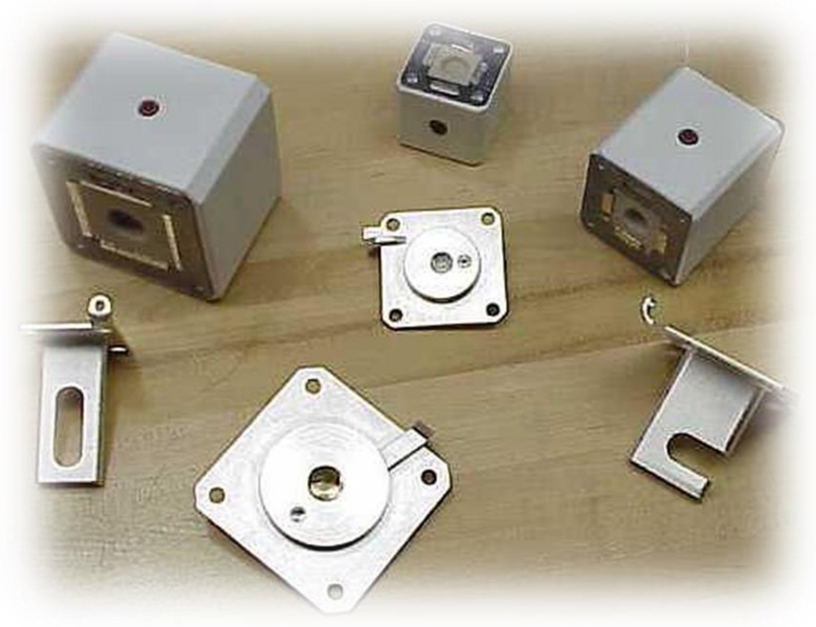
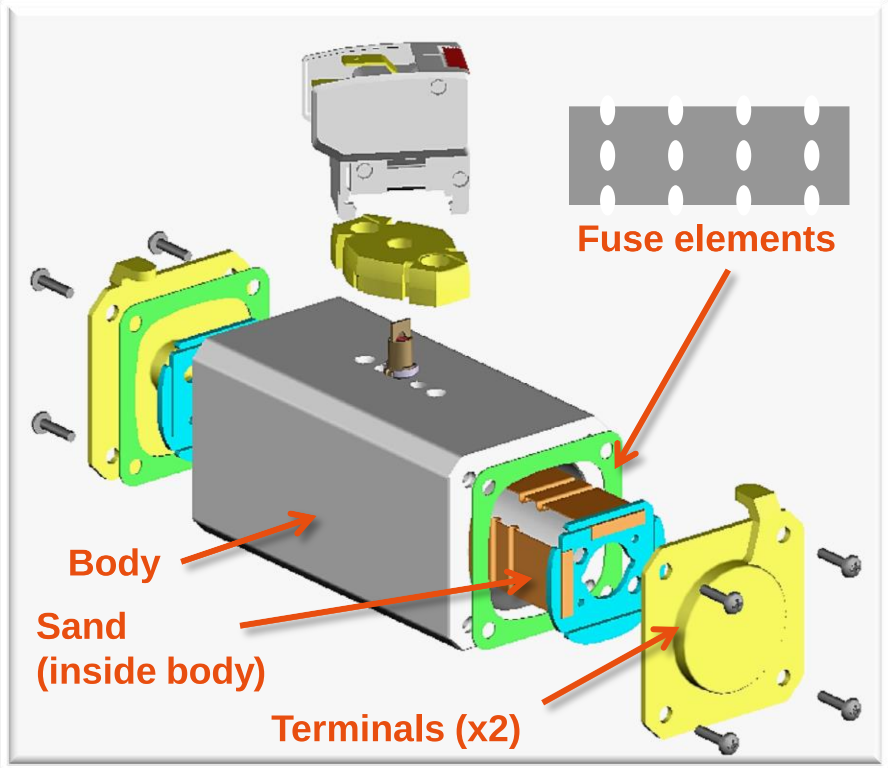
BEHAVIOUR AND OPERATION OF THE FUSE

EDUPACK TRAINING MODULE

2012

FUSE CONSTRUCTION (EXAMPLE OF SQUARE-BODY PSC)





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SOME DEFINITIONS

Rated voltage

For IEC 60269 fuses other than 690 V are tested between 110% to 115% of their rated voltage.

