EE 491 – sdmay19-26
115kV / 34.5kV SOLAR POWER PLANT/SUBSTATION DESIGN PROJECT
Week 9 Report

Monday (10/29/2018) – Sunday (11/4/2018)
Client: Black & Veatch
Advisor: Venkataramana Ajjarapu
Team Email: sdmay19-26@iastate.edu

Team Members:

Katayi Katanga – Communication Leader
Nur Shuazlan – Meeting Scribe
Yao Cheah – Website Manager #1
Ahmed Sobi – Team Leader/Layout Designer #1
Chufu Zhou – Website Manager #2/Layout Designer #2
Tam Nguyen – Report Manager

Weekly Summary:

In this week, we had a meeting with the client, and we talked about array wiring diagram, conductor sizing and type, voltage drop calculations, collector AutoCAD and parameters calculation, and feeder drawing. Then, we started working on the key protection diagram, and concept presentation for our advisor.

Summary of Client/Advisor Meeting:

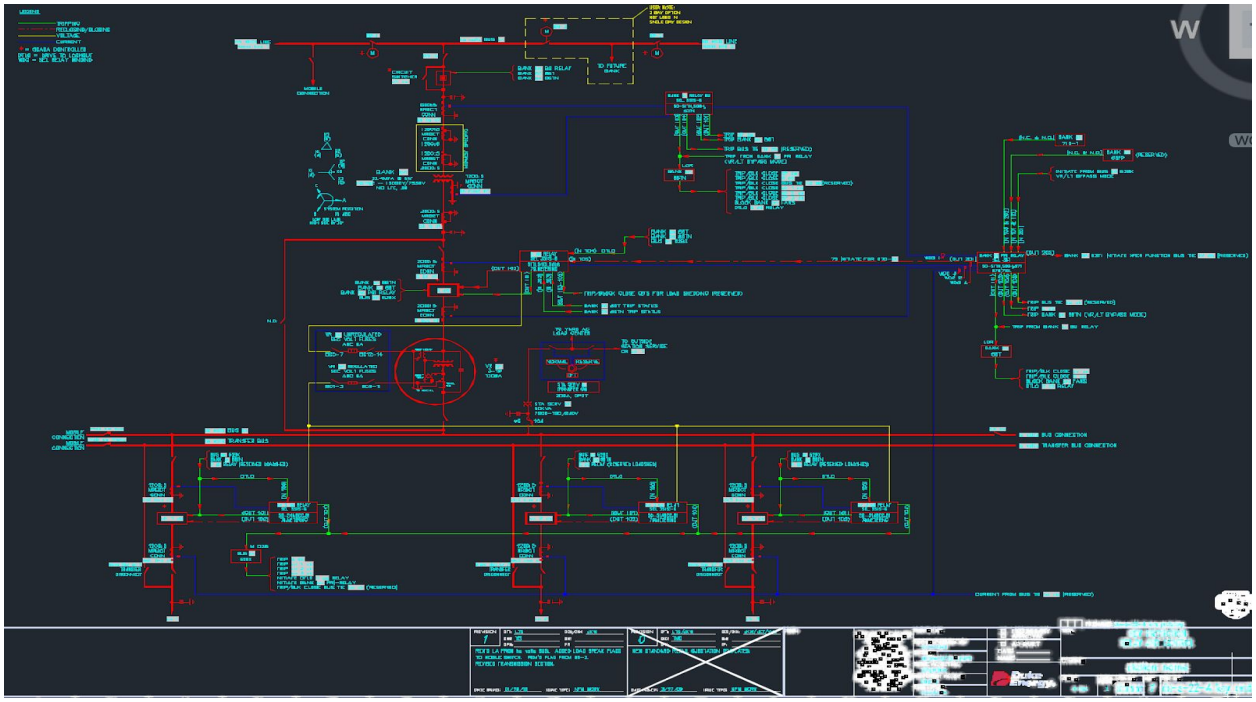
- Katayi did safety moment about how to safely reset a household circuit breaker.
- We talked about the Array/Solar Plant Wiring Diagram and Conductor Sizing. Katayi discussed our final array layout and how each component in the array is wired and connected. She also presented the average worst-case DCB voltage drop percentage and the wiring diagram of our entire solar power plant. Then, she explained how we did the conductor sizing for every cable that is used in the solar plant, including the IMP of each cable.
- Then, we talked about the collector. We presented the collector drawings based on calculations. The client wanted us to review the calculations and ensure that the inverter can handle that amount of current. The client also requested the students redo the AutoCAD drawings to make things more visible.
- Lastly, we talked about Collector & Feeder AutoCAD and Parameter Calculations. Ahmed presented calculations for the collector using equations found online. The single inverter skid output current is 30.64A. The output of the transformer will be collected with 8 AWG copper conductor and another collector with 1 AWG size will collect and combine all the current and deliver it to the feeder.

