Assessment of Wind Turbine Impacts on
4th Fighter Wing F-15E Low-Altitude Training
Seymour Johnson AFB, NC
10 September 2012

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An F-15E Strike Eagle lighting afterburners for take-off at Seymour Johnson AFB, NC.

Introduction

Growing demand for renewable energy and associated financial incentives for developers are driving an increased interest in wind energy development in North Carolina and several adjoining states where Seymour Johnson AFB aircraft utilize low-altitude training airspace. Although Seymour Johnson AFB is fully supportive of renewable energy, the 4th Fighter Wing based at Seymour Johnson AFB, Goldsboro, NC is deeply concerned about the potential impacts of wind turbines to its low-altitude flight training. Wind power projects sited within or near military low-altitude training airspace have the potential to produce significant impacts on the ability of Seymour Johnson AFB units to perform their mission. The 4th Fighter Wing conducted an internal study to assess the potential impacts of wind turbines on F-15E low-altitude training in the mid-Atlantic region and specifically eastern North Carolina.

Seymour Johnson AFB's unique mission shapes the type and amount of low-altitude training required. The assessment highlights aspects of low-altitude training, the airspace required to accomplish training, and the potential impacts turbines would likely have on low-altitude training.

Wind turbines would likely affect Seymour Johnson AFB training in three ways. First, the turbines themselves, depending upon location, would require crews to maintain higher altitudes than those required for low-altitude training profiles. Second, due to the nature of wind turbines, they could have a significant impact on other training conducted at low-altitude, specifically low-altitude intercept training. Third, adding potentially dozens of 498 foot obstacles within a route where thousands of low-altitude high speed military training sorties are flown every year will increase safety of flight risk, especially at night.

The US Air Force is conducting detailed testing and flight demonstrations of the impacts of wind turbines on certain aircraft and aircraft systems. The studies are ongoing and formal reports have yet to be published. However, initial results and analysis has been available and is used in this assessment. Additionally, much of the assessment is also based on aircrew experience flying the F-15E in areas where wind farms are already in operation, such as in Wales in the United Kingdom and numerous areas in the western US. The assessment is based on the best data and experience to date, but could potentially change as additional analysis is complete.

The 4th Fighter Wing wishes to ensure local and state government and developers are aware of Seymour Johnson AFB's crucial low-altitude training airspace, how it is used, why it is critical to the mission, and how wind turbines could potentially impact Seymour Johnson AFB's mission accomplishment.

4th Fighter Wing Mission

"Strike Eagle Airpower – On Target, On Time" The 4th Fighter Wing provides the United States with precision airpower whenever and wherever needed. Seymour Johnson AFB is home to the F-15E Strike Eagle, an all-weather, multi-role strike fighter. The F-15E is unique in that it is the only remaining US Department of Defense fighter that is required to maintain a low-altitude combat capability. It is the only remaining fighter utilizing terrain following (TF) radar to enable low-altitude flight day or night, and in all weather conditions.

Seymour is home to the only F-15E Formal Training Unit (FTU) in the US Air Force. The FTU is comprised of two squadrons conducting 100% of the US Air Force's F-15E basic qualification, requalification, and transition training. Every single pilot and weapon systems officer (WSO) destined to fly the F-15E trains at Seymour Johnson AFB.

In addition to the FTU, Seymour is home to two F-15E operational combat squadrons capable of deploying anywhere in the world within hours to engage in combat operations. The two squadrons have completed dozens of deployments to Southwest Asia over the last two decades. With its four squadrons, Seymour Johnson AFB is home to nearly half of the entire US Air Force F-15E fleet.

The F-15E Strike Eagle

The F-15E Strike Eagle is a dual-role fighter designed to perform air-to-air and air-to-ground missions. An array of avionics and electronics systems gives the F-15E the capability to fight at low-altitude, day or night, and in all weather.

The aircraft uses two crew members, a pilot and a weapon systems officer. Previous models of the F-15 are assigned air-to-air roles; the "E" model is a dual-role fighter. It has the capability to fight its way to a target over long ranges, destroy enemy ground positions and fight its way out.

The aircraft's navigation system uses a laser gyro and a Global Positioning System to continuously monitor the aircraft's position and provide information to the central computer and other systems, including a digital moving map in both cockpits.

The APG-70 radar system allows aircrews to detect ground targets from long ranges. One feature of this system is that after a sweep of a target area, the crew freezes the air-to-ground map then goes back into air-to-air mode to clear for air threats. During the air-to-surface weapon delivery, the pilot is capable of detecting, targeting and engaging air-to-air targets while the WSO designates the ground target.

The low-altitude navigation and targeting infrared for night—or LANTIRN—system allows the aircraft to fly at low-altitudes, at night and in any weather conditions, to attack ground targets with a variety of precision-guided and unguided weapons. The LANTIRN system gives the F-15E unequaled accuracy in weapons delivery day or night and in poor weather, and consists of two pods attached to the exterior of the aircraft.

The navigation pod contains terrain-following radar which allows the pilot to safely fly at a very low-altitude following cues displayed on a heads up display. This system also can be coupled to the aircraft's autopilot to provide "hands off" terrain-following capability.

The targeting pod contains a laser designator and a tracking system that mark an enemy for destruction at long ranges. Once tracking has been started, targeting information is automatically handed off to GPS or laser-guided bombs.

One of the most important additions to the F-15E is the rear cockpit, and the weapons systems officer. On four screens, this officer can display information from the radar, electronic warfare or infrared sensors, monitor aircraft or weapons status and possible threats, select targets, and use an electronic "moving map" to navigate. Two hand controls are used to select new displays and to refine targeting information. Displays can be moved from one screen to another, chosen from a "menu" of display options.

In addition to three similar screens in the front seat, the pilot has a transparent glass heads up display at eye level that displays vital flight and tactical information. The pilot doesn't need to look down into the cockpit, for example, to check weapon status. At night, the screen is even more important because it displays a video picture nearly identical to a daylight view of the world generated by the forward-looking infrared sensor.

Each of the low-drag conformal fuel tanks that hug the F-15E's fuselage can carry 750 gallons of fuel. The tanks hold weapons on short pylons rather than conventional weapon racks, reducing drag and further extending the range of the Strike Eagle.

For air-to-ground missions, the F-15E can carry most weapons in the Air Force inventory. It also can be armed with AIM-9M Sidewinders or AIM-120 advanced medium range air-to-air missiles, or AMRAAM, for the air-to-air role. The "E" model also has an internally mounted 20mm gun that can carry up to 500 rounds.