Fuses rated 690 V are tested between 105% and 110% of their rated voltage i.e. at least 725 V.

In North America fuses are tested as per UL standard at 100% to 105% of their rated voltage.

Rated current

Value of current that the fuse can carry continuously without deterioration under specified conditions.

Prospective current of a circuit (Available current in North America)

Current that would flow in a circuit if a fuse situated therein were replaced by a link of negligible impedance. The value of the prospective current in AC is the R.M.S. value of the AC component.

Breaking capacity

Value of prospective current (for a.c. the r.m.s. value of the a.c. component) that a fuse-link is capable of breaking at a stated voltage under prescribed conditions of use and behaviour.

Some definitions

Conventional non fusing current (I_{nf})

Value of current specified as that which the fuse is capable of carrying for a specified time (conventional time) without melting.

Conventional fusing current (I_f)

Value of current specified as that which causes operation of the fuse within a specified time (conventional time).

“ g “ fuse (formerly general purpose fuse)

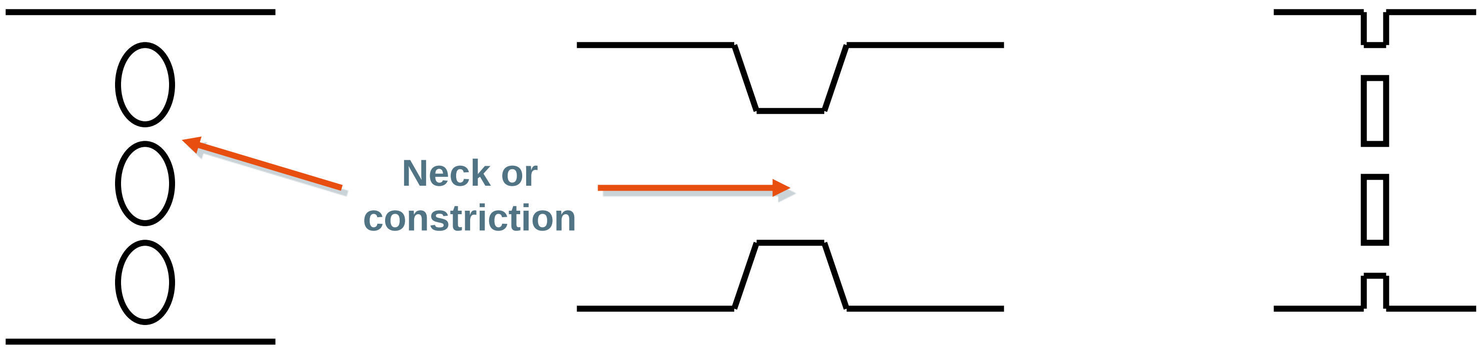
Current limiting fuse capable of breaking under specified conditions all currents which cause melting of the fuse element up to its rated breaking capacity.

“ a “ fuse (formerly back-up fuse)

Current limiting fuse capable of breaking of breaking under specified conditions all currents between the lowest current indicated on its operating time-current characteristic (see on the next slide “ minimum interrupting current “) and its rated breaking capacity.