Past Week Accomplishments:

In this week, we did two things, starting working on key protection diagram and preparing the concept presentation for our advisor.

- **Key Protection Diagram**:

We looked at the key protection diagram and come up with the questions about feeder, transformer in a circle, and capacitor bank.

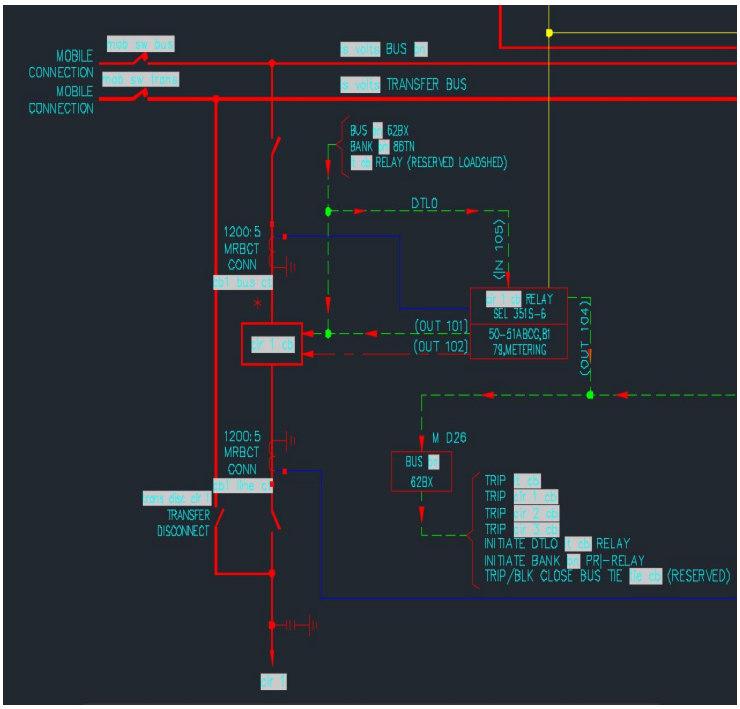


Single feeder components:

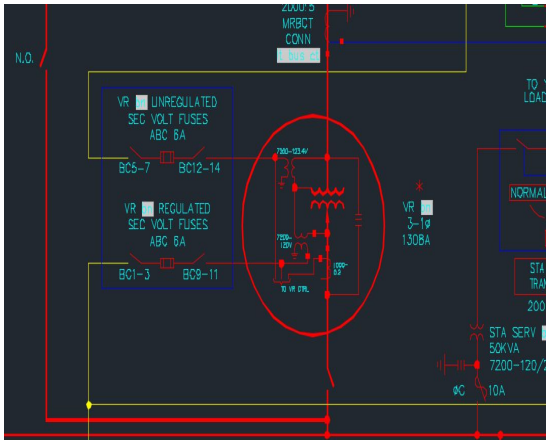
- Transfer disconnect switch
- Circuit breakers
- Protection relays

Questions:

- How does the transfer disconnect bus work? Is it at the same voltage level as the 34.5 kV bus?
- What is the mobile connection? How does it work?
- Why some relays have metering and other don't?

