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Program Release Form

Approved at July 21, 2021 EPAC

Link to Meeting Minutes

Date Prepared: 07/12/2021	**Project Title: BES Battery Monitor Installation Program – [redacted] Release**
Company: Eversource CT	**Facility Name: [redacted] Substation**
Organization: Asset Management	**Project Number CS00448**
Project Initiator: [redacted]	**Class(es) of Plant: D SS**
Project Manager: [redacted]	**Project Category: Stations - Monitoring - Batteries**
Project Sponsor: [redacted]	**Project Type: Program**
Program Level Title: BES Battery Monitor Installation Program	**Capital Investment Part of Original Operating Plan? Yes**
Program Level Project Number: CS00428	**O&M Expenses Part of the Original Operating Plan? N/A**
Total Request: $181K	**Estimated in service date(s): 12/30/2021**
	Facility Type (check all that apply): ☒ PTF ☐ non-PTF ☒ Distribution

Executive Summary

This Program Release is requesting full funding of $181K to install Bulk Electric System (BES) battery monitoring at [redacted] [redacted]. Approval of this request will provide for improved real-time condition monitoring. This data will provide a more comprehensive overview of system health, streamline data reviews for compliance, and reduce human error through standardized reports, analysis, and reviews.

This Program Release is requesting dollar authorization in accordance with the Program Level criteria specified in the BES Battery Monitor Installation Program PAF Rev_0 - CS00428 (Attachment D) and this document for this specific location. The Program Level PAF had $50K of initial funding approved in PowerPlan on 12/23/20 (CT-D). Preliminary engineering for this substation release has been completed. As of 6/30/2021, minimal charges have been spent for this substation; these costs will be journaled over to the individual release project number CS00448.

Project Scope

This project is part of a multistate program to add BES Battery Monitors to the remaining un-monitored BES battery systems. North American Electric Reliability Corporation (NERC) Std. PRC-005-2 requires periodic maintenance and testing practices of BES system protection elements which includes station batteries. This includes measurement and analysis of cell and connection resistance to determine any potential issues. Multiple monthly inspection measurements of each cell at hundreds of stations company-wide are required each year. The installation of substation battery monitors allows for real-time monitoring of the batteries on the Eversource system. This data will provide a more comprehensive overview of system health and

streamline data reviews for compliance, and reduce human error through standardized reports, analysis, and reviews.

Project Scope

The scope of this project is as follows:

- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

A constructability review was performed on 1/28/2021 (See Attachment C).

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Unitized Release Cost

Note: Since there are 2 monitors being installed at this substation, the unit cost shown below is double of the established unitized cost for CT Distribution. Dollar values are in thousands

Line item Category	Unitized Program Level PAF Cost*	Release Cost	Delta
1. ROW / Easements / Land Acquisition		$0	$0
2. Environmental Approvals / Permits		$0	$0
3. Outreach		$0	$0
4. Siting Approvals / Permits		$1	$1
5. Engineering / Design	$16	$8	($8)
6. Materials (Eversource purchased)	$6	$4	($2)
7. Construction (incl matl's by contractors)	$74	$77	$3
8. Testing / Commissioning	$2	$1	($1)
9. Project Mgmt. Team	$12	$6	($6)
10. Removals			$0
11. Other			$0
12. Risks	$18	$14	($4)
SUBTOTAL DIRECTS W/ RISKS	**$128**	**$110**	**($18)**
13. Indirects/Overhead	$94	$62	($32)
14. AFUDC	$2	$1	($1)
PROJECT TOTAL – BASELINE BUDGET	**$224**	**$173**	**($51)**
15. Contingency	$10	$8	($2)
			$0
TOTAL CAPITAL REQUEST	**$232**	**$181**	**($51)**
16. Reimbursables/Customer Contribution			$0
			$0
PROJECT TOTAL (LESS REIMBURSABLES)	**$232**	**$181**	**($51)**
O&M			$0
Total Request	**$232**	**$181**	**($51)**

*Program Unit Cost has been scaled for two (2) battery monitoring systems.

Justification for Modification

1. **ROW / Easements / Land Acquisition: $0K –** No changes
2. **Environmental Approvals / Permits: $0K –** No changes
3. **Outreach: $0K –** No changes
4. **Siting Approvals / Permits: $1K –** No major changes from the Program Level PAF.
5. **Engineering / Design: ($8K) –** Economies of scale. Unitized cost is based on a single monitor installation. This release is for the installation of two (2) monitors.
6. **Materials (by Eversource): ($2K) –** No major changes from the Program Level PAF.
7. **Construction (including materials supplied by contractors): $3K –** No major changes from the Program Level PAF.
8. **Testing / Commissioning: ($1K) –** No major changes from the Program Level PAF.
9. **Project Management Team: ($6K) –** Economies of scale. Unitized cost is based on a single monitor installation. This release is for the installation of two (2) monitors
10. **Removals: $0K –** No changes
11. **Other: $0K –** No changes
12. **Risk: ($4K) –** Economies of scale. Lower risk than doubled unitized risk cost.
13. **Indirects/Overhead: ($32K) –** Indirects are proportional to direct costs.
14. **AFUDC: ($1K) –** No major changes from the Program Level PAF.
15. **Contingency: ($2K) –** No major changes from the Program Level PAF.
16. **Reimbursables/Customer Contribution: $0K –** No changes

O&M: $0K – No changes

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Project Costs Summary

Note: Dollar values are in thousands

Line item Category	Prior Authorized	Actuals to Date	2021 to Go	2022	Total
1. ROW / Easements / Land Acquisition	$	$	$0	$	$0
2. Environmental Approvals / Permits	$	$	$0	$	$0
3. Outreach	$	$	$0	$	$0
4. Siting Approvals / Permits	$	$	$1	$	$1
5. Engineering / Design	$	$	$8	$	$8
6. Materials (Eversource purchased)	$	$	$4	$	$4
7. Construction (incl matl's by contractors)	$	$	$77	$	$77
8. Testing / Commissioning	$	$	$1	$	$1
9. Project Mgmt Team	$	$	$6	$	$6
10. Removals	$	$		$	
11. Other	$	$		$	
12. Risks	$	$	$14	$	$14
SUBTOTAL DIRECTS W/ RISKS	**$50**	**$0**	**$110**	**$**	**$110**
13. Indirects/Overhead	$	$	$62	$	$62
14. AFUDC	$	$	$1	$	$1
PROJECT TOTAL – BASELINE BUDGET	**$50**	**$0**	**$173**	**$**	**$173**
15. Contingency	$	$	$8	$	$8
TOTAL CAPITAL REQUEST	**$50**	**$0**	**$181**	**$**	**$181**
16. Reimbursables/Customer Contribution	$	$		$	
PROJECT TOTAL (LESS REIMBURSABLES)	**$50**	**$0**	**$181**	**$**	**$181**
O&M	$	$		$	
TOTAL REQUEST	**$50**	**$0**	**$181**	**$**	**$181**

Note: Risk allocation of $14K is included for: Building obstructions ($7K) and delays ($7K)

Breakout Costs

Note: Dollar values are in thousands

Line item Category	Prior Authorized	Actuals to Date	2021 to Go	2022	Total
ST Labor	$	$	$10	$	$10
OT Labor	$	$		$	
Outside Services Labor	$	$	$62	$	$62
Materials*	$	$	$24	$	$24
Removals	$	$		$	
Other	$	$	$22	$	$22
Indirects	$	$	$62	$	$62
AFUDC	$	$	$1	$	$1
TOTAL CAPITAL REQUEST - W/O REIMBURSABLES	**$50**	**$**	**$181**	**$**	**$181**

*All materials including Eversource purchased and outside service purchased. Note that outside service purchased material included in construction in project cost summary above

Future Financial Impacts:

Provide below the estimated future costs that will result from the project:
Note: Dollar values are in thousands:

Future Costs	Year 20__	Year 20__	Year20__	Year 20__+	Total Future Project Costs
Capital	$ -	$ -	$ -	$ -	$ -
O&M	-	-	-	-	-
Other	-	-	-	-	-
TOTAL	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**

Describe the estimated future Capital, O&M and/or Other costs noted above: N/A

What functional area(s) will these future costs be funded in? N/A
A representative from the respective functional area is required to be included as a project approver.

If this is other than a Reliability Project, please complete the section below;

Provide below the estimated financial benefits that will result from the project:
Note: Dollar values are in thousands:

Future Benefits	Year 20__	Year 20__	Year20__	Year 20__+	Total Future Project Benefits
Capital	$ -	$ -	$ -	$ -	$ -
O&M	-	-	-	-	-
Other	-	-	-	-	-
TOTAL	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**

Describe the estimated future Capital, O&M and/or Other benefits noted above:

What functional area(s) will these benefits be reflected in? N/A
A representative from the respective functional area is required to be included as a project approver.

Asset Retirement Obligation (ARO) and/ or Environmental Cleanup Costs (Environmental Liabilities):

Is there an ARO associated with this project? If yes, please provide details: No

Are there other environmental cleanup costs associated with this project? If yes, please provide details: If floor penetration is needed will dispose of floor tile properly if ACM is present.

Alternatives Considered with Cost Estimates

There are no changes from the Program Level PAF

Regulatory Approvals

N/A

Risks and Risk Mitigation Plans

Risk allocation is included for building obstructions and delays.

Contingency

Contingency of $8K is included in this release for any additional unknowns with respect to this release.

Project Schedule

Milestone/Phase Name	Estimated Date
EPAC Presentation and Approval	July 21, 2021
IFC Engineering	August 27, 2021
Construction Start	November 3, 2021
Monitor Procurement	November 19, 2021
In Service Date	December 30, 2021
Project Closeout	June 8, 2022

See Attachment B for the P6 schedule.

Attachments

- Attachment A - Engineering Cost Estimate Revision 01.61 dated 04192021
- Attachment B – BMIP CT [redacted] Program Release Schedule 06282021
- Attachment C – [redacted] Constructability Review Form
- Attachment D - BES Battery Monitor Installation Program PAF Rev_0

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Project Checklist - Transmission & Substation Capital Project					
Project Name: BES Battery Monitor Installation Program – [redacted]			**Project Number: CS00448**		
Facility Type: ☐ BPS ☒ BES ☒ PTF ☐ non-PTF ☐ CIP ☒ Distribution					
PLANNING					
Is a NX-9 required?			No		
Is an ISO-NE PAC presentation required?			No		
ISO-NE Presentation Date (if completed):			N/A		
Cost in ISO-NE Presentation ($M) (if completed):			N/A		
Is a PPA required?			No		
Is a TCA Application Required?			No		
TCA Submittal Date (if submitted):			N/A		
Cost in TCA Submittal ($M) (if submitted):			N/A		
Enter ISO-NE RSP / Asset Condition ID, if assigned:			N/A		
PLANNING/PROTECTION & CONTROLS					
Are RAS/SPS/UVLs affected?			No		
OPERATIONS					
Outage Required?	☐ Primary Equipment (Power Transfer)	☐ Secondary Equipment (P&C only)	☒ Outage Not Required		
Do SCLL Conditions Exist?			No		
Has an outage schedule been approved?			NR		
Are Operations & Maintenance procedures/training required?			Yes		
STANDARDS					
Does the project include standard equipment and designs?			Yes		
SUBSTATION ENGINEERING					
Does this impact Revenue Metering			No		
Is preliminary short circuit/ breaker duty analysis required?			No		
Are there any changes to the baseline audible noise?			No		
Is there an impact to the existing ground grid?			No		
Is a Transient Over Voltage (TOV) analysis required?			NR		

Project Checklist - Transmission & Substation Capital Project	
Project Name: BES Battery Monitor Installation Program – [redacted]	**Project Number: CS00448**

P&C ENGINEERING	
OP-22 - Are PMUs and DDR required?	No
If BPS, is an NPCC Directory #4 presentation required?	No
Are ISO-NE OP-24 Appendix B updates necessary?	No
TRANSMISSION LINE ENGINEERING	
Are there any changes that affect the baseline EMF?	No
Are there any changes that affect the baseline EMI?	No
SITING	
Is a Siting filing required? *(If yes, list in regulatory approvals section)*	No
PERMITTING	
Is there any permitting required? *(If yes, list in regulatory approvals section)*	No
SITING & CONSTRUCTION SERVICES (OUTREACH)	
What is the level of outreach expected?	None
INITIATOR	
Has a field constructability review been completed?	Yes
INVESTMENT RECOVERY	
Does the project require development of an Investment Recovery plan?	No
COST ESTIMATING	
What team/firm prepared the cost estimate?	Estimate was prepared by Eversource Engineering
Name of the person who prepared the estimate:	[redacted]
Was the estimate reviewed by Eversource Estimating?	Yes - Full Review

Cost Estimate Backup Details

Please see Attachment A for the cost estimate backup file.

ESTIMATE SUMMARY

Project Title: [redacted] Battery Monitors
Project Mgr/Lead: [redacted]
Project Number:CS00448
WO & Task #:80041984
Est. Revision # 00
Estimate Type - Station work

Estimate By: [redacted]
Date of Estimate:4/19/21
ISD:08/06/2021
Estimate #

Template Revision # 01.61

ESTIMATE SUMMARY

Estimate Type: Planning

WBS	Description	TOTAL	% of Directs	% of Total	Priors	2021	2022	2023	2024	2025	2026
1	ROW / Easements / Land purchases										
2	Environmental Approvals / Permits										
3	Outreach	$200	0.2%	0.1%		$200					
4	Siting Approvals / Permits	$500	0.5%	0.3%		$500					
5	Engineering / Design	$7,600	6.9%	4.2%		$7,600					
6	Materials (Eversource purchased)	$3,900	3.5%	2.2%		$3,900					
7	Construction (incl matl's by	$76,900	69.6%	42.5%		$76,900					
8	Testing / Commissioning	$1,100	1.0%	0.6%		$1,100					
9	PMT Project Mgmt Team	$6,300	5.7%	3.5%		$6,300					
10	Removals										
11	Other										
12	Risks	$14,000	12.7%	7.7%		$14,000					
	Project Directs Total w/Risks	**$110,500**	100.0%	61.1%		**$110,500**					
13	Indirects/Overhead	$61,700		34.1%		$61,700					
14	AFUDC	$1,000		0.6%		$1,000					
	Project Total - Baseline Budget	**$173,200**		95.7%		**$173,200**					
15	Contingency	$7,700		4.3%		$7,700					
	Project Total - Funding Approval Level	**$180,900**		100.0%		**$180,900**					
16	Reimbursables/Customer Contribution										
	Project Total (less reimbursables)	**$180,900**				**$180,900**					
		-									
	Amount of Escalation included above										
6	Total materials - Eversource	$3,900				$3,900					
	Total materials - Contractor	$19,800				$19,800					
	Total materials	$23,700				$23,700					

NOTE: Risk / Contingency is 13.6% of Project Total Costs (incl escal/indirects/AFUDC but excl reimb.)

Estimate Range	-25%	-	25%
	$136,000	-	**$226,000**

COMMENTS:

Project Scope:

[redacted]

Assumptions/Clarifications:
Indirect rates based on: 11 - CT Station work

Inhouse resources will be used for LCE & Engineering.
PM, Construction & SCADA will be outsourced.
Construction Rep will not be needed.
Real Power will provide a UXIM monitor including any wiring to the battery with their installation services.
A Mobile battery cart will not be needed

RISKS

Potential Obstructions	$	7,000
Delays	$	7,000

Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors	Successors	Activity Flag	DEPT - DEPARTMENT	Resources
BES Battery Monitor Prgm-Glenbrook 01K		257	01-Jun-21 A	08-Jun-22					
PROJECT INITIATION		108	01-Jun-21 A	03-Nov-21					
Project Initiation		76	01-Jun-21 A	16-Sep-21					
A0001	SCHEDULE START MILESTONE	0	01-Jun-21 A	01-Jun-21 A		A3020, A3000, A2990, A2980		PM	CT- Project Manager Generic
A2730	ES Review and Provide Updates to Project Scope Document - ELEC	1	01-Jun-21 A	01-Jun-21 A	A3020	A2760		ENG.ST.SS.ELEC	CT- Substation Designer Generic
A2740	ES Review and Provide Updates to Project Scope Document - P&C	1	01-Jun-21 A	01-Jun-21 A	A3020	A2760		ENG.ST.P&C.P&C	CT- P&C Engineer Generic
A2760	Incorporate Comments Project Scope Document & Submit	1	01-Jun-21 A	01-Jun-21 A	A2730, A2740	A2770		ENG.AM.ENG	Planning / Asset Management Generic
A2770	Issue Project Scope Document	1	01-Jun-21 A	01-Jun-21 A	A3010, A2760	PC360, BT2605, PC440, A2782		ENG.ST.SS.ELEC	CT- Substation Designer Generic
A2782	Preliminary Engineering Packages Sent to Asset Management	1	01-Jun-21 A	01-Jun-21 A	PC280, A2847, A2770, A2550	A2784		ENG.ST.SS.ELEC	CT- Substation Designer Generic
A2784	Asset Management Send Preliminary Engineering Packages to Estimating	1	01-Jun-21 A	01-Jun-21 A	A2782	A2670		ENG.AM.ENG	Planning / Asset Management Generic
A2980	Assign Project Manager	1	01-Jun-21 A	01-Jun-21 A	A0001	A3010	PM-AM		CT- Project Engineer Generic
A2990	Assign Project Scheduler	1	01-Jun-21 A	01-Jun-21 A	A0001	A3000		PPS	CT- Project Engineer Generic
A3000	Develop Project Schedule PM/PPS	1	01-Jun-21 A	01-Jun-21 A	A2990, A0001	A2670		ENG.ST.SS.ELEC	T- Project Scheduler Generic, CT- Project Manager Generic
A3010	Request Project Team Assignments	1	01-Jun-21 A	01-Jun-21 A	A2980	A2770		PM	CT- Project Manager Generic
A3020	Project Scope Document Created	1	01-Jun-21 A	01-Jun-21 A	A0001	A2740, A2730		ENG.ST.SS.ELEC	CT- Substation Designer Generic, CT- P&C Engineer Generic, CT- Project Engineer
A2670	Develop Full Funding Estimate	10	14-Jun-21 A	14-Jun-21 A	A3000, A2784	A2680	EST-FULL	ENG.BQA.EST	Generic Estimating, CT- Project Manager Generic
A2680	Prepare Full Funding PAF for EPAC and Internal Review	10	15-Jun-21 A	08-Jul-21	A2670	A2690		ENG.AM.ENG	Planning / Asset Management Generic, CT- Project Manager Generic
A2690	Submit Full Funding PAF Draft to EPAC	2	09-Jul-21	12-Jul-21	A2680	A2700	PAF Submit	ENG.AM.ENG	Planning / Asset Management Generic
A2700	EPAC Full Funding Meeting	0		21-Jul-21	A2690	A2710			
A2710	Incorporate Full Funding PAF EPAC Comments	5	22-Jul-21	28-Jul-21	A2700	A2720	EPAC-F	ENG.AM.ENG	Planning / Asset Management Generic
A2720	Route Full Funding EPAC, Sign-offs, PowerPlan Approval	20	29-Jul-21	25-Aug-21	A2710	PAF1080		PM	CT- Project Manager Generic

