Proposed workflow for PLS-CADD

A high-level sample of a proposed workflow for a typical project in PLS-CADD

Proposed workflow for PLS-CADD

The intent of this flow-chart is to assist both new and experienced users of our software with a handy and general reference for the typical decisions and steps needed to develop and model a complete PLS-CADD project.

The steps and processes are not exhaustive, and some projects may well require a different sequence to that proposed in this document.

Not all steps are mandatory/required for every type of project.

The main process flow can be comfortably printed/plotted on A0 size paper (47x33"). Although it is expected that this will remain as an electronic PDF file in most cases.

KEY:

Process

Process – with subsequent steps *- linked to the Subprocess details*

Process – additional process covered/linked back to other steps

Process – with subsequent steps.
Not necessary on every project

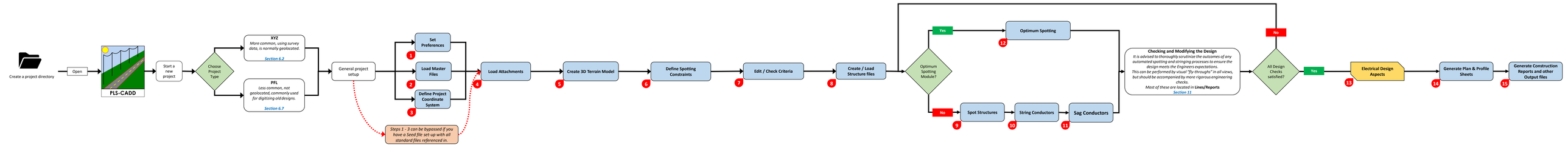
- Back to Main Process workflow

- Webinar Available for download through latest version of PLS-CADD

- YouTube Feature Overview video available

- Technical Note Available at https://www.powerlinesystems.com/technical-notes

- Sample files available on the PLS online Library


Create a project directory
Open
PLS-CADD
Start a new project
Choose Project Type
XYZ
More common, using survey data, is normally geolocated.
Section 6.2
PFL
Less common, not geolocated, commonly used for digitizing old designs.
Section 6.7
General project setup
Set Preferences
Load Master Files
Define Project Coordinate System
1
2
3
Steps 1 - 3 can be bypassed if you have a Seed file set-up with all standard files referenced in.
4
Load Attachments
5
Create 3D Terrain Model
6
Define Spotting Constraints
7
Edit / Check Criteria
8
Create / Load Structure files
Optimum Spotting Module?
Yes
No
12
Optimum Spotting
9
Spot Structures
10
String Conductors
11
Sag Conductors
Checking and Modifying the Design
It is advised to thoroughly scrutinize the outcomes of any automated spotting and stringing processes to ensure the design meets the Engineers expectations.
This can be performed by visual "fly-throughs" in all views, but should be accompanied by more rigorous engineering checks.
Most of these are located in Lines/Reports
Section 11
All Design Checks satisfied?
No
Yes
13
Electrical Design Aspects
14
Generate Plan & Profile Sheets
15
Generate Construction Reports and other Output files

Imperial (U.S.)

S.I. (N Force)

S.I. (daN Force)

What Unit System should be used?

Catenary Constants

Tensions

How to Sag Conductors?

Equation Stations

True Stations

Which Stations should be displayed?

Set Preferences
Preferences are set and controlled under the **File/Preferences** *menu.*

When you **OK** *the Preferences dialog, all the preference settings, are automatically saved in a file named PLS_CADD.ini which is located in your WINDOWS directory or in "C:\Users\<user name>\AppData\Roaming\PLS\pls_cadd.ini".*
The file name may vary based on the WINDOWS installation. These preferences remain in effect until changed.

Section 5.2

File and Directory Mapping
The location of default locations for the directories or library files is mapped here. Normally only need to define the ***Structure Directory****, the* ***Cable and Marker Balls Directory*** *and the* ***Part/Assembly Library*** *(.prt file).*
The Schema file Schema file (.sma) for personal customizations such as report or toolbars is also mapped and selected here.

***Apply a variety of* Settings *or* Mini-Preferences.**
These control a range of attributes or settings from unit preferences, coordinates systems, display settings and many more.

Select the **Fonts and Colors** *for various reports and graphics views generated by the program and control the* **View background color.**

Feature Code file
.fea
Section 6.1

Criteria file
.crt
Section 7.1 & 7.3

Plan and Profile Sheet display settings
.ppt
Section 13.2.5

Parts and Material file
.prt
Section 8.5

Load Master Files
These are company or client specific master files to preserve settings and calculations between projects

Load imagery through the Web Mapping Service (WMS)

Drafting/ Attachments/ WMS *or it can be accessed through the* **Drafting/ Attachments/ *Attachment Manager*** *by clicking on the* **WMS** *button.*

These servers could be any of the predefined WMS servers or a customised server can be used.
Section 6.6.5

Load the imagery through **Drafting/ Attachments/ Attachment Manager** *and click on the* **Attach** *button*
Section 6.6.2

No

Do you have aerial imagery?

Yes

These points can be used to generate survey points in the model using the **Terrain/ Edit/ Merge Points from External File/ Create XYZ or PFL Points from DXF or SHP Attachment** *command.*

Attach **DXF/SHP** files with information on obstacles and infrastructure in the project extents.
DXF files can be 3-dimensional and represent ground surface or proposed ground surfaces after construction projects; or could represent buildings or other structures.
Section 6.6.1

Attach **Aerial Imagery**

Load Attachments
Raster or vector attachments can enhance the look and feel of the terrain model, but can also provide valuable additional data to clarify and contextualize the model.

Drafting/ Attachments/ Attachment Manager
Section 6.6

/ Station Range
Along the alignment. Linked to Station coordinate, and not georeferenced.

/ Polygonal Zones
Can be a polygon, polyline or point. Can snap to survey points or be created base don DXF/SHP files. Is georeferenced.

Can be linked to the Feature code table to apply a "buffer" zone around the constraint. (Required Clearance Structure Base/Guy to Spotting Constraint)
Section 6.1

/ Based on TIN Slopes
Station based constraints added automatically based on centerline and cross-section slopes.

Define Spotting Constraints
Spotting constraints defined to control where structure ***are*** *or* ***are not*** *allowed. Possible types are:*
- *Prohibited Zones*
- *Extra Cost Zones*
- *Required Positions (or Structures)*

Structures/ Automatic Spotting/ Spotting Constraints/

Section 6.10.3 & 14.1.4

Edit / Check Criteria
It is recommended that most general Criteria is saved and loaded into the project under **Criteria/ Load Cfr file***. However, there may be some specific things to control on a given project, these can include:*
- *Add specific* **Criteria Notes** *for the Project*
- *Set any* **Code Specific Wind and Terrain Parameters** *applicable to the project location and Code of practice*
- *Ensure that* **Cable Tension** *and* **Automatic Sagging** *Criteria are pointed to the correct instance of the conductor .wir files to be used on the project.*

Section 7.3

BEFORE you begin, ensure the following:
- *You have purchased the* ***Optimum Spotting Module****.*
- *Appropriate* ***Criteria*** *defined, in particular:*
  - *Survey Point Clearances*
  - *Insulator Swing*
  - *Automatic Sagging*
- *Structure models defined and added to* ***Available Structure List*** *and for each tower indicate the:*
  - *Cost of the structure*
  - *Indicate if the structure should be considered by the algorithm*
  - *Indicate which conductor Set to use for determining clearance calculations*
  - *Define the minimum line angles to be considered*
- *Ensure that the* ***Spotting Constraints*** *are defined.*

Section 14.1

Select the cable file to be used.
Usually this is lowest cable (so ground clearance controls).

