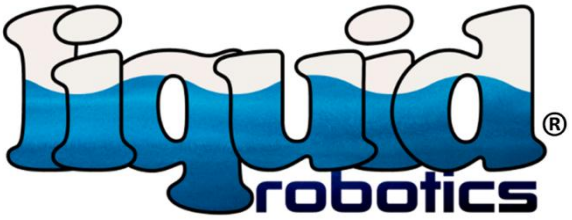

Model 08 Wave Glider™

User Manual

Version 2.5

(Through WGMS Release 3.7.2)

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REVISION HISTORY

Rev	Changes	WGMS	Author(s)
1.00	Initial Production Release		FJ
1.10	Update Chapt 5. Create Chapt 6 from Chapt 5.		FJ
1.20	Various local revisions. Delete Chapt 11		FJ
1.21	Removed Eurostile font. Hyperion→WGMS		FJ
1.22	Added Appendix A: Specifications.		GH
2.00	Removed Chapts 7, 8, 9. Add DB3. Updated Notes.		FJ
2.10	Updates to Appendix A. XBee command updates.		GH, FJ
2.20	Add ™. Mod figures for updated UI	3.5.1	FJ
2.30	Revisions to section 5.1. Mod part #. Add WGMS vers # Update dwgs and text for WGMS v3.6.1	3.6.1	FJ,GH,RO
2.40	New Roles. Update dwgs/text for WGMS v3.7.1. Add XBee Relay config.	3.7.1	FJ, EP
2.41	Updated specifications to reflect Revised Drybox. Added water speed performance chart	3.7.2	GH
2.5	Updated Layout	3.7.2	JS

TRADEMARKS

PATENTS & INVENTIONS

The Wave Glider mechanism is patented under US Patent Number 7,371,136 and other patents pending. All aspects of the Wave Glider product have been developed at private expense by Liquid Robotics, Inc.

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Table of Contents

Figures and Tables

Chapter 1 – Wave Glider Introduction

This chapter describes the main features of Liquid Robotics Inc. (LRI) Wave Glider Vehicle system.

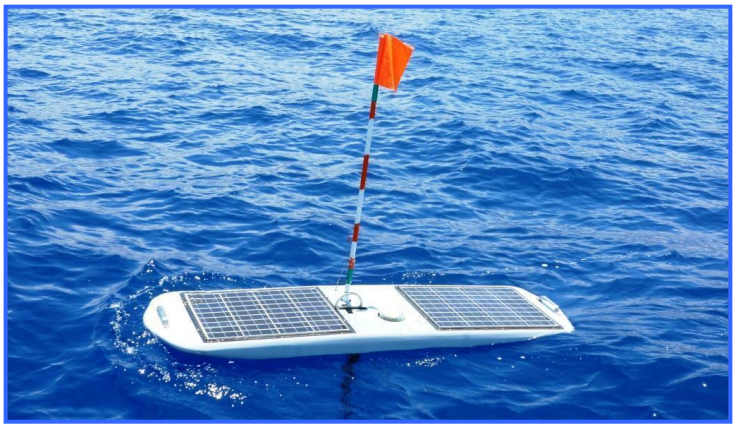


Figure 1-1: The Wave Glider Vehicle

1.1 Basic Configuration

The Wave Glider "Vehicle" is composed of two main parts, connected by a flexible tether. Figure 1-2 shows the basic configuration.

The **Float** rides on the surface of the water.

The **Glider** (also called the **Sub**) stays submerged below and slightly ahead of the Float.

A long, flexible, high-strength **Umbilical** connects the Float to the Glider.

The actual length of the Umbilical is longer than shown in the Figure.

During operation, the Glider provides the thrust that pulls the Float through the water. Operation is explained in section 1.5 “Propulsion Method".

Figure 1-2: Wave Glider Vehicle Main Parts

1.2 Surface Float

1.2.1 Float External Features

The Float is based on a fiberglass composite hull. Figure 1-3 below shows the names of the Float's main external features.

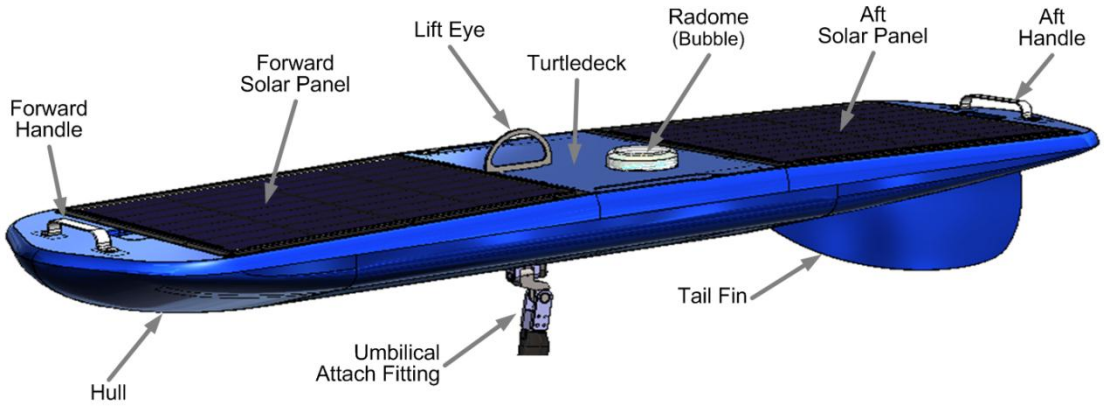


Figure 1-3: Surface Float External Features

1.2.2 Float Main Components

The exploded drawing below shows the main components of the Float. Note that the forward and aft Payload Bays are not the same shape or depth, and thus the forward and aft Payload Dryboxes are different. The Solar Panels are identical and interchangeable.

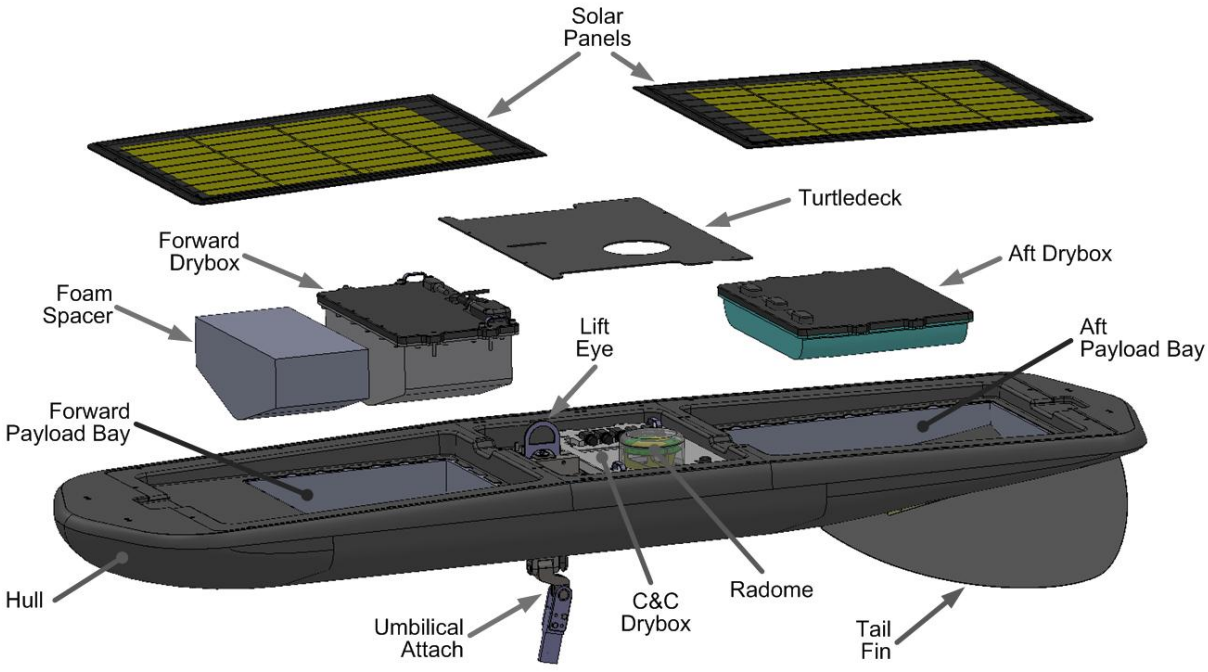


Figure 1-4: Float Basic Components

1.2.3 Command and Control Drybox

The center "C&C Drybox" contains the primary control electronics for the Wave Glider. It also contains batteries to provide power when the Solar Panels cannot.

On the top are electrical connectors for the Solar Panels, Umbilical, Payload Dryboxes, and other optional functions.

There are two models of the C&C Drybox. The original model has seven electrical connectors mounted along one edge. The revised model has ten connectors on both edges, and also uses an insertion key for powering on the system.

Both models are identical in size; the primary difference is the top lid.

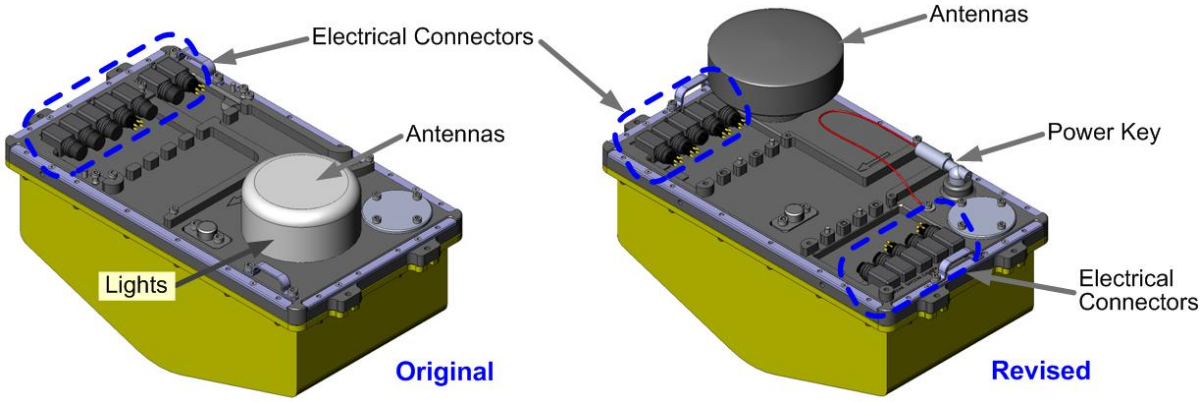


Figure 1-5: Original and Revised C&C Dryboxes

1.2.4 Fore and Aft Payload Dryboxes

The Float contains fore and aft payload bays where optional dryboxes can be installed that contain customer-supplied electronics. The standard drybox configurations are shown below.

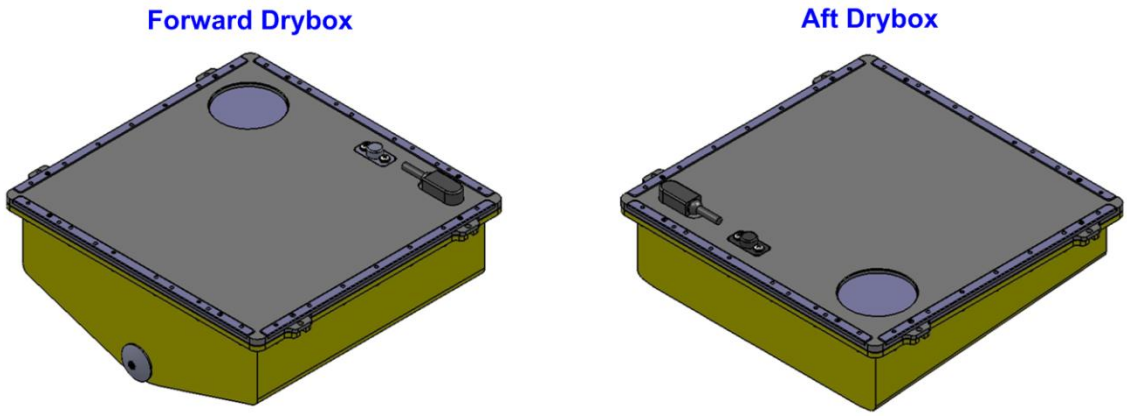


Figure 1-6: Fore/Aft Float Payload Dryboxes

Note that the types and locations of the connectors on the top of the Payload Dryboxes will vary depending upon the payloads and their connections to the C&C Drybox or other external equipment (sensors, antennas, etc.).

1.3 Submerged Glider

1.3.1 Glider Components

The basic components of the Glider (Sub) are shown in Figure 1-7.

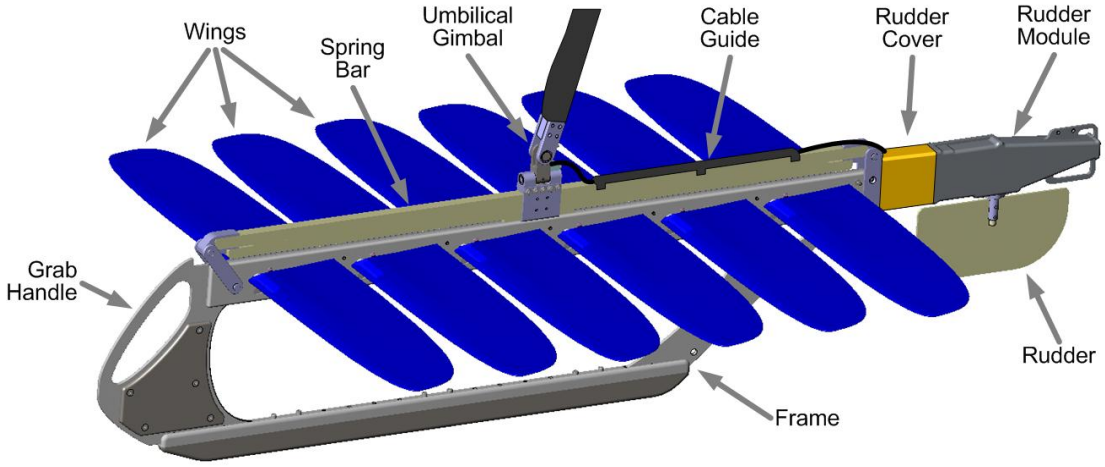


Figure 1-7: Glider (Sub) Basic Components

1.3.2 Glider Payloads

Payloads can be attached to the Glider in various ways. One possible payload carry is shown in Figure 1-8. Note the electrical connection between the payload and the Rudder Module. Payloads can receive electrical power through the Umbilical connection.

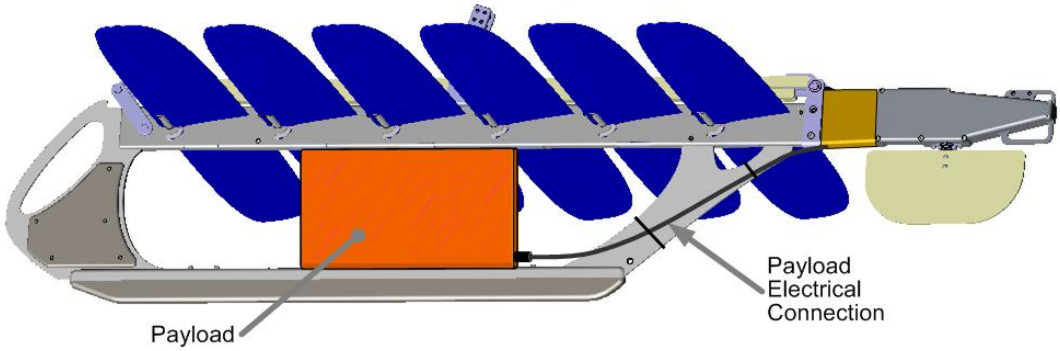


Figure 1-8: Glider With Example Payload

Other types of payloads may be carried on the Glider. Refer to the *Interface Control Description* document for more information.

1.4 Float-to-Glider Umbilical

The Umbilical is a key component in the Wave Glider Vehicle. It must be strong, flexible and streamlined. It also contains electrical wires that control the rudder movement and supply power to both the rudder motor and (optionally) any payload attached to the Glider.

1.4.1 Umbilical Components

Figure 1-9 below shows the basic components of the Umbilical. Note that there are electrical connectors at each end to provide power and control to the Rudder (and optional payloads).

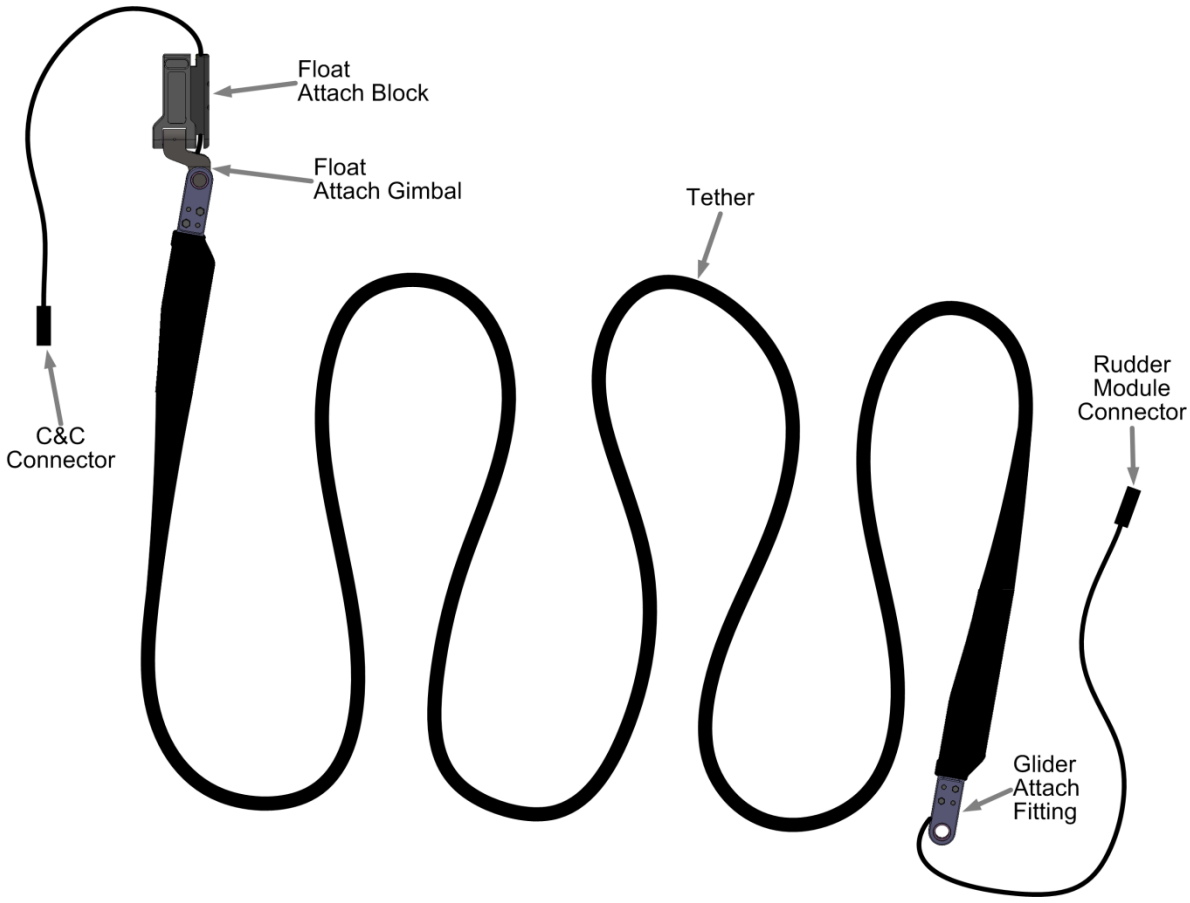


Figure 1-9: Umbilical Components

1.4.2 Umbilical Attachment

Although shown as a separate component in the figure above, the Umbilical is attached to the Glider (Sub) at the factory (the Rudder Module cable is also routed and connected). Thus, assembly of the Umbilical only requires connecting to the Float.

Umbilical attachment to the Float is via the Float Attach Block that engages a quick-connect (and release) mechanism on the Float.

1.5 Propulsion Method

The Wave Glider derives its propulsion from the rise and fall of surface waves.

1.5.1 Wing Action

The wings are spring-loaded to a neutral position. However they are free to pivot, depending upon the motion of the water relative to the Glider.

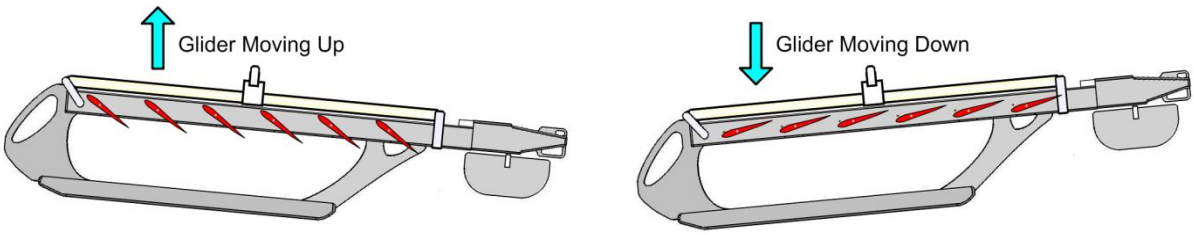


Figure 1-10: Glider Wing Motion

1.5.2 Wave Propulsion

The vertical wave motion is only near the surface of the water; well below the surface there is essentially no vertical water movement. Thus, the Float rising and falling alternately pulls up on the Glider, or lets it sink down due to its weight.

The motion and hydrodynamics of the Glider's wings thus provides forward propulsion regardless of whether the Glider is moving up or down.

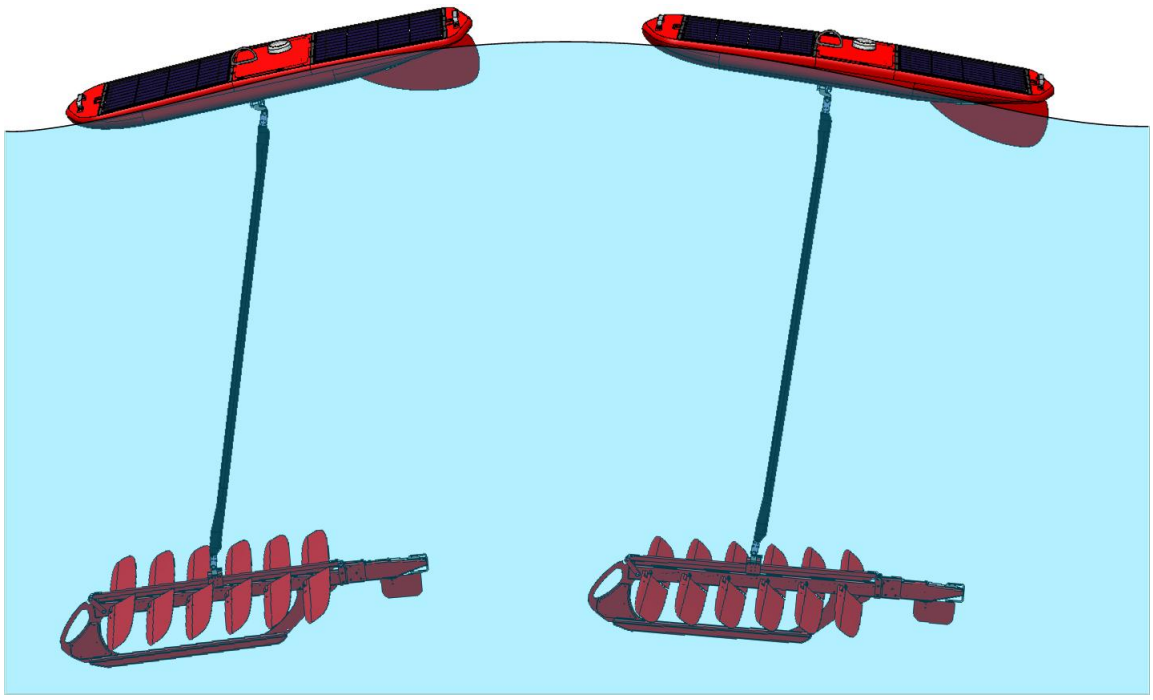


Figure 1-11: Propulsion Using Rising and Falling Wave Motion

1.5.3 Directional Control

Directional control is accomplished with a rudder on the Glider, which is controlled and powered by electrical wires through the Umbilical. The Float has a stabilizing Tail Fin, but no direct control of direction.

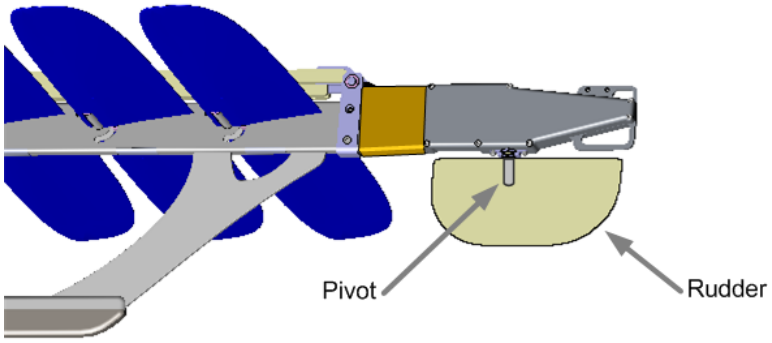


Figure 1-12: Glider Rudder Detail

1.6 Electronics

1.6.1 Control Electronics

The primary control electronics are contained in the center Command & Control Drybox, described in 1.2.3. As shown in the general schematic below, all electrical signals connect to the C&C Drybox, including the communication antennas, described in following sections.

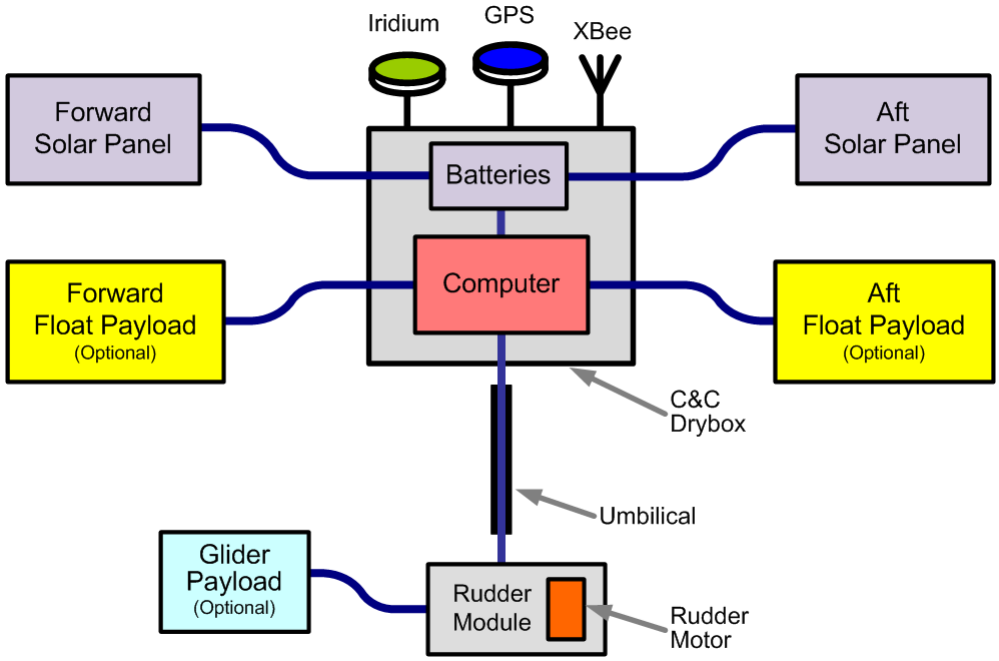


Figure 1-13: Basic Electrical Schematic

1.6.2 GPS Satellite Localization

The Wave Glider computer constantly updates the Vehicle position using signals received from the Global Positioning System satellite constellation.

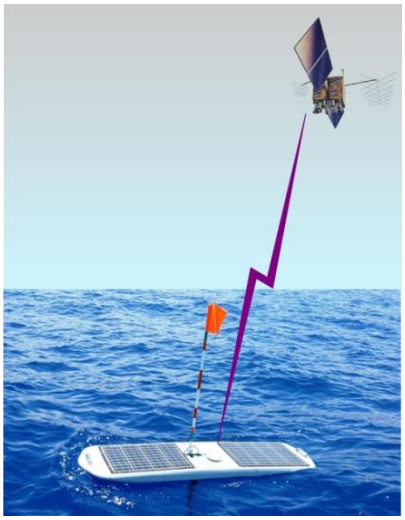


Figure 1-14: Vehicle Location Using GPS Satellites

The GPS also provides an accurate time reference for the Vehicle.

1.6.3 Iridium Satellite Datalink

The Wave Glider computer is remotely linked to the Internet through the Iridium satellite system, as shown in the figure below. This allows anyone with a fixed or mobile Web interface to communicate with and control the Wave Glider, regardless of location.

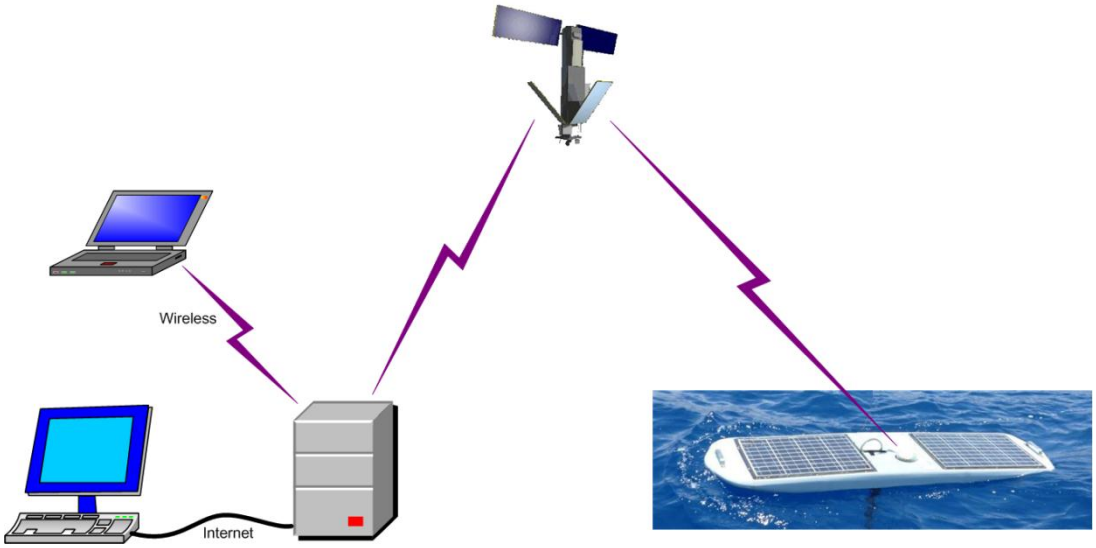


Figure 1-15: Web-Iridium-Vehicle Communications

The Iridium interface uses the Liquid Robotics Wave Glider Management System (WGMS) software, described briefly below in section 1.7 and in detail in Chapter 2.

1.6.4 XBee Communications

An XBee radio link can be used for short-range (less than 100 meter) communications to and from the Vehicle. The XBee link is primarily intended to assist in Vehicle preparation, launch and retrieval. However, XBee is also useful for testing during payload development and integration.

Figure 1-16: Ship-to-Vehicle XBee Communications

XBee commands and communications operate differently than the Graphical User Interface. Refer to Chapter 3 for a detail description of the XBee commands.

1.7 Wave Glider Management System

The Wave Glider Management System (WGMS) Web-based interface is the primary means of communicating with and controlling the Wave Glider. It also manages a database of all communications to and from the Vehicle.

1.7.1 WGMS Home Page

The overall appearance of the home page screen is shown below.

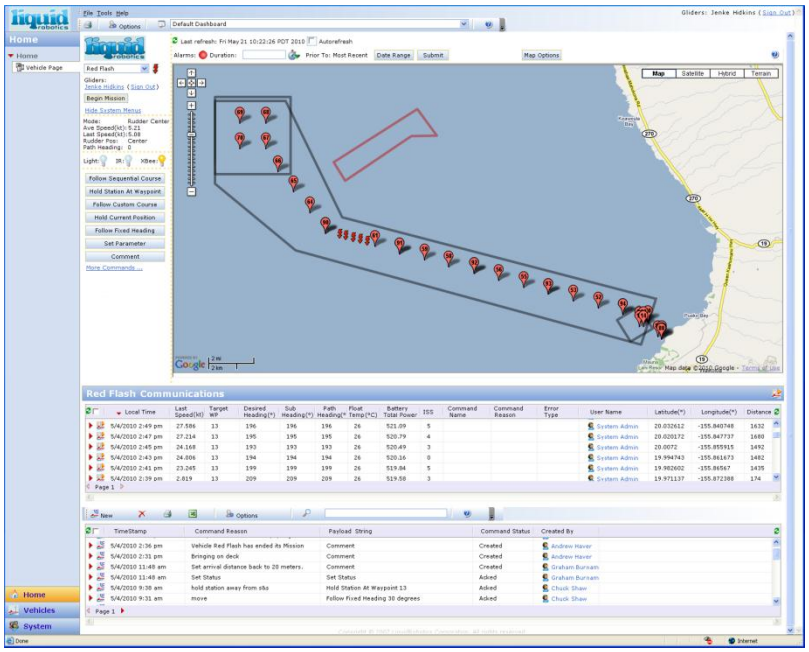


Figure 1-17: WGMS Home Page Screen

A detailed description of the WGMS User Interface is given in Chapter 2. Additional explanations of its use are given in Chapter 4, Chapter 5 and Chapter 6.

1.7.2 Primary Definitions

The WGMS and Wave Glider systems embody many concepts. The most fundamental definitions are:

Vehicle: Refers to a Wave Glider combined Float + Umbilical + Glider.

Organization: A company or other entity that owns or operates one or more Vehicles.

Course: The path a Vehicle is to follow.

Waypoints: Numbered (and named) geographical locations used to define the Course. Each Vehicle has its own set of Waypoints.

Mission: A planned event involving the use of one or more Vehicles.

Command: An instruction sent to the Vehicle to perform a certain action. [See note below]

Telemetry: Data sent back from the Vehicle, usually at periodic intervals.

Alarm: Indicates that an error has occurred on the Vehicle or in the software.

Note: Data in the "Comment" command is stored in the WGMS database, but is not sent to the Vehicle.

A complete Glossary of terms is given in Chapter 8.

Chapter 2 – WGMS User Interface

The Liquid Robotics WGMS software has a graphical interface to the Wave Glider system. WGMS uses the Internet World-Wide-Web to communicate to the Vehicle via Iridium satellites.

2.1 Dashboard Overview

The Home Page of the WGMS is called the "Dashboard". Shown below is an annotated image of an example Dashboard.

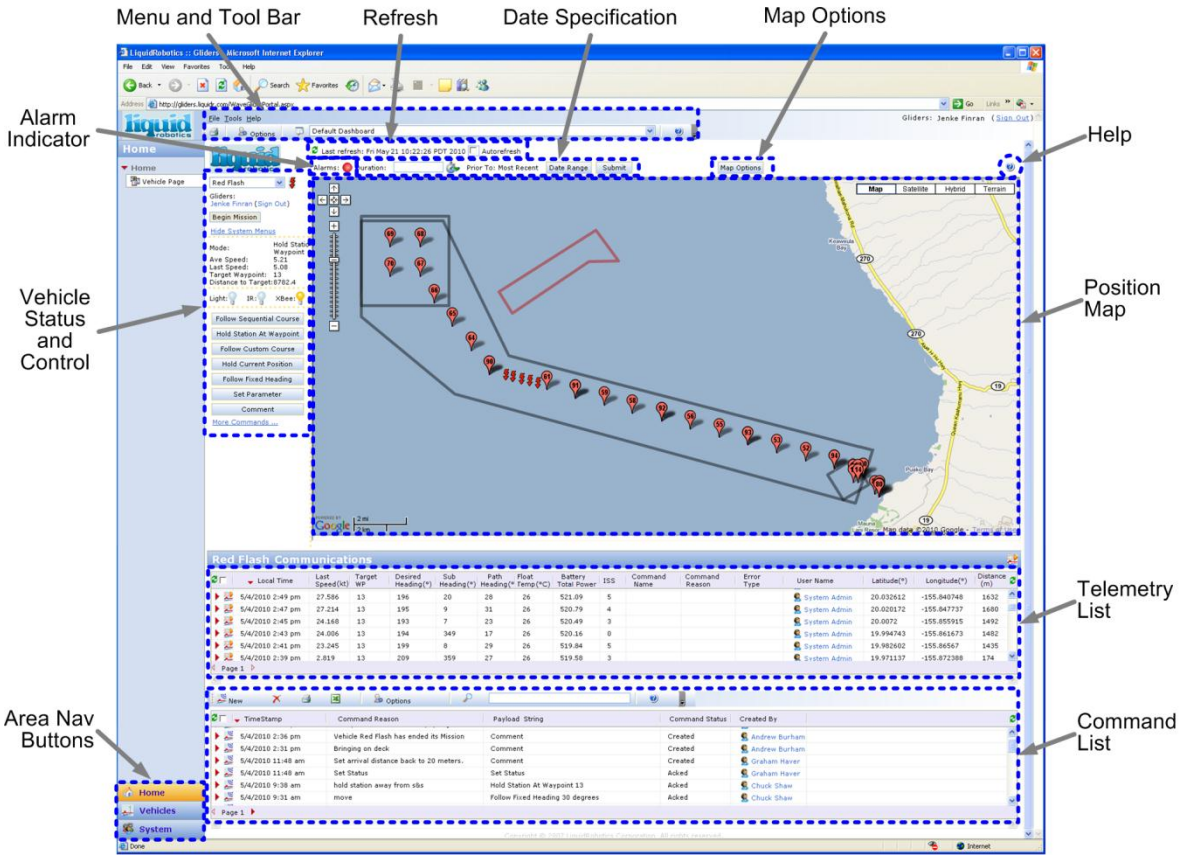


Figure 2-1: Dashboard Main Features

The main features of the Dashboard are:

Alarm Indicator: Indicates if one or more alarms are currently active. (Ref. 2.5.1)

Area Nav Buttons: Used to select one of the three basic Dashboard pages. (Ref. 2.8.1)

Command List: Shows command and comment data sent to the specified Vehicle. (Ref. 2.6.2)

Date Specification: Changes the time and date of all the displayed data. (Ref. 2.5.3)

Help: Clicking on icon calls up help screen. (Ref. 2.3.8)

Map Options: Used to change the Position Map's default values. (Ref. 2.5.5)

Refresh: Manually or automatically updates the Position Map and its Options. (Ref. 2.5.4)

Menu and Tool Bar: Menu and presentation selections. (Ref. 2.8.2)

Position Map: Displays a scalable map of a Vehicle's operating area. (Ref. 2.4)

Telemetry List: Shows the most recent data returned from the specified Vehicle. (Ref. 2.6.1)

Vehicle Status and Control: Specifies the Vehicle to be displayed. For that Vehicle, shows a summary of its status. Also used to issue commands to the Vehicle. (Ref. 2.7)

2.2 Accessing the Dashboard

To use the on-line Dashboard, you must have been assigned access rights and privileges by your Organization's System Administrator.

2.2.1 System Administrator

The System Administrator ("Sys Admin") is someone at your Organization who has access to all the WGMS program settings and features, including some privileges not available to any other users.

A Sys Admin is the person to contact in the event that you have problems with the system, or if you need to do some special task.

2.2.2 Getting Access

Your Sys Admin will set up an account for you, give you the URL address for signing on, and assign an initial password. The Sys Admin will also assign you an appropriate Role, as described below.

2.2.3 Roles

All Users of the WGMS system are assigned "Roles", that specify what features they have access to, and what things they can control.

The Roles are:

Guest User: Can only view certain data on certain Vehicles, and cannot modify anything.

Data Analyst: Can look at existing Vehicle and WGMS data and can download selected database information.

Master: Manages Vehicle provisioning, mission planning and operations, as well as payload and Web Services development.

Admin: A System Administrator who has all the permissions required to handle the day-to-day administration of the WGMS, add users, manage customizations, and deal with data.

The Roles privileges are transparent to you; the screen will only display the features that are allowed for your assigned Role.

Certain features described in this document may not be displayed, or may not be operative on your screen. That is because you have been assigned a Role that doesn't allow access to, or control of, that feature.

More detailed information on Roles is provided in the LRI *Interface Control Description* and *System Administration* documents.

2.2.4 Signing-In

When you enter the Wave Glider URL in your browser, you should get a user Sign-In page that indicates your Organization name ("SGStride" in this example).

Figure 2-2: Initial Sign-In Dialog

Enter your email address and (case sensitive) password as shown in the example above. Then click the "Sign In" button.

If you make an error on the initial sign-in, you will get a sign-in page that includes a "Captcha" input, designed to prevent automated entry attacks. In addition to entering your email and password, you also need to enter in the two distorted character strings, in the order shown, matching the upper and lower case, with the strings separated by one or more blank spaces. (The characters can be letters, numbers or symbols.)

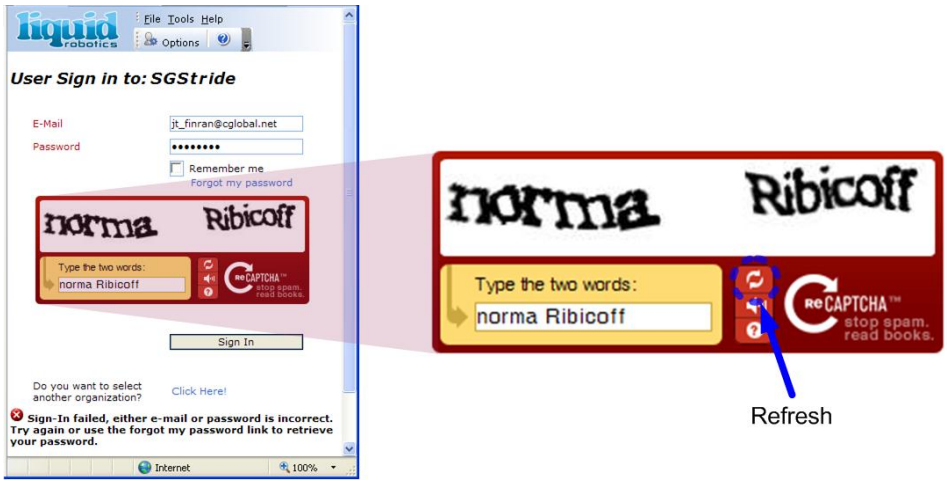


Figure 2-3: Error Sign-In with Detail.

Note: If you have trouble reading a string, click on the white "refresh" symbol to get different strings.

When you have entered the values, click the "Sign In" button and (after a few seconds) you should get the WGMS Home Page, described below.

2.2.5 Initial Home Page

After signing on, the initial WGMS Home Page should look something like Figure 2-4.

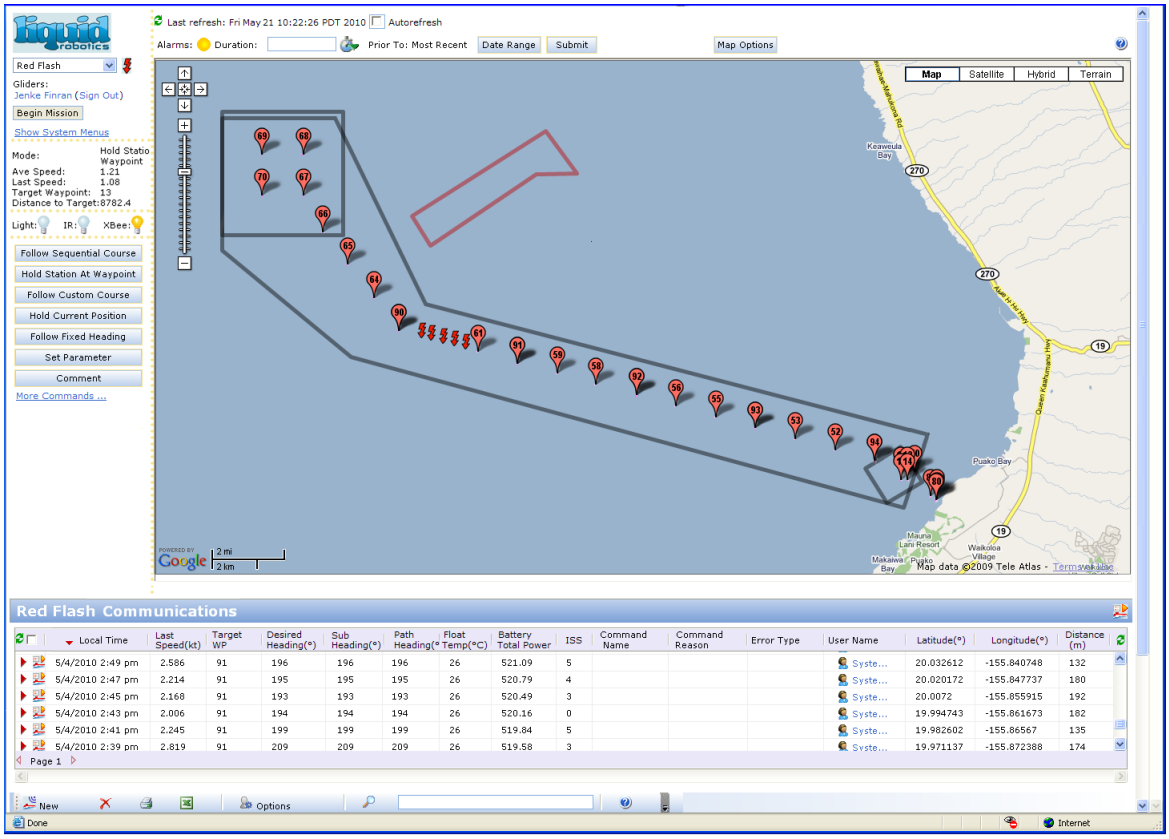


Figure 2-4: Initial Home Page Example

Unless you have a very-high resolution widescreen, you will not see the whole Home Page, and will need to use the scroll bars to move about.

Also, you will not see the Area Nav buttons (ref. 2.8) in the lower-left corner. If you want to show them, click on the Show System Menus link at the upper-left.

Note: If you appear to be getting a blank map, it has probably defaulted to full zoom-in and is thus showing you a very small patch of water or land. In this case, use the zoom bar on the upper-left to zoom out (note the position of the slider in the figure above.)

The sections below describe each of the main features of the Wave Glider Dashboard.

Depending upon your Organization and the particular Vehicle you are monitoring, the map and other data will be different than the examples shown, and the colors may be different. However, the interface features and their operation should be the same.

It is instructive to be connected online to the Dashboard while reading this chapter. This will allow you to try out some of the features described.

2.3 Using the WGMS Interface

The Wave Glider User Interface uses common terminology, symbols and protocols similar to those on Microsoft Explorer®. These are briefly reviewed here.

2.3.1 Icons

Icons are small pictograms, sometimes paired with a word indicating the icon type. Left-clicking on an icon initiates some action. An example below shows three icons.

Figure 2-5: Example Icons

In the example, the left icon (and "New" text) opens a new record. The "X" icon deletes selected items. The right icon (and "Copy To ..." text) copies selected items.

You can "mouse over" (place the cursor on top of the icon) and a description of the icon action will usually be displayed.

2.3.2 Buttons

Buttons are like icons in that they initiate an action. However, buttons are typically larger than icons and have text indicating their function. Typically, buttons are used in sets to select alternate actions. Shown below are three example buttons.

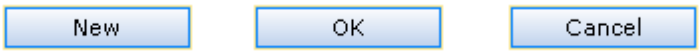


Figure 2-6: Example Buttons

2.3.3 Links

Links are references to other data displays. Links are indicated as blue, underlined text. A link that is commonly used on the Dashboard page is:

Figure 2-7: Example Link

2.3.4 Check Boxes

Check boxes are used to select or de-select an item (usually in a list of items). Clicking in an empty box will put a check in the box. Clicking a checked box will delete the check.

Figure 2-8: Example Checked and Unchecked Boxes

2.3.5 Single and Double Clicking

Typically, placing the cursor over an icon, button, or link and then single-clicking the left mouse button will initiate some action.

However, when selecting items from a list, you typically have to double-click on the text to call up a window or dialog box related to the data on that line.

2.3.6 Input Boxes

Input boxes are used to enter text strings, including numbers. The WGMS interface uses basically three types of input boxes.

The basic input box is designed for direct text entry. Click in the box, then enter the text. If the text is longer than the box, the text will move out the left side of the box. Use the "Home" or "End" keys to move to the beginning or end of the text string. The Figure below shows an Input Box for entering a telephone number

Figure 2-9: Example Basic Input Box

The second type is a Pulldown Selection Box, indicated by the down arrow (V) on the right side of the box. Text cannot be entered directly. Instead, click on the arrow. This creates a selection list. Click on the selection to make an entry into the box, as shown below.

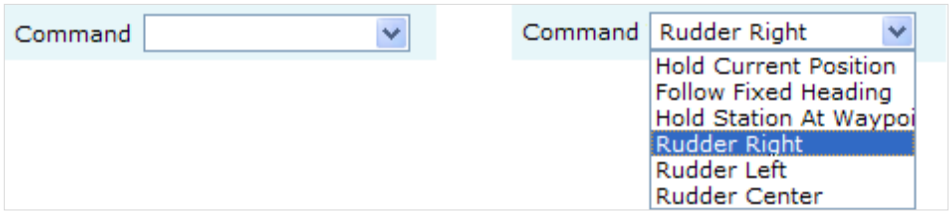


Figure 2-10: Example Pulldown Selection Box

The final type of Input Box has a "Click to select..." icon at the end of the box. Click on the icon and another window will open with a list of items to select. Highlight to select the item, close the new window, and the name or value will appear in the Input Box.

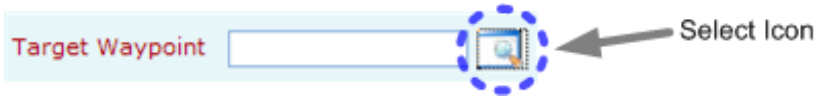


Figure 2-11: Example List Selection Box

Grayed-out text in the box indicates that the entry is predefined, and cannot be changed.
A non-White box background indicates that the box is "closed" and no data can be entered.

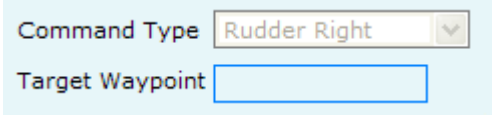


Figure 2-12: Example Predefined and No-Entry Input Boxes

2.3.7 Pages

A "Page" is a complete display that usually contains multiple displays and/or lists. The Wave Glider WGMS Interface has three main pages:

Home Page: The display page for a given Vehicle, also called the "Dashboard". Ref. 2.2.5

Vehicles Page: A page displaying all Vehicles, allowing selection. Ref. 2.9

Systems Page: A page displaying specialized system data. Ref. 2.10

Some common usage features of Pages are:

- Icons at the upper right allow minimizing, maximizing or closing the Page.
- The display size can be re-sized by placing the cursor over an edge or the lower-right corner. When an arrow appears, hold down the left mouse button and move the border.
- The green "Refresh" icon can be used to re-display a page to incorporate new data or changed display options.

Figure 2-13: Refresh Icon

2.3.8 Help Icon

The Help Icon is shown in Figure 2-14. Clicking on the icon will bring up reference information about the window or page on which the icon is located.

Figure 2-14: Help Icon

2.3.9 Page Select

Pages that contain lists of items can only display 25 items per page. At the bottom left of the page is the page number, with two "arrowheads" (triangles) on either side, such as:

Figure 2-15: Page Indicator

If the right triangle is solid (as in the example above), it means you can click on the triangle to go to the next page. If the left triangle is solid, you can click it to go to the previous page.

2.3.10 Dialog Boxes

Dialog boxes are windows that typically appear as the result of double-clicking on a name, or single-clicking on an icon or button.

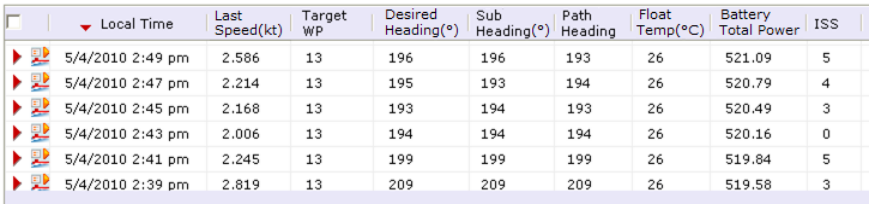
Some dialog boxes are simple confirmation requests (e.g., "Do you want to copy these 3 items"), but they can also be quite complex, with multiple icons, entry boxes, check boxes and buttons.

A typical characteristic of a dialog box is that it contains one or more buttons (such as "OK", "Save" and "Cancel") that are used to exit and close the box.

2.3.11 Sorting Lists

A universal feature of all the lists is that they can be sorted by clicking on the header name above the column you want to use for sorting. When done, a small Red triangle will appear in the header, indicating ascending (up-pointing) or descending (down-pointing) sorting based upon the column below. Single-click on the heading name to reverse the sorting direction.

Note that some lists have a default sorting order for one of the columns, such as the "Local Time" in the example Telemetry list shown below.

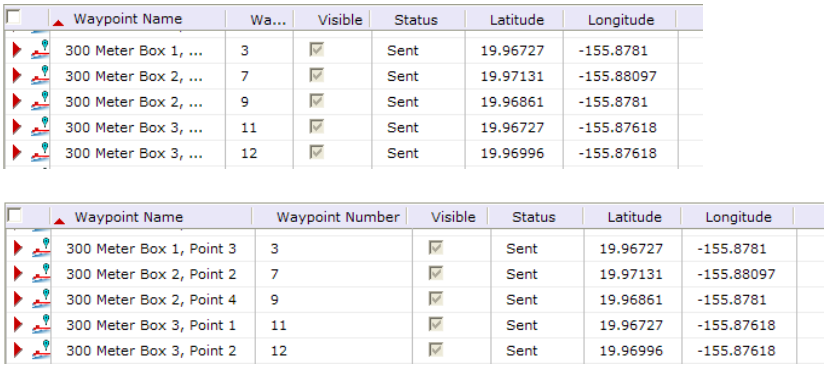


Local Time	Last Speed(kt)	Target WP	Desired Heading(°)	Sub Heading(°)	Path Heading	Float Temp(°C)	Battery Total Power	ISS
5/4/2010 2:49 pm	2.586	13	196	196	193	26	521.09	5
5/4/2010 2:47 pm	2.214	13	195	193	194	26	520.79	4
5/4/2010 2:45 pm	2.168	13	193	194	193	26	520.49	3
5/4/2010 2:43 pm	2.006	13	194	194	194	26	520.16	0
5/4/2010 2:41 pm	2.245	13	199	199	199	26	519.84	5
5/4/2010 2:39 pm	2.819	13	209	209	209	26	519.58	3

Figure 2-16: List Sorting Example

2.3.12 Changing Column Widths

On some lists, a column may be too narrow to display all of the text or data. In such cases, you can change the column width by placing the cursor over the separator bar in the header. The curser should change to a double bar with arrows (←ll→). Click and hold the left mouse button and move the separator bar left or right to adjust the column width.



Waypoint Name	Wa...	Visible	Status	Latitude	Longitude
300 Meter Box 1, ...	3	☑	Sent	19.96727	-155.8781
300 Meter Box 2, ...	7	☑	Sent	19.97131	-155.88097
300 Meter Box 2, ...	9	☑	Sent	19.96861	-155.8781
300 Meter Box 3, ...	11	☑	Sent	19.96727	-155.87618
300 Meter Box 3, ...	12	☑	Sent	19.96996	-155.87618

Waypoint Name	Waypoint Number	Visible	Status	Latitude	Longitude
300 Meter Box 1, Point 3	3	☑	Sent	19.96727	-155.8781
300 Meter Box 2, Point 2	7	☑	Sent	19.97131	-155.88097
300 Meter Box 2, Point 4	9	☑	Sent	19.96861	-155.8781
300 Meter Box 3, Point 1	11	☑	Sent	19.96727	-155.87618
300 Meter Box 3, Point 2	12	☑	Sent	19.96996	-155.87618

Figure 2-17: Original and Modified Column Widths

2.4 Using the Position Map

The position map is in the standard Google Map format, and can be manipulated using the same methods:

- Move the map around by placing the mouse cursor in the map image and holding down the left mouse button. When the cursor changes to a "hand" symbol, keep the left button pressed and "pull" the map around with the hand. You can also use the Nav Arrows on the upper left of the map.
- Zoom in or out using the scroll wheel on the mouse. You can also move the Zoom Control slider on the upper left of the map. The map's scale is shown in the lower-left corner.

Note: Without a very fast broadband connection, moving and scaling of the map can take several seconds. Use the move or scale in small increments, and then wait for the map to re-paint.

2.4.1 Position Map Display Features

An annotated Position Map image is shown in Figure 2-18, followed by basic explanations of the map display features.

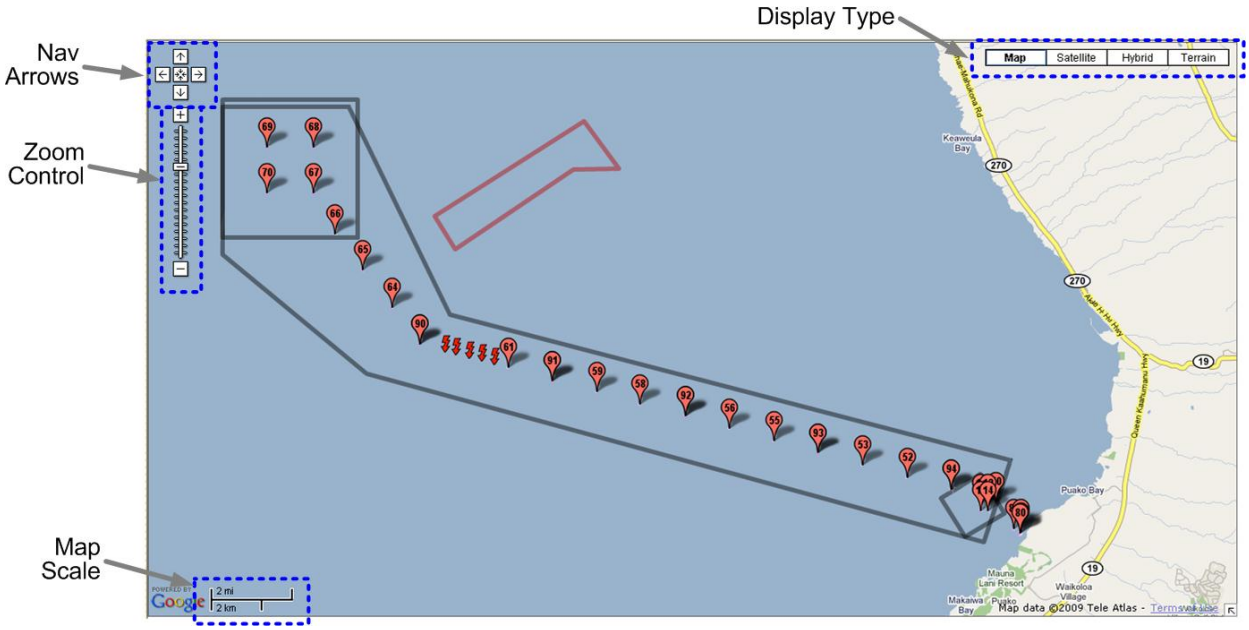


Figure 2-18: Position Map Display Features

Display Type: Selects different mapping formats.

Map – The standard line-drawn map, as shown above.

Satellite – Shows a photographic aerial view.

Hybrid – Overlays the Satellite view with roads and place names.

Terrain – Displays a 3-D terrain view overlaid with roads and place names.

Map Scale: Shows the distance scale of the map. Clicking on this will have no effect; the scale is adjusted using Zoom Control.

Navigation Arrows: Used to move the position of the map display. Clicking the center button moves the map back to the previous position.

Zoom Control: Used to change the scale of the map. Adjusted by moving the "slider". Up moves in; down moves out.

Note: You can also use a mouse scroll wheel to zoom in or out.

Note that when using any of the map controls described above, there is no need to click the Refresh icon. The display will refresh automatically.

2.4.2 Vehicle Symbols

As shown below, the WGMS uses various icons and other markings to indicate properties associated with the Vehicle displayed on the map.

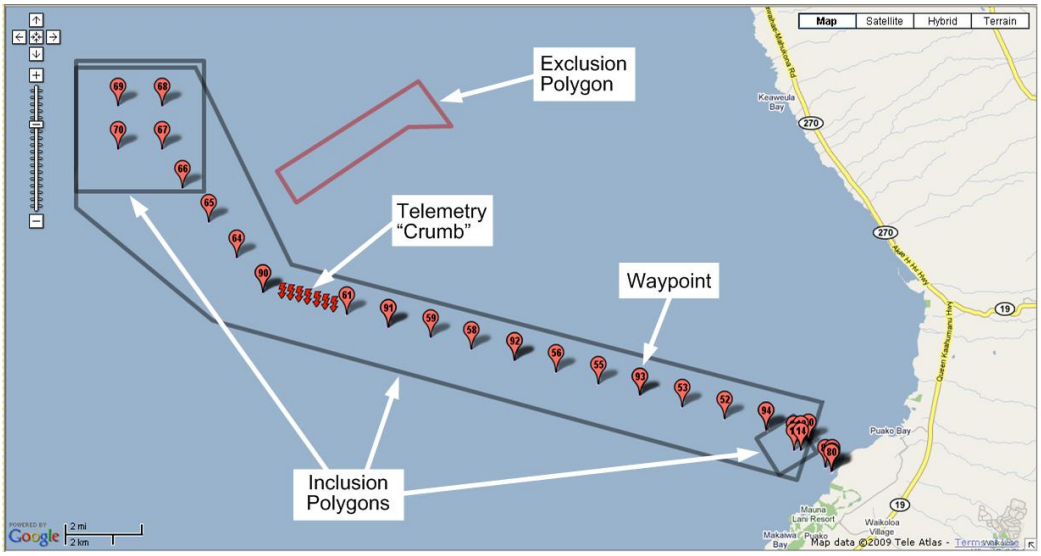


Figure 2-19: Position Map Vehicle Symbols

Arrival Distance: Indicates the "size" of a Waypoint. When the Vehicle is within the Arrival Distance from the Waypoint, it considers that it has reached that Waypoint. The Arrival Distance is too small to see at the map scale of Figure 2-19. Zooming in on a Waypoint will show a Purple circle that indicates the arrival distance, as shown below.

