

IOWA STATE UNIVERSITY

Department of Electrical and Computer Engineering



**BLACK & VEATCH**

# 115/34.5kV Solar Plant & Substation

## Senior Design Project

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| Senior Design Team 41

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## AGENDA

- Safety Moment
- New Technology
- AutoCAD Drawings
- ETAP Simulation Progress
- Progress on Sections Views
- Grounding Grid Layout
- AC Panel

## SAFETY MOMENT: ELECTRICAL HAZARDS & GROUNDING IN SUBSTATIONS

### - Proper Grounding Systems

Grounding is a life-saving system. A proper grounding network provides a low-resistance path to safely discharge fault currents. It helps protection devices operate quickly.

### - Step and Touch Potential Hazards

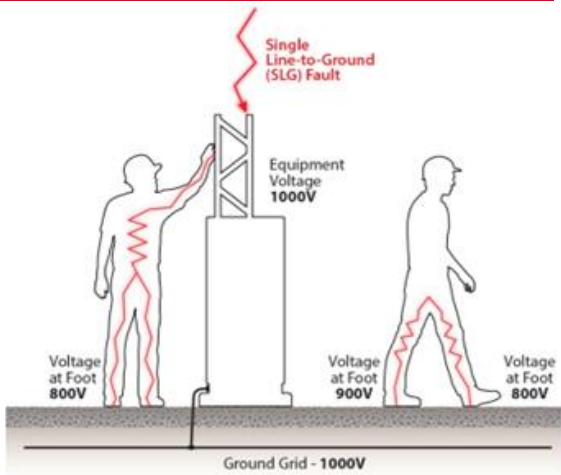
- Invisible dangers that can exist during and after a ground fault.
- Step Potential occurs when there's a voltage difference between your feet as you walk near a faulted area.
- Touch Potential happens when you touch a grounded object that's at a different potential than the surface you're standing on.

### - Equipotential Bonding

When working on de-energized or isolated parts, such as busbars or transformer terminals, it's critical to create an equipotential zone. This means bonding all conductive parts to the same ground potential.

### - Actions:

- Regularly inspect ground rods, and connections.
- In the event of a ground fault, stay clear of fences and grounded equipment.
- Always apply temporary grounding clamps from the ground side first. Use insulated tools and PPE, and never assume something is de-energized.



# NEW TECHNOLOGY

## Digital Substation

### A. What is a Digital Substation?

A digital substation replaces traditional copper cabling with fiber optics and uses digital sensors, merging units, and communication networks (IEC 61850) to monitor, control, and protect power systems efficiently.

### 6 Key Benefits of Digital Substations:

- **Cost Reduction** – Saves on cabling, installation, and engineering efforts.
- **Improved Safety** – Reduces exposure to high voltage; enhances personnel safety.
- **Greater Availability** – Enhances system reliability and uptime.
- **Better Asset Management** – Enables predictive maintenance and lowers lifecycle costs.
- **Cybersecurity** – Protects against digital threats, ensuring grid stability.
- **Scalability & Flexibility** – Simplifies integration of new technologies and devices.

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
PVA_1	PV Array	Overload	70.924	Amp	1225.253	1727.6	3-Phase
PVA_2	PV Array	Overload	70.924	Amp	1225.253	1727.6	3-Phase
PVA_3	PV Array	Overload	70.924	Amp	1225.253	1727.6	3-Phase
PVA_4	PV Array	Overload	79.494	Amp	1225.253	1541.3	3-Phase
T_1	Transformer	Overload	90.000	MVA	145.620	161.8	3-Phase
T_2	Transformer	Overload	90.000	MVA	145.620	161.8	3-Phase

Info

PV Panel

PV Array

Inverter

Physical

Time Domain

Remarks

Comments

PV Array - Total Rated

Volts,dc

301600

kW,dc

79170

Amps,dc

262.5

Inverter

ID

Inv20

kW

V

FLA

%EFF

DC

4709

955

4931

90

kVA

kV

FLA

%PF

AC

4238.1

34.5

70.92

100

Inverter Editor...

