COURSE 6

LV dimensioning calculation starts from the receiver to the source, in the following order:

- Sizing receiver's (or equipment's) circuit
- Sizing supply columns
- Sizing substations

Dimensioning LV networks is to determine the conductors' section and to choose the equipment that ensures the protection of networks and of receivers.

According to norm I7 / 2011 (Standard for the design, construction and operation of electrical installations for buildings), normal lighting circuits must be separate from socket-outlet circuits and generally have common electrical distribution board with the following exceptions:

- If are applied different tariffs for electricity consumption
- If the power receiver's operation causes disturbing phenomena in lighting installation (flicker, lumens reduction)
- If it is necessary to separate the technological installations for safety or economic considerations.

Load and peak current calculation for receiver or equipment circuits

Load current for a single phase circuit

Socket-outlet single phased circuits are used in supplying single-phased power receivers, whether directly or through a flexible conductor from an outlet. The load current (calculation current) coincides in this case with the receiver's rated current and it's determined with:

$$I_n = \frac{P_n}{U_n \cdot \eta_n \cdot \cos \varphi_n}$$

The installed power on a socket-outlet circuit is considered P_i=2kW. Receivers with power over 2 kW (washing machines, air-conditioning units) can be connected through dedicated outlets or through fixed junctions. For connecting/disconnecting these receivers there are foreseen electrical drives on the supplying circuit.

Load current for lighting systems

See seminar

For industrial installations, the standards establish:

- Installed power is maximum 3kW
- On a circuit cannot be connected more than 30 luminaires.

In practice there are adopted half of the values above.

For household lighting installations, the standards (norms) establish:

- At the apartments with an installed power of 6kW, the lighting installed power is maximum 1,5kW and maximum 15 luminaires can be connected;
- At the apartments with an installed power of 4kW, the lighting installed power is maximum 1kW and maximum 12 luminaires can be connected.

Load and peak current for a three-phase circuit

1. three-phased receiver

Given the rated parameters of the three-phased receiver: P_n[W] – output power (mechanical power), rated voltage, rated power factor and rated efficiency, can be determined:

- Load (calculation) current: $I_{cm} = \beta \cdot I_n$ or $I_n = \frac{P_n}{\sqrt{3} \cdot U_n \cdot \eta_m \cdot \cos\varphi_m}$, where $\beta = \frac{P_s}{P_n}$ represents the load coefficient (factor). Its value is always less than one because maximum demand is always more than average demand since we will not connect all the loads at a time and that to we will not operate its full capacity. A high load factor means power usage is relatively constant. Low load factor shows that occasionally a high demand is set.
- Peak current or start-up current of electrical motors is determined with: $I_{pm} = \lambda^* \cdot I_n$, where λ* is the relative start-up current, calculated as follows:
  - For $\lambda_n = I_p/I_n$, $\lambda^* = \lambda_n$ at direct starting
  - $\lambda^* = \lambda_n/3$ - at star-delta starting;
  - $\lambda^* = \lambda_n/k_T^2$ - autotransformer starting with k_T transforming ratio;
  - $\lambda^* = \lambda_n/(1,2\ldots2)$ - rheostat start-up.

In case of consumers connected directly to the grid, the start-up of electrical motors is:

- direct, for motors having:
  - maximum 4kW when U_f=230V
  - maximum 5.5kW when U_f=400V.
- with special devices, having a preset start-up current (for electrical motors with higher powers than above, to the related voltages).

In case of consumers supplied through a substation, the power of the largest motor that can start directly is determined by calculation - based on thermal stability and electrodynamic verification of the power transformer (from substation), but must not exceed 20% of the transformer's power and will be connected directly to the TG (general electrical distribution board).

For other cases are established appropriate methods of starting, by type and motor power (taking into account the specifics of the driven electrical machines).

Reminder:

The nominal power in kW (P_n) of a motor indicates its rated equivalent mechanical power output.

The apparent power in kVA supplied to the motor is a function of the output, the motor efficiency and the power factor.

Although high efficiency motors can be found on the market, in practice their starting currents are roughly the same as some of standard motors.

The use of start-delta starter, static soft start unit or variable speed drive allows to reduce the value of the starting current.

2. equipment

It is allowed to supply several power receivers of the same kind (eg. motors) through a circuit fitted with a short circuit common protection if total installed capacity of these receivers does not exceed 15 kW.

For **machines/equipment (= more than 4 receivers)** or groups of receivers, with maximum group power of 15 kW, the load current is determined as the sum of the load currents of receivers or with relationship:

$$I_{cu} = \frac{\beta}{\sqrt{3}U_n \eta_m \cos\varphi_m} \sum_{j=1}^{s} P_{nj} \text{ , } s > 4 \text{ , where:}$$

$$\eta_m = \frac{\sum_{j=1}^{s} P_{nj}}{\sum_{j=1}^{s} \frac{P_n}{(\eta_n)_j}} \text{ and } \cos\varphi_m = \frac{\sum_{j=1}^{s} (P_n / \eta_n)_j}{\sum_{j=1}^{s} \left(\frac{P_n}{\eta_n \cos\varphi_n} \right)_j} \text{ - if } P_{nj} \text{ is the output power (mechanical)}$$

$$\eta_m = \frac{\sum_{j=1}^{s} (P_{nj} \eta_n)_j}{\sum_{j=1}^{s} P_{nj}} \text{ and } \cos\varphi_m = \frac{\sum_{j=1}^{s} P_{n\,j}}{\sum_{j=1}^{s} \left(\frac{P_n}{\cos\varphi_n} \right)_j} \text{ - if } P_{nj} \text{ is the input power (electrical, absorbed power).}$$

The peak current (start-up current) is determined assuming the worst case, that of all the receivers (machine/equipment's components), there remains to start only the one with the heaviest start:

$$I_{pu} = I_{cu} + \left(I_{pm} - I_{cm} \right)_{\max}$$

Where $(I_{pm} - I_{sm})_{max}$ is the biggest difference between starting current and load current of one of the receivers.