Figure 2-20: Arrival Distance Circle

Inclusion Polygon: Closed Gray polygons indicate an Inclusion Operation Polygon. If the Vehicle goes outside this boundary, it will trigger an "Out of Bounds" alarm.

Exclusion Polygon: Closed Red polygons indicate an Exclusion Operation Polygon. If the Vehicle goes inside this boundary, it will trigger an alarm.

Telemetry Crumb: The Vehicle icon displayed on the map indicates the position of the vehicle at each telemetry timepoint over a fixed period of time.

Waypoint: The bottom tip of a Waypoint icon indicates the Waypoint's location. Waypoints numbered 1 thru 99 are Red and show the Waypoint number inside. Waypoints with numbers 100 or greater use White icons and a dot instead of a number, as shown below.

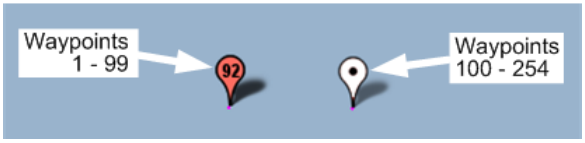


Figure 2-21: Red and White Waypoint Icons

2.4.3 Latitude and Longitude Representation

The WGMS software displays Latitude and Longitude numbers in two ways:

1) As degrees and decimal fractions of a degree (e.g., 19.98790). The sign of the value indicates the direction as follows:

   Latitude: Positive → **North** Negative → **South**
   Longitude: Positive → **East** Negative → **West**

2) As unit degrees and decimal minutes, with the direction indicated using an N, S, E or W character (e.g., 19 59.27438N).

In most cases, the first representation (signed degrees) will be used.

2.4.4 Clicking on Map Icons

Clicking on a Waypoint Icon will call up a description of that Waypoint, including the Vehicle name, the Waypoint number/name and the coordinates, as shown in Figure 2-22. This feature is particularly useful for changing the position of a Waypoint (ref. 5.4.2).

Figure 2-22: Waypoint Data Callout

In a similar way, clicking on a Vehicle icon (Telemetry Crumb) will call up information about the time, status and position of the Vehicle at the indicated point. Clicking on the name will bring up a dialog for editing data on the Vehicle.

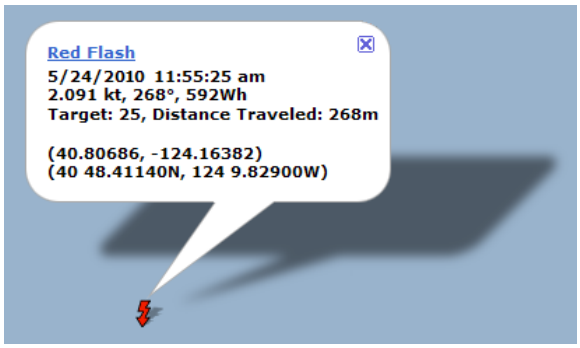


Figure 2-23: Vehicle Icon Telemetry Callout

2.5 Map Bar Features

2.5.1 The Map Bar

Above the Position Map is a bar that contains an indicator, an input box, buttons and icons, as shown in Figure 2-24.

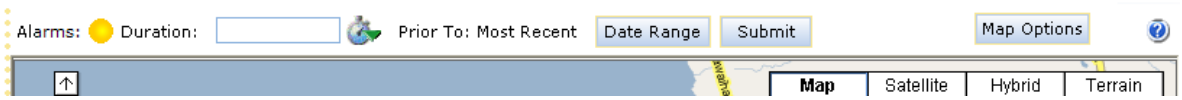


Figure 2-24: Default Map Bar

2.5.2 Alarms

On the left, the circular "indicator light" icon indicates if there are any alarms on the system. A Yellow icon indicates no active alarms. A Red icon indicates that one or more alarms are active on the Vehicle. Clicking on the Alarm Icon will show a list of all alarms, similar to:

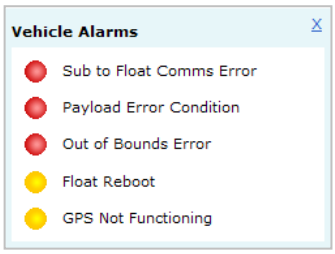


Figure 2-25: Example Alarms List

In the Alarms list, a Yellow icon on the left indicates that the alarm has been "acknowledged" (or "reset").

To reset an active alarm, click on the icon (or text description) to open a dialog box. For example, clicking on "Payload Error Condition" (in Figure 2-25) will bring up:

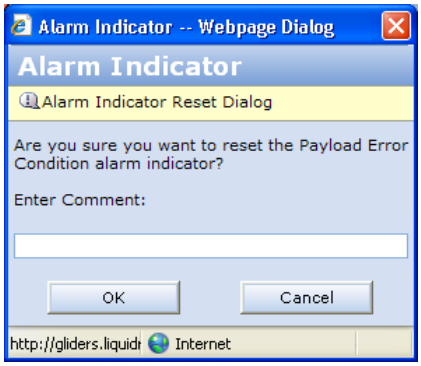


Figure 2-26: Alarm Indicator Dialog

You must enter a comment before clicking the "OK" button.

Resetting an alarm will change its status to "Acknowledged" (ref. 2.10.1). However, resetting an alarm will not delete the database record of its occurrence.

2.5.3 Duration/Date/Time Specification

The Duration/Date/Time specification allows you to specify the "time window" for data display in the Position Map and the Telemetry and Command lists. Since all Vehicle data is stored in a database, any data from any time can be retrieved.

There are two basic formats that can be used. The default specification allows you to change only the duration time window:

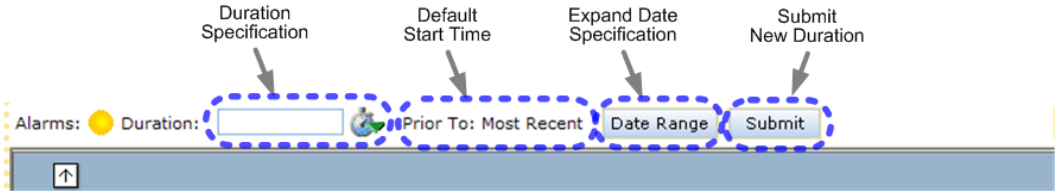


Figure 2-27: Default Date Specification

This format allows changing only the duration of the time window. Click on the clock icon to display and select the time value, from 1 minute, up to 3 days. The new value will show in the input box. Click the "Submit" button to enter the new duration.

Clicking on the "Date Range" button, will change the format of the Date Specification to that shown in Figure 2-28.

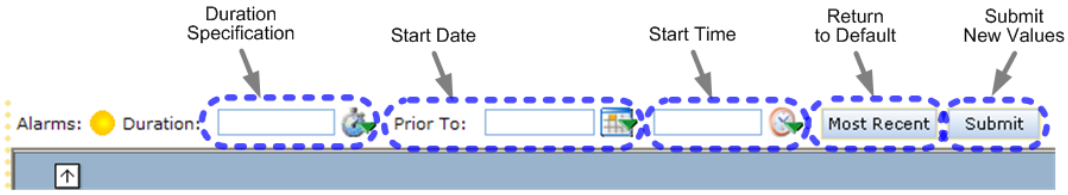


Figure 2-28: Expanded Date Specification

The expanded format allows you to specify not only the duration, but also the starting date and time. Clicking the **Most Recent** button returns you to the default specification.

A more thorough explanation is given in section 6.5.2 “Changing the View Time/Date".

2.5.4 Refresh and Autorefresh

Above the Date/Time specification is a green Refresh icon and text indicating the last time the display was refreshed. To the right of that is a checkbox labeled “Autorefresh”.

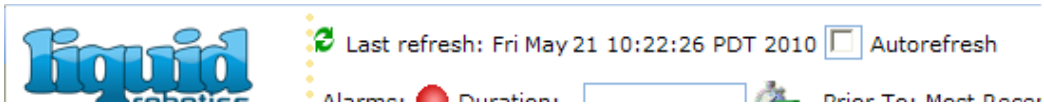


Figure 2-29: Refresh Time and Autorefresh Checkbox

Putting a check in the Autorefresh box will cause the Dashboard page to automatically refresh every **five** minutes. Even if the box is checked, you can still click on the Refresh icon at any time.

Note: When using the Dashboard online, the refresh times can be many seconds long. Don't continually click on the Refresh Icon as that will only delay re-painting of the display.

2.5.5 Map Options

The Map Options button is above the map on the right.

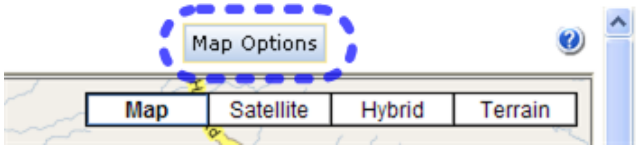


Figure 2-30: Map Options Button

Clicking on the button brings up the dialog box shown in Figure 2-31. The Map Options dialog allows setting of several map characteristic and default values. The values set here also define the initial map appearance at Sign-In.

After any of the values have been changed, click the "Set Defaults" button to exit the dialog. Then click the green "Refresh" icon to show the changes on the map.

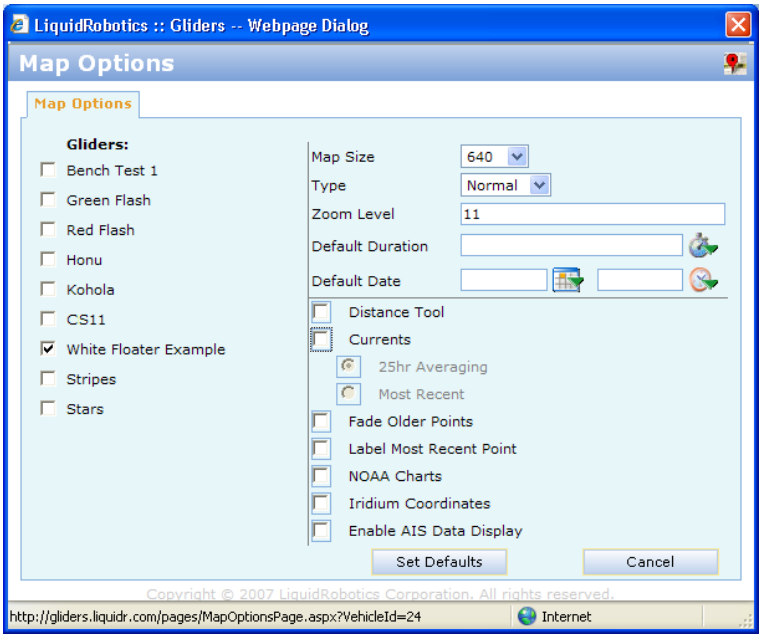


Figure 2-31: Map Options Dialog Box

Options are as follows:

Gliders: Clicking in one or more of the boxes below will cause the Position Map to display Telemetry Crumbs (icons) for the selected Vehicles, in addition to the Vehicle specified on the Dashboard page.

Note: If the icons for the specified Vehicles are not near each other, it may be necessary to zoom out to be able to see all the icons.

Map Size: A pulldown allows setting of the map vertical size, in pixels. Options are:

480
640 (Initial Default)
720
1080

Type: Type of Map to be displayed. These have the same functions as the four buttons on the Position Map (ref. 2.4.1).

Normal (Map)
Terrain
Satellite
Hybrid

Zoom Level: A value from 1 thru 18. Zoom level 18 gives maximum resolution, but shows only a very small area. A default of 10 or 11 is recommended.

Default Duration: The period of time over which the communications data (Command and Telemetry) will be displayed. The normal default is 60 minutes.

Default Date: Date and time up to which the communications data is displayed. If blank, the current date and most recent time are used.

Distance Tool: Calls up the Distance Measuring Tool (ref. 2.5.6 below).

Currents: On-map display of the ocean currents. Readings are taken every 4 hours. Options:

Average of readings in the last 25 hours
Most recent reading

Fade Older Points: Older Telemetry Crumbs are displayed progressively lighter.

Label Most Recent Point: Puts a "Current Position" marker on the Vehicle icon at the last reported Vehicle position.

NOAA Charts: The Position Map is displayed in NOAA chart format.

Iridium Coordinates: Graphically displays the relative coordinates of the Iridium satellites in contact with the Vehicle.

Enable AIS Data Display: Displays sources of AIS broadcasts. Clicking in the box will bring up additional boxes to indicate which AIS sources you want to display on the screen. See section 2.5.7 below for additional information on the AIS display.

At the bottom of the Dialog Box are two buttons:

Set Defaults Clicking on this will exit the Map Options box and save the set values.

Cancel Clicking on this will exit the Map Options box without saving any changed values. This has the same effect as clicking on the "X" icon at the upper-right.

Note: Any settings changed in the Map Options Dialog Box will not take effect until either the screen is refreshed, or you log out and sign-in again.

2.5.6 Distance Measuring Tool

When the Distance Tool box is showing on the map, clicking on any two points will place marker icons on the screen and the box will show the coordinates and distance. Continued clicking on the map will create additional markers with straight-line segments and show the accumulated distance for all segments.

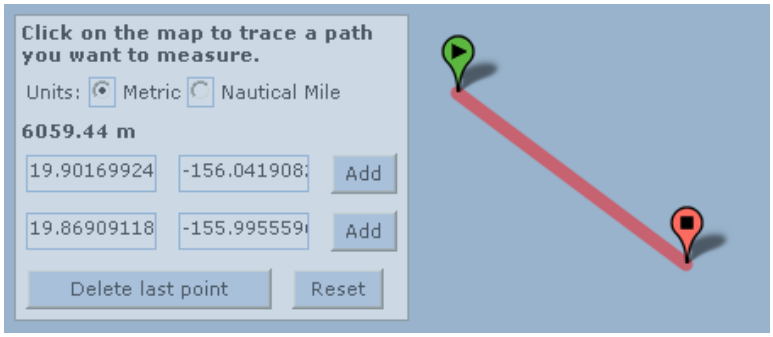


Figure 2-32: Distance Measuring Tool Example

The Distance Measuring Tool can also be used as a quick way to add Waypoints on the map. Refer to section 5.4.1 “Adding Waypoints on the Map" for detailed instructions.

2.5.7 AIS Display

When the “Enable AIS Data Display” box is checked, additional boxes will appear below, as shown in Figure 2-36. This allows you to check or uncheck which AIS sources you want to be displayed on the map.

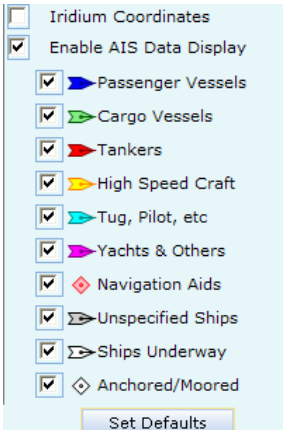


Figure 2-33: AIS Display Options

The icons to the right of the checkboxes indicate the type of marker for each source type.

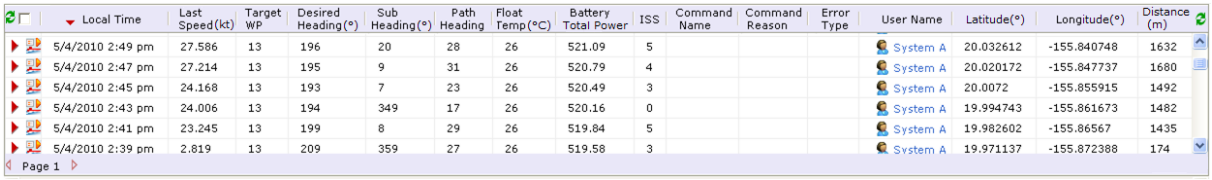
2.6 Communications Lists

Below the map on the Dashboard page are two lists. The upper list displays Telemetry data. The lower list displays Commands sent to the Vehicle.

2.6.1 Telemetry List

The Telemetry List shows all the received Vehicle transmissions for a specified time period and duration (default: during the last hour). This list will typically contain mostly telemetry data, but can also contain command responses and error records.

Figure 2-34 below shows an example telemetry list. The meanings and measurement units for each of the columns are explained below.



Local Time	Last Speed(kt)	Target WP	Desired Heading(°)	Sub Heading(°)	Path Heading	Float Temp(°C)	Battery Total Power	ISS	Command Name	Command Reason	Error Type	User Name	Latitude(°)	Longitude(°)	Distance (m)
5/4/2010 2:49 pm	27.586	13	196	20	28	26	521.09	5				System A	20.032612	-155.840748	1632
5/4/2010 2:47 pm	27.214	13	195	9	31	26	520.79	4				System A	20.020172	-155.847737	1680
5/4/2010 2:45 pm	24.168	13	193	7	23	26	520.49	3				System A	20.0072	-155.855915	1492
5/4/2010 2:43 pm	24.006	13	194	349	17	26	520.16	0				System A	19.994743	-155.861673	1482
5/4/2010 2:41 pm	23.245	13	199	8	29	26	519.84	5				System A	19.982602	-155.86567	1435
5/4/2010 2:39 pm	2.819	13	209	359	27	26	519.58	3				System A	19.971137	-155.872388	174

Page 1

Figure 2-34: Telemetry List Example

Local Time: Date and time the data was recorded on the Vehicle.

Last Speed (kt): The calculated speed, in knots, between the last two telemetry points.

Target WP: Number of the Waypoint that the Vehicle is currently headed towards.

Desired Heading (°): Computed heading value, in degrees, to get to the next Waypoint.

Sub Heading (°): Actual heading of the Sub, in degrees.

Path Heading (°): Calculated heading, in degrees, between the last two telemetry points.

Float Temp (°C): Temperature inside the Float C&C Drybox, in °C.

Battery Total Power: Estimated energy reserve, in Watt-hours, of the C&C Battery pack.

ISS: Iridium Signal Strength, from 0 (no reception) to 5 (strongest).

Command Name: If a Command Line response: Name of the command.

Command Reason: If a Command Line response: User-entered comment for the command.

Error Type: If an error line: A text string indicating the type of error.

User Name: User who issued the command.

Latitude (°): Current Latitude, in decimal degrees. Positive → North. Negative → South.

Longitude (°): Current Longitude, in decimal degrees. Positive → East. Negative → West.

Distance (m): Linear distance, in meters, covered since the previous Telemetry transmission.

Clicking on the Red triangle icon at the left calls up any additional data.

The icon to the right of the Red triangle indicates whether the line contains telemetry or command data.

2.6.2 Command List Features

The Command List is a log of the commands and comments sent from the Shore during a specified time period and duration (default: during the last hour). Unlike the Telemetry list, there is a header bar that can be used to initiate various actions.

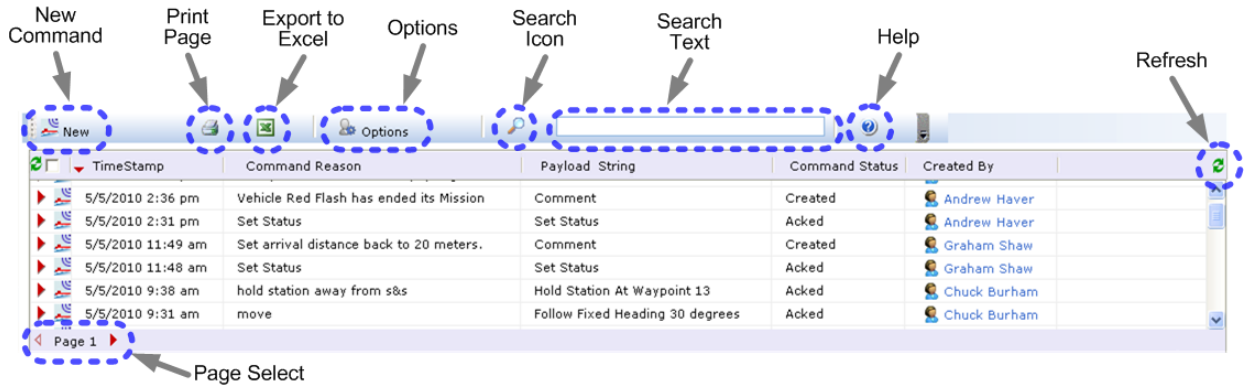


Figure 2-35: Command List Example

The Icons and Input Box in the header do the following:

New Command: Calls up a dialog to issue a new command (or comment). (Ref. 2.7.9)

Print Page: Prints a page of the command list. Each page contains 25 entries.

Export to Excel: Re-formats the Command list data into Excel spreadsheet format.

Options: Clicking here calls up a dialog to change the User Data settings. (Ref. 2.7.3)

Search Icon: Starts a search for a specified character string in the Command List.

Search Text: Character string to search for when the Search Icon is clicked.

Help: Calls up a screen describing the Command List features.

Refresh: Refreshes (updates) the list with the latest data.

Page Select: Moves to a different page in the list. Only 25 records are shown on each page.

The Command List has the following columns:

Time Stamp: Date and time the command was issued.

Command Reason: A comment associated with the command. Entered by the User when the command was created.

Payload String: Displays the interpreted command type and data as a text string.

Command Status: There are three possibilities:

Acked – Command received by Vehicle and processed.

Nacked – Command received, but Vehicle was unable to process.

Comment – Comment. Recorded in the database, but not sent to Vehicle.

Created By: Name of the person who originated the command.

2.7 Vehicle Status and Control Features

To the left of the Position Map is a group of displays, buttons and links that enable monitoring and control of a given Vehicle.

2.7.1 Status and Control Bar Overview

An annotated image of the Vehicle Status and Control Bar is shown in the Figure below.

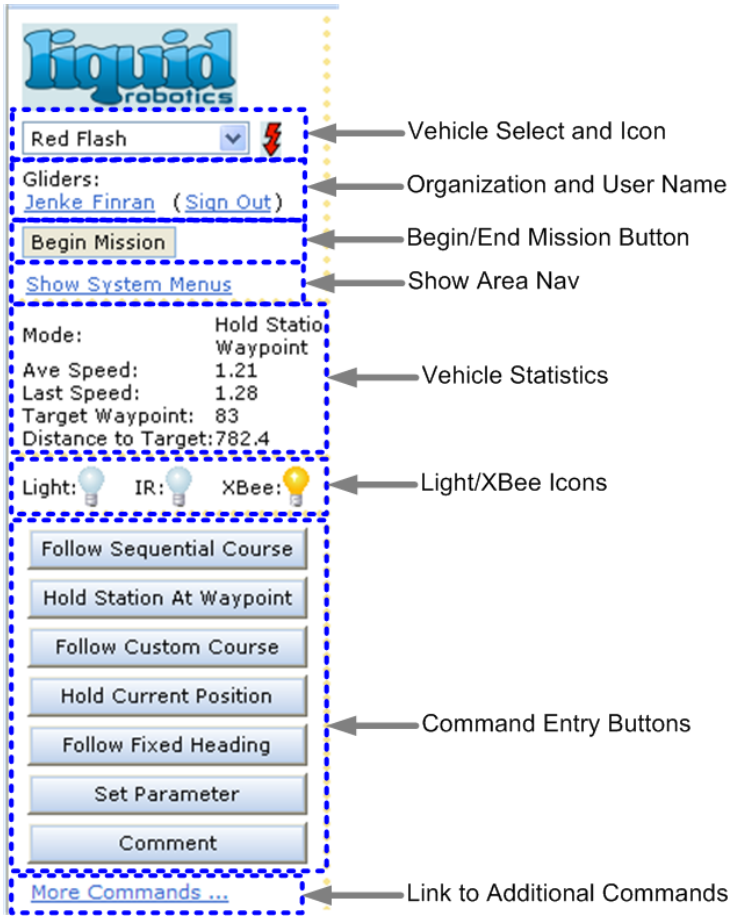


Figure 2-36: Vehicle Status/Control Bar

Vehicle Select and Icon: Name and associated icon for the Vehicle to be displayed and controlled. Ref 2.7.2

Organization and User Name: Link to User information. Also used for logging off. Ref 2.7.3

Begin/End Mission Button: Used for starting or ending a Mission. Ref. 2.7.4

Show Area Nav: Brings up the Page Menu in the lower-left corner. Ref. 2.7.5

Vehicle Statistics: Vehicle status at the last telemetry point. Ref. 2.7.6

Light/XBee Icons: Color indicates state. Click to issue an On or Off command. Ref. 2.7.7

Command Entry Buttons: Calls up the dialogs for commonly-used commands. Ref. 2.7.8

Link to Additional Commands: Calls up the dialog to execute any command. Ref. 2.7.9

2.7.2 Vehicle Select and Icon

The Vehicle Select Box is used to choose the Vehicle that you want to monitor. The Vehicle Icon to the right is displayed on the Position Map to indicate the Vehicle position.

Figure 2-37: Vehicle Select Box and Icon

Clicking on the down arrow (V) at the right of the box brings up a list of the active Vehicles. Click on the Vehicle name in the list to select it. The Dashboard screen will automatically refresh to show the map and data for the selected Vehicle. The Vehicle Icon will also change to correspond to the new name.

Clicking on the Vehicle icon is a "shortcut" way to call up the Vehicle Data window, which is used extensively for both Vehicle Provisioning (Chapter 4) and Mission Planning (Chapter 5).

2.7.3 Organization and User Name

Your Organization and your User Name are displayed below the Vehicle name.

Figure 2-38: Organization and User Name

Click on the User Name Info Link to bring up the User Options dialog:

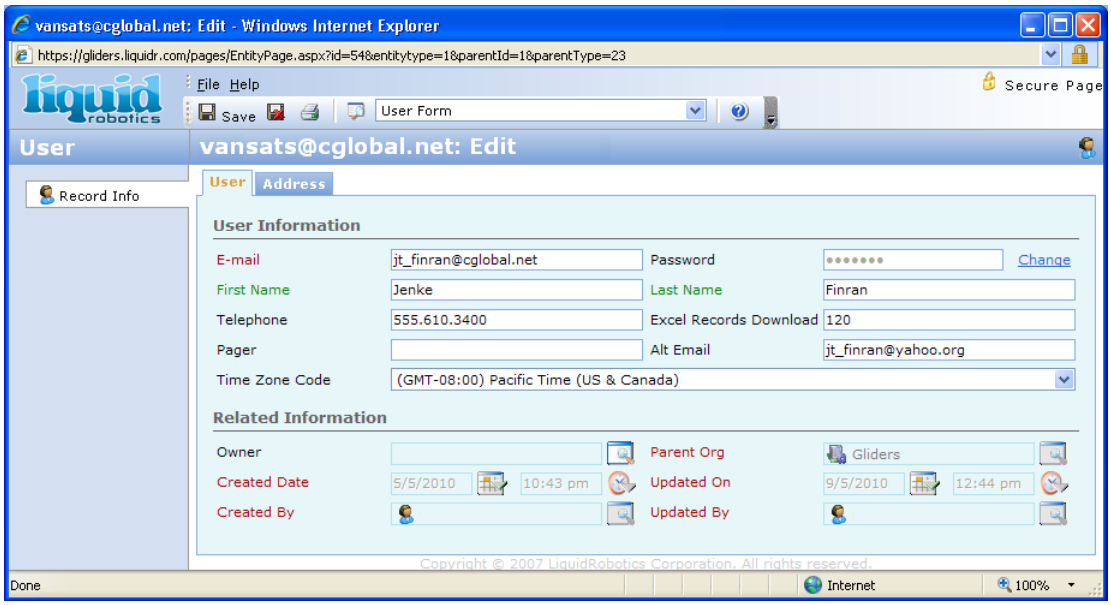


Figure 2-39: User Options Dialog

The User Options dialog contains your personal information. This data can be accessed by others in your Organization who have the appropriate Role permission.

This dialog also allows you to change your password (note the Change at the far right).

The User Options dialog can also be accessed using the Options Icon in the Menu and Tool Bar (ref. 2.8.2). The Options Icon is also available at the top of other windows and dialog boxes.

2.7.4 Begin/End Mission Button

The Begin Mission button is used to create a new Mission or to join a Mission already in progress.

Figure 2-40: Begin Mission Button

Refer to section 6.2 “Mission Operations" for more detailed information.

2.7.5 Show Area Nav Buttons

Clicking the Show System Menus link brings up the Area Nav buttons at the lower left of the Dashboard (ref. 2.8).

The link is changed to Hide System Menus when the Area Nav buttons are displayed.

2.7.6 Vehicle Statistics

This shows the state of the Vehicle. These values are not continuously updated; the screen must be refreshed to show the latest values.

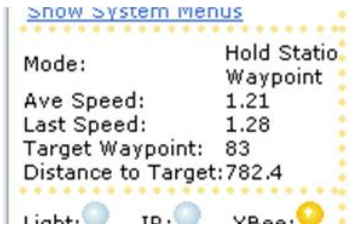


Figure 2-41: Vehicle Statistics Info

The values are basically self-explanatory, but some details are not obvious:

Mode: The name of the command that the Vehicle is executing. Longer command names can be truncated.

Ave Speed: The average speed, in knots, during the entire Mission.

Last Speed: The computed speed, in knots, between the last two Waypoints.

Target Waypoint: The number of the Waypoint that the Vehicle is heading towards.

Distance to Target: The distance, in meters, to the Target Waypoint.

2.7.7 Light/XBee Icons

The three lightbulb icons show the state of the visible light, the IR light and the XBee radio.

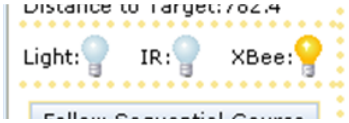


Figure 2-42: Light and XBee Icons

A Blue bulb indicates Off. A Yellow bulb indicates On.

Also, clicking on any of the icons will bring up a Command Dialog box (ref. 2.7.8) that allows changing the On/Off state of the selected component.

2.7.8 Command Buttons

The Command Buttons are used to call up dialog boxes for frequently-used commands.

Figure 2-43: Command Buttons

For example, clicking on the "Hold Current Position" button brings up the dialog page:

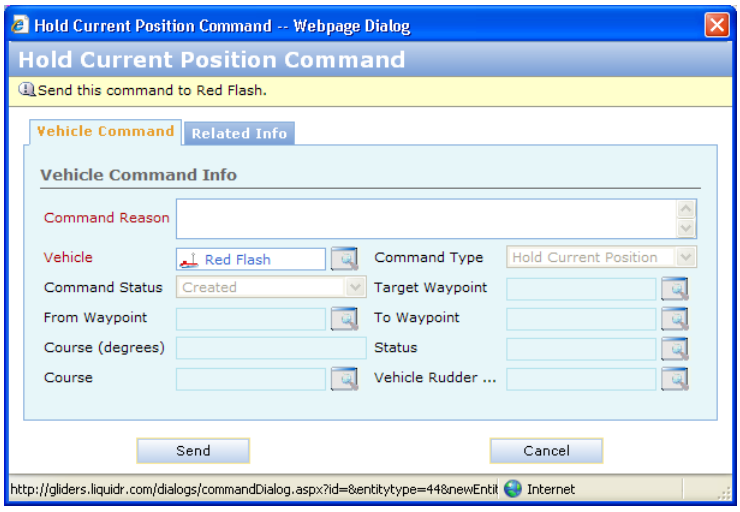


Figure 2-44: Command Dialog – Hold Current Position

The basic dialog box will be the same for all of the "button" commands. However, the command name in the header and the "Command Type" box will be different. Note that the name in the "Command Type" box is grayed-out, indicating that it cannot be changed.

Depending upon the command type, different data input boxes will be open or closed. Refer to "2.7.9 General Commands Link" below for a more detailed explanation of the Command Dialog Box entries.

If an input box is labeled with Red text, then an entry in that box is required. The "Command Reason" will always be in Red text and thus has to be entered for every command.

When the required data entries have been made, click on the "Send" button to queue the command for sending to the Vehicle.

2.7.9 General Commands Link

Clicking on the More Commands ... link brings up the dialog box shown in Figure 2-45. The basic dialog format is the same as for the Command Buttons. However, the "Command Type" box now has a pull-down list to select a command, as shown in Figure 2-45.

Note that both the type of input boxes and the commands listed in the pulldown will be dependent upon the Role you have been assigned.

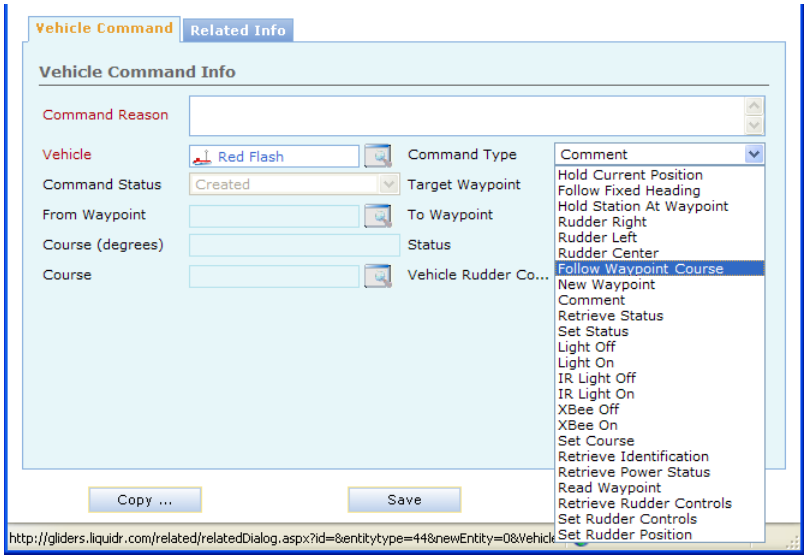


Figure 2-45: Command Selection Pulldown

Also, different input boxes will be open depending upon the parameters required for the selected command type. (As stated above, the Command Reason box will always be open.)

Figure 2-46 shows what the dialog box would look like if the "Follow Waypoint Course" command is selected.

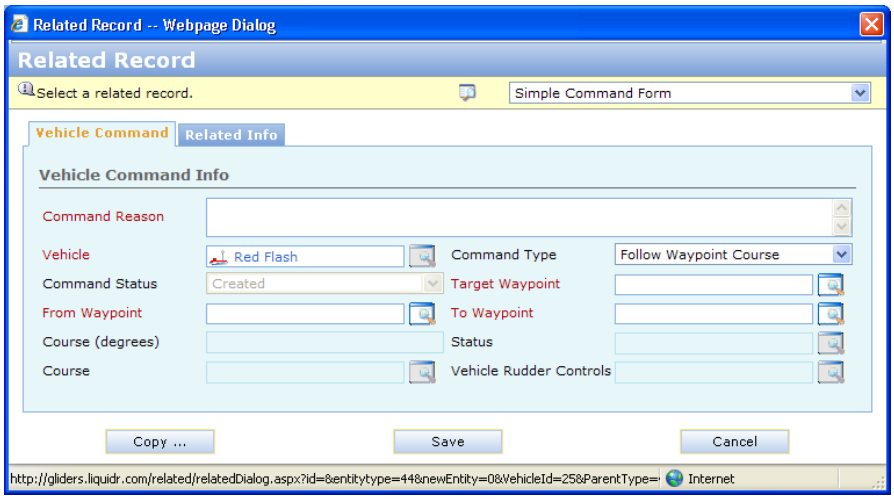


Figure 2-46: General Command Dialog

A blank box with a Red label indicates that data must be entered. In the Figure 2-46 example, four data inputs are required.

The data input boxes are:

Command Reason: This is a comment that must be entered for each command.

Vehicle: Name of the Vehicle to which the command will be sent. This cannot be changed.

Command Status: The status will always be "Created" and cannot be changed.

Target Waypoint: The number of the Target Waypoint. Used for the "Follow Waypoint Course" and "Hold Station at Waypoint" commands.

From Waypoint: The number of the first Waypoint in a sequence. Used for the "Follow Waypoint Course" command.

To Waypoint: The number of the last Waypoint in a sequence. Used for the "Follow Waypoint Course" command.

Course (degrees): Course heading (0° to 359°) used for the "Hold Fixed Heading" command.

Status: Used to enter status information for the "Set Status" command.

Course: Course heading used for the "Set Course" command. This cannot be entered directly; you have to use the "Click to select …" icon to the right of the box.

Vehicle Rudder Controls: Used to enter information for the "Set Rudder Controls" command. This has to be entered by using the "Click to select …" icon.

At the bottom of the Dialog Box are three buttons:

Save Clicking on this button queues the command to send to the selected Vehicle.

Cancel Clicking on this will close the box without saving any changed values. This has the same effect as clicking on the "X" icon at the upper-right.

Copy … Clicking on this button brings up a list all previous commands issued to the Vehicle on this Mission, similar to:

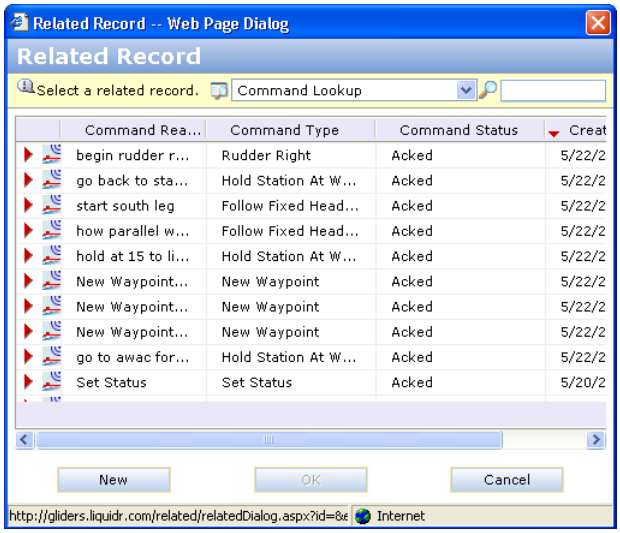


Figure 2-47: Copy Command Selection

Double-clicking on a command will place that command in the Command dialog box and close the Copy Command Selection dialog.

2.8 Show System Menus

As described in 2.7.5, clicking the Show System Menus link calls up display of the Area Nav buttons at the lower left of the Dashboard. Also displayed is the Menu and Tool Bar.

2.8.1 Area Nav Buttons

The Area Navigation buttons at the lower left of the screen can be used to call up alternate screen pages.

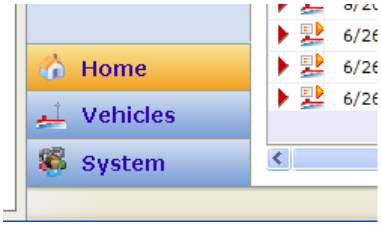


Figure 2-48: Area Nav Buttons

The Buttons call up Pages as follows:

Home The Home Page "Dashboard", described above in 2.2.5.

Vehicles Page lists data for all Vehicles. Ref. section 2.9 “Vehicles Pages".

System Page for system-wide settings of all Vehicles. Ref. section 2.10 “System Pages".

2.8.2 Menu and Tool Bar

When the Area Nav Buttons are visible, the Menu and Tool Bar is displayed near the top of the Dashboard window.

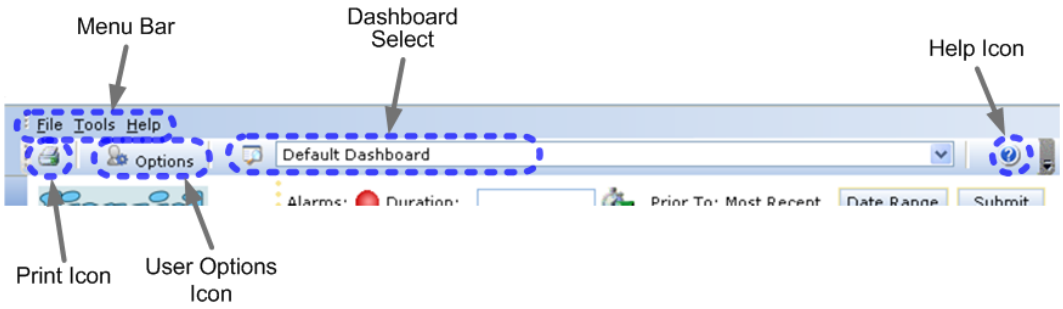


Figure 2-49: Menu and Tool Bar Components

The primary components of the Menu and Tool Bar are:

Menu Bar: The three options in the Menu Bar are:

File – Can be used to exit the window.

Tools – Can be used to call the User Options dialog.

Help – User Interface help.

Print Icon: Extracts the current window for printing.

User Options: Clicking here brings up the User Options dialog, shown in Figure 2-39.

Dashboard Select: Pulldown list allows selection of Vehicle-specific Dashboards.

Help Icon: This option is currently not functional.

2.9 Vehicles Pages

Clicking on the "Vehicles" Area Nav button brings up the Vehicles page, which can be used to access data on any of the Organization's Vehicles.

2.9.1 Vehicles Display Options

Note that the left bar of the Vehicles page has seven total options tabs:

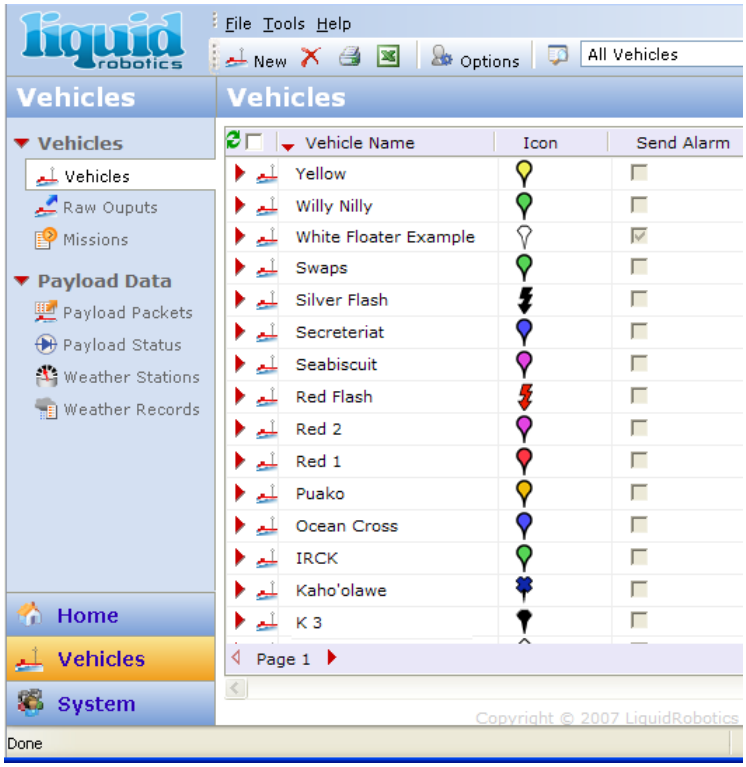


Figure 2-50: Vehicles Display Options

The display options are:

Vehicles: Lists the names of all Vehicles and their map display icon. (Ref. 2.9.2)

Raw Outputs: Lists the raw data packets recently received from all Vehicles. (Ref. 2.9.5)

Missions: Lists the currently active Missions. (Ref. 2.9.6)

Payload Packets: Lists recently-received payload packets. (Ref. 2.9.7)

Payload Status: Lists any recently-received payload status data. (Ref. 2.9.8)

Weather Stations: Lists weather stations for which data is available. (Ref. 2.9.9)

Weather Records: Lists data received from weather stations. (Ref. 2.9.10)

Each option is selected by clicking on the name in the left bar.

Of the above options, the "Vehicles" option is the primary one that you will use. The other options are primarily for data analysis and troubleshooting.

2.9.2 Vehicles - Vehicles List

The Vehicle listing shows all of the Vehicles and looks similar to:

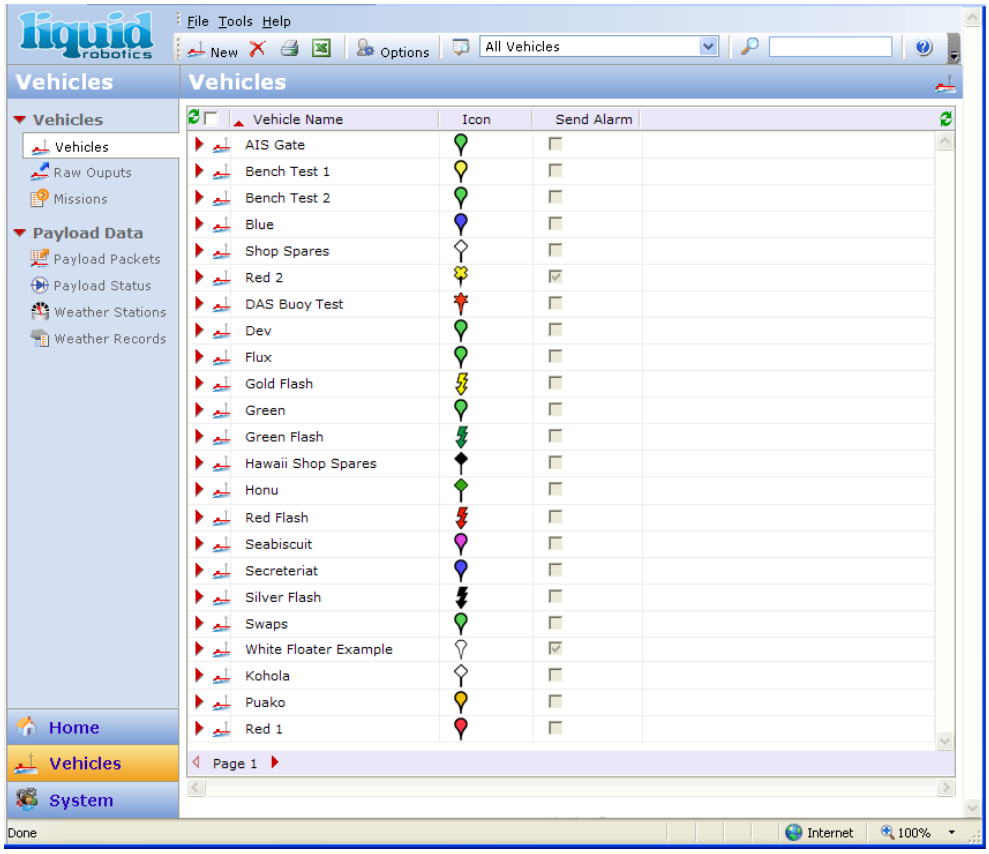


Figure 2-51: Vehicles Page - Vehicles List

Note that the "Page" indicator in the lower-right corner indicates that there are additional Vehicles listed on the next page.

Clicking on the Red triangle to the left of the Vehicle name will pull down a list of telemetry data for that Vehicle. Click the triangle again to close the pulldown list.

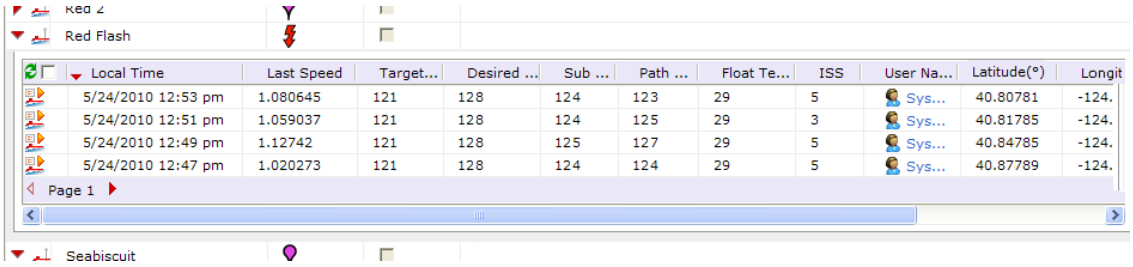


Figure 2-52: Vehicle Telemetry Pulldown

The most important use of the Vehicles List page is to get access to the Vehicle Data window, described below. To do this, double-click on a Vehicle name. For example, double-clicking on the name "Red Flash" will bring up the vehicle data on Red Flash.

2.9.3 Vehicle Data Window

The Vehicle Data window is used to view or change all data related to a Vehicle. This dialog is used extensively when provisioning a Vehicle and planning a mission.

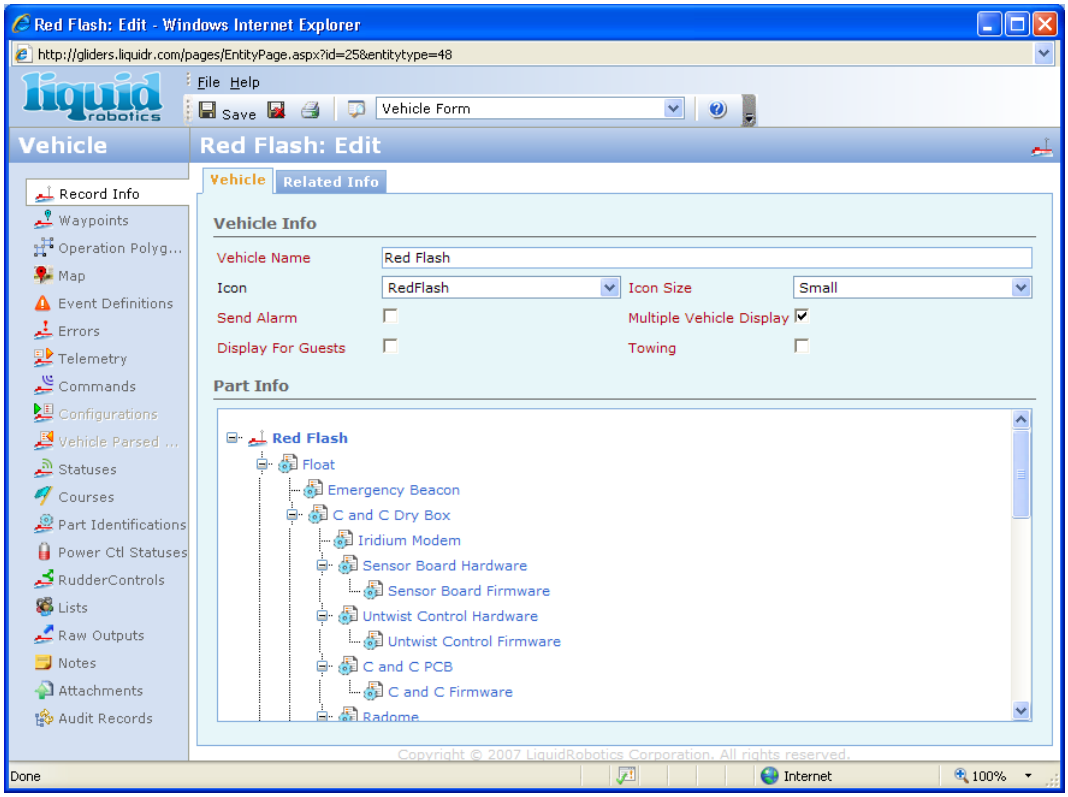


Figure 2-53: Vehicle Data Dialog

(As indicated in 2.7.2, clicking on the Vehicle icon in the Status and Control Bar of the Dashboard will also call up this dialog.)

Note that the left-side bar offers many "tab" options for displaying Vehicle configuration and operational data values. Some of the options also allow you to change the Vehicle's configuration values.

(Some options may be "grayed-out" if your assigned Role does not allow you access.)

The options are:

Record Info: Basic info on the Vehicle, and the parts definition tree. (Changeable)

Waypoints: Lists all the Waypoints assigned to the Vehicle. (Changeable)

Operation Polygons: Lists all the Operation Polygons assigned to the Vehicle. (Changeable)

Map: Displays a Position Map of the Vehicle location. Identical to the Dashboard map.

Event Definitions: Definitions of Alarm types and parameters. (Changeable)

Errors: Latest error messages received from the Vehicle.

Telemetry: Latest telemetry data received from the Vehicle.

Commands: Latest commands sent to the Vehicle.

Configurations: Legacy option, pre-Model 08 Wave Gliders.

Vehicle Parsed Configurations: Legacy option, pre-Model 08 Wave Gliders.

Statuses: Latest Status data received from the Vehicle.

Courses: Lists Courses assigned to Vehicle. (Changeable)

Part Identifications: Lists Hardware/Software version numbers.

Power Ctl Statuses: Latest Power Control Status data received from the Vehicle.

Rudder Controls: Latest rudder-control commands sent to the Vehicle.

Lists: Alarm Escalation and User Group lists. (Changeable)

Raw Outputs: Latest raw data packets received from the Vehicle.

Notes: User-entered text notes for the Vehicle. (Changeable)

Attachments: User-entered links to files associated with the Vehicle. (Changeable)

Audit Records: Changes or updates made to the Vehicle and/or its parts.

2.9.4 Search String Feature

Often, a Vehicles option will contain a list that is several pages long. The Search Icon and text input box in the upper right can be used to select only those records containing specific text.

The example below shows the result of entering "flash" in the text search box of the example list shown in Figure 2-51, then clicking on the Search [Search String] Icon:

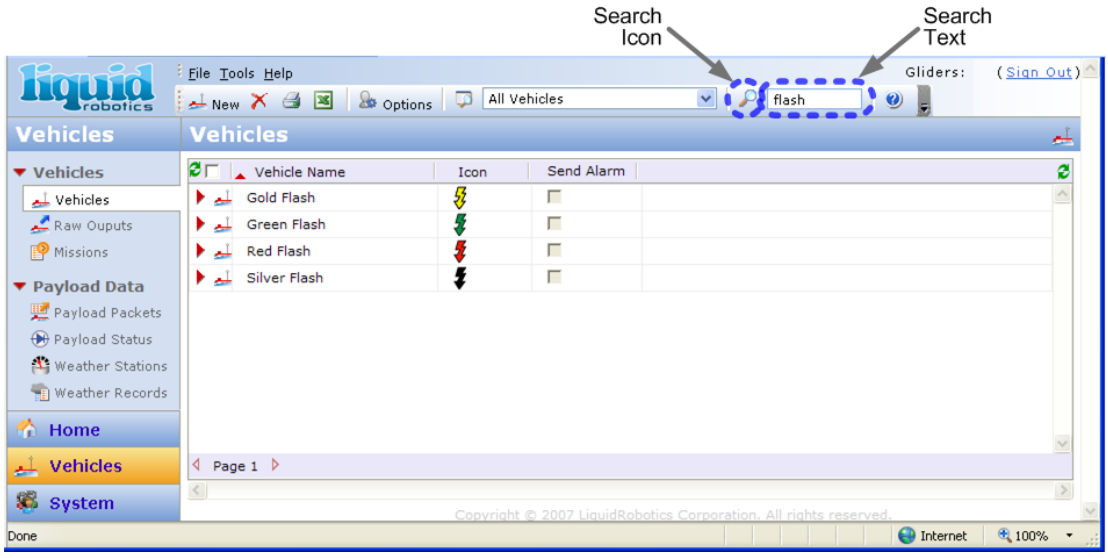


Figure 2-54: Search Feature Example

The search is not case-sensitive. More important: If a list spans multiple pages, all pages will be searched.

The Search Icon and text input box are shown at the top of most pages with data lists.

2.9.5 Vehicles - Raw Outputs List

The Raw Outputs listing looks similar to the Figure below, which shows all Iridium data sent from the selected Vehicle, prior to stripping off the Iridium packet header. Thus, the list will include any erroneous Iridium data that the WGMS software cannot decode.

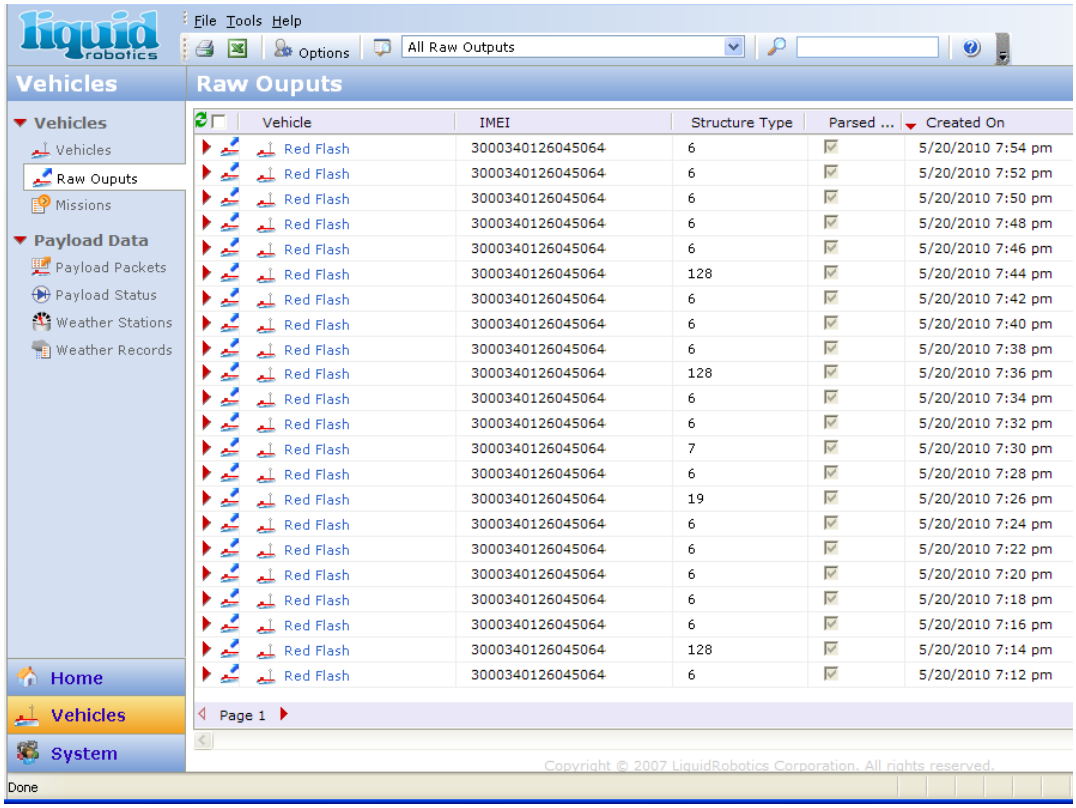


Figure 2-55: Example Vehicles Page – Raw Outputs

The columns indicate the following:

Vehicle: Name of the Vehicle.

IMEI: International Mobile Receiving Identity. 15-digit code of the Vehicle's Iridium modem.

Structure Type: Indicates the type of telemetry data sent from the Vehicle.

Parsed Flag: Indicates that the record was parsed by the system.

Created On: Timestamp showing when the telemetry data was created.

Double-clicking on a Vehicle name will bring up detail information about the Iridium data packet at that timepoint.

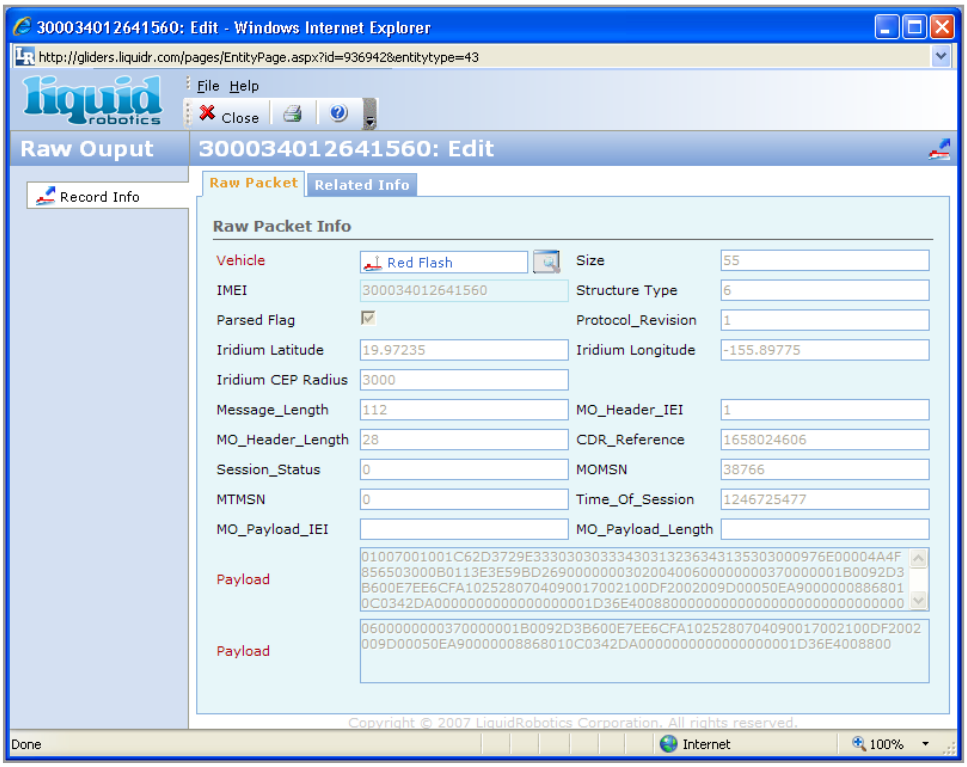


Figure 2-56: Vehicles -- Raw Output Dialog

Note that this dialog does not allow changing any values. The data is primarily used for diagnostic and troubleshooting purposes.

Refer to the LRI *Interface Control Description* document for more information on the structure of the Iridium data packets.

2.9.6 Vehicles – Missions

The Vehicles Missions option shows the status of all the Missions created by your Organization. Figure 2-57 shows the general output format.