The F-15's superior maneuverability and acceleration are achieved through its high engine thrust-to-weight ratio and low-wing loading. It was the first U.S. operational aircraft whose engines' thrust exceeded the plane's loaded weight, permitting it to accelerate even while in vertical climb. Low-wing loading (the ratio of aircraft weight to its wing area) is a vital factor in maneuverability and, combined with the high thrust-to-weight ratio, enables the aircraft to turn tightly without losing airspeed. The F-15E is powered by two Pratt & Whitney F100-PW-220 or 229 engines that incorporate advanced digital technology for improved performance.

F-15E General Characteristics

Primary function: Air-to-ground attack aircraft
Contractor: The Boeing Company
Power plant: Two Pratt & Whitney F100-PW-220 or 229 turbofan engines with afterburners
Thrust: 25,000 - 29,000 pounds each engine
Wingspan: 42.8 feet (13 meters)
Length: 63.8 feet (19.44 meters)
Height: 18.5 feet (5.6 meters)
Weight: 37,500 pounds (17,010 kilograms)
Maximum takeoff weight: 81,000 pounds (36,450 kilograms)
Fuel capacity: 35,550 pounds (three external tanks plus conformal fuel tanks)
Payload: depends upon mission
Speed: 1,875 mph (Mach 2.5 plus)
Range: 2,400 miles (3,840 kilometers) ferry range with conformal fuel tanks and three external fuel tanks
Ceiling: 60,000 feet (18,288 meters)
Armament: One 20mm multi-barrel gun mounted internally with 500 rounds of ammunition. Four AIM-9 Sidewinder missiles and four AIM-120 AMRAAM, or eight AIM-120 AMRAAM missiles. Any air-to-surface weapon in the Air Force inventory (nuclear and conventional)
Crew: Pilot and weapon systems officer
Unit cost: $31.1 million (fiscal 98 constant dollars)
Initial operating capability: September 1989
Inventory: 219

Two Seymour Johnson AFB F-15Es drop GPS guided GBU-31 Joint Direct Attack Munitions

Seymour Johnson AFB Low-Altitude Training Requirements

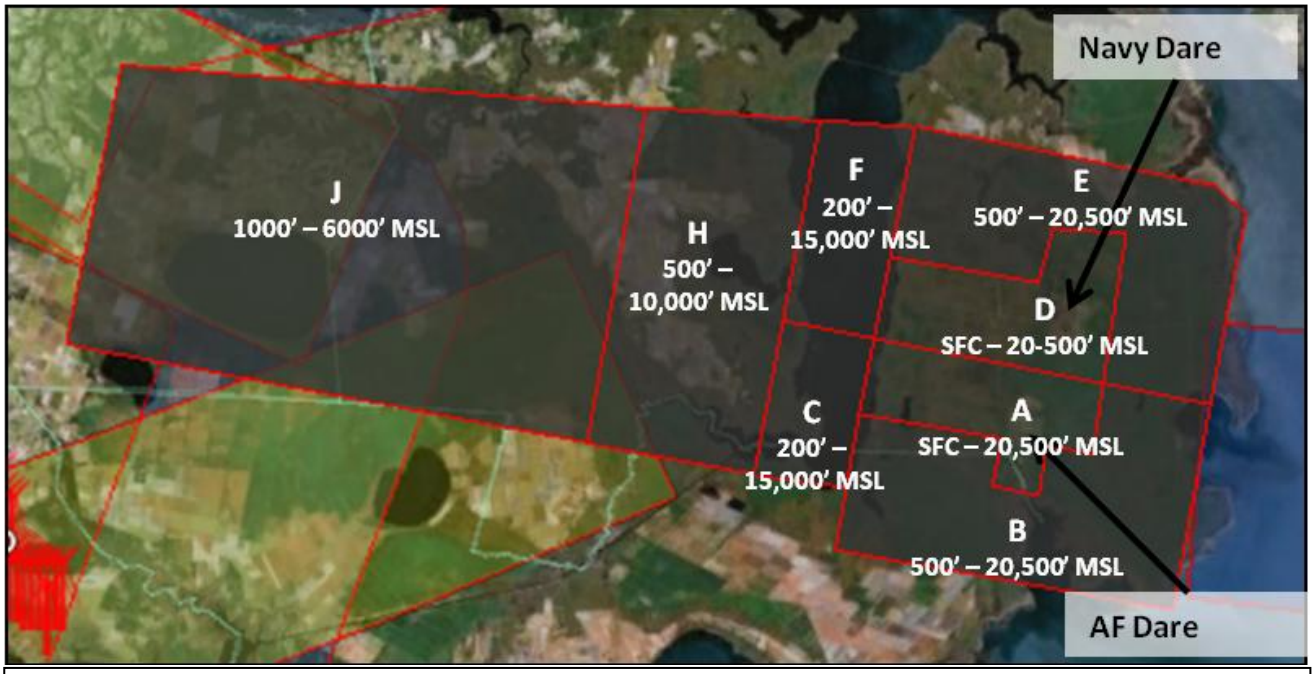
Due to its unique capability and mission, crews flying the F-15E are required to learn, develop, refine, and maintain the unique skills associated with employing the Strike Eagle at low-altitude. Those skills are best taught and practiced in the aircraft at low-altitude. F-15E FTU training requirements are directed by the FTU syllabus. The syllabus is built to ensure crews graduating from the FTU have the skills required when assigned to an operational combat squadron. Low-altitude training prescribed in the syllabus includes but is not limited to: low-altitude tactical navigation and maneuvering to 500 feet above ground level (AGL), terrain-following radar operations to 500 feet AGL, low-altitude weapons delivery from 500 feet AGL, and low-altitude radar intercepts from and against targets at 500 feet AGL. All of these skills are flown both day and night. In addition to the FTU syllabus requirements, the operational combat squadrons must maintain their skills and further develop and qualify aircrew in more advanced roles such as two and four-ship Flight Lead, Instructor Pilot, and Instructor WSO. Those upgrade programs are also defined by syllabi that include low-altitude training. In addition, operational squadron crews are required to fly a prescribed number of low-altitude events annually in order to maintain proficiency and combat readiness. Those proficiency requirements are directed in Air Combat Command's F-15E Ready Aircrew Program Tasking Memorandum.