TASK filter: All Activities

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Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors	Successors	Activity Flag	DEPT - DEPARTMENT	Resources
PAF1080	WO # Created	15	26-Aug-21	16-Sep-21	A2720	LCE100, A2820, A2917, A2887, A2857	PPA-FF	PM	CT- Project Manager Generic
T-Minus Milestones		127	28-Jun-21	03-Nov-21					
Electrical T-Minus Milestones		109	16-Jul-21	03-Nov-21					
AT2605	Preliminary Engineering Completed - Elect	0		16-Jul-21	A2550	AT00	ENG-PRELIM	ENG.ST.SS.ELEC	
AT0602	Units of Property Values provided to Plant Accounting	0		18-Aug-21	A2600	AT00		PM	
AT1811	Detailed Engineering Completed - Elect	0		18-Aug-21	A2600	AT00	ENG-DTL	ENG.ST.SS.ELEC	
AT0805	Final IFC Drawings w/BOM Issued - Elect	0		27-Aug-21	A2660	AT00	AG-IFC	ENG.ST.SS.ELEC	
AT0401	Final Mat'l Receipt Review	0		13-Sep-21	A2947, A2610	AT00		PM	
AT0814	Construction Contracts / PSA In Place	0		30-Sep-21	A2830	AT00		PM	
AT0203	Go/No Go CAN form Completed	0		07-Oct-21	A2840	AT00		PM	
AT00	T-00 START - Install Battery Monitoring System - Elect	0	03-Nov-21*		AT0805, AT0401, AT0203, AT0602, AT1811, AT2605	COMP, 4997407-10, A1750, 4997407-20		PM	
P&C T-Minus Milestones		127	28-Jun-21	03-Nov-21					
BT2605	Preliminary Engineering Completed - P&C	0		28-Jun-21	PC280, A2847, A2770	BT00	ES-PRELIM	ENG.ST.P&C.P&C	
BT1811	Detailed Engineering Completed - P&C	0		16-Jul-21	PC390	BT00	ES-DTL	ENG.ST.P&C.P&C	
BT0805	Final IFC Drawings w/BOM Issued - P&C	0		04-Aug-21	PC430	BT00	P&C-IFC	ENG.ST.P&C.P&C	
BT0203	Go/No Go CAN form Completed - P&C	0		07-Oct-21	A2840	BT00		PM	
BT00	T-00 START - Install Battery Monitoring System - P&C	0	03-Nov-21*		BT0805, BT0203, BT1811, BT2605	COMP, 4997407-10, A1750, 4997407-20		PM	
ENGINEERING AND DESIGN		49	21-Jun-21	27-Aug-21					
Electrical Engineering		49	21-Jun-21	27-Aug-21					
SS Electrical Engineering Preliminary Design		19	21-Jun-21	16-Jul-21					
A2225	SS Electrical Eng Prepare and Issue Preliminary Design to Drafter	5	21-Jun-21	25-Jun-21		A2540		ENG.ST.SS.ELEC	CT- Substation Designer Generic

TASK filter: All Activities

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Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors	Successors	Activity Flag	DEPT - DEPARTMENT	Resources
A2540	Drafting Issues Electrical Eng Preliminary Package to Design	10	28-Jun-21	12-Jul-21	A2225	A2550		ENG.ST.SS.ELEC	CT- Substation Design Drafter Generic
A2550	SS Engineer Reviews SS Electrical Engineering Preliminary Design Pkg	4	13-Jul-21	16-Jul-21	A2540	AT2605, A2560, A2780, A2782	ES-PRELIM	ENG.ST.SS.ELEC	CT- Substation Designer Generic
SS Electrical Engineering Detailed Design		23	19-Jul-21	18-Aug-21					
A2560	SS Electrical Eng Prepare and Issue Detailed Design to Drafter	5	19-Jul-21	23-Jul-21	A2550	A2570, A2780		ENG.ST.SS.ELEC	CT- Substation Designer Generic
A2780	Intiate CASCADE Forms for Construction Package	15	19-Jul-21	06-Aug-21	A2550, A2560	A2570		ENG.ST.SS.ELEC	CT- Substation Designer Generic
A2570	Drafting Issues Electrical Eng Detail Package to Design	5	09-Aug-21	13-Aug-21	A2560, A2780	A2600		ENG.ST.SS.ELEC	CT- Substation Design Drafter Generic
A2600	SS Engineer Reviews & Approves Electrical Detailed Design Pkg	3	16-Aug-21	18-Aug-21	A2570	A2610, AT1811, AT0602	ES-DTL	ENG.ST.SS.ELEC	CT- Substation Designer Generic
SS Electrical Engineering IFC Design		7	19-Aug-21	27-Aug-21					
A2610	SS Electrical Eng Prepare and Issue IFC Design Markups to Drafter	2	19-Aug-21	20-Aug-21	A2600	A2957, AT0401, COMP, 4997407-10, A2620		ENG.ST.SS.ELEC	CT- Substation Designer Generic
A2620	Drafting Issues Electrical Eng IFC Package to Design	3	23-Aug-21	25-Aug-21	A2610	A2660		ENG.ST.SS.ELEC	CT- Substation Design Drafter Generic
A2660	SS Electrical Engineering IFC Design Package Issued to the Field	2	26-Aug-21	27-Aug-21	A2620	AT0805	ES-IFC	ENG.ST.SS.ELEC	CT- Substation Designer Generic
P&C Engineering		32	21-Jun-21	04-Aug-21					
P&C Engineering Preliminary Design		6	21-Jun-21	28-Jun-21					
PC270	Prepare and Issue P&C Eng Preliminary Design to Drafter	5	21-Jun-21	25-Jun-21		PC280, A2847		ENG.ST.P&C.P&C	CT- P&C Engineer Generic
PC280	Drafter SS P&C Engineering Preliminary Package back to Design	1	28-Jun-21	28-Jun-21	PC270	PC360, BT2605, PC440, A2782		ENG.ST.SS.ELEC	CT- Substation Design Drafter Generic
A2847	P&C Issues Preliminary Design Package	1	28-Jun-21	28-Jun-21	PC270	PC360, BT2605, PC440, A2782	ES-PRELIM	ENG.ST.P&C.P&C	CT- P&C Engineer Generic
P&C Engineering Detailed Design		13	29-Jun-21	16-Jul-21					
PC360	P&C Engineering Develops Detailed Design Package	5	29-Jun-21	06-Jul-21	PC280, A2847, A2770	PC370		ENG.ST.P&C.P&C	CT- P&C Engineer Generic
PC440	P&C Designer Develops RTU & ESCC Tab Sheets	5	29-Jun-21	06-Jul-21	PC280, A2847, A2770	PC370, PC450		ENG.ST.P&C.P&C	CT- P&C Engineer Generic
PC370	Drafter P&C Engineering Detail Package back to Design	5	07-Jul-21	13-Jul-21	PC360, PC440	PC390		ENG.ST.SS.ELEC	CT- Substation Design Drafter Generic
PC450	P&C Engineer Reviews & Comments on RTU & ESCC Tab Sheets	5	07-Jul-21	13-Jul-21	PC440	PC390		ENG.ST.P&C.P&C	CT- P&C Engineer Generic

TASK filter: All Activities

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Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors	Successors	Activity Flag	DEPT - DEPARTMENT	Resources
PC390	P&C Engineer Issues Detailed Design Package	3	14-Jul-21	16-Jul-21	PC370, PC450	PC400, BT1811	ES-DTL	ENG.ST.P&C.P&C	CT- P&C Engineer Generic
P&C Engineering IFC Design		13	19-Jul-21	04-Aug-21					
PC400	Designer Develops P&C Engineering IFC Design Package	5	19-Jul-21	23-Jul-21	PC390	PC410		ENG.ST.P&C.P&C	CT- P&C Engineer Generic
PC410	Drafter P&C Engineering IFC Package back to Design	5	26-Jul-21	30-Jul-21	PC400	PC430, PC460		ENG.ST.SS.ELEC	CT- Substation Design Drafter Generic
PC460	Designer Issues RTU & ESCC Tab Sheets	3	28-Jul-21	30-Jul-21	PC410	PC430		ENG.ST.P&C.P&C	CT- P&C Engineer Generic
PC430	P&C Engineer Issues IFC Design Package to the Field	3	02-Aug-21	04-Aug-21	PC410, PC460	BT0805	ES-IFC	ENG.ST.P&C.P&C	CT- P&C Engineer Generic
MATERIALS		44	17-Sep-21	19-Nov-21					
Electrical Material-Battery		44	17-Sep-21	19-Nov-21					
A2857	DR Entered for Battery	5	17-Sep-21	23-Sep-21	PAF1080	A2867	DR-AGMAT	ENG.ST.SS.ELEC	CT- Substation Designer Generic
A2867	PO Issued - Battery	1	24-Sep-21	24-Sep-21	A2857	A2877		PURC	Purchasing Department
A2877	Manufacture/ Fabricate/ Deliver Battery	56	25-Sep-21	19-Nov-21	A2867			PURC	T- Material Coordinator Generic, T- Material Coordinator Generic
Electrical Materials- Battery Monitor		44	17-Sep-21	19-Nov-21					
A2887	DR Entered for Battery Monitor and Harness	5	17-Sep-21	23-Sep-21	PAF1080	A2897	DR-AGMAT	ENG.ST.SS.ELEC	CT- Substation Designer Generic
A2897	PO Issued - Battery Monitor and Harness	1	24-Sep-21	24-Sep-21	A2887	A2907		PURC	Purchasing Department
A2907	Manufacture/ Fabricate/ Deliver Battery Monitor and Harness	56	25-Sep-21	19-Nov-21	A2897			PURC	T- Material Coordinator Generic
Electrical Material		44	17-Sep-21	19-Nov-21					
A2917	DR Entered for Battery Charger	5	17-Sep-21	23-Sep-21	PAF1080	A2927	DR-AGMAT	ENG.ST.SS.ELEC	CT- Substation Designer Generic
A2927	PO Issued - Battery Charger	1	24-Sep-21	24-Sep-21	A2917	A2937		PURC	Purchasing Department
A2937	Manufacture/ Fabricate/ Deliver Battery Charger	56	25-Sep-21	19-Nov-21	A2927			PURC	T- Material Coordinator Generic
Electrical Services		15	17-Sep-21	07-Oct-21					
A2820	DR Entered for Electrician	5	17-Sep-21	23-Sep-21	PAF1080	A2830		PURC	Purchasing Department

TASK filter: All Activities

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Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors	Successors	Activity Flag	DEPT - DEPARTMENT	Resources
A2830	Confirm PO Issued for Electrician	5	24-Sep-21	30-Sep-21	A2820	A2840, AT0814		PURC	Purchasing Department
A2840	Pre-Construction Conference	5	01-Oct-21	07-Oct-21	A2830	AT0203, BT0203		PM	CT- Project Manager Generic, Construction Substation Electrical
CONSTRUCTION		89	23-Aug-21	30-Dec-21					
Electrical Construction		89	23-Aug-21	30-Dec-21					
Equipment		89	23-Aug-21	30-Dec-21					
A2957	Lead time for Battery Trailer delivery	15	23-Aug-21	13-Sep-21	A2610	A2967, A2947		NH.SCHD	
A2947	Battery Trailer Confirmed on Site	0		13-Sep-21	A2967, A2957	AT0401		NH.CTMT	
A2967	Battery Trailer Needed Go/No Go!	0		13-Sep-21	A2957	A2947		NH.CTMT	
A1750	Install Conduit	1	03-Nov-21	03-Nov-21	AT00, BT00	A1760		CONS	Construction Substation Electrical
A1760	Install New Wires	1	04-Nov-21	04-Nov-21	A1750	A1500		CONS	Construction Substation Electrical
A1500	Install Battery Monitor	8	05-Nov-21	17-Nov-21	A1760	A1520		CONS	Construction Substation Electrical
Construction		39	03-Nov-21	30-Dec-21					
4997407-10	10 - GENERAL CONSTRUCTION	39	03-Nov-21	30-Dec-21	A2610, AT00, BT00	COMP, 4997407-20		CONS	Construction Substation Electrical
4997407-20	20 - ELECTRICAL CONSTRUCTION	39	03-Nov-21	30-Dec-21	4997407-10, BT00, AT00	COMP, 4997407-30		CONS	Construction Substation Electrical
4997407-30	30 - ELECTRICAL TEST	1	03-Nov-21	03-Nov-21	4997407-20	COMP		TEST	Test Vendor Generic
TEST AND COMMISSION		181	17-Sep-21	08-Jun-22					
P&C Test and Commission In-House		2	18-Nov-21	19-Nov-21					
A1520	Test New Battery Monitoring System	1	18-Nov-21	18-Nov-21	A1500	A1570		ENG.ST.SUBTECH.LCE	Test Vendor Generic
A1570	Witness and Sign Off on Test by Automation/Communication	1	19-Nov-21	19-Nov-21	A1520	COMP		CONS	Transmission Automation
P&C Test and Commission Contracted		82	17-Sep-21	18-Jan-22					
LCE100	PM to Request LCE & Test Vendor GO/NO-GO	1	17-Sep-21	17-Sep-21	PAF1080	LCE200, TSBID100		PM	CT- Project Manager Generic

TASK filter: All Activities

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Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors	Successors	Activity Flag	DEPT - DEPARTMENT	Resources
TSBID100	DR Entered for Test Services	5	20-Sep-21	24-Sep-21	LCE100	TSBID200		PURC	Purchasing Department
LCE200	Assign Lead Commissioning Engineer	1	20-Sep-21	20-Sep-21	LCE100	LCE320, LCE310		ENG.ST.SUBTECH.LCE	[redacted]
LCE320	Mobilize Testing Vendor Prior to Construction	2	21-Sep-21	22-Sep-21	LCE200	LCE400		TEST	Test Vendor Generic
LCE310	Mobilize LCE Prior to Construction	2	21-Sep-21	22-Sep-21	LCE200	LCE400		ENG.ST.SUBTECH.LCE	CT - Lead Commissioning Engineer
LCE400	Develop Test and Commissioning Plan	10	23-Sep-21	06-Oct-21	LCE320, LCE310	LCE500	V-COMPLN	TEST	Test Vendor Generic
TSBID200	Confirm PO Issued for Test Services	5	27-Sep-21	01-Oct-21	TSBID100			PURC	Purchasing Department
LCE500	Eversource LCE Review and Approve Testing and Commissioning Plan	10	07-Oct-21	21-Oct-21	LCE400	LCE620, LCE610	ES-COMPLN	ENG.ST.SUBTECH.LCE	CT - Lead Commissioning Engineer
LCE610	LCE Oversee Execution of Test and Commissioning Plan	10	22-Oct-21	04-Nov-21	LCE500			ENG.ST.SUBTECH.LCE	CT - Lead Commissioning Engineer
LCE620	Execute Test and Commissioning Plan	10	22-Oct-21	04-Nov-21	LCE500	ISD, LCE700		TEST	Test Vendor Generic
LCE700	LCE Ensure Test Group Prepare Electrical Field Mark Ups	1	05-Nov-21	05-Nov-21	LCE620	ISD		ENG.ST.SUBTECH.LCE	CT - Lead Commissioning Engineer
LCE800	LCE Ensures Marked up Prints Ready for Pick-up	1	03-Jan-22	03-Jan-22	ISD	LCE900		ENG.ST.SUBTECH.LCE	CT - Lead Commissioning Engineer
LCE900	LCE Review Test Data and Issue Commissioning Report	10	04-Jan-22	18-Jan-22	LCE800	9180		ENG.ST.SUBTECH.LCE	CT - Lead Commissioning Engineer
Communications Test and Commission		5	02-Jun-22	08-Jun-22					
Battery Monitor Settings		5	02-Jun-22	08-Jun-22					
PC475	Issue Battery Monitor Settings	5	02-Jun-22	08-Jun-22				ENG.ST.P&C.P&C	Construction Resources
PROJECT CLOSE OUT		110	30-Dec-21	08-Jun-22					
COMP	New Battery Monitoring Equipment Project - Work Complete	0		30-Dec-21	A2610, AT00, BT00, 4997407-10, 4997407-20	ISD, 9999, A1630, A1700, A1670, 9150, 10049, A1680		CONS	
ISD	New Battery Monitoring Equipment Project - In Service (ISD)	0		30-Dec-21	LCE620, LCE700, COMP	LCE800	ISD	CONS	
9999	New Battery Monitoring Project Completion	10	25-May-22	08-Jun-22	COMP, A1670	END		PM	CT- Project Manager Generic
END	New Battery Monitoring Equipment Install Project - Close Out Tasks Complete	0		08-Jun-22	9999, A2842			CONS	
Electrical Close Out		16	03-Jan-22	25-Jan-22					

