Flight Plan Addendum

GS Weather Radar Product Line

FCC License Application

16 October 2014

Contents

1 Program Overview

Rockwell Collins Government Systems (GS) Division is developing a Weather Radar Product Line for use by the Department of Defense, and other customers. The initial product line is a modification of the RTA-41XX Weather Radar developed by Rockwell Collins Commercial Systems (CS) Division for use by Commercial airlines. The RTA-41XX Weather Radar was issued a Grant of Equipment Authorization by the FCC in July 2009 (FCC identifier AJL8222256). That product has been certified by the FAA and is currently in use on civilian aircraft. This effort therefore leverages radar technology developed for the civilian market by Rockwell Collins for rotary wing and fixed wing platforms into the military and commercial market space.

1.1 Limitations

All modifications to the product line will be constrained such that certain parameters of the Signal in space remain unmodified. RF power output, occupied frequency bandwidth, frequency stability, spurious emissions, and field strength of spurious radiation will all be kept within the limits of the current FCC license for the RTA-41XX. Any change that would require modification to these parameters would require the acquisition of new experimental license. Note that changes to the basic frequency determining and stabilizing circuitry (including clock and data rates), frequency multiplication stages, basic modulator circuit or maximum power or field strength ratings will always require reapplication.

1.2 Initial Product

The initial target market for the Government Systems Weather Radar Product line is the helicopter market. Rockwell Collins was selected by the United States Coast Guard to upgrade the Weather Radar on the USCG MH-65 Helicopter Fleet (Contract Number HSCG23-14-C-2DA014). All current weather functionality will be maintained. Modifications required by the Coast Guard included:

a. Survivability and operation in the presence of helicopter vibration profiles.
b. Survivability in the high saline environment for Ocean Search and Rescue Operations.
c. A Sea Search mode for finding survivors in the water in Sea State 2 or less.
d. An enhanced shoreline mapping Radar Mode to aid navigation in poor weather.

1.3 Modifications

1.3.1 General Philosophy

It is fully expected that the Weather radar product line will continue to develop. Future modifications to the product will be dictated by customer requirements as the product evolves. Future flight testing in response to such modifications cannot be accurately predicted. Requirements could dictate selection of test locations from a broad and diverse set of locations across the continental United States. Neither can future modifications to the radar itself be predicted. Flight tests will be designed to test and verify the new modes of operation in a manner similar to the testing described for the MH65 program.

1.3.2 Anticipated Modifications

One expected future modification is an extension of the Weather Radar product line into fixed wing aircraft. Although the CS version was developed exclusively for fixed-wing aircraft, development for the

GS product line has so far been focused of helicopter platforms. In the future, a version will be GS will be developed for fixed wing aircraft. This version will be tested only to the milder vibration profiles experienced in fixed wing aircraft. Testing for this modification would focus on only those modes required for the mission. For example, it is unlikely that modes developed for helicopter Search and Rescue operations would be verified in a fixed wing platform. Otherwise, testing will proceed in a manner similar to the testing described for the MH65 program.

1.4 Initial Product Flight Testing

Flight testing will be required for both development and verification of these modifications. Only so much testing can be accomplished on the ground in the absence of actual conditions. The radar must be operated in the environment in which it is intended to function. Toward this end, the radar will be flown into the proximity of weather cells. It will also be operated over representative water surfaces and shorelines. Radar performance under operational conditions will be analyzed to find errors introduced during development. Radar data will be recorded during flight so that it may be played back though the radar in a laboratory setting. When product development is complete, the radar will have to be flown to collect data for purposes of verification. Data will be collected for all new modes of operation, and analyzed to verify proper performance against the requirements of the system. Finally, the flight tests will facilitate the collection of data for future FCC certification and TSO certification with the FAA.

1.5 Selection of Test Locations

The nature of the product necessitates some flexibility in testing. For example, in order to test the weather function, the radar must be operated in the presence of weather. This means waiting for the required weather cells to develop, or flying to locations where the weather cell exists. The location of a test event may be nominally selected. However, deviation may be required upon arrival at the selected area due to the absence of sufficient weather conditions. In addition, any test event involving water must account for water conditions and freezing weather. If the sea state is too high, then the capacity of the radar to discern targets will be exceeded and no useful testing may be accomplished. Water surfaces typically freeze in winter months. Without open water, the radar cannot perform its function. In addition, the occurrence of ice causes the removal of any targets of opportunity on the water surface (i.e. ships, buoys) that might be used to test operational capability. The radar must therefore be transported to open water. The potential locations for flight testing must therefore of necessity be drawn from a wide range of territory.