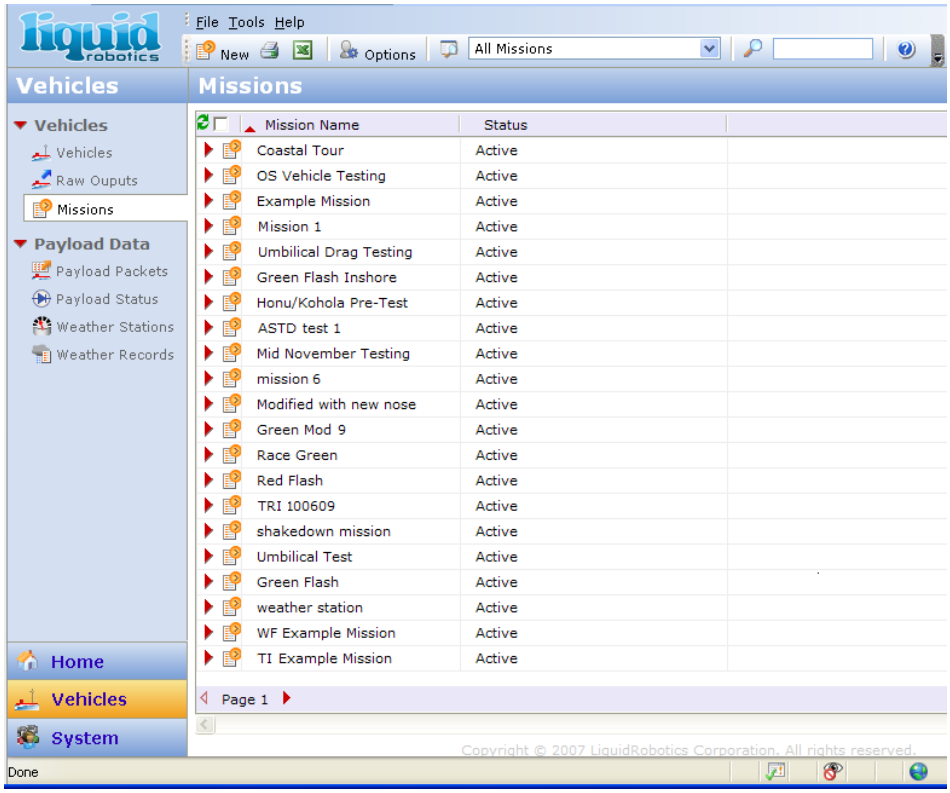


Figure 2-57: Example Vehicles Page – Missions

The columns indicate data created or updated by a User:

Mission Name: The name assigned to the Mission.

Status: The Mission status, which can be one of the following:

Active – The Mission is available to use or join.

Expired – The Mission is no longer assigned to any Vehicle

Note: Only a System Administrator can delete a Mission.

Double-clicking on a Mission Name will bring up a dialog box that allows updating of the Mission Status. See 6.2 "Mission Operations" for a description of using that dialog.

2.9.7 Payload Data – Payload Packets

Payload Packets contain data issued by Vehicle payload sensors and electronics, rather than the C&C computer. The Payload Packets Data screen looks similar to the Figure below, which shows the different payload types. These are the packets before any interpretation of the data.

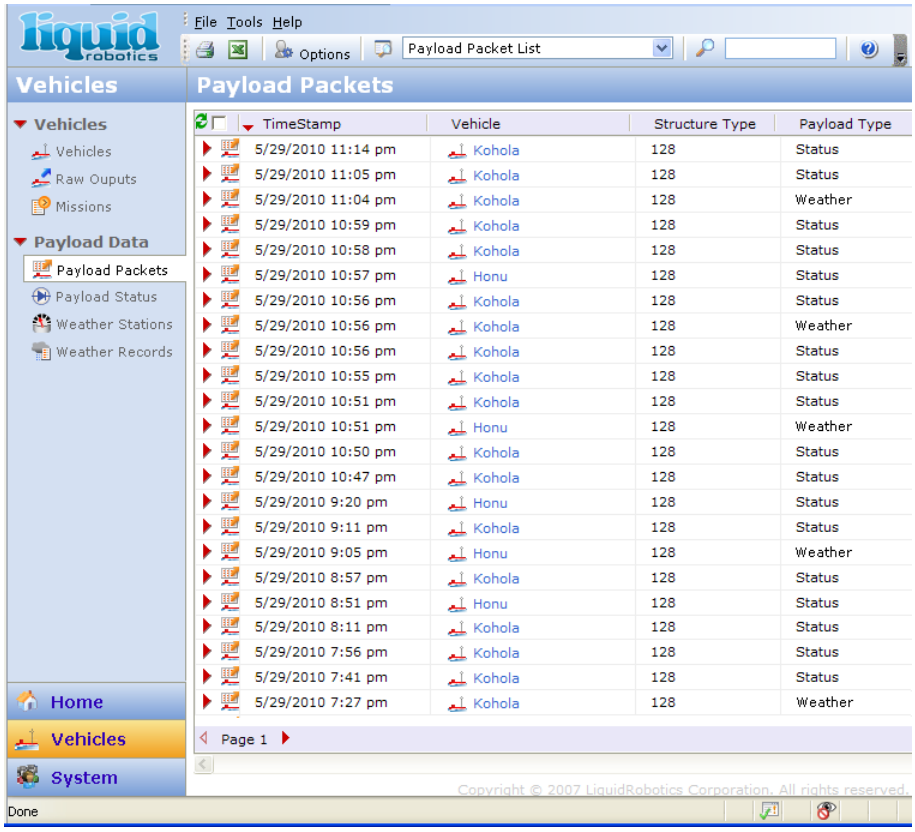


Figure 2-58: Example Payload Packet Data List

The columns indicate the following:

TimeStamp: The time the packet was created by the Vehicle's C&C computer.

Vehicle: The name of the Vehicle sending the packet.

Structure Type: A number indicating the structure type of the packet.

Payload Type: The type of data returned from the payload. Multiple types can be supported, depending upon the payload.

Double-clicking on a TimeStamp or Vehicle name will bring up detailed additional information on the packet, including the packet's raw payload data.

2.9.8 Payload Data – Payload Status

The Payload Status listing shows only the status reports returned from a payload. It looks similar to Figure 2-59, which shows the status data returned.

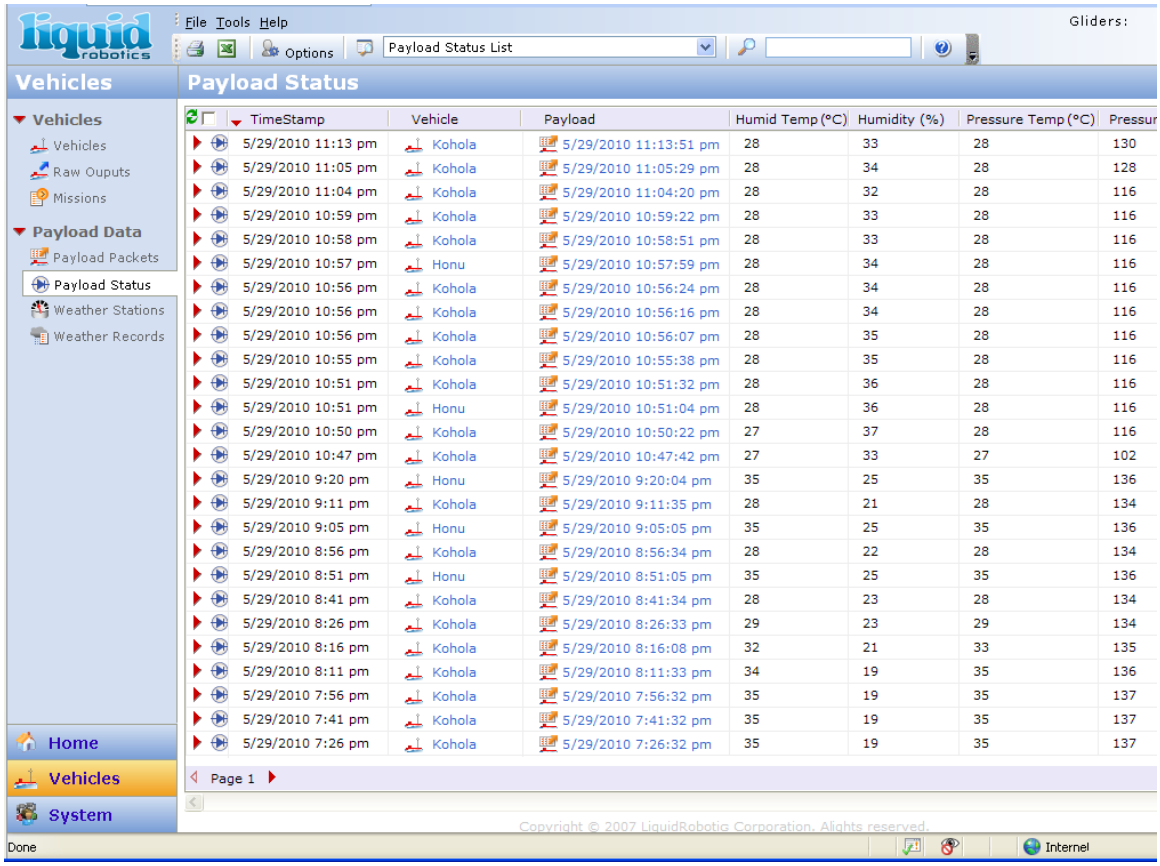


Figure 2-59: Example Payload Status Data List

The columns indicate the following:

TimeStamp: The time the data was recorded by the Vehicle's C&C computer.

Vehicle: The name of the Vehicle sending the packet.

Payload: Exact timestamp from the payload itself.

Humid Temp (°C): Payload humidity temperature in °C.

Humidity (%): Payload percent humidity level.

Pressure Temp (°C): Payload pressure temperature in °C.

Pressure (kPa): Payload pressure, measured in Kilo-Pascals.

Double-clicking on a TimeStamp, Vehicle name or Payload timestamp will bring up detailed additional status information.

2.9.9 Payload Data – Weather Stations

The Weather Stations list shows the weather stations that your Organization has chosen to subscribe to. Typically, these are stations in your Vehicle's operating areas.

Your Sys Admin is the person who subscribes to services for your Organization.

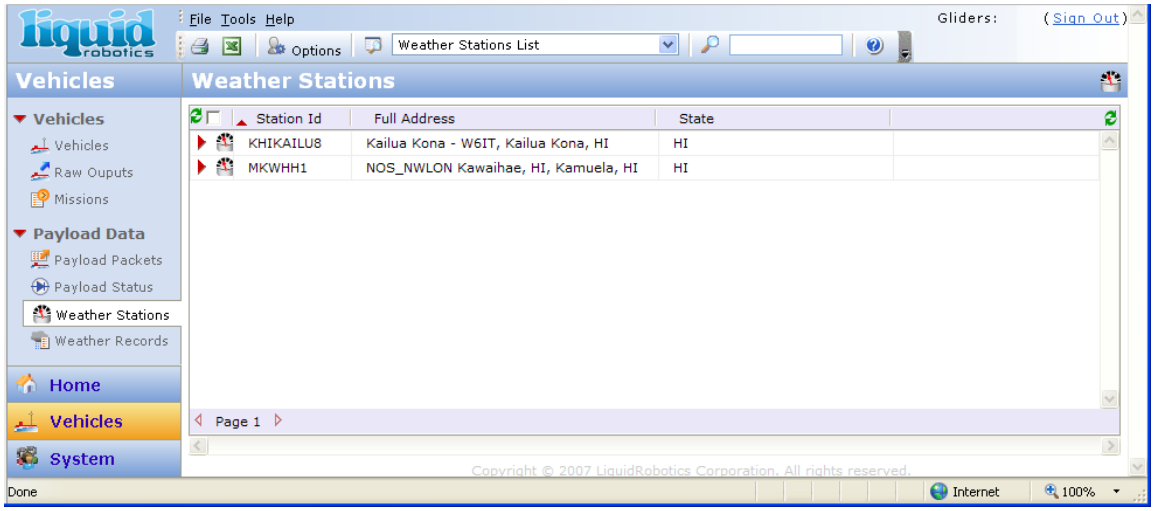


Figure 2-60: Example Weather Station List

Double-clicking on a Station ID code will bring up options for displaying information on the station location, or recent weather reports from that station.

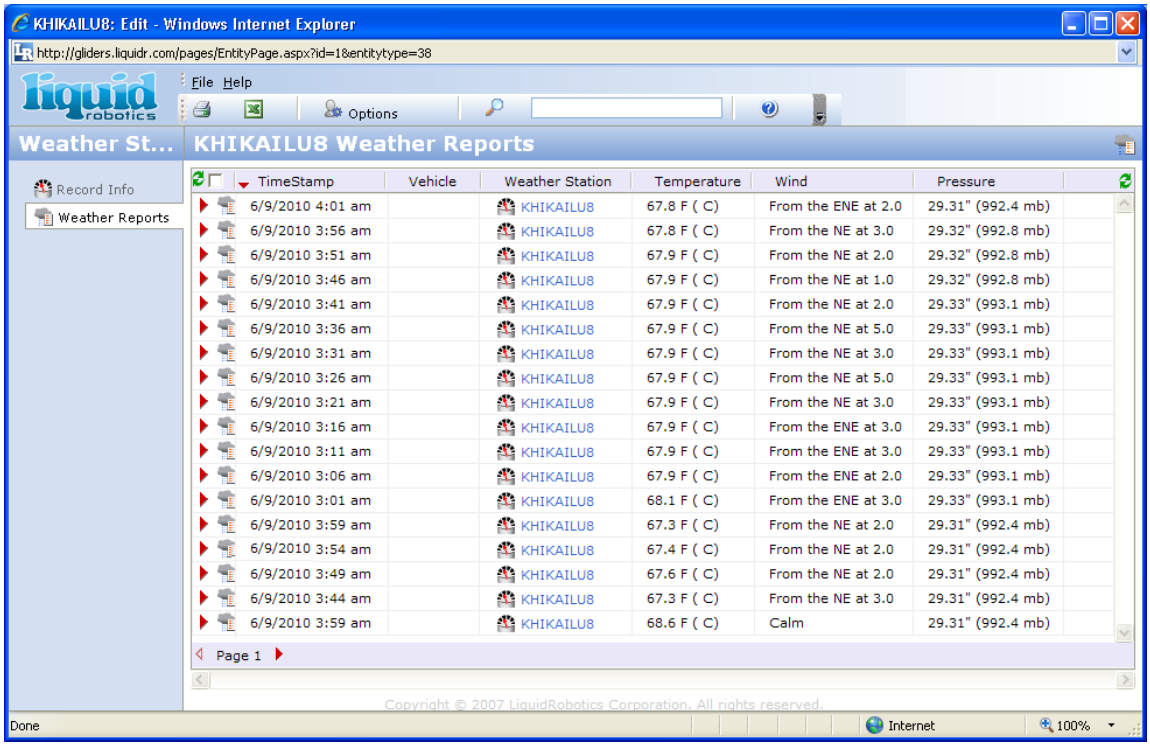


Figure 2-61: Example Weather Station Reports

2.9.10 Payload Data – Weather Records

The Weather records are a mix of data from both Shore-based stations and also from any Vehicle payload measurements.

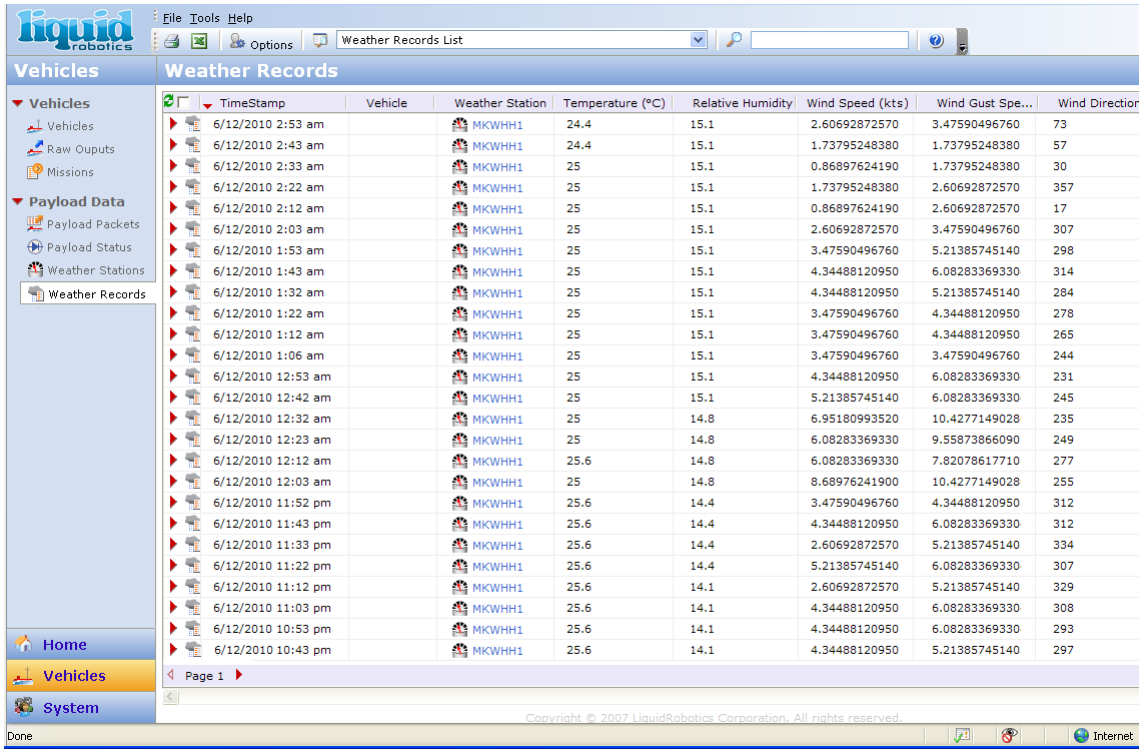


Figure 2-62: Example Weather Record List

Double-clicking on a TimeStamp will bring up detailed additional weather information.

Weather Station information is available from the Weather Underground service (www.weatherunderground.com). Your Sys Admin will have to subscribe to receive the appropriate information for your Organization's operating area.

Note that Weather Underground provides historical weather data. This data can be valuable for Mission Planning (Ref. 5.1.6).

2.10 System Pages

Clicking on the "System" Area Nav button brings up the System pages, which are used to display information about all software and all Vehicles within an Organization. The System pages and all referenced dialogs cannot be used to change any settings; they are for information only.

This data can be useful for post-Mission analysis (ref. 6.5 "Analyzing Mission Data").

2.10.1 System – Alarms

The Alarms page is a combined list of an Organization's Vehicle and software errors.

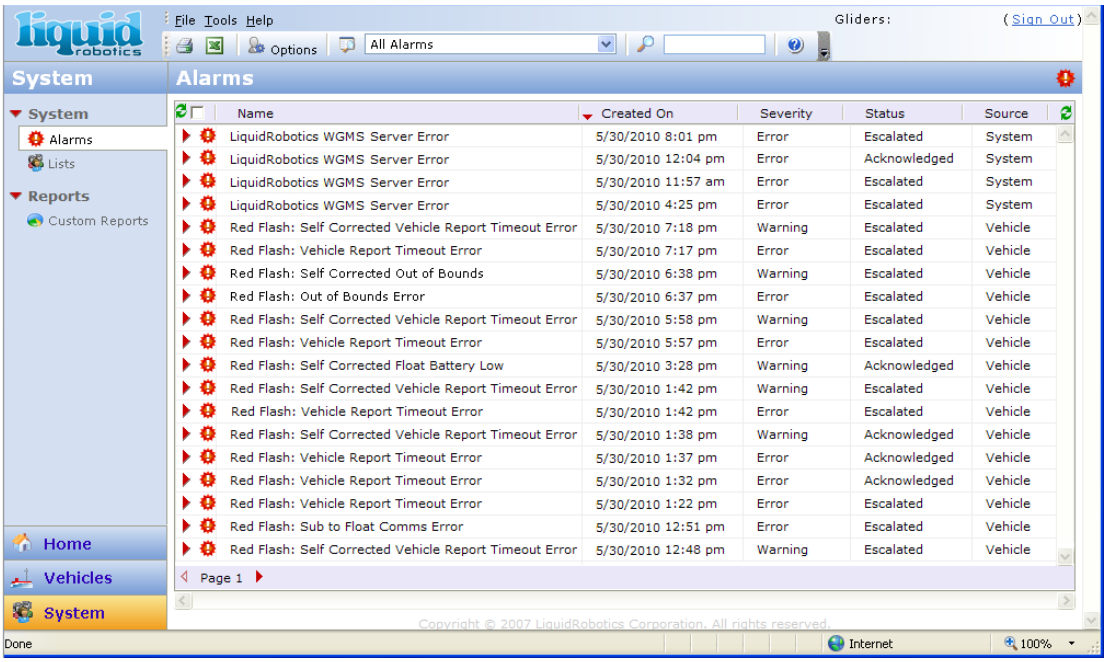


Figure 2-63: Example System – Alarms List

The columns indicate the following:

Name: The name of the Vehicle or software system issuing the alarm.

Created On: Timestamp of when the alarm was issued.

Severity: The level of the alarm:

Error – An alarm occurred which requires attention.

Warning – An alarm occurred, but reset automatically.

Informational – An event occurred, but it is not a problem.

Status: The current status of the alarm:

Active – The alarm was issued, but no other action has been taken.

Acknowledged – The alarm was reset by a user (ref. 2.5.1).

Self-Corrected – The alarm situation corrected itself.

Escalated – The alarm triggered the Escalation List (ref. 2.10.2; ref. 4.7).

Note: Not all Alarms trigger an Escalation List.

Source: What entity the alarm is associated with:

Vehicle – Indicates a problem with or situation on a Vehicle.

System – Indicates a problem with the Shore-based software system.

2.10.2 System – Lists

Lists are any grouping of data records of the same type. Lists are most often used for alarm escalation, but they can be used for other purposes.

An example of a System – Lists page is:

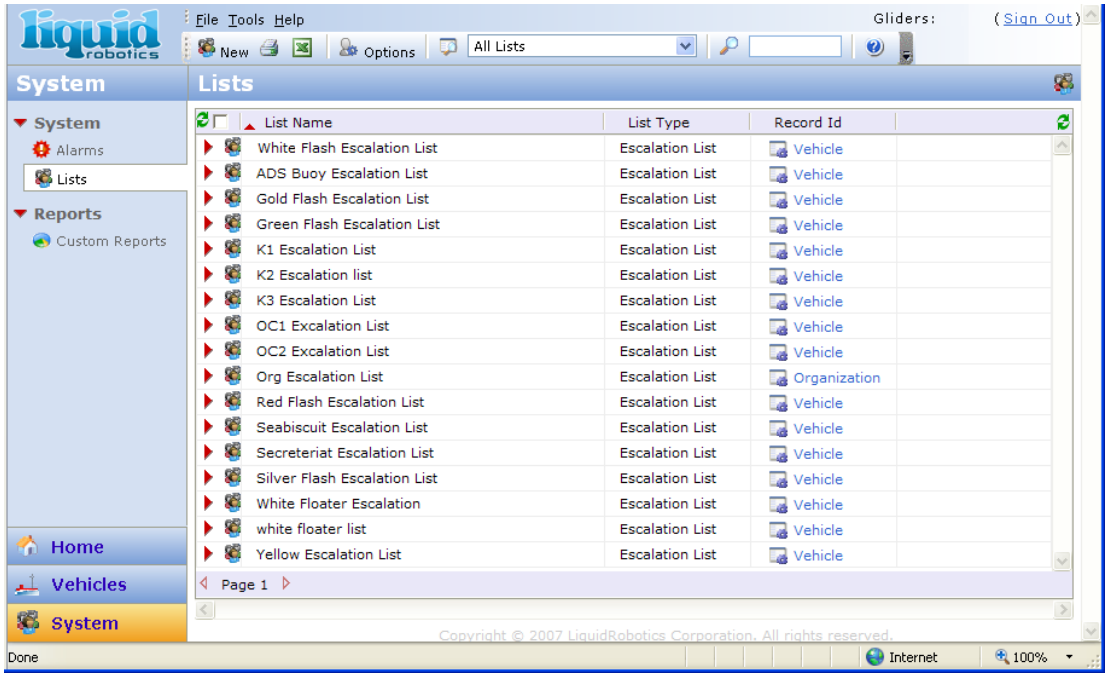


Figure 2-64: Example System – Lists

The columns indicate the following:

List Name: The name describing the list.

List Type: There are currently two types of lists:

Escalation List – A list of contact people/points in case of an Alarm. A list is typically associated with a specific Vehicle, but it can be associated with an Organization.

Group List – Any list of people within an Organization.

Record ID: Type of list, as follows:

Vehicle – The list is associated with a specific Vehicle.

Organization – The list is associated with the Organization.

Note that each record shown above in Figure 2-64 is itself a list. Double-clicking on a line in the Systems – Lists will bring up the indicated Escalation or Group List.

For example, double-clicking on "Secretariat Escalation List" brings up the dialog:

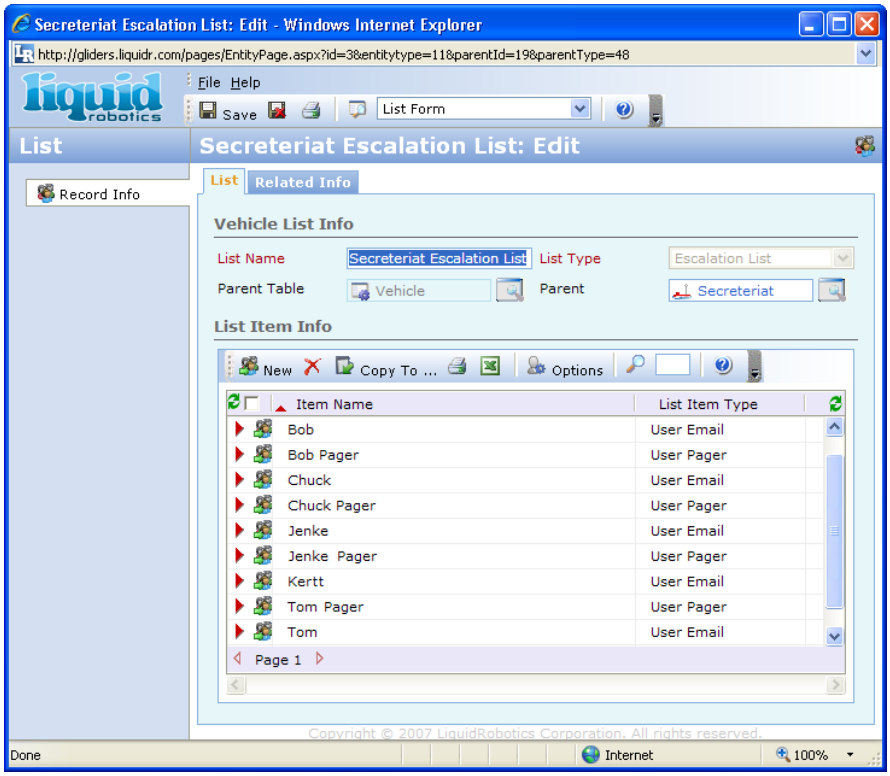


Figure 2-65: Example Escalation List

Note that names in this list can be added, deleted or copied, assuming that you have the appropriate Role privileges.

Double-clicking on an Item Name will bring up a dialog box that shows additional information, and allows changing the List Item Type.

For a description of how to create a new list, see section 4.7 “Adding a List".

2.11 Reports Pages

The Reports Pages are used to create, view and archive information related to Vehicle operations. Currently, the only type you can access is a “Custom Report” that you generate.

2.11.1 Custom Reports

Custom Reports are pre-defined reporting structures, used for graphing or otherwise documenting data trends.

Click on the “Custom Reports” Tab on the left side.

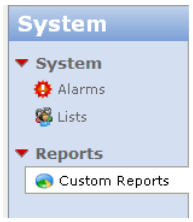


Figure 2-66: Custom Reports Tab

This will bring up the blank form with Telemetry data at the bottom.

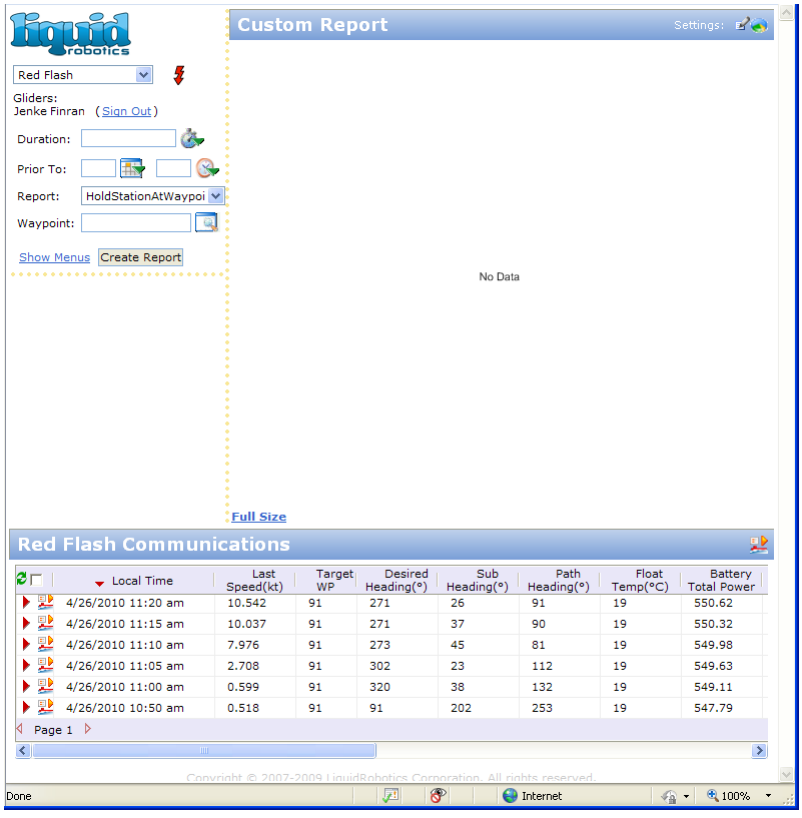


Figure 2-67: Custom Report Initial Page

To allow maximum screen space for displaying reports, the left-hand navigation bar is automatically hidden. To restore the left-side navigation bar and buttons, click on the Show Menus link on the upper-left.

There are currently two “Report” options that can be selected:

Hold Station at Waypoint - Indicates the position, over time, of the Vehicle relative to a specific Waypoint.

Pressure Over Temperature - Indicates the Pressure divided by the Temperature, over time.

Additional Report options may be added in the future, but the general procedure should be similar to that used for the above reports.

Note that to generate a report you must fill in the necessary data boxes:

Duration: The length of time over which the data is to be plotted. Click on the stopwatch icon to the right of the box to pull down a list (in 1-hour increments).

Prior To: The date and time of the last data point to be plotted. Click on the calendar icon to select the date, then click on the clock icon to select the time.

Report: Use the pull-down arrow to select the report type.

Waypoint: Required only for the “Hold Station at Waypoint”. The Waypoint from which the distance is to be calculated. The value is ignored for the “Pressure Over Temperature” report. Click on the icon to select from a list of Vehicle Waypoints.

Once the data has been entered, click the **Create Report** button. If the data entered above is in the Vehicle’s Telemetry database, the report will be generated. An example “Hold Station at Waypoint” report is shown in Figure 2-68.

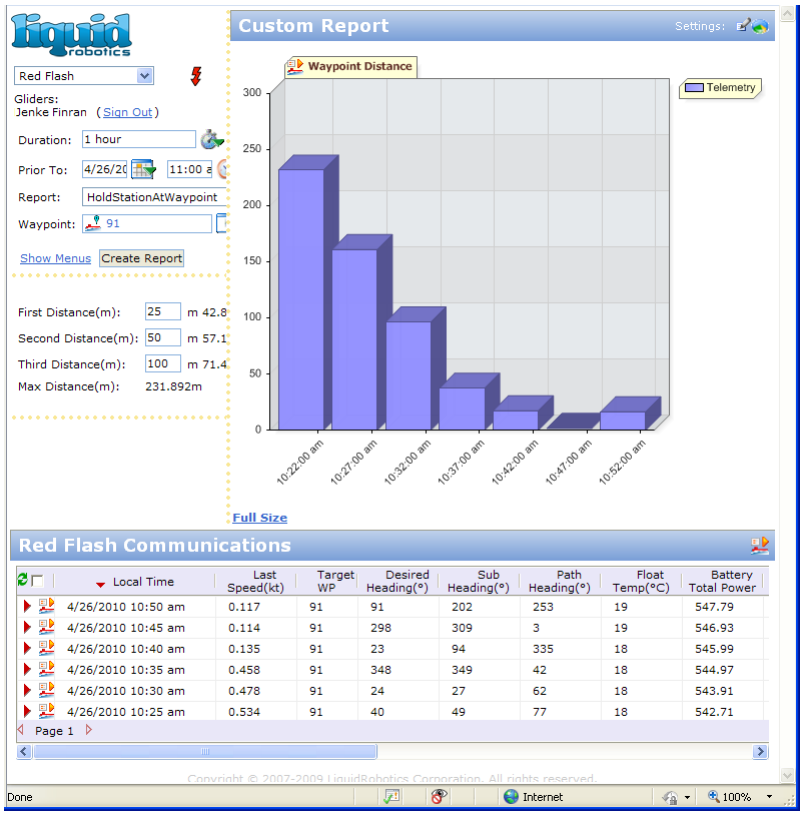


Figure 2-68: Custom Report - Hold Station at Waypoint

An example “Pressure Over Temperature” report is shown in Figure 2-69.

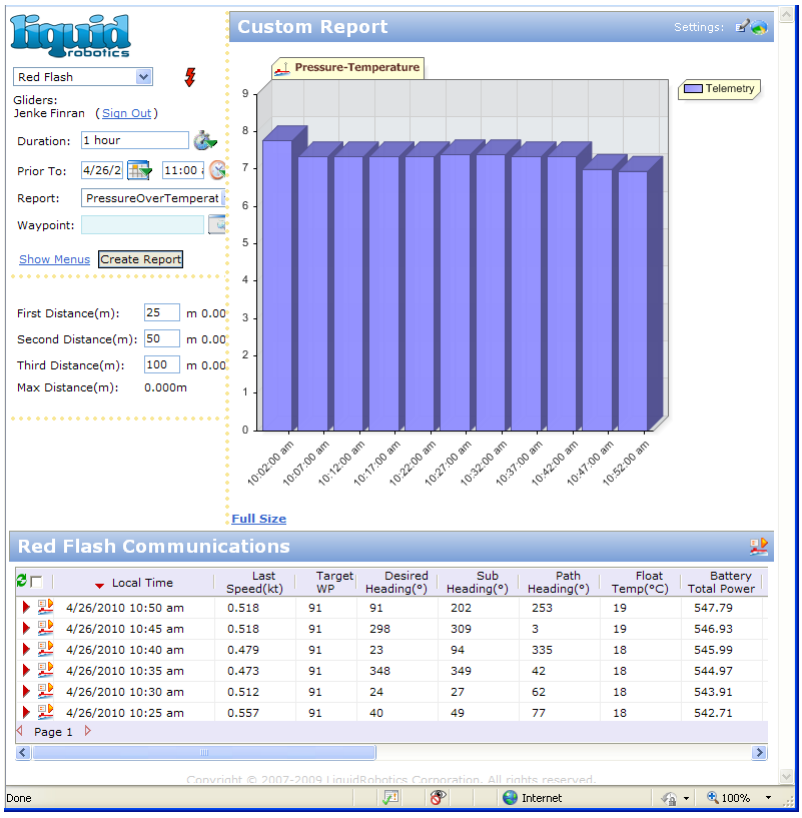


Figure 2-69: Custom Report - Pressure Over Temperature

To save the report image, place the cursor over the image and right-click. Select the option “Save Picture As …”. Then select the name and the location where it is to be stored.

Note that if all the values selected for the report are not in the database, no report will be generated and the Communications list at the bottom will be blank. Correct the values as necessary and click on the **Create Report** button again.

2.11.2 Show/Hide Menus

To recover back to the Reports initial page (Figure 2-67), do the following:

1) Click on the Show Menus link to show the left-side bar.
2) Click on the “Custom Reports” tab.

When the left-side tabs and buttons are shown, the link changes to Hide Menus. Clicking this link will remove the left bar to allow more space for the reports display.

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Chapter 3 – XBee Communications

3.1 XBee Overview

The XBee radio link is an alternative method of issuing commands to, and retrieving status data from the Vehicle. Unlike the Iridium-based Dashboard interface, XBee has no telemetry or other Vehicle-initiated data transmissions. All XBee transmissions from the Vehicle are in response to specific XBee requests.

XBee communications are via a menu, with some prompts. These are described below.

3.1.1 XBee Range

The XBee radio aboard the Vehicle is low-power and short-range. The XBee range is dependent upon weather and terrain, but is generally not dependable at distances greater than about 100 meters. Thus, it is used primarily for launch-ship communications and land-based testing.

However, when first establishing XBee communications, the distance should be no more than about 20 meters.

3.1.2 Roles and XBee

Roles (as described in 2.2.2) have no effect on XBee communications. All XBee commands can be used by anyone with an XBee connection to the Vehicle.

3.1.3 XBee Hardware

In order for your computer to communicate with the Wave Glider XBee system, you will need to attach a transceiver to your computer. The required hardware, shown in Figure 3-1, is:

Digi XBee-PRO 802.15.4 USB Adapter, internal wire antenna

Model # XA-A14-CE1P

Figure 3-1: XBee USB Adapter

This is available from Digi at their website:

www.digi.com

It is also available from some electronics distributers.

When you've received the transceiver, unwrap the cord and plug into a USB port in your computer. Plugging in should power it up, indicated by a blinking Green light on the end.

3.2 Configuring the Modem

3.2.1 Installing the Device Driver

The device driver software is available for download on the Digi website.

1) On the website, click: **Support → Drivers**
2) Go down in the list to select: **XBee / XBee Pro 802.15.4 Adapters**,
3) Click **Submit**.
   This should bring you to a page with download links for different operating systems.
   Note that the link for Windows 7 and Vista is at the bottom of the page.
4) Download the the ZIP file to your computer. A special directory for the files (e.g., "Digi Driver") is recommended.
5) Extract All from the ZIP file to the directory.
6) Open the README.TXT file and follow the instructions for installing the software on your computer.

The key configuration parameters are:

Baud Rate: **115,200 bps**
Data Bits: **8**
Stop Bits: **1** (or 2)
Parity: **None**

*Note: If necessary, use the Digi diagnostics software **X-CTU** to detect and configure the modem.*

3.2.2 Firmware Updates

If there are problems establishing communications, it may be necessary to update the firmware on the XBee modem. The key parameters for updating are:

Modem Type: **XBP24**
Function Set: **XBee PRO 802.15.4**

3.2.3 Establishing Communications

Communications is established by first turning on the Digi transceiver and starting up the XBee Relay. Then turn on the Wave Glider XBee power. A key point to remember is:

Power up the Digi transceiver before starting up XBee on the Wave Glider

The Wave Glider XBee transceiver starts up when the Vehicle is powered up. So the typical procedure would be to connect the Digi, then power up the Wave Glider.

However, the Iridium link can also be used to switch the XBee On or Off (ref. 2.7.7). Thus, if the Digi transceiver was turned on after the Wave Glider, use the Dashboard control to first turn Off the XBee, then turn it back On.

You can also cycle power on the Wave Glider Off, then back On. Note that when doing this, wait about 10 seconds after turning Off before turning the Vehicle On again.

3.3 XBee Relay Software

3.3.1 The XBee Communication Components

The XBee "Relay" is a software package that acts as a translation program between WGMS and the XBee modem. It is what you use to communicate via XBee.

During configuration, you will see a reference to a "Packet Reflector". This is another software package that is used to route messages.

Your System Administrator should have previously set up the software on your system. If not, the procedure for installation is described in the LRI *System Administration* manual.

3.3.2 Configuration Parameters

The first time you start up the XBee Relay, you will need to configure it for the XBee adapter and for the specific Vehicle you want to communicate with.

For configuration, you will need to have the **PAN ID** for the Wave Glider. The PAN ID is a 4-digit hexadecimal number, and should be listed on the LRI Packing List for the Vehicle.

Note: The PAN ID can possibly be obtained using the Iridium connection Dashboard. On the Vehicles page, select your Vehicle, then click on "Part Identifications" on the left side, which should bring up a dialog box. In the dialog box, click on the icon next to the timestamp. This should bring up a dialog that includes the PAN ID.

Once the initial configuration has been done, the configuration values will be stored on your computer. Thus, you will not need to change them unless you change the Digi adapter or the Vehicle.

3.3.3 Starting the XBee Relay

To start the XBee Relay, click on the XBee Relay icon on your main screen:

Figure 3-2: XBee Relay Start Icon

If there is no icon on the screen, you can start by by clicking the **Start** button, then using **Programs → WGMS XBee Relay → WGMS XBee Relay**, as shown in Figure 3-3.

Figure 3-3: XBee Relay Alternate Start

It is a good idea to review the "Software Release Note" prior to configuring the XBee software.

3.3.4 XBee Start-Up Screen

When the XBee Relay program is launched, the start-up screen shown in Figure 3-4 below should come up.

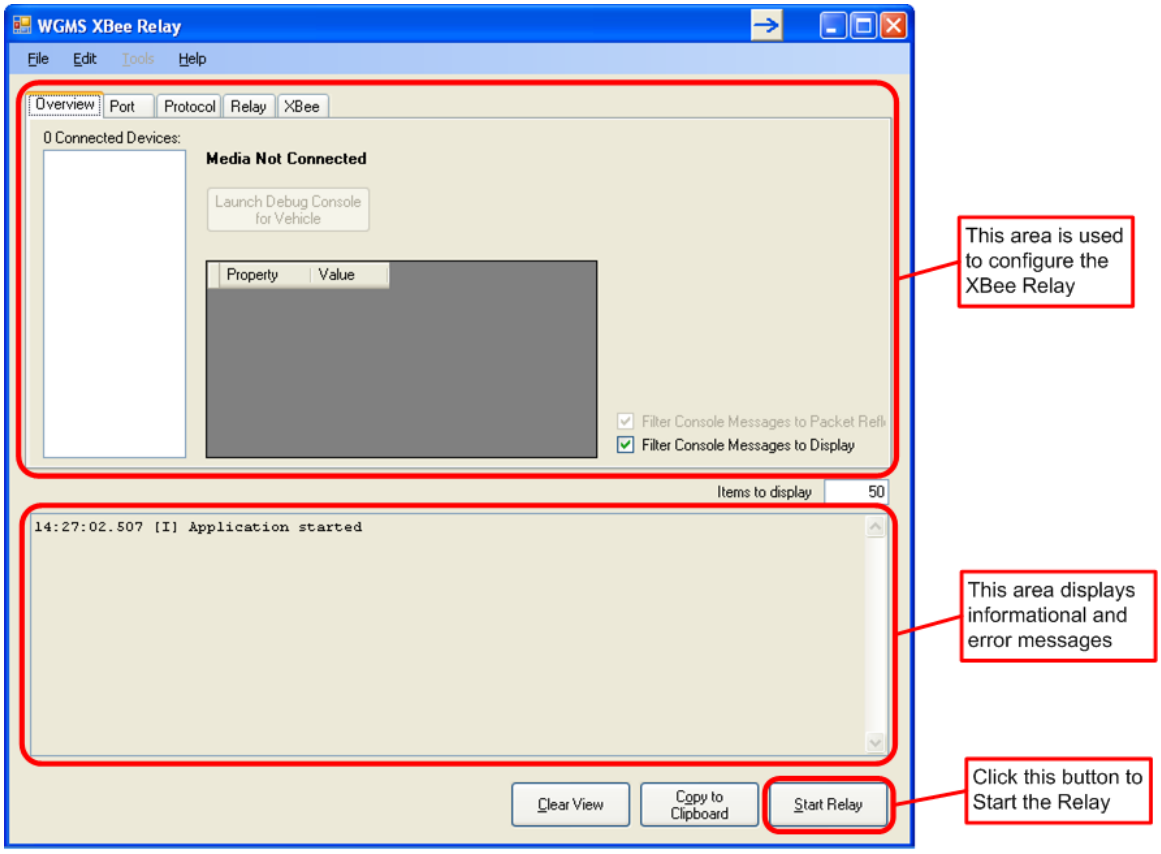


Figure 3-4: XBee Relay Start-Up Screen

Three main areas of the screen should be noted:

1) The upper (tabbed) area is used to configure the XBee for a specific modem and Vehicle.
2) The lower area displays information and error messages from the operation of the relay.
3) The **Start Relay** button at the lower-right is used to initiate the connection between your modem and the Vehicle.

   *Do not use the **Start Relay** until you have configured XBee, as described below.*

3.4 XBee Relay Configuration

Before using the XBee for the first time, you need to configure the Relay both for the modem you are using, and for the Vehicle you are communicating with.

Since the configuration values are stored on your computer, so as long as the modem and the Vehicle are not changed, you don't need to configure each time you start up.

However, if you have problems communicating via XBee, the first response should be to check the configuration values, as described below.

3.4.1 Setting the Port Configuration

The first step in configuration is to set up the serial port configuration.

1) Click the **Port** tab.

Figure 3-5: XBee Port Selection Tab

2) Verify that the correct **Serial Port** is selected (i.e. the one provided by the Digi modem). This value should show on the screen when the Digi modem is plugged in.

   If the value in the box is not correct, use the pull-down menu to select the correct port. Only detected serial ports are listed in the drop-down menu.

3) Check that the **Baud Rate**, **Data Bits** and **Stop Bits** values are the same as you specified for the Digi modem (ref. 3.2.1).

4) Leave the other values (Parity, Handshake, etc.) as-is.

5) Click the **Apply** button to save any changes made.

   *Note: The **Revert** button causes the settings to go back to the values they had when you clicked the **Port** tab; it does not reset them to any default installation values.*

3.4.2 Setting the Network Configuration

Next, you need to check/set the XBee network values.

1) Click the **XBee** tab.

Figure 3-6: XBee Parameter Selection Tab

2) Verify that the **PAN ID** is correct.

   Note: For hexadecimal numbers, be sure to use the "0x" at the beginning of the number. As an example, use 0x5000 to indicate hexadecimal 5000 (20480 decimal).

3) If you want to specify a specific channel, un-check the **Scan for Clear Channel** checkbox. Then specify one of the available channels in the **Fixed Channel** box. (By default, the modem scans for the clearest channel and uses that.)

3) There is typically no need to change any of the other values.

4) Click the **Apply** button to save any changes made.

3.4.3 Setting the Address Values

Finally, you need to set up the IP communication addresses.

1) Click the **Relay** tab.

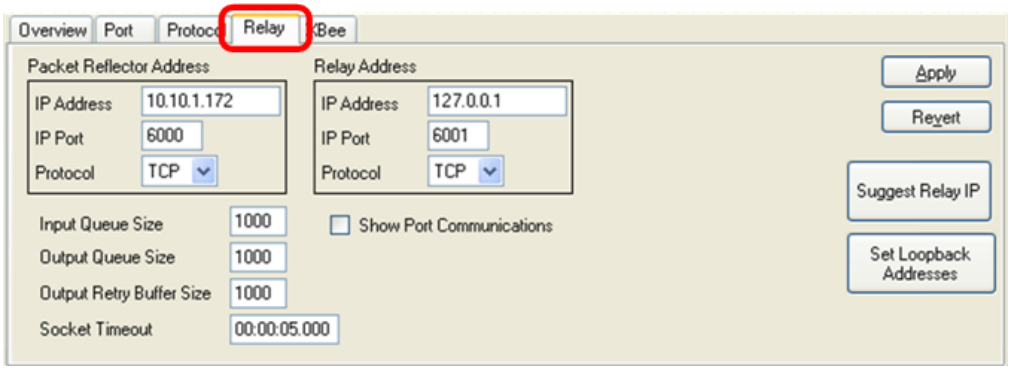


Figure 3-7: Relay IP Address Selection

2) Enter the Packet Reflector **IP Address** value. If you are only using XBee communications, you can use the "Home" address value: **127.0.0.1**.

   If you are also using a Packet Reflector on your computer, use the **IP Address** value provided by LRI or by your IT staff.

3) Set the Relay Address **IP Address** value. You can use **127.0.0.1**.

4) Set the IP Port addresses. In general, the two port addresses should not be the same. Suggested values are **6000** and **6001**.

   Note that if the IP Addresses are the same, the IP Port numbers must be different.

   To see what numbers are currently in use, open a Command Prompt window and enter the command **netstat**.

5) There is typically no need to change any of the other values.

6) Click the **Apply** button to save the changed values.

3.4.4 Starting the Relay

Once the port and network configurations have been set, you can start the XBee relay.

1) Click the **Start Relay** button on the lower right.

   Some configuration values are grayed out during execution. The log display (Figure 3-8) shows events as they occur, along with a time stamp.

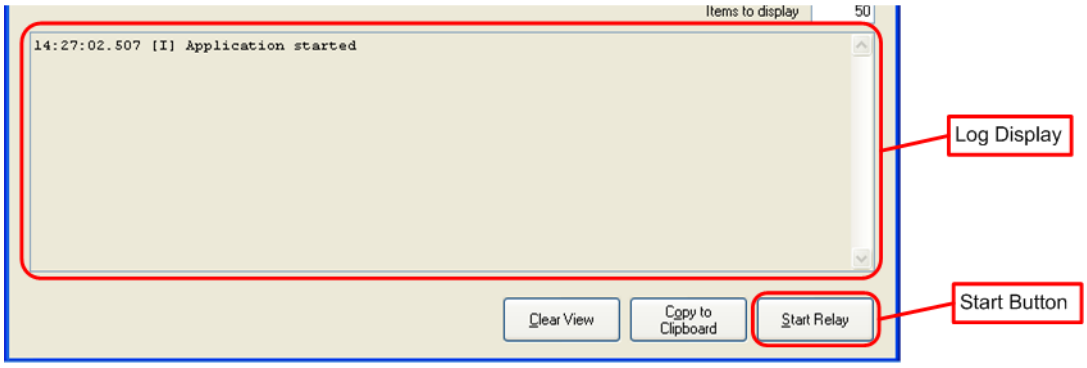


Figure 3-8: Start Relay Button and Log Display

When communication has been established with the modem, the bold indicator field changes to **Media Connected** and the log shows "XBee modem communication established" as shown in Figure 3-9. Also, the "Start Relay" button changes to **Stop Relay**.

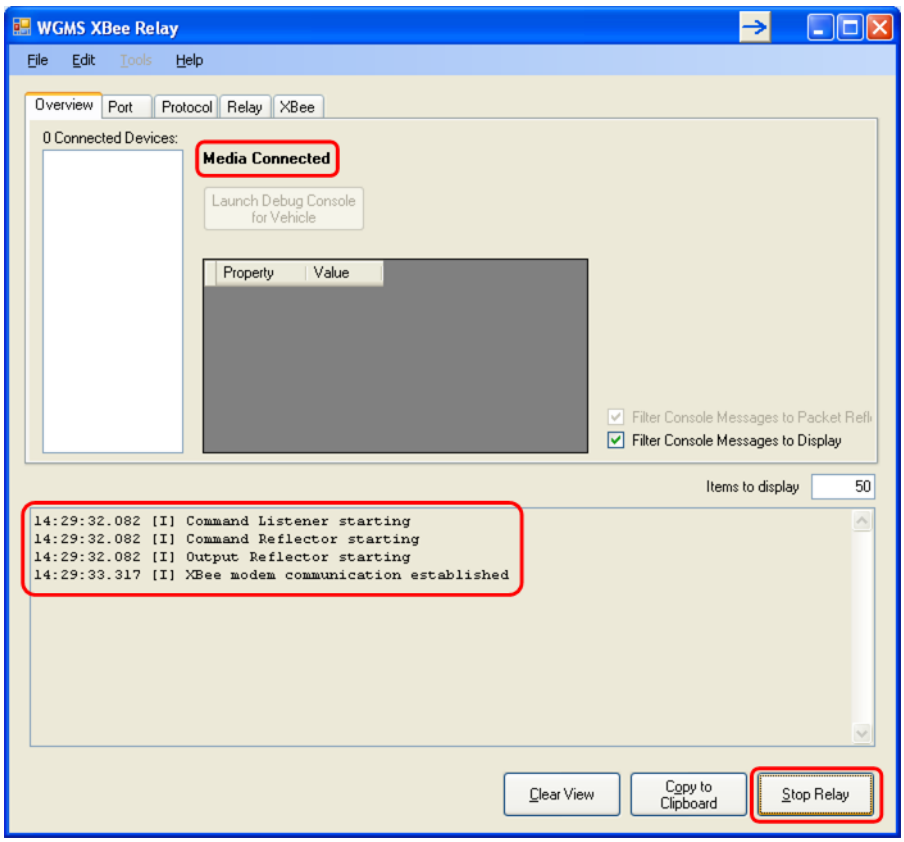


Figure 3-9: XBee Relay Media Connected

3.4.5 Selecting the Vehicle

Any Vehicles with active XBee modems, and within range, connect automatically. The Vehicle numbers are shown in the "Connected Devices" box.

1) If more than one Vehicle is shown in the "Connected Devices" box, you will need to click to select the Vehicle to which you want to communicate. Clicking on a Vehicle causes the details of the selected device to be shown in the adjacent control box.

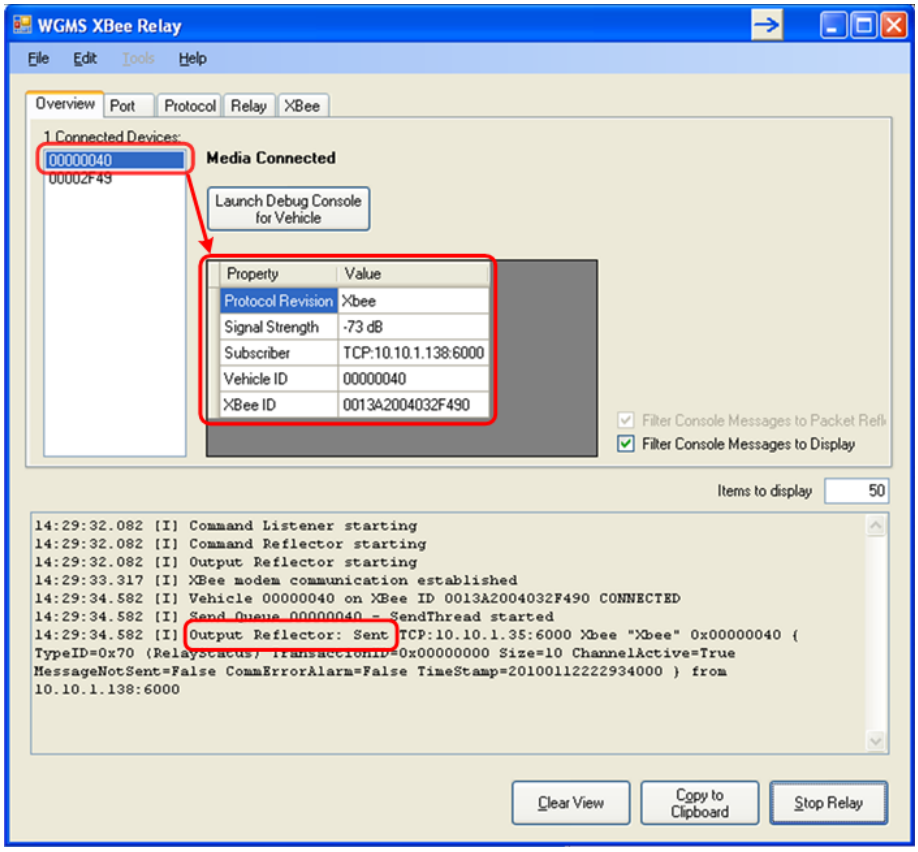


Figure 3-10: XBee Connection Established

If the Packet Reflector IP address was set to a value other than **127.0.0.1**, the "Output Reflector: Sent …" line in the log display indicates successful transmission to the Packet Reflector. If the message reads "Added", instead of "Sent", then there is an error in the IP Address.

If the Packet Reflector UP address was set to **127.0.0.1** ("Home") then it is OK for the message to read "Output Reflector: Added".

3.4.6 Command Line Console

To communicate with the Wave Glider's command-line console, click on the button:

Clicking the button will bring up the small window:

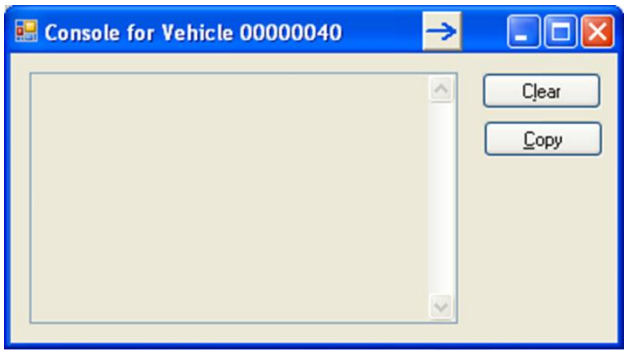


Figure 3-11: Initial Console Screen

Note that the console window size can be expanded by using the mouse to “drag” the right and/or bottom borders.

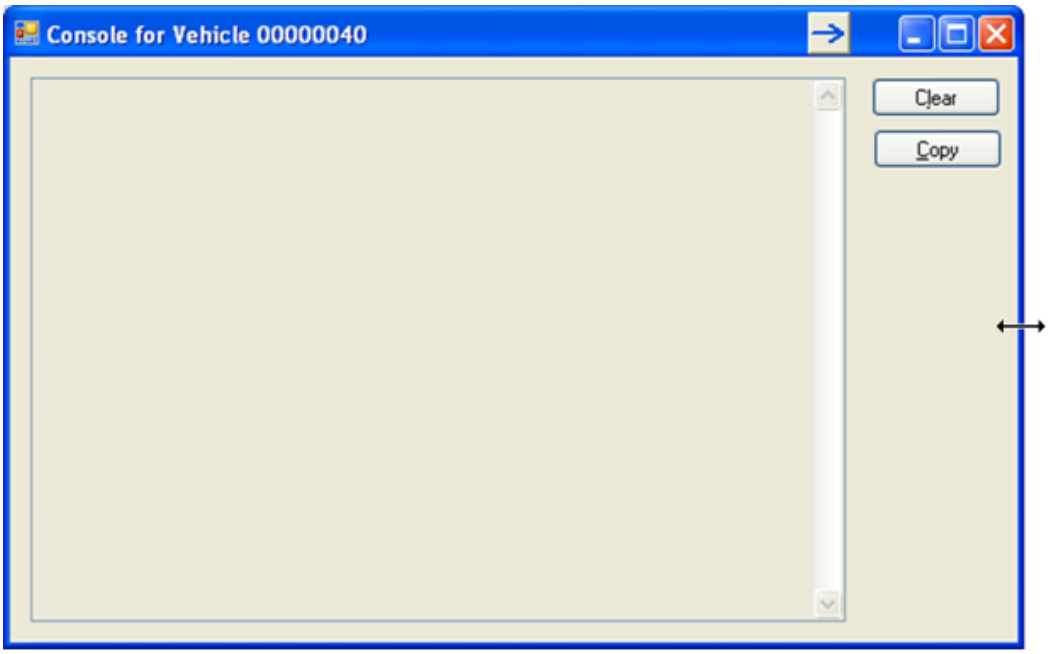


Figure 3-12: Expanded Console Screen

3.4.7 Getting the XBee Menu Screen

Initially, there will be no text in the console window. To show the XBee Menu Screen, (described in section 3.5 below), click in the Console window and enter the value:

100

followed by the "Enter" key.

3.5 XBee Menu Screen

When the line "**100** [Enter]" is typed in, the screen should display the command options:

```
 1) LED On
 2) LED Off
 3) IR On
 4) IR Off
 5) Turn XBee On
 6) Rudder position
 7) Rudder Right
 8) Rudder Center
 9) Rudder Left
10) Set Rudder Trim
11) Show Rudder Trim
12) Set Heading
13) Add Waypoint
14) Clear Waypoint
15) Go To Waypoint (0=hold)
16) Set Course
17) Set Declination
18) Set Sub Compass Cal
19) Show Compass Offsets
20) Rudder Delta
21) Set steering params
22) Set debug level and mask
23) Set float compass offset
24) Show steering params
25) Show WayPoint
26) Show System Charge
27) Show Ind. Battery
28) Pyld1 On
29) Pyld1 Off
30) Pyld2 On
31) Pyld2 Off
32) Show Rudder Compliance
33) Set Rudder Compliance
34) Set GPS Alarm Threshold
35) Bubble On
36) Bubble Off
37) Sub On
38) Sub Off
39) Set Float/Sub Nav Rate
40) Show Float/Sub Nav Rate
41) Set P, I, Sat. values
42) Show P, I, Sat. values
43) PID Navigation On
44) PID Navigation Off
45) Sub Pyld On
46) Sub Pyld Off
47) Ir. Modem Always On
48) Ir. Modem Idle=>Off
49) Show Ir. Mode
50) Cur. Ir. Mode=Default
51) I-PIB On
52) I-PIB Off
54) Set XBee Default
55) Set Ir. Default
91) Reset Pyld File Xfer
92) Set Default Radio   (rev 3 only)
93) Set Default Modem   (rev 3 only)
94) Show Error Counts
95) Show WayPoint Table
96) Show IMEI
97) Show Versions
98) XBee Off
99) Reboot Float
100) Menu
```

Each of the menu commands is described in the next section.

3.6 XBee Command Menu Options

Some XBee menu commands have no confirming responses. Others request additional information. Some of the options are for LRI engineering use only. These are noted.

Also, hitting the Enter key without entering a number will cause the computer to print out status data. Refer to "3.7 Status Response".

1) LED On
2) LED Off

Turns the visible LED lights ON or OFF. The LEDs go On at full power, non-blinking.

