APATOR

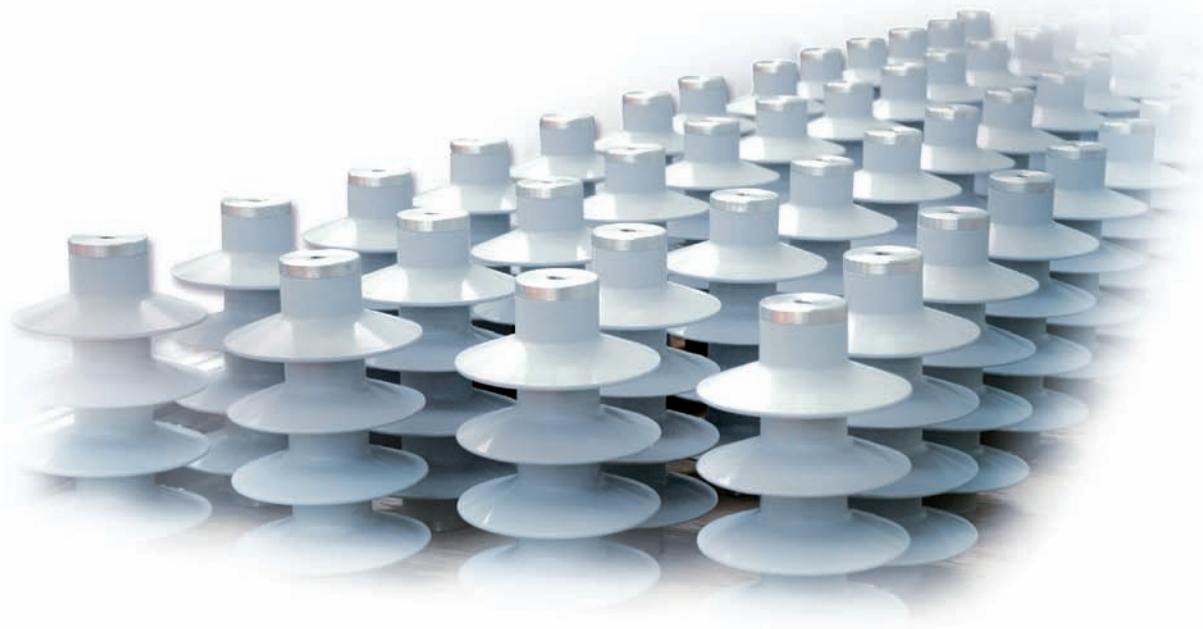
Najbardziej innowacyjna firma

EURO LEADER

RZETELNY PARTNER

Medium voltage surge arresters

ASM



VISION OF GRUPA APATOR

We want our metering systems to help our customers with economical management of electricity, heat, water and gas consumption. We pursue to accuracy and flexibility of configuration of our metering systems, sophisticated technologies of settlement and read out of data supported by the latest achievements in telecommunication in order to allow our customers in very easy, cheap and saved method to settle the utilities. Our offer is enriched with services that guarantee our customers to save time and money. Systems, applications and switchgear apparatus being in our offer help our customers with safe and reliable current making and breaking, providing and distributing of electricity. Safety operation of our switchgear equipment is the key to our success and complete satisfaction of our customers.

Manufacturing range:
SWITCHGEAR EQUIPMENT
METERING EQUIPMENT

ASM surge arresters are intended for protection of power engineering a.c. devices against destructive operation of lighting and switching overvoltages.

OPERATING CONDITIONS

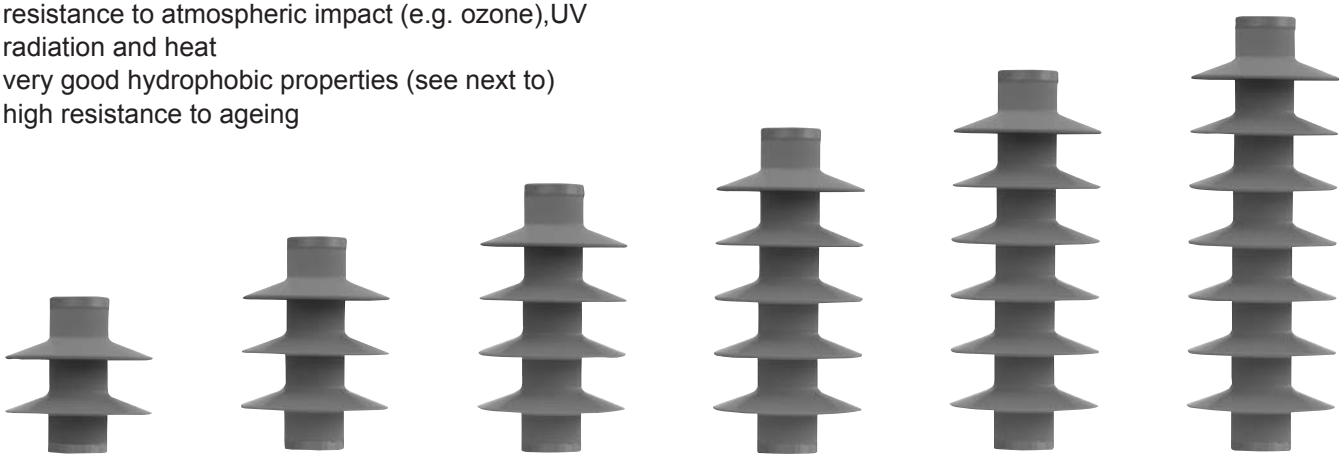
ASM surge arresters are intended for operation at outdoor and indoor conditions (in moderate climate) at the temperatures from - 55°C (218K) up to + 55°C (328K), at altitude up to 1000 m above sea level. The power frequency of the system should not be lower than 48 Hz and higher than 62 Hz. The r.m.s. value of alternating voltage applied to the terminals should not exceed its continuous operating voltage Uc.
However, the r.m.s. value of alternating - current component of short circuit current in place of installation of a surge arrester should not be higher than 31,5 kA.