2 Flight Test Overview for MH65 Initial Product

Rockwell Collins will perform several flight tests in order to both develop and verify performance of this new radar under operational conditions. Each flight test would consist of several flights. Each flight test corresponds with an iterative development phase of the radar. Employees of Rockwell Collins will perform all test actions during Flight testing.

2.1 Schedule

Eight flight tests are currently envisioned between the present date and program completion at the end of July 2015 – four with fixed wing platform and four with a helicopter platform. The testing date cannot be specifically planned because testing requires a specific sea state. A window would be determined, and Sea State evaluated to determine the date of testing within the window. Because NOAA removes buoys from the Great Lakes during winter, any testing during winter months would have to be performed over the Gulf of Mexico.

ID	Type	Fixed Wing	Helicopter
FT1	Development	Nov 14	Nov 14
FT2	Development	Feb 15	Feb 15
FT3	Development	Apr 15	Apr 15
FT4	Verification	Jul 15	Jul 15

Table 1 Notional Flight Test Schedule

2.2 Fixed Wing Test Flights

a. **Objective:** The fixed wing platform will be used to test the radar over large bodies of water. A large body of water is required to observe performance in the presence of representative waves.

b. **Proposed Test Area:** Testing would take place over either the one of the Great Lakes, the inland lakes attached to the Great Lakes, or the Gulf of Mexico. This allows the use of NOAA buoys as targets for testing. These buoys come prefixed with radar reflectors for use by maritime navigation, and will react to waves as would a target. The buoys selected as surrogate targets will determine the specific location of the testing. Buoys would be chosen to avoid conflicts with civilian air traffic. Shorelines in the vicinity of the selected buoy will also be used to demonstrate enhanced mapping.

c. **Flight Ops:** During the flight to and from the Test Area, the Radar will be operated by the Flight Crew as normal weather radar. Once the aircraft arrives at the test location, the radar will be commanded to perform the new modes so that data may be collected in an operational environment. In addition, the radar will be commanded to switch between weathers modes and the new modes during flight operation. The Radar will therefore be transmitting at all times during the flight. If required, the aircraft will re-fuel prior to operation in the Test Area.

d. **Radius of Action:** When in the target area, the aircraft will nominally operate within a 15 NM radius of the target location. Maximum altitude will notionally be 5000' AWL. Flight testing could be performed as low as 500' AWL commensurate with Flight Safety and FAA regulations.

2.3 Helicopter Test Flights

a. **Objective:** The helicopter platform will be used to test the radar under helicopter dynamics and vibration conditions. This includes testing at low altitudes and slow speeds.

b. **Proposed Test Area:** All testing is envisioned to happen in the local area of Eastern Iowa. The range of the helicopter is limited so it would be a considerable logistical effort to move the helicopter to an area that would allow testing over a large body of water. The proposed test areas include Lake MacBride and the Coralville Reservoir. Both bodies of water are in close proximity (i.e. 10 minutes flying time) to Iowa City. There is a possibility that the Mississippi River could be used as well. A radar target will be placed in selected body of water in order to facilitate testing.

c. **Flight Ops:** The radar would not be operating as weather radar for the pilot on this platform. It would be purely used as a test asset for development and verification. The radar will be used in weather mode but only to verify the performance of the radar.

d. **Radius of Action.** When in the target area, the helicopter will nominally operate within a 15 NM radius of the target location while always maintaining separation from controlled airspace of CID. This implies that the helicopter will operate south and east of Lake MacBride. Maximum altitude will notionally be 5000' AWL. Flight testing could be performed as low as 500' AWL commensurate with Flight Safety and FAA regulations.

2.4 Unplanned Events

Program needs might dictate additional flight tests beyond what has been planned. Any such unplanned flight tests would conform to the structure of the planned test flights.

2.5 Potential Fixed Wing Test Areas

A number of buoys have been have been selected as potential targets. Other buoys could possibly be considered if the need arises.

ID	Location	Latitude	Longitude	Water Depth (meters)
45002	Lake Michigan North	N45°20'39"	W86°24'40"	175
45007	Lake Michigan South	N42°40'26"	W87°1'32"	160
45008	Lake Huron South	N44°17'0"	W82°24'59"	54
42012	Orange Beach, AL	N30°3'55"	W87°33'19"	28
42035	Galveston, TX (East)	N29°13'54"	W94°24'46"	13
42043	Galveston, TX (South)	N28°58'56"	W94°53'56"	19
42051	Holly Beach, LA	N29°38'6"	W93°38'30"	9

2.5.1 Lake Michigan North

This buoy is Halfway between North Manitou and Washington Islands.

