

**CALIFORNIA INSTITUTE OF TECHNOLOGY**  
 LIGO Project, 102-33 East Bridge Laboratory, Pasadena, California 91125  
 818-395-2129, Fax 818-304-9834

**LETTER OF TRANSMITTAL**

<b>REFER TO:</b> LIGO-T960059-00-0
<b>TO:</b> Mel Weingart (Parsons)

<b>DATE:</b> 3/25/96	<b>PROPOSAL #:</b>
<b>PROJECT NAME:</b>	
<b>RE:</b>	

Dear

WE ARE SENDING YOU as checked below:

- U.S. Mail     
  Overnight     
  Courier

COPIES	DATED	DESCRIPTION
1	Jan. 92	PUD Surge Arresters Detail/Hanford

THESE ARE TRANSMITTED as checked below:

- For Approval     
  For your signature     
  Resubmit\_\_copies for review  
 For your use     
  Make changes noted     
  Submit\_\_copies for distribution  
 As requested     
  Revise and resubmit     
  Return\_\_corrected prints  
 For review and comment  
 \_\_\_\_\_

REMARKS: For your info.

Signed: *Fred Asiri*  
 transmit.

# Surge Arresters

## VariGAP™ Type AZLP Heavy Duty Distribution Class Silicone Rubber Housed MOV Gapped Arrester

Electrical Apparatus

235-42

### GENERAL

The Cooper Power Systems VariGAP Type AZLP heavy duty distribution class silicone rubber housed MOV gapped arrester (Figure 1) in ratings of 3 through 30 kV, incorporates the latest in metal oxide varistor (MOV) and resistance graded gap technology. With this unique combination of technologies, Cooper Power Systems has advanced the performance characteristics of distribution class arresters beyond previously attainable limits.

### CONSTRUCTION

The VariGAP Type AZLP arrester is a combination of both metal oxide and gapped arrester technologies. Construction consists of metal oxide varistors in series with a non-linear resistance graded gap structure. The mating of these two service proven technologies results in a sharing of voltage during steady state conditions, minimizing voltage stress on both components. This results in a significant improvement in protective characteristics.

The VariGAP Type AZLP arrester is designed with a 60 Hz sparkover in excess of 1.5 times duty cycle rating. This feature ensures a temporary overvoltage (TOV) capability greatly in excess of that available with gapless metal oxide arresters.

The silicone rubber housed VariGAP Type AZLP arrester is totally non-fragmenting providing increased safety for personnel and equipment. In addition, silicone rubber is the industry recognized optimum polymer material which combines excellent track resistance, surface hydrophobicity, resistance to solar ultraviolet radiation and chemical inertness.

The VariGAP Type AZLP design is available with or without an isolator and can be supplied with a variety of mounting brackets to satisfy a wide range of applications.

### OPERATION

The operation of the VariGAP Type AZLP arrester differs from conventional gapless metal oxide arresters. During steady state conditions, line voltage is shared by both the resistance graded gap structure and metal oxide varistors. When overvolt-

