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DISTRIBUTION SYSTEMS TESTING APPLICATION AND RESEARCH

Electric Utilities and GE in Cooperation to Promote Pragmatic Distribution Systems Research

Secondary Electrical Design Software (SEDS)
Application Guide
DSTAR’s
Secondary Electrical Design Software (SEDS)
Application Guide

DSTAR Project 13-4

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Foreword

This project was conducted by General Electric International, Inc. for a consortium of utility companies and utility organizations known as the Distribution Systems Testing, Application, and Research (DSTAR) group as part of DSTAR Program 13. The participating companies are:

Ameren Corporation
American Public power Association, DEED
Duke Energy
National Rural Electric Cooperative Association, CRN
Progress Energy
South Carolina Electric and Gas
Southern Company
We Energies
Wisconsin Public Service Corporation

This software development was performed by General Electric International, Inc. This project was performed under the guidance of a Project Review Committee whose membership is comprised by representatives of the companies listed above. This committee is responsible for both the Program 13 research and long-range goals of the DSTAR program.
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Section 1  SEDS Overview
What is SEDS?

Initially developed in 1998, the Secondary Electrical Design Software (SEDS) enables users to quickly layout a secondary design and easily assess performance measures such as voltage drop, flicker, loading and short circuit current using a customized load flow algorithm. SEDS includes load diversity in the calculations, and uses a sophisticated approach to calculating the coincident demand of dissimilar types or sizes of loads -- a situation which can give silly results using conventional coincidence tables.

SEDS development benefited significantly from the testing, guidance, and input of the consortium member utilities. Development with such tight user integration resulted in a final product that provides significant flexibility and usability to the large number of utility planners all across the United States.

SEDS performs a variety of calculations for both single-phase and three-phase systems:

Single Phase Systems:
- Distribution transformer coincident loading
- Secondary cable loading coincident current
- Secondary service voltages
- Mutual and self-flicker
- Service-entrance short circuit currents
- Cold load pickup guidelines
- Optimization based upon first cost or first order total owning cost

Three Phase Systems:
- Distribution transformer loading
- Secondary cable loading
- Secondary service voltages
- Voltage unbalance
- Mutual and self-flicker
- Service-entrance short circuit currents

The recently developed optimization algorithm uses a member utility's existing SEDS database, and employs a unique method to improve overall computational time while always finding the best solution in a defined pragmatic space. The optimization objective function can be set for lowest first cost or lowest total owning cost taking into account overall secondary system losses. SEDS is the ideal software package for helping planners design the most efficient secondary systems using standard
equipment (transformers and secondary conductors) while meeting technical service requirements.

**Optimization**

The recently developed optimization algorithm uses a member utility's existing SEDS database, and employs a unique method to improve overall computational time while always finding the best solution in a defined pragmatic space. The optimization objective function can be set for lowest first cost or lowest total owning cost taking into account overall secondary system losses. SEDS is the ideal software package for helping planners design the most efficient secondary systems using standard equipment (transformers and secondary conductors) while meeting technical service requirements.

![Optimization dialogue box](image)

**Figure 1-1** Optimization dialogue box

**Customization**

SEDS data selections are customizable, similar to the DSTAR Engineering Toolbox. The Administrator sets up the database with standard load types, cables, and transformers. Motor types for flicker calculations and coincidence factor categories can also be set up by the Administrator. The user can simply select on one of these standard types from the database, or directly input data. The administrator can also customize the images used for each component represented in SEDS. To save the user the effort of specifying equipment over and over again, SEDS provides a "data copy" function which transfers the specifications from one load or cable to another with a simple mouse click on the graphic object.
Designing Secondary Systems Using SEDS

SEDS allows users to construct a secondary system design very quickly. However, there are some basic engineering questions that need to be addressed before SEDS can perform the calculations necessary to evaluate and optimize a design. Some of the key engineering questions related to secondary system design are:

- What is the steady-state and flicker characteristic of the connected loads?
• How long are the conductor runs?
• Is the service overhead or underground?
• What are allowable limits for flicker, voltage drop, and short circuit current?
• What transformers and conductors are available?
• Are losses going to be considered?
• What is the first cost of each piece of equipment?
• What is the single-phase coincident factor for the connected loads?

After careful consideration of these key questions and populating the database with the relevant equipment data, users are ready to build a secondary system design. Users can build a base secondary design, similar to the example shown in Figure 1-3, by selecting components shown in the toolbar and dropping them on the screen in the desired location. Double-clicking the component and either selecting pre-populated data or entering user specified data specifies the attributes of the components. Each DSTAR utility has developed its own set of pre-populated data for transformers, loads, and conductors.

![Figure 1-3 SEDS Sample Layout](image-url)
Figure 1-4 shows an example of a secondary design with calculation results. In this example, there are no voltage drop or flicker violations. The voltage drop and flicker results are shown next to each of the loads in the design. SEDS shows color-coded results to indicate whether or not the user defined voltage drop or flicker warning criteria has been violated. Additionally, the user will be warned if the transformer or conductor is overloaded. If there are violations, the user can make adjustments to the design to remove violations. Alternatively, the user can use the optimization feature in SEDS to remove violations while minimizing cost.

Figure 1-4  SEDS Sample Results Screen
Capabilities of SEDS

Single Phase

The SEDS Single Phase mode is limited to radial, single-phase secondary distribution systems. SEDS can accommodate up to one hundred loads and up to twenty-five tiers. Figure 1-5 illustrates the definition of a load tier.

SEDS is limited to 120/240 V secondaries, and handles both unbalanced and balanced single phase loads connected phase-to-phase or phase-to-neutral. It is rarely necessary to perform calculations assuming unbalanced single-phase loads, but this capability exists in SEDS.

Three Phase

The SEDS Three Phase mode is limited to radial, three-phase secondary distribution systems. SEDS can accommodate up to one hundred loads and up to twenty-five tiers. Figure 1-5 illustrates the definition of a load tier.
SEDS Structure

The program opens to a main menu where the user is presented with the three main areas of the program; Single Phase Design, Three Phase Design, and Database Utilities.