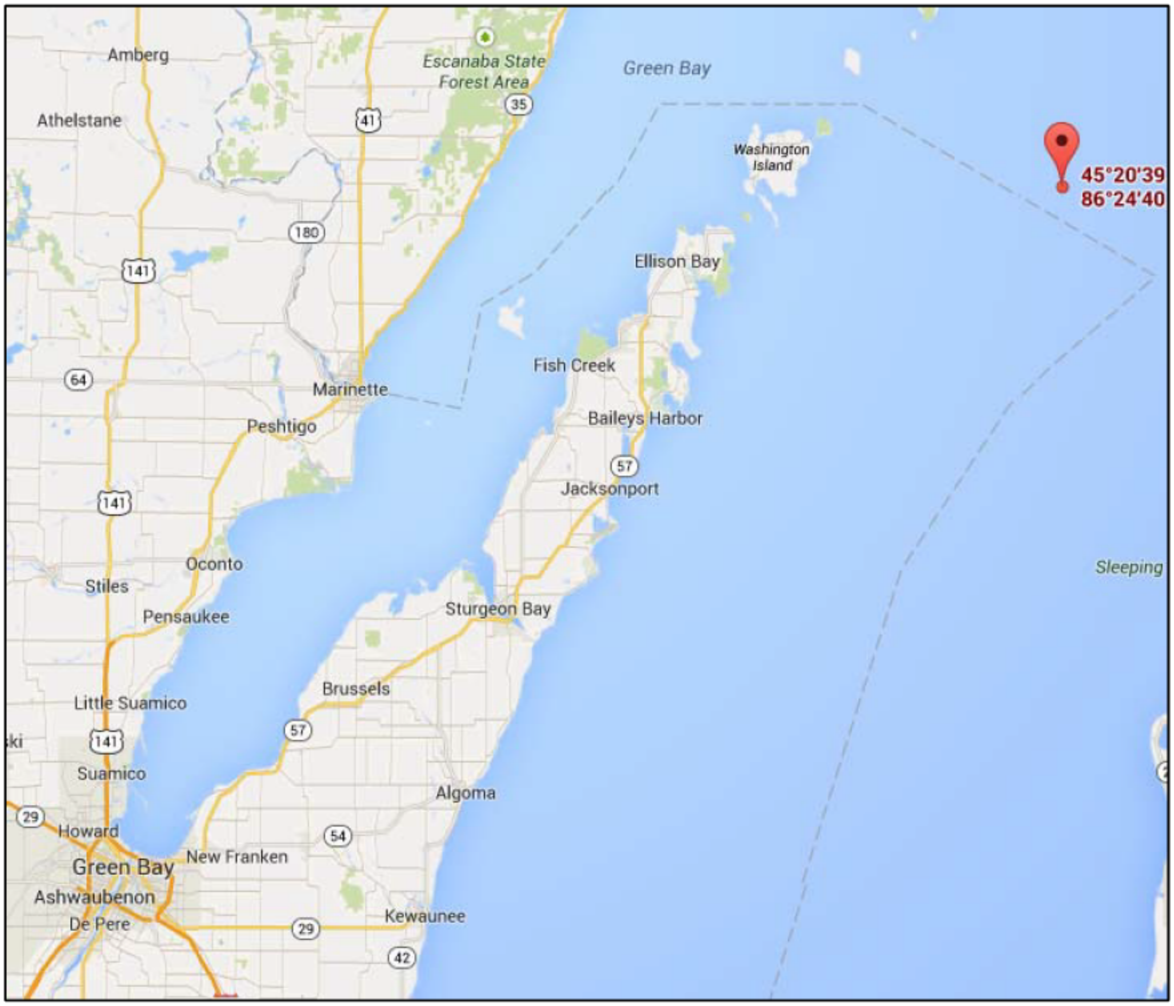

Figure 1. Location of Buoy 45002

2.5.2 Lake Michigan South

This Buoy is located 43NM East Southeast of Milwaukee, WI.