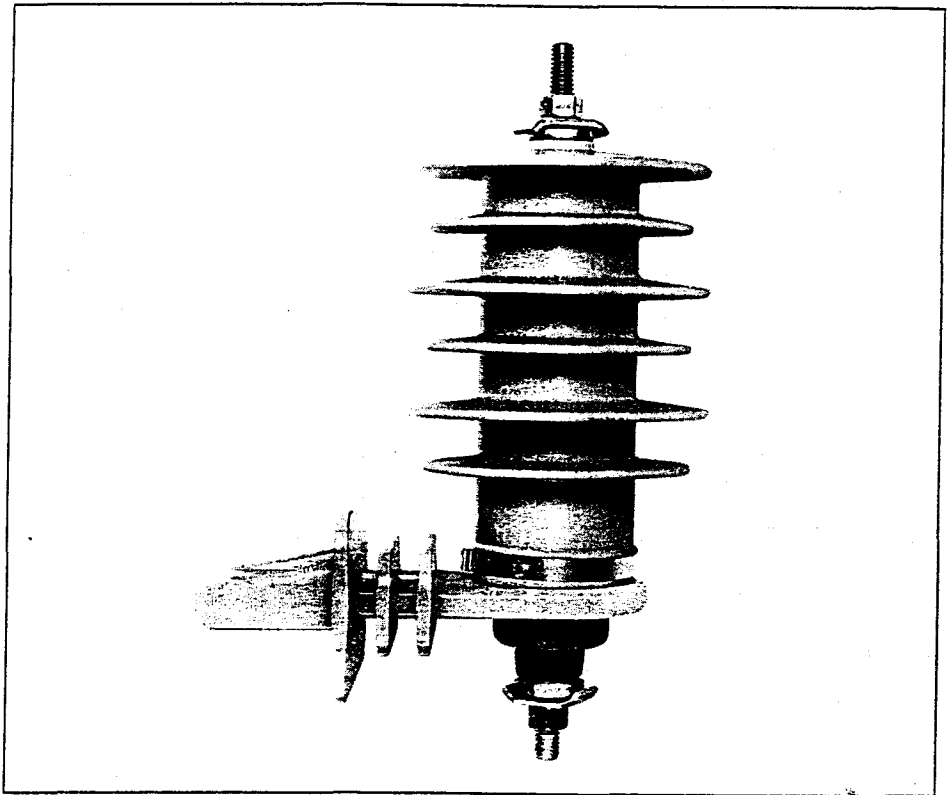


Figure 1.  
VariGAP Type AZLP Heavy Duty Distribution Class  
Silicone Rubber Housed MOV Gapped Arrester.

ages occur, the gaps sparkover, leaving only the metal oxide varistors in the circuit. This results in lower sparkover and discharge voltages than are possible with silicon carbide arresters, and lower discharge voltages than are possible with gapless metal oxide arresters.

The superior protective characteristics of the VariGAP Type AZLP arrester provide excellent protection for distribution transformers with lower impulse withstand capabilities. The superior reliability of the VariGAP Type AZLP arrester makes it an ideal choice for areas with high isokeraunic levels. In many cases, the VariGAP Type AZLP distribution class arrester can be used in place of gapless metal oxide riser pole arresters because of its superior characteristics.

### PRODUCTION TESTS

A complete production test program ensures a quality product. Each

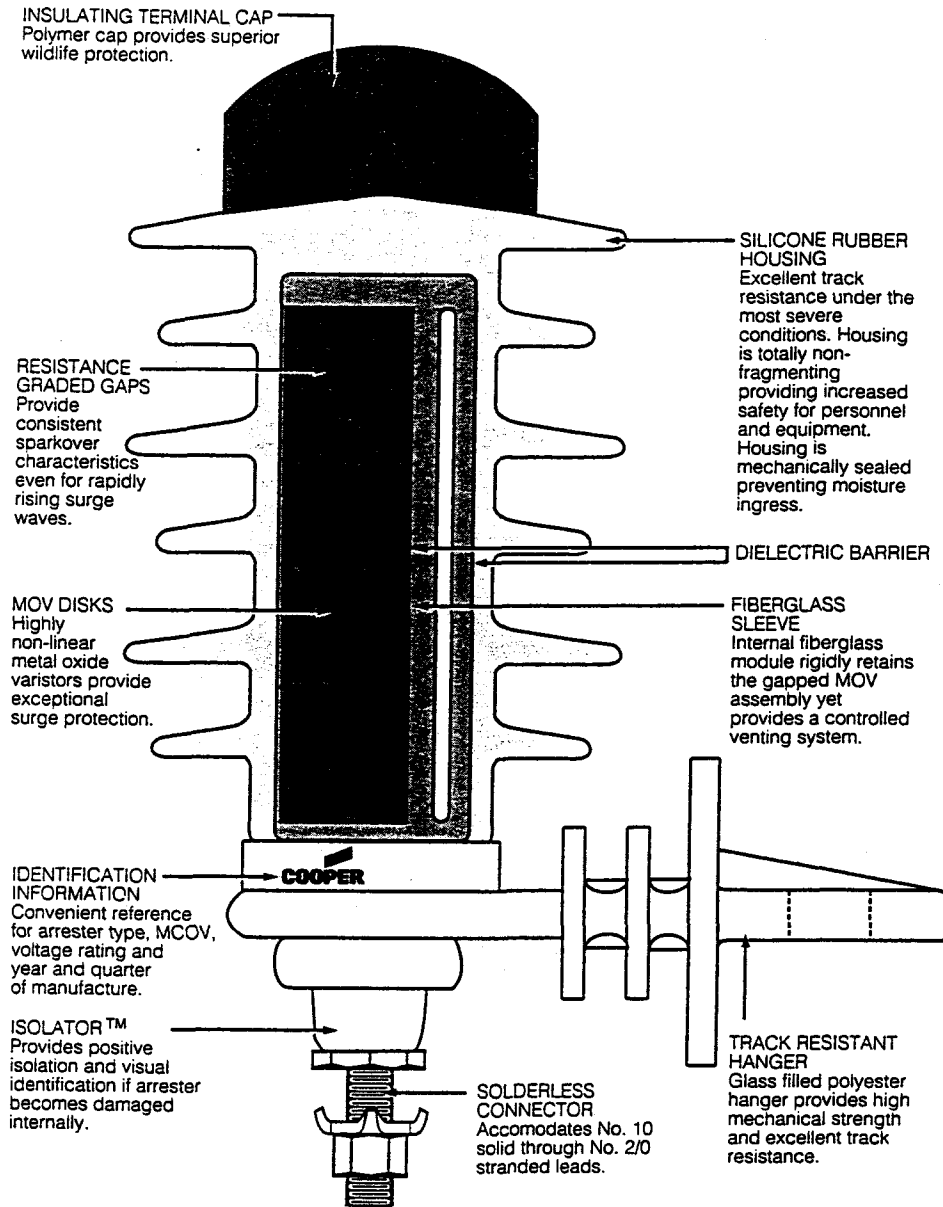
VariGAP metal oxide varistor receives a series of 100% electrical tests. Quality is further ensured by a series of destructive tests performed on every batch of varistors. Listed are the tests that are performed on the varistors:

- 100% Physical Inspection
- 100% Discharge Voltage Test
- 100% V1mA/cm<sup>2</sup>
- 100% Leakage Current at 80% of V1mA/cm<sup>2</sup> Voltage
- Batch High Current Short Duration Test
- Batch Thermal Stability Test

Each VariGAP Type AZLP arrester must pass the following production tests:

- 100% Physical Inspection
- 100% Leakage Current Test
- 100% RIV Test
- 100% Sparkover Level Test

# Features and Detailed Description



**Figure 2.**  
Cutaway illustration of VariGAP Type AZLP Arrester.

## STANDARDS

The VariGAP Type AZLP arrester complies with the latest revision of ANSI/IEEE C62.11 "IEEE Standard for Metal Oxide Surge Arresters for AC Power Circuits".

## GENERAL APPLICATION RECOMMENDATIONS

The rating of an arrester is the power frequency line-to-ground voltage at which the arrester is designed to pass an operating duty-cycle test. Table 1 provides a general application guide for the selection of the proper arrester rating for a given system voltage and system grounding configuration.

Cooper Power Systems application engineers are available to make recommendations. The following information is normally required:

1. System maximum operating voltage.
2. System grounding conditions.
  - A. For four-wire circuits, grounding conditions depend upon whether the system is multi-grounded, whether it has a neutral impedance and whether common primary and secondary neutrals are used.
  - B. For three-wire circuits, grounding conditions depend upon whether the system is solidly grounded at the source, grounded through neutral impedance at the source transformers or ungrounded.

Where unusual conditions exist (high ground resistance, high capacitive load, arc-welding equipment, etc.), the following supplementary information is necessary:

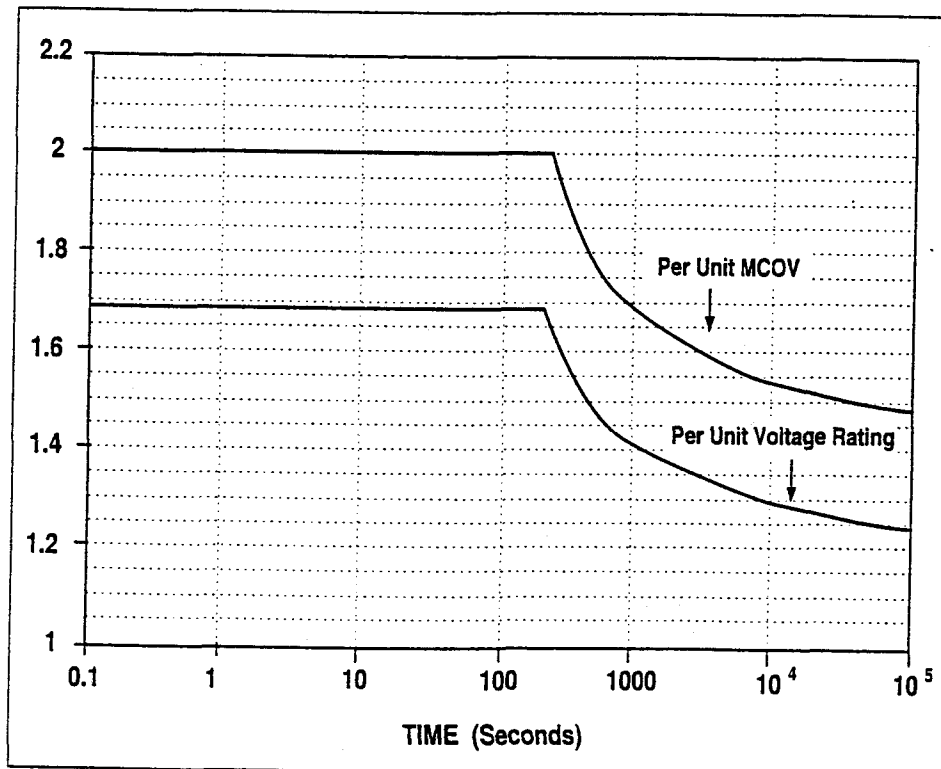
1. The unusual condition.
2. Type of construction, phase spacing, length of line, conductor size.
3. BIL of equipment and line insulation.
4. Phase-sequence components of impedances on the load side of the distribution substation.

The impedance of the transformer and the impedance and grounding of supply to the substation all affect the voltage during faults.

**TABLE 1**  
Commonly Applied Voltage Ratings of the VariGAP Type AZLP Arrester

Nominal	Maximum	Recommended Arrester Rating (kV rms)		
		Four-Wire Wye; Multi-Grounded Neutral	Three-Wire Wye; Solidly Grounded Neutral	Delta and Ungrounded Wye
2.4	2.54	—	—	3
4.16Y/2.4	4.4Y/2.54	3	6	6
4.16	4.4	—	—	6
4.8	5.08	—	—	6
6.9	7.26	—	—	9
8.32Y/4.8	8.8Y/5.08	6	9	—
12.0Y/6.93	12.7Y/7.33	9	12	—
12.47Y/7.2	13.2Y/7.62	9	15	—
13.2Y/7.62	13.97Y/8.07	10	15	—
13.8Y/7.97	14.52Y/8.38	10	15	—
13.8	14.52	—	—	15
20.78Y/12.0	22Y/12.7	15	21	—
22.86Y/13.2	24.2Y/13.87	18	24	—
23	24.34	—	—	24
24.94Y/14.4	26.4Y/15.24	18	27	—
27.6Y/15.93	29.3Y/16.89	21	30	—
34.5Y/19.92	36.5Y/21.08	27	*	—
46Y/26.6	48.3Y/28	*	—	—

\*Contact your Cooper Power Systems Sales Engineer.



**Figure 3.**  
Temporary overvoltage curve. No prior duty - 60 C ambient.

### TEMPORARY OVERVOLTAGE (TOV) CAPABILITY

The Temporary Overvoltage (TOV) capability of the VariGAP Type AZLP arrester is shown in Figure 3.

### PERFORMANCE TEST CHARACTERISTICS

The VariGAP Type AZLP arrester consistently withstands the following design tests as described by ANSI/IEEE C62.11:

- **Duty Cycle:**  
20 current surges of 10 kA crest 8/20  $\mu$ s waveshape followed by 2 current surges of 40 kA crest 8/20  $\mu$ s waveshape.
- **High-Current, Short-Duration Discharge:**  
2 current surges of 100 kA crest 4/10  $\mu$ s waveshape.
- **Low-Current, Long-Duration Discharge:**  
20 current surges of 250 A crest 2000  $\mu$ s rectangular wave duration.

Following each of these tests, the arresters remain thermally stable as verified by:

- Continually decreasing power values during a thirty minute power monitoring period.
- No evidence of physical or electrical deterioration.
- The 60 Hz sparkover and 10 kA (8/20  $\mu$ s) discharge voltages measured after each test changed by less than 10% from the initial values.

### FAULT CURRENT WITHSTAND TESTS

Fault current withstand tests demonstrate the arrester's ability to withstand fault currents for specific durations without expelling any internal components. The VariGAP Type AZLP arrester's construction is totally non-fragmenting at the levels shown in Table 2.

