Southwire

SG10™

Extending Our Lines To Your Desktop

User's Manual Version 3.10.7

Southwire®

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Welcome to SAG10

1 Welcome to SAG10

1.1 What is SAG10?

Southwire SAG10 is a PC-based program that automates execution of the Alcoa Graphic Method of sag-tension calculations for overhead conductors. The Alcoa Graphic Method has been the standard for sag and tension calculations for over 80 years.

1.2 Who can use SAG10?

Southwire intends the SAG10 program to be used by qualified engineers and designers who have a foundation of knowledge about overhead power transmission and distribution lines, and the performance of conductors used in those lines. When using SAG10, a qualified engineer should review the parameters input for the calculations, and the resulting calculated data, and verify that they are correct for the specific application.

1.3 SAG10 Highlights

1.3.1 SAG10 features

SAG10 calculation features include:

- Alcoa graphic method of sag and tension calculation
- Sag and tension with creep
- Elevated temperature creep
- Inclined span calculation
- Stringing sag calculation
- Offset clipping
- CLASH module for calculating clearance between conductors and ADSS conductor
- Galloping calculations
- Ruling Span variation calculations

Other SAG10 features include:

- Easy-to-use menu-driven interface
- Capability to Create, Save, and Open project files
- Basic ice and wind loading tables, as well as the ability to create, edit and save custom loading tables.
- Editable tension limits
- Ability to easily create, save, and edit custom conductors
- Automatic creep check
- Easy modification of the temperatures displayed in the outputs
- Extensive conductor database, including stress-strain chart associations
- Graphic Output of Galloping Ellipses and Sag Curves
- Ability to add attachments and supported loads to conductors

Data furnished includes:

- Stress-strain coefficients

- Conductor database including:
    - AAC
    - AAAC
    - ACAR
    - ACSR
    - ACSR/AW
    - ACSR/TW
    - ACSR/SD
    - ACSS
    - ACSS/TW
    - ACSS/AW
    - All-Alumoweld
    - Steel
    - All-Copperweld
    - Copperweld - Cu
    - HD Copper
    - Multiplex
    - Covered Line Wire
    - ADSS
    - OPGW
    - Custom
    - AAC British
    - AAAC British
    - ACSR British
    - 3M ACCR

1.3.2 What's new in SAG10 v3.10.7?

- Free-form heading editing
- Ability to customize the Page Setup heading to include your Company Name on data output
- Conductor data loads automatically when a conductor is selected
- Customized conductors can be edited, saved, and deleted from the Custom conductor file
- A completely redesigned, simpler, and more intuitive user interface
- Conductor types are grouped for easier selection
- Easier creation and editing of custom conductor data
- Simplified and centralized selection of conductor attachments
- Main screen has been enhanced so loadings and ruling spans can be entered without having to access additional screens
- Data output format has been improved
- All data required to run a stringing calculation is now entered on one screen
- The selected Options can now be saved
- Improved flexibility in saving and deleting custom conductor data for individual or multiple projects
- Enhanced loading table editor
- Updated conductor data
- Improved performance and reliability

1.3.3 History of SAG10 and the Graphic Method

The Alcoa Graphic Method of sag-tension calculations was developed in 1926 by H. H. Rodee. The Alcoa Graphic Method is based on analysis of the stress-strain behavior of the complete conductor and its component parts. The method is useful for steel core conductors such as ACSR and ACSS, as well as conductors composed of a single metal such as aluminum, copper, or steel.

In 1963, a mainframe-based program named SAGTEN became available to automate execution of the extensive calculations required by the Alcoa Graphic Method. In 1994, developers released SAG10, a PC-based enhancement of the original mainframe-based SAGTEN.

In 2008, Southwire Company acquired ownership of the SAG10 program. In Version 3.10, Southwire completely redesigned the SAG10 user interface to simplify use of the program. Southwire also made many other enhancements to improve the accuracy and reliability of SAG10. However, this release is simply an upgrade of the existing SAG10 software. Further development of the SAG10 software will continue under Southwire, with a new version already in the planning phase.

Release history:

1992, SAG10 Version 5 and SAGPLOT Version 1
1994, SAG10 for Windows
1997, SAG10 for Windows Version 1.1
1998, SAG10 for Windows Version 2.0
2001, SAG10 for Windows Version 3.0.
2008, SAG10 for Windows Version 3.10 from Southwire

1.3.4 Future Directions for SAG10

Southwire is proud to offer SAG10 to the Transmission and Distribution market, and we are committed to improving and expanding SAG10 usability and benefits. In keeping with that commitment, we have already begun planning the first Southwire version of the SAG10 software.

As a leading innovator in the industry, many Southwire developments have come through its partnership with its Transmission and Distribution customers. That's why we want to hear from you to help us grow and improve SAG10 even further.

Please visit www.sag10.com/feedback and tell us what you like, what you dislike, and what you would like to see added to future releases of SAG10. Help us to continue to provide you the best sag and tension tool possible.

1.4 Installation

1.4.1 Your Southwire SAG10 package includes:

1. Installation Guide
2. License Agreement
3. Installation CD-ROM with Registration number
4. Printed copy of the Users Manual. For the latest version of the manual, visit our technical support page on the web at www.sag10.com/support
5. Complimentary copy of the Southwire Overhead Conductors Manual

1.4.2 Minimum system requirements

- Pentium 1.2 GHz or greater with at least 128 MB of RAM.
- Microsoft Windows XP or higher.
- CD-Rom drive
- Hard disk with at least 40 MB of free space (5 MB used by program for file storage).
- VGA or better monitor

1.4.3 Installation – single user

NOTE

If you are upgrading from a previous version of SAG10, any custom conductors and charts will have to be re-entered after installing the new version of SAG10. You should print copies of any custom data before uninstalling any prior versions of the software that you wish to enter into the new version. It was necessary to change the way custom data is entered to correct some issues in prior versions of SAG10.

NOTE

See the ***Installation Guide*** provided with your CD for detailed installation on the installation process.

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1. Uninstall all previous versions of SAG10.
2. Close any open applications running in Windows.
3. Insert SAG10 CD-ROM into the CD-ROM drive.
4. If the Startup Menu does not launch automatically locate the file StartUpMenu.exe on the CD-ROM and open the file.
5. From the SAG10 Startup Menu, pick Install SAG10 3.10.6.
6. Follow the installation screen prompts.
7. When setup is complete, click the **Finish** button.

8. Any additional instructions that were too late to put in this manual will be stored in a file named README.1ST. The instructions may be viewed from the CD-ROM Menu, Windows Notepad, or any text editor or word processor.

You are now ready to proceed to Chapter 2 *Getting Started with SAG10*.

1.4.4 Installing and using SAG10 on a network

On a network, many users can share the SAG10 program and data files. Once SAG10 is set up on the network, the program can be run from the network server, or it can be installed onto the hard disks of individual workstations. This document assumes that you know how to use network software to connect to network drives and how to find files stored on network computers.

NOTE

Every SAG10 user must either have a SAG10 Single User License, or the user's company must have a LAN/Client Server license or a Site License.

Before you set up SAG10

The network must be operational, and you must have read-write access to the network directory in which you want to install SAG10. For more information, contact your network administrator.

Setting up SAG10 on a network is a two-step process. You first install SAG10 on the network server. Then you set up the workstations, either by setting up the workstations to run SAG10 from the server or by installing SAG10 on each workstation's hard disk. Note: Each workstation should have at least 128 MB of RAM in order to run the SAG10 program.

1.4.5 Installation of SAG10 on a network server

Follow steps 1 thru 5 for **Installation - Single User**, with the exception that the drive is likely to be some letter higher than C:, such as R:\Sag10Net3\.

Although the SAG10 program directory on the server (the directory containing Sag10w3.EXE) can be either read-write or read-only, you should make it read-only after installing SAG10 to prevent users from unintentionally overwriting files. For more information, see your operating system documentation.

1.4.6 Installation of SAG10 on a workstation

You can install SAG10 onto local workstations so that users run the program from the network server, or you can install so that users run the program from their local workstation's hard drive. You perform the following procedures from the local workstation on which you are installing SAG10.

1. Follow steps 1 thru 5 for **Installation - Single User** at each workstation licensed to use SAG10. This will place the appropriate files in the \Windows\System directories for each workstation.

2a If the user intends to access SAG10 from his own hard disk, and use the network only for printing and plotting and perhaps sharing common Project files, then the installation is complete.

-or-

2b If the user intends to access SAG10 from the network drive, then perform the steps below.

3. In Windows Explorer, Pick Start, Programs and highlight SAG10 from the list.
4. Click on the right mouse button, select Properties, Shortcut.
5. Change the Target: from the name of the local drive to the name of the server drive, such as from C:\Program Files\Sag10w3\Sag10w3.EXE to R:\SAG10Net\Sag10w3.EXE if C is the local drive and R is the server drive.
6. Change the Start In: from the name of the local drive to the name of the server drive, such as from C:\Program Files\Sag10w3 to R:\Sag10Net (or similar).
7. Select OK to close the Properties form.
8. Use Windows Explorer to delete the SAG10 files in the local drive, such as DELETE C:\Program Files\Sag10w3*.*.

1.4.7 Using SAG10 on a network

Using SAG10 on a network is essentially the same as using SAG10 from a hard disk on an individual computer. On the network, you can make a data file available to other users and allow them to make changes to the file, or you can protect the file from changes. You can use the network server to store and exchange data files between users, and many people can use a printer attached to the network server.

1.4.8 Printing over a Network

For information on setting up printers, see your Windows documentation. The procedures for printing over a network generally are the same as printing procedures for an individual computer. You use the Windows Setup program to set up all printers available to you. Then you choose the Page Setup command on the Setup menu in SAG10 and choose the Printer Setup button to select a printer for use with SAG10 and to change the settings for the active printer. If you have installed more than one printer, when you start SAG10 for the first time, make sure you select the printer you will be using for your documents. If you select one printer when you format a document and a different printer when you print the document, some fonts, point sizes, and other character formatting options may not be available when you print.

NOTE

Your network software may require you to issue a system command to make a network printer available to your computer. For specific procedures for your network, contact your network administrator.

Special Note for Bates™ TLCADD users:
For installation details and additional information, refer to Appendix C, "Notes for Bates Spotting Program" in the White Papers section at www.SAG10.com/documentation

1.5 Known Issues

If you are a current user of SAG10, you are probably aware of several issues with the software. Southwire has endeavored to correct as many of these as possible. Currently, we are aware of the following issues:

The "wind only" selection on the ADSS parameters entry screen has "ice only" choices.
This was an error in the previous version of SAG10 and will be corrected in the next version.

When you change the font from the Sag & Tension Data screen, the does not change.
To see the change, you have to return and run the calculations again.

Some of the project files saved in prior versions of ACA will not load.
Southwire has attempted to maintain compatibility with prior saved project files, but prior versions of SAG10 did not always save the project information correctly. In fact, sometimes they would not even load in the ACA versions. You may be requested to re-enter data that SAG10 does not recognize, or you may have to re-build your project in Southwire SAG10 to have the data store correctly.

When I set my monitor to a high resolution, like 1920x1200, some of the screens look different.
The software may look different based on your monitor resolution. If you are having problems reading screens, please set your monitor to a lower resolution.

What happened to Vibrec?
The Vibrec vibration analysis software was kept by ACA so is not longer a feature in SAG10. Please visit their website to obtain a free copy of the Vibrec software.

For the most up-to-date information on issues and questions, please visit us on the web at www.SAG10.com.

1.6 Technical Support

For SAG10 technical support, call 1-877-SWSAG10 (1-877-797-2410) or visit us on the web at www.SAG10.com/support.

Getting Started with SAG10

Create a Project File

Select the Conductor

Enter the Ice/Wind Load and Tension Limits

Enter the Ruling Span Lengths

Calculate Sag and Tension

2 Getting Started with SAG10

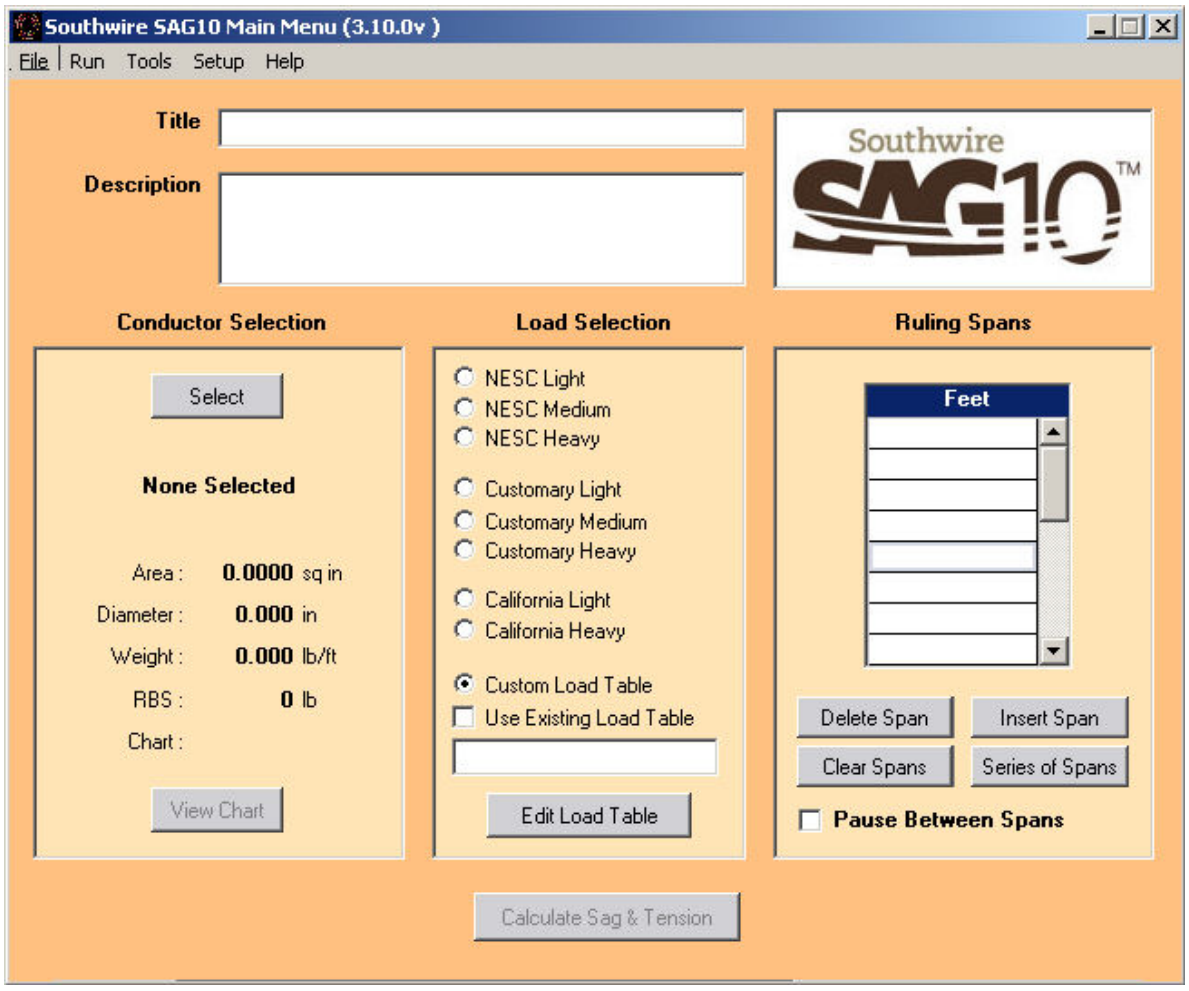
There are five basic steps to creating a sag and tension report.
Each of these steps has multiple options, and each step may be affected by options you select for the entire project.

- Create a project file (This is an optional step.)
- Select the conductor for the project
- Enter the ice/wind load and tension limits for the project
- Enter the ruling span lengths
- Calculate sag and tension

Within some steps, you can either use standard data from SAG10 tables, or you can edit and save custom data.

2.1 Create a project file

To begin using SAG10, click on the Southwire SAG10 icon. The SAG10 banner will display briefly, then the SAG10 **Main Menu** screen will appear.



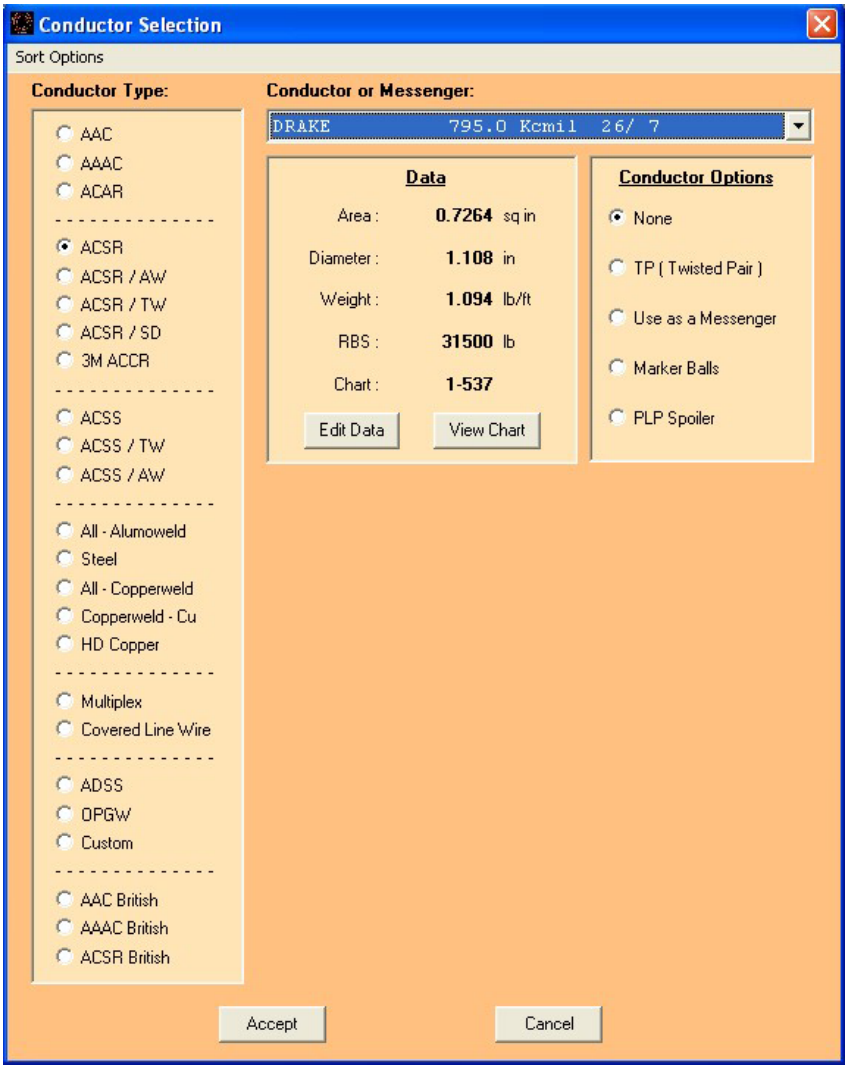
- Enter the project title or number in the **Title** box.
- Enter descriptive information in the **Description** box.
- You can edit this information at any time by simply right clicking in one of the text boxes, or highlighting text you wish to change.

NOTE

The **Tools→Options** menu in the SAG10 **Main Menu** screen toolbar offers many important project option choices. For **Options** details, refer to the **Main Menu** toolbar controls section.

2.2 Select the conductor

In the *Conductor Selection* panel of the **Main Menu** screen, click on the **Select** button. The **Conductor Selection** screen will open.



Select a conductor construction from the *Conductor Type* panel. For this example, choose ACSR. A list of available ACSR conductors will open under the **Conductor or Messenger** box. Select a conductor, and data for that conductor will automatically be loaded. Buttons in the *Data* and *Conductor Options* panels of the **Conductor Selection** screen let you customize conductor construction data to suit your application. You can save custom conductor constructions to the SAG10 database or use and save them only with the current project (See below). Any conductor options you select will be saved with the project.

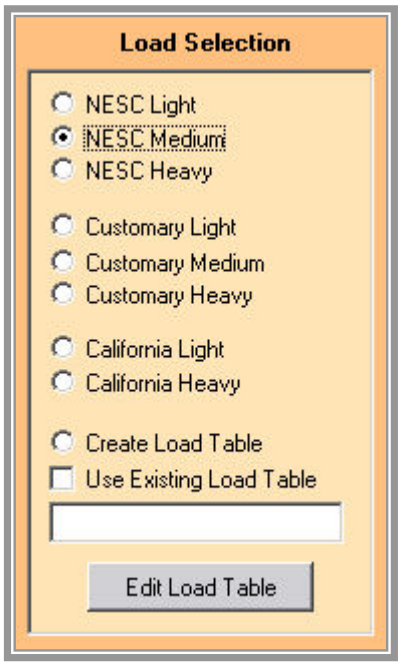
When you have completed your conductor selection, and any conductor data edits you want, click on the **Accept** button in the **Conductor Selection** screen to return to the **Main Menu**.

Conductor selection screen details

For more details on conductor selection, refer to the chapter on the **Conductor Selection** screen.