This conductor should be intended to match the Conductor Set defined in the Available Structure's List.

Structures/ Automatic Spotting/ Optimum Spotting/ Select Station Range to indicate over which length of the Alignment the optimization should be considered.

Input parameters in the **Optimum Spotting** Dialog Box.
These include the data for:
- *Conductor :- voltage, sag parameters, conductors per phase*
- *Spotting parameters :- Min and Max spans and station spacing interval*
- *An initial guess of the Ruling Span*
- *Click* ***OK*** *to run the optimization*

INSPECT THE RESULTS
Always review the computer generated results, as the Engineer of Record.

String & Sag additional conductor sets that were not strung during the Optimization.

Sections/ Add Graphical

Optimum Spotting will only string the one designated Conductor Set.
Section 10.3.1.3

Attach a DXF:
Additional items can be added in to embellish PLS-CADD P&P Sheets. This will allow the drawings to match company/client standards and layout.
These include:
- *Titleblock or Drawing Frame if needed*
- *North Arrow*

This is controlled under the:
Drafting/ Attachments/ Attachment Manager
Section 6.6.1

Defining and Labeling Circuits and Electrical Phasing in PLS-CADD
In PLS-CADD you can define and label wires into circuits and phases. These labels are integrated into certain reports, can be used as a display case for the wires, can be part of plan and profile drawing sheets, and used to create phasing diagrams.
Sections/ Electric/ Define Circuits & Phases
Section 9.4

Thermal Rating
Thermal rating calculations performed by PLS-CADD are based on
- *IEEE Standard 738 (2006 or 2012)*
- *CIGRE Brochure 207*
- *CIGRE Brochure 601, or*
- *TNSP 2009*

Sections/ Thermal Calculations (IEEE, CIGRE and TNSP)
Section 10.3.1.3

Electro-Magnetic Field Calculations
Electricity in overhead lines produces an electric field and a magnetic field. These fields are also called Electro Magnetic Fields or EMF. The Electro Magnetic Field (EMF) is a factor which can be calculated during the design or analysis of overhead transmission lines. The EMF calculation may determine width of a Right of Way (ROW) or have a particular limit at the edge of a Right of Row for an overhead line.

Within PLS-CADD there are two distinct options to calculate Electro-Magnetic Field Calculations:
- *2D EMF*
- *3D EMF*

Completed drawings can be output either as an Exported DXF
Sections/ Electric/ 3D EMF Calculator *or /* **3D EMF Along Line**
Section 11.2.8

PLS-CADD can calculate the space potential, electrical field or magnetic field at structures. The software will create cross sections at selected structures and plot contours for the space potential, electrical field or magnetic fields.
Sections/ Electric/ Structure Space Potential Calculator…
Section 11.2.8.3

Line Constants Calculator
PLS-CADD can calculate the following line constants: the resistance, positive sequence inductive reactance, capacitive reactance, impedance magnitude, and phase angle for all sets with a voltage in the selected range of spans. Using the
Sections/ Electric/ Simple Line Constants Calculator
Section 11.2.10

PLS-CADD can calculate all three symmetrical components (zero, positive and negative sequence values) of the line impedance. The software accounts for ground wires, ground return, and mutual coupling of nearby circuits either on the same structure or span, or a neighboring line sharing a corridor.
Sections/ Electric/ Full Line Constants Calculator
Section 11.2.11

Lightning Protection Calculator
PLS-CADD can calculate the lightning coverage surface based on the ground wires of a line. The basis of the calculation is the Electromagnetic Method (EGM) which is also known as the Rolling Sphere Method.
Sections/ Electric/ Lightning Protection Calculator
Section 11.2.12

Use PLS-CADD for all your drafting
All drawing sheets auto-update if any model changes are made.

Set Page Size
Page size can now be defined for Drawing Sheets and also now for Reports that are exported as PDF files.

Drafting/ Plan & Profile Sheet Configuration/ Page Size
Section 13.2.1

Set the Pages and Station Range
You can build a complete drawing pack for the project and not just the Plan & Profile Sheets.
This can include the addition of:
- *A Title Page*
- *Notes page/s*
- *P&P Drawing Sheets*
- *Appendix Page/s*

This can be coupled with the ability to Inset graphical views and information tables to generate a rich data driven drawing pack.

You also select the section of the alignment (station coordinates or structure numbers) to be shown in the drawings.
Drafting/ Plan & Profile Sheet Configuration/ Pages and Station Range
Section 13.2.2.1

Page Layout
You can control what is visible on each Drawing Sheet, and the relative position and size that each "section" of the drawing covers. This gives the User control to meet most Utility or Client Drafting standards and requirements.
Drafting/ Plan & Profile Sheet Configuration/ Page Layout
Section 13.2.2

Set The Scales…Long-axis plot etc.
Once the Page Layout and Paper size has been set, you can control the overall appearance of the P&P drawings under the Scales menu.
This not only controls the actual Scales at which the drawing is produced, but allows for the insertion of Grid Lines and various other functions to control the appearance of the Sheets view.
It's also possible to select whether or not the view should be a Long-Axis Plot or not (normally driven by Client Preferences)

Drafting/ Plan & Profile Sheet Configuration/ Scales
Section 13.2.3

Add Annotations
The drawings can be further embellished with Annotations to fully portray the granular details of the project.
These annotations can be:
- *Lines*
- *Arrows*
- *Arcs*
- *Circles*
- *Polygons*
- *Dimensions*
- *Text*

Section 13.3

Inset Views and Tables
Additional views or data can be placed on the Title, Notes and Appendix pages in the form of Inset Views or Inset Report/Tables to create a full drafting pack for the project.

Many ways to do this, but mainly controlled via:
Drafting/ Inset Views/ Add
Section 13.5 – 13.8

Output
Completed drawings can be output either as an Exported DXF drawing for further manipulation in a drafting package,
File/ Export/ DXF

Or as a PDF file for printing and sharing:
- *Can be done either by* **File/ Print**
- *or by Right-clicking on the Sheets View tab and selecting* **Save as PDF/ To File**

Section 13.4

Create a project directory

Open

PLS-CADD

Start a new project

Choose Project Type

XYZ
More common, using survey data, is normally geolocated.
Section 6.2

PFL
Less common, not geolocated, commonly used for digitizing old designs.
Section 6.7

General project setup

1 Set Preferences

2 Load Master Files

3 Define Project Coordinate System

4 Load Attachments

5 Create 3D Terrain Model

6 Define Spotting Constraints

7 Edit / Check Criteria

8 Create / Load Structure files

Optimum Spotting Module?

Yes

12 Optimum Spotting

No

9 Spot Structures

10 String Conductors

11 Sag Conductors

Checking and Modifying the Design
It is advised to thoroughly scrutinize the outcomes of any automated spotting and stringing processes to ensure the design meets the Engineers expectations.
This can be performed by visual "fly-throughs" in all views, but should be accompanied by more rigorous engineering checks.
Most of these are located in **Lines/Reports**
Section 11

All Design Checks Satisfied?