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Activity ID	Activity Name	Original Duration	Start	Finish	Predecessors	Successors	Activity Flag	DEPT - DEPARTMENT	Resources
9150	FE Scan Field Marks and Send to SS Electrical Engineer	2	03-Jan-22	04-Jan-22	COMP	9160	ES-FLDASB	ENG.ENGR.FIELD	
9160	Engineering Reviews & Approves As-built Markups	3	05-Jan-22	07-Jan-22	9150	9180		ENG.ST.SS.ELEC	CT- Substation Designer Generic
9180	ES Designer/Drafter Finalizes Asbuilts & Signs into Adept	2	19-Jan-22	20-Jan-22	LCE900, 9160	9190	ES-ASB	ENG.ST.SS.ELEC	CT- Substation Designer Generic, CT- Substation Design Drafter Generic
9190	ES Prepares Electrical As-Built Package and Issues to Field	3	21-Jan-22	25-Jan-22	9180	9195		ENG.ST.SS.ELEC	CT- Substation Designer Generic, CT- Substation Design Drafter Generic
P&C Close Out		11	03-Jan-22	18-Jan-22					
10049	FE Scan Field Marks and Send to P&C Engineer	2	03-Jan-22	04-Jan-22	COMP	10059	ES-FLDASB	ENG.ENGR.FIELD	
10059	P&C Engineering Reviews & Approves As-built Markups	3	05-Jan-22	07-Jan-22	10049	10069		ENG.ST.P&C.P&C	CT- P&C Engineer Generic
10069	P&C Designer/Drafter Finalizes Asbuilts & Signs into Adept	3	10-Jan-22	12-Jan-22	10059	10084	ES-ASB	ENG.ST.P&C.P&C	CT- P&C Engineer Generic, CT- Substation Design Drafter Generic
10084	P&C Prepares Package and Forwards to Doc Control for Printing	3	13-Jan-22	18-Jan-22	10069	10089		ENG.ST.P&C.P&C	CT- P&C Engineer Generic
Work Order / Financial Close Out		90	03-Jan-22	10-May-22					
A1630	Foward Documents to Plant Accounting	1	03-Jan-22	03-Jan-22	COMP	A1670		PM	CT- Project Manager Generic
A1700	Perform Material Reconciliation & Work Order Analysis	90	03-Jan-22	10-May-22	COMP	A1670		PM	CT- Project Manager Generic
Project Management Close Out		100	03-Jan-22	24-May-22					
10089	PM Verifies P&C As-Builts Complete	3	19-Jan-22	21-Jan-22	10084		ES-FLSASB	PM	CT- Project Manager Generic
9195	PM Verifies Electrical As-Builts Complete	3	26-Jan-22	28-Jan-22	9190		ES-FLSASB	PM	CT- Project Manager Generic
A1670	Complete Project Closout Forms	10	11-May-22	24-May-22	A1700, A1630, COMP	9999		PM	CT- Project Manager Generic
Cascade Forms (IF REQUIRED)		36	03-Jan-22	23-Feb-22					
A1680	Con-Rep Complete CASCADE Forms for Installed Equipment	1	03-Jan-22	03-Jan-22	COMP	A1690		CONS	Construction Resources
A1690	Review + Accept CASCADE Forms for Database Entry	5	04-Jan-22	10-Jan-22	A1680	A2842		OPS	[redacted]
A2842	Assett Management Completed Assets Updates in CASCADE	30	11-Jan-22	23-Feb-22	A1690	END		OPS	

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Constructability Review Form: **Substation**

Project Title: Battery Monitor – [redacted]	☐	Prior Constructability Review Performed?
	☐	Program Related Site Specific Review?
Project Numbers(s): CS004481	**Project Constructability Phase:**	
Date(s) of Constructability Review: **01/28/2021** Click to enter a date	☐ Conceptual Engineering Design ☒ Preliminary Engineering Design ☐ Detailed Engineering Design	
Project Scope Statement: **Review of Battery Monitor Installations with Real Power & Construction**		

Department Review/Walkdown Attendees*:

Required [X]	Attended [X]	Department	Name	Required [X]	Attended [X]	Department	Name
☒	☒	Project Management	[redacted]	☒	☒	S/S Engineering	[redacted]
☐	☒	Civil Construction		☒	☒	S/S Engineering	
☐	☐	Asset Management		☒	☒	S/S Engineering	
☒	☒	S/S Technical / LCE		☐	☐	P&C Engineering	
☐	☐	Constr. Management		☐	☐	Civil Engineering	
☐	☐	Test/LCE		☐	☐	Telecom	
☐	☐	S/S Operations**		☐	☐	Environmental	
☐	☐	Field Engineering		☐	☐	Real Estate	
☐	☐	Line Engineering		☐	☐	T&D ROW	
☐	☐	Vegetation Management		☐	☐	Survey Engineering	
☐	☐	Siting		☐	☐	Real Power	
☐	☐	Safety		☐	☐	Real Power	
☐	☐	SCADA		☐	☐	Real Power	

*** Sign-off in the table above for the Detailed Engineering Design Constructability Review indicates that all Action Items/Concerns from prior Constructability Reviews have been mitigated/resolved as documented in this form. Not every department is required to attend walkdowns for every project but should be consulted for project impact considerations**

** Internal Eversource Substation Operations must be included in the review even if external construction resources are planned

[Project Manager] certifies that this review was performed to completeness, that all applicable departments were informed of the project and have had opportunity to provide input to this review:

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Constructability Review Form: **Substation**

[redacted] 1/28/21 *Name / Signature*

Date

Documents available for use prior to Constructability Review					
[X]	Document	[X]	Document	[X]	Document
☒	Initial Scope -Birdseye site plan -General Arrangement	☐	Preliminary Drawings -Civil Site Drawing -Electrical Drawing -Section Drawings	☒	Prints in hand for marking up -Panel Front/Read View -Control Enclosure Layout -Floor / Wall Plans
☒	Detailed Scope Document	☐	Proposed Schedule	☐	Construction Sequence/Timeline
☐	Previous Notes / Comments / Observations	☒	Major Material / Equipment List	☐	Replace / Reuse of equipment

Action Items and Resolutions:

Item No.	Const. Review Action Item/Concern	Design Resolution/Mitigation:
1		
2		
3		
4		
5		

	Key Review Item Description	N/A or No Concern	Review Notes, Concerns, or Additional Info Needed
A	**Engineering & Asset Management**		
1	**Scope of Work** - Is scope adequately developed and sufficiently detailed for intended deliverable? - Any complimentary projects or other adjacent obsolete equipment for inclusion? - Any overlapping projects that could impact work/outages? - Consider Physical Installation, P&C Scope, Civil Scope, Engineering studies, Design standard adherence - Any remote station impacts?	☐	Battery Monitor installation including review of wall space for monitor and junctions box, review security cabinet and communication (SCADA) cabinet for available points. Determine if battery cart is required.

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Constructability Review Form: **Substation**

	Key Review Item Description	N/A or No Concern	Review Notes, Concerns, or Additional Info Needed
	- Engineering Estimates for Design and Technical Support? (EE and EOC) Total Project		
2	**Materials Identified/Ordered** -Any concerns with BOM/Major Materials? Review BOM lead times and project need dates -Specialty Major Materials: Identify Specialty Equipment & Materials potentials - temporary/replacement - long lead items? -Any Materials needed to facilitate construction access?	☐	Battery Monitor will be longest lead item, all other equipment should be readily available.
3	**Control House** - Review Unmapped equipment interferences, Control/Battery Enclosure Layout, HVAC System (if equipment added), space for new or modified equipment, AC / DC station breaker availability and service loading, Panel Space, Expansion, one-line and/or riser type panelboard drawings, other..	☐	Reviewed AC panel spacing if Battery Cart is needed.
4	**Ratings & Dimensions** for Major Equipment. Any concerns upon field review? Equipment Rating One Line (and/or equipment thermal ratings tables) - Review for any errors in field	X	

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Constructability Review Form: **Substation**

	Key Review Item Description	N/A or No Concern	Review Notes, Concerns, or Additional Info Needed
5	**Wall, Fence, Gate, and Foundation Considerations** -Any permanent / temporary alterations or relocations required? -Pre-Project Sound Measurements Needed? Sound Walls? -Take measurements for Foundation quantities, dimensions and concrete volumes -CIP Review/Ballistic needs. Any Physical Security Requirement Consideration? -Assess condition of existing yard equipment foundations and viability for reuse (if proposed) -Review station expansion areas (if needed) for structures, old foundations, etc. -Any Steel Structural Plan Considerations? -Any impacts to construction plan?	X	
6	**Below Grade / Enclosure Raceway** - If possible, evaluate existing raceway and review spacing requirements. Review for any subsurface investigation needs or potential below grade obstructions. GPR/test pits needed? Geotechnical Investigation - is soil boring or resistivity investigation needed?	X	
7	**Underground Obstructions** -Drawing review concerns? -Is preconstruction or test excavation needed? -Is reuse of underground control cables / Conduits /replace Non-Shielded Cable feasible (if applicable) -Are spare conduits available? Are they useable? -Review if any areas will need to be plated for increased load bearing for equipment access (i.e. large Xfmr, etc.)	X	
8	**Grounding Plan (Ground Grid)** - Will footprint impact layout or other equipment? Identify locations to improve grounding. Impacts to foundations and ground grid plans. Observations on wetlands or ability to perform tests	X	

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Constructability Review Form: **Substation**

	Key Review Item Description	N/A or No Concern	Review Notes, Concerns, or Additional Info Needed
9	Nomenclature / Switching One-Line Diagram -Any obvious deviations from diagrams provided?	X	
10	BPS Separation Requirements - Is this BPS Substation? Y/N (part of PAF) - Changes to pre-existing BPS standards?	☐	Identify if Primary & Backup are separated and maintain separation.
11	IEC 61850 Substation Automation and Communication Requirements - Any Impacts/Retrofit needed?	X	
12	Any Upgrades to ES Standards - Is retrofit needed to bring up to ES standards? Can that be done?	X	
B	**Construction**		
1	**Any safety hazards specific to the facility? i.e. Low Bus, Deterioration, etc.**	☐	Identify if Lead Paint or ACM flooring of other tiles.
2	**Prior known Site Specific Conditions** -Common or Obvious station Issues -Missing scope items that could impact costs?	X	
3	**Identify/Consider Required Depts for Construction?** -Who is constructor: Internal vs External Resources -S/S Ops, GO, Test, Field Engineering, etc -Specialty Contractors Required? -Required Oversite Needed - Estimated level of CR and LCE support needed	☐	Consult with Internal Construction and Area Work Centers or District for construction. Real Power to install Battery Monitors

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Constructability Review Form: **Substation**

	Key Review Item Description	N/A or No Concern	Review Notes, Concerns, or Additional Info Needed
4	**Site Plan, Access, and Temporary Construction Facilities:** -Confirm maintenance access for proposed new or replaced equipment -Verify clear footprint for yard equipment / Property Plan -General access to site, can areas outside substation be utilized? -Substation Entry Plan (driveway and drive path modifications) - Identification of Unique Requirements, i.e. (access bridges, station service, etc.) -Site Development Plan (grading and drainage) with Cut/Fill -Existing Rock Conditions? Potential Impacts (rock quantity)? -Any police details needed for deliveries, restricted hours, and/or need for extended hour approvals -Any Sanitary Civil Requirements? (Septic tanks, etc) -Review turning radius for delivery trucks (if critical) -Any Substation Access and site/yard access Limitations? -Office Trailer Needs: Facilities, Utilities, Restroom, Container, Dumpster Space -Weather impacts to Site (Snow Placement) -Identify Material Laydown and Security -Where will new vs removed equipment go? -Construction permit for trailers outside substation fence?	X	
5	Unique Equipment Considerations: Gas insulated substation, Gas insulated line, Gas insulated bus, Pass Breaker, Statcom, Sync Condenser	X	

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Constructability Review Form: **Substation**

	Key Review Item Description	N/A or No Concern	Review Notes, Concerns, or Additional Info Needed
6	**Outage & Energization Plan and Construction Sequence:** *Review electrical working clearances for equipment during construction, Detailed look at protection zone changes, Locked sequence or random outages, Outage durations minimized.* ***Considerations:*** -Approach Distances – Outage Requirements to maintain electrical clearances throughout proposed installation -Distribution Clearances -Clearance Holder Assignments -Drawings vs Field Conditions -Outage boundaries and interconnections -Phased approach needs for additional mobilizations -Verify outage sequence supports the planned construction sequence and timeline. (Lead Commissioning Engineer "LCE", Substation Operations, and Outage Planner input) -Any design alterations or considerations to Eliminate SCLL Conditions, Reduce Recall Time, Reduce Outage durations, Special Conditions -Additional outage requirements: Railroad Catenaries, Fiber outage, SCADA outage, Relay permissions -Seasonal or weather conditions impacts	X	
7	**Equipment Testing & Acceptance** -Grounding plans / Resources? Will we need grounds hung? -Hi-pot testing and where will the equipment be set up?	☐	S/S Tech Engineering to commission and Real Power to test
8	Need for mobile generator and where connected (if needed)	X	
9	Need for mobile battery and where connected (if needed)	☐	Portable Battery is not needed.
10	OT work required or Notable Permit Conditions (special hours)?	X	
11	Coordination of boundaries/seams (Identification of point of demarcation for connection to existing equipment and/or for coordination with other municipalities)	X	

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Constructability Review Form: **Substation**

	Key Review Item Description	N/A or No Concern	Review Notes, Concerns, or Additional Info Needed
C	**Environmental**		
1	Soil Pre-Characterization or Grab Sampling Completed/Planned	X	
2	**Desktop investigation and EAD Review** -Required Permits -Stormwater Considerations -Dewatering requirements -Wetland and buffer review	X	
3	Risk or presence of PCB's/Asbestos/Lead/SF6	☐	Review if Lead Paint or ACM are present
4	Transformer Spill Containment Recommended?	X	
5	Expanding Footprint / New Buildings or future Expansion Plans? (Enviro Impact)	X	
6	Environmental oversight considerations? (Inspection type/Interval)	X	
7	Environmental mitigations - Any matting or seasonal needs? Review D&M Plan with CR.	X	
D	**Siting, S&CS, and T&D Real Estate**		
1	**Any regulatory concerns or approvals needed?** - Consider scope/design alterations to mitigate concerns - Consider Visual screening considerations (feasibility or location) -Zoning Relief and Permits required	X	
2	**Neighbor/Abutter impacts:** - Any noise, visual impacts, or sensitive abutters - Any changes to lighting or additional lighting needed?	X	
3	Review for roadway, gate access, trailers, equip height, noise, weekend/night work, or any potential public disturbance related to work	X	
4	Installation within Eversource Rights - Is Rights and Restrictions Review required?	X	
5	Expanding Footprint / New Buildings or future Expansion Plans?	X	
6	Proposed Equipment on same property? - Any Encroachments	X	

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Constructability Review Form: **Substation**

	Key Review Item Description	N/A or No Concern	Review Notes, Concerns, or Additional Info Needed
F	**Protection & Controls**		
1	Panel Graphic additions and/or Modifications	X	
2	Space on existing panels for new equipment? (front & rear of panel fronts)	X	
3	Panel fronts conform to drawings	X	
4	Access to bring new panels into control enclosure	X	
5	Nameplate list and location of nameplates	X	
6	Verifies that relays and meters that will be an interconnected project work are as shown on the drawings.	X	
7	Temporary protection, relays, control cable needed? How long will they be required?	X	
8	Will relay setting changes be needed? Any additional outage requirements for changes?	X	
G	**Telecom Engineering**		
1	Review telecom equipment in existing control enclosure	☐	Review for available SCADA Points
2	Review path to get telecom circuits into the station and paths within the control house. Determine whether new underground duct or overhead tray work is needed.	☐	Review path within substation
3	Review current or proposed Telecom equipment power connections and validate with P&C any need for system 1 and system 2 separation.	X	
4	Review current Telecom fiber diversity and validate with P&C any fiber diversity requirements.	X	
5	Review and list any remote station impacts/updates	X	
6	Confirm whether correct interface equipment is available (i.e.) for fiber termination or multiplexor termination	☐	Available Spares reviewed
7	Confirm whether existing communications cabinets are enough to support additional telecommunications equipment installed	☐	Review internet switches

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Constructability Review Form: **Substation**

	Key Review Item Description	N/A or No Concern	Review Notes, Concerns, or Additional Info Needed
8	Review space for any required additional communications cabinets which may be required to support additional telecommunications equipment installed	X	
9	Review third party Telecommunications at substation and confirm whether additional capacity or Ground Potential Rise protection is required	X	

Photos

(Ex. Equipment control cabinet, Breakers, MODs, CCVTs, PTs, Transformers)