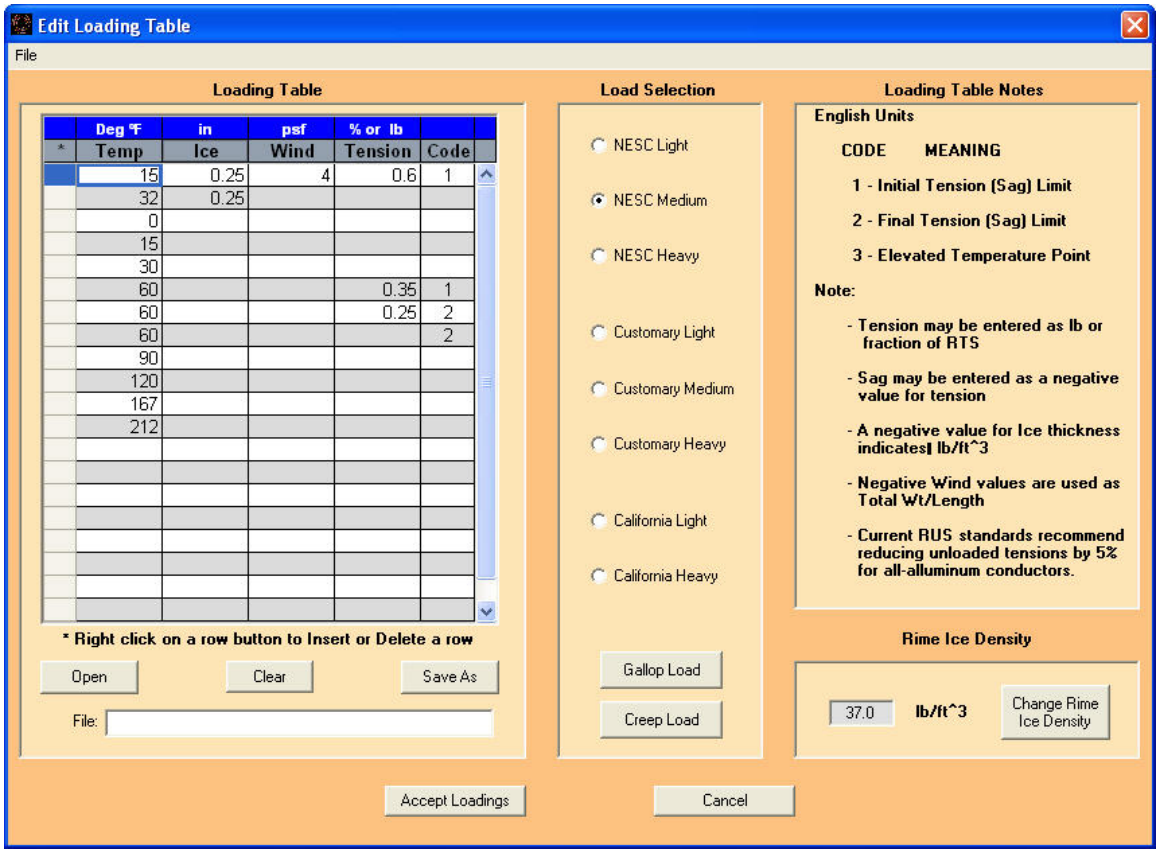
2.3 Enter the ice/wind load and tension limits

The *Load Selection* panel of the **Main Menu** contains a list of industry-standard load configurations. The Customary loads and tensions are the equivalent of the old REA/Alcoa loads and tensions. You can select a standard load table, create a custom load table, or open a saved load table. For the purposes of this example, select **NESC Medium**.



To view or modify a load table, click on the **Edit Load Table** button in the *Load Selection* panel. The **Edit Load Table** screen will appear, preloaded with any selection

you have made in the *Load Selection* panel of the **Main Menu**. In our example, this screen should open preloaded with the **NESC Medium** values since we previously selected NESC Medium from the *Load Selection* panel of the **Main Menu**.



For the purposes of this example, click on the **Accept Loadings** button to return to the **Main Menu**.

Load selection details

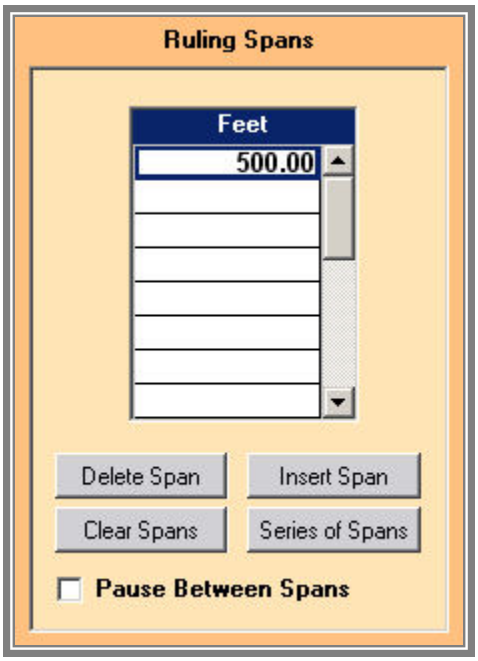
For more details on load selection, refer to the **Edit Loading Table** chapter.

2.4 Enter the Ruling Span lengths

You can enter up to 50 ruling spans in the *Ruling Spans* panel of the **Main Menu**.

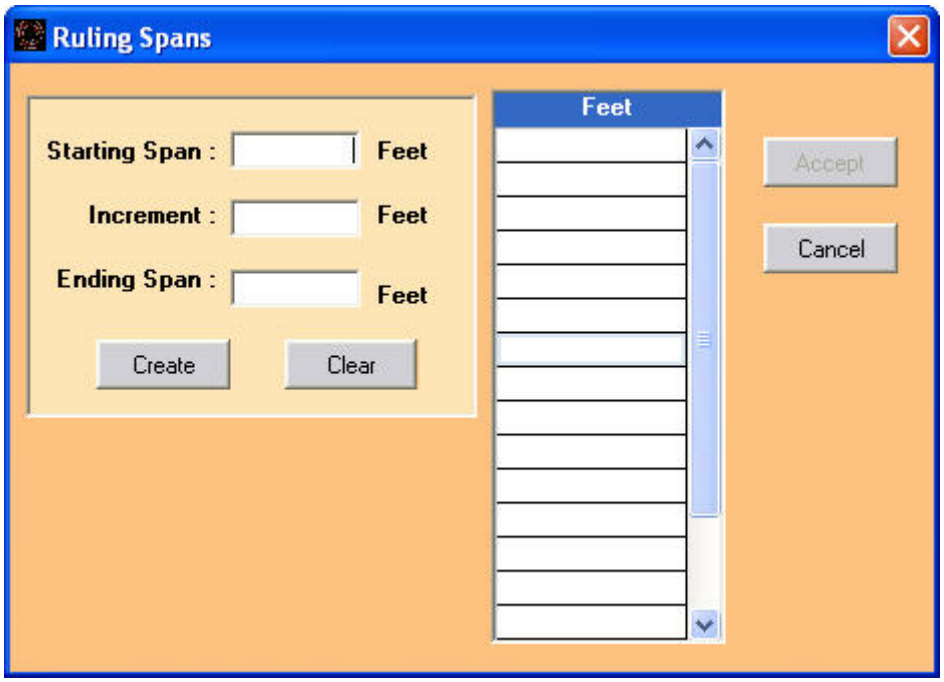
- You can enter spans individually
- You can create a series of spans.
- Accept each entry by pressing the **Enter** key.
- Units are Feet or Meters, depending on option selected in the SAG10 **Main Menu** toolbar→**Tools**→**Options** screen.

For our example, type in a value of 500 feet, and press the **Enter** key.



The buttons in the *Ruling Spans* panel of the **Main Menu** let you edit the ruling spans list. You can:

- **Insert Span** will insert a span above the currently selected span.
- **Delete Span** will delete the selected span.
- **Clear Spans** will clear all of the spans in the table.
- **Series of Spans** opens the **Ruling Spans** window to create a series of spans.



To create a list of multiple ruling spans, equally spaced, simply enter a starting span length, the length you want to increment the spans by, and an ending span length. Click on the **Create** button, and the table will be filled in. Click on the **Accept** button, and these values will appear in the **Ruling Spans** table on the **Main Menu**.

2.5 Calculate sag and tension

NOTE

Before calculating sag and tension, be sure to:

1. Select a conductor
2. Specify load conditions
3. Enter a ruling span or spans

You can initiate SAG10 sag and tension calculations in two ways:

- Click on the **Calculate Sag & Tension** button at the bottom of the SAG10 **Main Menu**
- Select **Main Menu** toolbar→**Run**→**Sag & Tension.**

Either way, SAG10 will generate a **Sag & Tension Data** screen that can be viewed, saved to a file, or printed.

Sag and tension output details

For more details on sag and tension outputs, refer to the **Sag & Tension Data Screen** chapter.

NOTE

The **Tools**→**Options** menu in the toolbar of the SAG10 **Main Menu** offers many important project option choices. For **Options** details, refer to the **Main Menu** chapter.

Main Menu Toolbar Controls

File Menu

Run Menu

Tools-Options Menu

Tools-Chart Explorer

Set-up Menu

Help Menu

3 Main Menu toolbar controls

The **Main Menu** toolbar is located at the top of the SAG10 **Main Menu**.

3.1 File menu

3.1.1 New

Select **New** to clear all previous Project file data.

3.1.2 Open

Select **Open** to browse for an existing Project file and open it. Loading a file will clear all current Project file data.

3.1.3 Save

Select **Save** to save a newly created file, or to save an existing Project file. This selection is active only after you have selected a conductor, load parameters, and ruling span data. Save SAG10 project files with an .s10 extension.

3.1.4 Save As

Select **Save As** to save a Project file under a new name. This selection is active only after you have selected a conductor, load parameters, and ruling span data. Save SAG10 project files with an .s10 extension.

3.1.5 Exit

Select **Exit** to close SAG10 and return to Windows.

3.2 Run menu

3.2.1 Sag & Tension

The SAG10 **Main Menu** toolbar→**Run**→**Sag & Tension** selection executes the SAG10 sag and tension calculations. Choose this selection only after selecting a conductor, load parameters, and ruling span, and any options in the SAG10 **Main Menu** toolbar **Tools**→**Options** screen.

Sag and tension output details

For more details on sag and tension outputs, refer to the **Output Screen** chapter.

3.2.2 Pause between Spans

If you select the **Main Menu** toolbar→**Run**→**Pause between Spans** option, or the **Pause between Spans** box in the *Ruling Spans* panel of the **Main Menu**, a **Next Span** option will be displayed in the toolbar of the **Sag & Tension Data** screen. Selecting **Next Span** will step through the sag and tension calculation for each ruling span entered.

If there is only one span to run, then this option does not affect the output.

If you have selected the **Marker Balls** or **Use as a Messenger** option in the **Conductor Selection** screen, and **Pause between Spans** is not checked, there will be no query for changing quantities of marker balls or cables among spans.

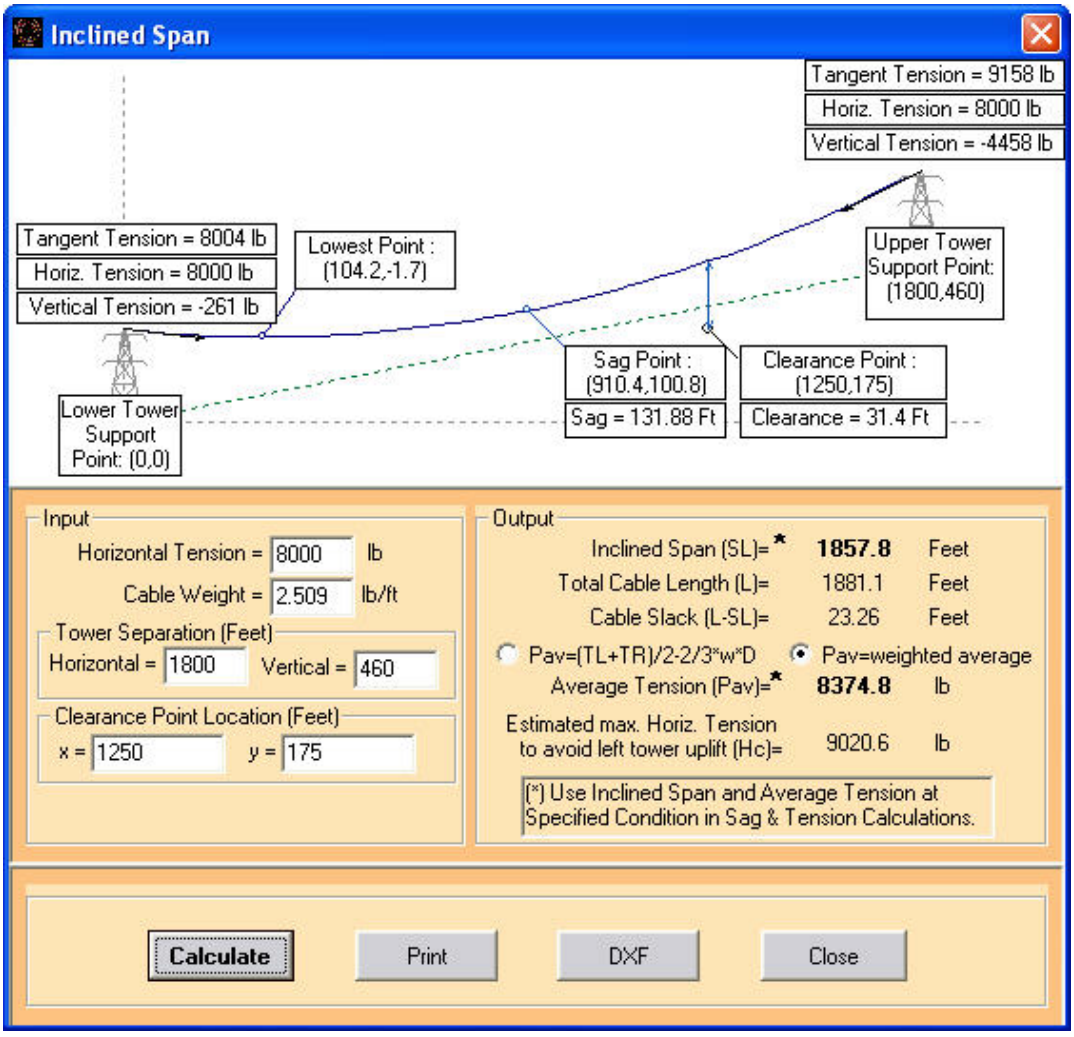
If you enter a large number of spans and a *Warning Message* is received during calculation that indicates *Out of Memory* or *Output Exceeds Buffer Size*, then you may have to either:

- Use the **Pause between Spans** option, or
- Reduce the number of ruling spans.

If these messages are displayed, the screen output will be incomplete, but the **Print to File** output will not be affected.

3.2.3 Inclined Spans

If you select the **Main Menu** toolbar→**Run**→**Inclined Spans** option, the **Inclined Span** screen will open.



Stringing sags generated by the graphic-method are for level ground spans and are based on the average tension (Pav) of the conductor. There are times when the combination of a long span and difference in elevation creates difficulties in sagging conductor.

Depending on the span length and difference in elevation, the lowest point of sag may fall beyond the lower support (indicated by a negative value for the x-coordinate in the **Lowest Point** box) or the vertical tension at the lower tower may become positive. If either of these conditions occurs, this indicates that there may be an up-lift problem at the lower support attachment point. To correct this, enter a lower value for the **Horizontal Tension**.

Sag calculation temperature

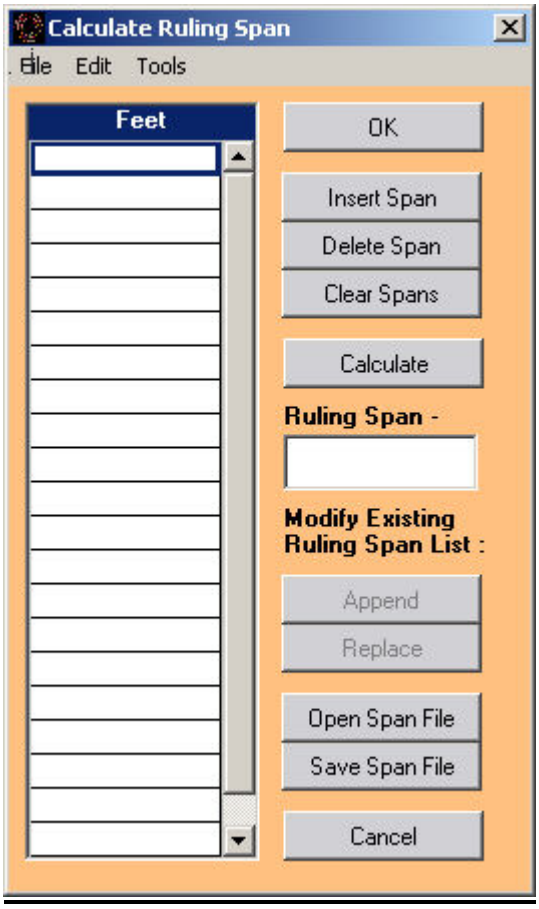
The SAG10 inclined span option calculates the proper inclined Span length (SL) and average tension (Pav) to be used based on the **Horizontal Tension** input. Therefore, as tension varies with temperature, the sags and clearances resulting from the inclined span calculations are only valid at the temperature associated with the **Horizontal Tension** input. For example, if the horizontal tension is an initial tension at 60°F, the resulting sag and clearance values are valid only for the 60°F initial condition.

Inclined Span control buttons

- **Calculate** will re-calculate the inclined catenary after changing any data.
- **DXF** will save the inclined catenary as a .DXF file to a location you specify. A DXF file can be imported into most CAD programs. Typical uses would be to generate a sag template, or to import the sag curve into a drawing containing some ground profile for structure spotting.
- **Print** will send the inclined span results to the printer.
- **Close** will close the **Inclined Span** screen and return you to the **Main Menu** screen.

3.2.4 Ruling Span Calculation

If you select the **Main Menu** toolbar→**Run**→**Ruling Span Calculation** option, the **Calculate Ruling Span** screen will open. This SAG10 utility calculates a ruling span from a list of spans.



Enter a list of spans within a ruling span into the table and click on the **Calculate** button. The resulting ruling span calculation shows in the box below the **Calculate** button.

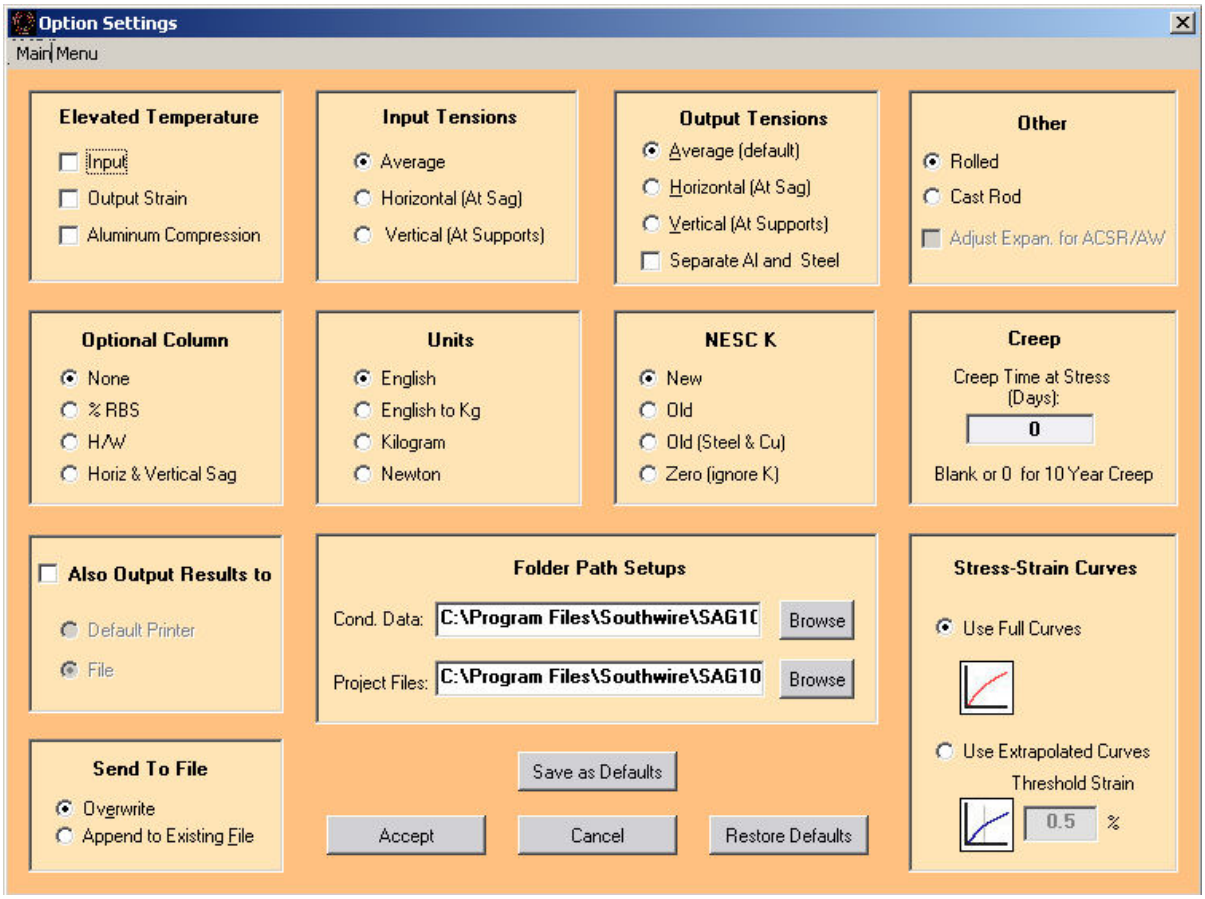
Calculate Ruling Spans control buttons

- **Append** will append the calculated ruling span to the bottom of the ruling span list in the *Ruling Spans* panel of the **Main Menu** screen.
- **Replace** will remove any existing ruling spans from the ruling span list in the *Ruling Spans* panel of the **Main Menu** screen and replace them with the calculated ruling span.
- **Save Span File** saves the span file to a location you specify as a .SPN file type.
- **Open Span File** retrieves an existing span file.

Saved span lists can also be recalled and used when creating stringing sag tables. For more information, refer to the **Stringing Module** section in the **Output Screen** Chapter.

