“Trends of the technical development of fuse cutouts manufactured by ETI”

Over the recent years, instead of announced by many groups of specialistic atrophic tendencies fuse cut-outs, made the scene many new and enhanced solutions regarding construction and technology of low voltage fuse cut-outs made the scene. They there are still most certain protections **of lines and** devices **against short-circuit.**

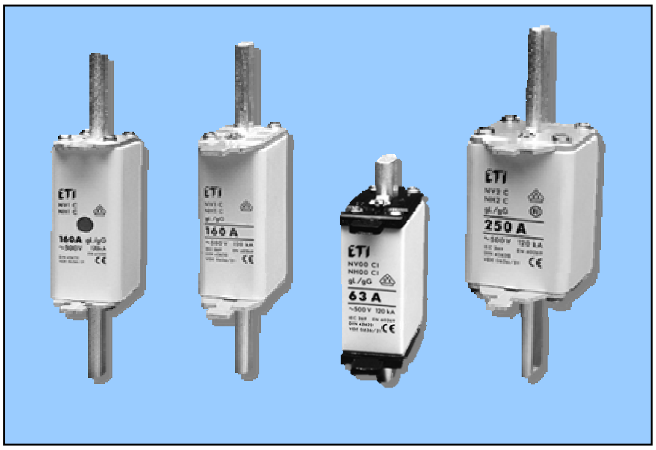
Andrius Bajoras

ETI Baltus

Currently main trends regarding development of installation (for general use) and industrial fuse cutouts manufactured by ETI, pursue:

- improvements and introductions of new time-current characteristics
- extension of rated currents ranges for installation fuses type D
- improvement of electrical parameters, such as - decreasing power losses ΔP, **through the usage of silvered contact points in installation links** D **and knife contacts in industrial links** NH**, (**Fig. 1) increasing short-circuit capacity Ic, through the fuse elements geometry modification,

- adapting of new fuses design eg. with not full range characteristics aM **(**industrial WT and cylindrical C**)** intended for cooperation with automatic current protections devices in circuits supplying electric motors.
- improvements of the construction of fuses with transformer characteristics gTr, to protect secondary circuits of power transformers.
- extension the family of fuses with very quick characteristics gR and **aR,** intended to protect solid-state devices- diodes, thyristors etc. with very small Joul's switch off integrals values and very small values of surges generated during short-circuits switching off.
- adapting of new implementations of fuses, making easy their exploitation - compact fuses C -- smaller ceramic bodies, insulated attachments for insertion and takings out from the base - to increase the safety, the side- indicator - to ease the visual qualification of fuse link disconnector work stages.
- the modernization of side indicator - to eliminate defecting of no matter which part (even isolating) after getting down to work the fuse. (requirement of the Low-Voltage Resolution)
- replacement of porcelain- bodies with more temperature differences resistant and more captive of heat emission - the steatite.



- a common feature of actually driven work over a development of fuse cut-outs is the adaptation of their construction to the optimum- protection of the installations according to obligatory requirements of European Union norms. One of the most important of fuse links parameters, is **power loss** $\Delta\Pi$ i.e. the power lost on the fuse during the current flow. Given in catalogues rated power loss is measured at the current flow through the fuse link the rated current in time of 1 hour. In order to the fuse has the lowest temperatures increases, his power loss must be also as lowest as possible. In structure of fuses, occurs very much close relationship between three most important electric parameters: rated power loss - ΔΠ, thermal Joule′s integral of switching off I^2t**,** and short-circuit ability to switching off Ic by the fuse. The smaller value of rated power loss ΔΠ, the more difficult is to obtain the high short-circuit ability to switching off Ic value and the small value of the Joule's integral I^2t **.** Fuse links manufactured by ETI, thanks to the use of the special technology, the high grade of colored metals (copper, brass, silver, aluminum), ensure the high short-circuit ability to switching off Ic, low power losses ΔP (lower than allowed by IEC norms) and also low values of thermal Joule's integrals for switching off I^2t**.** The limitation of power losses in fuse links was obtained through the suitable construction of the fuse elements and by choosing the suitable profile of their contact- knives and to cover them with galvanic layer of silver. The European norm IEC 60269- 2 sensitively defines admissible power losses ΔΠ **for fuses of each** size**. (Table 1)**

