Vermont Electric Cooperative Inc.

Maintenance Plan

1 Introduction and Objectives

As part of a concerted effort to maintain and document all Transmission and Distribution (T&D) assets, VEC implemented a robust and comprehensive maintenance program on January 1, 2019. The plan is broken up into two major components:

- A five year "System Assessment" with the goal of gathering accurate asset data such as conductor and transformer sizes, manufacturers, serial numbers, and proper phasing. VEC hired contractors will utilize NISC's AppSuite Inspections software to populate VEC's GIS system. The current goal is to complete this work by 2025.
- VEC internal operations crews will complete an ongoing, scheduled, system-wide maintenance process on all hardware and major equipment.

VEC Operations will identify the following year's circuits and update the plan annually during the third quarter of the previous year. The objectives of VEC's electrical maintenance program include:

- Maintain VEC's electric transmission, substation, distribution, and metering system on a comprehensive schedule and scale that allows for work prioritization and changing requirements while complying with:
    - Rural Utility Service (RUS) requirements/recommendations
    - National Electric Safety Code (NESC) requirements
    - ISO-NE Regional Reliability Standards
    - Institute of Electrical and Electronics Engineers (IEEE) standards
    - American National Standards Institute (ANSI)
    - Manufacturers' recommendations
    - Prudent utility practices
    - VEC standards and operating policies
- Enhance reliability and proactively reduce preventable outages for VEC's members as measured annually by duration (SAIDI,) frequency (SAIFI,) and customer average (CAIDI) outage minutes as well as system-wide root cause analysis findings to drive maintenance programs related to VEC's worst performing circuits.
- Extend plant life of VEC's capital assets and thereby reduce upward pressure on member rates.
- Deliver accurate system data to various departments within VEC and ensure the highest level of data integrity.
- Provide a documented system maintenance policy that clearly defines VEC's system operations core business, employee expectations, and specific maintenance work functions. In addition, this program provides the information that ensures consistency across all maintenance guidelines to system operations personnel in the inspection, testing, and maintenance of VEC's electric system plant, equipment, and other facilities.
- Capture maintenance information by leveraging technology. This includes using mobile devices so VEC can input information electronically into GIS.

VEC Engineering and Operations will review all completed gathered data and inspection results. VEC will use Severity Ratings to identify conditionally poor assets with higher severity ratings applying to high risk concerns. In addition, VEC Engineering will develop capital projects to replace assets as required will feed those projects through VEC's prioritization scheme.

Note: VEC's Maintenance Plan does not include specific information on Vegetation Management actives as that information is housed in the Vegetation Management plan.

1.1 Asset Inspection and Replacement Cycle

The following table lists out the assets that are covered in this document as well as the test or replacement cycle. It should be noted that VEC has equipment in its electric system is maintained or tested at varying frequencies, some of which are on a five-year cycle. Any assets such as distribution transformers will be inspected by VEC as part of the system assessment but are not tested/inspected after the initial five-year assessment.

Equipment Type	Test /Inspect Cycle	Tests/Replacement Required
Stray Voltage Checks	**Annual**	Visual inspection, testing
Substation batteries	**Annual**	Testing
Line voltage regulators	**Annual**	Visual inspection, testing
Infrared on Key Equipment	**Annual**	Inspection
Avian Protection	**Annual**	Inspection
CT/PT Metering	**See Section**	Inspection and validation
Non-Revenue Substation and SPEED/Standard Offer Metering	**See Section**	
Capacitors	**Every 5 Years**	Visual inspection, testing
Hydraulic Reclosers and Trip Savers	**Every 5 Years**	Visual inspection, testing, replacement
Pad Mounted Transformers and Vaults	**Every 5 Years**	Inspection
Underground Conductor	**Every 5 Years**	Inspection
Fuses and Cutouts	**Every 5 Years**	Inspection
Sectionalizers	**Every 5 Years**	Inspection
Switches (Gang/Motor Operated)	**Every 5 Years**	Visual inspection, testing
Disconnects (Solid, Knife Blades, Inlines)	**Every 5 Years**	Visual inspection, testing
Pad mounted transformers	**Every 5 Years**	Inspection, testing
Fault Indicators	**Every 5 Years**	Inspection , replacement (if needed)
Pole hardware (insulators, crossarms, etc.)	**Every 5 Years**	Inspection
Electronic recloser and relay	**Every 5 Years**	Visual inspection, testing
Breaker and relay	**Every 5 Years**	Testing
Substation transformers	**Every 5 Years**	Testing, visual inspection monthly, *DGA annually*
Substation switches	**Every 5 Years**	Testing
Substation control houses and RTU's	**Every 5 Years**	Testing
Residential Metering	**Every 10 years**	Inspection and Testing
Distribution poles	**Every 10 years**	Inspection and treatment
Transmission poles	**Every 10 years**	Inspection and treatment
Substation structure	**Every 10 Years**	Inspection

Further details on testing and inspection requirements are provided in the sections below.

1.2 Timeline

The timeline is broken down into two sections:

- A five year "System Assessment" with the goal of gathering of accurate asset data such as conductor and transformer sizes, manufacturers, serial numbers, and proper phasing.
- VEC internal operations crews will complete an ongoing, scheduled, system-wide maintenance process on all hardware and major equipment.

1.2.1 System Assessment

In 2019, VEC selected Davey Resource Group (DRG) to perform the system assessment of VEC's system. DRG will complete the system assessment by December of 2026. Once DRG has completed their work VEC will modify the internal maintenance plan accordingly to ensure that VEC inspects all pole hardware on a routine basis.

The following timeline indicates the rough timeline for the system assessment:

Description	Timeline (by)
Identify what data to collect	**Mid-July 2018**
Attributes/Fields and modify GIS	**Early August 2018**
Develop and send out RFP for contractor	**Late August 2018**
Review bid proposals	**Early September 2018**
Develop and gain approval from Finance on ROI	**Late September 2018**
Award Contract	**October 2018**
Identify how communication from the field comes to the office with contractors	**Late October 2018**
Finalize documentation (for fields, and for maintenance testing) and send out Maintenance plan for review	**December 2018**
AppSuite installed on all VEC line crews iPads	**December 2018**
GIS changes completed	**February 2019**
Training of Contractors via Pilot	**March 2019**
Cycle 1 DRG assessment begins, Maintenance completed	**April 2019**
Internal VEC cleanup of 2019 work complete	**July 2020**
Cycle 2 DRG assessment begins, Maintenance completed	**2020**
GIS changes to transmission complete	**May 2021**
Internal VEC cleanup of 2020 work complete	**July 2021**
Cycle 3 DRG assessment begins, Maintenance completed	**2022**
Internal VEC cleanup of 2022 work complete	**December 2023**
Cycle 4 DRG assessment begins, Maintenance completed	**2024**
Internal VEC cleanup of 2023 work complete	**December 2025**
Cycle 5 DRG assessment begins, Maintenance completed	**2026**
Internal VEC cleanup complete	**December 2027**

1.2.2 Distribution and Transmission Circuit Schedule

The Manger of Line Operations determines the following years circuits by September of each year.

In 2018, VEC's Engineering and Operations personnel prioritized each of the five years by district based upon historical reliability measures. Year one is the worst performing area within each outpost and scheduled to have a "detailed transmission/distribution inspection" competed in that initial year. Year two is the second worst performing area within each district and is scheduled to have a "line patrol distribution inspection" completed. Additionally, VEC completes a transmission aerial inspection on the entire transmission system quarterly.

Substation	District	Internal Inspection Timeline	Cycle
Hinesburg #19	Grand Isle	**2019**	**1**
Cambridge #3, Fairfax #1	Johnson		
Sheldon #32	Richford		
Burton Hill #43	Newport		
South Hero #29	Grand Isle	**2020**	**2**
Johnson #14, St. Rocks #6	Johnson		
Richford #31	Richford		
Irasburg #42	Newport		
South Alburg #28	Grand Isle	**2021**	**3**
Madonna #15, Eden #2	Johnson		
Jay #17	Richford		
North Troy #41, Island Pond #46, Norton #50	Newport		
	Grand Isle	**2022**	**4**
Richmond #8, Jericho #10, Pleasant Valley #13	Johnson		
	Richford		
Island Pond #47, West Charleston #48, Canaan #51	Newport		
Williston #9	Grand Isle	**2023**	**5**
Underhill #4, Lowell #5, Montgomery #7, Fairfax #12	Johnson		
Highgate Springs#27	Richford		
Derby Line #25, Hay Peak #40, Newport #44, Derby #45	Newport		

1.3 Responsibilities

1.3.1 Overall Management of the Plan

The Manager of Engineering will manage and coordinate the maintenance plan. The Manager of Engineering will work closely with the Manager of Line Operations to identify the schedule and work with line resources to get the work done. The Manager of Service Operations will coordinate the substation group and metering resources.

