**THE STATE CORPORATION COMMISSION
OF THE STATE OF KANSAS**

Before Commissioners: Jay Scott Emler, Chairman
Shari Feist Albrecht
Pat Apple

In the Matter of the Complaint Against Kansas City Power & Light by Jamie Littich) Docket No. 16-KCPE-195-COM

REPLY TO KCPL'S REPLY

As will be discussed further in this reply, additional evidence has been obtained through a parallel process of discovery that provides additional consistency to the complaint and brings into question Kansas City Power & Light's (KCPL) responses and investigation of the electrical fire. As a result, I hereby request KCC to discover key evidence from KCPL where appropriate:

1. SmartMeter data for each circuit attached to the primary located in the lateral behind the building at 5800 Walmer St. The SmartMeter data shall include timestamps, voltage readings and current readings from 8:30 AM to 10:30 AM on May 20, 2015 with 500 millisecond resolution. The export for each circuit shall be provided in an excel (xlsx) file format.
2. The OEM manual for the transformer installed on the utility pole JO 4869.
3. The OEM manual and model number for the transformer fuse installed on utility pole JO 4869.
4. The OEM manual and model number for the related lateral fuse installed on utility pole KCPL 32011.
5. The OEM manual and model number for the upstream dead-end fuse located on the unidentified utility pole north of 55th St on Riggs St.
6. The OEM manual and model number for the auto-reclosure serving the primary feed including its as-found settings, maintenance records and calibration records for the previous ten years.
7. A complete copy of KCPL's investigation of the event that occurred on May 20, 2015 including collected photographs and witness accounts. The investigation in reference was conducted on June 10th, 2015.

8. The KCPL procedures or standards for conducting the KCPL investigation that took place at 5800 Walmer St. by KCPL on June 10th, 2015.
9. The last ten years of dispatch records for each system served by the lateral primary. The record set shall include at a minimum, the time of the dispatch call, the time of the dispatch arrival and a summary of the trouble man repairs/maintenance for that trouble call.
10. Asset tracking or business intelligent data to show the GPS location of each of KCPL's line trucks responding to the event from 8:30 AM to 10:30 AM on May 20, 2015 with 30 second resolution. The export shall be provided in an excel (xlsx) file format.
11. As referenced in the KCPL Property Damage Claim letter dated September 10, 2015, the KCPL standard in which the rating of the installed fuse is selected.
12. The engineer sealed one-line or schematic of the circuit showing the coordinated fuse sizes.
13. KCPL's upgrade plan for the relevant circuit and lateral for 2016.
14. Any additional items deemed appropriate by KCC for their investigation.

Please distribute all information to each party via email in addition to the KCC docket 16-KCPE-195-COM via e-file. The Exhibits contained hereafter are provided to establish a time line of events based on available evidence.

EXHIBIT A: The Consolidated Fire Department #2 (CFD2) Photo time stamped 5/20/15 10:25 AM

This photo is a depiction of items downstream of KCPL circuit 6849 on pole JO 4829. Please observe:

1. The primary conductor intact in both north and south directions of the lateral.
2. Both secondary conductors intact in both north and south directions of the lateral.
3. The neutral to have fallen in both north and south directions of the lateral. Take special care to note the position of each neutral conductor.
4. The cutoff door in an open state and the fuse in an unblown condition.
5. The secondary service to the 5800 Walmer Street house intact.

The following Exhibits are composed starting at the beginning of the event and working towards the last known event which is a repeat of Exhibit A. Before proceeding to the following Exhibits, I call your attention to the multiple manners in which KCPL has described the fault(s) and in the order in which they have been provided.

<u>From the KCPL Denial of Property Damage Claim dated September 10, 2015:</u>

1. Paragraph 1 where "KCPL has completed our investigation and we share the result with you below" referencing the KCPL investigation conducted on June 10th, 2015 (yet to be disclosed).

> We have completed our investigation and evaluation of your claim filed with KCP&L on 8/11/15 . The City of Mission has also communicated with us regarding your concerns about KCP&L's electrical system and your desire to review the results of our investigation. KCP&L has completed our investigation and we share the results with you below.

2. Paragraph 4 where *"**<u>the fault at issue here is on the secondary conductors</u>** and [5800 Walmer St Home Owners]* photographs confirm the conductors involved in the fault. The photo with the "red" secondaries indicates there is a secondary fault (possible tree limb between the secondary lines) somewhere near where the secondaries go through the tree, located [north] of the tree."* and *"The troubleman that responded to this incident opened this [transformer's] fuse to clear the fault. **He indicated that there was a down primary <u>neutral</u>** due to a tree."*

> The fault at issue here is on the secondary conductors and your photographs confirm the conductors involved in the fault. The photo with the "red" secondaries indicates there is a secondary fault (possible tree limb between the secondary lines) somewhere near where the secondaries go through the tree, located to the right of the transformer pole. It is hard to tell, but it doesn't appear the secondaries are "red" to the right of the tree. The transformer that feeds this is protected by a transformer fuse. The nature and impedance of the fault did not generate sufficient fault current to clear the transformer fuse. The troubleman that responded to this incident opened this fuse to clear the fault. He indicated that there was a down primary neutral due to a tree. The neutral in this area is a combined neutral for the primary and secondary. The neutral wire was repaired as noted in your photos.

From KCPL's Answers and Motion to KCC dated December 11th, 2015:

1. KCPL Item 9 where there was *"a report of a primary wire down"* and *"KCP&L removed the meter at the [5800 Walmer Street] house, put the primary back in place"*.

> 9. On May 20, 2015, KCP&L responded to a house fire at 5800 Walmer Street, Mission, Kansas, and a report of a primary wire down in the rear of the property, which is located off of Circuit No. 6824. KCP&L removed the meter at the house, put the primary wire back in place, and re-energized the transformer for that location. KCP&L determined the likely cause of the downed wire to be a fallen tree limb due to a storm event that had recently occurred in the area.

2. KCPL Item 19 where *"the fault in question occurred on the secondary conductor"*.

> 19. In the current instance, the primary conductor at the location involved has a load rating of 140 amps, with an 80 amp primary fuse protecting the conductor. However, the fault in question occurred on the secondary conductor.

3. KCPL Item 21 where *"records indicate that most likely a large tree limb, one large enough to lie on the primary, primary neutral and secondary conductors, cause the electrical fault."* and *"The fault that occurred was a high impedance fault"*.

> 21. KCP&L's records indicate that most likely a large tree limb, one large enough to lie on the primary, primary neutral and secondary conductors, caused the electrical fault. The fault started to generate fault current at the secondaries. The fault that occurred was a high impedance fault, which is characterized as a fault that occurs when a tree limb, for example, makes unwanted electrical contact to the conductors and where the flow of fault current is restricted to a level below that reliably detectable by conventional overcurrent devices. A system cannot be designed to guarantee that high impedance faults will not occur.

4. KCPL Item 22 where KCPL explains the *"[trouble man] cut the power to KCP&L equipment by opening the [cutout door of] the transformer fuse because the conductors"*, non-specific, *"were still arcing, which allowed him to remove a large tree limb off of the conductors"*, again non-specific. In the following sentence *"Before personnel were able to open the transformer fuse, the primary conductor broke"*. The multiple claims that KCPL provided within this paragraph conflict with each other.

> 22. The personnel who responded to the incident indicated that he cut power to KCP&L equipment by opening up the transformer fuse because the conductors were still arcing, which allowed him to remove the large tree limb off of the conductors in order to clear the hazard. Before personnel were able to open up the transformer fuse, the primary conductor broke and fell against the primary neutral. This action caused the lateral fuse to blow up-stream from where Complainant lives. The damage to KCP&L equipment from this incident required personnel to make repairs on the primary, primary neutral, and secondary conductors. All of the activities performed by KCP&L as a result of the May 2015 incident were in accordance with the NESC.

5. KCPL Item 30 where *"the cause for the outage was the downing of a primary line"*, non-specific, *"likely caused by a broken tree limb"*.