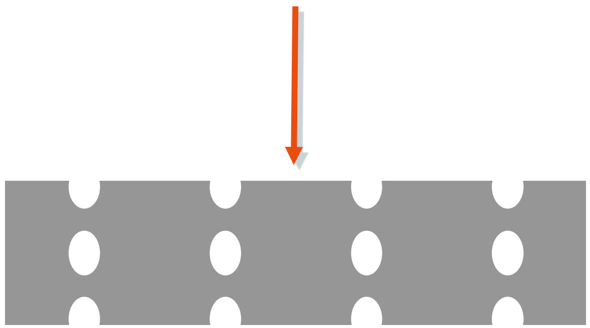
DIFFERENT KINDS OF CONSTRICTIONS…

… leading to different shapes of the time vs current curve



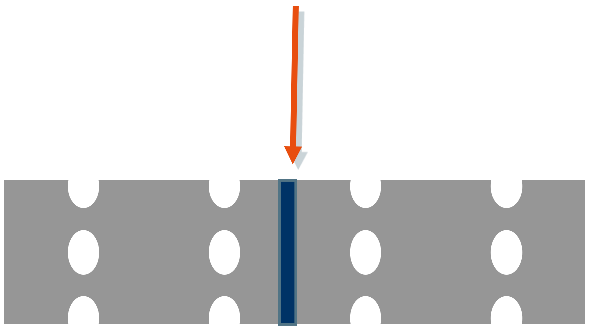
" a " type fuse (aM, URD, A70QS etc.)

Generally very fast acting fuse

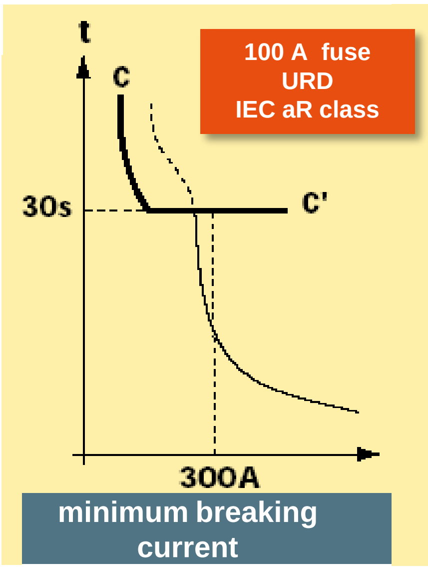


" g " type fuse (gRB, gG, etc.)

with M-effect fuse element



SOME DEFINITIONS – 2 LARGE FAMILIES OF FUSES



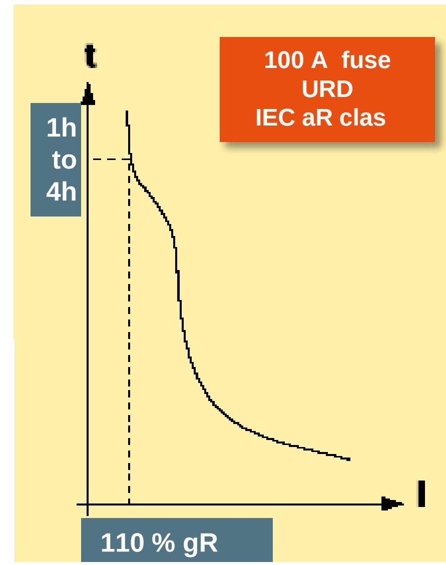
Above the CC' curve it is forbidden to use the fuse (association with another protective device is absolutely necessary)

IEC 60269 « a » type fuses:
aM (motor)
aR (semiconductor)

UL 248 part 13 fuses: protection of semi conductors (component « UL Recognized »)

Mersen examples:
PSC 690 V URD (semiconductors)
aM fuses (motors)
Form 101 fuses (A50P, A70P, A70QS, …)

As soon as the overcurrent can cause the melting of the fuse (even in 4 hours), « g » fuses can break all currents.

