRU is a manned HRU and it has no personnel systems, its weighted strength is zero. For unmanned HRUs, if the HRU has none of the HUP CRITICAL COMBAT SYSTEMS, then its weighted strength is zero, Under all other circumstances the following equation is used:

$$\text{Strength} \equiv \frac{\sum_{\text{CS}} \text{CS SCORE} \times \text{AVAILABLE}}{\sum_{\text{CS}} \text{CS SCORE} \times \text{TOE}}$$

3.9 New Destruction Rules For UVs

Currently, HRUs are destroyed when the last personnel combat system is killed, even if the HRU has other non-personnel combat systems. Because the UV HRU will not possess a personnel combat system, a different algorithm is needed to determine when an HRU is no longer effective and must be removed from the game.

Each HUP will have a new attribute called the HUP CRITICAL COMBAT SYS. If specified, the HUP is assumed to be represent an Unmanned Vehicle (UV). If not specified, the HUP presents a manned capability, and an HRU using the HUP will die when all personnel combat systems have been destroyed. For UV HRUs, when the all HUP CRITICAL COMBAT SYS have been destroyed, the HRU is removed from the game.

If the HRU represents a UUV or USV, it must have an organic Small Boat and this Small Boat must also be represented as a Combat System that has a special capability (CS SPECIAL CAPABILITY) of AMPHIB. The HUP CRITICAL COMBAT SYS can be and in most circumstances is expected to be an AMPHIB special capability Combat System, but this is not necessarily true. If it is not, the UUV and USV will also be considered destroyed if all of its CS SPECIAL CAPABILITY Combat Systems that represent its Organic Small Boat are destroyed

Note that this last Small Boat rule only applies to UUVs and USVs. Manned HRUs are assumed to be able to swim even if the Small Boat is destroyed.

Table 10 summarizes the three destruction rules that will be implemented..

Table 10. Summary Of HRU Destruction Rules

RULE	USV	UUV	ULV	MANNED HRU
When all personnel have been killed.				
The HUP will have a specific critical combat system that, if destroyed, renders the HRU completely ineffective. This critical combat system could represent an on-board artificial intelligence system (i.e. a piloting robot) or some other specified combat system.				

Table 10. Summary Of HRU Destruction Rules

Rule	USV	UUV	ULV	Manned HRU
When all Combat Systems with a CS SPECIAL CAPABILBITY of AMPHIB are killed. This rule is only applied if the unmanned HRU is on the water at the time of the system being killed.				

3.10 Converting To JTLS 5.1 Database Format

The HUP conversion process will be straight forward. The existing HUPs will all be given the following values during the conversion from a JTLS 5.0 database to a JTLS 5.1 database.

- HUP CRITICAL COMBAT SYS - will be set to NONE
- HUP CONTROL TYPE will be set to MANNED
- HUP CONTROL DISTANCE will be set to the default of zero.
- HUP LOITERING MUNITION FLAG will be set to NO

3.11 Standard Database Plans

Although not normally included in designs, the reader may get a better idea of the impact of this design by understanding the types of unmanned HUPs planned for Standard Database.

3.11.1 Unmanned Surface Vehicle (USV) HUPs

The US Navy currently has two types of USVs: Harbor (7M) and Fleet (11M). Each type will be defined in a new HUP that is accessed when the HRU is created. There will be multiple HUPs to represent the USV variants based on equipage and mission purpose.

Table 11 shows the new USV HUPs that will be added to the standard database. A Small Boat that represents the surface platform will be specified as the HUP CRITICAL COMBAT SYS.

The 50 caliber machine gun or the Mk 19 grenade launcher will be designated the HUP CRITICAL COMBAT SYS for each HUP.

Table 11. USV HUPs

HUP Name	Weapon Systems		Sensors
HARBOR.SEN	HARBOR Platform Combat System	Critical Combat System	Surface, Air, and Sonar