> 30. KCP&L is unclear as to what specific property damage is being referred to in this question. Notwithstanding, KCP&L's investigation into the May 2015 incident involving the Complaint indicates that the cause for the outage was the downing of a primary line likely caused by a broken tree limb caused by a storm event that had occurred a few days prior to the incident. Any damage experienced by Complainant may have been a result of a lack of surge protection on the Customer side of the point of delivery. KCP&L is responsible for exercising diligence to supply continuous electric service to the Customer but cannot guarantee the supply of electric service against irregularities and interruptions,[19] such as the storm event in May 2015. Additionally, KCP&L is not "liable in negligence or otherwise for any claims for loss, expense or damage (including indirect, economic, special or consequential damage)..."[20]

From KCPL's Reply and Motion dated January 25th 2016:

1. KCPL Item 12 where *"it responded to a report of a primary wire down"*, *"it is believed, based on the nature of the fault and observations made by the dispatch personnel, that the fault occurred on the secondary"*. *"[A]fter the power was cut, "*; mechanism unspecified; *"a large tree limb was removed from the conductors, "*; non-specific; *"and before the transformer fuse could be opened the primary conductor broke and fell against the primary neutral."*

> 12. In response to Item 19, KCP&L notes that (1) it responded to a *report* of a primary wire down,[9] (2) it is believed, based on the nature of the fault and observations made by dispatched personnel, that the fault occurred on the secondary, (3) after the power was cut, a large tree limb was removed from the conductors, and (4) before the transformer fuse could be opened the primary conductor broke and fell against the primary neutral.[10]

In summary, KCPL's first report in the Denial of Claim letter was that (1) there was a fault on the secondary north of the transformer likely due to a large tree limb and (2) the neutral was down and was later repaired after the dispatched personnel opened the cutout door. In KCPL's latest response they indicate it was (1) merely a **report** of a primary wire down (2) the dispatched personnel **believed** (implying he was incorrect) it was a fault occurring on the secondary (3) the dispatched personnel cut the power and proceeded to remove a large tree limb (large enough to touch the primary, the secondary and the neutral) (4) even though the power had been cut the transformer fuse door was still closed and the primary conductor then broke and fell against the neutral. In KCPL's descriptions to KCC, no downed conductors are reported up until the instance where the primary falls.

The sequence of events in KCPL's investigation has evolved from their first response (Property Damage Claim date June 10th, 2015) through their later responses to KCC. KCPL has resolved the disagreement of the troubleman's description and KCPL's counsel's latest description (and the simultaneous disagreement contained in their Answers and Motion) by discrediting the troubleman's observation which coincidentally was the only on-scene KCPL observation available from the event.

EXHIBIT B: The Emergency 911 Call of 5813 Riggs St, CFD2 time stamped 5/20/15 8:46:28 AM

Starting from the beginning of the available evidence, please review the emergency 911 call alerting the first response authorities to the scene. The Consolidated Fire Department #2, date May 20th, 2015, records the time of the call.

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On 05/20/2015 at 08:46:28  CFD2 was dispatched To 5800 WALMER ST /House Fire/MISSION, KS
66202.  The location is a  1 or 2 family dwelling.  Johnson County ECC dispatched the call as
a(n) House Fire.  The incident was determined to be a(n) Building fire.

08:52:11 arrived on scene.
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In Exhibit B, an emergency 911 call was made by a resident of 5813 Riggs St. alerting the authorities to an electrical event occurring in the lateral behind [east of] her residence. The homeowner describes the electrical fire being *"in my back yard"* and later moving *"down"* the lateral. Given that the majority of the evidence is of the area north of her home and also the majority of the damages recorded being north of her home, a simple deduction is that by *"down"* she meant north. Her dialogue to the operator is indicative of panic and she is as a result confused of directions; despite that, her descriptions sufficiently correlates to other evidence.

The call describes a scenario where some type of interference must have occurred on the secondary of the lateral; reportedly south of the transformer, just east of 5813 Riggs in the lateral. The previously submitted video to KCC depicts a known behavior of the circuit/lateral where once the secondary begins arcing, the arcs persist until the transformer fuse is blown. In the submitted video the arcs cycle north and south on the secondary of the lateral. The distance of the travel is attributed to vegetation interaction cause by the storm event. Based on the emergency call and the absence of storm evidence, it is my belief that the arcs remained localized in the area behind 5813 Riggs long enough for the neutral to fatigued and fall.

EXHIBIT C.1: 5800 Walmer Fire Escape Photo #1, time stamped 5/20/15 8:46:03 AM (-25 s from Ex.B)

The senior homeowner of 5800 Walmer St. was alarmed of smoke coming from her basement (where her main electrical panel is installed). She exited her home with her husband (now late husband) to the closest exit on the west side of her home. After exiting she captured a series of photos with her smart phone camera; this initial photo shows the northbound (cardinal directions provided here and after are with relation to the transformer on pole JO 4829) neutral and secondary intact and radiating as if in a low impedance fault condition. The southbound secondary is shown intact but the southbound neutral is absent of its normal location and appears to be in a hanging position consistent with Exhibit A. Given the amount of smoke localized behind the area of the lower secondary conductor and hanging southbound neutral, this photo is believed to show at least one short circuit (low impedance) fault location. In this scenario, the transformer fuse should have functioned prior to the secondary conductor and neutral radiating red.

EXHIBIT C.2: 5800 Walmer Fire Escape Photo #2, time stamped 5/20/15 8:46:25 AM (-3 s from Ex.B)

The 5800 Walmer St. homeowner's second photo shows a continuation of a sustained short circuit fault. The northbound neutral is shown to be falling toward the lower, northbound secondary.

Approximately 45 seconds after this photo, the emergency caller in Exhibit B proclaims *"oh my gosh"*. Since that moment in Exhibit B correlates between Exhibit C.2 where the northbound neutral is falling and Exhibit C.3 where the northbound neutral is downed, it is probable that the *"oh my gosh"* moment in Exhibit B occurs when the northbound neutral contacts the northbound secondary and subsequent arcs or smoke becoming more and more visible.

EXHIBIT C.3: 5800 Walmer Fire Escape Photo #3, time stamped 5/20/15 8:49:52 AM (+3 m 24 s from Ex.B)

The 5800 Walmer St. homeowner's third photo is the first photo to show the northbound neutral to have fallen. The photo also shows damage occurring on alternative ground paths including Time Warner Cable's (TWC) service and AT&T's service. The southbound neutral is still absent from where it is normally located and you can see both southbound secondaries still intact. The northbound secondary is also shown intact and no evidence of the primary falling is present.

EXHIBIT C.4: 5800 Walmer Fire Escape Photo #4, time stamped 5/20/15 8:50:03 AM (+3 m 33 s from Ex.B)

The 5800 Walmer St. homeowner's fourth photo more clearly shows the result of the prior events. Both northbound and southbound neutrals are down. The secondary is still active evident by the "continuing to seek all available grounds" smoke. In the picture there are at least 7 active ground paths for the energized secondary to disperse:

a. The ground at the pole. The JO 4829 ground runs into earth on the southwest side of the pole starting from the neutral connection on the primary side (top) of the transformer. As the ground runs downward toward earth it is also tied to the northbound and southbound neutral on the secondary side of the transformer.
b. The ground available through the 5800 Walmer St. residence and/or at the utility meter.
c. Through the shared service toward 5825 Riggs St. and 5819 St., the grounds available at each residence and/or related utility meter.
d. The grounds available through the AT&T and TWC support/ground connections.
e. The "open neutral" paths found by the fallen neutral lines including the lateral fence.

See photo 5 in Exhibit C to review the ground paths connected to the neutral on pole JO 4829 as of January 27th, 2016.

EXHIBIT D: 5806 Walmer Photos: time stamped 5/20/15 8:58 AM thru 9:02 AM (+15 m from Ex.B)

At the beginning of this series of photos, the Consolidated Fire Department #2 has been on scene for a little over five minutes based on the fire report. The photos show that over the course of 4 minutes, the communications box on the AT&T line starts to ignite due to the open neutral and short circuit condition in the lateral. The downed northbound neutral is visible in each photo.

The final photo in Exhibit D is the photo provided to KCTV 5 for their 10 o'clock report. The photo is time stamped at 9:02 AM meaning the short circuit fault persisted in causing damage on the secondary for at least 15 minutes.

EXHIBIT A and the Volatile Timeline recovered from Witness Accounts

The 5800 Walmer St. homeowner's recollection, provided to my husband on June 10, 2015, was that the time required for KCPL to be arrive on site, starting from the time she called KCPL at 8:47 AM, was approximately 45 minutes.

