VI - HOW TO CALCULATE THE POWER OF CAPACITORS

1) CALCULATION FROM ELECTRICITY BILLS (LV or MV metering EDF "Tarif Vert" rate subscribers)

ÉNERGIE RÉACTIVE P + HP	ÉNERGIE RÉACTIVE P + HP au niveau du comptage	TANGENTE phi			
		secondaire		primaire	
120.000	125.000			0	96

kvar h en franchise	kvar h en consommés
	120.000

kvar h à ristourner	kvar h à facturer
	70.000

	PUISSANCES SOUSCRITES					PUISSANCES RETENUES POUR CALCUL DE PRM					PR		PRM		Dépassement à facturer
	P1	P2	P3	P4	P5	P1	P2	P3	P4	P5					
	525	590	590	590	590						560	1			

From 1st November 1987, in France, the reactive energy billing limit changed for all "tarif Vert" rate subscribers (LV or MV metering) to:

* tg φ = 0.4 or cos = 0.928: on the primary winding,
* tg φ = 0.31 or cos = 0.955: on the secondary winding.

For the calculation of the capacitor banks to be installed, proceed using the following method:

- analyse the 5 electricity bills from November to March,
- select the month for which the bill is the highest (kvarh to be billed),
- evaluate the number of hours of operation of the installation every month in day-tariff and peak hours (generally 6 a.m. to 10 p.m. excluding Sundays),

- calculate the capacitor power Qc to be installed

$$Qc = \frac{\text{kvarh to be billed (monthly)}}{\text{Nb.of working hours (monthly)}}$$

* for LV metering, in the calculation of the kvarh to be billed, EDF introduces a fixed rate transformer consumption by applying a coefficient of 0.09 on the secondary winding tg φ calculated to obtain the primary winding tg φ.

Example

Take the subscriber SMITH :

. highest reactive energy bill : December 87,

. number of kvarh to be billed : 70,000,

. monthly number of hours of operation : 350 hours (day-tariff + peak)

$$Qc \text{ (bank to be installed)} = \frac{70.000}{350} = 200 \text{ kvar}$$

2) CALCULATION FROM MEASURING ELEMENTS READ ON THE HV/LV TRANSFORMER SECONDARY WINDING/ PkW - COS φ

Example :

Take a plant powered from an 800 kVA HV / LV subscriber station which would like to change the power factor of its installation to :

* Cos φ = 0.928 (tg φ = 0.4) on the primary winding
* or Cos φ = 0.955 (tg φ = 0.31) on the secondary winding

with the following readings :

- voltage: 400 V three-phase 50 Hz
- P = 475 kW
- Cos (secondary) = 0.75 (or tg φ = 0.88)

Qc (bank to be installed) = Pkw (tg φ measured - tg φ to be obtained)

Qc = 475 (0.88 - 0.31) # 270 kvar

Note: the coefficient K = (tg φ measured - tg φ to be obtained) is obtained easily from the Cos φ values using the conversion table on page 9.

3) CALCULATION FOR FUTURE INSTALLATIONS :

For future installations, compensation is frequently requested from the commissioning stage. In this case, it is impossible to calculate the bank using conventional methods (electricity bill or measurements on-site).

For this type of installation, it is recommended to install a capacitor bank equal to approximately **25% of the nominal power of the corresponding HV / LV transformer.**

Example:

1000 kVA transfomer => Q capacitor = 250 kvar

Note : this type of ratio corresponds to the following operating conditions:

- 1000 kVA transformer
- real transformer load = 75%
- Cos φ of load = 0.80
- Cos φ to be obtained = 0.95

} k = 0.421 (table on page 9)

Qc = 1000 x 75% x 0.80 x 0.421 = 250 kvar

4) CALCULATION FOR INDEPENDENT PRODUCERS (SMALL POWER STATIONS)

For this type of installation, the independent producer must supply the electricity company with a quantity of reactive energy equal to at least 40% of its active energy production during WINTER day-tariff and peak hours.

In this case, the calculation of the capacitor bank should account for:

- the on-load reactive consumption of the generator
- the on-load consumption of the LV / HV transformer (if applicable)
- the reactive energy to be supplied, or 40% of the active energy produced