Westinghouse Electric Corporation
Switchgear Division
East Pittsburgh, PA 15112

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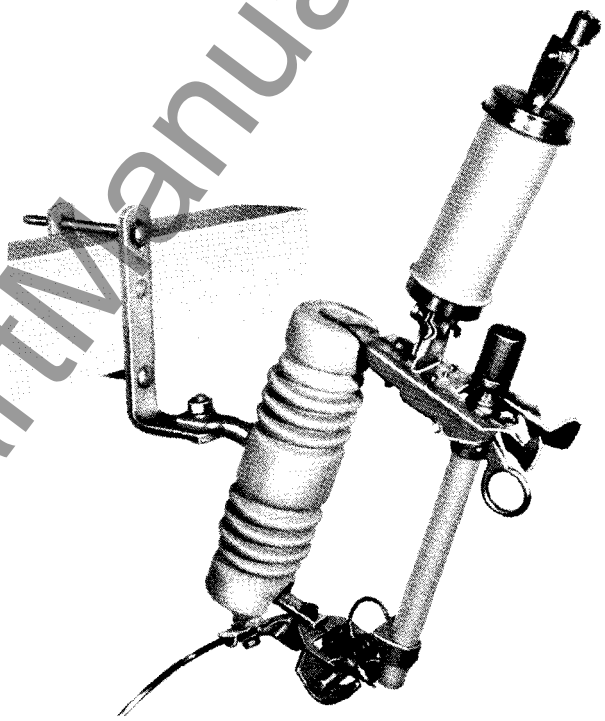
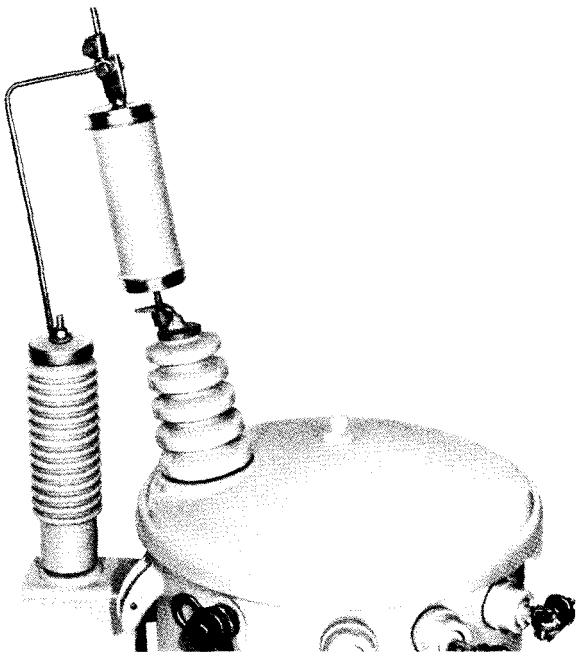
New Information
E, D, C/1971/DB

Type CLTX Power Fuses





Introduction

Increasing load densities and other factors have dictated that the Electric Utility use higher distribution voltages, larger MVA capacity substation transformers, larger conductors for feeders and shorter feeders, all resulting in significantly higher available fault currents throughout the distribution system. These higher fault currents can exceed the interrupting rating of various equipments including fuse cutouts, transformer weak link fuses, and liquid fuses. Furthermore, the maximum power and energy which can be transferred into an arc in a faulted transformer, capacitor, or other types of distribution equipment increases as available fault current increases. Thus higher available fault currents raise the probability of disruptive failure in this type of equipment. To reduce the probability of disruptive failure, it is necessary to reduce the amount of power and energy which can be transferred into the faulted equipment. Since expulsion fuses such as transformer weak links, cutouts, and liquid fuses are essentially zero current clearing devices, they allow at least the first loop of the available fault current to flow unattenuated. Consequently, they cannot reduce the power and sub-cycle energy which can be transferred into faulted equipment, and they can not prevent sub-cycle disruptive failures due to high available fault currents.

The Westinghouse CLTX is an outdoor, partial range, current limiting fuse designed to protect new or existing installations of overhead distribution transformers or capacitor banks from excessively high fault currents by limiting the peak let-thru current and energy (I^2t)

The CLTX, when applied correctly, can significantly reduce the energy (I^2t) available to distribution equipment subjected to high magnitude faults to minimize disruptive transformer and capacitor tank failures, prevent line lockout due to external bushing flashover and improve series coordination of system protective devices.

The CLTX fuse is designed as a back-up type fuse to be used in series with new or existing distribution fuses (distribution fuse cutouts, internal weak link fuses, liquid fuse, or Westinghouse Power fuse type DBS) when applied to protect overhead conventional distribution transformers, CSP transformers, capacitor banks or line sectionalizing.