3.3 Tools – Options menu

You can adjust key project option settings by selecting **Main Menu** toolbar→**Tools**→**Options**. The **Option Settings** screen will open.

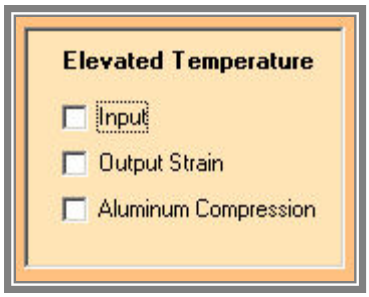


Options you set are saved as part of the current project file. When you are finished selecting options, you can:

- Click on the **Save** button, and the selected options will become the defaults when you load the program, or
- Click on the **Accept** button, which saves your selections for the current session only.

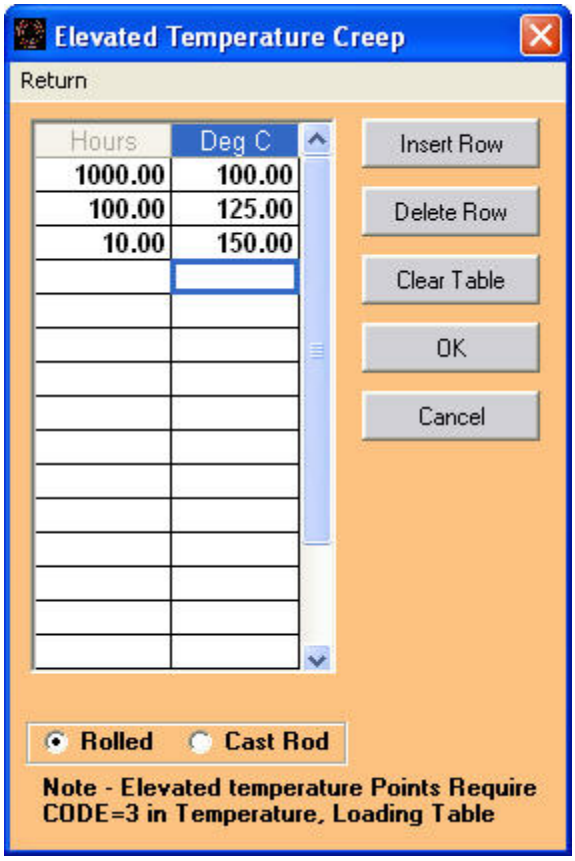
3.3.1 Elevated Temperature

The **Elevated Temperature** options are provided for you to include various affects due to operation of conductors at elevated temperatures. These options should not be used for ACSS conductors, which are designed for high operating temperatures.



Input

This option will cause SAG10 to include the effects of increased creep due to operating a conductor at elevated temperatures. The default selection for this option is unchecked. When you check the **Input** box, the **Elevated Temperature Creep** screen opens. When working with elevated temperature calculations, SAG10 will modify the Load Table before calculating sag and tension. For each temperature in the Elevated Creep Table at or above 16°C (60°F), SAG10 will create an additional row in the Load Table and assign that row a code value of 3 to designate the row as an Elevated Temperature Point.



Enter the total time for which the conductor is expected to experience elevated temperatures over the life of the line. Entries are in hours and °C.

If the conductor selected is all-aluminum (AAC, AAAC, ACAR) or an ACSR with strands of 84/19, 84/7, 45/7, 20/7, 18/1, 42/7, 76/19, 72/7, or 36/1 (ACSRs with less than 7.5% steel by area), the values entered into the **Elevated Temperature Creep** table will be used in the elevated temperature calculations.

Elevated temperature creep of ACSRs with more than 7.5% steel by area is less than room temperature creep and can be ignored. If you have chosen an ACSR with more than 7.5% steel, the program will issue a warning message, uncheck the **Elevated Temperature Input** box, and bypass the **Elevated Temperature Creep** table.

Finally, click on either the **Rolled** or **Cast Rod** option, whichever is appropriate for the conductor being modeled.

NOTE
Elevated temperature creep for non-standard loading temperatures

If you are entering a non-standard loading, you must enter the Elevated Temperatures manually, as follows:

- Click on the **Edit Load Table** button in the *Load Selection* panel of the **Main Menu** screen.
- Each of the temperatures in the Elevated Temperature Creep table at or above 16°C (60°F) should be entered in TWO rows in the Load Table.
- The first row should have NO Code entry.
- The second row should have a Code value of 3.

For example, if the Elevated Temperature Creep table has a temperature of 125°C entered, then the Load Table should have two rows with a temperature of 257°F, one with NO Code entry and one with a Code value of 3. This shows up in the sag and tension output as a comparison of sag at 257°F with and without elevated temperature creep. In the **Sag & Tension Data** screen, the elevated temperature creep line is identified by a # sign.

Temperatures less than 16°C in the **Elevated Creep Table** will be ignored, as they are not affected by elevated temperature.

Output Strain

This option is considered only if the **Elevated Temperature Input** box is checked. If that box is checked, the sag and tension output will include a line of data at the first elevated temp creep point, indicating normal creep (EC) and elevated temperature creep (ECRP).

Creep is a function of time and temperature. SAG10 will select the time/temperature that will cause the maximum micro-strain increase in elongation and convert it to a temperature differential.

For more background on elevated temperature creep, research the following papers:

- J. R. Harvey, R. E. Larson - Use of Elevated Temperature Creep Data in Sag-Tension Calculations, IEEE Paper 69 TP 674-PWR.
- J. R. Harvey, R. E. Larson - Creep Equations of Conductors for Sag-Tension Calculations, IEEE Paper C 72 190-2.
- J. R. Harvey, R. E. Larson - Technique to Include Elevated Temperature Creep in Sag-tension Calculations, IEEE T and D Conference and Exposition April 1-9, 1979.
- W. B. Zollars - Aluminum Conductor Elevated Temperature Considerations, Seminar sponsored by Georgia Power Co., the Aluminum Association, and EPRI on the

Effects of Elevated Temperature Operation on Overhead Conductors and Accessories - May 20, 1986, Atlanta Georgia.

Aluminum Compression

ACSR conductors are composed of two materials, steel and 1350-H19 hardened aluminum. These materials expand at different rates when heated. The coefficient of linear thermal expansion for aluminum is approximately twice that of steel, so as an ACSR conductor is heated, the aluminum will attempt to expand more than the steel core. Since the aluminum and steel are connected together at various points along the line, the steel prevents the aluminum from elongating as much as it wants to. Under these conditions, the helical path of the aluminum grows and a compressive force builds in the aluminum, similar to a compressed spring.

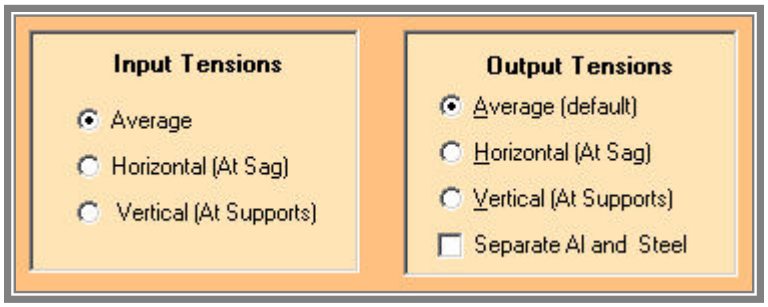
This is not a problem in the normal operating temperature range of ACSR, which is below 100°C. However, at elevated operating temperatures, the amount of growth in the aluminum is much more than the growth in the steel. Since they are connected together, the aluminum "spring" pushes against the steel core as it grows. This extra force on the steel is not part of the normal sag and tension calculations. It causes the steel to elongate more, and thus the conductor to sag more, than the standard calculations predict. Selecting the **Aluminum Compression** option will cause SAG10 to take into consideration the additional expansive force imparted to the steel by the aluminum.

Note: This only applies to ACSR conductors. This is not an issue in ACSS conductors due to the use of fully annealed 1350-O aluminum, which yields more readily than hardened 1350-H19 aluminum. For this reason, compressive forces do not build in the aluminum to a level high enough to affect the steel core.

For details, refer to Appendix V, "Theory of Compressive Stress in Aluminum of ACSR" and Appendix Y, "Some Effects of Mill Practice on the Stress Strain Behavior of ACSR", in the White Papers section on the web at www.SAG10.com/documentation.

3.3.2 Input and Output tensions

A tension value may mean several things. It can describe horizontal tensions, vertical tensions (tension magnitude at support points) or average tensions (an in-between value representing the tension state of the entire span).



When you fill in the **Load Table**, you may require a limit based on a particular tension type. Conversely, in the sag and tension data output, you may want to display a different type of tension. SAG10 lets you specify input and output tension types separately in the *Input Tensions* and *Output Tensions* panels of the **Options Settings** window. In addition, the *Output Tensions* panel has a box that lets you select a display that separates the tension components attributed to steel and aluminum. (See below for details.)

Average tension

The default used for tension is the average value. This is the tension in the conductor.

Horizontal tension (at sag)

The horizontal tension (at sag) subtracts out the weight of the wire. Horizontal tension is used in offset clipping and inclined span options. Formulas used for leveled spans are as follows:

$$H = P - WD/2$$

Where: H = Horizontal tension at center of span, lb.
P = Average tension, lb.
W = Conductor weight, lb./ft.
D = Sag, ft.

Vertical tension (at supports)

The vertical tension (at supports) includes the weight of wire. The tension at the supports is used in tower-design calculations. Formulas used for leveled spans are as follows:

$$T = P + WD/2$$

Where T = Tension at support, Lbs.
P = Average tension, Lbs.
W = Conductor weight, Lbs./ft.
D = Sag, ft.

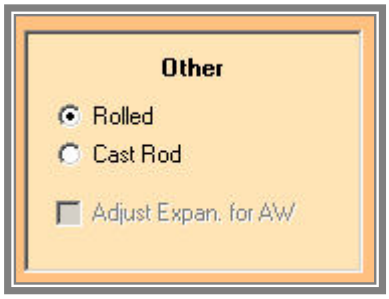
Separate Aluminum and Steel Tension

The basis for the Alcoa Graphic-Method of sag and tension is stress-strain testing. When stress-strain tests are performed on steel core conductors, both composite (aluminum combined with steel) and single (that of the steel only) data are generated. When dealing with steel core conductors, the Graphic Method derives the stress-strain data of the aluminum portion by subtracting the available steel data from that of the composite.

At each temperature specified in the **Load Table**, the calculations are performed using the data from the components, which are then added vectorially to form the composite. The **Separate Aluminum and Steel Tensions** option will cause the tensions in each of the components to be displayed, as well as the total tension in the conductor. The ability

to view the separate tensions can be a valuable tool when evaluating operation of ACSRs at high temperatures, or when calculation pre-tensioning for ACSS conductors.

3.3.3 Other (Estimated Cast Rod Creep)



Rolled verses Cast Rod

Cast rod generates less overall creep than rolled rod. In order to switch the calculations to Cast Rod, check the **Cast Rod** option.

Adjust Expan for ACSR/AW

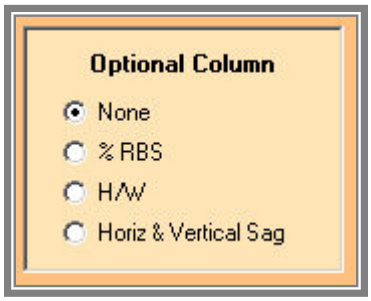
SAG10 uses stress-strain charts for standard Galvanized steel core for calculations involving ACSRs with aluminum-clad steel core wire. Aluminum-clad steel actually has a slightly higher coefficient of linear thermal expansion due to its aluminum coating. Selecting this option will cause the calculations to use the appropriate thermal expansion rate.

NOTE

This box will be active only if you have selected an ACSR conductor with an AW option.

3.3.4 Optional Columns in Output

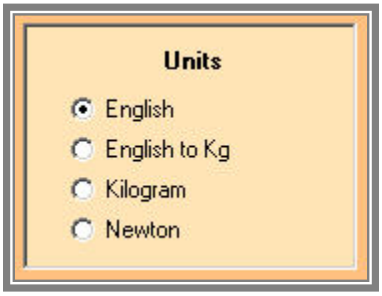
These option boxes add columns to the sag and tension output for final and initial tension.



- **None –** no added columns
- **% RBS –** Percentage of Rated Breaking Strength
- **H/W** – Horizontal Tension divided by Weight. This is often referred to as the "Catenary Constant" or "C" value
- **Horizontal and Vertical Sag –** displays the resultant sag as horizontal and vertical components.

3.3.5 Units

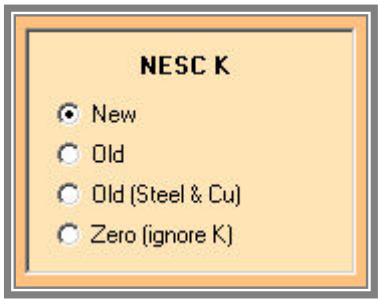
There are four options available for Units:



- **English** - Both Input and Output are in Pounds, Feet or Inches, and Deg. Fahrenheit.
- **English-to-Kg** - English Input and Metric Output in Kilograms, Meters or Millimeters, and Deg. Centigrade.
- **Kilogram** - Both Input and Output are in Kilograms, Meters or Millimeters, and Deg. Centigrade.
- **Newton** - Both Input and Output are in Newtons, Meters or Millimeters, and Deg. Centigrade.

3.3.6 NESC K

Occasionally it is necessary to distinguish between NESC 5th or 6th Edition and the rounded-off K factor of the NESC 7th Edition.



New – Designates NESC 7th edition
Old – Designates NESC 5th or 6th edition
Old (Steel and Cu) – Match calculations for steel or copper cable for the older NESC manuals
Zero - Ignore K

3.3.7 Creep (time selection)

SAG10 normally calculates final sag and tension data assuming 10 years of conductor creep.

Entering a number in **Creep Time at Stress (Days)** lets you calculate the final creep that would result from a longer or shorter time period. A shorter time period may be helpful in evaluating conductors that have been in air for any time period less than 10 years. A longer time period may be helpful to see if any additional creep may occur if a conductor has been in the air for 20 or 30 years. Enter the time period in days. Blank or 0 will default to 10 years.

3.3.8 Also Output Results to

Default Printer

Automatically sends the results shown in the sag and tension calculation output screen to the default printer specified in the Print Setup section of this manual.

File

Automatically sends the results shown in the sag and tension calculation output screen to a specified file. SAG10 will prompt you for a file name to save the output when you run the sag and tension calculation.

3.3.9 Folder Path setups

Conductor Data

Browse or specify a path to a default folder containing conductor data.

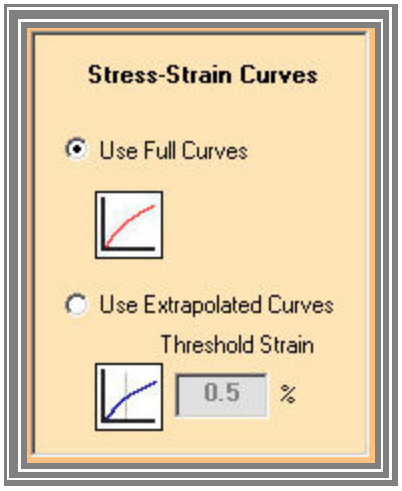
Project Files

Browse or specify a path to a default folder containing Project File data.

3.3.10 Stress-Strain Curves

Typically SAG10 uses the full stress strain curves. These return the stress level at ANY strain value as calculated using the polynomial coefficients from the stress-strain charts. The default for this option is **Use Full Curves** and Southwire recommends that you do not change this. The **Threshold Strain** is now set to 0.5%.

There are times, especially when large mechanical loadings are placed on a conductor, particularly in longer spans, that very large strains are encountered. SAG10 may have to estimate, to the best of its ability, the stress-strain curve in these situations to complete the calculation. However, the user should be aware that this is occurring as it may affect the accuracy of the results. If this occurs, a message will display on your output indicating that SAG10 used an extrapolated curve.



3.3.11 Send To File

Overwrite

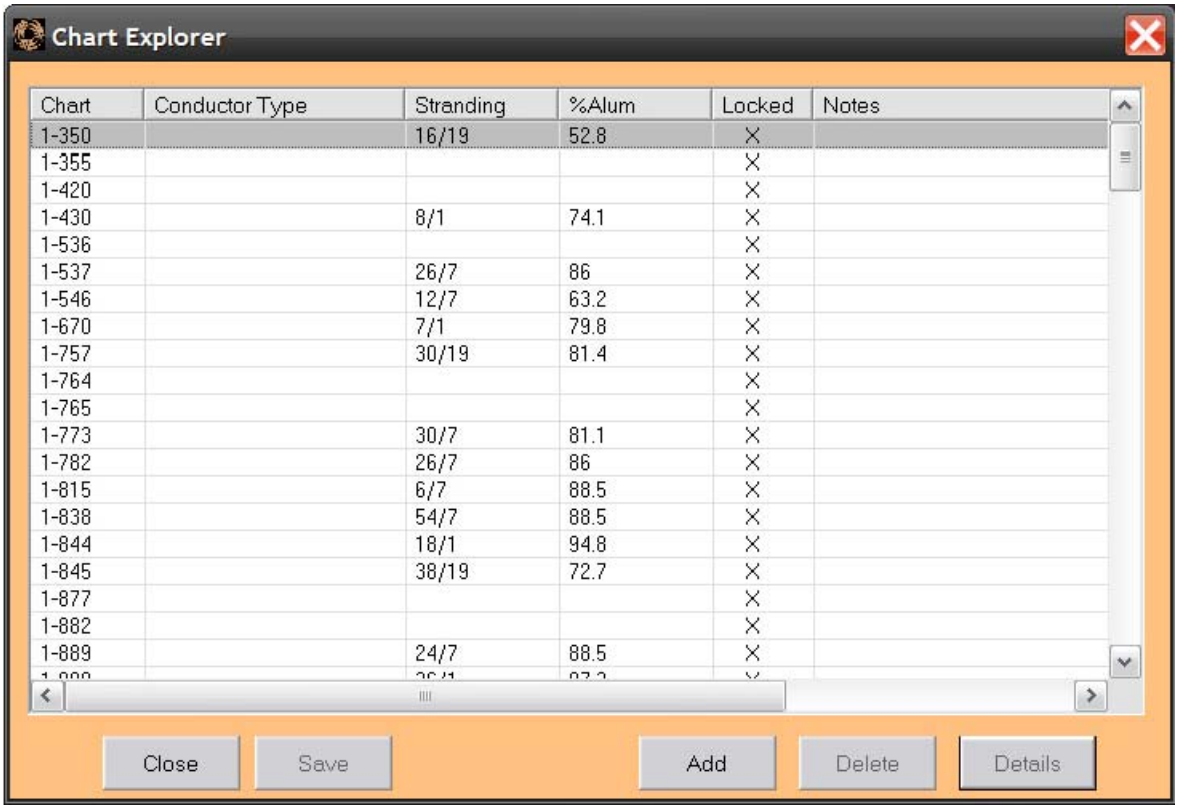
When you check this box, the data sent to a specified file will overwrite the existing data.

Append to Existing File

When you check this box, the data sent to a specified file will be appended to the existing data.

3.4 Tools – Chart Explorer

Selecting **Main Menu** toolbar→**Tools**→**Chart Explorer** will open the **Chart Explorer** screen. This screen shows a list of conductor detail charts, sorted by chart number.



The chart explorer lets you quickly view any charts available in SAG10, including those you create. Charts that are Locked cannot be edited.

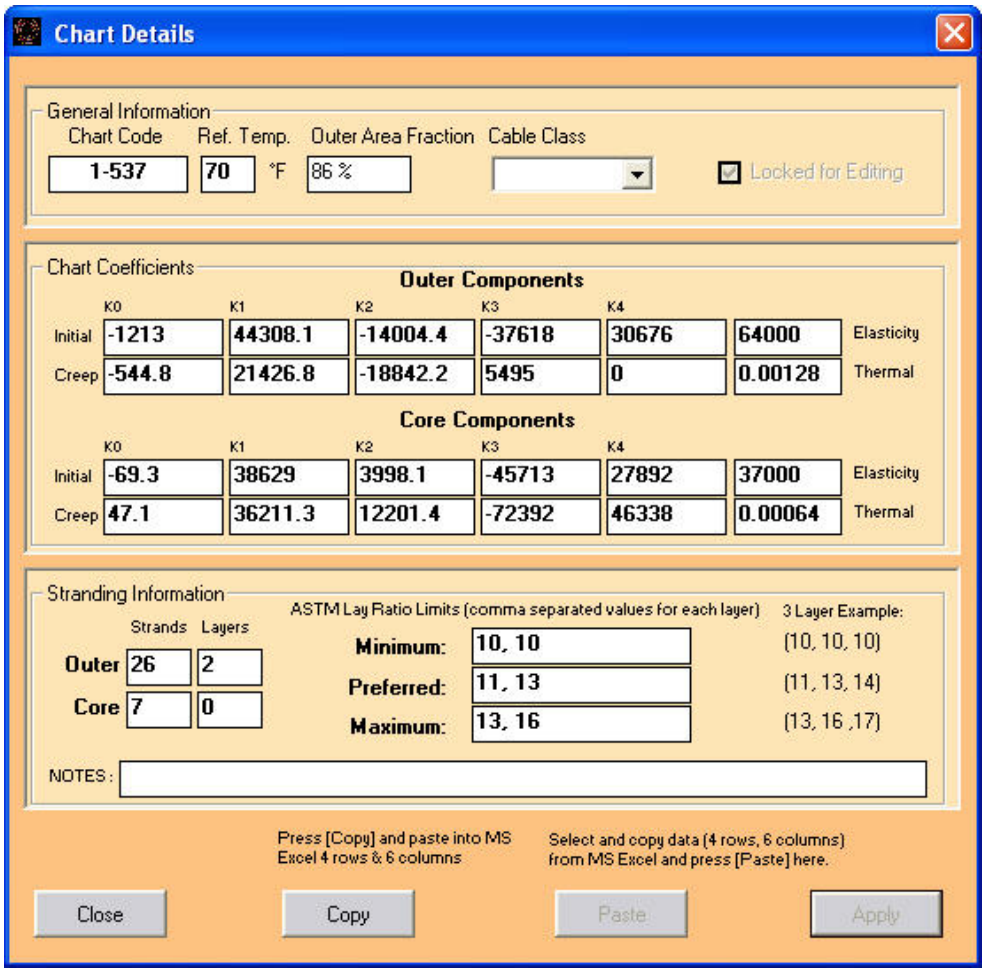
Add
The **Add** button allows you to create a custom chart. Clicking on this button will open a blank **Chart Details** screen for you to fill in.