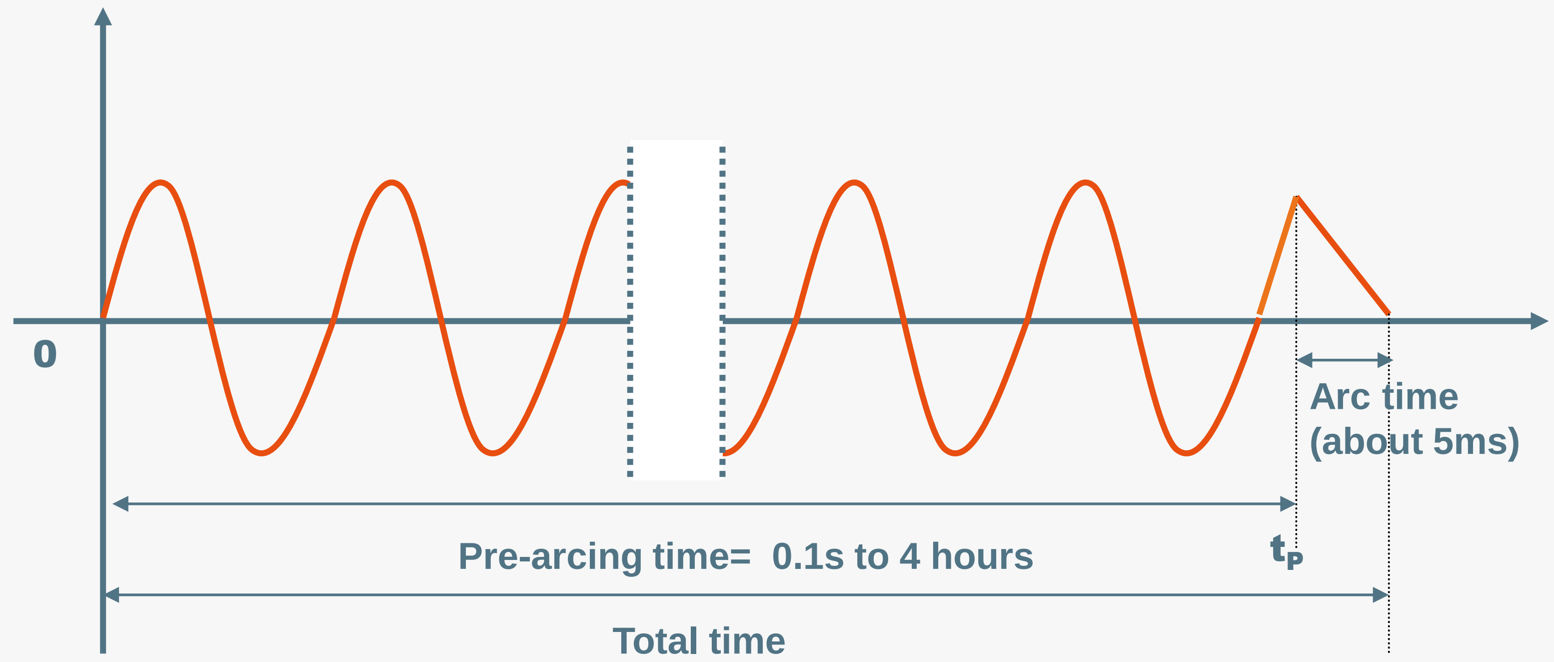


IEC 60269 « g » type fuses :
general purpose: gG, gM, gN, gD
semiconductor: gS & gR

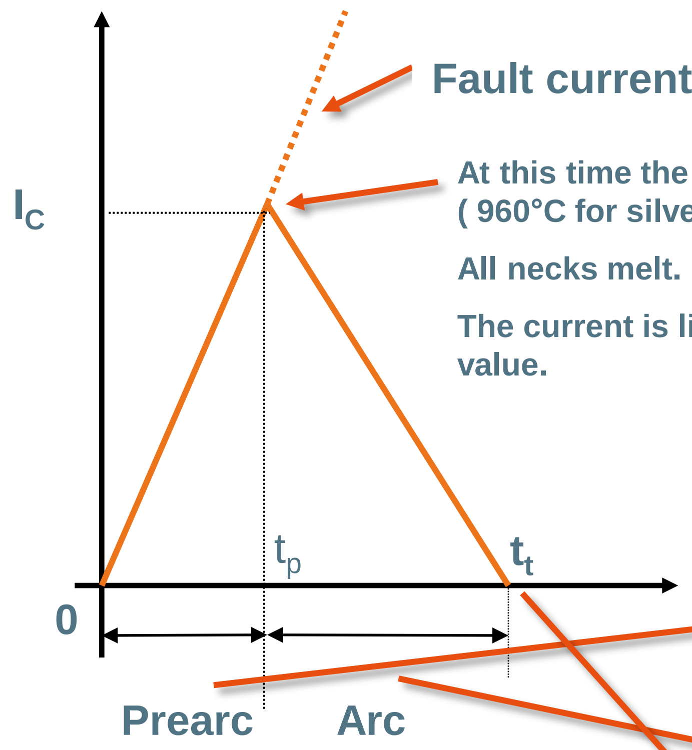
UL 248 fuses: classes J, L, RK5, RK1, T, K5, K,H…..(component « UL Listed »)