No

Yes

13 Electrical Design Aspects

14 Generate Plan & Profile Sheets

15 Generate Construction Reports and other Output files

Start a new Project
In the **PLS-CADD Project Wizard** *Dialog, select the radio button to Create a New Project and select the option to start a PLS-CADD/Standard project.*

If you have selected to bypass the Wizard, you can click on:
File/ New/ PLS-CADD

Define Project Coordinate System
PLS-CADD has the capability to designate the coordinate system used by your project in order to make cartographic calculations. You use the **Terrain/Coordinate System/Define** *command to pick from the thousands of coordinate systems now built into PLS-CADD. If you need to use a coordinate system not within PLS-CADD, you can do this by referencing a PRJ file containing a WKT or PROJ string.*

Once this has been done you may use other commands that rely on knowing the project coordinate systems.

Section 6.2.1

Create 3D Terrain Model

Do you have survey data?

Yes

No

What kind of data?

Use SRTM Internet Data

LIDAR

CSV / ASCII

DXF / SHP

KML / KMZ

Raster Attachment

Terrain/ Edit/ Merge Points from External File/

/ Merge Points from Internet…
Appendix D.3.1

/ Merge Points from LAS/LAZ Files…
Appendix D.7

/ Merge XYZ Points from User Defined XYZ Files…
Appendix D.3

/ Create XYZ or PFL Points from DXF or SHP Attachment
Appendix D.8

/ Merge Points from KML/KMZ Files…
Appendix D.9

/ Merge Points from KML/Raster Attachment…
Appendix D.10

Point Cloud Loaded

These points can be edited, feature codes changed, etc… using the various commands in the **Terrain/ Edit** *menu*

Create TIN Model *to turn ground point cloud into ground surface*

Terrain / TIN/ Create
Section 6.4

Once the TIN model is created, ground points can be filtered out/deactivated to reduce the model size

Create Route Alignment:
The alignment is needed for most of the traditional modelling processes. It generates the Profile view, which is not available before the alignment is created.
Note: It will be created automatically in a .PFL project type

Terrain/ Alignment/ New Alignment
Section 6.3

For added accuracy it is proposed to limit the adding of P.I.'s to snap to selected Feature codes or DXF file positions. Multiple Alignments can be added, as well as branches and loops as needed for any particular route needs.

Clearance Line setup:
Display the clearance lines as per the correct project ***Voltage Level****. Choose if you want to* ***Display spikes*** *for points with extra clearance (Yes or No), & Choose the Clearance Line Type*

Terrain/ Clearance Line
Section 6.10.2

Set the Terrain/:
- **/ Terrain Widths:** Depth of the profile view and the tolerance for points to be considered as a part of the Centerline.
- **/ Side Profiles:** location and tolerances and display options for the side profiles

Section 6.3.2 & Section 6.10.1

Create Interpolated Points:
This command will add program generated survey points directly along the Centerline (and any Side Profiles) using the TIN model to provide a very accurate ground profile where needed.

Terrain/ TIN/ Create Interpolated Points
Section 6.4.4

Create / Load Structure files
Note: If you plan to use Optimum Spotting then structures must be either Method 1 or Method 2 structures.

Structure files for use in the project should be added to the Available Structure List

Structures/ Available Structure List/ Add or Delete Structures
Section 14.1.5

Material (Parts and Assemblies) should be added in if this needs to be tracked through later Bill of Material functions.
Section 8.5

Do you have PLS-POLE or TOWER?

No

Yes

Structure files made in PLS-CADD
These structures are essentially stick figures. There is no graphical display of the structure beyond vertical and horizontal lines that define the basic insulator and wire attachment geometry.
Appendix F.1

Structure files made in PLS-POLE or TOWER
These structures are based on finite element models developed in the separate structural modelling programs.

TOWER

PLS-POLE

Method 1: Basic Allowable Spans Method
Strength defined simply by:
- *Angle range*
- *Horizontal Span (Wind Span)*
- *Vertical Span (Vertical Span) for 3 separate conditions can be checked*
- *Uplift capacity*

Section 8.3.1 & Appendix F.1.4.1

Method 2: Allowable Spans Interaction Diagram Method
- An interaction diagram between allowable wind and weight spans is defined for certain combinations of weather and cable conditions.
- Can produce more economical lines than with Method 1 structures, especially when used in conjunction with automatic spotting.

Section 8.3.2 & Appendix F.1.4.2

PLS-POLE and TOWER:
Method 1 and 2 files
These packages can be used in conjunction with ***PLS-CADD/Lite*** *and the Wire Load file formats (*.LIC) to make either Method 1 or 2 files for use with Optimum Spotting Algorithms.*
The full capability of the models is not lost and can be used for more detailed analysis at any time
F1/ Use method 4 Structure Edit/Check when possible
Section 8.3.1 - 2 & Appendix F.2
PLS-POLE & TOWER Manuals = Section 5.4

Method 4: Detailed Structural Analysis Method
- *PLS-CADD first determines the Loading Tree based on the wires, tensions and design Criteria.*
- *This is then passed (in the background) to the respective structural package.*
- *After the analysis, results are obtained directly in PLS-CADD to the level of detail required.*

This is the most accurate and general structure check technique.
Section 8.3.4 & Appendix F.3

Spot Structures
Section 10.2

Spot Angle Structures
This makes use of automatic features to place structures at P.I. positions or alternatively at selected Feature Codes. These tools are:
Structures / Automatic Spotting / Angle Structures *&*
Structures / Automatic Spotting / Spot at Feature Codes
Section 10.2.1

Spot Tangent Structures
This is the manual spotting/placing of structures.

Standard projects will have structures placed along an alignment between P.I. points.
Structures/ Add/ Along Alignment
Section 10.2.2

It is also possible to place structures independent of alignments as XY based structures ***Structures/ Add/ XY Structure/ (Freehand, Along a Line*** *or at a* ***Survey Point)****.*
Section 10.2.8

Spotting multiple copies of a structure
Once the angle structures are placed, manually placing suspension structures can be a time consuming and repetitive task. To speed up the placement of structures it is possible to copy and paste single instances of a structure file.
Structures/ Copy &
Structures/ Paste
Section 10.2.3.1

Spotting structures at equal spacing
A further time saving approach is to paste multiple instances of a structure file at a specified span length between two station coordinates.
This will allow for the rapid placement of many structures at equal span lengths.
Structures/ Automatic Spotting/ N-Paste
Section 10.2.3.2

Sag Conductors
Assign the Reference Sagging Condition - by defining:
- *Cable Condition (typically Initial RS)*
- *Temperature (typically 60°F or 15-15.5°C)*
- *Horizontal Tension (Typically determined by using the automatic sagging function)*

Section 10.3.2

String Conductors

Manual Stringing
This is the original technique to add wires to a model.
Sections/ Add *or*

Some limitations:
- *Stringing must be in order of increasing station value.*
- *Stringing must start and end on a "Dead-End" Set*
- *Can only string one section at a time*

Section 10.3.1

Automatic Stringing
This technique can speed up the stringing process by allowing the stringing of all (or selected) Sets in one command.
Sections/ Automatic Stringing

Some limitations:
- *You can only string one Set type at a time.*
- *You can string Sets or Sections based on the "Set Description" which can assist in transposing or preventing the twisting of wires.*

Section 10.3.1.2

Graphical Stringing
This is the newest and most versatile technique to add wires to a model.
Sections/ Add Graphical