The economic advantage of using the CLTX as a back-up fuse in series with an expulsion or weak link type fuse is that the majority of faults are of the low magnitude or incipient-type transformer faults, where normally only the low cost expulsion or weak link will melt and clear the fault. Where higher magnitude fault currents are imposed on the system, which can cause a disruptive failure (catastrophic damage), the CLTX fuse will operate to limit the amount of let-thru energy to the protected distribution equipment to low levels.

Benefits

The CLTX fuse offers a unique advantage in its ability to limit the let-thru current/energy within tolerable limits when operating above its threshold current value, and in addition, it operates in a silent nonventing mode. Retrofitting the CLTX fuse to existing installations or installing it on new applications greatly increases the ability of the Electric Utility system to handle high fault current especially on older systems where increased loads are occuring. Using the CLTX energy limiting fuse on a distribution system will provide the user with the following benefits.

1. Better protection for OH Distribution transformers subjected to high internal fault currents by minimizing disruptive tank failures.
2. Less severe damage to distribution equipment on bushing flashover.
3. Closer coordination between expulsion type fuse ratings for improved circuit sectionalizing and performance.
4. Does not necessitate changing fusing practices based upon present usage, loading or coordination requirements.
5. Visual indication of fuse operation when used with standard distribution type cutouts or Westinghouse power fuses type DBS, RDB.
6. Significant reduction in transient recovery voltage limitations associated with expulsion fuses.
7. Improved high current interruption performance without sacrificing superior low current clearing capabilities of standard expulsion type fuse links.
8. Significant reduction in the expulsion of gas and the noise generated by a normal fuse cutout operation.
9. Extended life of cutout holder by reducing let-thru energy.
10. Prevention of line lock-out in bushing flashover.
11. Reduction of replacement cost compared to a general purpose current limiting fuse to achieve the same degree of protection.
12. Retrofittable to existing installations because the CLTX back-up type fuse is generally smaller in size than a general purpose type current limiting fuse.

Operation and Coordination

The CLTX is a back-up type, current limiting fuse with the ability to limit and clear fault currents up to 50 KA RMS. The CLTX must be used in series with an expulsion or liquid type fuse to provide full range protection in the area of low current faults and overloads.

The series expulsion type link or submersible weak link type fuse must be coordinated with the CLTX fuse so that the expulsion fuse will always melt whether the series combination is subject to a low or high current fault. This type of coordination insures that the cutout will always drop open to provide a positive visual indication that a fuse operation has occurred and in addition, provide additional open gap voltage insulation.

The CLTX can be used in series with any type of expulsion or liquid fuse providing proper coordination is observed. At 0.01 seconds on the time-current characteristic curve the minimum melting current of the CLTX fuse should be at least 20% greater than the minimum melting current of the series expulsion fuse link. See Figure 1 for typical coordination curve and Table 1 for the proper coordination between fuse links and the CLTX. Failure to observe this guideline will possibly allow miscoordination to occur which could defeat the purpose of using the CLTX fuse. If miscoordinated, the following could occur:

1. The CLTX could melt and clear before the link melted, thus losing the dropout indication of the cutout.

2. The CLTX could melt on low currents which it is not designed to interrupt.

Normal withstand energy of the transformer must be greater than the let-thru of the back-up CL fuse. The true transformer withstand value is measured in KW. seconds and the commonly accepted value of the measurement of let-thru energy of a current limiting fuse is I^2t or ampere squared seconds. Utilizing a large back-up fuse to reduce stocks or confusion may produce let-thru energies of sufficient magnitude to seriously damage smaller transformer KVA sizes.

Utilizing this type of coordination provides for the low current clearing efficiency of the expulsion link and turns the high fault current clearing duties over to the energy limiting capabilities of the CLTX. This minimizes the replacement costs to the user because the CLTX fuse generally will not respond to transformer secondary faults. Reduced replacement costs are substantiated by the fact that over the years, it has been reported that 70 to 80% of the transformer fuse interruptions have been created by low current fault conditions generated by either an overload condition, external secondary line fault or an internal secondary fault.

Although the CLTX can be used to protect equipment from fault currents as high as 50,000 amperes RMS symmetrical, it is necessary in all applications that the series distribution fuses be capable of interrupting all fault currents up to the level listed in Table 1. For coordination with conventional distribution transformers (not self-protected) and capacitor banks, the utilities normal fusing practice can be followed but in no case should the "T" or "K" link rating of the series expulsion fuse be larger than the corresponding CLTX rating.

For coordination with Westinghouse self-protected distribution transformers (CSP-CP), the transformer KVA rating should not exceed the maximum rating indicated in Table 2. To protect other manufacturers self-protected transformers, the minimum melting time current characteristic curve of the internal submersible link must be coordinated with the CLTX fuse as previously described to determine the maximum transformer KVA rating that can be protected.