The fire reports provides that [sometime after 8:52:11 AM] T21 made entry into the home, found interior power lines glowing and used CO2 extinguishers to keep fire from extending until KCPL could get power shut off. Later, *"BC21 declared the fire out at 10:01 and CH20 called for a fire investigator to respond to the scene."*

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T21 made entry into that house with the homeowner and found smoke in the basement.  T21 had
homeowners evacuate and called for a modified response.  T21 entered the basement to find
heavy smoke and found the interior power lines were glowing.  With the appearance of reverse
polarity, T21 used CO2 extinguishers to keep the fire from extending until KCPL could get
power shut off to the residence.  Once power was shut off to the residence, a hose line was
used to extinguish the fire and control hot spots.  BC21 declared the fire out at 10:01 and
CH20 called for a fire investigator to respond to the scene.
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The 5800 Walmer St. homeowner's witnessed account places KCPL on scene around 9:40 AM. After trouble man opened the cutout door at the transformer, as initially described by KCPL, the firefighters took ten to fifteen minutes to extinguish the house fire, reported to be 10:01 AM, then call the fire investigator to the scene in which he then recorded Exhibit A at 10:25 AM. The course of events on KCPL's part is currently vague; reviewing GPS data from the responding line trucks as well as reviewing a detailed account of downed lines and work performed by the dispatched personnel should help complete the timeline.

RESPONSE TO KCPL'S REPLY, ITEM 13

In response to:

> 13. Complainant alleges in Item 20 that KCP&L's use of a 20E fuse is inappropriate for a 50kVA transformer, and that a 10A fuse is "common practice" for utilities. First, Complainant offers no evidence to support this claim.

The IEEE standard repeatedly instructs to follow manufacturer guidelines or recommendations. Since the manufacturer and model of both the transformer fuse and transformer are currently unknown, appropriate supporting evidence cannot be provided. It is also believed that as the system owner, KCPL, bears the burden of proof and has yet to submit any fuse sizing standard or design documents. Additionally, the review of the SmartMeter data from the event will correlate to the claimed fuse size.

In response to:

> However, whether one utility chooses to use a 10A fuse for a 50kVA transformer is irrelevant because it disregards the design of KCP&L's system.

The fuse size was very relevant to causing the electrical fire and there are national standards for sizing fuses. The design of the KCP&L system, as described and operated to date, does not appear to follow a nationally recognized standard.

In response to:

The type of fuse selected is based on the available fault current at a particular location. There are many types of fuses a utility company can use to protect a 50kVA/120/240 volt transformer with a variety of operating characteristics.

The first sentence is consistent with manufacturer documentation; a review of a few sample manufacturer recommendations shows that KCPL may be referring to the Short Circuit Rating calculation. I request KCPL to complete the short current rating calculation and submit the documentation to KCC with any appropriate engineering reference such as the manufacturer documents and relevant national code. To the commission, please note that the fuse is installed on the primary side of the transformer even though KCPL has only provided secondary voltages. Additionally, manufacturer documents describe the engineered function that the *"variety of operating characteristics"* serve for a given application and normal operation. They also recommend compliment circuit protection equipment, where appropriate.

In response to:

KCP&L chose to use a 20E fuse link that has the same fuse-blowing characteristics as does the 10A fuse. This means that the time it takes for the 20E fuse to "blow-open" above this size transformer is approximately the same time as with a 10A fuse. However, of the two types of fuse schemes, the 20E standard fuse is more sophisticated than the traditional 10A fuse.

1. Type E fuses have a time-based blowing characteristic but relative to the rating of the fuse. With regard to the IEEE's definition of the type E fuse, 200-240% of a 10 amp rating is not equal to 200-240% of a 20

amp rating so the time-based characteristics of a 20 amp type E fuse will likely not be triggered in an application requiring a 10 amp fuse.

2. By "traditional fuse", KCPL may be referring to what Eaton describes as a "full range" fuse. Please review Exhibit E, page 4. The type E fuse would classify as the "general purpose" fuse. The described time characteristics between a full range and general purpose fuse are significantly different.