Both the Single and Three Phase areas open to the Design Tab. All entry and changes of system data are performed on this tab. Switching to any of the other tabs causes system calculations to be performed. A valid system must be entered before switching to the calculations tabs, which are:

- Voltage
- Flicker
- Short-Circuit
- Detailed Results

In the Database Utilities area the Program Administrator has access to customized parameters that are available for convenient selection by the user. The customized data for Single Phase SEDS are below. Three Phase SEDS only has the first three.

- Transformer parameters
- Standard load data
- Secondary cable data
- Motor starting current characteristics
- Load coincidence factors
- End user Equipment data

The customized data are maintained in a database structure that is accessible only with the appropriate password.
What’s New in SEDS V4.2

Seasonal Coincidence Factors

The SEDS database has been modified to allow storage and retrieval of seasonal coincidence factors for single phase loads, and the logic and output are also updated accordingly. The Coincidence Data entry form can be accessed using the **Edit Custom Parameters** menu item after the database is unlocked with the correct password (see Database Utilities in Section 3). The original data Coincidence Data entry form and the new Coincidence Data entry form for V4.2 are shown in Figure 1-6.

![Original Data Entry Form](image1.png)

![New Data Entry Form](image2.png)

**Figure 1-7** Original (V4.1) and new (V4.2) coincidence data entry forms

Store and Retrieve Three-Phase Loads

The SEDS database has been modified to allow storage and retrieval of three-phase load data, and the logic and output are also updated accordingly. The Three-Phase Load Data entry form for the equipment database can be accessed using the **Edit Custom Parameters** menu item after the database is unlocked with the correct password (see the Database Utilities subsection of Section 2). In V4.2, there is now a menu item for Loads, as shown in Figure 1-8.
Figure 1-8  Data entry selections for three-phase SEDS V4.2

When **Edit Custom Parameters → Loads** is selected, the new Load Data entry form for the SEDS equipment database is shown (see Figure 1-9).

The new form allows users to define parameters for three-phase loads and save them in the equipment database for retrieval. Loads can be defined as a combination of
balanced and unbalanced phase-to-neutral (wye connected) and phase-to-phase (delta connected) loads. Summer and Winter KVA and PF can be specified. In addition, the largest motor load can be specified (for short-circuit and flicker calculations) and the total motor running load can be specified (for use in steady state calculations).

Once loads have been added to the SEDS equipment database, they can be added to any load in SEDS. Double-click on a load object to open the window shown in Figure 1-10. This window will set the parameters for the selected load. The parameters of each load object need to be selected from the loads stored in the SEDS equipment database and modified in this window if needed.

![Figure 1-10 Updated load data input window for three-phase SEDS V4.2](image-url)
In addition, end-use equipment such as (freezers and stoves) that are defined as being three-phase in the equipment database can also be added to the three-phase loads in this window (as shown in Figure 1-10). Note that to edit or add equipment, you have to switch to Single-Phase SEDS and chose Edit Custom Parameters → Equipment. More information on entering three-phase load data is available in the Load Parameters subsection of Section 7.
Section 2    Installing SEDS
System Requirements

The DSTAR Secondary Electrical Design Software (SEDS) program is designed to run on Windows 2000, Windows XP and Windows 7.

In addition to the minimum requirements of the operating system, SEDS requires approximately ninety megabytes (MB) for the program files and dependencies, and a screen resolution of at least 1024x768 for best results.

Installation Instructions

The DSTAR Secondary Electrical Design Software (SEDS) program is contained in a compressed installation file distributed via the DSTAR web site (www.dstar.org) or from your company intranet site. An automatic installation utility will install SEDS onto your computer. Installation should take only a few minutes.

NOTE: The latest version of SEDS is version 4.2.0. If you have the previous version (4.1.0) installed, you can either uninstall it and install SEDS 4.2.0 or retain it and install SEDS 4.2.0 in a different location. The steps are as follows:

1. Download and Run the SEDS 4.2.0 installation package. It may be named SEDSSetup-4.2.0.0.exe, or SEDSSetup-4.2.0.0_Trial.exe or SEDSSetup-4.2.0.0_Beta.exe, or something similar. You should a welcome screen similar to the one below. Click Next.
2. The next screen is the standard License Agreement shown below. Read in its entirety and click **I Agree** or Cancel.

![License Agreement Screen]

3. If you accept the licensing terms, the third screen shown below will ask to choose an install location. The default is shown below. You can accept this default if you uninstalled your previous version of SEDS or change to another location such as `\DSTAR\SEDS 4.2` if you wish to keep the old version. Click **Next**.

![Install Location Screen]
4. On the next screen, make sure that **Full Sample Database** is checked (see below). Click **Next**.

![Installation screen with Full Sample Database selected](image)

5. The final screen allows you to specify a start menu shortcut. If you have an older version of SEDS installed, it is recommended that you modify the Start Menu entry, as shown below. Click **Install** to complete the installation.

![Start Menu setting](image)
Installing SEDS

You can now run SEDS V4.2 by double-clicking on SECONDARY.exe file in the installation folder, or using the shortcut on your start menu. If you encounter an error during installation or when you run SEDS, please contact your DSTAR representative for assistance or send an email to dstar-support@dstar.org.
Section 3  Launching SEDS
This section of the SEDS Application Guide provides instructions for starting the SEDS application. This section will cover the Main Menu (SEDS: Design Selection) and the Database Utilities.

**Opening the Program**

When you first launch SEDS, it opens to the Main Menu or Design Selection window shown below in Figure 3-1. The main menu window allows the user to select from the three main areas of SEDS: Single Phase Secondary Systems, Three Phase Secondary Systems, and Database Utilities.

![Figure 3-1 SEDS main menu window](Image)

**NOTE**: The latest version of SEDS V4.2 includes some changes to database structure so old databases (.mdb files) will not work with SEDS 4.2. They will have to be converted, which is a manual process for now. In order to convert an old database to the latest format, please contact your local DSTAR representative and ask them to contact GE Energy. GE Energy will update the database to the latest structure.