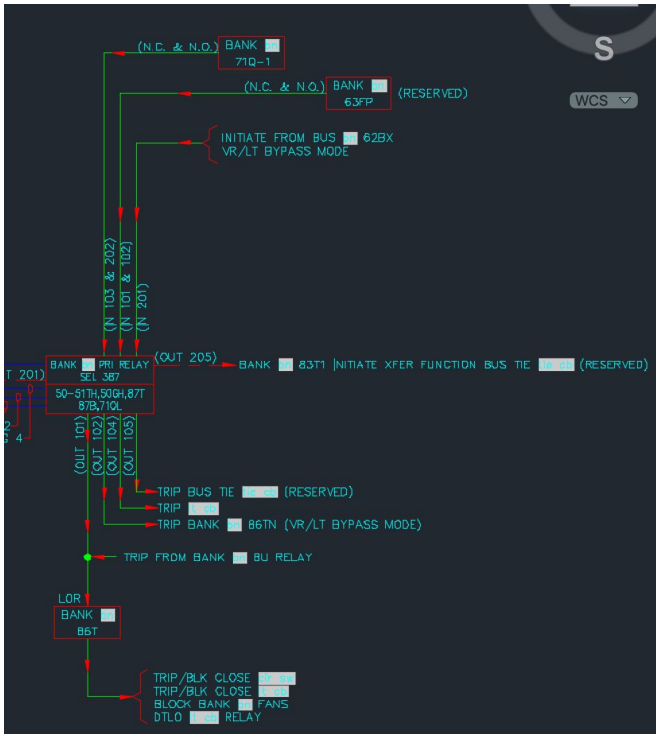


The transformer in the circle:
What is happening in the circle? What does the transformer represent?



Capacitor banks:
- Set of many identical capacitors connected parallel
- Power factor correction and substation protection
- Reduction of the phase difference between voltage and current.

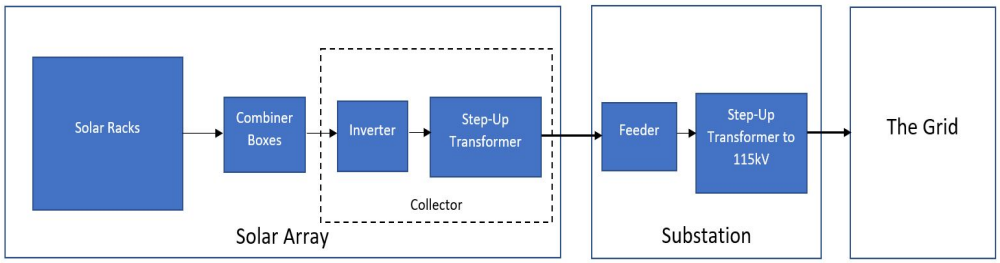
Question:
- What is a trip bank?



- **Concept Presentation:**

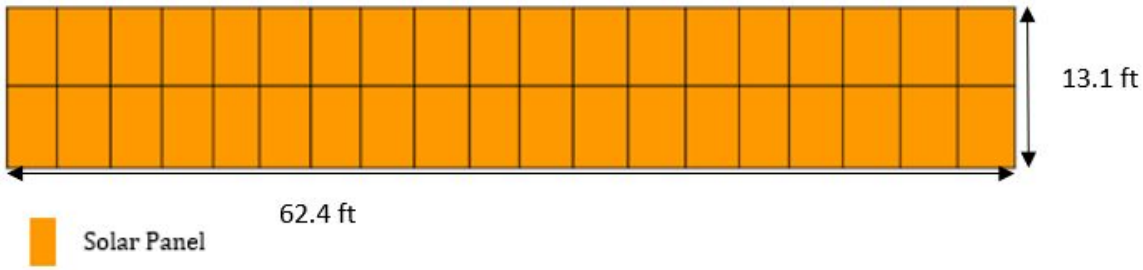
Nur Shuazlan & Katayi Katanga

- Power flow from generation to transmission:

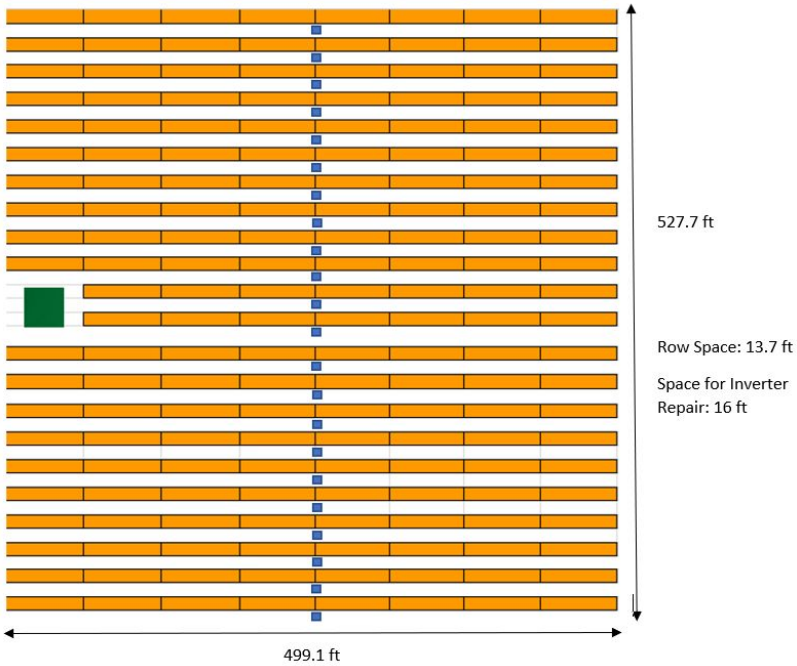


- Single Rack Layout (2x19 Panels)

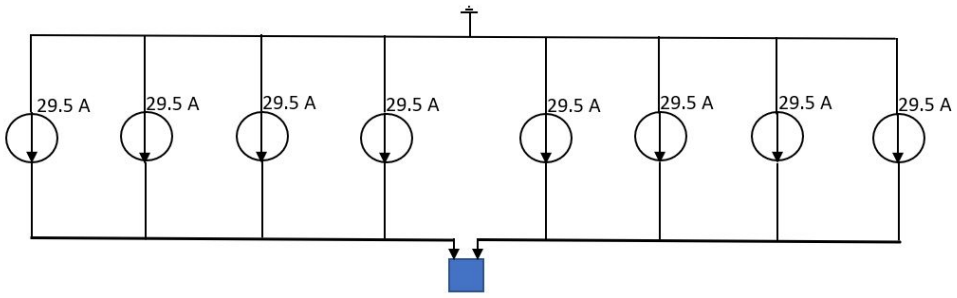
- Solar Rack:



- Single Array Layout (6x6 Arrays)



