Elpro

Surge Protection Specialists

DISTRIBUTION CLASS
Surge Arrester

- **Excellent protective characteristics**
- **High Durability**
- **Excellent Temporary Overvoltage Capabilities**
- **Designed & tested in accordance with IEC 99-4 and ANSI-IEEE C62.11**

GENERAL

The performance and reliability of today's electric power systems can be enhanced with the unique characteristics of Elpro Surge Arresters Starting with the state-of-the-art world class Zinc Oxide Disc technology all the way through the ISO 9001-2000 quality system approved design assemble & test processes, ELPRO offers extremely reliable arrester products. Product & power systems. Engineers work closely to optimise product performance on the system. This tradition has made Elpro one of the world's leading manufacturer & suppliers of metal oxide arresters and speciality zinc oxide discs.

The Elpro arrester provides both excellent protective characteristics and temporary overvoltage capability the gapless construction provides a design which is simple & reliable while remaining economical.

Elpro arresters are designed to meet the most demanding service conditions.

Elpro Distribution Class arresters are designed and tested in accordance with ANSI/IEEE C62.11 and IEC 99-4. The standard Elpro arrester consists of a stack of metal oxide discs housed in sealed porcelain housing. On the end faces of each disc, a conducting surface is applied to assure proper contact and uniform current distribution.

Elpro arresters provide exceptional dynamic & transient overvoltage protection of major power system equipment under normal system conditions, the arrester conducts less than one milliampere. During dynamic transient overvoltage the arrester conducts only the current necessary to limit the overvoltage. As a result, Elpro arresters absorb minimum energy to protect equipment insulation.

Metal Oxide Disks

MODs are composed of a specially formulated compound of zinc oxide and small amounts of other selected metal oxides. These ingredients are mixed in powdered form, pressed to form a disc and fired at high temperatures under specific temperature profile resulting in a dense polycrystalline ceramic. The basic molecular structure is a matrix of highly conductive ZINC OXIDE grains surrounded by resistive intergranular layers of metal oxide elements. Under electrical stress the intergranular layers conduct resulting in a highly non linear characteristic. For example, change of Arrester current of 0.001A to 10000 A results in a voltage change of only 54%

Metal oxide element in Elpro arresters maintain stable characteristics. Accelerated life tests show drooping characteristics during an arresters service life when exposed to a continuous steady-state voltage. Stable metal oxide characteristics enable Elpro Arresters to maintain their low protective characteristics. As a result equipment protection is never compromised.

DISC COLLARING

The collaring systems used on Elpro zinc oxide discs, has a dual purpose:

(1) to provide an insulating collar to prevent flashover at high currents.
(2) To prevent the disc watts from increasing during aging from surface oxygen reduction.

The Elpro high dielectric insulating collar system is a non porous crystalline that completely seals the circumference of the disc preventing any oxygen depletion from the zinc oxide grains. This system ensures the zinc oxide disc will have a stable aging characteristic in any surrounding atmosphere: gas, liquid or solid. Many collar systems can provide the insulation withstand to prevent flashover at high currents but only a non porous inorganic material can ensure long-term stable aging characteristics.

ARRESTER TESTING

DURABILITY TESTS & QUALITY ASSURANCE

Elpro arresters comply with the design tests outlined in ANSI/IEEE C62.11 and IEC 99-4. they exceed the requirements for the duty –cycle test, high current short duration test, and the low-current long duration test (transmission line discharge test) with no loss in protective capability.

The ANSI/IEEE duty-cycle test and IEC operating duty test verify that Elpro arresters can dissipate lightning discharge while operating at rated voltage, and thermally recover at maximum continuous operating voltage (MCOV) at 60^{o}C which is an elevated temperature. In other words, the arrester can self cool under applied voltage after absorbing transient energy.

Gapless construction and a special shed design provide excellent contamination performance exceeding ANSI/IEEE contamination test requirements. Factory tests are performed on each metal oxide disc. Long term stability tests are conducted on each and optimised. A disc strength test series, consisting of multiple transmission-line discharges is performed to make certain that the disc has full energy capability.

The objective of arrester application is to select the lowest rated surge arrester that will have a satisfactory service life on the power system while providing adequate protection of equipment insulation. An arrester of the minimum practical rating is generally preferred because it provides the highest margin of protection for the insulation.