Delete
This will delete the currently selected chart from the database.

Details
This will open the **Chart Details** screen for the selected chart.

Save
This will save any charts you have created or edited to the database.

If you select a chart in the **Chart Explorer** screen and click on the **Details** button, a **Chart Details** window will open.



The **Paste** and **Copy** buttons allow you to move data to and from a Microsoft Excel spreadsheet.

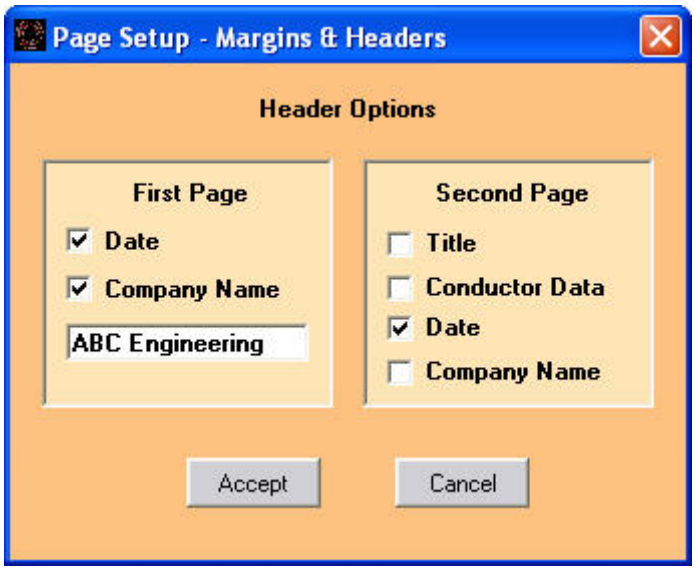
3.5 Setup menu

3.5.1 Print setup

Selecting **Main Menu** toolbar→**Setup**→**Print Setup** displays the standard MS Windows printer setup and selection window. Refer to the MS Windows User's Guide for details on use of Print Setup.

3.5.2 Page setup

Selecting **Main Menu** toolbar→ **Setup**→**Page Setup** opens the SAG10 **Page Setup** screen where you can set page header options.



First Page

These header options will appear on the first page of output only.

- The **Date** is checked by default. Uncheck it if you do not wish the date to appear on the output.
- **Company Name** is a new feature that allows you have you company name appear on the outputs. Check the **Company Name** checkbox and enter your company name in the text box.

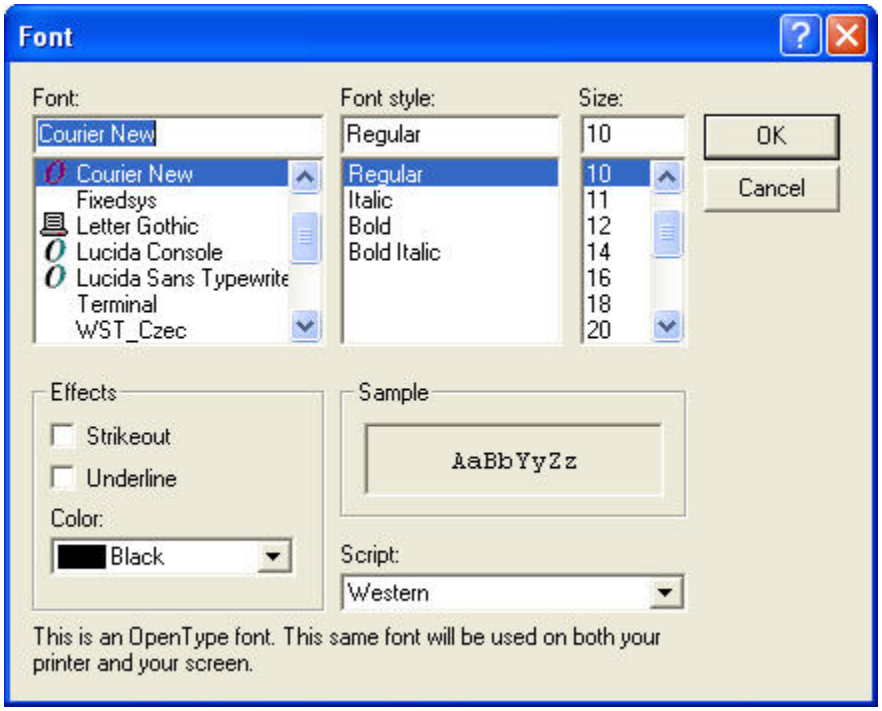
Second Page

These header options will appear on any subsequent pages of output.

- Checking **Title** will cause the text entered in the **Title** field of the **Main Menu** to appear on subsequent pages. Note that the **Title** and **Description** entered on the **Main Menu** always appear on the first page.
- Checking **Conductor Data** will cause the description for the conductor to appear on all subsequent pages.
- The **Date** is checked by default. Uncheck it if you do not wish the date to appear on the subsequent pages.
- **Company Name** can only be selected if it is selected in the *First Page* header options.

3.5.3 Fonts

Selecting **Main Menu** toolbar→ **Setup→Fonts** opens the SAG10 Font window. Only Fixed Pitch Fonts may be selected. SAG10 requires that the ***Courier New*** font be loaded into Windows. If the proper fonts are not currently installed on your computer, refer to the Windows Control Panel, Fonts for information on loading addition fonts.



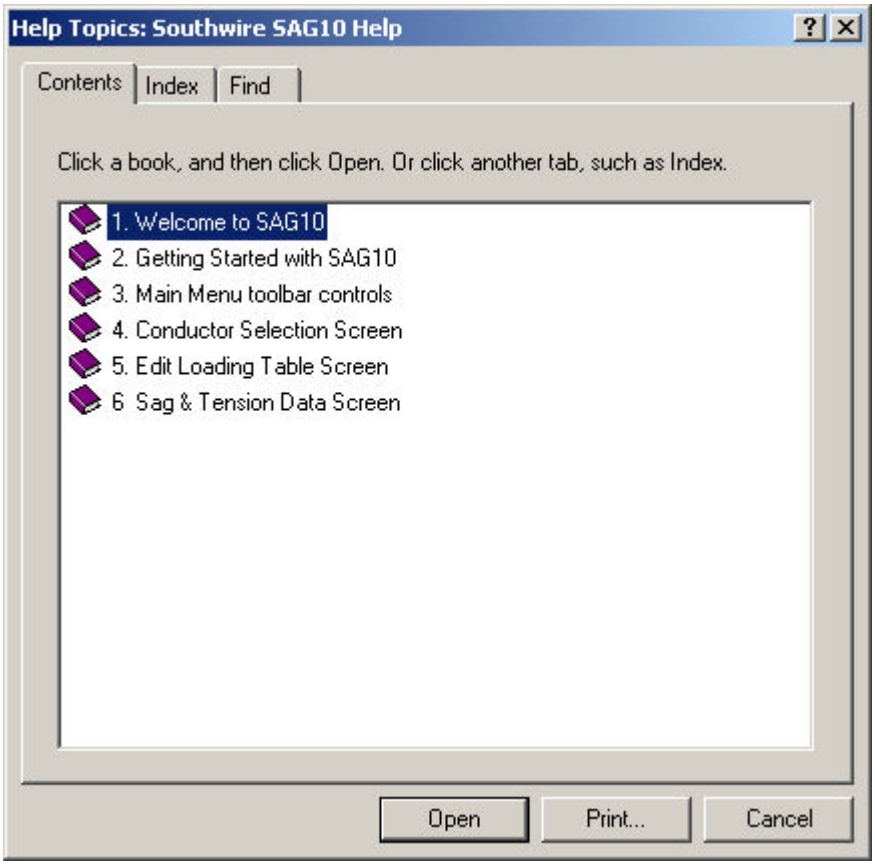
3.6 Help menu

Selecting **Main Menu** toolbar→**Help** in the SAG10 Main Menu tool bar will open a submenu with these options:

- Contents
- Search for Help On …
- Tech Support
- View License
- About SAG10

All of the material in this manual is available in SAG10 **Help**.

3.6.1 Help→Contents→function tabs



Contents

This tab gives access to a list of SAG10 User Manual topics organized in Table of Contents order.

Index

This tab gives access to the standard Microsoft index feature.

Find

This tab gives access to the standard Microsoft word or phase search feature.

3.6.2 Help →Search for Help On …

This tab gives you direct access to the standard Microsoft index feature.

3.6.3 Help →Tech Support

This menu item displays contact information for Southwire SAG10 technical support.

3.6.4 Help →View License

This menu item displays selected licensing information and other information about Southwire SAG10.

3.6.5 Help →About SAG10

This menu item displays the version number and registration number of the current SAG10 program installation.

Conductor Selection Screen

Conductor Type

Conductor Messenger Box

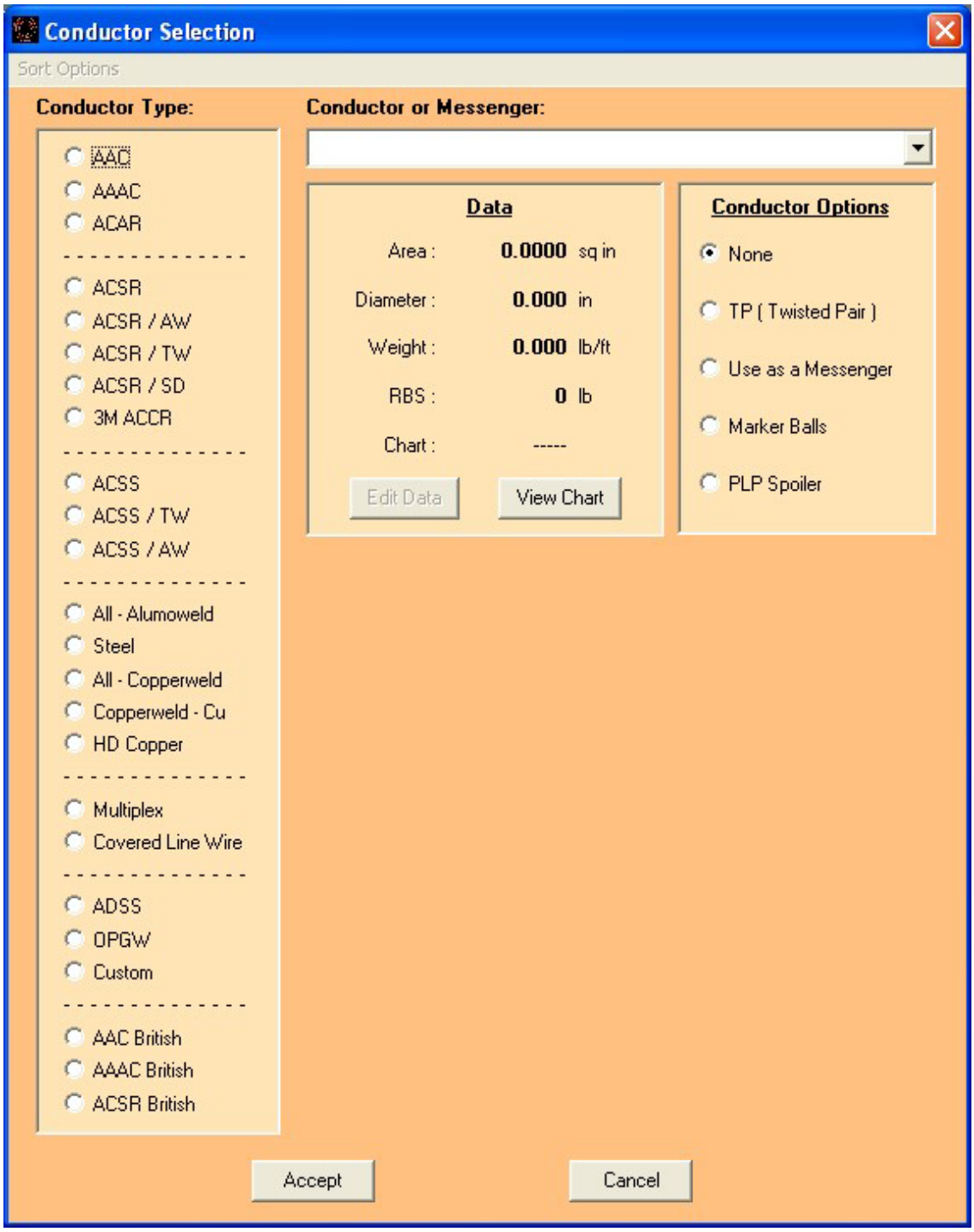
Data Panel

Conductor Options

Sort Options

4 Conductor Selection Screen

To access the **Conductor Selection** screen, click the **Select** button in the *Conductor Selection* panel of the SAG10 **Main Menu** screen.

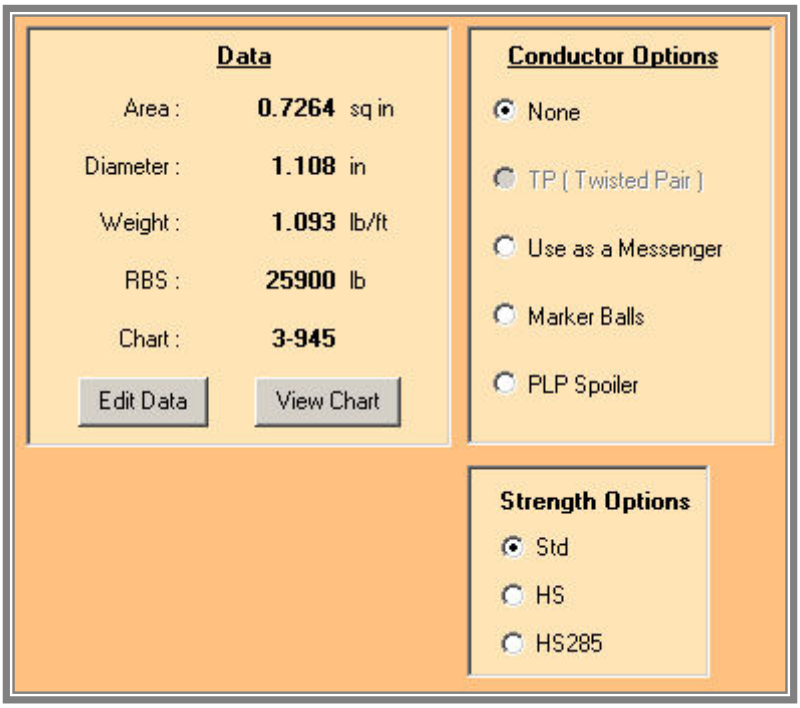


The **Conductor Selection** screen has five main components:

- The *Conductor Type* panel, where you choose the type of conductor to use.

- The **Conductor or Messenger** box, where a drop down menu lets you select a specific conductor or support messenger.
- The *Data* panel, which shows a data summary for the specific conductor you have chosen.
- The *Conductor Options* panel, where you can select options for the specific conductor you have chosen. Not all options are available for some conductor types.
- The menu toolbar which allows you to change the sort options for the dropdown list for the **Conductor or Messenger** box.

In addition to these five main panels, other panels may appear with additional information for a specific conductor type. For example, ACSS conductors are available in three different strength options. When you choose an ACSS conductor, a *Strength Options* panel appears, with the available strength options. When you click on a strength option, the **RBS** value in the *Data* panel automatically updates.



4.1 Conductor Type

This panel lets you select a construction type. When you choose a general construction type, a dropdown menu will open below the **Conductor or Messenger** box and display specific conductors. Southwire has updated the conductor tables to match current ASTM standards, where standards exist.

Some data has been provided by other manufacturers, or is based on historically accepted industry values. Data for these conductors is provided as-is, and should be verified as accurate for your particular conductor.

Note

Standards and manufacturing methods have changed over the years and older conductor designs may not exactly match the values in use today.

Custom conductor types

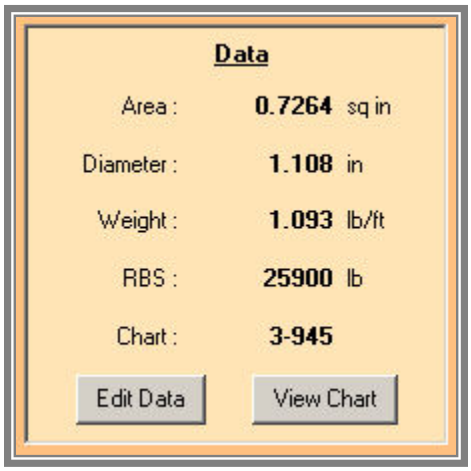
Any custom conductor types you build and save are stored in a central file that you can access by selecting the **Custom** type in the *Conductor Selection* panel. For details on creating custom conductors, refer to the **Editing Conductor Data** section, below.

4.2 Conductor or Messenger Box

This is where you select the specific conductor to use, either as a conductor or as a support messenger for an assembly. The dropdown list automatically opens when a **Conductor Type** is selected, or you can open the dropdown at any time by clicking on the dropdown arrow on the right side of the box.

4.3 Data Panel

Once you select a specific conductor, the data for that conductor will automatically load into the conductor *Data* panel.



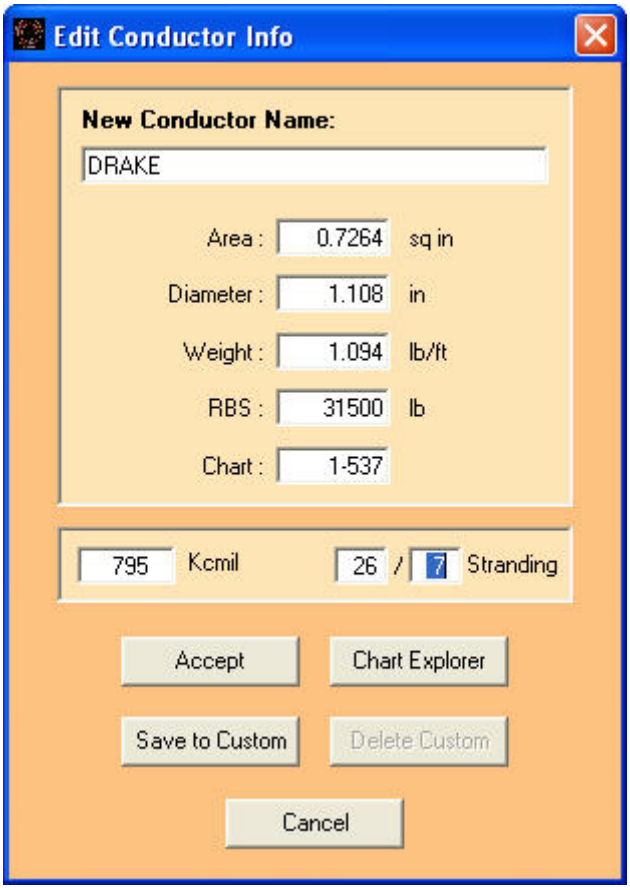
If this is the conductor you want, choose any conductor options you need, then simply click the **Accept** button at the bottom of the **Conductor Selection** screen to return to the **Main Menu** screen. There are two other buttons in the *Data* panel that allow you to view the stress-strain chart associated with the conductor or edit the conductor data and create a custom conductor.

4.3.1 View Chart

The **View Chart** button in the *Data* panel will take you to the **Chart Details** screen and show you the stress-strain data assigned to the selected conductor. A unique chart number identifies each chart.

4.3.2 Editing conductor data

The **Edit Data** button in the *Data* panel opens the **Edit Conductor Info** screen, shown below, where you can create a custom conductor by modifying the name and characteristics of the conductor you're working with. Note that the contents of this screen will change based on the conductor type selected.



You can create a custom conductor by editing the conductor data, then saving this to the custom conductor file.

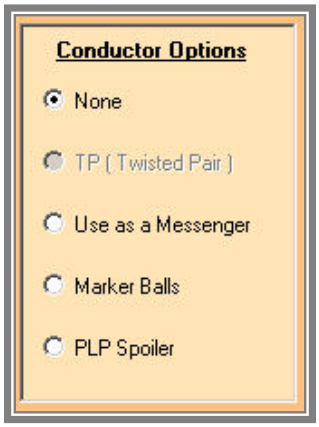
- The **Accept** button will close the screen and retain the modified values for this Project File only – it will not save them to the conductor database.
- To save your modified values to the **Custom** type in the conductor database, assign a new conductor name and click on the **Save to Custom** button.
- The **Delete Custom** button lets you remove unnecessary custom files from the **Custom** type in the conductor database.
- The **Chart Explorer** button takes you to the Chart Explorer screen. Here you can review available charts or create a new stress-strain chart if needed. For

more details, refer to the **Tools→Chart Explorer** panel of the **Main Menu** chapter.

4.4 Conductor options

The **Conductor Options** box lets you add special features to your conductor selection:

- TP (Twisted-Pair)
- Use as a Messenger
- Marker balls
- PLP spoilers.