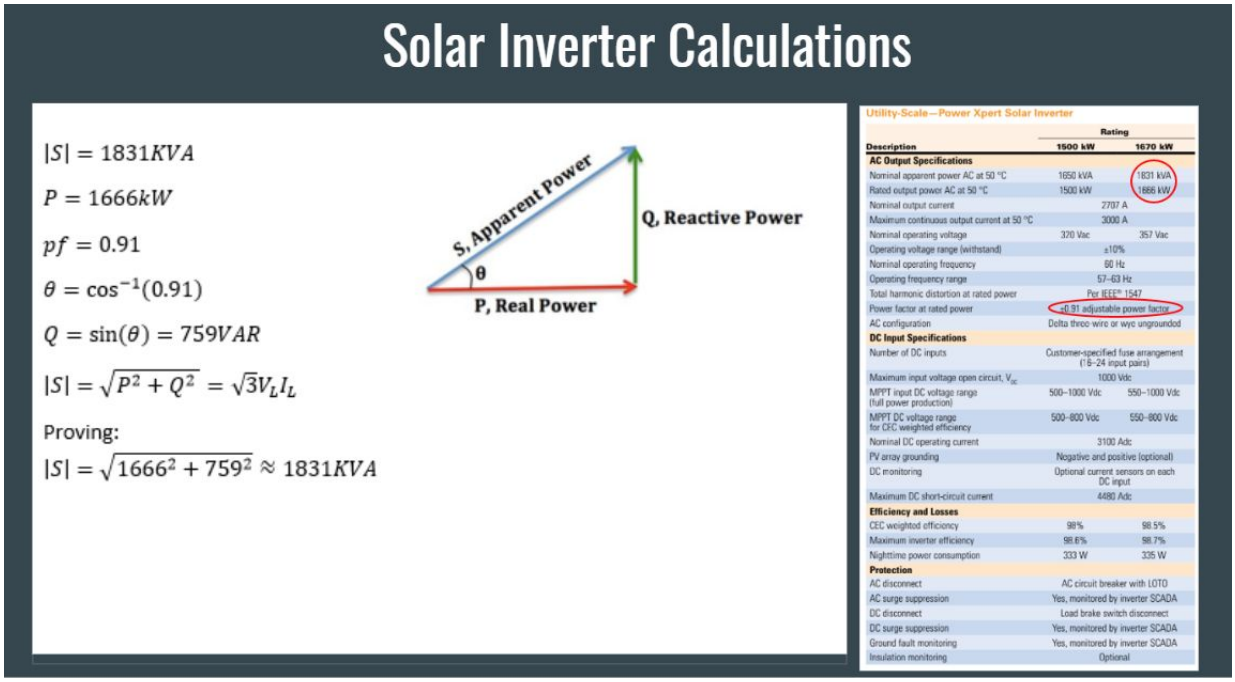
- Circuit model of a row of racks connected to a combiner box



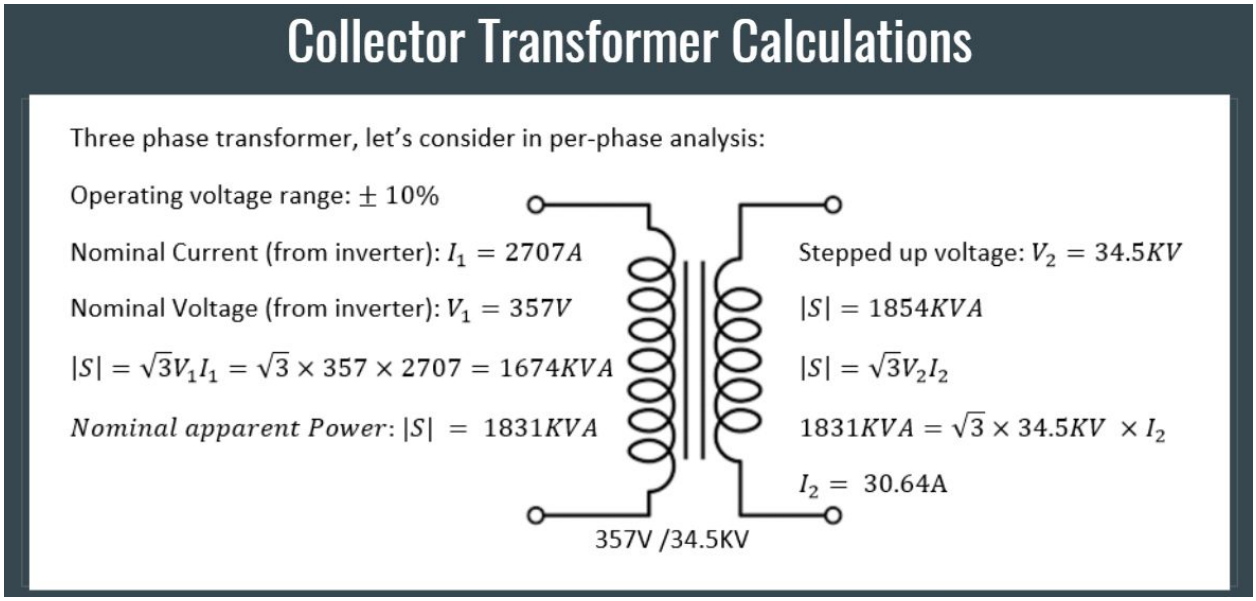
- What's a combiner box? How many do we have? How many inputs does a combiner box have?