Respectfully submitted,

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Mission, KS 66202
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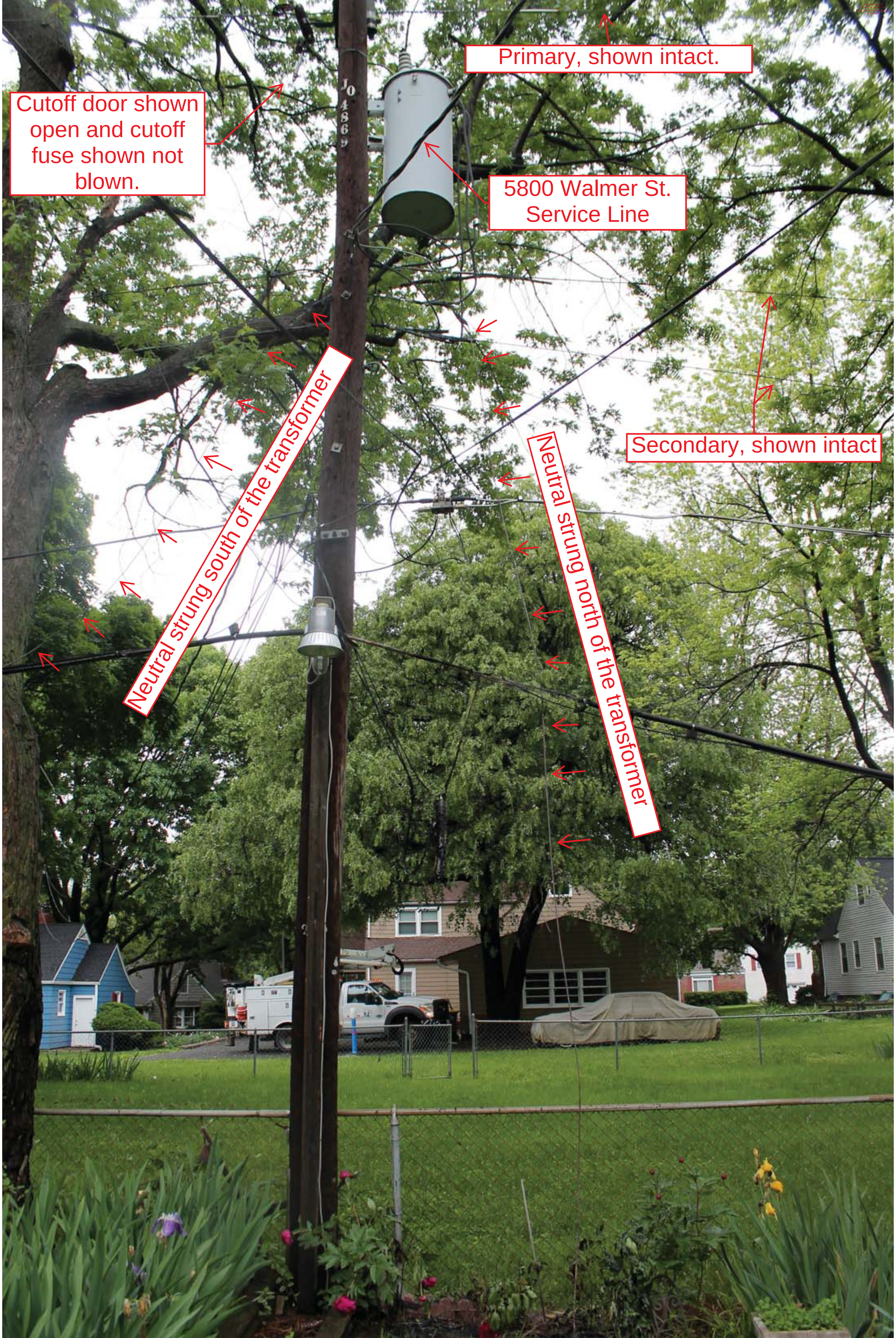
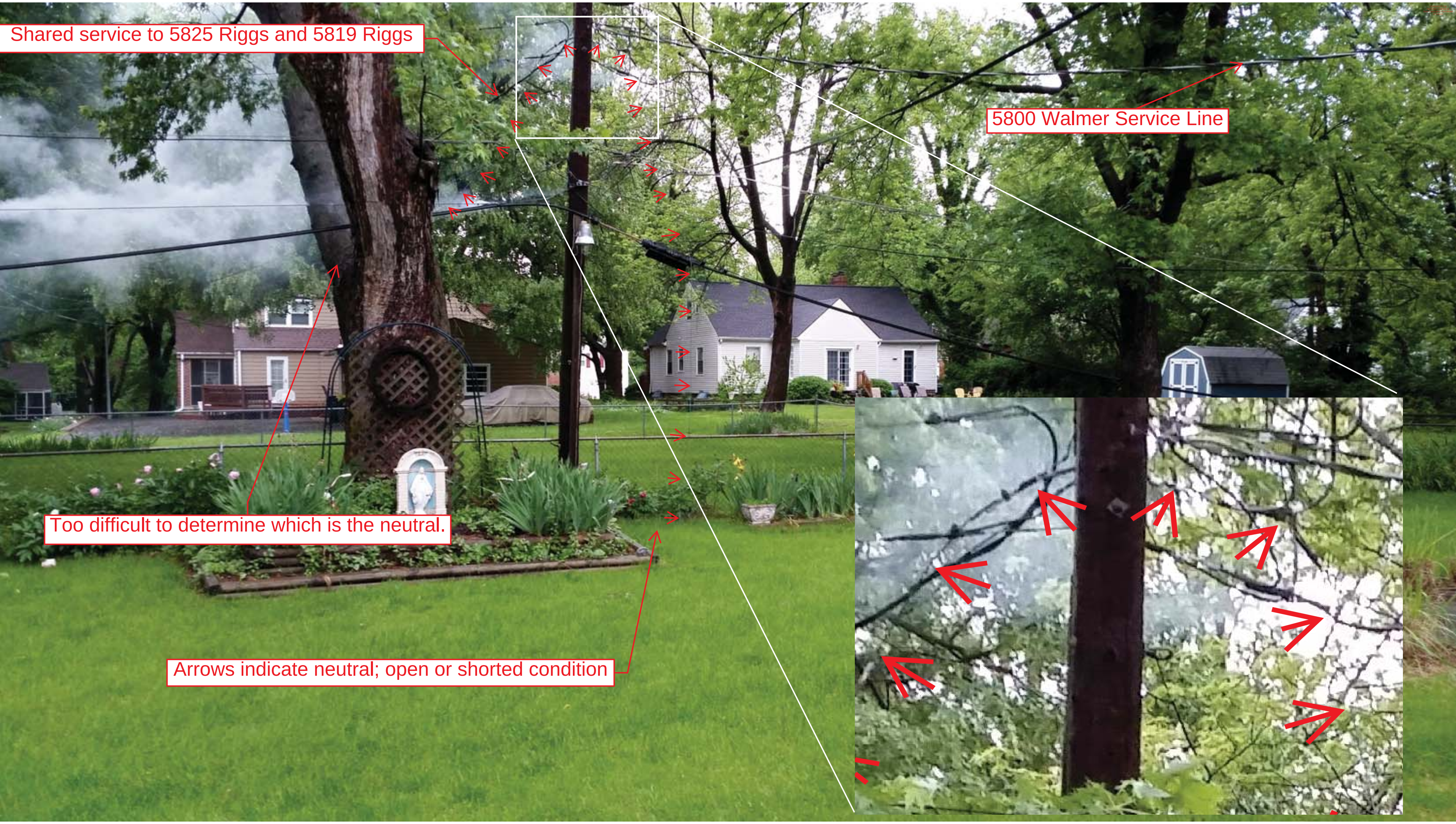
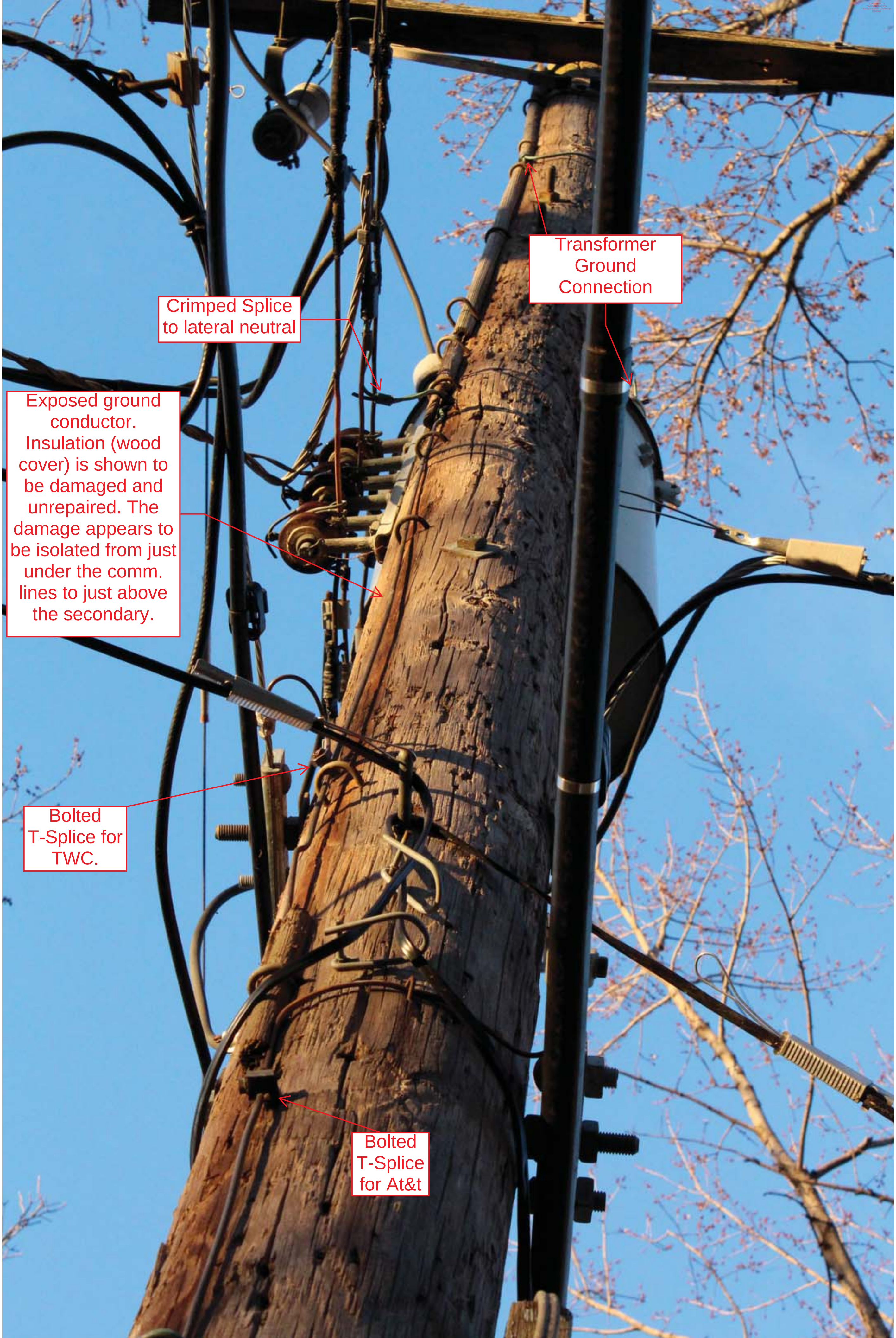

Primary, shown intact.
Cutoff door shown open and cutoff fuse shown not blown.
5800 Walmer St. Service Line
Secondary, shown intact
Neutral strung south of the transformer
Neutral strung north of the transformer


Short circuit fault location. Smoke shown near the location of the fault.
Secondary, shown intact.
Fallen neutral
Secondary, shown intact
high current; transformer fuse should've blown before these conductors radiated in this manner.


Fallen southbound neutral
Northbound neutral fatigues and droops toward the lower secondary


Neutral conductor still appears to be absent from the expected location despite being able to see the secondary.
Secondary in tact.
Northbound neutral has fallen.
Fallen support cable for Time Warner Cable (TWC).
Smoke is due to open neutral/short circuit. Energy is seeking earth on one of its available grounds. The path shown smoking is the communication line (At&t) that is beginning to separate from its support cable.
Photos taken days after show a "large tree limb" in this location. No tree limb is present during the event. Initial fault occurred somewhere south of 5800 Walmer.


Shared service to 5825 Riggs and 5819 Riggs
5800 Walmer Service Line
Too difficult to determine which is the neutral.
Arrows indicate neutral; open or shorted condition


Transformer Ground Connection
Crimped Splice to lateral neutral
Exposed ground conductor. Insulation (wood cover) is shown to be damaged and unrepaired. The damage appears to be isolated from just under the comm. lines to just above the secondary.
Bolted T-Splice for TWC.
Bolted T-Splice for At&t


Start of communication box fire on At&t line.

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State Corporation Commission
of Kansas

Fuses—Medium Voltage

Contents

Specifications

See Eaton's *Product Specification Guide*, available on CD or on the Web.

	1995	2010
CSI Format:	1995	2010
	Section 16362	**Section 26 18 16**

Current Limiting Fuses

General Description

Medium Voltage Fuses

Eaton's entry in the power fuse business began over 75 years ago under Westinghouse® Electric. In 1935, Westinghouse introduced the medium voltage boric acid expulsion fuse followed by the medium voltage current limiting fuse. Even today, medium voltage fuses continue to use the core Westinghouse technology. Eaton continues to build on the Westinghouse technology legacy by engineering higher performance, cost-effective power fuse products.

