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DISTRIBUTION ENGINEERING DEPARTMENT
SCADA, USS, OH & POWER QUALITY GROUP

EO-4019
REVISION 42

Testing of Distribution Feeders Operating at 4, 13, 27 & 33kV

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TARGET AUDIENCE:	**ENGINEERING AND PLANNING, ELECTRIC OPERATIONS, SUBSTATION OPERATIONS, SYSTEM OPERATIONS, FIELD OPERATIONS**
REVIEWED BY:	**DE SCADA, USS, OH & POWER QUALITY**
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Table Of Contents

1.0 Purpose

This document specifies the electrical tests performed on 4, 13, 27, & 33kV distribution feeders to verify the restoration of adequate electrical insulation levels and the absence of short-circuit conditions following an outage. These tests are described as a High Potential Test (Hipot) and an Ammeter Clear Test.

2.0 Application

This specification applies to all regions.

3.0 General Requirements

3.1 The application of this specification shall be in accordance with the "General Instructions Governing Work on System Electric Equipment," and under the jurisdiction of the District Operator. The Regional Engineering Manager, Control Center Shift Manager, District Operator, or the System Design Department Manager of Distribution Engineering may waive Hipot test requirements based on system conditions. These conditions include: network feeder contingencies, local conflicts, next contingency resulting in overloads or customer outages, customers out of service, extreme weather, or evidence that additional damage on the feeder is very unlikely. The criteria used to waive the Hipot test must be entered in the Electric Control Center Shift Manager's logbook and communicated (e.g., emailed) to the System Design Department Manager of Distribution Engineering in a timely manner. Additional guidance on requirements are in Sections 8 & 9.

3.2 A 0.1Hz Very Low Frequency Hipot test is the preferred Hipot test and shall be used whenever a test set is available.

3.3 Hipot tests on 4kV feeders, for forced outages or scheduled work, are only required when:

- Four (4) or more sections of underground cable are being replaced on that run of 4kV cable.
- 4kV three phase underground cable is out-of-service on all three phases and de-energized for 12 months or more.

3.4 Testing of feeders that contain Metro North open-wire portions is covered by SO 18-07.

4.0 Definitions

4.1 **VLF Hipot Test** – A High-Potential withstand test using a Very Low Frequency (VLF) power source. The typical VLF frequency is 0.1 hertz. A VLF Hipot test is the preferred method of High-Potential testing and shall be used whenever a VLF test set is available.

4.2 **DC Hipot Test** – A High-Potential withstand test using a DC power source. A DC Hipot test shall be used only when a VLF test set is not available.

4.3 **High impedance faults** – High impedance faults are real faults on a feeder. Attempts to establish a condition are frequently unsuccessful, caused by poor electrical paths to the faulted components. Examples of high impedance faults include partial carbonization in cable joints, and some internal transformer faults.

4.4 **Ammeter Clear Test** – A low-voltage test using a 60 Hz 125V AC power source to verify the absence of short circuits on or between the primary feeder conductors or grounds on transformer secondary windings.

4.5 **Critical Feeder Crossing** – Refers to the portion of a feeder that runs along a substantial bridge, under a large waterway, or under a highway.

4.6 **Network Reliability Index (NRI)** – A statistical value indicating a network's susceptibility to a shutdown. Refer to EO-2152 and EOP-5022 for more information.

4.7 **Forced Outage** – Any outage where a feeder was automatically removed from service or unable to be restored to service due to a fault. This includes:

- Open-Auto (AUTO)
- Cut-In-Open-Auto (CIOA) due to a fault
- Fail-on-Test (FOT)

4.8 **Planned Outage** – Any outage where a feeder was deliberately taken out of service. This includes

- Scheduled (SCHD)
- When Ready (WR)
- Isolated (ISO)
- Rapid Availability (RAP)
- Off-On-Emergency (OOE1 or OOE2) outages

4.9 **RTF Match** – The location of a fault found and repaired is consistent with the RTF result (within the yellow, pink, or red range on the RTF Site or HUD application).

4.10 **Line-to-Line Faults** (not involving ground) – Are rare, but real faults, that do not involve ground. Attempts to establish a condition are unsuccessful because there is no fault path to ground. Examples of line-to-line faults include faults in HV compartments (dry or wet), on USS transformers, and some internal transformer faults.

5.0 Ammeter Clear Test

AC distribution feeders will be subjected to an Ammeter Clear Test conforming to Appendix C requirements, before they are restored to service. If a Hipot test is required, the Ammeter Clear Test shall be performed prior to the Hipot test. Refer to System Operation Procedure SO 11-06 for information on waiving the Ammeter Clear Test.

5.1 For URD portions on the load side of a fuse, and where the URD portion is under the jurisdiction of the Regional Control Center, the Regional Control Center can waive the Ammeter Clear Test.

5.2 If fuses are blown on the 103 side of an Auto Transfer Switch (ATS), an ammeter clear test is not necessary if these two conditions are met:

- Evidence exists indicating the cause of the blown fuses has been identified and corrected.
- There is no other evidence suggesting an additional fault is present on the feeder.

See Section 9 for comments on Hipot waivers.

6.0 Equipment to be Disconnected Prior to Tests

The following apparatus shall be disconnected prior to performing a Phase-to-Ground DC or VLF Hipot Test on any distribution feeder:

- Phase to neutral connected potential transformers
- Lightning arrestors (not required to be disconnected during Reduced Voltage Hipot Test)
- Grounding transformers (open neutral connection)
- Shunt reactors (open neutral connection)
- Any transformer with a neutral/ground connected HV winding
- High tension customer equipment

7.0 Validating Test Measurements

Test facilities leakage measurements shall be made at Hipot Test voltage for five (5) minutes:

- Prior to the application of any Hipot Test
- Upon the completion of any failed Hipot Test

At stations with ammeter test sets, the condition of the test set shall be checked for ground continuity before and after each test.