Yao Cheah

- Solar Inverter Calculations: Did explanation about the relationship between real power, apparent power, and power factor ratio that are being mentioned on the solar inverter datasheet.



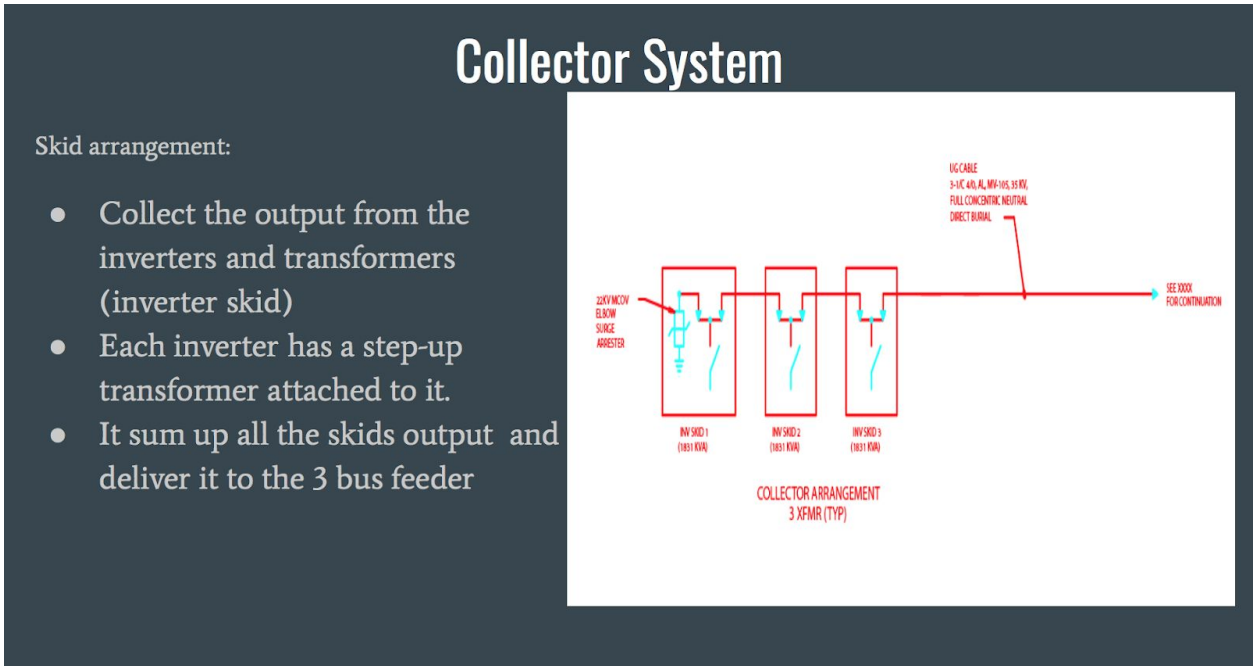
- Calculation for the step-up transformer in the collector.



- Researched about the relationships between wire size and wire type on its resistance value.

Ahmed Sobi, Chufu Zhou

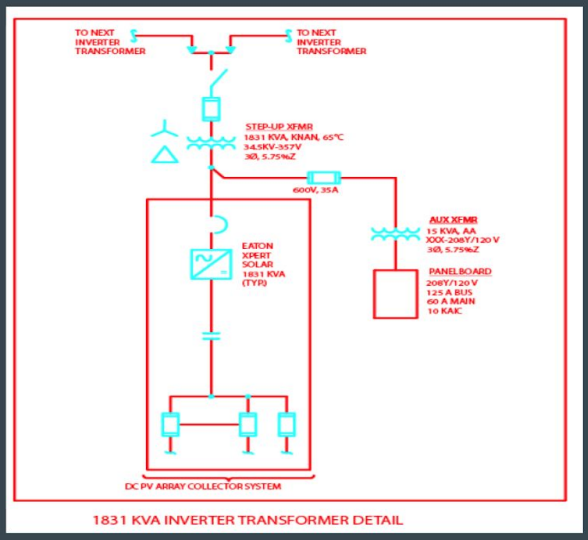
- Understanding the key protection diagram
- Recognize the key components of the key protection diagram
- AutoCAD modification to the key protection diagram
- We worked on the Advisor presentation to show our progress and understanding of the project so far
- Worked on the collector system concept