Eaton medium voltage fuses are manufactured and tested to the requirements of the ANSI C37.4X series of standards.

Eaton is the only North American manufacturer of both current limiting and expulsion medium voltage power fuses. A full range of general purpose, backup and boric acid fuses is available for distribution and power applications.

All Eaton medium voltage fuses are thoroughly tested and conform to ANSI specifications. Some motor starter fuses are UR® recognized, and both current limiting and expulsion fuses have been approved in UL® rated switchgear.

Current limiting and expulsion fuses can be used to meet any overcurrent protection need. At any point along the medium voltage electrical distribution system, Eaton has a fuse to satisfy your overcurrent protection needs.

The following fuse terminology will assist in understanding and selecting the correct fuse. The following is a brief overview of those terms.

Power vs. Distribution

The differentiation is intended to indicate the test conditions and where fuses are normally applied in a power system, based on specific requirements for generating sources, substations and distribution lines. Each class has its own unique set of voltage, current and construction requirements (see ANSI C37.42, .46 and .47).

Low vs. Medium vs. High Voltage

While fuses are defined in the ANSI standards as either low or high voltage, Eaton's Electrical Sector has elected to name their fuses to correspond with the equipment in which they are installed. Therefore, per ANSI C84, fuses are named as follows:

Low Voltage	1000V and below
Medium Voltage	Greater than 1000–69,000V
High Voltage	Greater than 69,000V

Expulsion vs. Current Limiting

Expulsion Fuse: An expulsion fuse is a vented fuse in which the expulsion effect of the gases produced by internal arcing, either alone or aided by other mechanisms, results in current interruption.

An expulsion fuse is not current limiting and as a result limits the duration of a fault on the electrical system, not the magnitude.

Current Limiting Fuse: A current limiting fuse is a fuse that, when its current responsive element is melted by a current within the fuse's specified current limiting range, abruptly introduces a high resistance to reduce current magnitude and duration, resulting in subsequent current interruption.

Table 9.0-1. General Fuse Comparison

Expulsion	Current Limiting
Vented	Sealed
Electromechanical	Static
Interrupts at current zero, limits fault current duration	Limits fault current magnitude and duration
Generally higher voltage ratings	Generally higher interrupting ratings
Different time/current characteristics	Different time/ current characteristics

Table 9.0-2. Eaton Medium Voltage Fuse Family

Current Limiting	Expulsion
HLE: Helical configuration current limiting, E-rated CLE: Current limiting, E-rated CLS: Current limiting starter (motor starter) HCL: Current limiting, clip-mount, E-rated CX: Current limiting, C-rated CLPT: Current limiting, E-rated	RBA: Refillable, boric acid RDB: Refillable, dropout, boric acid DBU: Dropout, boric acid, indoor/outdoor S&C equivalent

Table 9.0-3. Application Guide

Type	Fuse Voltage Range (kV)	Fuse Ampere Rating	Fuse Maximum Interrupting Rating (kA Sym.)	Class Use Indoor/Outdoor	Applied in:
Current Limiting					
CLE	2.4–15.5	10E–1350A	65	General purpose indoor/outdoor	Fused switches, feeder circuit sectionalizing, power transformers, dip poles, substation capacitor banks.
CLPT	2.4–38	0.25E–10E	80	General purpose indoor	Potential transformers. BAL-1 mountings and clips are no longer available.
CLS	2.4–8.3	2R–44R	50	Backup distribution indoor	AMPGARD® and non-AMPGARD motor starters. HCLS version is the same as the CLS except hermetically sealed for hazardous locations.
CX/CXI CXN	4.3–15.5	3.5C–300C	50	General purpose distribution indoor	Pad mounted distribution transformers, Substation service transformers, and fused switches. Direct substitution for McGraw's NX fuse.
HCL	2.4–15.5	10A–900A	63	General purpose distribution indoor	Fused switches, feeder circuit sectionalizing, power transformers, dip poles, substation capacitor banks.
HLE	2.4–15.5	10E–450E	65	General purpose indoor/outdoor	Fused switches, feeder circuit sectionalizing, power transformers, dip poles, substation capacitor banks.
Expulsion Fuses					
RBA	2.4–38	0.5E–720E	37.5	Boric acid power indoor	Fused switches, feeder circuit sectionalizing, and power transformers.
RDB	2.4–38	0.5E–720E	37.5	Boric acid power outdoor	Feeder circuit sectionalizing, power transformers, substation service transformers, dip poles, potential transformers, and substation capacitor banks. Outdoor version of the RBA.
DBU	4.4–38	5E–200E, 3K–200K	50	Boric acid power indoor/outdoor	Feeder circuit sectionalizing, fused switches, power transformers, substation service transformers, dip poles, and potential transformers. Direct equivalent for S&C's SMU-20 fuse units.

Table 9.0-4. Power Fuse Ampere Characteristic Ratings

Rating	Definition
E	Fuses rated 100E or below will melt in 300 seconds at some current value between 2.0 and 2.4 times the E number.
	Fuses rated above 100E will melt in 600 seconds at some current value between 2.2 and 2.64 times the E number.
R	The fuse will melt in 15 to 35 seconds when the current equals 100 times the R number.
C	The fuse will melt in 1000 seconds at some current value between 1.7 and 2.4 times the C number.
A	Class A fuses have parameters that do not fall within the 'C', 'E', or 'R' definitions above.
X	Meet C37.40 temperature requirements, but not the E rating.

9

Current Limiting Fuses

Current Limiting Fuse Types

There are three current limiting fuse types: backup, general purpose and full range. It is important that the user have an understanding of these definitions to ensure proper application of the fuse (**Figure 9.0-1**).

Backup Fuse: A fuse capable of interrupting all currents from the rated maximum interrupting current down to the rated minimum interrupting current.

Backup fuses are normally used for protection of motor starters and are always used in series with another interrupting device capable of interrupting currents below the fuse's rated minimum interrupting current.

General Purpose Fuse: A fuse capable of interrupting all currents from the rated maximum interrupting current down to the current that causes melting of the fusible element in no less than one hour.

General purpose fuses are typically used to protect feeders and components such as transformers.

Full Range Fuse: A fuse capable of interrupting all currents from the rated maximum interrupting rating down to the minimum continuous current that causes melting of the fusible element, with the fuse applied at the maximum ambient temperature specified by the manufacturer.

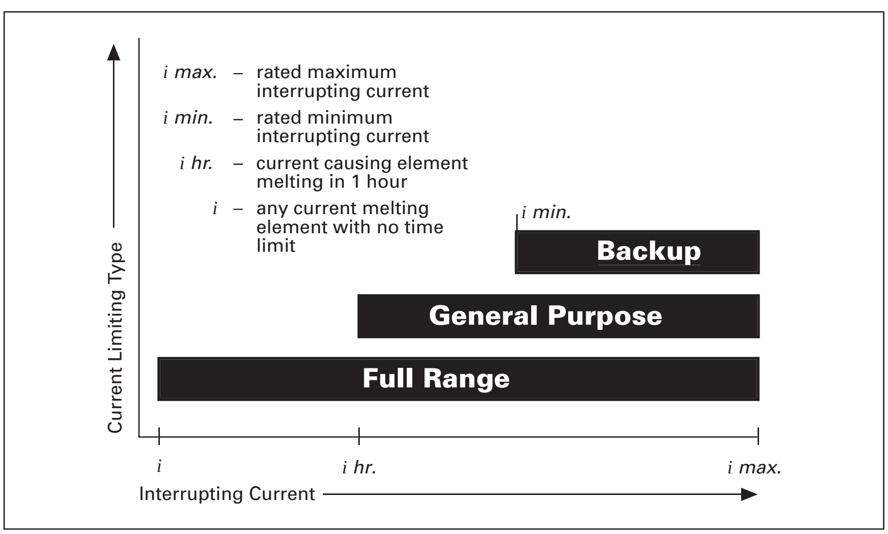

Figure 9.0-1. Current Limiting Types Protection Range

Current limiting fuses are constructed with pure silver fuse elements, high purity silica sand filler, and a glass resin outer casing.

A high fault current melts the silver element almost instantly and loses energy to the surrounding sand. The sand melts and forms fulgurite, a glass-like substance. The arc voltage rapidly increases to nearly three times the fuse voltage rating and forces the current to zero.

Low fault current melts a solder drop on the silver fuse element that, in turn, melts the silver. The element burns back until there is a sufficient internal gap to interrupt the current. This is known as the M-effect.

Eaton offers current limiting fuses in two basic types: backup and general purpose. Backup fuses are applied in series with another circuit protective device, such as a contactor or an expulsion fuse, to interrupt high fault currents beyond the other device's range. General purpose fuses are designed to interrupt low fault currents that cause them to melt in one hour or less.