**Single Phase Secondary Systems**

Clicking on this button will launch the Single Phase application of SEDS. This requires a valid connection to a single phase SEDS database. Section 4, Inputting Single Phase Data has further information and instructions for using the single phase application. If a valid connection does not exist then you will be prompted to use the Database Utilities function to establish a valid connection (see Database Utilities subsection).
Three Phase Secondary Systems

Clicking on this button will launch the Three Phase application of SEDS. This requires a valid connection to a three phase SEDS database. Section 7, Inputting Three Phase Data has further information and instructions for using the three phase application. If a valid connection does not exist then you will be prompted to use the Database Utilities function to establish a valid connection or convert a single phase database to three phase (see Database Utilities subsection).

Remember This Selection

This option will allow you to launch SEDS directly into your preferred mode, skipping this screen on startup. To use this feature, select this check box before entering either Single Phase or Three Phase mode. Next time SEDS is started, it will go directly into the selected mode. To return to this main menu, select File ➔ Main Menu from either mode.

Database Utilities

SEDS provides a database utilities feature that allows the user to easily maintain, manage, and convert SEDS input data. The Database Utilities feature opens to the window shown in Figure 3-2.

![Database Utilities Window](image)

Figure 3-2  Database Utilities Window

This window allows the user two basic functions:

- Maintain user input data
- Maintain the database connection path

When finished using the utilities, a click of the OK button will close the Database Utilities window and display the Design Selection main menu.

See Section 10 Program Administrator Information for more on maintaining the database.
Maintaining the Database Connection

The path of the current database is shown when the Database Utilities window opens. This can be changed by either editing the path and filename or by clicking the Browse... button. The Browse... button allows the user to select a database file by using a Windows Explorer dialog box. Any change in the database connection path will be discarded if the Cancel button is used to close the Database Utilities window.

**CAUTION!** - The user must be careful when changing databases and loading previously saved projects. If a saved project is loaded while using a connection to a different database than the one that was used to create the project, the solutions will be unreliable. SEDS will warn the user if the saved project appears to be inconsistent with the loaded database. Extreme care must be taken to ensure that the saved project data is consistent with expectations.

![User warning if database is inconsistent with saved file.](image)

**Figure 3-3** User warning if database is inconsistent with saved file.
Section 4  Inputting Single Phase Data
This section of the SEDS Application Guide provides step-by-step instructions for inputting data for an example single phase system. SEDS is a very easy to use program, and following through this example will provide you with sufficient familiarity to set up and run your own cases.

**Opening the Program**

SEDS opens to the Design Tab window shown below in Figure 4-1. The Design Tab is a drawing tablet where all the system components are graphically added and their parameters (properties) are set. The other tabs (Voltage, Flicker, Short-Circuit, and Detailed Results) are selected to reveal calculation results, after the circuit design has been entered.

![Figure 4-1  SEDS Design Tab Window](image)

**Inputting the Circuit Configuration**

The first step of inputting case data in SEDS is to draw the secondary system configuration. On the Design Tab is the object toolbar, shown on the top right side of Figure 4-1, which has buttons for each circuit element plus a button for copying
properties (parameters) of the elements and creating freeform text boxes. Only one of these buttons can be selected at a time.

**Placing the Transformer and Primary Source Objects**

Circuit configuration input begins by placing the distribution transformer on the drawing tablet. Select either UG Trans or OH Trans by clicking the appropriate button. Now, using the mouse, click on the location on the drawing tablet where the symbol (object) for the transformer is desired to be placed. Hold down the left mouse button and drag the mouse slightly, then release. Symbolic objects representing the transformer and its primary source will appear on the tablet as illustrated in Figure 4-2.

![Figure 4-2 Padmount transformer and primary source object placed on the tablet.](image)

The primary source and the transformer objects can be moved together to a new location on the tablet by clicking on the source symbolic object (three parallel lines) once, and then pressing the mouse button again and holding the button down while dragging the source and transformer to the new location. Clicking and dragging the transformer object in a similar manner will move the transformer object alone while keeping it connected to the source symbol.

Note that the transformer background is initially red in color. This indicates that transformer parameters have not yet been selected. Later when the parameters have been entered, the background turns white.

**Inserting Nodes**

Connection points where two or more secondary cables come together (other than at the transformer) are called nodes. Nodes can represent a secondary pedestal or a pole where several secondary service cables connect to the secondary main. Nodes can also be used for transition points where the secondary cable size or type changes, or for transition between overhead and underground secondaries.
The next step to laying out the secondary configuration is placing nodes (if any) on the tablet. In the object toolbar, select the button for Node. Now place the node object onto the drawing tablet by holding down the mouse button and dragging at the desired location. Repeat click and drag for any other nodes. Figure 4-3 illustrates two nodes added to the example circuit layout.

![Figure 4-3 Two nodes added to the circuit.](image)

Adding Loads

The secondary circuit needs to have at least one load. Load objects are placed on the tablet by first selecting Load in the object toolbar. Click and drag on the tablet in the desired location for each load. Note that the secondary cable interconnections between the transformer, nodes, and loads are added in the next step. The load object color is initially red, indicating that the parameters of the load have not yet been entered. Figure 4-4 shows five loads added to the example circuit.

![Figure 4-4 Example circuit with five loads placed.](image)
Adding Secondary Cables

Secondary cables (overhead or underground) are added to the circuit in a different way than the transformer, nodes, and loads are placed. First, select Cable from the object toolbar. Next select the beginning point (upstream end) of the first cable by clicking the object to which it is connected (e.g., the distribution transformer object). Now click the end point object of the same cable. If, after clicking the beginning point object, a different beginning point object is desired, select a different object on the toolbar and then re-select Cable. The next object selected will be a cable beginning point, instead of an end point.

In our example, cables have been placed connecting the transformer to the two secondary pedestals (nodes) and to the load in the upper right. Cables have also been placed from the pedestals to two loads each. The configuration of the example is illustrated in Figure 4-5. Note that the cable objects appear as broken lines, indicating that their parameters have not yet been specified.