DESIGN AND PRINCIPLE OF OPERATION

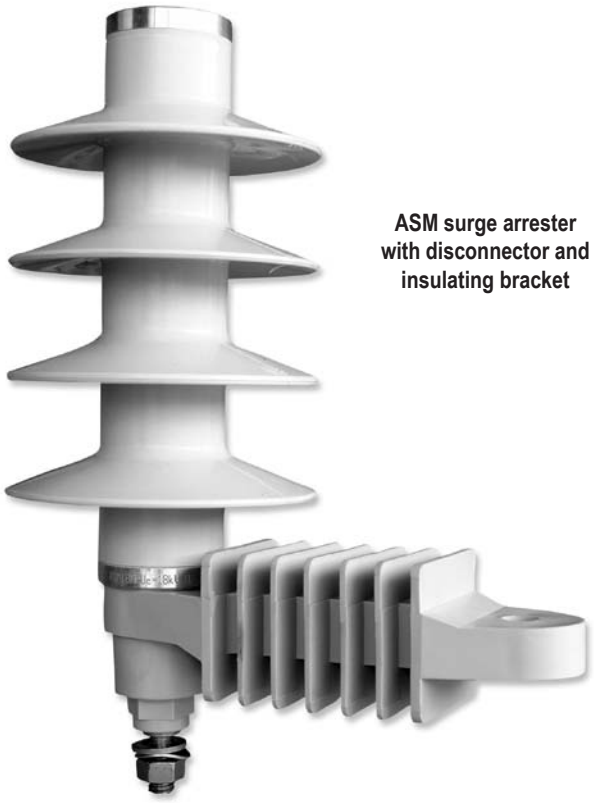
Basic part of surge arrester is the pile of varistors made of zinc oxide with other metal oxide additives. Varistors made by ceramic technology have high non linear voltage-current characteristic, high current withstand and stability of electrical parameters under continuous operating voltage during whole lifetime.
The pile of varistors is located in insulating material which is an internal housing of surge arrester and it provides very good mechanical strength. There are aluminium electrodes on both sides. An electrical contact between varistors and electrodes is obtained by suitable pressure. External housing of an arrester – integral and uniform - is made of silicone type LSR, which has very good insulating properties.
Design of a mould for direct injection of silicone type LSR provides the removal of air bubbles from the inside of surge arrester. It is confirmed by one of the routine tests - partial discharges measurement.
Advantages of silicone type LSR are the following:

- flexibility even at low temperatures
- high mechanical strength
- resistance to atmospheric impact (e.g. ozone),UV radiation and heat
- very good hydrophobic properties (see next to)
- high resistance to ageing
- less weight comparing to porcelain housed surge arresters

Silicone is the only material for housing that can transfer hydrophobic properties
(i.e. non-wettability) on surface layer of impurities. It causes decrease of leakage current and the danger of spark-over. Silicone is known as a self-cleaning material.
ASM surge arresters have got integral and uniform housing without any sheds pulled over a core. It is sure that impurities don't concentrate on a surface of housing and particularly on the contact between core and shed.
The principle of operation is the following: active current of order of microamps flows through an arrester at operating voltage. Each rise of voltage on overhead line, therefore on the terminals of a surge arrester causes prompt rise of current. Conductivity of varistors increases according to their voltage-current characteristic and the overvoltage is carried away to the ground by the surge arrester.
The drop of voltage in surge arresters called residual voltage does not exceed the withstand value of protected insulation, in the case of proper selection of surge arrester to the operating conditions.
Return to operating voltage completes the operation of surge arrester which comes to standby position waiting for the next overvoltage and the heat is carried out to the environment. Operation of a surge arrester does not cause any interference in the operation of systems.
Short-circuit current which can flow through varistors in case of their damage does not cause sudden and dangerous to environment tear of housing, like in the case of porcelain housed surge arresters and it does not require suitable overpressure protection.