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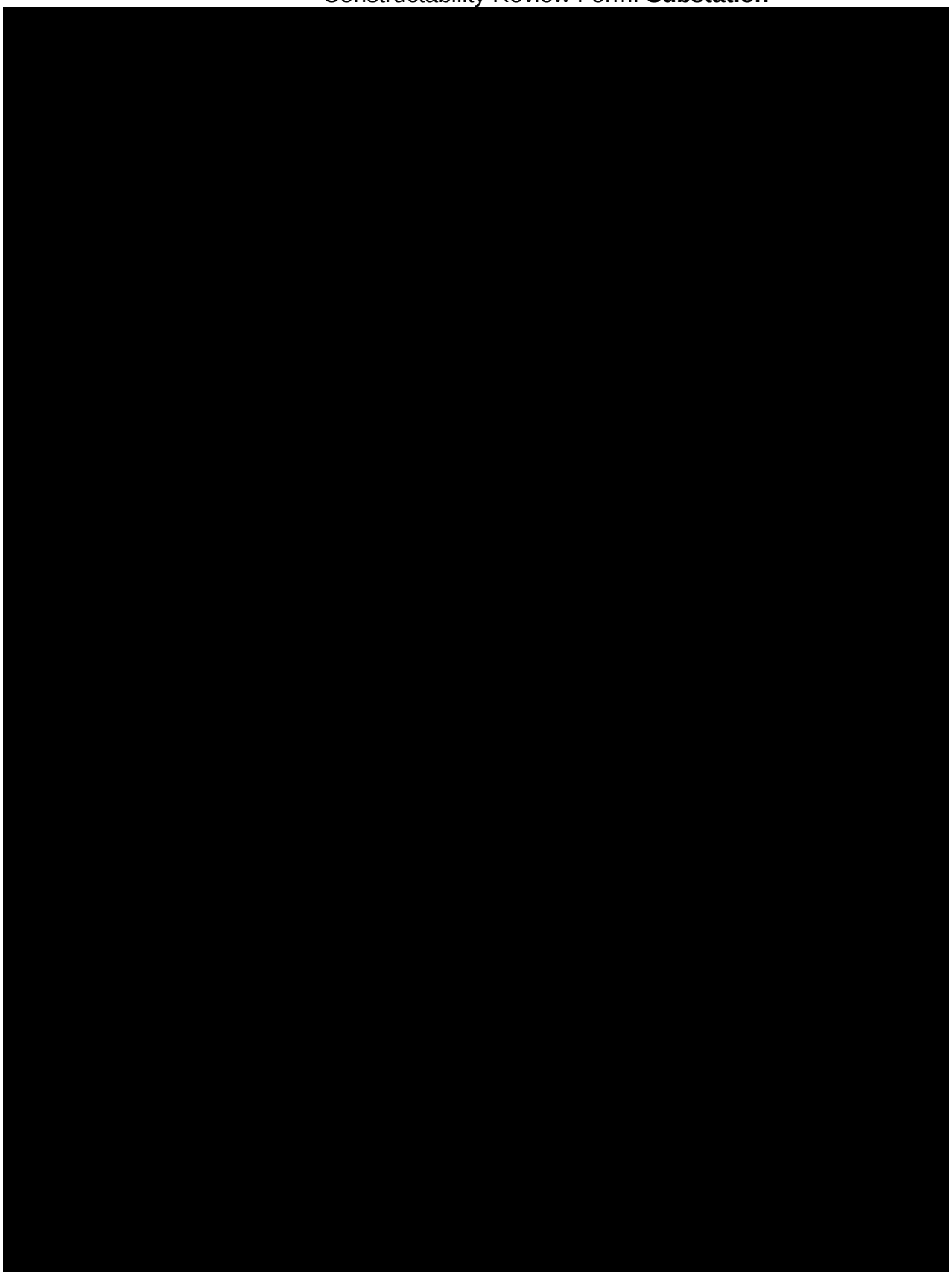
Constructability Review Form: **Substation**



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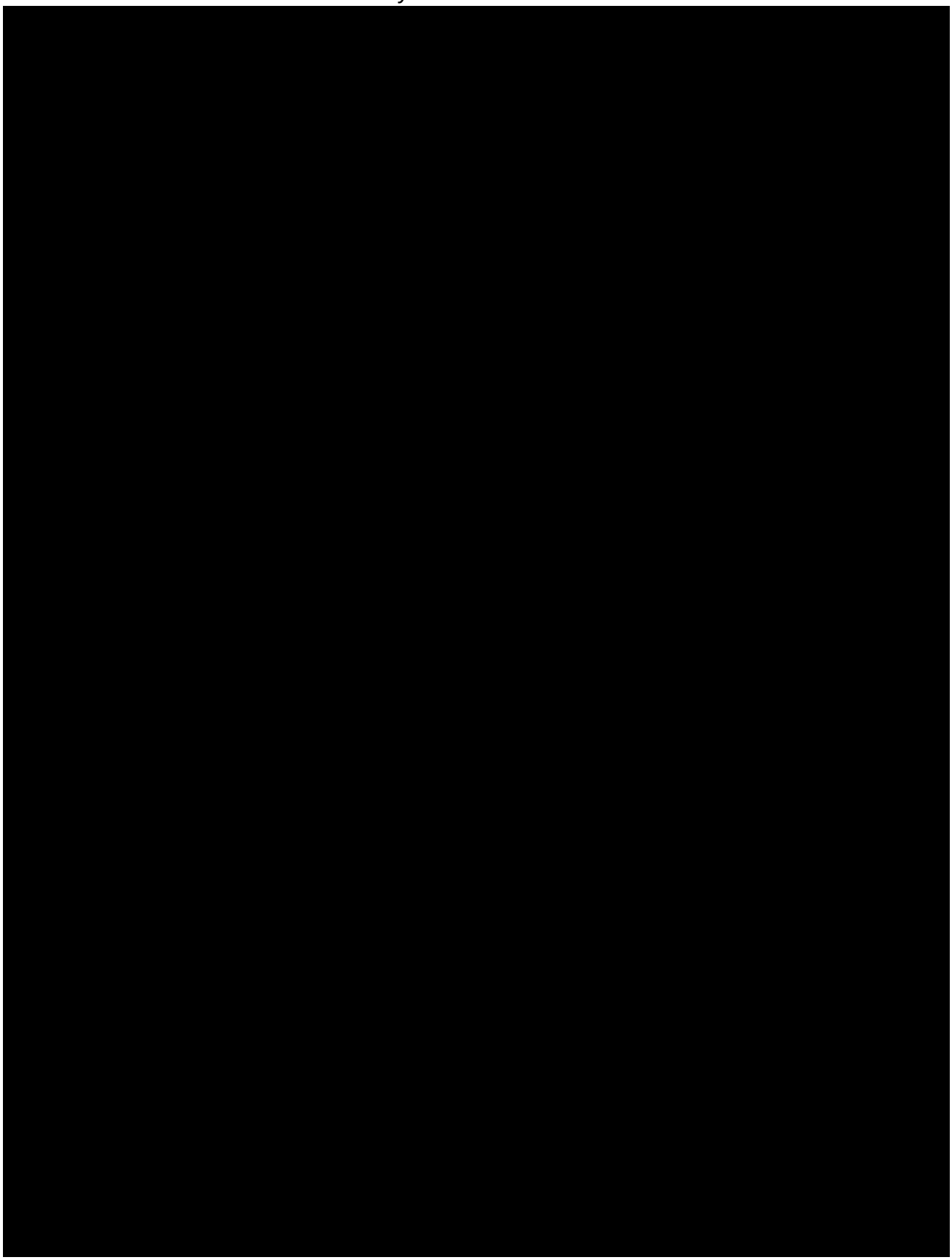
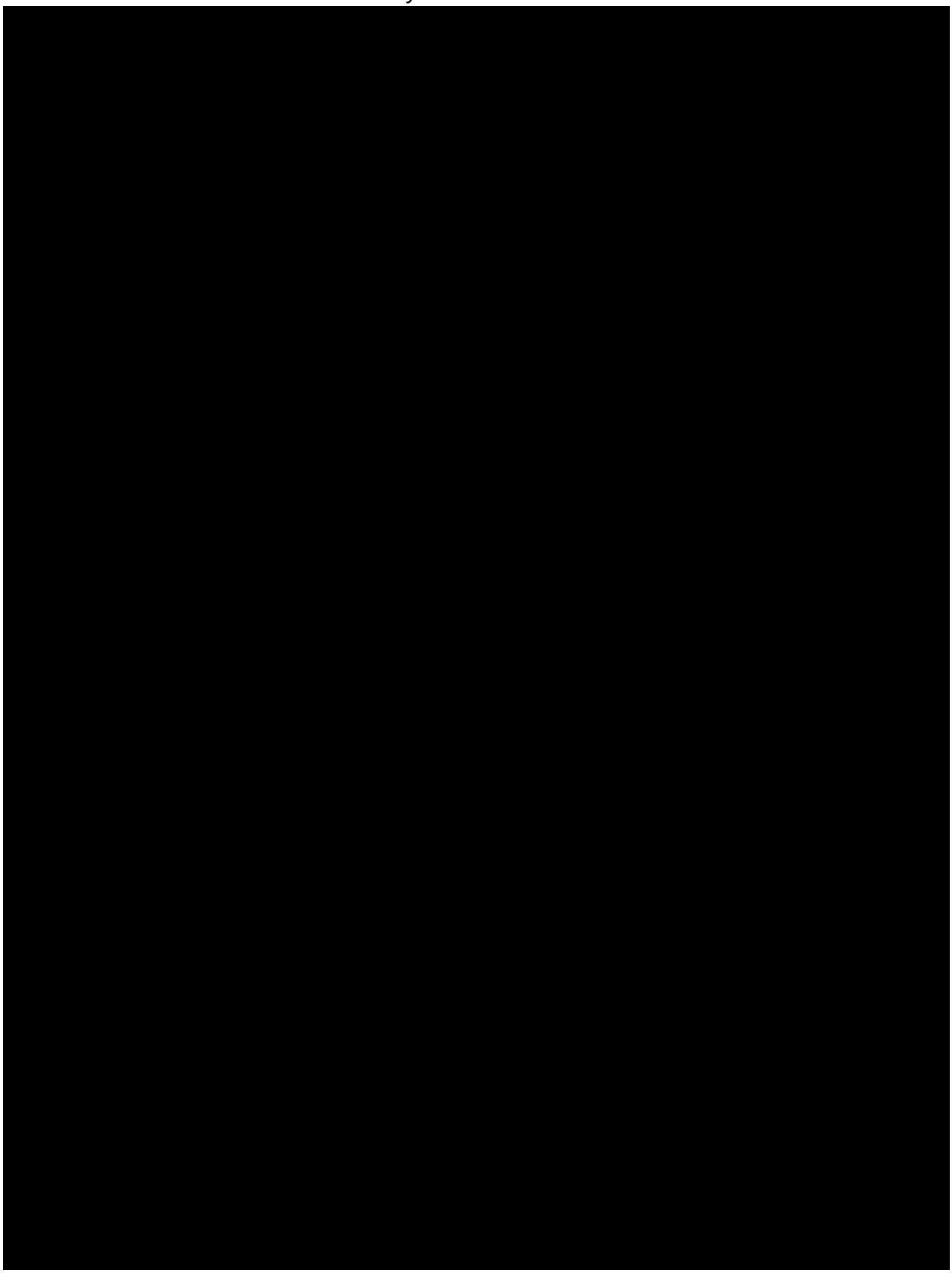
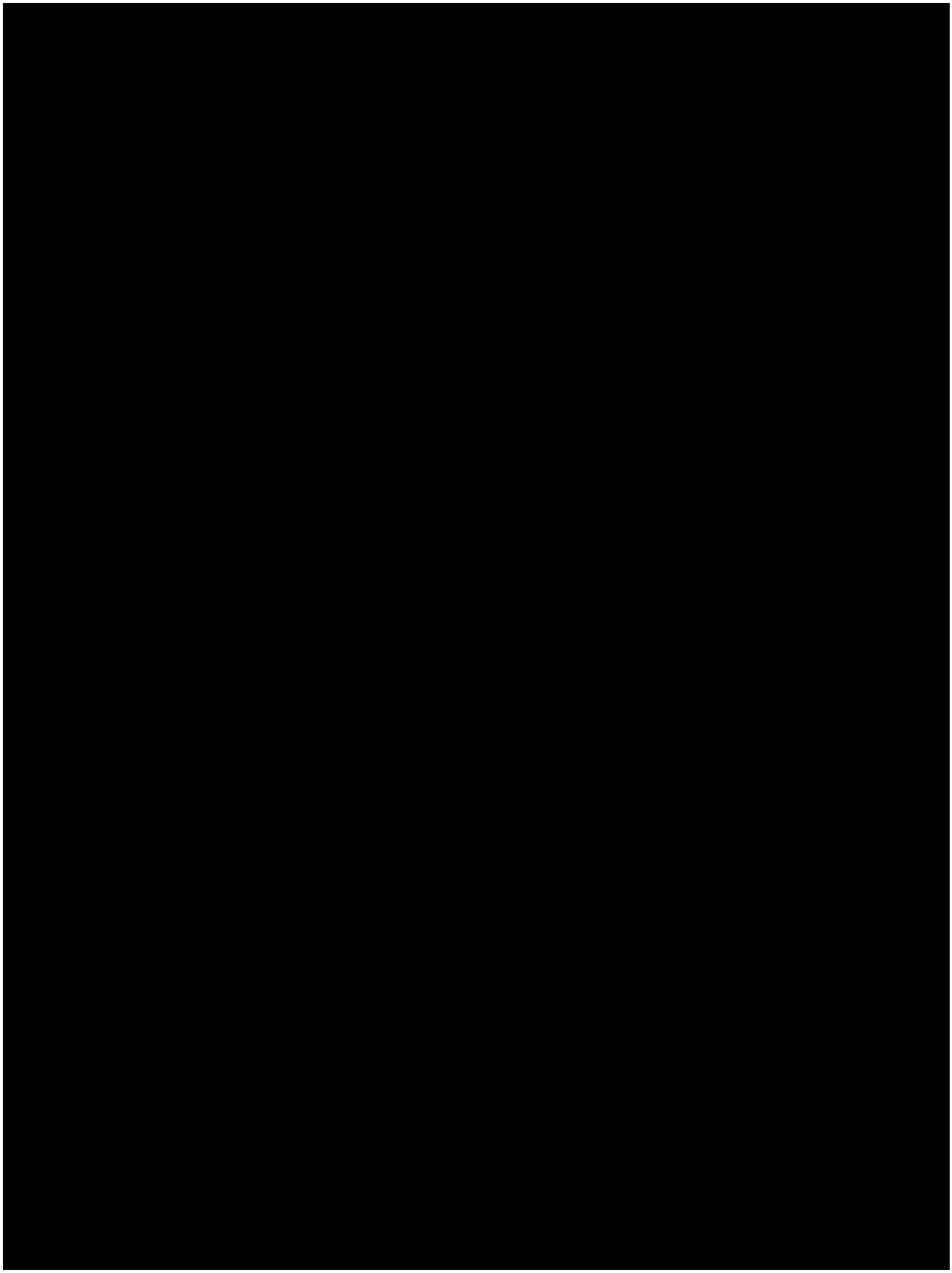
Constructability Review Form: **Substation**