![Figure 4-5](image)

**Figure 4-5**  Transformer, nodes, and loads interconnected by cables.

There are limitations to the placement of secondary cables:

- Only one cable can have its end point on a given object. This prohibits closing a secondary loop, and also prohibits parallel cables. (Secondary circuits with parallel cables can be analyzed by representing the parallel cables as one equivalent cable, with an impedance equal to the parallel combination.
- Only the beginning end of cables can be connected to the distribution transformer object.
• Only the downstream ends of cables can connect to a load. You cannot connect a cable from one load to another. If the actual circuit has the secondary cable connecting to one load and then continuing on to another, then terminate the incoming cable before the first load at a fictitious node, and insert a very short cable between that load and the first load. The cable from the first to second load in the actual system is represented in SEDS by a cable between the fictitious node and the second load.

Order of Object Placement

In the example shown above, the objects were placed in the order of transformer, nodes, loads, and cable. It is necessary to begin with placing the transformer, and cables must connect existing objects. Otherwise, the order of object placement is arbitrary. For example, the configuration shown in Figure 4-5 could be fully assembled and then a new node and load added, connected by new cable sections.

Drawing Over a Graphic Image

A useful feature of SEDS is that it allows the secondary circuit to be drawn on top of another graphic image, such as a development plat showing home and transformer locations. Figure 4-6 illustrates this capability.

![Development plat loaded as a SEDS background image.](image)

Figure 4-6  Development plat loaded as a SEDS background image.

To insert the background image, click the View → Insert Back Picture menu item, and select the desired image file. The background image must be in bitmap, Windows
metafile, or enhanced metafile formats. The background image can also be removed by clicking **View → Remove Back Picture**.

**Creating Captions**

Free form text can be added to the tablet at any time by selecting the **Caption** button from the toolbar. To create a caption, click and drag a box the approximate area and size desired.

![Caption Editor window](image)

**Figure 4-7** Caption Editor window that is displayed after creating a caption

After releasing the mouse button, the window shown in Figure 4-7 will appear. This is where you enter the text to display and also select the font and background color. The text color is set in the font dialog. To set a transparent background, set the background color to black.

**Detailed Design View**

The detailed design view (**View → Detailed Design**) allows the user to view, at a glance, the length of cables and the description of the loads, as shown in Figure 4-8.
Specifying Object Parameters

Object parameters are set by double-clicking on the object to open its data entry form. It is also possible to copy properties from one object to another similar object (e.g., from a load to a load or a cable to a cable). This will be described later.

Equipment parameters in SEDS are set by selecting from a pre-existing list, or by directly entering the data. The pre-existing lists in SEDS can be set up by your company’s SEDS Program Administrator, based on materials and practices used by your company. These lists are maintained in a separate password-protected area of SEDS (see Database Utilities).

Some users may want to uniquely identify loads and nodes for viewing purposes. Users can assign special identifiers to nodes and loads by clicking on Edit Custom Parameters → Node and Load Prefixes. The window shown in Figure 4-9 allows users to edit the prefix used for various items shown in design mode. The Preview field shows an example of how the actual assignment will look in the design mode. This is a useful feature for labeling items consistent with the normal nomenclature used in your utility.

Figure 4-8  Showing the design tab in detailed view.
Figure 4-9  Node and Load Prefix Settings.

Source Parameters

Optionally, the primary source impedance can be included in SEDS calculations of flicker and short-circuit currents. Primary impedance is never included in SEDS steady-state voltage drop calculations.

The SEDS default is to ignore primary-side impedance in flicker and short-circuit calculations, which is the same as assuming that the primary side of the distribution transformer is connected to an infinite bus.

To include primary feeder impedance in flicker and short-circuit calculations, double click on the primary source object to open the window shown in Figure 4-10.

Figure 4-10  Primary source impedance data window.
Click the button marked **Consider primary source impedance**. Next select the nominal voltage applied to the primary winding. If the transformer is connected phase-to-neutral, then the input must be the phase-to-neutral voltage (e.g., 7.2 kV). If the transformer is connected phase-to-phase, then the input voltage is the phase-to-phase voltage (e.g., 12.47 kV). Input the available short-circuit current at the transformer primary terminals, in Amperes. This short-circuit current should be the available current if the transformer primary winding is short circuited. Thus, the appropriate short-circuit current for a phase-neutral (wye) connected transformer is the phase-ground fault current, and the input short-circuit current for a phase-to-phase (delta) connected transformer is the available phase-to-phase fault current. Enter the ratio of inductive reactance to resistance (X/R ratio) for the primary system. For a phase-to-neutral connected transformer, the X/R ratio should be that of the phase-to-neutral current path impedance (one-third of the sum of the positive, negative, and zero-sequence source impedances). Typical overhead primary systems have an X/R ratio in the range of 0.5 to 10, and typical underground primary system X/R ratios range from 0.3 to 3. After entering and selecting the source object parameters, click **OK**. Clicking **Cancel** closes the primary source data window without executing the inputs provided. Chose **Save As Defaults** if you want SEDS to remember and use these parameters as the defaults for flicker and short circuit calculations.

**Transformer Parameters**

Double-click on the transformer object to open the window shown in Figure 4-11. The list box in the middle of the window all padmount transformers (if the transformer object placed on the tablet is a padmount transformer), or all polemount transformers (if that type was placed), for which your company’s SEDS Program Administrator has provided data (or the default transformers included in the sample database, if that database is associated with SEDS). One of these transformers may be selected. If so, that transformer’s parameters will show below the selection list.

The transformer list can be filtered by using the selection boxes at the top of the Transformer Data window. The default filtering selection is an asterisk (*), meaning “wild card,” or unrestricted by that category. There are four categories of filtering: kVA rating, primary winding voltage, “type,” and polemount /padmount. Selection of a parameter in a category will limit transformers shown in the list box to those having the same parameter for that category. The “type” category can be used for various purposes, depending how the company SEDS Program Administrator sets it up. For example, it can be used to indicate special transformer features such as CSP or fusing options. The filtering selection for each category can be reset to the wild card value by
clicking the appropriate Reset button. All categories can be reset using the Reset All button.