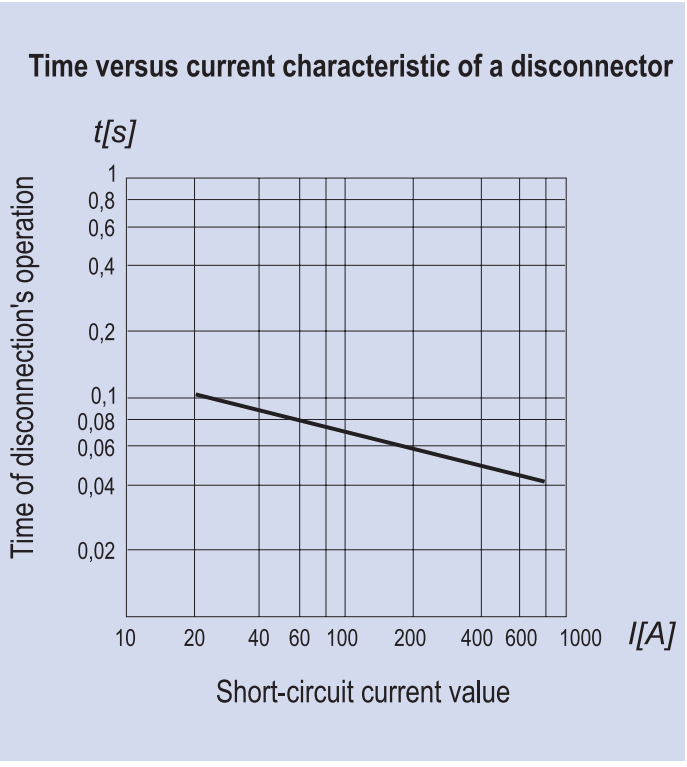


ASM 04-06 ASM 07-12 ASM 13-18 ASM 19-24 ASM 25-30 ASM 33-36



ASM surge arrester with disconnector and insulating bracket

DIAGRAM No.1



Surge arrester can be fitted with a disconnector, which indicates its damage in a simple way. When a short circuit current flows through a damaged surge arrester the operation of a disconnector take place in accordance with its time-current characteristic (diagram no.1). It causes permanent disconnection of an earthing of surge arresters, which forms clear gap in a circuit. This solution guarantees failure – free network's operation and easy location of the place with a lack of overvoltage protection.

DEFINITIONS

Continuous operating voltage of an arrester U_c – maximum permissible r.m.s. value of power frequency voltage, which can be applied continuously between terminals of surge arrester.

Rated voltage of an arrester U_r – maximum permissible r.m.s. value of power frequency voltage, which can be applied between the arrester terminals, at which correct operation under temporary overvoltage conditions is provided, proved in the operating duty test as a 10s - voltage. The rated voltage is used as a reference parameter for the specification of operating characteristic.

Energy absorption capability E – maximum energy value in kJ, which a surge arrester can absorb without "thermal runaway". Energizing a surge arrester causes the rise of temperature of varistors. Since current flowing through varistors rises together with the rise of temperature, therefore dissipated power under operating alternating voltage also rises. If this power is higher than power carried out to the outside (cooling) then further temperature rise and "thermal runaway of surge arrester" occur and in consequence its damage. In catalogues E energy is usually indicated in kJ referred to 1 kV of Ur - rated voltage.

Rated discharge current – it is the peak value of current impulse with the shape of 8/20, at which lightning protection level of surge arrester is defined.

High discharge current – it is the peak value of current impulse with the shape of 4/10, which is intended to check withstand of surge arresters to the stresses related to direct or near lightning strike.

Protection level of surge arrester U_P – it is residual voltage at rated discharge current. It is a basic parameter determining the effectiveness of protection system.

Short circuit withstand of surge arrester – it is a peak value of short circuit current in the system in the place of installation of surge arrester, which surge arrester withstands without dangerous to environment damage.

TABLE No.1 TECHNICAL SPECIFICATION OF ASM SURGE ARRESTERS

Typ	Rated voltage U_r	Continuous operating voltage U_c	Residual voltage at nominal discharge current U_o not higher than	Residual voltage at steep current impulse	Residual voltage at switching impulse 500A	Minimum creepage distance L (version with normal creepage distance)	Height H
	kV_{sk}	kV_{sk}	kV_{max}	kV_{max}	kV_{max}	mm	mm
ASM 04	5,0	4,0	14,0	14,5	10,0	250	136
ASM 05	6,3	5,0	17,5	18,3	12,6		
ASM 06	7,5	6,0	21,0	21,8	15,0		
ASM 07	8,8	7,0	24,5	25,5	17,6	370	186
ASM 08	10,0	8,0	28,0	29,0	20,0		
ASM 09	11,3	9,0	31,5	32,8	22,6		
ASM 10	12,5	10,0	35,0	36,3	25,0		
ASM 11	13,8	11,0	38,5	40,0	27,6		
ASM 12	15,0	12,0	42,0	43,5	30,0		
ASM 13	16,3	13,0	45,5	47,3	32,6	490	236
ASM 14	17,5	14,0	49,0	50,8	35,0		
ASM 15	18,8	15,0	52,5	54,5	37,6		
ASM 16	20,0	16,0	56,0	58,0	40,0		
ASM 17	21,3	17,0	59,5	61,8	42,6		
ASM 18	22,5	18,0	63,0	65,3	45,0		
ASM 19	23,8	19,0	66,5	69,0	47,6	610	286
ASM 20	25,0	20,0	70,0	72,5	50,0		
ASM 21	26,3	21,0	73,5	76,3	52,6		
ASM 22	27,5	22,0	77,0	79,8	55,0		
ASM 23	28,8	23,0	80,5	83,5	57,6		
ASM 24	30,0	24,0	84,0	87,0	60,0		
ASM 25	31,3	25,0	87,5	90,8	62,6	730	336
ASM 26	32,5	26,0	91,0	94,3	65,0		
ASM 27	33,8	27,0	94,5	98,0	67,6		
ASM 28	35,0	28,0	98,0	101,5	70,0		
ASM 29	36,3	29,0	101,5	105,3	72,6		
ASM 30	37,5	30,0	105,0	108,8	75,0		
ASM 33	41,3	33,0	115,5	119,8	82,6	850	386
ASM 36	45,0	36,0	126,0	130,5	90,0		