Table 11. USV HUPs

HUP NAME	WEAPON SYSTEMS		SENSORS
HARBOR.EW	HARBOR Platform Combat System	Critical Combat System	EW ELINT and Jammer
HARBOR.50CAL	HARBOR Platform Combat System	Critical Combat System	Surface and Sonar
	50 Cal Machine Gun	Combat System	
	Depth Charges	SSM Target	
HARBOR.MK19	HARBOR Platform Combat System	Critical Combat System	Surface and Sonar
	Mk19 Grenade Launcher	Combat System	
	Depth Charges	SSM Target	
FLEET.50CAL	FLEET Platform Combat System	Critical Combat System	Surface and Sonar
	50 Cal Machine Gun	Combat System	
	Depth Charges	SSM Target	
	Torpedoes	SSM Target	
FLEET.MK19	FLEET Platform Combat System	Critical Combat System	
	MK19 Grenade Launcher	Combat System	Surface and Sonar
	Depth Charges	SSM Target	
	Torpedoes	SSM Target	
FLEET.SEN	FLEET Platform Combat System	Critical Combat System	Surface, Air, and Sonar
FLEET.EW	FLEET Platform Combat System	Critical Combat System	EW ELINT and Jammer

The attribute values for each USV HUP are shown in Table 12.

Table 12. USV HUP Attributes

HUP NAME	HUP CONTROL TYPE	HUP CONTROL DISTANCE (KM)	HUP LOITERING MUNITION FLAG
HARBOR.50CAL	REMOTE	8.0	NO
HARBOR.MK19	REMOTE	8.0	NO
HARBOR.SEN	REMOTE	8.0	NO
HARBOR.EW	REMOTE	8.0	NO
FLEET.50CAL	AUTONOMOUS	0.0	NO
FLEET.MK19	AUTONOMOUS	0.0	NO
FLEET.SEN	AUTONOMOUS	0.0	NO
FLEET.EW	AUTONOMOUS	0.0	NO

The HARBOR and FLEET USV HUPs will be assigned organic Small Boats with attribute values shown in Table 13. Different Small Boat types are necessary because the generated noise levels are not the same. Each HUP will also have a Combat System Amphib representative of the organic Small boat.

Table 13. USV Small Boats

SB NAME	SB OPERATIONAL DEPTH	SB NOISE
HARBOR	0.0	63 decibels
FLEET	0.0	112 decibels

3.11.2 Unmanned Underwater Vehicles (UUV) HUPs

The US Navy currently has one type of UUV: SNORKELER (7MM SS). This UUV type will be defined in a new HUP that is accessed when the HRU is created. There will be multiple HUPs to represent the UUV variants based on equipage and mission purpose.

Table 14 shows the new UUV HUPs that will be added to the standard database.

Table 14. UUV HUPs

HUP NAME	WEAPON SYSTEM		SENSOR
SNORKELER.WPN	SNORKELER Platform Combat System	Critical Combat System	
	Torpedoes	SSM Target	Surface and Sonar
SNORKELER.SEN	SNORKELER Platform Combat System	Critical Combat System	Surface and Sonar
SNORKELER. EW	SNORKELER Platform Combat System	Critical Combat System	EW ELINT and Jammer
SNORKELER.BOMB	SNORKELER Platform Combat System	Critical Combat System	
	Torpedo	SSM Target	Surface and Sonar

The SNORKELER.BOMB will represent a UUV that only carries a single torpedo and surface search sensor and sonar. This UUV will have the capability of attacking a ship or submarine as a one way weapon. The HUP LOITERING MUNITION FLAG will be set to YES for the HUP. If the UUV fires its single torpedo using the Fire Missile order, the UUV is immediately destroyed. If no weapon is fired, the UUV can return to its launch ship.

The attribute values for each UUV HUP are shown in Table 15.

Table 15. UUV HUP Attributes

HUP NAME	HUP CONTROL TYPE	HUP CONTROL DISTANCE	HUP LOITERING MUNITION FLAG
SNORKELER.WPN	AUTONOMOUS	0.0	NO
SNORKELER.SEN	AUTONOMOUS	0.0	NO
SNORKELER. EW	AUTONOMOUS	0.0	NO
SNORKELER.BOMB	AUTONOMOUS	0.0	YES

Only one type of organic Small Boat will be assigned to all the Snorkeler UUV HUPs. This Small Boat will be named SNORKELER. The SB OPERATIONAL DEPTH will be set to 80 feet. The SB NOISE will be set to 56 decibels.

3.11.3 Unmanned Land Vehicles (ULV) HUPs

The US Army operates the Talon ULV and the USMC is developing the Gladiator ULV. Both will be represented by a multi-purpose HUP that is accessed when the HRU is created. There will be multiple HUPs to represent the ULV variants based on equipage and mission purpose.