8.0 Hipot Test Tables

8.1 Table 1: Hipot Test (5 Minute Duration)

Hipot Test

Voltage and Leakage Current Limits
Refer to Appendix B for notes.

Normal Operating Voltage Between Conductors (kV)	Test Voltage (kV)	Acceptable Leakage Current (mA)
4	5	5
13	15	15
27	25	15
33	30	5

8.2 Table 2: Reduced Voltage Hipot Test (5 Minute Duration)

Reduced Voltage Hipot Test Voltage and Leakage Current Limits Refer to Appendix B for notes.		
Normal Operating Voltage Between Conductors (kV)	Test Voltage (kV)	Acceptable Leakage Current (mA)
4	5	5
13	10	15
27	20	15
33	30	5

8.3 Table 3: Raised Voltage Hipot Test (30 Minute Duration)

Raised Voltage Hipot Test Voltage and Leakage Current Limits Refer to Appendix B for notes.		
Normal Operating Voltage Between Conductors (kV)	Test Voltage (kV)	Acceptable Leakage Current (mA)
13	20	15
27	30	15

8.4 Table 4: Hipot Test Criteria for 13, 27, & 33kV Feeders

Hipot Test Criteria for 13, 27 & 33kV Feeders		"Normal" Table I (5 minutes)	"Reduced" Table II (5 minutes)	"Raised" Table III (30 minutes)
All Scheduled Outages	**Feeder is on Appendix A**	**If TV < 82°F**		
	Station work that disturbed insulation or feeder clearances.	✓		
	High-tension equipment/cable installation or repair, directly connected to the Company's supply feeder or energized by closing the line circuit breaker or circuit closing device that has not received a Hipot in six months.	✓		
	Customer high tension cable repairs made by contractors.	✓		
	Four (4) or more sections of underground cable are installed or replaced.	✓		
	Underground cable, out of service for > 12 months (only applies to out of service section)	✓		
	Contains crossings (refer Appendix D), not a forced outage, and any of the above conditions are met		✓	
Forced Outages	**Feeders with a backfeed source & no Grounding Transformer** and there was either a: - 2nd fault detected or - Multiphase fault or - Damage is outside of RTF Zone	**If TV < 82°F**	**If TV ≥ 82°F, (or next day TV ≥ 81.5)**	
	Feeder has a Grounding Transformer or no backfeed source: and there was either a: - 2nd fault detected or - Multiphase fault		✓	
	Contains crossings (refer Appendix D), if any of these conditions are met: - Multiphase fault - 2nd fault detected - Damage is outside of RTF Zone		✓	
	Cannot establish condition, with a confirmed fault on the feeder. See Section 9.26 for more information.	Feeders with GTV		Feeders without GTV
	Cannot establish condition, after feeder was taken out of service to locate a self-clearing fault. See Section 9.26 for more information.	Feeders with GTV		Feeders without GTV

9.0 Hipot - Additional Notes

9.1 Phase(s) of a fault are determined by the data returned from PQ nodes.

9.2 2nd Faults are detected by PQ nodes. Damage found by field crews in separate locations may also be categorized as a 2nd fault condition.

9.3 Certain electrical events may look like 2nd faults to the automated detection systems, as a result:

- 2nd fault notifications received after the feeder is dead on backfeed or grounded shall be ignored.
- 2nd fault notifications caused by a transmission disturbances, or in some cases disturbances in other networks, shall be ignored.

9.4 2nd fault notifications that come in when two feeders out of the same area station have Opened Auto, and are still potentially ABF, cannot generally be attributed to one feeder or the other and therefore it shall be assumed that both feeders have had a 2nd fault.

9.5 A Hipot test shall be performed if the phase damage identified in the field is not consistent with the faulted phase captured by the power quality monitor (“phase mismatch”).

9.6 A situation where the phasing information of the fault cannot be identified (e.g., cable section or 3W-1W joint), shall not be considered a “phase mismatch” unless the fault is on the single-conductor side of the 3W/1W.

9.7 When using the Hipot Decision Table, examples of backfeed sources include network transformers and unit substations.

9.8 Hipot test shall be performed when PQ information is not available. Availability of nodes can be checked on the RTF webpage.

9.9 For situations where the station PQ nodes are working and not indicating any fault and no relay targets are received, the feeder can be restored without a Hipot test.

9.10 When possible, during high voltage fault locating, determine if current is going out on phases other than the faulted phase as captured by the power quality monitor. If this is the case, an attempt to find additional damage on the feeder can be made.

9.11 For feeders with open wire sections, under wet conditions, Hipot "Acceptable Leakage Current Limits" shall be doubled.

9.12 For feeders with a VISO interrupter, their voltage sensors may increase total leakage current when energized during a Hipot Test. Additional leakage current of 1.0 mA, per set of 3-Phase voltage sensors is to be expected.

This equates to 2.0 mA additional leakage current, if Hipotting both sides of a VISO. (1.0 mA for line side sensors + 1.0 mA for load side sensors = 2.0 mA total.)

9.13 If there is single phase fault damage found on a fused URD section (and the fuse is blown) do not Hipot the feeder proper and URD section. There must be no evidence of damage on the feeder proper.

9.14 If a feeder has been liberated from asphalt or concrete via chipping/jackhammering, a Hipot is required.

9.15 A Hipot is not required if the area station breaker and the VisoVac Interrupter trip simultaneously and if the following conditions are both met:

- Simultaneous trip is due to instantaneous overcurrent element at station breaker and VisoVac interrupter.
- At least part of the RTF zone is on the load side of the interrupter.