3) IR On
4) IR Off

Turns the Infrared LED lights ON or OFF. The LEDs go On at full power.

5) Turn XBee On

This command has no effect.

6) Rudder position

Sets a specific rudder position (not a heading) in degrees. Positive values indicate Right rudder, negative indicate Left rudder. Zero centers the rudder. The allowed range is from –30 to 30.

Request:

```
Enter Rudder Position in Degrees (+30(Right) ==> -30(Left)):
```

7) Rudder Right
8) Rudder Center
9) Rudder Left

Positions the rudder full Right, full Left, or in the center. Left or Right deflection is 30°.

10) Set Rudder Trim

Sets the rudder trim value, in unit degrees. The positive or negative trim value is added to the rudder position.

Request:

```
Enter Rudder Trim Value in Degrees (+30(Right) ==> -30(Left)):
```

11) Show Rudder Trim

Shows the rudder trim value, in degrees.

Output:

```
Rudder Trim: [degrees]
```

12) Set Heading

Sets a new Vehicle heading value, in degrees:

Request:

```
Enter New Heading in Degrees  (0 ==> 359):
```

13) Add Waypoint

Adds a single new Waypoint number and its Latitude/Longitude. Seven items have to be entered in the following order:

Waypoint number (1 to 254)
Degrees Latitude (0 to 89)
Minutes Latitude (0 to 59.9999)
The letter N or S indicating Latitude direction
Degrees Longitude (0 to 179)
Minutes Longitude (0 to 59.9999)
The letter E or W indicating Longitude direction

Request:

```
Enter New Waypoint [# dd mm.mmmm n/s dd mm.mmmm e/w ]:
```

Note: A Waypoint's value can be checked using XBee command 25.

14) Clear Waypoint

Deletes a single Waypoint, defined by the Waypoint number.

Request:

```
Enter Waypoint Number To Clear:
```

15) Go To Waypoint (0=hold)

Directs Vehicle to proceed to a previously-defined Waypoint. If the Waypoint number is zero, the Vehicle holds at the current position.

Request:

```
Enter Target WayPoint Number:
```

16) Set Course

Defines a course consisting of sequential Waypoint numbers, and instructs the Vehicle to proceed toward the Target Waypoint, and then begin looping the course.

Request:

```
Enter Course Info [First_WayPt Last_WayPt Initial_WP_Target]:
```

17) Set Declination

Sets the magnetic declination value at the current location. The value is specified in unit degrees, and can be positive or negative.

Request:

```
Enter The New Declination:
```

18) Set Sub Compass Cal

Adds a fixed offset to the Sub (Glider) compass reading. This is positive or negative value in unit degrees.

Request:

```
Enter The Calibration Factor For The Sub Compass:
```

19) Show Compass Offsets

Shows the compass offset values for both the Float and the Glider (Sub).

Output:

```
Declination: [degrees]  -- Sub Offset: [offset]
```

20) Rudder Delta

Used by LRI for engineering purposes only.

21) Set steering params

Sets the control parameters used for the rudder servo. All 21 values (3 sets of 7) must be specified in a single space-delimited string (which may wrap onto multiple lines). The string is terminated with the "Enter" key.

Request:

```
Settings are:  <Gain> <Timebase> <Deadband> <Goal> <RudderMax>
<MoveMin> <TrimMax>
Format: <Normal Power Settings> <Reduced Power Settings>
<Critical Power Settings>
```

Note: The steering parameter values can be checked using XBee command 24.

22) Set debug level and mask

Used by LRI for engineering purposes only.

23) Set float compass offset

Adds a fixed offset to the Float compass reading. This is positive or negative value in unit degrees.

Request:

```
Enter float offset:
```

Output:

```
Offset = [degrees]
```

24) Show steering params

Shows the various Vehicle heading and steering values. Values are given for all three power levels (Normal, Reduced and Critical).

Output:

```
Normal Power
Gain = [gain], Timebase = [divisor], Deadband = [degrees], Goal = [degrees]
RudderMax = [degrees], MoveMin = [degrees], TrimMax = [degrees]
Reduced Power
Gain = [gain], Timebase = [divisor], Deadband = [degrees], Goal = [degrees]
RudderMax = [degrees], MoveMin = [degrees], TrimMax = [degrees]
Critical Power
Gain = [gain], Timebase = [divisor], Deadband = [degrees], Goal = [degrees]
RudderMax = [degrees], MoveMin = [degrees], TrimMax = [degrees]
```

25) Show WayPoint

Shows the Latitude and Longitude values for a specific Waypoint number.

Request:

```
Enter The WayPoint Number:
```

Output:

```
Way Point #[1→254]: [lat °] [min.dddd] [N,S]  [long °] [min.dddd] [E,W]
```

26) Show System Charge

Shows the current draws, power usage and solar panel charging values.

Output:

```
Pyld1=[nn](10mA), Pyld2=[nn](10mA), Umb=[nn](10mA), Twst=[nn](10mA)
          (128=Off, 129=Over Current)
Total Pwr=[nn](10mWh), Bat Cur=[mA]mA, Sys Cur=[mA]mA, Sys Volt=[mV]mV
Panel0=[nn], Panel1=[nn], Panel2=[nn], Panel3=[nn]
```

27) Show Ind. Battery

Shows the condition of all seven batteries. The bits for the "Status" indicate the following:

Hex	Binary	State
0x00	0000 0000	No Battery
0x01	0000 0001	Battery Present
0x02	0000 0010	Discharged
0x04	0000 0100	Charged
0x08	0000 1000	Discharging
0x10	0001 0000	Discharge Alarm
0x20	0010 0000	Charge Alarm
0x40	0100 0000	Temperature Alarm
0x80	1000 0000	On-Line

The Status bits are OR'ed together to show combinations of states for each battery.

Output:

```
Battery 0: Status=[0xhh], Temp = [deg]C
           Power=[nn] (10mWh), Current=[mA]mA, Voltage=[mV]mV
Battery 1: Status=[0xhh], Temp = [deg]C
           Power=[nn] (10mWh), Current=[mA]mA, Voltage=[mV]mV
  . . . . . . . . . . . . . . . . . . . . .
  . . . . . . . . . . . . . . . . . . . . .
Battery 5: Status=[0xhh], Temp = [deg]C
           Power=[nn] (10mWh), Current=[mA]mA, Voltage=[mV]mV
Battery 6: Status=[0xhh], Temp = [deg]C
           Power=[nn] (10mWh), Current=[mA]mA, Voltage=[mV]mV
```

28) Pyld1 On
29) Pyld1 Off

These options turn On or Off the power to Payload #1 (Forward).

Note: At power-up or re-boot, the Payload 1 power is Off.

30) Pyld2 On
31) Pyld2 Off

These options turn On or Off the power to Payload #2 (Aft).

Note: At power-up or re-boot, the Payload 2 power is Off.

32) Show Rudder Compliance
33) Set Rudder Compliance

Used by LRI for engineering purposes only.

34) Set GPS Alarm Threshold

Sets the count of contiguous invalid GPS fixes that have to be detected before the "GPS Not Functioning" alarm is issued.

The default value is 12. The maximum value that can be set is 255.

Request:

```
Enter The New GPS Error Count Threshold:
```

35) Bubble On
36) Bubble Off

Turns On or Off the power to the Radome (Bubble). Turning On the Radome power does not automatically turn on the lights.

37) Sub On
38) Sub Off

Turns On or Off the power to the Glider (Sub).

39) Set Float/Sub Nav Rate

Sets the rate at which the Float sends navigation (rudder position) commands to the Glider. After the value has been entered, there is no response.

Request:

```
Enter The New Float Navigation Rate in Seconds (2 --> 120):
```

40) Show Float/Sub Nav Rate

Shows the rate at which the Float sends rudder position commands to the Glider.

Output:

```
Current Float Navigation Rate is once every [secs] seconds
```

41) Set P, I, Sat. values
42) Show P, I, Sat. values

Used by LRI for engineering purposes only.

43) PID Navigation On
44) PID Navigation Off

Enables or disables navigation using the PI filter parameters. There is no response.

45) Sub Pyld On
46) Sub Pyld Off

Turns On or Off power to the Sub Payload if present.

47) Ir. Modem Always On

Sets the power for the Iridium Modem to always be On.

48) Ir. Modem Idle=>Off

Allows the Iridium Modem to power Off when not in use.

49) Show Ir. Mode

Displays the current power mode for the Iridium Modem.

50) Cur. Ir. Mode=Default

Sets the default power state of the Iridium Modem (i.e. when the system restarts) to whatever the current mode is (set by 47 or 48).

Note: Unless otherwise set, the default state on a vehicle is that the modem is always on

51) I-PIB On
52) I-PIB Off

Turns On or Off the Internal Payload (weather, water speed and AIS) power.

54) Set XBee Default

Sets the XBee radio as the default communication channel (i.e., the channel over which telemetry is sent).

55) Set Ir. Default

Sets the Iridium Modem as the default telemetry communication channel. (Iridium is the default channel at start-up.)

91) Reset Pyld File Xfer

If a file transfer to a payload is in progress or has stalled, or if the user wants to reset, this command will clear any active file transfers to payloads.

92) Set Default Radio (Rev 3 only)
93) Set Default Modem (Rev 3 only)

These commands are used only for the Rev 3 hardware. This hardware will support either a 9522B modem or a 9601 for the satellite connection. It will eventually support either an XBee connection or a GPRS connection for the short range radio link and the user can specify which type is in the system.

Requests:

```
Enter 0 for XBee and 1 for GPRS:
Enter 0 for 9601 and 1 for 9522:
```

94) Show Error Counts

Shows the counts for all errors since the last re-boot.

Note: The output response shown below is abbreviated. The actual output is longer.

Output:

```
Field Name                  | Count
----------------------------|------
Sub RX Timeout              | [cnts]
Sub RX CRC                  | [cnts]
Sub RX Overflow             | [cnts]
Sub RX Incomplete           | [cnts]
Sub Download Fail           | [cnts]
Sub Program Fail            | [cnts]
Sub Low Power               | [cnts]
Sub Local Power             | [cnts]
Sub Bad Heading             | [cnts]
Sub Magnetometer            | [cnts]
Sub Accelerometer           | [cnts]
Sub Pressure Fail           | [cnts]
Sub Brd Temp Fail           | [cnts]
Sub H2O Temp Fail           | [cnts]
Sub Cal Eeprom Bad          | [cnts]
Sub Nav Eeprom Bad          | [cnts]
. . . .
Charge Twist Over Current   | [cnts]
Bubble RX Timeout           | [cnts]
Bubble RX CRC               | [cnts]
Bubble RX Overflow          | [cnts]
Bubble RX Incomplete        | [cnts]
Bubble Download Fail        | [cnts]
Bubble Program Fail         | [cnts]
Bubble GPS Off              | [cnts]
. . . .
GPS Invalid Fix             | [cnts]
GPS Invalid Checksum        | [cnts]
GPS RX Timeout              | [cnts]
Leak Alarm Triggered        | [cnts]
Shield Fault Triggered      | [cnts]
Iridium SBDWB               | [cnts]
Iridium SBDRB               | [cnts]
Iridium SBDI                | [cnts]
Iridium SBDI Overflow       | [cnts]
Iridium SBDI Timeout        | [cnts]
Iridium IMEI                | [cnts]
Iridium Queue Full          | [cnts]
Iridium Signal Quality      | [cnts]
```

95) Show WayPoint Table

Displays a complete table of all possible Waypoint values. A line of all dashes indicates that no values have been assigned to that Waypoint.

Note: The output response shown below is abbreviated. The actual output is 256 lines long.

Example Output:

```
 Num |   Latitude     | N/S |   Longitude    |E/W
-----|--------------- |-----|--------------- |---
#001 | [deg] [mm.mmmm] |[N,S]| [deg] [mm.mmmm] |[E,W]
#002 |--------------- |-----|--------------- |---
#003 |--------------- |-----|--------------- |---
#004 | [deg] [mm.mmmm] |[N,S]| [deg] [mm.mmmm] |[E,W]
#005 | [deg] [mm.mmmm] |[N,S]| [deg] [mm.mmmm] |[E,W]
#006 | [deg] [mm.mmmm] |[N,S]| [deg] [mm.mmmm] |[E,W]
#007 | [deg] [mm.mmmm] |[N,S]| [deg] [mm.mmmm] |[E,W]
  . . . . . . . . . . . . . . . . . . . . . .
  . . . . . . . . . . . . . . . . . . . . . .
#253 |--------------- |---|--------------- |---
#254 |--------------- |---|--------------- |---
```

96) Show IMEI

Shows the 15-digit International Mobile Equipment Identity number for the Iridium modem in the C&C Drybox.

Output:

```
Modem IMEI: [15 digits]
```

97) Show Versions

Shows the versions of all the Vehicle software and hardware. The Build number is a 4-digit value. Each version number is defined as "major.minor", using two 2-digit numbers.

Output:

```
Float Software Version [nn.nn] Build [mmmm]
Rudder Software Version [nn.nn] -- Hardware Version [nn.nn]
Radome Software Version [nn.nn] -- Hardware Version [nn.nn]
Sensor Module Software Version [nn.nn] -- Hardware Version [nn.nn]
Battery Charger Software Version [nn.nn] -- Hardware Version [nn.nn]
```

98) XBee Off

Turns Off the XBee. If this is done, the XBee can only be turned On again by using an Iridium command (or by manually power-cycling the Vehicle). Thus, a confirmation is requested.

Request:

```
Are You Sure You Want To Turn Off The XBee (Y/N):
```

99) Reboot Float

Re-boots the C&C computer. All Vehicle parameters will revert to the default values, and all Waypoint values will be lost. Thus, a confirmation is requested.

Request:

```
Are You Sure You Want To Reboot The Float (Y/N):
```

100) Menu

Re-displays the complete menu command list shown in section 3.5 “XBee Menu Screen".

3.7 Status Response

Simply hitting the "Enter" key without entering a number will get the status response in the format:

```
Position: [Lat °] [min.dddd] [N/S]  [Long °] [min.dddd] [E/W]
Float Heading: [deg] -- Float Temp: [°C] -- Float Pressure: [kPa]
Sub Heading: [deg] -- Sub Temp: [°C] -- Sub Pressure: [kPa]
Sub Rudder Position: [deg (*)] -- Sub Rudder Driver Position: [deg (*)]
[course description (**)]
```

(*) The rudder position is indicated using symbols as follows:

| → Centered
^/ → Left
\^ → Right

(**) Possible course descriptions are:

```
Performing Sequential Course - Loop: Now heading to Waypoint [wpt #]
Performing Custom Course: Now heading to Waypoint [wpt #]
Holding Fixed Rudder Position [degrees]
Holding Fixed Heading [degrees]
```

3.8 Menu Error Responses

If there is a Menu entry error, you will get one of the following responses:

```
This option is not supported yet!
Position **INVALID**: [Lat °] [min.dddd] [N,S]  [Long °] [min.dddd] [E,W]
One (or more) of the waypoints entered did not exist!
The waypoint requested does not exist!
```

Chapter 4 – Provisioning a Wave Glider

This chapter covers the general steps required to provision a new Wave Glider Vehicle. The planning of a Mission is described in Chapter 5.

If the Vehicle is new (to your Organization), its data and configuration will need to be entered onto WGMS system database. If your Vehicle has already been named and entered onto the system, then you can skip this chapter.

For details on Vehicle unpacking and assembly, refer to the Wave Glider *Unpacking and Assembly* document. For information on configuring payloads for the Float and Glider, refer to the *Interface Control Description* document.

4.1 Provisioner Role Requirements

As described in section 2.2.2, "Roles" are assigned by a System Administrator, and each Role grants specific privileges for mission controls when using the WGMS.

In order to provision a Vehicle, as described below, you will need to be assigned either "Master" or “Admin” Role privileges.

4.2 Entering a Vehicle Into the Database

4.2.1 Organizations

When you logged on, you selected your Organization. All of the descriptions below refer to provisioning Vehicles within this Organization.

Even if you are allowed to log into more than one Organization, you cannot directly copy or otherwise transfer information from one Organization to another.

4.2.2 Vehicle Name

The first step is to come up with a name for your Vehicle. This can be whimsical (e.g., "Shark Bait"), descriptive (e.g., "Yellow Boat") or indicate its purpose (e.g., "#5 Weather Station").

All database information (e.g., Waypoint numbers, Polygon positions/shapes, etc.) will be associated only with that Vehicle name.

The name can have a maximum of 128 characters and can include blanks, numbers or any printable keyboard character. However, most of the name display boxes in the user interface show about 20 characters. So if your Organization has more than one Vehicle, it is best if the first characters of your Vehicle name are descriptive and unique. Thus the example names:

#1 North Station, Acme Oceanic Inc.
#2 South Station, Acme Oceanic Inc.

would be preferable to:

Acme Oceanic Inc. Station North #1
Acme Oceanic Inc. Station South #2

There is nothing to prevent provisioning different Wave Gliders with the same name. The database will store each Vehicle's data separately. However, this is not recommended as it can obviously cause confusion about which Vehicle's data is being referenced.

4.2.3 Create and Name a New Vehicle

First, sign-in to get on the Dashboard home page (ref. 2.2.5). Next, click on Show System Menus to bring up the Home/Vehicles/System Area Nav Buttons at the lower left.

Click on "Vehicles" to bring up the Vehicles page, which should look similar to the Figure below.

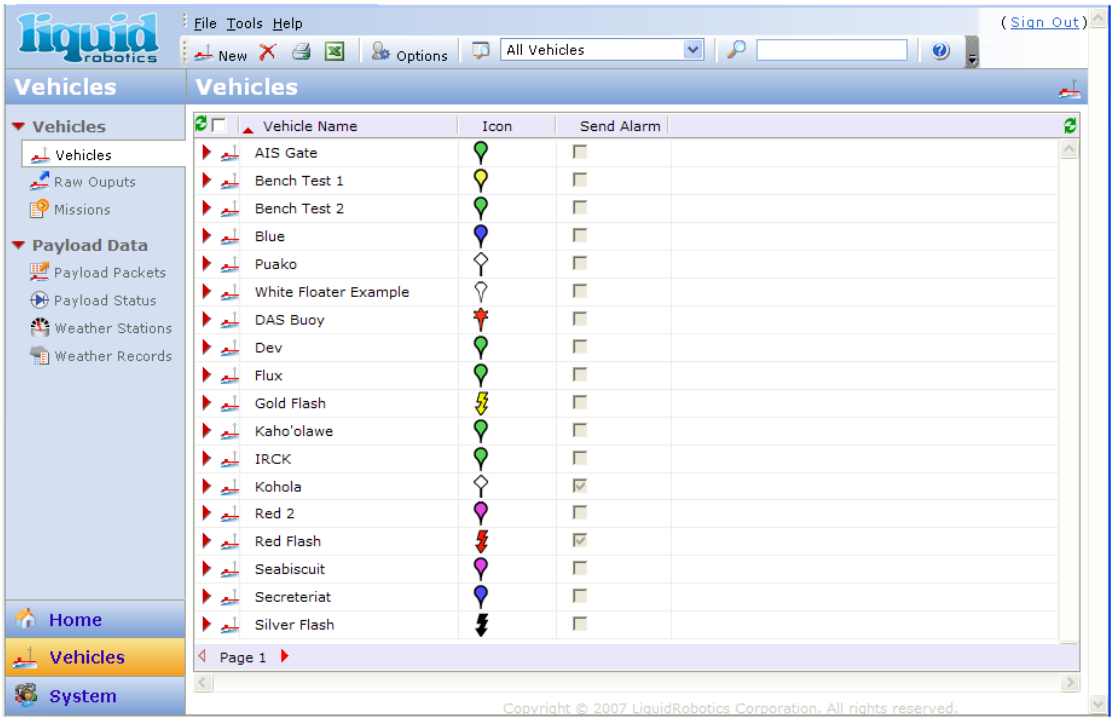


Figure 4-1: Vehicles Initial Page

Note: Only 25 Vehicles are shown on each page. If there are more than 25 Vehicles in the list, the right-pointing triangle in the lower-right corner will be solid. Click on the solid triangle to go to the next page.

In the upper left corner of the page is the [New Vehicle] icon, highlighted in Figure 4-2.

Figure 4-2: New Vehicle Icon

To create a new Vehicle in the system, click on the "New" (or the icon to the left).

Clicking on the "New" icon should bring up the New Vehicle dialog box:

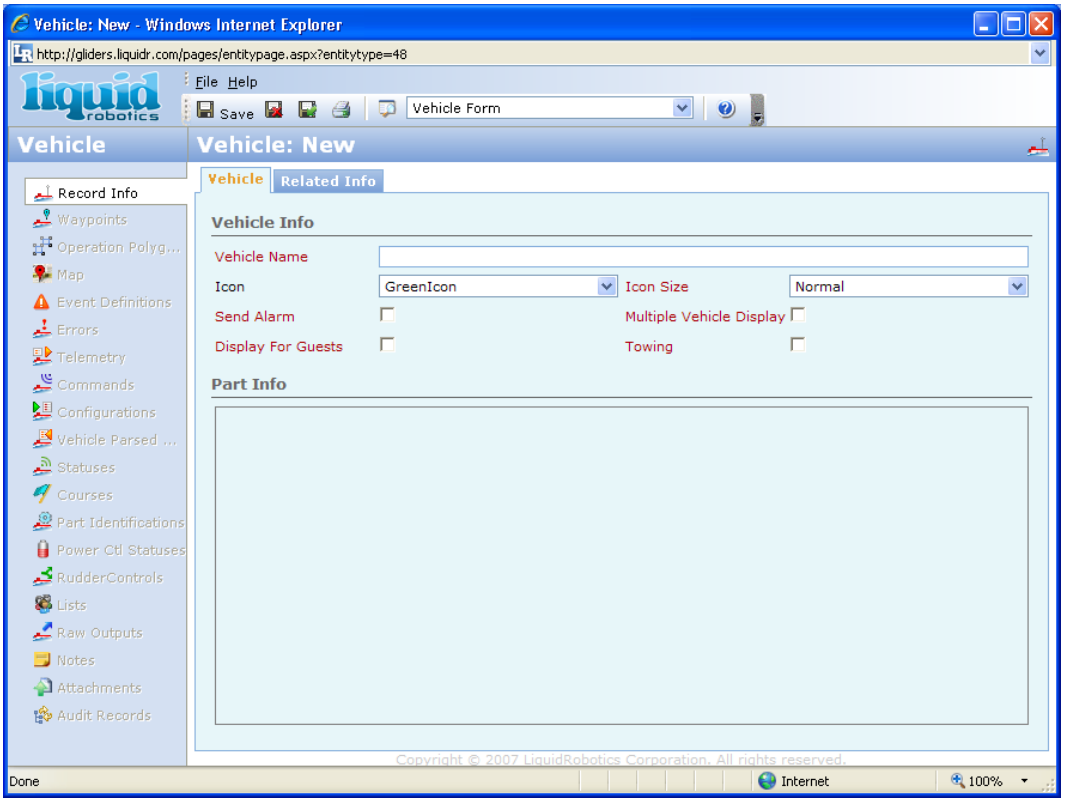


Figure 4-3: New Vehicle Dialog Box

1) First enter the Vehicle Name. See 4.2.2 above for suggestions on Vehicle names.

2) Next select the icon that will be used to represent the Vehicle on the Position Map. With 6 shapes and 9 colors, there are 54 possible combinations. They are:

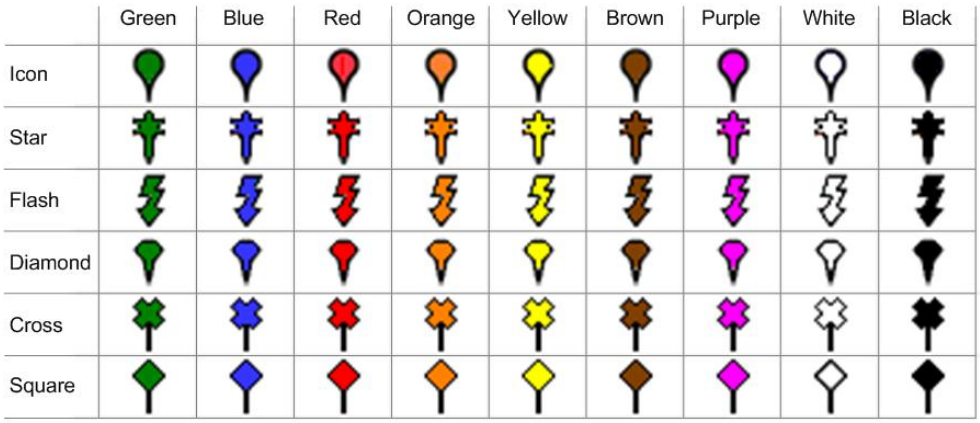


Figure 4-4: Vehicle Icons

It can be helpful to select a color and an icon that is in some way representative of the Vehicle name (e.g., "Blue Star Buoy").

3) Select the Icon Size. The recommended size is "Small". All of the examples in this document use the small-size icons.

4) Vehicle alarms are always recorded in the database, and indicated on-screen. Checking the "Send Alarm" box specifies that, in addition, the alarms are to be sent to the Escalation List (ref. section 4.7 “Adding a List").
5) Checking the "Multiple Vehicle Display" box specifies that the vehicle will be available for selection on the Dashboard Vehicle Select List.

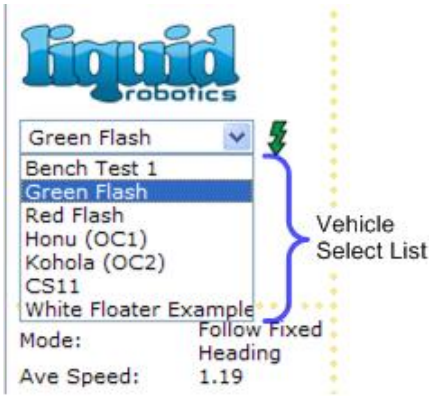


Figure 4-5: Dashboard Vehicle Select List

6) Checking the "Display for Guests" box specifies that the Vehicle will be allowed to be viewed by persons within your Organization with Guest User Role privileges.
7) Checking the "Towing" box specifies that the towing alarm will be checked. (This currently has no effect.)

Note: The large "Part Info" box does not allow entering data yet. This data will be entered beginning in section 4.3 “Initializing the Part Info Tree".

8) When all the data has been entered, click the Save Icon (on the left) to keep the form open.

Figure 4-6: New Vehicle "Save" Icons

Alternatively, click the Save and close Vehicle" icon (on the right) to close the dialog box. Then re-open the newly created Vehicle Data window for editing, as described in 4.3 below.

Note: The "Copy Vehicle" icon (see Figure) can be used to copy the information from another Vehicle in your Organization. However, once you have clicked the "Save" icon, the Copy Icon is not shown.

Figure 4-7: New Vehicle "Copy Vehicle" Icon

4.3 Initializing the Part Info Tree

The Part Info tree specifies the basic characteristics of your new Vehicle. The steps below show how to create the initial Part Info data. Section 4.8 describes how to complete the tree using data sent from the Vehicle itself.

4.3.1 Obtaining the IMEI Number

In order to set up the Part Info data, you will need the IMEI number of the Iridium modem in the Vehicle. The IMEI is the "phone number" of the modem. It is a 15-digit number starting with the numbers: **300034012**. The number can be obtained as follows:

1) The IMEI should be on the Packing Slip that accompanied the Vehicle.
2) If the Packing Slip is not available, the IMEI may be shown on the top of the C&C drybox in the Vehicle. You will need to remove the turtledeck cover to access the C&C box.
3) If neither of the above sources yields the IMEI, you can obtain it using an XBee connection. Follow the procedures shown in Chapter 3 to get on XBee. Then issue the XBee command number **96** [Show Modem IMEI]. XBee should then return the number.

4.3.2 Adding Part Info Data

If the New Vehicle dialog box was closed, re-open it by double-clicking again on the Vehicle name on the Vehicles page.

Note that the header in the dialog box is now "Edit", rather than New, and the "Part Info" box now contains the Vehicle name, as shown in the example below.

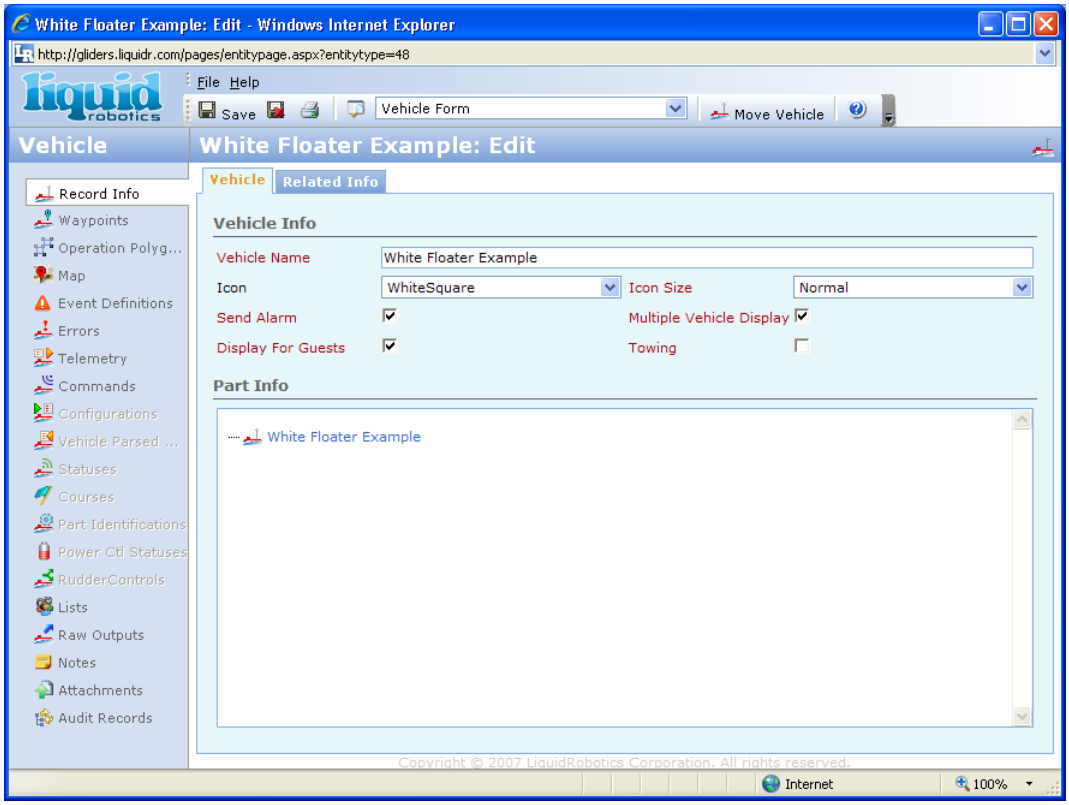


Figure 4-8: New Vehicle Edit Dialog Box

First, add the Float and its basic sub-assemblies to the Part Info tree:

1) Right click on the Vehicle name in the Part Info box. Select "New Part" and left click. The dialog box below should appear:

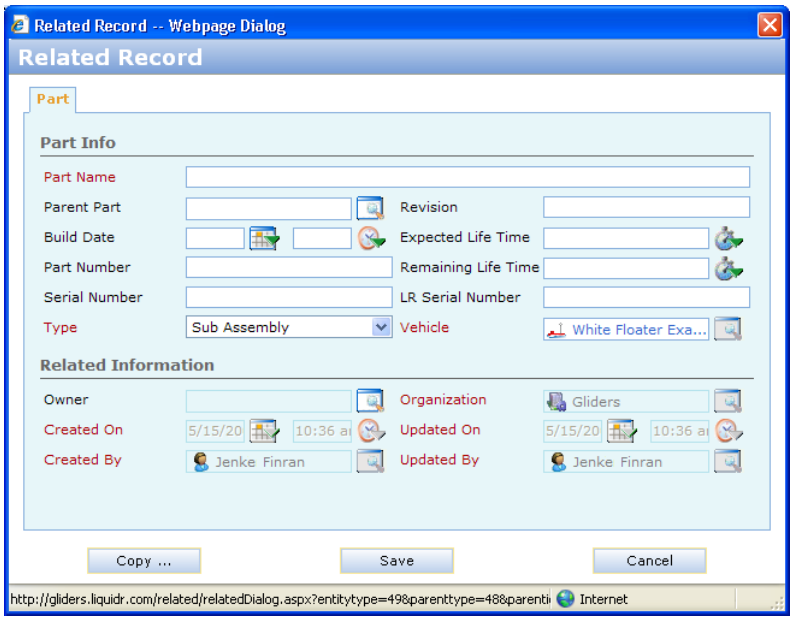


Figure 4-9: New Part Dialog Box

2) For the Part Name, enter **Float**.
3) For the Type, leave **Sub Assembly**.
4) Click the "Save" button at the bottom center. The dialog box will close, and "Float" should now show in the Part Info box below the Vehicle name.
5) In the Part Info box, right click on "Float", then select "New Part" to again bring up the dialog box.
6) Add a new Part Name of **C&C Drybox**. Leave the Type as **Sub Assembly**. Click the "Save" button to close the dialog box.
7) Now, right click on "C&C Drybox", and again select "New Part" to bring up the dialog box.
8) Add a new Part Name of **Iridium Modem**. For the "Type" click down to select from the list "Iridium Modem".
9) In the Serial Number field, type in the 15-digit IMEI number you obtained earlier, as described in section 4.3.1 above.
10) Click "Save" to exit. The Part Info box should now look similar to:

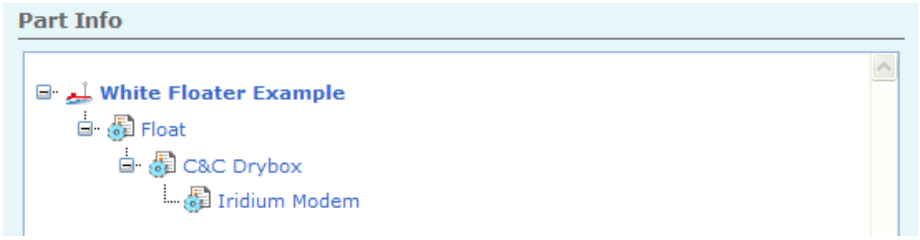


Figure 4-10: Part Info Box With Float Info

Next, add the basic software data to the Part Info tree:

1) Right click on the Vehicle name at the top, and click New Part to bring up the dialog box.
2) Add a new Part Name of **Shoreside Software**. Leave the Type as "Sub Assembly".
3) Click "Save" to exit.
4) Now, right click on Shoreside Software, and then New Part.
5) Add a new Part Name of **Firmware Level**. Click down to set the Type as "Firmware Level".
6) In the Revision field, enter the value of **2.0** (this indicates a Model 08).
7) Click "Save" to exit the dialog box. The Part Info box should now look like:

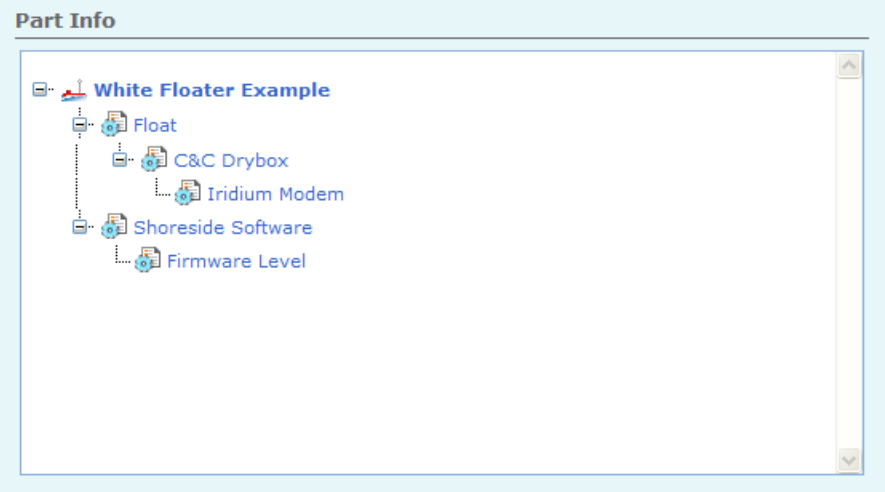


Figure 4-11: Part Info Box Initial Setting

This completes the initial setting of the Part Info box. Additional data will be added in the section 4.8 “Completing the Part Info Tree".

For now, click on the "Save" icon at the top to exit the Vehicle Edit dialog.

4.4 Adding Event Definitions

All alarms have default values to indicate when each type of alarm will be triggered, and what the response should be. Event Definitions are used to modify these defaults.

There are two ways Event Definitions can be added:

- If this is your first Vehicle, you will need to enter each of the definitions manually, as described in 4.4.1 “Creating New Event Definitions".
- If your Organization has another Vehicle that has already been provisioned, and has similar characteristics to your new Vehicle, then you can copy over the definitions from the other Vehicle, as described in section 4.4.2 “Copying Event Definitions".

4.4.1 Creating New Event Definitions

Double-click on the Vehicle name in the list on the Vehicles Page. When the Vehicle Data window comes up, click on the "Event Definitions" tab in the left-side bar. You should get a box with no definitions, similar to:

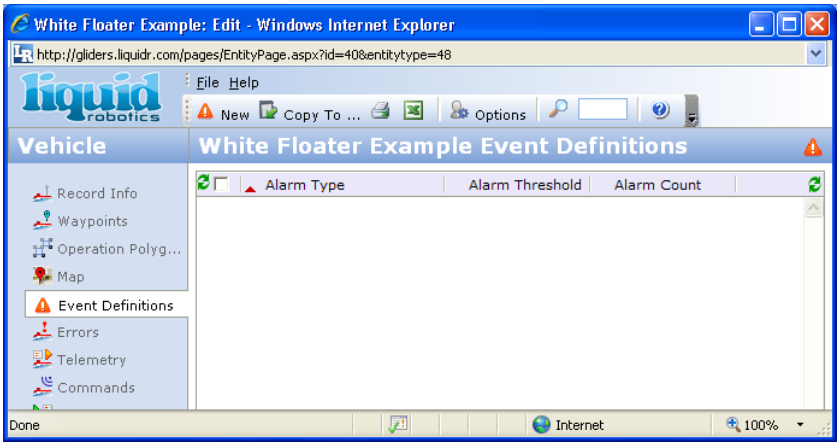


Figure 4-12: Event Definitions Empty Specification

You want to add nine sets of alarm values. To start, click on the "New" [New Event Definition] icon. This should bring up the dialog page:

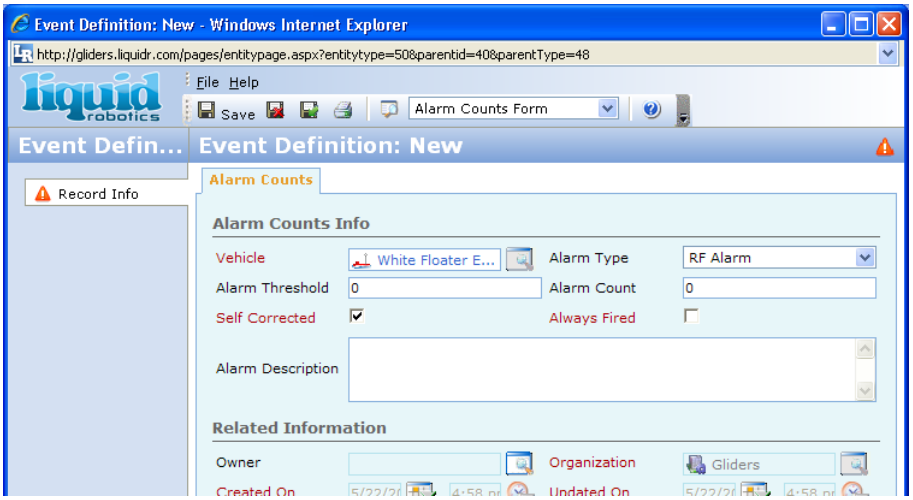


Figure 4-13: New Event Definition Dialog

First, set the "Sub To Float" alarm:

1) In the "Alarm Type" box, pull down to select **Sub To Float**.
2) In the "Alarm Threshold" box, enter the number **1**
3) Verify that the "Self Corrected" box is checked.
4) Add a check in the "Always Fired" box.
5) Click the left "Save" [Save Event Definition] icon to save the data, but not exit the dialog.

Next, set the "Sub Reboot" alarm:

1) In the "Alarm Type" box, pull down to select **Sub Reboot**.
2) In the "Alarm Threshold" box, enter the number **1**
3) Add checks in the "Self Corrected" and "Always Fired" boxes.
4) Click the "Save" [Save Event Definition] icon to save the value.

Next, set the "GPS Not Functioning" alarm:

1) Select **GPS Not Functioning**.
2) Set the "Alarm Threshold" to **15**
3) Check the "Self Corrected" and "Always Fired" boxes, then Save.

Next, set the "RF Alarm":

1) Select **RF Alarm**.
2) Set the "Alarm Threshold" to **5**
3) Check the "Self Corrected" and "Always Fired" boxes, then Save.

Repeat the procedure to set the remaining Alarm Type names and Threshold numbers:

- Out of Bounds [**3**]
- Communication Timeout [**15**]
- Empty Packet [**5**]
- Stuck GPS [**5**]
- File Read Timeout [**25**]

The final Event Definitions box should now look similar to:

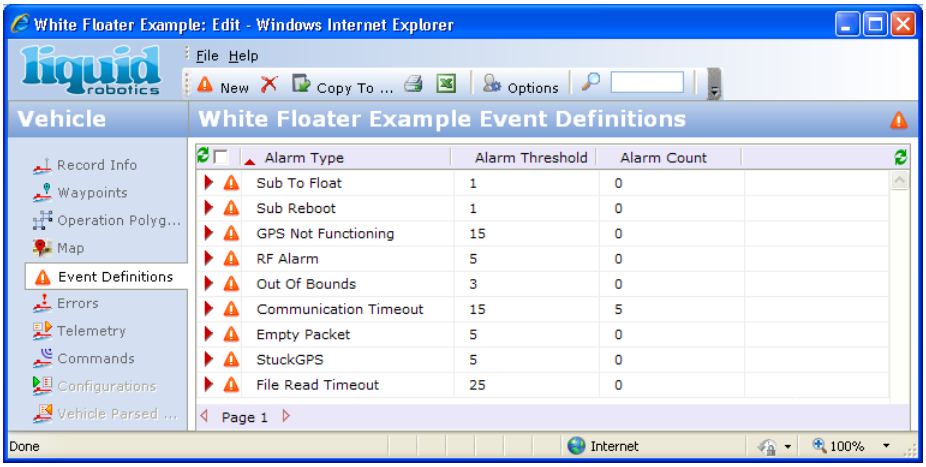


Figure 4-14: Completed Event Definitions Specification

Any of the above data values (including the Alarm Type name) can be changed by double-clicking on a name to call up a dialog box for editing.

4.4.2 Copying Event Definitions

To copy Event Definitions from another Vehicle, do the following:

1) On the Vehicles page, locate another Vehicle that is identical or similar to your new Vehicle.
2) Double-click on the other Vehicle's name to bring up its Vehicle Data.
3) On the left side, click on the "Event Definitions" tab to bring up the dialog for event definitions. The box should be similar to Figure 4-15.
4) Click in the "Select All" checkbox. A check should appear in the box, and all the items below should be selected (indicated by a blue-grey background).

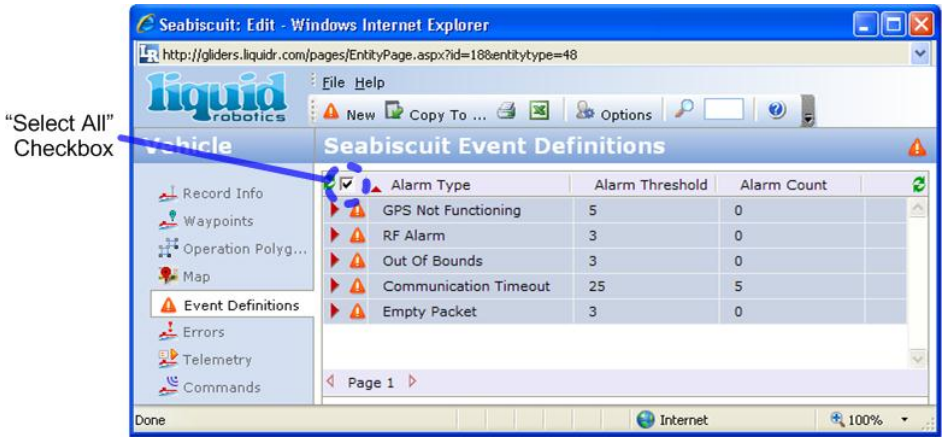


Figure 4-15: Event Definitions Copy Dialog

5) Click on the icon for "Copy To ..." [Copy to another Event Definition]. Click "OK" when queried with the "Are You Sure….?"
6) A new Related Record dialog box should come up, showing a current list of the Vehicles. Single-click on the name of your new Vehicle (the one to want to copy the event data to). The name should be highlighted in Blue-Gray, similar to:

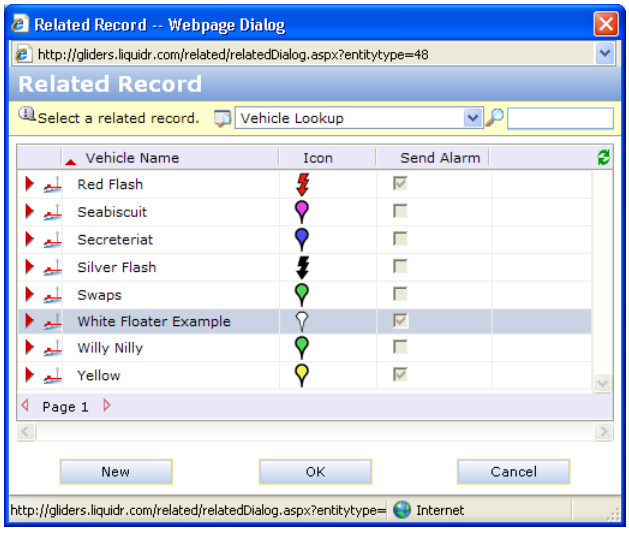


Figure 4-16: Copy-To Dialog Box (Event Definition)

7) To copy the data, click the "OK" button at the bottom center.

8) You should now see a small box with the words "Records Copied". Click on the "OK" button at the bottom.
9) Close the Event Definitions dialog box for the Vehicle you copied from.

You can cross-check that the values were copied. Double click on your Vehicle's name on the Vehicles page to bring up the Vehicle Edit page, then click on "Event Definitions" on the left bar. You should see the copied values.

Note: There may be more Alarm Types than shown in the above Figure 4-15. However, the five shown are considered the "minimum set" necessary.

4.4.3 Changing or Deleting Event Definitions

Event Definitions can be changed or added by double-clicking on an Alarm Type name to call up a dialog box for editing. (You can even change the Alarm Type name itself.)

Deleting Event Definitions requires Master or Admin Role privileges.

4.5 Adding Operation Polygons

4.5.1 Operation Polygon Definition

Recall that there are two types of Operation Polygons, Inclusion and Exclusion.

- Inclusion Polygons are used to define the "boundary" of a course. If the Vehicle goes outside an Inclusive Polygon boundary, an Alarm will be issued.
- Exclusion Polygons are used to define "off-limits" areas where the Vehicle is not supposed to go. If the Vehicle crosses into one of these areas, an Alarm will be issued.

An Operation Polygon is specified as a series of points. Each of the points has:

1) A sequence number (the "Order" number)
2) A Latitude position value
3) A Longitude position value

The polygon is defined by connecting each of the position points in the specified order. The polygon is closed by connecting the last point with the first. The Order numbers need not start at zero or one, though that is recommended. Also, the numbers do not need to be sequential (i.e., you can skip numbers).

The minimum number of points (sides) is three, and there is no maximum limit. The polygon can be any shape but must enclose a single area (i.e., none of the defining edges can cross). The points have to be specified in a counter-clockwise order.

In addition to defining the points, you assign each Operation Polygon a descriptive name (e.g., "Marine Sanctuary Exclusion"). Each Operation Polygon has the option of being displayed (or not) on the Dashboard map. Typically, an Alarm will be sent if the Vehicle crosses an Operation Polygon boundary, but this feature can be disabled.

As with Event Definitions, Operation Polygons can be either defined "from scratch" (ref. 4.5.2), or copied over from another Vehicle (ref. 4.5.3).

4.5.2 Creating New Operation Polygons

Go to the Vehicles Page and double-click on the new Vehicle's name, which will bring up the Vehicle specification box. Then click on the "Operation Polyg..." tab on the left side. You should get a box with no definitions, similar to:

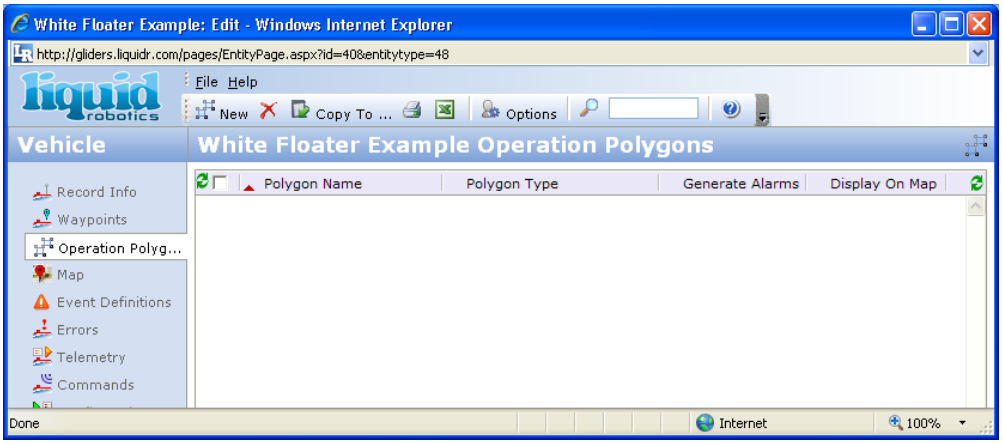


Figure 4-17: Operation Polygons List (Empty)

To add a new Operation Polygon, click on the "New" [New Operation Polygon] icon. This should bring up the dialog page:

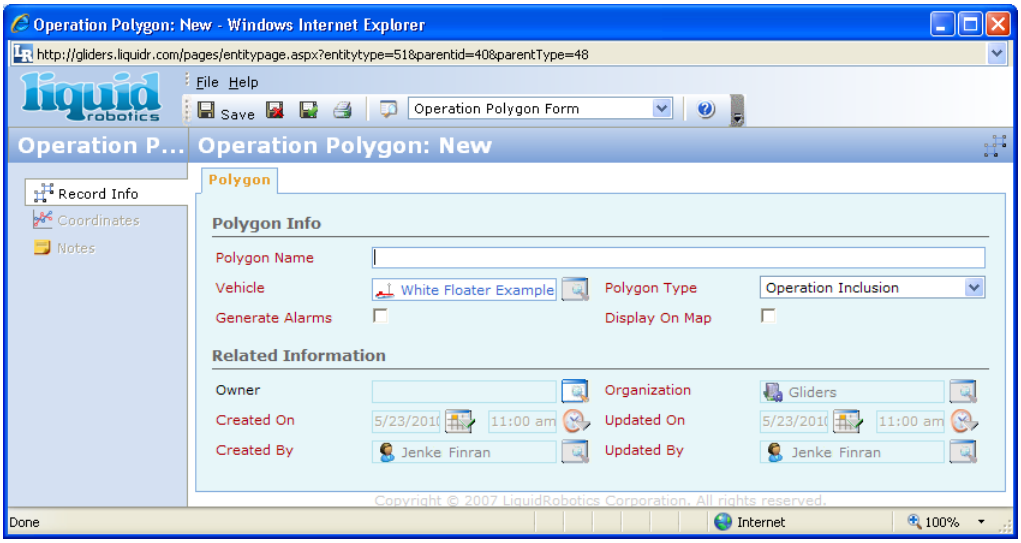


Figure 4-18: New Operation Polygon Definition

Fill in the following:

1) In the "Polygon Name" box, enter a name for the polygon. This name should be descriptive of the polygon, such as "Shipping Lane Exclusion".
2) In the "Polygon Type" box, pull down to select one of the two options:

   Operation Inclusion
   Operation Exclusion

3) Click in the box for "Generate Alarms" if you want the Vehicle to issue an alarm if the polygon boundary is crossed.
4) Click in the box for "Display on Map" if you want the Operation Polygon to be visible on the Dashboard map.
5) Click the left "Save" [Save Operation Polygon] icon to save the data, but not exit the dialog.

For the example below, assume that the assigned Polygon Name was "WF Inclusion Polygon".

The next step is to assign the set of points defining the polygon. Notice that the "Coordinates" tab on the left side is now active. Click on this to bring up the dialog for defining the Lat/Long coordinates and Order number, as shown below.

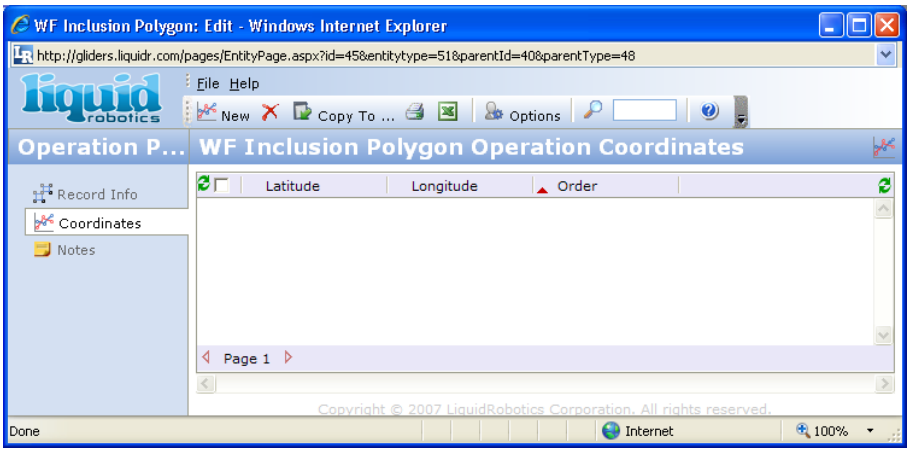


Figure 4-19: Operation Polygon Coordinates List (Empty)

Now, click on the "New" [New Operation Coordinate] icon. This should bring up a dialog box to enter the coordinates and Order number:

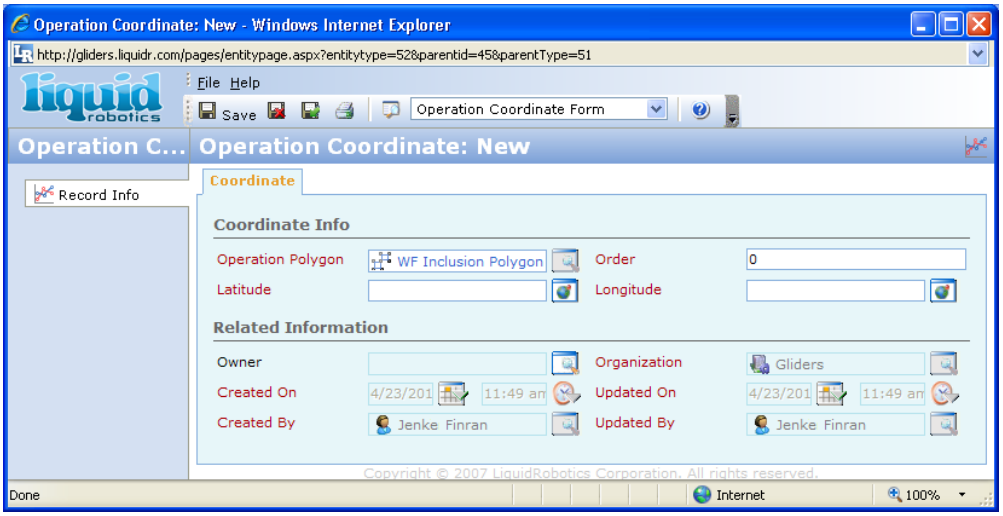


Figure 4-20: New Operation Coordinate Entry Dialog

Note: The icons to the right of the "Latitude" and "Longitude" entry boxes call up a dialog that converts degrees and minutes to the required degrees and fractions format.

In the box:

1) Enter the "Order" number. It is suggested that you start from 0 or 1 and count up.
2) Enter the "Latitude" in degrees and fractions (positive → N, negative → S).
3) Enter the "Longitude" in degrees and fractions (positive → E, negative → W).
4) Click on the left-side "Save" [Save Operation Coordinate] icon. This saves the values and clears the box for another entry.
5) Repeat steps 1 thru 4 until all the points for "WF Inclusion Polygon" have been entered.
6) Finally, click the "X" in the upper right to close the dialog box.

At this point, the polygon has been defined. Re-opening (or refreshing) the Operation Polygon Coordinates List will show the set of coordinates that have been defined for the polygon named "WF Inclusion Polygon".

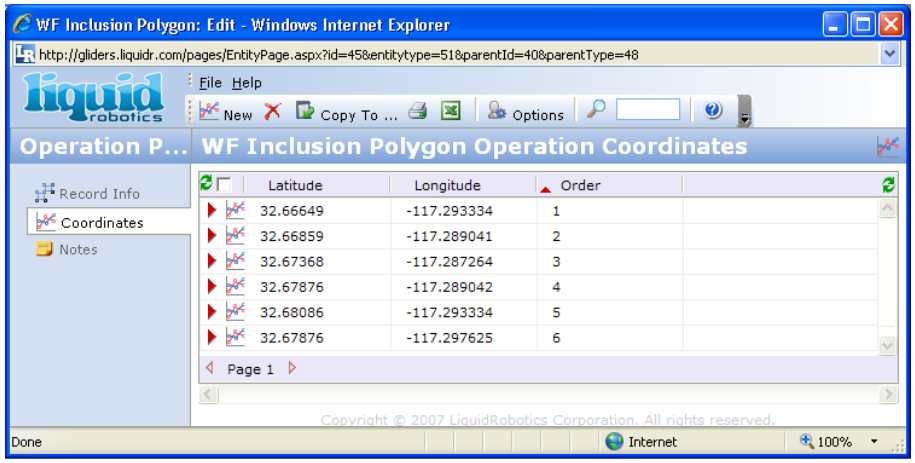


Figure 4-21: Operation Polygon Coordinates List

If you re-open (or refresh) the Vehicle Operation Polygons box, you will now see an entry for the polygon just defined:

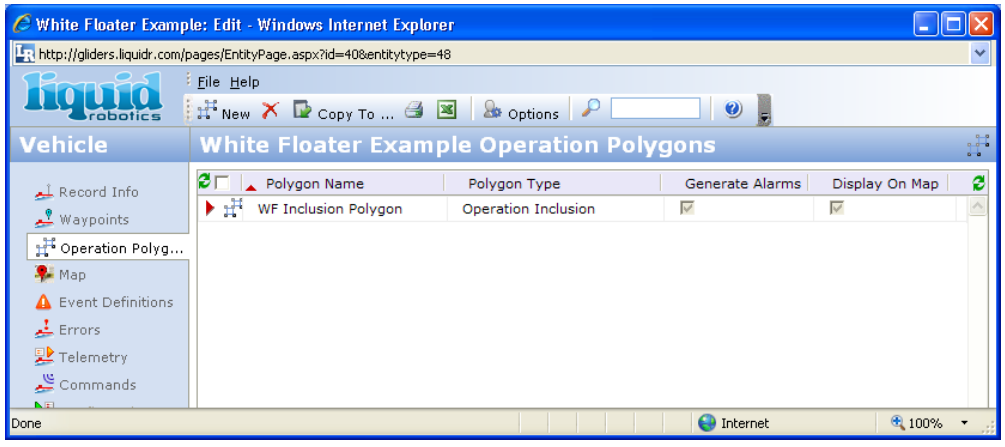


Figure 4-22: New Operation Polygon Specification

For each additional polygon, click on the "New" icon to repeat the procedure defined above.

When complete, the above specification box will likely have multiple Inclusion and Exclusion polygons, such as the example list shown below:

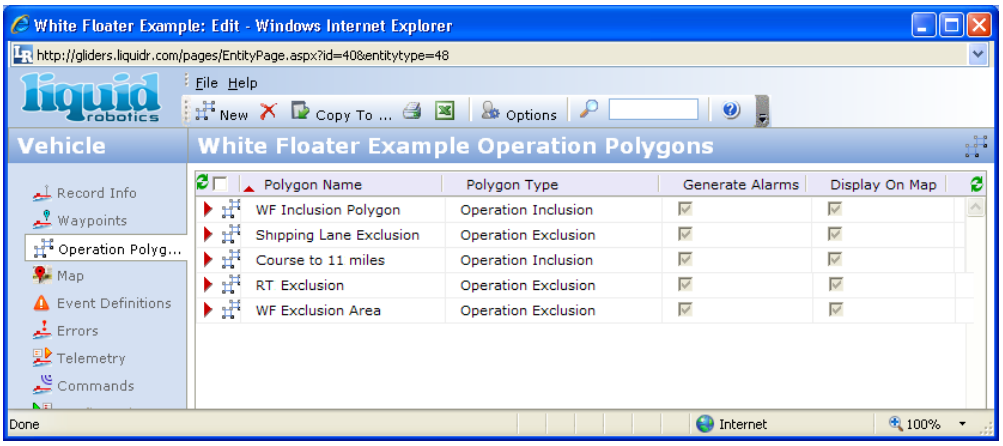


Figure 4-23: Example Operation Polygons List

4.5.3 Copying Operation Polygons

When copying Operation Polygons, the assumption is that the new Vehicle will be operating in essentially the same area as the Vehicle whose data is being copied. The copied polygons can then be deleted or edited as necessary.