Table 16 shows the new ULV HUPs that will be added to the standard database.

Table 16. ULV HUPs

HUP NAME	WEAPON SYSTEM		SENSOR
ULV.SEN	ULV Platform Combat System	Critical Combat System	Surface
ULV.EW	ULV Platform Combat System	Critical Combat System	EW ELINT and Jammer
ULV.50CAL	ULV Platform Combat System	Critical Combat System	Surface
	50 Cal Machine Gun	Combat System	
ULV.MK19	ULV Platform Combat System	Critical Combat System	Surface
	Mk19 Grenade Launcher	Combat System	
ULV.BOMB	IED Platform Combat System	Critical Combat System	Surface
	Bomb	SSM Target	

The ULV.BOMB will represent a ULV that only carries a single explosive weapon and surface search sensor. This ULV will have the capability of attacking a target as a one-way weapon. The HUP LOITERING MUNITION FLAG will be set to YES for the HUP. If the ULV fires its single weapon using the Fire Missile order, it will be immediately destroyed. If no weapon is fired, the ULV can return to its controlling ground unit.

The attribute values for each ULV HUP are shown in Table 17.

Table 17. ULV HUP Attributes

HUP NAME	HUP CONTROL TYPE	HUP CONTROL DISTANCE (KM)	HUP LOITERING MUNITION FLAG
ULV.50CAL	REMOTE	10.0	NO
ULV.MK19	REMOTE	10.0	NO
ULV.SEN	REMOTE	10.0	NO
ULV.EW	REMOTE	10.0	NO
ULV.BOMB	AUTONOMOUS	10000.0	YES

The ULV HUPs will not include an organic Small Boat or Combat System Amphib in the standard database, although they could. The ULV HRUs will be confined to only operating in land, dual-purpose, or small island terrain grids.

3.12 Scenario Verification Program Considerations

Several new checks will be added to the Scenario Verification Program (SVP) to ensure the UV data is consistent:

3.12.1 HUP CRITICAL COMBAT SYS Verifications

If the HUP CRITICAL COMBAT SYS is set to NONE, the following checks will be made:

- ERROR: HUP must have at least one Personnel Combat System
- WARNING: HUP CONTROL TYPE must be set to MANNED

If the HUP CRITICAL COMBAT SYS is set, the following checks will be made:

- ERROR: HUP must have at least one of the specified Combat System
- WARNING: HUP CONTROL TYPE must be not be set to MANNED

3.12.2 HUP LOITERING MUNITION FLAG Verifications

If the HUP LOITERING MUNITION FLAG is set to YES, the following Errors checks will be made:

- ERROR: HUP must have one SSM Prototype Owned Target (POT) to launch the weapon when it is told to fire on an enemy object.
- ERROR: HUP has a targetable weapon assigned that can be fired from the HUP's SSM POT. This will not be a straight forward verification to accomplish. No where in the HUP structure does the database indicate exactly what Targetable Weapon the HRU is carrying. The current model logic works based on supply availability. The verification will look at every type of weapon that can be fired by the SSM POT. The verification will insure that there are enough supplies to "create" at least one targetable weapon from the list of legal weapons that can be fired by the SSM POT.
- WARNING: If the HUP owns supplies that would end up creating more than one weapon that can be fired by the SSM POT. Since the HRU will be destroyed as soon as the first weapon is fired, any excess supplies will be lost and makes little sense if tracking supplies is important.

3.12.3 HUP CONTROL TYPE Verifications

- ERROR: If the HUP CONTROL TYPE is not MANNED, the HUP must specify a critical non-personnel combat system.
- ERROR: If the HUP CONTROL TYPE is not MANNED, the HUP must have at least one sensor target.
- WARNING: If the HUP CONTROL TYPE is not MANNED, the HUP cannot have any personnel combat systems.
- WARNING: If the HUP CONTROL TYPE is not MANNED, all combat systems specified cannot be crewed combat systems.
- ERROR: If the HUP CONTROL TYPE is REMOTE, the HUP CONTROL DISTANCE must be greater than zero.
- WARNING: If the HUP CONTROL TYPE is AUTONOMOUS, the HUP CONTROL DISTANCE must be zero.

3.12.4 HUP CONTROL DISTANCE Verifications

- WARNING: If HUP CONTROL DISTANCE is greater than zero, insure that the HUP CONTROL TYPE is REMOTE.