Multi-Range Fuses

CLE and HLE fuses are also available in user-selectable multi-range versions 10–40A, 50–125A and 150–200A.

Disconnect End Fittings and Disconnect Live Parts

Accessories

A wide assortment of mountings, live parts and end fittings are available to facilitate power fuse installation.

Mountings

Mountings include a base, porcelain or glass polyester insulators, and live parts. They help enable the fuse to be safely attached to the gear. Mountings can be either disconnect or non-disconnect.

Live Parts

Live parts attach the fuse to the insulators and are considered part of the mounting. All parts above the insulators are live parts.

Current Limiting Fuses

Table 9.0-5. CLE, HLE, HCL and CLS Fuses

Description	Family			
	CLE	HLE	HCL	CLS
				
General				
Class	General purpose	General purpose	General purpose	Backup
Use	Power	Power	Power	Power
Maximum kV	2.75–15.5	5.5–15.5	5.5–15.5	2.4–15.5
Maximum kA	63	63	63	50
Rating	10E–1350A	10E–450A	10E–900E	2R–44R
Mounting	Clip	Clip, bolt-on, hookeye	Clip lock, bolt-on	Clip, bolt-on, hookeye
Indicator	Standard	Standard	Standard	Standard
Approvals	IEEE, ANSI	IEEE, ANSI	IEEE, ANSI	UL®, IEEE, ANSI
Applications				
Feeder circuits	■	■	■	
Motor starters				■
PTs and CTs				
LV breakers				
Substation service				
Transformers	■	■	■	
Capacitor banks	■	■	■	
Fused switches	■	■	■	

Table 9.0-6. CLPT, CX, CLT and DSL Fuses

Description	Family			
	CLPT	CX	CLT	DSL
				
General				
Class	General	General	General	Back-up
Use	Power/distribution	Distribution	Distribution	Power
Maximum kV	5.5–38	4.3–15.5	2.75–15	600V
Maximum kA	80	50	25	200
Rating	0.25E –10E	3.5C–300C	5–150	100–5000
Mounting	Clip	Clip	Stud bolt-on	Bolt-on
Indicator	Optional	None	None	None
Approvals	IEEE, ANSI	IEEE, ANSI	IEEE, ANSI	UL
Applications				
Feeder circuits				
Motor starters				
PTs and CTs	■			
LV breakers				■
Substation service		■		
Transformers		■	■	
Capacitor banks				
Fused switches				

9

Expulsion Fuses

RBA
E-Rated Refillable Boric Acid

RDB
E-Rated Refillable Outdoor Dropout Boric Acid

DBU
Dropout Boric Acid—for Use Indoors, Inside Switchgear or Outdoors

Eaton's expulsion fuses use boric acid as the interrupting medium. Under a fault condition, arc heat decomposes the boric acid into water vapor. The water vapor blast deionizes the arc path preventing arc re-ignition after a natural current zero.

Type RBA indoor expulsion fuses must be fitted with a discharge filter or condenser that moderates the discharge exhaust. The discharge filter limits the exhaust to a small and relatively inert amount of gas and lowers the noise level without affecting the fuse interrupting rating. Steam discharge, that can effect the interrupting, is fully restricted by the condenser.

Type RDB outdoor dropout fuses include an ejector spring that forces the arcing rod through the top of the fuse. The arcing rod strikes a latch on the mounting that forces the fuse to swing outward through a 180° arc into the dropout position.

Refill units can be field installed into RBA and RDB expulsion fuses. Once the operated unit has been removed, the separately purchased unit can be easily installed into the fuse holder.

Type DBU fuse units are designed for new and aftermarket utility applications. End fittings are available, in both indoor and outdoor versions, as well as live parts and mountings. Mufflers confine the arc within the fuse and substantially reduce the noise and exhaust when the fuse interrupts.

Accessories

The following accessories are available for expulsion fuses:

Mountings

Mountings include a base, porcelain or glass polyester insulators, and live parts. They help enable the fuse to be safely attached to the gear. Mountings can be either disconnect, non-disconnect or dropout. Non-disconnect mountings are available in either bolt-on or clamp-type arrangements. Fuses may be vertical or underhung.

Live Parts

Live parts attach the fuse to the insulators and are considered part of the mounting. All parts above the insulators are live parts.

End Fittings

End fittings are metal parts that attach to each end of the fuse at the ferrules. They are used only on disconnect fuses or when converting a non-disconnect to a disconnect fuse.

Technical Ratings

Table 9.0-7. Transformer Primary Fuse Application

System Voltage	Fuse Type	Maximum Transformer kVA ①		Fuse Family/Characteristics			
		Self-Cooled	Forced Air	Type	Current Range	Maximum kV	Interrupting Rating Amperes (Symmetrical) ②
2400	Current limiting	742	866	CLE	10–250	5.5	63,000
		1336	1560	CLE	300–450		63,000
		2228	2600	CLE-750	600–750		40,000
		4010	4676	CLE-750	1000–1350		31,500
		742	866	CXN	60–250	8.3	50,000
		890	1039	CXN	300		50,000
	Expulsion	600	695	RBA-200	10–200	8.3	19,000
		1190	1385	RBA-400	5–400		37,500
		2140	2500	RBA-800	450–720		37,500
				DBU-17	3–200	17.1	14,000
4160	Current limiting	1287	1502	CLE/HLE	10–250	5.5	63,000
		2317	2703	CLE/HLE	300–450		63,000
		3862	4506	CLE-750	600–750		40,000
		6952	8111	CLE-750	1000–1350		31,500
		1286	1501	CXN	60–250	8.3	50,000
		1545	1802	CXN	300		50,000
	Expulsion	1030	1200	RBA-200	10–200	8.3	19,000
		2055	2400	RBA-400	5–400		37,500
		3700	4320	RBA-800	450–720		37,500
				DBU-17	3–200	17.1	14,000
4800	Current limiting	1483	1731	CLE/HLE	10–250	5.5	63,000
		2671	3116	CLE/HLE	300–450		63,000
		4451	5193	CLE-750	600–750		40,000
		8013	9348	CLE-750	1000–1350		31,500
		1483	1731	CXN	60–250	8.3	50,000
		1780	2077	CXN	300		50,000
	Expulsion	1190	1385	RBA-200	10–200	8.3	19,000
		2375	2775	RBA-400	5–400		37,500
		4280	5000	RBA-800	480–720		37,500
				DBU-17	3–200		14,000
6900	Current limiting	1536	1792	CLE/HLE	10–175	8.3	50,000
		2987	3485	CLE	200–350		50,000
		2134	2490	CXN	60–250		50,000
		2560	2987	CXN	300		50,000
	Expulsion	1705	2000	RBA-200	10–200	8.3	19,000
		3415	3985	RBA-400	5–400		37,500
		6150	7170	RBA-800	450–720		37,500
				DBU-17	3–200		14,000
7200	Current limiting	222	259	CLE/HLE	10–25	8.3	50,000
		890	1039	CLE/HLE	30–100		50,000
		1603	1870	CLE/HLE	125–180		50,000
		3117	3637	CLE	200–350		50,000
		2226	2598	CXN	60–250		50,000
		2672	3117	CXN	300		50,000
	Expulsion	1785	2080	RBA-200	10–200	8.	19,000
		3565	4160	RBA-400	5–400		37,500
		6420	7500	RBA-800	450–720		37,500
				DBU-17	3–200	17.1	14,000

① Maximum transformer kVA ratings are based on ratios of maximum fuse current rating to transformer full load current (I_F/I_T) as listed. For a 55°C rise liquid-filled transformer, use the kVA rating for 65°C rise (55°C rating x 1.12). For suggested minimum fuse applications, see **Tables 9.0-9**, **9.0-10** and **9.0-11.**

② The type RBA interrupting ratings shown are those of the discharge filter type, in which the noise is minimized and deionization of expulsion gases is assured.

These applications are subject to modification when specific factors such as transformer characteristics, other protective devices, coordination requirements and load variations may indicate a different I_F/I_T ratio.

Caution: Primary fuses must not be relied upon for clearing secondary ground faults.