Generally, most back-up type current limiting fuses will not clear currents that melt the element in .02 seconds or longer. This reduces the window of coordination to a minimum and enhances the chances of miscoordination which can defeat the purpose of minimizing the probability of catastrophic failures. Miscoordination that causes the cur-

TABLE 1. CLTX-Performance and Coordination Data

Technical Data and Ratings									Maximum Ampere Rating of Required Series Distribution Fuse									Dimensional Data & Style Reference			
		Maximum System KV							Cutout Expulsion Links		● Power Fuse Type DBS		CSP Submersible Weak Link③								
KV Class	CLTX Fuse Rating	Three Phase ①	Phase to Phase ②	Phase to Neutral	I.C. Rms. Amps Sym. KA	Peak Arc Voltage KV ⑦	Let Thru Energy I^2t KA²Sec.	Approx. .01 Sec. Melt Amps	Nema K	Nema T	K Speed	E Speed	● Link	RTE 351-2 Link 355-7 Link OS	RTE 351-2 Link 355-7 Link FS	124090-92 Kearney Dual Element	GE 9F54	Min. Rms. Asym. Amp. I.C. of Series Connected Expulsion Link⑤	Weight in Lbs.	Leakage Distance Inches	Style Number
														④	⑤		A7-B7				
15	15	14.4	14.4	8.3	50	26	13	800	15	10	15	10	7A	C5	C7	15	C7-H7	700	3.5	5.18	151D930G03
																	A9-B9				
15	25	14.4	14.4	8.3	50	26	50	1600	25	15	25	20	8	C8	C10	30	C9-H9	1200	4.0	8.54	151D930G07
																	A11-B11				
15	40	14.4	14.4	8.3	50	26	120	2800	40	25	40	30	9	C10	C16	35	C11-H11	2100	4.5	8.54	151D930G04
																	A7-B7				
25	15	27	27	15.5	50	49	13	800	15	10	15	10	7A	C5	C7	15	C7-H7	700	4.5	8.54	151D930G02
																	A9-B9				
25	25	27	27	15.5	50	49	50	1600	25	15	25	20	8	C8	C10	30	C9-H9	1200	5.5	13.18	151D930G08
																	A11-B11				
25	40	27	27	15.5	50	49	120	2800	40	25	40	30	9	C10	C16	35	C11-H11	2100	6.0	13.18	151D930G05
																	A7-B7				
35	15	40	40	23	50	75	13	800	15	10	15	10	7A	C5	C8	15	C7-H7	700	6.0	13.18	151D930G06

① CLTX can be used with bank connected, single phase, conventional or CSP type transformers if primary windings are wye connected, or conventional or CSP integrally connected in a Delta or wye configuration. Single phase CSP type transformers with primary windings connected in Delta configuration must use phase-to phase voltage rated CLTX fuses.

② CLTX fuses must be connected in each phase.

③ See Table 2 for Westinghouse type CSP transformer KVA ratings. Consult transformer manufacturer for correct weak link TCC and rating before using CLTX fuse.

④ Overload sensing weak link.

⑤ Fault sensing weak link.

⑤ Minimum RMS asymmetrical ampere interrupting current of series connected expulsion link.

⑦ Maximum peak arc voltages. In actual practice generated arc voltages are normally well below these limits.

rent limiting fuse to melt on low currents that take longer than .02 seconds will cause most back-up type current limiting fuses to fail during its clearing operation. The Westinghouse back-up type CLTX fuse is designed to melt and clear all currents that will melt the element in 0.1 seconds or less which considerably increases its coordination capabilities and enhances the CLTX total clearing performance when subjected to low currents.

When the series combination of the CLTX and fuse link operates it is an indication that one of five failure situations has occurred.

1. Primary or secondary fault internal to the transformer.
2. Secondary fault external to the transformer.
3. Primary bushing flashover.
4. Overloaded transformer.
5. Lighting stroke (if arresters on load side of CLTX)

Generally, both the CLTX fuse and expulsion fuse will melt when subjected to a primary fault internal to the transformer or a bushing flashover. For secondary faults, internal or external, and overloads which are most frequent, the expulsion fuse link will melt and clear relieving the CLTX from this duty.

For utilities that require the lineman to refuse and close the cutout to determine if the conventional distribution transformer is in operable condition, it is recommended that one of the following two procedural checks be followed.

1. Replace the back-up current limiting fuse with a new CLTX. If the replacement method is utilized then the replaced CLTX can be checked for continuity and returned to stock or used elsewhere at a later time.
2. Remove the CLTX from service and check for continuity. If the fuse is not open, it can be restored to service.