3.13 Other Considerations

The Design Team considered implemented the following additional capabilities but decided against doing so for the reasons specified.

- UUV that acts as a submarine decoy. Since at this time submarines do not emit electronic or specific propeller signatures in the model, but are detectable based solely on their generated noise level, it was decided to not add this type UUV. Furthermore, a decoy SUP could be defined in the database and then created as a special naval unit by the controller as needed.
- UUV that rescues crews from submarines that are damaged. Such an operation could be represented simply by moving a UUV to the distressed submarine. Explicit crew extraction does not add much training value to an operational-level exercise, therefore it was decided to not add this type UUV.
- UUV/USV that performs contraband trafficking, such as smuggling arms, narcotics, etc. Covert UUV/USV HRU movement is sufficient to represent transport of illegal items. Existing SOF Alert capability, sonars, and surface search radars are capable of detecting

the covert UUV/USV, although difficult. Once the covert HRU is detected, naval units could be sent to perform a Maritime Interdiction Operation at its location. Therefore, it was decided to not add this type UUV/USV.

- Add a Small Boat Endurance Time. The concept was rejected because currently Small Boats have no Endurance Time. Furthermore, the Instructor Controllers (ICs) can maintain realistic deployment times for unmanned systems by ordering the HRUs to rejoin parent units when appropriate.

4.0 Data Changes

The database requires several new attributes for the SMALL BOAT and HIGHRES UNIT PROTOTYE entity data structures.

SB NOISE

- Dimension: Variable – Entity Attribute
- Mode: Real
- Unit of Measure: Decibels
- Range: 0.01 or greater
- Default Value: 0.01
- Definition: This variable is an attribute of the SMALL BOAT permanent entity. SB NOISE holds the noise a small boat generates when it is operating.
- Relationships: This data parameter is used to extrapolate noise values for small boats based on range attenuation. Small boats add ambient noise to an area, thereby impacting the ability of passive sonars to detect them.

SB OPERATIONAL DEPTH

- Dimension: Variable – Entity Attribute
- Mode: Real
- Unit of Measure: Feet
- Range: 0.0 or greater
- Default Value: 0.0
- Definition: This variable is an attribute of the SMALL BOAT permanent entity. This attribute represents the typical cruising or loitering depth to perform normal operations for the small boat. If set to zero, the

small boat operates only on the surface. If set to greater than zero, the small boat operates only beneath the surface. Note this attribute is referenced by unmanned surface or unmanned underwater vehicles represented by HRUs with organic small boats.

- **Relationships:** The TH DEPTH attribute of the terrain grid square holds water depth as a negative value. The absolute value of TH DEPTH must be greater (greater depth) or equal to SB OPERATIONAL DEPTH for a small boat of this type to enter the grid square. If SB OPERATIONAL DEPTH is greater than zero, this value represents the depth that the small boat can be considered submerged and not vulnerable to surface detection. Although the water depth is held as a negative value in the TH DEPTH attribute, it is treated as a positive value by the model when compared to the SB OPERATIONAL DEPTH to determine whether a small boat may enter the grid square at operational depth.

HUP CONTROL TYPE

- Dimension: Variable – Entity Attribute
- Mode: Text
- Unit of Measure: N/A
- Range: MANNED, REMOTE, or AUTONOMOUS
- Default Value: MANNED
- Definition: This variable is an attribute of the HIGHRES UNIT PROTOTYPE permanent entity. It specifies the CONTROL TYPE name for the HUP.
- Relationships: A HUP CONTROL TYPE value of REMOTE indicates the HRU that accesses this HUP cannot move further than the HUP CONTROL DISTANCE from its parent unit. MANNED and AUTONOMOUS HRUs ignore the HUP CONTROL DISTANCE.

HUP CONTROL DISTANCE

- Dimension: Variable – Entity Attribute
- Mode: Real
- Unit of Measure: Kilometers
- Range: 0.000 to 9999
- Default Value: 0.0

- Definition: This variable is an attribute of the HIGHRES UNIT PROTOTYPE permanent entity. It holds the maximum straight line distance an HRU that accesses this HUP can move from its parent unit and remain under positive control.
- Relationships: The HUP CONTROL DISTANCE limitation only applies if the HUP CONTROL TYPE is equal to REMOTE. It is ignored for MANNED and AUTONOMOUS HRUs.