Seymour Johnson AFB Low-Altitude Training Airspace

In order to accomplish its training, Seymour Johnson AFB requires a unique combination of low-altitude airspace including Restricted Area R-5314, Military Training Routes (MTRs), and Military Operations Areas (MOAs). Seymour Johnson AFB maintains and manages R-5314, 13 MTRs, and 4 MOAs. Of the four MOAs, none includes low-altitude airspace.

R-5314 is a 46 x 12 nautical mile area overlying portions of Dare, Hyde, Tyrrell, and Washington Counties in eastern North Carolina and includes the Dare County Bombing Range (DCBR). R-5314 is subdivided into eight sections of airspace. The eastern areas associated with DCBR include altitudes from surface up to 20,500 feet above mean sea level (MSL). As the areas step to the west, the bottom of the airspace steps up to 200 feet above ground level (AGL) over the Alligator River, 500 feet AGL west from the Alligator River to just west of Gum Neck, and then 1000 feet AGL in and around the western area that includes Phelps Lake. DCBR is sub-divided into two impact areas. The U.S. Navy operates Navy Dare which is the primary range for the Navy's F-18s based at NAS Oceana, VA. Seymour Johnson AFB operates Air Force Dare (the southern of the two impact areas) which is the primary training range for Seymour Johnson-based F-15Es. The ranges provide targets that can be targeted with inert training and heavyweight guided or unguided ordinance as well as internally mounted aircraft cannons.

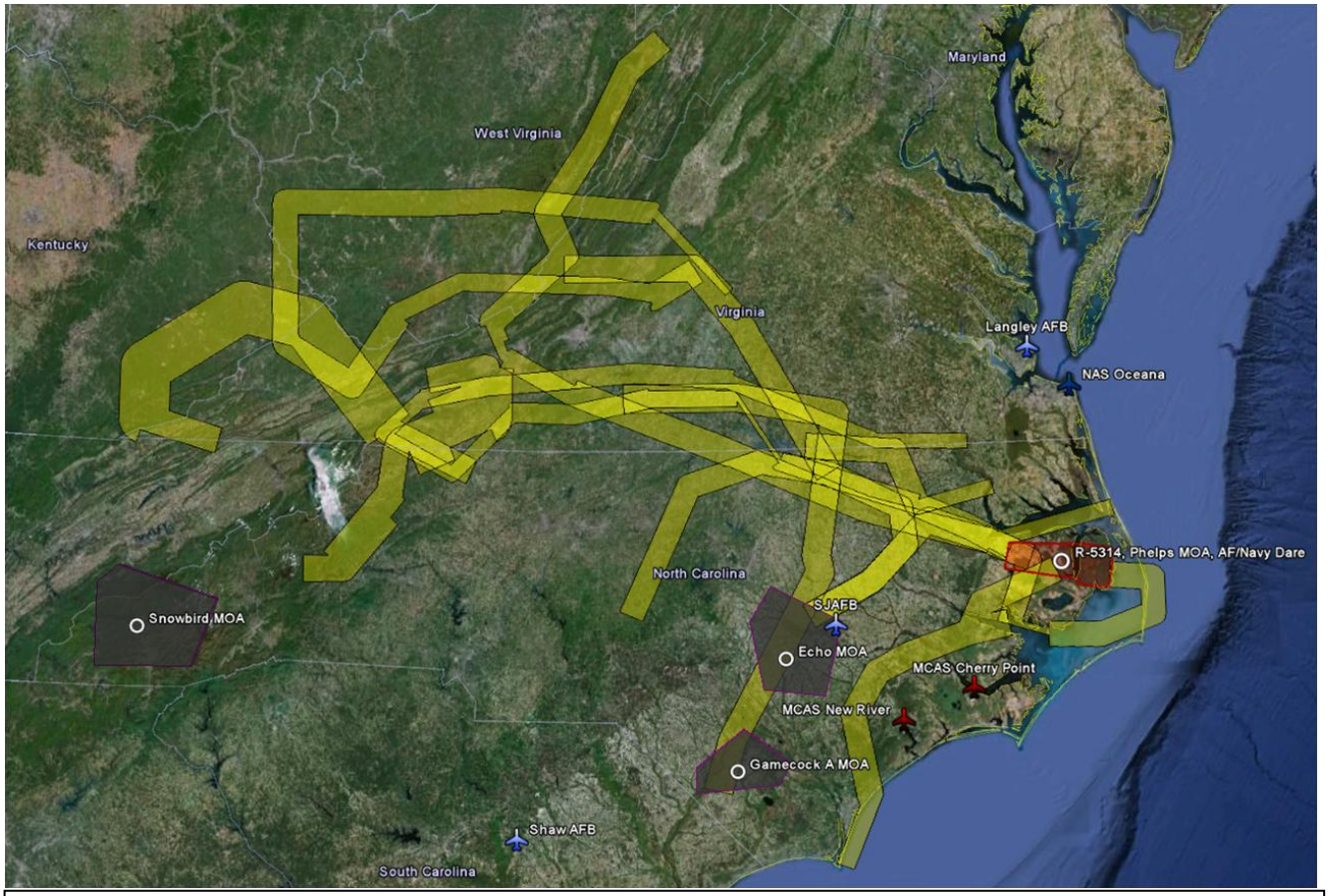
R-5314 is also the primary airspace used for F-15E low-altitude intercept training. Although its 46 mile length is relatively small for such training, it is the only airspace with the required altitudes within range of Seymour Johnson's F-15Es. R-5314 is classified as a Restricted Area that civil aircraft are restricted from entering during active hours. The airspace is generally inactive on weekends but can be activated if needed for military training.