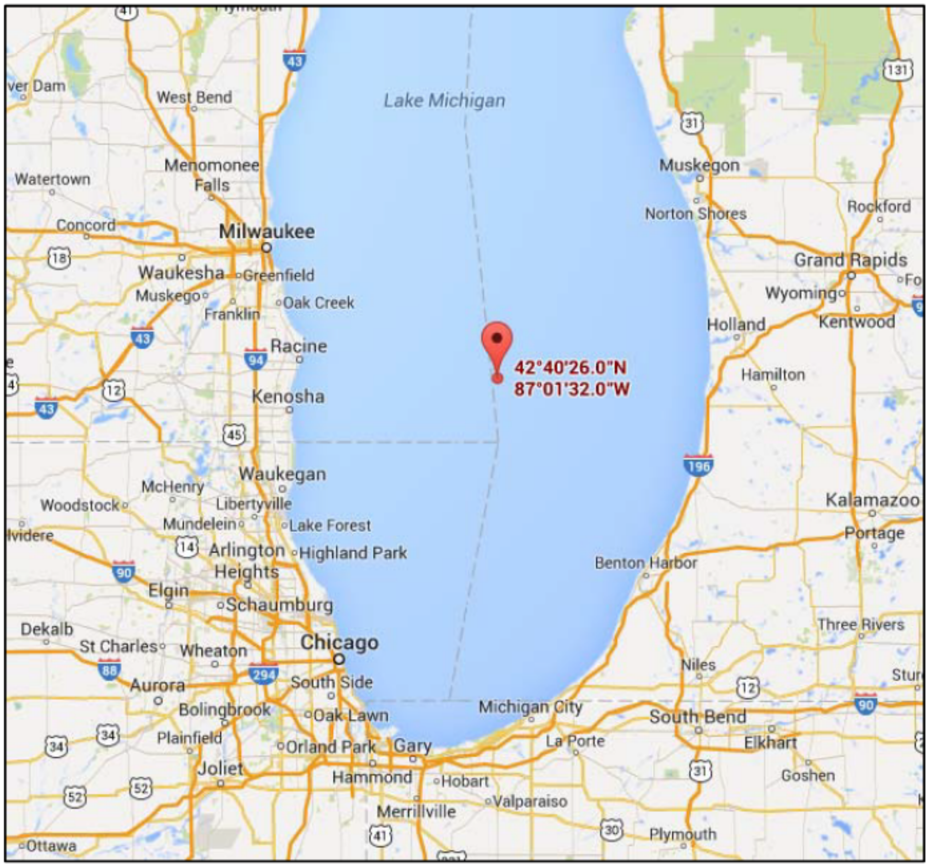

Figure 2. Location of Buoy 45007

2.5.3 Lake Huron South

This buoy is located 43NM East of Oscoda, MI

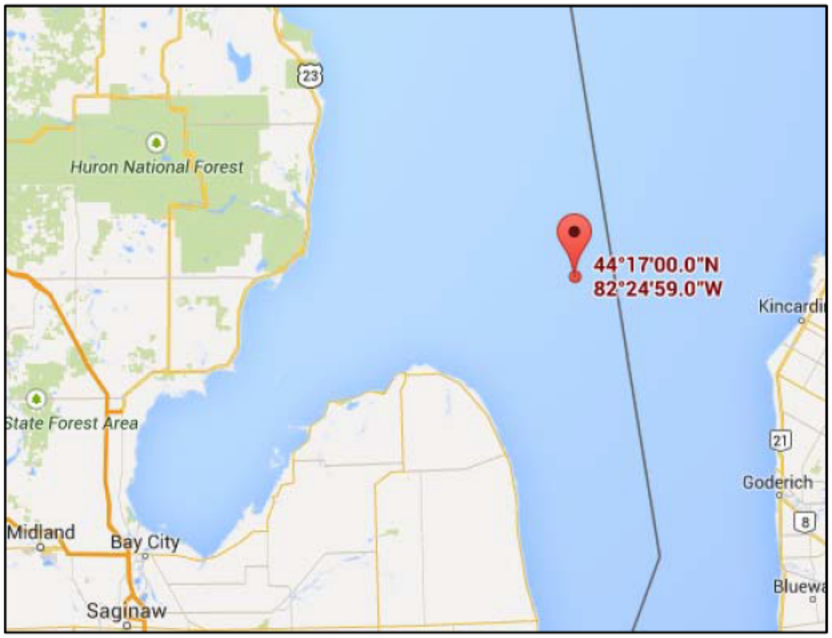

Figure 3. Location of Buoy 45008