If the statements above are true:

- The portion of the feeder between the area station breaker and the VisoVac Interrupter should be returned to service by closing the area station breaker.
- On feeders with multiple legs, the confirmed unfaulted leg shall be restored to service.
- If there is no evidence of a fault on the line side, an Ammeter Clear Test is not necessary.

Even if there is a 2nd fault notification, we do NOT need to Hipot or perform an ammeter clear test on the good portion of the feeder.

9.16 The following 2nd fault scenarios shall not require a Hipot <u>if the first fault phasing and location is supported by RTF, and second fault notification phase matches the additional damage found in the field</u>:

- Both first and second fault are at the same location
- Find first fault and second fault at two different locations on the same outage.
- First fault is repaired and receive FOT with a second fault at a different location.

Example that does not require a Hipot: First fault is on A-ph, with a second fault notification on C-ph. A-ph damage is found in one structure within the RTF Zone, and C-phase damage is supported by damage found in the field and found in another structure outside of the first fault RTF zone.

9.17 A Hipot is not required on the un-faulted portion of a feeder, where the fault has been isolated via a switch or a live end cap (LEC), if there is no evidence that a fault exists on the station side of the isolation switch/LEC.

- The fault location needs to be verified beyond the switch or LEC.
  - Verified is defined as the following, when there is no second fault indicator:
    1) With RTF and fault indicators (to confirm fault indicators are operational refer to EO-1025)
    2) With RTF and fault locating readings.
    3) Contractor damage or visual damage
    4) A fault with HTV damaged, where the RTF zone identifies the fault location as the HTV.
    5) A fault with Network Transformer internal damage, where the RTF zone identifies the fault location as the Network Transformer
- A portion of the RTF Zone must be beyond the point of isolation (e.g., Switch or LEC) to waive the Hipot on the un-faulted portion; there must be no indication of a second fault.
- The isolated portion shall require a Hipot on restoration if the identified fault location was outside of the original RTF zone.
- A Hipot test is not needed on a feeder with a grounding transformer unless a second or multiphase fault is detected.

9.18 For any forced outage where the evidence supports that it is an overtrip for a fault on the load side of a downstream device (e.g., Auto-Loop FVRS, ATS Fuse, High Tension Primary Breaker), then the feeder proper (emanating from the Area Station) shall not be HIPOT tested.

Note: If the Area Station Relay protection settings look like they may be in violation of EO-2147 then the matter should be referred to the Manager of the DE PQ Group and or the DE/Chief Engineer.

9.19 The Shift Manager can waive a Hipot test for an open auto feeder which has a grounding transformer if they have evidence of the fault location being on the open wire portion of the feeder. This supersedes sections 8.4 and 9.17.

9.20 Any forced outages due to a non-fault condition on the feeder proper, such as a CIOA due to a breaker problem or inrush, shall not require the feeder to be Hipot tested. (Refer to the Power Quality SharePoint site for more information on inrush versus fault characteristics).

9.21 If there is single phase fault damage found on an unfused URD section, do not Hipot the feeder proper and URD section unless there is a 2nd fault indication. Hipot the feeder proper and URD section if there is a 2nd fault detected.

9.22 If fuses are blown on the 103 side of an Auto Transfer Switch (ATS), a Hipot is not necessary if these two conditions are met:

- Evidence exists indicating the cause of the blown fuses has been identified and corrected.
- There is no other evidence suggesting an additional fault is present on the feeder.

See Section 5.2 for comments on ammeter clear test.

9.23 A feeder Hipot is not necessary when picking up a new High Tension Vault (new business vault installation), if these two conditions are met:

- The new cable and equipment passes a separate Hipot test.
- Prior to energization, the only new work on the feeder that remains untested (never received a Hipot) is a small section that is used to connect to the existing feeder section.

9.24 When a feeder has multiple jobs with different levels of Hipot Test required in section 8.4 (Table 4 “Hipot Test Criteria for 13, 27, &

33), the lower of the two should be selected. For example, if we have two jobs on one feeder, where one job is due to a forced outage that meets the criteria for a Reduced hipot, and a job which usually would be scheduled as a separate outage is added to the forced outage to pick up a portion of the feeder that was out of service for longer than 12 months (meets the criteria for a Normal Hipot), then a Reduced Hipot should be performed.

9.25 When a Hipot is requested before the feeder restoration, despite the repair being outside the RTF Zone, a Raised Voltage Hipot test is not required; in these scenarios, the Normal Hipot Test (Section 8.1 Table 1) is acceptable.

9.26

After a forced outage, if it is not possible to establish a condition:

9.26.1 If the feeder does NOT have a GTV and RTF shows a hit only on the open wire portion of the feeder:

- A Raised Voltage Hipot test is not required. In these scenarios, the Normal Hipot Test (Table 1) is acceptable.

9.26.2 For all feeders that do not meet the criteria in 9.26.1, and the suspected cause of the forced outage is a high impedance fault, based off oscillography and/or the inability to establish a condition during feeder processing (see Appendix E for examples of PQ curves of high impedance fault), **if system conditions permit**, follow the below procedure:

a. Review either the transformer pressure traces for anomalies (see Appendix E for examples of PQ curves of internal transformers fault) or post OA “Network Transformer Pressure Readings” email.

I. If there are suspect units identified: Visually inspect the units for damage and drop any that show damage. If no damage is found, perform an oil sample. Drop transformers with bad results. If all the samples are good, proceed to next step (9.26.2.a.II). For all transformers inspected, perform thorough visual inspections and record pressure data for DE review: *As Found Pressure*, *Pressure Test* results, and *As Left Pressure*.

II. Target the transformers in the RTF zone (within the yellow, pink, and red). Rule out the transformers that showed good pressure before and good pressure after the OA. The remaining transformers (pressure drops, negative pressure, bad data, UNR) should be reviewed, with priority placed on units closest to the RTF center. Visually inspect the units for damage and drop any that show damage. If no damage is found, perform an oil sample. Drop transformers with bad results. If all the samples are good, proceed to Section 9.26.2.b below. For all transformers inspected, perform thorough visual inspections, and record these items: *As Found Pressure*, *Pressure Test* results, and *As Left Pressure*.

