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PSS®CAPE Line Constants

Organized computation of positive- and zero-sequence impedances

At a glance

If you need to study a proposed expansion, upgrade of your transmission system, or simply need a reliable model for existing lines, the PSS®CAPE Line Constants module will enable you to compute positive- and zero-sequence impedances.

The challenge

Getting a handle on transmission line data is especially convenient for computing mutual coupling in complicated rights-of-way with many lines.

Our solution

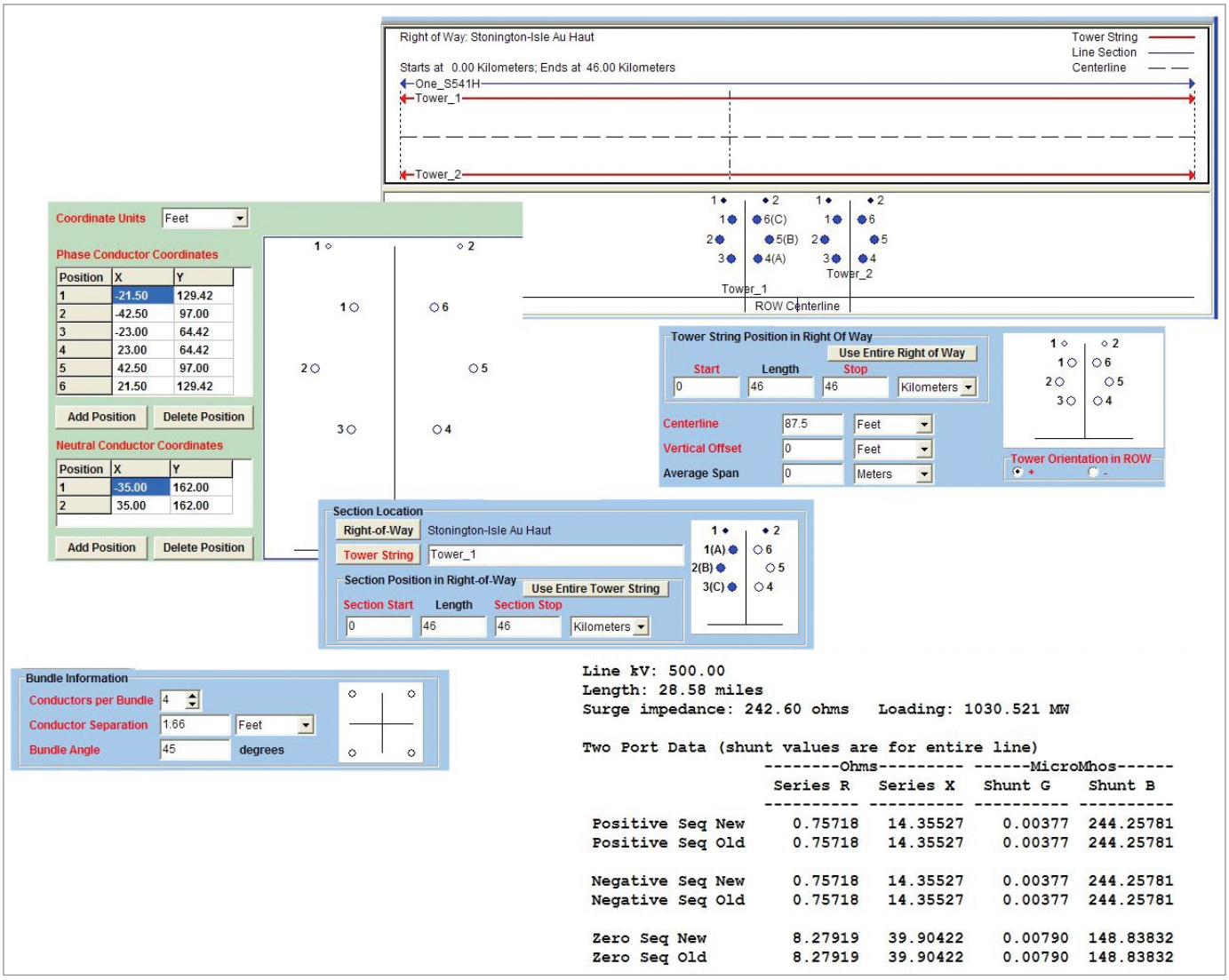
The clear, organized data structures employed by Line Constants and the outstanding data entry forms in PSS®CAPE's Database Editor make Line Constants ideally suited for studying today's dense transmission corridors. Database Editor's excellent graphics support during data entry shows you what you have as you enter it. Typos are easy to find when you can see the layout at every step. PSS®CAPE's "Database Doctor" finds even subtle data errors.