- Rated frequency ..... 48-62 Hz
- Operating conditions – location ..... Normal or Overhead
- Nominal discharge current 8/20 µs ..... 10 kA
- Line discharge class 1
- Long- duration impulse current ..... 280 A [2000 µs]
- High current 4/10 µs ..... 100 kA
- Short-circuit current withstand ..... 31,5 kA [200 ms]
- Energy absorption capability E/1 kV (U_c) ..... 4,4 [kJ]

MECHANICAL LOADS

- Bending moment ..... 250 Nm
- Torque moment ..... 50 Nm
- Load capacity ..... 625 N

TESTING OF VARISTORS AND SURGE ARRESTERS

The methods and criteria of evaluation are defined in details by every manufacturer.
The production of surge arresters in APATOR is precisely controlled starting from raw materials through parts and components to the final product.
The program of testing of varistors is the part of technological process and contains:

- checking of raw materials
- checking of physical properties and technological parameters in particular steps of production like
  - grain size of raw materials,
  - viscosity of varistor's slurry,
  - humidity and grain size of granulated mass,
  - density of pressing etc.

Technology of production of varistors is composed of very precise mixing of all ingredients in water slurry, spray drying of this slurry, cylindrical pressing of granulated mass and high temperature sintering of pressed pieces.

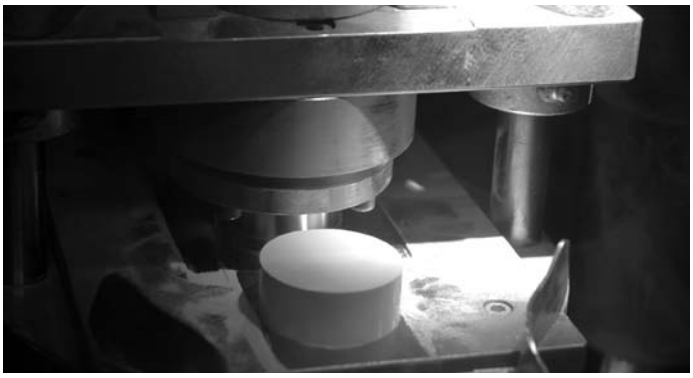


Fig.1 Piece formed on the highly efficient pressing machine

Fig.2 System for metallization of varistors

Fig.3 Operator sets parameters of metallization

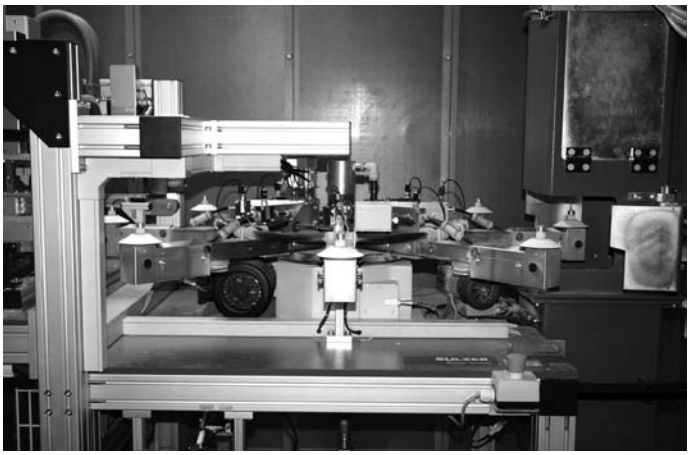


Fig.4 Automatic process of metallization

Then the top surfaces are metallized and side surfaces are coated by suitable insulating material.
Electrical tests of varistors contain:

- selection due to the energetic withstand (long duration current test),
- residual voltage test,
- reference voltage test,
- accelerated ageing test.

Each new type of varistor and also every change of material or technology cause necessity of type tests, which additionally contain:

- high current withstand test,
- long duration current withstand test.

Routine tests of surge arrester (Fig.5) are made to verify, that this product meets the requirements indicated in technical specification.
They are following routine tests:

- reference voltage test,
- partial discharge test,
- detailed visual inspection.

Fig.5 Stand for tests of ASM surge arresters

All these tests including previously made type test guarantee effectiveness of operation and durability and reliability of surge arresters.

COMPLIANCE WITH THE STANDARDS

PN-EN 60099- 4: 2005 (U) standard
Surge arresters. Part 4: Metal oxide surge arresters without gaps for a.c. systems.

SELECTION OF SURGE ARRESTERS

Proper selection of surge arresters with parameters suitable to the place of installation and operating conditions is crucial to the effectiveness of protection and durability of surge arrester. Proper selection of surge arrester aims, first of all, to provide optimal protection of insulation of protected equipment.

Selection of surge arresters should be preceded by collection of complete and reliable information related to:
- power network, where a surge arrester will be installed,
- operating conditions expected in the place where surge arrester will be installed,
- protected equipment.

