INDUSTRIAL SOLUTIONS LABORATORY

Company Information

Company Name	*RWE*	**Date Submitted**	*04/16/2024*
Project Title	*Design of a Wind Turbine Blade Bolt Monitoring (WTBBM) System (RWE_BOLT)*	**Planned Starting Semester**	*Fall 2024*

Senior Design Project Description

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills.

Discipline	Number	Discipline	Number
Mechanical	3	Electrical	1
Computer		Systems	1

Company and Project Overview:

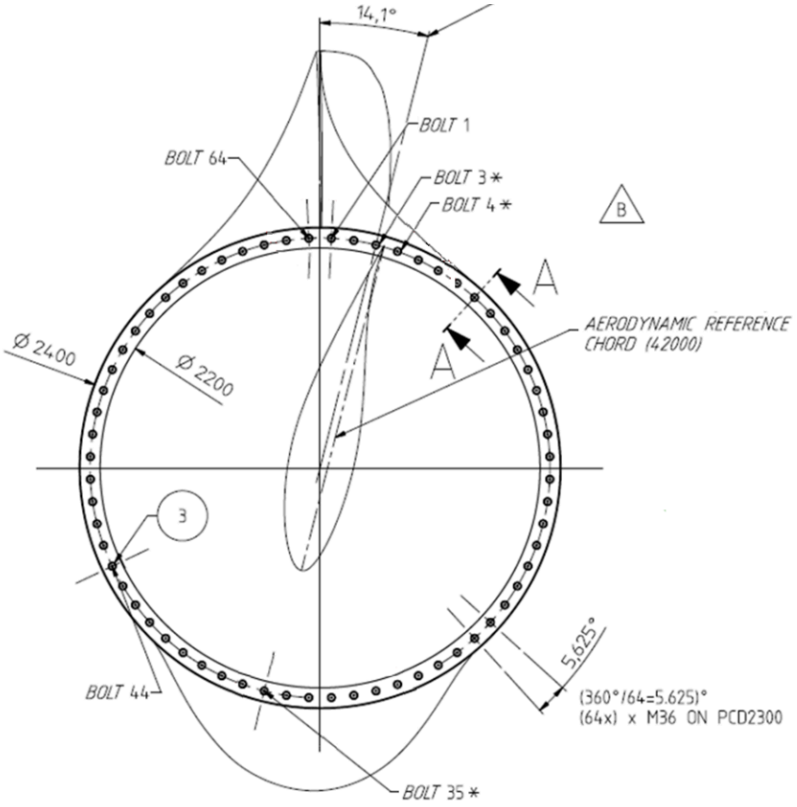
RWE Clean Energy, a subsidiary of RWE Group, is a top tier renewable energy company in the United States. RWE Clean Energy operates a renewable energy portfolio of about 8 gigawatts (GW) installed capacity of onshore wind, solar, and battery storage, making it the number four renewable energy company in the U.S. and the country's second largest solar owner and operator, present in the majority of U.S. states. As part of the RWE Group's Growing Green strategy to expand globally its green portfolio to more than 65 GW of installed capacity and to invest globally EUR 55 billion in the period from 2024 until 2030, RWE Clean Energy is determined to significantly increase its operating asset base in the U.S. This is backed by a project pipeline of more than 24 GW in onshore wind, solar and battery storage which provides for one of the largest development platforms in the United States.

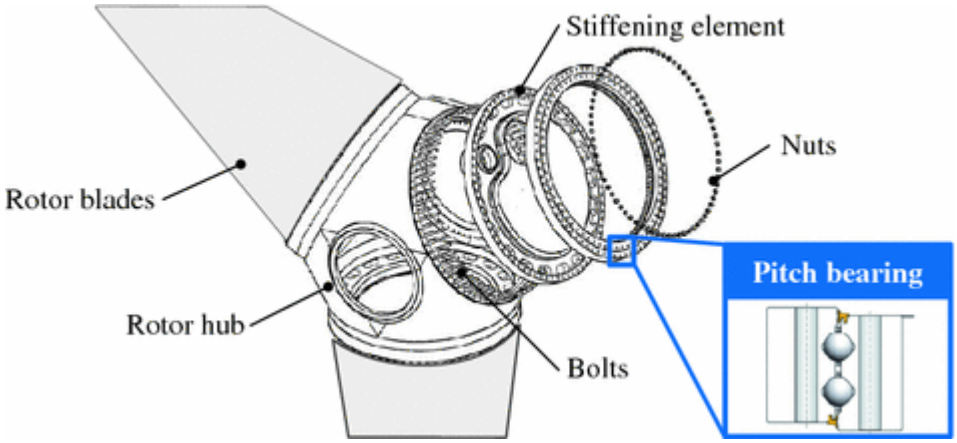
As a major owner and operator of wind turbines across the world, RWE Clean Energy has a diverse portfolio of different turbines manufactured by different Original Equipment Manufacturers (OEM). One particular turbine type is experiencing a significant amount of downtime and repairs associated with the failure of bolts that connect the blade to the pitch bearing. There are currently no sensors on the blade bolts to alert the operators when a failure occurs. Furthermore, broken studs and nuts can bounce around in the wind turbine hub during operation, leading to collateral damage to other equipment, such as hydraulic lines. This project will encompass creating a

detection system for a bolt failure and a containment system to prevent collateral damage inside the turbine hub.

Project Requirements:

A blade is connected to a pitch bearing by (64) M36 blade studs, with a Bolt Circle Diameter (BCD) of 2.3m per the drawing below:





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The blade studs are threaded into barrel nut that is embedded into the composite root of the blade. The stud penetrates a hole in the pitch bearing. The joint is clamped together using a hydraulic tensioner. Typically bolts nearest the Trailing Edge (TE) and Leading Edge (LE) of the blade have a higher failure rate, however bolts have been known to fail throughout the circumference of the blade.

The goal of this project is to design and create operational prototype system for the blade bolts. The prototype system shall:

1.) Detect when blade bolts fail and either trigger a fault or sound an audible alarm to alert operators of a bolt failure
2.) Have a retaining feature to capture the broken studs to prevent collateral damage in the turbine
3.) Material cost of the design shall not exceed $3000 per turbine
4.) Maximum weight of the design shall not exceed 200 lbs per turbine
5.) Design must be capable of being installed on all 3 blades of a turbine within 4hrs by 2 workers
6.) The Design must be segmented for installation (i.e. cannot be a full hoop solution)
7.) The Design must be easily removed to allow for the replacement of bolts
8.) The Design must be capable of installation without any special tools

Expected Deliverables/Results:

- Mechanical drawing of design (electronic format OKAY)
- Electrical schematic of sensor circuit (electronic format OKAY)
- BOM for all purchased components (electronic format OKAY)
- 1 prototype sensor
- Description of set-up to test the retention solution at UNC Charlotte
- Description of set-up to test the sensor at UNC Charlotte
- Report of the testing results

Disposition of Deliverables at the End of the Project:

Students will return all operational prototypes to RWE after their exposition. They may keep copies of the design products (drawings, schematics, BOMs, etc.).

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):

- Mechanical Design
- General understanding of dynamic systems – both electrical and mechanical
- Basic circuit design and assembly capability