Simple forms for scratchpad calculations and standard pole designs
The PSS®CAPE team designed Line Constants to compute the self and mutual coupling impedances of overhead lines and to do so for realistic combinations of circuits in dense or sparse rights-of-way. Moreover, all your data resides in one place, your database. However, accurate detail is not necessary for (1) for distribution engineers who prefer to work with pre-computed impedances per unit length for standard pole configurations, and (2) for engineers and consultants who are looking for quick, approximate numbers for a line whose detailed design isn't available yet. PSS®CAPE offers simplified forms to support quick calculations for these people. Click the images on the next page to see them.

Pre-computing standard pole configurations – With this form, the engineer describes a single-circuit configuration, gives it a name, and stores it in a line parameters table. Later, when the distribution engineer adds a line to his network model, he picks the configuration by name, enters the line length, and clicks "Calculate."

Scratchpad line constants calculations – This form supports any user who wishes to compute the self and mutual coupling impedances of simple configurations of single or multiple lines. "Scratchpad" calculations assume a single right-of-way and the results are not intended to be stored automatically in the database. However, circuits on the optional second tower need not run the same length as those on the first tower.

Easy forms for complex configurations
The real work in a line constants study – for the user if not the computer – is the data preparation, not the calculation. In PSS®CAPE, the preparation is natural and easy. You build a line in the database similar to how you would actually construct one. First you decide what tower designs you are going to use, adding them to your library if needed. Just give each design a name and specify the positions of the phase and shield wires. Then you prepare the rights-of-way; that is, you assign a name and soil resistivity to each one. Next you place strings of empty towers in the rights-of-way. (This does not mean that you spot each tower. You simply choose the tower design and the start and stop point of the string.) Lastly, you string the conductors. That means you assign each section of line to a tower string and, with the mouse, choose the conductor and tower position of each phase. When the line sections have been defined, PSS®CAPE Line Constants has all it needs to compute the series, shunt self, and mutual impedances. It's ready to go!



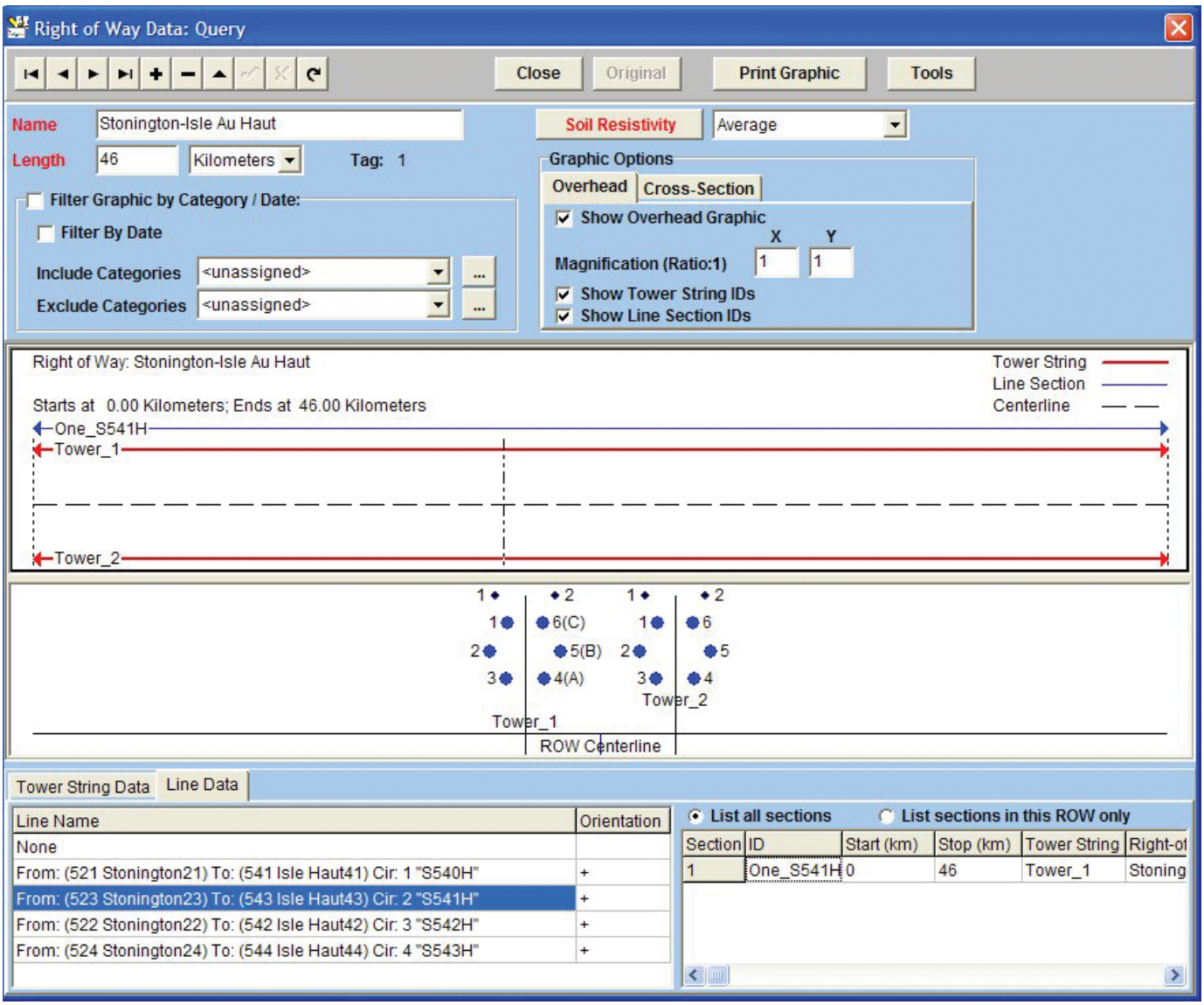
PSS®CAPE helps with data preparation in a natural manner. Prepare the rights-of-way; place strings of towers in it, and assign conductors to the towers. Graphics help verify your work. The Database Doctor does a comprehensive review.