Mersen examples:
PSC 690 V gRB (semiconductors)
gG (general purpose)
AJT fuses (class J Time Delay)

OVERLOAD FAULT



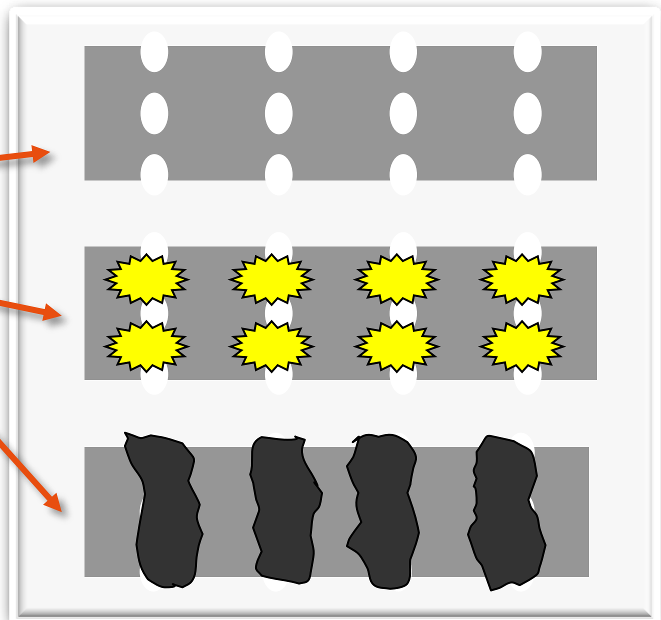
BREAKING OF A SHORT CIRCUIT CURRENT



At this time the melting temperature of the fuse elements is reached (960°C for silver).