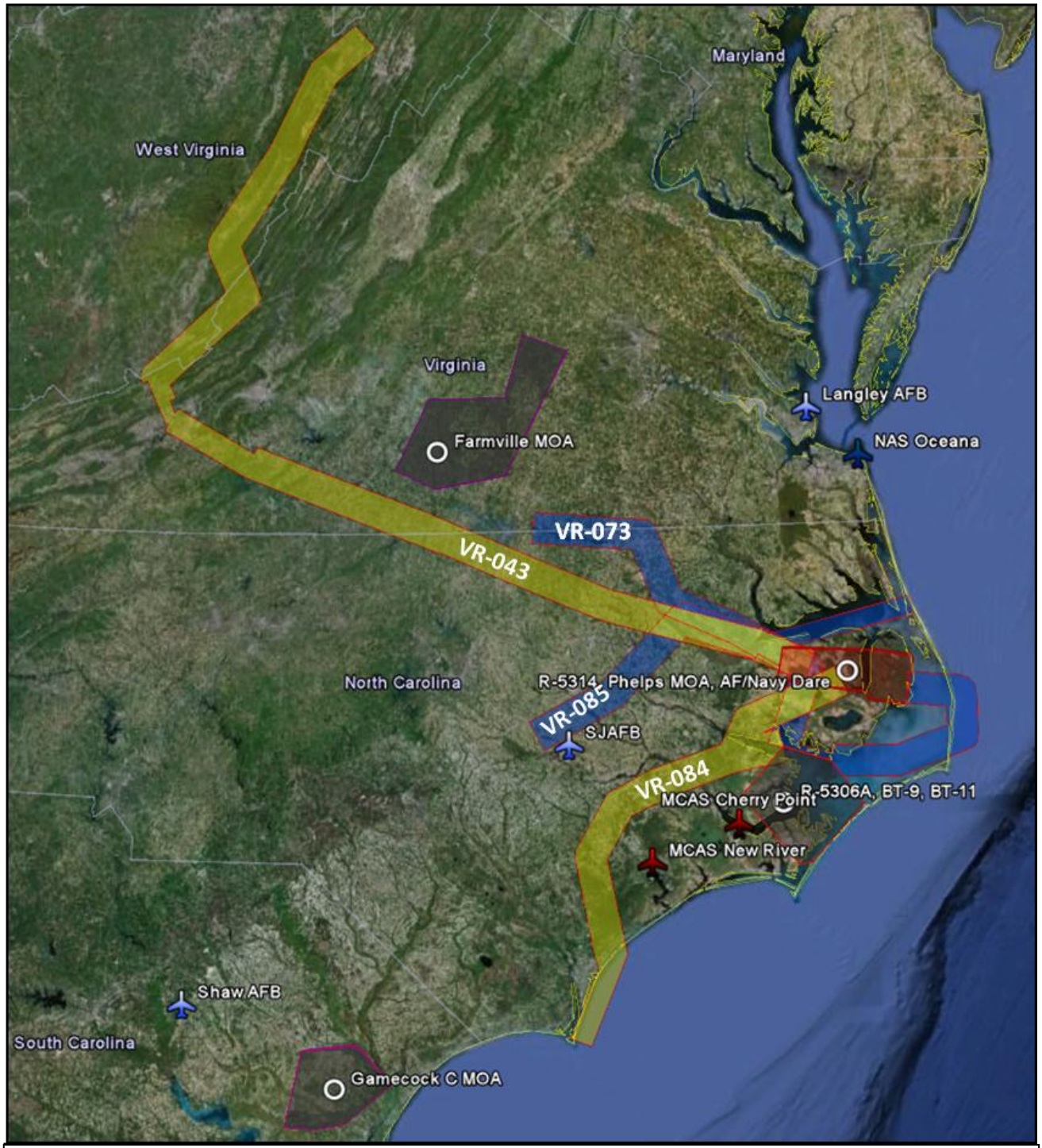
Restricted Area R-5314 with US Air Force Dare County Range (located in area A) and the US Navy Dare County Range (located within area D). The Phelps MOA is located on top of R-5314 areas C, F, H, & J raising the top altitude of those portions to 18,000' MSL.

Military Training Routes (MTRs) are utilized to carry out low-altitude tactical navigation and maneuvering training. Seymour Johnson AFB manages 13 such routes that extend over five states and stretch from the mountains of Tennessee and West Virginia to coastal North Carolina. Four of these routes feed into and terminate within R-5314. These four routes enable crews to fly a full mission profile including low-altitude ingress to low-altitude target attacks within the DCBR. The MTRs vary in width and height, but are generally 10 nautical miles wide and include altitudes from 100 feet AGL to 6,500 feet AGL. Currently, US Air Force F-15Es are restricted to no lower than 500 feet AGL on the routes. Many of the routes maintain a 100 foot AGL floor in the event that training to a lower altitude is required. Previously, several aircraft types were approved to fly as low as 100 feet on the routes.

MTRs were established over three decades ago to provide high performance military aircraft the ability to navigate at low-altitude and at high speeds. Aircraft often fly the routes at speeds approaching 540 miles per hour. The MTRs, though managed by Seymour Johnson AFB, are used by aircraft from all services, particularly aircraft stationed at MCAS Cherry Point, NC and NAS Oceana, VA. Other services and other USAF bases manage and maintain similar routes in their areas for use by their locally based aircraft.



Seymour Johnson AFB maintains 13 low-altitude Military Training Routes (in yellow) that stretch across NC, VA, WV, KY, and TN. Seymour also maintains four Military Operations Areas (in purple) for medium-altitude training.



Four of Seymour Johnson's MTRs feed directly into R-5314 providing the required low-altitude airspace for low-altitude ingress to low-altitude target attacks on Dare County Bombing Range.

The diverse locations of Seymour Johnson's MTRs ensure that crews are able to find both flat and mountainous terrain sufficiently clear of weather to accomplish training. This also ensures that the noise of low-altitude flight is spread across the area and not entirely focused on a single route. MTRs often have multiple entry and exit points, allowing crews the flexibility to use the portions of the route clear of weather or most appropriate for their training. MTR

airspace is not de-conflicted from civil traffic. Military crews flying the routes are responsible for maintaining safe separation from other air traffic that may be transiting through the route. De-confliction of the routes between military users is handled by the requirement for users to schedule the routes with the managing base.

Of critical importance to Seymour Johnson AFB are the four MTRs that feed into R-5314. Due to their proximity to Seymour Johnson and DCBR, as well as their ability to provide a seamless low-altitude route into R-5314, these four routes account for 61% of the 4th Fighter Wing's MTR utilization from 1 July 2011 through 30 June 2012. 4th Fighter Wing F-15Es utilized Seymour Johnson managed MTRs 6,013 times during that period, including 3,653 uses of the four feeder routes. In addition to F-15Es, other Department of Defense aircraft utilized Seymour Johnson's MTRs 4,894 times during that same period.

Of the four feeder routes, VR-043 and VR-084 are the two most utilized. Aircrew used VR-084 3,581 times between 1 July 2011 and 30 June 2012, making it the most heavily utilized MTR managed and scheduled by Seymour Johnson AFB. It is the only one that also provides low level entry into R-5306 for aircraft wishing to utilize the Marine Corps' BT-9 and BT-11 ranges. In addition, it is the only one of the four that runs near the coast and enters R-5314 from the south, often making it usable when weather conditions further inland and further north prevent flight on the other three MTRs that enter R-5314. An additional benefit of VR-084 is its close proximity to Seymour Johnson AFB, allowing all configurations of F-15Es to fly the route without the need for the F-15Es to carry external fuel tanks. This allows the F-15Es to keep mission durations shorter, using less fuel while still accomplishing necessary training.