EVERSOURCE

Constructability Review Form: **Substation**





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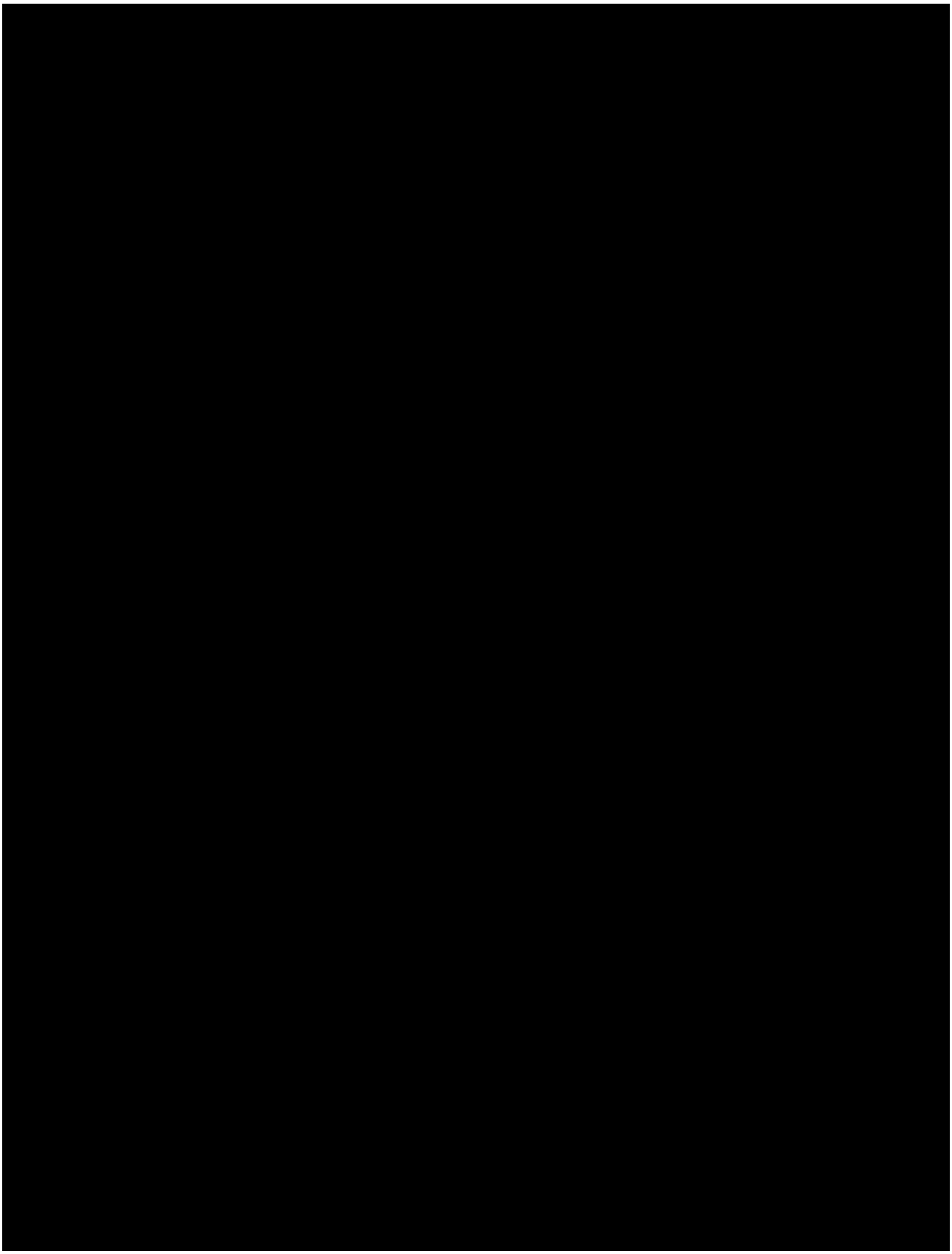
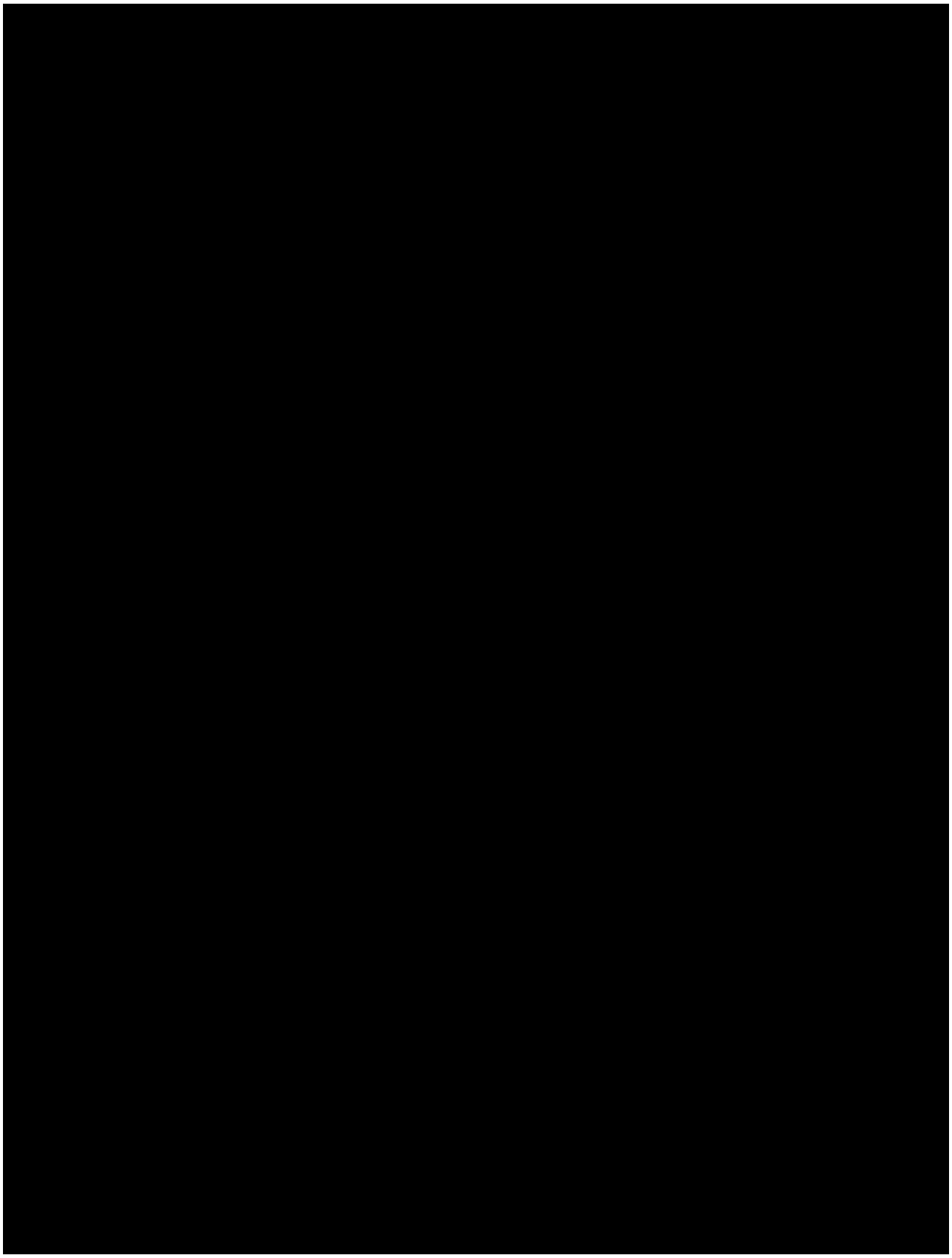
Constructability Review Form: **Substation**



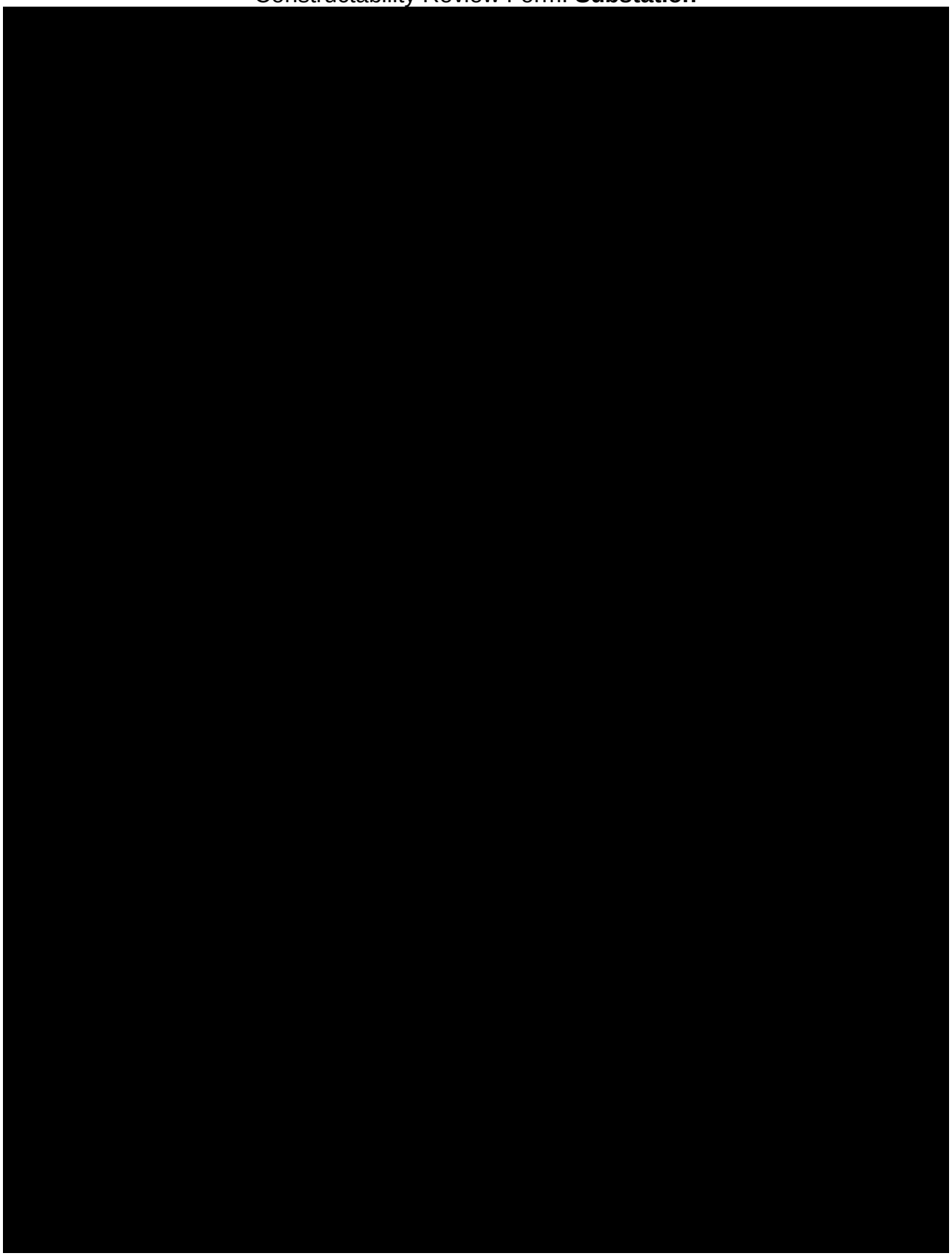
EVERSOURCE

Constructability Review Form: **Substation**



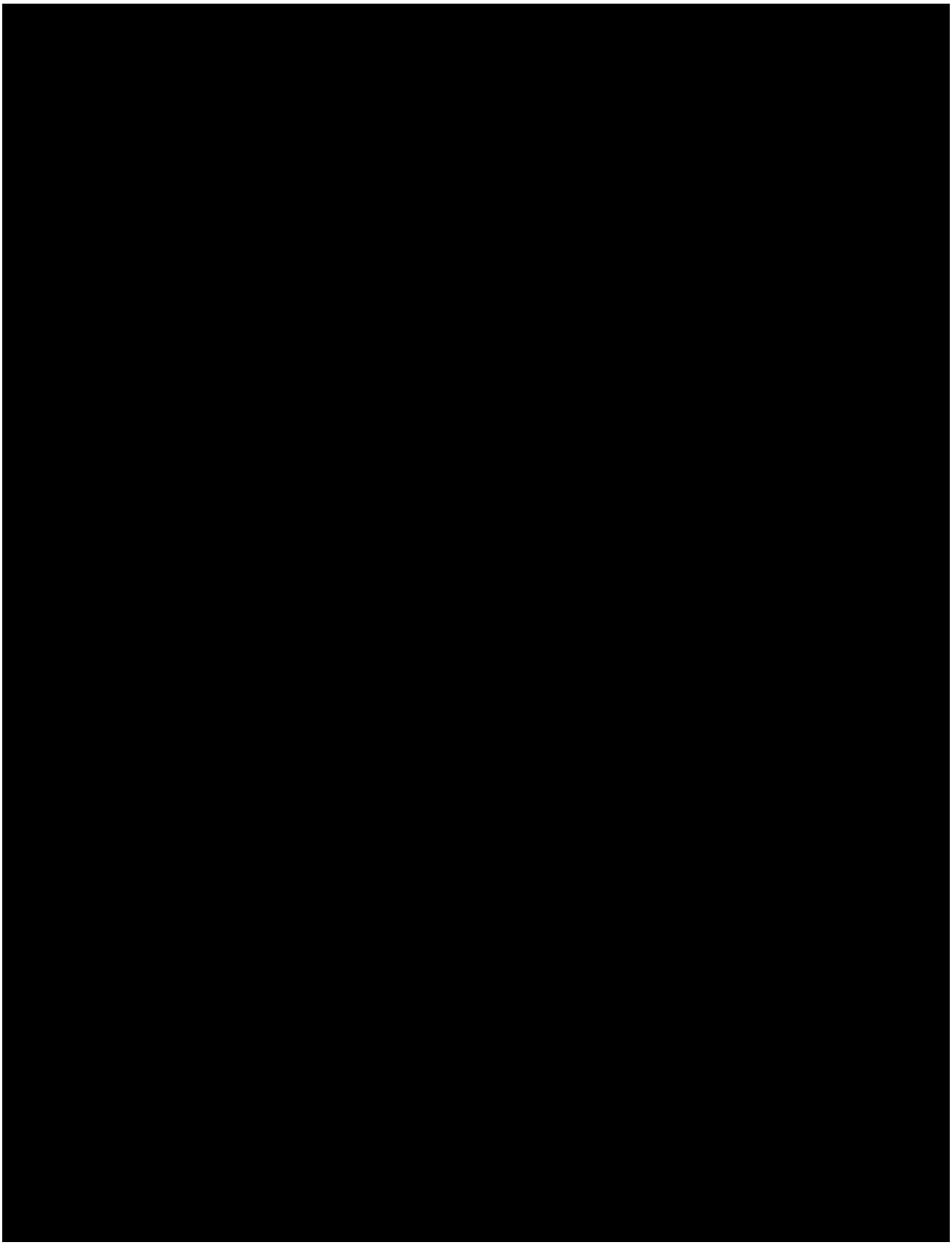
EVERSOURCE

Constructability Review Form: **Substation**



EVERSOURCE

Constructability Review Form: **Substation**



EVERSOURCE

Constructability Review Form: **Substation**

EVERSOURCE

Operations Program Level Project Authorization Form

Approved at July 21, 2021 EPAC
Link to Meeting Minutes

Date Prepared: 05/17/2021 (Rev. 0), 7/14/2021 (Rev. 1)	**Program Title: BES Battery Monitor Installation Program**
Companies: Eversource CT, WMA, NH, EMA	**Project Number (by state):** **Distribution - 20346 (EMA), CS00428 (CT), WS00080 (WMA), NS00002 (NH)** **Transmission - 21163 (EMA), 405229 (CT), 405230 (WMA), T1431A (NH)**
Organization: Asset Management	**Class(es) of Plant: D SS and T SS**
Project Initiator: [redacted]	**Project Category: Stations - Monitoring - Batteries**
Project Manager: [redacted]	**Project Type: Program**
Project Sponsor: [redacted]	**Project Purpose: Install Battery Monitors at BES Stations**
Estimated in service date: December 2023 for full program	**If Transmission Project: PTF/Non-PTF?** **See associated Program Release Forms**
Eng. / Constr. Resources Budgeted? Yes	**Capital Investment Part of Original Operating Plan? Yes**
Authorization Type: Program Approval	**O&M Expenses Part of the Original Operating Plan?** **See associated Program Release Forms**
Initial Funding Request: N/A	**Estimated Program Value (by State):** **CT D $4.7M ($116K Unit cost/monitor) – T $.7M ($93K Unit cost/monitor)** **EMA D $/Unit TBD – T $/Unit TBD** **NH D $/Unit TBD) – T $.4M ($100K Unit cost/monitor)** **WMA D $/Unit TBD – T $.6M ($120K Unit cost/monitor)**

Financial Requirements:

Project Authorization

ERM: _____

FP&A: _____

Executive Summary

Revision History

- Rev_0: Total number of stations and systems updated. CT Transmission and Distribution, NH Transmission and WMA Transmission unitized costs established. Unitized costs for the remaining territories will be brought for approval in subsequent revisions.
- Rev_1: Remove from scope - control house environmental evaluation and enhancements. Removed due to the extensive work involved. It is more efficient to coordinate with battery replacement projects.

This Program Level Project Authorization Form (PAF) request establishes a Program that will install Bulk Electric Substation (BES) Battery Monitors for all remaining Eversource (ES) BES batteries. North American Electric Reliability Corporation (NERC) Std. PRC-005-2 requires periodic maintenance and testing practices of BES system protection elements which includes station batteries and chargers. This includes various visual and physical inspections, as well as measurement and analysis of cell and connection resistance to identify potential problems. The latter test consists of multiple measurements of each cell (typically 60 per bank) at hundreds of stations company-wide each year. The battery monitoring program will design and install battery monitors at all remaining Transmission and Distribution BES substations to maintain compliance more efficiently with NERC Standard PRC-005-2. The installation of battery monitors will alleviate annual testing (voltage and ohmic measurements) as required by PRC-005 and provide a more comprehensive overview of system health.

Over 100 Eversource CT, WMA, EMA, and NH BES system sites rely on approximately 230 battery systems that support BES relay protection systems. The Program had a total of $400K ($50K each - Distribution (EMA, CT, WMA and NH; $50K each for Transmission (EMA, CT, WMA and NH) of initial funding approved in PowerPlan between December 2020 and February 2021. The approved Initial Funding Request (IFR) provides $100K each for the CT/WMA/EMA/NH regions to perform constructability reviews ($30K), engineering evaluations ($30K), project management ($20K), and cost estimating and PAF development support ($20K). In accordance with the IFR, 123 un-monitored BES battery systems at 100 substations were identified across all three (3) states. Currently nine (9) stations with ten (10) systems have been removed from this Program due to completion of the work as part of other projects. Also, as part of Program Level PAF Rev. 0, WMA added two (2) stations with two (2) systems that were not included in the original list at the time of the IFR. The current total is 93 stations with 115 systems. This Program is modeled after the TPS-16-164-T (Legacy NU, Transmission only) program completed in 2018 by using a region-based unitized scope cost. See attached Table 1 for a list of the stations included in the Program.

The funds approved for the IFR Program PAF will be used to develop individual project releases for full funding to complete the remaining battery monitor installations at all project sites not considered in the 2018 Program initiative. Some sites will require multiple monitor installations on Distribution Assets, with some on Transmission Assets. However, most sites require monitoring on Distribution Assets only in this Program.

Financial Unit Cost Evaluation (CT Distribution Substation Monitors)

Note: Dollar values are in thousands and are unit level costs for Program PAFs

Line item Category	Year 1	Total
1. ROW / Easements / Land Acquisition		
2. Environmental Approvals / Permits		
3. Outreach		
4. Siting Approvals / Permits		
5. Engineering / Design	$8	$8
6. Materials (Eversource purchased)	$3	$3
7. Construction (incl matl's by contractors)	$37	$37
8. Testing / Commissioning	$1	$1
9. Project Mgmt Team	$6	$6
10. Removals		
11. Other		
12. Risks	$9	$9
SUBTOTAL DIRECTS W/ RISKS	**$64**	**$64**
13. Indirects/Overhead	$47	$47
14. AFUDC	$1	$1
PROJECT TOTAL – BASELINE BUDGET	**$112**	**$112**
15. Contingency	$5	$5
TOTAL CAPITAL REQUEST	**$116**	**$116**
16. Reimbursables/Customer Contribution		
PROJECT TOTAL (LESS REIMBURSABLES)	**$116**	**$116**
O&M		
Total Request	**$116**	**$116**

Risk of $9K is included for the following: building obstructions ($4.5K) and delays ($4.5K)

Unit Breakout Costs

Note: Dollar values are in thousands

Line item Category	Year 1	Total
ST Labor	$12	$12
OT Labor		
Outside Services Labor	$29	$29
Materials*	$13	$13
Removals		
Other	$14	$14
Indirects	47	47
AFUDC	$1	$1
TOTAL REQUEST	**$116**	**$116**

*All materials including Eversource purchased and outside service purchased. Note that outside service purchased material included in construction in unit cost evaluation above.