**TABLE 2**  
Fault Current Withstand Tests

Fault Current Amplitude (kA rms)	Fault Current Duration (cycles)
0.5	120
2.5	60
5.0	30
10.0	10
20.0	10

## PROTECTIVE CHARACTERISTICS

The protective characteristics of the VariGAP Type AZLP arresters are shown in Table 3.

**TABLE 3**  
Protective Characteristics

Arrester Rating (kV rms)	MCOV (kV rms)	Minimum 60 Hz Sparkover (kV crest/ $\sqrt{2}$ )	Front-of-Wave Protective Level* (kV crest)	Maximum Discharge Voltage 8/20 $\mu$ s Current Wave (kV crest)						Switching Surge** (kV crest)
				1.5 kA	3 kA	5 kA	10 kA	20 kA	40 kA	
3	2.55	9.0	8/13	8.6	9.2	9.8	10.9	12.7	16.0	7.5
6	5.10	15.0	15/25	16.6	17.8	18.9	21.0	24.6	30.8	14.5
9	7.65	16.5	21/26	17.2	18.4	19.6	21.7	25.5	31.9	15.1
10	8.40	16.5	21/29	19.4	20.8	22.1	24.5	28.8	36.0	17.0
12	10.2	21.0	29/38	25.8	27.6	29.4	32.6	38.3	47.8	22.6
15	12.7	25.0	37/42	28.4	30.5	32.4	35.9	42.2	52.7	24.9
18	15.3	31.0	44/51	34.4	36.8	39.2	43.4	51.0	63.8	30.1
21	17.0	34.0	51/57	37.9	40.6	43.2	47.8	56.2	70.3	33.2
24	19.5	39.0	58/68	45.6	48.9	52.0	57.6	67.7	84.6	39.9
27	22.0	45.0	64/77	51.5	55.3	58.8	65.1	76.6	95.6	45.2
30	24.4	50.0	71/85	56.8	60.9	64.8	71.8	84.4	105.4	49.7

\*Number 1/Number 2.

Number 1 - This is the value of the sparkover of the gap assembly based on a wave rising 100 kV per  $\mu$ s per 12 kV of arrester rating.

Number 2 - Based on 10 kA current impulse that results in a discharge voltage cresting in 0.5  $\mu$ s.

\*\*45-60  $\mu$ s rise time 500 A current surge.

## INSULATION CHARACTERISTICS

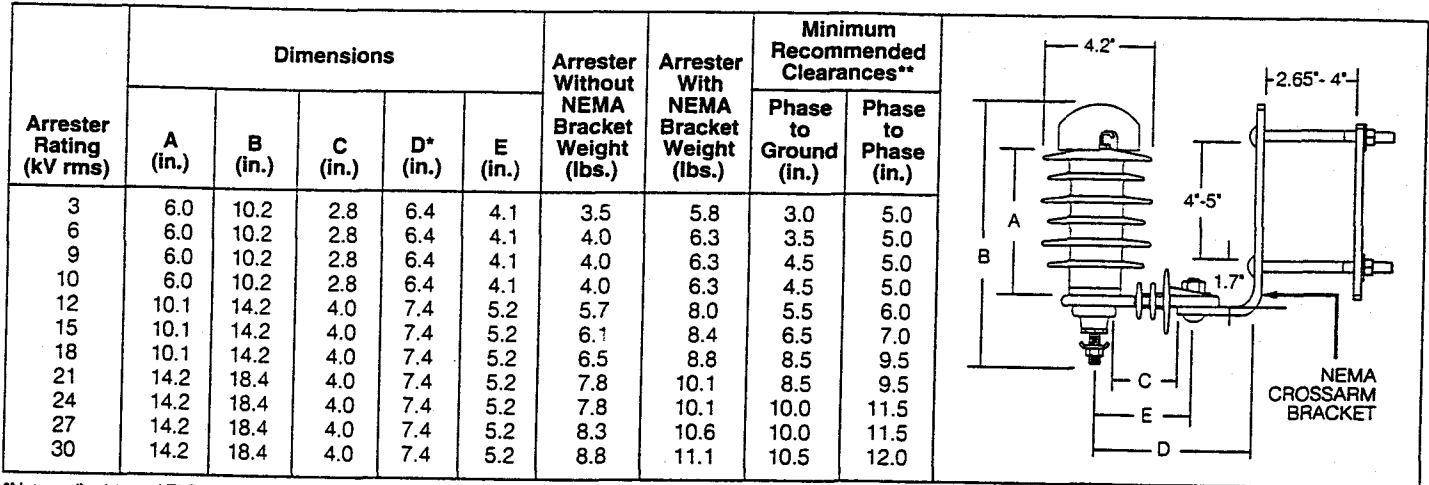
The insulation characteristics of the VariGAP Type AZLP arresters are shown in Table 4.

