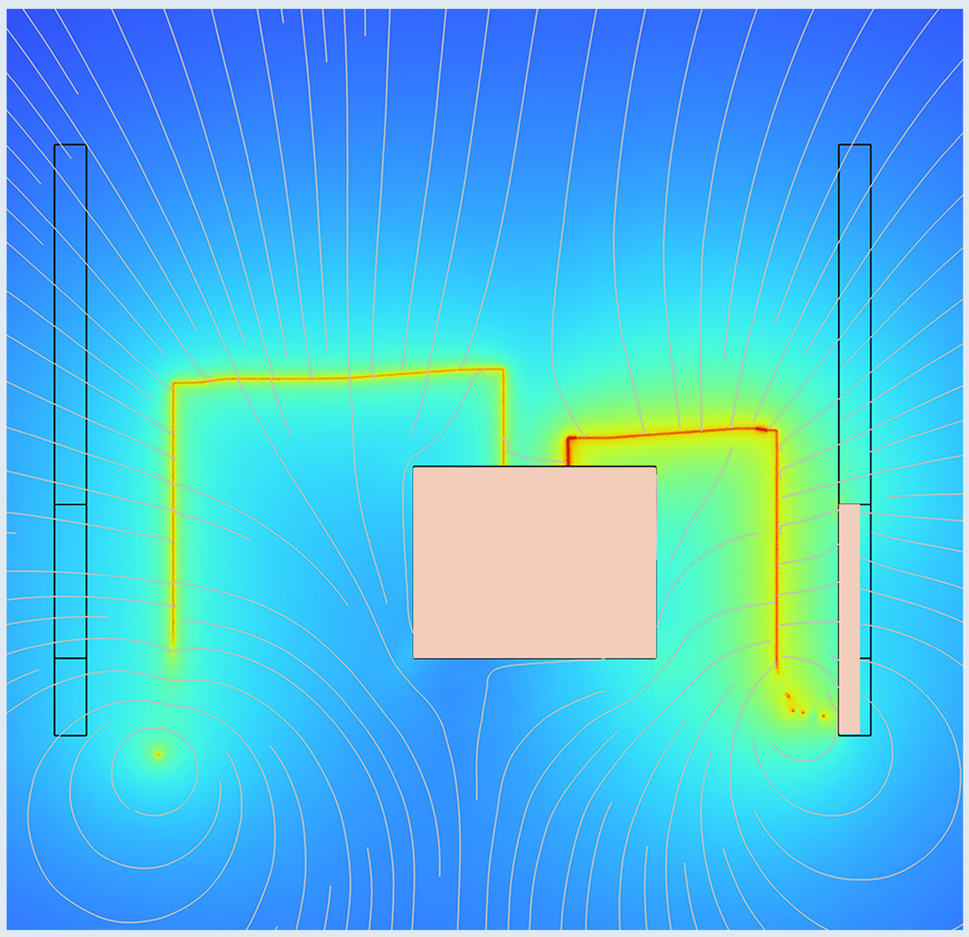

Magnetic Shielding of an Electrical Substation

Consistent and convenient treatment of current paths in a 3D model.

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Abstract

In an electrical substation, electrical cables are connected to transformers via unshielded components such as switching boards and busbars. The currents through these components generate large magnetic fields. There are regulations concerning the exposure of humans to magnetic fields.

For 50 Hz – the frequency used in the electrical grid – the maximum limit is 100 µT. To simulate the magnetic fields, the current distribution through the cables is calculated using an Edge PDE. This made it possible to calculate the magnetic fields, and in turn design magnetic shielding that reduces the magnetic field outside the substation.

