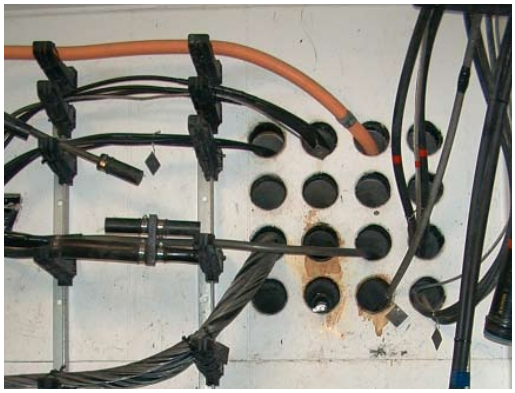


CYMCAP Additional Modules - Analyses

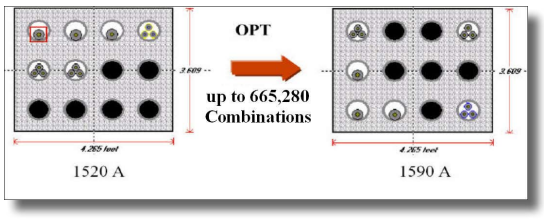
CYMCAP Additional Modules allows performing several analyses of interest for cables installations other than thermal analysis. With those modules, the user can evaluate the magnetic flux density at any point on or above the ground of an underground cable installation, determine the positive and zero sequence impedances and admittances for all the cables present in an installation, perform short-circuit cable ratings; determine the optimal placement of several circuits within a ductbank given specified constraints; and calculate of the ampacity of two circuits crossing each other.

CYMCAP/OPT, Duct Bank Optimizer Module

The duct bank optimizer is an add-on module to CYMCAP that allows the user to determine the optimal placement of several circuits within a duct bank. More specifically, the module can recommend the various circuit disposition within the duct bank in order that:

- The duct bank overall ampacity, i.e. the sum of the ampacities for all circuits, is maximized.
- The duct bank overall ampacity, i.e. the sum of the ampacities for all circuits, is minimized.
- The ampacity of any given circuit is maximized.
- The ampacity of any given circuit is minimized.

For a 3 by 4 duct bank with three trefoils and one three-phase circuit (one phase per conduit), there are up to 665,280 possible combinations. CYMCAP elaborated mathematical algorithm prevents the repetitive calculation of equivalent cases, therefore the solution is obtained very efficiently. The condition illustrated on the right hand side of the illustration shows the cable locations for maximum ampacity.



Cable Impedance Calculation

The Cables Impedance calculation module (ZMat) is the optional add-on to CYMCAP that determines the electrical parameters for cables necessary for performing network studies at the power frequency (50/60 Hz). The estimation of parameters is performed after an ampacity or temperature steady state simulation has been successfully completed. The final results of ZMat are the positive and zero sequence impedances and admittances for all the cables present in an installation.

All impedance and admittance matrices are displayed in the report: starting from the primitive matrices per section per metallic component, the transposed matrixes (if they exist), then the reduced to phase conductor matrices and finally the resulting symmetrical components matrices.

- Computation of the sequence impedances for all the cables present in an installation.
- Computation of the sequence admittances for all cables present in an installation.
- Multiple cables per phase are supported.
- One or more neutrals can be represented and are taken into account in the calculations.

R_Sequence [Ω/mile]

		Circuit 1		
	Sequence	0	1	2
Circuit 1	0	0.479803	0.00315	0.003266
	1	0.003266	0.161351	-0.008096
	2	0.00315	-0.008086	0.161351

X_Sequence [Ω/mile]

		Circuit 1		
	Sequence	0	1	2
Circuit 1	0	0.160424	0.000879	0.000727
	1	0.000727	0.136366	-0.015287
	2	0.000879	-0.015419	0.136366

CYMCAP Additional Modules - Analyses

Perform analyses of interest for cable installations in addition to thermal analysis.

Magnetic Fields

The Magnetic Fields Module (EMF) is an optional add-on that can be connected to CYMCAP. Although this module is not directly related to cable thermal rating, it offers convenience to the CYMCAP users. After an ampacity or a temperature steady state simulation the module computes the magnetic flux density at any point on or above the ground of an underground cable installation. The output is a plot (or a table) of magnetic flux density versus position. Modeling features include:

- Infinite-length thin-wire two-dimensional approach.
- Consideration of time-varying currents producing an elliptically polarized rotating magnetic vector.
- The currents in a three-phase circuit can be unbalanced (in magnitude and phase).
- All media is assumed homogenous, isotropic and linear.
- The induced currents are neglected.

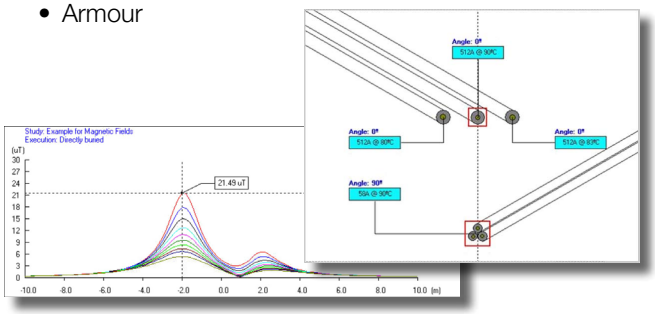
Short Circuit Cable Rating

The Short Circuit Cable Rating (SCR) add-on module to CYMCAP is dedicated to the rating of cables for short circuit currents. The implemented method is based on the IEC Standard 949© (1988) “Calculation of thermally permissible short-circuit currents, taking into account non-adiabatic heating effects”. CYMCAP computes both adiabatic and non-adiabatic ratings. CYMCAP /SCR offers two possibilities according to the known input data:

- Compute the maximum short-circuit current that a cable component can carry given the short circuit time together with the initial and final temperatures.
- Compute the final temperature that a given cable component will reach for a specified short circuit current, initial temperature and time interval.

The short circuit rating can be computed for up to the five metallic layers in the CYMCAP model:

- Conductor
- Sheath
- Sheath Reinforcement
- Concentric Neutral / Skid Wires
- Armour



Cable Crossing

The Cable Crossing (Xing) module is the optional add-on to CYMCAP that allows the user to determine the steady state ampacity of circuits crossing each other.

When two circuits cross each other, each behaves as a heat source for the other one. The amount of generated heat, the vertical distance between the crossing circuits and the crossing angle are the important parameters that influence the crossing rating. In the absence of crossing calculations, the general practice is to use the conservative result where the circuits are assumed to be parallel. When the circuits are parallel, the thermal interaction is maximum. It goes to a minimum when they cross each other at a right angle. The conservative approach unnecessarily derates both circuits. By using the Cables Crossing module, one can achieve ratings up to 20% higher than the conservative ampacities that are obtained based on the parallel installation scenario.

- Capable of modeling two circuits crossings each other in the same installation.
- Cable crossing is supported in directly buried underground, buried ducts and buried pipes underground.
- Rating approach follows the IEC standard 60287-3-3©.

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