2.5.4 Orange Beach AL

This buoy is located 44 NM SE of Mobile, AL

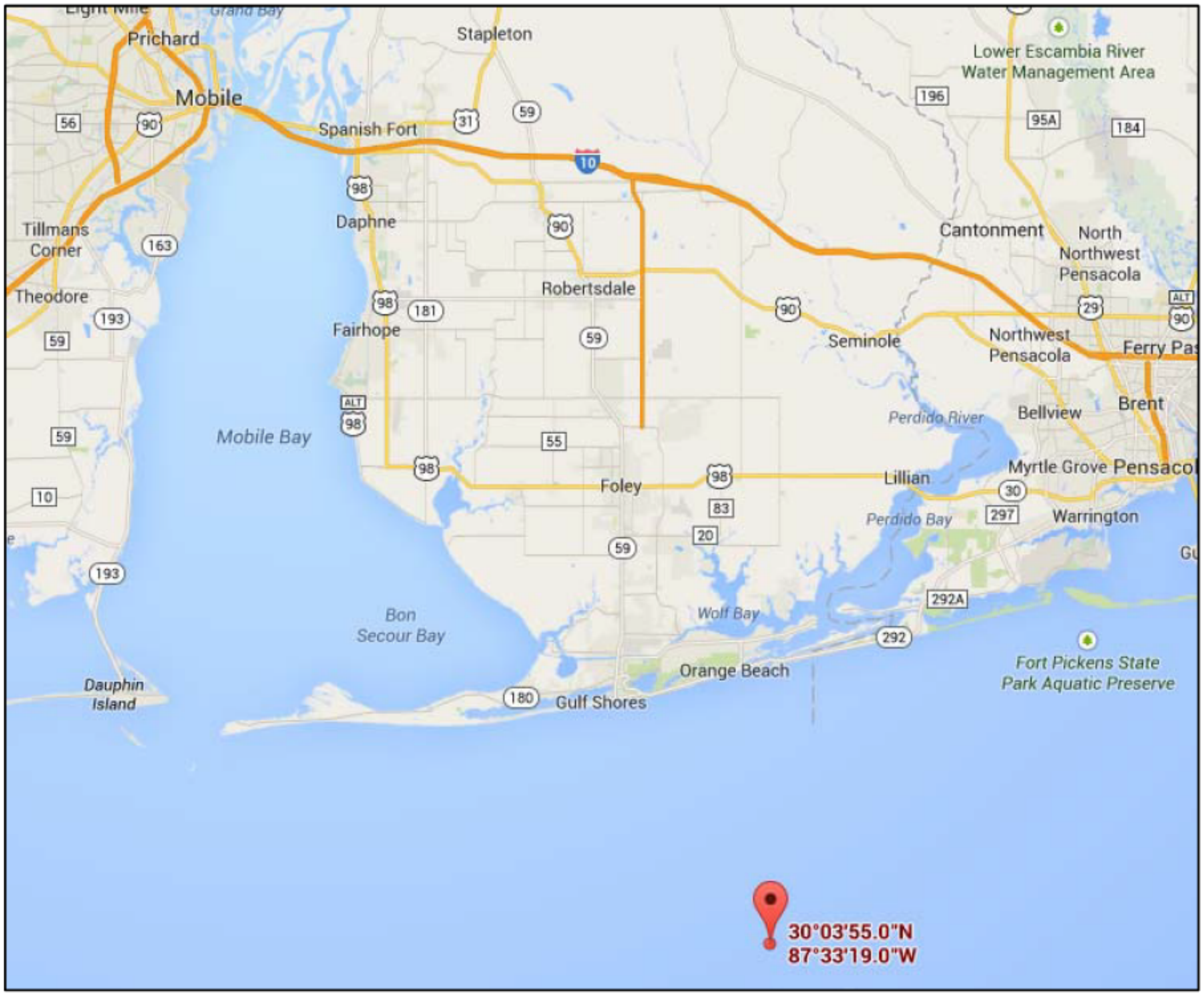

Figure 4. Location of Buoy 42012

2.5.5 Galveston, TX (East)

This buoy is located 22 NM East of Galveston, TX.