VR-043 is the most versatile and unique MTR managed and flown by Seymour Johnson F-15Es. The route begins in the mountains of West Virginia, flows south into Virginia, and then turns east across southern Virginia and northern North Carolina and into the northwest corner of R-5314. With its diverse terrain and long distance, the route provides aircrew with challenging terrain combined with the ability to seamlessly flow into DCBR at low-altitude. VR-043 is the second most utilized route managed by Seymour Johnson AFB and was used 2,469 times between 1 July 2011 and 30 June 2012. Its long distance provides aircrew the opportunity to fully exercise the F-15E's low-altitude endurance capability.

The other two MTRs that enter R-5314 enter in the same area as VR-043. VR-073 and VR-085, like VR-084, are in close proximity to Seymour Johnson AFB and provide aircrew with training flexibility should weather or scheduling prevent use of or VR-043 or VR-084.

Likely Wind Turbine Impacts on Low –Altitude Military Training Routes

Wind turbines (most extending approximately 498 feet AGL) placed within MTRs will force aircrew flying at 500 feet AGL (the required altitude for most low-altitude training) to climb over the turbines to avoid potential collisions. Many wind farms extend for several miles, forcing aircrew to stay at a higher altitude for a longer period of time. This would effectively reduce the area within the MTRs available to accomplish 500-foot training. In the case of wind turbines placed within the four MTRs as they enter R-5314, the required climb over the top of the wind farms would interfere with the seamless flow at 500 feet into R-5314.

There are currently other structures (radio towers, cell towers, etc) and noise avoidance areas that restrict flight within the MTRs, however, most of these other types of obstructions

are relatively small and can be avoided laterally while remaining at 500 feet. The expanse of a wind farm, depending upon placement, may not allow for lateral avoidance and may demand avoidance by climbing.

An additional impact is that of the calculated Minimum Safe Altitude (MSA). Air Force Instructions require aircrew to calculate an MSA based on the highest obstacle within five nautical miles of their planned route. If aircraft encounter weather or a failure of the TF system at night, they must climb to the MSA in order to remain clear of all potential obstacles. In general, lower MSAs are desired, particularly in the event of weather. If the weather is clear enough to fly the route below clouds, the requirement to climb to MSA may put the aircraft into the cloud ceiling above and into instrument conditions, preventing sight of the ground or of other aircraft. Aircrew must then maintain that MSA, terminate their low-altitude training, and contact an air traffic control agency for service and routing back to an area of clear air if wishing to continue low-altitude training. In the event of a low enough MSA, the aircraft flying at MSA may be able to continue under visual conditions and descend back to 500 feet once safe to do so, continuing training. Depending upon the height of other obstacles in the area, wind turbines may require MSAs for MTRs to increase. In the case of the MTRs entering R-5314, 498 foot turbines would increase current MSAs by 100-200 feet.

A unique capability and mission of the F-15E is using its terrain-following radar. The TF radar scans the terrain ahead of the aircraft, providing inputs to the pilot or the aircraft's autopilot system to maintain a set altitude over terrain. Wind turbines can cause significant interference to this mission. Since the blades of the wind turbine are turning, it is impossible for the aircrew to know what portion (blade, turbine, tower, etc) of the structure the TF radar is "seeing." If the TF radar sees the turbine at approximately 340 feet, it may not see or command a climb over the tip of the turbine that reaches nearly 500 feet at the top of its arc. Aircrew will have to avoid wind turbines laterally to remain on TF at 500 feet, or climb over the turbines. Depending upon turbine placement within MTRs, climbing over them may be the only option. The F-15E is the only fighter remaining in the U.S. inventory that maintains and is required to train to a terrain-following radar capability.

Additionally, the presence of large numbers of turbines within an MTR poses a potential safety of flight hazard, primarily at night. Although aircrew would be aware of the location of turbines through mission planning, the remote potential exists for crews to miss the planned climb point to overfly the turbines and continue on TF into the wind farm. If the TF system does not receive a strong enough return to command a climb over the turbines, an aircraft flying at 500 feet could potentially strike a turbine blade, with the likely loss of two lives and a $31 million irreplaceable combat asset. Even if every turbine were lit, the blade tips themselves are not, and may not be seen through the night vision goggles worn by aircrew. Additionally, depending upon the type of lighting used and the number of turbines in the wind farm, the lighting could gain down the night vision goggles reducing the ability of aircrew to break out details in the scene. Night vision goggles have a narrow field of view, making it difficult for aircrew to see every potential hazard. Although every precaution would be taken to overfly the wind farms, the size of the wind farm and the number of turbines (anywhere from a dozen to more than 100) simply provides more potential obstructions and a higher risk of collision in the event of a chain of events leading to a crew not climbing to avoid a wind farm.

Likely Impacts of Wind Turbines on Low-Altitude Air-to-Air Intercept Training

Wind turbines have been demonstrated to have an effect on air-to-air intercept training. Based on the demonstrations and analysis done by the US Air Force to date, it is extremely likely that any wind turbines within R-5314 (or within 15 nautical miles of the western and eastern external perimeters and 10 nautical miles of the southern and northern external perimeters of R-5314) will have a significant adverse impact on low-altitude intercept training, possibly preventing such training from being conducted in R-5314.

Nascent US Air Force research has shown that turning windmills have a significant negative effect on the operation of air intercept radars of the type used by the F-15E. FTU training in particular requires a "clean" radar picture for student crews to work, and would be most severely affected. With the relatively small dimensions of R-5314 and the high speeds at which both the student formation and the target aircraft are moving, students have very little time to detect a target formation and then maneuver their own formations for an intercept. Any delay induced by a complex radar picture in this already compressed and challenging mission will result in ineffective training. R-5314 is the only airspace of the required size and altitude for Seymour Johnson aircraft to accomplish that training. Based on early data from flight demonstrations and the need to maintain a clean radar picture for student training, any turbines located within 15 nautical miles (10 nautical miles on the south or north) of the perimeter of R-5314 could severely impact low-altitude air-to-air intercept training.