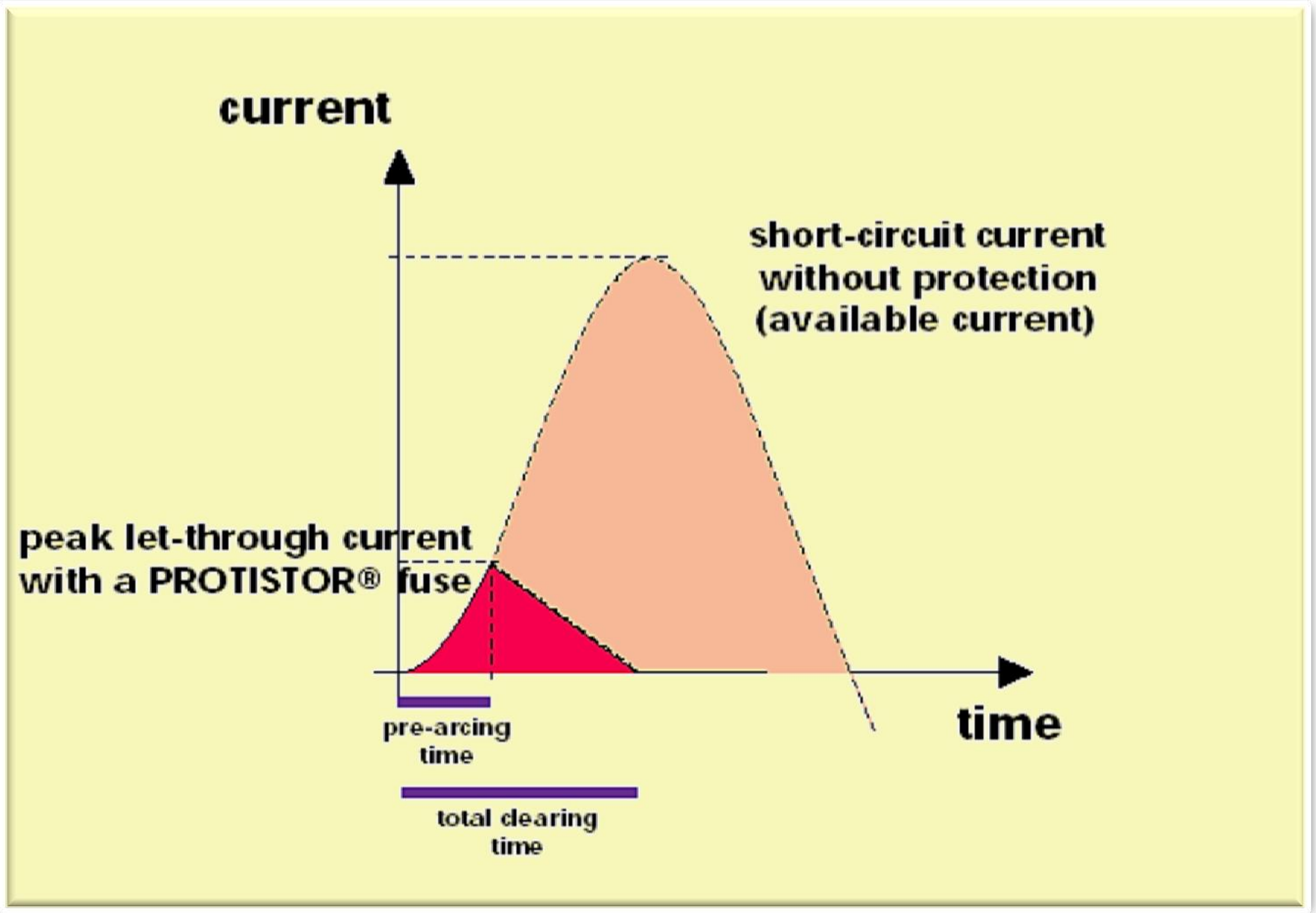
All necks melt.

The current is limited at I c and starts to decay toward the zero value.

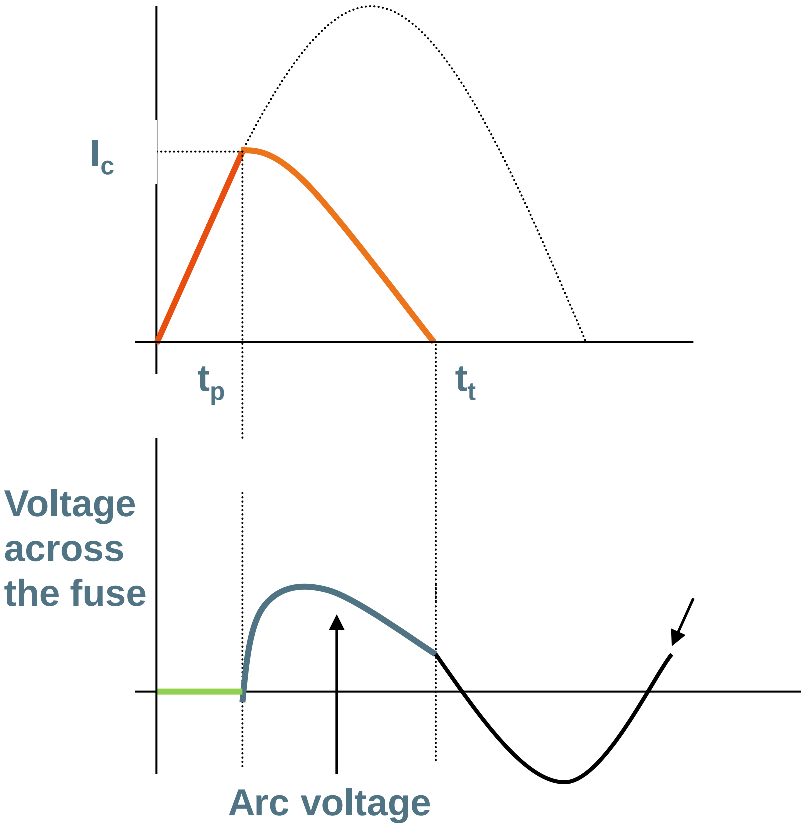


t_p = prearc time (10 µs to 10 ms)
t_t = total clearing time
$t_t - t_p$ = arcing time (about 5 ms)
I_C = peak let through current or cut off current

