

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

| 03/31/2025

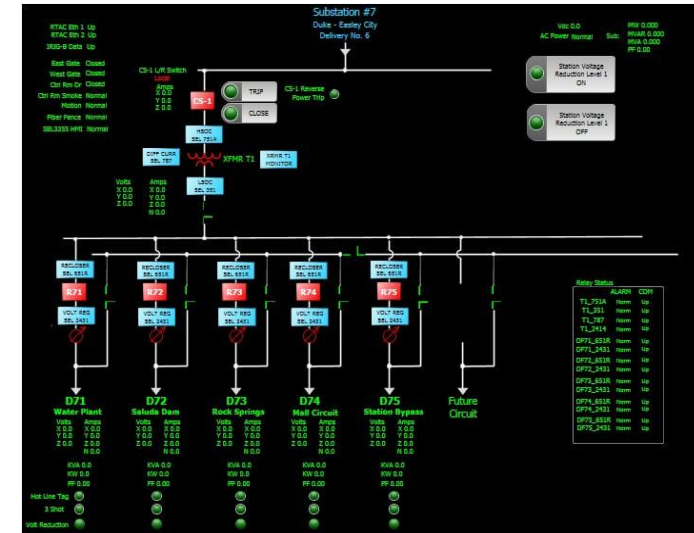
## AGENDA

- Safety Moment
- New Technology
- Three Line Updated
- Relaying Plan
- AutoCAD Updated
- DC Calculations update

# Safety Moment

## Cybersecurity in Substations - SCADA Systems

- SCADA
  - Software used for controlling and monitoring grid operations
- Vulnerabilities
  - Susceptible to unauthorized access
  - Targets for cyber attacks
  - Safety hazard if compromised
- How to Improve Protection
  - Implement regular software updates
  - Continuous monitoring and real-time intrusion detection
  - Consider multi-factor authentication methods for users



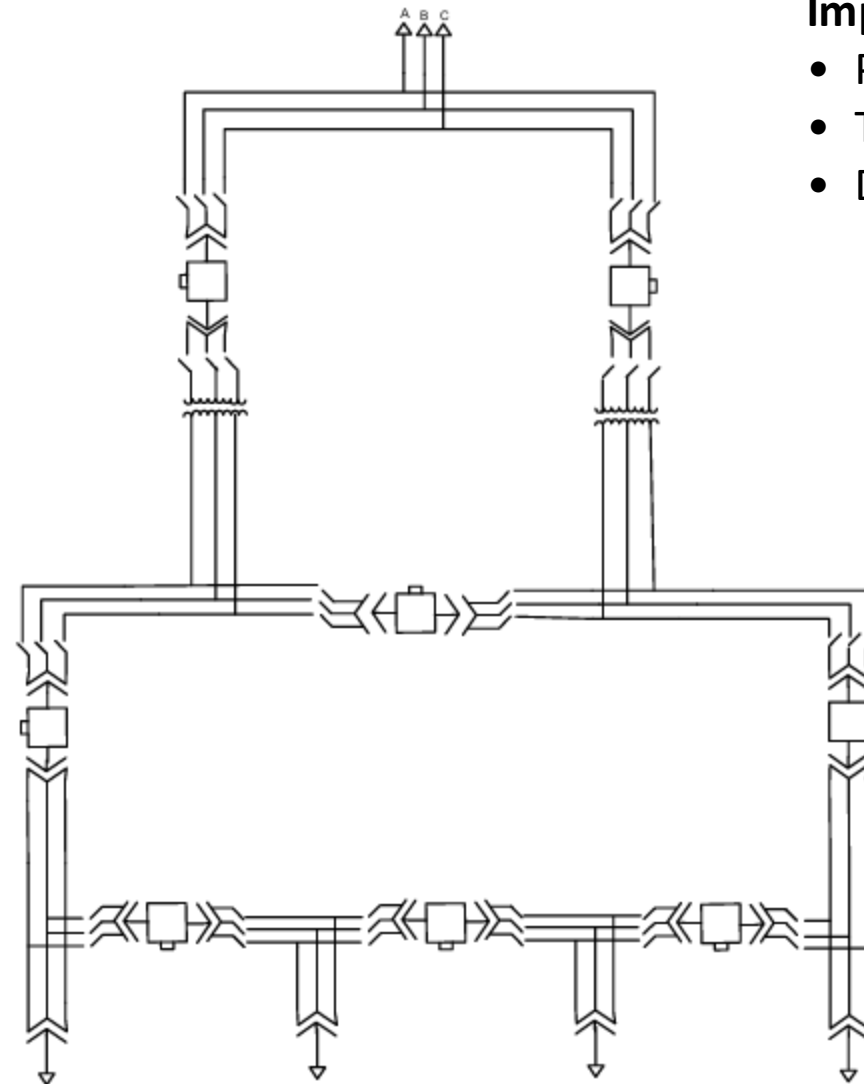
## New Technology

### Solid-State Batteries

- Uses solid electrolytes instead of traditional liquid batteries
- Benefits
  - Has higher energy density than liquid batteries
  - Improved safety compared to other types like lithium batteries
    - Less likely to cause fires
  - Longer Lifespan – less degradation
  - Faster charging



## 3-line progress



### Improvements Included:

- Phase labels clearly indicated (Phase A, B, C).
- Transformers location updated
- Disconnect Switches Reoriented

## Relaying Plan

- Most changes made
  - PTs and SSVTs added
  - Comments from BV updated
- Will send the updated version for review

## AutoCAD Update

- Updated the physical plan based on the comments left
- Adding a few more late changes
- Will send the updated version for review