When the CLTX is used to protect a CSP type transformer the hot lead must be disconnected to remove the CLTX and perform the continuity check. If the CLTX does not have continuity, then the transformer has experienced an internal fault and must be replaced. In all cases, the internal link would have melted making it necessary to replace the CSP transformer. Merely closing the secondary breaker should easily establish whether the transformer should be replaced. An attempt to re-energize the distribution transformer after the CLTX fuse has operated is not recommended, never by-pass the CLTX fuse to test the transformer.

Voltage Rating

CLTX is available in 8.3, 15.5 and 23 KV maximum voltage designs. It can be applied to single-phase transformers, three phase banks of single phase transformers, three phase transformers and three phase delta, grounded wye or ungrounded wye connected capacitor banks. The CLTX is designed and rated for single as well as three phase application. The voltage class used with single phase transformers connected phase-to-ground are also applicable to three phase combinations connected in a grounded wye configuration utilizing either conventional or self-protected, single phase transformers or integrally connected, three phase type. When single phase self-protected transformers are banked with the primary windings connected in delta, it is recommended that a phase-to-phase voltage rated CLTX be used. A phase-to-ground voltage rated CLTX fuse can be used with three phase, integrally connected, self-protected transformers. Where single phase transformers are connected phase-to-phase a CLTX fuse must be connected in each phase and can be phase-to-ground voltage rated.

As previously stated, the CLTX is a back-up fuse designed to be used in conjunction with a low fault current protective device. This low fault current protective device, normally a protective link is used to withstand recovery voltage after the link and CLTX has operated. In the event that the low current protective device should fail to operate or is refused, the CLTX is able to withstand a recovery voltage equal to its maximum design voltage for a minimum of several days due to the exclusive weather seal system.

When applying the CLTX to either the source or load side of the distribution fuse, normal system clearances must be maintained between phases and between energized parts and ground.

Table 2. Maximum Westinghouse Self-Protected Transformer ① Rating Selection Chart ④

Maximum KV Rating	Transformer Rating, KV			CLTX ⑥ Rating	Max. Transf. Rating, KVA ④		
	Single-Phase		Three-Phase ③		Single-Phase		Three-Phase ③
	Phase-Neutral	Phase-Phase ②			Phase-Neutral	Phase-Phase	
8.3 (15 KV Class)	6.9	12	12	15K/10T 25K/15T 40K/25T	50 75 100	100 100 ⑥ 100 ⑥	75 112½ 150
	7.2		12.47	15K/10T 25K/15T 40K/25T	50 75 100	100 100 ⑥ 100 ⑥	75 112½ 150
	7.62	13.2	13.2	15K/10T 25K/15T 40K/25T	50 75 100	100 100 ⑥ 100 ⑥	75 112½ 150
	7.96	13.8	13.8	15K/10T 25K/15T 40K/25T	50 75 100	100 100 ⑥ 100 ⑥	75 112½ 150
	8.32	14.4	14.4	15K/10T 25K/15T 40K/25T	50 75 100	100 100 ⑥ 100 ⑥	75 112½ 150
15.5 (25 KV Class)	12		20.8	15K/10T 25K/15T 40K/25T	100 100 ⑥ 100 ⑥		
	13.2	22.9	22.9	15K/10T 25K/15T 40K/25T	100 100 ⑥ 100 ⑥		
	13.8	23.9	23.9	15K/10T 25K/15T 40K/25T	100 100 ⑥ 100 ⑥		⑥
	14.4	24.9	24.9	15K/10T 25K/15T 40K/25T	100 100 ⑥ 100 ⑥		
	15		26	15K/10T 25K/15T 40K/25T	100 100 ⑥ 100 ⑥		
23 (35 KV Class)	19.92		34.5	15K/10T	100 ⑥		

① Transformer having an internal fuse and secondary breaker either with or without surge arresters.

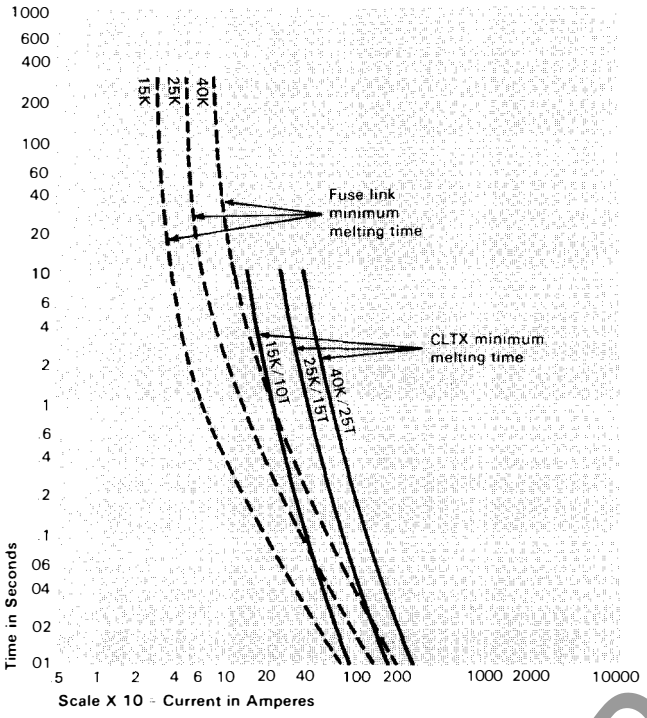
② When single phase transformers are connected phase-to-phase, a CLTX must be used in each phase. Single phase CSP transformers connected in Delta configurations must use phase-to-phase voltage rated CLTX fuses.