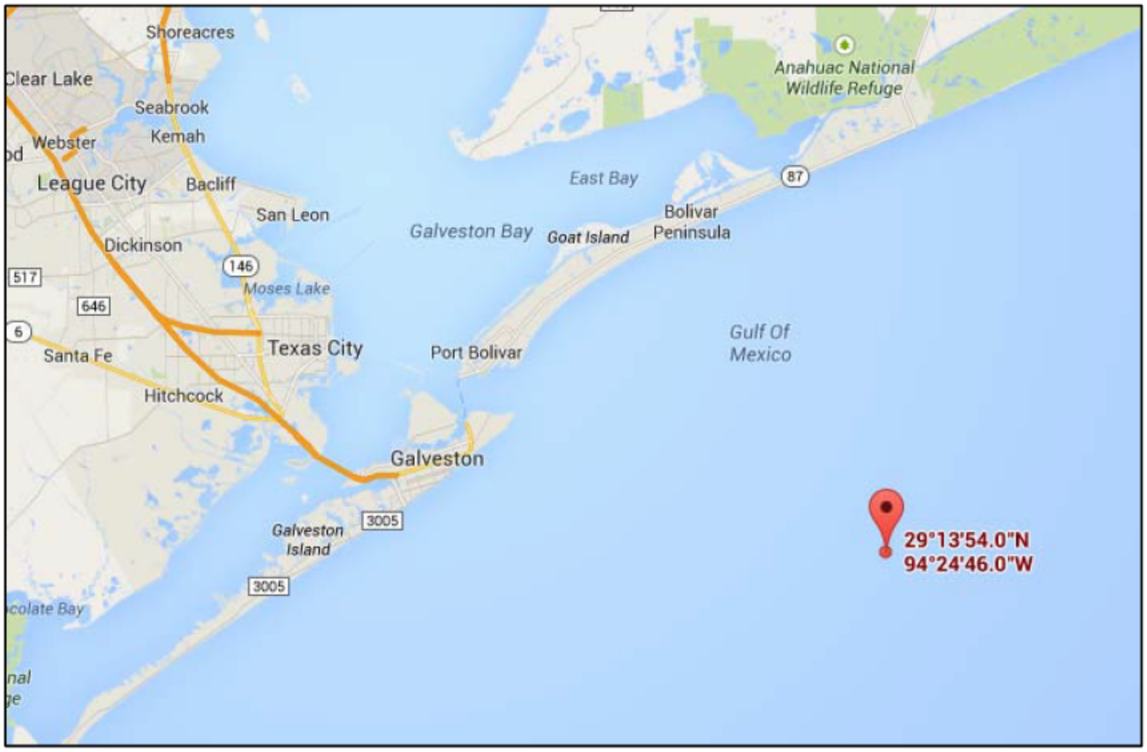

Figure 5. Location of Buoy 42035

2.5.6 Galveston, TX (South)

This buoy is located 20 NM south of Galveston, TX.

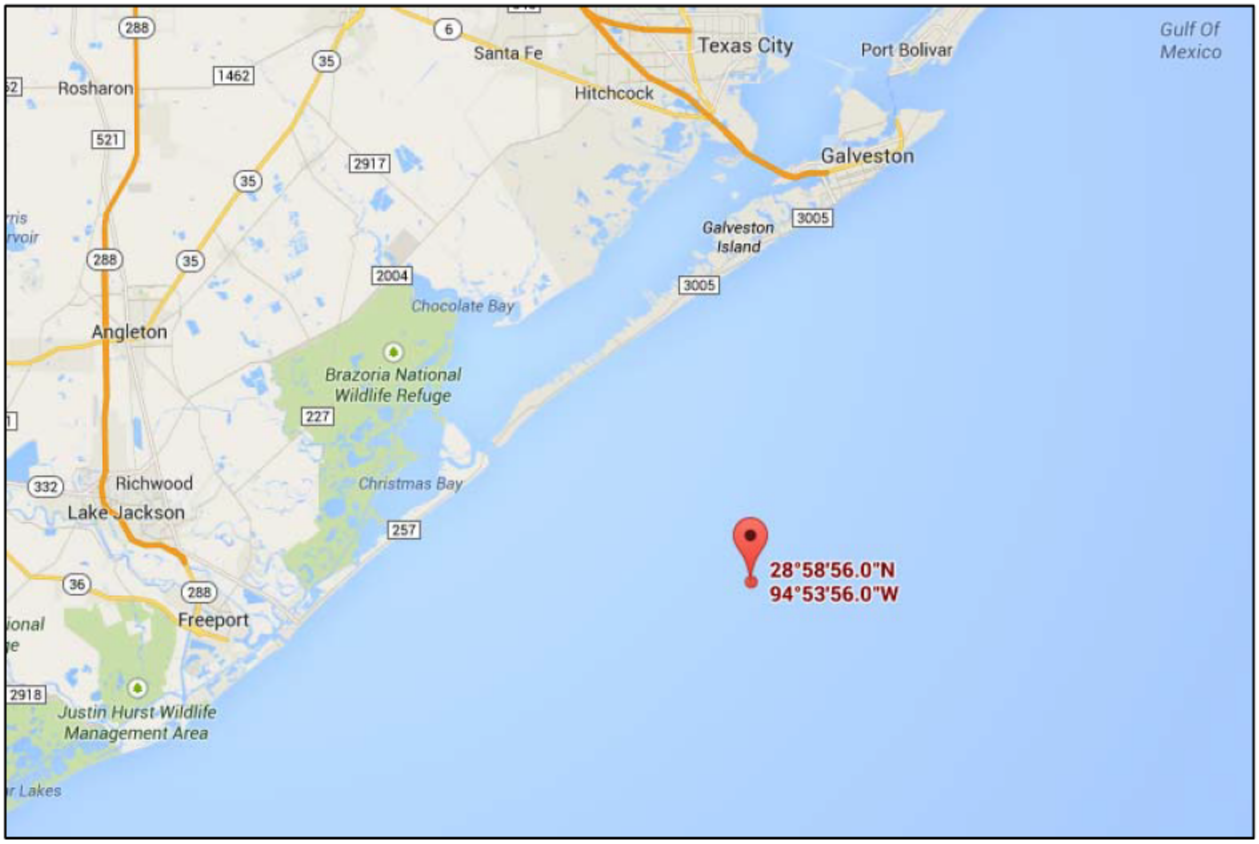

Figure 6. Location of Buoy 42043

2.5.7 Holly Beach, LA

This buoy is located 25 NM SE of Port Arthur TX.