1.3.2 External Contract Resources - DRG

DRG and Pole Inspection Contractor will gather data on the following assets:

- DRG (Davey Resource Group)
  - *Pole hardware and Attaching Entities*
  - *Overhead Conductor*
  - *Street Lights*
  - *Overhead Transformers*
- SMI (Smith Mountain Investments)
  - *Pole Inspection and Treatment*
  - *Substation Structure Inspection*

1.3.3 Internal Resources

VEC line and substation personnel will inspect and gather the following information and perform any associated maintenance work on all identified concerns.

- VEC Lineman
  - *Fuses/Cutouts*
  - *Hydraulic Reclosers, Sectionalizers and Trip Savers*
  - *Capacitors*
  - *Pad mounted Transformers, Vaults, and Underground Conductor*
  - *Disconnects (Solid Blade, Knife Blade, Inline)*
  - *Gang operated Switches*
  - *Fault Indicators*
  - *Stray Voltage*
- VEC Service Operations group
  - *Substation and Line Regulators*
  - *Electronic Reclosers, Relays, and Breakers*
  - *Substation Transformers*
  - *Substation SCADA Equipment*
  - *Key asset infrared*
  - *Motor Operated Switches*
  - *CT/PT Metering*
  - *Non-revenue tie point/substation meters, and SPEED/Standard Offer metering*
- VEC System Engineering – *Phasing*
- VEC Vegetation Management – *Aerial Patrols*
- VEC Metering – *Single-phase, self-contained metering (residential)*

2 Distribution

The next section of this document details the distribution procedures completed by VEC personnel and contractors working on behalf of VEC. It is broken out first by responsibility (VEC versus Contractor) and then by asset. Each asset contains the following:

- Brief overview of the asset including:
  - What the asset is.
  - Who will perform maintenance.
  - How often the maintenance will be done.
- Location of Associated attribute table, inspection documentation, and CIS entry
- Test and inspection procedures, in general this includes the following:
  - Inspection - visual and mechanical inspections shall be performed.
  - Verify/document nameplate data.
  - Check that there are no broken/cracked parts or other physical damage. Check that screws are tight. This includes relays, synchronizers, cases, and covers.
  - Check devices for moisture or damage from moisture and foreign materials that could inhibit the proper operation and functioning of the devices.
  - Check for proper contact alignment and travel, disc rotation for freedom of movement, target operation, etc. Adjust mechanical alignments according to the manufacturer's specification.
- Conditions based on severity reporting as well as mitigation strategies.

2.1 Severity Ratings

VEC line and/or contract crews will utilize severity ratings to determine the response time and severity of a discovered issue. VEC utilizes the rating system on all assets and the rating varies by asset. When an issue is identified, it is forwarded on to the appropriate Operations Supervisor and E&O Coordinator who will generate a Maintenance type service order.

2.1.1 Severity Rating Table

The E&O coordinators will use priority codes to determine the severity of the issue.

Priority Codes	Rating	Description	Time to Address
Low	1	Very minor condition but no immediate repairs are required at this time.	**180 days**
Normal	2	May cause a circuit outage or problem in the future	**60 days**
High	3	Likely to cause an interruption of service	**10 days**
Immediate	4	Immediate repair or replacement (this rating is used when there is an imminent threat to safety or reliability)	**1 day**

2.2 Davey Resource Group (DRG) Responsibilities

2.2.1 Poles and Attaching Entities

DRG will complete this work as part of the System Assessment. This does not include treatment or inspection of the pole life. For more information, VEC's pole inspections see the Pole Inspections and Treatment section of this document.

Asset Information

For more information on asset data, attribute tables, and entry into VEC's CIS system please see the Data Dictionary SharePoint Site

- **GIS Attribute Table-** gs_support_structure
- **CIS Entry-** No
- **Inspection-** Yes, completed by Davey

Test and Inspection Procedure

1. Stop at each structure
2. Inspection from ground of pole, attachments and hardware of the items listed in the inspection.
3. Identification of any of the following concerns (see Severity Reporting section below)
    - Pole Ground rot
    - Pole broken
    - Pole leaning
    - Pole washing out
    - Woodpecker holes
    - Evidence of flashover
    - Severe pole damage
    - Damage to pole by snowplows/vehicles/etc.
    - Pole top rotted
    - Fill ground level
    - Missing pole ground
    - Missing guy guard
    - Missing guy
    - Broken guy
    - Attachment NESC violation
    - Broken cross arm
    - Burnt cross arm
    - Broken cross arm brace
    - Broken Insulator
    - Lightning arrestor not attached
    - Broken/blown lightning arrestor
    - Verify that cross arms are solid and straight
    - Rotten/corroded anchor
    - Damaged riser

- Broken riser standoff

4. Clear photos without obstructions of each pole tag as well as the associated VEC's equipment and attachments on the pole. These photos shall be uploaded to DocVault via AppSuite Inspections.
5. Photos and documentations showing all NESC violations. These photos shall be uploaded to DocVault via AppSuite Inspections.
6. Pole markings - See VEC standard for pole Markings in VEC's Transmission and Distribution Standards Manual.

Severity Reporting

Description	Rating	Time to Address
Ground rot	2	**60 days**
Pole broken	4	**1 days**
Pole leaning	1	**180 days**
Pole washing out	2	**60 days**
Woodpecker holes	1	**180 days**
Evidence of flashover	3	**10 days**
Severe pole damage	3	**10 days**
Damage to pole by snowplows/vehicles/etc.	1	**180 days**
Pole top rotted	2	**60 days**
Fill ground level	1	**180 days**
Missing pole ground	2	**60 days**
Missing guy guard	2	**60 days**
Missing guy	2	**60 days**
Broken guy	2	**60 days**
Attachment NESC violation	2	**60 days**
Broken cross arm	2	**60 days**
Burnt cross arm	2	**60 days**
Broken cross arm brace	2	**60 days**
Broken Insulator	3	**10 days**
Lightning arrestor not attached	2	**60 days**
Broken/blown lightning arrestor	3	**10 days**
Rotten cross arm	2	**60 days**
Rotten/corroded anchor	2	**60 days**
Damaged riser	2	**60 days**
Broken riser standoff	2	**60 days**
Missing Communication guy	1	**180 days**
Pulled Anchor	1	**180 days**

If DRG identifies any of the above items, DRG will contact the E&O Coordinator who will generate a Maintenance type service order or work order

2.2.2 Overhead Transformers

DRG will complete this work as part of the System Assessment.

Asset Information

For more information on asset data, attribute tables, and entry into VEC's CIS system please see the Data Dictionary SharePoint Site

- **GIS Attribute Table-** gs_transformer
- **CIS Entry-** Yes, Transformer Inventory
- **Inspection-** Yes, completed by VEC line crews

Test Procedure

1. Stop at each overhead transformer
2. Inspection of padmount identification of attributes listed in the inspection.
3. Take photo of nameplate
4. Take photo of transformer in location
5. Identification of any of any condition concerns (see Severity Reporting section below)

Severity Reporting

Description	Rating	Time to Address
Oil leak	4	**1 days**
Broken bushing	4	**1 days**
Broken/blown lightning arrestor	3	**10 days**
Other transformer condition	2	**60 days**

If DRG identifies any of the above items, DRG will contact the E&O Coordinator who will generate a Maintenance type service order or work order.

2.2.3 Overhead Conductor

DRG will complete this work as part of the System Assessment. This includes all primary overhead conductor on VEC's system.

Asset Information

For more information on asset data, attribute tables, and entry into VEC's CIS system please see the Data Dictionary SharePoint Site

- **GIS Attribute Table-** gs_span
- **CIS Entry-** No
- **Inspection-** Yes, completed by Davey

Test Procedure

1. Stop at each span
2. Inspection of conductor and identification of attributes listed in the inspection.
3. Identification of any of any condition concerns (see Severity Reporting section below)

Severity Reporting

Description	Rating	Time to Address
Insufficient clearance	2	**60 days**
Sag	2	**60 days**
Damaged primary	3	**10 days**
Damaged neutral	3	**10 days**
Bird caging at splice	2	**60 days**
Phase wire off pin	4	**1 days**
Phase wire on ground	4	**1 days**

If DRG identifies any of the above items, DRG will contact the E&O Coordinator who will generate a Maintenance type service order or work order. DRG will contact the Utility Joint Use Coordinator for communications violations or concerns.

2.2.4 Street Lights

DRG will complete this work as part of the System Assessment.