Characteristics of the power network should regard such basic parameters like:
- highest voltage of the system,
- voltage frequency,
- earth fault factor of the system and stability level of conditions, which have an influence on its value,
- maximum time of occurrence of earth fault,
- maximum value of temporary overvoltages (dynamic) and maximum time of their occurrence,
- short circuit current in place of installation of surge arrester.

Operating conditions expected for a surge arrester should include:
- ambient air temperature,
- altitude of surge arrester installation,
- pollution conditions,
- other possible threats for surge arrester,
- expected position of operation of surge arrester,
- expected place and method of installation of surge arrester,
- expected mechanical loads,
- possible limits between the distances of phases.

The following information related to protected equipment is useful:
- kind of equipment to be protected,
- method of installation into the system,
- the length of cables if apply,
- rated test voltage of insulation of protected equipment,
- expected maximum length of conductor between surge arrester and equipment to be protected.

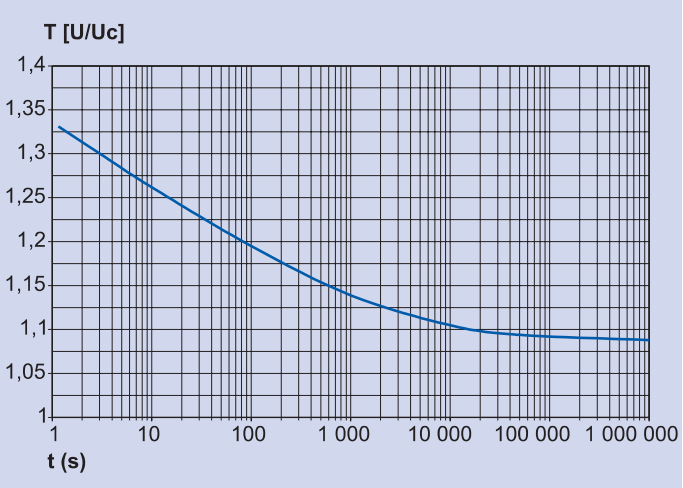
The most important parameter of surge arrester is continuous operating voltage Uc.

Continuous operating voltage is strictly related to other parameters, mainly guaranteed protection level.

SELECTION OF CONTINUOUS OPERATING VOLTAGE

First of all, continuous operating voltage U_c has to be selected as the most important parameter of surge arrester. Generally, two basic conditions have to be met:
- U_c should be higher than voltage in the system which may occur for a longer time on terminals of surge arrester during operating conditions,
- temporary overvoltage withstand of surge arrester should be higher than temporary ovevoltages expected in the system. It means that voltage versus time characteristic of T withstand of surge arrester should go above the value of expected overvoltages that may occur in the system.

DIAGRAM No. 2



Typical characteristic of temporary overvoltages withstand Curve after preload load of energy E (about 5kJ/1kV U_c sec.)

EXAMPLES OF APPLICATION

SURGE ARRESTER BETWEEN PHASE AND THE GROUND

System with isolated neutral point or system with ground fault current compensation with unknown time to fault clearance

Under conditions of single phase earth fault the voltage of other phases can reach the value of $\mathbf{U_m}$. The voltage can occur for a longer time and if the time to fault clearance is unknown, then required $\mathbf{U_c}$ continuous operating voltage of surge arrester should be:

$$U_c \geq U_m$$

System with isolated neutral point and self-acting ground fault clearance or ground fault clearance after known period of t time

Selection of $\mathbf{U_c}$ voltage is made in respect to the time of duration of single phase earth fault. Temporary overvoltage on not grounded phases can reach in relation to the ground the value of $\mathbf{U_m}$ - peak voltage of the system.

If the earth fault is cleared after t time continuous operating voltage of surge arrester should be:

$$U_c \geq \frac{U_m}{T}$$

System with effectively grounded neutral point

If earth fault factor is $\mathbf{k_Z \leq 1,4}$ then it is considered that the system has effectively grounded neutral point. In this case continuous operating voltage of surge arrester should fulfill with the following relation:

$$U_c \geq \frac{U_m}{T \times \sqrt{3}} \times k_Z$$

Note: Uc should not be lower in any case than

$$\frac{U_m}{\sqrt{3}}$$

THE SURGE ARRESTER BETWEEN PHASES

Regardless of grounding method of the neutral point $\mathbf{U_c}$ continuous operating voltage for surge arrester installed phase to phase, should be higher than the highest phase to phase voltage which may occur for longer time on terminals of surge arrester during operation and it should be:

$$U_C \geq U_m \times 1{,}05$$

where 1, 05 is safety factor due to the possibility of harmonics in the operating voltage of the system.
In case of installation of surge arrester phase to phase, the terminal marked with ground symbol is allowed to be connected to any of phases.

THE SURGE ARRESTER BETWEEN NEUTRAL POINT OF A TRANSFORMER AND THE GROUND

The system with grounded neutral point

Continuous operating voltage should be:

$$U_C \geq \frac{U_m}{T \times \sqrt{3}}$$

and it depends on expected time of earth fault clearance.