This allows for the ability to:
- *Automatically transpose/untangle wires*
- *String wires between intermediate or skipped structures.*
- *Can string in any direction (and also to structures not on alignments - XY Based structures)*
- *Can string any number of *.wir files and Set numbers at one time.*
- *Can apply sagging criteria per set.*
- *Can also set the Display conditions for the sets being strung.*

Section 10.3.1.3

Add Jumpers
Modeling jumpers give you the ability to evaluate clearances from the jumper to structures, ground, other jumpers, and other wires. It also allows you to include its material in the material tracking and reporting features of the program. Jumpers connect the ahead and back section of wire attachments and up to seven idler or jumper insulators. Their cable properties are the same as the back section of conductor that it is connecting.
Jumpers can be Flexible or Rigid.
Structures / Jumpers/ Add

Or by clicking on the ***Jumpers*** *button in the* ***Structure Modify*** *Dialog.*
Section 10.3.8

Sag Conductors
Assign the Reference Sagging Condition - by defining:
- *Cable Condition (typically Initial RS)*
- *Temperature (typically 60°F or 15-15.5°C)*
- *Horizontal Tension (Typically determined by using the automatic sagging function)*

Section 10.3.2

Manual Sagging
The reference sagging condition is defined for each section in the ***Section Modify*** *dialog box.*
Only the one single condition is specified which represents the conditions the wire was constructed at
Section 10.3.2.1

Automatic Sagging
Multiple sagging/tension rules can be checked as defined in the ***Criteria/ Automatic Sagging****.*
This basically results in the wire being as pulled as tight as it is allowed - and sets the reference sagging condition accordingly.
Section 10.3.2.1.3

Graphical Sagging
The sagging rules can be determined based on the mouse coordinates, or on the proximity of the wire to survey points ("shots on the wire").

This technique can be used simplistically with Ruling Span methods (RS), but can also be rather accurately used with Finite Element method (FE) to accurately model As-Built wire systems where tensions can vary between spans within a section.

Sections/ Graphical Sag, *select on a wire section and click the* **Options** *button to use some of the higher level techniques, or using the methods in* **Sections/ Table…**
Section 10.3.2.1.4

Construction Stringing Charts
These charts are needed by Construction crews to install the wires at the correct tensions for different install temperatures to match the design assumptions.

You can generate them using:
Sections/ Stringing Chart/ Single Section, *or*
Sections/ Stringing Chart/ Multiple Sections
Sections 11.2.4

KMZ files
It can be very convenient to share the line model and even several types of reports by using KML/Z files, as these can be viewed by Google Earth® or other GIS applications.

To export your model as a KMZ (ideally from the 3D View in PLS-CADD), select:
File/ Export/ KMZ (Google Earth)

Some of the reports that can be exported to KMZ files are:
- *P.I. Report*
- *Construction Staking Report*
- *Leg and Guy Extension Report*
- *Terrain Clearances by Span Report*
- *Thermal Rating Report*
- *Danger Tree Locator Report*
- *Vegetation Work Site Centroids (can also be exported as a SHP file)*

Structure Loads Report
These detailed loads can be shared with structure designers/suppliers to verify the structures are fit for purpose.

This can be done for a single structure at a time:
Structures/ Loads/ Report

Or for a selected range of structures:
Lines/ Reports/ Structure Loads Report

Bills of Materials
The Bills of Material can be generated if the model includes this data. The material data includes:
- *Material captured for each Structure file*
- *Structure Specific Material - tied to the structure site (such as foundations, signs, dampers, etc. material described in the Material button of Structure Modify dialog box).*
- *Line Specific material for anything more general regarding the line but not necessarily tied to a specific location (described in the Line Specific Material button of Lines Edit dialog box).*
- *Wire quantities and concentrated loads (such as aerial marker balls)*

Cost information for both Material and Labor can be included to enable cost tracking of the design. Furthermore, the status of the assets can be included so that life-cycle tracking and maintenance/replacement activities can be quantified as well.
The Bill of Material can be generated by either:
Lines/ Reports/ Bill of Material by Structure Location, *or*
Lines/ Reports/ Bill of Material
Appendix M

Construction Staking Report
You can generate a Construction Staking Report which is relating to the construction of the line. This includes:
- *The coordinates (either as XY or as Lat/Long) for Stakes , which indicate the field location of:*
  - *poles,*
  - *tower legs*
  - *Anchors*
  - *P.I.'s, and*
  - *reference stakes.*
- *It can also include up to four different graphical views and*
- *A material list for each of the structures.*

Lines/ Reports/ Construction Staking Report
Appendix R.3

Set Preferences

Preferences are set and controlled under the **File/Preferences** *menu.*
When you **OK** *the Preferences dialog, all the preference settings, are automatically saved in a file named PLS_CADD.**ini** which is located in your WINDOWS directory or in "C:\Users\<user name>\Appdata\Roaming\PLS\pls_cadd.ini".*
The file name may vary based on the WINDOWS installation.
These preferences remain in effect until changed.

Section 5.2

1

What Unit System should be used?

- Imperial (U.S.)
- S.I. (N Force)
- S.I. (daN Force)

How to Sag Conductors?

- Catenary Constants
- Tensions

Which Stations should be displayed?

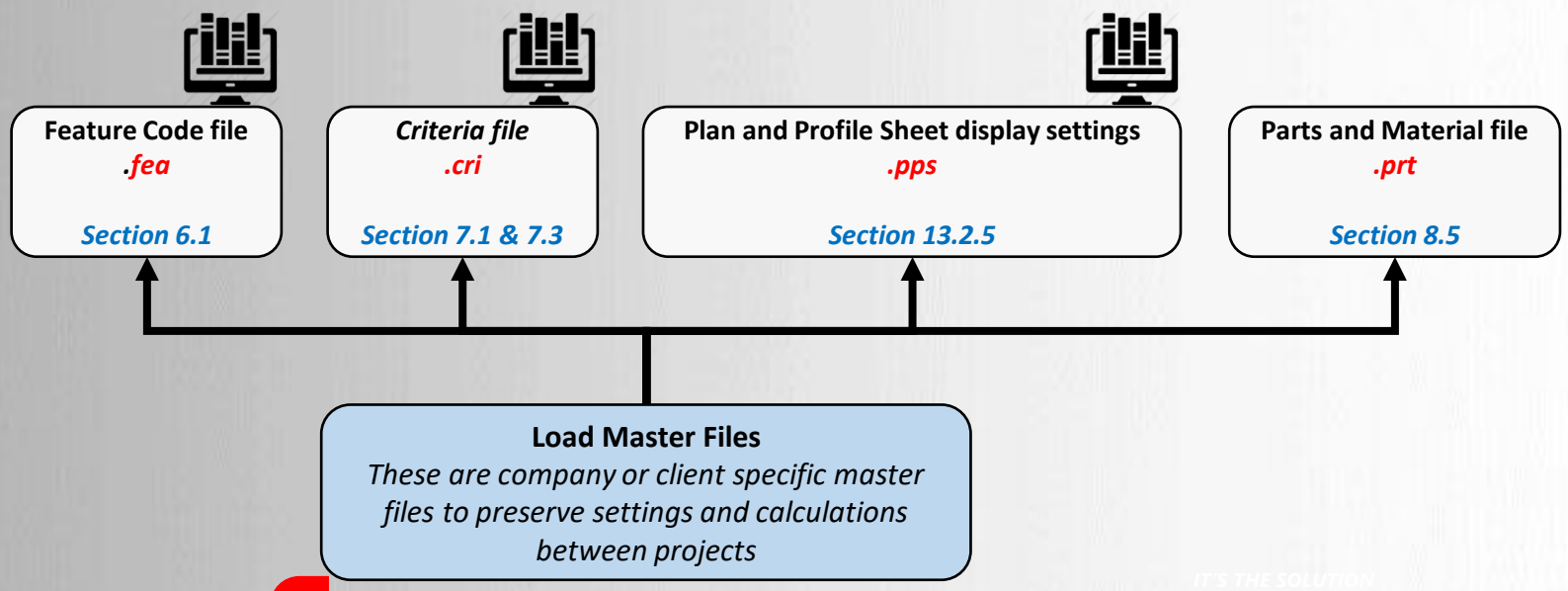
- Equation Stations
- True Stations

File and Directory Mapping

The location of default locations for the directories or library files is mapped here. Normally only need to define the ***Structure Directory****, the* ***Cable and Marker Balls Directory*** *and the* ***Part/Assembly Library*** *(.prt file).*
*The Schema file Schema file (**.sma**) for personal customizations such as report or toolbars is also mapped and selected here.*