Asset Information

For more information on asset data, attribute tables, and entry into VEC's CIS system please see the Data Dictionary SharePoint Site

- **GIS Attribute Table-** gs_span
- **CIS Entry-** Yes,
- **Inspection-** Yes, completed by Davey

Test Procedure

1. Stop at each streetlight
2. Inspection of streetlight
3. Take photo of streetlight in location
4. Identification of any of any condition concerns (see Severity Reporting section below)

Severity Reporting

Description	Rating	Time to Address

Damaged streetlight	3	**10 days**

If DRG identifies any of the above items, DRG will contact the E&O Coordinator who will generate a Maintenance type service order or work order.

2.3 SMI Contractor Responsibilities

2.3.1 Pole Inspection and Treatment

VEC hires a contractor, Smith Mountain Investments (SMI), to perform a pole inspection and treatment program on a ten-year cycle for distribution poles and once every ten years for transmission poles. These timelines are in line with RUS Bulletin 1730B-121. VEC's program consists of ground line inspection, treatment 18 inches below ground level and internally (Mitci-Fume), visual inspection of above ground condition and other maintenance work such as replacing missing guy guards and pole numbers.

VEC's joint ownership agreement with Consolidated Communications identifies pole-set and maintenance areas. VEC inspects all of its sole owned distribution poles across the system and the joint owned poles with Consolidated in VEC's maintenance area. Consolidated Communications is responsible for pole inspection of joint owned poles in their maintenance area.

VEC replaces any reject poles within twelve months of the pole inspection.

VEC does not maintain or inspect "tree poles" as part of its pole inspection process. While a tree pole is not a clear violation of NESC, it is the responsibility of VEC to maintain in a safe manner. VEC will visit these locations periodically to determine their adequacy to hold the lines up under expected and normal conditions. If replacement is required, VEC will work with the member to eliminate these types of poles.

Asset Information

For more information on asset data, attribute tables, and entry into VEC's CIS system please see the Data Dictionary SharePoint Site

- **GIS Attribute Table-** gs_support_structure
- **CIS Entry-** No
- **Inspection-** Yes, completed by Smith Mountain

Test and Inspection Procedure

1. Stop at each structure
2. Sound and Bore.
    - Hammer each pole at ground level to six feet
    - If voids are discovered a shell thickness indicator shall be used to measure them
3. If concerns exist
    - Excavate to a depth of 18 inches and scrape pole clean to detect early surface decay.
    - Apply a preservative treatment
    - The pole shall then be backfilled and the dirt should be tamped firm every six to eight inches.

- The backfill should mound up around the pole to allow for future settling and drainage away from the pole
- Internal treatment will be completed if a void is present and

4. Inspection from ground of pole of the items listed in the above section
5. Identification of any of the following concerns (see Severity Reporting section below)
    - Priority Reject –
        - Less than one inch of pole shell remaining and less than 50 percent of good wood.
        - Decay, insect or mechanical damage has reduced pole strength at the ground line below code requirement.
        - Hazardous conditions exist above ground, such as split top
        - Severe woodpecker hole damage has weakened the pole below safety standards.
        - A priority reject shall not be climbed and needs to replaced immediately
    - Replace Pole –
        - Greater than one inch of pole shell remaining (greater than 50 percent of good wood remaining) but less than two inches of pole shell (less than 67 percent of good wood remaining)
        - VEC should replace within 12 months.
    - Reinforceable Reject –
        - A "reinforceable reject" is a replace pole, which is suitable for restoration of the ground line bending capacity with a method of reinforcement. In general, VEC will treat these as a replace pole.
    - Missing pole ground
    - Missing guy guard
    - Missing guy
    - Broken guy
6. Marking of reject poles and priority reject poles per VEC Standard 205 – Pole Inspection Markings
7. Clear photos without obstructions of each pole tag as well as the associated VEC's equipment and attachments on the pole. These photos shall be uploaded to DocVault via AppSuite Inspections

Severity Reporting

Description	Time to Address	VEC Action
Priority Reject	**30 days**	Open a OSMOSE POLE Service Order
Reinforceable Reject	**360 days**	Open a REPLACE POLE Service Order
Replace Pole	**360 days**	Open a REPLACE POLE Service Order
Missing pole ground	**360 days**	Open a OSMOSE MAINTENANCE Service Order
Missing guy guard	**360 days**	Open a OSMOSE MAINTENANCE Service Order
Missing guy	**360 days**	Open a OSMOSE MAINTENANCE Service Order
Broken guy	**360 days**	Open a OSMOSE MAINTENANCE Service Order

The pole inspection contractor sends reports to System Engineering. System Engineering reviews these reports and forwards on to the appropriate Operations Supervisor and E&O Coordinator to generate Work/Service Orders to complete the work.

2.4 Line Crew Responsibilities

2.4.1 Hydraulic Reclosers (OCR) and Trip Saver

The VEC Line Crew completes this work. All Districts will replace one fifth of the hydraulic reclosers within their District (five-year plan). In addition, VEC will inspect and maintain trip savers on the same cycle as hydraulic reclosers.

Asset Information

For more information on asset data, attribute tables, and entry into VEC's CIS system please see the Data Dictionary SharePoint Site

- **GIS Attribute Table-** gs_overcurrent_device
- **CIS Entry-** Yes, CIS distribution equipment inventory
- **Inspection-** No

Procedure

VEC replaces all hydraulic reclosers on a five-year cycle. As such, an inspection procedure is not required. All hydraulic reclosers and trip savers should have both an inline disconnect and fused bypass per VEC standards. A general procedure is provided below on identifying these replacements:

1. The Manager of Engineering will identify the reclosers to be replaced in the upcoming maintenance year based off the GIS attribute table.
2. System Engineering will review this list and identify any size changes and replacements. VEC will standardize on types V4H and V4L with a sequence of 1A-2B. There is one exception, we do have type D on the system because of inventory levels, and VEC will eventually convert to a DV or use a 651R, 351R.
3. VEC will be using available re-built hydraulic inventory before purchasing and installing a Trip Saver.
4. The E&O Coordinator will open up work orders based on the updated list provided by System Engineering.
5. Coordinators will be provided the list to create an equipment replacement WO for each location to be reviewed and designed by the Utility Designer.
6. When VEC line crews take down OCRs VEC will send them to a vendor (Salomon) to be rebuilt. They will convert 4H and L reclosers to V4H and V4L. Any H type reclosers taken down will automatically be removed from inventory by the Purchasing Department. Any that fail will be also be removed from inventory by the Purchasing Department.
7. When Salomon returns the rebuilt OCRs to VEC, VEC update the equipment inventory in CIS and the Service Operations group will test the device. VEC uses a Phoenix primary injection tester to make sure the device trips at proper settings.
8. When completing Hydraulic Recloser replacements VEC lineman will charge to a specific work order and utilize the recloser change form.
9. All Hydraulic Reclosers will be labeled with a unique Coop Number

2.4.2 Sectionalizers

The VEC Line Crew completes this work. All Districts will inspect one fifth of the sectionalizers within their District (five-year plan).

Asset Information

For more information on asset data, attribute tables, and entry into VEC's CIS system please see the Data Dictionary SharePoint Site

- **GIS Attribute Table-** gs_overcurrent device
- **CIS Entry-** Yes, Distribution Equipment Inventory
- **Inspection-** Yes, completed by VEC line crews

Test Procedure

1. Stop at each Sectionalizer
2. Inspection of Sectionalizer, identification of attributes listed in the inspection.
3. Jumper out the sectionalizer, remove cap and check for water.
4. Verify functionality of Sectionalizer
5. Identification of any condition based concerns (see Severity Reporting section below)
6. Pole markings - See VEC standard for pole Markings in VEC's Transmission and Distribution Standards Manual
7. All Sectionalizers will be labeled with a unique Coop Number

Severity Reporting

Description	Rating	Time to Address
Sectionalizer not functional	3	**10 days**

If VEC line crews identify any of the above items, the line crew shall contact the E&O Coordinator who will generate a Maintenance type a work order.

2.4.3 Fuses and Cutouts

The VEC Line Crew completes this work. All Districts will inspect one fifth of the fuses and cutouts within their District (five-year plan).

In the event that line personnel identify either, a broken cutout/fuse or flashover/burn marks, the line crews replace the fuse/cutout and fill out the appropriate fuse form.

Asset Information

For more information on asset data, attribute tables, and entry into VEC's CIS system please see the Data Dictionary SharePoint Site

- **GIS Attribute Table-** gs_overcurrent_device
- **CIS Entry-** No
- **Inspection-** Yes, completed by VEC line crews

Inspection Procedure

1. Stop at each fuse
2. Inspection of fuse, identification of attributes listed in the inspection.

3. Identification of any condition based concerns (see Severity Reporting section below)
4. Pole markings - See VEC standard for pole Markings in VEC's Transmission and Distribution Standards Manual

Severity Reporting

Description	Rating	Time to Address
Fuse Cracked	2	**60 days**
Replace Cutout	1	**180 days**

If VEC line crews identify any of the above items, the line crew shall contact the E&O Coordinator who will generate a work order.