Collector System

Single Skid Parametres:

- 22 CB serve as input to 1666 KW Eaton Inverter
- Inverter output 1831 KVA will be matched with 1831 step-up transformer
- The output of transformer will be collected with 8 AWG copper conductor
- Another collector with 1 AWG size will collect and combine all the current and deliver it to the feeder.



1831 KVA INVERTER TRANSFORMER DETAIL

Tam Nguyen

- Feeder System Calculation:

<u>Current go into the feeder:</u>

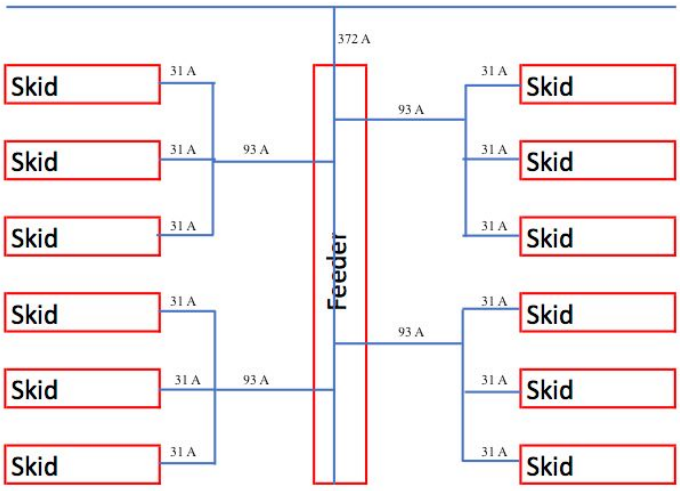
I_{feeder} = 93 x 4 = 372 A

<u>Choosing conductor:</u>

Add 10%

$I_{real\ feeder}$ = 372 x 1.1 = 409.2 A

So we choose 800 Kcmil because it can handle 410 A.



Pending Issues:

- N/A

Plans For Next Week:

We will wait for the answers of the client about the key protection diagram, then we will divide tasks for everyone. However, next week, we will read the project scope and single line diagram to understand more about the key protection diagram, then we will make some changes.

Individual Contributions

Team Member	Individual Contributions	Hours	Cumulative Hours
Katayi Katanga	Did research on: - Circuit model of our solar power plant - Key protection diagram Created/Performed: - Concept presentation for the advisor - Key protection diagram	15	117
Nur Shuazlan	Did research on: - Circuit model of our solar power plant - Key protection diagram Created/Performed: - Concept presentation for the advisor - Key protection diagram	15	119
Yao Cheah (YJ)	Did research on: - The relationship between conductor sizing and types towards its resistance value - Solar inverter calculation - Transformer calculation Created/Performed: - Attended all meetings - Prepared presentation slides	13	95
Ahmed Sobi	Did research on: - Capacitor bank - Circuits breakers - Disconnect switch Created/Performed: - Prepared slide for key protection diagram - AutoCAD modification to the	14	110

	diagram - Attended all of the meetings		
Tam Nguyen	Did research on: - Knowledge in EE 455 class for the concept presentation - Components in key protection diagram Created/Performed: - Finalize feeder calculation - Attend all meetings	14	88.5
Chufu Zhou	Did research on: - Capacitor bank - Circuits breakers - Disconnect switch Created/Performed: - AutoCAD modification to the diagram - Attend all meetings	13	84

Team Hours: 84
Cumulative Team Hours: 613.5