Apply a variety of **Settings** *or* **Mini-Preferences.**
These control a range of attributes or settings from unit preferences, coordinates systems, display settings and many more.

Select the **Fonts and Colors** *for various reports and graphics views generated by the program and control the* **View background color.**



2

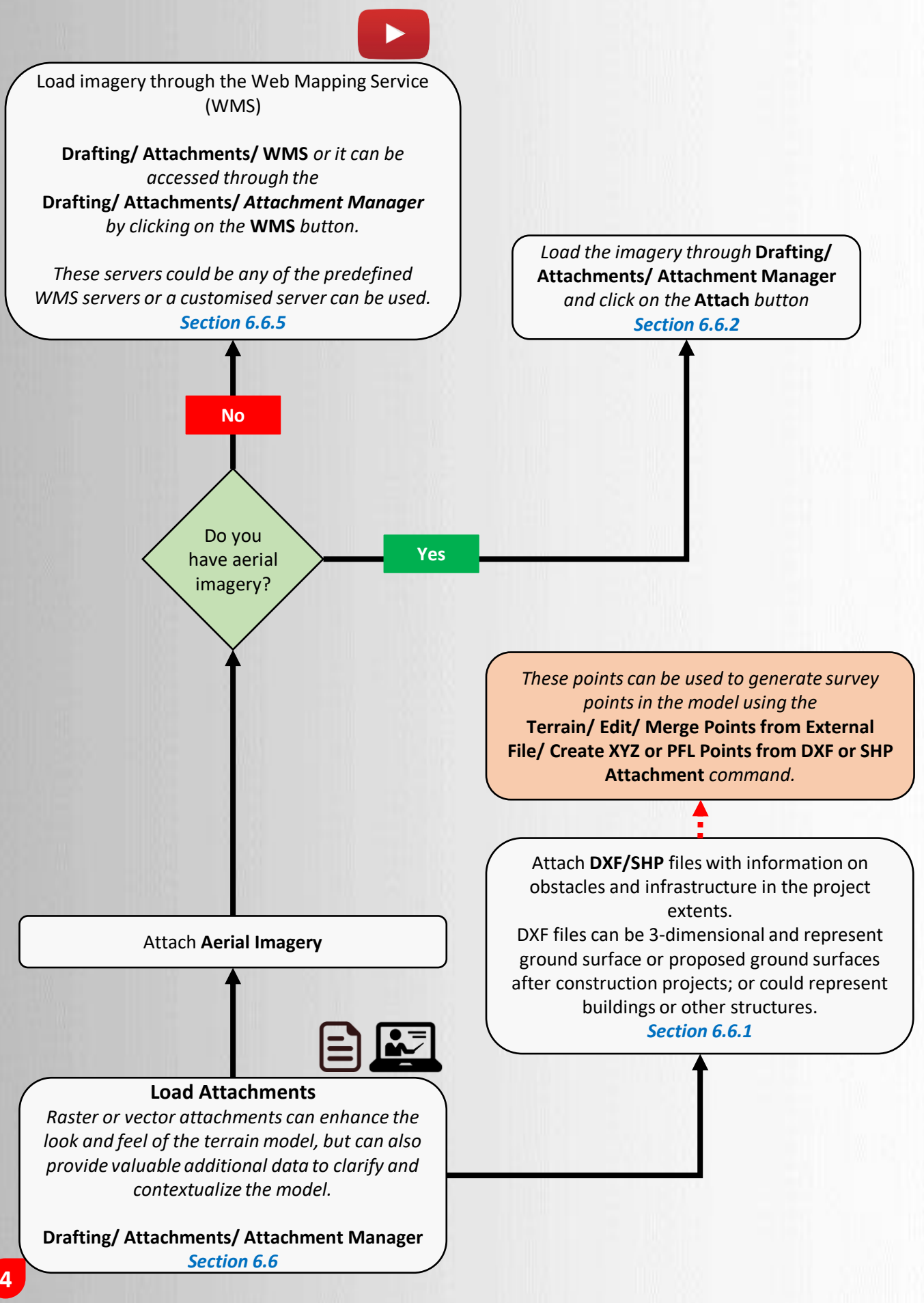
Define Project Coordinate System

PLS-CADD has the capability to designate the coordinate system used by your project in order to make cartographic calculations. You use the **Terrain/Coordinate System/Define** *command to pick from the thousands of coordinate systems now built into PLS-CADD. If you need to use a coordinate system not within PLS-CADD, you can do this by referencing a PRJ file containing a WKT or PROJ string.*

Once this has been done you may use other commands that rely on knowing the project coordinate systems.

Section 6.2.1

3


Load imagery through the Web Mapping Service (WMS)
Drafting/ Attachments/ WMS or it can be accessed through the Drafting/ Attachments/ Attachment Manager by clicking on the WMS button.
These servers could be any of the predefined WMS servers or a customised server can be used.
Section 6.6.5
Load the imagery through Drafting/ Attachments/ Attachment Manager and click on the Attach button
Section 6.6.2
No
Yes
Do you have aerial imagery?
These points can be used to generate survey points in the model using the Terrain/ Edit/ Merge Points from External File/ Create XYZ or PFL Points from DXF or SHP Attachment command.
Attach DXF/SHP files with information on obstacles and infrastructure in the project extents.
DXF files can be 3-dimensional and represent ground surface or proposed ground surfaces after construction projects; or could represent buildings or other structures.
Section 6.6.1
Attach Aerial Imagery
Load Attachments
Raster or vector attachments can enhance the look and feel of the terrain model, but can also provide valuable additional data to clarify and contextualize the model.
Drafting/ Attachments/ Attachment Manager
Section 6.6
4

POWER LINE SYSTEMS

Create 3D Terrain Model

5

Do you have survey data?

Yes

What kind of data?