III. Consider that a fault may also be inside a Unit Substation transformer, shunt reactor, or Grounding Transformer.

b. If no transformers show signs of damage and no transformer samples return with bad results, consider checking structures in the RTF zone for flooded manholes**, if system conditions permit**.

I. If the feeder Cut-In Open Autos (CIOAs) upon restoration, consult with Distribution Engineering.

II. If the feeder opens auto again and there is a similar RTF zone and trouble establishing a condition, consults with Distribution Engineering.

c. After the feeder is repaired, a Raised Voltage Hipot test is not required. In these scenarios, the Normal Hipot Test (Section 8.1 Table 1) is acceptable.

9.26.3 Before attempting to break down a “confirmed fault on the feeder” or a “self-clearing fault” using higher Hipot levels: confirm that oscillography from either Power Quality (PQ) nodes or relays provides supporting data.

9.27 There is no need to disconnect a series reactor to use capacitive discharge (“High Voltage” or “thumper”) on a feeder for fault location.

9.28 In cases where a condition cannot be established (feeder is holding voltage prior to attempting a condition), an Ammeter Clear Test shall be performed to investigate the presence of an abnormal fault condition. Refer to Section 13 Appendix C for interpretation of ammeter clear readings and use of tracing current to locate faults.

10.0 References

SPECIFICATION	TITLE	FILE
EO-2022	General Specification for High Tension Service	Engineering Manual No. 4, Application & Design
EO-4035	Operating and Maintenance of Equipment on High Tension Customer's Premises	Engineering Manual No. 5, System Operation
EO-1025	Installation of directional fault indicators with SF6 switches	Engineering Manual No. 3, Construction Standards0
EO-2152	Method of Planning Distribution Network Reliability Improvement	Engineering Manual No. 4, Application & Design
EO-2147	Protection Setting Guidance for 13, 27 & 33kV Feeders Supplied from Area Substations	Engineering Manual No. 4, Application & Design
EOP-5022	Automated Voltage Reduction Program and Demand Response Programs	Engineering Manual No. 9, Electric Operations Procedure
SO11-06	Guide for Waiving Ammeter Clear Test	
SO18-07	Operating Requirements Associated with Distribution Feeders Supplying Metro North	
	CIOA Guideline	http://pq/CIOA/Visio-CIOA%20guideline.pdf

Revision 42:

- 3.3 – Changed out of service Hipot to 12 months. Also removed aerial cable Hipot.
- 4.10 - Line-to-line faults definition added.
- 8.4 (Table 4) – Changed out of service Hipot required to 12 months. Applies only to underground cable, now. Also, removed aerial cable Hipot for 4+ sections.
- 9.12 - VISO leakage clarification.
- 9.15 – Clarification - no need to Hipot or ammeter clear the good portion of feeder (amended 5/27/25).
- 9.23 – Clarified language to include new business installs.
- 9.24 – Corrected example given (amended 6/9/25)
- 9.26.3 - Use oscillography to confirm high impedance fault.
- 9.27 - Leave series reactor connected, during cap discharge.
- 9.28 - Ammeter clear testing, after trouble establishing condition.
- Appendix C - Tracing current to fault locate.
- Appendix D - Only Hipot portion of 7Q feeder that is necessary.

11.0 Appendix A – Feeders Requiring Hipot

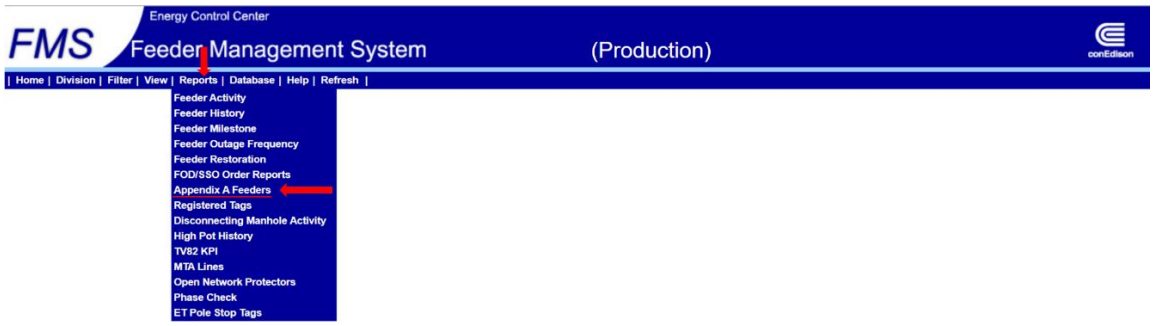
FMS Online provides a list of feeders that meet both of the following criteria:

- Has not had a Hipot test during previous three (3) calendar years.
- Resides in a network with an NRI greater than 0.2.

Collectively, these feeders are called “Appendix A” feeders.

To view the real time generated list of Appendix A feeders in FMS:

1. Open FMS Online.
2. Select “Reports”; a drop-down list will appear.
3. Select “Appendix A Feeders”.



The Control Center Shift Manager may waive a Hipot Test on any feeder on this list if:

- It can be verified that a Hipot was carried out during the previous three (3) calendar years.
- The outage occurs during high load or contingency.

To request access to FMS Online:

- Access the Product Access System via http://sto/Information/Request.aspx.
- Select ‘New Access Request.’
- Check ‘Feeder Management System (FMS); select Read Only in the ‘Type of Access’ field. After you acknowledge the requirements, you can submit your request.

12.0 Appendix B – Notes to Table 1, Table 2, Table 3, & Table 4

Note A The VLF Hipot test is preferred and shall be used whenever the test set is available.