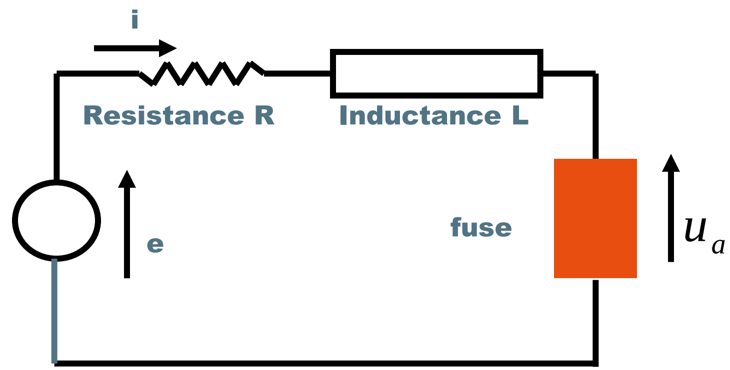
CURRENT LIMITING EFFECT OF A FUSE



FUSE MUST PRODUCE AN OVERVOLTAGE



breaking oscillogram



$$u_a = e - L\frac{di}{dt} \rightarrow \frac{di}{dt} = \frac{1}{L}(e - u_a)$$

The di/dt is negative when U_a is larger than e

↓

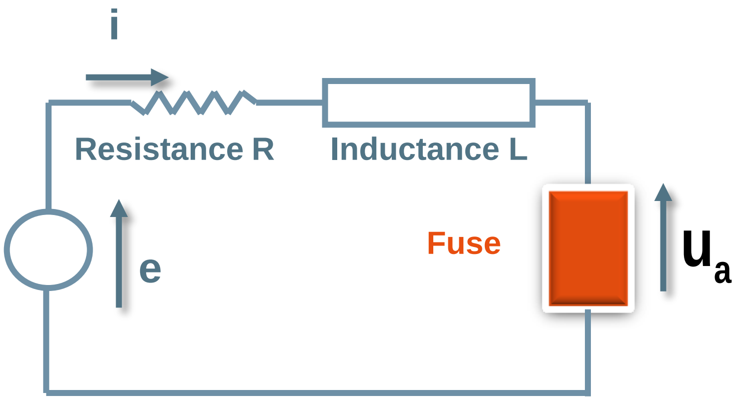
The arc voltage must be higher than the generator voltage