The system with effectively grounded neutral point ($k_z \leq 1{,}4$)

In case of earth fault in the system with effective grounded neutral point, temporary overvoltage in non grounded neutral point of a transformer does not exceed the value of 0,46 x $\mathbf{U_m}$ and the time of fault clearance is shorter than 3 seconds. Therefore recommended continuous operating voltage of surge arrester is:

$$U_C \geq \frac{0{,}46 \times U_m}{T}$$

THE SELECTION OF RATED DISCHARGE CURRENT

There is a probability of direct lighting strike to the medium voltage overhead line in the case of lack of arrester conductors. Normally discharge current of the arrester is lower than lighting current. Current wave flows in the overhead line in two directions from the place of stroke. Moreover, occurrence of the flash-over on insulation of the overhead line causes carrying out the meaningful part of lighting current to the ground and current wave along the overhead line undergoes a significant suppression.
Extreme values of discharge current of surge arrester may occur in the case of lighting stroke in the adjacent to surge arrester. The probability of the occurrence of defined value of discharge current caused by direct lighting stroke to the overhead line depends on many factors like level of overhead line insulation (overhead line on wooden pillars with grounded or not grounded crossbar), isoceraunic level in the area of overhead line, distance from the place of lighting stroke etc. It is assumed that surge arresters with rated discharge current of 10 kA provide sufficient protection of distribution transformers in medium voltage overhead lines, without making any detailed analysis of the system.

INSTALLATION OF SURGE ARRESTERS

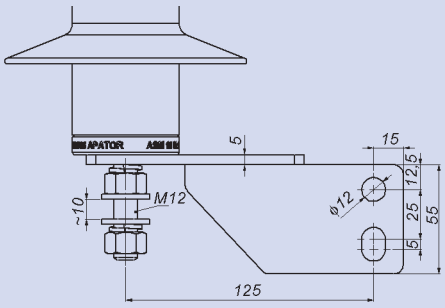
One should check if technical data on the nameplate of surge arrester comply with project specification data or repair specification. Surge arresters should be located possibly close to protected equipment with keeping the distances specified in assembling specification and providing the lowest resistance to earth. (Rz ≤ 10 Ω). The distance between protected equipment and surge arrester (measured along the conductors) is recommended not to exceed the following values:

- in case of wooden pillar with ungrounded cross bar <2,0 m
- in case of wooden pillar with grounded cross bar <3,5 m
- in case of concrete pillar < 2,0 m

However, in case of difficulties in mounting of surge arrester close to the protected equipment the distance between objects should not be longer than 20 m (the best method of protection against overvoltage is surge arrester to be mounted directly on equipment to be protected).

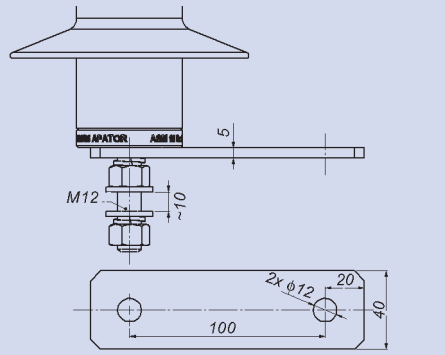
MOUNTING ACCESORIES

W1



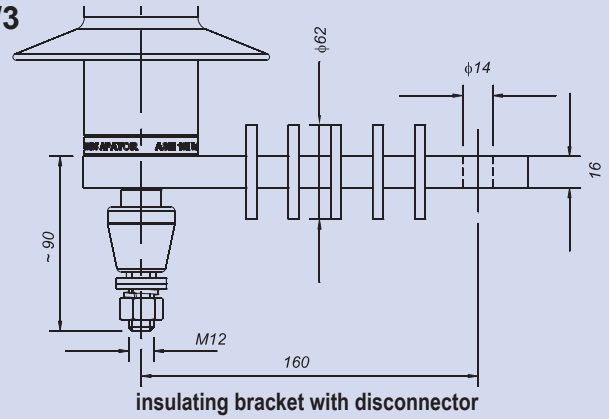
angle metal bracket

W2



straight metal bracket

W3

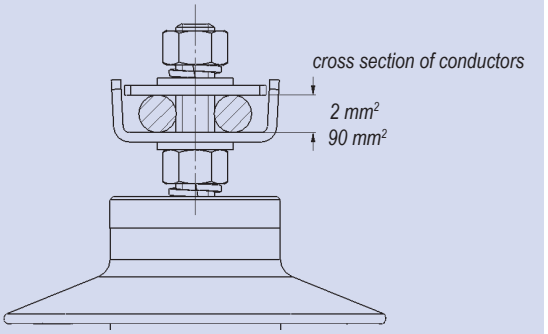


insulating bracket with disconnector

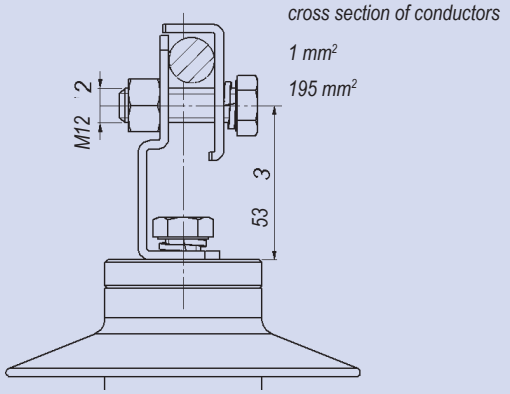
Operating position of surge arrester can be optional from vertical to horizontal one. Surge arresters are also adopted to be suspended on the line terminal.
Line and earth connections of surge arresters should be made by use of conductors with cross-section not less than16 mm^2 (cooper), 35 mm^2 (aluminium) and 50 mm^2 (steel).Connections should be the shortest possible ones.
In case of connection of surge arrester with earth or line conductor using of copper conductors one should pay particular attention to them to avoid their sticking to aluminium electrodes of surge arresters. The connection should always be made by use of intermediate steel element between e.g. washer or nut with protecting coating for indoor applications or stainless ones for outdoor applications. Connection can be also made by use of cable terminal of pipe or eyelet type.