Note B The rate of rise of the applied voltage during a Hipot shall not exceed 1kV per second with a pause of two or three seconds (not to exceed 5 seconds) after every 5kV step.

Note C Hipot tests are satisfactory only if the leakage current is constant or decreases without fluctuations or surges after the full test potential has been applied and is below the specified values at the end of the test. An increase of less than 4mA in the result can be considered a passing test. Current readings in excess of those specified may be accepted if they are consistent with the results of previous tests on the feeder.

Note D Upon the completion of tests on each phase and with the test set still connected to the cable, the supply voltage to the test set shall be reduced to zero and the cable grounded.

Note E High tension customer's incoming devices shall be opened prior to performing a Hipot test. All high tension customer's equipment connected to the line side of the incoming disconnect device shall be subject to the Company Hipot values in force during the time of the test.

Note F Hipot tests are to be made with all phase conductors connected together.

On 33kV cable, Hipot tests on 3-conductor cable or where 3 single conductor cables are in 1 duct, test between all 3 conductors connected together and ground. On single conductor cable in separate ducts, test between phase and ground with the other phases grounded.

13.0 Appendix C - Ammeter Clear Test Limits

Recommended Maximum Limits

If the ammeter reading obtained during an Ammeter Clear Test is in excess of the following values, the feeder *shall not* be placed in service until the cause of the high reading has been determined and, if necessary, eliminated:

Nominal Operating Voltage Between Conductors (kV)	Maximum Allowable Ammeter Clear Test Reading (Amps)
33	0.3
27	0.4
13	0.2

Readings Above Maximum Limits

Current readings in excess of those specified above may be accepted. The results must be close to previous AC tests on the feeder, that resulted in a successful restoration. Some Bronx and Westchester feeders have had successful restorations with ammeter clear values as high as 0.7 Amps.

Backfeed Awareness

If an ammeter clear test results fails at or around 5A on two or three phases, additional steps shall be taken to verify no backfeed condition exists on the feeder. The feeder neons should be re-checked and the ground-and-test device spark gaps shall be inspected. If the neons are alive or there is evidence of charring, carbonization, or damage around the spark gaps, feeder processing shall stop and notifications shall be made to Distribution Engineering, the Regional Control Center, and an Associate Chief District Operator, who will review and advise on next steps to resume feeder processing.

Interpretation of Ammeter Clear Readings

The following tabulation shall be used as a guide to interpret readings of the Ammeter Clear Tests:

Condition of Feeder	***Reading (Amps)***
Feeder grounded	3-5
Phase to phase short circuit	3-5
Short Circuit on low voltage side of substation transformer or large high tension customer transformer	2-3
Short circuits on low voltage side of distribution transformer *(33 kV System)*	0.9*
Short circuits on low voltage side of distribution transformer *(27 kV System)*	1.4*
Short circuits on low voltage side of distribution transformer *(13 kV System)*	4.0*
Short circuits on low voltage side of distribution transformer *(4 kV System)*	2.0**
27kV shunt reactor, neutral ground switch closed	0.1 (per shunt reactor)
13kV grounding transformer neutral ground switch closed	2.25 (per grounding transformer)
Excitation current of transformer and charging current of cable.	Less than 0.1

* Per 1000 kVA of transformer capacity.

** Per 10 kVA of transformer capacity.

Various forms of tracing current can be used to locate the conditions in the above table.

These types of TC can be configured as follows to locate a fault **when conventional methods are unsuccessful**:

Fault condition	TC Type
Grounded condition, full ammeter clear deflection on 1 or more phases	LVFLTC
Ungrounded condition, A-ph ammeter clear failure (AB short)	CATC, +A, -B, C clear
Ungrounded condition, B-ph ammeter clear failure (BC short)	CATC, A clear, +B, -C,
Ungrounded condition, C-ph ammeter clear failure (CA short)	CATC, +A, B clear, -C

Alternate forms of TC (i.e. reversing polarities of the TCs above) should be attempted until TC is detected flowing to the fault condition.

If any of the following types of transformers are connected to the feeder when the Ammeter Clear Test is made, an abnormally high reading will be obtained:

- Three-phase transformer or auto-transformer banks with a three-legged core with the feeder winding wye-connected and the neutral grounded.
- Wye-delta transformer banks with the neutral grounded, where the wye winding is connected to the portion of the feeder on which the Ammeter Clear Test is being made.

14.0 Appendix D – Critical Feeder Crossings

The regions below represent where the feeders originate. When performing a Hipot on a portion of the feeder that does not include the “crossing”, then that portion should not be considered a “crossing” feeder.

Manhattan

For all 3M feeders are recommended to have a Hipot Test every 3 years (see EO-4019 section 8.1 Table 1)