Value	NH - 00C	NH - 00	NH - 1	NH - 2	NH - 3
ΔP	7,5 W		23 W	34 W	

Catalogues values of imported fuse cut-outs from Far East have considerably higher declared power losses than allowed in IEC norms. Thus eg. NH 00C - 11W, NH-1 - 25W, NH-2 - 40 W. The real measured in laboratory power losses are much higher (from 20% to 200%). So large exceeds of admissible power lossesεσ ΔP threatens to fuse link overheat, and consequently fuses accessories- fuses bases , fuses disconnectors, cable clamps what can cause weaknesses isolation and may lead to the short-circuit in the switch box. Further more, the fuse being characterized by high power losses, working in conditions of the elevated ambient temperature - approx. +40 oC can get down to work (burn) already when charged with rated current In. If the user determines to use cheap fuses with large power loss ΔP takes all kinds of risks, like uncertainty of power supply and incurrence of additional consequential costs from the damage of the electric equipment, frequent fuses replacements and higher consumption of electric energy .

About the importance of the ΔP parameter - rated power loss - speaks also the fact, that industrial fuse links most often determine the before meters protection, then all consequential costs from the excessive heat emission by fuse links carries electrical energy provider - Electricity Generating Board. Evaluating the quantity installed and working in the country industrial fuse links type NH and installation type D, on approx. several millions pieces is - theoretically decrease of rated power losses ΔP only one 1W fuse, adds up to the energy saving approx. several megawatts in the scale of the country !.

Further more, silvered contact points ensure low resistance of the contact point between fuse link and fuse base, consequently preventing the local exceeding of the admissible overgrowth of the temperature ΔT . The silver- coat prevents also the oxygenation himself of the copper or brass contact- knife. The low value of the parameter I^2t - the thermal Joule's integral was obtained through the special construction of the fuse element made from the copper coated belt with the galvanic layer of silver and in case of Ultra-Quick fuses with thyristor characteristic gR or **aR - with** pure silver. Example- shapes of fuse elements shows Figure. 2.

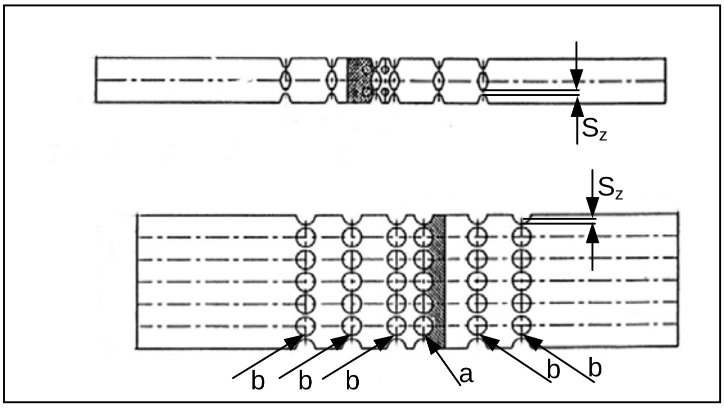


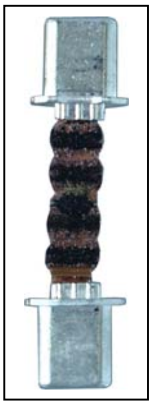
Fig. 2 Cutouts fuse elements

Values of thermal Joule's integrals I^2t are perfectly fitted for short-circuit selectivity analyses of the electric circuit touched with the short-circuit. The thermal integral is a measure of the heat energy in joules [J/R]- A^2s (on the unit of resistance of 1 ohm) portioned out in the fuse link and on all elements of the examined circuit. On the Figure 2 showed (a)- row of surcharge strangulations and (b)- row of short-circuit narrowings. In case of the surcharge of protected circuit, the fuse element of the cutout, should burn on surcharge narrowings (a) in time corresponding to its characterization t-**I characteristic.** In case of the short-circuit, the cutout fuse element burns on all short-circuit narrowings- b (Rys.2) after interception of the definite value of the energy I^2t, strongly dependent from the cross-section of short-circuit narrowing S_z according to following formula:

$$\int_0^{tp} i^2 \, dt = S_z^2 K$$

Where K is a materials factor (Meyer's constant) of the fuse link narrowings, dependent from its melting-point, specific heat and electric conductivity.
During switching off the short-circuit depends on, that the fuse-link should break up on as longissimus section as possible, so that isolating gap will be as much long as possible. In consequence of operation very the high temperature of the voltaic arc on quartz- sand in the arched space of the fuse, the clod of the glass blend with melted copper or silver so-called „zeszkleniec (glassy)" is forming up. (Fig.. 3).

Fig. 3 Burned fuse element



Its resistance is not infinitely great and in unfavorable circumstances the fuse can again begin to conduct the current . Hence, the necessity of the creation by constructor in the fuse narrow arched chamber of advantageous terms for extinction of the voltaic arc during switching off large short-circuit currents. One these conditions is the entire fulfillment of the fuse with properly well-chosen quartz- sand. **Not the full level of quartz- sand in the arched space of the fuse (Fig. 4) in the moment of switching off the short-circuit, makes impossible extinguishing burning voltaic arc, what can cause the fuse explosion or the get out the arc outside through the upper cover of the fuse (Fig. 5).**

Fig. 4 To low level of the quartz sand in arched chamber for the fuse imported from Far East.

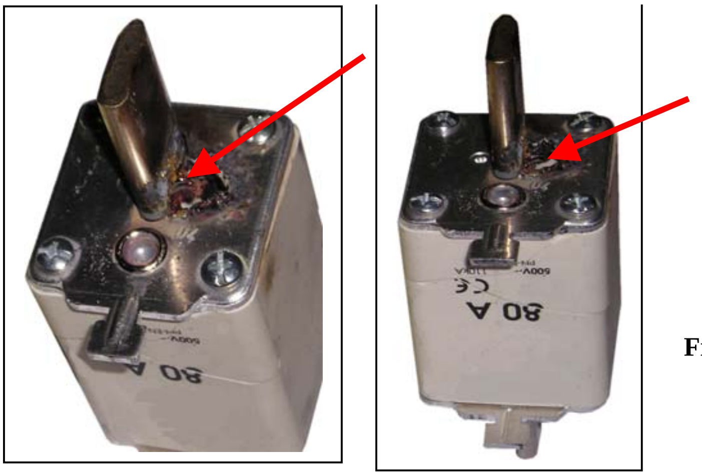


Fig. 5 Get out of the voltaic arc, because of the to small level of the quarto sand.

This occurrences are very dangerous ,because both the fuse explosion and the get-out of the voltaic arc outside can cause the full short-circuit in the switch box and as a result can lead to big material losses as well as the possibility of the fatal accident among servicing personnel. The special attention should be pay to the quality of used fuses and to reject these, which are descended from unknown manufacturers, and especially these very cheap imported from Far East.
Design of power NH fuse cutouts according to IEC 60269-1 norm should ensure consistency of fuse parameters within the range temperatures range from - 5 ^{o}C to + 40 ^{o}C. If manufacturer declares other temperature range (eg. from -35 ^{o}C to +35 ^{o}C, must have the confirmation in the form of the official record from research issued by accredited laboratory). Detailed technical data of fuses , especially values of the integral Joule's I^2t of power losses ΔP, are given in tables in the summary ETIPolam catalogue. Power fuse cutouts

manufactured by ETI through the precise construction assure correct switching off currents surcharges and the highest short-circuit currents. They ensure short-circuit ability to switching off current of 120 kA for 500 V(gG) voltage.

Andrius Bajoras

ETI Baltus