③ Applies to integrally connected three phase transformers only.

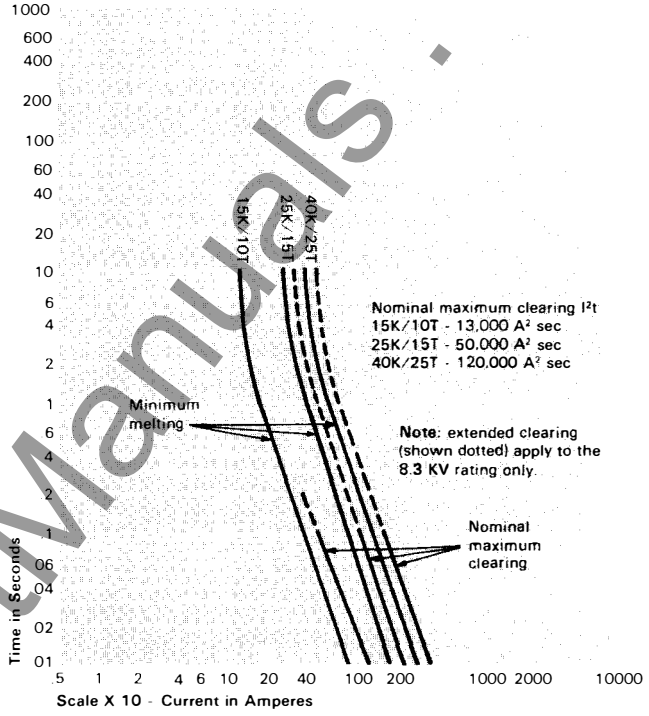
④ Ratings based on use of Westinghouse #7A or smaller weak link for 15K/10T CLTX #8 or smaller for 25K/15T CLTX and #9 or smaller weak link for 40K/25T CLTX, in self-protected transformer.

⑥ The surge arrester, if any, should be connected to the source side of CLTX.

⑥ Maximum KVA rating limited by secondary breaker and/or internal link rating availability.



Minimum Melting Time-Current Characteristic Curves for CLTX Fuses Rated 8.3/15.5 KV., 15K/10T, 25K/15T and 40K/25T; 23 KV. 15K/10T with Corresponding Maximum K Rated Expulsion Link.



Minimum Melting and Total Clearing Time-Current Characteristic Curves for CLTX Fuses Rated 8.3/15.5 KV., 15K/10T, 25K/15T and 40K/25T; 23 KV. 15K/10T