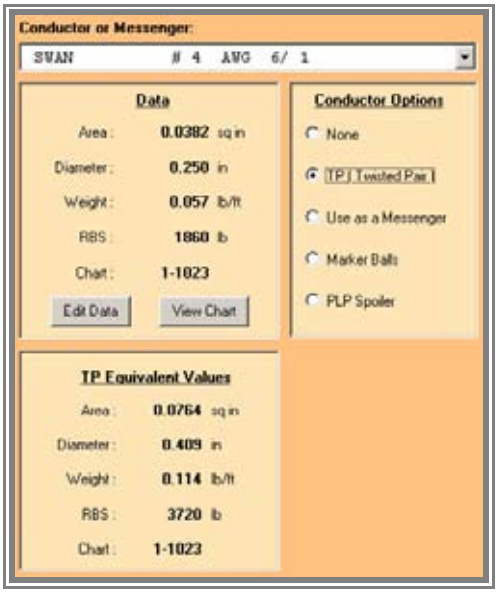


Conductor options that are not available for the selected **Conductor Type** will appear in gray, as is the **TP (Twisted Pair)** option in the example above.

4.4.1 TP (Twisted Pair) option

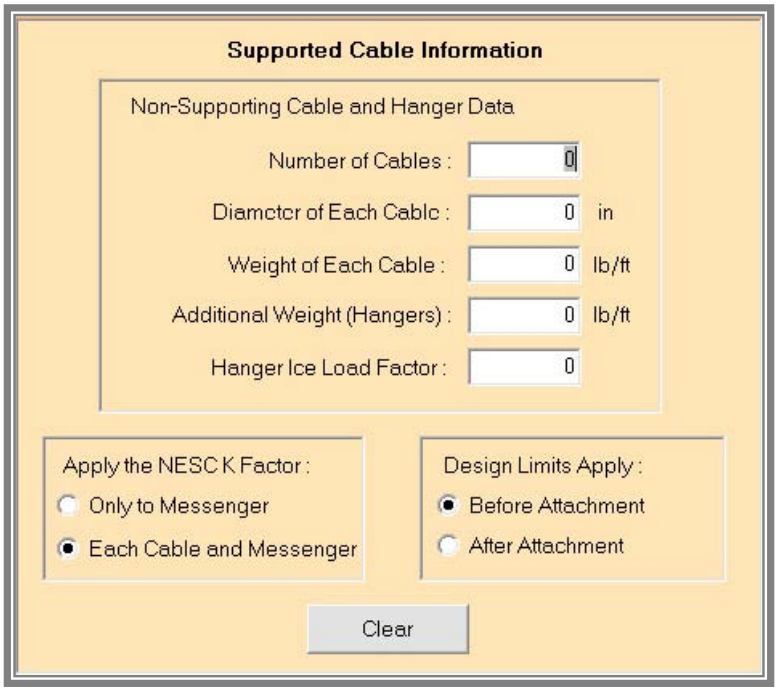
Any of the ACSR, AAC, AAAC, or ACAR conductors may be modeled as a twisted-pair conductor. You may be more familiar with this construction by one if its trade names, such as VR™ by Southwire, or T-2™ by General Cable. If you select the **TP (Twisted Pair)** option, the conductor description will indicate use of TP by appending the "/TP" suffix to the codeword.

The weight, strength, and area of the wire are doubled, and the diameter is considered to be 1.637 times larger than the single conductor for wind and ice calculations. When this option is selected, a *TP Equivalent Values* panel appears with the resulting data used by SAG10.



4.4.2 Use as a Messenger

This option allows you to add several non-supporting cables to a supporting conductor or messenger. Each of the non-supporting cables must be of equal diameter and weight.



In the **Additional Weight** entry, you can add the weight of additional items, such as hangers, as an evenly distributed weight. Enter it in lb/ft (kg/m or N/m for metric). Do this by manually summing the total weight of additional attachments, and dividing by the total span length.

Hanger Ice Load Factor is a factor added to account for ice buildup on the hangers. Determination of the amount of ice is left to the design engineer. The number that has traditionally been used, based on 0.5 inches of ice buildup on the hanger, is a value of 1.8. Southwire does not endorse or recommend this number. For other ice buildup thicknesses, enter your calculated value.

SAG10 multiplies the weight of a cable by the quantity of cables and adds that to the total weight. This total weight is evenly distributed over the span length. Radial ice is applied as a uniform layer over each of the cables, as well as the supporting messenger. Wind pressure is applied over the cross sectional area of the cables and messenger. Radial ice will increase all cable and messenger diameters, and resulting wind areas, by twice the radial ice thickness.

Apply the NESC K Factor

The NESC K factor can be applied in two ways: **Only to Messenger** or to **Each Cable and Messenger**. The NESC manual does not clearly define whether the K factor should

be applied to the messenger only, or to each of the cables and the messenger, so both options have been offered to allow for the users discretion.

Design Limits Apply

The design limits for messenger-supported assemblies can be applied **Before Attachment** or **After Attachment**. If you want SAG10 to apply the design limits to the complete assembly, click on the **After Attachment** button. This will ensure that the design conditions are met, after installation of cables and additional weights.

You may also design messenger-supported systems by applying the design limits to the messenger only. If you want SAG10 to apply the design limits to the messenger only, click on the **Before Attachment** button. The sag and tension output will then display two calculations per span, the first with the design limits applied to the messenger only, the second to showing the effect on the total assembly.

WARNING!

When you select the **Before Attachment** option, pay special attention to the two calculations per span. It is possible for the first, where the limits are applied to the messenger only, to meet all of the design limits, and the second, showing the effect on the total assembly, to exceed the bare wire design limits. This method should only be used with qualified engineering supervision.

The **Supported Cable Information** options do **NOT** apply to the following designs:

- Any non-supporting cable in direct contact with the messenger, such as figure-8 cable or lashed cable.
- Any pre-assembled non-supporting cable that is strung at the same time as the messenger, such as figure-8 cable.

Calculations for these situations are explained below.

4.4.3 Non-supporting cable, pre-assembled or lashed

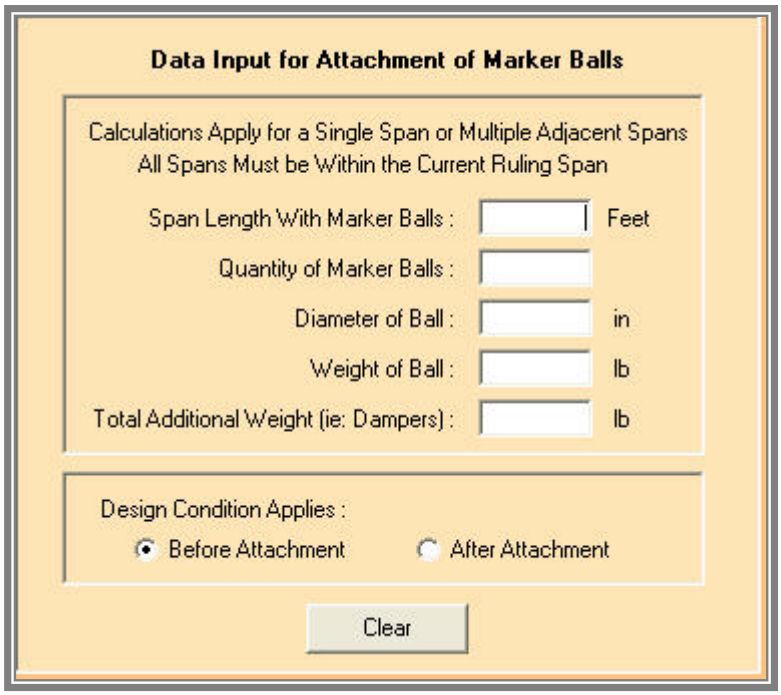
Use this calculation method for non-supporting cables pre-assembled to a messenger prior to stringing.

1. Determine basic information for the messenger, such as area, diameter, weight (per foot, or unit of measure), RTS and chart number.
2. Determine the diameter and weight (per foot, or unit of measure) of the cable(s) being supported.
3. In the **Conductor Selection** screen, select a **Conductor Type** for the messenger, then a specific conductor to be used as the messenger.
4. Click **Edit Data** in the *Data* panel and enter the **Area** of the messenger. Enter the **Weight** (per foot, or unit of measure) of the messenger plus cables. For the **Diameter**, enter the assembly diameter exposed to the wind. Enter the RTS of the messenger cable and **Chart** number for the messenger.
5. You can now use this selection for your sag and tension calculations.

If the cables are in direct contact, such as with lashed cable, the actual amount of combined ice build-up will vary depending on the configuration, quantities and diameter of the attached cable(s). As a result, all calculations assume the most conservative situation: that each cable will be covered with a uniform layer of the radial ice specified in the loadings table. If this is too conservative, it is up to the user to calculate an appropriate reduction of ice, and then reduce the radial ice indicated in the loadings table accordingly.

4.4.4 Marker Balls

This option allows you to add marker balls to a conductor. Each of the marker balls must be of equal diameter and weight.



SAG10 multiplies the **Weight of Ball** by the quantity of balls and adds that to the total weight. This total weight is evenly distributed over the span length. Radial ice is applied as a uniform layer over the balls, as well as over the conductor. Wind pressure is applied over the cross sectional area of the balls and conductor. Radial ice will increase all diameters, and resulting wind areas, by twice the radial ice thickness.

If marker balls are placed on all the spans within a ruling span, and their weight is evenly distributed among all spans, then the results may be obtained using this method. Fill in the **Data Input for Attachment of Marker Balls** prompt screen, using the ruling span length, total quantity of marker balls, their individual diameter and weight, and any additional weight you may have.

If the marker balls are on a single span within the ruling span, meaning the span is not dead-ended on either side, then additional calculations must be performed to determine the sag and tension information within that span. For details, refer to appendices G11A and G11B in the White Papers section at www.SAG10.com/documentation.

When you have selected the **Marker Ball** option, the marker ball data appears in the middle of the sag and tension run, serving as a break between the sag and tension data before and after the balls are installed. The second line indicates the quantity of balls, span, diameter and weight of one ball, and the additional weight (such as total weight of the vibration dampers) as the last item.

Design Limits Apply

The design limits for marker balls can be applied **Before Attachment** or **After Attachment**. If you want SAG10 to apply the design limits to the complete assembly, click on the **After Attachment** button. This will ensure that the design conditions are met, after installation of marker balls and additional weights.

You may also design systems by applying the design limits to the messenger only. If you want SAG10 to apply the design limits to the messenger only, click on the **Before Attachment** button. The sag and tension output will then display two calculations per span, the first with the design limits applied to the messenger only, the second to showing the effect on the total assembly.

WARNING!

When you select the **Before Attachment** option, pay special attention to the two calculations per span. It is possible for the first, where the limits are applied to the messenger only, to meet all of the design limits, and the second, showing the effect on the total assembly, to exceed the bare wire design limits. This method should only be used with qualified engineering supervision.

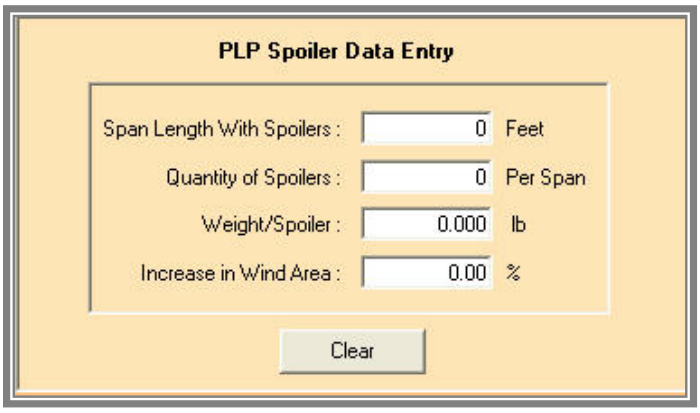
Stringing Sag Table Output for Marker Balls

If you are running a Stringing Sag Table for a line with marker balls, SAG10 will generate output with the Initial data prior to adding balls, Final data with balls attached, and Final loaded data with balls attached. For more information, refer the **Stringing Module** entry in the section on **Output Screen toolbar controls**.

4.4.5 PLP Spoiler

Click on the **PLP Spoiler** button in the *Conductor Options* panel if you want the SAG10 calculations to account for the horizontal and vertical loading created by PLP Spoilers.

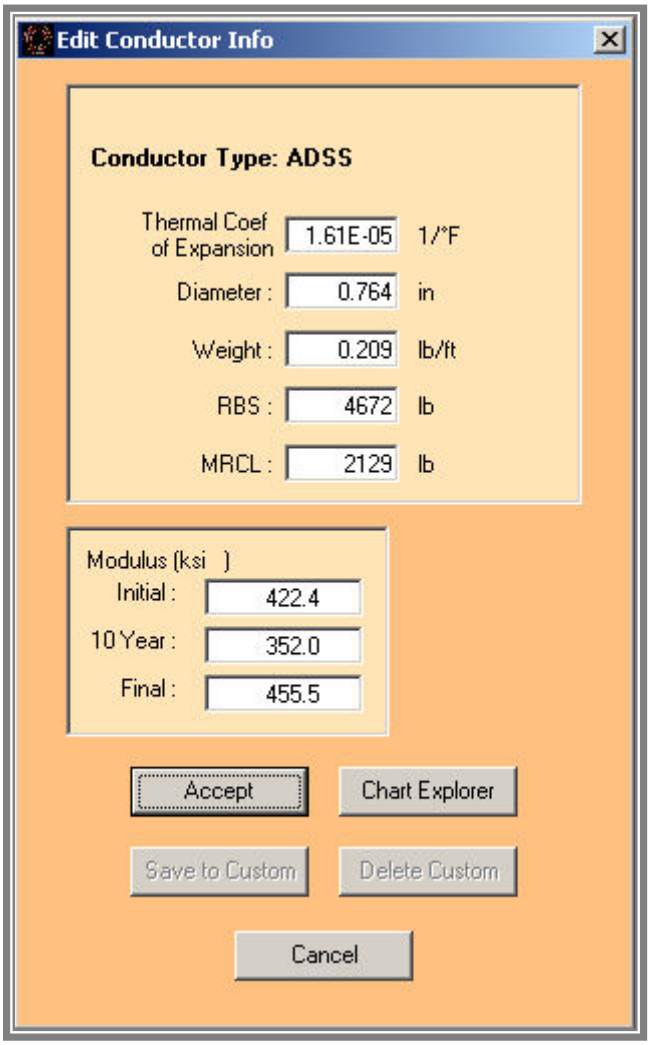
Fill in the requested data, then click on the **Accept** button at the bottom of the **Conductor Selection** screen to return to the **Main Menu** screen. When you run sag and tension calculations, the output will show the added spoilers and the conductor weight for each load condition will include the additional loads created by the spoilers.



4.4.6 ADSS Cable

The SAG10 *Conductor Selection* panel of the **Main Menu** includes a selection for **ADSS** (All Dielectric Self Supporting) cable. This feature was written specifically for cable manufactured by Alcoa Fujikura Ltd. (AFL). As such, it requires data that is not typically supplied by other cable manufacturers. There are no standard conductor designs available for this conductor type. Contact your ADSS cable manufacturer to obtain the information you need for this feature.

In order to perform ADSS calculations, first choose **ADSS** from the *Conductor Type* panel. The *Data* panel will load with no values, so click on the **Edit Data** button and type in the proper values requested on the screen. These values may be obtained from your ADSS cable manufacturer for your particular cable. Currently, the ability to store custom ADSS cable designs is not available.



The **MRCL** stands for Maximum Rated Conductor Limit and **RBS** stands for Rated Breaking Strength, which is the same as Rated Tensile Strength. It is important that both **MRCL** and **RBS** values be accurate in order to allow stringing the cable to the proper design tensions.

SAG10 obtains the allowed percentage of RBS by dividing the MRCL by the RBS. This percentage is often 50%, but may range from 45% to 63+%, depending on the particular cable. The allowable percentage is increasing as new designs are developed.

4.4.7 OPGW cable

The SAG10 **Conductor Selection** list includes the **OPGW** (Optical Ground Wire) type. The standard OPGW constructions listed are provided, as is, courtesy of Alcoa Fujikura Ltd. (AFL). For information and values for OPGW, contact your OPGW manufacturer.

4.4.8 AAAC conductor

The SAG10 **Conductor Selection** list includes the **AAAC** (All-Aluminum Alloy Conductor) type. The standard conductor tables supplied with SAG10 are for AAAC made from 6201-T81 aluminum alloy. There are other alloy types that have been, and are currently, being used, most notably 5005 alloy. However, 6201-T81 is the only aluminum alloy recognized by ASTM for AAAC at this time.

4.4.9 3M ACCR conductor

Aluminum Conductor Composite Reinforced (ACCR) is a high temperature low sag conductor available from 3M Corporation (www.3m.com/accr). ACCR is comprised of a stranded aluminum based composite wire core, which exhibits strength and stiffness comparable to a traditional ACSR steel core, but has about half the weight, and about half the thermal expansion coefficient of steel. The outer wires of ACCR made from a hardened aluminum zirconium alloy, which has properties similar to the 1350 H19 Aluminum wires used in ACSR. However, the zirconium alloying of these wires prevents annealing of the wires at high temperature. The combination of these materials results in ACCR having strength and stiffness similar to ACSR, but with less sag due to lighter weight and lower thermal expansion. ACCR conductors can be operated at up to 410 F (210 C) continuously, or 464 F (240 C) for 1000 hours over the life of the conductor.

3M has conducted extensive high temperature testing of ACCR and associated accessories. If you choose to consider aluminum compression in your high temperature sag and tension analysis, then the default value of 2500 psi gives results consistent with high temperature tests.

4.4.10 ACSR/TW Codewords

Previous versions of the software identify diameter equivalent trap-wire constructions using a TWD suffix rather than the correct codeword. The codewords for the diameter equivalent ACSR/TW conductors have been updated to the new Aluminum Association codewords, where they exist. For conductors that have not been assigned codewords, the codewords have been renamed to a generic name of "-----".

4.5 Sort Options

Once a conductor type has been selected, you can change the sort order for the selections in the **Conductor or Messenger** box dropdown menu from the **Sort** menu selection on the screen toolbar.

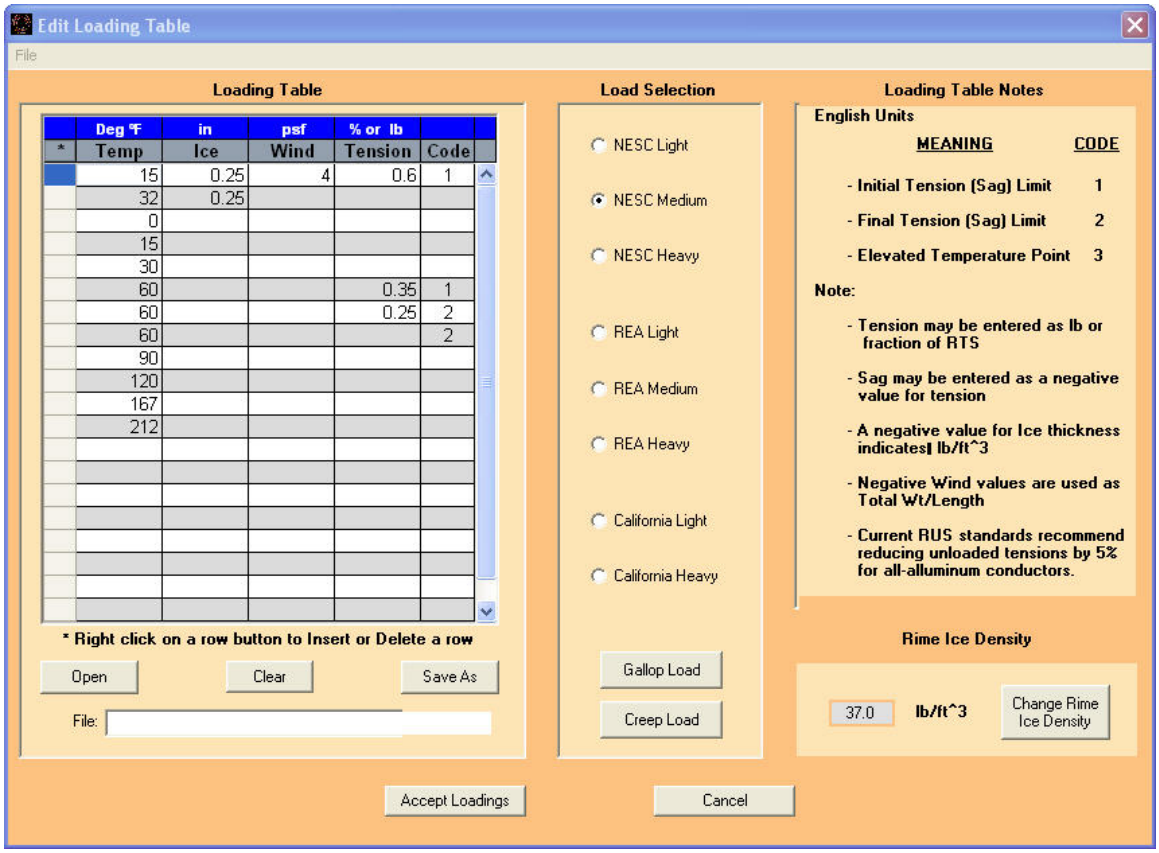
- **By Size** will cause SAG10 to arrange the conductor choices by size, from smallest to largest.
- **By Codeword** will cause SAG10 to arrange the conductor choices alphabetically based on the codeword, or the concatenated description for products without codewords.

Edit Loading Table Screen

5 Edit Loading Table Screen

In the *Load Selection* panel of the **Main Menu** screen, you can choose from a list of industry-standard loading configurations. The **Customary** loadings and tensions are the equivalent of the old Alcoa or REA loadings and tensions. The user should always check these values to be sure they are still valid, as standards can change.

