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# 138kV/ 13.8kV Substation

PROJECT PLAN

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# 1 Introduction

## 1.1 PROJECT STATEMENT

The purpose of this project is to design a 138kV / 13.8kV distribution substation that safely steps down voltage for distribution lines.

## 1.2 PURPOSE

A distribution substation steps high voltages from transmission lines down to lower voltages for distribution lines. The lower voltages of distribution lines can be supplied to buildings much more easily and safely.

## 1.3 GOALS

The goals for this senior design project are as follows:

- Design and refine a 138kV / 13.8kV substation one-line and three-line diagram
- Create a protection plan for the substation
- Plan the layout for the substation control house
  - Panel Layouts
  - Wiring Diagrams
- Create a final presentation of the design to be presented to Black & Veatch

# 2 Deliverables

To meet our goals for this project, we have the following list of deliverables:

- Develop a Gantt chart and man-hour budget for the project
  - Man-hour budget should track actual hours in comparison to predicted hours
- Based on the protective relay scheme identified by Black & Veatch:
  - System one-line diagram
  - System three-line diagram
  - Protection and control schematics
  - Wiring diagram and panel layouts
- Materials List
- Weekly teleconference with Black & Veatch
  - Weekly progress report & meeting minutes
  - Weekly meeting agenda in advance of meeting
- Project Design Review
- Final Presentation to Black & Veatch

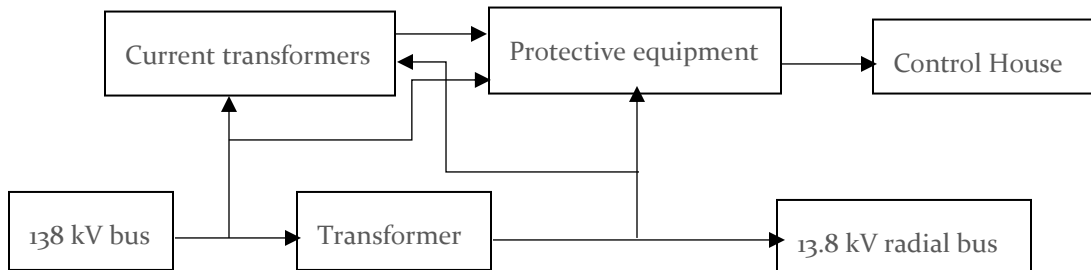
### 3 Design

To design this substation, we are taking a preliminary one-line diagram provided by Black & Veatch and modifying it to suit our design needs. We will also create a three-line diagram from our final version of the one-line diagram, as well as a wiring diagram for the system protection and controls.

#### 3.1 PREVIOUS WORK/LITERATURE

As common as distribution substations are in the world today, we have a lot of information at our disposal for this project. Black & Veatch is our primary source of information, and they have provided us with many preliminary drawings, as well as a PowerPoint explaining various concepts we can use for the one-line and three-line diagrams.

#### 3.2 PROPOSED SYSTEM BLOCK DIAGRAM



#### 3.3 ASSESSMENT OF PROPOSED METHODS

We are taking an approach to our design project that involves laying out our schedule first with a Gantt chart and man-hour budget, and then creating one-line and three-line diagrams, wiring diagrams, panel layouts, and control schematics in AutoCAD. Since we are working with Black & Veatch, we are using an approach very similar to their own.

#### 3.4 VALIDATION

Since we will only be designing a substation, and not building it, we will be using our weekly teleconferences and final presentation with Black & Veatch to validate our design. Black & Veatch has a wealth of experience with distribution substations that we will be using not only for guidance, but also for confirmation that our design project is successful.

## 4 Project Requirements/Specifications

### 4.1 FUNCTIONAL

The technical requirements for this project include designing a distribution substation to convert 138kV to 13.8kV using a radial bus system, and the panel layout, protection and control schematics, and wiring diagrams that go along with it. All of the functional components for this project will be designed in AutoCAD.

### 4.2 NON-FUNCTIONAL

The biggest non-functional component of this project is weekly meetings with Black & Veatch via Google Hangout to provide updates on our progress, with meeting agendas beforehand and meeting minutes after. The other non-technical deliverables include a Gantt chart, man-hour budget, materials list, and final presentation to Black & Veatch.

### 4.3 STANDARDS

The standards for our design project are based on the 2014 NFPA National Electrical Code. I seriously doubt anything in our design project will be considered unethical, given the necessity for electrical power we have in today's society and the multitude of distribution substations that have already been built. The applicable standards for our project are those concerning electrical fire safety in the event of things like lightning strikes or equipment failure.