2.4.4 Capacitors

The VEC Line Crew completes this work. All Districts will inspect one fifth of the capacitors within their District (five-year plan).

Asset Information

For more information on asset data, attribute tables, and entry into VEC's CIS system please see the Data Dictionary SharePoint Site

- **GIS Attribute Table-** gs_capacitor_bank
- **CIS Entry-** Yes, Distribution Equipment Inventory
- **Inspection-** Yes, completed by VEC line crews

Test Procedure

1. Stop at each capacitor
2. Inspection of capacitor, identification of attributes listed in the inspection.
3. Verify functionality (is capacitor working)
4. Verify fuse is closed
5. If Fuse is open, test the capacitor before closing:
    a. Use a load break capable device to de-energize the cap
    b. If the cutout/fuse is open then move to step three
    c. Verify grounding bushing is bonded to ground/neutral
    d. Wait five minutes so the cap can bleed off. (in the safety manual Sec 2300 Special Conditions Rev13)
    e. Shunt the primary bushing and the grounding bushing (in the safety manual it reads "Touch a piece of wire or metal attached to a hot stick across the terminals of each unit")
    f. Test cap using a devise measuring micro farads (uF) (some fluke models are capable of doing this)
    g. Match measurement to name plate capacitance, according to IEEE 18 2002 it cannot vary more than -0% to + 10% to the nominal
6. Identification of any of any condition concerns (see Severity Reporting section below)
7. Pole markings - See VEC standard for pole Markings in VEC's Transmission and Distribution Standards Manual

If VEC line crews identify any of the above items, the line crew shall contact the E&O Coordinator who will generate a Maintenance type a work order.

2.4.5 Disconnects (Solid, Knife Blades, Inlines)

The VEC Line Crew completes this work. All Districts will inspect one fifth of the disconnects (Solid, Knife Blades Inlines) within their District (five-year plan).

Inline Disconnects

Knife Blade Disconnects

Solid Blade Disconnects

Asset Information

For more information on asset data, attribute tables, and entry into VEC's CIS system please see the Data Dictionary SharePoint Site

- **GIS Attribute Table-** gs_switch
- **CIS Entry-** No
- **Inspection-** Yes, completed by VEC line crews (Disconnect)

Test Procedure

1. Stop at each switch
2. Inspection of switch, identification of attributes listed in the inspection.
3. Verify grounding
4. Verify blade seating properly
5. Remove Nests/Sticks/Bee Hives
6. Test switch operation
7. Identification of any of any condition concerns (see Severity Reporting section below)
8. Take photo of switch
9. Pole markings - See VEC standard for pole Markings in VEC's Transmission and Distribution Standards Manual

Severity Reporting

If VEC line crews identify any condition concerns, the line crew shall contact the E&O Coordinator who will generate a type work order.

2.4.6 Switches

The VEC Line Department completes this work. All Districts will inspect one fifth of the motor/gang operated switches on VEC's system every year (Five-year plan).

Asset Information

For more information on asset data, attribute tables, and entry into VEC's CIS system please see the Data Dictionary SharePoint Site

- **GIS Attribute Table-** gs_switch
- **CIS Entry-** Yes, Distribution Equipment Inventory
- **Inspection-** Yes, completed by VEC line crews with support from Substation crew (Switch)

Test Procedure

1. Stop at each switch
2. Inspection of switch, identification of attributes listed in the inspection.
3. Verify grounding
4. Verify blade seating properly
5. Check switch handle
6. Lubricate Pivot Points
7. Remove Nests/Sticks/Bee Hives

8. Test switch operation
9. Identification of any of any condition concerns (see Severity Reporting section below)
10. Pole markings - See VEC standard for pole Markings in VEC's Transmission and Distribution Standards Manual

Severity Reporting

The VEC Operations Supervisor shall report any condition concerns to VEC Engineering for further review and identification of potential capital budget impacts.

2.4.7 Fault Indicators

The VEC Line Crew completes this work. All Districts will inspect and replace if needed one fifth of the fault indicators within their District (five-year plan).

Asset Information

For more information on asset data, attribute tables, and entry into VEC's CIS system please see the Data Dictionary SharePoint Site

- **GIS Attribute Table-** gs_fault_indicator
- **CIS Entry-** Yes, Distribution Equipment Inventory
- **Inspection-** Yes, completed by VEC line crews

Test Procedure

1. Stop at each fault indicator
2. Inspection of fault indicator, identification of attributes listed in the inspection.
3. Verify manufacturer year, if greater than 5 years replace
4. Add coop number
5. Pole markings - See VEC standard for pole Markings in VEC's Transmission and Distribution Standards Manual

2.4.8 Pad Mounted Transformers

The VEC Line Crew completes this work. All Districts will inspect one fifth of the pad-mounted transformers within their District (five-year plan).

Asset Information

For more information on asset data, attribute tables, and entry into VEC's CIS system please see the Data Dictionary SharePoint Site

- **GIS Attribute Table-** gs_transformer
- **CIS Entry-** Yes, Transformer Inventory
- **Inspection-** Yes, completed by VEC line crews

Test Procedure

1. Stop at each padmount transformer
2. Inspection of padmount and identification of attributes listed in the inspection.
3. Check arrestor installation

4. Check for rust holes
5. Check padmount labels
6. Check transformer connections
7. Very condition of ground connections
8. Check vault condition
9. Check for oil leaks
10. Check hinged condition
11. Check Elbow Condition
12. Remove obstructions if applicable.
13. Verify coop number
14. Take photo of nameplate
15. Take photo of transformer in location
16. Identification of any of any condition concerns (see Severity Reporting section below)
17. Verify Labeling - See VEC standard for pole Markings in VEC's Transmission and Distribution Standards Manual

Severity Reporting

Description	Rating	Time to Address
Oil leak	4	**1 days**
Broken bushing	4	**1 days**
Broken/blown lightning arrestor	3	**10 days**
Other transformer condition	2	**60 days**
Obstruction follow-up	1	**180 days**

If VEC line crews identify any condition concerns, the line crew shall contact the E&O Coordinator who will generate a maintenance type work order or service order.

2.4.9 Underground Conductor

This includes all primary underground conductor on VEC's system. **VEC line crews shall complete this work during the first five-year cycle and complete the work in tandem with the vault and padmounted transformer inspection**

Asset Information

For more information on asset data, attribute tables, and entry into VEC's CIS system please see the Data Dictionary SharePoint Site

- **GIS Attribute Table-** gs_span
- **CIS Entry-** No
- **Inspection-** Yes, completed by VEC

Test Procedure

1. Stop at each underground location
2. Inspection of underground conductor and identification of attributes listed in the inspection.

3. Identification of any of any condition concerns (see Severity Reporting section below) Photos and documentations showing all NESC violations. These photos shall be uploaded to DocVault via AppSuite Inspections

Severity Reporting

Description	Rating	Time to Address
Underground failure	4	**1 days**

If VEC line crews identify any of the above items, they should contact the control center.

2.4.10 Vaults

This includes all primary underground conductor on VEC's system. **VEC line crews shall complete this work during the first five-year cycle and complete the work in tandem with the underground conductor and padmounted transformer inspection**

Asset Information

For more information on asset data, attribute tables, and entry into VEC's CIS system please see the Data Dictionary SharePoint Site

- **GIS Attribute Table-** gs_surface_structure
- **CIS Entry-** No
- **Inspection-** Yes, completed by VEC

Test Procedure

1. Stop at each vault
2. Inspection of vault identification of attributes listed in the inspection.
3. Very condition of ground connections
4. Check vault condition
5. Check hinged condition
6. Check Elbow Condition
7. If no cabinet, verify if cover is secure
8. Remove obstructions if applicable.
9. Take photo of vault in location
10. Identification of any of any condition concerns (see Severity Reporting section below)
11. Verify Labeling - See VEC standard for pole Markings in VEC's Transmission and Distribution Standards Manual

Severity Reporting

Description	Rating	Time to Address
Cracked elbow	4	**1 days**
Water drainage needed	1	**180 days**
Other condition of concern	1	**180 days**

Obstruction follow-up	1	**180 days**

If VEC line crews identify any condition concerns, the line crew shall contact the E&O Coordinator who will generate a maintenance type work order or service order.