If the transformer to be studied is not available on the equipment list, then the user can enter the transformer data directly by clicking on the check box marked **User Specified Transformer Parameters**. The transformer impedance (%Z) and resistance (%R) are in percent of the impedance base for the selected nameplate kVA rating. Resistance may not exceed the total transformer impedance. Enter the maximum summer and winter loading capability of the transformer, based on your company’s loading practices. Typically, these maximum loadings exceed the nameplate kVA.

After all entries are complete, click **OK** to assign the parameters to the transformer object.

![Figure 4-11](image)

**Figure 4-11**  Transformer data input window.
Cable Parameters

Double-click on any cable object to open the window shown in Figure 4-12 for specifying the parameters of that cable. A selection list of cables is shown in this window. This list is maintained by your company SEDS Program Administrator in the equipment database, and should contain the service cable types and sizes that your company uses. Clicking the Overhead or Underground radio buttons at the top of the window causes the cable list to show only that category of conductor.

Selection of a cable in the listbox on the right causes the resistance and reactance per 1000' of that cable to be shown in the fields on the left, as well as the summer and winter cable ampacity. After selecting the desired cable type, enter the length of the particular cable section in feet and click OK. The parameters of each cable object need to be set in this manner, or by using the Properties button described later.

NOTE: The cable length entered for single phase systems is the one-way length, not the round-trip length of the conductor. SEDS doubles the impedance/length of the cable to account for the voltage drop in the neutral.
Load Parameters

Double-click on any load object to open the Load Data window shown in Figure 4-13. This window will set the parameters for the selected load. The parameters of each load object need to be set using the procedure described below, or load parameters can be copied from one load to another using the **Copy Properties** function (explained later).

SEDS assigns a default name for the load, depending on which node the load is connected to. This is shown in the Load Name box at the top of the load data window. By default the pattern N2L1 is used, which indicates the first load (in order of entry) connected to the second node (in order of entry). This pattern can be changed and will be discussed later. If the load is supplied directly from the transformer secondary without an intervening node, the default name will begin with S instead of N#.

Optionally, the user can provide a descriptive name for the load, such as the house number or meter number. The user-supplied name is entered by overwriting the default name in the load data window. The load name appears on the circuit configuration drawing, and in the results reports.

![Load Data Window](image)

**Figure 4-13** Load data input window.
If the **Database Loads** button is pressed, the load data window will display a drop-down list of standard single-phase load types. Your company’s SEDS Program Administrator maintains this list in the SEDS equipment database. Assigned to each of these loads are summer and winter peak values, power factors, coincidence factor category, and starting-current data for any critical motor load associated with that load type. Selecting a database load from the drop-down list causes the parameters of that load type to populate the data fields below the list box. Click **OK** to assign the standard database load parameters to the selected load object.

Alternatively, the user can enter load data directly by clicking the **User Specified Loads** button. SEDS would now display fields for the user to enter Summer and Winter KW and power factor, and coincidence as shown in Figure 4-14. Coincidence is the load classification with respect to the coincidence factors used for voltage drop, transformer loading, and secondary cable current calculations. The descriptions of the coincidence classes, and the factors used, are established and maintained by your company’s SEDS Program Administrator in the SEDS equipment database. The user can also click the **Transfer from Database Loads** button to transfer the parameters of a selected database load to the user specified parameters fields to be modified.

![Figure 4-14 Partial load data input window showing user specified parameters](image)

In addition to the standard list of single-phase loads, your company’s SEDS Program Administrator may have included a set of equipment to build your own composite load. By clicking the checkbox next to the **Equipment** label and choosing **Add Equipment**, a new blank row will added to the equipment list. This is shown in Figure 4-13. To select the equipment to add, simply click in the cell with the description label and select the equipment from the drop-down list provided. It **should be noted that this equipment will be ADDED to the other steady state selected loads. The Total Load listed will be updated after selection and addition of equipment.**

Flicker calculations require the largest transient current to be specified for each load. Usually, this transient current is the starting current for a relatively large motor, such
as a central air conditioner compressor. The starting current may be included in the standard load type, or it may be directly entered by the user. To directly input motor starting current (or any other transient current such as a welder, etc.), click on User Specified Motor. The user has a choice of the three following ways to input the current.

1. The first option is to click **Database Motor**, and then select a description of the load from the selection list. Your company’s SEDS Program Administrator maintains this list in the SEDS equipment database. Associated with each type is a starting current and starting power factor, which show in the fields below the selection list when this input option is used. This is shown at the bottom on the load data window in Figure 4-13.

2. The second option is to click **Starting Amps/PF** and input the motor starting current and starting power factor directly. This option can be particularly useful for a non-motor load which cause flicker, such as a welder. This is shown in the partial load data window below.

3. The third option is to click **HP/PF/Code**. Motor horsepower and starting power factor is input and the NEMA rotor code for the motor is selected.

   ![Figure 4-15 Partial load data input window showing motor starting amps and PF option](image1)

   ![Figure 4-16 Partial load data input window showing motor HP/PF/Code option](image2)

**NOTE:** The starting currents specified are used only for flicker calculations. The motor running load should be included in the total steady-state load. Transient current (i.e., motor starting current) data are not mandatory. If there is no transient current data provided for a load, the voltage flicker calculated will be the worst flicker caused by transient currents drawn by another load fed from the same transformer. If no transient loads at all are specified for the secondary system, the calculated self-induced flicker will be zero.
After selecting or specifying load parameters, click **OK** to assign the parameters to the
displayed load. Repeat for all of the loads, or use the **Copy Properties** function
described below.

### Copying Properties

The **Copy Props.** button can be used to copy parameters from one cable to another, or
from one load to another. To use this function, select **Copy Props.** on the object
toolbar. Select the object from which the parameters are to be copied. Next, select the
object (must be of the same type: cable or load) to which the parameters are to be
added.

If cable parameters are being copied, SEDS will prompt the user for the length of the
cable section to which parameters are being copied. (In essence, SEDS allows the type
of cable to be transferred, not the section length).

The “copy to” process can be repeated multiple times without performing another
“copy from.” If another object is desired to be the “copy from” object, click a different
button on the object toolbar (such as **Select**) to reset the copy function and then click
the **Copy Props.** button again.

**NOTE:** Choosing the **Copy Props.** button then double clicking a load will copy the
properties of that load to all loads on the tablet.