No

Use SRTM Internet Data

LiDAR

CSV / ASCII

DXF / SHP

KML / KMZ

Raster Attachment

Terrain/ Edit/ Merge Points from External File/

/ Merge Points from Internet… *Appendix D.3.1*

/ Merge Points from LAS/LAZ Files… *Appendix D.7*

/ Merge XYZ Points from User Defined XYZ Files… *Appendix D.3*

/ Create XYZ or PFL Points from DXF or SHP Attachment *Appendix D.8*

/ Merge Points from KML/KMZ Files… *Appendix D.9*

/ Merge Points from KML/Raster Attachment… *Appendix D.10*

Point Cloud Loaded

These points can be edited, feature codes changed, etc… using the various commands in the **Terrain/ Edit** *menu*

Create TIN Model *to turn ground point cloud into ground surface*
Terrain / TIN/ Create
Section 6.4

Once the TIN model is created, ground points can be filtered out/deactivated to reduce the model size

Create Route Alignment:
The alignment is needed for most of the traditional modelling processes. It generates the Profile view, which is not available before the alignment is created.
Note: It will be created automatically in a ***.PFL*** *project type*
Terrain/ Alignment/ New Alignment
Section 6.3

For added accuracy it is proposed to limit the adding of P.I.'s to snap to selected Feature codes or DXF file positions. Multiple Alignments can be added, as well as branches and loops as needed for any particular route needs.

Clearance Line setup:
Display the clearance lines as per the correct project ***Voltage Level****, Choose if you want to* ***Display spikes*** *for points with extra clearance (Yes or No), & Choose the Clearance Line Type*
Terrain/ Clearance Line
Section 6.10.2

Set the Terrain/:
- **/ Terrain Widths:** Depth of the profile view and the tolerance for points to be considered as a part of the Centerline.
- **/ Side Profiles:** location and tolerances and display options for the side profiles

Section 6.3.2 & Section 6.10.1

Create Interpolated Points:
This command will add program generated survey points directly along the Centerline (and any Side Profiles) using the TIN model to provide a very accurate ground profile where needed.

Terrain/ TIN/ Create Interpolated Points
Section 6.4.4

/Station Range
Along the alignment. Linked to Station coordinate, and not georeferenced.

/ Polygonal Zones
Can be a polygon, polyline or point.
Can snap to survey points or be created base don DXF/SHP files.
Is georeferenced.

Can be linked to the Feature code table to apply a "buffer" zone around the constraint. (Required Clearance Structure Base/Guy to Spotting Constraint)
Section 6.1

/ Based on TIN Slopes
Station based constraints added automatically based on centerline and cross-section slopes.

Define Spotting Constraints

*Spotting constraints defined to control where structure **are** or **are not** allowed. Possible types are:*

- *Prohibited Zones*
- *Extra Cost Zones*
- *Required Positions (or Structures)*

Structures/ Automatic Spotting/ Spotting Constraints/
Section 6.10.3 & 14.1.4

6

Edit / Check Criteria

It is recommended that most general Criteria is saved and loaded into the project under **Criteria/ Load CRI file**. *However, there may be some specific things to control on a given project, these can include:*

- *Add specific* **Criteria Notes** *for the Project*
- *Set any* **Code Specific Wind and Terrain Parameters** *applicable to the project location and Code of practice*
- *Ensure that* **Cable Tension** *and* **Automatic Sagging** *Criteria are pointed to the correct instance of the conductor* ***.wir*** *files to be used on the project.*

Section 7.3

7

8

Create / Load Structure files

Note: If you plan to use Optimum Spotting then structures must be either Method 1 or Method 2 structures.

Structure files for use in the project should be added to the Available Structure List
Structures/ Available Structure List/ Add or Delete Structures
Section 14.1.5

Material (Parts and Assemblies) should be added in if this needs to be tracked through later Bill of Material functions.

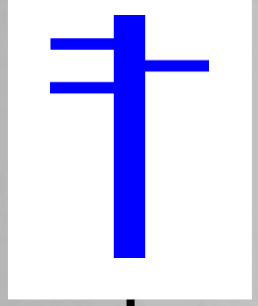
Section 8.5

Do you have PLS-POLE or TOWER?

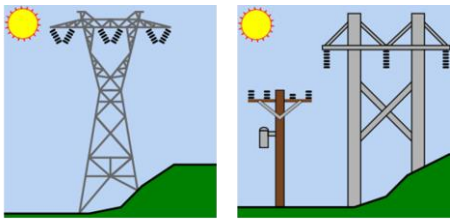
No

Yes

Structure files made in PLS-CADD
These structures are essentially stick figures. There is no graphical display of the structure beyond vertical and horizontal lines that define the basic insulator and wire attachment geometry.
Appendix F.1



Structure files made in PLS-POLE or TOWER
These structures are based on finite element models developed in the separate structural modelling programs.



Method 1: Basic Allowable Spans Method
Strength defined simply by:
- *Angle range*
- *Horizontal Span (Wind Span)*
- *Vertical Span (Vertical Span) for 3 separate conditions can be checked*
- *Uplift capacity*

Section 8.3.1 & Appendix F.1.4.1

PLS-POLE and TOWER:
Method 1 and 2 files
*These packages can be used in conjunction with **PLS-CADD/Lite** and the Wire Load file formats (*.LIC) to make either Method 1 or 2 files for use with Optimum Spotting Algorithms.*
The full capability of the models is not lost and can be used for more detailed analysis at any time
F1/ Use method 4 Structure Edit/Check when possible
Section 8.3.1 - 2 & Appendix F.2
PLS-POLE & TOWER Manuals = Section 5.4

Method 2: Allowable Spans Interaction Diagram Method
- An interaction diagram between allowable wind and weight spans is defined for certain combinations of weather and cable conditions.
- Can produce more economical lines than with Method 1 structures, especially when used in conjunction with automatic spotting.

Section 8.3.2 & Appendix F.1.4.2

Method 4: Detailed Structural Analysis Method
- *PLS-CADD first determines the Loading Tree based on the wires, tensions and design Criteria.*
- *This is then passed (in the background) to the respective structural package.*
- *After the analysis, results are obtained directly in PLS-CADD to the level of detail required.*

This is the most accurate and general structure check technique.
Section 8.3.4 & Appendix F.3

Spot Structures

Section 10.2

9

Spot Angle Structures

This makes use of automatic features to place structures at P.I. positions or alternatively at selected Feature Codes.
These tools are:
Structures / Automatic Spotting / Angle Structures
&
Structures / Automatic Spotting / Spot at Feature Codes
Section 10.2.1

Spot Tangent Structures

This is the manual spotting/placing of structures.

Standard projects will have structures placed along an alignment between P.I. points.
Structures/ Add/ Along Alignment
Section 10.2.2

It is also possible to place structures independent of alignments as XY based structures ***Structures/ Add/ XY Structure/*** *(****Freehand****, **Along a Line*** *or at a* ***Survey Point****).*
Section 10.2.8

Spotting multiple copies of a structure

Once the angle structures are placed, manually placing suspension structures can be a time consuming and repetitive task. To speed up the placement of structures it is possible to copy and paste single instances of a structure file.
Structures/ Copy *&*
Structures/ Paste
Section 10.2.3.1

Spotting structures at equal spacing

A further time saving approach is to paste multiple instances of a structure file at a specified span length between two station coordinates.
This will allow for the rapid placement of many structures at equal span lengths.
Structures/ Automatic Spotting/ N-Paste
Section 10.2.3.2

String Conductors

10

Manual Stringing

This is the original technique to add wires to a model.

Sections/ Add *or*

Some limitations:

- *Stringing must be in order of increasing station value.*
- *Stringing must start and end on a "Dead-End" Set*
- *Can only string one section at a time*

Section 10.3.1

Automatic Stringing

This technique can speed up the stringing process by allowing the stringing of all (or selected) Sets in one command.

Sections/ Automatic Stringing

Some limitations:

- *You can only string one Set type at a time.*
- *You can string Sets or Sections based on the "Set Description" which can assist in transposing or preventing the twisting of wires.*

Section 10.3.1.2

Graphical Stringing

This is the newest and most versatile technique to add wires to a model.