In addition to the effects on low-altitude air-to-air intercept training, wind turbines within R-5314 would increase the eastern MSA from 1,400 feet to 1,600 feet. Although only a 200 foot difference, the change would be significant for training on DCBR. Air Force Instructions require weather no lower than 1,500 feet AGL to continue training. In the event the cloud base layer is at 1,500 feet, aircraft within R-5314 can currently descend to MSA (1,400 feet) and clear of the weather, continuing their work on the range. If the MSA were raised to 1,600 feet that option would no longer be possible since aircraft could not descend through the weather to get below the 1,500 foot requirement and determine if the weather was suitable to continue. A number of opportunities to get effective training would certainly be lost.

Conclusion

The construction of wind turbines inside or within 15 nautical miles of R-5314 (10 nautical miles on the north and south) and within MTRs will likely have significant impacts on Seymour Johnson AFB low-altitude training, particularly FTU training and safety of flight for all F-15E aircrew. The impacts are largely focused within three key areas:

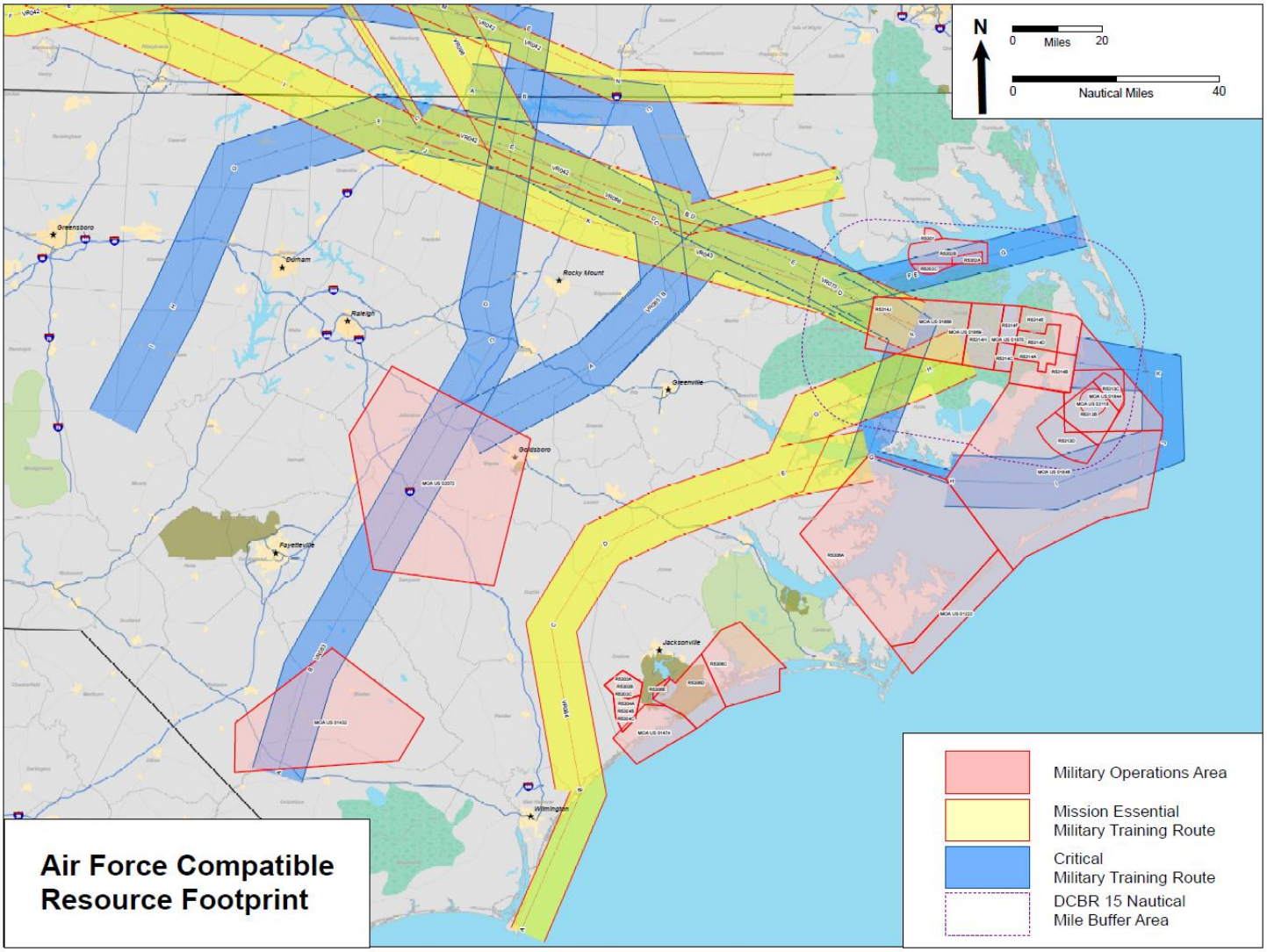
First, low-altitude air-to-air intercept training will almost certainly be severely impacted within R-5314, leading to the inability of Seymour Johnson AFB to accomplish specific syllabus and proficiency training requirements. There is no other suitable and available airspace within range of Seymour Johnson AFB that could be used for this training. With R-5314 unsuitable for low-altitude intercept training, Seymour Johnson AFB squadrons would have to deploy to other locations within the US, adding significant costs and time delays to aircrew training along with increased time away from home for 4th Fighter Wing personnel.

Second, wind turbines located within MTRs, especially the four MTRs feeding into R-5314 would certainly force crews to overfly the wind farms, interrupting required low-altitude tactical navigation and maneuvering at 500 feet AGL and preventing seamless 500 foot flight into R-5314 and Dare County Bombing Range. This interruption would be a significant distraction, taking away from the realism and intent of training at 500 feet. Approximately 60 percent of the 4th Fighter Wing's current low-altitude MTR training is conducted on the four MTRs feeding into R-5314. The relatively small airspace currently available on the east coast already reduces the flexibility and realism that is highly desired for high performance combat aircraft training. Adding additional restrictions to operating altitudes and maneuvering only further reduces the overall effectiveness of training, and in the end creates less capable and less proficient combat aviators.