LINE TERMINALS

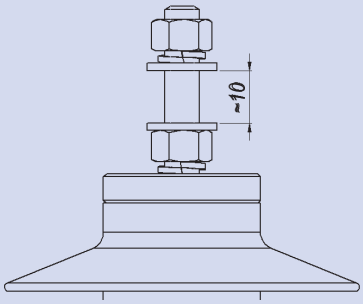
A



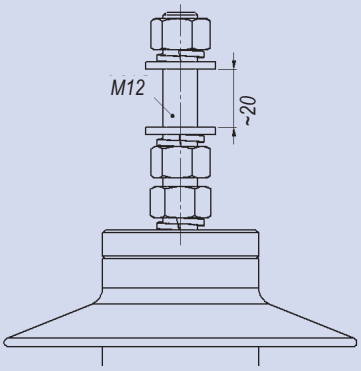
B



C

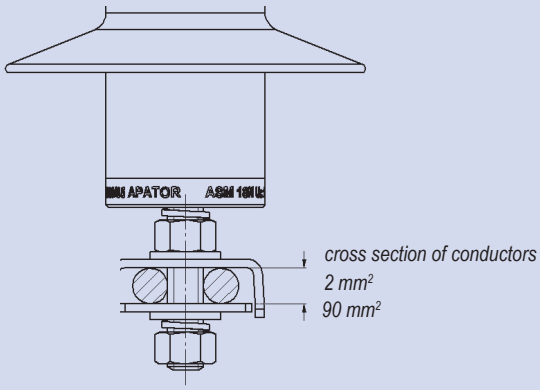


D

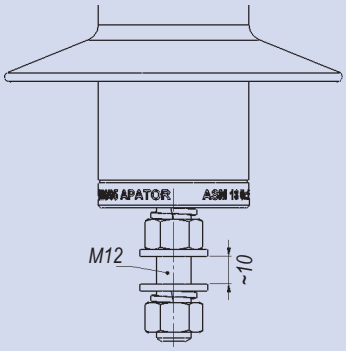


EARTH TERMINALS

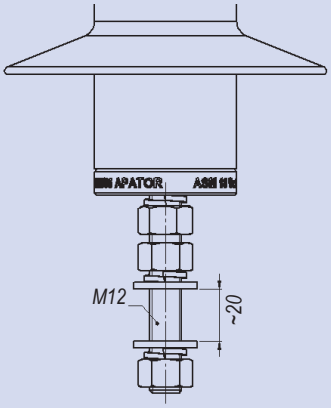
A

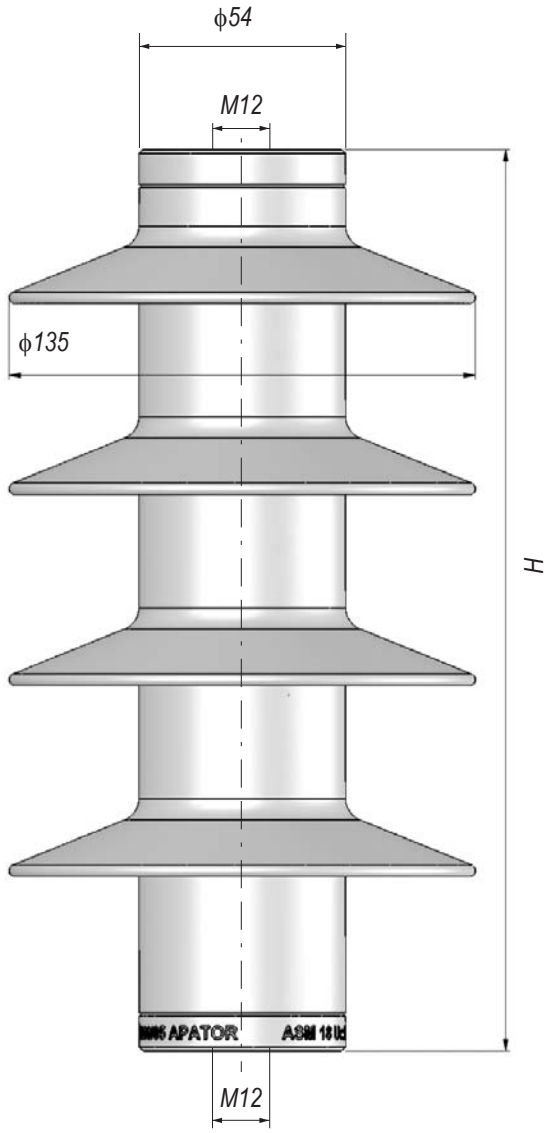


C



D



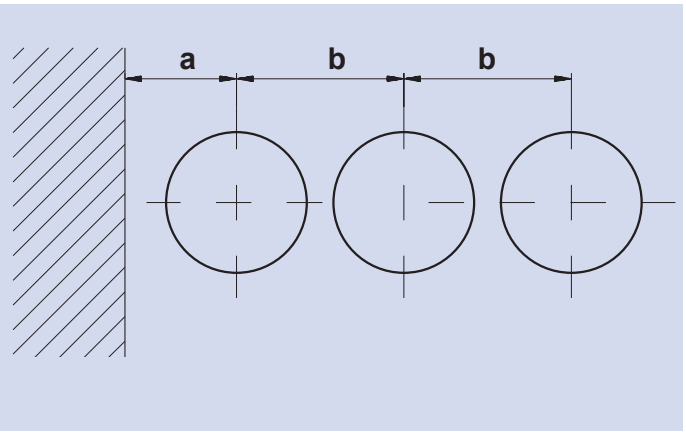


Surge arresters with standard fittings can be mounted directly to grounded metal construction and in case of non-metal one by use of grounding metal bar with the suitable cross-section and width not less than 20 mm.
In case when additional fittings are delivered as not installed it should be properly installed to the surge arrester. Surge arrester can be also used as auxiliary post-off insulator e.g. on transformer pillar stations where such function is usually played by ceramic insulator providing safety distance between steel structure elements and line conductors. Application of surge arrester for that function allows eliminating intermediate insulators and assures avoiding using indirect isolators and providing close distance of the arrester to the protected equipment.

During mounting of surge arresters one should draw his attention to the torque moment to be Ms ≤ 50 Nm and bending moment to be Mg≤ 250 Nm. It also regards to operating conditions. In case of keeping for the above conditions – operating position for ASM surge arresters can be optional from vertical to horizontal one.

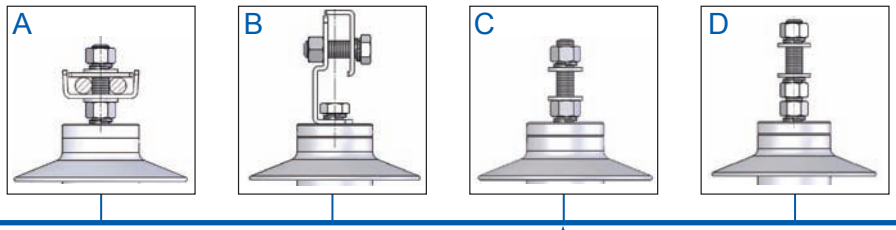
TABLE No. 2 MOUNTING DATA