2.4.11 Stray Voltage

VEC Line Crews inspect all active farms within its service territory for stray voltage on an annual basis. This includes all locations that have active neutral separation as well. VEC engineering reviews the results of the inspection.

A list of all farms on VEC's system is available in NISCs CIS via an open filed. The VEC E&O Coordinator updates the open field every time they add a new account or when VEC identifies a stray voltage issue.

For specific information on tests, please see the latest version of VEC's Stray Voltage Policy

2.4.12 Avian Protection

The VEC line crew completes this work. Ospreys are primarily a concern in the Grand Isle, Richford, and Newport districts. VEC performs routine "stick patrols" during summer months on three phase main lines and removing any nests. If the osprey comes back to same location, VEC works with Vermont Fish and Wildlife to identify a location to set a pole away from our distribution line to allow the osprey to build their nest while not affecting the power system.

In some cases, VEC line workers will install guarding or blockers to prevent Osprey from nesting on VEC facilities.

2.5 Metering Department Responsibilities

The VEC Metering department is responsible for all residential meters. The VEC metering group will complete random testing of 10 percent of meters on all route audits (1S, 2S, 12S, 16S), unless the area is part of an active scheduled meter replacement initiative. For all other meters, testing will be done by the VEC Service Operations group and the frequency is defined in the section below.

2.5.1 General Metering

When completing meter testing and verifications, VEC personnel will charge to GL account 586.00 for meter testing, communications, inspection and maintenance and 107.20 for new meter installations as follows (XXXX = year):

10720	XXXXGEN	ALF self-contained (1S, 2S)
10720	XXXXENDIS	AXR-SD self-contained w/disconnect
10720	XXXXCOMM	Commercial meters (3S,4S,9S,12S,16S)
10720	XXXXIND	Industrial Meters (Nexus, Shark)

2.5.2 Meter Testing Standards

The formal regulations that VEC's meter testing and verification program must conform to:

VEC Schedule of Electric Rates and Rules Governing Service https://www.vermontelectric.coop/images/pdf/vec-tariff-effective-01-01-2017.pdf Specifically, (at Original Sheets #7 &8):

MEASURING OF SERVICE

a. All energy sold to customers and all energy consumed by the Cooperative, except that sold according to fixed charge schedules, shall be measured by commercially acceptable measuring devices owned and maintained by the Cooperative except where it is impractical to install meters, such as street lighting or security lighting, or where otherwise authorized by the Board.

b. If any meter after testing is found to be more than two percent (2%) in error, either fast or slow, proper correction of the error shall be made of previous reading and adjusted bills shall be rendered for a period of up to one year immediately preceding the removal of such meter from service for test or from the time the meter was in service since last tested, but not exceeding one year since the meter shall have been shown to be in error by the test.

c. No adjustment shall be made by the Cooperative except to the customer last served by the meter tested.

d. A Meter Test Fee will be required for performing a second meter test on the same meter within a one-year period. The fee will be based on time to travel and perform the test at $90.00 per test. The fee will be refunded if the meter proves inaccurate by greater than plus or minus four percent (4%).

VEC's internal standard for meter accuracy shall be +/-2%. Target calibration, where applicable, shall be +/-0.5%. Unless stated elsewhere in this document, VEC's Meter Testing and Verification program will verify meter accuracy according to:

1. ANSI for Electric Meters Code for Electric Metering (ANSI C12.1)
2. American National Standard Sampling Procedures and Tables for Inspection by Variables for Percent Non-Conforming (ANSI/ASQ Z1.9-2008) for sampling

2.5.3 Meter Testing

VEC will meet the following qualifications:

1. 100% testing of all meters by the manufacturer prior to shipment to VEC. Testing information will be loaded into VEC's billing system for historical reference;
2. Ability to monitor all in-service meters for performance through daily reads;
3. Ability to monitor customer usage abnormalities on a route cycle basis (CIS, by query);
4. Random sample testing of meters after ten years in service.
5. Unless otherwise stated, the weighted average test results shall be calculated using the formula: [4HL + 2 LL + PF] / 7.
6. The Senior Field technician shall inspect new CT/PT metered services within six weeks of the date of the installation.
7. Meter test results are shared for member requested work. Any routine testing results related to the maintenance plan is not shared externally.
8. Whenever possible, meters shall be tested on-site and in their existing socket.

2.5.4 Single-phase, self-contained metering (residential)

The VEC Metering group completes this work. The VEC metering group will complete random testing of 10% of meters on all route audits (self-contained, 1S, 2S, 12S). If the area is part of an active scheduled meter replacement initiative, the meters will not be tested.

Asset Information

For more information on asset data, attribute tables, and entry into VEC's CIS system please see the Data Dictionary SharePoint Site

- **GIS Attribute Table-** gs_meter
- **CIS Entry-** Yes, Meter Inventory
- **Inspection-** Not in Inspections, done in CIS (meter Test)

Test Procedure

1. When completing field meter test and verifications, VEC personnel will charge to GL account 586.00.
2. General inspection and observe for
    a. signs of heat or arching,
    b. meter display register (e.g. missing segments, discoloration),
    c. cracks in the meter face or housing,
    d. water/salt/ice damage,
    e. unprotected wires,
    f. broken conduit,
    g. unsecured meter socket,
    h. signs of tampering
    i. physical damage
3. All services which contain a secondary lightning arrestor will have the lightning arrestor removed and the hole to the meter base filled appropriately.
4. When doing a meter test or verification, test and/or replace batteries, if applicable. Upgrade meter firmware where applicable, or replace meter with reprogrammed meter.
5. Identification of attributes listed in the inspection.
6. Verify grounding

Severity Reporting

The VEC metering group shall report any safety or condition concerns to the VEC Key Account Manager for further review and resolution.

2.6 Service Operations Group Responsibilities

2.6.1 Motor Operated Switches

The VEC Service Operations group completes this work. The Service Operations group will inspect one fifth of the motor operated switches on VEC's system every year (Five-year plan).

Asset Information

For more information on asset data, attribute tables, and entry into VEC's CIS system please see the Data Dictionary SharePoint Site

- **GIS Attribute Table-** gs_switch
- **CIS Entry-** Yes, Distribution Equipment Inventory
- **Inspection-** Yes (Switch)

Test Procedure

1. Stop at each switch
2. Inspection of switch, identification of attributes listed in the inspection.
3. Verify grounding
4. Verify blade seating properly
5. Check switch handle
6. Lubricate Pivot Points
7. Remove Nests/Sticks/Bee Hives
8. Test switch operation
9. Identification of any of any condition concerns (see Severity Reporting section below)
10. Pole markings - See VEC standard for pole Markings in VEC's Transmission and Distribution Standards Manual

Severity Reporting

The VEC Service Operations group shall report any condition concerns to VEC Engineering for further review and identification of potential capital budget impacts.

2.6.2 Electronic Reclosers (Line)

The VEC Service Operations group completes this work. This includes any electronic Reclosers that are outside VEC's substations and on VEC transmission taps are inspected on a 5-year cycle.

Asset Information

For more information on asset data, attribute tables, and entry into VEC's CIS system please see the Data Dictionary SharePoint Site

- **GIS Attribute Table-** gs_overcurrent_device
- **CIS Entry-** Yes, Distribution Equipment Inventory (separate entry for relay and recloser)
- **Inspection-** Yes, completed by Service Operations group

Test Procedure Cooper VWE / VWVE38X

1. Stop at each electronic recloser
2. Inspection of fuse, identification of attributes listed in the inspection.
3. **Doble:** Perform the test to Doble standards using their software.
    a. Results: Compare to Doble expected results and compare to other units in service
4. **Oil Dielectric Test**: Test oil from near bottom of tank before any filtering and determine breakdown strength. If not a minimum of 22KV (cooper guideline) filter oil and retest continue filtering until a minimum of 22KV is obtained.
5. **Micro- Ohm**: With the breaker closed micro-ohm each phase at 200A to determine contact resistance, should be less than 200u Ohms.
6. **AC High Pot Test:** Follow Cooper test guideline in the VWE maintenance manual (S280-40-6) perform test at 75% of rated withstand voltage level for one minute. VWE 37.5Kv
7. Follow Cooper Maintenance Manual S280-40-6 for the operational tests, bushing inspection and closing coil checks.
8. Photo of Recloser
9. Photo of Relay
10. Identification of any of any condition concerns (see Severity Reporting section below)

Test Procedure for ABB OVR

1. Stop at each electronic recloser
2. Inspection of fuse, identification of attributes listed in the inspection.
3. **Doble:** Perform the test to Doble standards using their software.
    a. Results: Compare to Doble expected results and compare to other units in service
4. **Micro- Ohm:** With the breaker closed micro-ohm each phase at 200A to determine contact resistance, should be less than 150u Ohms.
5. **AC High Pot Test:** Need to investigate what ABB recommends for High Pot test voltage and procedure.
6. Follow the ABB Service Manual for the operational tests.
7. Photo of Recloser
8. Photo of Relay
9. Identification of any of any condition concerns (see Severity Reporting section below)

G&W Viper ST and S Tests

1. Stop at each electronic recloser
2. Inspection of fuse, identification of attributes listed in the inspection.
3. **Doble:** Perform the test to Doble standards using their software.
    a. Results: Compare to Doble expected results and compare to other units in service
4. **Micro- Ohm:** With the breaker closed micro-ohm each phase at 200A to determine contact resistance, should be less than 200u Ohms.
5. **AC High Pot Test:** Follow G&W recommendations for high pot test in their maintenance manual, located with each new breaker.
6. Follow G&W service manual for the operational tests.
7. Photo of Relay
8. Photo of Recloser
9. Identification of any condition based concerns (see Severity Reporting section below)

Severity Reporting

The VEC Service Operations group shall report any condition concerns to VEC Engineering for further review and identification of potential capital budget impacts.