If you are using the standard table values, all you have to do is click on a selection in the *Load Selection* panel on the **Main Menu** screen. However, if you would like to view or modify the Load Table, click on the **Edit Load Table** button in the *Load Selection* panel. The Edit Loading Table screen will appear, and if you have selected one of the standard loading, will pre-load those values into the loading table. If you have selected **Create Load Table** on the **Main Menu** screen, a blank table with one row, 60°F and Code of 2, for creep check will pre-load. Table units and headings are based on your selection of **Units** in the **Main Menu→Tools→Options** screen.



The figure above shows a load table with NESC Medium values selected. You can make additional entries up to a total of 50.

You can create custom loading tables with the **Save As** button. Once created, Custom load files can be selected on the **Main Menu** screen by checking the **Use Existing Load**

Table box. This lets you create a standard load table with the temperatures you need and select it, without having to return to this screen each time you want to use those temperatures.

5.1 Load Table fields

The Load Table fields (columns) are:

- **Conductor Temperature** (°F or °C)
- **Radial thickness of ice** (in or mm). The default ice density is 57.3 lb/ft^3 for glazed ice, per the NESC. Entering a negative value will cause SAG10 to use the ice density for Rime ice (or wet Snow). The default density for Rime Ice is 37 lb/ft^3, but can be modified by clicking on the **Change Rime Ice Density** button. The value for Rime Ice resets to 37 lb/ft^3 whenever the program is closed and started again.
- **Horizontal wind load** (Psf, Kg/M^2, or N/M^2). Negative wind values are used as total wind weight per unit length. Negative wind values cannot be used when the **Marker Balls** or **Use as a Messenger** options are selected on the **Conductor Selection** screen.
- **Tension limit** (Lb, Kg, or N, Ft, or a decimal fraction of RTS). If a negative value is entered, SAG10 will use the number as a sag limit.
- **Code** values indicate when a condition or limit is to be applied. Options are:
  1 = Initial Tension (Sag) limit
  2 = Final Tension (Sag) limit
  3 = Elevated Temperature Point

NOTE

The bare weights in the outputs are from the conductor database or a custom conductor you create. Loaded weights are calculated by adding the bare weight plus the effect of the wind and ice as defined in the load table.

5.2 Load Selections

You can quickly load a standard table using the loadings listed in the *Load Selection* panel. Selecting from this list will cause any values currently in the load table to be deleted, and the new values loaded.

5.2.1 NESC

The NESC (National Electric Safety Code) Heavy, Medium, and Light Loadings for Overhead Conductors are shown in the tables below. Tension limits shown are % RTS. These limits indicate the maximum tensions allowed by the NESC. The user should verify these values, as they may change as the NESC code is revised.

The user should be familiar with the NESC standard, as there are exceptions and cases where it may be inappropriate to apply these limits. It is left to the user to determine if these values are appropriate and sufficient for the conductor selected and the operating conditions. For example, these limits and loads may need to be modified for all-

aluminum conductors to prevent vibration, or loading conditions may be modified for operating conditions such as extreme ice and wind loads.

Note that AFL recommends that NESC Limits be reduced to 0.50 (50%) for ADSS cables.

NESC Tension Limits

NESC Light Load					NESC Medium Load					NESC Heavy Load				
Temp °F	Ice In	Wind lb/ft^2	Tension % or lb	Code	Temp °F	Ice In	Wind lb/ft^2	Tension % or lb	Code	Temp °F	Ice In	Wind lb/ft^2	Tension % or lb	Code
30		9	0.60	1	15	0.25	4	0.60	1	0	0.5	4	0.60	1
30					32	0.25				32	0.5			
60			0.35	1	0					-20				
60			0.25	2	15					0				
60				2	30					30				
90					60			0.35	1	60			0.35	1
120					60			0.25	2	60			0.25	2
167					60				2	60				2
212					90					90				
					120					120				
					167					167				
					212					212				

5.2.2 Customary

The Customary Heavy, Medium, and Light Loadings for Overhead Conductors are shown in the tables below. Tension limits shown are % RTS. These tables have been previously known as Alcoa or REA limits. They are more conservative than the NESC limits. If the user is designing to RUS standards, they should verify what values are correct per the latest RUS documents.

It is left to the user to determine if these values are appropriate and sufficient for the conductor selected and the operating conditions. For example, these limits and loads may need to be modified for all-aluminum conductors to prevent vibration, or loading conditions may be modified for operating conditions such as extreme ice and wind loads.

Customary Tension Limits

NESC Light Load					NESC Medium Load					NESC Heavy Load				
Temp °F	Ice In	Wind lb/ft^2	Tension % or lb	Code	Temp °F	Ice In	Wind lb/ft^2	Tension % or lb	Code	Temp °F	Ice In	Wind lb/ft^2	Tension % or lb	Code
30		9	0.50	1	15	0.25	4	0.50	1	0	0.5	4	0.60	1
30			0.333	1	32	0.25				32	0.5			
30			0.25	2	0					-20				
30				2	15			0.333	1	0			0.333	1
60					15			0.25	2	0			0.25	2
60					15					0				
60					30					30				
90					60				2	60				2
120					90					90				
167					120					120				
212					167					167				
					212					212				

5.2.3 California

The California Heavy and Light Loadings for Overhead Conductors are shown in the tables below. Tension limits shown are % RTS. If the user is designing to California standards, they should verify what values are correct per the latest California standards documents.

It is left to the user to determine if these values are appropriate and sufficient for the conductor selected and the operating conditions. For example, these limits and loads may need to be modified for all-aluminum conductors to prevent vibration, or loading conditions may be modified for operating conditions such as extreme ice and wind loads.

NESC Tension Limits									
California Light Load					California Heavy Load				
Temp °F	Ice In	Wind lb/ft^2	Tension % or lb	Code	Temp °F	Ice In	Wind lb/ft^2	Tension % or lb	Code
25		8	0.60	1	0	0.5	6	0.60	1
25					32	0.5			
60			0.25	1	-20				
60			0.25	2	0				
60				2	30				
90					60			0.35	1
120					60			0.25	2
167					60				2
212					90				
					120				
					167				
					212				

Customary Tension Limits									
California Light Load					California Heavy Load				
Temp °F	Ice In	Wind lb/ft^2	Tension % or lb	Code	Temp °F	Ice In	Wind lb/ft^2	Tension % or lb	Code
25		8	0.50	1	0	0.5	6	0.50	1
25			0.333	1	32	0.5			
25			0.25	2	-20				
25					0			0.333	1
60				2	0			0.25	2
90					0				
120					30				
167					60				2
212					90				
					120				
					167				
					212				

5.3 Gallop Load

Clicking on the **Gallop Load** button in the *Load Selection* panel will insert the loads shown below into the Load Table. These are required to calculate the Galloping Ellipses.

Gallop Loads				
Temp °F	Ice in	Wind Psf	Tension % or lb	Code
32.0	0.50			
30.0				

NOTE

The NESC and Customary Heavy loads already include the gallop load conditions.

Refer to the **Gallop module** section in the **Sag & Tension Data** screen chapter for more information on galloping calculations.

5.4 Creep Load

To make a standard check for creep, click on the **Creep Load** button in the *Load Selection* panel. SAG10 will add a Load Table entry of :

Creep Load				
Temp °F	Ice in	Wind Psf	Tension % or lb	Code
60.0				2

Any row with a zero value for the **Tension** entry and a 2 for **Code** entry will allow the program to check for creep. If all such entries are removed, creep will not be checked, and incorrect data may result. In such a case, the output also will read **Creep is NOT Considered**.

If the final sag is controlled by creep, the output will read **Creep IS a Factor.** If the final sag is controlled by the ice and wind from one of the load cases, the output will read **Creep is NOT a Factor.**

5.5 Printing the Load Table

Saved Loading Table files with a .LOD extension can be opened with a word processor, such as MS WordPad or Word. Highlight the text and select a fixed pitch font such as Courier New. If you want the table headings, you will have to type them in manually. When you have chosen your font and headings, print from the word processor.

Sag & Tension Data Screen

6 Sag & Tension Data Screen

NOTE

The toolbar in the SAG10 **Sag & Tension Data** screen offers many important project calculation choices. For details, refer to the **Data Screen toolbar controls** section below.

6.1 Data screen

When you run sag and tension calculations, either from the **Calculate Sag & Tension** button on the **Main Menu** screen, or from the **Main Menu** toolbar→**Run** menu, the SAG10 program generates a **Sag & Tension Data** screen to display the output. You can use the scroll bars to view data that extends off the screen.

If you selected the **Pause between Spans** option, either in the *Ruling Spans* panel of the **Main Menu** screen, or in the **Main Menu** toolbar→**Run** menu, the toolbar at the top of the **Sag & Tension Data** screen will contain the **Next Span** option. Clicking on **Next Span** will allow SAG10 to calculate each span until the last span is displayed.

The SAG10 **Main Menu** screen toolbar→**Tools**→**Options**→*Also Output Results to* panel lets you send sag and tension output to either a printer or a file, as well as the **Sag & Tension Data** screen when a calculation is run. If you select this, the output of calculations for the modules listed in the **Sag & Tension Data** screen toolbar→**Modules** menu selection: **Stringing**, **Offset Clip**, **RS Variation**, **Gallop** and **Clash** are also sent to the printer or file.

Refer to the SAG10 **Main Menu** screen toolbar→**Page Setup** menu selection for options such as adding your Company name and date to the page header.

6.2 Creep messages in the Data Screen

6.2.1 Extrapolated curve message.

If your output indicates that SAG10 has had to extrapolate a stress-strain curve beyond the point where it may be valid, this message will appear. This may happen anytime large mechanical loadings are placed on a conductor, particularly in longer spans, and very large strains are encountered. SAG10 estimates the stress-strain curve in these situations to the best of its ability and completes the calculation. However, the user should be aware that this is occurring as it may affect the accuracy of the results.

6.2.2 Creep messages and critical tension

- If your output indicates that **Creep is a Factor**, it means that final sag and tension are controlled by the elongation caused by the long-term creep of the conductor.

- If your output indicates that **Creep is Not a Factor**, it means that final sag and tension are controlled by the elongation caused by one of the loaded conditions.
- If your output indicates that **Creep is Not Considered**, it means that the user has bypassed the normal creep check by leaving out the 60°F, Code 2 load case from the Loading Table and that the output is therefore probably incorrect.

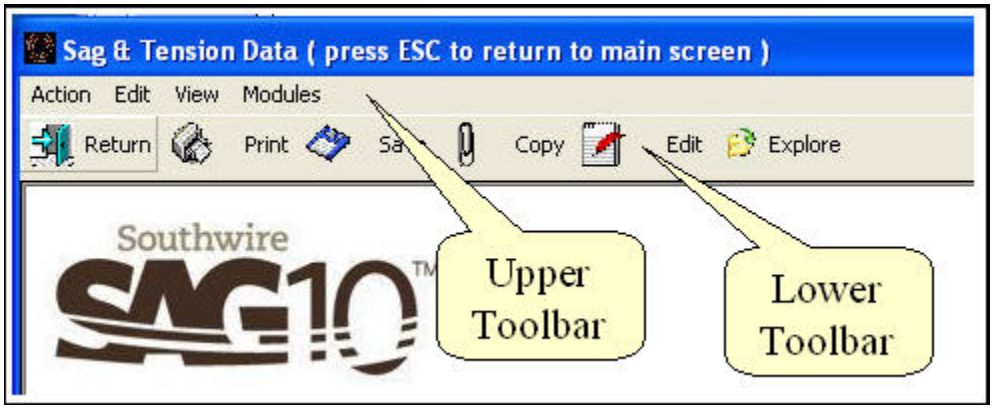
For hotter climates, the normal creep check condition of 60-0-0-0-2 may be changed to a higher temperature, such as 70-0-0-0-2. Likewise, for a colder climate, the normal creep check condition may be changed to a lower temperature, such as 50-0-0-0-2. The 10 year creep load will be applied at the highest temperature in the loading table with a no load, no tension limit and a code 2 entry.

The critical tension (Tcr) is the tension corresponding to the intersection between final modulus curve and 10 years creep curve in the conductor stress-strain chart.

If T>Tcr, then the 10 year creep curve strain is greater than the final modulus curve strain, and the final sag and tension will be based on the 10 year creep curve. The Data Screen message will read: **Creep is a Factor.**

If T<Tcr, then the 10 year creep curve strain is less than the final modulus curve strain, and the Final sag and tension will be based on the final modulus curve. The **Data Screen** message will read: **Creep is Not a Factor.**

6.3 Data Screen upper toolbar controls



6.3.1 Action

Export to Printer
This menu item displays the standard MS Windows printer setup and selection window.

Export to File
This menu item saves the report file to a location you specify.

Set up Fonts
This menu item opens the SAG10 Font window. For details, refer to the **Main Menu** screen toolbar→**Setup** menu section.

Explore Folder
This menu item lets you browse for a file or folder location you specify.

Exit to Main Screen
This menu item closes the **Sag and Tension Data** screen and returns you to the SAG10 **Main Menu** screen.

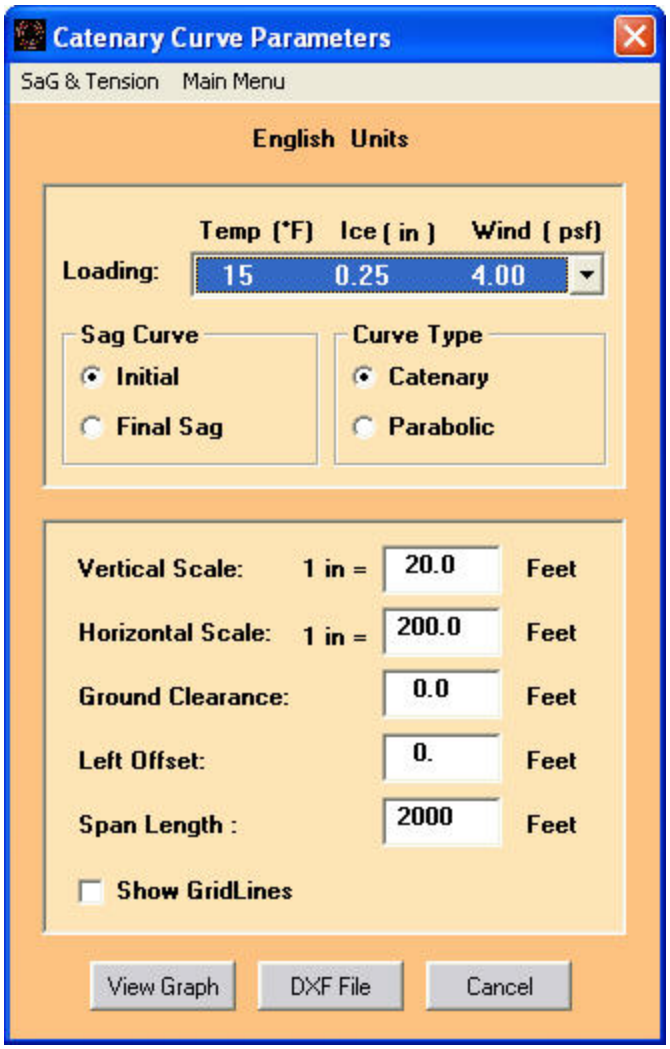
6.3.2 Edit

Cut, copy, paste to clipboard
These menu items implement the standard MS Word commands.

Edit with WordPad
This menu item opens a Word window and loads the output report for editing.

6.3.3 View

Sag Curves
This menu item opens the **Catenary Curve Parameters** window.



This window lets you set parameters for the sag curve display.

Catenary Curve Parameter window controls

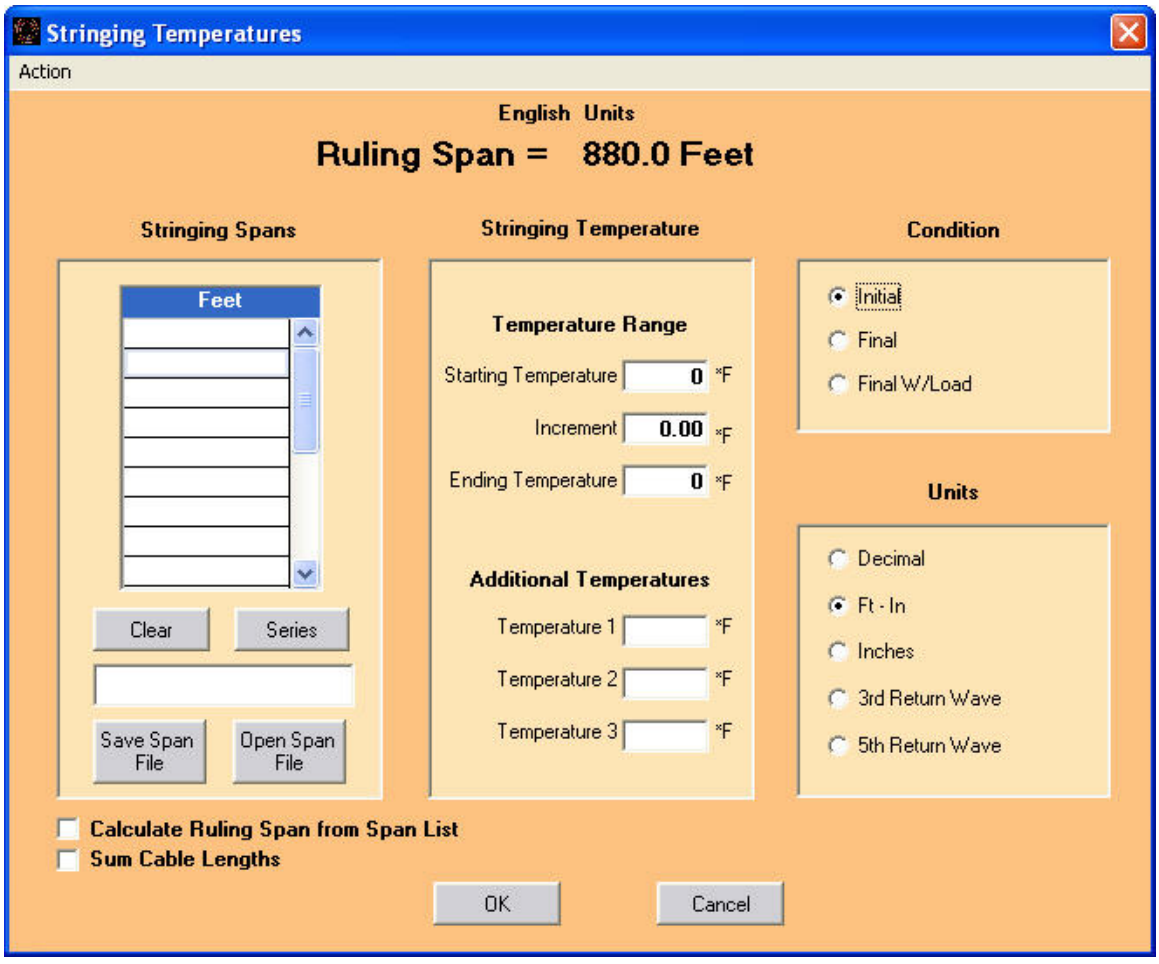
- *Sag Curve* settings for **Initial** or **Final** sag
- *Curve Type* settings for **Catenary** or **Parabolic** curve.
- Adjustable **Horizontal** and **Vertical** scales
- You can specify a **Ground Clearance** for the sag curve. If you enter a value of 0, no ground clearance will be shown with the sag curve
- Set a **Left Offset** for the sag curve to allow better viewing of flatter sag curves.
- Checking the **Show Gridlines** box will put gridlines on the screen, printed and DXF output. This may aid in alignment of the sag curves with your own grid system.
- The **View Graph** button opens the **Catenary Curve** screen. You can print or plot the image directly, or transfer it to a graphics program for further editing. Toolbar options in the **Catenary Curve** screen toolbar:
    - **Save as BMP file** saves the curve to a .BMP file.
    - **Print/Plot** will send the curve to the default printer or plotting device.

- **Page Setup** allows you select print options such as portrait or landscape print orientation in a standard MS Word printer setup window.
- **Return** takes you back to the **Catenary Curve Parameter** screen.

- The **DXF File** button saves the sag file as a .DXF file in a location you specify. A DXF file can be imported into most CAD programs. Typical uses would be to generate a sag template overlaid with other conductors, or to import the sag curve into a drawing containing some ground profile for structure spotting.
- The **Cancel** button closes the **Catenary Curve Parameters** screen and returns you to the **Sag & Tension Data** screen.

6.3.4 Stringing module

Selecting this option from the **Sag & Tension Data** screen toolbar **Modules** list will open the **Stringing Temperatures** screen.



Stringing Spans

You can enter multiple spans within the ruling span, or select up to 40 individual spans. The number of spans times the number of temperatures may not exceed a total of 1880.

Calculate Ruling Span from Span List
You can also retrieve a span list from a .spn file created and saved in the **Ruling Span Calculation** screen (Refer to the **Main Menu** toolbar→**Run** menu section). If this box is checked, SAG10 will calculate a ruling span for the list of spans used.

Sum Cable Lengths box
If you check the **Sum Cable Lengths** box, the **Sag &Tension Data** screen will show the sum of the level ground catenary lengths for all of the spans listed and for the range of selected stringing temperatures and corresponding horizontal tensions. SAG10 will calculate one length for each temperature and tension.

Stringing Temperatures
You can enter up to 30 stringing temperatures. The stringing temperatures you enter are independent of the temperatures you selected for the normal sag and tension calculation.

The only unloaded temperatures required in the normal sag and tension calculation are temperatures with controlling conditions, such as 60-0-0-2 for creep check, checking cold temperature for NESC or Customary tension limits, and/or high temperature sag.

The stringing temperature values you enter will be retained for the entire SAG10 session, and are saved with the Project file.