**TABLE 4**  
Insulation Characteristics

Arrester Rating (kV rms)	Housing		Hanger				Insulation Withstand Voltages		
	Leakage (in.)	Strike (in.)	Leakage		Strike		1.2/50 $\mu$ s Impulse (kV crest)	1 min. Dry (kV rms)	10 sec. Wet (kV rms)
			Top (in.)	Bottom (in.)	Top (in.)	Bottom (in.)			
3	14.7	7.5	5.8	6.0	2.8	3.5	75	27	24
6	14.7	7.5	5.8	6.0	2.8	3.5	75	27	24
9	14.7	7.5	5.8	6.0	2.8	3.5	75	27	24
10	14.7	7.5	5.8	6.0	2.8	3.5	75	27	24
12	26.6	11.6	8.5	8.9	3.8	4.4	125	42	36
15	26.6	11.6	8.5	8.9	3.8	4.4	125	42	36
18	26.6	11.6	8.5	8.9	3.8	4.4	125	42	36
21	38.5	15.8	8.5	8.9	3.8	4.4	150	70	60
24	38.5	15.8	8.5	8.9	3.8	4.4	150	70	60
27	38.5	15.8	8.5	8.9	3.8	4.4	150	70	60
30	38.5	15.8	8.5	8.9	3.8	4.4	150	70	60

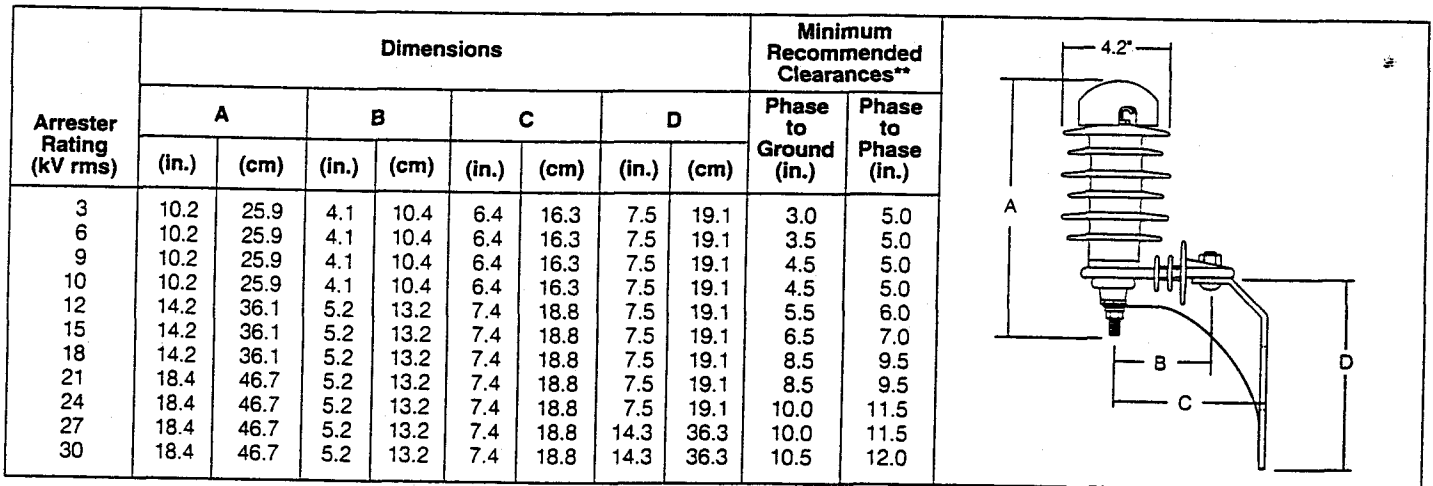
### DIMENSIONS AND CLEARANCES

The dimensions and clearances of the VariGAP Type AZLP arresters are shown in Figures 4, 5 and 6.