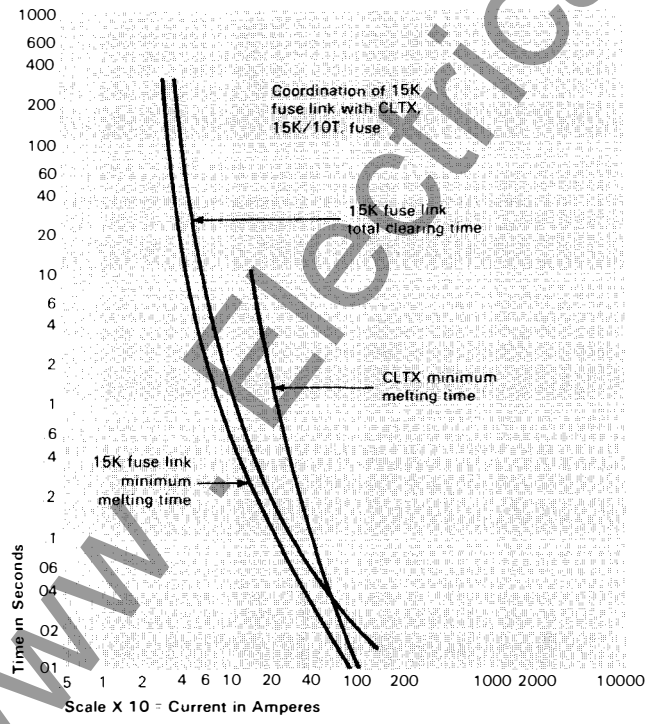
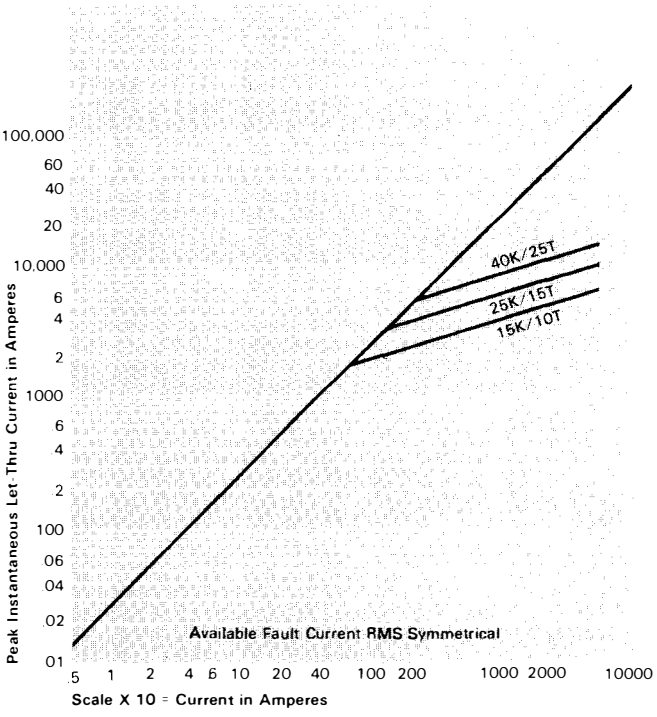
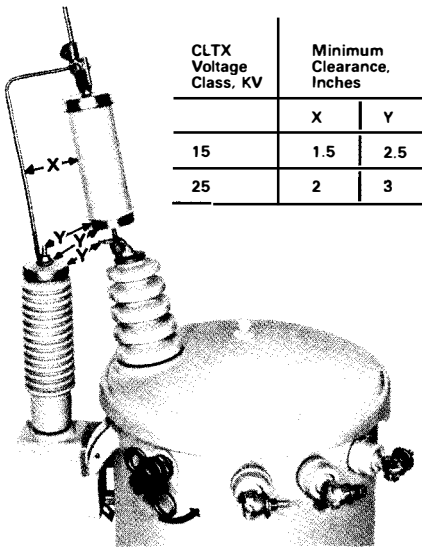


Figure 1 Example of Recommendation Coordination Between CLTX and Series Expulsion Link.



Let-Thru Current Characteristic Curves for CLTX Fuses Rated 8.3/15.5 KV., 15K/10T, 25K/15T and 40K/25T, 23 KV. 15K/10T

Peak Arc Voltage and Arrester Coordination



CLTX Voltage Class, KV	Minimum Clearance, Inches	
	X	Y
15	1.5	2.5
25	2	3

Figure 2. CLTX mounted on self-protected overhead distribution transformer

The peak arc voltage that is generated by the current limiting fuse during a high current interruption forces the current to zero before the first natural current zero occurs. This generated peak arc voltage may create some concern when applying a current limiting fuse in conjunction with surge arresters. Since the CLTX fuse utilizes a punched ribbon element, the peak arc voltage generated by each fuse size is dependent on the system voltage on which the fuse is applied. As a rule of thumb, the maximum peak voltage will not exceed 3 times the applied system RMS voltage plus 1000 volts. The CLTX is designed to comply with ANSI. Standard C37.40 thru 48 which limits the peak arc voltage to 26, 49 and 75 KV for fuse maximum applied voltage ratings of 8.3, 15.5 and 23 KV, respectively. When properly applied, the CLTX fuse will not sparkover surge arresters. If the arrester is located on the load side of the CLTX, the lightning impulse strike may or may not melt the fuse depending on the arrester performance and the energy of the stroke. Therefore, it is recommended practice to locate the arrester on the line or source side of the CLTX fuse.

When using the CLTX to protect a self-protected overhead distribution transformer with a tank mounted surge arrester, Figure 2 indicates the clearances necessary to reconnect the surge arrester to the source side of the CLTX.

Installation and Mounting

The CLTX fuse can be mounted in several different ways:

1. Conventional transformer with fused cutout. The usual method of mounting is to attach the CLTX to either the source side or the load side of the distribution fuse. The fuse can be attached to the cutout source side (break jaw end) in a vertical upright position as illustrated in Figure 3. Where overhead clearance is at a premium, the CLTX can be mounted in a horizontal position extending from either side of the distribution fuse mounting providing the connector will accommodate the CLTX fuse and the connector is keyed to prevent fuse rotation.