Type of surge arrester	Continuous operating voltage [V]	Rated voltage [V]	Minimal distance	
			Between the axis of surge arrester and "a" earthed structure	Between axes of surge arresters and "b" adjacent phases
			mm	mm
ASM 06	6,0	7,5	106	141
ASM 12	12,0	15,0	172	206
ASM 18	18,0	22,5	239	271
ASM 24	24,0	30,0	306	336
ASM 30	30,0	37,5	370	401
ASM 36	36,0	45,0	436	466



NOTE:
Regulations regarding the performance of power engineering equipment in appropriate country should be respected during operation of surge arresters.
In case of application of minimal distances in the place of installation of surge arrester local regulations should be also respected.

ORDERING SYSTEM



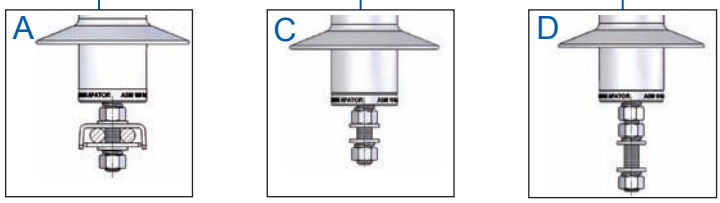
LINE TERMINALS

ASM	18	N		+		+	

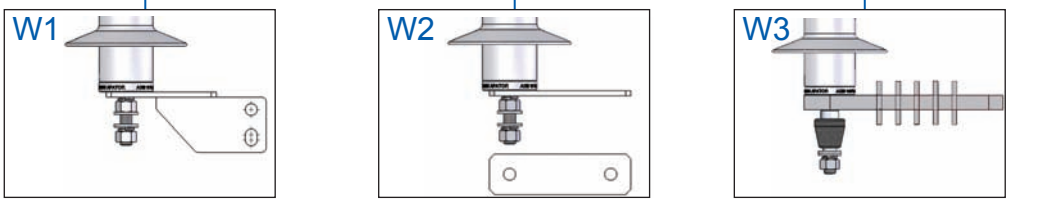
18 – U_c voltage from 04,05,06,..... to 36

N – normal creepage distance

EARTH TERMINALS



ASSEMBLING ACCESSORIES



angle metal bracket | straight metal bracket | insulating bracket with disconnector

The example of ordering of surge arrester

ASM 18 N + A + C + W3

ASM – designation
18 – continuous operating voltage U_c
N – creepage distance
A – line terminal type A
C – earth terminal type C
W3 – type of mounting accessories

CAUTION: Surge arresters are packed in the system of 1 unit together with accessories ordered in one package. Manufacturer reserves the right to make technical changes. Mounting accessories are ordered as separate items.

APATOR

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