Technical Ratings (Continued)

Table 9.0-7. Transformer Primary Fuse Application (Continued)

System Voltage	Fuse Type	Maximum Transformer kVA ①		Fuse Family/Characteristics			
		Self-Cooled	Forced Air	Type	Current Range	Maximum kV	Interrupting Rating Amperes (Symmetrical) ②
12,000	Current limiting	371 1484 2226 4452 1484 2597	432 1731 2597 5195 1731 3030	CLE HLE CLE HLE CXN CXN	10–150 10–125 175–300 150–250 45–100 120–175	15.5	63,000 63,000 63,000 63,000 50,000 50,000
	Expulsion	2970 5945	3465 6930	RBA-200 RBA-400 RBA-800 DBU-17	10–200 5–400 450–720 10–200	15.5	14,400 29,400 29,400 14,000
13,200	Current limiting	408 1632 2449 4898 1632 2857	476 1905 2857 5715 1905 3333	CLE HLE CLE HLE CXN CXN	10–150 10–125 175–300 150–250 45–100 120–175	15.5	63,000 63,000 63,000 63,000 50,000 50,000
	Expulsion	3265 6530	3810 7620	RBA-200 RBA-400 RBA-800 DBU-17	10–200 5–400 450–720 7–150	15.5	14,400 29,400 29,400 14,000
13,800	Current limiting	426 1707 2560 5121 1707 5855	497 1991 2987 5975 1991 3485	CLE HLE CLE HLE CXN CXN	10–150 10–125 175–300 150–250 45–100 120–175	15.5	63,000 63,000 63,000 63,000 50,000 50,000
	Expulsion	3415 6830 3415	3985 7970 3985	RBA-200 RBA-400 RBA-800 DBU-17	10–200 5–400 450–720 7–150	15.5 17.1	14,400 29,400 29,400 14,000
23,000	Expulsion	5690 8535 5690	6635 9950 6635	RBA-200 RBA-400 RBA-800 DBU-27	10–200 5–300 450–540 3–200	25.5 27.0	10,500 21,000 21,000 12,500
34,500	Expulsion	8535 12800 8535	9950 14925 9950	RBA-200 RBA-400 RBA-800 DBU-38	10–200 5–300 450–540 3–200	38.0	6,900 16,800 16,800 10,000

① Maximum transformer kVA ratings are based on ratios of maximum fuse current rating to transformer full load current (I_F/I_T) as listed. For a 55°C rise liquid-filled transformer, use the kVA rating for 65°C rise (55°C rating x 1.12). For suggested minimum fuse applications, see **Tables 9.0-9**, **9.0-10** and **9.0-11.**

② The type RBA interrupting ratings shown are those of the discharge filter type, in which the noise is minimized and deionization of expulsion gases is ensured.

These applications are subject to modification when specific factors such as transformer characteristics, other protective devices, coordination requirements and load variations may indicate a different I_F/I_T ratio.

Caution: Primary fuses must not be relied upon for clearing secondary ground faults.

Table 9.0-8. Selection of Minimum Primary Fuse for Transformer Protection

Instructions: Multiply the transformer primary full load current (FLA) times the multiplier shown in the table to determine suggested minimum size fuse. Use fan-cooled primary FLA with forced air transformer multiplier. See **Tables 9.0-9** thru **9.0-11** for suggested minimum fuse size.		For self-cooled transformers	For forced air transformers
Type CLE current limiting fuses Type RBA, DBU expulsion type fuses	All ratings	1.4 x FLA of XFMR	1.2 x FLA of XFMR

Interrupting Ratings of Fuses

Modern fuses are rated in amperes rms symmetrical. They also have a listed asymmetrical rms rating, which is 1.6 x the symmetrical rating.

Refer to ANSI/IEEE C37.48 for fuse interrupting duty guidelines.

Calculation of the fuse required interrupting rating:

Step 1—Convert the fault from the utility to percent or per unit on a convenient voltage and kVA base.

Step 2—Collect the X and R data of all the other circuit elements and convert to percent or per unit on a convenient kVA and voltage base same as that used in **Step 1**. Use the substransient X and R for all generators and motors.

Step 3—Construct the sequence networks using reactances and connect properly for the type of fault under consideration and reduce to a single equivalent reactance.

Step 4—Same as above except using resistances (omit if a symmetrically rated fuse is to be selected).

Step 5—Calculate the E/X_I value, where E is the prefault value of the voltage at the point of fault normally assumed 1.0 in pu. For three-phase faults E/X_I is the fault current to be used in determining the required interrupting capability of the fuse.

Note: It is not necessary to calculate a single phase-to-phase fault current. This current is very nearly $\sqrt{3}/2$ x three-phase fault. The line-to-ground fault may exceed the three-phase fault for fuses located in generating stations with solidly grounded neutral generators, or in delta-wye transformers with the wye solidly grounded, where the sum of the positive and negative sequence impedances on the high voltage side (delta) is smaller than the impedance of the transformer.

For single line-to-ground fault;

$$X_I = X_I(+) + X_I(-) + X_I(0)$$

$$I_f = \frac{E}{X_I} \times 3$$

Step 6—Select a fuse with a published interrupting rating exceeding the calculated fault current.

Table 9.0-10 should be used where older asymmetrically rated fuses are involved.

The voltage rating of power fuses used on three-phase systems should equal or exceed the maximum line-to-line voltage rating of the system. Current limiting fuses for three-phase systems should normally be applied so that the fuse voltage rating is equal to or less than 1.41 x nominal system voltage. However, the insulation levels on 2.4 kV systems normally allow 4.3 or 5.5 kV rated fuses to be used.

Table 9.0-9. Suggested Minimum Current Limiting Fuse Current Ratings for Self-Cooled 2.4–15.5 kV Transformer Applications—E-Rated Fuses

System Nominal kV	2.4		4.16		4.8		7.2		12.0		13.2		13.8		14.4	
Fuses Maximum kV	2.75		5.5		5.5		8.3		15.5		15.5		15.5		15.5	
Transformer kVA Rating Self-Cooled	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E
112.5	27.1	50E	15.6	25E	13.5	20E	9.0	15E	5.4	10E	4.9	10E	4.7	10E	4.5	10E
150	36.1	65E	20.8	30E	18.0	25E	12.0	20E	7.2	15E	6.6	10E	6.3	10E	6.0	10E
225	54.1	80E	31.2	50E	27.1	50E	18.0	25E	10.8	15E	9.8	15E	9.4	15E	9.0	15E
300	72.2	125E	41.6	80E	36.1	65E	24.1	40E	14.4	20E	13.1	20E	12.6	20E	12.0	20E
500	120.3	200E	69.4	125E	60.1	100E	40.1	65E	24.1	50E	21.9	30E	20.9	30E	20.0	30E
750	180.4	300E	104.1	150E	90.2	150E	60.1	100E	36.1	65E	32.8	65E	31.4	65E	30.1	65E
1000	240.6	350E	138.8	200E	120.3	175E	80.2	125E	48.1	80E	43.7	80E	41.8	80E	40.1	80E
1500	360.8	600E	208.2	300E	180.4	250E	120.3	175E	72.2	100E	65.6	100E	62.8	100E	60.1	100E
2000	481.1	750E	277.6	400E	240.6	350E	160.4	250E	96.2	150E	87.5	125E	83.7	150E	80.2	125E
2500	601.4	1100E	347.0	600E	300.7	450E	200.5	300E	120.3	200E	109.3	175E	104.6	175E	100.2	175E
3000	721.7	1100E	416.4	600E	360.8	600E	240.6	350E	144.3	250E	131.2	200E	125.5	200E	120.3	200E
3750	902.1	1350E	520.4	750E	451.1	750E	300.7	—	180.4	250E	164.0	250E	156.9	250E	150.4	250E
5000	1202.8	—	693.9	1100E	601.4	1100E	400.9	—	240.6	—	218.7	300E	209.2	300E	200.5	300E
7500	1804.2	—	1040.9	—	902.1	1350E	601.4	—	360.8	—	328.0	—	313.8	—	300.7	—
10,000	2405.6	—	1387.9	—	1202.8	—	801.9	—	481.1	—	437.4	—	418.4	—	400.9	—

Note: Fuse ratings represent the fuse that will withstand transformer inrush (12 x FLC for 0.1 second and 25 x FLC for 0.01 second) and be able to handle temporary overloads (133% of FLC, 150% for 15.5 kV).