Table 1A & 1B lists arrester ratings that would normally be applied on systems of various line-to-line voltages. The rating of the arrester is defined as the rms voltage at which the arrester passes the duty-cycle test as defined by the referenced standard. To decide which rating is most appropriate for a particular application, consideration must be given to the following systems.

The use of a higher rating increases the capability of the arrester to survive on the power systems, but reduces the margin of protection it provides for a specific insulation level. Thus arrester selection must strike a balance between arrester survival and equipment protection.

Stresses to which the arrester will be exposed:

- Continuous system voltage
- Temporary overvoltages
- Lightning surges

The arrester selected must have sufficient capability to meet the anticipated service requirement in all categories.

Table 1 A

- Nominal Discharge current: 4kAP
- Reference current: 1 mAP
- High current impulse withstand (4/10 µ sec): 65 kAP
- Long duration current impulse withstand as per IEC 99-4
- Energy dissipation capability 0.9 kJ/kV of rated voltage
- Watt loss 0.10 W/kV rating

<table>
<tr><th></th><th></th><th></th><th></th><th colspan="4">Discharge Voltage Characteristics (kVP)</th><th colspan="3">Temporary Overvoltage Characteristics (kVrms)</th><th rowspan="2">Creepage Distance</th><th colspan="2">Insulation Withstand of Housing</th></tr>
<tr><th>Max System Voltage</th><th>Rated Voltage</th><th>MCOV</th><th>Ref. voltage</th><th colspan="3">Lightning Impulse 8/20 µ sec wave</th><th rowspan="2">Steep Current 1/2 µ sec at NDC</th><th rowspan="2">0.1 sec</th><th rowspan="2">1 sec</th><th rowspan="2">10 sec</th><th>Wet Power Frequency withstand Voltage (1min)</th><th>Dry Lightning Impulse Withstand Voltage</th></tr>
<tr><th>(kVrms)</th><th>(kVrms)</th><th>(kVrms)</th><th>(kVrms)</th><th>2.5kA</th><th>5 kA</th><th>10 kA</th><th>(mm)</th><th>kVrms</th><th>kVP</th></tr>
<tr><td>4.16</td><td>3</td><td>2.55</td><td>3</td><td>11.5</td><td>12</td><td>13.5</td><td>13</td><td>3.7</td><td>3.5</td><td>3.4</td><td rowspan="4">300</td><td rowspan="4">28</td><td rowspan="4">75</td></tr>
<tr><td>6.9</td><td>6</td><td>5.1</td><td>6</td><td>22.5</td><td>24</td><td>26.5</td><td>26</td><td>7.4</td><td>7.1</td><td>6.8</td></tr>
<tr><td>12.47</td><td>9</td><td>7.65</td><td>9</td><td>28</td><td>30</td><td>33.5</td><td>32.5</td><td>11</td><td>10.6</td><td>10.1</td></tr>
<tr><td rowspan="2">13.2, 13.8</td><td>12</td><td>10.2</td><td>12</td><td>36.5</td><td>39</td><td>43</td><td>42</td><td>14.7</td><td>14.1</td><td>13.5</td></tr>
<tr><td>15</td><td>12.7</td><td>15</td><td>43.5</td><td>46.5</td><td>51.5</td><td>50</td><td>18.4</td><td>17.7</td><td>16.9</td><td rowspan="4">600</td><td rowspan="4">50</td><td rowspan="4">125</td></tr>
<tr><td rowspan="3">23, 24, 94</td><td>18</td><td>15.3</td><td>18</td><td>53.5</td><td>57</td><td>63</td><td>61.5</td><td>22.1</td><td>21.2</td><td>20.3</td></tr>
<tr><td>21</td><td>17</td><td>21</td><td>63</td><td>67</td><td>74</td><td>72</td><td>25.8</td><td>24.7</td><td>23.7</td></tr>
<tr><td>24</td><td>19.5</td><td>24</td><td>70.5</td><td>75</td><td>83</td><td>81</td><td>29.4</td><td>28.2</td><td>27</td></tr>
<tr><td rowspan="2">34.5</td><td>27</td><td>22</td><td>27</td><td>79</td><td>84</td><td>93</td><td>90.5</td><td>33.2</td><td>31.8</td><td>30.4</td><td rowspan="3">900</td><td rowspan="3">70</td><td rowspan="3">170</td></tr>
<tr><td>30</td><td>24.4</td><td>30</td><td>84.5</td><td>90</td><td>99.5</td><td>97</td><td>36.8</td><td>35.3</td><td>33.8</td></tr>
<tr><td>36</td><td>36</td><td>29</td><td>36</td><td>101</td><td>108</td><td>119</td><td>116</td><td>43.5</td><td>41.8</td><td>40</td></tr>
</table>

Note: 1. The above specifications conform to IEC 99-4 standard.
2. Special Voltage ratings available on request.