The procedure for copying is:

1) On the Vehicles page, locate another Vehicle in your Organization that operates in the same region as your new Vehicle.
2) Double-click on the other Vehicle's name to bring up its Vehicle Data.
3) On the left side, click on the "Operation Polygons" tab to show the polygons defined for that Vehicle. The window should be similar to:

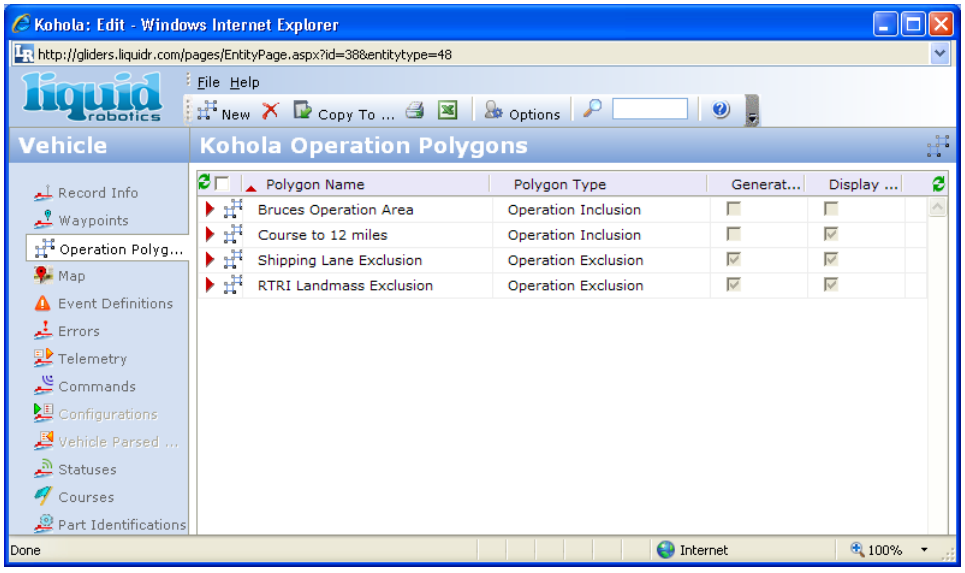


Figure 4-24: Operation Polygons Copy Dialog

4) Hold down the "Ctrl" key and left-click to select each of the polygons that you want to copy. Or, click in the box to the left of "Polygon Name" to select all. The selected lines will turn Blue-Gray. (Ctrl-clicking a selected line will un-select it.)
5) Click on the icon for "Copy To …" [Copy to another Operation Polygon]. Click "OK" when queried on the copy.
6) A new Related Record dialog page should come up, showing a current list of the Vehicles:

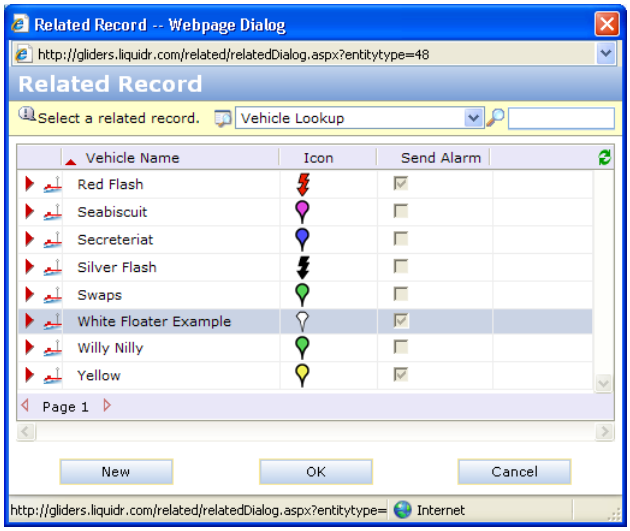


Figure 4-25: Copy-To Dialog Box (Polygons)

7) Click on the name of your new Vehicle (the one to want to copy the polygons to). The name line should be highlighted in Blue-Gray (as shown above).
8) Click the center "OK" button.
9) Expect to see a small box with the words "Records Copied", then click on its "OK" button.

Cross-check that the values were copied: On the Vehicle page, double click on the new Vehicle's name to bring up the Vehicle Edit page, then click on Operation Polygons on the left bar.

4.6 Adding Waypoints

Each Vehicle has its own set of Waypoints. As with other data, the Waypoint numbers and values can be added in directly (ref. 4.6.1), or copied from another Vehicle (ref. 4.6.2).

4.6.1 Creating New Waypoints

As before, bring up the Vehicles page and double-click on the new Vehicle's name. This will call up the familiar Vehicle Data window.

Click on the "Waypoints" tab on the left side.

Selecting the "Waypoints" tab should show an empty Waypoints list, similar to:

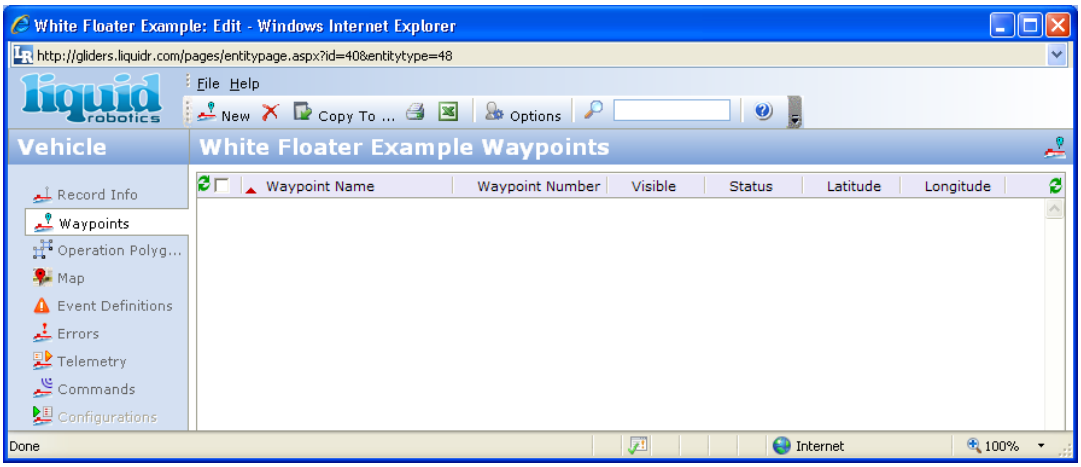


Figure 4-26: Empty Waypoint List

To create a new Waypoint, click on the "New" [New Waypoint] icon near the upper left. That should bring up the New Waypoint dialog page:

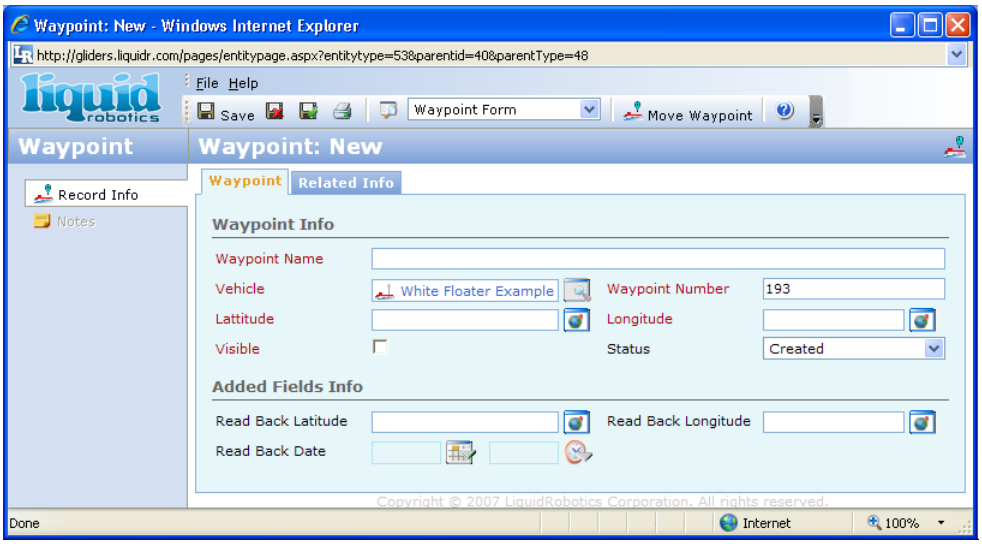


Figure 4-27: New Waypoint Dialog

1) Enter the Waypoint Name. This should be descriptive of the Waypoint's position and purpose.
2) Enter both the Latitude and Longitude Coordinates in degrees and fractions.
3) Change the "Waypoint Number" if desired. The value in the box is initially set to the previous largest number, plus one. You can change the number, but if the number is used for an existing Waypoint, you will overwrite that Waypoint's coordinates.
4) Check the "Visible" box if you want to see the Waypoint on the map.
5) Click the left "Save" [Save Waypoint] icon to save the Waypoint, and leave the box open.

Repeat steps 1 through 5 for each new Waypoint.

When done, click the right "Save" [Save and Close Waypoint] icon to save the Waypoint and close the dialog box. (Or, click the "X" at the upper right of the box).
There will be no "Are you sure?" confirmation.

Re-open or refresh the Vehicle Waypoints list. You should see the names and values you entered, similar to:

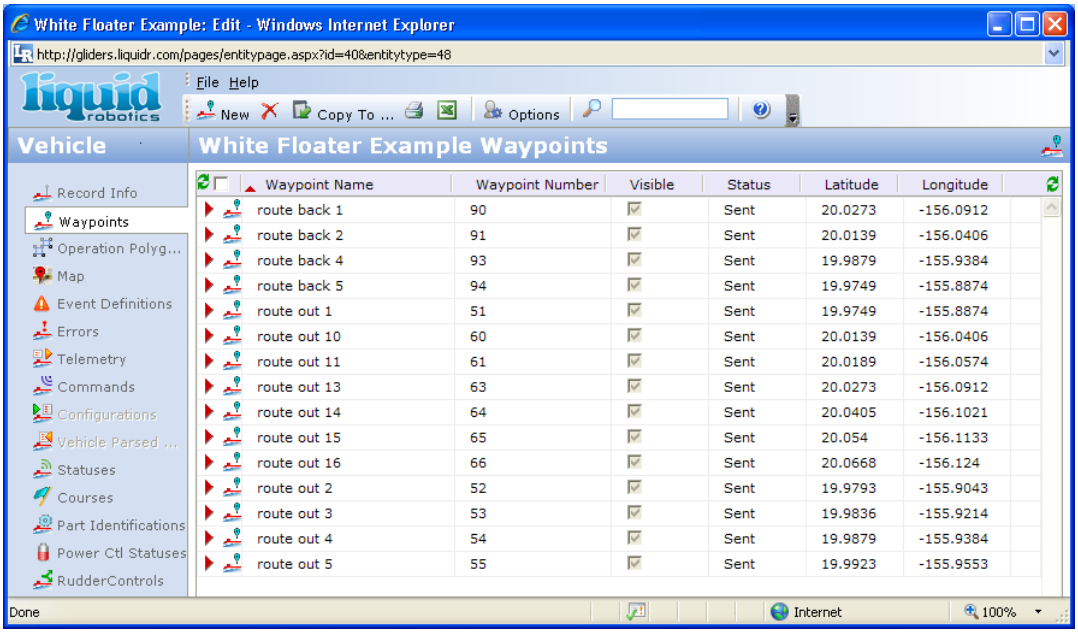


Figure 4-28: Example New Waypoints List

Note: A way of creating new Waypoints by directly using the Dashboard map is described in "5.4.1 Adding Waypoints on the Map".

4.6.2 Copying Waypoints

Where possible, it is easier to add initial Waypoints by copying selected Waypoints from another Vehicle operating in the same area. Waypoints can be changed or added as necessary later.

To copy Waypoints:

1) Locate another Vehicle that operates in the same region as the one you are provisioning.
2) Double-click on the other Vehicle's name to bring up its Vehicle Data.
3) Click on the "Waypoints" tab on the left to bring up a list of the Waypoints defined for that Vehicle.

The Waypoints list should generally look like:

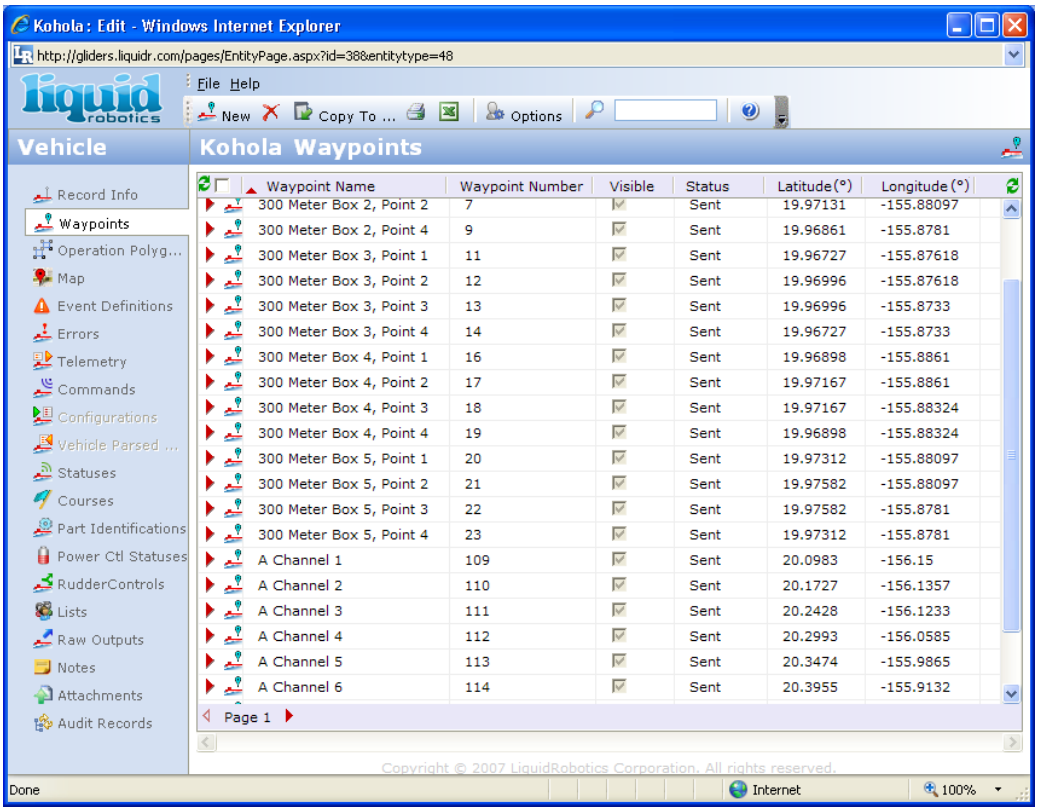


Figure 4-29: Waypoints List for Copying

4) In the list, use the Ctrl-click to select those waypoints that you want to copy over to your new Vehicle.

Note: You can only select 20 records at a time from the list. If you want to copy more than 20 Waypoints, you'll need to repeat the copy operation (steps 4 thru 8) multiple times.

5) Click on the "Copy To …" [Copy to another Waypoint] icon. When queried on the copy, click "OK".

6) A new Related Record dialog page should come up, showing the current list of Vehicles (similar to Figure 4-25).

7) Single-click on the name of your new Vehicle, which should highlight it in Blue-Gray. Then, click the "OK" button.

8) Expect a box with the words "Records Copied", and click on its "OK" button.

Cross-check that the values were copied: Double-click on your Vehicle's name on the Vehicle Page to bring up its Vehicle Data, then click on the "Waypoints" tab on the left. You should see the newly-copied Waypoints.

4.7 Adding a List

A Vehicle can reference multiple lists of data. There are currently two types:

- An Escalation List specifies the people to contact (and the order of contact) in case of a serious alarm or other emergency involving a Vehicle.
- A Group List contains the names of people with some associated purpose (such as the people who support a specific Vehicle).

As with other data, a list can be either created (ref. 4.7.1), or else copied over from another Vehicle (ref. 4.7.2).

4.7.1 Creating a New Escalation List

To create an Escalation List from scratch:

1) Go to the Vehicles Page and double-click on the new Vehicle's name, which will bring up the Vehicle Data window.
2) Click on the "Lists" tab on the left. You should get a box with no lists, similar to:

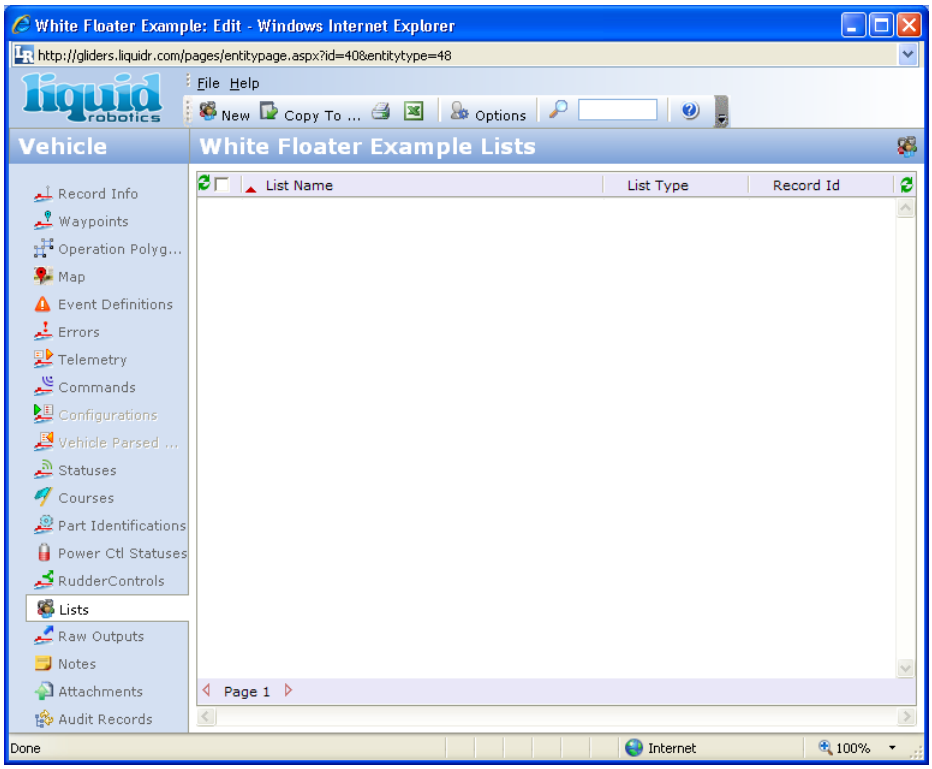


Figure 4-30: Lists (Empty)

3) Click on the "New" [New List] icon. This will bring up the New List dialog box shown below in Figure 4-31.

4) Enter your choice of a List Name, as shown in the example below.

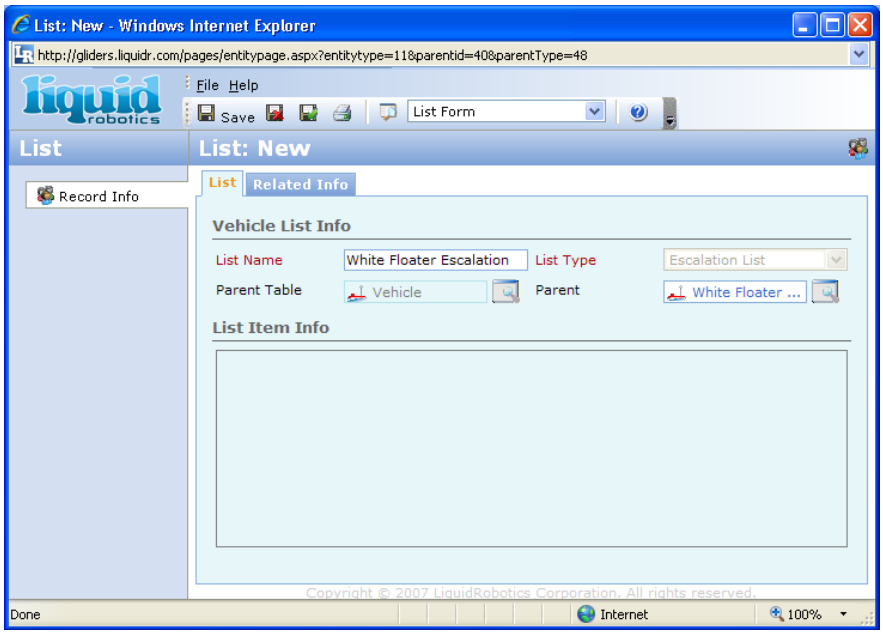


Figure 4-31: New List Dialog Example

5) Click on the Save [Save and close List] icon near the top. The Lists page should now show the new Escalation List name entered.

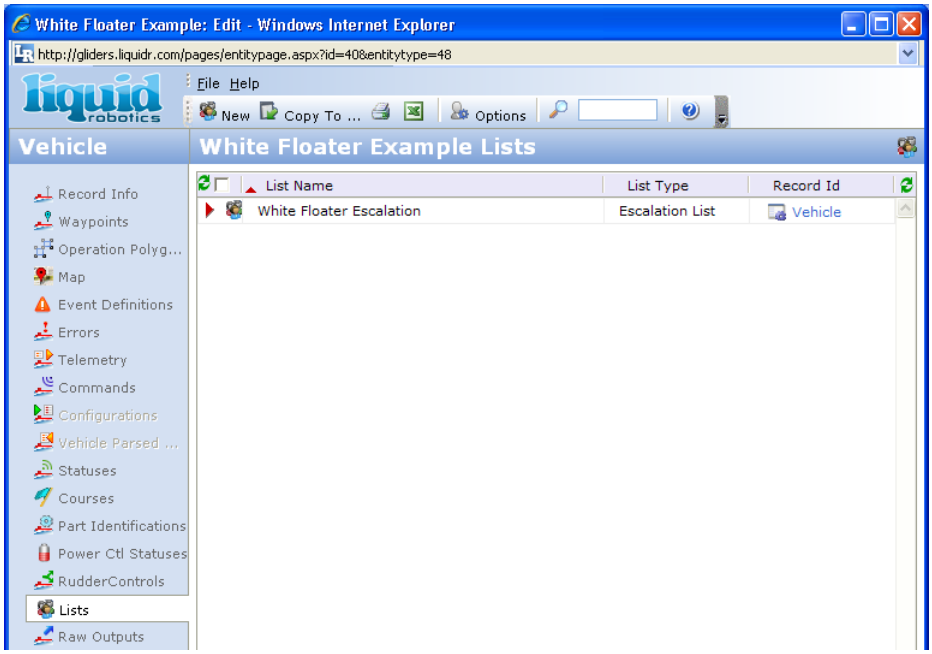


Figure 4-32: Escalation List Name Entry

6) Now, double-click on the "White Floater Escalation" name. This will bring up the dialog (Figure 4-33) to enter new names in the list.

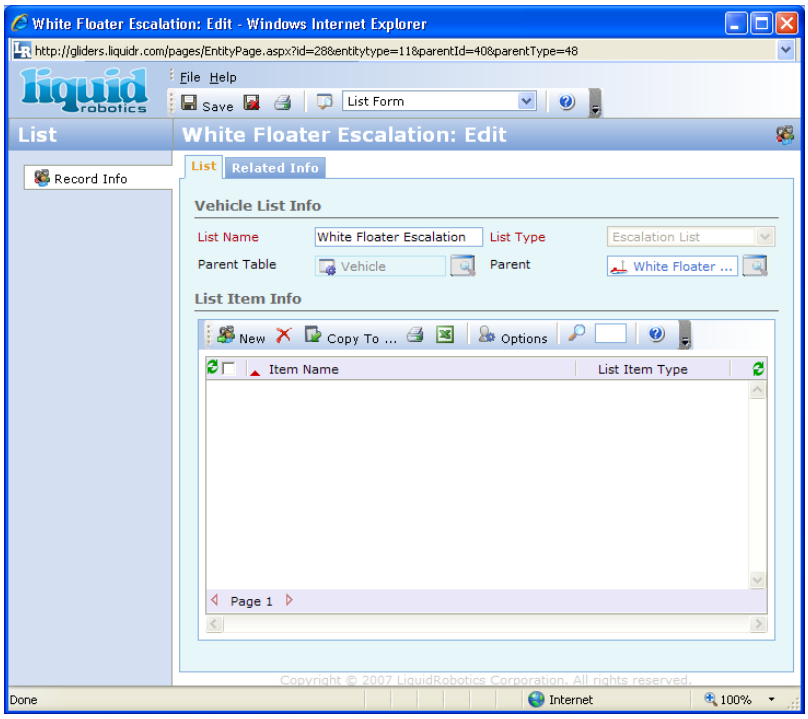


Figure 4-33: Escalation List Edit Dialog (Empty)

7) Click on the "New" [New List Item] icon just above the list data box. This should bring up the dialog that allows you to enter a new list item.

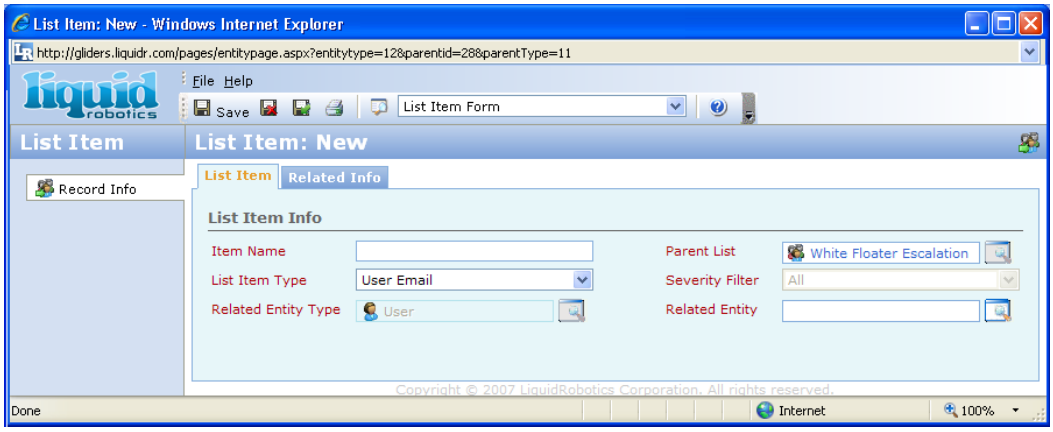


Figure 4-34: New List Item Dialog

8) For the "Item Name", enter the name of a contact person and an indication of the communications mode (e.g., "Chuck Pager").

9) For the "List Item Type", use the pull down to select one of three choices:
   User Email
   User Pager
   User Alt Email

10) Click on the icon to the right of the "Related Entity" box. This should bring up a list of the contact people in your Organization, similar in format to:

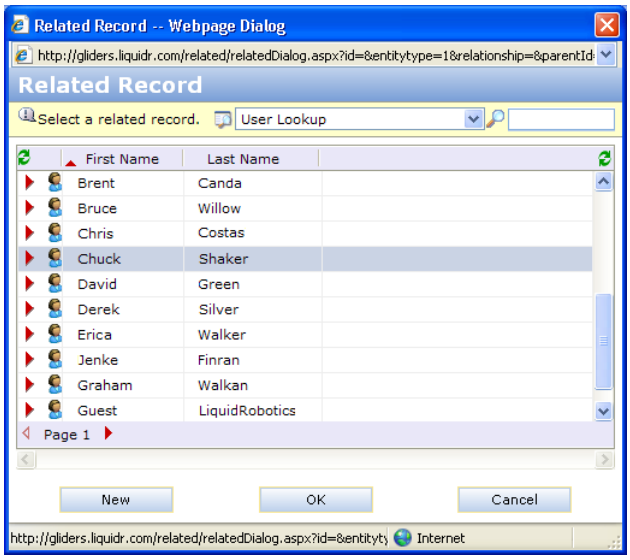


Figure 4-35: Contact List Records

11) Click on the name of the person you want to go into the Related Entity box. Then Click the center "OK" button.

A completed List Item entry would look similar to:

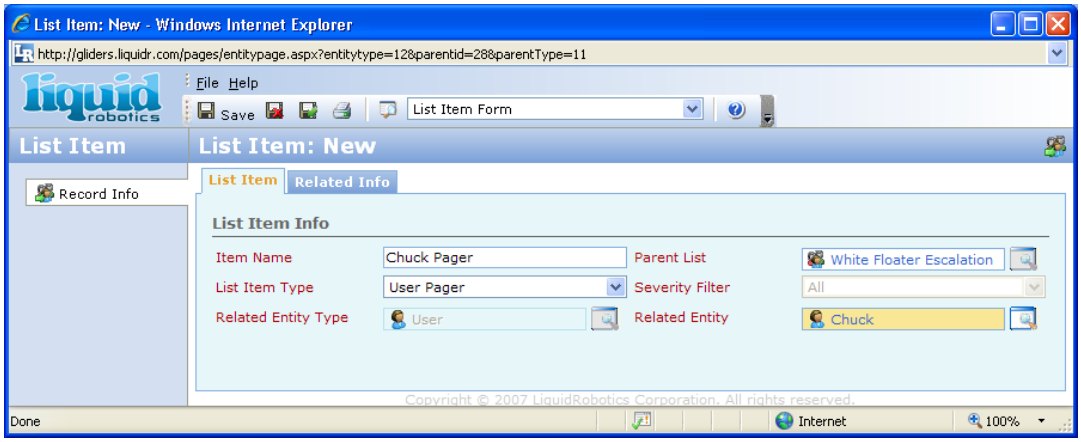


Figure 4-36: New List Item Example Entry

Note: The name in the "Related Entity" box is now a link to the contact information for that person.

12) Click on the "Save" [Save List Item] icon to save the new list item.

13) Repeat steps 7 thru 12 for each person (and contact method) that you want to be in the Escalation List.

When the names have been entered, the new Escalation List should look similar to:

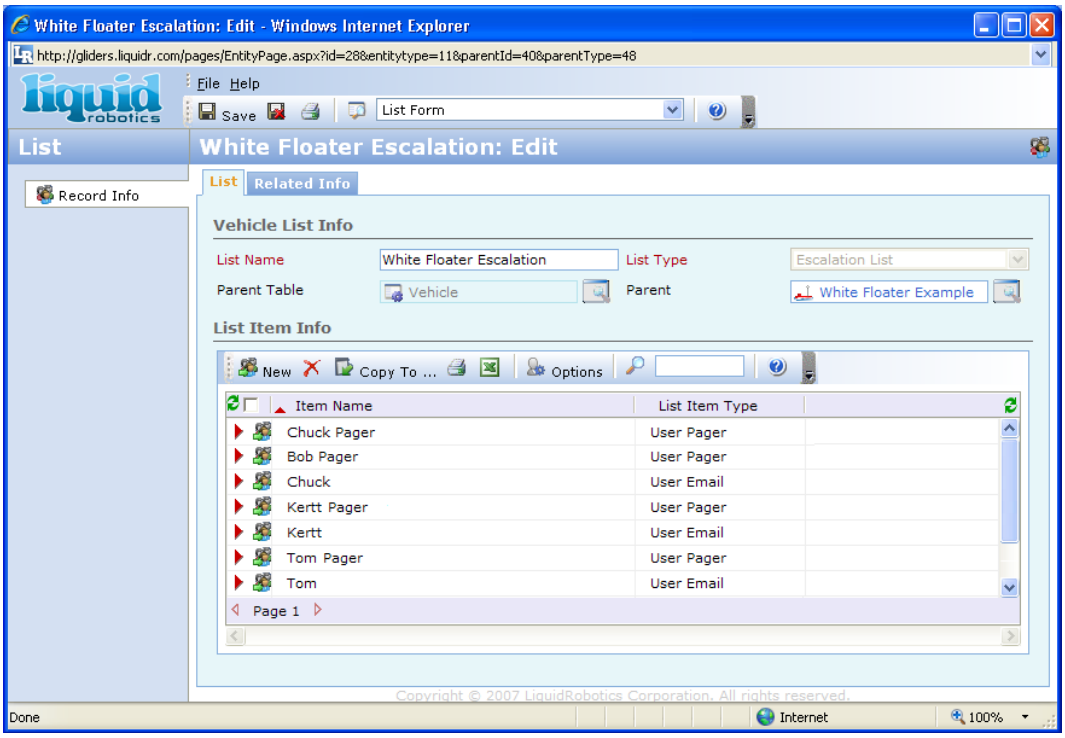


Figure 4-37: Example New Escalation List

4.7.2 Copying Existing Escalation Lists

As with other data, you can create an Escalation list by copying from another of your Organization's Vehicles. However, in this case there are two lists that you have to copy:

a) The Escalation List itself.

b) A selected list of names in the Escalation list.

Thus, you will have to copy lists within a list.

The procedure for copying is:

1) Locate another Vehicle whose Escalation list you want to use.
2) Double-click on that Vehicle's name to bring up its Vehicle Data.

3) Click on "Lists", to bring up the lists defined for that Vehicle. Usually, there is only the Escalation list as shown the Figure below:

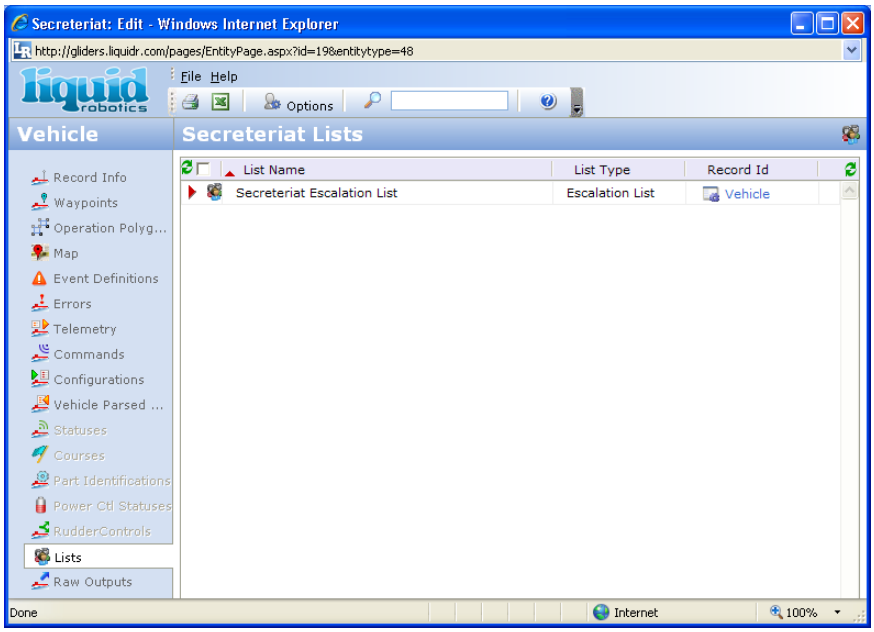


Figure 4-38: List of Vehicle Lists

4) Double-click on the name to select the Escalation List. This should bring up an Edit box with a list of the names in the Escalation List, as shown below:

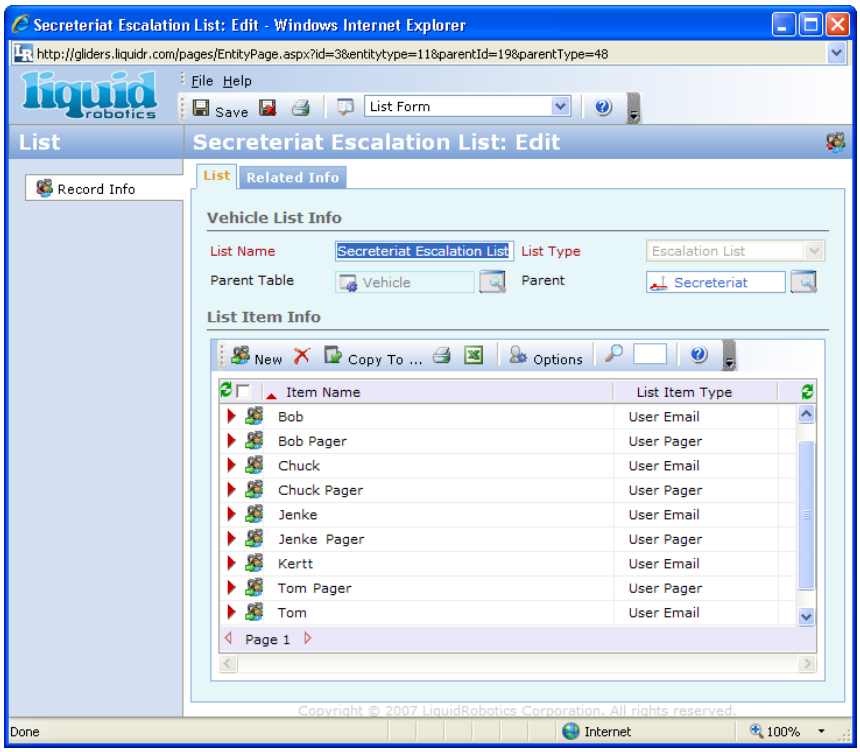


Figure 4-39: Escalation List Edit Dialog

5) Use the Ctrl-click to select those names that you want to copy over. Or, to select all the names, click to check the box left of the "Item Name" header.
6) Click on the icon for "Copy To …" [Copy to another List Item]. Click "OK" when queried on the copy.
6) A current list of the Vehicles should come up. Click on the name of your new Vehicle (the one to want to copy the list to). Then click the "OK" button.
7) Expect the box with the words "Records Copied", and click on its "OK" button.

Finally, cross-check that the Escalation List was copied:

1) Double click on your Vehicle's name on the Vehicle page to bring up the Vehicle Edit window, then click on the "Lists" tab on the left bar.
2) Double-click on the Escalation List name to bring up and check the names in the list.
3) When you've checked the list, click on the "Home" button at the lower left to go back to the Home (Dashboard) page.
4) Close any remaining dialog boxes by clicking on the "X" icon in the upper-right corner.

4.8 Completing the Part Info Tree

The Part Info tree that was started in "4.3 Initializing the Part Info Tree" above can now be completed by having your new Vehicle "tell" the software its configuration.

4.8.1 Powering Up the Vehicle

First, locate the Vehicle so that it has a clear view of the sky. This is necessary to get good Iridium reception.

Next, power up the Vehicle. If you have the Original C&C Drybox, start power by connecting one of the Solar Panel cables to either one of the C&C Drybox Solar Panel connectors. Alternatively, connect a shorting plug designed to mimic solar panel connection.

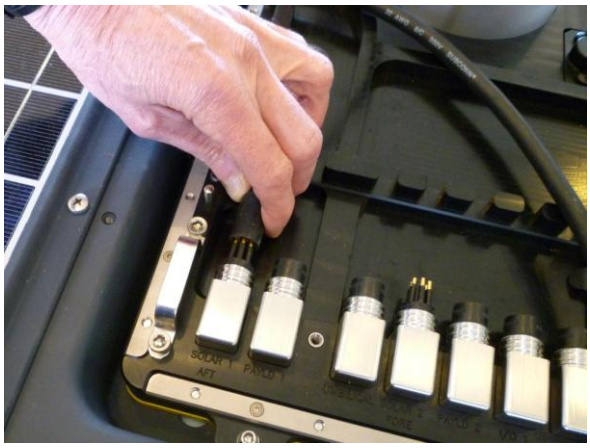


Figure 4-40: Attaching a Solar Panel Connector

The light should turn on, indicating that the electronics have been powered-up.

If you have the Revised C&C drybox, start power by inserting the power key on the top of the drybox, as shown in Figure 4-41. There is no need to connect a solar panel.

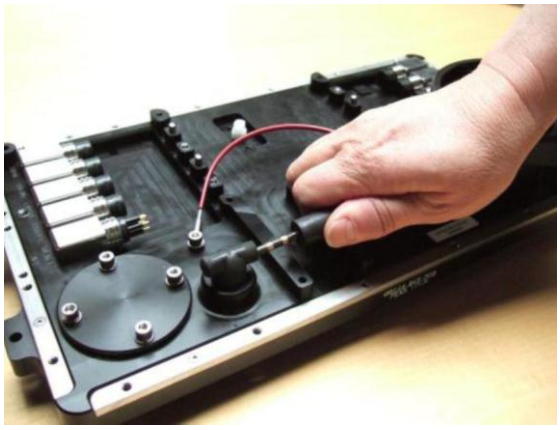


Figure 4-41: Inserting the Power Key

4.8.2 Getting Part Info Data

When Vehicle powers on, it will start transmitting telemetry records and respond to commands. The following action is needed to complete the Part Info tree:

1) Select the name of new Vehicle in the select box, as shown:

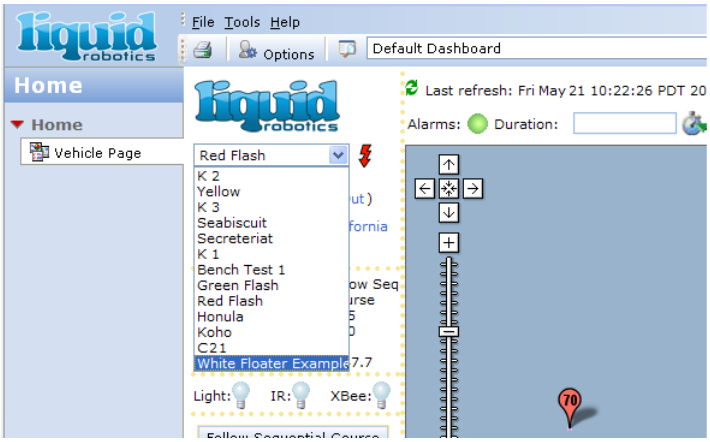


Figure 4-42: Vehicle Name Select

2) Next, click the More Commands ... link below the other Command buttons. This should bring up the Vehicle Command dialog.
3) In the "Command Type" box, select the "Retrieve Identification" command. Enter an appropriate comment in the "Command Reason" box.
4) Send the command to the Vehicle by clicking the "Save" button at the bottom.

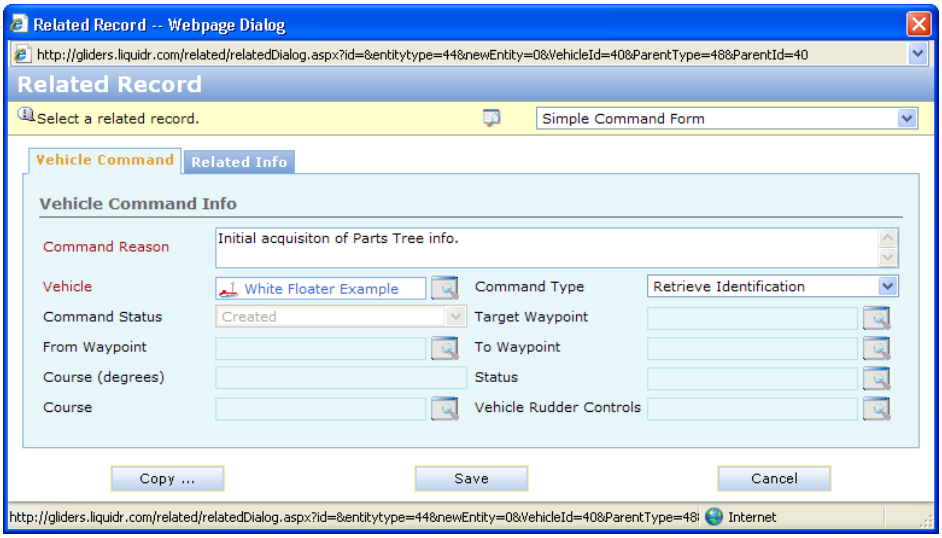


Figure 4-43: Retrieve Identification Command Dialog

5) Monitor the Telemetry List on the Dashboard. Wait for the command to be ACK'ed by the Vehicle. Note that you will have to refresh the screen to see the telemetry updates.

Note: The default telemetry transmission interval is 2 minutes. However, the interval could be set to a longer time.

6) Single-click on the icon to the right of Vehicle name in the Dashboard, shown below.

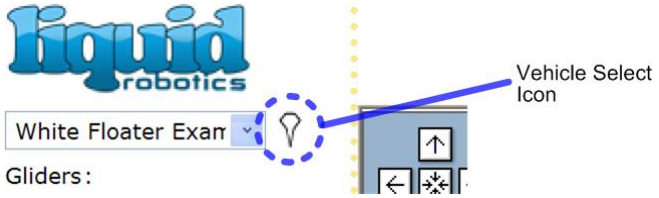


Figure 4-44: Vehicle Select Icon

This should bring up the Vehicle Data window.

7) Click on the "Part Identifications" tab on the left. This should bring up the Part Identifications data received from the Vehicle, similar to:

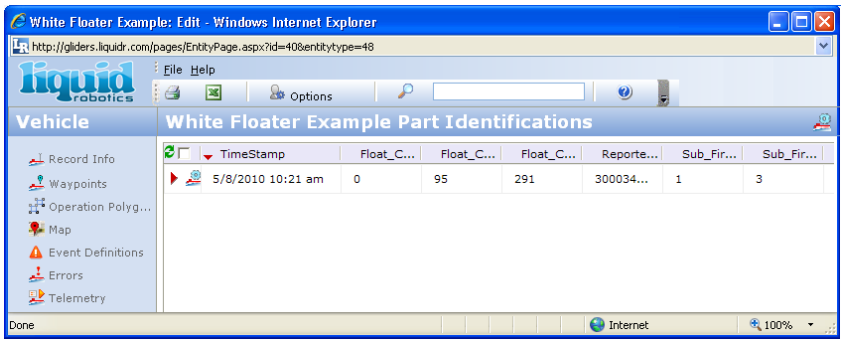


Figure 4-45: Received Part Identification

8) Double-click on the time stamp in the line to open the Part Identification Edit form. It should appear similar to:

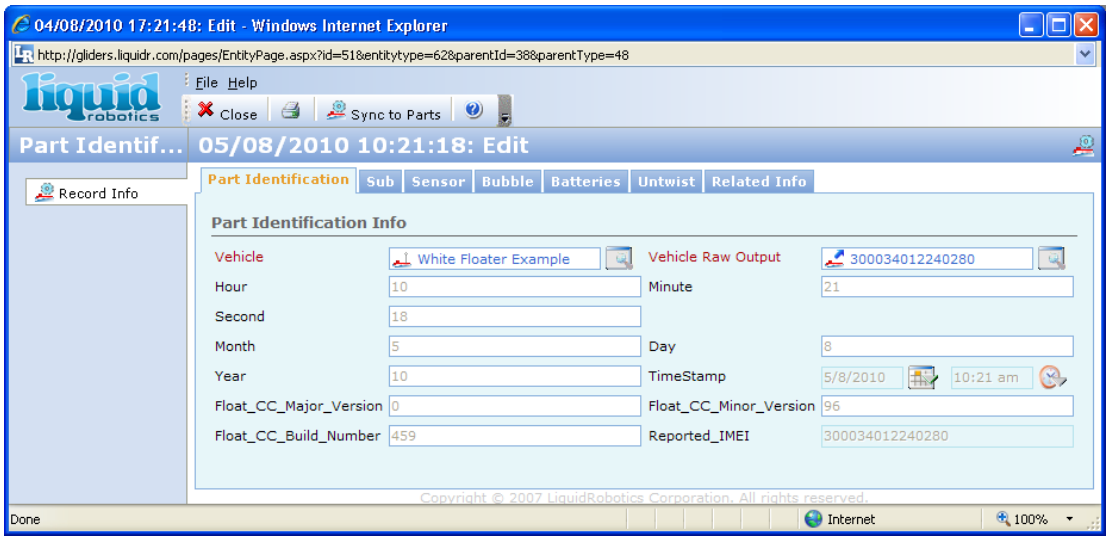


Figure 4-46: Part Identification Edit Dialog

9) Click on the "Sync to Parts" text or icon near the top of the form. You should receive a message from the system that it synchronized the parts successfully.

10) Click on the "Record Info" tab of the Vehicle Data window. This should now display the completed Part Info tree, showing all data for Vehicle parts.

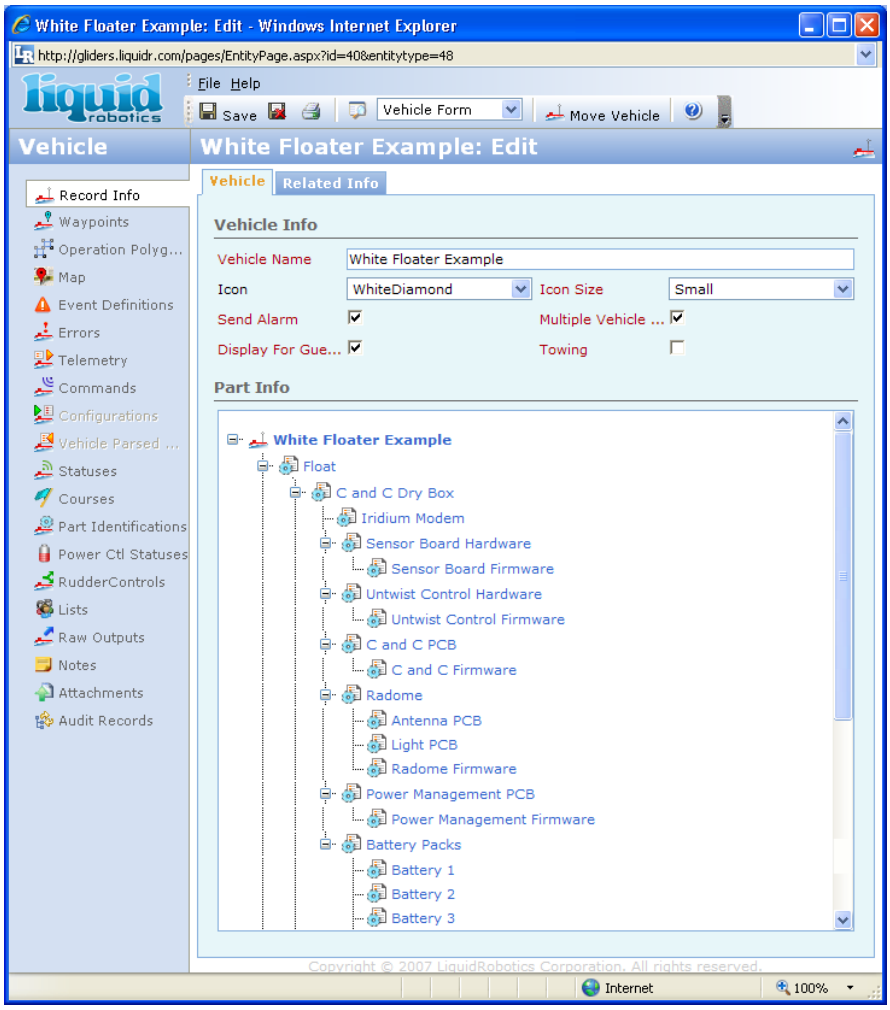


Figure 4-47: Completed Part Info Data Tree

Note: Be sure to power-off the Vehicle once the data has been transferred.

4.9 Adding Serial Numbers

Now that the complete Part Info tree has been created, the part serial numbers for your new Vehicle can be entered. This is optional, but recommended.

Numbers can be entered for the:

- Float
- Glider (Sub)
- Umbilical

Each serial number should be listed in the Packing Slip, or on the part itself.

4.9.1 Setting the Float Serial Number

Add the Float Serial Number as follows:

1) Click on the Vehicle Icon on the Dashboard page to bring up the Vehicle Edit box.

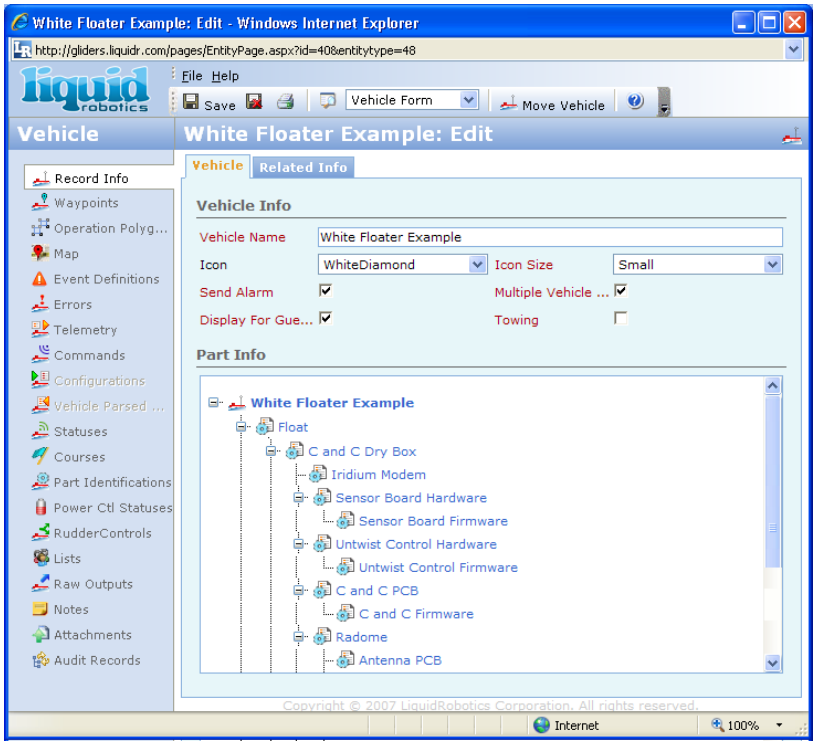


Figure 4-48: Vehicle Edit With Part Info

2) In the "Part Info" box, single-click on "Float" to call up the Float Info data.

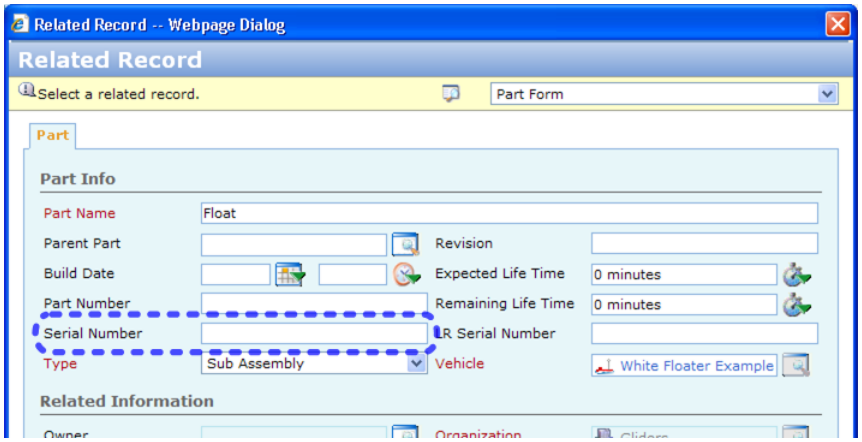


Figure 4-49: Float Part Info Dialog

3) Enter the Float serial number in the left-side box labeled "Serial Number". (Do not enter data in the "LR Serial Number" box).

4) Click the "Save" button, bottom left, to save the value and close the dialog box.

4.9.2 Setting Remaining Serial Numbers

Using the same procedure described above in 4.9.1 above, you can set the serial numbers for the Sub (Glider) and the Umbilical.

4.10 Provisioning Completion

4.10.1 Pressure Over Time Custom Report

Verify that the C&C Drybox pressure has remained constant over time.

Follow the procedure described in section 2.11.1 “Custom Reports” to output the report “Pressure Over Temperature”.

4.10.2 Commenting On Provisioning

This step is optional, but recommended.

1) Click on the "Comment" command button on the Dashboard page to open the dialog box for entering a comment.
2) In the "Command Reason" box, enter a comment indicating that initial provisioning of the new Vehicle has been completed.

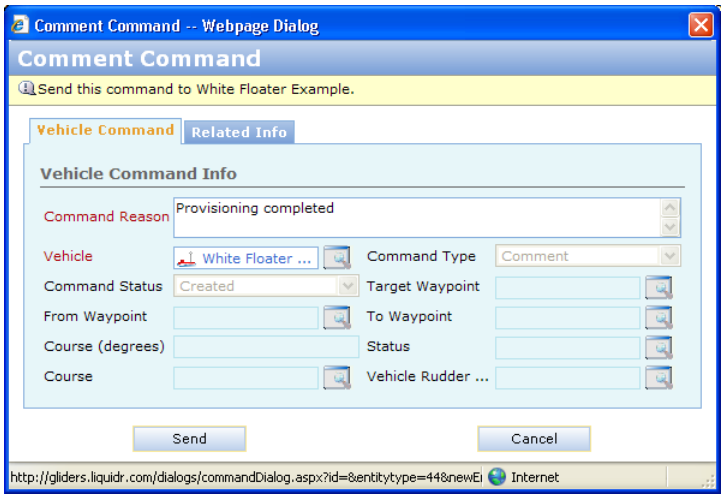


Figure 4-50: Provisioning Completed Comment

3) Click the "Send" button.

The software will record the comment, along with your name and a timestamp, in the WGMS database. This completes initial provisioning.

Chapter 5 – Mission Planning

This chapter covers the general steps required to plan and execute a mission involving a single Wave Glider Vehicle. Chapter 6 describes the actual Operation of a Mission.

It is assumed that the Vehicle has been provisioned as described in Chapter 4, and has been outfitted with the payloads and other equipment required for the Mission.

5.1 Planning Considerations

A successful mission depends upon careful planning and preparation. Although the Wave Glider Mission can be changed "on the fly", a poorly-planned mission can result in wasted time, premature retrieval, or even Vehicle loss.

5.1.1 Planner Role Requirements

In order to be able to plan a Mission you need appropriate Role permissions. For Mission planning, you will need to be assigned a "Master" Role. A System Administrator (“Admin” Role) also has the necessary privileges.

5.1.2 Missions and Courses

As explained in 1.7.2, a Mission and a Course are not the same thing.

The Mission has a name and an objective. The Mission can be one Vehicle on a single course, or multiple Vehicles on different courses, and/or multiple Vehicles on the same course.

For a given Vehicle, you first define its course. When you launch a Vehicle, you can either assign the Vehicle to a new mission, or else join another mission already in progress.

Some mission possibilities are:

1) Fixed buoy (warning or weather station)
2) Mobile weather station
3) Multi-Vehicle sea floor scanning
4) Sub-surface sensing (e.g., temperature, salinity)
5) Sonar sensing and recording
6) Atmospheric sensing

5.1.3 Vehicle Configurations

A key virtue of the Wave Glider is that it can accommodate a wide variety of sensor packages with corresponding variations in weight, mounting points and power demands. It is important to confirm that the physical and electrical demands of the proposed mission fit inside the Wave Glider’s operating envelope as well as the constraints of your mission.

For example, the Wave Glider relies on solar energy for powering electronics for long duration missions. You need to apply your knowledge of the latitude, length of day and expected cloud cover in the mission area to ensure that your power budget is consistent with the Wave Glider’s capabilities.

Similarly, the ability of the Wave Glider to make progress on the course required by the mission is a function of the local currents, wave frequency and height and the drag of the Vehicle. The location and hydrodynamics of your sensor package can increase the drag of the glider and the float. When planning a route and a mission timetable, you should consider expected currents in the mission area in the context of your modified vehicle. And, you should develop contingency plans in the event the Wave Glider encounters unexpected currents.

5.1.4 Communications

Operators have several options when designing the communications plan for their mission. The built-in Iridium Short Burst Data link can be configured to report at different rates, and can carry payload telemetry data. The link is slow, however, and relatively expensive for large files. If a payload is to be integrated, it might be desirable to mount on board an additional communications channel with a higher data rate.

Cost is also a consideration when planning communications use. Plan on the vehicle consuming between 300kB and 1.6MB per month for its core telemetry and health data, depending on how the communication frequencies are configured (one message every 30 minutes, to one message every 2 minutes, as shown in the table below).

Core Telemetry Report Rate	Bytes/Month (Estimated)*
2 Minutes	1,417,680
5 Minutes	614,160
10 Minutes	346,320
30 Minutes	167,760

**Note: These estimates make some assumptions about other telemetry types and their frequency usage. In addition to the core telemetry (breadcrumbs), command, power telemetry, payload and configuration messages all utilize bandwidth. Typically, the core rate is the biggest factor in determining data costs.*

5.1.5 Sea Conditions

The sea conditions at the time and area of operations should be considered. Wave Gliders have endured up to 60 knot winds and 6.7 meter waves, but extended operation in such conditions or exposure to even more violent seas could result in damage to the Vehicle. Extremely low sea conditions (sea state 0 to 1) do not provide a lot of wave energy for propulsion, so the Vehicle will slow down.

5.1.6 Season and Weather

Weather and seasonal conditions need to be considered. The solar panels can charge the batteries in bright but cloudy conditions. However clouds reduce the charging. Also, at far Northern and Southern latitudes during the local "winter" time, the daylight can be short and the Sun angle low. The Vehicle may not have adequate battery reserves, especially if the Vehicle has a high power-draw payload. Reference 2.9.10 for a discussion on obtaining archived weather data. Refer to Appendix A for a chart of solar flux at various Latitudes and dates.

5.1.7 Currents and Tides

The Wave Glider's expected water speed should be compared to expected currents. In areas of strong current or high tidal flow, the Vehicle may not be able to make headway moving against the current. In some cases one can navigate perpendicular to the current flow in order to exit a particularly strong current, and in others the pilot may just have to "go with the flow."

5.1.8 Waypoints and Current

Unless PID Navigation is enabled, the Wave Glider steers by aiming at its target Waypoint. That is, the Vehicle is always heading towards the next Waypoint from its present position. If there is a strong cross-current, the path between two waypoints will be an arc, rather than a straight line. Thus if not in PID Navigation mode, multiple Waypoints should be used for long distance straight courses.

In Figure 5-1 below, the Yellow "Flash" symbols indicate telemetry reporting points and the vehicle is navigating without PID. Note that when two Waypoints are widely separated, there can be considerable deviation from the intended course.