Sections/ Add Graphical

This allows for the ability to:

- *Automatically transpose/untangle wires*
- *String wires between intermediate or skipped structures.*
- *Can string in any direction (and also to structures not on alignments - XY Based structures)*
- *Can string any number of* ****.wir*** *files and Set numbers at one time.*
- *Can apply sagging criteria per set.*
- *Can also set the Display conditions for the sets being strung.*

Section 10.3.1.3

Add Jumpers

Modeling jumpers give you the ability to evaluate clearances from the jumper to structures, ground, other jumpers, and other wires. It also allows you to include its material in the material tracking and reporting features of the program. Jumpers connect the ahead and back section of wire attachments and up to seven idler or jumper insulators. Their cable properties are the same as the back section of conductor that it is connecting. Jumpers can be Flexible or Rigid.

Structures / Jumpers/ Add

Or by clicking on the ***Jumpers*** *button in the* ***Structure Modify*** *Dialog.*

Section 10.3.8

11

Sag Conductors

Assign the Reference Sagging Condition - by defining:

- *Cable Condition (typically Initial RS)*
- *Temperature (typically 60°F or 15/15.5°C)*
- *Horizontal Tension (typically determined by using the automatic sagging function)*

Section 10.3.2

Manual Sagging

*The reference sagging condition is defined for each section in the **Section Modify** dialog box.*

Only the one single condition is specified which represents the conditions the wire was constructed at.

Section 10.3.2.1

Automatic Sagging

*Multiple sagging/tension rules can be checked as defined in the **Criteria/ Automatic Sagging**.*

This basically results in the wire being as pulled as tight as it is allowed - and sets the reference sagging condition accordingly.

Section 10.3.2.1.3

Graphical Sagging

The sagging rules can be determined based on the mouse coordinates, or on the proximity of the wire to survey points ("shots on the wire").

This technique can be used simplistically with Ruling Span methods (RS), but can also be rather accurately used with Finite Element method (FE) to accurately model As-Built wire systems where tensions can vary between spans within a section.

Sections/ Graphical Sag**, select on a wire section and click the **Options** button to use some of the higher level techniques, or using the methods in **Sections/ Table…

Section 10.3.2.1.4

Optimum Spotting

12

BEFORE you begin, ensure the following:

- *You have purchased the **Optimum Spotting Module**.*
- *Appropriate **Criteria** defined, in particular:*
  - *Survey Point Clearances*
  - *Insulator Swing*
  - *Automatic Sagging*
- *Structure models defined and added to **Available Structure List** and for each tower indicate the:*
  - *Cost of the structure*
  - *Indicate if the structure should be considered by the algorithm*
  - *Indicate which conductor Set to use for determining clearance calculations*
  - *Define the minimum line angles to be considered*
- *Ensure that the **Spotting Constraints** are defined.*

Section 14.1

Select the cable file to be used.
Usually this is lowest cable (so ground clearance controls).

This conductor should be intended to match the Conductor Set defined in the Available Structure's List.

Structures/ Automatic Spotting/ Optimum Spotting/ Select Station Range to indicate over which length of the Alignment the optimization should be considered.

Input parameters in the **Optimum Spotting** Dialog Box.
These include the data for:

- *Conductor :- voltage, sag parameters, conductors per phase*
- *Spotting parameters :- Min and Max spans and station spacing interval*
- *An initial guess of the Ruling Span*
- *Click **OK** to run the optimization*

INSPECT THE RESULTS
Always review the computer generated results, as the Engineer of Record.

String & Sag additional conductor sets that were not strung during the Optimization.

Sections/ Add Graphical

Optimum Spotting will only string the one designated Conductor Set.

Section 10.3.1.3

13 Electrical Design Aspects

Defining and Labeling Circuits and Electrical Phasing in PLS-CADD

In PLS-CADD you can define and label wires into circuits and phases. These labels are integrated into certain reports, can be used as a display case for the wires, can be part of plan and profile drawing sheets, and used to create phasing diagrams.

Sections/ Electric/ Define Circuits & Phases

Section 9.4

Thermal Rating

Thermal rating calculations performed by PLS-CADD are based on

- *IEEE Standard 738 (2006 or 2012)*
- *CIGRE Brochure 207*
- *CIGRE Brochure 601, or*
- *TNSP 2009*

Sections/ Thermal Calculations (IEEE, CIGRE and TNSP)

Section 10.3.1.3

Electro-Magnetic Field Calculations

Electricity in overhead lines produces an electric field and a magnetic field. These fields are also called Electro Magnetic Fields or EMF. The Electro Magnetic Field (EMF) is a factor which can be calculated during the design or analysis of overhead transmission lines. The EMF calculation may determine width of a Right of Way (ROW) or have a particular limit at the edge of a Right of Row for an overhead line.

Within PLS-CADD there are two distinct options to calculate Electro-Magnetic Field Calculations:

- *2D EMF*
- *3D EMF*

Completed drawings can be output either as an Exported DXF.

Sections/ Electric/ 3D EMF Calculator…** or **/ 3D EMF Along Line…

Section 11.2.8

PLS-CADD can calculate the space potential, electrical field or magnetic field at structures. The software will create cross sections at selected structures and plot contours for the space potential, electrical field or magnetic fields.

Sections/Electric/Structure Space Potential Calculator

Section 11.2.8.3

Line Constants Calculator

PLS-CADD can calculate the following line constants:
the resistance, positive sequence inductive reactance, capacitive reactance, impedance magnitude, and phase angle for all sets with a voltage in the selected range of spans. Using the

Sections/ Electric/ Simple Line Constants Calculator

Section 11.2.10

PLS-CADD can calculate all three symmetrical components (zero, positive and negative sequence values) of the line impedance. The software accounts for ground wires, ground return, and mutual coupling of nearby circuits either on the same structure or span, or a neighboring line sharing a corridor.

Sections/ Electric/ Full Line Constants Calculator

Section 11.2.11

Lightning Protection Calculator

PLS-CADD can calculate the lightning coverage surface based on the ground wires of a line. The basis of the calculation is the Electromagnetic Method (EGM) which is also known as the Rolling Sphere Method.

Sections/ Electric/ Lightning Protection Calculator

Section 11.2.12

Generate Plan & Profile Sheets

Use PLS-CADD for all your drafting
All drawing sheets auto-update if any model changes are made.

Set Page Size
Page size can now be defined for Drawing Sheets and also now for Reports that are exported as PDF files.

Drafting/ Plan & Profile Sheet Configuration/ Page Size
Section 13.2.1

Set the Pages and Station Range
You can build a complete drawing pack for the project and not just the Plan & Profile Sheets.
This can include the addition of:

- *A Title Page*
- *Notes page/s*
- *P&P Drawing Sheets*
- *Appendix Page/s*

This can be coupled with the ability to Inset graphical views and information tables to generate a rich data driven drawing pack.