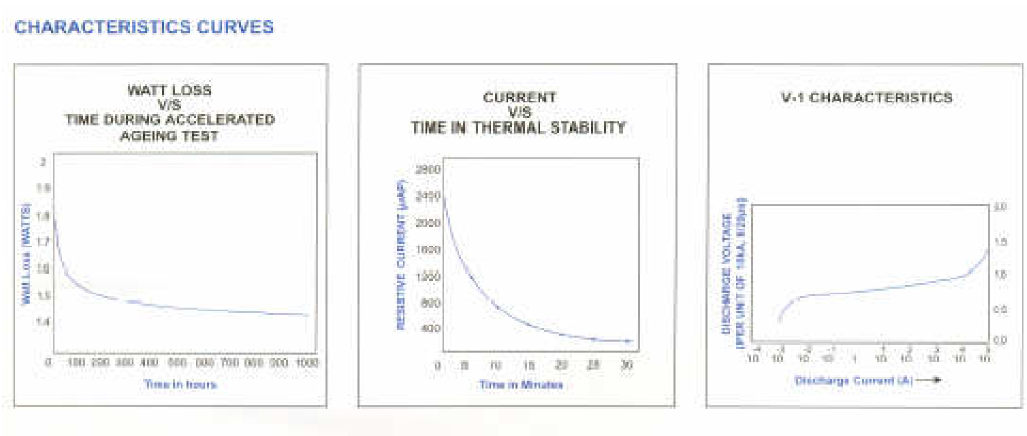
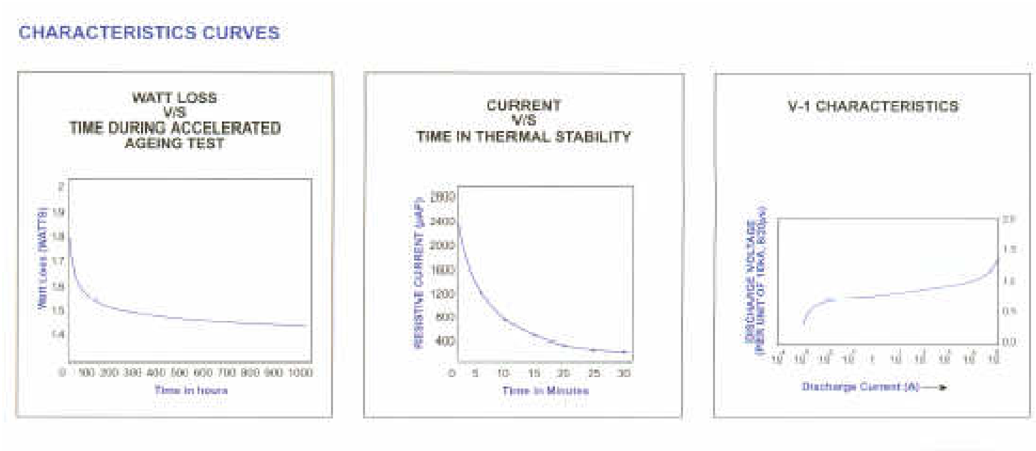


Table 1 B

- Nominal Discharge current: 10kAP
- Reference current: 1.5 mAP.
- High current impulse withstand (4/10 µ sec): 100 kAP.
- Long duration current impulse withstand as per IEC 99-4.
- Energy dissipation capability 1.0 kJ/kV of rated voltage.
- Watt loss 0.10 W/kV rating.