Any number of circuits in a right-of-way

There is a joke among planning engineers that one must have computed a line's positive-sequence impedance correctly if it works out to .8 ohms per mile. Of course, that isn't quite right, but the point is that a line constants calculation program is best judged on its ability to compute zero-sequence mutual couplings of a group of adjacent lines. Today, with transmission line corridors becoming an endangered species, that often means large groups of lines. PSS®CAPE Line Constants is designed to allow any practical number of circuits on a tower and any practical number of towers in a right-of-way. So, no matter how dense your transmission corridor may be, you can count on Line Constants to make it easy to model and to calculate the couplings accurately.

Powerful graphics for data verification

The well-designed forms of the Database Editor certainly make it easy to enter data, but what if you make a mistake and mistype a number? How will you know? "We've got you covered!" as the expression goes. Special active graphics displays have been built into the most important edit forms. These show you pictures of your towers, rights-of-way, tower strings, conductor bundles, and line sections as you build them. Most mistakes show up right away in these pictures. For example, as you design a tower in the library, the phase and overhead shield wire positions are drawn in cross-section; a faulty position caused by a typo or missing sign stands out clearly. Each right-of-way is drawn in a plan view with its start and stop boundary indicated. As strings of towers are added, they are depicted graphically in the right-of-way. Then, as line sections are attached, these are drawn beside the tower strings. Now, if you click on any part of the right-of-way, an elevation view of that point on the right-of-way is added to the display. All towers are shown side by side, and with the proper proportionate spacing. The conductor positions are shown in solid color if you have assigned a conductor or as an empty circle if you have not. If you click on one of the line sections listed below, the phase assignments of that section are added to the drawing. You might not need to assign an engineer to this work.



The plan and elevation views in this Right-of-Way form help detect mistakes in data entry.

Extensive conductor library
Years ago, gathering basic conductor data was one of the annoying prerequisites for computing transmission line impedances. Not today. In PSS®CAPE, you'll have a library of all conductors we know about at your fingertips. (Currently, there are over 500 conductor types and sizes.) If we missed one, you can add it to your library in seconds. All you need is the actual radius, the geometric mean radius (GMR) or the inductance Xa, and the resistivity at one or more temperatures.

Company-specific library of tower designs
Historically, most companies have designed and built their own transmission towers. While it wouldn't have been useful to offer a standard tower library with PSS®CAPE, we have made it quick and easy for you to enter your company's standard designs. Tower designs are easy to find because they are organized by voltage level and drawing id, and when a choice is made the tower drawing appears automatically.

Often, a company will use the same basic "tower top" over and over but will change the tower height to fit the terrain. In PSS®CAPE, you only need one form of the tower design in your library. When you use that design in a tower string, you may specify a positive or negative vertical offset to make the overall tower taller or shorter.

Printed reports and direct transfer to your database
In the PSS®CAPE Line Constants module, you search to the line of interest; the calculation of impedances is done automatically. The report of self and mutual coupling impedances is written both to the screen and to your report file, depending on options you previously selected. If you like what you see, you can send them to your database with a single mouse click. No keyboard entry is required! The next time PSS®CAPE forms your network model, the new impedances will be part of it.

Features

- Special forms for quick calculations and standard designs.
- Easy forms for complex configurations.
- Any number of circuits in a right-of-way.
- Powerful graphics to verify your data.
- Extensive library of conductors.
- Company-specific library of tower designs.
- Clear printed reports and direct transfer to database.
- Support for date-specific, in-service and out-of-service configurations.

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