2.6.3 Line Regulators

This work is completed by the VEC Substation Crew. Line regulators are inspected annually.

Asset Information

For more information on asset data, attribute tables, and entry into VEC's CIS system please see the Data Dictionary SharePoint Site

- **GIS Attribute Table-** gs_regulator
- **CIS Entry-** Yes, Distribution Equipment Inventory
- **Inspection-** Yes, completed by Service Operations group

Test Procedure

It should be noted that the electric industry, as a whole, does not have a standard when a utility should conduct maintenance on their voltage regulators and the range of cycles acceptable to do that maintenance also varies greatly. When considering these factors, VEC has looked to manufacturers' recommendations as well as engineering best practices when developing this program.

1. Stop at each electronic recloser
2. Inspect physical and mechanical condition
3. Inspect anchorage, alignment, and grounding
4. Perform inspection and gather data as prescribed in the Inspections section above
5. Verify auxiliary device operation.
6. Verify correct liquid level in all tanks
7. Update panels, software, and firmware (e.g., Cooper CL-6B)
8. Photo of regulator
9. Identification of any condition concerns (see Severity Reporting section below)

Severity Reporting

The VEC Service Operations group shall report any condition concerns to VEC Engineering for further review and identification of potential capital budget impacts. When the inspection is complete, the Manager of Line Operations will notify System Engineering who will perform a review of the data collected during the inspection.

2.6.4 Infrared Testing

VEC retains an independent contractor to inspect with infrared cameras all substations, transmission lines, tie switches, and SCADA operable switches twice per year in July and December.

The Manager of Service Operations coordinates these inspections with Infrared Analyzers. This inspection makes use of infrared thermography, which detects differences in temperature with sensitive, non-contact, non-destructive electronic equipment and converts the infrared energy into a video image. Since infrared energy is a direct and

proportional function of temperature, the video image is designed to depict various shades of gray or color to indicate a difference in temperature levels. In color mode, lighter shades correspond with higher temperatures. In black and white mode, darker shades of gray correspond with lower temperatures, and lighter shades of gray or white correspond to higher temperatures; referred to as "hot spots." VEC utilizes the thermal-graphic information to help solve a variety of issues and, in many cases, allow technicians to mitigate an issue before a failure occurs.

The thermo-graphic images show the temperature difference between the areas of concern/deficiency and corresponding reference ("normal") areas. However, temperature variances alone do not necessarily indicate the severity of the issue. The importance of each potential issue is reviewed within the framework of the system as a whole and the resulting report assists with the process of properly identifying area of potential maintenance or replacement. VEC utilizes the infrared criteria from MIL-STD-105 (Military Specification for Electrical Inspection Criteria):

Severity Code	Temperature Rise degrees C Over Ambient	Repair Priority	Severity/Recommendation
1	Less than 74 degrees Fahrenheit (0-24 degrees Celsius)	Desirable	Component failure is improbable, but corrective action is required at the next maintenance period or as scheduling permits
2	75-103 degrees F (25-39 degrees Celsius)	Important	Component failure is probable unless corrective action is taken
3	104-157 degrees F (40-69 degrees C)	Mandatory	Component failure almost certain unless corrective action is taken
4	Over 158 degrees F (Over 70 degrees C)	Immediate	Component failure imminent, repair Immediately

The Manager of Service Operations shall maintain a list of the open issues on SharePoint. Infrared Analyzers provides a written report and VEC's Manager of Engineering and Manager of Service Operation review the results.

2.6.5 PT/CT Metering

The VEC Service Operations group completes this work on the following frequency:

1. VEC's Industrial accounts, consisting of approximately 12 of the largest retail members served shall be tested every three years. Testing shall include the entire meter package, in parts, or in whole.
2. Large power users - demand billed and Large Commercial TOU accounts, including instrument rated metering services, with usage above 250,000 kWh annually, will be tested once every three years. For 2021, this accounts for approximately 76 services. Testing shall include the entire meter package, in parts or in whole.
3. All other commercial metered services shall be tested every 5 years consistent with the system maintenance plan.

Asset Information

For more information on asset data, attribute tables, and entry into VEC's CIS system please see the Data Dictionary SharePoint Site

- **GIS Attribute Table-** gs_meter
- **CIS Entry-** Yes, Meter Inventory
- **Inspection-** Yes, completed by VEC Service Operations group

Test Procedure

1. When completing field meter test and verifications, VEC personnel will charge to GL account 586.00.
2. General inspection and observe for
    a. signs of heat or arching,
    b. meter display register (e.g. missing segments, discoloration),
    c. cracks in the meter face or housing,
    d. water/salt/ice damage,
    e. unprotected wires,
    f. broken conduit,
    g. unsecured meter socket,
    h. signs of tampering
    i. physical damage
3. When doing a meter test or verification, test and/or replace batteries, if applicable. Upgrade meter firmware where applicable, or replace meter with reprogrammed meter.
4. Identification of attributes listed in the inspection.
5. Verify grounding

Severity Reporting

The VEC Service Operations group shall report any safety or condition concerns to the Manager of Service Operations for further review and resolution. In addition, the Manager of Service Operations will review the finalized inspections.

2.6.6 Non-Revenue Substation/Tie Point and SPEED/Standard Offer

The VEC metering group completes this work. The Service Operations group will inspect 1/5 of the on-revenue substation and tie-point meters, as well as any SPEED Standard Offer (aka VT's feed-In tariff) annually. Non-revenue "VEC-use" and station service metering, if unique from generation, shall be tested every eight years.

The testing process and inspections for these types of meters is still in progress.

2.7 System Engineering Responsibilities

2.7.1 Phasing

VEC System Engineering will perform a review of existing phasing as part of the first 5 years of the maintenance plan. By the end of each calendar year the maintenance plan circuits will have phasing that is consistent with VEC system phasing as determined by the EDM Phase Trakker.

VEC substation personnel will work with Engineering to label and match substation distribution bus phasing to the VEC standard phasing as determined by the EDM Phase Trakker. This will involve:

- Utilization of Avistar phasing device to identify VEC standard system phasing
- Matching of AMI phases to VEC Phasing.
- SCADA updates to RTU's at substations and generator sites (if needed).

VEC will use AMI to identify the correct phase on each circuit in order for VEC GIS to match the substation and therefore VEC standard system phasing. The GIS department will need to update these phases in VEC's GIS system, which will automatically update connectivity in OMS. Phase changes will also need to be updated on the service point's Emergency address field.

3 Transmission

The next section of this document details the transmission procedures completed by VEC personnel and contractors working on behalf of VEC. It is broken out first by responsibility (VEC/Contractor) and then by asset. Each asset contains the following:

- Brief overview of the asset including:
  - What the asset is
  - Who will perform maintenance
  - How often the maintenance will be done
- Location of Associated attribute table, Inspection documentation, and CIS entry
- Test and inspection procedures, in general this includes the following:
  - Inspection - Visual and mechanical inspections shall be performed.
  - Verify/document nameplate data
  - Check that there are no broken or cracked parts or other physical damage. Check that screws are tight. This includes relays, synchronizers, cases, and covers.
  - Check devices for moisture or damage from moisture and foreign materials that could inhibit the proper operation and functioning of the devices.
  - Check for proper contact alignment and travel, disc rotation for freedom of movement, target operation, etc. Adjust mechanical alignments according to the manufacturer's specification.
- Conditions based on severity reporting as well as mitigation strategies.

There is currently no defined line maintenance program for transmission, the goal is to have an updated program developed in June of 2021.