				Discharge Voltage Characteristics (kVP)				Temporary Overvoltage Charcteristics (kVrms)			Creepage Distance	Insulation Withstand of Housing	
Max System Voltage	Rated Voltage	MCOV	Ref. voltage	Lightning Impulse 8/20 µ sec wave			Steep Current 1/2 µ sec at NDC	0.1 sec	1 sec	10 sec		Wet Power Frequency wihtstand Voltage (1min)	Dry Lightning Impluse Withstand Voltage
(kVrms)	(kVrms)	(kVrms)	(kVrms)	5kA	10 kA	20 kA					(mm)	kVrms	kVP
4.16	3	2.55	3	10.5	11	12	12.5	3.7	3.5	3.4	300	28	75
6.9	6	5.1	6	21	22	24	24.5	7.4	7.1	6.8			
12.47	9	7.65	9	29	30	33.5	35	11	11	10.1			
13.2, 13.8	12	10.2	12	37	40	45	47	14.7	14	13.5			
	15	12.7	15	45	48	53	58	18.4	18	16.9	600	50	125
23, 24, 94	18	15.3	18	53	56	62	70.5	22.1	21	20.3			
	21	17	21	60	63	69	73	25.8	25	23.7			
	24	19.5	24	67	71	78	85	29.4	28	27			
34.5	27	22	27	75	79	87	92	33.2	32	30.4	900	70	170
	30	24.4	30	84.5	90	99.5	97	36.8	35	33.8			
36	36	29	36	98	104	115	128	43.5	42	40			

Note: 1. The above specifications conform to IEC 99-4 standard.
2. Special Voltage ratings available on request.



CONTINUOUS SYSTEM VOLTAGE

Arresters in service are continuously exposed to system operating voltage. For each arrester rating there is a recommended limit to the magnitude of voltage which may be continuously applied. This has been termed the Maximum Continuous Operating Voltage (MCOV) of the arrester. The MCOV of each Elpro arrester is contained in Table 1A & 1B. These values meet or exceed those values contained in the referenced standard. The arrester rating must be selected such that the maximum continuous power system voltage applied to the arrester is less than, or equal to the arresters continuous voltage capability. Attention must be given to both the circuit connection (single phase, wye or delta) and the arrester connection (line-to-ground, line-to-line). In most cases the arrester is connected line-to-ground and therefore must withstand line-to-ground system operating voltage. If an arrester is to be connected line-to-line, phase-to-phase voltage must be considered. In addition, attention should be given to an arrester application on the delta tertiary winding of a transformer where one corner of the data is permanently grounded. In such circuits, the normal voltage continuously applied to the arrester will be the full phase-to-phase voltage even though the arresters are connected line-to-ground.

TEMPORARY OVERVOLTAGES

Temporary overvoltages (TOV) can be caused by a number of system events such as lien to ground faults, circuits backfeeding, load rejection and ferroresonance. The system configuration and operating practices should be reviewed to identity the most probable forms of temporary overvoltages, which may occur at the arrester location. The arrester temporary overvoltage capability must meet or exceed the expected temporary overvoltages.

If detailed transient system studies or calculations are not available, it is traditional to consider as a minimum, the overvoltages due to single line-to-ground faults. The arrester application standard ANSI-C62.22 gives some guidance in determining the magnitude of single –line-to-ground fault overvoltages. These overvoltages depend on details of systems grounding.

The primary effect of temporary overvoltages on metal oxide arresters is increased current & power dissipation, and a rising arrester temperature. Table 1A & 1B shows the temporary overvoltage capability of all Elpro arrester , designs. This table defines the duration and magnitude of temporary overvoltages that may be applied to the arrester before the arrester voltage must be reduced to the arresters continuous operating voltage.

ARRESTER SERVICE CONDITIONS & OTHER CONSIDERATIONS

ARRESTER CONTAMINATION

Elpro arresters are built in to exceed the contamination test out lines in ANSI/IEE C62.11. these tests have shown that Elpro arresters have outstanding capability to withstand the effects of very severe external contamination. In applications where severe contamination is anticipated and extra leakage (creepage) distance is required for other station installation, the arrester leakage distance should be reviewed and arrester connected line-to-ground needs to have a leakage distance no greater that that required for the other line-to-ground insulation in the station. Extra leakage distance arrester housings are available. Manual hot washing of Elpro Arrester with a single stream of pressurized, deionised water is permissible, provided electric utility industry accepted safety precautions are observed.