### Checking Transformer Size

After transformer and load parameters have been set, SEDS can check to ensure that
the selected transformer rating is appropriate for the load. SEDS calculates the
coincident peak summer and winter demands of the loads, and compares this to the
load rating ranges for the transformer. The upper limit of the summer and winter load
ranges for the transformer are provided in the transformer object properties. The lower
load range limits are the upper limits of the next smaller size transformer in the SEDS
database having the same winding voltage and type attributes. The SEDS database is
set up and maintained by your company’s SEDS Program Administrator.

To perform a check of transformer size, click the **Check Transformer Size** button to the
left of the toolbar on the Design Tab window. If the coincident load is within the range
for this transformer, a status box will appear at the bottom of the design tab with black
lettering which summarizes the peak coincident loads, the net coincidence factors, and
the transformer summer and winter load ranges. An example of this box is shown in
Figure 4-17. Where the demand or type of individual loads on a secondary system
differ from each other, SEDS uses a sophisticated approach to derive a net coincidence
factor, which is described in Section 9.
If the transformer is undersized, the transformer results that are out of bounds are displayed in red as shown in Figure 4-19. Also, the prompt shown in Figure 4-18 is shown on the screen. If the user selects "Yes", a list of alternative transformers with the appropriate voltage and type attributes is displayed, such as shown in Figure 4-20. Selecting a transformer, and clicking Accept, will replace the previous transformer selection with the new parameters.

<table>
<thead>
<tr>
<th>Transformer Results</th>
<th>Load</th>
<th>Limit</th>
<th>CF</th>
<th>Cold Load</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer Load (kVA)</td>
<td>30.3</td>
<td>37.5</td>
<td>1.00</td>
<td>30.3</td>
<td>150</td>
</tr>
<tr>
<td>Winter Load (kVA)</td>
<td>23.3</td>
<td>45</td>
<td>1.00</td>
<td>23.3</td>
<td>180</td>
</tr>
</tbody>
</table>

**Figure 4-17** Status box result when coincident peak demand and cold load pickup are within tx load range

If the transformer is oversized, meaning the next smaller transformer size can accommodate the coincident peak demand, the prompt shown in Figure 4-21 will be displayed. By clicking Yes, a list of alternative transformers, having the same voltage and type attributes, will be shown (similar to Figure 4-20). Selecting one of these transformers, and clicking Accept, will replace the previous transformer selection with the new parameters.

<table>
<thead>
<tr>
<th>Transformer Results</th>
<th>Load</th>
<th>Limit</th>
<th>CF</th>
<th>Cold Load</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer Load (kVA)</td>
<td>29.8</td>
<td>22.5</td>
<td>1.00</td>
<td>29.8</td>
<td>90</td>
</tr>
<tr>
<td>Winter Load (kVA)</td>
<td>22.9</td>
<td>27</td>
<td>1.00</td>
<td>22.9</td>
<td>108</td>
</tr>
</tbody>
</table>

**Figure 4-18** User prompt if selected transformer is overloaded.

**Figure 4-19** Status box result when summer coincident peak load exceeds the transformer’s range.

**Figure 4-20** Example list of suggested alternative transformers.
Checking Conductor Size

After transformer, conductor, and load parameters have been set, SEDS can check to ensure that the selected conductor current rating is appropriate for the load. Figure 4-22 shows a system design where one of the conductors is overloaded. The button next to the Optimization button located in the lower right corner of the window indicates “1 overloaded conductor” and is available to be clicked. If there are no overloaded conductors, then this button will not be shown.

Clicking the “Overloaded Conductor” button will display the window shown in Figure 4.20. From this window, the user may select the appropriate underground or overhead conductor based upon the loading calculated by SEDS. The user highlights the conductor from the list of available conductors and then clicks the Apply Change button to change to the selected conductor. After finishing the selection, click the OK button to close the window and return to the results window.
Deleting Objects

To delete load, node, cable, and caption objects on the design template, click on the object and press **Delete** on the computer keyboard. Be sure not to leave any “stranded” loads or nodes. Load deletion can cause the automatic load naming function to assign the same name to multiple loads. This can be overcome by providing a user-specified load name. SEDS will not allow you to delete a transformer.

**Saving and Loading SEDS Data**

SEDS allows saving of case data, and loading of saved case data using standard Windows commands such as Save, Save As, and Open on the File menu. SEDS cases are saved with the file extension *.flw. Note that the parameters for cables, transformers (other than user-defined), and standard loads are contained in a separate
SEDS database maintained by your company's SEDS Program Administrator. An individual saved case contains references to this database. Any changes to parameters stored in the database can cause calculation results in a retrieved saved case to differ from the results obtained before database modification. To get reliable results from a saved case, the appropriate equipment database must be associated with SEDS when the case is loaded. SEDS will give a warning if they are not consistent. Use the Database Utilities button on the Main Menu to change the equipment database (see the Database Utilities subsection in Section 3, Launching SEDS).
Section 5  Obtaining Single Phase Results
Information about each of the objects on the design palette can be seen in the information box located at the bottom left of the application window by moving the mouse pointer over the desired object. An example of the mouse-over feature when hovering over a cable while on the Design tab is shown in Figure 5-1.

![Figure 5-1 Example of Information Box using the mouse-over feature](image)

After completing input of the secondary system configuration and parameters, SEDS performs calculations automatically when any of the output tabs (Voltage, Flicker, Short Circuit, or Detailed Results) are selected. Results are shown directly on the circuit diagram for each of these tabs. A printed summary of results can also be obtained from SEDS, as explained later in this section.

**Voltage Tab**

Clicking the Voltage tab displays steady-state results for the system. An example is shown in Figure 5-2. Summer peak conditions are shown when SEDS is switched to the Voltage tab. Winter peak conditions can be displayed by clicking the button marked **Show Winter**. Summer peak conditions can be shown again by clicking **Show Summer**.