\*Not applicable to AZLP519B series.  
 \*\*All clearances are measured from centerline of arrester per IEEE C62.22.

Figure 4. Dimensions for AZLP501B and AZLP519B series.

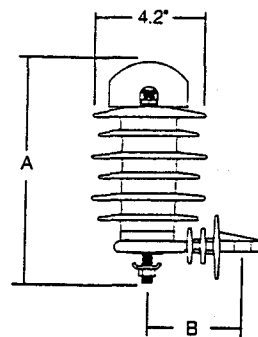


\*Mounting Lug Spacing for 3 through 24 kV is 2.5" (6.4 cm) and for 27 through 30 kV is 9.25" (23.5 cm).  
 \*\*All clearances are measured from centerline of arrester per IEEE C62.22.

Figure 5. Dimensions for AZLP531A and AZLP531B series.

**VariGAP™ Type AZLP**  
**Heavy Duty Distribution Class Silicone Rubber Housed MOV Gapped Arrester**

Arrester Rating (kV rms)	Dimensions				Minimum Recommended Clearances*	
	A		B		Phase to Ground (in.)	Phase to Phase (in.)
	(in.)	(cm)	(in.)	(cm)		
3	10.2	25.9	4.1	10.4	3.0	5.0
6	10.2	25.9	4.1	10.4	3.5	5.0
9	10.2	25.9	4.1	10.4	4.5	5.0
10	10.2	25.9	4.1	10.4	4.5	5.0
12	14.2	36.1	5.2	13.2	5.5	6.0
15	14.2	36.1	5.2	13.2	6.5	7.0
18	14.2	36.1	5.2	13.2	8.5	9.5
21	18.4	46.7	5.2	13.2	8.5	9.5
24	18.4	46.7	5.2	13.2	10.0	11.5
27	18.4	46.7	5.2	13.2	10.0	11.5
30	18.4	46.7	5.2	13.2	10.5	12.0



\*All clearances are measured from centerline of arrester per IEEE C62.22.

**Figure 6.**  
**Dimensions for AZLP519C series.**

**ORDERING INFORMATION**

To order a Cooper Power Systems VariGAP Type AZLP arrester, determine the voltage rating for the intended application using Table 1. Specify the appropriate catalog number from Table 5. Contact the Cooper Power Systems sales engineer in your location for applications not listed.

**TABLE 5**  
**Ordering Information**

Arrester Rating (kV rms)	Catalog Numbers: VariGAP Type AZLP Arrester				
	With NEMA Crossarm Bracket	Without NEMA Crossarm Bracket	Transformer Bracket and Line Lead	Transformer Mounting Bracket	Cubicle Mounted (Without Isolator)
3	AZLP501B3	AZLP519B3	AZLP531A3	AZLP531B3	AZLP519C3
6	AZLP501B6	AZLP519B6	AZLP531A6	AZLP531B6	AZLP519C6
9	AZLP501B9	AZLP519B9	AZLP531A9	AZLP531B9	AZLP519C9
10	AZLP501B10	AZLP519B10	AZLP531A10	AZLP531B10	AZLP519C10
12	AZLP501B12	AZLP519B12	AZLP531A12	AZLP531B12	AZLP519C12
15	AZLP501B15	AZLP519B15	AZLP531A15	AZLP531B15	AZLP519C15
18	AZLP501B18	AZLP519B18	AZLP531A18	AZLP531B18	AZLP519C18
21	AZLP501B21	AZLP519B21	AZLP531A21	AZLP531B21	AZLP519C21
24	AZLP501B24	AZLP519B24	AZLP531A24	AZLP531B24	AZLP519C24
27	AZLP501B27	AZLP519B27	AZLP531A27	AZLP531B27	AZLP519C27
30	AZLP501B30	AZLP519B30	AZLP531A30	AZLP531B30	AZLP519C30

VariGAP™ and Isolator™ are trademarks of Cooper Power Systems, Inc.



**CAUTION:** The values shown in Figures 4, 5 and 6 are the minimum clearances recommended by Cooper Power Systems. These clearances may be revised to meet local or system requirements for spacing or energized equipment. However, safe operating procedures must always be followed.



**Cooper Power Systems**

Quality from  
 Cooper Industries

P.O. Box 2850, Pittsburgh, PA 15230