AMBIENT TEMPERATURE

Ambient temperature is an important consideration in an application of metal oxide arresters. metal oxide materials exhibit a temperature dependent loss characteristic; the higher the ambient temperature, the higher will be the disc temperature when the arrester is operated at it continuous voltage capability. The reference standard indicate that the ambient temperature not exceeding 40oC is the standard service condition for arresters. Elpro Arrester are designed to operate at a weighted average temperature of 45oC with excursion to 60oC

ALTITUDE

Elpro arresters are designed for altitudes not exceeding 600 feet (1800 m) above sea level. For higher altitude applications, extra clearances arching distance may be required in the design of the arrester housing. In general, the insulation design of the substation will dictate the arrester clearances. For ach 300 ft (100 m) above a 6000 ft (1800 m) altitude, arrester clearances should increase approximately 1%.

MOUNTING CONSIDERATIONS

Elpro Distribution class arrester are for pole mounting in a vertical position. However, units for other mounting arrangements are available on request. Kindly contact us for mounting arrangement other than vertical position.

In the installation of arresters, recommended clearances between the arrester and any adjacent equipment must be observed. Failure to do so may result in unwanted flashovers and electrical over stress to internal arrester elements.

Elpro arresters are designed to have a uniform voltage gradient along the length of the porcelain column clearly if the arrester were mounted adjacent to a ground plane, this uniformity would be disturbed to avoid such a situation the minimum clearances to ground planes and other phase conductors must be observed.

ARRESTER SELECTION SUMMARY

The arrester selection process should include a review of all system stresses and service conditions expected at the arrester location. System stresses include continuous operating voltage, temporary overvoltages, and lightning surges. If arresters of different ratings are required to meet these individual criteria, the highest resulting rating must be chosen.

SHIPPING DETAILS & DIMENSIONS

TABLE 2A

5 kA Distribution Class Without Disconnector								
Arrester Rating (Ur)	Arrester Dimensions in mm (A)	Arrester Weight * kg		Shipping Dimensions in mm			Shipping Weigth inclusive of accessories as and when applicable (kg)	Qty Packed
		NEEMA Bracket	Standard Bracket	l	b	h	(with NEEMA Bracket)	Nos.
3, 6, 9 , 10, 12	350	3.8	2.8	1118	1092	500	233	42
15, 18, 21, 24	500	6	5	1118	1092	662	339	42
27, 30, 33, 36	625	7.7	6.7	1118	1092	780	422	42
10KA Distribution Class with Disconnector								
3, 6, 9 , 10, 12	385	3.9	2.9	1118	1092	572	251	42
15, 18, 21, 24	535	6.95	5.95	1118	1092	787	402	42
27, 30, 33, 36	660	9.55	8.55	1118	1092	900	479	42