INTERRUPTING ENERGY = ARC ENERGY

$$W_a = W_L + W_S - W_R$$

W_a : Arc energy

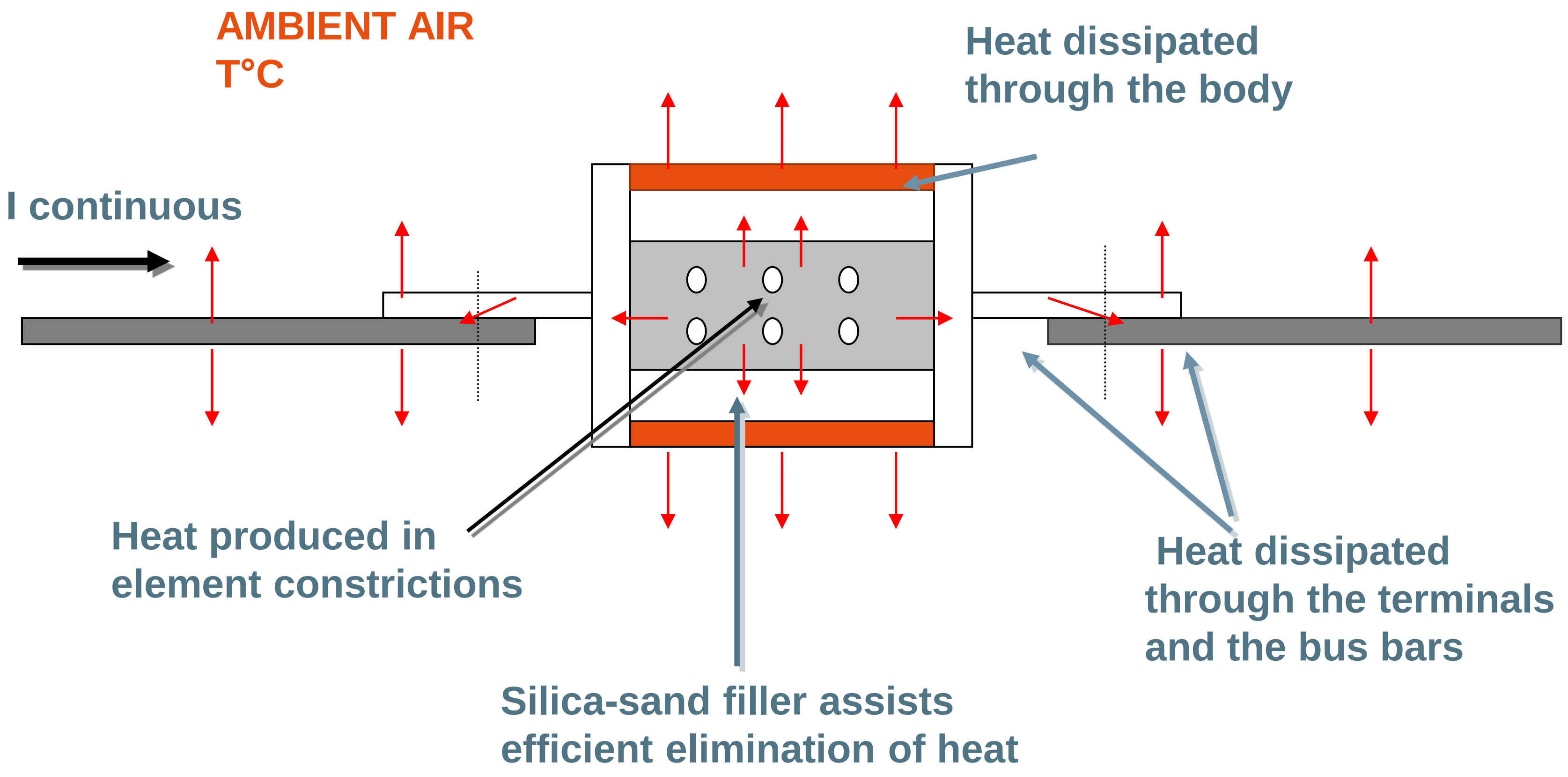
W_L : Energy stored in the inductance $W_L = \frac{1}{2} L I_C^2$



W_S : Energy supplied by the power source

W_R : Energy dissipated in the resistance

FUSE UNDER NORMAL CIRCUIT CONDITIONS (TEMPERATURE RISE TEST)



INFLUENCE OF THE COOLING

		FUSE		
Fuse length		So called 'short fuses' U_n<700V	So called 'long fuses' U_n=1000V to 2000V	Very long fuse U_n>3000V
Heat removal		80% via connections 20% via fuse body	20% via connections 80% via fuse body	1% via connections 99% via fuse body
Influence On I_{ccc} Current Carrying Capacitiy	Air flow 5m/s	Necessary on both body and connections Iccc = 1.25 I_n	Necessary on body Iccc = 1.25 I_n	Necessary on body Iccc = 1.25 I_n
	Low temperature on fuse connections (less than 60°c)	I_{ccc}= 1.25 I_n to 1.35 I_n	I_{ccc}= 1.05 I_n to 1.25 I_n	I_{ccc} = I_n

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Expertise, our source of energy