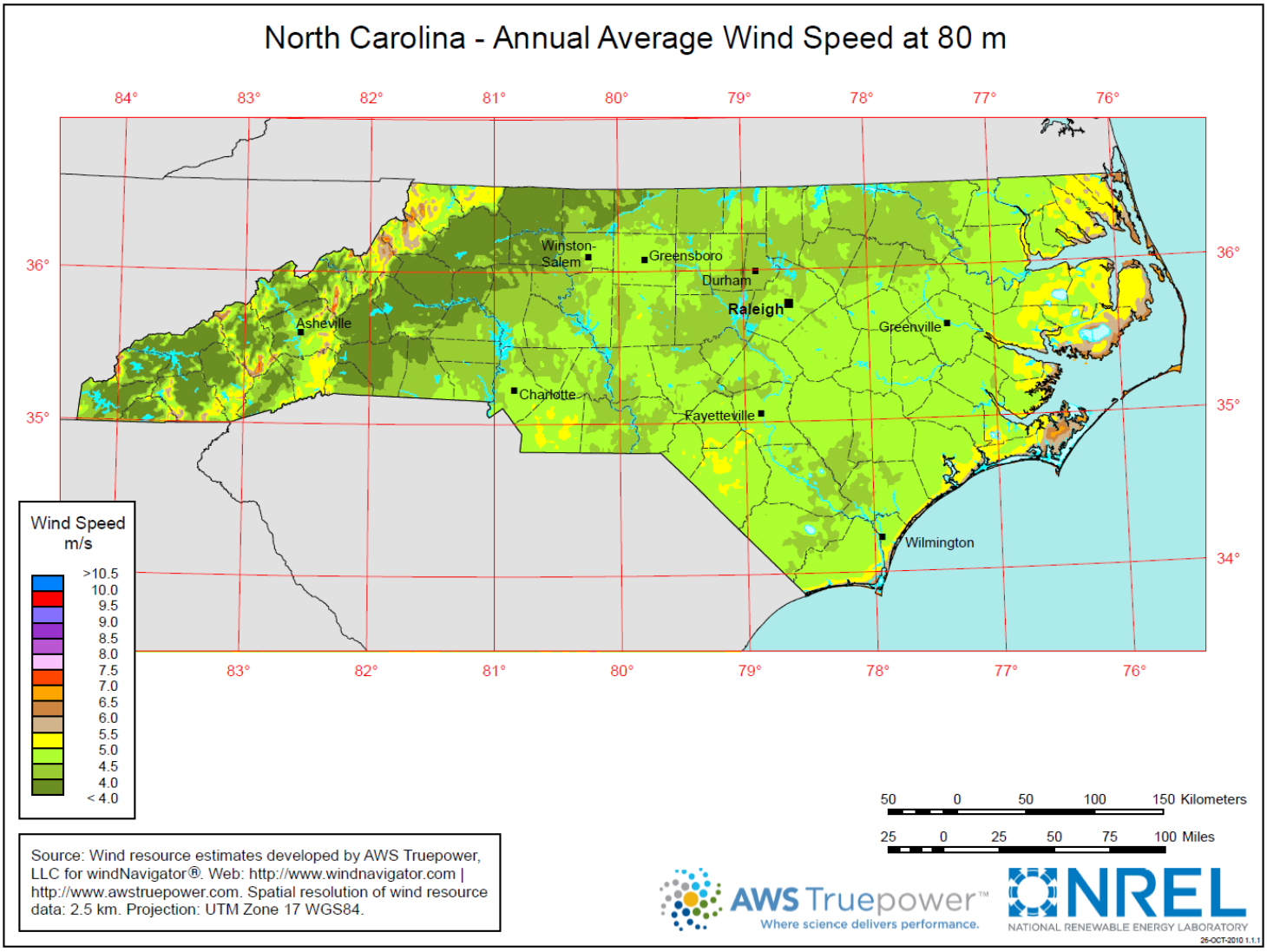
Third, adding significant numbers of additional obstructions within airspace heavily used by high speed military aircraft flying as low as 500 feet raises safety of flight risk, especially at night. Although many things can be done to minimize collision potential, a single wind farm with 50 turbines would multiply the number of 400+ foot obstructions within a typical MTR by a factor of five.

Although development of renewable energy is critically important for the United States and the State of North Carolina, care should be taken to understand the impacts of placing wind turbines in and around military training airspace. Unlike many other forms of energy, wind turbines can have a significant impact on individuals and organizations far from the parcels of land where wind farms are built. The 4th Fighter Wing wishes to ensure that all parties involved in planning and development of renewable energy are fully aware of the serious impacts wind turbines placed within and near low-altitude training airspace could have on the mission of the 4th Fighter Wing. Seymour Johnson AFB remains committed to working with local, state, and federal agencies and developers in an effort to cooperatively plan for the future while maintaining Seymour Johnson AFB's ability to accomplish required low-altitude training critically important to the continued combat readiness of the US Department of Defense.