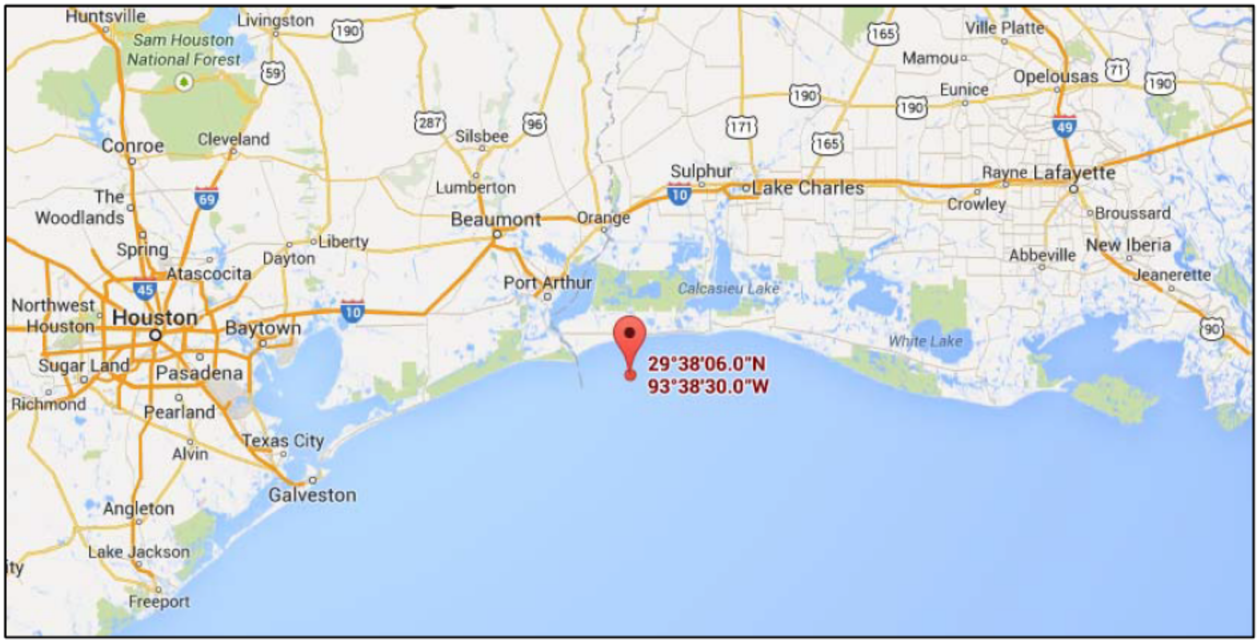

Figure 7. Location of Buoy 42051

2.6 Potential Helicopter Test Area

Helicopter testing will take place in the area around Lake MacBride.