Technical Ratings

Table 9.0-10. Suggested Minimum RBA Expulsion Fuse Ratings for Self-Cooled 2.4–15.5 kV Transformer Applications—E-Rated Fuses

System Nominal kV	2.4		4.16		4.8		7.2		12.0		13.2		13.8		14.4	
Fuses Maximum kV	2.75		5.5		5.5		8.3		15.5		15.5		15.5		15.5	
Transformer kVA Rating Self-Cooled	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E
112.5	27.1	40E	15.6	25E	13.5	20E	9.0	15E	5.4	10E	4.9	10E	4.7	10E	4.5	10E
150	36.1	50E	20.8	30E	18.0	25E	12.0	20E	7.2	10E	6.6	10E	6.3	10E	6.0	10E
225	54.1	80E	31.2	50E	27.1	40E	18.0	25E	10.8	15E	9.8	15E	9.4	15E	9.0	15E
300	72.2	100E	41.6	65E	36.1	50E	24.1	40E	14.4	20E	13.1	20E	12.6	20E	12.0	20E
500	120.3	175E	69.4	100E	60.1	80E	40.1	65E	24.1	40E	21.9	30E	20.9	30E	20.0	30E
750	180.4	250E	104.1	150E	90.2	125E	60.1	80E	36.1	50E	32.8	50E	31.4	50E	30.1	50E
1000	240.6	400E	138.8	200E	120.3	175E	80.2	125E	48.1	65E	43.7	65E	41.8	65E	40.1	65E
1500	360.8	450E ①	208.2	300E	180.4	250E	120.3	175E	72.2	100E	65.6	100E	62.8	100E	60.1	80E
2000	481.1	720E ②	277.6	400E	240.6	350E	160.4	250E	96.2	150E	87.5	125E	83.7	125E	80.2	125E
2500	601.4	—	347.0	540E ①	300.7	400E	200.5	300E	120.3	175E	109.3	150E	104.6	150E	100.2	150E
3000	721.7	—	416.4	720E ②	360.8	540E ①	240.6	350E	144.3	200E	131.2	175E	125.5	175E	120.3	175E
3750	902.1	—	520.4	720E ②	451.1	720E ②	300.7	400E	180.4	250E	164.0	250E	156.9	250E	150.4	200E
5000	1202.8	—	693.9	—	601.4	—	400.9	540E ①	240.6	400E	218.7	300E	209.2	300E	200.5	300E
7500	1804.2	—	1040.9	—	902.1	—	601.4	—	360.8	540E ①	328.0	450E ③	313.8	450E ③	300.7	450E ③
10,000	2405.6	—	1387.9	—	1202.8	—	801.9	—	481.1	720E ②	437.4	720E ②	418.4	720E ②	400.9	540E ①

① Two 300E-ampere fuse refill units in parallel with 10% derating.
② Two 400E-ampere fuse refill units in parallel with 10% derating.
③ Two 250E-ampere fuse refill units in parallel with 10% derating.

Note: Fuse ratings represent the fuse that will withstand transformer inrush (12 x FLC for 0.1 second and 25 x FLC for 0.01 second) and be able to handle temporary overloads (133% of FLC, 150% for 15.5 kV).

Table 9.0-11. Suggested Minimum RBA Expulsion Fuse Ratings for Self-Cooled 25.8–38 kV Transformer Applications

System Nominal kV	22.9		23.9		24.9		34.5	
Fuses Maximum kV	25.8		25.8		24.8		—	
Transformer kVA Rating Self-Cooled	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E
750	18.9	30E	18.1	25E	17.4	25E	12.6	20E
1000	25.2	40E	24.2	40E	23.2	40E	16.7	25E
1500	37.8	65E	36.2	50E	34.8	50E	25.1	40E
2000	50.4	80E	48.3	65E	46.4	65E	33.5	50E
2500	63.0	100E	60.4	100E	58.0	80E	41.8	65E
3000	75.6	125E	72.5	100E	69.6	100E	50.2	80E
3750	94.5	150E	90.6	125E	87.0	125E	62.8	100E
5000	126.1	175E	120.8	175E	115.9	175E	83.7	125E
7500	189.1	300E	181.2	250E	173.9	250E	125.5	175E
10,000	252.1	450E ④	241.6	450E ④	231.9	450E ④	167.3	250E

④ Two 250E-ampere fuse refill units in parallel with 10% derating.

Note: Fuse ratings represent the fuse that will withstand transformer inrush (12 x FLC for 0.1 second and 25 x FLC for 0.01 second) and be able to handle temporary overloads (133% of FLC, 150% for 15.5 kV).

Table 9.0-12. Suggested Minimum DBU Expulsion Fuse Current Ratings for Self-Cooled 2.4–15.5 kV Power Transformer Applications

System Nominal kV	2.4		4.2		4.8		7.2		12.0		13.2		13.8		14.4	
Fuses Maximum kV	17.1		17.1		17.1		17.1		17.1		17.1		17.1		17.1	
Transformer kVA Rating Self-Cooled	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E
Three-Phase Transformers																
112.5	27	40E	16	25E	14	20E	9	15E	5	10E	5	7E	5	7E	5	7E
150	36	50E	21	30E	18	25E	12	20E	7	10E	7	10E	6	10E	6	10E
225	54	80E	31	50E	27	40E	18	25E	11	15E	10	15E	9	15E	9	15E
300	72	100E	42	65E	36	50E	24	40E	14	20E	13	20E	13	20E	12	20E
500	120	200E	69	100E	60	100E	40	65E	24	40E	22	30E	21	30E	20	30E
750	180	—	104	150E	90	125E	60	100E	36	50E	33	50E	31	50E	30	50E
1000	241	—	139	200E	120	200E	80	125E	48	80E	44	65E	42	65E	40	65E
1500	361	—	208	—	180	—	120	200E	72	100E	66	100E	63	100E	60	65E
2000	481	—	278	—	241	—	160	—	96	150E	87	125E	84	125E	80	125E
2500	601	—	347	—	301	—	200	—	120	200E	109	150E	105	150E	100	150E

Note: Fuse ratings represent the fuse that will withstand transformer inrush (12 x FLC for 0.1 second and 25 x FLC for 0.01 second) and be able to handle temporary overloads (133% of FLC, 150% for 15.5 kV).

Table 9.0-13. Suggested Minimum DBU Expulsion Fuse Current Ratings for Self-Cooled 2.4–15.5 kV Power Transformer Applications

System Nominal kV	22.9		23.9		24.9		34.5	
Fuses Maximum kV	27.0		27.0		27.0		38.0	
Transformer kVA Rating Self-Cooled	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E	Full Load Current Amps	Fuse Rating Amps E
Three-Phase Transformers								
750	19	30E	18	25E	17	25E	13	20E
1000	25	40E	24	40E	23	40E	17	25E
1500	38	65E	36	50E	34	50E	25	40E
2000	50	80E	48	80E	46	65E	33	50E
2500	63	100E	60	100E	58	80E	42	65E
3750	95	150E	91	150E	87	125E	63	100E

Note: Fuse ratings represent the fuse that will withstand transformer inrush (12 x FLC for 0.1 second and 25 x FLC for 0.01 second) and be able to handle temporary overloads (133% of FLC, 150% for 15.5 kV).

Table 9.0-14. Type DBU Expulsion Fuses, Boric Acid, Indoor/Outdoor

Maximum Design kV	Current Rating Amperes	Interrupting Rating rms (kA Symmetrical)
17.1	3K, 6K, 8K, 10K, 12K, 15K, 20K, 25K, 30K, 40K, 50K, 65K, 80K, 100K, 140K, 200K, 5E, 7E, 10E, 13E, 15E, 20E, 25E, 30E, 40E, 50E, 65E, 80E, 100E, 125E, 150E, 175E, 200E, 15SE, 20SE, 25SE, 30SE, 40SE, 50SE, 65SE, 80SE, 100SE, 125SE, 150SE, 175SE, 200SE	14
27	3K, 6K, 8K, 10K, 12K, 15K, 20K, 25K, 30K, 40K, 50K, 65K, 80K, 100K, 140K, 200K, 5E, 7E, 10E, 13E, 15E, 20E, 25E, 30E, 40E, 50E, 65E, 80E, 100E, 125E, 150E, 175E, 200E, 15SE, 20SE, 25SE, 30SE, 40SE, 50SE, 65SE, 80SE, 100SE, 125SE, 150SE, 175SE, 200SE	12.5
38	3K, 6K, 8K, 10K, 12K, 15K, 20K, 25K, 30K, 40K, 50K, 65K, 80K, 100K, 140K, 200K, 5E, 7E, 10E, 13E, 15E, 20E, 25E, 30E, 40E, 50E, 65E, 80E, 100E, 125E, 150E, 175E, 200E, 15SE, 20SE, 25SE, 30SE, 40SE, 50SE, 65SE, 80SE, 100SE, 125SE, 150SE, 175SE, 200SE	10–outdoor 8.5–indoor with muffler

Note: Used on overhead distribution transformers, substation equipment, industrial transformer installations, and radial distribution circuits.

For additional information, see:
Volume 4, CA08100005E . . . . **Tab 26**

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