Financial Unit Cost Evaluation (CT Transmission Substation Monitors)

Note: Dollar values are in thousands and are unit level costs for Program PAFs

Line item Category	Year 1	Total
1. ROW / Easements / Land Acquisition		
2. Environmental Approvals / Permits		
3. Outreach		
4. Siting Approvals / Permits		
5. Engineering / Design	$8	$8
6. Materials (Eversource purchased)	$2	$2
7. Construction (incl matl's by contractors)	$27	$27
8. Testing / Commissioning	$1	$1
9. Project Mgmt Team	$6	$6
10. Removals		
11. Other		
12. Risks	$6	$6
SUBTOTAL DIRECTS W/ RISKS	**$50**	**$50**
13. Indirects/Overhead	$40	$40
14. AFUDC	$0	$0
PROJECT TOTAL – BASELINE BUDGET	**$90**	**$90**
15. Contingency	$3	$3
TOTAL CAPITAL REQUEST	**$93**	**$93**
16. Reimbursables/Customer Contribution		
PROJECT TOTAL (LESS REIMBURSABLES)	**$93**	**$93**
O&M		
Total Request	**$93**	**$93**

Risk of $6K is included for the following: building obstructions ($3K) and delays ($3K)

Unit Breakout Costs

Note: Dollar values are in thousands

Line item Category	Year 1	Total
ST Labor	$22	$22
OT Labor		
Outside Services Labor	$19	$19
Materials*	$2	$2
Removals		
Other	$10	$10
Indirects	$40	$40
AFUDC	$0	$0
TOTAL REQUEST	**$93**	**$93**

*All materials including Eversource purchased and outside service purchased. Note that outside service purchased material included in construction in unit cost evaluation above.

Financial Unit Cost Evaluation (NH Transmission Substation Monitors)

Note: Dollar values are in thousands and are unit level costs for Program PAFs

Line item Category	Year 1	Total
13. ROW / Easements / Land Acquisition		
14. Environmental Approvals / Permits		
15. Outreach		
16. Siting Approvals / Permits		
17. Engineering / Design	$13	$13
18. Materials (Eversource purchased)		
19. Construction (incl matl's by contractors)	$28	$28
20. Testing / Commissioning	$2	$2
21. Project Mgmt Team	$5	$5
22. Removals		
23. Other		
24. Risks	$6	$6
SUBTOTAL DIRECTS W/ RISKS	**$55**	**$55**
13. Indirects/Overhead	$42	$42
14. AFUDC	1	1
PROJECT TOTAL – BASELINE BUDGET	**$98**	**$98**
15. Contingency	$2	$2
TOTAL CAPITAL REQUEST	**$100**	**$100**
16. Reimbursables/Customer Contribution		
PROJECT TOTAL (LESS REIMBURSABLES)	**$100**	**$100**
O&M		
Total Request	**$100**	**$100**

Risk of $6K is included for the following: building obstructions ($2K) and delays ($2K) and design development ($1.5K)

Unit Breakout Costs

Note: Dollar values are in thousands

Line item Category	Year 1	Total
ST Labor	$20	$20
OT Labor		
Outside Services Labor	$20	$20
Materials*	$8	$8
Removals		
Other	$9	$9
Indirects	$42	$42
AFUDC		
TOTAL REQUEST	**$100**	**$100**

*All materials including Eversource purchased and outside service purchased. Note that outside service purchased material included in construction in unit cost evaluation above.

Financial Unit Cost Evaluation (WMA Transmission Substation Monitors)

Note: Dollar values are in thousands and are unit level costs for Program PAFs

Line item Category	Year 1	Total
25. ROW / Easements / Land Acquisition		
26. Environmental Approvals / Permits		
27. Outreach		
28. Siting Approvals / Permits		
29. Engineering / Design	$29	$29
30. Materials (Eversource purchased)	$1	$1
31. Construction (incl matl's by contractors)	$21	$21
32. Testing / Commissioning		
33. Project Mgmt Team	$17	$17
34. Removals		
35. Other		
36. Risks	$5	$5
SUBTOTAL DIRECTS W/ RISKS	**$73**	**$73**
13. Indirects/Overhead	$45	$45
14. AFUDC	0	0
PROJECT TOTAL – BASELINE BUDGET	**$119**	**$119**
15. Contingency	$2	$2
TOTAL CAPITAL REQUEST	**$120**	**$120**
16. Reimbursables/Customer Contribution		
PROJECT TOTAL (LESS REIMBURSABLES)	**$120**	**$120**
O&M		
Total Request	**$120**	**$120**

Risk of $5K is included for the following: building obstructions ($2K), delays ($2.5K) and design developments ($0.8K)

Unit Breakout Costs

Note: Dollar values are in thousands

Line item Category	Year 1	Total
ST Labor	$30	$30
OT Labor		
Outside Services Labor	$30	$30
Materials*	$8	$8
Removals		
Other	$8	$8
Indirects	$45	$45
AFUDC		
TOTAL REQUEST	**$120**	**$120**

*All materials including Eversource purchased and outside service purchased. Note that outside service purchased material included in construction in unit cost evaluation above.

Future Financial Impacts:

Provide below the estimated future costs that will result from the project: N/A
Note: Dollar values are in thousands:

Future Costs	Year 20__	Year 20__	Year20__	Year 20__+	Total Future Project Costs
Capital	$ -	$ -	$ -	$ -	$ -
O&M	-	-	-	-	-
Other	-	-	-	-	-
TOTAL	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**

Describe the estimated future Capital, O&M and/or Other costs noted above:

What functional area(s) will these future costs be funded in?_N/A_____
A representative from the respective functional area is required to be included as a project approver.

If this is other than a Reliability Project, please complete the section below;

Provide below the estimated financial benefits that will result from the project: N/A
Note: Dollar values are in thousands:

Future Benefits	Year 20__	Year 20__	Year20__	Year 20__+	Total Future Project Benefits
Capital	$ -	$ -	$ -	$ -	$ -
O&M	-	-	-	-	-
Other	-	-	-	-	-
TOTAL	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**

Describe the estimated future Capital, O&M and/or Other benefits noted above: N/A

What functional area(s) will these benefits be reflected in? N/A

Asset Retirement Obligation (ARO) and/ or Environmental Cleanup Costs (Environmental Liabilities):

Is there an ARO associated with this project? TBD

Are there other environmental cleanup costs associated with this project? TBD

Technical Justification:

Project Need Statement:

Install battery monitoring at all remaining Bulk Electric System (BES) stations system wide to maintain compliance and have real-time data to support NERC Std PRC-005-2.

Project Objectives:

Design and install battery monitors at all remaining Eversource Transmission and Distribution BES substations to maintain compliance more efficiently with NERC Std PRC-005-2. Design will include a review of the associated station batteries and chargers for age-related or performance based replacement.

Measurements of internal resistance can be taken remotely, offering consistent values to accurately trend the health of the batteries, while removing inconsistencies due to human factors (different measurement points, general human error, etc.). Minimum and maximum limits can also be set for values such as voltage, current, and internal resistance. The monitors can provide notifications to users, which can then be addressed using a targeted approach. The program will comply with NERC standards and increase system reliability.

While installing battery monitors is the primary objective of the program, a review of batteries and chargers reaching end of life conditions will also be considered at each station. Battery systems are considered obsolete at 20 years of age; due to that fact, batteries aged 15 years or older will be scheduled for replacement, evaluated for capacity, and replaced under separate funding projects. Through review of initial locations identified by the regional project teams, a unitized cost will be generated for "monitor installation only" for both Distribution and Transmission projects within each region. CT Transmission and Distribution, NH Transmission, and WMA Transmission unitized costs were developed for Revision 0. Releases will be issued under the Program on a station by station basis.

Replacement batteries and environmental concerns (i.e. hydrogen detection and evacuation) will be addressed and funded separately as battery replacements are determined to be needed. Those control house systems include air conditioning, heating, hydrogen detection, and fire alarms.

Project Scope

There are 115 monitor installations remaining to complete. The unitized cost for CT Distribution was based on the estimate for [redacted]. In choosing this estimate, 11 Distribution substation estimates in this program in CT were evaluated and it most represents the typical scope and costs. The unitized cost for CT Transmission was based on the estimate for [redacted]. This estimate includes two (2) monitoring systems. For unit cost purposes all estimated costs are divided in half, except for Project Management and Engineering, since these costs are relatively fixed per station. In choosing the unit value for CT (T) the unit cost was also compared to two (2) other estimates for upcoming Transmission

releases in NH and WMA along with actual costs incurred in the previous monitoring installation program in 2018.

The unitized cost for NH Transmission was based on the estimate for [redacted]. The unitized cost for WMA Transmission was based on the estimate for [redacted] The WMA estimate includes two (2) monitoring systems. For unit cost purposes, all estimated costs are divided in half except for Project Management and Engineering since these costs are relatively fixed per station.

The installation unit cost is for the Alber Xplorer Industrial Monitor (UXIM) System for all remaining BES installations. This Program Level PAF will be revised in the future to include updated unitized costs for the remaining three (3) Regions where unit costs have not yet been established. Dollar authorization for these costs shall be through submission of Program Revisions.

Background / Justification

The battery monitoring installation program will design and install battery monitors at all remaining Transmission and Distribution BES substations to maintain compliance more efficiently with NERC Standard PRC-005-2. The installation of battery monitors will alleviate annual testing (voltage and ohmic measurements) as required by PRC-005 and provide a more comprehensive overview of system health.

Business Process and / or Technical Improvements:

The installation of battery monitors will alleviate annual testing (voltage and ohmic measurements) as required by PRC-005 and provide a more comprehensive overview of system health.

Alternatives Considered with Cost Estimates

The "Do Nothing" approach was not acceptable with the modeled program TPS-16-164-T and applies as well to this new program. The installation of the BES battery monitoring systems will result in O&M savings. Also, there is an expectation of improved DC system reliability and a resultant improvement in system protection reliability.

Project Schedule

It is anticipated to complete the entire replacement program by Q4 2023 or earlier.

Milestone/Phase Name	Estimated Date
Preliminary scope developed (All Regions)	Q4 2020 - Complete
First Project Releases presented to EPAC	May 2021 (Actual)
Program Level PAF with all Unit Costs Approved	September 2021

Milestone/Phase Name	Estimated Date
Begin Construction	August 2021
Program ISD	December 2023

Regulatory Approvals

Not applicable

Risks and Risk Mitigation Plans

Risk allocation is included in the Program unitized cost estimates for the following:

- Building obstructions
- Delays
- Environmental remediation (lead/asbestos in wall or ceiling)

Risks will be evaluated for each station and allocation and mitigation plans included in the Releases.

Contingency

There is $3K – D and $5K - T of contingency included in the CT unitized costs.
There is $2K - T of contingency included in the NH T unitized costs.
There is $2K - T of contingency included in the WMA T unitized costs.

Individual Program Releases will include contingency as needed.

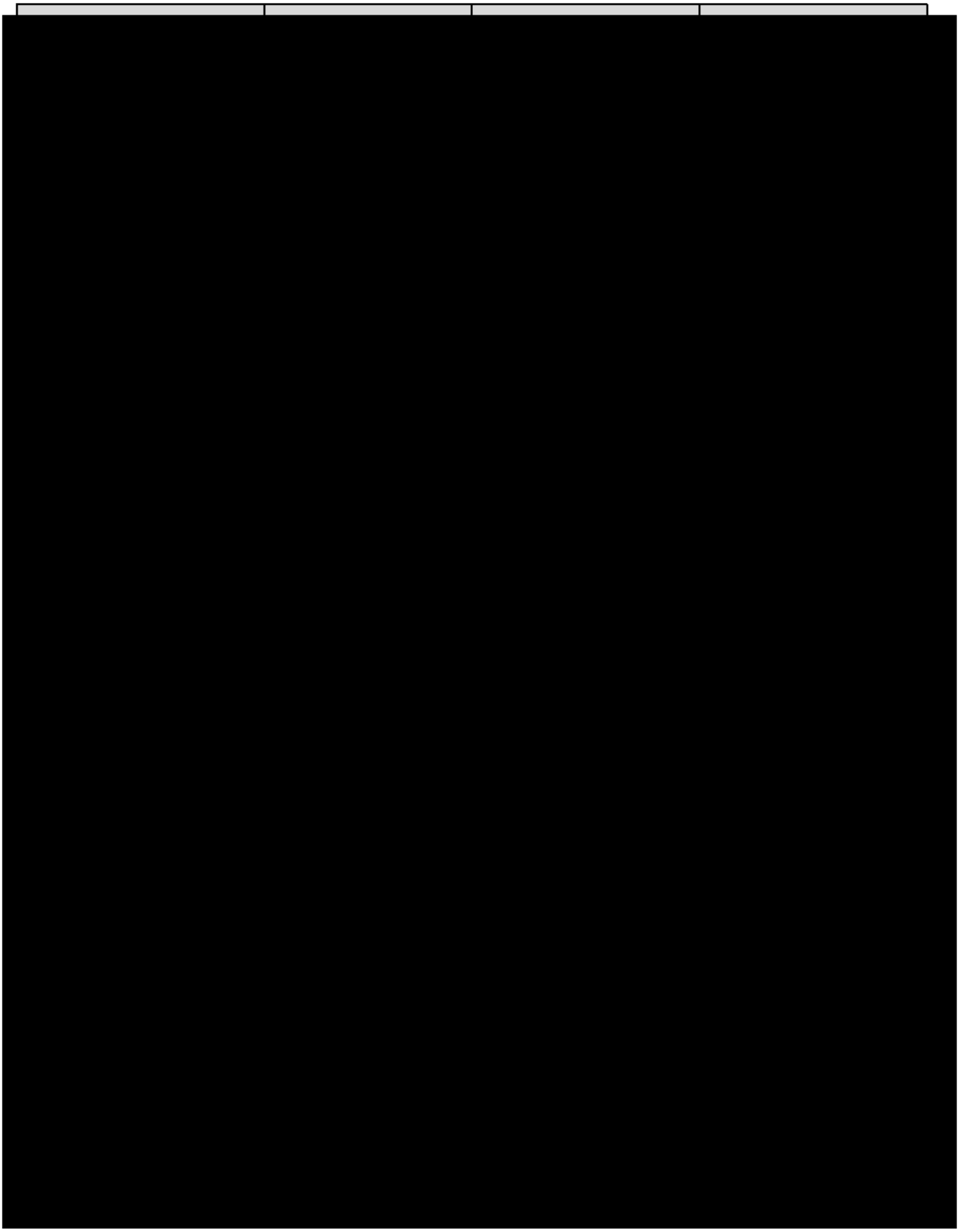
References

1. North American Electric Reliability Corporation (NERC) Std. PRC-005-2
2. Eversource TPS-16-164-T, BES Battery Monitoring (T-Only)
3. BES Battery Monitor Installation Program PAF Rev_0

Attachments (One-Line Diagrams, Images, etc.)

- Table 1 - Substations to be Addressed for the Overall Program
- Attachment A1 – Southington 4C Distribution Control House Eversource Estimate Template rev 1.61
- Attachment A2 - Southington 4C Transmission Control House Eversource Estimate Template rev 1.61
- Attachment A3 – West Brookfield 14H Transmission Control House Eversource Estimate Template rev 1.61
- Attachment A4 – Curtisville Transmission Control House Eversource Estimate Template rev 1.61
- Attachment A5 – West Springfield 8C Transmission Control House Eversource Estimate Template rev 1.61
- Attachment B – TPS-16-T_TOnly_BES_Battery_Monitoring_042516

TABLE 1 - SUBSTATIONS TO BE ADDRESSED FOR OVERALL PROGRAM



[redacted]			

* Two (2) batteries
** Three (3) batteries
*** Four (4) batteries

Red text indicates stations added to the program since the IFR approval. (included in Rev_0)

Blue stations removed from the program since the IFR approval due to scope inclusion in other projects (included in Rev_0)

ESTIMATE SUMMARY

Project Title:Southington 4C Distribution Control House Battery Monitors
Project Mgr/Lead [redacted]
Project Number:CS00428
WO & Task #:80067152
Est. Revision # 00
Estimate Type - Station work

Estimate By: [redacted]
Date of Estimate:4/16/21
ISD:07/30/2021
Estimate #

Template Revision # 01.61

ESTIMATE SUMMARY

Estimate Type: Conceptual

WBS	Description	TOTAL	% of Directs	% of Total	Priors	2021	2022	2023	2024	2025	2026
1	ROW / Easements / Land purchases										
2	Environmental Approvals / Permits										
3	Outreach	$200	0.2%	0.1%		$200					
4	Siting Approvals / Permits	$400	0.4%	0.2%		$400					
5	Engineering / Design	$7,600	7.1%	3.3%		$7,600					
6	Materials (Eversource purchased)	$3,200	3.0%	1.4%		$3,200					
7	Construction (incl matl's by contractors)	$69,900	65.5%	30.0%		$69,900					
8	Testing / Commissioning	$1,100	1.0%	0.5%		$1,100					
9	PMT Project Mgmt Team	$6,300	5.9%	2.7%		$6,300					
10	Removals										
11	Other										
12	Risks	$18,000	16.9%	7.7%		$18,000					
	Project Directs Total w/Risks	**$106,700**	100.0%	45.7%		**$106,700**					
13	Indirects/Overhead	$118,400		50.8%		$118,400					
14	AFUDC	$500		0.2%		$500					
	Project Total - Baseline Budget	**$225,600**		96.7%		**$225,600**					
15	Contingency	$7,700		3.3%		$7,700					
	Project Total - Funding Approval Level	**$233,300**		100.0%		**$233,300**					
16	Reimbursables/Customer Contribution										
	Project Total (less reimbursables)	**$233,300**				**$233,300**					
		-									
	Amount of Escalation included above										
6	Total materials - Eversource	$3,200				$3,200					
	Total materials - Contractor										
	Total materials	$3,200				$3,200					
	NOTE: Risk / Contingency is 12.4% of Project Total Costs (incl escal/indirects/AFUDC but excl reimb.)										