Partial Map of Seymour Johnson AFB Critical Airspace

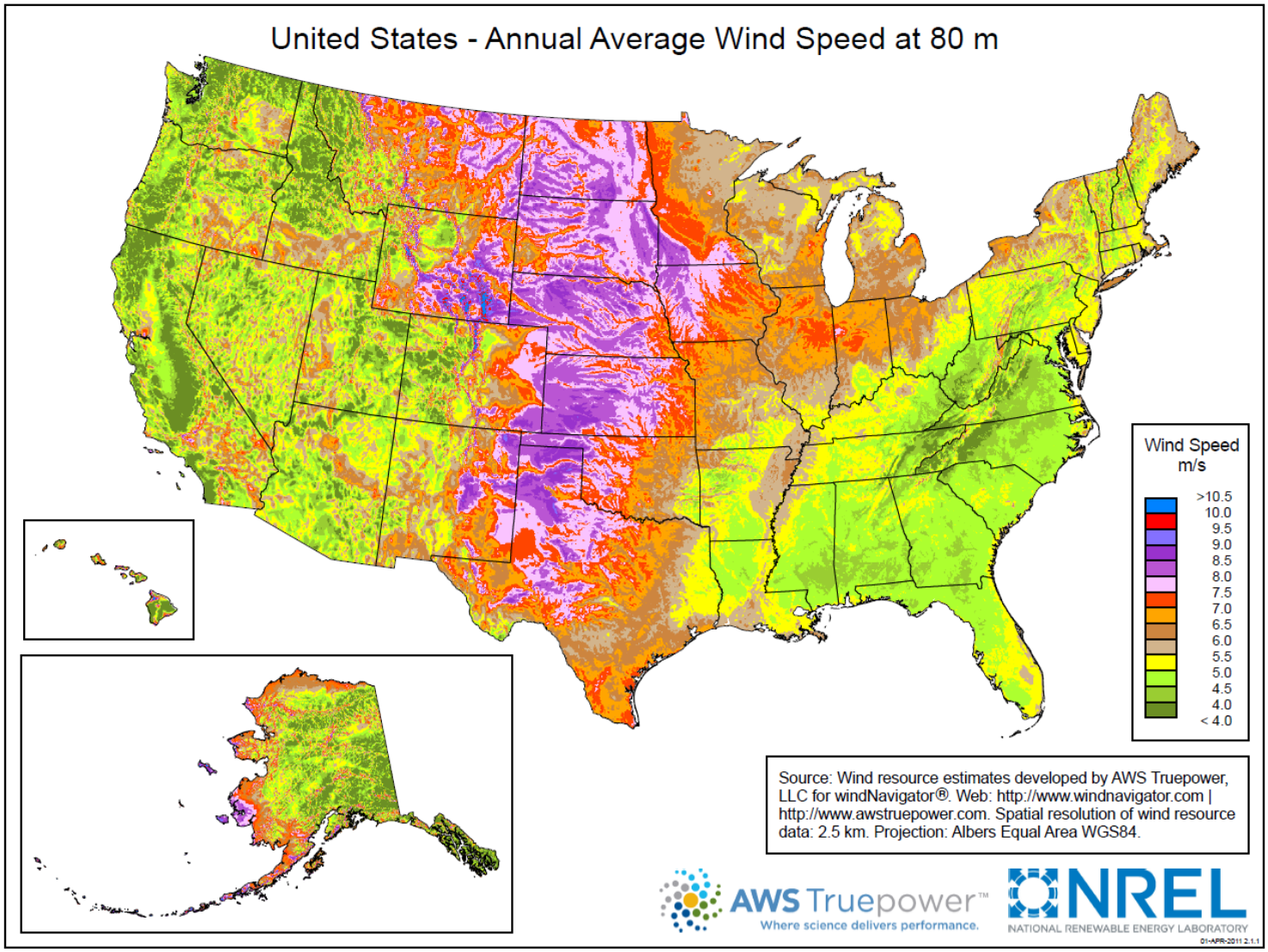


North Carolina 80 Meter Wind Map



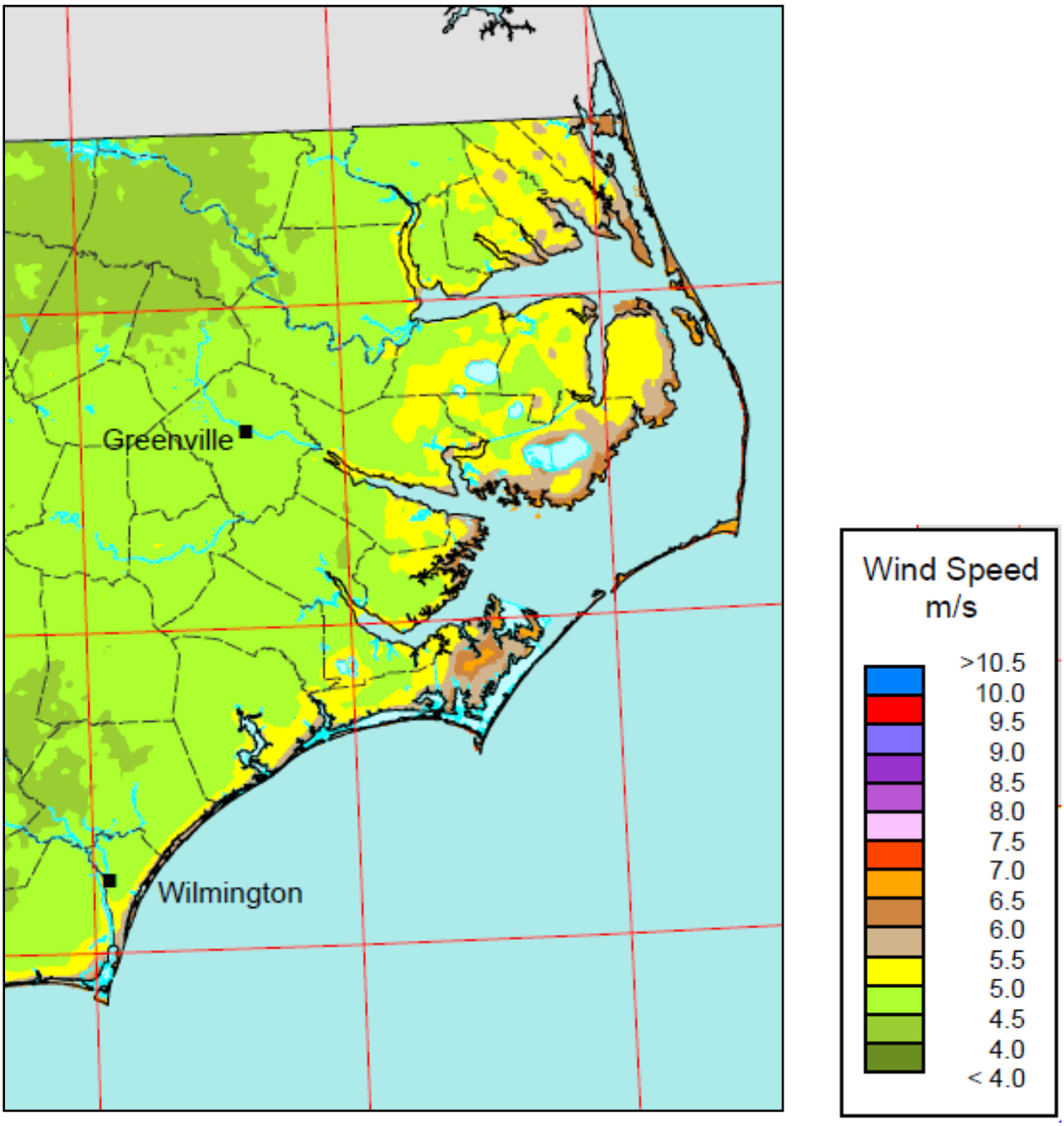
Source: http://www.windpoweringamerica.gov/wind_maps.asp

U.S. 80 Meter Wind Map



Source: http://www.windpoweringamerica.gov/wind_maps.asp

Eastern North Carolina 80 Meter Wind Map



Source: Wind resource estimates developed by AWS Truepower, LLC for windNavigator®. Web: http://www.windnavigator.com | http://www.awstruepower.com. Spatial resolution of wind resource data: 2.5 km. Projection: UTM Zone 17 WGS84.

Source: http://www.windpoweringamerica.gov/wind_maps.asp

Additional Information

For further information about Seymour Johnson AFB, the F-15E, or F-15E training, contact:

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