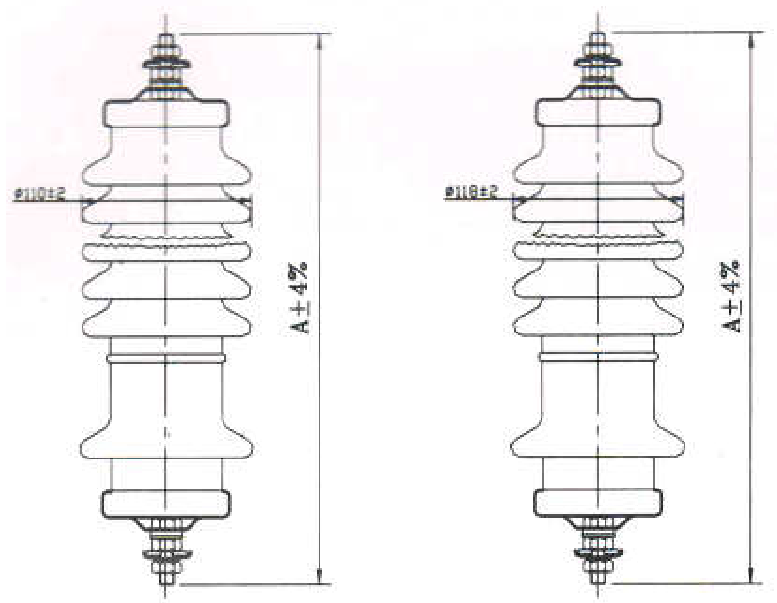
TABLE 2B

10 kA Distribution Class Without Disconnector								
Arrester Rating (Ur)	Arrester Dimensions in mm (A)	Arrester Weight * kg		Shipping Dimensions in mm			Shipping Weigth inclusive of accessories as and when applicable (kg)	Qty Packed
		NEEMA Bracket	Standard Bracket	l	b	h	(with NEEMA Bracket)	Nos.
3, 6, 9 , 10, 12	350	3.9	2.9	1118	1092	500	235	42
15, 18, 21, 24	500	6.2	5.2	1118	1092	662	351	42
27, 30, 33, 36	625	7.9	6.9	1118	1092	780	436	42
10KA Distribution Class with Disconnector								
3, 6, 9 , 10, 12	385	5.12	4.12	1143	1092	572	308	42
15, 18, 21, 24	535	7.5	6.5	1143	1092	787	429	42
27, 30, 33, 36	660	9.7	8.7	1143	1092	900	485	42