Condition
If you have chosen **Marker balls** or **Use as a Messenger** in the **Conductor Selection** screen (For more details, refer to the **Conductor Selection Screen** chapter.), **Initial** will calculate without balls or cables, and **Final** will calculate with balls or cables attached. This will let you string the bare wire before attaching balls and cables, and then check the final sag after attachment.

If you are stringing pre-assembled aerial cable, enter the data without balls or cables. The Stringing Sag Table will be output as Initial Sag with the attached cable load. (For more details, refer to the **Conductor Selection Screen** chapter.)

Final W/Load will calculate with balls attached. This selection will generate stringing sag tables using all of the temperatures with ice or wind loading.

Horizontal tensions are, by definition, the same in all spans within a ruling span section. SAG10 calculates and stores the horizontal tension for each temperature needed in constructing a stringing chart. Stringing sag tables are not available when running elevated temperature creep.

Units

- The default stringing sag output is **Ft-In** for English Units. **Ft-In** allows the output to be shown in feet and inches. **Inches** shows the output in inches only.
- The setting will default to **Decimal** for Metric Units. **Decimal** units are feet for English and meters for Metric.
- **3rd** and **5th Return Wave** will generate stringing sag output as the time in seconds for sagging done by stopwatch.

6.3.5 Offset Clip module

Insulator offsets and sag corrections are sometimes needed in rough terrain because the conductor, strung over "frictionless" sheaves, tends to run downhill. The result is that the conductor will come to equilibrium with sag greater than chart sag in the lower spans and less in the upper spans. The stringing sheaves usually swing toward the uphill spans.

The SAG10 offset clipping program uses techniques presented in AIEE Paper 59-900, "Sag-Tension Computations and Field Measurements of Bonneville Power Administration" by Paul F. Winkelman.

Required data

You will need to know the following factors: ruling span, horizontal stringing tension, stringing temperature, maximum design tension, loading-ice, wind, temperature, bare weight, area and modulus. Many of these factors are already part of SAG10.

The program asks for elevation, station and structure number. You must also know the direction of pull. The printout produces positive or negative insulator offsets and sag corrections by structure number.

Create a file

You will need to create a file in a text editor that has ASCII output. Set the file extension to .CLP. In the file, each structure will have its own line with the following information, in this order, separated by commas:

- Elevation
- Station back
- Station ahead (Set to 0 if there is no equation station.)
- Structure identification, enclosed in single quote marks

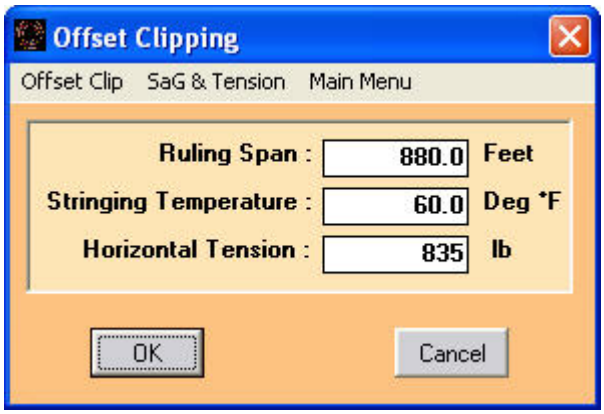
A sample file called SAMPLE.CLP appears below. The example shows the pull from Structure 1-1 to 1-12. Structure 1-6 is a sample of an equation station.

Sample clipping data file (sample.clp)

```
1951,107253,0,'Str # 1-1'
1851,107353,0,'Str # 1-2'
1941,107453,0,'Str # 1-3'          COLUMN 1 = Elevation
1851,107553,0,'Str # 1-4'
1051,107653,0,'Str # 1-5'          COLUMN 2 = Station Back
1921,107753,107783,'Str # 1-6'
1971,107853,0,'Str # 1-7'          COLUMN 3 = Station Ahead ( Only >0 if equation station)
1981,107953,0,'Str # 1-8'
1955,108053,0,'Str # 1-9'          COLUMN 4 = Structure No.
2051,108153,0,'Str # 1-10'
1651,108253,0,'Str # 1-11'
1451,108353,0,'Str # 1-12'
```

Offset Clipping run procedure

1. Create a .clp file as described above.
2. Create and execute a sag and tension run for the ruling span in which the offset clipping will be used.
3. In the **Sag and Tension Data** screen toolbar, select **Modules→Offset Clipping**.
4. A standard **Open File** window will appear. Select the file you created in step #1.
5. When you click on **Open** in the **Open File** window, the **Offset Clipping** screen will appear.



   The most recently calculated Ruling Span is displayed as the first input. If you choose that Ruling Span and a stringing temperature from the most recent Sag and Tension run, then the correct Horizontal Tension will be offered as the third input.
6. Click on the **OK** button. The Offsets will appear on the **Sag & Tension Data** screen.

6.3.6 Ruling Span Variation module

This module calculates the variation in sags and tensions when spans of differing lengths see large temperature excursions.

Causes of sag and tension variations

Between deadend structures, there are typically a variety of different span lengths. The ruling span is a mathematical number that represents a best approximation of the average characteristics that will occur within each of those spans. At initial stringing temperature, the horizontal tension is the same for all of the spans, assuming the conductor is pulled in evenly across the various spans. However, the further the temperature deviates from the stringing temperature, and the further a span-length varies from the ruling span, the greater the variation in sag and tension.

These variations are normally small enough to fall within the safety margin allowed in line design. However, at elevated or cold temperatures and with large span variations, these variations may be large enough that they should be considered during line design. This section allows the user to become aware that certain spans may have more sag and other spans may have more tension than was calculated by the ruling span sag and tension data – and to quantify those differences.

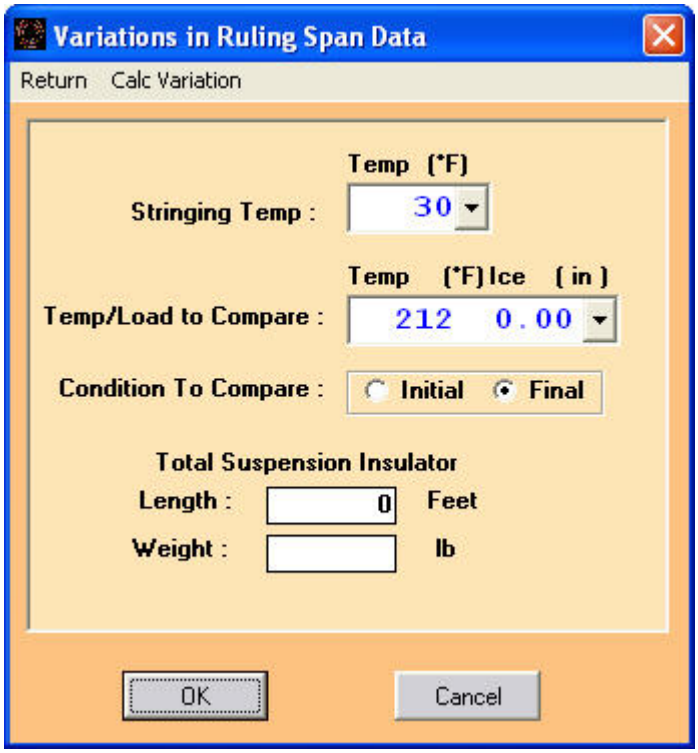
Calculations are limited to suspension insulators

These calculations apply only for suspension insulator systems, where the insulators are free to swing, limited only by gravity. Fixed insulators, such as post insulators, would have less change in sag and tension and are not calculated here. Calculating the exact stiffness of the support structure would be required, numbers that would be difficult to obtain.

Running ruling span variations

To use this module:

1. Select **Modules→RS Variation** in the **Sag & Tension Data** screen toolbar. A standard **Open File** window will open. Select either a .SPN file created in **Ruling Span Calculations** screen or a .CLP file from clipping offset calculations. When you click on **Open** in the **Open File** window, the **Variations in Ruling Span Data** screen will appear.
2. Select the correct stringing temperature from the **Stringing Temp** drop-down menu.
3. Select the temperature to compare with in the **Temp/Load to Compare** drop-down menu. You



can view the extreme variations by selecting an elevated temperature, a cold temperature, or an ice load condition for comparison.

4. Set the comparison condition by clicking on **Initial** (for cold temperature or ice load comparison) or on **Final** (for elevated temperature comparison).
5. Enter the **length** and **weight** of the entire string of suspension insulators.
6. Click on the **OK** button, and the Variations in Ruling Span calculations will appear on the **Sag & Tension Data** Screen.

6.3.7 Gallop module

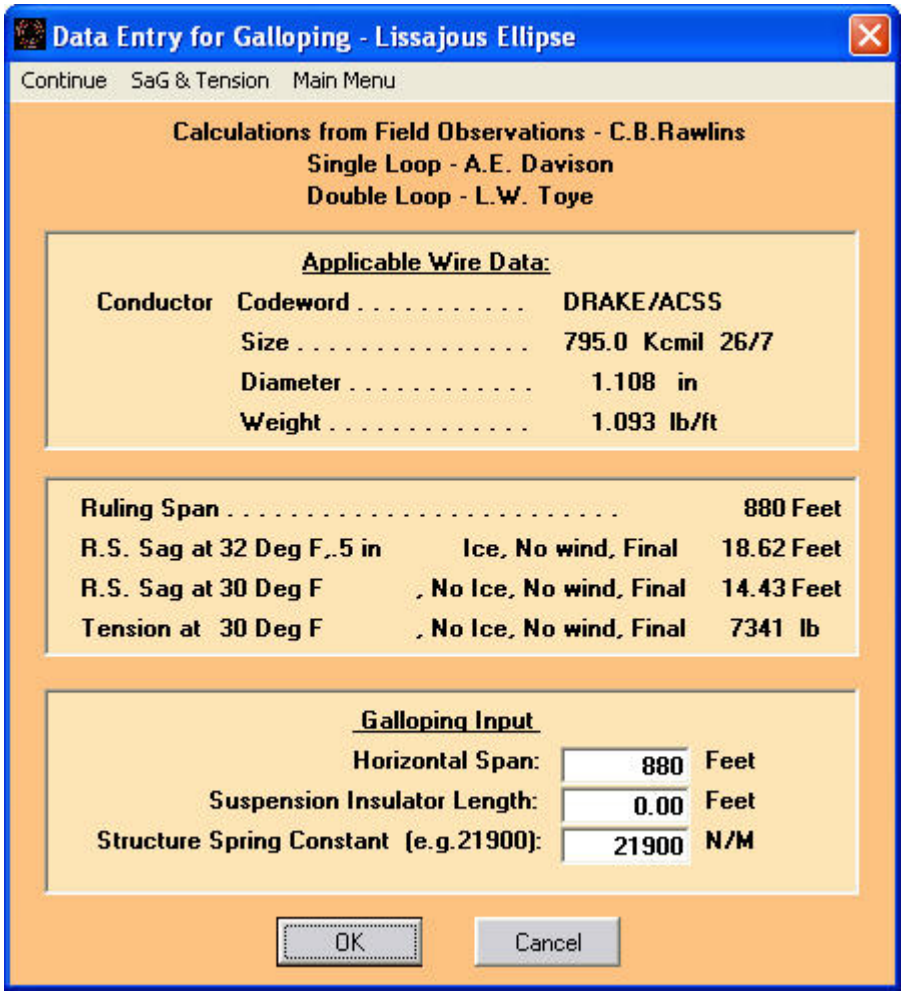
SAG10 will calculate galloping by three methods, the two common methods of Davison and Toye, and calculations by C.B.Rawlins, based upon his IEEE paper.

Add gallop loads

Before you can do galloping calculations, you must have gallop load entries in your load file:

- One line showing 30 Deg. F., no ice, no wind
- One line showing 32 Deg. F, 0.5 ice, no wind.

Clicking on the **Gallop Load** button in the *Load Selection* panel of the **Edit Load Table** screen will add these entries to the load table automatically.



Running gallop calculations

Select **Modules→Gallop** in the **Sag and Tension Data** screen toolbar and the **Galloping Data Entry** screen will open.

The **Galloping Data Entry** screen displays current conductor information, applicable sag and tension calculation results, and prompts for additional information.

Horizontal Span: The displayed value defaults to the current ruling span. This may be made larger or smaller, to match specific span lengths within the ruling span.

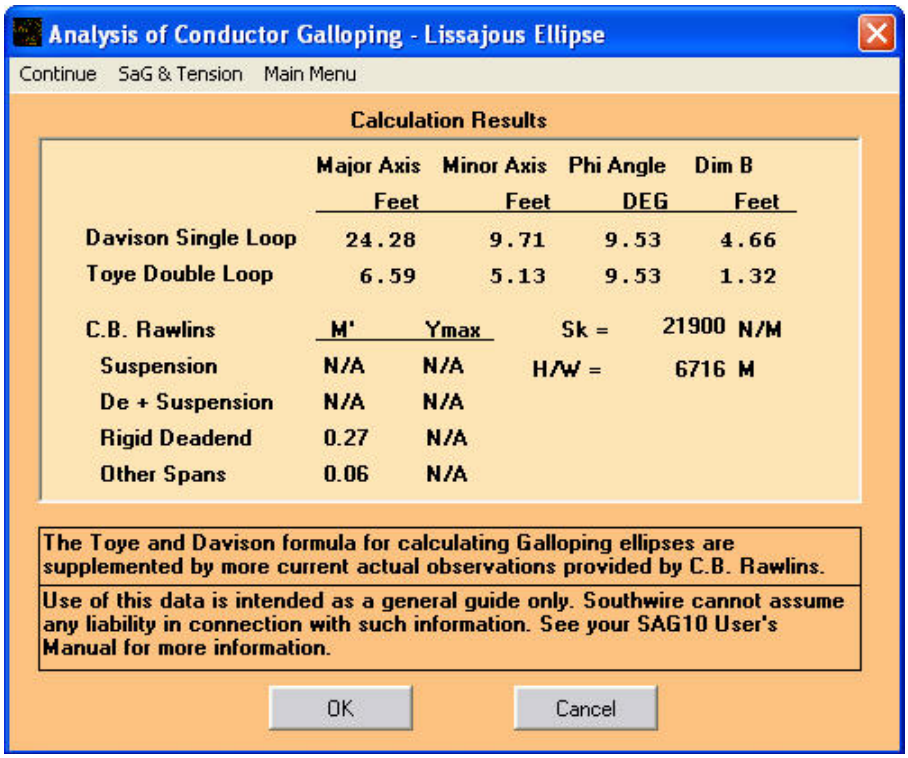
Suspension Insulator Length: If this value is greater than zero, the Rawlins calculations will create a Ymax (peak to peak amplitude) result for suspension structures, and an insulator length will be shown in the graphical display.

Structure Spring Constant: This value is used in calculating the Ymax value in the Rawlins calculations. The value will vary from the sample entry of 21900 and should be determined specifically for your structures. For more details, refer to Appendix R, "Rawlins Galloping" in the White Papers section at www.SAG10.com/documentation.

The Davison and Toye formulas give ellipse dimensions recommended for use in design, based on observations available at the time they were published. These dimensions have been widely applied in designing clearances for galloping. A more recent, larger collection of field observations provides the basis for the Ymax values given in SAG10.

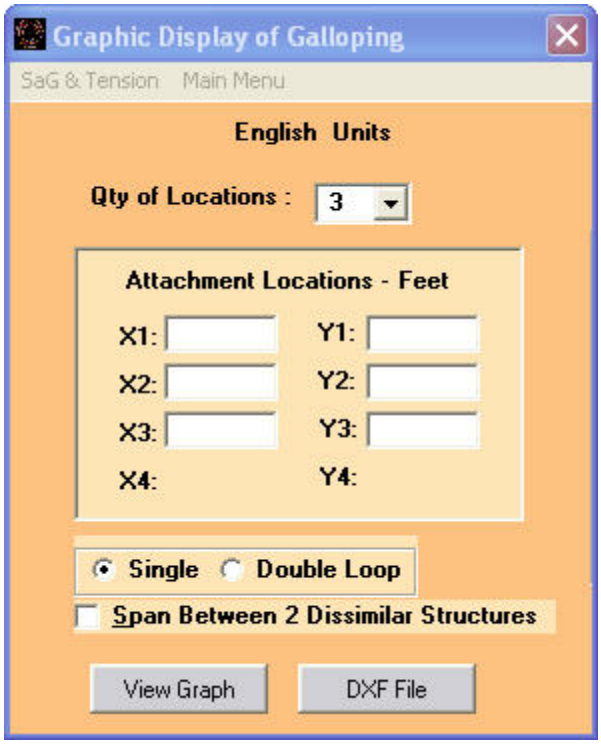
Designers are cautioned that a wide variety of ellipse orientations and eccentricities occur in practice. Refer to Fig. 4-6 of EPRI's Transmission Line Reference Book, "Wind Induced Conductor Motion" for information on the ranges of variation.

When you click on the **OK** button in the **Galloping Data Entry** screen, the **Analysis of Conductor Galloping** screen opens. This window shows the results of the Davison, Toye and Rawlins galloping calculations.



If suspension insulator length prompted for in the **Galloping Data Entry** screen is set to zero, the Rawlins results for suspension insulators will show N/A. If M` has a value, but Ymax indicates N/A, it means that the value for Ymax is outside of the range of test data available in the galloping study in Rawlins IEEE paper. No input is required at this screen.

If you click on the **OK** button in the **Analysis of Conductor Galloping** screen, the **Graphic Display of Galloping** screen will open.



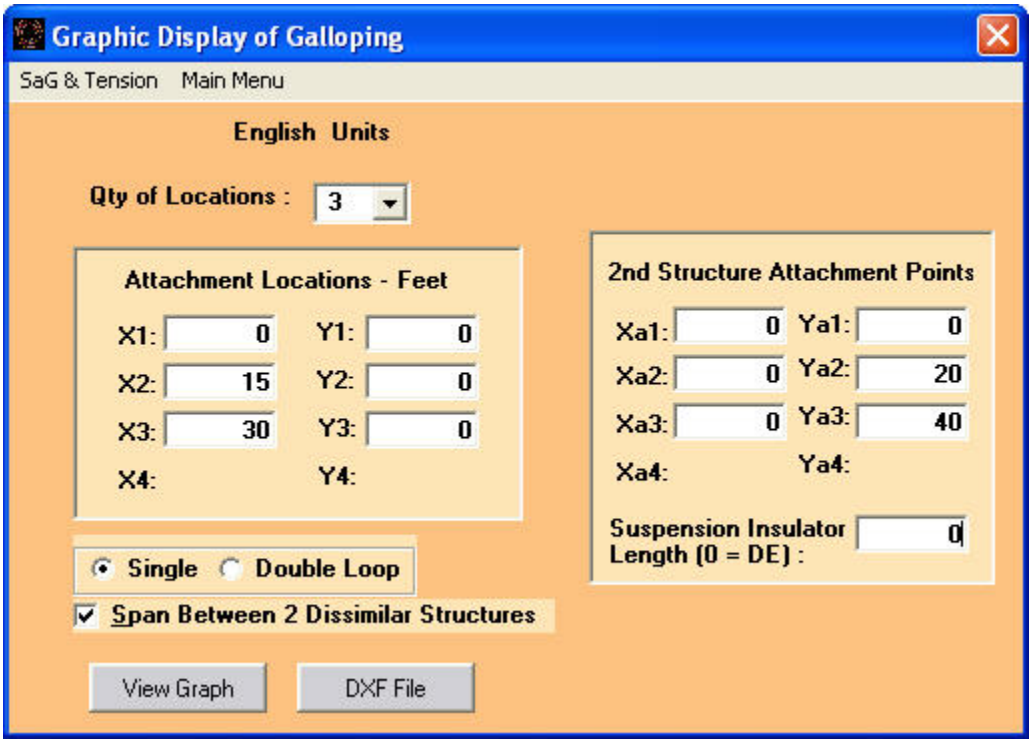
To display a graphical layout of the galloping ellipses, you will need to enter the requested data. Click on the arrow to the right of the **Qty of Locations:** box to select a display of 1 to 4 conductors. An equal number of pairs of attachment point boxes will be displayed, (X1,Y1) thru (X4,Y4).
For more details, refer to Appendix I, “Galloping Attachment Locations" in the White Papers section at www.SAG10.com/documentation.

Galloping loops may be graphed as either Single loop (Davison) or Double loop (Toye).

Clicking on the **DXF File** button will open a standard **File Open** window where you can browse for a location to create a DXF file that can be imported into most CAD programs. A typical use for this would be to overlay the Galloping Ellipses from more than one conductor with the image of a powerline structure.

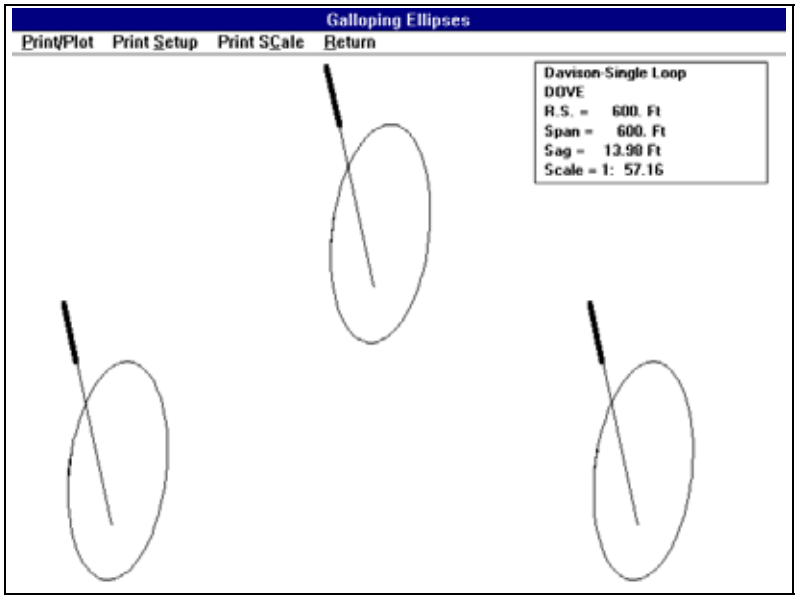
If you have two dissimilar structures, such as a suspension tangent and a deadend structure, or a horizontal phase layout that rolls into a vertical layout, and you want to

determine the midspan galloping performance, check the **Span Between 2 Dissimilar Structures** box. The **2nd Structure Attachment Points** screen will be added to the **Graphic Display of Galloping** screen.