![Figure 5-2 Example voltage tab display](image)
Transformer Loading Results

A box on the screen shows a summary of distribution transformer results. This includes summer and winter peak coincident load, as well as the transformer’s maximum load per your company's loading guidelines. A net coincidence factor is shown, which is the ratio of the coincident peak demand on the transformer divided by the sum of the individual peak demands of all the loads. SEDS uses an approach to determining net coincidence factors that is explained in Section 5. The transformer results also include the peak load current at the transformer secondary terminals (summer or winter, depending on the voltage drop tab display mode), as well as the secondary terminal voltage at peak demand.

The transformer loading results will display in red text if the selected transformer is overloaded in either summer or winter seasons. Also, text is displayed indicating the season in which the overload occurs.

Secondary Cable Currents

The peak coincident current flow is shown for each secondary cable section for the selected season. Note that this is the predicted peak current for that section, and is not necessarily the current in that section at the instant that the overall secondary system is at its peak. Thus, current into a node does not equal the sum of the currents out of the node, unless the coincidence factors for all loads are 1.0.

SEDS compares the secondary cable peak coincident load with the cable rating, for the chosen season. If the cable current exceeds the ampacity limit, the cable will be displayed as a thick red line on the diagram.

Service Entrance Voltages

Service-entrance voltages at peak demand for the selected season are shown on the graphic circuit diagram. The user has the option of displaying voltage results on three different bases: a 120 V nominal base (although SEDS does not calculate separate voltage drops for each of the two 120 V legs at each load), a 240 V nominal base, and in terms of percent voltage drop with respect to the nominal 240/120 nominal voltage. To change the voltage display mode, choose the appropriate base in the voltage selection box located to the right of the Short-Circuit tab. Note that this selection also changes the mode of voltage display in the transformer results box.

If the voltage drop at a load exceeds a limit, the voltage is displayed in red text. The warning threshold can be set via the Edit Custom Parameters → Warning Criteria menu.
Flicker Tab

Switching to the Flicker tab will display voltage change caused by the transient loads, such as motor starting. An example is shown in Figure 5-3. Note that the total transient voltage regulation is the sum of the transient voltage change (flicker) and any steady-state voltage drop present at that time. Customer irritation from transient load changes is a function of the relative change in light output, and not the minimum absolute voltage present during the event. Thus, the Flicker tab displays only the transient voltage change.

When SEDS is switched to the Flicker tab, the display shows percent voltage change at service entrances due to transient loads at that service only. This is termed self-induced flicker. The effects of a transient load at one service on flicker voltages at another can also be displayed by clicking the button on the upper right of the window marked Show Mutual. There are two options for the mutual flicker display. The option marked Include Self (the default option), displays shows the worst-case flicker from loads anywhere on the system, including flicker caused by loads at the same service. The second option, Exclude Self, shows only the greatest mutual flicker at each service as a result of transient loads at another service. Some utilities have different flicker thresholds for a customer’s flicker caused by his own load, and the allowed flicker due
to the customer’s neighbors. The Exclude Self option allows both types of flicker to be viewed. All of the mutual flicker output includes an indication of the load responsible for the worst-case flicker that is shown.

If any load is subject to a voltage flicker magnitude greater than a specified threshold, the flicker magnitude is displayed in red text. The warning threshold can be set via the Edit Custom Parameters → Warning Criteria menu.

A box on the flicker tab window displays the worst-case flicker at the secondary terminals of the transformer. This display also indicates the load responsible for the flicker. If this flicker is greater than a specified flicker criterion, red text is displayed. The flicker magnitude warning threshold for the transformer secondary voltage is separate from the load flicker warning threshold.

**Short Circuit Tab**

Switching to the Short Circuit tab will cause SEDS to calculate and display the available short-circuit currents at the service entrances and the transformer secondary terminals. Figure 5-4 shows an example. Any short-circuit currents greater than a specified threshold is displayed in red text. The warning threshold can be set via the Edit Custom Parameters → Warning Criteria menu.

![Figure 5-4 Example short circuit calculation results.](image)
Detailed Results Tab

The detailed results tab will show the results from both the voltage tab and the flicker tab, on one sheet. The first time that this tab is accessed, the dialog shown in Figure 5-5 will be displayed for the user. This dialog is a combination of the options for both tabs, plus a “Worst Case” option for the season. This option will calculate results for both seasons and display the worst.

![Detailed Results Setup Dialog](image)

**Figure 5-5** Detailed Results Setup Dialog.

Figure 5-6 shows the detailed results tab. The text next to each cable shows the cable type and the length of that section.

![Detailed Results Tab](image)

**Figure 5-6** Detailed Results Tab.
Each load displays the following information:

- Load Description from the Load Parameters dialog
- Voltage Drop. If “Worst Case” is selected for the season, this is color coded to the season (Orange for summer, blue for winter).
- Flicker, based upon the mode selected in the setup dialog.

To change the settings at any time, you can click the Change Settings button to display the Detailed Results Setup dialog.

Printed Output

Results Summary Report

A summary of SEDS results can be previewed on-screen or sent to a selected printer. Figure 5-7 shows an example SEDS report. To view the printed report, click File → Print Report.

![Figure 5-7: Example SEDS printed summary report](image-url)
Printing Graphic Screens

Clicking on the **File → Print Design** menu item can print the secondary circuit image, with the result showing on that tab.

Copying Circuit Configuration to Other Documents

The secondary circuit configuration can be copied to other documents by two different methods. By clicking **File → Save Graphics**, the circuit configuration is saved as an enhanced metafile. This file can then be inserted into another document, such as a report. The other approach is to click **Edit → Copy to Clipboard**. Then, switch to the other application, such as a word processor, and paste the image into the document. Neither method includes calculation results, other than cable current loading.
Section 6  Advanced Single Phase Applications
Since its creation in 1997, SEDS has had significant new functionality built on top of the base calculation engine. This section is dedicated to providing users information on how to use the advanced features of SEDS. Although these features may not be used as often as the standard SEDS functionality, they have the potential to improve efficiency and lower overall design costs.

**Optimization**

The intent of this guide is to help users of older versions of SEDS understand the new optimization capability. This new version is very powerful because it enables designers to develop secondary systems that have the lowest cost for available equipment. There is the potential that SEDS optimization will help utilities save significant costs related to secondary system layout.