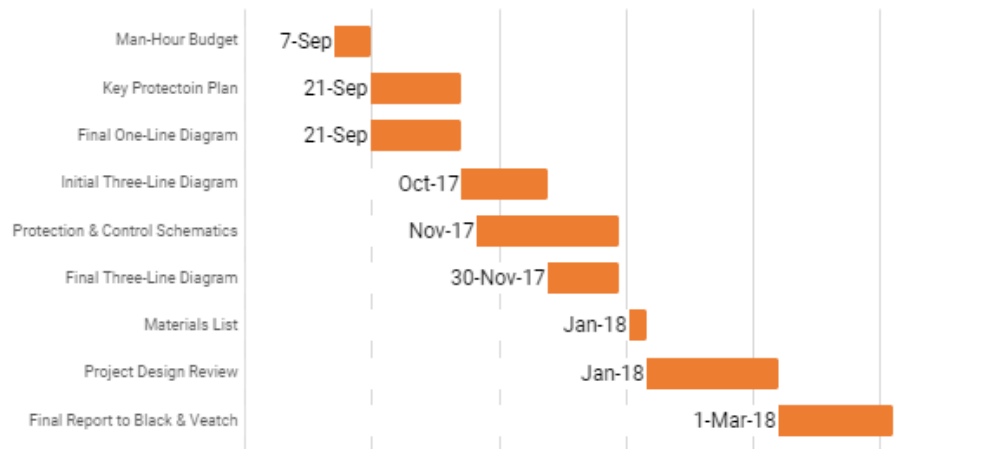
## 5 Challenges

One challenge our group will have is using AutoCAD to complete our designs. We are mostly new to AutoCAD, so we have a lot to learn for that portion of our project. Two challenges we can omit entirely are cost and materials. We are designing, but not building, a substation with Black & Veatch, so we can use the free CAD software available to us through Iowa State to omit the cost portion, and there will be no physical materials involved in the project.

## 6 Timeline

The timeline for our project is outlined in the following Gantt chart:

138/13.8 kV Substation Senior Design Project Gantt Chart



### 6.1 FIRST SEMESTER

For the first semester of our senior design project, we are developing a Gantt chart and man-hour budget for the project. We are also finalizing the one-line diagram of the substation, as well as our key protection plan for the substation. Lastly, we will be starting the three-line diagram of the substation and the schematics for protection and control.

### 6.2 SECOND SEMESTER

During the second semester of our design project we will be finalizing the three-line diagram of the substation, as well as the protection and control schematics. We will be developing a materials list for the project, and send our design to Black & Veatch for review. With feedback from Black & Veatch, we will make any necessary changes to our design and create a presentation for Black & Veatch of our final design.

## 7 Conclusions

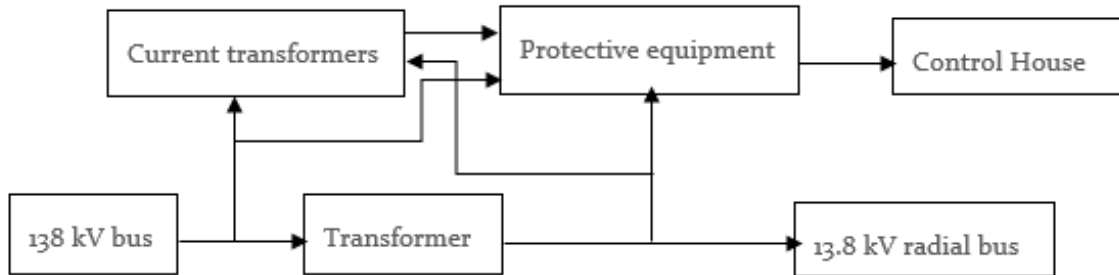
In conclusion, we are tasked with designing a substation and all the protection, controls, wiring that goes along with it. In addition, we are to develop a schedule for the design project with a Gantt chart and man-hour budget. After all this, we will have our design reviewed so that we can make any necessary changes, and then present our final design to Black & Veatch.

## 8 References

Our references for this project were provided by Black & Veatch and include a reference powerpoint with details on electrical and safety components of the substation, a preliminary one-line diagram for the substation, and the 2014 NFPA National Electrical Code. Our final design will be built on the skeleton that is the initial one-line diagram and will meet the standards outlined in the National Electrical Code.

## 9 Appendices

System Block Diagram:



Gantt Chart:

138/13.8 kV Substation Senior Design Project Gantt Chart

