

**5\* A** At least, the substation transformer are to replaced or modified, in order that output voltage become 30 % higher. Check if the rectifier can support higher input voltage, if yes, the current will be 30 % lower. If no, they are to be replaced by new ones. Insulation distances are to be checked. Perhaps insulators do not need to be changed, if type 1500V= were installed in order to receive cheaper standards components. All the system has to operate by peak voltage of 1800 V=. The contact wire dont need changes: at the same power, the currents will be 30 % lower. The losses on line will be reduced of 30 %!

**B** To series have to be studied separate: 8 EMU, 16 years old, and only 2, 30 years old (in 2008).

**Be8/8** If all equipments – included motors – have isolating characteristics to support the voltage 1800 V= (1500 V= + 20%), a simple solution could be chosen: bound the duty cycle at 80 %, to have the same traction effort characteristics. Control electronic has to be change is this sense. Auxiliary systems could probably be powered through a 1500/1200V= chopper. Seeing the age of these vehicles and the remaining life, the study and modification costs can probably not be redeemed. The best solution is probably to be scrapped. They have no chance to be sold as second hand. If isolations are not sufficient, it remains only scrap.

**Be4/4** Insulation of the main chopper GSS has to be checked: is its insulation sufficient for 1800V=? If yes, its duty cycle can simply be limited at 80 % =  $100 \cdot 1200 / 1500$  %, by an update of control program; perhaps the actual control program is sufficient to control the DC-link. In this case, the DC-link remains unchanged, as all components below (inverters and motors). If no, a financial analysis has to be done for the replacement of the input chopper.

For the auxiliary services, only the inverters « Umformer » are to be adapted at the new voltage. Perhaps a replacement by a standard device 1500V=/400V~ (16 pieces + reserve) is cheaper. Its output is a 50 Hz network: all connected devices can remain unchanged.