Region	Feeder	V	Waterway/Highway Crossed	Associated Crossing Name
Manhattan	3M40	13	Harlem River	Submarine Crossing
	3M41	13	Harlem River	Submarine Crossing
	3M42	13	East River & Bronx Kill	Randall's Island Connector Bridge
	3M43	13	Harlem River	Submarine Crossing
	3M44	13	East River & Bronx Kill	Randall's Island Connector Bridge
	3M45	13	Harlem River	Submarine Crossing
	3M46	13	East River & Bronx Kill	Randall's Island Connector Bridge
	3M47	13	Harlem River	Submarine Crossing
	3M48	13	East River & Bronx Kill	Randall's Island Connector Bridge
	3M49	13	Harlem River	Submarine Crossing
	3M50	13	Harlem River	Submarine Crossing
	3M51	13	Harlem River	Submarine Crossing
	3M52	13	Harlem River	Submarine Crossing
	3M53	13	Harlem River	Submarine Crossing
	3M54	13	Harlem River	Submarine Crossing
	3M55	13	Harlem River	Submarine Crossing
	3M56	13	Harlem River	Submarine Crossing
	3M57	13	Harlem River	Submarine Crossing
	3M58	13	Harlem River	Submarine Crossing
	3M60	13	Harlem River	Submarine Crossing
	3M61	13	Harlem River	Submarine Crossing
	3M62	13	East River & Bronx Kill	Randall's Island Connector Bridge
	3M63	13	East River & Bronx Kill	Randall's Island Connector Bridge
	3M64	13	Harlem River	Submarine Crossing
	3M65	13	Harlem River	Submarine Crossing
	3M66	13	Harlem River	Submarine Crossing
	3M67	13	Harlem River	Submarine Crossing
	3M68	13	Harlem River	Submarine Crossing
	3M69	13	Harlem River	Submarine Crossing
	14M80	13	Bronx Kill	Randall's Island Connector Bridge
	14M81	13	Bronx Kill	Randall's Island Connector Bridge
	14M82	13	Bronx Kill	Randall's Island Connector Bridge
	14M83	13	Bronx Kill	Randall's Island Connector Bridge
	14M84	13	Bronx Kill	Randall's Island Connector Bridge
	14M85	13	Bronx Kill	Randall's Island Connector Bridge
	31M08	13	East River	Queensboro (Ed Koch) Bridge
	31M09	13	East River	Queensboro (Ed Koch) Bridge
	31M51	13	East River	Queensboro (Ed Koch) Bridge
	31M56	13	East River	Queensboro (Ed Koch) Bridge
	31M57	13	East River	Queensboro (Ed Koch) Bridge
	31M58	13	East River	Queensboro (Ed Koch) Bridge

Brooklyn/Queens

For 7Q feeders, if possible (system conditions permitting), use DM switches to isolate and only Hipot the section of feeder that is necessary (e.g. repairs on a forced outage, vaults picked up on a scheduled outage).

Region	Feeder	V	Waterway/Highway Crossed	Associated Crossing Name
Queens	9B08	27	Cross Bay Channel	Cross Bay Channel (North channel bridge)
	9B13	27	Cross Bay Channel	Cross Bay Channel (North channel bridge)
	7Q01	27	Flushing River	Gas Tunnel
		27	Grand Central Pkwy	Northern Blvd & Grand Central Pkwy
		27	Alley Creek	Alley Creek Bridge
	7Q02	27	Flushing River	Submarine Crossing
		27	Grand Central Pkwy	Northern Blvd & Grand Central Pkwy
		27	Alley Creek	Alley Creek Bridge
	7Q61	27	Flushing River	Flushing Bridge
	7Q62	27	Flushing River	Submarine Crossing
	7Q63	27	Flushing River	Flushing Bridge (Northern Blvd)
	7Q64	27	Flushing River	Submarine Crossing
	7Q65	27	Flushing River	Roosevelt Ave. Bridge
		27	Grand Central Pkwy	Roosevelt Ave & Grand Central Pkwy (7 train)
		27	Grand Central Pkwy	44 Ave & Grand Central Pkwy (LIRR)
	7Q66	27	Flushing River	Roosevelt Ave. Bridge
		27	Grand Central Pkwy	Roosevelt Ave & Grand Central Pkwy (7 train)
	7Q67	27	Flushing River	Meridian Rd. Bridge
		27	Grand Central Pkwy	44 Ave & Grand Central Pkwy (LIRR)
	7Q68	27	Flushing River	Meridian Rd. Bridge
		27	Grand Central Pkwy	44 Ave & Grand Central Pkwy (LIRR)
	7Q71	27	Flushing River	Underwater, Willets Pt. Gas Tunnel
		27	Grand Central Pkwy	Northern Blvd & GCP
	7Q72	27	Flushing River	Underwater, Willets Pt. Gas Tunnel
		27	Grand Central Pkwy	Northern Blvd & GCP
	7Q77	27	Flushing River	Roosevelt Ave. Bridge
		27	Grand Central Pkwy	Roosevelt Ave & GCP (7 train)
	7Q78	27	Flushing River	Roosevelt Ave. Bridge
		27	Grand Central Pkwy	Roosevelt Ave & Grand Central Pkwy (7 train)
	7Q81	27	Flushing River	Meridian Rd Bridge
		27	Grand Central Pkwy	44 Ave & Grand Central Pkwy (LIRR)
	7Q82	27	Flushing River	Meridian Rd Bridge
		27	Grand Central Pkwy	44 Ave & Grand Central Pkwy (LIRR)
	7Q85	27	Flushing River	Flushing Bridge (Northern Blvd)
		27	Grand Central Pkwy	Roosevelt Ave & Grand Central Pkwy (7 train)
	7Q86	27	Flushing River	Flushing Bridge (Northern Blvd)
		27	Grand Central Pkwy	Roosevelt Ave & Grand Central Pkwy (7 train)
	7Q87	27	Flushing River	Submarine Crossing
	7Q88	27	Flushing River	Underwater, Willets Pt. Gas Tunnel
	1208	4	Flushing River	Flushing Bridge (Northern Blvd)
	1253	4	Flushing River	Flushing Bridge (Northern Blvd)
	1Q02	27	East River (Bowery Bay)	Rikers Island Bridge (Customer Cable)
	1Q14	27	East River (Bowery Bay)	Rikers Island Bridge (Customer Cable)
	1Q25	27	East River (Bowery Bay)	Rikers Island Bridge (Customer Cable)
	Sd3123	4	Upper NY Bay	Brooklyn Battery Tunnel (Customer Cable)