HUP CRITICAL COMBAT SYS

- Dimension: Variable – 1-Dimensional Entity Attribute
- Mode: Text
- Unit of Measure: N/A
- Range: Any text string. The characteristics #, &, /, @ and $ are prohibited. Limited to 15 characters with no spaces.
- Default Value: NONE
- Definition: This variable is an attribute of the HIGHRES UNIT PROTOTYPE permanent entity. It holds the general (or generic) text name of the combat system type that is considered critical to the operation of the HRU that accesses this HUP. If the critical combat system is ever destroyed, the entire HRU is considered destroyed.
- Relationships: If the HUP CRITICAL COMBAT SYSTEM is NONE, then the model will treat all personnel combat systems as critical. The attribute is intended to define the critical combat system on an unmanned vehicle, as manned HRUs are considered destroyed only after all personnel combat systems are lost by attrition.

HUP LOITERING MUNITION FLAG

- Dimension: Variable – Entity Attribute
- Mode: Text
- Unit of Measure: N/A
- Range: YES or NO
- Default Value: NO
- Definition: This variable is an attribute of the HIGHRES UNIT PROTOTYPE permanent entity. A YES value indicates an HRU accessing this HUP is expendable and immediately destroyed after it attacks an object or location, or explicitly fires a weapon. A NO value

indicates the HRU is reusable and may continue to operate after attacking.

- Relationships: The flag is set to YES for one-way, one-use unmanned surface, underwater, and land vehicles that are modeled as HRUs.

HUP TRAFFIC CONTROL CAPABLE FLAG

- Dimension: Variable – Entity Attribute
- Mode: Text
- Unit of Measure: N/A
- Range: YES or NO
- Default Value: NO
- Definition: This variable is an attribute of the HIGHRES UNIT PROTOTYPE permanent entity. A YES value indicates an HRU accessing this HUP is capable of facilitating traffic flow in the local area. A NO value indicates the HRU cannot perform this function.
- Relationships: The flag is one of several HUP capability flags that determine if an HRU is allowed to perform the corresponding tasks in the model.

5.0 Order Changes

5.1 Order SET HUP PARAMETER

The HUP CRITICAL COMBAT SYS, HUP CONTROL TYPE, HUP CONTROL DISTANCE, HUP LOITERING MUNITION FLAG, and HUP TRAFFIC CONTROL CAPABLE FLAG (for consistency with other flags) will be added as new fields to the Set HUP Parameters order template. New constraints will be added to the order template or the underlying Simscript subroutine as appropriate:

- If the HUP CONTROL TYPE is changed to REMOTE, then a HUP CONTROL DISTANCE greater than zero must be entered. There will be some limitations concerning what changes the controller will be allowed to make. These limitations are identified in Table 18.

Table 18. Changing HUP CONTROL TYPE

OLD VALUE	NEW VALUE		
	MANNED	REMOTE	AUTONOMOUS
MANNED	Allowed	Not Allowed	Not Allowed

Table 18. Changing HUP CONTROL TYPE

OLD VALUE	NEW VALUE		
	MANNED	REMOTE	AUTONOMOUS
REMOTE	Not Allowed	Allowed	Allowed
AUTONOMOUS	Not Allowed	Allowed	Allowed

- If the HUP CONTROL DISTANCE is changed to zero, then a HUP CONTROL TYPE must also be set to AUTONOMOUS.

5.2 Order SET SMALL BOAT PARAMETER

The SB OPERATIONAL DEPTH and SB NOISE fields will be added to the Set Small Boat Parameter order template.

5.3 Order HRU Task

The two new HRU Tasks, “Lay Mines” and “Clear Mines” will be added to the HRU TASK Order as described in Section 3.7.

6.0 JODA Changes

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

7.0 Test Plan

This is a large and fairly detailed ECP. It is expected that these tests will take some time.

7.1 Check Basic UV Capabilities

Purpose: The purpose of this test is to ensure that all three types of UVs can be created and used to execute the existing HRUs.

Step 1: Create a database that has the following UVs as part of the initialization database.

a. A ULV that is created from a Ground Unit and should arrive at the parent unit’s location. Call this HRU A.

b. A UUV that is created from a Ground Unit and should arrive in the water at a location other than the parent’s location. Call this HRU B.

c. A USV that is created from a Naval Unit and should arrive in the water at a location other than the parent's location. Call this HRU C.

d. A ULV that is created from a Naval Unit and should arrive at the parent's location. Call this HRU D.