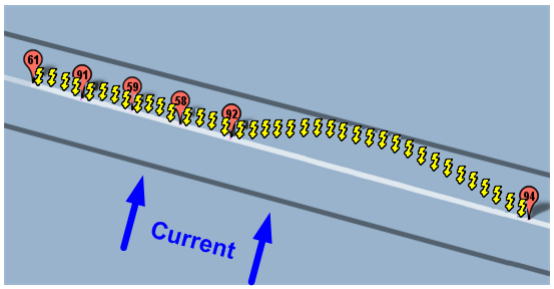


Figure 5-1: Waypoint Spacing and Vehicle Path

5.2 Elements of a Course

A Course is defined primarily by Waypoints and the path between them. However, Operation Polygons and the Arrival Distance are also part of a Course definition.

5.2.1 Waypoints

Recall that Waypoints are each defined by a number from 1 to 254. Each Waypoint is also assigned a name (which can simply be the Waypoint's number).

A set of Waypoints should have been defined for the Vehicle during its Provisioning (Chapter 4), however, some Waypoints may need to be changed, and additional Waypoints may need to be added. If the existing Waypoints are not sufficient, additional Waypoints can be added or changed as described below in 5.4.1 and 5.4.2 below.

A Vehicle's Waypoints are stored both on the shore-based software database, and in memory on-board the Wave Glider. However, when a Waypoint is created or changed, the new coordinate values exist only on the database. The Waypoint is not "valid" until the identical values also reside on the Vehicle's computer.

Thus, a Waypoint has a defining "status" as follows:

Created: The Waypoint has been defined, but only resides in the Shore-based database.

Queued: The Waypoint values are ready to be sent to the Vehicle.

Sent: The Waypoint data has been sent to the Vehicle.

Waypoints cannot be sent to the Vehicle until it has been powered up and begins sending telemetry.

5.2.2 Courses and Waypoints

To specify the Course, you specify the sequence of "Course Waypoint" numbers (these are a subset of all the Vehicle's Waypoints). If the Course was previously used by this Vehicle (or another) then the necessary Waypoints may already be defined. However, consider the effects of cross-currents and add additional Waypoints if necessary.

All courses require you to define an initial "Target Waypoint" to which the Wave Glider will proceed immediately after launch. Ideally, the Target Waypoint should be close to the launch point. This allows early verification that the Vehicle is operating nominally.

5.2.3 Types of Courses

There are basically four types of course-based "navigation modes":

1) Continuously loop through a series of sequential Waypoints, starting from a Target Waypoint within the sequence. When the Vehicle reaches last Waypoint in the sequence, it then goes back to the first Waypoint in the sequence, and continues to loop.
2) Continuously loop through a series of non-sequential Waypoints, starting from a Target Waypoint. When the Vehicle reaches last Waypoint in the series, it then goes back to the first Waypoint and continues.
3) Move between a series of Waypoints, starting from a Target Waypoint, and hold position at last Waypoint.
4) Move to a Target Waypoint and hold there.

You can change navigation modes during a Mission. However, it's prudent to anticipate the possible modes in advance and define all the Waypoints that may be needed. There is no penalty for defining Waypoints that are not used.

5.2.4 Non-Waypoint Navigation Modes

There are three navigation modes that aren't strictly "Courses", in that they don't use Waypoints. They are:

1) Maintain a fixed heading (0° to 359°).
2) Maintain a fixed rudder position (Left/Right/Center).
3) Hold station at the current position (a Lat/Long pair).

Typically, these non-Waypoint modes are used for special situations and real-time operation of the Vehicle, rather than as pre-planned operations.

5.2.5 Operation Polygons

Operation Polygons are closed regions defined by three or more numbered Lat/Long location points. Each Operation Polygon is assigned an identifying name and can optionally be displayed on the Dashboard Position Map.

The basic purpose of the Operation Polygons is to verify that the Vehicle has not deviated significantly from the defined Course, or has not entered into a restricted region. The shore software monitors the Vehicle position and issues an alarm if:

- The Vehicle goes outside a boundary region (Inclusion Polygon)
- The Vehicle enters into a boundary region (Exclusion Polygon)

There is no restriction against using multiple overlapping Operation Polygons on the same course. This can be useful for sending out a signal (alarm) when the Vehicle enters a different part of the Course.

A set of Operation Polygons should have been defined for the Vehicle during its Provisioning (Chapter 5). However, some polygons may need to be changed, and additional ones may need to be added. The procedure for changing Operation Polygons is described in 5.6 below.

5.2.6 Arrival Distance

The "Arrival Distance" is a radius around each Waypoint that defines the "size" of the Waypoint. That is, when the Vehicle enters the circle, the Vehicle's computer considers that it has "arrived" at the Waypoint, and proceeds to the next Waypoint. The Arrival Distance is shown as the Purple-Red dot at the base of each Waypoint marker.

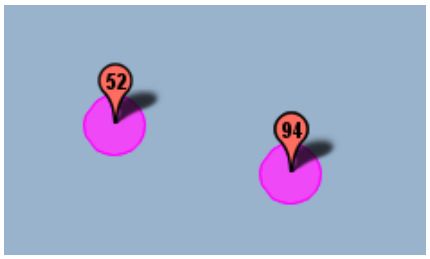


Figure 5-2: Arrival Distance Symbols

Generally, the Arrival Distance radius should not be made too small, as it could cause the Vehicle to "hunt" around the Waypoint, trying to get within the circle. The default Arrival Distance is 20 meters, but a larger distance may be acceptable for your mission.

Note that the Arrival Distance is a characteristic of the Vehicle, not any individual Waypoint. Thus, the Arrival Distances are the same for all a Vehicle's Waypoints. Changing the Arrival Distance is described in 5.5.

5.3 Planning a Course

5.3.1 Using an Existing Course

If a course has previously been defined and saved for this Vehicle, it can be simply called up and used again. If the Vehicle will be operating on such a course, refer to section 5.7.4 "Using a Previously-Defined Course".

5.3.2 Laying Out the Course

Laying out the course usually means plotting the key points on the Course. Typically, these points are:

1) The launch position
2) The course starting position
3) Change-of-direction positions
4) Holding positions
5) The retrieval position
6) Obstacles and restricted areas

The Course may be plotted on conventional paper nautical charts and manually entered. Or, it can be created dynamically using the Position Map of the interactive Dashboard system, as described in 5.4.1 below.

5.3.3 Defining a New Course

If the Vehicle will be operating on a new course, or a modified version of an existing course, the general steps are:

1) Add and/or change the Course Waypoints.
2) Adjust the Arrival Distance if necessary.
3) Enter or update the Operation Polygons.
4) Specify the Course and its navigation mode.

Each of the above steps is described in detail below.

5.4 Adding and Changing Waypoints

From the Vehicle's point of view, a Waypoint is simply a numbered pair of Lat/Long coordinate values; the Waypoint's name resides only on the shore software database. So, while there is generally no problem in adding a new Waypoint, in some cases it may be more convenient to simply change the name, number, and/or coordinates of an existing Waypoint.

5.4.1 Adding Waypoints on the Map

The Waypoints can be plotted on a conventional paper map, measured and then added as described in Chapter 4 (4.6.1). However, it can be more convenient to set them up dynamically using the Dashboard Position Map, as follows.

First, click on the "Map Options" button above the map on the right.

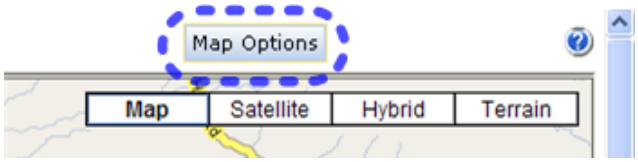


Figure 5-3: Map Options Button

This will call up the Map Options dialog box:

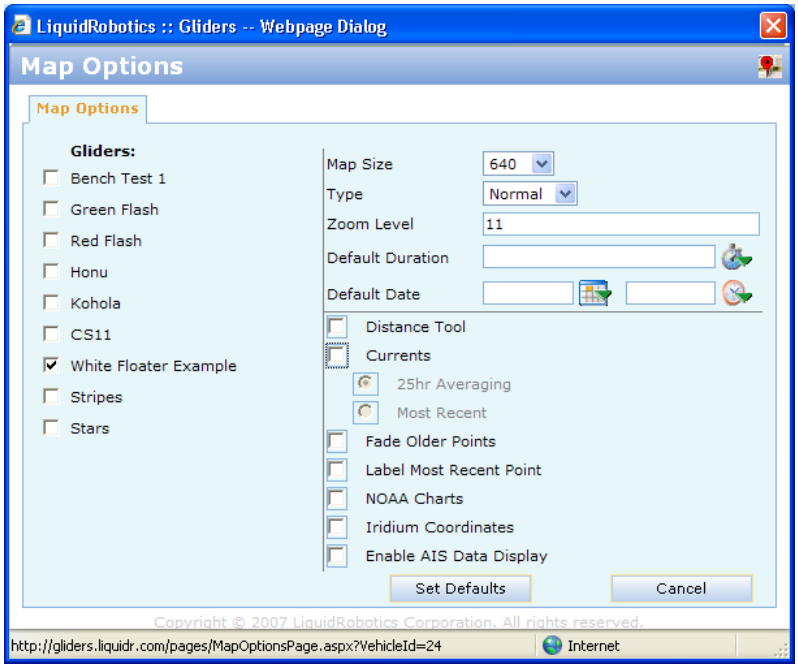


Figure 5-4: Map Options Dialog Box

Click to place a check in the "Distance Tool" box, as shown above, then click the "Set Defaults" button to exit the dialog.

Just changing a default map option will not automatically change the map. To display the Distance Tool box, click the Green "Refresh" icon at the upper-left of the map.

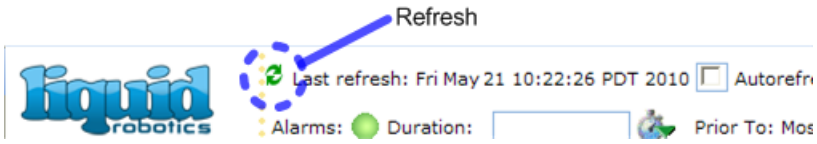


Figure 5-5: Refresh Icon

After refresh, an empty Distance Tool box should show in the lower left of the map. Note that this box is "transparent", so the underlying map topography and symbols will show through.

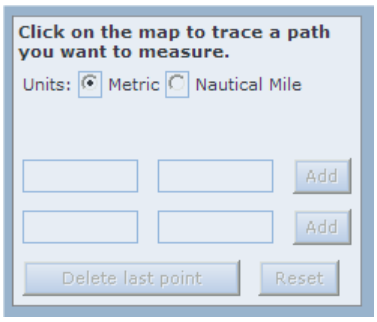


Figure 5-6: Distance Tool Box

Single-click on the map in the approximate place you want to place a Waypoint. A Green icon should appear where you clicked, and the Lat/Long coordinates of the icon will be shown in the Distance Tool box, similar to the Figure below.

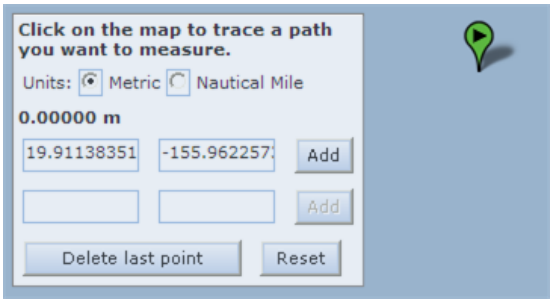


Figure 5-7: Distance Tool and Position Icon

This new icon can be moved around by placing the cursor on the icon and holding down the left mouse button. Move the icon where you want and then release the mouse button. When you release, the icon's new coordinates will appear in the Distance Tool box.

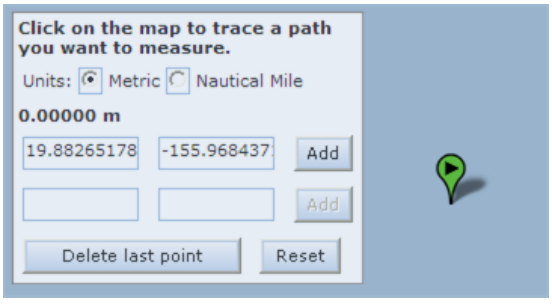


Figure 5-8: Distance Tool with Moved Icon

Note: You can't directly edit the Lat/Long values shown in the Distance Tool box. However, the Lat/Long values can be adjusted after the new Waypoint has been created, as described below.

When you've moved the icon to the desired location, click on the "Add" button. This will bring up the New Waypoint dialog box, similar to:

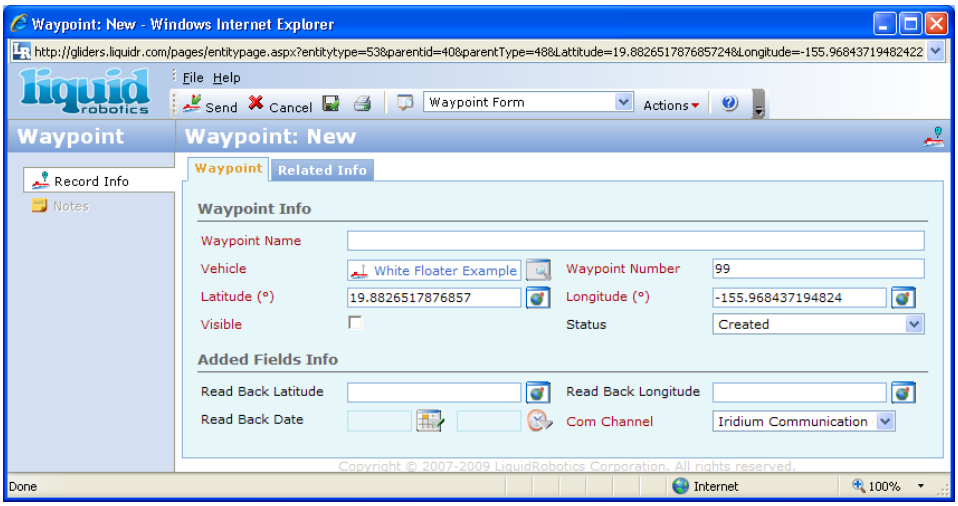


Figure 5-9: New Waypoint Dialog Box

Note that the Waypoint's Lat/Long values are already entered. Now, do the following:

1) Enter the "Waypoint Name". This should be descriptive of the Waypoint's position and purpose.
2) Leave the "Vehicle" name as-is; do not attempt to change it.
3) Edit the "Latitude" and "Longitude" coordinates if desired. You may want to change the precision to, for example, 5 digits to the right of the decimal.
4) Change the "Waypoint Number" if desired. The value in the box is initially set to the previous largest number, plus one. There is no problem changing the number, but if it is the same as an existing Waypoint number, you will overwrite that Waypoint's values.
5) Check the "Visible" box if you want to see the Waypoint on the Position Map.

A completed New Waypoint specification might look like:

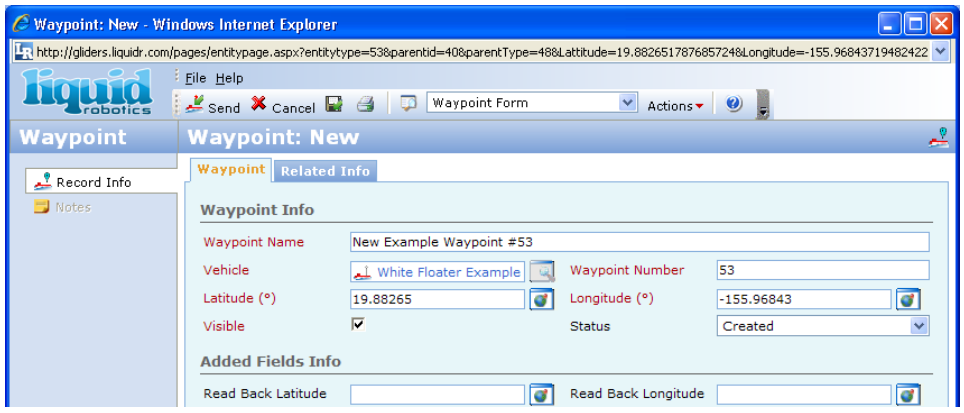


Figure 5-10: Completed New Waypoint Dialog

6) Click the "Send" [Save and send Waypoint to vehicle] icon to save the new Waypoint values on the database, and queue them for sending to the Vehicle.

After you save the Waypoint, click on the Green "Refresh" icon and Waypoint 53 should show on the Dashboard map.

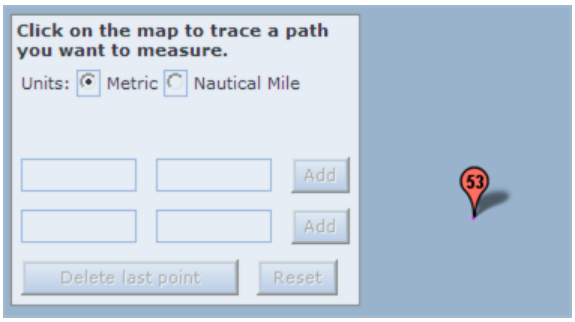


Figure 5-11: New Defined Waypoint

Note: As described in 5.1.3, this new Waypoint is only stored in the shore database at this point. The Waypoint number and values will not be uploaded to the Vehicle until the next Vehicle telemetry transmission.

When you are finished adding Waypoints, you can edit the Map Options box to delete the Distance Tool. Then click the Refresh icon.

5.4.2 Changing a Waypoint

Calling up the dialog to change Waypoint data can be done in two ways.

The "formal" way is to call up the Vehicle Waypoint List, similar to Figure 5-12.

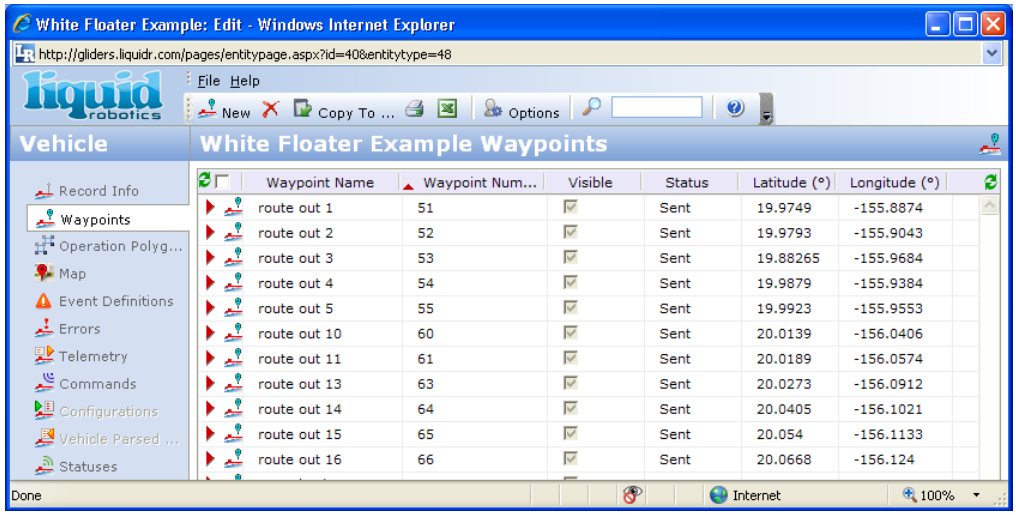


Figure 5-12: Example Waypoints List

Double-click on the Waypoint line that you want to change. For example, double-clicking on either the "54" or "route out 4" will bring up the Edit Waypoint dialog box shown in Figure 5-14, below.

Another way to call up the Waypoint dialog (Figure 5-14) is to locate the Waypoint on the Dashboard map. Then single-click on the Waypoint icon. This will bring up an "Information Callout" for the Waypoint, as shown:

Figure 5-13: Waypoint Information Callout

The callout indicates the Waypoint number, name and coordinates (in both fractional degrees and in degrees plus fractional minutes). Click anywhere on the link (Red Flash:54:route out 4, in this example) on the upper part of the callout.

Clicking on the link will bring up the Edit dialog for Red Flash Waypoint 54.

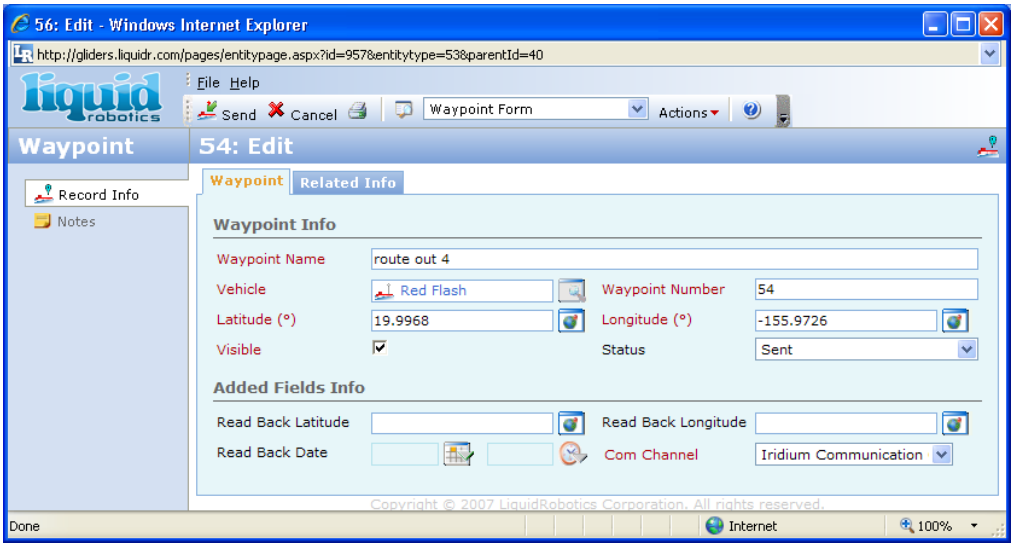


Figure 5-14: Waypoint Edit Dialog Box

The Waypoint number, Latitude and Longitude can be changed, as well as the Waypoint Name and whether it is to be Visible. Change the values as appropriate.

Note: If the Waypoint Number is changed, and is the same as an existing number, then the Waypoint with that original number will be assigned the newly- specified values.

When done, click the "Send" [Save and send Waypoint to vehicle] icon near the upper left of the box. Then click the "X" at the upper right to close the dialog box.

The updated Waypoint value will be "Queued", but won't be "Sent" until the Vehicle transmits a telemetry message.

5.4.3 Using the Actions List

Note that in the header bar of the Waypoint Edit dialog (Figure 5-14) is a button labeled "Actions". This is a pulldown list with three options, as shown:

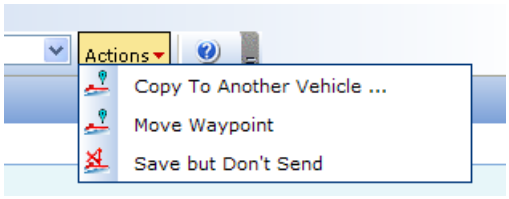


Figure 5-15: Actions Pulldown List

The three options are as follows:

Copy to Another Vehicle: Clicking on this brings up a list of other Vehicles registered to your Organization. Click to select the Vehicle name and then click the "New" button to create a copy of that Waypoint for the selected Vehicle.

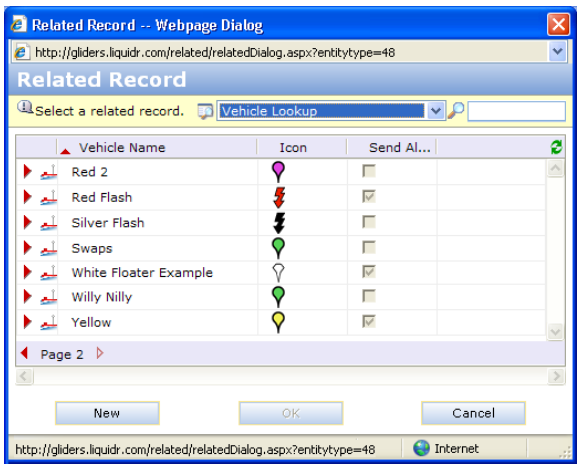


Figure 5-16: Copy-To Dialog Box

Move Waypoint: Clicking this brings up a dialog that allows you to change the Waypoint by moving it relative to either its current position, or the position of another Vehicle Waypoint.

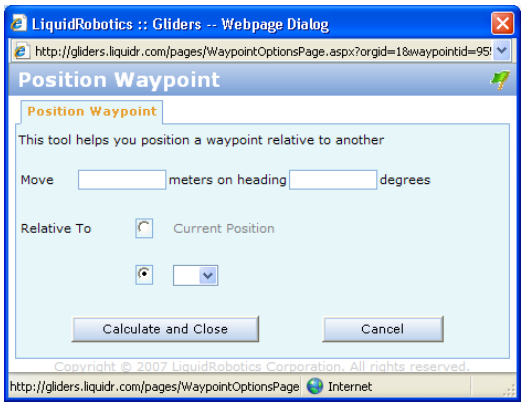


Figure 5-17: Waypoint Move Position Dialog

Save but don't Send: This option is an alternative to the "Send" [Save and send Waypoint to Vehicle] icon. If selected, the updated Waypoint data is saved on the shore database, but not sent to the Vehicle. If you've only changed the Waypoint's name or whether it will be shown on the screen, there's no need to send to the Vehicle. However, if you've changed the Waypoint's number or its coordinates, use the regular "Send" icon.

5.4.4 Deleting a Waypoint

Note that if you "delete" a Waypoint, you will only delete the Waypoint's data on the shore database and Dashboard map. Once sent to the Vehicle, a Waypoint's number and coordinates cannot be deleted from the Vehicle's C&C computer memory. (However, the Waypoint's coordinates can be changed.)

Deleting a Waypoint is primarily useful when the Waypoint has been queued, but not yet sent to the Vehicle.

Deleting a Waypoint is straightforward:

1) Call up the Vehicle Edit box by clicking on the Vehicle icon on the Dashboard page (or, click on "Vehicles" and double-click to select your Vehicle).
2) Next, click on the "Waypoints" tab on the left. This should bring up a list of the Waypoints, similar to Figure 5-18.
3) Single-click on the name of the Waypoint you want to delete. Select multiple Waypoints for deleting by using Ctrl-click.

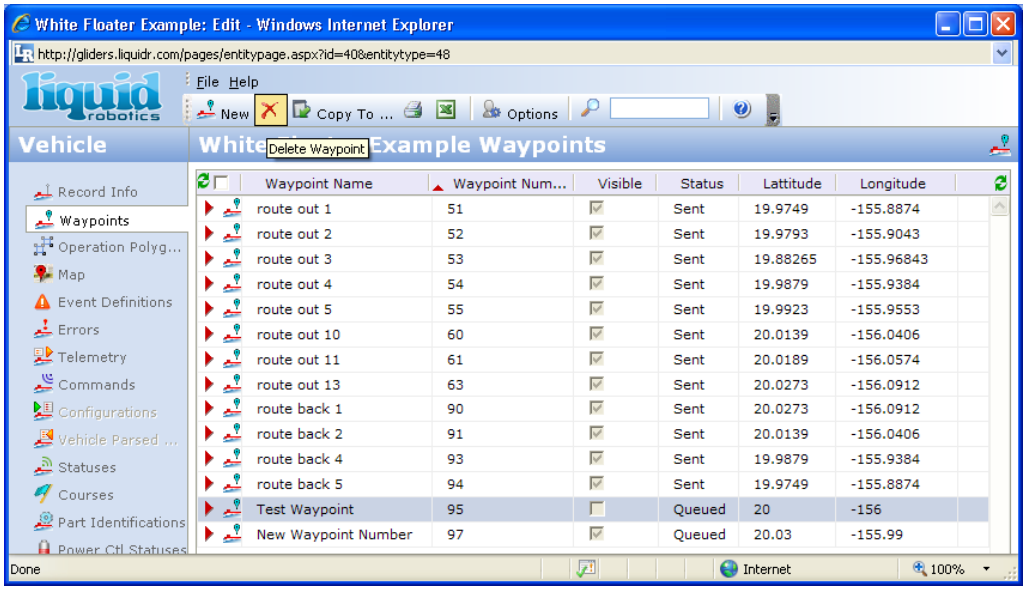


Figure 5-18: Vehicle Waypoints List With Delete Select

4) Single-click the "X" [Delete Waypoint] icon at the upper left. You will get an "Are you sure…" confirmation request.
5) Click the "OK" button to confirm. You should then get a "Deleting Records …" dialog.
6) Click the "OK" button to close the box. The Waypoints list should automatically refresh with the selected Waypoint(s) deleted.

5.5 Changing the Arrival Distance

Depending upon the Mission, you may want to change the Vehicle's Arrival Distance radius. The Arrival Distance can be checked and updated by viewing the "Vehicle Status: New" dialog box shown in Figure 5-20. Depending upon the Vehicle status, this box can be retrieved in two ways:

If the Vehicle icon is not displayed on the Dashboard map, call up the Vehicle Data window, and click on the "Statuses" tab on the left. This should show a list of Status reports, the top portion which is shown in Figure 5-19.

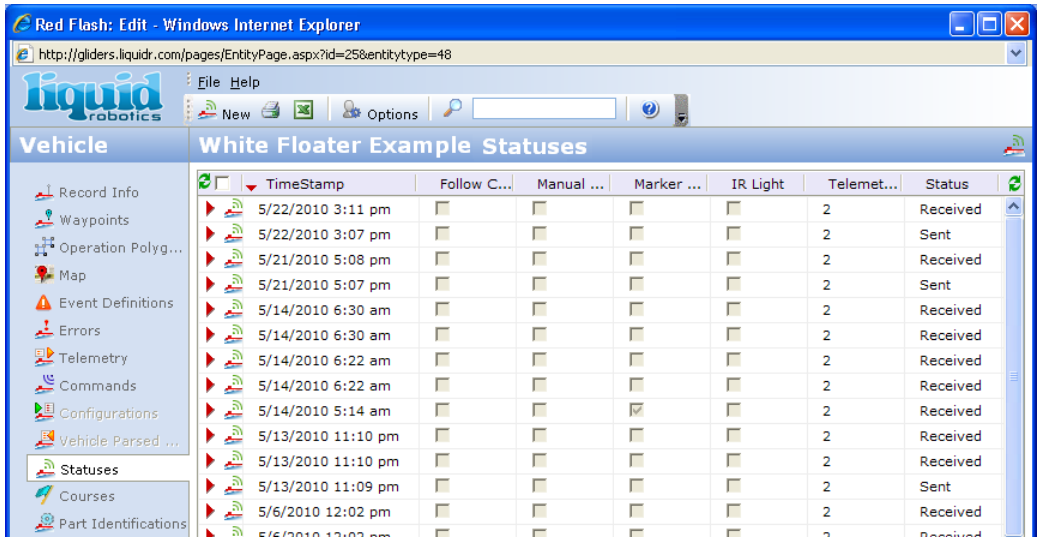


Figure 5-19: Vehicle Statuses Page

Click on the "New" [New Statuses] icon at the upper left. This will bring up the Status: New dialog box shown in Figure 5-20.

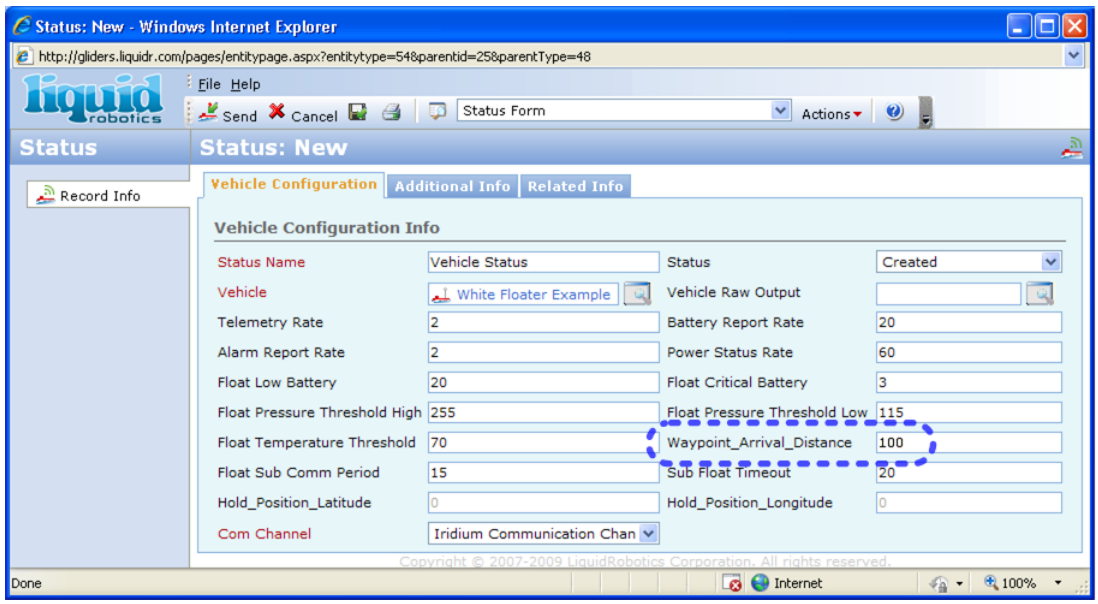


Figure 5-20: Status: New Dialog Box With Arrival Distance

Note that "Waypoint_Arrival_Distance" is specified in a box near the lower right. The value is defined in meters (100 meters in this example).

To change the distance, simply change the value, then click the "Send" [Save and send Status to vehicle] icon at the upper left. You will have to refresh the map (and possibly zoom in) to see the changed distance.

5.6 Modifying Operation Polygons

During provisioning of the Vehicle, an initial set of Operation Polygons may have been defined. If so, these may be adequate for the planned Mission. However, it may also be necessary to change existing Operation Polygons, or to create new ones.

Recall that, unlike Waypoints, Operation Polygon data is stored only on the shore database, and not transmitted to the Vehicle. All checking for Operation Polygon boundary crossing is done entirely by the shore software.

5.6.1 Changing an Operation Polygon

To change an Operation Polygon's basic info:

1) Get onto the Vehicles page and double-click on the name of the Vehicle. This should bring up the Vehicle Data window. Alternatively, click on the Vehicle Icon next to the name on the Dashboard page.
2) Click on the "Operation Polygons" tab on the left. This will bring up a list:

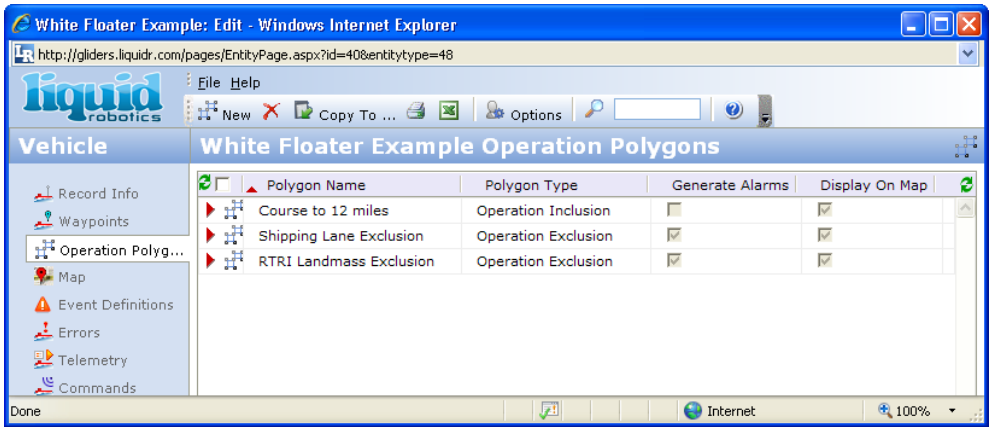


Figure 5-21: Operation Polygon List

3) Double-click on a Polygon Name to bring up the definition dialog for that polygon.

   For example, double-clicking on "Course to 12 miles" brings up:

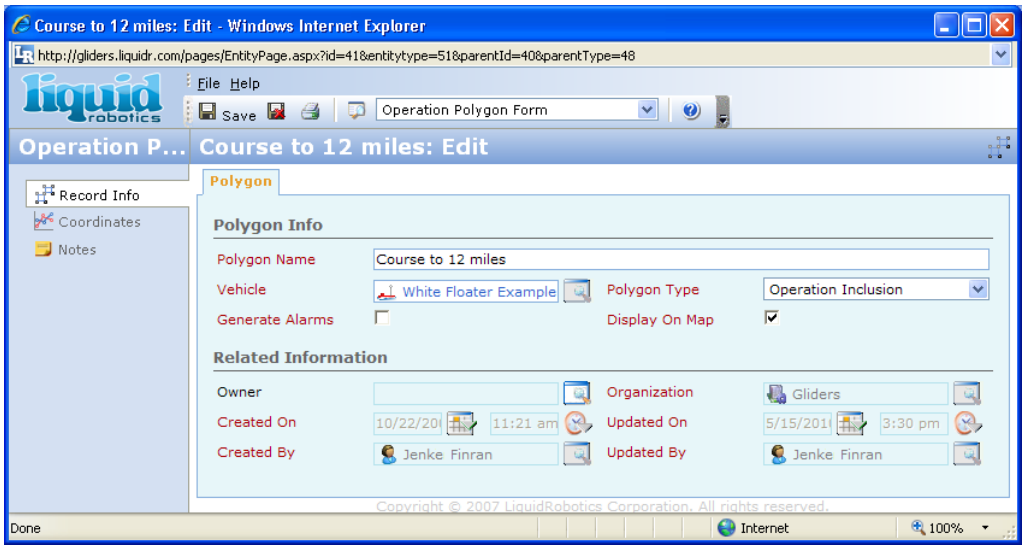


Figure 5-22: Operation Polygon Record Info

   This dialog shows the Polygon Name, the type (Inclusion or Exclusion), whether to generate an alarm if the Vehicle crosses the polygon boundary, and whether the polygon will be displayed on the Dashboard map.

4) Change any of the Polygon Info values (except the Vehicle's name) as desired.
5) Click on the "Coordinates" tab to show a list of the Operation Polygon coordinate points and the order of connection. The list will look something like:

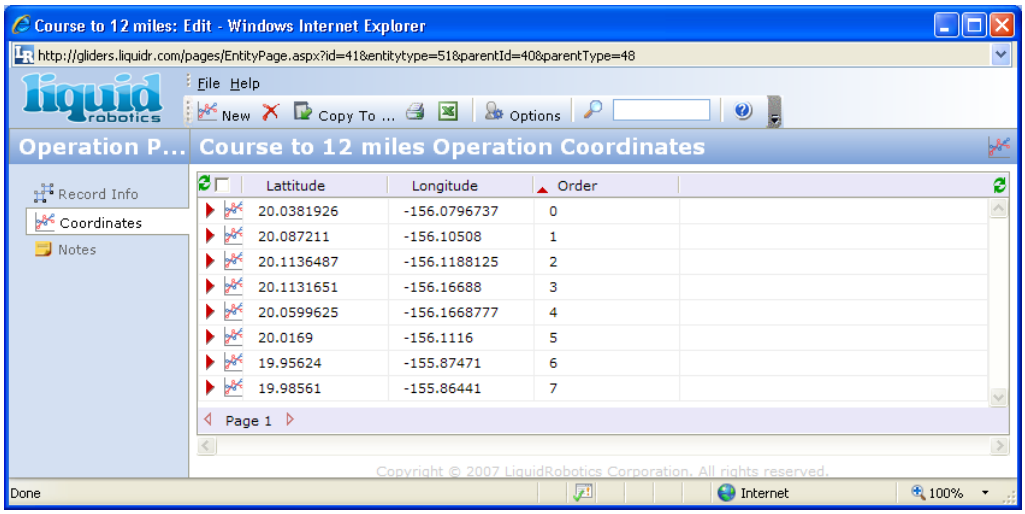


Figure 5-23: Operation Polygon Coordinates List

   This dialog box can be used to add, change or delete coordinates for the named Operation Polygon ("Course to 12 miles" in this example).

To add a new coordinate point:

1) Click the "New" [New operation coordinate] icon. This will bring up the "Coordinate: New" dialog box shown below.

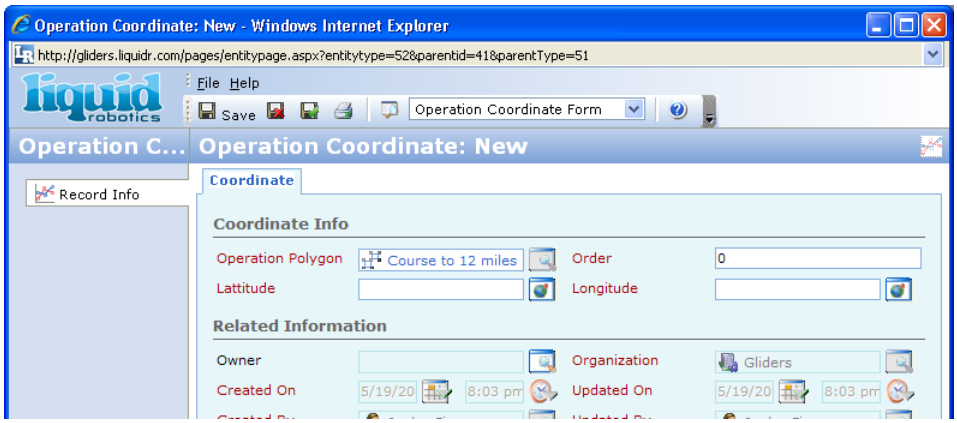


Figure 5-24: Operation Coordinate New Dialog

2) Enter the Latitude, Longitude and Order numbers. (The Operation Polygon name cannot be changed.)

   Note: There is no restriction against two different coordinates having the same Order number. In the case of duplicate numbers, the order will be determined by the order of creation of the points. However, duplicate Order numbers should be avoided.

3) Click on the "Save" [Save Operation Coordinate] icon to save the new values.

To change an existing point's coordinate:

1) Double click on either the Latitude or Longitude value in the coordinates list (Figure 5-23).

   For example double clicking on the "20.1136487" number in the third line would bring up a "Coordinate: Edit" Dialog box that is almost identical to the "Coordinate: New" dialog box, except that the Lat/Long/Order values are already entered.

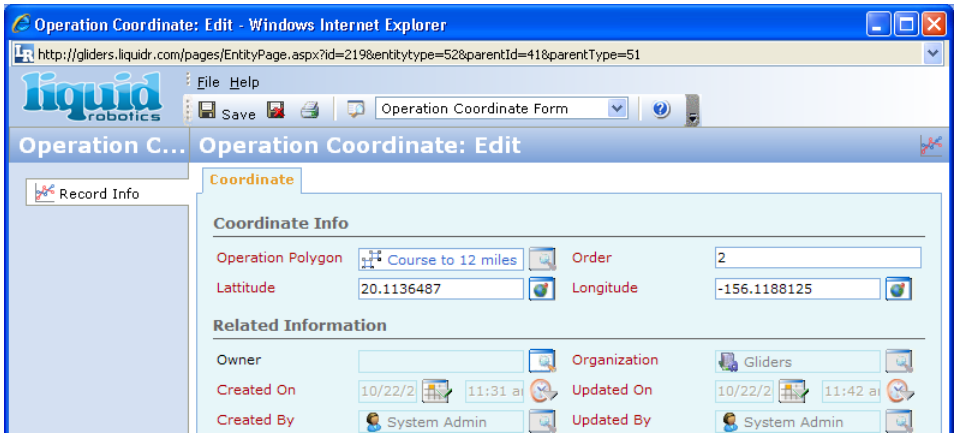


Figure 5-25: Operation Coordinate Edit Dialog

2) For this Polygon point, change the Latitude, Longitude and (if appropriate) Order number as required. The Operation Polygon name cannot be changed.

3) Click on the "Save" [Save Operation Coordinate] icon to save the changed values.

To delete one or more coordinate pairs:

1) Click to select a coordinate (or Ctrl-click to select multiple coordinates).

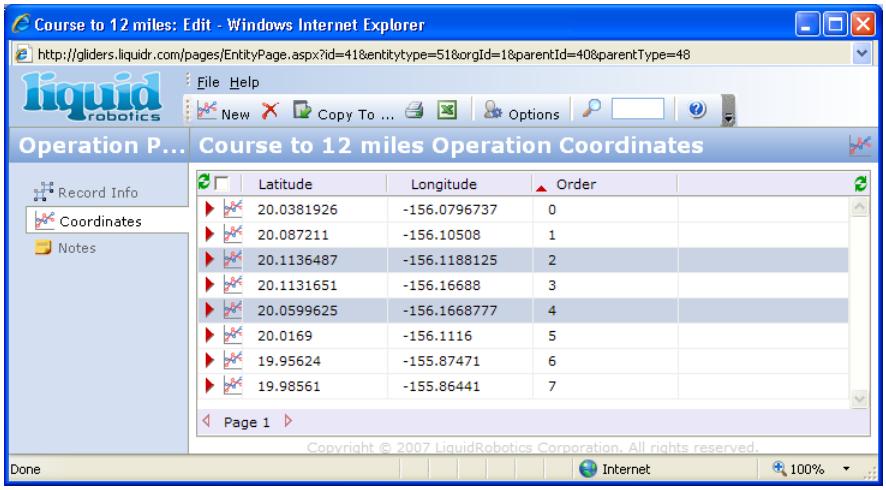


Figure 5-26: Coordinates Selected for Deletion

2) Click the "X" [Delete Operation Coordinate] icon to delete the selected coordinates. You should get the usual confirmation request:

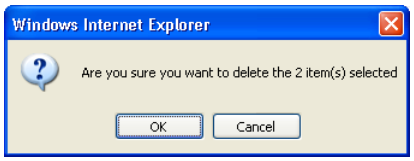


Figure 5-27: Deletion Confirmation Dialog

3) Click "OK". The Coordinates list will change to reflect the deletion:

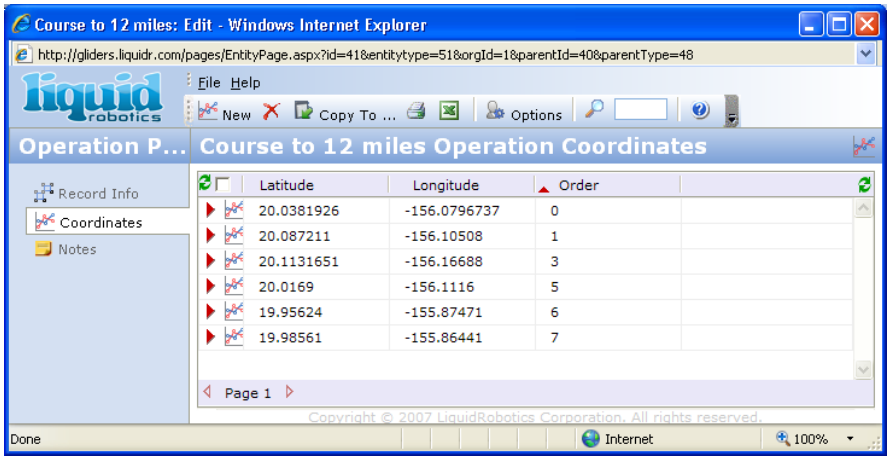


Figure 5-28: Operation Coordinates After Deletion

Note: The polygon Order numbers need not be contiguous (as long as no edges cross).

5.6.2 Adding a New Operation Polygon

To add a new Operation Polygon, bring up the Vehicle Data window and click on the "Operation Polygons" tab on the left to bring up the list of currently-defined polygons.

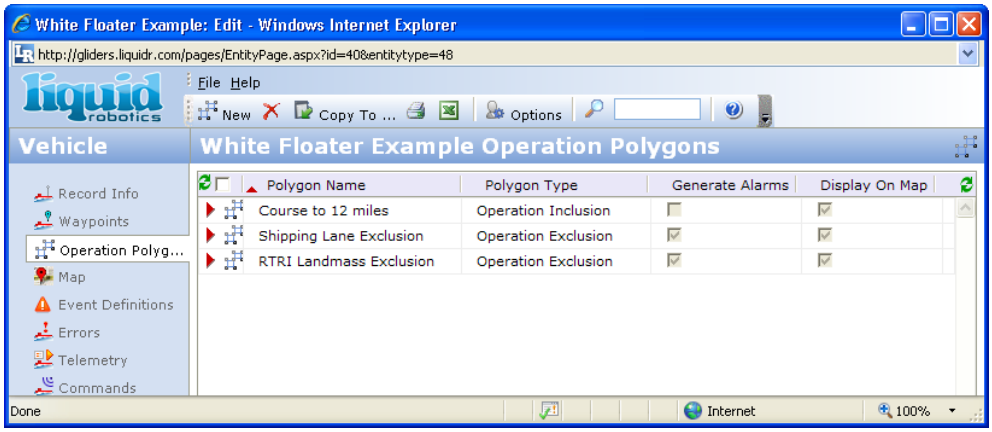


Figure 5-29: Operation Polygon List

Click on the "New" [New Operation Polygon] icon and then follow the procedure described in Chapter 4 (4.5.2).

5.6.3 Deleting an Operation Polygon

To delete an Operation Polygon, in the coordinates list (Figure 5-23) select the line you want to delete (Ctrl-click to select multiple lines). For example, select "RTRI Landmass Exclusion":

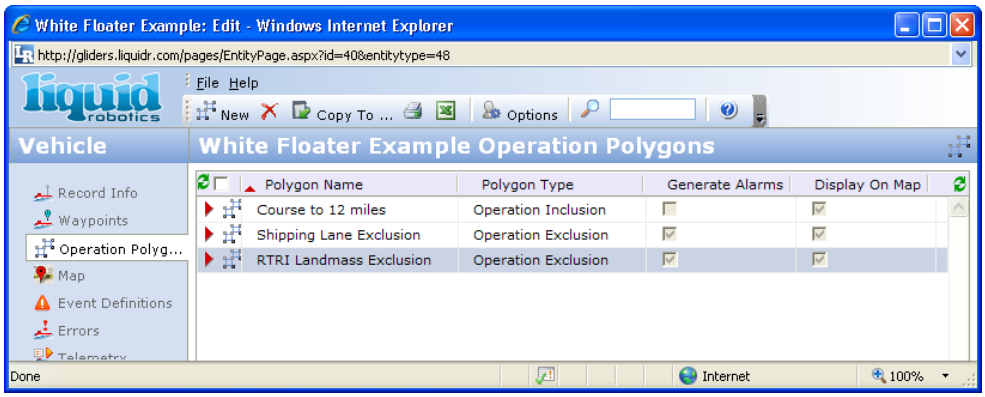


Figure 5-30: Operation Polygon Selected for Deletion

Then click on the "X" (Delete Operation Polygon) icon in the menu bar. You will have to respond by clicking the "OK" button in the usual confirmation dialog.

5.7 Specifying the Course

5.7.1 Course Specification Options

Two types of courses can be started by issuing simple commands:

- If the Vehicle is to just go to a Waypoint and hold position there, you can issue a simple command that defines the Target Waypoint (ref. 5.7.2).
- If the Course involves looping through a sequentially-numbered set of Waypoints, you can start the Vehicle on the Course by issuing a command that defines the first and last Waypoints and the Target Waypoint (ref. 5.7.3).

If a new course uses non-sequential Waypoints, or if the Vehicle is to hold position at the end, you will have use a custom-defined course.

- If the Course has previously been defined, you can simply call up that course and tell the Vehicle to start using it (ref. 5.7.4).
- If a previously-defined course is similar to what you want to use, you can modify that course as necessary (ref. 5.7.5).
- If neither of the above options can be used, you will have to define a new course. This involves specifying the "Course Waypoints" and the order that they are to be visited by the Vehicle (ref. 5.7.6).

5.7.2 Moving to a Target Waypoint

To command the Vehicle to move to a Target Waypoint and hold:

1) Click on the "Hold Station at Waypoint" command button on the Vehicle Control Bar. This brings up the dialog:

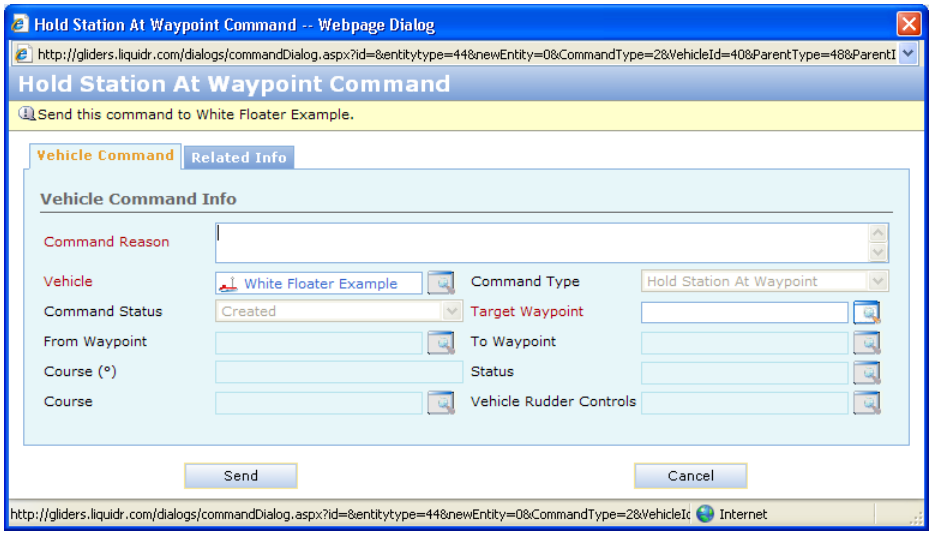


Figure 5-31: Hold Station at Waypoint Dialog

2) Enter the "Command Reason". This comment should be meaningful to other people.

3) Enter the number of the "Target Waypoint".

   Note: The icon to the right of the input box can be used to bring up a list of the Waypoints.

4) Click the "Send" button at the bottom. The command will be queued for transmission to the Vehicle.

5.7.3 Looping Through Sequential Waypoints

If the Vehicle's Course involves continuously looping through a series of sequential Waypoints, the command is relatively simple. However, the Waypoints need to be carefully defined so that the numbers used for the Course are contiguous (no skipped numbers).

To loop through a set of sequential Waypoints:

1) Click the "Follow Sequential Course" command button in the Dashboard Status and Control Bar. This should bring up the dialog shown below in Figure 5-32.
2) Enter the "From", "To" and "Target" Waypoint numbers, as shown in the figure. You will get an error message if you enter Waypoint number that has not been defined.

   Note: You can call up a list of Waypoints by clicking on the [View] icon to the right of the data input boxes.

3) You are required to enter a "Command Reason".

   The filled-out dialog might look like:

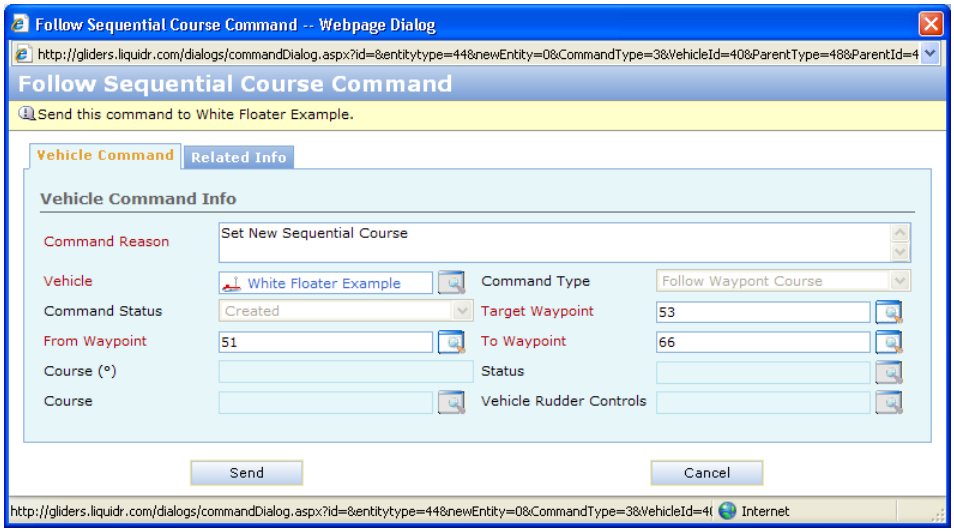


Figure 5-32: Follow Sequential Course Command Dialog

4) Click on the "Send" button at the bottom to queue the command for sending to the Vehicle.

   Note: The above procedure can only be used for continuously looping through Waypoints. If the Vehicle is to hold at the last Waypoint (even if the Waypoints are sequential), you will have to use the method described in 5.7.4 below.

5.7.4 Using a Previously-Defined Course

Check what courses (if any) have already been defined for the Vehicle. Call up the Vehicles List and double-click on your Vehicle. Or click on the Vehicle's icon on the Dashboard page.

Then, click on the "Courses" tab on the left side. This should bring up a list of the Courses that have previously been defined. An example list could look like:

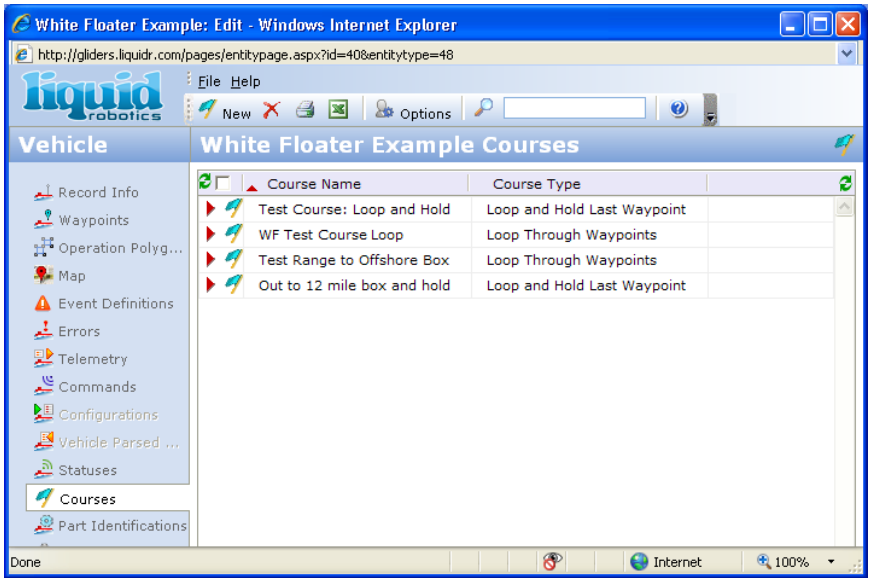


Figure 5-33: Example Courses List

If this is a new Vehicle, there may be no courses listed. In this case, skip down to the section 5.7.6 “Creating a New Course".

Even you are familiar with this Course, it's always a good idea to check the Course before sending it. To select the Course, double-click on the Course Name to bring up the Course Edit dialog.

For example, double clicking on "WF Test Course Loop" would bring up a dialog like:

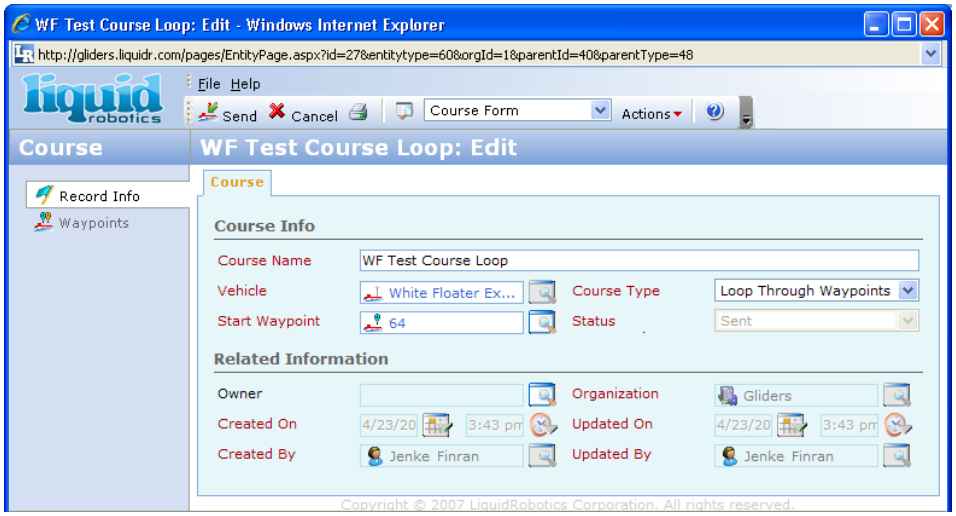


Figure 5-34: Course Edit Dialog

To re-check the Waypoints and the order of visit, click on the "Waypoints" tab on the left side. This will bring up a list of the Waypoints associated with this Course and with the Vehicle.

For this example, the list could look similar to:

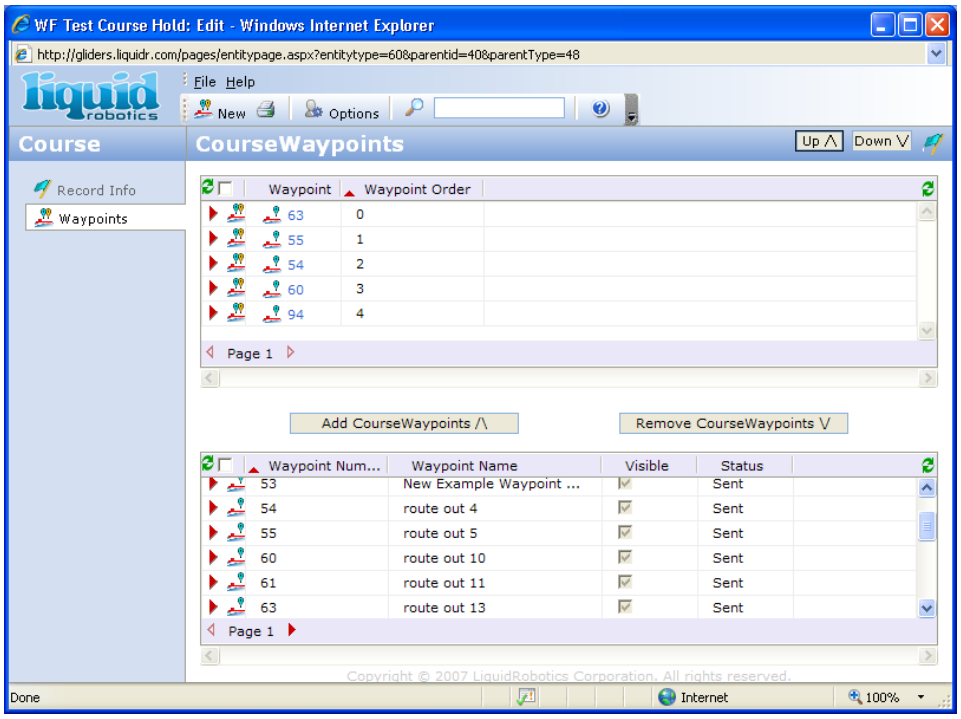


Figure 5-35: Course Waypoints Lists

The upper list shows the Course Waypoints, and their order of visit. The lower list shows all of the Waypoints created for this Vehicle.