You also select the section of the alignment (station coordinates or structure numbers) to be shown in the drawings.
Drafting/ Plan & Profile Sheet Configuration/ Pages and Station Range
Section 13.2.2.1

Page Layout
You can control what is visible on each Drawing Sheet, and the relative position and size that each "section" of the drawing covers. This gives the User control to meet most Utility or Client Drafting standards and requirements.
Drafting/ Plan & Profile Sheet Configuration/ Page Layout
Section 13.2.2

Set The Scales...Long-axis plot etc.
Once the Page Layout and Paper size has been set, you can control the overall appearance of the P&P drawings under the Scales menu.
This not only controls the actual Scales at which the drawing is produced, but allows for the insertion of Grid Lines and various other functions to control the appearance of the Sheets view.
It's also possible to select whether or not the view should be a Long-Axis Plot or not (normally driven by Client Preferences)

Drafting/ Plan & Profile Sheet Configuration/ Scales
Section 13.2.3

Add Annotations
The drawings can be further embellished with Annotations to fully portray the granular details of the project.
These annotations can be:

- *Lines*
- *Arrows*
- *Arcs*
- *Circles*
- *Polygons*
- *Dimensions*
- *Text*

Section 13.3

Inset Views and Tables
Additional views or data can be placed on the Title, Notes and Appendix pages in the form of Inset Views or Inset Report/Tables to create a full drafting pack for the project.

Many ways to do this, but mainly controlled via:
Drafting/ Inset Views/ Add
Section 13.5 – 13.8

Output
Completed drawings can be output either as an Exported DXF drawing for further manipulation in a drafting package,
File/ Export/ DXF

Or as a PDF file for printing and sharing:

- *Can be done either by* **File/ Print**
- *or by Right-clicking on the Sheets View tab and selecting* **Save as PDF/ To File**

Section 13.4

Attach a DXF:
Additional items can be added in to embellish PLS-CADD P&P Sheets. This will allow the drawings to match company/client standards and layout.
These include:

- *Titleblock or Drawing Frame if needed*
- *North Arrow*

This is controlled under the:
Drafting/ Attachments/ Attachment Manager
Section 6.6.1

Generate Construction Reports and other Output files

15

Construction Stringing Charts

These charts are needed by Construction crews to install the wires at the correct tensions for different install temperatures to match the design assumptions.

You can generate them using:
Sections/ Stringing Chart/ Single Section, *or*
Sections/ Stringing Chart/ Multiple Sections
Sections 11.2.4

KMZ files

It can be very convenient to share the line model and even several types of reports by using KML/Z files, as these can be viewed by Google Earth© or other GIS applications.

To export your model as a KMZ (ideally from the 3D View in PLS-CADD), select:
File/ Export/ KMZ (Google Earth)

Some of the reports that can be exported to KMZ files are:

- *P.I. Report*
- *Construction Staking Report*
- *Leg and Guy Extension Report*
- *Terrain Clearances by Span Report*
- *Thermal Rating Report*
- *Danger Tree Locator Report*
- Vegetation Work Site Centroids (can also be exported as a SHP file)

Structure Loads Report

These detailed loads can be shared with structure designers/suppliers to verify the structures are fit for purpose.

This can be done for a single structure at a time:
Structures/ Loads/ Report

Or for a selected range of structures:
Lines/ Reports/ Structure Loads Report

Bills of Materials

The Bills of Material can be generated if the model includes this data. The material data includes:

- *Material captured for each Structure file*
- *Structure Specific Material - tied to the structure site (such as foundations, signs, dampers, etc. material described in the Material button of Structure Modify dialog box).*
- *Line Specific material for anything more general regarding the line but not necessarily tied to a specific location (described in the Line Specific Material button of Lines Edit dialog box).*
- *Wire quantities and concentrated loads (such as aerial marker balls)*

Cost information for both Material and Labor can be included to enable cost tracking of the design. Furthermore, the status of the assets can be included so that life-cycle tracking and maintenance/replacement activities can be quantified as well.
The Bill of Material can be generated by either:
Lines/ Reports/ Bill of Material by Structure Location, *or*
Lines/ Reports/ Bill of Material
Appendix M

Construction Staking Report

You can generate a Construction Staking Report which is relating to the construction of the line. This includes:

- *The coordinates (either as XY or as Lat/Long) for Stakes , which indicate the field location of:*
  - *poles,*
  - *tower legs*
  - *Anchors*
  - *P.I.'s, and*
  - *reference stakes.*
- *It can also include up to four different graphical views and*
- *A material list for each of the structures.*

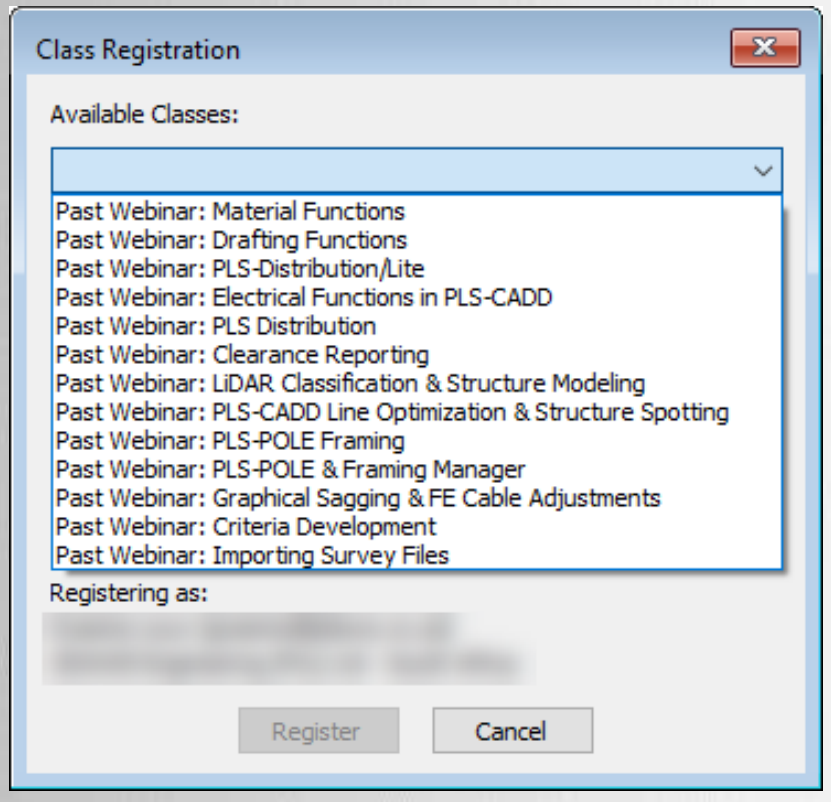
Lines/ Reports/ Construction Staking Report
Appendix R.3

Webinars:

Power Line Systems produced a series of Webinars on selected topics during 2020.

These webinars are available through the latest version of the software by selecting:

Help/ Register for Training Classes…



In this dialog box you can access the Past Webinars. These are available in the drop down list.

You will receive a URL link to either watch the videos online, or to download them.

In total there is about 18 hours covering the 13 topics

Power Line Systems

IT'S ALL ABOUT YOUR POWER LINES

Advanced Sag & Tension
IEC
FAC 008/009
Materials Management
NESC
PLS-CADD ®
LiDAR Modeling
Structural Analysis
CSA
Pole Analysis
FAC 003
Distribution
CENELEC
Transmission
Line Ratings
Joint Use
IEEE
NERC Ratings
Line Optimization
Storm Hardening
Drafting
Project Estimating
Vegetation Management
1000+ Users in 100+ Countries
PLS-POLE
GO95
TOWER
ASCE

See www.powerlinesystems.com for more information
Contact info@powerlinesystems.com for additional information
Contact sales@powerlinesystems.com for quotation
Contact support@powerlinesystems.com for technical inquiries

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