Outline Dimensional Details

DISTRIBUTION. CLASS SURGE ARRESTER
WITH DISCONNECTOR

FOR 5 kA | FOR 10 kA

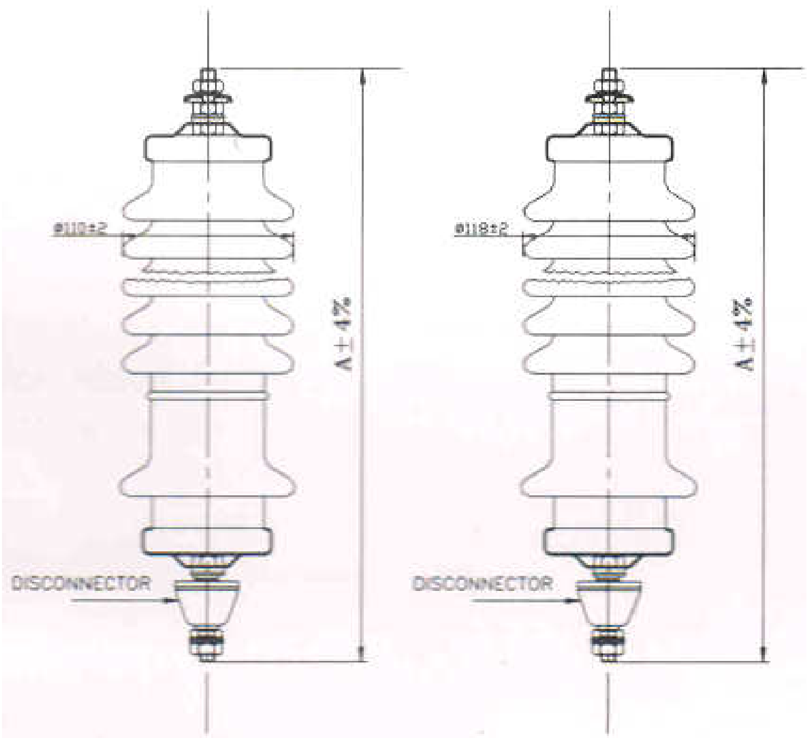


DISTRIBUTION. CLASS S.A. TABLE

kV RATING	HEIGHT 'A' 5 KA	HEIGHT 'A' 10 KA
3-12 kV	350	350
15-24 kV	500	500
27-36 kV	625	625

DISTRIBUTION. CLASS SURGE ARRESTER
WITH DISCONNECTOR

FOR 5 kA FOR 10 kA

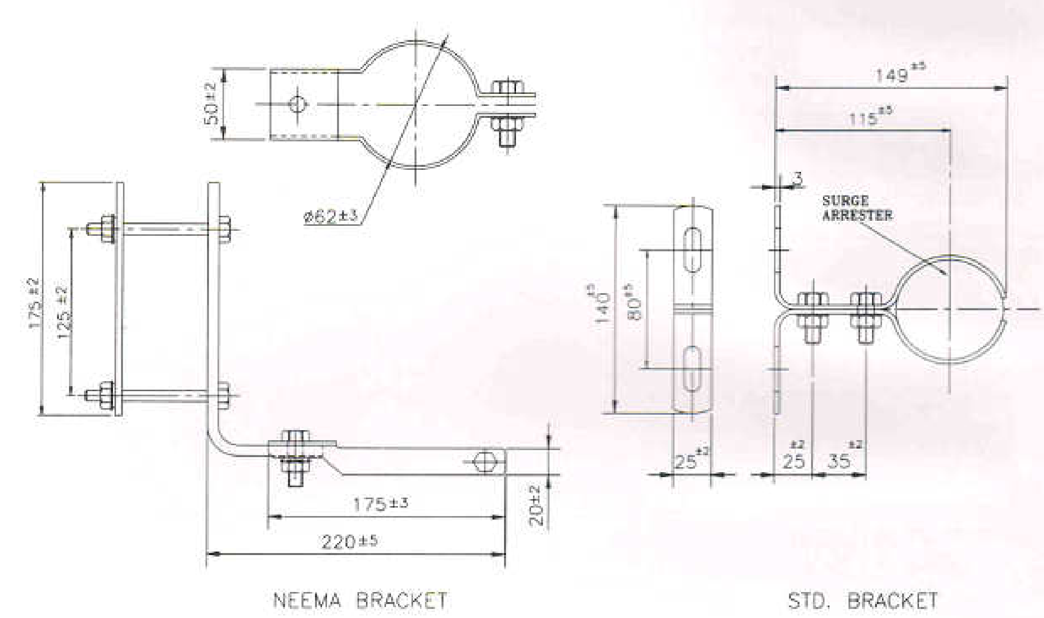


DISTRIBUTION. CLASS S.A. TABLE

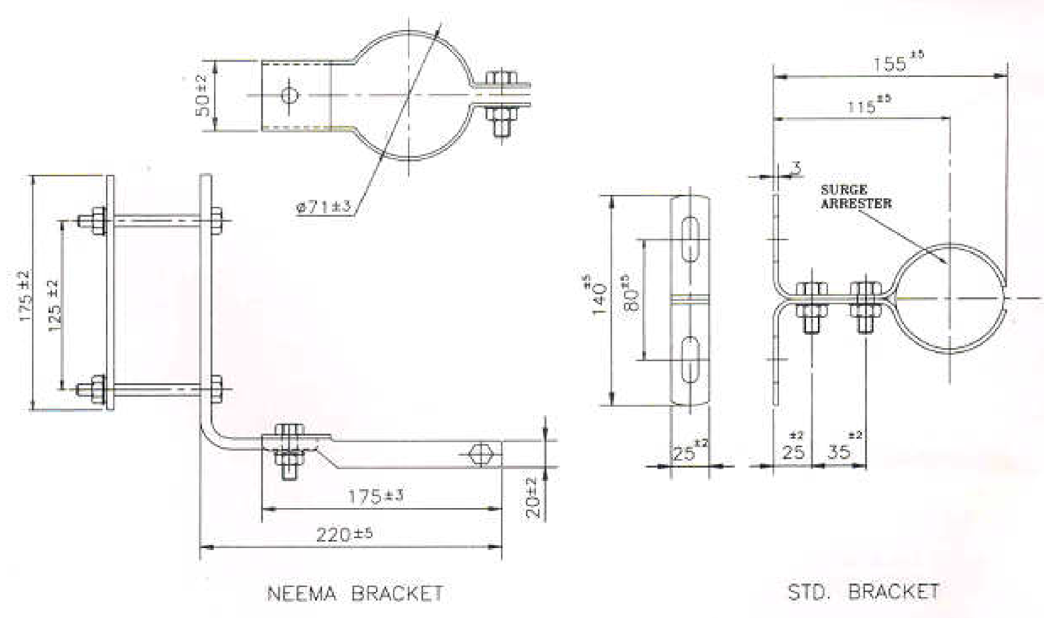
kV RATING	HEIGHT "A" 5 KA	HEIGHT "A" 10 KA
3-12 kV	385	385
15-24 kV	535	535
27-36 kV	660	660

Mounting Arrangement for Elpro Distribution Class Arrester

MOUNTING ARRANGEMENT FOR ELPRO DISTRIBUTION CLASS ARRESTER (FOR 5 kAp NDC)



MOUNTING ARRANGEMENT FOR ELPRO DISTRIBUTION CLASS ARRESTER (FOR 10 kAp NDC)



INSULATION CO-ORDINATION

Once an arrester has been selected, the protection it provides to the equipment insulation can be determined. This protection is dependent on the protective characteristics of the arrester , the lightning and switching surges expected on the system, and the insulation characteristics of the protected equipment. It is quantified in terms of the protective ration which is the ratio of the equipment insulation withstand to the arrester protective level. The objective is to meet or exceed minimum protective ratios for the various classes of voltage surges as recommended in the application standards. An alternate measure is the percent protective margin which is the protective ration minus one, times 100%. For example, a protective ration of 1.53 corresponds to a 53% protective margin.