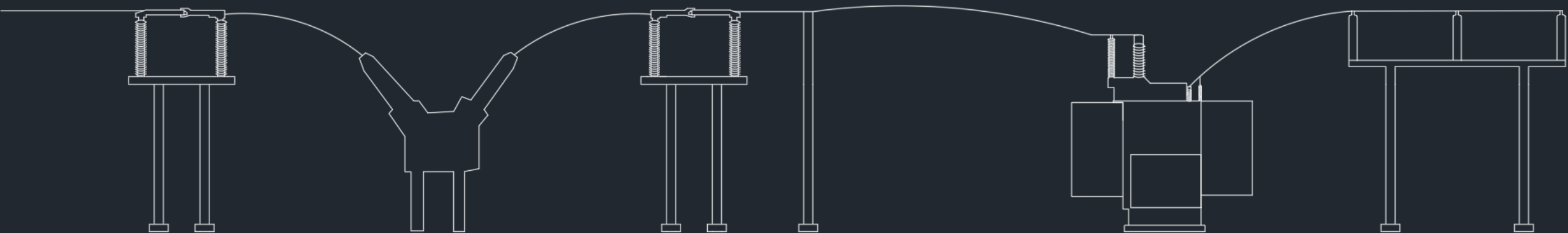
☒ Maximum Power Point Tracker (MPPT)