Estimate Range	**-25%**	-	**50%**
	$175,000	-	**$350,000**

COMMENTS:

Project Scope:

[redacted]

Assumptions/Clarifications:

Indirect rates based on: 11 - CT . Station work

Inhouse resources will be used for Construction, LCE, SCADA, and Engineering.
PM will be outsourced.
No construction Rep will be needed.
Real Power will provide a UXIM monitor including any wiring to the battery with their installation services.
Environmental testing needed before drilling through walls

RISKS

Potential Obstructions	$ 6,000
Delays	$ 6,000
Lead/Asbestos in wall or ceiling	$ 6,000

ESTIMATE SUMMARY

Project Title:Southington 4C Transmission Control House Battery Monitors
Project Mgr/Lead [redacted]
Project Number:CS00428
WO & Task #:80042113
Est. Revision # 00
Estimate Type - Station work

Estimate By: [redacted]
Date of Estimate:4/16/21
ISD:07/30/2021
Estimate #

Template Revision # 01.61

ESTIMATE SUMMARY

Estimate Type: Conceptual

WBS	Description	TOTAL	% of Directs	% of Total	Priors	2021	2022	2023	2024	2025	2026
1	ROW / Easements / Land purchases										
2	Environmental Approvals / Permits										
3	Outreach	$100	0.1%	0.1%		$100					
4	Siting Approvals / Permits	$300	0.4%	0.2%		$300					
5	Engineering / Design	$7,600	8.9%	4.8%		$7,600					
6	Materials (Eversource purchased)	$4,000	4.7%	2.5%		$4,000					
7	Construction (incl matl's by contractors)	$54,100	63.3%	34.0%		$54,100					
8	Testing / Commissioning	$1,100	1.3%	0.7%		$1,100					
9	PMT Project Mgmt Team	$6,300	7.4%	4.0%		$6,300					
10	Removals										
11	Other										
12	Risks	$12,000	14.0%	7.5%		$12,000					
	Project Directs Total w/Risks	**$85,500**	100.0%	53.7%		**$85,500**					
13	Indirects/Overhead	$68,300		42.9%		$68,300					
14	AFUDC										
	Project Total - Baseline Budget	**$153,800**		96.6%		**$153,800**					
15	Contingency	$5,400		3.4%		$5,400					
	Project Total - Funding Approval Level	**$159,200**		100.0%		**$159,200**					
16	Reimbursables/Customer Contribution										
	Project Total (less reimbursables)	**$159,200**				**$159,200**					
		-									
	Amount of Escalation included above										
6	Total materials - Eversource	$4,000				$4,000					
	Total materials - Contractor										
	Total materials	$4,000				$4,000					
	NOTE: Risk / Contingency is 12.3% of Project Total Costs (incl escal/indirects/AFUDC but excl reimb.)										

Estimate Range	**-25%**	-	**50%**
	$119,000	-	**$239,000**

COMMENTS:

Project Scope:

[redacted]

Assumptions/Clarifications:

Indirect rates based on: 1T - CT . Station work

Inhouse resources will be used for Construction, LCE, SCADA, and Engineering.
PM will be outsourced.
No construction Rep will be needed.
Real Power will provide a UXIM monitor including any wiring to the battery with their installation services.
A Mobile battery cart will be provided while Real power is installing the battery tab washers.

RISKS

Potential Obstructions	$ 6,000
Delays	$ 6,000

ESTIMATE SUMMARY

Project Title:West Brookfield 14H Battery Monitor
Project Mgr/Lead [redacted]
Project Number:CS00458
WO & Task #:
Est. Revision # 00
Estimate Type - Station work

Estimate By: [redacted]
Date of Estimate:4/19/21
ISD:08/20/2021
Estimate #

Template Revision # 01.61

ESTIMATE SUMMARY

Estimate Type: Planning

WBS	Description	TOTAL	% of Directs	% of Total	Priors	2021	2022	2023	2024	2025	2026
1	ROW / Easements / Land purchases										
2	Environmental Approvals / Permits										
3	Outreach	$100	0.2%	0.1%		$100					
4	Siting Approvals / Permits	$300	0.5%	0.3%		$300					
5	Engineering / Design	$7,600	11.9%	6.5%		$7,600					
6	Materials (Eversource purchased)	$3,000	4.7%	2.6%		$3,000					
7	Construction (Incl matl's by contractors)	$36,600	57.2%	31.4%		$36,600					
8	Testing / Commissioning	$1,100	1.7%	0.9%		$1,100					
9	PMT Project Mgmt Team	$6,300	9.8%	5.4%		$6,300					
10	Removals										
11	Other										
12	Risks	$9,000	14.1%	7.7%		$9,000					
	Project Directs Total w/Risks	**$64,000**	100.0%	54.9%		**$64,000**					
13	Indirects/Overhead	$46,900		40.2%		$46,900					
14	AFUDC	$900		0.8%		$900					
	Project Total - Baseline Budget	**$111,800**		95.9%		**$111,800**					
15	Contingency	$4,800		4.1%		$4,800					
	Project Total - Funding Approval Level	**$116,600**		100.0%		**$116,600**					
16	Reimbursables/Customer Contribution										
	Project Total (less reimbursables)	**$116,600**				**$116,600**					
		-									
	Amount of Escalation Included above										
6	Total materials - Eversource	$3,000				$3,000					
	Total materials - Contractor	$9,900				$9,900					
	Total materials	$12,900				$12,900					
	NOTE: Risk / Contingency is 13.4% of Project Total Costs (incl escal/indirects/AFUDC but excl reimb.)										

Estimate Range

-25%	-	25%
$87,000	-	$146,000

COMMENTS:

Project Scope:

[redacted]

Assumptions/Clarifications:
Indirect rates based on: 11 - CT . Station work

Inhouse resources will be used for LCE & Engineering.
PM & SCADA will be outsourced.
Construction will be Outsourced/Inhouse combination
Construction Rep will not be needed.
Real Power will provide a UXIM monitor including any wiring to the battery with their installation services.
A Mobile battery cart will be provided while Real power is installing the battery tab washers by Inhouse resources.

RISKS

Potential Obstructions	$	4,500
Delays	$	4,500

ESTIMATE SUMMARY

Project Title: Battery Monitor Installation - Curtisville, NH
Project Mgr/Lead [redacted]
Project Number: T431A
WO & Task #: 80038958
Est. Revision # 00
Estimate Type - Station work

Estimate By: [redacted]
Date of Estimate: 5/25/2021
ISD:12/31/2021
Estimate # P-21-356

Template Revision # 01.64

ESTIMATE SUMMARY

Estimate Type: Planning

WBS	Description	TOTAL	% of Directs	% of Total	Priors	2021	2022	2023	2024	2025	2026
1	ROW / Easements / Land purchases										
2	Environmental Approvals / Permits										
3	Outreach	$100	0.2%	0.1%		$100					
4	Siting Approvals / Permits	$200	0.4%	0.2%		$200					
5	Engineering / Design	$13,000	23.8%	13.0%	$4,100	$8,900					
6	Materials (Eversource purchased)	$300	0.5%	0.3%		$300					
7	Construction (incl matl's by contractors)	$28,400	52.0%	28.3%		$28,400					
8	Testing / Commissioning	$1,600	2.9%	1.6%		$1,600					
9	PMT Project Mgmt Team	$5,500	10.1%	5.5%	$1,000	$4,500					
10	Removals										
11	Other										
12	Risks	$5,500	10.1%	5.5%		$5,500					
	Project Directs Total w/Risks	**$54,600**	100.0%	54.5%	**$5,100**	**$49,500**					
13	Indirects/Overhead	$42,000		41.9%	$4,000	$38,000					
14	AFUDC	$1,300		1.3%		$1,300					
	Project Total - Baseline Budget	**$97,900**		97.7%	**$9,100**	**$88,800**					
15	Contingency	$2,300		2.3%		$2,300					
	Project Total - Funding Approval Level	**$100,200**		100.0%	**$9,100**	**$91,100**					
16	Reimbursables/Customer Contr bution										
	Project Total (less reimbursables)	**$100,200**			**$9,100**	**$91,100**					
		-									
	Amount of Escalation included above										
6	Total materials - Eversource	$300				$300					
	Total materials - Contractor	$7,400				$7,400					
	Total materials	$7,700				$7,700					
	NOTE: Risk / Contingency is 8.4% of Project Total Costs (incl escal/indirects/AFUDC but excl reimb.)										
	Estimate Range	**-25%**	-		**25%**						
		$75,000	-		**$125,000**						

COMMENTS:

[redacted]

Assumptions/Clarifications:
Indirect rates based on: 6D - NH Station work

[redacted]

Mobile battery trailer is required during installation of the new monitor
In service date of 12/31/2021 provided in the Estimate Request Form - 5/10/2021
Engineering and project management support will be performed by Eversource personnel
Construction Rep performed by Eversource personnel
LCE performed by Eversource personnel
Electrical contractors will install wiring and the Alber monitor - see Real Power, Inc. quote dated 2/24/2021, proposal #2329
Electrical contractors will test connections to battery, alarms and commission monitoring system - see Real Power, Inc. quote dated 2/24/2021, proposal #2329
Construction schedule, engineering responsibilities and scope provided in Project Scope Document - Rev. #1 dated 4/2/2021
Panduit and alarm cables to be installed ahead of Real Power, Inc. company installing the new Alber monitor by contractors
Outages not required
No additional costs for battery cart
All work will be installed to Eversource Bookshelf latest standards and procedures
Prior costs from Power Plan dated 5/19/2021
Distribution Asset per Estimate Request Form dated 5/10/2021
Switching is not needed per PM

RISKS

Potential Obstructions	$ 2.000
Work Delays	$ 2.000
Design development	$ 1.500

ESTIMATE SUMMARY

Project Title: Battery Monitor Installation - West Springfield , MA.
Project Mgr/Lead: [redacted]
Project Number: 405230
WO & Task #: 80043086
Est. Revision # 01
Estimate Type - Station work

Estimate By: [redacted]
Date of Estimate: 6/2/2021
ISD:12/31/2021
Estimate # W-21-368

Template Revision # 01.64

ESTIMATE SUMMARY

Estimate Type: Planning

WBS	Description	TOTAL	% of Directs	% of Total	Priors	2021	2022	2023	2024	2025	2026
1	ROW / Easements / Land purchases										
2	Environmental Approvals / Permits										
3	Outreach	$100	0.1%	0.1%		$100					
4	Siting Approvals / Permits	$400	0.4%	0.2%		$400					
5	Engineering / Design	$29,200	29.1%	17.6%	$700	$28,500					
6	Materials (Eversource purchased)	$1,200	1.2%	0.7%		$1,200					
7	Construction (Incl matl's by contractors)	$41,900	41.8%	25.2%		$41,900					
8	Testing / Commissioning										
9	PMT Project Mgmt Team	$16,900	16.9%	10.2%	$2,600	$14,300					
10	Removals										
11	Other										
12	Risks	$10,500	10.5%	6.3%		$10,500					
	Project Directs Total w/Risks	**$100,200**	100.0%	60.4%	**$3,300**	**$96,900**					
13	Indirects/Overhead	$61,800		37.2%	$400	$61,400					
14	AFUDC	$600		0.4%		$600					
	Project Total - Baseline Budget	**$162,600**		98.0%	**$3,700**	**$158,900**					
15	Contingency	$3,400		2.0%		$3,400					
	Project Total - Funding Approval Level	**$166,000**		100.0%	**$3,700**	**$162,300**					
16	Reimbursables/Customer Contribution										
	Project Total (less reimbursables)	**$166,000**			**$3,700**	**$162,300**					
		-									
	Amount of Escalation included above										
6	Total materials - Eversource	$1,200				$1,200					
	Total materials - Contractor	$14,800				$14,800					
	Total materials	$16,000				$16,000					

NOTE: Risk / Contingency is 9.1% of Project Total Costs (incl escal/Indirects/AFUDC but excl reimb.)

Estimate Range	-25%	-	25%	
	$125,000	-	**$208,000**	

COMMENTS:

[redacted]

Assumptions/Clarifications:
Indirect rates based on: 4T - WMA . Station work

[redacted]

Battery cart is not needed - per Estimate Request Form Dated 5/13/2021
Prior Costs per Power Plan on 5/19/2021
Construction Rep is internal per Project Team
In service date of 12/31/2021 provided in the Estimate Request Form - 5/13/2021
Installation of the battery monitor will be located above the battery charger about 6 feet high - per Scope of Work dated 5/13/2021
Installation of the junction box will be mounted above the monitor - per Scope of Work dated 5/13/2021
All engineering and design shall be performed in accordance with Eversource Standards
Engineering and project management support will be performed by Eversource personnel
Electrical contractor will install wiring, the two junction box's and the two monitors - turn key - see Real Power, Inc. quote dated 3/2/2021, proposal #2336
Electrical contractor will test connections to battery, alarms and commission monitoring system - see Real Power, Inc. quote dated 3/2/2021, proposal #2336
Monitor will be connected to battery with harnesses
Monitor is powered through the battery harness connections and does not require a DC power feed from the DC panelboard
Data collected by monitor will be sent to a dedicated server on PI historian system via Ethernet connection
Monitor trouble alarm will be sent to the ESCC
Panduit and alarm cables to be installed ahead of Real Power, Inc. company installing the new Alber monitor - by Eversource Personnel
Switching not needed per Project Team
Outages not required
LCE is not required per Project Team

RISKS

Potential Obstructions	$	4,000
Delays. OT	$	5,000
Design development	$	1,500

Project Name: BES Battery Monitoring (T-Only)	**TPS Number:** TPS-16-164-T
Project Numbers: Later	**I.3.9 Required:** No
Operating Company: Eversource CT, WMA & NH	**TCA Application Required:** No
Load Area: Various	**Submitted By:** [redacted]
Proposed In Service Date: 12/31/18	**LTAMP Plan Scope?** Yes
Need: Moderate	**SPS/UVLs Affected:** No
SCLL Yes/No: No	**Requires NX-9 Change:** No
System Impact Review Completed: Yes	**ISO-NE PAC Presentation Completed: Y/N/NR** NR

Problem Statement

NERC Std. PRC-005-2 requires periodic maintenance of BES system protection elements. These elements include the station batteries. The Eversource CT, WMA and NH BES transmission system relies on approximately 230 battery systems that support BES protective relaying systems.

NERC Std. PRC-005-2 requires verification and inspection of the battery system parameters without monitoring systems:

- Every 4 months – verify DC supply voltage and inspect electrolyte level and for unintentional grounds
- Every 18 months – verify float battery charger float voltage, battery continuity, battery terminal connection resistance, battery inter-cell connection resistance and inspect cell condition or measure battery cell ohmic values
- Every 18 months – verify station battery can perform as manufactured by evaluating cell measurements against a baseline

The battery monitoring system will provide remote and real-time monitoring of these attributes. The monitoring capability will relieve the burden of station inspections at the 4 and 18 month intervals.

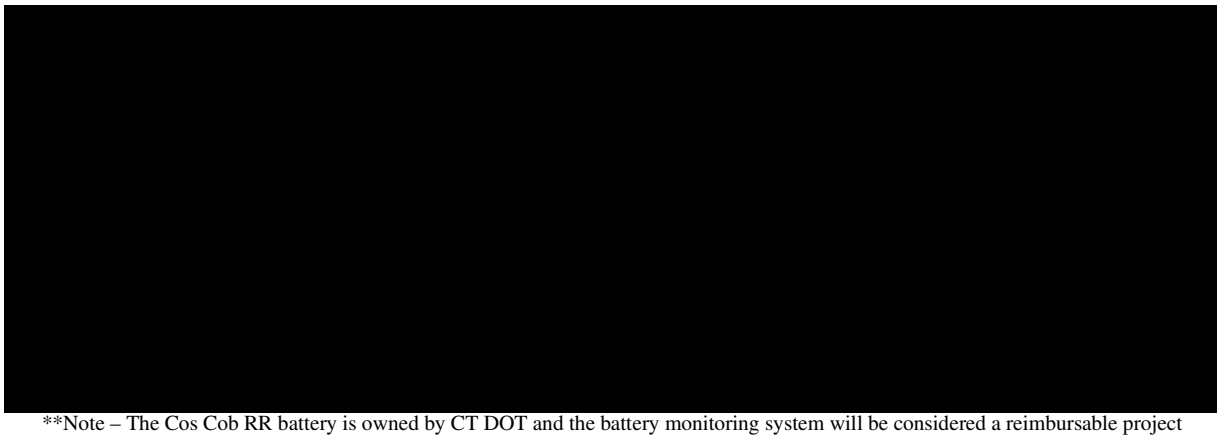
The battery system is a component to ensure safe and reliable operation of the transmission system. A battery monitoring system provides continuous capability to inform operations and maintenance personnel with the operational status of the DC systems. The passive nature of a battery system to provide critical control power to protective devices at the onset of system contingencies will ensure events are minimized and contained. The time of the event is not when the unavailability of a battery system should be identified. Battery monitoring for Eversource EMA BES DC systems will be addressed by future projects.

Project Driver Statement

Reliability Compliance and O&M Savings

Description/ Solution

The proposed battery monitoring system will comply with the NERC - Protection System Maintenance - PRC-005-2 which will eliminate the need for maintenance to perform annual battery monitoring (specific gravity, cell resistance and connection resistance). The scope proposed under this TPS are for the 111 transmission "owned" batteries.



**Note – The Cos Cob RR battery is owned by CT DOT and the battery monitoring system will be considered a reimbursable project

For illustrative purposes, the monitoring features for the Alber Battery Monitoring system are shown. BTech is another company that provides comprehensive battery monitoring systems. While this TPS discusses features of battery manufacturers, it does not preclude any manufacturer that may be specified during the engineering phase of the project, as long as the stated requirements are met. It should be noted that once one manufacturer is deployed with baseline data, changing manufacturers will require the establishment of new baseline data.

Future projects will be initiated to address the Eversource EMA BES batteries as well as the distribution "owned" BES batteries for CT, WMA and NH.