Expected Results: All four HRUs should be created. HRU D should start the game out in coalition support to its parent Naval Unit

Step 2: Give HRU A, the following tasks and make sure that it executes each task. If the HRU dies, simply create a new HRU of the same type and continue the tests.

a. Move

b. Patrol

c. Raid an object

d. Civil Military Operations

e. Overwatch

f. Traffic Control

Expected Results: Each task should execute without incident.

Step 3: Give HRU B an order to go into Coalition Support with a Naval Unit.

Expected Results: HRU B should move to the Naval Unit and go into coalition support.

Step 4: Given HRU B an order to Rejoin the Naval Unit selected for coalition support.

Expected Results: HRU B should rejoin the Naval Unit and be removed from the game. Ensure that all of HRU B's assets are now owned by the Naval Unit.

Step 5: Create another HRU B, call this HRU B2 from the same Naval Unit.

Expected Results: HRU B2 should be created.

7.2 Test Control Range For UVs

Purpose: The purpose of this test is to ensure that REMOTE Controlled UVs stay within their database specified Control Range.

Step 1: Create a ULV from a Ground Unit. Use a HUP that is labeled as a REMOTE Control type. Call this HRU E.

Step 2: Note the HUP specified control distance.

Step 3: Give HRU E a move order that will take it twice its control distance away from its parent.

Expected Results: The HRU should move to a position just short of its HUP CONTROL DISTANCE,

Step 4: Using the HRU Task Order, give HRU E another move order to bring it half way back to its parent unit.

Step 5: Using the Manage HRU Task Order, cancel HRU E' Ground Wait Task and its old Move Task.

Expected Results: HRU E should move to its newly assigned location and stop.

Step 6: Give HRU E another Move Task to again take it twice the distance away from its Parent Unit.

Step 7: Take a Running Checkpoint. This is called Checkpoint 0002.

Step 8: At the same time give HRU E's Parent Unit a Move order in the same direction as the ULV is heading.

Expected Results: HRU E should make it to its designated move location.

Step 9: Take a Stop Checkpoint. This is called Checkpoint 0003.

Step 10:Restart the game from Checkpoint 0002. Do not push orders.

Step 11:This time give HRU E's Parent Unit a Move order in the opposite direction the ULV is heading.

Expected Results: When the distance between the Parent Unit and HRU E is just short of the Control Distance, HRU E should stop, generate a WHIP Alert, and be given a Ground Wait task.

Step 12:Using the Manage HRU Task order, clear HRU E of all tasks.

Step 13:Magic Move HRU E to a location that it is half its control distance from its Parent Unit.

Step 14:Given HRU E a Patrol polygon order that coverts an area that is both within the Control Distance and outside of the control distance.

Expected Results: The HRU should patrol the area. It should never enter the part of the polygon that is outside the control distance from its parent unit.

Step 15: Have HRU E's parent unit move 1/4 of its control distance away from the HRU Patrol Polygon.

Expected Results: HRU E should continue to patrol, but more of the assigned patrol polygon will not get used.

Step 16: Create a USV HRU, call this HRU F.

Step 17: Repeat Steps 2 through 6.

Expected Results: The result should be the same as those experienced for HRU E.

Step 18: Repeat Steps 12 through 15.

Expected Results: The result should be the same as those experienced for HRU E.

7.3 Test UUV and USV Detection Capability

Purpose: The purpose of this test is to ensure that a UUV is submerged and cannot be seen by overhead assets and that all other detection modes are properly working.

Step 1: Given HRU B2 and HRU C the exact same patrol polygons.

Step 2: Have the Controller set the Detection Multiplier for the Small Boat owned by HRU B2 and the Small Boat owned by HRU C to 10.0. This should ensure detection.

Step 3: Send an Reconnaissance mission with Imagery / Observed Type Sensor to the patrol area.

Expected Results: HRU C should be detected, but HRU B2 should not be detected.

Step 4: Move HRU B2 into shallow water. The water should be shallower than HRU B2's SB OPERATIONAL DEPTH. Alternatively, using the Controller order, change the depth of several grids around HRU B2.

Expected Results: When HRU B2 enters a shallow grid, it should be detected.

Step 5: Magic Move HRU B2 to a deep water area with no ships close by.