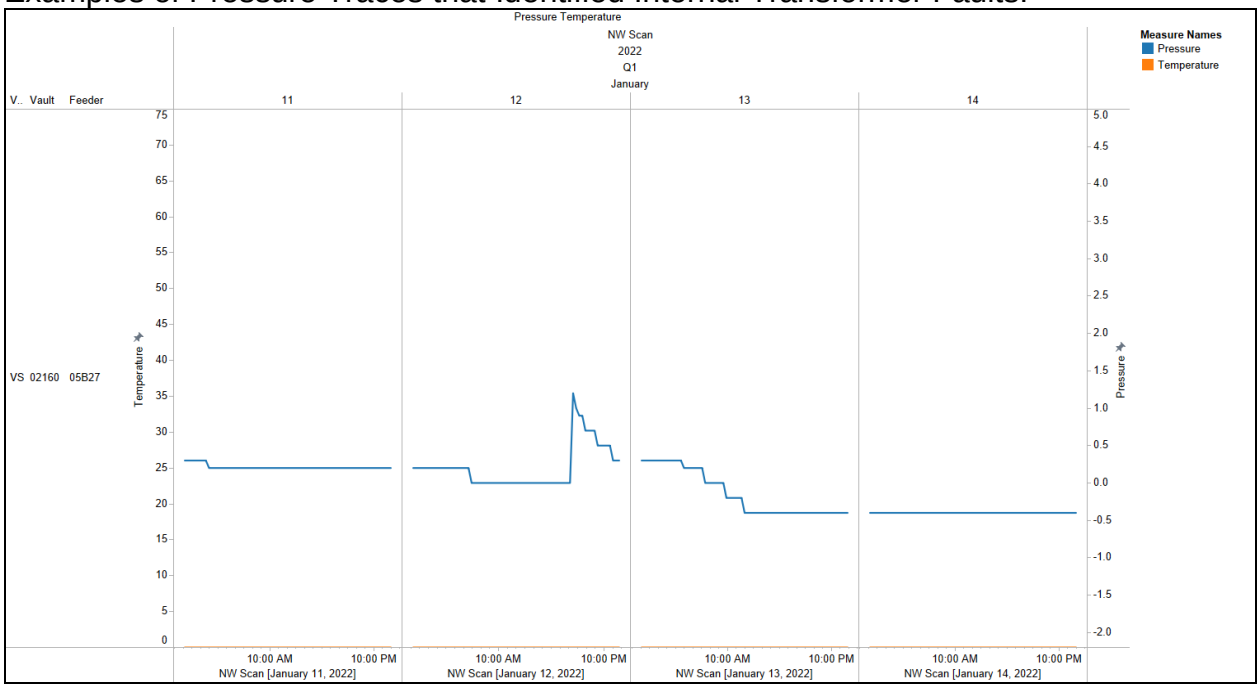
	Sd3124	4	Upper NY Bay	Brooklyn Battery Tunnel (Customer Cable)
	Sd3125	4	Upper NY Bay	Brooklyn Battery Tunnel (Customer Cable)
	9473	4	Cross Bay Channel	Cross Bay Blvd (North Channel Bridge)
			Portion under BQ jurisdiction, should not get a Hipot Test	

Bronx/Westchester

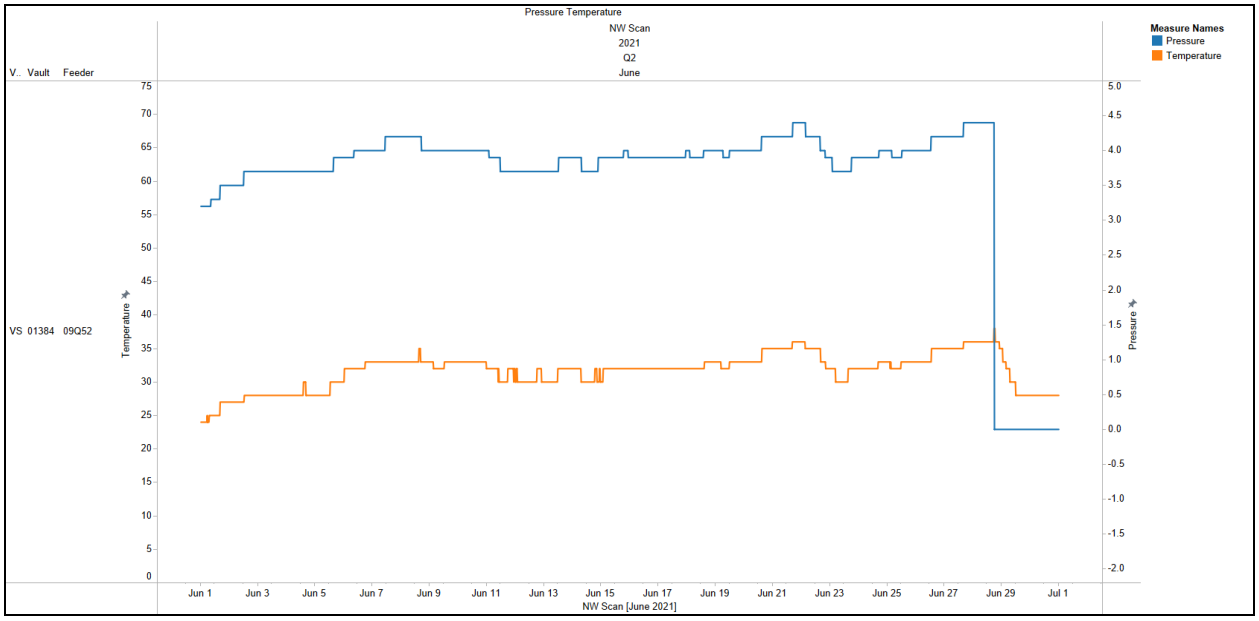
Region	Feeder	V	Waterway/Highway Crossed	Associated Crossing Name
Bronx	1X21	13	Harlem River	Submarine Crossing
	1X22	13	Harlem River	Submarine Crossing
	1X23	13	Harlem River	Submarine Crossing
	1X24	13	Harlem River	Submarine Crossing
	1X25	13	Harlem River	Submarine Crossing
	1X26	13	Harlem River	Submarine Crossing
	1X27	13	Harlem River	Submarine Crossing
	1X28	13	Harlem River	Submarine Crossing
	1X29	13	Harlem River	Submarine Crossing
	1X30	13	Harlem River	Submarine Crossing
	1X31	13	Harlem River	Submarine Crossing
	1X32	13	Harlem River	Submarine Crossing
	5361	4	City Island Channel	City Island Bridge
	7207	4	City Island Channel	Pelham Bay Bridge/City Island
Westchester	6W62	13	Croton River	Submarine Crossing along South Riverside Ave
	6W69	13	Croton River	Submarine Crossing along South Riverside Ave