Once you are sure that the Course is what you want, click the left-side "Record Info" tab to bring back the Course Edit dialog:

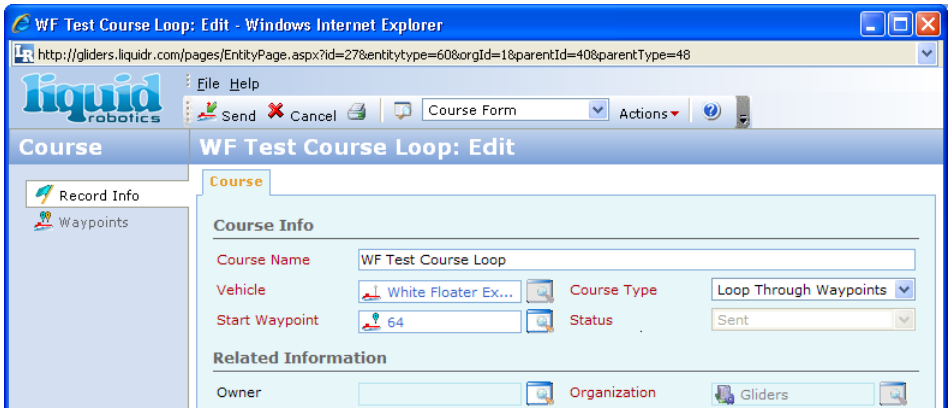


Figure 5-36: Course Edit Dialog

There are two basic options:

1) Click on the "Send" [Save and send Course to vehicle] icon to queue the command for sending to the Vehicle. As with all WGMS commands, this command will not be sent to the Vehicle until it is powered up and sending telemetry.

2) Click on the "X Cancel" [Cancel, don't send and close the form] icon to close the dialog box without sending the command.

Note: There is also an "Actions" pull-down option. This option is typically used in the context of a modified or new course, described below.

5.7.5 Modifying an Existing Course

If a course has already been defined that is similar to the one you want, you can modify it as necessary to create the new Course. This can be especially useful if you don't want to change the Course itself, but just modify the Start Waypoint, or change from looping to hold-at-end.

Call up the Vehicles List and double-click on your Vehicle. Click on the "Courses" tab on the left side to bring up the list of courses.

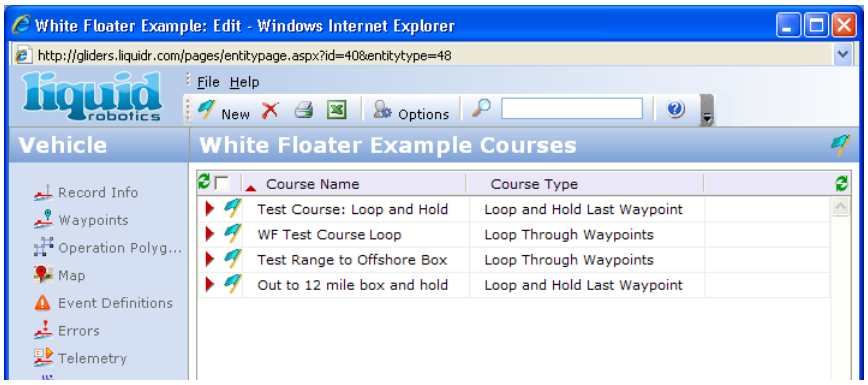


Figure 5-37: Example Courses List

Select the Course you want to modify by double-clicking on the Course Name (or the flag icon to its left). For example, double clicking on "WF Test Course Loop" brings up the familiar dialog:

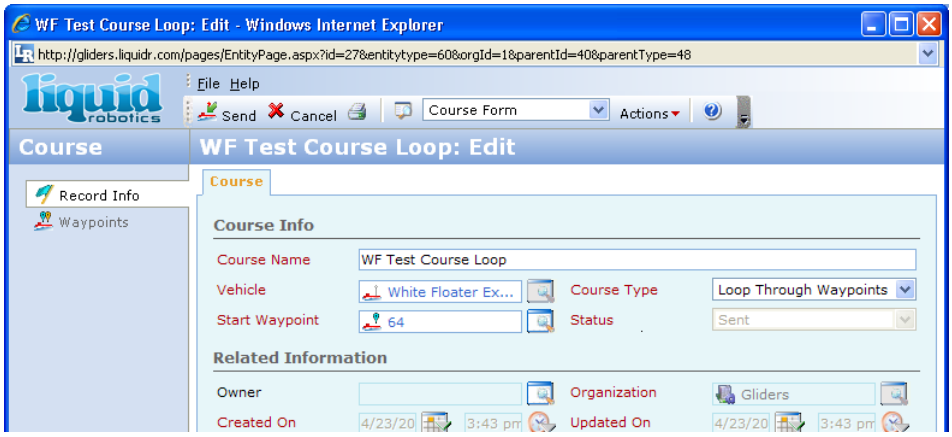


Figure 5-38: Course Edit Dialog

Modify the values in the boxes to change the Course Name, Course Type, and/or Start Waypoint.

If, for example, you are changing from a looping course, to a single-pass, use the pulldown list to change the Course Type to "Loop and Hold Last Waypoint".

It's a good idea when changing the Course to also change the name. In this example, perhaps change the Course name to "WF Test Course Hold".

The Start Waypoint can be changed also. Just be sure that any new number is one of the Course Waypoints. For this example, change it to 95.

If there are no changes to the Course Waypoints, you can click on the "Send" [Save and send Course to vehicle] icon. This will send the new (modified) Course to the Vehicle on the next Vehicle telemetry transmission.

Alternatively, you can click on the "Actions" pull-down.

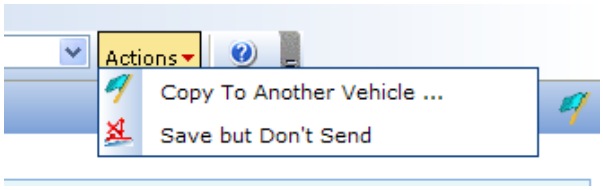


Figure 5-39: Course Actions Pulldown

If you click on the "Save but Don't Send" option, the new course will be saved on the database but not sent to the Vehicle. At a future time, you can call up this course and send it.

Note: Use of the "Copy to Another Vehicle" option is currently not recommended.

If you want to change one or more of the Waypoints, you need to will bring up the list of Waypoints associated with this Course. Click on the "Waypoints" tab on the left side.

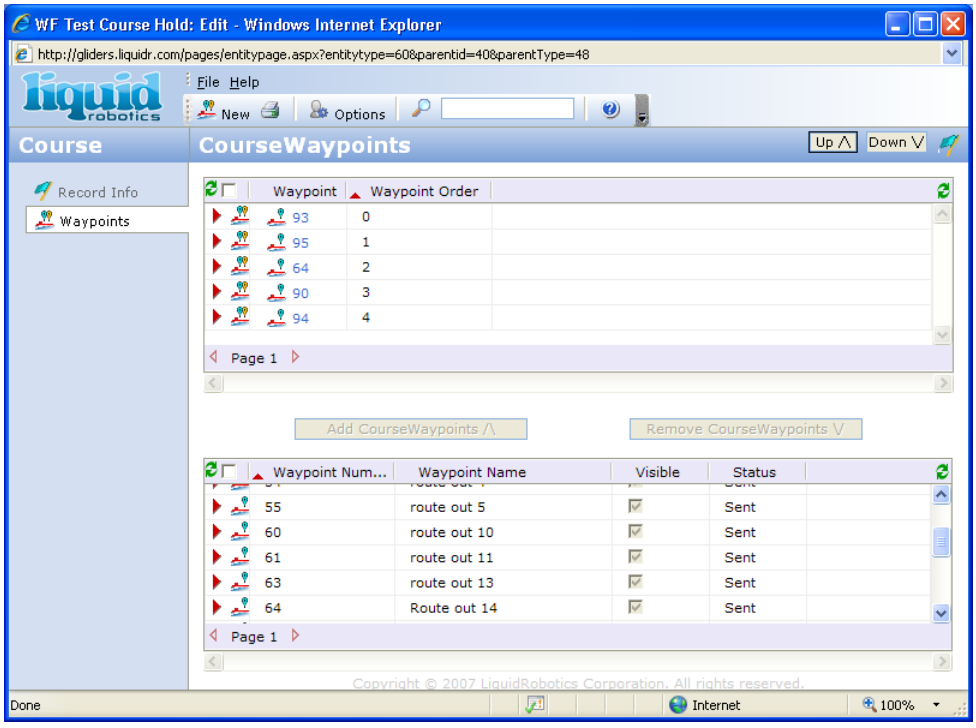


Figure 5-40: Course Waypoints List to Change

The upper list shows the Course Waypoints, and their order of visit. The lower list shows all of the Vehicle's Waypoints. If additional Waypoints need to be added to the lower list, this can be done as described in 5.4.1.

If all you want to do is change the priority (order of visit) of any Waypoint in the upper list, a convenient method is to use the Up/Down buttons at the upper-right of the dialog.

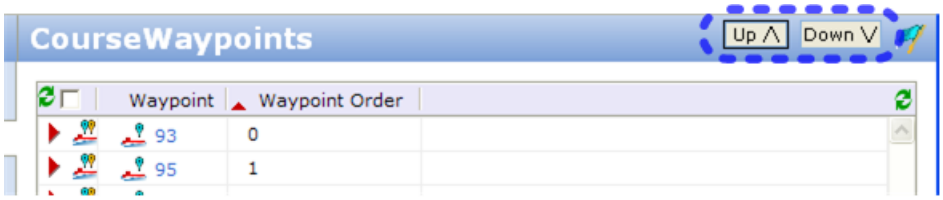


Figure 5-41: Waypoint Priority Up/Down Buttons

Click to select a Waypoint number in the list. Clicking "Up" will move it up one position in the list. Clicking "Down" will move it down by one position. The other Waypoint Order numbers will change to maintain the sequence.

Note: The Up and Down refer to the Waypoint's position in the list, not the value of the Order number. Thus "Up" decreases the Waypoint's number and "Down" increases it.

To delete a Waypoint from the Course, click on the Waypoint number in the upper list (select multiple Waypoints using Ctrl-click). This will highlight the "Remove Course Waypoints V" button. Clicking on the button will remove the selected Waypoint(s) from the list and reorder the remaining Waypoint Order numbers.

As an example, suppose you want to delete Course Waypoint 64. Click to highlight 64 in the upper list:

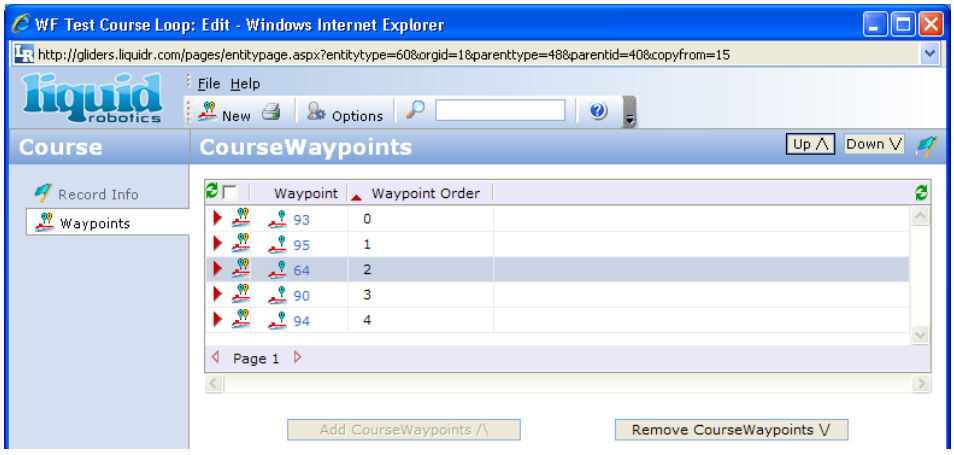


Figure 5-42: Course Waypoint Selected for Removal

When you click the "Remove Course Waypoints" button, the dialog will automatically refresh to show that Waypoint 64 was deleted.

Figure 5-43 shows the list with the deleted Waypoint. Note that the Order numbers for Waypoints 90 and 94 automatically changed to maintain the sequence.

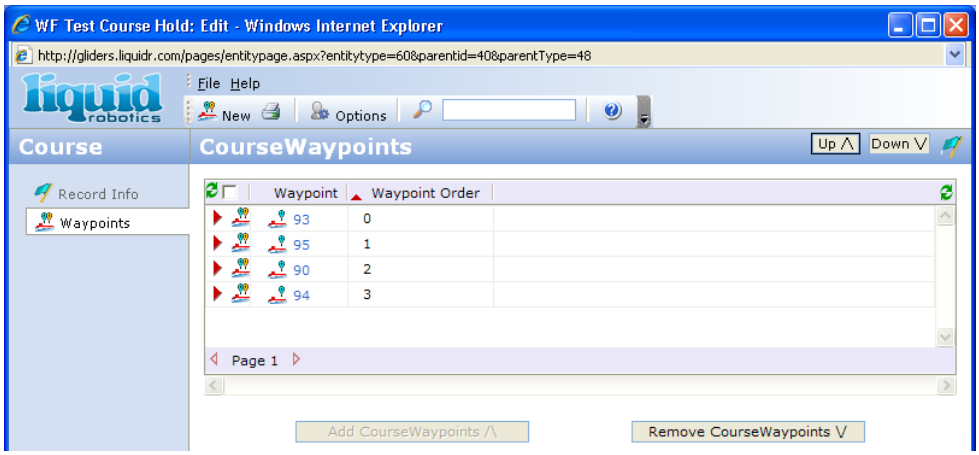


Figure 5-43: Course Waypoints with Deleted Waypoint

To add one or more Waypoints to the Course, click (or Ctrl-click) to select in the lower list, then click the "Add Course Waypoints". This will add the selected Waypoint(s) to the upper list.

For example, assume you want the Vehicle to go to Waypoint 55 after reaching Waypoint 95. First select Waypoint 55 in the lower list.

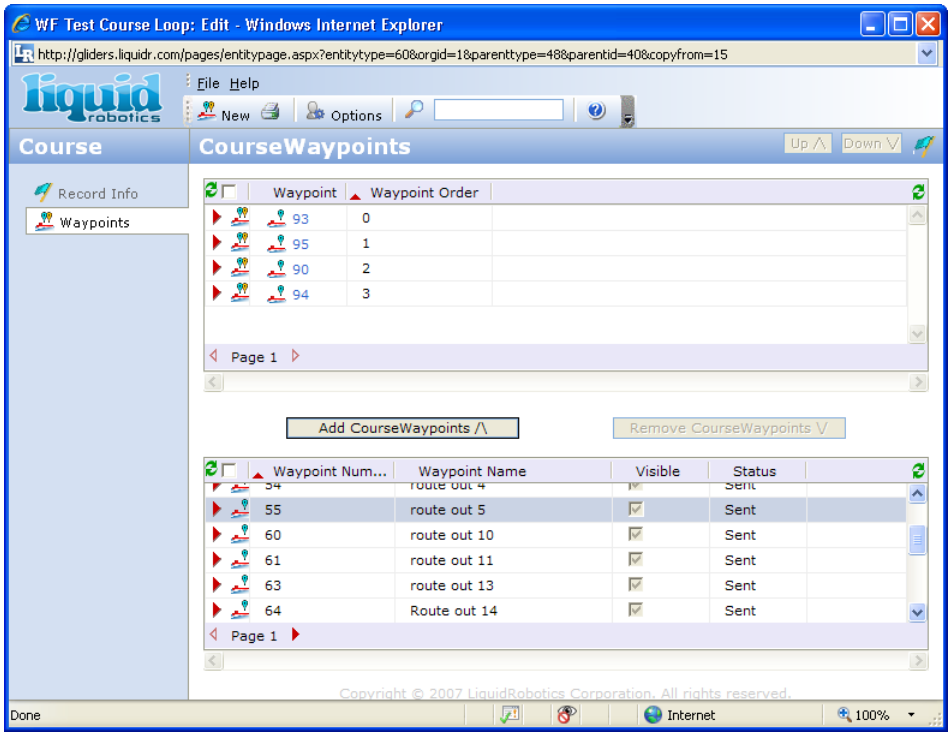


Figure 5-44: Waypoint Selected for Adding

Click the "Add Course Waypoints" button.

The Course Waypoints would now look like:

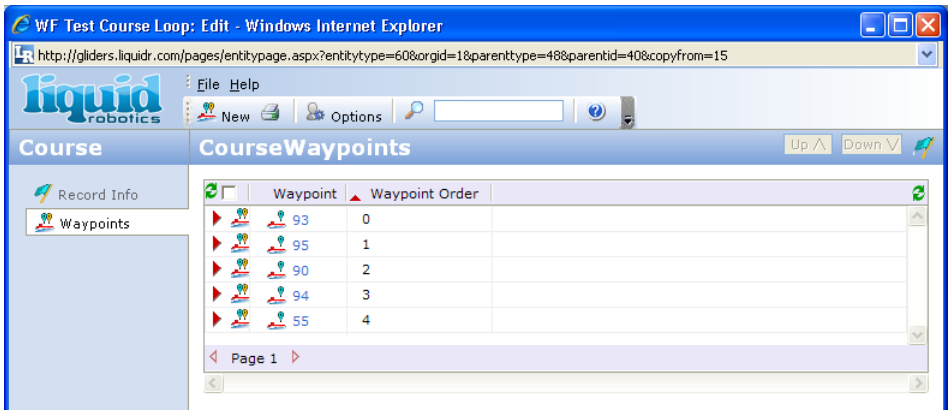


Figure 5-45: Waypoint Added to Course

As can be seen, the Order number for the added Waypoint 55 is set to the next largest Waypoint Order number. If Waypoint 55 is to follow Waypoint 95, then its Waypoint Order number will need to be changed to 2.

To change the Order number, double-click on the "55" (or single-click on the icon next to it). This will bring up the dialog for Course Waypoint 55:

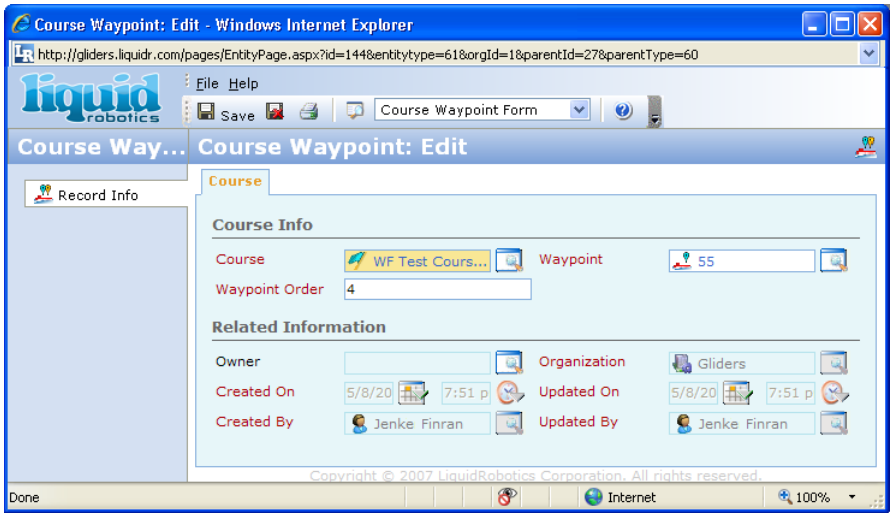


Figure 5-46: Course Waypoint Edit Dialog

Change the number in the Waypoint Order box to 2. Then click on the [Save and close Course Waypoint] icon (with the Red "X").

The updated list would now look like:

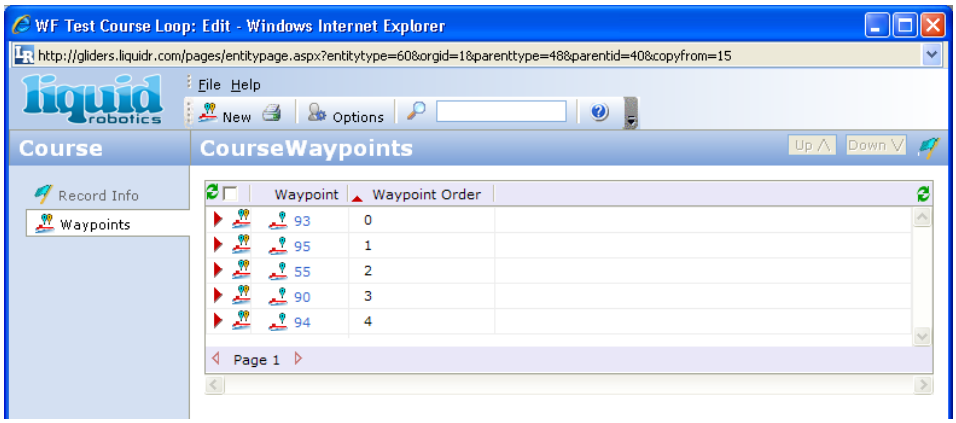


Figure 5-47: Course Waypoints With Order Changed

Note that the order numbers for Waypoints 90 and 94 have changed to accommodate the new value for Waypoint 55.

Note that you could have accomplished the re-ordering by selecting Course Waypoint 55 in the upper list, then clicking the "Up" button twice.

Now that the Course Waypoints and their sequence have been defined, you can return to the Course Edit dialog to either send the Course to the Vehicle, or save it for future use.

Clicking on the "Record Info" tab on the left brings up the Course Edit dialog, shown below with the Actions pull-down.

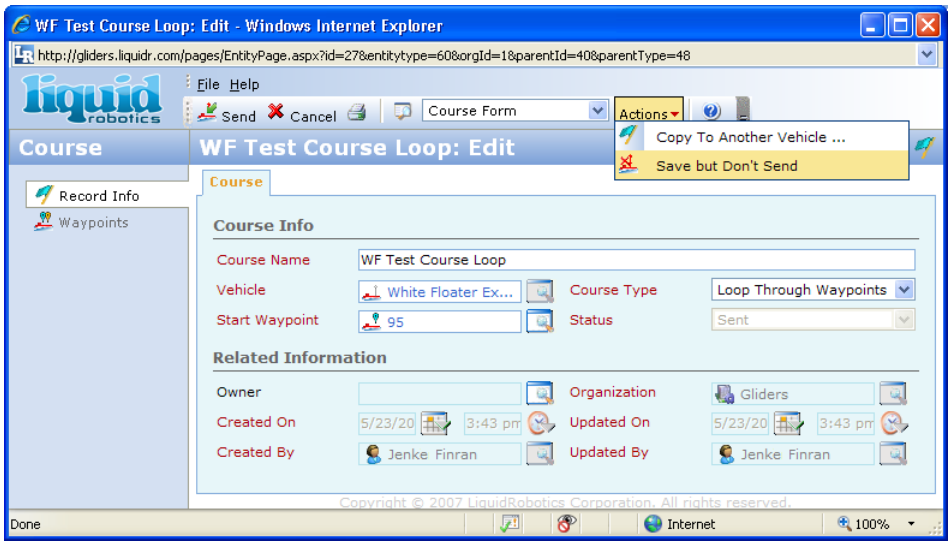


Figure 5-48: Course Edit Dialog with Actions Pulldown

The two basic options are:

1) Click on the "Send" [Save and send Course to vehicle] icon on the upper-left. The modified Course will be sent to the Vehicle at the next telemetry transmission.

2) Alternatively, you can click on the "Actions" pulldown "Save but Don't Send" option. This will save the modified Course in the database, but not send it to the Vehicle. The Course can then be sent to the Vehicle at a later time.

   Note: Do not use the "Copy to Another Vehicle" option.

5.7.6 Creating a New Course

If you can't use or modify an existing course, you will have to create a new one from scratch. Creating is similar to modifying an existing course, except that you have to enter in all the values.

The procedure is:

1) Call up the Vehicles List and double-click on your Vehicle. Or click on the icon on the Dashboard page. Then, click on the "Courses" tab on the left side.

   This should bring up a list of the Courses that have already been defined. (If this is a new Vehicle, the list may be empty.)

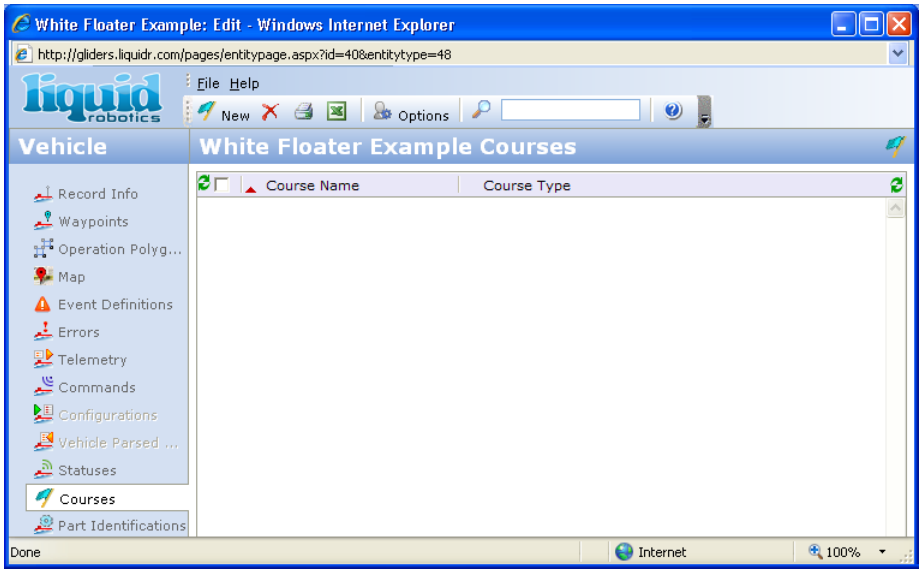


Figure 5-49: Empty Courses List

2) Click on the "New" [New Course] icon at the top.

   This will bring up the "New Course" dialog box:

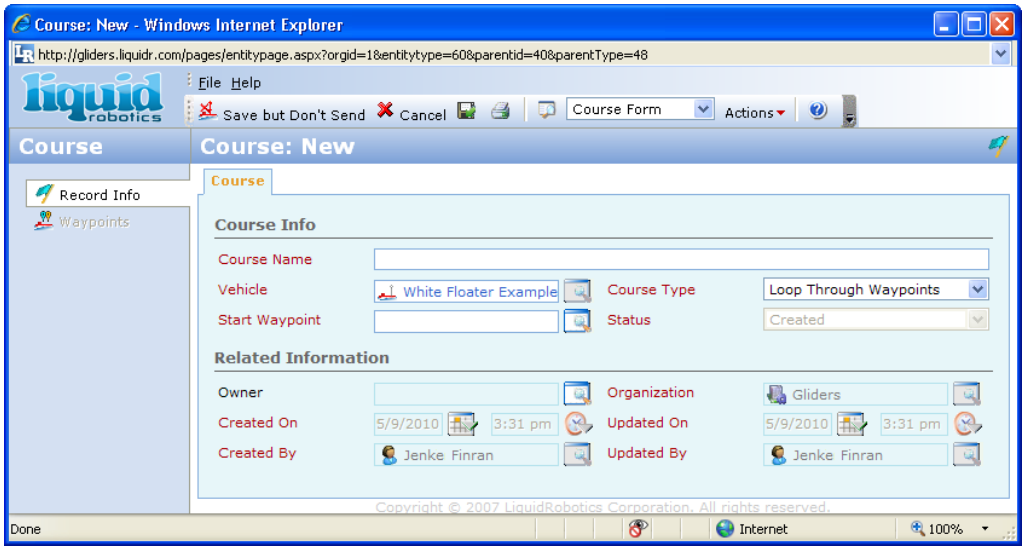


Figure 5-50: New Course Dialog

3) In the "Course Name" box, enter a descriptive name. For example: "New Example Course".
4) In the "Course Type" box, pull down to select either:

   Loop Through Waypoints

   Loop and Hold Last Waypoint

5) You must select a Start Waypoint value, but you cannot enter it directly. Instead, click on the icon to the right of the box. This will bring up a list of the existing Waypoints.

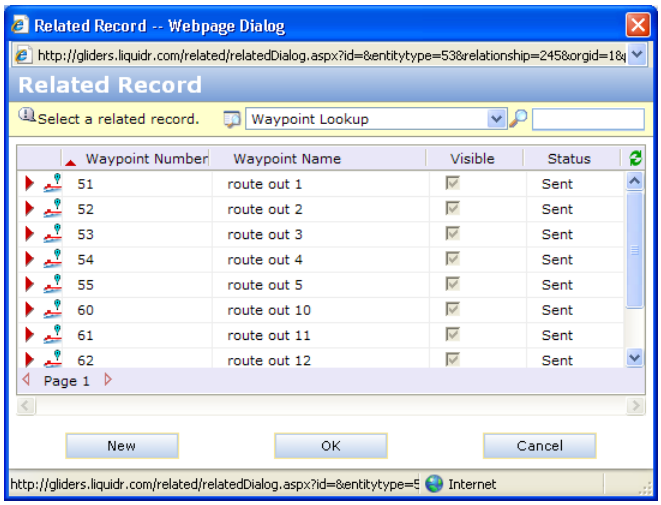


Figure 5-51: Waypoint Select List

6) Click to select the Waypoint that you want to enter as the Start Waypoint.

   Note: If you're not sure which Waypoint will be the Start Waypoint, make your best guess and select it as a "placeholder". You can always change it later.

   For the example, assume that Waypoint 63 is selected.

7) Click the "OK" button at the bottom to exit the Waypoints list.

   The New Course dialog should now have all the required data:

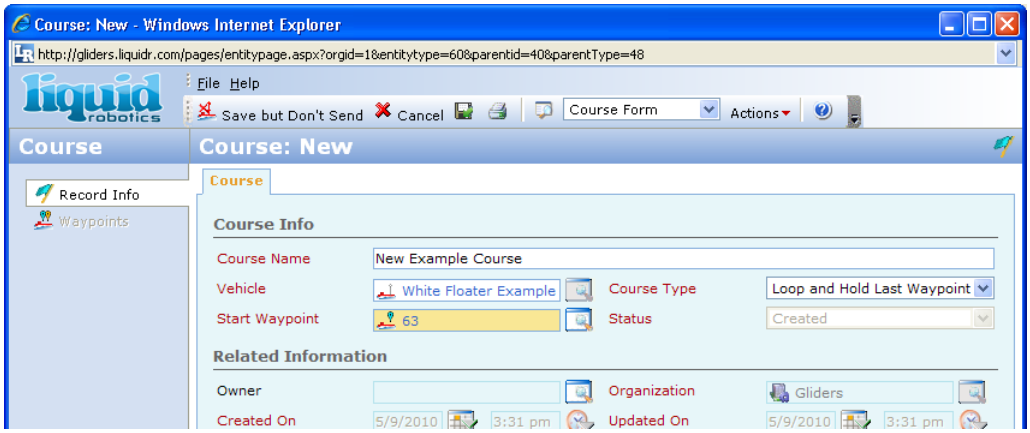


Figure 5-52: New Course Dialog – Completed

At this point, you have created a new course, but you cannot yet specify the Waypoints that define the Course. First, you have to save the Record Info data.

8) Click on the "Save but Don't Send" icon at the upper left. This will save the basic Course data and activate the Waypoints selection option.

9) Click on the "Waypoints" tab on the left to bring up the Course Waypoints List.

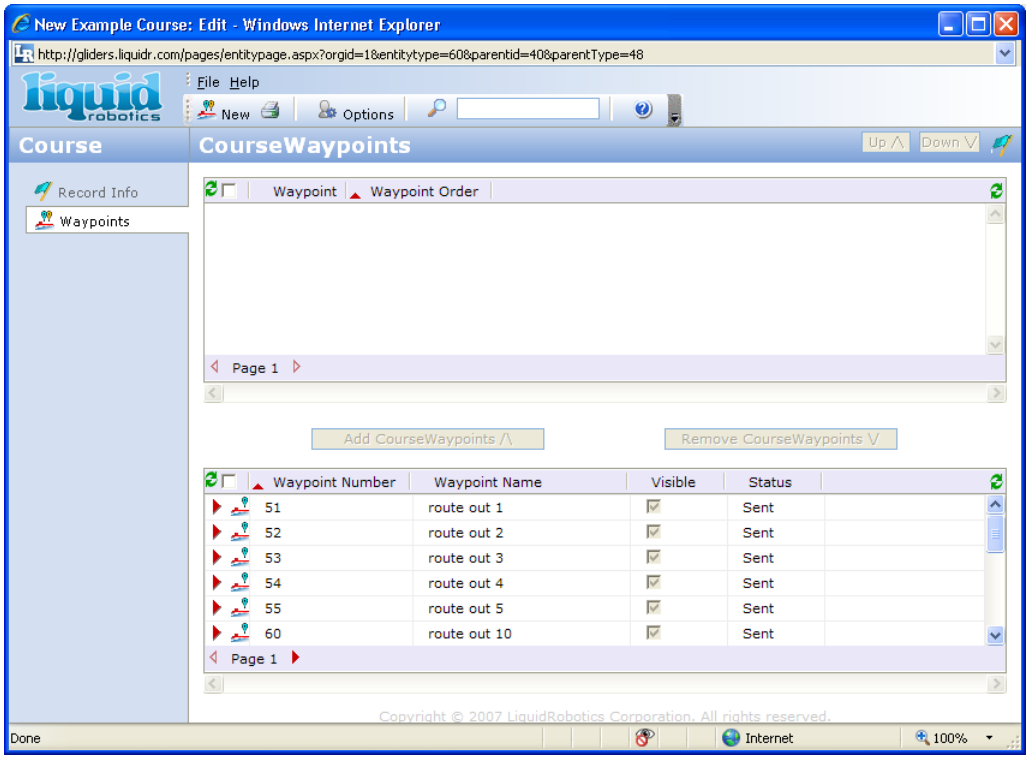


Figure 5-53: Course Waypoints List (Empty)

The upper box is a list of the Course Waypoints and their order of visit. The lower box lists all the Waypoints that have been defined for the Vehicle.

10) In the lower list, click on the number of the first Waypoint you want to put in the Course. This will select the Waypoint and activate the "Add Course Waypoints" button on the left.

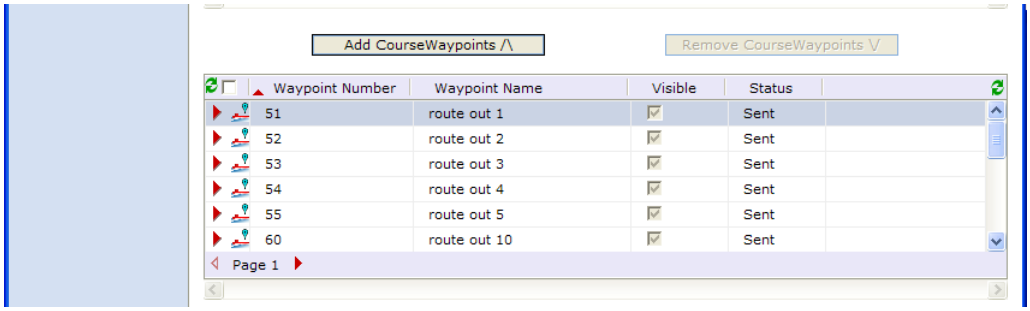


Figure 5-54: Waypoint Selected for Copy

11) Now, click the "Add Course Waypoints" button to copy the Waypoint to the upper list.

Note that the first copied Waypoint has been assigned a Waypoint Order of zero.

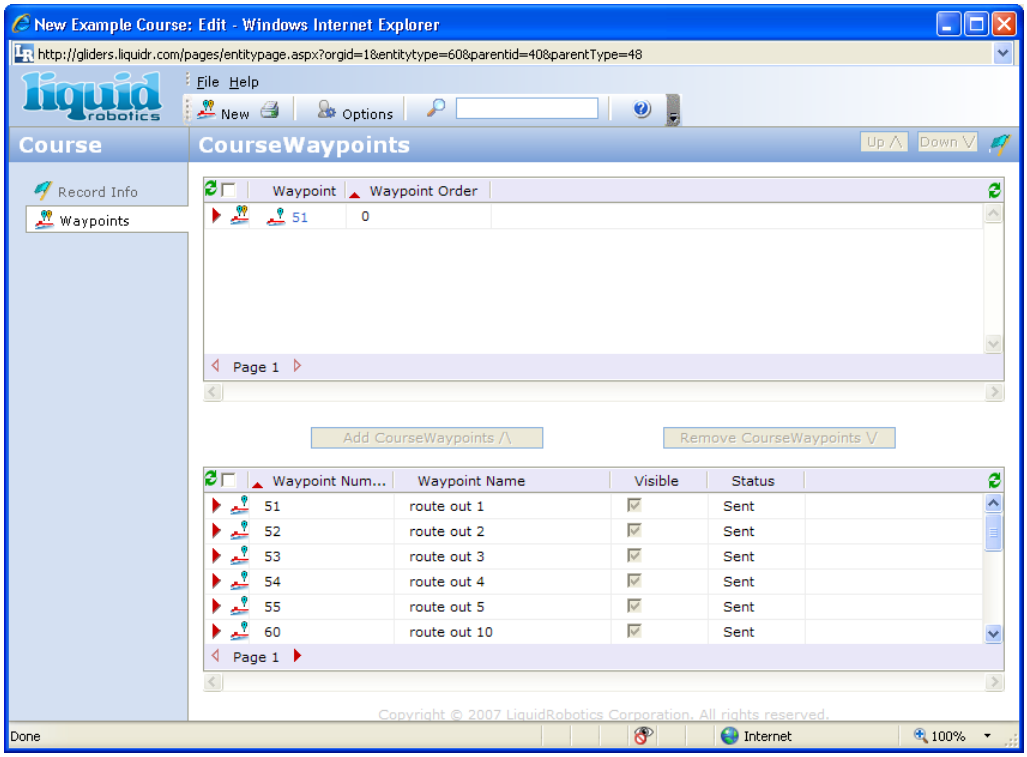


Figure 5-55: First Waypoint Copied

Note also that Waypoint 51 is still listed in the bottom box. You've copied the Waypoint, not moved it. This allows any Waypoint to be used more than once in a course.

12) Repeat steps 10 (select) and 11 (add) to create additional Course Waypoints. As you copy each Waypoint, you'll notice that the Waypoint Order numbers automatically increment.

Note: If one or more Course Waypoints are not in the sequence you want, they can be changed later using the procedure defined in section 5.7.5 "Modifying an Existing Course".

After copying five Waypoints, the Course Waypoints list might look something like:

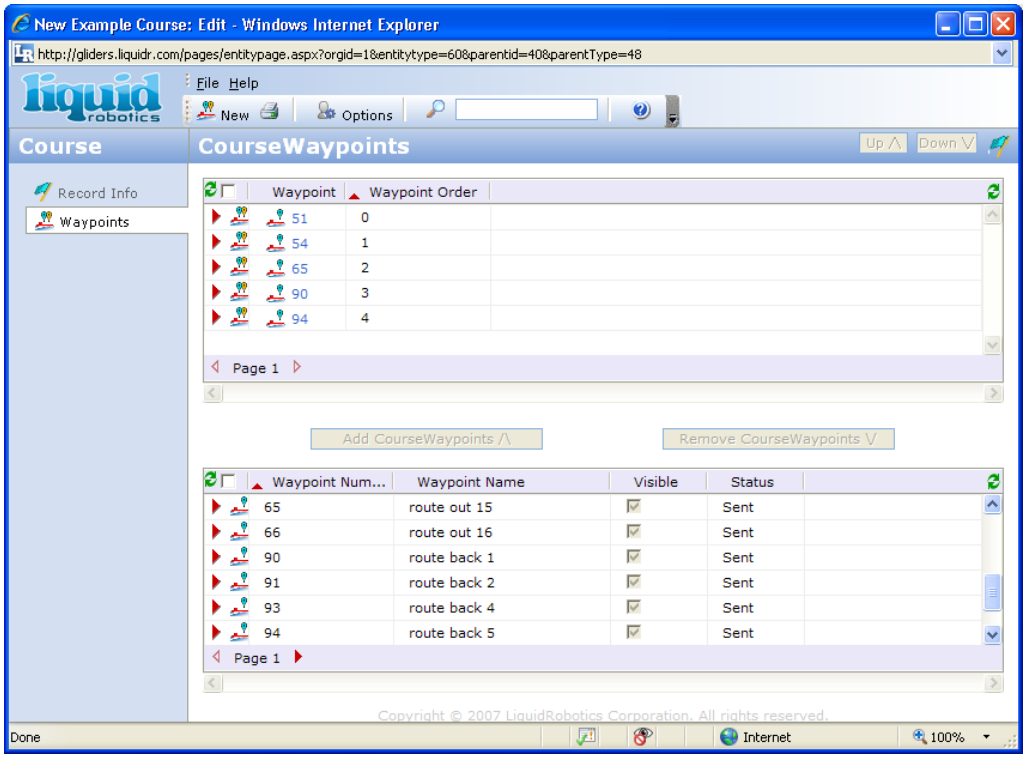


Figure 5-56: Course Waypoints Created

13) Now click on the "Record Info" tab on the left to bring back the main Course dialog.

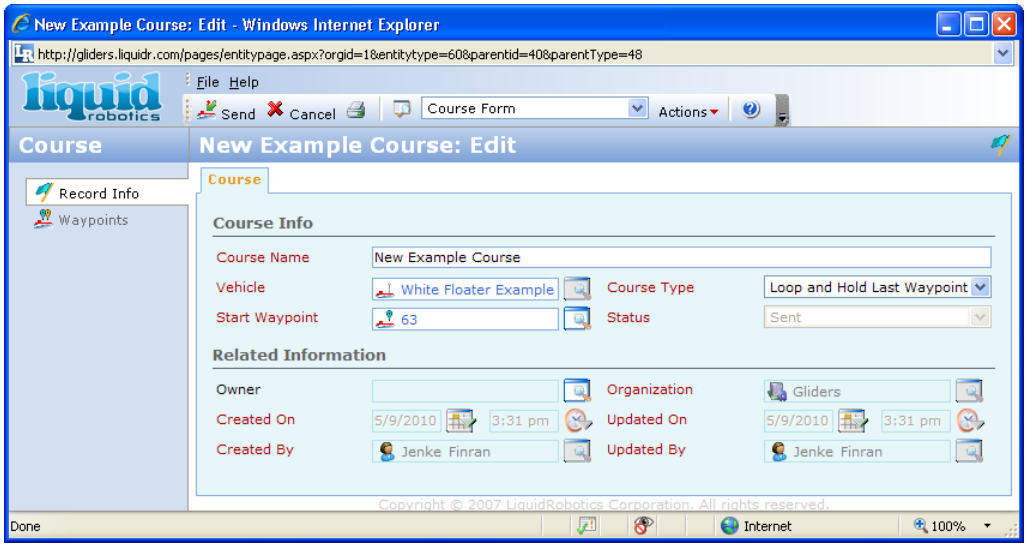


Figure 5-57: Example Course Waypoint Edit

Note that the Start Waypoint number (63) is not on the specified Course, so it needs to be changed.

14) Click on the icon to the right of the Start Waypoint box to bring up the list of Waypoints. Select a new Start Waypoint value (similar to steps 5 to 7 above).

For this example, assume you've selected Waypoint 54 as the Start Waypoint.

The "final" Course Waypoint edit dialog is shown below (with the Actions pulldown clicked).

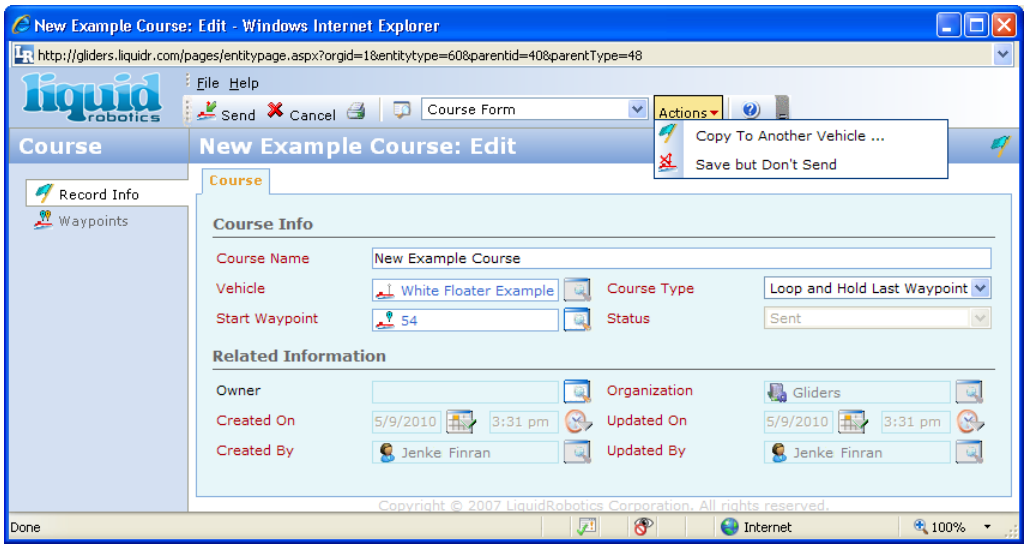


Figure 5-58: Course Waypoint Edit, Ready to Save

At this point you have two options:

15a) Click on the "Send" [Save and send Course to vehicle] icon at the upper left. For a newly-created Course, this is not recommended.

15b) Click on the "Actions" button and pull down to select "Save but Don't Send". Saving at this point will allow you to re-check the Course data before sending to the Vehicle.

Now that the new Course has been created and saved, you can access it, check it, and then send it using the procedure described in 5.7.4 "Using a Previously-Defined Course".

5.8 Basic Navigation Modes

For navigation modes that don't require a Waypoint, a simple Dashboard command entry is basically all that is required. No course data needs to be set up.

Two procedures use the command buttons on the Dashboard Page. The third requires clicking on the **More Commands ...** link at the bottom.

Figure 5-59: Command Buttons

The procedures are very similar; the main difference is the data that needs to be entered.

5.8.1 Hold Station at Position

To tell the Vehicle to stay at its present position:

1) Click on the **Hold Current Position** button to bring up the dialog:

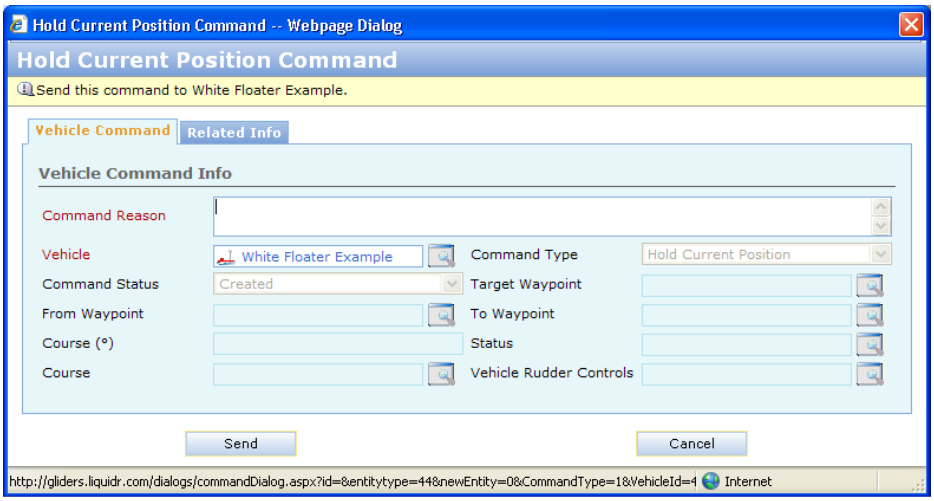


Figure 5-60: Hold Current Position Command Dialog

Note that the "Command Type" (Hold Current Position) is set and cannot be changed.

2) Enter the "Command Reason". This explanation is required (you can use multiple lines). No other data should be entered.

3) Click the **Send** button at the bottom to queue the command for sending to the Vehicle.

5.8.2 Maintain a Fixed Heading

To command the Vehicle to maintain a fixed heading:

1) Click on the **Follow Fixed Heading** button to bring up the dialog:

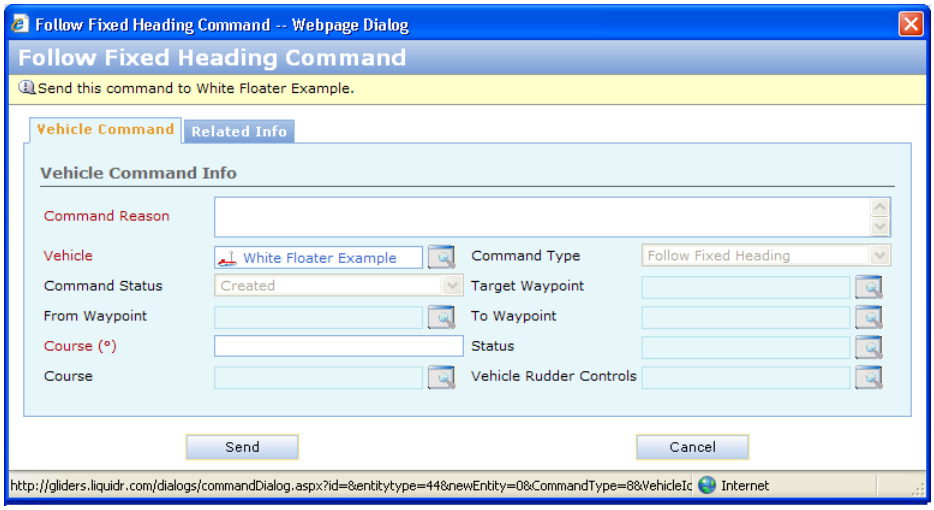


Figure 5-61: Follow Fixed Heading Command Dialog

2) Enter the required "Command Reason".

3) Enter the "Course (degrees)" numerical value, from **0** to **359**. The value must be a simple positive integer with no decimal point.

4) Click the **Send** button at the bottom. The command will be queued for sending.

5.8.3 Set a Fixed Rudder Position

This is usually used for troubleshooting purposes. However, it can also be used for temporary maneuvers (e.g., to avoid a restricted area).

To access the rudder position commands, click on the More Commands … link below the command buttons.

1) Use the “Command Type” pull-down list to select one of the rudder position commands, as shown in Figure 5-62.

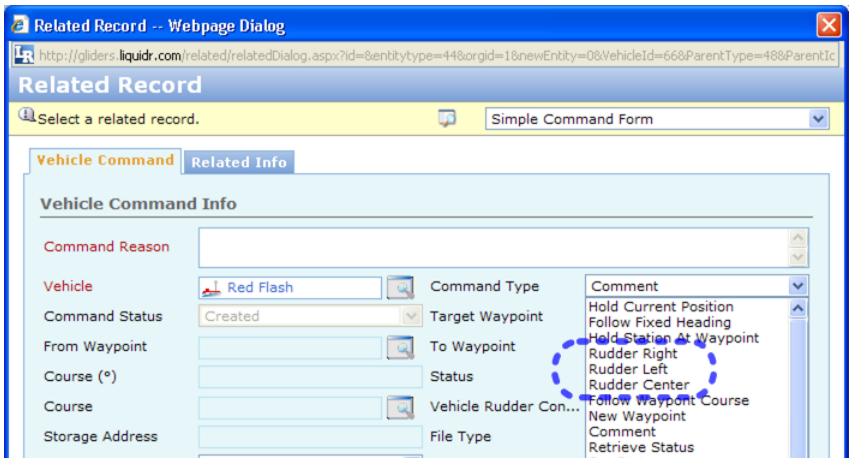


Figure 5-62: Rudder Position Selection:

2) Click on the "Rudder Right", "Rudder Left" or "Rudder Center" to get a dialog similar to:

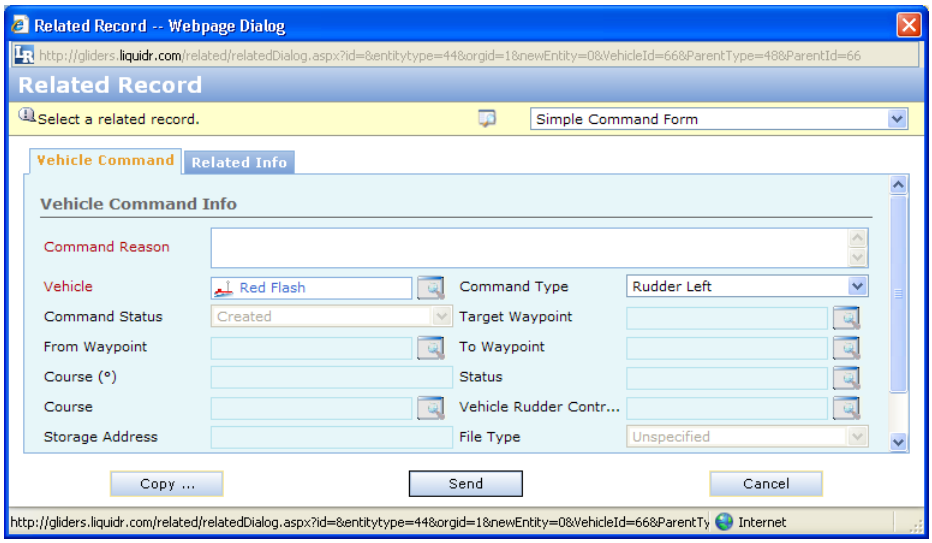


Figure 5-63: Rudder Position Command Dialog

3) Enter the required "Command Reason". The Vehicle name should not be changed.

4) Click the **Send** button at the bottom and the command will be queued for sending.

Chapter 6 – Operating a Mission

Shipboard Operations are described in detail in Wave Glider *Water Operations* document. The descriptions in this chapter cover Mission operations that are typically performed using the WGMS software system.

6.1 Operation Considerations

6.1.1 Operator Role

In order act as an Operator during a Mission, you will need to be assigned the "Master" Role. System Administrators (“Admin” Role) also have the necessary privileges.

As mentioned in 3.1.2, Roles have no effect when using the short-range XBee communications. This allows anyone the use of all the XBee commands for launch, in-water checkout and recovery. Thus, you should be aware that your commands may conflict with – or be overridden by – XBee commands from the launch/retrieval vessel.

6.1.2 Coordinating With Shipboard Ops

While not absolutely essential, being able to communicate directly with shipboard operations via cell or satellite phone can be useful, especially during preparation and launch.

This allows the launch crew to notify you when the Vehicle has been powered up and when you should be receiving telemetry. It also allows you to notify the launch crew if there is an alarm or other problem that shows up on the telemetry (or if you're not receiving any telemetry).

6.1.3 Pre-Launch Vehicle Checking

If the Vehicle is powered up prior to leaving the dock (the usual case), it's possible to determine the approximate status of the launch by watching the telemetry. You can also final-check the status of various systems (battery voltage, drybox pressure, etc.).

The default telemetry rate is 2 minutes, but that value can be changed. The telemetry rate can also slow down in certain low-battery situations. Verify that the telemetry rate is either the default, or whatever rate you have specified.

XBee should have automatically turned on when the Vehicle was powered up. Verify that the XBee is operating.

The external light and the rudder position can be used to verify shore control of the Vehicle. Although the light and rudder status can be determined via telemetry, it can also be useful to confirm via voice contact, if available.

6.2 Mission Operations

6.2.1 Starting a Mission

Just prior to launch, you should create a new Mission, or join a Mission already in progress.

To start a mission, click on the "Begin Mission" button at the top of the Vehicle Status and Control bar.

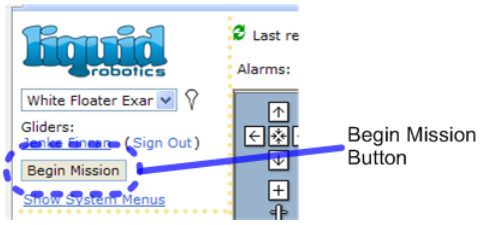


Figure 6-1: Begin Mission Button

The system should respond with:

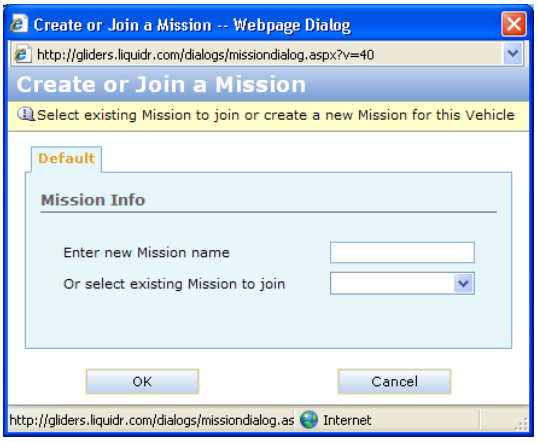


Figure 6-2: Create or Join Mission Dialog

You can create a new Mission by entering the Mission name in the upper box. Or you can click the arrow on the lower box to pull down and select from a list of existing Missions to join.

When done, click "OK". You should get the response:

Figure 6-3: Mission Confirmation Message

After you click "OK", the Dashboard "Begin Mission" button label will change to "End Mission", and the name of the Mission will show to the right of the button. Click on the Mission name (or icon) and a dialog box will show the basic Mission data.

For example, if the Mission was assigned the name "Example Mission", the dialog box would show:

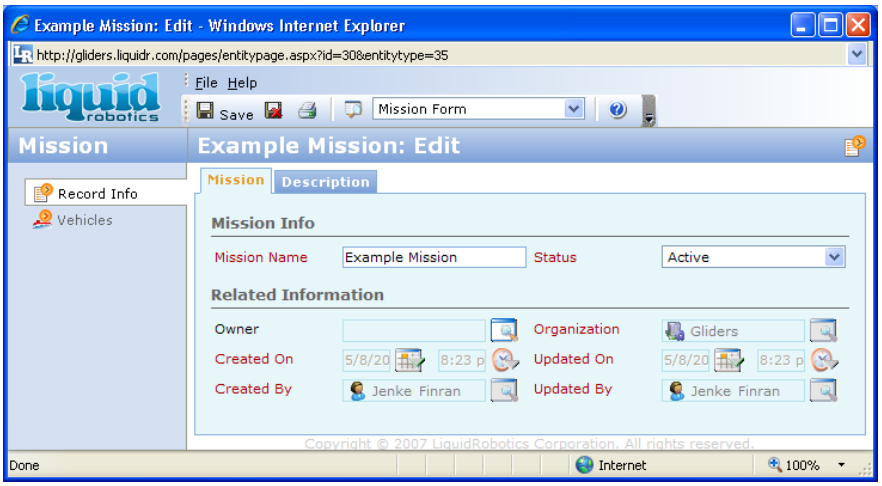


Figure 6-4: Edit Mission Dialog

Clicking on the "Vehicles" tab on the left side brings up a dialog that allows you to add other Vehicles to your Mission.

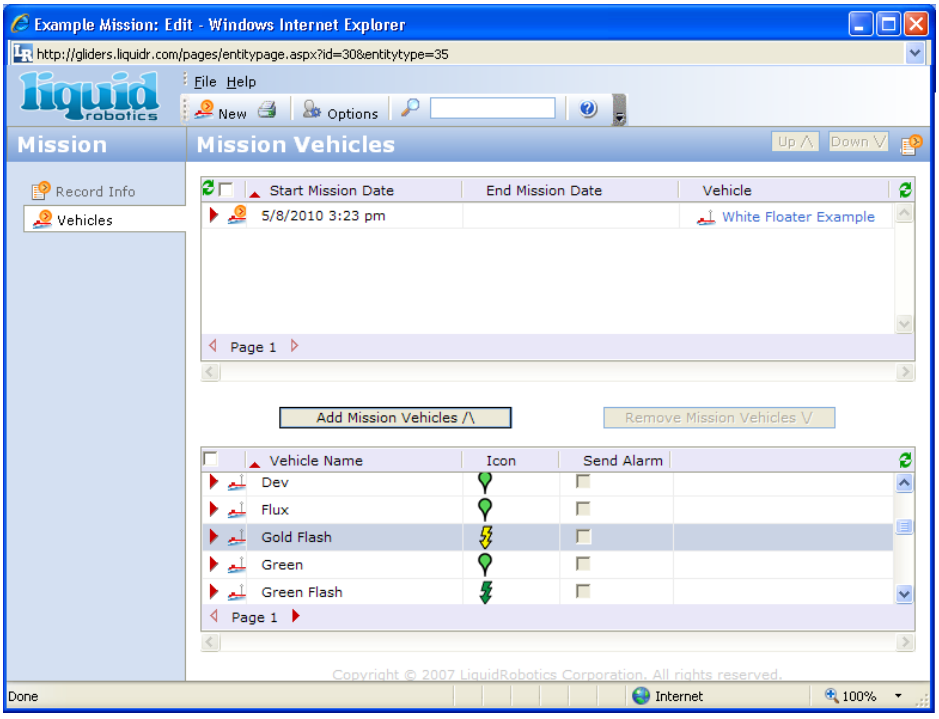


Figure 6-5: Mission Vehicles Dialog

Click (or Ctrl-click) to select one or more Vehicles in the lower box. Then click the button "Add Mission Vehicles" to put the selected Vehicles in the upper box.