3.1 Vegetation Management Responsibilities

3.1.1 Aerial Patrols

The Manger of Forestry will coordinate aerial patrols and one infrared scan of all VEC transmission lines, as well as some major distribution lines, five times per year. The objective is to identify equipment concerns and danger trees and/or vegetation concerns, as well as any safety hazards that may exist, due to public activity taking place in close proximity to transmission structures or facilities.

When completing aerial transmission line inspection, VEC personnel will charge to GL account 571.45.

VEC's transmission facilities will be air patrolled through an aerial line inspection process on an annual basis. The aerial transmission line inspection will be completed by VEC's Manager of Line Operations or designee September through November depending on weather and atmospheric conditions. VEC personnel will take pictures, as appropriate, for supporting documentation. Corrective work will have service orders prepared and the corrective action completed within 90 days.

VEC personnel will document all corrective maintenance items on VEC's Aerial Transmission Inspection Form. All critical conditions identified that, in the judgment of the employee conducting the aerial inspection, pose imminent danger or are very likely to cause an outage in the next 30 days will be reported to the Control Center at the

conclusion of each day's aerial inspection. The Control Center will create a service order, inform the Manager of Line Operations (if that is not the person conducting the aerial inspection) and schedule the corrective work for immediate, priority repair. If VEC replaces a pole on any transmission facility, who will conduct a detailed inspection. For all other repairs on a transmission facility, the fixes VEC will record on the aerial inspection form.

The pilot of the aircraft will provide permits and or notifications to fly.

The following guideline constitutes an aerial transmission line inspection (at approximately 70 mph):

- Check overall condition of structures
- Look for and document any damage to structure
- Poles
- Cross arms
- Braces
- Insulators and ties
- Conductors
- Static line
- Pins
- Check hardware on structure
- Look for and document obvious gaps between bolts, nuts and washers
- Check for and document broken/tracking/burnt insulators and bells
- Review and document condition of conductor (if the issues can be seen from the air)
- Burn marks
- Broken strands
- Strands exposed and separated out of splices
- Strands exposed and separated out of armor-rod
- Check for and document broken guy wires
- Inspect for broken avian protection devices
- Visually inspect and document switch condition
- Document any obstructions or foreign objects on structures (e.g., bird nest, signs, etc.)
- Specifically check and document any trees in right-of-way
- Check and document any breeches in clearances in right-of-way (e.g., buildings, rock piles, cranes, chain hoists, etc.)
- Document all non-normal system switch line-up conditions

Transmission Inspection Verification: The aerial inspection will serve as verification to the Transmission Line Inspection process. The Manager of Line Operations will review any issues provide the information to the appropriate Operation Supervisor.

4 Substation

The next section of this document details the substation procedures completed by VEC personnel and contractors working on behalf of VEC. It is broken out first by cadence (Monthly/Annual/Multi-year) and then by asset.

4.1 Monthly Substation Inspections

- **Physical Yard Inspection –** Includes Fence, signage, locks, grounds, switch sticks, and lights
- **Structure Condition-** Check poles, wood and steel structures for condition
- **FR Cabinet inspection –** Includes Tags, Switching Pad, Heater, Shield, Jacket, Silicon Wipes
- **Insulator Check-** Insulators, switches, and bushings checked for chips and cracks
- **Switch Locking and Position –** Verify switches fully open/closed, locked
- **Control House Check-** Control House HVAC, Fire Extinguisher, eyewash, emergency lights, cleanliness, rodents, switching gear, tags, switching pad.

When completing monthly transmission substation inspections, VEC personnel will charge to GL account 592. VEC has 32 Distribution Substations, 3 Sub transmission switching substations with 46kv breakers, and 5 distribution metering points. When completing monthly distribution substation inspections, VEC personnel will charge to GL account 582.

The VEC Service Operations group will perform a visual inspection of all substations by utilizing VEC's Monthly Substation Inspection Form. The visual inspection will include those items on the substation inspection form as specified in RUS Bulletin 1730-1. The VEC Service Operations group will fix or correct any issues found at the time of inspection, if possible. Any issues found that are not in danger of causing an outage but cannot be addressed while the substation is energized, will be noted on the inspection form and a service order will be created by the VEC Dispatch group and assigned to the Manager of Service Operations for scheduling. The Service Operations group will either address these issues at the next schedule substation outage, a special substation outage, or during detailed substation maintenance. Finally, the Manager of Service Operations will seclude and coordinate any issues found that are in danger of causing an outage, within 30 days of the inspection.

The following guideline constitutes a monthly substation inspection.

- List date, time, substation number, inspector and outpost
- Transformer (all phases)
    - Winding temperature
    - Oil temperature
    - Nitrogen pressure
    - Nitrogen bottle
    - Ambient temperature
- Regulators (all phases)
    - Counter reading
    - Max boost
    - Min buck
    - Load indicator
    - Volts
    - Amps
    - Max amps
    - High voltage
    - Low voltage
    - Note any alerts or alarms
- Reclosers (all circuits, all phases)
    - OCR number
    - Amps

    - Operations (OP) counter
    - Target counter
    - Electronic reclosers
        - Reset OP and target counters (yes/no)
        - Battery test (pass/fail)
        - Lamp test (pass/fail
- Battery charger
- Voltage
    - Amps
    - Target LED (yes/no)
- Breaker/circuit switcher (for each breaker/circuit switcher)
    - Number
    - Counter
    - Open/Closed
    - Note oil or gas levels
- Capacitors (testing of the capacitor control relay will be performed during five-year detailed testing)
    - Inspect capacitors and relays for any abnormalities/alarms
    - Check individual fuse for each bank

For each of the above apparatus the following visual inspections will be made, as appropriate, and specifically noted on the Monthly Substation Inspection Form according to RUS Bulletin 1724E-300 and NESC Code Part I: Rules for the Installation and Maintenance of Electrical Supply Stations and Equipment Sections 10 through 19:

- Review overall external condition of the apparatus
    - Oil leaks
    - Excessive rust
    - Unusual sounds, vibrations, odors
    - Nitrogen levels
- Check and document condition of bushings
    - Broken or cracked porcelain
    - Oil leaks
    - Oil levels
    - Burn marks or other indications of tracking
    - Proper grounding
- Check and document condition of lightning arrestors
    - Broken or cracked porcelain
    - Oil leaks
    - Burn marks or other indications of tracking
    - Proper grounding
- Verify and document oil levels and measures
    - Tank
    - Load and no load tap changers
    - Oil and winding (“hot spot”) temperature gauge readings
- Check and document readings of inert air system including spare nitrogen cylinders
- Check and document condition of cooling equipment
    - Radiators
    - Fans
    - Controls
- Review and document the condition of all pressure relief devices
- Review and document condition of buss work
- Review and document condition of disconnect switches

- Verify that they are tagged
- Verify that they are clearly marked/identified

- Review and document condition/type of fuses

4.2 Annual Substation Testing

4.2.1 Substation Infrared Inspection

The VEC Service Operations group and Infrared Analyzers performs infrared inspections on substation apparatus (e.g. reclosers, switches, and transformer and voltage regulators) and, switches, SCADA operable devices (e.g., switches) twice per year, typically in July and December.

The Manager of Service Operations coordinates the inspection and hires Infrared Analyzers who specialize in this type of testing. VEC utilizes the infrared criteria from MIL-STD-105 (Military Specification for Electrical Inspection Criteria):

Severity Code	Temperature Rise degrees C Over Ambient	Repair Priority	Severity/Recommendation
1	Less than 74 degrees Fahrenheit (0-24 degrees Celsius)	Desirable	Component failure is improbable, but corrective action is required at the next maintenance period or as scheduling permits
2	75-103 degrees F (25-39 degrees Celsius)	Important	Component failure is probable unless corrective action is taken
3	104-157 degrees F (40-69 degrees C)	Mandatory	Component failure almost certain unless corrective action is taken
4	Over 158 degrees F (Over 70 degrees C)	Immediate	Component failure imminent, repair Immediately

The Manager of Service Operations shall maintain a list of the open issues on SharePoint. Infrared Analyzers provides a written report and VEC's Manager of Engineering and Manager of Service Operation review the results.

4.2.2 Substation Transformer DGA Testing

The VEC Service Operations group draws substation transformer oil samples twice per year and sends these samples to SD Meyers for Dissolved Gas Analysis (DGA). The Manager of Engineering review the rainbow reports provided by SD Meyers in accordance with IEEE C57.139. The Manager of Engineering provides recommendations to the Manager of Service Operations based on these test results.