ARRESTER PROTECTIVE CHARACTERISTICS

The protective characteristic of Elpro arresters is solely defined by the discharge voltage and is generally proportional to arrester MCOV. For any one arrester, the discharge voltage and is generally proportional to arrester MCOV. For nay one arrester, the discharge voltage is a function of the magnitude of the arrester current and, in the impulse region, of the time to crest of the arrester current. In general, for any specific applied impulse current through the arrester, the time-to-crest for the voltage wave will be less than the time-to-crest for the current wave. Fig 1 shows the test results of a 10kA 8/20 µs. Available date on lightning strokes and simulation studies on impulse transients within substations both indicate that arresters in service may be subjected to fast current impulse waves.

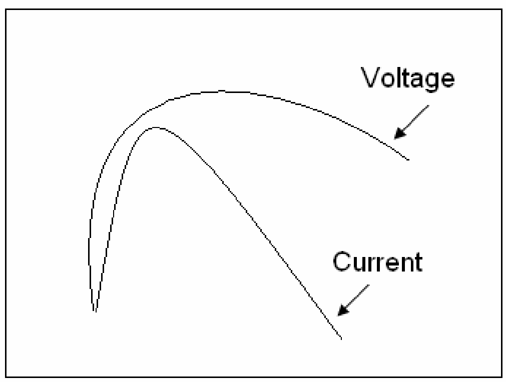


Fig. 1.

To illustrate arrester protection for slower transients, the discharge voltages have been defined for standard switching surge currents. The arrester protective characteristic is a continuous function defined over a range of discharge currents and their resultant discharge voltages. The insulation withstand of equipment on the other hand is generally defined only at three voltage point through the use of the standard switching surge, the full wave and the chopped wave tests. Three protective levels are selected for co-ordination with the transformer insulation characteristics. They are described as follows:

SWITCHING SURGE PROTECTIVE LEVEL

This is the crest discharge voltage that results when an 8/20 µs current impulse is applied to the arrester. The resultant crest voltages for a variety of crest currents are given in the applicable Arrester Characteristics table. To allow co-ordination with transformer insulation, a specific current impulse magnitude must be selected based on the system voltage.

FRONT-OF-WAVE PROTECTIVE LEVEL

This is the discharge voltage for current impulses having a faster time to crest that the 8/20 µs current impulse. This resultant crest voltage is listed as the front-of-wave (FOW) protective level. This protective level is derived by applying a series of current wave impulses to an arresters with varying times to crest (1, 2 8 µs) and extending the measured voltages to 0.5 µs in accordance with IEC.

PROTECTIVE RATIOS

The three point method is usually applied for insulation co-ordination. In this method the protective ratios are calculated at three separate points within the volt-time domain; namely switching surge, full wave, and chopped wave regions. If the following protective rations are met or exceeded, satisfactory insulation co-ordination will be achieved according to the minimum recommendations given in ANSI C62.22. These calculated protective ratios assume negligible arrester lead length and separation distance between the arrester and the transformer.

$$\frac{\textbf{Switching Surge Withstand}}{\textbf{Switching Surge Protective Level}} \geq 1.15$$

$$\frac{\textbf{Full Wave Withstand (BIL)}}{\textbf{Impulse Protective Level}} \geq 1.20$$

$$\frac{\textbf{Chopped Wave withstand}}{\textbf{Front-of-wave Protective Level}} \geq 1.25$$

In many cases, the calculated protective rations exceed the minimum protective rations recommended by ANSI by a considerable amount in actual power system applications.

If the separation distance between the transformer voltage can oscillate above the arrester voltage during lightning transients thus reducing the protective ratio. When making such transformer voltage estimates for shielded stations, it is suggested that the front-of-wave protective level of the arrester be used as an approximation for the arrester voltage. In decisive situations, it is suggested that digital computer studies be performed in which the arrester and details can be modelled.

Surge Protection Specialists

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