

# Power Cable Ampacity Rating - Installations

## Installations modeling including non-standard configurations

The CYMCAP Additional Modules offer extended capabilities to the CYMCAP software, allowing modeling more installations, particularly non-standard installations. This includes the modeling of installations with multiple ductbanks and backfills each with different thermal resistivity; the calculation of the ampacity and temperature of cables in unventilated tunnels; the rating of cables in both filled and unfilled troughs; and the rating of cables in one or more non-magnetic casings.

### Multiple Duct Banks and Backfills

The Multiple Duct Banks and Backfills add-on module (MDB) is designed to determine the steady-state ampacity of cables installed in several neighboring duct banks and/or backfills with different thermal resistivity. The module presents a unique solution combining standard and non-standard calculation methods. The module computes the values of T4 (the external thermal resistance to the cable) using the finite element method and then the ampacity (or operating temperature) of the cable installation is obtained using the IEC standardized solution method.

The following capabilities are highlighted:

- Modeling unlimited number of rectangular areas with different thermal resistivity
- Modeling up to three duct banks in a single installation

- Modeling one heat source or heat sink in the installation
- Computation of the steady-state ampacity or temperature
- Transient analysis, cyclic loading and emergency ratings are supported
- Computation of the thermal rating of cables installed in filled troughs

### Cables in Tunnels

The optional Cables in Tunnels module allows the user to determine steady-state temperature and ampacity, cyclic loading, emergency rating and transient analysis for cables installed in unventilated tunnels. Note that only equally loaded cables having the same type and loading are considered.

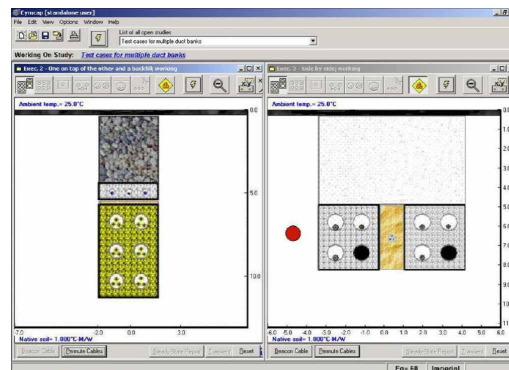
This add-on module supports a large variety of cable arrangements for single core (flat formations or trefoils) and three-core cables.

Major features are:

- Modeling of a large variety of installation methods: laying on the floor; hanging from a wall; in ladder-type racks; or in cable trays
- Cables and groups of cables can be single-core or three-core. Single-core cables can be arranged in flat formations (vertically or horizontally) or in trefoil
- Computation of the steady-state ampacity or temperature. Cyclic loading using daily, weekly and yearly load factors. Computation of emergency ratings



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# Power Cable Ampacity Rating - Additional Modules - Installations

Installations modeling including non-standard configurations.

## Cables in Troughs

The thermal rating of cables installed in unfilled or in filled troughs is determined using the CYMCAP/UNF and the CYMCAP/MDB modules respectively.

In these modules, a trough (or a trench) is defined to be a long shallow rectangular-shaped excavation, where the walls, bottom and cover are made of concrete. The cables can be installed on the floor, hanging from supports on the walls or racks. The trough can be filled with a material with good thermal properties or it can be left unfilled (air filled). The heat transfer mechanism is different for filled and unfilled troughs and therefore they are treated independently.

### Unfilled Troughs

Initially, the only option to rate unfilled trough installations was to use the IEC standard. In this approach the cables ratings are calculated as for cables in free air, but the temperature inside the trough is computed according to the IEC Standard 60287-2-1©. The module has been improved significantly and includes three options in addition to the IEC standard to model a given trough installation: Slaninka Method 1, Slaninka Method 2 and Anders-Coates Method.

With the IEC standard, thermal resistivities of the soil and the trough's cover are ignored. With the Slaninka Method 1, the thermal resistivity of the trough's cover is considered. The Slaninka Method 2 considers both the thermal resistivities of the cover and the soil surrounding the trough. With the Anders-Coates method, in addition to the thermal resistivities of the soil and the cover, the wind velocity above the trough is taken into account. In all options the user can choose whether the trough is exposed to sun radiation or it is shaded. The approaches

are all based on field research by independent parties and published in scientific journals.

### Filled Troughs

Filled troughs are treated in the CYMCAP/MDB module as multiple backfills. Cables in filled troughs are rated in the CYMCAP software using:

- Finite elements method to compute the external-to-the-cable thermal resistance T4
- IEC Standards procedures to perform efficiently ampacity calculations

Besides, the module offers:

- Computes the temperature and steady-state unequally loaded ampacity
- Facilities to move the troughs and model asymmetrical troughs
- Ability to perform cyclic loading rating through the use of load factors

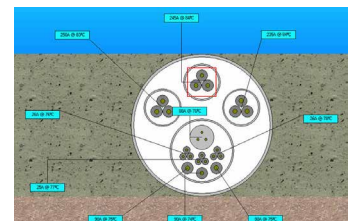
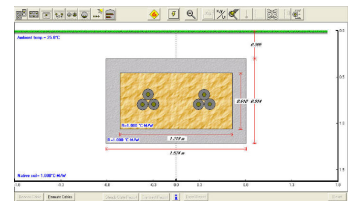
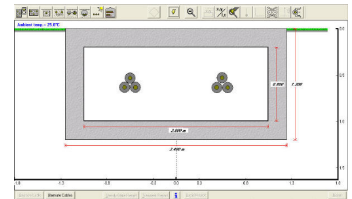
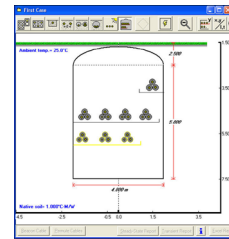
### Multiple Casings

The Multiple Casings add-on module (MCAS) allows the user to determine the steady-state unequally loaded ampacity and/or temperature rating of cables installed in one or more non-magnetic casings. In the CYMCAP software, a casing is defined to be a large non-magnetic conduit filled with air, inside which cables in ducts and cables not in ducts can be installed. Casings can be immersed in water, placed on the sea bed or buried underground. No other filling material other than air is considered in the casing(s) or in the duct(s).

The module features many modeling facilities among which the following capabilities can be highlighted:

- Different burial environments are allowed: water or underground

- Modeling of any number of casings in parallel in the same installation
- Modeling of any number of ducts inside one or more casings at the same time
- Capable of modeling any number of circuits inside a casing and a duct
- Circuits in ducts and in casings can be multiple cables per phase
- Several materials (including non-magnetic metallic materials) are available to model ducts and casings (PVC, polyethylene, earthenware, non-magnetic metal, etc.)
- Sizes of ducts and casings are not limited



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