Likewise, you can remove Vehicles from the mission by selecting in the upper box, then clicking "Remove Mission Vehicles"

6.2.2 Monitoring the Launch Procedure

During the actual launch procedure, there is little that can be done from the shore side to help the launch crew. However, you can use telemetry to monitor the status of the launch.

Typically, the Vehicle is powered-up and sending telemetry while it is being transported to the launch site. Thus, the Dashboard map should show the Vehicle during transport. This telemetry should show a relatively high Vehicle speed (the speed of the transport boat).

At the launch site (typically near the Target Waypoint), the speed will be near zero. However, once the Vehicle is free and in the water, it should begin moving towards the Target Waypoint.

Just after the launch, the boat crew may be using the XBee link to check out the Vehicle. Unless you are in contact with the launch crew, or have a pre-arranged plan, do not issue movement commands to the Vehicle since it risks overriding commands from the boat.

At some point after launch you may see that the XBee has been turned off. If not, you should pre-arrange with the launch crew to turn off the XBee after a certain period of time, in order to conserve power.

6.2.3 Monitoring Telemetry Data

While on a Mission, Status-command responses can give detailed information on the Vehicle, but the primary continuous source of Vehicle information is via telemetry.

An advantage of telemetry is that the information is sent continuously at short evenly-spaced time intervals. This allows consistent checking for trends or discontinuities in the Vehicle operational status.

Some trends to watch on the telemetry are:

1) Rising Float temperature
2) Decreasing battery capacity during daylight
3) Decreasing C&C Box or Rudder Module pressure
4) A sudden decrease in speed along a constant heading
5) A deviation between the desired heading and the actual heading

One-time anomalies, such as a zero value for speed, are usually the result of a telemetry fault. However, if an anomalous value persists for multiple telemetry transmissions, there could very well be a problem, even if no alarms are issued.

Keep in mind that the telemetry data is only shown for the last hour of operation. Earlier telemetry data is available by using the date and time selections above the map (ref. 6.5.2).

6.2.4 Alarms and Responses

Alarms fall generally into two categories:

1) A Vehicle problem (low voltage, etc.)
2) An Operation Polygon crossing

Troubleshooting responses to Vehicle problems are discussed in detail in Chapter 7. In general, the first response to an alarm is to cross-check against other data to try to determine the nature of the problem.

For Operation Polygon crossings, manual override of the course may be necessary to move the Vehicle back on course. If the Vehicle does not seem to be responding to direct commands, then recovery may be necessary.

6.2.5 Sending Commands

When sending a command to the Vehicle, remember that the command will not be received by the Vehicle, responded to, or ACK'ed until the next message (usually telemetry) is sent by the Vehicle.

The default telemetry interval is 2 minutes. However, that interval can be increased by the Operator. This will slow the response to commands.

Also, there can be a loss of Iridium communications for several minutes. The command will not be sent until communications are restored and all accumulated telemetry data has been sent.

Most commands involve checking the status of various Vehicle systems. However, if the Vehicle is commanded to deviate from the previously assigned course, it will probably have to be put back on course afterwards. Refer to 6.3.3 below for the procedure.

6.3 Changing a Mission

6.3.1 Updating Course Waypoints

In general, there is no problem changing the location of one or more Waypoints while a Vehicle is following a course. However, there can be a problem if you change the location of the Waypoint that the Vehicle is currently navigating towards.

If the Wave Glider is en-route to a particular Waypoint, and you send a new Lat/Long location for that Waypoint number, the Vehicle may continue to head towards the original Lat/Long coordinates. To correct this, do the following:

1) If the Vehicle was following a course, you have to re-issue the Course specification command with the revised Waypoint as the new Target Waypoint.
2) If the Vehicle was following a "Go To Waypoint" command, you have to re-issue that command.

If a Wave Glider is en-route on a course with multiple Waypoints, and you change the location of a Waypoint that is not the current target, the Vehicle will correctly use the new location value when it comes time to head towards the changed Waypoint.

6.3.2 Manual Navigation

Manual navigation typically uses one or more of the following commands:

1) Hold Station At Waypoint
2) Hold Current Position
3) Move Rudder Left/Right/Center
4) Follow Fixed Heading

All of the above are available to call up as single-buttons in the Vehicle Status and Control bar on the Dashboard Home Page.

Manually navigating a Vehicle (rather than letting it run automatically on a course) can be useful in the following situations:

1) Troubleshooting an alarm. An example would be moving the rudder full left or right to check that the C&C computer still has directional control.
2) Perform an intermediate task not on original course. For example, if an interesting sensor reading was noticed on the telemetry at a previous position, it may be worthwhile to return to that position.
3) Error recovery. If a Vehicle has gone (or is about to go) over an Operation Polygon border, manual control can be used to correct or avoid the crossing.
4) Discontinuing a Mission. For example, if it's observed that available battery power appears to be falling unexpectedly, you might want to send the Vehicle towards a recovery area.
5) To aid in normal Vehicle recovery. For example, have the Vehicle hold station at a specific point until the recovery vessel arrives.

Manual navigation often involves giving the Vehicle a specific heading, watching its position on the Dashboard map, then changing the heading as necessary.

However, if the goal is to get the Vehicle to a certain location, an alternate method would be to create a new Waypoint on the map using the method described in 5.4.1 "Adding Waypoints on the Map". Then use the "Go Here" option (described in 5.7.2 "Moving to a Target Waypoint").

6.3.3 Recovering From Manual Navigation

If you issue a manual navigation command such as those described above, any previous course-following command will no longer be in effect.

In order to get the Vehicle back on the original course you will have to re-issue the "Follow Sequential Course" or the "Set Course" command, as appropriate. Click to select the name of the previous course to get the Course Edit dialog.

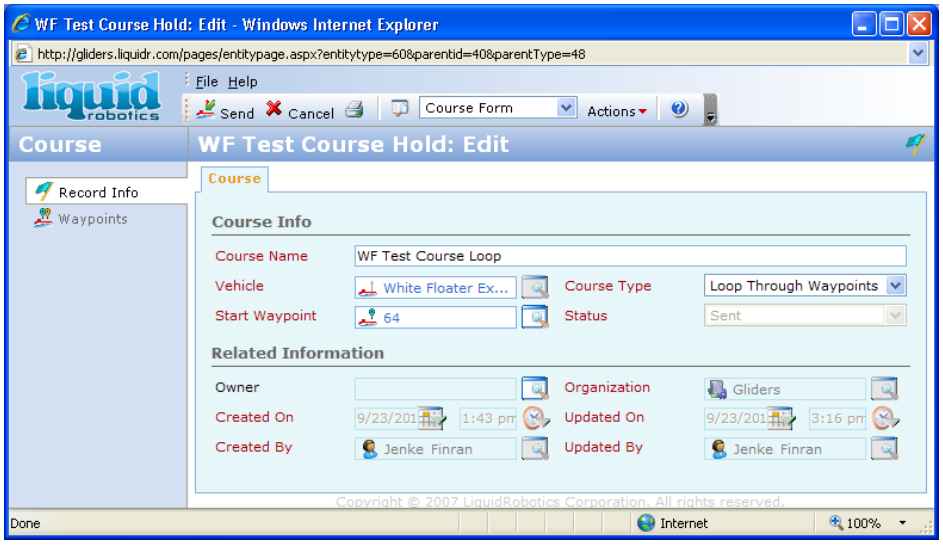


Figure 6-6: Course Edit Dialog Box

Typically, the only thing you should have to change is the Target Waypoint number.

6.4 Completing a Mission

6.4.1 Coordinating With Recovery Crew

The primary steps when initiating Vehicle recovery are:

1) Communicate with the recovery crew the time and exact location where the Vehicle will be for recovery. Real-time telephone communications can be helpful, but is not essential.
2) Move the Vehicle to the recovery location (if necessary) and have it hold station there.
3) Turn on the XBee so that the recovery vessel will have short-range control of the Vehicle when during recovery.
4) In dark overcast conditions, turn on the visible light to aid location of the Vehicle.
5) Monitor telemetry to ensure that the Vehicle is holding at the prescribed location.

6.4.2 Shoreside Actions

When the Vehicle has been recovered:

1) Click on the “End Mission” button.
2) Use the "Comment" command to log that the Mission was completed.
3) Notify the Mission Planner that the Mission was competed.

6.5 Analyzing Mission Data

Some reasons for analyzing the Mission data are:

1) Search for specific events (e.g., a certain sensor reading).
2) Graph data over time (e.g., speed, power, etc.).
3) Correlate one set of data with another (e.g., actual vs. commanded heading).

6.5.1 The Database

During a Mission, all communications to and from the Vehicle (telemetry, Shore-issued commands and ACK/NAK responses) are stored in a database file for later retrieval.

There are basically two ways to view this data.

1) Directly view the "Telemetry" and "Command" panes at the bottom of the Dashboard page.
2) Download the telemetry data into an Excel compatible file, and use the Excel features to search or manipulate the data.

In both cases, you may need to change the date and time window for the data being examined.

6.5.2 Changing the View Time/Date

The Duration/Date/Time Bar above the Dashboard Position Map can be used to indicate what telemetry or command data is to be displayed.

The default bar looks like:

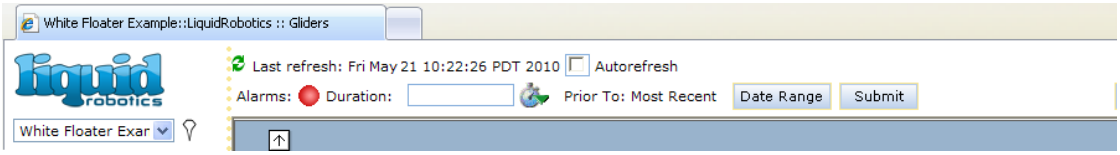


Figure 6-7: Default Duration/Date/Time Bar

The default values are:

Duration: 1 hour (the value is not shown)

Prior To: "Most Recent" (the last message received)

The Duration can be changed by clicking on the stopwatch icon to the right of the box. This will bring down a list of time duration values.

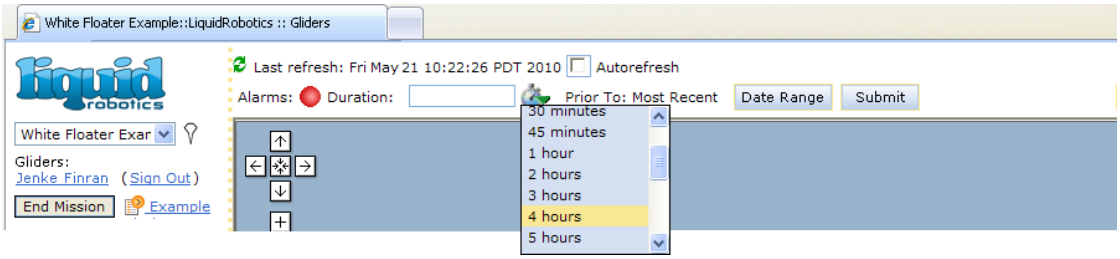


Figure 6-8: Duration/Date/Time Bar with Duration Pulldown

Click to select the new duration, which will now show in the box.

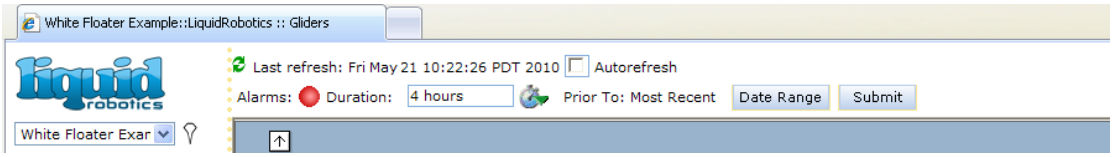


Figure 6-9: Duration/Date/Time Bar with Duration Set

Click on the "Submit" button to change the displayed duration, then wait for a screen refresh.

If you want to view the data at some previous date and/or time, click on the "Date Range" Button. This will create two new boxes for entering the date and starting time.

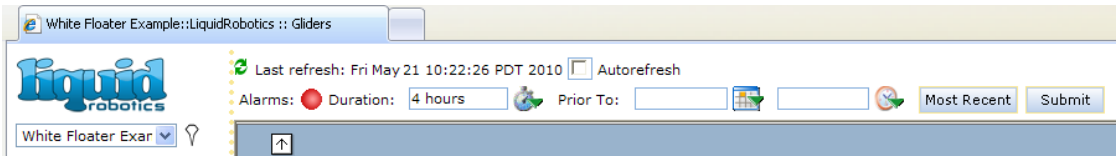


Figure 6-10: Duration/Date/Time Bar with Date/Time Entry

Click on the Calendar icon to set the Date.

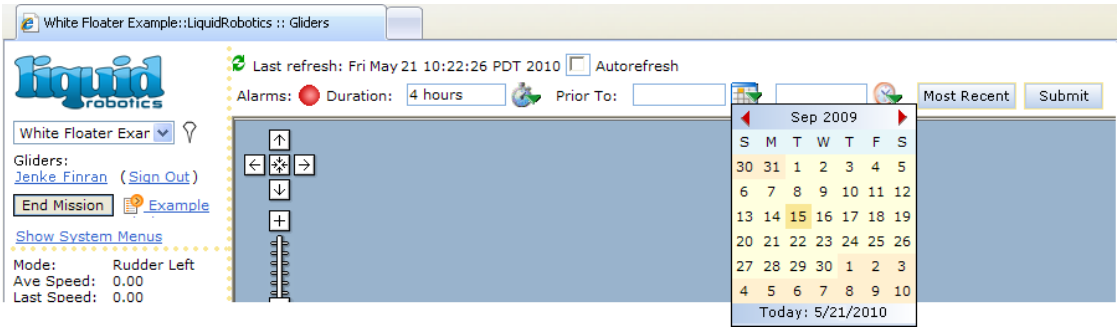


Figure 6-11: Duration/Date/Time Bar with Calendar

Then click the clock icon to select the start time

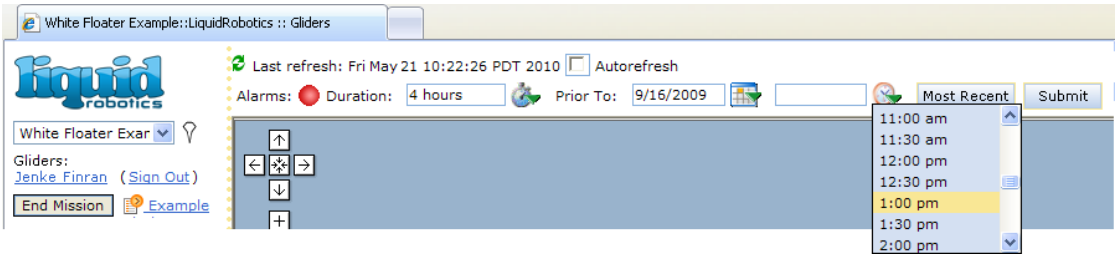


Figure 6-12: Duration/Date/Time Bar with Time List

When the time has been set, click on the "Submit" button to enter the new start date and time.

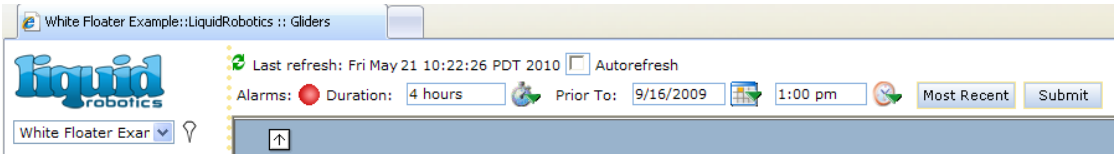


Figure 6-13: Duration/Date/Time Bar with Time Set

If you want reset the date and time back to the most recent time, click on the "Most Recent" button, which will change the bar back to the original format, but will not reset the Duration value.

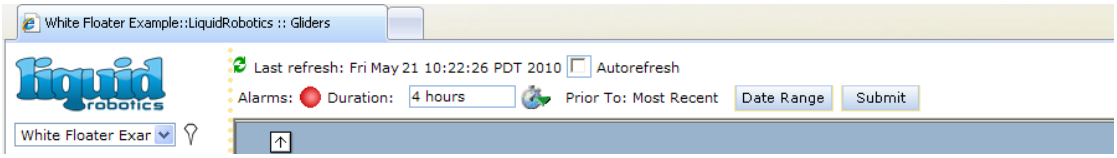


Figure 6-14: Duration/Date/Time After Reset to "Most Recent"

6.5.3 Using the System Pages

The System Pages (ref. 2.10) of the WGMS software contains information on all your Organization's Vehicles. This data can be useful for checking alarms and reports, as well as for plotting data over time.

6.5.4 Copying Telemetry Data to Excel

Telemetry records can be downloaded to an Excel file for analysis using the Excel features.

First, review the Telemetry data by going to the Vehicle Edit page and clicking on "Telemetry". This shows the same telemetry records as the Dashboard.

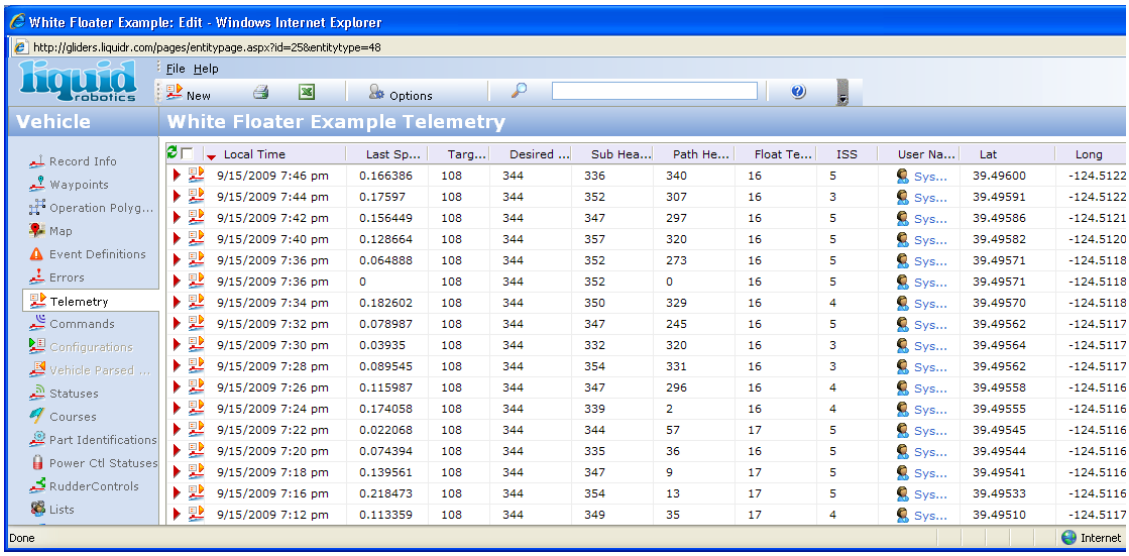


Figure 6-15: Telemetry Data Records

Before downloading, verify or set the number of Telemetry points that you want to download. The value is set in the User Information Dialog, which can be accessed using the "Options" name/icon at the top of the Telemetry list.

Figure 6-16: User Options Selection Icon

Clicking the "Options" name or the icon will call up the User Options dialog box:

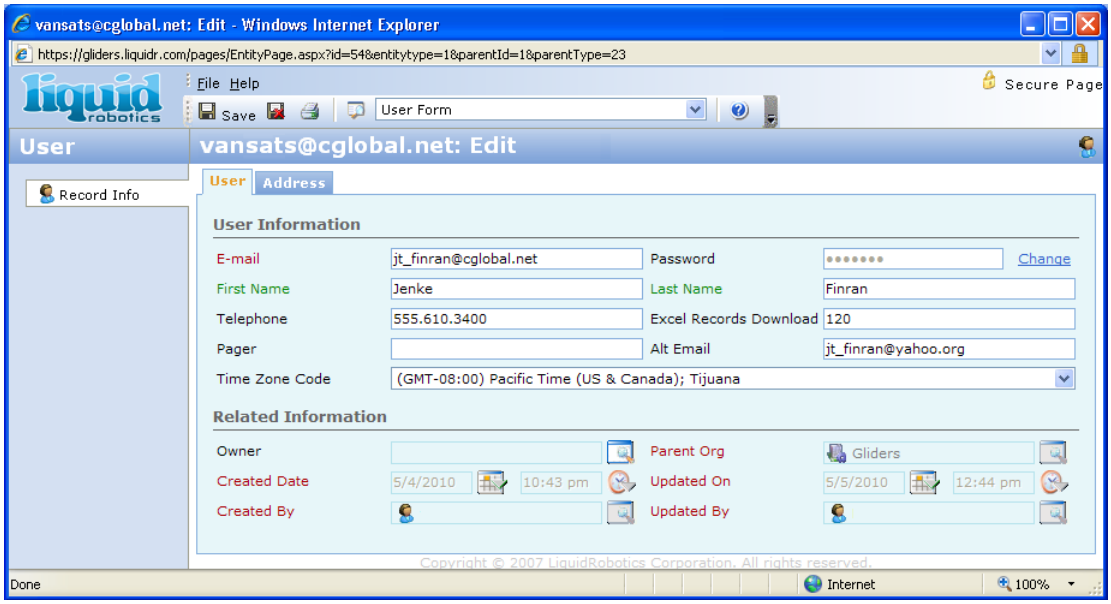


Figure 6-17: User Options Dialog Example

The box indicating "Excel Records Download" specifies the number of records that will be downloaded (120 in the example). Change the value as desired.

Note: Large numbers (i.e., thousands) of records can take a long time to convert.

Click the "Save" [Save and close User] icon to exit the dialog and save the Excel Records Download value.

To download the records, click on the Green Excel icon [Export Telemetry to Excel].

Figure 6-18: Excel Download Icon

You should get the confirmation request:

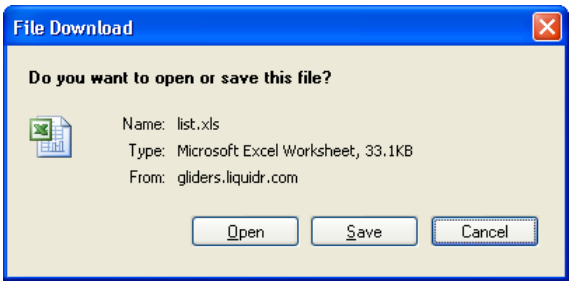


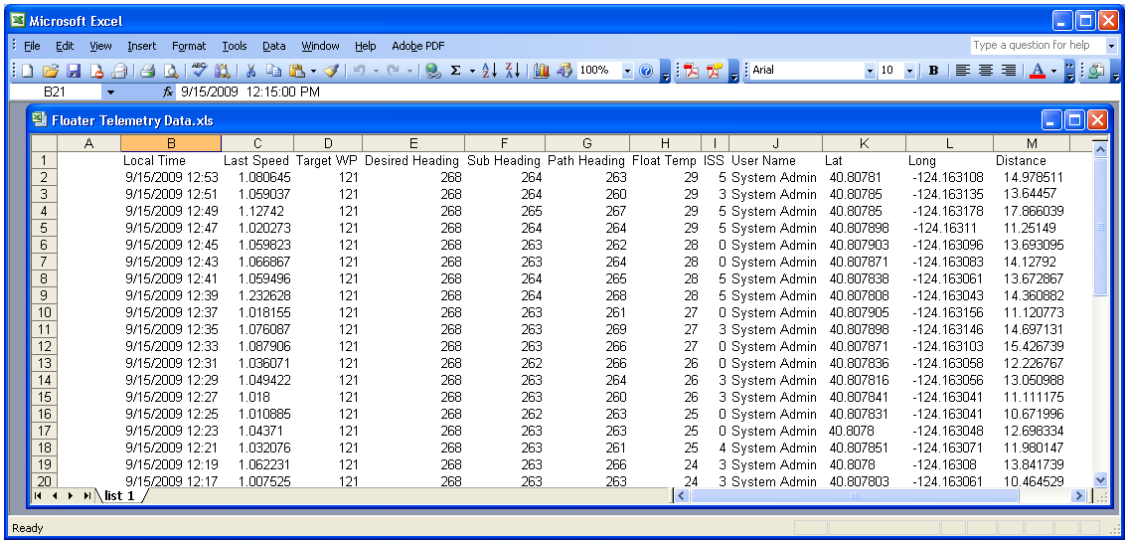
Figure 6-19: Excel File Download Confirmation

Before clicking in this box, check the size of the file indicated (33.1 KB in the example). If this value is large (hundreds of KB), it can take considerable time to download. In such cases, it may be prudent to reduce the number of records to be downloaded.

If you are satisfied with the file size, you can:

- Click "Open" to view the file directly.
- Click "Save" to get the standard request for the name and location to save the .XLS file.

The Excel file will be in the format:



	Local Time	Last Speed	Target WP	Desired Heading	Sub Heading	Path Heading	Float Temp	ISS	User Name	Lat	Long	Distance
2	9/15/2009 12:53	1.080645	121	268	264	263	29	5	System Admin	40.80781	-124.163108	14.978511
3	9/15/2009 12:51	1.059037	121	268	264	260	29	3	System Admin	40.80785	-124.163135	13.64457
4	9/15/2009 12:49	1.12742	121	268	265	267	29	5	System Admin	40.80785	-124.163178	17.866039
5	9/15/2009 12:47	1.020273	121	268	264	264	29	5	System Admin	40.807898	-124.16311	11.25149
6	9/15/2009 12:45	1.059823	121	268	263	262	28	0	System Admin	40.807903	-124.163096	13.693095
7	9/15/2009 12:43	1.066867	121	268	263	264	28	0	System Admin	40.807871	-124.163083	14.12792
8	9/15/2009 12:41	1.059496	121	268	264	265	28	5	System Admin	40.807838	-124.163061	13.672867
9	9/15/2009 12:39	1.232628	121	268	264	268	28	5	System Admin	40.807808	-124.163043	14.360882
10	9/15/2009 12:37	1.018155	121	268	263	261	27	0	System Admin	40.807905	-124.163156	11.120773
11	9/15/2009 12:35	1.076087	121	268	263	269	27	3	System Admin	40.807898	-124.163146	14.697131
12	9/15/2009 12:33	1.087906	121	268	263	266	27	0	System Admin	40.807871	-124.163103	15.426739
13	9/15/2009 12:31	1.036071	121	268	262	266	26	0	System Admin	40.807836	-124.163058	12.226767
14	9/15/2009 12:29	1.049422	121	268	263	264	26	3	System Admin	40.807816	-124.163056	13.050988
15	9/15/2009 12:27	1.018	121	268	263	260	26	3	System Admin	40.807841	-124.163041	11.111175
16	9/15/2009 12:25	1.010885	121	268	262	263	25	0	System Admin	40.807831	-124.163041	10.671996
17	9/15/2009 12:23	1.04371	121	268	263	263	25	0	System Admin	40.8078	-124.163048	12.698334
18	9/15/2009 12:21	1.032076	121	268	263	261	25	4	System Admin	40.807851	-124.163071	11.980147
19	9/15/2009 12:19	1.062231	121	268	263	266	24	3	System Admin	40.8078	-124.16308	13.841739
20	9/15/2009 12:17	1.007525	121	268	263	263	24	3	System Admin	40.807803	-124.163061	10.464529

Figure 6-20: Excel File Example Output

With this .XLS file, you can convert the format as desired, then do searching, sorting and plotting of the data using all the standard Excel features.

6.5.5 Copying Command Data to Excel

Like telemetry data, Command data can be also be reviewed by going to the Vehicle Edit page and clicking on the left-side "Commands" tab. This brings up the list of commands issued to the vehicle.

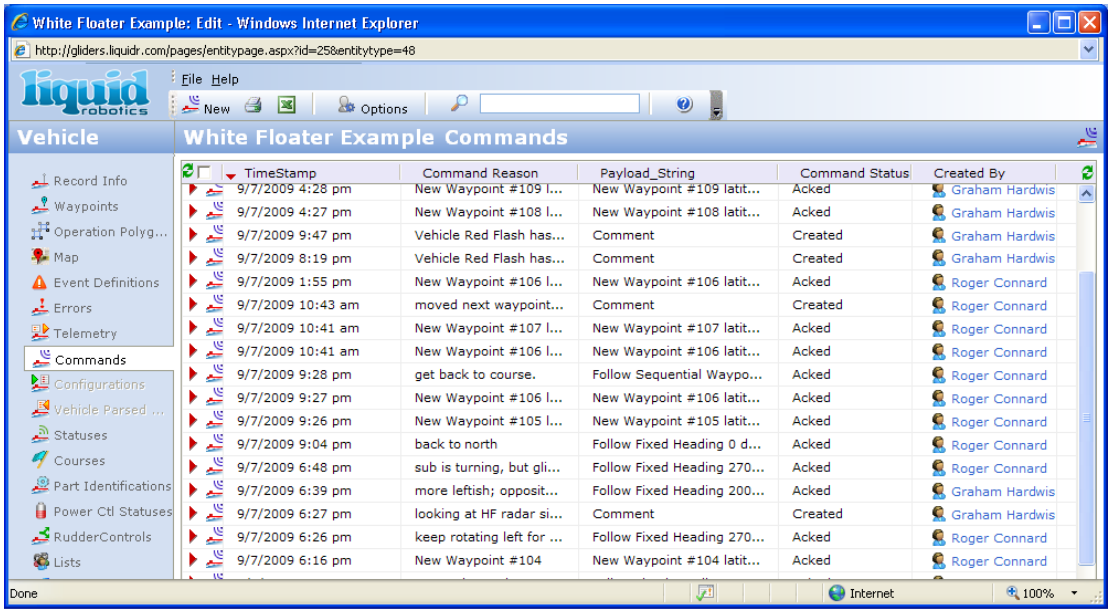


Figure 6-21: Command Records for Excel Conversion

As with the Telemetry records, clicking on the Green Excel icon [Export Commands to Excel] specifies that the data be converted into an Excel format file. This Excel data can be evaluated independently, or it can be merged with the Telemetry Excel file.

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Chapter 7 – Troubleshooting

Generally, troubleshooting involves responding to alarms while on a Mission. However, other problems may occur when the Vehicle is being tested or prepped for launch.

7.1 C&C Initiated Alarms

Alarms detected by the C&C computer are sent as telemetry data. They are displayed on the Dashboard page and are accessed by clicking on the "Alarms" icon (ref. 2.5.1)

A summary of the C&C alarms is given below. More complete descriptions and responses are given in the sections referenced.

Alarm Type	Description	Ref.
Sub Leak Alarm	Water leak detected in Rudder Module.	7.4.1
Float Leak Alarm	Water leak detected in the C&C Drybox.	7.4.2
Sub-to-Float Comm Error	C&C computer detected a datacomm error from the Rudder Module computer.	7.4.3
Payload Alarm	Communications problem between the C&C computer and a payload.	7.4.4
Float Battery Low	C&C battery level is below the defined "Low Battery Power" value.	7.4.5
Umbilical Fault	Umbilical integrity problem detected.	7.4.6
GPS Not Functioning	Vehicle has not received a valid GPS fix within a specified time.	7.4.7
Sub Reboot Alarm	An automatic re-boot occurred on the Rudder Module computer.	7.4.8
Float-to-Sub Comm Error	Rudder Module computer detected a datacomm error from the C&C computer.	7.4.9
Float Temperature Exceeded	Temperature in the C&C Drybox is above the "Float Temperature Threshold".	7.4.10
Float Pressure Outside Range	Pressure in the C&C Drybox is outside the "Float Pressure Threshold" values.	7.4.11
EEPROM Error	Error uploading data from EEPROM to Flash during re-boot.	7.4.12
Float Reboot Alarm	An automatic re-boot occurred on the C&C computer.	7.4.13

Table 7-1: C&C-Initiated Alarms

7.2 Shore Software Alarms

Some alarms are created by the WGMS software. These are:

Software Alarm	Explanation	Ref.
Report Timeout	No telemetry was received for 25 minutes	7.5.1
Link Error	Error in Iridium data packet	7.5.2
Invalid GPS	GPS time-stamp or coordinates are all zeros	7.5.3
Empty Record	Iridium packet from Vehicle contains no data	7.5.4
Checksum Error	Data packet checksum is not correct	7.5.5
Out of Bounds	Outside/Inside of Operation Polygon	7.5.6

Table 7-2: Shore Software Alarms

7.3 General Alarm Response

Generally, the first response to any alarm is to check other sensors to both verify the problem, and determine the cause of the alarm.

Vehicle retrieval is sometimes the best option, but in certain cases, it's acceptable to monitor the telemetry to see if the alarm has any detrimental effect on Vehicle performance.

7.3.1 Intermittent Alarms

Alarms on the Wave Glider are not self-resetting; an alarm will continue until the triggering problem has been fixed. Occasionally, an alarm may be caused by a temporary electrical or communications glitch. Thus, if an alarm shows only on a single telemetry transmission, it is probably not cause for concern. Obviously, if the same alarm shows up relatively often, some action needs to be taken.

7.3.2 Multiple Alarms

Often, one problem on the Vehicle will trigger more than one alarm. In this case, correlating the alarms and their meanings can be a useful diagnostic tool. For example, a "Low Float Pressure" alarm by itself may not be an issue, but if there is also a "Float Leak" alarm, there probably is a problem.

7.3.3 XBee Communication

It can be helpful to have XBee available. This gives you an alternate method of communication for troubleshooting, though it does require close proximity to the Vehicle.

XBee also allows re-booting of the system without System Administrator (“Admin”) privileges. However, re-booting the system is generally a solution of last resort. Re-booting may temporarily reset the alarm, but not address the root cause.

7.3.4 Contacting Liquid Robotics

If you've tried the solutions suggested below, and the problem persists, gather up the data and contact LRI, as described in section 7.7 “Contacting Liquid Robotics Inc.".

7.4 C&C Alarm Responses

Responses to the C&C alarms are described below. The responses generally assume that the Vehicle is operational in the water.

Responses to the Shore alarms are given in 7.5.

7.4.1 Sub Leak Alarm

A water leak was detected in the Rudder Module. Salt water in the Rudder Module can damage or short out the rudder-control electronics and result in failure of the Vehicle steering mechanism.

Responses:

1) Check for a Float-Sub comm error alarm. If there is, immediately initiate Vehicle retrieval.
2) If no other alarms, monitor. If the alarm continues for more than one hour, initiate Vehicle retrieval.

7.4.2 Float Leak Alarm

A water leak was detected in the C&C Drybox. Salt water in the C&C can short out the batteries and eventually result in failure of the communications electronics. Telemetry failure can make locating the Vehicle difficult.

Responses:

1) Check the Float C&C pressure. If the pressure is OK, monitor. If the pressure is low, immediately initiate Vehicle retrieval.
2) Check for a change in the battery storage capacity. If it is decreasing rapidly (especially in daytime), initiate Vehicle retrieval.

7.4.3 Sub-to-Float Comm Error

The C&C computer detected a datacomm transmission error from the Glider's rudder controller. Unless the problem is persistent, it is probably not critical.

Responses:

1) Monitor. If the alarm continues for more than 10 minutes, command the Vehicle to make a 90° turn and check telemetry to verify a correct response.
2) If no response to the 90° turn (or an incorrect response), try again. If still no response, prepare for Vehicle retrieval.

7.4.4 Payload Alarm

Indicates a general problem with a payload. Possibly a data transmission error between the C&C and one (or both) of the Payloads. It also may be an electrical or environmental issue.

Responses:

1) Check if a payload is supposed to be transmitting data, but is not.
2) If a payload is transmitting data, check the data for correctness.
3) Check the Payload currents on the Power Controller Status.

7.4.5 Float Battery Low

C&C battery capacity level is below the specified "Low Battery Power" value. This could be the result of several days' operation with limited sunlight, failure of a solar panel, or high current draw from a payload. This condition will trigger a longer telemetry interval in order to conserve power.

Responses:

1) Check the solar panel outputs.
2) Turn off power to the payloads and check if the alarm stops.
3) Check the present and previous battery energy values in the telemetry data.
4) Turn off lights, center the rudder and check if the alarm stops.
5) If no solution, prepare for Vehicle retrieval.

7.4.6 Umbilical Fault

The C&C continually checks the current in the Umbilical wires. This alarm indicates either a broken conductor or possibly a damaged (or broken) Umbilical.

Responses:

1) Check the course on the telemetry to verify that the Umbilical has not broken.
2) Check telemetry for an abnormal slowdown in Vehicle speed.
3) Command the Vehicle to make a 90° turn and use telemetry to verify a correct response.
4) Check for a Float-Sub communications alarm.
5) If poor directional control or other alarm, prepare for Vehicle retrieval.

7.4.7 GPS Not Functioning

The Vehicle has not received a valid GPS fix for two minutes. The GPS signal can be lost for several minutes, but longer outages usually indicate a problem with the Vehicle. There may be an electronics failure, or possibly something is blocking the antenna.

Responses:

1) If telemetry stops after receiving the alarm, initiate immediate retrieval.
2) If the telemetry is OK, check to see how long the problem has been going on.
3) Check the battery voltage levels.
4) If the problem persists for more than 20 minutes, prepare for retrieval.

7.4.8 Sub Reboot Alarm

An error occurred in the Rudder Module computer, causing a re-boot. If this happens only once, it may not be a problem. However, if it occurs often (or continuously), it's probably serious.

Responses:

1) Turn the Vehicle 90° and monitor the course. Then turn the Vehicle back 90° onto the original course.
2) If no response (or an incorrect response) to the maneuvers, prepare for Vehicle retrieval.

7.4.9 Float-to-Sub Comm Error

The Glider (Sub) rudder-control computer detected a datacomm transmission error from the C&C computer. Unless the problem is persistent, it is probably not critical.

Responses:

1) Monitor. If alarm continues for more than 10 minutes, command Vehicle to make a 90° turn and check telemetry to verify a correct response.
2) If no response to the 90° turn (or an incorrect response) prepare for Vehicle retrieval.

7.4.10 Float Temperature Exceeded

The temperature in the C&C Drybox is above the "Float Temperature Threshold". This may be caused by high outdoor temperatures and direct sunlight, especially if the Turtledeck has become detached. At night, or if the outside temperature is moderate, the alarm may indicate either an electronics error or a battery problem.

Responses:

1) If the Vehicle is not in water, shade the C&C box from direct sunlight.
2) If on water during the day, power down as much as possible and monitor.
3) Check for rapid drop in battery capacity.
4) If the float pressure is high and rising, initiate retrieval.
5) Monitor. If the temperature alarm persists, prepare for retrieval.

7.4.11 Float Pressure Outside Range

The pressure in the C&C Drybox is above or below the "Float Pressure Threshold" values. It is most likely that the pressure has gone below the minimum pressure value. If it goes above the pressure limit, check the float temperature alarm.

Responses:

1) Check the Float pressure value.
2) If the pressure value is within the OK range, re-boot and see if the alarm goes off again.
3) If the pressure value is too low, monitor for a Float leak alarm.
4) If low pressure or a Float leak alarm, initiate Vehicle retrieval.

7.4.12 EPROM Error

During the initial power-up booting, the system transfers data from EEPROM to Flash memory, using error checking. This alarm is activated if there is an error in the data transfer.

Responses:

1) Try re-booting. If the error occurs again, contact LRI.

7.4.13 Float Reboot Alarm

A serious error occurred on the C&C computer, causing a re-boot. This can happen occasionally due to a temporary electrical glitch. If it occurs repeatedly, there is a serious problem.

Responses:

1) Turn the Vehicle 90° and monitor the course. Then turn the Vehicle back 90° onto the original course.
2) If no response (or an incorrect response) to the maneuvers, prepare for Vehicle retrieval.

Note: After a Float Reboot, the IR light will be OFF, and the visible light will be ON in a low-power-consumption mode. The Shore-side software will attempt to restore the light to the state that it was in prior to the re-boot. This will result in a Vehicle ACK of the light ON/OFF command.

7.5 Shore Alarm Responses

The Shore alarms are generated by the software not the C&C computer. Often, this occurs when there is an error in the telemetry data.

7.5.1 Report Timeout

No telemetry has been received from the Vehicle for 25 minutes.

Responses:

1) Check previous telemetry for alarms or other anomalies.
2) Check the last-transmitted battery power level. If it is low, the C&C computer may have reverted to a longer (lower-power) telemetry interval.
3) If battery power is low, consider Vehicle retrieval.

7.5.2 Link Error

Each Iridium message contains a descriptive header followed by a data packet. This alarm indicates that the Iridium message header has flagged an error in the data packet.

Responses:

1) Check previous and subsequent telemetry for errors.
2) Monitor. If the alarm persists, consider Vehicle recovery.

7.5.3 Invalid GPS

The GPS time-stamp is received from the satellites. The coordinates are computed aboard the Vehicle. This alarm is generated if either the time-stamp is zero, or the coordinates compute to zero.

Responses:

1) Check previous telemetry for possible position errors.
2) Monitor. If the alarm persists, consider Vehicle retrieval.

7.5.4 Empty Record

The Iridium message from the Vehicle consists of a header followed by a data packet. This alarm indicates that the data packet is empty.

Responses:

1) Monitor to check if this is a sporadic event, or a constant occurrence.
2) If the error occurs consistently, plan on Vehicle retrieval.

7.5.5 Checksum Error

Each Iridium data packet contains an error-checking checksum. This alarm indicates that the data has been corrupted. This may be a one-time communications glitch, or it may indicate a problem with the Vehicle computer or antenna.

Responses:

1) Monitor to check if this is a sporadic event, or a constant occurrence.
2) If error occurs consistently, plan on Vehicle retrieval.

7.5.6 Out of Bounds

The Vehicle has moved outside its Operation Polygon. Or else it has entered an Exclusionary Polygon. This alarm can be triggered by a one-time data transmission error.

Responses:

1) Check the telemetry crumbs on the Dashboard position map.
2) Check the Vehicle's Waypoints and commanded course to verify that it was not deliberately sent to its current position.
3) If off-course, issue a heading command that will take the Vehicle back into bounds.
4) Monitor. If the Vehicle does not respond to the heading command, initiate retrieval.

7.6 Other Vehicle Problems and Actions

The responses below generally assume that the Vehicle is on-shore during testing or pre-launch.

7.6.1 No XBee Connection

The XBee should power up when the Vehicle electronics are first turned on, or when the system is re-booted.

Responses:

1) Move closer to the Vehicle. When initiating contact, the range should be under 20 meters.
2) Verify that the serial port speed is set to 115,200 bps on the computer terminal software.
3) Verify that the PAN ID has been set correctly.
4) Check that the dongle for the XBee is fully plugged into the computer.
5) Turn on the XBee connection using the Dashboard Iridium link.

7.6.2 No Iridium Connection

The Iridium connection is initiated by the Vehicle at the Telemetry intervals. The interval can be set for an especially long time (as much as 24 hours). Also, if the batteries are low, the Vehicle may revert to the "Low Battery" telemetry rate, which is typically longer than the standard rate (to conserve battery power).

Responses:

1) Check that the correct Vehicle is selected on the Dashboard.
2) Refresh the Dashboard page.
3) Use the Dashboard to check the strength of the last-sent Telemetry data. The column "ISS" indicates the Iridium Signal Strength, from 0 to 5. Level zero indicates no signal.
4) Use XBee to get the IMEI and verify that it is the correct one for the Vehicle.

7.6.3 LED Light Won't Turn ON/OFF

The visible LED lights turn ON whenever the system is powered-up. If it fails to do this, there is probably an electrical failure in the C&C box, requiring repair. If the light was ON at power-up, but fails to turn OFF, or if it won't go from OFF to ON, then it's probably a software or communications issue.

Responses:

1) Check that other commands (e.g., rudder position) work.
2) If using XBee, try using the Dashboard.
3) If using the Dashboard, try using XBee.

7.6.4 IR Light Won't Turn ON/OFF

The IR light is not visible, even in a dark room. Typically, it can be seen on the view screen of a digital camera. It can also be checked using an IR "Viewing Card".

If it's verified that the light is not turning on, try the responses described in 7.6.3 .

7.6.5 No Float Payload Power

When the system is powered up (or re-booted), power to the payloads is turned off. The payload power needs to be explicitly turned on.

Also, the maximum current that can be supplied to any payload is limited to one Amp. Any attempt to use more current will result in power to that payload being shut off.

Responses:

1) Check that the payload is connected to the correct connector on the C&C Drybox.
2) Check the connectors on C&C and Payload Dryboxes.
3) Check for an over-current alarm.
4) Check the power status for low batteries.

7.6.6 No Sub Payload Power From C&C

As with the Float payloads, Glider payload power is off when the Vehicle power is turned on. Also the maximum current that can be supplied to both the Rudder motor and Glider payload combined is one Amp.

Responses:

1) Verify that rudder can move. If not, check both the Float and Rudder Module Umbilical connectors. Also check the Umbilical for cracks or tears.
2) Check for an over-current alarm.
3) Check the power status for low batteries.
4) Disconnect the Glider payload power cable from the Rudder Module, then re-connect.

7.6.7 Float Continuously Re-Boots

This indicates a serious electronics problem. Contact LRI.

7.6.8 Sub Continuously Re-Boots

This indicates a serious electronics problem. Contact LRI.

7.7 Contacting Liquid Robotics Inc.

If you cannot determine or correct the cause of a problem, contact LRI.

To expedite resolving the problem, make a brief list beforehand with the following information.

1) Wave Glider Model Number
2) Any special or added payloads on the Vehicle
3) Time/date when problem occurred
4) Location of Vehicle when problem occurred
5) Initial indication of problem
6) Any other indications or unusual readings
7) Attempts at corrective actions and their results

For time-critical problems, call LRI at:

1 (650) 493-6300

or

1 (888) 574-4574

and select the option for Customer Service

For non-critical problems, send the above information via email to:

support@liquidr.com

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Chapter 8 – Notes

8.1 Glossary

Acknowledged (Alarm) – The alarm was reset by a User.

Active (Alarm) – The alarm was issued, but no other action has been taken.

Admin (Role) – A User who has all the permissions required to go through the day-to-day administration of the WGMS, add users, manage customizations, and deal with data.

Alarm – A message either from the Vehicle C&C or from the Shore-based software indicating that a problem has occurred.

Arrival Distance – Distance from a Waypoint at which the C&C computer assumes that the Vehicle has "arrived" at the Waypoint.

Audit Records – Record of changes or updates made to a Vehicle and/or its parts.

Checkbox – A yes/no selection box in a Dialog Box. Checking one box does not preclude checking another. (ref. Radio Button)

Coastal Explorer – A mapping service that provides a DVD with nautical maps. Used as an alternative to Google Maps.

Command and Control Drybox – The center-mounted Drybox in the Wave Glider Float. Contains the main control computer and communications equipment.

Command Packets – Data packets containing Commands sent to the Vehicle.

Commands – Messages sent to the Vehicle for control or to request status.

Course – The path a Vehicle is attempting to follow. (ref. Track)

Create (Permission) – A Role permission that allows creation of a Vehicle-related system parameter.

Dashboard – The Home Page of the User Interface to the Wave Glider Management System.

Data Analyst (Role) – A User who looks at existing Vehicle and WGMS data and can download database data.

Database (WGMS) – The part of the WGMS that stores configuration and communications data for one or more Vehicles.

Delete (Permission) – A Role permission that allows deletion of a Vehicle-related system parameter.

Dialog Box – An on-screen box that typically requests data to be entered.

Drybox – A sealed watertight container on either the Glider or the Float. Typically used for housing electronics.

Errors – Messages sent by the Vehicle or the Shore-based software indicating a problem.

Escalation List – A prioritized list of people to contact in case of an error.

Events – Types of Alarms.

Float – The part of the Wave Glider Vehicle that rides on the surface of the water.

Glider – The submarine portion of the Vehicle, connected by the Umbilical to the Float.

Global Positioning System (GPS) – A satellite-based broadcasting system that allows determination of geographical coordinates.

Google Maps – A mapping service provided by Google.

Guest User (Role) – Someone allowed to view certain Vehicle data, but who cannot create or modify any system parameters.

Home Page – The initial page that comes up on the browser after logging onto the WGMS system.

Hyperion – An alternate name for the WGMS Kernel

Icon – A small pictogram on a GUI. Typically, clicking on the Icon will start some other action.

International Mobile Equipment Identity (IMEI) – A 15-digit number used by the Iridium system to identify handsets and modems that can connect with the Iridium system.

Iridium – A constellation of satellites that provides world-wide voice and data transmission. Wave Glider Vehicles use the SBD form of transmission.

Iridium Network Server – A server maintained by the Iridium Corporation that provides access to the Iridium system via the Internet.

IP Address – Equivalent to IP Number.

IP Number – Internet Protocol Number. A combination of numbers that defines the destination of TCP or UDP data. Of the form xxx.xxx.xxx.xxx, where “xxx” represents a number from 1 to 255 (e.g., 10.10.5.145).

Master (Role) – A User who manages Vehicle provisioning, mission planning and operations, as well as payload and Web services development.

Menu – Allows selection of one or more items from a list.

Mission – A set of Vehicle operational actions, either by itself, or in cooperation with other Vehicles.

National Marine Electronics Association (NMEA) – An industry association that creates standards for, and certifies electronics used in marine applications.

Operation Polygon – A user-defined closed region in the water that defines limits on where a Vehicle should go.

Org – Abbreviation for Organization.

Organization – An entity that operates one or more Wave Glider Vehicles. Each Organization has its own data, and that data cannot be accessed by any other Organization.

Page – A browser window that displays data, and typically has links to other pages and data.

Part Identifications – Lists of hardware and software version numbers.

Payload Drybox – A Drybox that is optionally installed on/in a Vehicle. The Float has provision for two internal dryboxes. Payload Dryboxes may also be mounted externally on the Glider.

Permissions – For each Role, the specifications of what system parameters are allowed to be Created, Read, Updated and/or Deleted.

Privileges – Refers to the combined set of Permissions for someone who has been granted multiple Roles.

Protocol (Internet) – Method by which data is sent from one computer to another on the Internet.

Radio Button – One of a set round-icon selection options. Only one option can be selected. (ref. Checkbox).

Raw Outputs – Data packets received from the Vehicle as-is, with no processing.

Read (Permission) – A Role permission that allows read-only viewing of WGMS system parameters.

Roles – A set of Permissions granted to a person that allows them specific types of access to WGMS system parameters.

Self-Corrected (Alarm) – An Alarm situation corrected itself.

Shore-Side (Software) – Refers to any software that does not reside on the Vehicle. WGMS software in a laptop on a boat is still considered “Shore-Side”.

Short Burst Data (SBD) – An Iridium data communications method that utilizes small data packets.

Status Data – Information sent via Telemetry indicating the operational status (position and system health) of the Vehicle.

Sub – An alternate (and discouraged) term used to refer to the sub-marine Glider part of the Vehicle.

System Page – An alternate page used to display all System information for an Organization’s Vehicle(s).

Tab – A label in the WGMS GUI. Tabs may be placed near the top of a window, or on the left side. Clicking on a tab selects different data on a Page.

Telemetry – Data sent from the Vehicle on a periodic basis. Typically sent every two minutes.

Tether – An alternate (and incorrect) term for the Umbilical.

Tool Bar – A bar, typically along the top of a window, that contains data entry boxes and icons.

Track – The path a Vehicle actually traverses in the water when it is trying to stay on a course.

Umbilical – The flexible connecting cord between the Float and the Glider. Contains power and signal conductors, as well as strengthening elements.

Update (Permission) – A Role permission that allows updating of a Vehicle-related system parameter.

Vehicle – An alternate term used to describe the Wave Glider Float + Umbilical + Glider system.

Vehicles Page – An alternate page used to display all Vehicle information for an Organization.

Wave Glider Management System (WGMS) – The combined software package that is used to manage communications to and from a Vehicle.

Waypoint – A geographical point defined by Lat/Long coordinates. Used to define a Vehicle's Course or holding position.

Web Services – Automated information services that are conducted over the Internet, using standardized formats and protocols.

XBee – A short-range low-to-medium bandwidth radio communications method.

8.2 Abbreviations and Acronyms

AIS.....Automatic Identification System

AISyG..Automatic Identification System Gateway

API..... Application Programming Interface

AWAC.. Acoustic Wave and Current Profiler

BGAN... Broadband Global Area Network

COTS.... Commercial, Off-The-Shelf

EMSS.... Enhanced Mobile Satellite Service

GPS..... Global Positioning System

GSM..... Global System for Mobile Communications

GUI..... Graphical User Interface

IMEI..... International Mobile Equipment Identity

IP..... Internet Protocol

ISU..... Iridium Subscriber Unit

LRI..... Liquid Robotics, Inc.

M2M.... Mobile-to-Mobile

MTBF.... Mean Time Between Failures

NMEA... National Marine Electronics Association

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Appendix A: Wave Glider Specifications

General Characteristics & Operations	
Vehicle Configuration	Submerged glider and surface float joined by a 7-meter tether
Dimensions (cm)	Float: 208x60; glider: 40x191; wings: 107 wide
Weight and Buoyancy	90 kg mass, 150 kg displacement
Endurance	Variable and limited by conditions with a design target of 1 year of mission life. Biological fouling, extreme weather, and other factors may limit mission life.
Keel Depth	7 meters – do not operate in water depths less than 12 meters.
Submergence	Continuous wash and salt spray, brief submergence (such as might be caused by wave action) to 2 meters.
Vehicle Observability	Acoustic signature includes rudder motor, hull noises, and wing articulation. Deck height is from 3-20 cm above the water line, and the system can be painted blue. Payload/Communications mast(s) may increase visual and/or radar profile.
Water Speed	Water speed varies from 0.1 knots to 1.8 knots (0.05 m/s to 0.9 m/s). Water speed is highly dependent on conditions and the following list describes various factors (not a complete list) that can affect the water speed: • Wave height, frequency, and direction • Wind speed and direction • Accumulated drag due to bio-fouling • Drag from externally mounted payloads • Payload weight • Interruption of propulsion cycle by submarine-mounted payloads • The vehicle assumes a high-drag configuration (fouled or twisted umbilical, side to the seas, etc.) See Figure 8-1 “Water Speed vs. Sea Conditions” below for an empirically-based model of vehicle performance. The model does not account for all factors, and should not be taken as a definitive specification. ***Note**: Water speed and ground speed do not correlate exactly. If local currents are greater than the water speed, the Vehicle could drift off of its commanded course.*
Transportation	Shipping crates weigh between 70 and 120kg. Float weighs 45kg. Glider weighs 45kg. ***Note:** Weights do not include payloads.*
Shipping	Air freight compatible

Power Systems	
Propulsion	Mechanical conversion of wave energy into forward propulsion
Battery	665 watt-hours (battery manufacturer's rating): lithium-ion rechargeable batteries. 4.5 kg of lithium chemistry cells.
Solar Power	Two 43-watt solar panels charge the batteries and provide operating energy for onboard electronics and payloads. ***Note:*** *43 watts is the manufacturer's rating. Power available is highly dependent on available solar flux. In low solar conditions such as winter, cloudy conditions, or high latitudes power may be insufficient for continuous system operation without duty-cycling payloads or decreasing radio communications frequency.*
Command and Control	0.7 watts continuous
Payload Power	1 to 5 watts continuous (typical - environment dependent) Maximum current: 1 A for each payload; 13 to 17 volts ***Note:*** *Payload duty cycle can be moderated to accommodate low power environments.*
Communications System	
Satellite Communications	Iridium 9601 or 9522B satellite modem using Short Burst Data (SBD) protocol. Payloads can utilize this communications channel or mount their own communications system. Data is not encrypted.
Local Communications	XBee-PRO 2.4 GHz 802.15.4 modem RF data rate: 250 Kbps Power output: 63mW Receiver sensitivity: -100 dBm
Navigation System	
Heading Sensor	Compass calibrated to +/- 1 degree accuracy
GPS Receiver	12 channel, WAAS Capable (WAAS or SBAS is typically not enabled to prevent different performance inshore from offshore)
Navigation Accuracy	On board GPS determines position accurately to 3m radius CEP50 (Circular Error Probability of 50%). *Performance degrades if Selective Availability is turned on by the US.*
Station Keeping	40m radius CEP90 in WMO Sea State 3, current < 0.5 knots. *See Water Speed specification for influential factors.*
Operations	
Mission Control	Chart (Google Maps) based GUI interface accessible via web page. Waypoint and course generation.
Status Monitoring	Text and visual status indicators accessible via web page. Email alerts. Programmable inclusion and exclusion zones provide boundary alerts.
Autonomous Navigation	Programmable waypoint course. Follow course and hold. Follow course and loop. Station keeping at target position. Steering modes: magnetic or line following.

Payload Systems	
Architecture	Modular mechanical, electrical, and software interfaces to general-purpose housing. Support for 3rd party payloads.
Capacity	Float: • Forward payload bay under solar panel: 10kg* • Aft payload bay under solar panel: 16 kg.* • Float payloads must be balanced towards the aft of the vehicle. Float payloads must be evenly balanced port and starboard. Mast: • Antenna deck has four mounting positions for masts. Masts may be up to 1.5 m high with 1kg at the top. Masts must not have substantial sail area. Submarine: • Submarine-mounted payloads can be accommodated but will degrade water speed if they introduce drag. Consult with Liquid Robotics before attempting a submarine mounted payload. Towed: • The Wave Glider can tow small streamlined payloads from the float or submarine. Towed payloads add inertia and drag to the system that will degrade water speed performance. Towed payload may entangle the vehicle in some conditions. Consult with Liquid Robotics before attempting a towed payload. **Mechanical drawings of the payload bays and optional payload dryboxes are available upon request. Note that the approximate weight of the optional dryboxes is 8kg and must be subtracted from the capacity numbers listed above.*
Standard Payload Modules	AIS, meteorological sensors, passive acoustic recorder, acoustic modem
Safety Systems	
Emergency Location Devices	Optional shore-activated marker light. RF beacon.
Safety Sensors	Pressure, temperature and leak sensors in dry boxes
Battery System Safeties	Individual batteries in battery pack are isolated. Automatic charge cut-off or over-voltage or over-temperature. Discharge cut-off on under-voltage. Batteries are disconnected when solar panel connectors are removed for transit.
Marine Mammal Protection	Pressure-actuated release separates the float from the tether and glider if an entangled animal submerges the system.

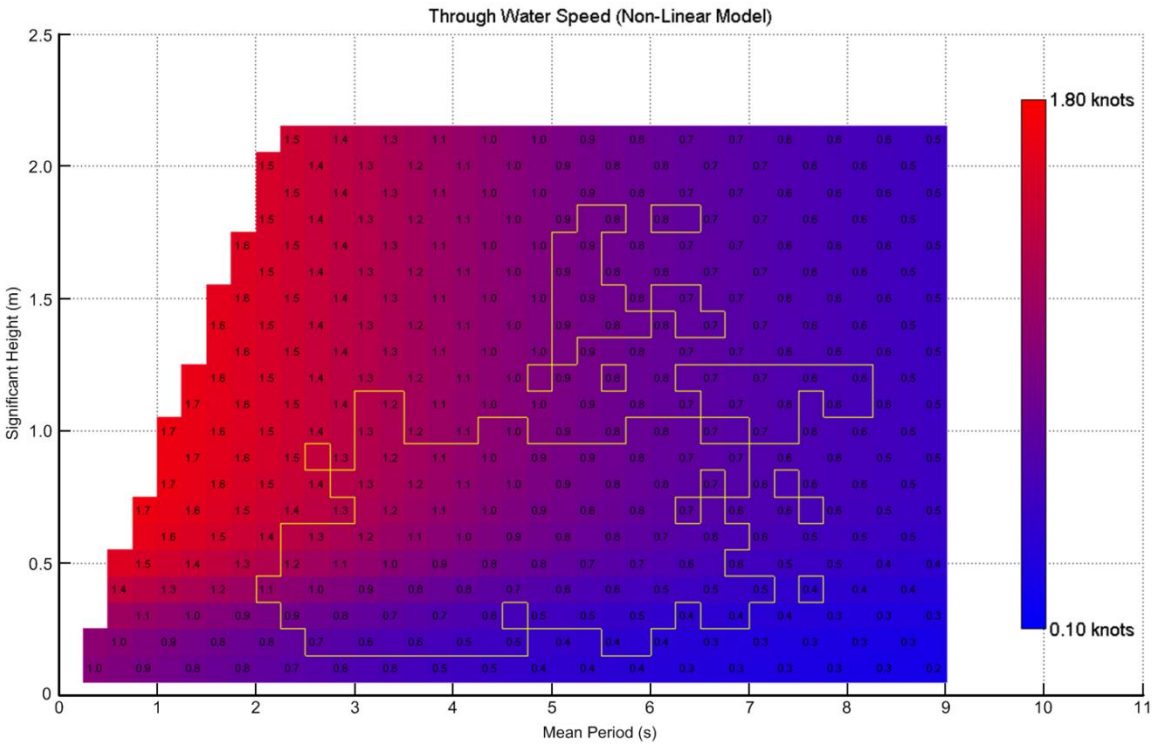

Figure 8-1: Water Speed vs. Sea Conditions

Appendix B: Solar Flux

Below is a chart of the average daily solar flux (Watts/Meter^2) for each month at various locations. The primary point of this chart is to show how much the flux can vary for different times of the year.

The numbers indicate Watt-hours per day.

		Puako HI	San Diego CA	Seattle WA	Nome AK	Puntas Arenas CHL
Latitude		**N 20°**	**N 32°**	**N 48°**	**N 64°**	**S 53°**
Month	Jan	378	288	90	90	549
	Feb	423	360	162	54	423
	Mar	477	450	261	180	288
	Apr	513	540	360	333	162
	May	522	576	441	441	81
	Jun	522	585	504	522	54
	Jul	531	594	522	468	72
	Aug	540	558	459	324	135
	Sep	504	486	351	198	252
	Oct	441	387	207	90	405
	Nov	387	315	108	27	531
	Dec	360	261	81	9	567
	Min	360	261	81	9	54
	Max	540	594	522	522	567

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