Inverter to PV Array Cable

## UPDATED SECTION VIEW A

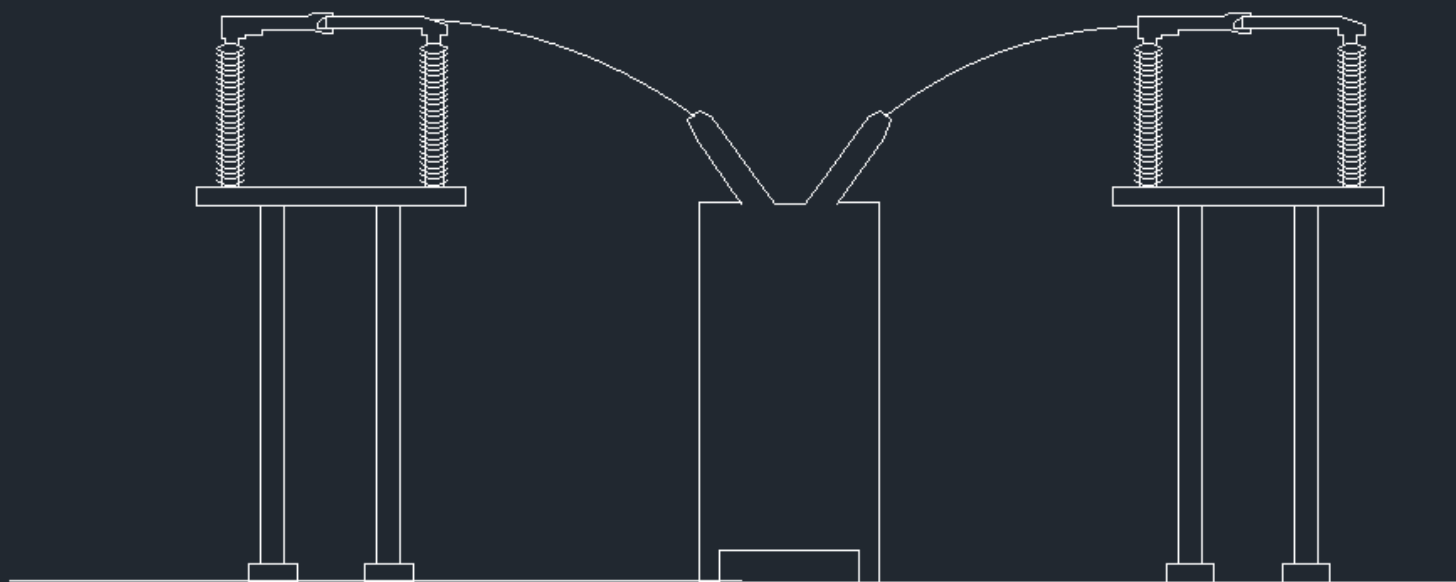
Section A

Not to scale



## UPDATED SECTION VIEW B

Section View B



## UPDATED SECTION VIEW C

Section C

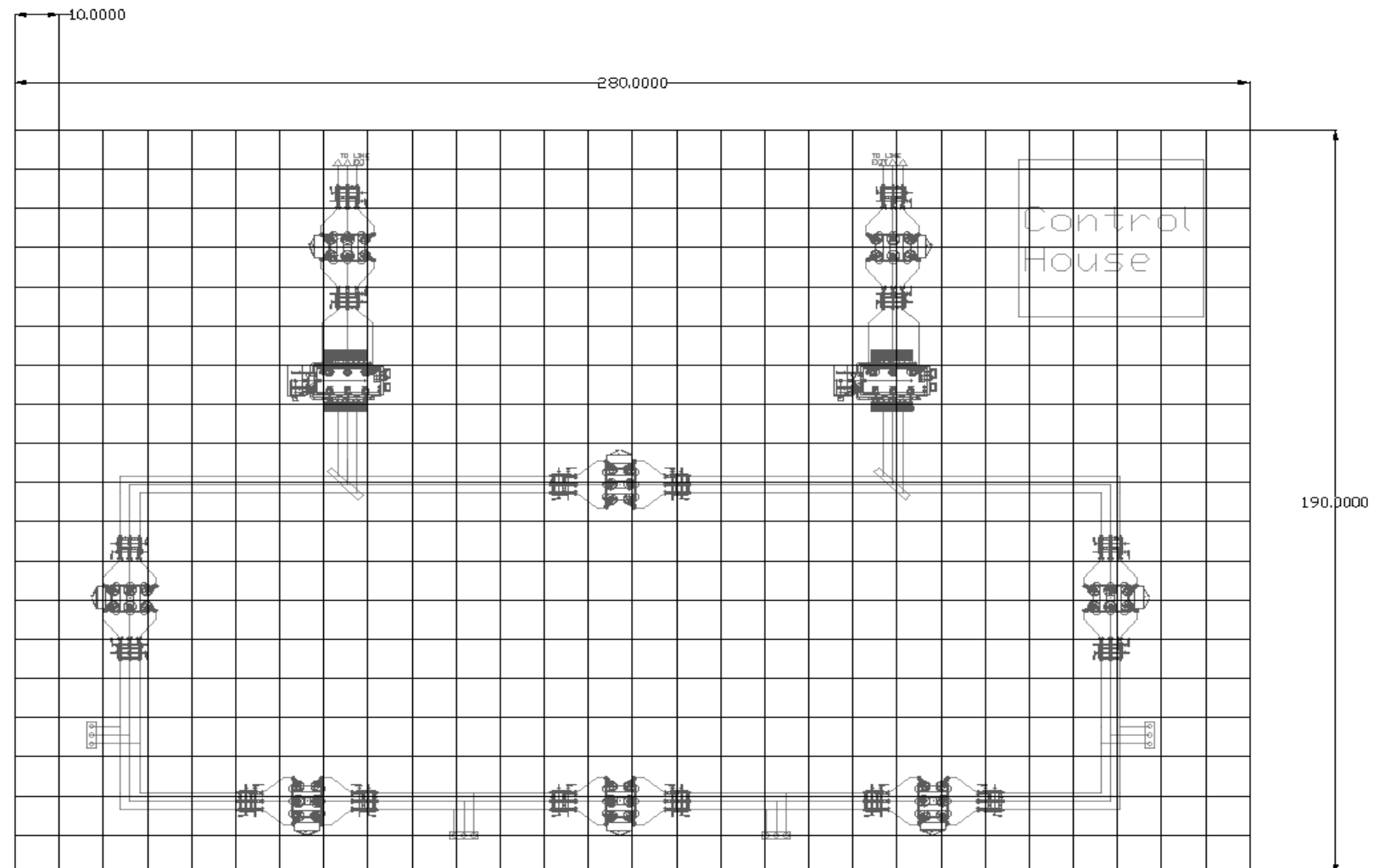
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## Ground Grid Layout

