

Senior Design Project Description

Company Name	<i>Duke Energy – McGuire</i>	Date Submitted	<i>7/31/2020</i>
Project Title	<i>7KV Switchgear Digital Relay Upgrade – Phase 2 (DUKE 7KV2)</i>	Planned Starting Semester	Fall 2020

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		Electrical	3
Computer	1	Systems	0
Other ()			

Company and Project Overview:

Duke Energy is one of the largest electric power holding companies in the United States, providing electricity to 7.7 million retail customers in six states. We have approximately 51,000 megawatts of electric generating capacity in the Carolinas, the Midwest and Florida – and natural gas distribution services serving more than 1.6 million customers in Ohio, Kentucky, Tennessee and the Carolinas. Our commercial business owns and operates diverse power generation assets in North America, including a portfolio of renewable energy assets. We are transforming our customers' experience, modernizing our energy grid, generating cleaner energy and expanding our natural gas infrastructure to create a smarter energy future for our customers.

The McGuire Nuclear Station is located on Lake Norman in Huntersville NC. There are two pressurized water reactors on site that started operation in 1981. Station capacity is 2,386 megawatts.

Phase 1 of the project was a two semester project to create a dynamic electrical model in ETAP of the plant's 7KV distribution system then compare the results of the study. Completed Spring 2020

Phase 2 of the project is a two semester project to use the models from Phase 1, existing plant calculations, drawings and relay settings to upgrade the existing relay protection scheme for the 7KV switchgear to digital multifunction relays. Phase 2 will be a follow-on project which will start in Fall 2020.

Project Requirements:

Phase 1 Completed Spring 2020.

1. Model McGuire Nuclear Station's eight 7KV switchgears in ETAP, including
 - a. Five 7KV pump motors per switchgear under various load conditions, including one 7000 HP reactor coolant pump with 7.5 ton fly wheel.
 - b. Effects of various load conditions from 4KV bus using existing ETAP models, on four of the eight switchgears
 - c. Various load conditions of down stream 7KV/600V transformer, three per switchgear
 - d. Effects of generator/grid transients on 7KV switchgear
2. Use dynamic model to validate coordination of relay settings for each type of load, 9 total, and one incoming feeder breaker.

Phase 2

1. Evaluate protection scheme and models from Phase 1 for improvements by upgrading to digital relays.
2. Create business cases for options and relay schemes. Design budget is \$260,000 for 2021-2022 and \$1.6 million for equipment and installation in 2023. Include options:
 - a. Replace all analog overcurrent relays with new equivalent models and determine an analog replacement for existing reactor coolant pump motor timed overcurrent relay.
 - b. Replace all analog relays with digital.
 - c. Replace all analog relays with digital in 2/2 logic scheme, consider using two different manufactures to prevent common mode failure. Include selector switch for Relay 1, Relay 1 & 2 and Relay 2
 - d. Hybrid option to upgrade to digital relays on more complex protection schemes and perform a simple replacement on the analog relays.
3. Present business case to McGuire Plant Health committee for direction of desired design option in Late October/Early November.
 - a. For the purpose of the project, if the Plant selects Option A which would not involve a design change, the students will design for option D for their final project
4. Create setting files and logic for digital relays including
 - a. Protection settings for motors and load centers
 - b. Control settings for hot bus transfer utilizing Reactor Coolant pump motor coast down to prop up system voltage long enough swap from a faulted Normal source to the Alternate source.



UNC CHARLOTTE

The WILLIAM STATES LEE COLLEGE of ENGINEERING

5. Use Phase 1 generated models to create Comtrade files for electrical testing of protective relays using signal injection test set
6. Perform functional tests on relays utilizing generated Comtrade files and signal injector.
7. If time allows, propose design drawing changes required to implement upgrade.

Expected Deliverables/Results:

- Per above

Disposition of Deliverables at the End of the Project:

Provide to the supporter at the conclusion of the Expo.

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

Team requirements:

- US Citizenship required for all team members due to security requirements for nuclear power plants.
- One or more members with experience in protective relaying. Internships with SEL, Beckwith, ABB or Transmission/Distribution preferred.
- It is desired to have a systems engineer or team member with a background in project management/finance and a basic understanding of electrical principals.

Course Work Prerequisites

- ECGR 3142 - Electrical Energy Conversion, Required for one or more members
- ECGR 4143 - Electrical Machinery, Required for one or more members
- ECGR 4141 - Power System Analysis, Required for one or more members
- ECGR 4142 - Power System Analysis II, Desired