Protection of Capacitor Banks

Problem: With the existing design of the capacitor banks it could happen that the capacitor explodes. The very probably reason for that is that the used MCCBs (Molded Case Circuit Breakers) do have a slow trip time.

Existing Design: Enclosure I shows a typical circuit arrangement as it is used at the moment.

As you can tell from enclosure I the capacitors are protected by MCCBs, which however cannot provide a sufficient protection of the capacitor banks.

By the assumption that the used MCCBs are with a bimetal for protection of the over current range as well as equipped with a striker for the short circuit range it can be concluded as follows.

By having an over current the switch mechanism of the MCCBs will be opened by the bimetal and disconnect the current supply, if the selection of the MCCB is correct for this current.

This over current could happen because of:
- ❖ higher system voltage
- ❖ harmonic disturbances
- ❖ tolerances of the capacitors

As of a determined current releasing should be given by the striker.
Enclosure II shows an example of a MCCB with a striker which is adjusted to release at 4-times I_N.

It is shown in enclosure II that the release time of the MCCB striker with increasing fault current is not getting shorter. Therefore the operating I^2t-value is getting higher (please refer to the time current characteristic of the HRC fuse-link).

Due to the above, it could be that the capacitor will explode.
The task of the short circuit protection is during a failure to protect the system by disconnecting the faulty (punctured) capacitor, before the capacitor will explode.

Solution: If in the system additional to an overload protection HRC fuse-links are installed the over-current protection is given sufficiently (see enclosure III).

The HRC fuse-link specification IEC 60 296 does not list any protection of capacitors or capacitor banks, as this application is for more or less inductive circuits only.

Because of the very difficult cut-off conditions in electric circuits with capacitors, HRC fuse-links cannot provide a protection for overload of capacitors.

In the case of a faulty (punctured) capacitor the short circuit current is not capacitive.

For the selection of HRC fuse-links please refer to table 9.1 of specification IEC 61818 or to the following table 1.

Table 1: Fuse selection for power factor correction capacitors (Fuses according to IEC 60269-2-1, section I)

	Rated voltage (3 phase 50 Hz system)		
P F Correction Capacitor	400 V (k = 2.5)	525 V (k = 2)	690 V (k = 1.5)
LV fuse-link	500 V	690 V	1000 V *
Capacitor Size Q_N / kVAr	Rated current I_N of the fuse		
up to 5 kVAr	16 A		
up to 7,5 kVAr	20 A		
up to 12,5 kVAr	35 A	35 A	
up to 20 kVAr	50 A		35A
up to 25 kVAr	63 A	50 A	
up to 30 kVAr	80 A	63 A	50 A
up to 40 kVAr	100 A	80 A	63 A
up to 50 kVAr	125 A	100 A	80 A
up to 60 kVAr	160 A	125 A	100 A
up to 80 kVAr	200 A	160 A	125 A
up to 100 kVAr	250 A	200 A	160 A
up to 125 kVAr	315 A	250 A	200 A
up to 160 kVAr	400 A	315 A	250 A
up to 200 kVAr	500 A	400 A	315 A
up to 250 kVAr	630 A	500 A	400 A

* 690 V also possible with fuses size 1 minimum