In the example shown, the first structure is horizontal suspension and the second is a vertical deadend structure. The resulting graphic output is equivalent to two structures with attachment points that are an average of the X and Y coordinates of the two structures, and an average of the attachment point suspension lengths.

When you click on the **View Graph** button, the graphic display of the galloping ellipses is created.



You can print or plot this image directly, or transfer it to a graphics program for further customizing, such as adding to or removing part of the image, setting margins, and/or rescaling before printing/plotting.

Galloping graphic display toolbar controls

Print/Plot will send the graphic image to the printer or plotter selected in Print Setup.

Print Setup opens a standard printer setup and selection window. You can select the printer or plotter you want to use here.

NOTE

When returning to the **Sag & Tension Data** screen, the output will continue to print in the direction that was most recently set. **Be sure to reset the print direction prior to leaving this area to whatever direction may be required for the next print operation.**

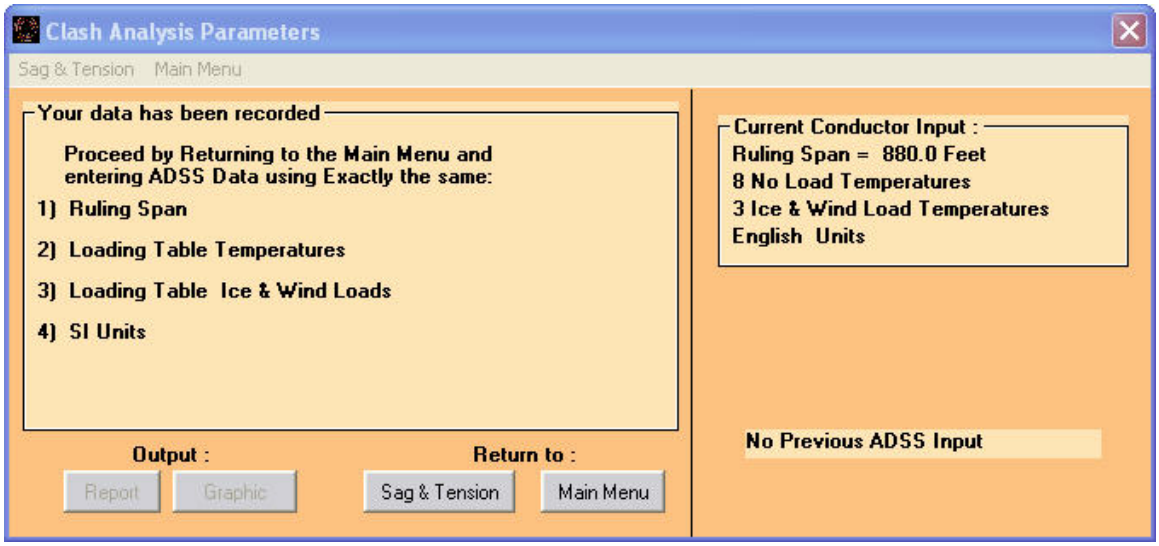
Print Scale opens a window that shows the smallest ratio that will fit on the currently selected printer/plotter paper. A larger number creates a smaller image. Try a scale such as 80:1 for Portrait and 60:1 for Landscape mode for the example shown.

BMP will generate a .BMP file of the graphic screen and open a browser window where you can select a file name and a storage location.

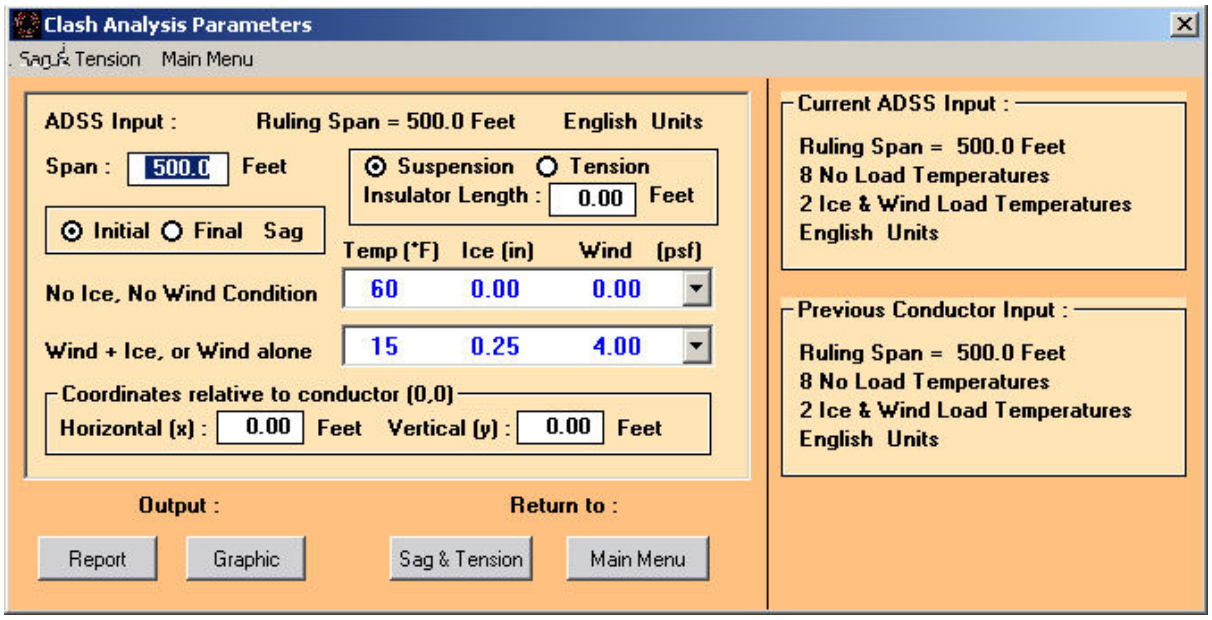
6.3.8 Clash module

Clash Analysis refers to the loaded and unloaded swing and static clearances between your chosen conductor and ADSS supported on the same structure, for both initial and final state. Conductor suspension insulator string length is taken in consideration. The steps required are:

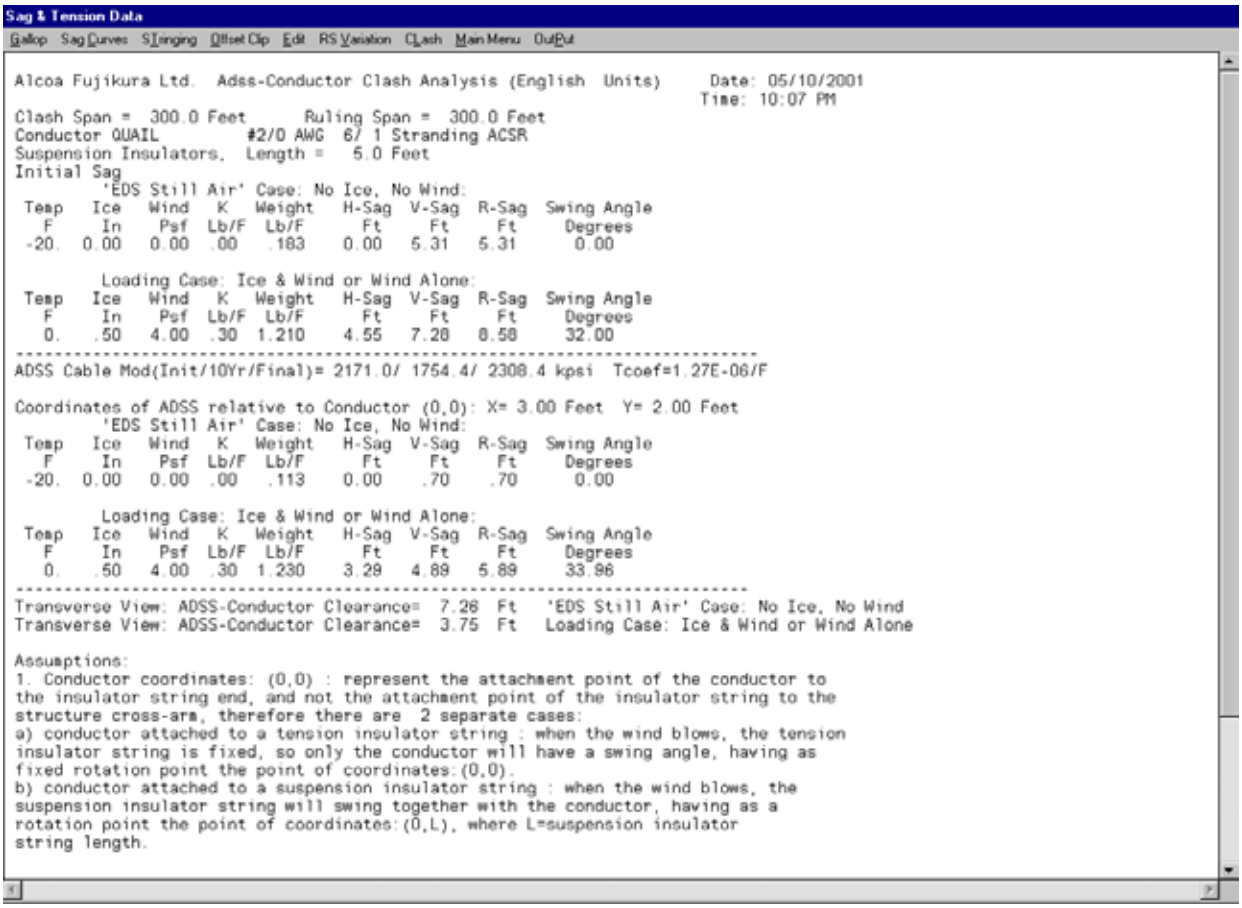
1) Create or Open a Project file for the chosen conductor with all the appropriate loads and ruling span.
2) Save the Project.
3) In the **Main Menu** toolbar, select **Run→Sag & Tension**.
4) In the **Sag & Tension Data** screen toolbar, select **Modules →Clash**.
5) The **Clash Analysis Parameters** screen will appear indicating that your data has been recorded. Click on the **Main Menu** button to return to return to the **Main Menu** screen to enter the ADSS cable data.



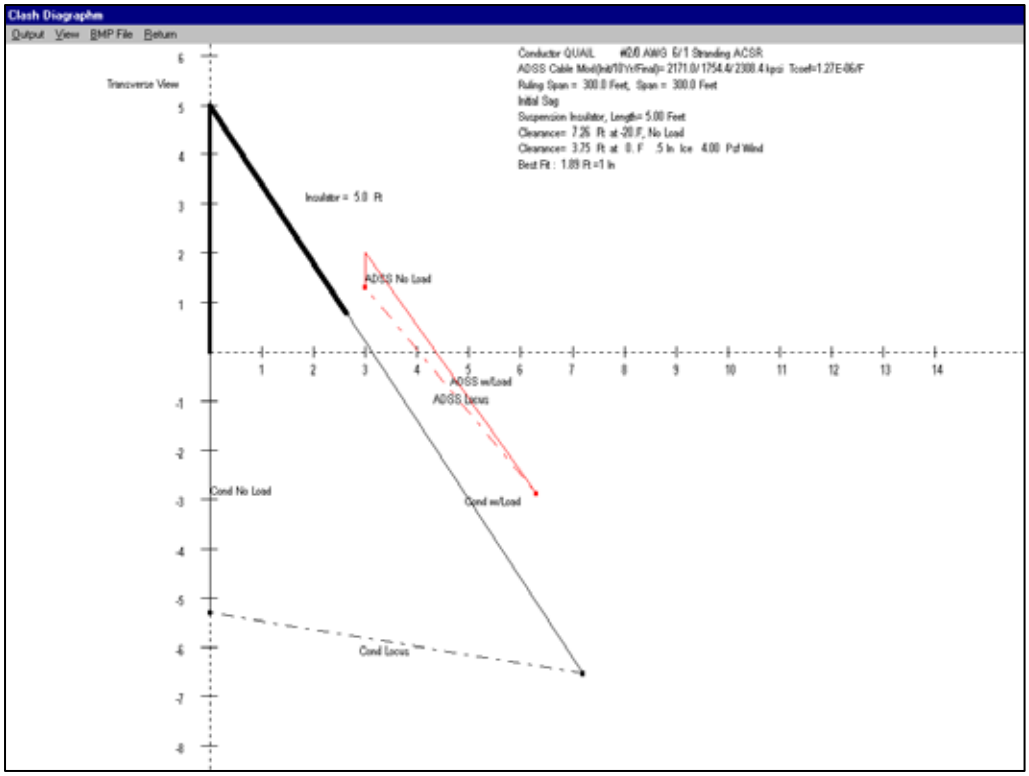
6) In the **Main Menu**, click on the **Conductor Selection** button. Select the **ADSS** conductor type and click on the **Edit Data** button in the *Data* panel. Enter the ADSS cable information.
7) Change the Load Limits (tension or sag) in the **Load Table** if that is appropriate, but **leave the temperature, ice and wind or wind alone conditions <u>exactly</u> the same.**
8) Save this second Project file under a different name.
9) In the **Main Menu** toolbar, select **Run→Sag & Tension**.
10) In the **Sag & Tension Data** screen toolbar, select **Modules →Clash** for a second time. A **Clash Analysis Parameters** screen with spaces for data entry will appear.

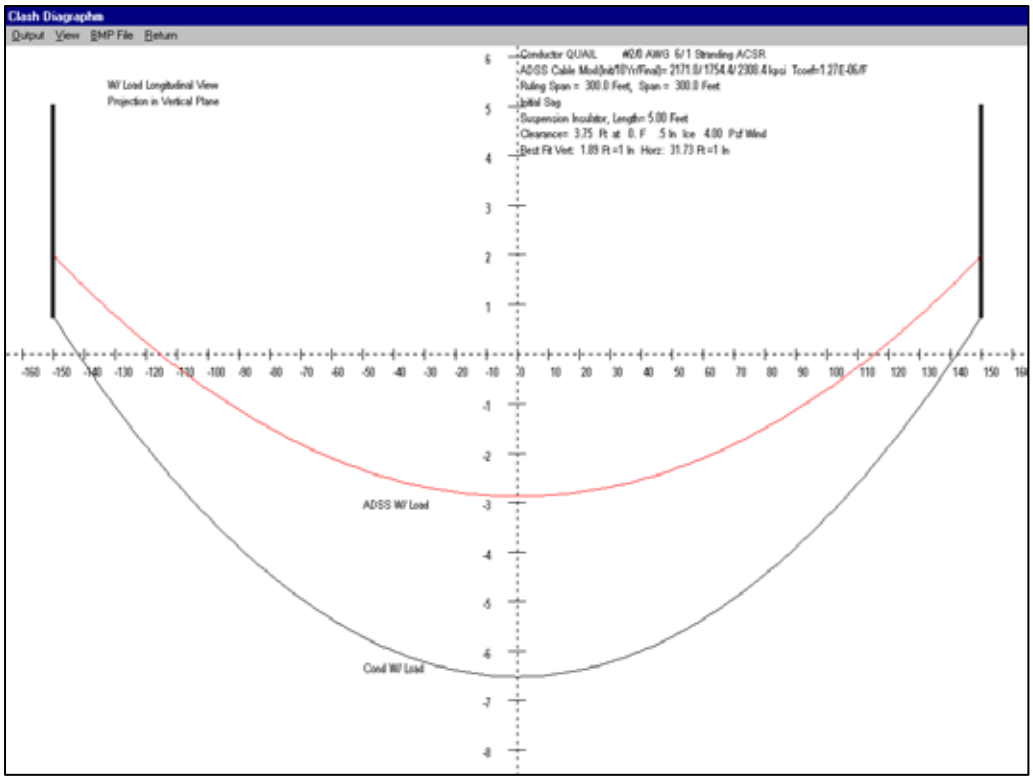


11) Adjust the parameters shown on the screen as needed. Be sure to fill in **Insulator Length** if **Suspension** is selected, and the **Horizontal** and **Vertical** offsets between the two cables
12) In the **Clash Analysis Parameters** window, click on the **Report** button to view the loading cases, cable swing angles, offsets, and conductor to ADSS clearances.



13) Click on the **Graphic** button to view the **Clash Diagram** screen. This screen displays the Transverse and Longitudinal clearances between the two conductors.





Options available on the **Clash Diagram** screen toolbar are:

Output menu choices:

- **Output, Print/Plot** will send the image to the Printer or Plotter.
- **Output, Print Setup** brings up the Printer Dialog box allows the image to be rotated to Portrait or Landscape.
- **Output, Scale** allows the scale to be adjusted independently for printed output.

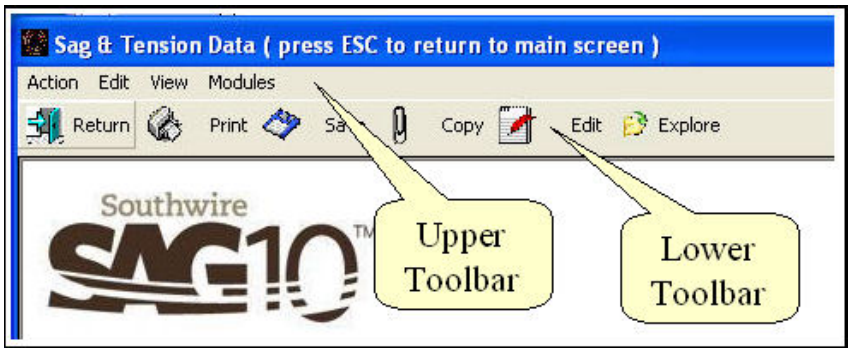
View menu choices:

- **View, Long No Load** displays a longitudinal view of the conductors under no load conditions.
- **View, Long W/ Load** displays a longitudinal view of the conductors with ice and wind load conditions.
- **View, Transverse** displays a transverse view of the conductors under both loaded and unloaded conditions.
- **View, Scale** allows the user to rescale the graphic image to an exact scale. The default is Best Fit, which is the largest size that will conveniently fit on the screen. The Longitudinal and Transverse Views are scaled separately.

BMP file:
This will generate a .BMP file of the graphic screen. This graphic image may then be stored on disk and/or emailed or otherwise shared as a permanent object.

Return
This option will close the **Clash Diagram** screen and return you to the **Sag & Tension Data** screen.

6.4 Data Screen lower toolbar controls



6.4.1 Return

The **Return** button closes the **Sag & Tension Data** screen and returns you to the SAG10 **Main Menu** screen.

6.4.2 Print

The **Print** button sends the sag and tension report to the default printer.

6.4.3 Save

The **Save** button opens a standard **Save File** window where you can choose a file name and a location to save the output report file.

6.4.4 Copy

The **Copy** button opens the default word processor and copies the output report to the word processor screen.

6.4.5 Edit

The **Edit** button opens the default word processor and copies the output report to the word processor screen for further editing.

6.4.6 Explore

The **Explore** button opens a browser window where you can select a file to open.

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7 SAG10 Software End User License Agreement

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Appendix – Reference Materials

8 Appendix - Reference materials

The following white papers and referenced materials are available online at www.sag10.com/documentation.

	File Name	File Size
B	List of Stress-Strain Charts.pdf	27 KB
C	Notes for Bates Spotting Program.pdf	50 KB
D	Notes for Metric Users.pdf	25 KB
E	Error Messages.pdf	73 KB
F	Plotter Cable Information.pdf	47 KB
G10	Non-Supporting Cable Example.pdf	41 KB
G11A	Determining Data on One Span_Original Design Not Known.pdf	53 KB
G11B	Determining Data on One Span_Original Data Known.pdf	47 KB
G12	Offset Clipping Example.pdf	25 KB
G13	Percent RTS_ HW or Horz & Vert Sag Example.pdf	50 KB
G1A	Stringing Sag Example.pdf	38 KB
G1B	Stringing Sag Example.pdf	39 KB
G2	Separate Steel & Aluminum Example.pdf	46 KB
G3	Elevated Temperature Example.pdf	47 KB
G4	Extra Heavy Load Control Example.pdf	27 KB
G5	Common Point Example.pdf	39 KB
G6	Rime Ice Example.pdf	37 KB
G7	Metric Example.pdf	35 KB
G8	TP Conductor Example.pdf	36 KB
G9	Marker Ball Example.pdf	39 KB
H	Stringing Sag Calculations.pdf	28 KB
I	GallopingAttachmentLocations.pdf	36 KB
J	Inclined Span Sag Example.pdf	73 KB
K	Sketch - Use of Offsets.pdf	27 KB
L1	Toye and Davison Clearances.pdf	433 KB
L2	Toye and Davison Clearances update.pdf	41 KB
P	Examples for AFL-ADSS Cables.pdf	167 KB
Q	Toye and Davison Galloping.pdf	131 KB
R	Analysis of galloping field obsevations.pdf	906 KB
R	Rawlins Galloping.pdf	895 KB
S	Update of galloping field obsevations.pdf	198 KB
T	Galloping Ellipses Plot.pdf	24 KB
V	Theory of Compressive Stress in Aluminum of ACSR.pdf	362 KB
W	Effects of Tangent Support Stiffness on Sags at High Temperature.pdf	236 KB
X	Limitations of Ruling Span Method at HiTemp.pdf	459 KB
Y	Some Effects of Mill Practive on Stress Strain of ACSR.pdf	731 KB

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