Alber Battery Monitoring Features

- All system configurations are field configurable
- Continual real time scanning of cell voltage, ambient temperatures, and discharge, float and ripple currents
- Automatic/scheduled testing of internal resistance, inter-cell and inter-tier connection measurements
- Stores discharge events to allow playback of recorded data including cell voltages, currents and temperatures
- Fiber optic connectivity for BDSU system network integration
- Two Form C contact for battery parameter and hardware alarms
- Embedded Web server for viewing battery data via Web browsers
- Embedded email manager for delivery of alerts and battery data on a defined priority to service technicians
- Isolated RS-485 interface for third party vendor integration
- Ethernet connectivity for connection to company network
- Compact 1U, 19" rack mount enclosure
- USB connectivity for PC to allow real time data viewing and configuration
- Local status indicators and alarm reset
- Maintenance override – global disarm of all alarms
- Self calibrating
- Supports MODBUS (via RS-485 and Ethernet) SNMP and SMTP (via Ethernet) protocols

There are three specification requirements that need to be used in the vendor selection for the battery monitoring system:

- One requirement is the use of a DC resistance method for the measurement of battery cell ohmic values
- Enterprise level software application and server for data gathering, monitoring, trending and record keeping
- Off-Normal SCADA Alarms for remote indication

The battery monitoring system will provide remote monitoring capability to the Maintenance and Support Engineering personnel. The information shall be transmitted over the corporate network. The CIP protected network will not be required, since no direct operational action will be taken based on any remote indication. Any problems will be verified by separate on-site test or inspection before proceeding with any operational action. Attachment B is a white paper prepared by the Substation Technical Engineering which outlines the needs and benefits of a BES battery monitoring system for PRC-005-2. Included in this white paper are the bases for the selection of the DC resistance method and the need for an enterprise software application. The white paper also discusses the construction and operational use of the battery monitoring system recently installed at Millstone.

The installation of the monitoring system will not require any system outages. The associated battery system may need to be taken out-of-service to install the monitor. For stations with redundant battery systems, the modifications should be implemented on only one battery system at a time. For stations without a redundant battery system, a temporary battery system will be provided while the battery is taken out of service to implement the modifications.

Background/Justification

The battery monitoring system will also aid in the compliance with NERC Std. PRC-005-2 by providing remote indication and data on most of the parameters to be verified, either on a 4 month or 18 month periodic basis. Specifically, PRC-005-2 requires verification and inspection of the following parameters for battery systems without monitoring systems:

- Every 4 months – verify DC supply voltage and inspect electrolyte level and for unintentional grounds
- Every 18 months – verify float battery charger float voltage, battery continuity, battery terminal connection resistance, battery inter-cell connection resistance and inspect cell condition or measure battery cell ohmic values
- Every 18 months – verify station battery can perform as manufactured by evaluating cell measurements against a baseline

The battery monitoring system will provide remote and real-time monitoring of these attributes. If successful, this monitoring capability could relieve the burden of station inspections at the 4 and 18 month intervals (ST-1 & ST-2 testing).

A pilot program was completed to install battery monitoring on the 345KV system batteries at Millstone and Manchester under TPS-14-163-CT and project numbers 404291 and 404294 with successful results. Refer to the Transmission Operational Engineering "white" paper attached that discusses the successful implementation and use of the battery monitors at the Millstone and Manchester stations.

Cost Estimate

Transmission Project Planning has estimated the pilot program to install battery monitoring for the "T" owned BES batteries at $97K to $194K ($128K-25%,+50%) per battery system for a total of $10.77M to $21.54M ($14.21M,-25%,+50%) for the 111 BES battery systems. In addition another $75K of funding should be made available to procurement of an enterprise software and server package ($30K) and Eversource IT services ($45K) for the testing and installation of the software on company systems. Note that the battery monitoring system for Cos Cob RR will be considered as a reimbursable project.

Possible Alternatives and Cost Estimates

- The "Do Nothing" approach was not acceptable. The installation of the BES battery monitoring system will result in O&M savings. Also, there is an expectation of improved DC system reliability and a resultant improvement in system protection reliability.



Approvals

_____ _____

[redacted], Director, Transmission Engineering Date

ATTACHMENT A – Alber Battery Monitoring Information (Illustrative Only)

Alber UXIM & Connections





[redacted]

Cell Connectors

[redacted]

ATTACHMENT B – White Paper

BES Batteries & PRC Compliance

Background-

Components such as protective relays are regarded as critical assets to substation operations, whereas the importance of substation batteries over the years has not been emphasized. Batteries function as the lifeblood of the substation and a robust battery maintenance program is necessary to ensure proper operation of Eversource's Bulk Electric System (BES) substations. With NERC enforcing standard PRC-005 (Protection System, Automatic Reclosing, and Sudden Pressure Relaying Maintenance) as of 4/1/2015 it's extremely important to understand the new protection system maintenance requirements and how their maintenance activities enhance the reliability of substation DC battery systems. Failure to comply with the NERC standard can compromise safe, reliable station operations and result in monetary penalties. In order to comply with NERC's requirements, many utilities, including Eversource, have been driven to make changes to their maintenance practices which have been in place for many years.

Operational Experience

[redacted]

Procedural Changes-

Be advised that the NERC PRC-005 standard governs maintenance practices for a number of devices and systems but this document covers only Station DC Supply associated with protective functions which includes vented lead-acid (VLA) batteries and battery chargers.

NERC defines BES as generally all Transmission elements greater than or equal to 100kV. Per NERC, if a substation has any BES elements than those elements must be maintained per NERC Standard PRC-005. With regards to batteries, if a substation has a relay that protects a BES element, then the battery must be tested and meet PRC requirements because that battery provides power to the protective relay.

Prior to PRC-005 Eversource performed time based, minor and major inspections on all vented lead-acid batteries. The minor and major inspections consisted of the following tasks:

- **Minor Inspection: Time Interval- Monthly**

  Record battery voltage and pilot cell specific gravity, check flame arresters/vent caps, check electrolyte level in each cell and a general inspection for cleanliness, electrolyte spills, sediment deposits, plate buckling or sulfation and condition of terminals. A general inspection of the battery charger was also performed.

- **Major Inspection: Time Interval- Yearly**

  Perform all tasks included in a minor inspection along with the cleaning of flame arrestors, recording of AC volts (ripple) at battery terminals, testing and recording of individual cell voltages, internal cell resistance, intercell connection resistance, specific gravity values and cell temperatures.

  Note: See Table 1 (Attachments, Page 5) for Logic Table

As of 4/1/2015 Eversource is required to perform the following time based preventative maintenance on BES substation batteries:

- **Minor Inspection: Time Interval- Monthly**
  - Measure and verify battery voltage and pilot cell specific gravity.
  - Inspect electrolyte level
  - Inspect for unintentional grounds

- **Annual Inspection (ST-1): Time Interval- Every 18 Calendar Months**

  Verify and measure float voltage of battery charger, specific gravity of each cell, battery intercell or unit-to-unit connection resistances, battery terminal connect resistance, individual cell voltages, internal cell impedance/resistance, inspect the physical condition of the battery rack and clean all flame arrestors/vent caps.

- **Battery Continuity (ST-2): Time Interval- Every 18 Calendar Months**

  Perform a 30 minute discharge test by turning off the battery charger and record battery voltage after 30 minutes has surpassed. During this test verify that an alarm from the battery charger conveys a signal to the control center.

- **Verification to Baseline: Time Interval- Every 18 Calendar Months**

  Evaluate the measured cell/unit internal ohmic values against the station battery baseline.

- **Load Verification (ST-3): Time Interval- Every 5 Calendar Years**

  Engineering performs a design review to confirm that all critical substation and telecommunication loads are connected to battery supplies as appropriate.

- **Capacity Test (ST-4): Time Interval- Every 5 Calendar Years**

  Perform a capacity test as defined by IEEE standards.

Note: The procedure to perform each of the tasks above can be found in M8-MT-2023 (PSMP-CASCADE Procedures). See Table 2 (Attachments, Page 6) for Logic Table

Batteries subject to the new preventative maintenance requirements are listed in Eversource procedure TD718, NERC Bulk Electric System (BES) Protection System Components Identification and Testing. A total of 132

batteries in Connecticut, located in Transmission and Distribution substations, have been identified as needing to be PRC-005 compliant.

[redacted]

With the proper training and the understanding of expectations from field personnel human error can be reduced however there are provisions within the NERC standard that allow utilities to take a different approach to these tasks. Exceptions written into the standard allow all battery requirements to be satisfied without the need to do annual testing if continuous monitoring is put in place.



Monitoring Technology-

Battery monitoring systems on the market today are stationary units designed for use in industrial or utility applications. These monitors are stand-alone systems that do not require an external computer for normal operation and can be integrated into customer owned networks or existing enterprise systems.

Internal ohmic measurements are used to determine the health of a battery by monitoring the internal resistance of its individual cells. Resistance and impedance test equipment all measure some form of a cells resistance but the methods used to obtain these measurements is what differs.

Cell Resistance vs. Cell Impedance Measurements:

As a cell ages, ohmic values will deviate from their baseline values slowly over time. For cell resistance, these values will trend upwards. AC impedance measurements will track these changes but may not be as accurate as DC resistance.

The simplified battery equivalent circuit (shown on the right) can be used to help the discussion.

A cells electrical makeup is comprised of resistors and an extremely large capacitor. When performing a DC Resistance test the capacitor is ignored and overall internal resistance is equal to the series resistance. An AC measurement is unable to ignore the capacitor in the circuit which is in parallel with part of the conduction path. Because of this the capacitor tends to mask any potential problems or increases in internal resistance which affects the results of your ohmic measurement.

Another concern associated with impedance measurements is the interference caused by the battery charger (ripple) on the AC test equipment. DC measurements are unaffected and can essentially ignore the ripple producing a more accurate and consistent measurement.

For the reasons stated above, an online monitor capable of performing DC resistance measurements is preferred due to its ability to correctly identify changes in a cells internal resistance. Increased resistance is a cause for concern and requires corrective actions to be taken. Most factors that increase a cells internal resistance will decrease its capacity. Problems like grid corrosion, grid swelling, loss of active material, sulfation and internal short circuits are all problems that can be identified by a cells increasing internal resistance.

Features & Benefits:

For a monitoring system to prove to be effective it must, as a minimum, monitor the following parameters:

- Overall String Voltage
- Individual Cell Voltages
- Ambient Temperature
- Internal Cell Resistance*
- Intercell Resistance*
- Load (Discharge) Current
- Float Current

* The ability to accurately measure battery internal resistance separate from intercell connection resistance is extremely important. Having these two ohmic measurements separate from one another allows you to diagnose a problem with the cell versus a problem with the cell connection easier than a combined measurement. A combined measurement provides a single ohmic measurement for both parameters which requires a follow-up test to further investigate the cause of the increasing resistance.

The battery monitoring system to be chosen shall also have an enterprise software package available to facilitate efficient PRC-005-02 monitoring. The software shall have the following capabilities:

- Automatic polling of all battery monitors at a frequency that satisfies PRC-005-02
- Data storage and retention
- Trending
- Preset alarm limits
- Probable cause and corrective action diagnositics
- email or text or electronic notification to authority to identify urgent problems
- supports new and legacy data entry from other products
- web browser functionality
- smart phone/tablet capable

Why is online battery monitoring necessary?

- Increased System Reliability
- O&M Cost Savings
- Optimized Battery Life
- Personnel Safety
- Regulatory Compliance

Increased System Reliability- improves system reliability by detecting battery problems at an early stage.

O&M Cost Savings- reduction of man hours spent on test and maintenance activities.

Optimized Battery Life- the life of a battery is greatly affected by its environment and how it's operated. A monitor assists with identifying any abnormal or out of tolerance condition that is present which if left untreated can cause premature aging or failure of the batteries.

Personnel Safety- having a permanently connected monitor reduces the need for personnel to come in direct contact with voltages present on in-service battery strings.

Regulatory Compliance- by installing online monitoring systems we're able to take credit for two annual preventative maintenance activities (ST-1 and ST-2) required by NERC PRC-005.

White Paper Attachments-

PM Task - Substation Batteries and Chargers

		1	2
Critical Component	**Yes**	**X**	
	No		**X**
PM Task			
Time Based			
Minor Inspection		1M	1M
Major Inspection		1Y	1Y
Discharge Test		1Y	
Capacity Test		5Y	
Condition Monitoring			
SCADA Monitor		C	C
Condition Based			
Equalizing Charge		AI	AI
Thermography		AI	AI
Major Maintenance		AI	AI

1M - Once every month
1Y - Once per year
5Y - Once every five years
C - Continuous
AI - As Indicated

(Table 1: PM Logic Table Before PRC Requirements)

TPS-16-164-T

Project Name: BES Battery Monitoring

Checklist For Studies and Processes Of A Capital Project

Activity/Study	Typical Duration	Check If Necessary	Owner
Problem Identification		X	Planning
Power Flows-Thermal Voltage Analysis			Planning
Alternative Analysis			Planning
Preliminary Stability			Planning
Preliminary Short Circuit			Engineering
Cable Sizing			Engineering
Cost Magnitude			Project Planning Cost/Schedule
TPS Submitted Milestone - Procedure # M2-TP-3012			
Cost Magnitude		X	Project Planning Cost/Schedule
Cable Sizing			Engineering
Preferred Solutions		X	Planning
TRC Approval Of TPS Milestone - Procedure # M2-TP-3012			
EMTP Study			Planning
TOV - (Transient Over Voltage)			Planning
TRV - (Transient Recovery Voltage)			Engineering
Harmonics			Planning
Energization/De-Energization			Planning
Conceptual Operations			Planning
Power Flow-Thermal/Voltage			Planning
Transfer Studies			Planning
Stability			Planning
Breaker Duty			Engineering
Various Load Level Testing			Planning
BPS - (Bulk Power System)			Planning
Steady State			Planning
Short Circuit			Engineering
PPA Approval Milestone			
Transmission Alternatives			Planning
Estimate All Alternatives For Project			Project Planning Cost/Schedule
(SPS) NPCC Approval Milestone			
TCA Approval Milestone			
EMF - (Electromagnetic Frequency)			Engineering
EMI - (Electromagnetic Interference)			Engineering
Audible Noise			Engineering
Siting and Permitting Required			
Siting Application or Petition			Siting & Permitting
Permitting			Siting & Permitting
Grounding Study Trans & S/S			Engineering
Real Time Digital Simulation Protection			Engineering
Insulation Coordination			Engineering
Order Material Milestone			
NPCC Protection C-22 Procedure (4-month lead time)			Engineering
Revenue Metering			Engineering
Redo PPA Revise Accordingly Milestone			
Construction (Technical Specs) For Contracting Milestone			
Outage Planning Sequencing Studies			Operations
Outage Schedule Approvals			Operations
Outage Request Milestone			
Pre-Construction EMF			Engineering
Pre-Construction EMI			Engineering
Construct Project Milestone			
Operational Studies/Operational Procedures			Operations
Energization/De-Energization T.O.V			Operations
Energization Milestone			
Testing Studies Milestone			
In-Service Milestone			
Post In-Service Milestone			
Post Construction Audible Noise			Engineering
Post Construction EMF			Engineering

Table 1-4(b) Component Type – Protection System Station dc Supply Using Valve-Regulated Lead-Acid (VRLA) Batteries Excluding distributed UFLS and distributed UVLS (see Table 3) Protection System Station dc supply used only for non-BES interrupting devices for SPS, non-distributed UFLS systems, or non-distributed UVLS systems is excluded (see Table 1-4(e)).		
Component Attributes	**Maximum Maintenance Interval**	**Maintenance Activities**
Protection System Station dc supply **with Valve Regulated Lead-Acid (VRLA) batteries** not having monitoring attributes of Table 1-4(f).	4 Calendar Months	Verify: • Station dc supply voltage Inspect: • For unintentional grounds
	6 Calendar Months	Inspect: • Condition of all individual units by measuring battery cell/unit internal ohmic values.
	18 Calendar Months	Verify: • Float voltage of battery charger • Battery continuity • Battery terminal connection resistance • Battery intercell or unit-to-unit connection resistance Inspect: • Physical condition of battery rack
	6 Calendar Months -or- 3 Calendar Years	Verify that the station battery can perform as manufactured by evaluating cell/unit measurements indicative of battery performance (e.g. internal ohmic values or float current) against the station battery baseline. -or- Verify that the station battery can perform as manufactured by conducting a performance or modified performance capacity test of the entire battery bank.

Table 1-4(f) Exclusions for Protection System Station dc Supply Monitoring Devices and Systems		
Component Attributes	**Maximum Maintenance Interval**	**Maintenance Activities**
Any station dc supply with high and low voltage monitoring and alarming of the battery charger voltage to detect charger overvoltage and charger failure (See Table 2).	No periodic maintenance specified	No periodic verification of station dc supply voltage is required.
Any battery based station dc supply with electrolyte level monitoring and alarming in every cell (See Table 2).		No periodic inspection of the electrolyte level for each cell is required.
Any station dc supply with unintentional dc ground monitoring and alarming (See Table 2).		No periodic inspection of unintentional dc grounds is required.
Any station dc supply with charger float voltage monitoring and alarming to ensure correct float voltage is being applied on the station dc supply (See Table 2).		No periodic verification of float voltage of battery charger is required.
Any battery based station dc supply with monitoring and alarming of battery string continuity (See Table 2).		No periodic verification of the battery continuity is required.
Any battery based station dc supply with monitoring and alarming of the intercell and/or terminal connection detail resistance of the entire battery (See Table 2).		No periodic verification of the intercell and terminal connection resistance is required.
Any Valve Regulated Lead-Acid (VRLA) or Vented Lead-Acid (VLA) station battery with internal ohmic value or float current monitoring and alarming, and evaluating present values relative to baseline internal ohmic values for every cell/unit (See Table 2).		No periodic evaluation relative to baseline of battery cell/unit measurements indicative of battery performance is required to verify the station battery can perform as manufactured.
Any Valve Regulated Lead-Acid (VRLA) or Vented Lead-Acid (VLA) station battery with monitoring and alarming of each cell/unit internal ohmic value (See Table 2).		No periodic inspection of the condition of all individual units by measuring battery cell/unit internal ohmic values of a station VRLA or Vented Lead-Acid (VLA) battery is required.