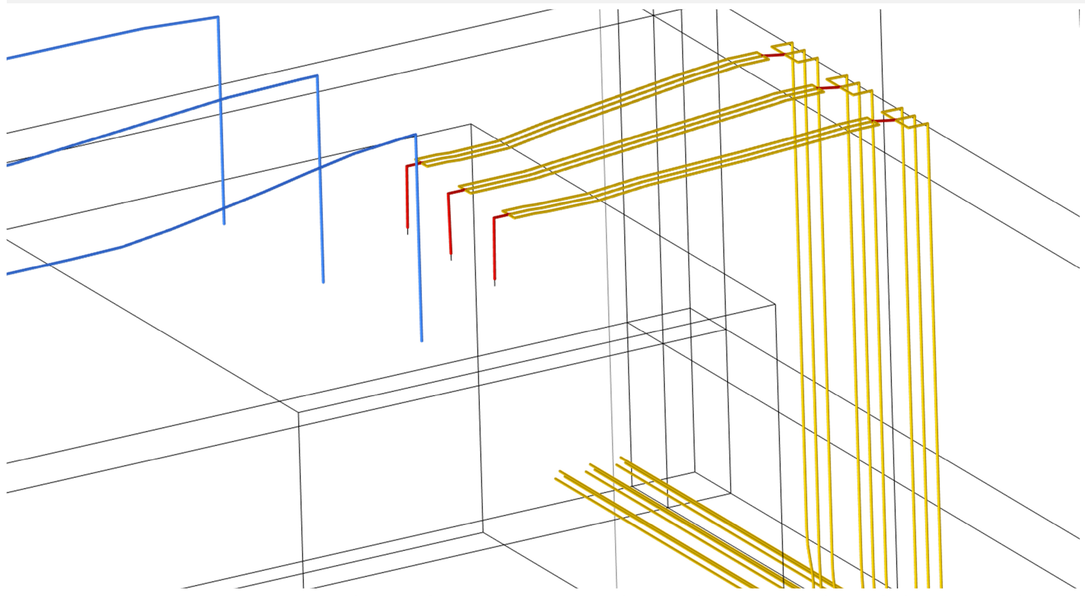

FIGURE 1. Current distribution on the electrical cables in the substation.

Current Distribution via an Edge PDE

To impose currents on electrical cables using the Edge Current feature, it is necessary to specify the current for each of the line segments. The direction of an edge is arbitrarily defined in the geometry, this requires consistent sign usage to apply the correct current to each line segment This becomes too tedious and error-prone to setup manually.

Therefore, the model contains an Edge PDE that defines and solves a Laplace equation on each of the edges. The current distribution computed by this function is then used as input for the Edge Current feature. This in turn allows for the calculation of magnetic fields and design of the magnetic shielding.

Results

Imposing a Laplace Edge PDE is an elegant solution for computing the current distribution for all cable segments, the result is shown in FIGURE 1. With this current distribution, we were able to compute the magnetic fields generated by the cables of the substation. The resulting 100 µT contour before magnetic shielding was applied, is shown in FIGURE 2 (left).

FIGURE 2 (right) shows the resulting 100 µT contour once magnetic shielding is applied to the right wall of the substation. The contour is now mostly confined to the interior of the substation, except for a small region that is inaccessible due to its height. With these simulations, we were able to design an effective shielding in the desired region.

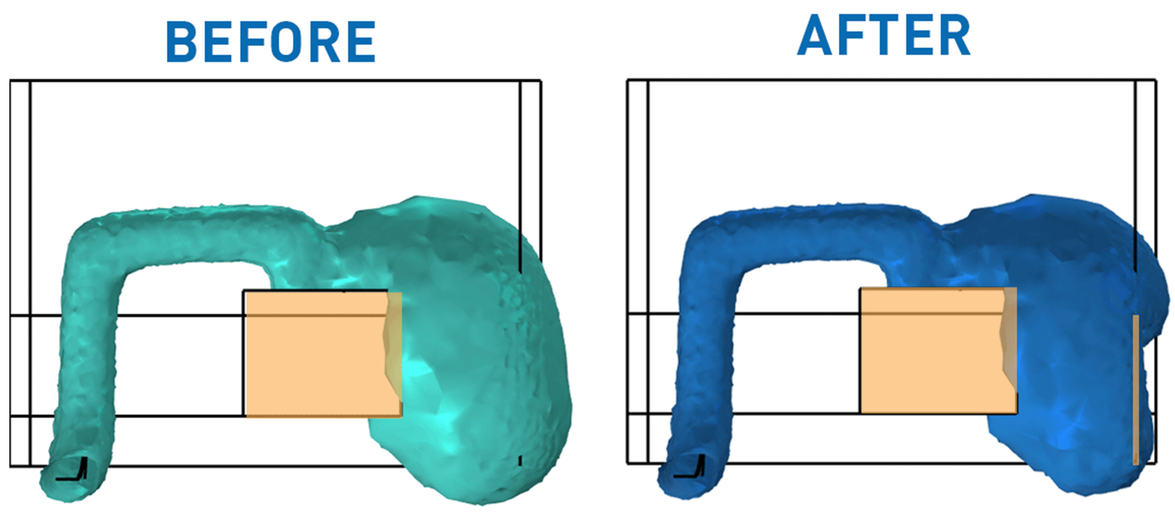

FIGURE 2. 100 µT contour before (left) and after (right) the inclusion of magnetic shielding, indicated by the orange line on the right.

REFERENCES

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