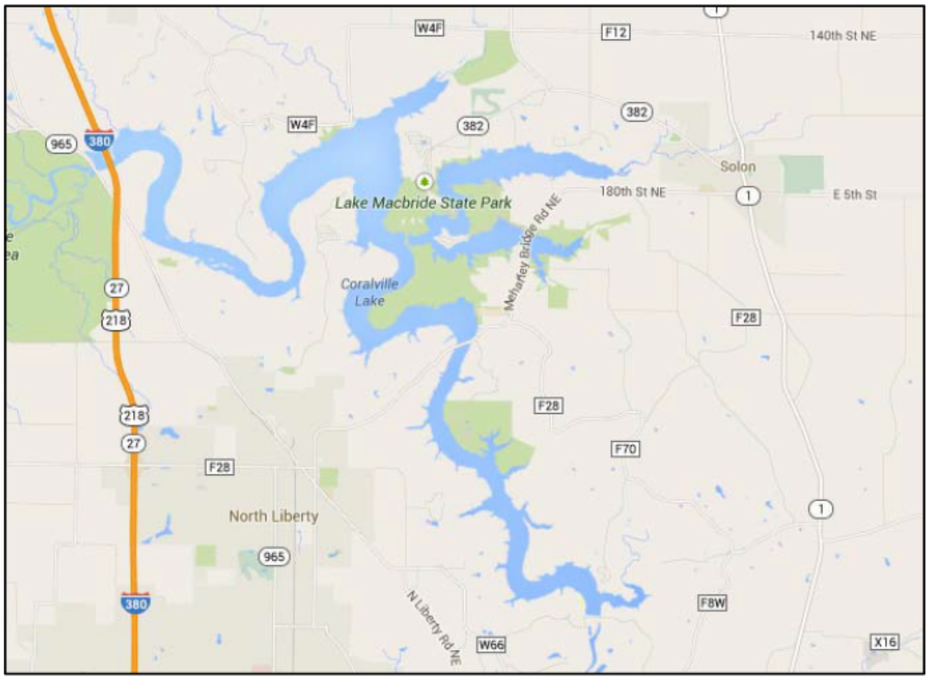

Figure 8. Lake MacBride

Lake MacBride is located between Iowa City and Cedar Rapids. The straight line distance from Lake MacBride to the Eastern Iowa Airport south of Cedar Rapids IA is approximately 8 NM.

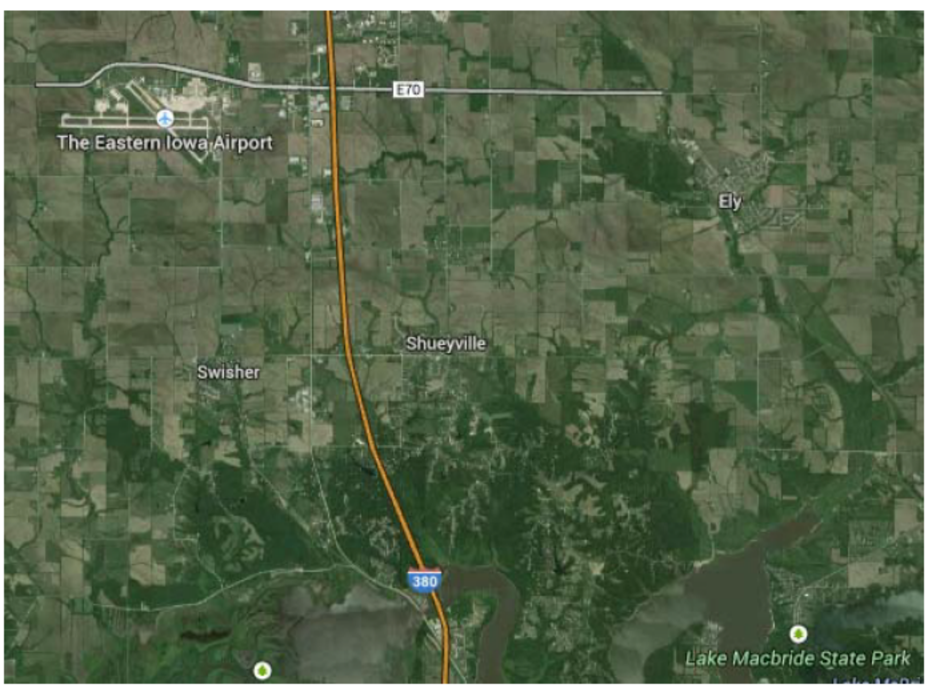

Figure 9. Lake MacBride relative to Eastern Iowa Airport

2.7 Test Hardware

The UUT is a version of the RTA-4114 Weather radar that has been modified to withstand helicopter vibration and a salt-fog environment. The same radar unit will be flown for each flight test. This unit will use different software builds as the flight testing progresses. The danger to humans from exposure to radar transmission is limited to 6 ft in front of the helicopter. The UUT uses a 14" flat-plat circular antenna with maximum gain of 28.9 dB. The antenna is directional and the width of the beam in degrees at the half power point is 6.7°. The antenna is mounted in the nose of the aircraft and points relative to the aircraft +/- 60° of the center line and +/- 20° of the aircraft vertical. The maximum speed for keying in bauds is 7.56 MHz, the frequency deviation is .005%, and the PRF is 120-3000 pps with a pulse width of 3.4 to 55 microseconds.

Figure 10. RTA-41XX

2.8 Test Platforms

Flight Testing for MH65 will be conducted using two platforms.

2.8.1 Challenger

a. Type: Bombardier Challenger 601
b. Tail Number: N601RC
c. Designation: Experimental
d. Base: Eastern Iowa Airport (CID)
Cedar Rapids IA
N41°53'21" W91°42'01"
e. Owner: Rockwell Collins

Figure 11. Challenger

2.8.2 MI-2

a. Type: Mil Moscow MI-2 Hoplite

b. Tail Number: N211PZ

c. Designation: Experimental

d. Base: Iowa City Municipal Airport (IOW)
Iowa City IA
N41°38′21″ W91°32′47″

e. Owner: Operator Performance Laboratory
University of Iowa
116 Engineering Research Facility
Iowa City, IA 52242

Figure 12. MI-2