# DC Calculations Update

Components	Load Current (A)	Nominal Voltage (V) DC	Inception and Active Shutout Time	number of components	Total Load Current (A)	Power Requirement	Power (Units)
34.5kV Breaker:	Tripping Current: 3.3	70 – 140	0 -1	6	Tripping Current:19.8	343	W
	Closing Current: 2.6	90 - 140			Closing Current :15.6	364	W
115kV Breaker:	Tripping Current : 6.6	125	239- 240	2	Tripping Current: 13.2	1050	W
	Closing Current : 3.6	125			Closing Current : 7.2	950	W
SEL-311C	0.20	125	1 - 240	8	1.60	25	W
SEL-311L	0.20	125	1 - 240	8	1.60	25	W
SEL-587	0.044	125	1 - 240	2	0.08	6	W
SEL-487E	0.280	125	1 - 240	2	0.56	35	W
Battery Monitoring Equipment	0.024	50 -180	1 - 240	1	0.02	6	VA
DC Ammeter	0.048	125	1 - 240	1	0.048	3	VA
DC Voltmeter	0.048	120	1 - 240	1	0.048	3	VA
SACO Annunciator (L8)	0.150	125	1 - 240	2	0.30	15	W
Edwards Bell	0.012	125	1 - 240	1	0.012	1.5	VA
Power Line Indicating Lamps (LEDs)	0.017	125	1 - 240	8	0.136	2.125	W

60 Cell Sysem	Continuous Load	Discontinuous Load Current
	4.404A	19.8 A

Power Supply Burden (W)	t = 0 min	t = 1 min	t=240min
	37.40	4.404 A	27.2 A



# DC Calculations Update



## Summary Margin Report

Customer:	Iowa State University
Location:	
Project:	
Date Prepared:	3/23/25
Prepared By:	Sergio Sanchez Gomez
Phone:	5155679974
E-Mail:	sergiosg@iastate.edu

<u>Sizing Parameters</u>
Application: Utility
Lowest Temp (°F): 77.00
Min. Voltage (Vpc): 1.75
Design Margin: 1.10
Aging Factor: 1.25

Line	Cell Model	Margin
1	ESG-05	2.7%
2	6 OGi 170	5.5%
3	6 OGi 80 (2 Strings)	5.5%
4	CA-09M	11.2%
5	CA-05M (2 Strings)	11.2%
6	CC-09M	11.3%
7	CC-05M (2 Strings)	11.3%
8	EA-05M	14.9%
9	EC-05M	15.3%
10	4 OPzS 200	23.0%
11	DSG-05	65.7%
12	GC-09M	376.7%
13	Vb 2408	432.9%

<u>Battery Load Details</u>		
Number of Cells: 60		
Total Time (Minutes): 241.00		
Amp Hour Removed: 108.87		
Period	Time (Mins.)	Load
1	0.00	37.40 A
2	1.00	4.40 A
3	240.00	27.20 A

# DC Calculations Update (Sizing Report)

Lowest Expected Electrolyte Temp		77.0 F (25.0 C)	Minimum Cell Voltage	1.75			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	
PERIOD	LOAD (A)	CHANGE IN LOAD (A)	DURATION OF PERIOD (HH:MM:SS)	TIME TO END OF SECTION (HH:MM:SS)	CAPACITY AT T MIN RATE K FACTOR (Kt)	REQUIRED SECTION SIZE = (3)*(6) =	
						RATED AMP HOURS	
						POS VALUE	NEG VALUE
SECTION 1 - FIRST PERIOD ONLY - IF A2 IS GREATER THAN A1. GO TO SECTION 2							
1	37.404	37.404	0:00:00	0:00:00	0.31	11.595	0.000
					Sub Total	11.595	0.000
					Section 1 Total	11.595	
SECTION 2 - FIRST 2 PERIOD ONLY - IF A3 IS GREATER THAN A2. GO TO SECTION 3							
1	37.404	37.404	0:00:00	0:01:00	0.735	27.492	0.000
2	4.404	-33.00	0:01:00	0:01:00	0.735	0.000	-24.255
					Sub Total	27.492	-24.255
					Section 2 Total	3.237	
SECTION 3 - FIRST 3 PERIOD ONLY - IF A4 IS GREATER THAN A3. GO TO SECTION 4							
1	37.404	37.404	0:00:00	4:01:00	4.822	180.362	
2	4.404	-33.00	0:01:00	4:01:00	4.822	0.000	-159.126
3	27.204	22.8	4:00:00	4:00:00	4.807	109.600	0
					Sub Total	289.962	-159.126
					Section 3 Total	130.836	
		Aging factor		179.899071	180 Ah		
		1.25					
		Design margin			3CC-09	nominal capacity	200
		1.1				margin	11.30%

# DC Calculations Update

## Constant Current

1.215 Specific Gravity  
Discharge Rates in Amperes per Cell to 1.75Vpc at 77°F (25°C)

Battery Type	Nominal Capacity*	Minutes			Hours								
		1	15	30	1	1.5	2	3	4	5	8	12	24
3CC-03M	50	70.8	50.7	38.7	27.0	20.9	17.2	12.9	10.4	8.8	6.3	4.5	2.5
3CC-05M	100	141.6	101.3	77.3	53.9	41.9	34.4	25.7	20.8	17.7	12.5	9.0	4.9
3CC-07M	150	212.4	152.0	116.0	80.9	62.8	51.7	38.5	31.2	26.5	18.8	13.5	7.4
3CC-09M	200	283.1	202.7	154.6	107.8	83.8	68.9	51.4	41.6	35.3	25.0	17.9	9.8

\*Nominal Ah Capacity based on an 8 hour discharge  
Rates are subject to change without notice.

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THANK YOU

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