When attaching the CLTX to the load end of the distribution fuse mounting, the CLTX can be mounted in an offset straight down to the rear or horizontally, extending to either side of the mounting. Again, the connector must be keyed to prevent rotation of the fuse. See Figure 4. When the CLTX is mounted at the load end of a distribution fuse, the connecting conductor to the transformer and the CLTX fuse must be routed clear of the exhaust path of the distribution fuse cutout. In addition, the exhaust path and byproducts of interruption must not be directed over the CLTX fuse.

2. When protecting self-protected distribution transformers (CSP), the CLTX can be connected directly to the high voltage bushing terminal connector per Figure 2.

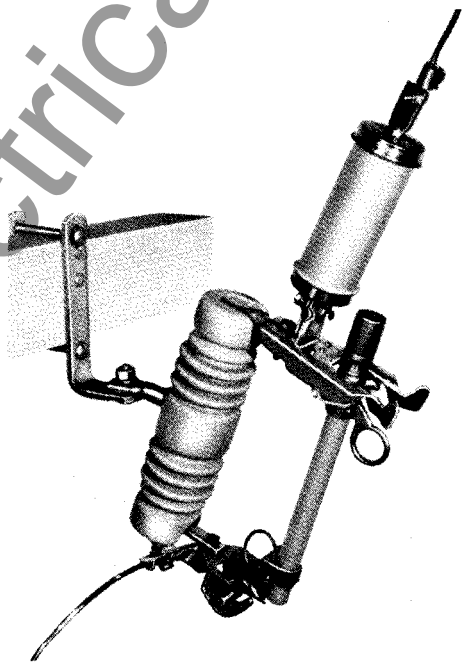


Figure 3. CLTX vertically mounted on source side of cutout

3. The CLTX can also be suspended from the high voltage lead by connecting a short cable lead to the stud using a companion-type splicing sleeve or suitable parallel groove clamp. The opposite end of the short conductor can then be connected to the hot line clamp which in turn is connected to a bail clamp attached to the main line. The spade end of the fuse is then connected to the cutout or transformer bushing by the drop line conductor.

4. When mounting the CLTX to a double vented cutout, there is no need to replace the expendable cap when using the 15K rating CLTX fuse. For larger sizes, the expendable cap must be replaced with a solid cap when the CLTX is mounted on the source side of the double vented cutout. This will prevent flashover of the CLTX by eliminating the venting of conductive gas from the top of the cutout. When modifying the cutout to a single from a double vented device, the cutout must still be capable of interrupting all faults up through the current values listed in Table 1.

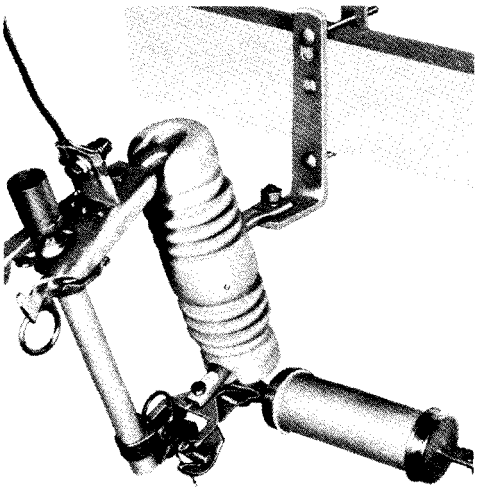


Figure 4. CLTX mounted on load side of cutout

Mechanical Strength

The following average values have been tested on the CLTX fuse:

1. Torque: 250 inch-pounds
2. Tensile: 2600 pounds
3. Cantilever: 175 inch-pounds

Weatherseal System

A breakthrough in outdoor coating technology has made possible a new line of Westinghouse outdoor fuses which can remain electrically stressed after operation. This significant advance in protective coatings for fuses was made possible by a unique Westinghouse patented epoxy resin system. Extensive outdoor and accelerated life testing has proven the superiority of this protective system for fuses.

Pioneer work in the use of epoxy resin systems as outdoor electrical insulation was started in Europe over 20 years ago. Shortly afterwards U.S. electrical manufacturers and the military started studies on outdoor exposure of epoxy resin systems. The general attitude was a conservative approach with much testing and evaluation of various formulations. Westinghouse R&D was an early pioneer in evaluating and testing epoxy compositions simultaneously outdoors and under high voltage stress. Eight outdoor test stations were established throughout the country to obtain a variety of climatic and contamination conditions. With the advent of the cycloaliphatic epoxies weathering characteristics of epoxy resin systems improved markedly. The compositions made from this epoxy resin have been the basis of the outdoor coatings for fuses. With these compositions it became possible to design a weather resistant fuse which would, with a very high degree of realibility, resist the effects of outdoor weathering.