- Have initial layout created - Grid with 10ft spacing
- Need to add fencing



## Ground Grid Layout

- May need to modify grounding analysis spreadsheet to include ground rods
- Researched NEC standards and confirmed the 10ft spacing with NEC 250.53

### **250.53 Grounding Electrode System Installation.**

**(A) Rod, Pipe, and Plate Electrodes.** Rod, pipe, and plate electrodes shall be free from nonconductive coatings such as paint or enamel. Rod, pipe, and plate electrodes shall meet the requirements of 250.53(A)(1) through (A)(3).

**(1) Below Permanent Moisture Level.** If practicable, rod, pipe, and plate electrodes shall be embedded below permanent moisture level.

**(2) Supplemental Electrode Required.** A single rod, pipe, or plate electrode shall be supplemented by an additional electrode of a type specified in 250.52(A)(2) through (A)(8). The supplemental electrode shall be permitted to be bonded to one of the following:

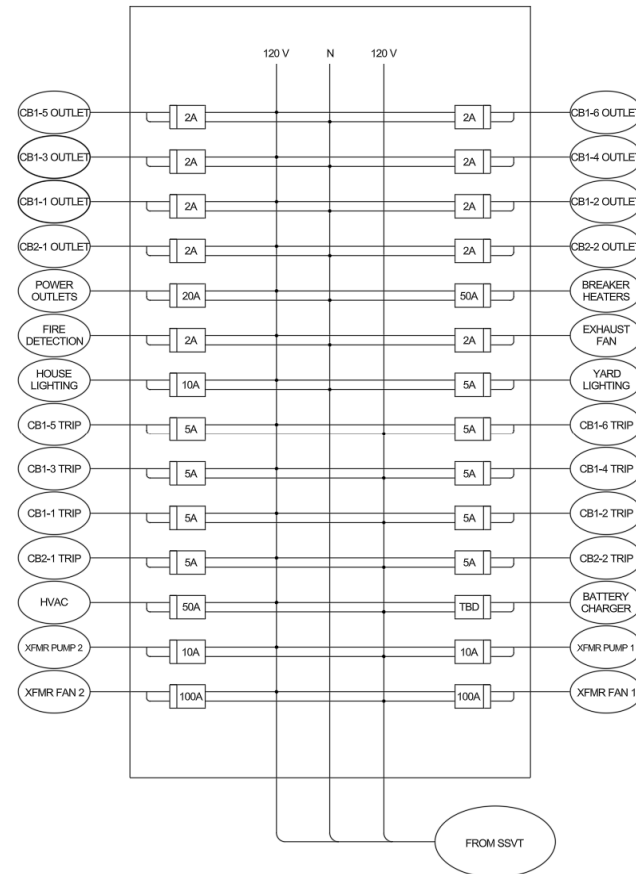
- (1) Rod, pipe, or plate electrode
- (2) Grounding electrode conductor
- (3) Grounded service-entrance conductor
- (4) Nonflexible grounded service raceway
- (5) Any grounded service enclosure

*Exception: If a single rod, pipe, or plate grounding electrode has a resistance to earth of 25 ohms or less, the supplemental electrode shall not be required.*

**(3) Supplemental Electrode.** If multiple rod, pipe, or plate electrodes are installed to meet the requirements of this section, they shall not be less than 1.8 m (6 ft) apart.

## AC Panel

- Working on making sure things are properly sized and adhering to standards



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THANK YOU

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