UNC CHARLOTTE
The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

UNC Charlotte – Lee College of Engineering Senior Design Program

Senior Design Project Description

Company Name	*Duke Energy – Fleet Electrical Analysis*	**Date Submitted**	*10/25/2019*
Project Title	*Brunswick Battery Calculation Conversions* **(DUKE_ETAP)**	**Planned Starting Semester**	Spring 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	4
Computer		Systems	
Other ( )			

Company and Project Overview:

Duke Energy is one of the largest electric power holding companies in the United States, providing electricity to 7.6 million retail customers in six states. Duke Energy has approximately 49,500 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. Duke Energy generates power from a number of sources including Nuclear.

In a nuclear station the vital battery system is required to power plant control equipment during serious events that require the Unit to be put in a safe condition. Chargers and batteries are sized to meet the load flow needs and time duration of the DC control system's various loads (breaker charging motors, MOVs, lights, etc.) to ensure operation during those serious events. This is referred to as the duty cycle of the DC system (sequence of operation, duration, size of load of components). Calculations document the evaluation of this duty cycle to ensure that the batteries and charger are sized appropriately. Modern DC analysis software (i.e. ETAP) can make this analysis routine and intuitive. However, since analyses were performed many years ago they utilized spreadsheets and DOS programs which have become cumbersome and obsolete. Modifications to a plant's DC system components are expected over time to make various improvements and upgrades. The subsequent calculation revisions to show these modifications are difficult and time consuming due to the dated software they are built in.

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Project Requirements:

This project will serve to convert the evaluation from outdated software to the industry preferred software, ETAP. Provided inputs will include calculation files, electrical diagrams and the raw data to be converted. The team will benefit from an understanding of DC power systems and the data or computer science skills to accurately map fields from the old data format into something that can be used by the ETAP Data Exchange module and provide reliable calculation results.

Expected Deliverables/Results:

Phase 1 (building ETAP files):

Inputs will be data in text files, system diagrams, calculations

1. Develop ability to transfer necessary duty cycle and battery discharge attributes to ETAP
2. Develop ability to transfer necessary control system attributes to ETAP
3. Using ETAP Data Exchange, provide ETAP model (for use in Phase 2)

Deliverables (can be combined with Phase 2 deliverables):

a. A template which shows the mapping for data from outdated software into ETAP. Proof of concept will show that small changes to input parameters/attributes carry though to final product as desired
b. Documentation of method, process and assumptions
c. Document results: comparison of old and new inputs (criteria: new should = old)
d. ETAP Model with files

Phase 2 (performing ETAP analysis):

1. Perform DC Pro Model Brunswick 125/250 VDC Vital Battery System into ETAP utilizing best practices of ETAP Nuclear Utilities
    a. Develop DC Duty Cycles for 14 - 125VDC Panels.
    b. Develop DC Duty Cycles for 4 – 125/250VDC Panels
    c. Develop DC Duty Cycle for 2 - 250VDC Panels

2. Develop DC sizing, DC Short Circuit, and Battery Charging calculations

3. Perform Voltage drop calculation for the control devices on the DC Panel Boards
    a. Develop DCSDM circuits for 14 – 125VDC Panel Circuits
    b. Develop DCSDM circuits for 4 – 125/250VDC Panel Circuits
    c. Develop DCSDM circuits for 2 – 250VDC Panel Circuits

Deliverables (can be combined with Phase 1 deliverables):

a. Documentation of method, process and assumptions

b. Document results: comparison of old and new results (identify significant differences)
c. ETAP model with output reporting files

Disposition of Deliverables at the End of the Project:

No hardware development planned. Reports and software outputs to be provided to Supporter after Expo.

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

- US Citizenship required due to security requirements for nuclear power plants.
- Phase 1 - One or more members with experience in system modeling. ETAP software for electrical system model.
- Desirable Course Work
  - ECGR 3142 - Electrical Energy Conversion, Required
  - ECGR 4141 - Power System Analysis, Required
  - ECGR 2254 - Analytical Foundations of Electrical and Computer Engineering, Desired
  - ECGR 4142 - Power System Analysis II, Desired
- Data skills desired to provide a conversion product (phase 1)