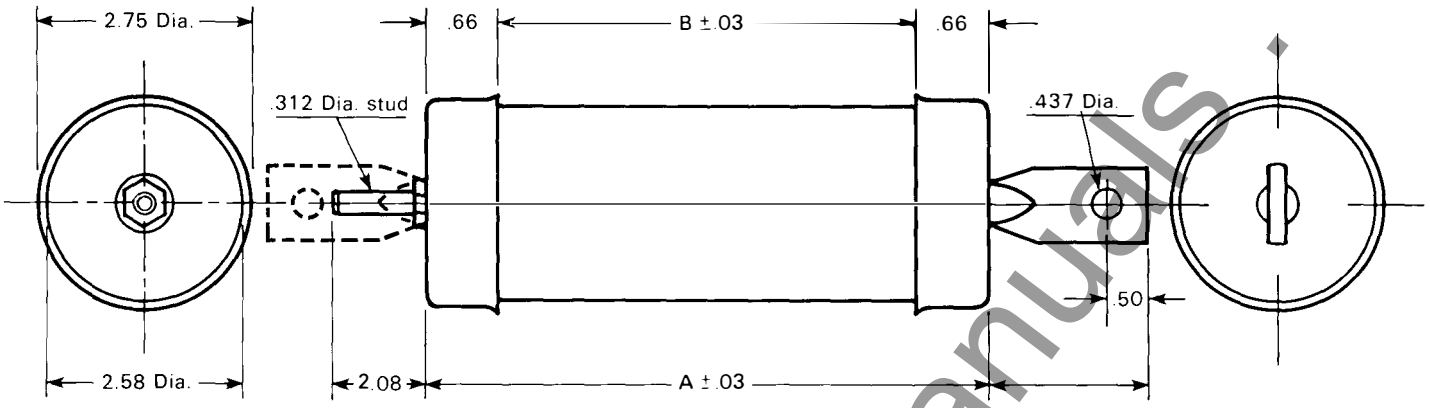
The following tests have been performed to verify the reliability of the coating.

1. Cycloaliphatic epoxy resin compositions are still in good condition after 10 years in the outdoor test rack with continuous voltage stress applied.

2. Simulated outdoor weathering has been conducted on this coating in the Weatherometer per ASTM D1499. The Weatherometer not only exposes the sample to intense UV radiation but periodically applies a water spray. After exposure equivalent to five years the fuse coating showed no significant signs of degradation. Coatings made from this same epoxy resin system show only a ten percent loss in thickness after a weatherometer exposure equivalent to ten years.

3. A salt-fog chamber, which affords a convenient way of comparing materials and is an accelerated outdoor life test, was used in our evaluation. The test indicated a probable life **under voltage stress** of more than 12 years.

These tests along with many others made during the development program indicate the fuse coating has a long outdoor life under high voltage stresses. Under normal conditions the fuse is unstressed and an even longer life is predicted.



Specification Data – Dimensions, Weights and Terminal Connectors

Dimensions In Inches

Maximum KV Rating	Maximum NEMA Expulsion Link Rating	Westinghouse Style Number	Ramad Number ①	Approx. Weight in Lbs.	Dimensions A	B
Fuse – Spade to Stud Type						
	15K/10T	151D930G03	48524	8.5	6.50	5.18
8.3 (15KV Class)	25K/15T	151D930G07	57725	4.0	9.86	8.54
	40K/25T	151D930G04	48419	4.5	9.86	8.54
	15K/10T	151D930G02	48523	4.5	9.86	8.54
15.5 (25KV Class)	25K/15T	151D930G08	70448	5.25	14.5	13.18
	40K/25T	151D930G05	48420	6.0	14.5	13.18
23 (35KV Class)	15K/10T	151D930G06	48421	6.0	14.5	13.18
Fuse – Spade to Spade Type						
	15K/10T	6911D50G03	57705	3.5	6.50	5.18
8.3 (15KV Class)	25K/15T	6911D50G07	57721	4.0	9.86	8.54
	40K/25T	6911D50G04	57714	4.5	9.86	8.54
	15K/10T	6911D50G02	57704	4.5	9.86	8.54
15.5 (25KV Class)	25K/15T	6911D50G08	57724	5.25	14.5	13.18
	40K/25T	6911D50G05	57719	6.0	14.5	13.18
23 (35KV Class)	15K/10T	6911D50G06	57720	6.0	14.5	13.18

Cable Connectors

Type	Style Number	Cable Size	Ramad ②
Parallel Groove Clamp Tin Plated Aluminum	507B242H02	#8 thru 2/0	57679
Single Eye-Bolt Bronze Unplated	665A500G04	#8 thru 2/0	48275

① Order CLTX from W-16 warehouse
② Order connectors from W-89 warehouse

Terminal Connections

The standard terminal is a 5/16 inch diameter copper-bronze stud terminal at one end and a spade type terminal at opposite end. Spade type terminals are suitable for 3/8 inch single bolt type connectors. All terminations are tin plated to accept aluminum connectors. Cable connectors are available as indicated.

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