Step 6: Using Controller Orders make sure that the Small Boat being used by HRU B2 and HRU C makes significant noise and has a positive PK from an opposing force Targetable Weapon normally carried by an opposing force aircraft. If not, alter the data to ensure the detection and kills that are about to happen will work.

Step 7: Have HRU B2 patrol the area again.

Step 8: Take a running checkpoint. This should be checkpoint 0004.

Step 9: Send an ASW Patrol Air Mission with only Passive Sonar on board to patrol a polygon. Do not give it ROE.

Expected Results: All Controller Orders needed should work as expected. Shortly after the mission starts to patrol, HRU B2 should be detected.

Step 10:Have the opposing force give positive ROE to the ASW Patrol mission.

Expected Results: The Air Mission should kill HRU B2 and remove it from the game.

Step 11:Take a Stop Checkpoint. This should be checkpoint 0005.

Step 12:Restart the game from Checkpoint 0004. Do not push orders.

Step 13:Select an HRU B2 opposing force squadron that can conduct ASW, and give the squadron positive ROE against HRU B2's Force Side.

Step 14:Send a different ASW Patrol Air Mission with only Active Sonars on board to the same area, Give it a Target Type List of the Small Boat Type being used by HRU B2.

Expected Results: Shortly after the ASW mission starts to patrol, HRU B2 should be detected and killed.

Step 15:Cancel the ASW Patrol mission.

Step 16:After it has completely left the area, Magic Move HRU C into the same area and have it start to patrol.

Step 17:Take a running checkpoint. This is checkpoint 0006.

Step 18:Send another opposing force ASW aircraft to the area with only passive sonar. Keep this aircraft out of Visual Range of HRU C.

Expected Results: HRU C should be detected shortly after the passive sonar covers HRU C.

Step 19:Take a Stop Checkpoint. This should be checkpoint 0007.

Step 20:Restart the game from Checkpoint 0006. Do not push orders.

Step 21:Send another opposing force ASW aircraft to the area with only active sonar. Keep this aircraft out of Visual Range of HRU C.

Expected Results: HRU C should be detected shortly after the active sonar covers HRU C.

7.4 Test Transition From Feet Wet to Feet Dry

Purpose: The purpose of this test is to ensure that an HRU with Small Boats can properly transition between land and water operations and movement.

Step 1: Select an Unmanned HUP that uses a Small Boat that has an Agility Type that allows it to cross shore lines.

Step 2: Using the Controller Order change the speed of the Small Boat to a fast speed. The faster you make the speed, the easier it will be to see the difference in movement speed for the HRU. Don't make it so fast that the HRU become uncontrollable from a WHIP. Make sure you set the speed of the Small Boat and not the Combat System that represents the Small Boat

Step 3: Using Figure 1 as a guide, set up each of the five situations described in that Figure and in Table 7.

Expected Results: While in a "Feet Dry" situation, the HRU should move at its HUP ground speed. When in a "Feet Wet" situation, the HRU should move using its SB SPEED.

7.5 Check HUP LOITERING MUNITION FLAG Operations

Purpose: The purpose of this test is to ensure that the HUP LOITERING MUNITIONS FLAG capability is fully and properly implemented.

Step 1: Create a database with the following two HUPs.

a. HUP L1 should be a loitering munitions unmanned vehicle. It should be represented as a UUV and own a Torpedo SSM Target

b. HUP L2 should be a loitering munitions unmanned vehicle. It should be represented as a ULV and own a Combat System that can fire an Explicit Targetable Weapon.

Step 2: Start the game with this database.

Step 3: Create HRU L1 that uses HUP L1.

Step 4: Create HRU L2 that uses HUP L2.

Step 5: Create HRU L2A that uses HUP L2.

Step 6: Create HRU L2B that uses HUP L2.

Step 7: Send HRU L1 out to see and place it close to an opposing force ship.

Step 8: Give HRU L1 a Fire Missile Order against the opposing force ship.

Expected Results: The Torpedo should fire and HRU L1 should be removed from the game.

Step 9: Given HRU L2 a Raid order against an opposing force unit.

Expected Results: HRU L2 should move to the object, attack the object and then be removed from the game.

Step 10:Select another opposing force unit and give is a SOF Alert order.

Step 11:Look at all of the Explicit TW Combat systems that the opposing force unit owns and using Controller orders, set the Probability of Hit and Probability of Kill against HRU L2A's Critical Combat System to 1.0.