4.2.3 Station Battery and Charger Tests

Annual Station Battery and Charger Tests are scheduled by the Manager of Service Operations and conducted By the substation crew. The tests include:

- Voltage
- Impedance

- Strap resistance
- Specific gravity
- Visual check of charger, leaks, corrosion, heaters, and fluid level

VEC Manager of Service Operations will review all reports documented by the substation crew as part of the maintenance during the year, findings and recommendations for mitigation. VEC's Manager of Service Operations will coordinate with Line Operations to ensure that all issues and recommendations are completed.

4.3 5-Year Substation Testing

4.3.1 Substation Transformers

When completing power transformer maintenance on distribution substations, VEC personnel will charge to GL account 592.

The VEC Service Operations group performs the following testing on power transformers, bushings, and LTCs, as appropriate:

- Resistance measurements, insulation power factor ("Meggar" test) per IEEE C57.12.90
- Ratio test (turns ratio) – +/- 0.05% from calculated nameplate value
- Polarity/phase relation
- Applied potential test per IEEE C57.12.90
- Impulse/High frequency ("sweep frequency")
- Induced potential test per IEEE C57.12.90

Test results are located in the substation fileserver directory on the Doble DTA web.

In addition to the tests conducted above, the VEC Service Operations group will inspect oil levels in the transformer and add oil as necessary. The Service Operations group will also replace nitrogen once they refill.

The VEC Service Operations group tests Substation Transformers every 5 years the tests include: Power Factor Test (DOBLE), Insulation Resistance Test (Megger test), SFRA Sweep Frequency Reponses Analysis test (Doble), Transformer Turns Ratio Test (TTR) and visual Inspection.

- **Oil Containment-** Check for oil in containment, condition of containment
- **Power Transformers-** Winding temperature, max winding temp, indicated oil temperature, maximum oil temp, nitrogen pressure, oil levels, spare power fuses, resetting of drag hands

4.3.2 Substation Regulators

When completing voltage regulator inspections on distribution substations, VEC personnel will charge to GL 592.20.

Maintenance and inventory documentation on all regulators will be stored in the CIS database. In this manner, Service Orders can be automatically created and information updated to ensure the status, location, and inventory of each voltage regulator is always current.

The electric industry, as a whole, does not have a standard when a utility should conduct maintenance on their voltage regulators and the range of cycles acceptable to do that maintenance varies greatly. When considering these

factors, VEC has looked to manufacturers' recommendations as well as engineering best practices when developing this program. Refer to the Cooper Regulator Manual S225-10-10.

The main maintenance provider of VEC's voltage regulators is Solomon Corporation based in Solomon, KS. They service 38.1 to 833 kVA and from 2,400 to 24,940-volt regulators. As a "rule-of-thumb," if a repair or maintenance to a voltage regulator is more than 30% the cost of a new regulator, Solomon will recommend the purchase of a new regulator. This is a helpful guide in deciding when to purchase new regulators or continue with the maintenance and/or repair of an older regulator.

As per general manufacturer recommendations, VEC will remove voltage regulators from service and perform maintenance at the following intervals:

1. Voltage regulators which have reached 200,000 operations or ten (10) years in service for those regulators loaded to 50% or less of nameplate rating.
2. Voltage regulators which have reached 100,000 operations or five (5) years in service for those regulators loaded to more than 50% of nameplate rating.
3. During monthly substation inspections, raise and lower drag hands 1 or 2 positions both directions as described in the above Section 3.1.1 to ensure regulator is functioning properly.
4. If the regulator will not operate properly, change the control panel and verify the new to the old panel (side-by-side) before removing the unit from service.

4.3.3 Recloser Control Testing

The VEC Service Operations group tests substation recloser controls in accordance with the form located on VEC's SharePoint site. The Service Operations group records Recloser schemes and test following recloser control elements:

- Minimum Trip test
- Metering Test
- (3) Phase trip test points (ground trips disabled)
- 200%, 300%, and 400% of the minimum trip set-point
- (3) Ground trip test points (phase trips disabled)
- 200%, 300%, and 400% of the minimum trip set-point
- Cold Load Pickup
- VEC will replace Batteries will be for all relay controls on a 5-year rotating basis whether in substations on the line during DSI or DLI schedules, respectively.

4.3.4 Transmission Substation Relay and Breaker System Protection

VEC's Service Operations group performs testing on all transmission relays and breakers at the Lowell 05, Jay Tap 39, and Enosburg Tap 35 substations on a rolling 5-year cycle.

VEC's protection system maintenance and testing program focuses on testing to verify that the functional performance of the protection system equipment is operating within manufactures' design specifications throughout the service life. All maintenance and testing intervals are based on manufacturer's recommendations, industry standards (where applicable), and prudent utility practices.

VEC stores all test reports from the relays in the substation drive on SharePoint. The protection system maintenance and testing program is condition-based maintenance with scheduled interval maintenance, tests, and system operation evaluations.

The VEC Service Operations group performs commission testing on microprocessor and solid-state relays when a new relay scheme is installed or an electro-mechanical relay is replaced. The goals for this testing include:

- Ensure that all system AC and DC connections are correct
- Ensure that all relays function as intended using in-service settings
- Ensure that auxiliary equipment is functioning correctly

The relay shall be testing in accordance with the manufacturer's recommendations. The VEC substation group tests the following elements in all applicable groups, zones and schemes and the test procedure is developed by the transmission engineer (David Barnes from PLM) and tested by contracted testing company:

- Phase element pickup and timing
- Ground Element pickup and timing
- Instantaneous phase element pickup
- Instantaneous ground element pickup
- Current differential test on 87 type relays
- Harmonic blocking tests on 87 type relays
- Line current differential
- Distance protection
- Under frequency
- Under/Over voltage
- Synch Check
- Reclose

The Service Operations group regular testing on microprocessor relays on a five-year cycle or when there is an indication of a problem with the relay coordination or system problem. The goals for this testing include:

- Ensure that the relay is measuring AC quantities accurately
- Ensure that the scheme logic and protection elements are functioning correctly
- Ensure that auxiliary equipment is functioning correctly

Microprocessor relays are all equipped with self-diagnostics and are monitored and alarmed through SCADA. Relay trouble alarms are Priority 1 and require immediate attention. All protective relays are inspected monthly during routine station checks for outstanding alarms, targets and physical condition. Any items requiring attention are called into dispatch and reported to the Manager of Service Operations & Dispatch. All microprocessor relays are commission tested and regularly scheduled for maintenance testing every five years or when there is indication of a problem with the relay.

DC control circuits including auxiliary equipment are subject to commission tests when a new relay scheme is installed or when replacing an electromechanical relay or scheme. The goals for this testing include:

- Ensure all control, current transformer (CT), potential transformer (PT), and control panel board wiring is correct.
- Ensure the control system and protective relay is installed as designed.

DC relay control circuits are verified by viewing breaker indication lights during monthly sub inspections. Annually, breaker is tripped and closed to verify circuit integrity. Any problems are repaired as soon as detected. Circuit

switches cannot be operated without interrupting power, so the DC circuit is tested by exercising the device when the substation has been taken offline.

Auxiliary tripping relays will have their trip coils verified when the associated protective relay is tested. Full testing will be done on occasions when the transformer or bus is out of service, so no inadvertent tripping will occur. The associated protective relay will be tested every five years or when there is indication of a problem with the relay or system.

Transformer sudden pressure relays will be tested when LTC or large voltage regulator maintenance in done. On transformers that can be de-energized sudden pressure will be tested when regular transformer maintenance is scheduled.

Additionally, all relay coordination settings will be verified to ensure proper functionality.

4.3.5 SCADA

The VEC Service Operations group and EMS department will complete a functional point-to-point test of each transformer, relay, regulator, switches, and other SCADA points at the time of the transformer, regulator, and relay tests.

4.3.6 UFLS Testing

The VEC substation group will complete a UFLS (Under Frequency Load Shedding) tests as part of NPCC and NERC requirements as a separate functional test. VEC has established a UFLS Maintenance Plan that requires testing every 5 years (NERC requires six but our cycle allows for us to complete a test in the 6th year if we identify any relay that needs to be repaired, replaced, adjusted, re-tested, etc.

5 Maintenance Procedures – General

5.1 Labeling

Labeling standards are listed below and available in VEC's Transmission and Distribution Standards Manual

Description	Drawing Number
Pole Markings (Neutral Separator, Normally Open, Information, Generator)	**201 (Page 1)**
Pole Markings (Pole Numbering, Member Owned, Fuse Labeling, Company Information)	**201 (Page 2)**
Hydraulic Recloser Labeling	**202**
Transformer Markings	**203**
Pad Mount Transformer Labeling – Single Phase	**204 (Page 1)**
Pad Mount Transformer Labeling – Three Phase	**204 (Page 2)**
Pole Inspection Markings (Priority Reject, etc.)	**205**
Pole Marking Ordering	**206**