15.0 Appendix E – Examples of High Impedance Faults

Examples of Pressure Traces that Identified Internal Transformer Faults:

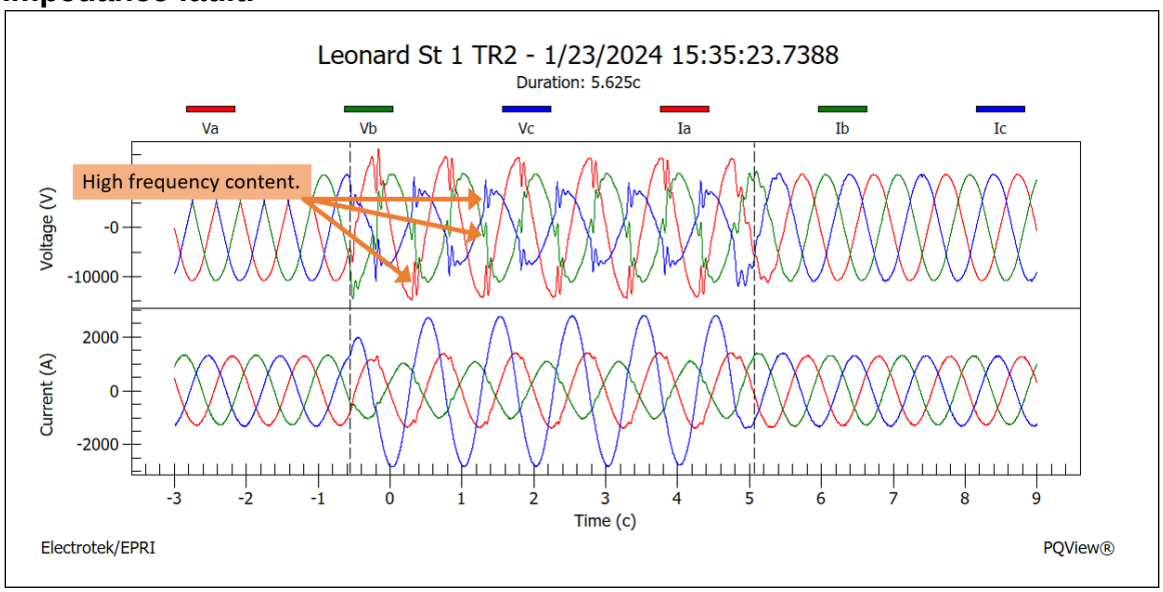


Sudden pressure rise followed by gradual decline.

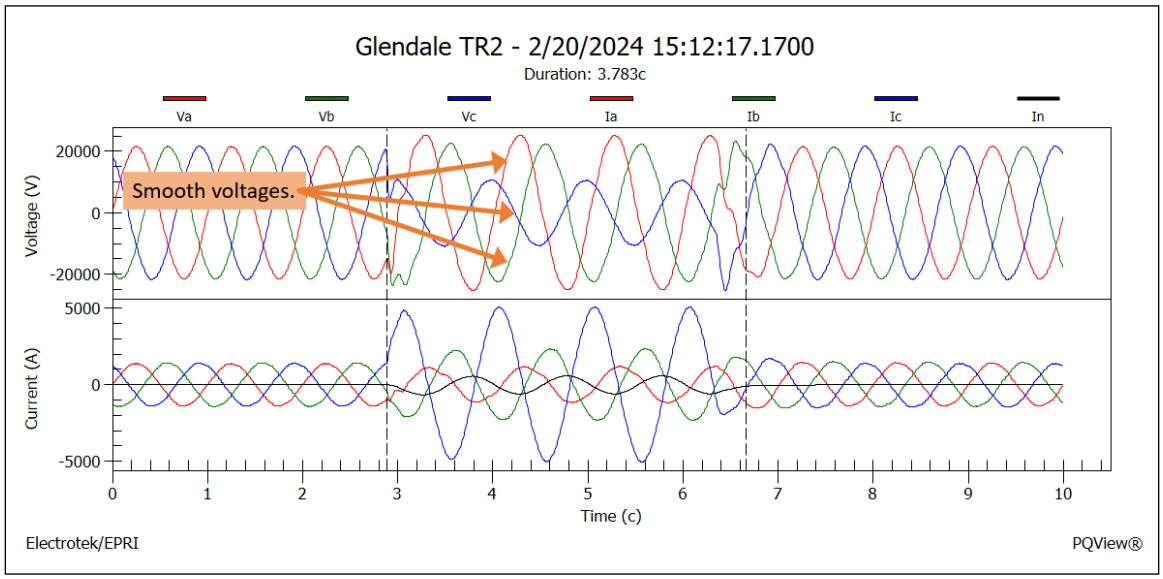


Sudden pressure drops.

“Jagged” high frequency content may indicate a hard to breakdown, high impedance fault.



Here is an example of a “smooth” voltage waveform during a different fault.



Here is an example of an RMS trace showing a “potential” internal failure.