Step 12:Given HRU L2A a Raid order against the opposing force unit.

Expected Results: HRU L2A should be destroyed and not do any damage to the selected opposing unit.

Step 13:Given HRU L2B an Ambush Order next to a road where opposing force convoys travel. Give it a Target Types List for the convoy truck assets.

Step 14:Wait for a convoy to come by.

Expected Results: HRU L2B should ambush the convoy and then be removed from the game.

7.6 Test The New Destruction Rules For HRUs

Purpose: The purpose of this test is to ensure that the HRU destruction rules are properly implemented for both manned and unmanned HRUs.

Step 1: Select three different HUPs that exist in the database. If necessary, use Controller Orders, to alter the three HUPs so they have the following characteristics:

a. HUP X1 should be a manned HUP

b. HUP X2 should be an unmanned HUP with a Truck Combat System that has at least three of the trucks and the Truck should be listed as HUP CRITICAL COMBAT SYSTEM. The HUP should not have a HUP ORGANIC SMALL BOAT.

c. HUP X3 should be an unmanned HUP with a HUP ORGANIC SMALL BOAT and a Combat System that represents the Small Boat. The HUP CRITICAL COMBAT SYSTEM should point to that Combat System

d. HUP X4 should be an unmanned HUP with a HUP ORGANIC SMALL BOAT and a Combat System that represents the Small Boat. In addition the HUP should have a Weapon Combat System and two of these Weapon Combat Systems in its equipment list. The HUP CRITICAL COMBAT SYSTEM should point to the Weapon Combat System.

Step 2: Create the following HRUs

a. HRU X1 using HUP X1

b. HRU X2 using HUP X2

c. HRU X3 using HUP X3

d. HRU X4 using HUP X4

e. HRU X5 using HUP X4

Expected Results: The HUP changes should be executed as expected and the HRUs should be created.

Step 3: Using a Controller Order, decrease the number of personnel combat systems in HRU X1 by 1.

Expected Results: The HRU weighted strength should be reduced.

Step 4: Using a Controller Order, remove all combat systems are not personnel.

Expected Results: The HRU weighted strength should be reduced.

Step 5: Using a Controller Order, give some of the combat systems are not personnel back to HRU X1.

Expected Results: The HRU weighted strength should be increased.

Step 6: Using a Controller Order, remove all personnel combat systems from HRU X1.

Expected Results: HRU X1 should be killed and removed from the game.

Step 7: Using a Controller Order, decrease the number of truck combat systems in HRU X2 by 1.

Expected Results: The HRU weighted strength should be reduced.

Step 8: Using a Controller Order, remove all combat systems that are not trucks from HRU X2.

Expected Results: The HRU weighted strength should be reduced.

Step 9: Using a Controller Order, give some of the combat systems are not trucks back to HRU X2.

Expected Results: The HRU weighted strength should be increased.

Step 10:Using a Controller Order, remove all truck combat systems from HRU X2.

Expected Results: HRU X2 should be killed and removed from the game.

Step 11:Send an Attack Mission from an opposing side and tell the mission to aim at a Target Type Group that includes the Small Boat used by X3.

Expected Results: The Air Mission should fire on the HRU, kill the boat and the HRU X3 should be killed and removed from the game.

Step 12:Make sure X4 is on the water. Magic Move it if necessary.

Step 13:Using a Controller Order, decrease the number of truck combat systems in HRU X4 by 1.

Expected Results: The HRU weighted strength should be reduced.

Step 14:Send an Attack Mission from an opposing side and tell the mission to aim at a Target Type Group that includes the Small Boat used by X4.

Expected Results: The Air Mission should fire on the HRU, kill the boat and the HRU X4 should be killed and removed from the game.

Step 15:Make sure X5 is on the land. Magic Move it if necessary

Step 16:Using a Controller Order, decrease the number of truck combat systems in HRU X5 by 1.

Expected Results: The HRU weighted strength should be reduced.

Step 17:Send an Attack Mission from an opposing side and tell the mission to aim at a Target Type Group that includes the Small Boat used by X5.

Expected Results: The Air Mission should fire on the HRU, kill the boat. HRU X5 should remain in the game.

Step 18:Using a Controller Order, decrease the number of truck combat systems in HRU X5 by zero.

Expected Results: X5 should be killed and removed from the game,