SEDS Single-Phase Optimization will select the lowest cost combination of cables and transformers from a specified list to satisfy the voltage drop, flicker, and cold load pickup constraints. The user interface for SEDS has remained largely the same with the addition of a Detailed Results tab and an Optimization button in the lower right corner of the main window. In fact, the basic SEDS program remains the same and can be operated without running the optimization engine. In addition to the optimization capability, the latest version of SEDS has several new user interface features.

**Algorithm Overview**

The SEDS design optimization feature is based upon a custom multi-pass algorithm that “crawls” from the loads back to the transformer and removes the voltage drop, flicker, transformer loading, cable ampacity, and short circuit violations while it traverses the topology. The algorithm methodically increases or decreases the conductor and transformer sizes to remove violations and minimize first cost plus cost of losses. If there are no technical violations, the algorithm will work to minimize the total system cost. This feature is useful to determine if there are alternative lower cost designs that could satisfy the technical requirements. It has been discovered that very few utilities effectively minimize secondary system costs while attempting to meet the technical design requirements, such as voltage drop. Often secondary systems were designed with significant margin between the technical requirement and the actual designed value. The algorithm tests various configurations within a set of user-definable constraints to find a lower cost option. The cost equation that is minimized is shown in Equation 1.
$$C_t = C_{trans} + \sum C_{cable} + \sum C_{node} + \left(A_{trans} \cdot \text{Loss}_{NL}\right) + \left(B_{trans} \cdot \text{Loss}_{LL}\right) \left(\frac{KVA_{Loading}}{KVA_{Rating}}\right)^2 + \sum B_{cable} \cdot I_{cable}^2 \cdot R_{cable}$$

Equation 1: Total Cost Equation

Where

- $C_t$ = Total owning cost of system
- $C_{trans}$ = Transformer first cost ($)
- $C_{cable}$ = Cable(s) first cost ($)
- $C_{node}$ = Node(s) or pedestal(s) first cost ($)
- $A_{trans}$ = Transformer A factor ($/watt$)
- $B_{trans}$ = Transformer B factor ($/watt$)
- $\text{Loss}_{NL}$ = Transformer no load losses (watts)
- $\text{Loss}_{LL}$ = Transformer load losses (watts)
- $B_{cable}$ = Cable B factor ($/watt$)
- $I_{cable}$ = Worst case conductor current (amps) - Calculated
- $R_{cable}$ = Worst case cable resistance (ohms)
- $KVA_{Rating}$ = The transformer kVA rating (kVA)
- $KVA_{Loading}$ = The worst case transformer kVA loading (kVA) - calculated

Equation 1 includes the A and B factors used to cost evaluate transformer losses. These factors are commonly used by planning engineers to cost-evaluate distribution transformers during the procurement process. The remaining data is either calculated or required input data.

**Optimization Data**

The optimization is based upon total owning cost including or without the cost of losses. This means that additional data is necessary for transformers, cables, and nodes. To view the additional data requirements, go to **Edit Custom Parameters** and view the data forms for each component. If you have an older SEDS database, then you will need to contact your DSTAR representative to have it updated. If you intend to use the optimization functionality, then you will also need to provide costs associated with transformers, nodes, and cables.

For transformers, the additional data items associated with optimization are cost, load loss, and no load losses. These are shown in Figure 6-1. For cables/conductors, cost per foot and “cable in stock” are new items. The “cable in stock” checkbox should be
selected for all cables/conductors that you would like to be used during the optimization. This feature enables users to perform calculations on old out of stock cable/conductors, but prevents them from being selected during the optimization process. These are also shown in Figure 6-1.

![Transformer Data](image1)

![Cable Data](image2)

**Figure 6-1  Transformer and Cable Custom Data**

Under **Edit Custom Parameters**, there is a new menu item, **Economic Parameters** (see Figure 6-2). The user specifies the A and B factors for transformers and cables and also the cost per node via this window. With all of this new data entered, the user is ready to start using optimization. It should be noted that the optimization routine needs costs to perform. If you choose not to enter costs, then SEDS can be run using traditional methods.
After entering a secondary system layout in the Design tab, the user may click on the **Detailed Results** tab to view the voltage drop, flicker, and item description in one single view. An example of Detailed Results is shown in Figure 6-3. In this example, all three loads show both voltage drop and flicker violations. Violations are indicated by color and also will blink (animation) on the screen. Flicker violations are shown as red and voltage drop violations are shown as orange or blue depending on if the violation occurs in the winter (blue) or summer (orange). Figure 6-4 shows the Detailed Results Setup window that may be accessed via the **Change Setting** button near the top middle of the main screen. The Detailed Results Setup window allows the user to define which result is displayed when viewing the detailed results. In previous version of SEDS, the user needed to click a button to view the summer and winter voltage drop results. Now, via the detailed results, SEDS will determine the worst-case voltage drop and automatically display that result.
After entering a design, the user may click on the **Optimization** button in the lower right-hand corner. This will display the window shown in Figure 6-5. The version 0 design shown is the calculated total cost for the system that appears in the Design tab. To see the details of the version 0 design, simply double-click on the row. The transformer, node, and cable cost details are shown in Figure 6-6. It should be noted
that this particular design shows 3 violations (at each node) that need to be cleared via the optimization process. The optimization algorithm will step through cable and transformers to determine the most economical mix that clears the violations.

![Design Optimization](image)

**Figure 6-5  Design Optimization Results**

Before clicking the **Optimize** button, the user should click the **Constraints** button to confirm the constraints that will frame the optimization engine. It is important that reasonable constraints are entered to limit the search space and improve the performance of the optimization engine. Figure 6-7 shows the transformer and cable constraints placed on the optimization process. If these constraints are changed, it is necessary to click the **Save As Defaults** button to save the changes.

![Design Details Window](image)

**Figure 6-6  Design Details Window**
After confirmation that the constraints are reasonable, click the **Run** button shown in Figure 6-7 or the **Optimize** button shown in Figure 6-6. Either of these buttons will initiate the optimization engine. A completed design optimization result is shown in Figure 6-8.
Each time the **Optimize** button is clicked, a new version appears in the Design Optimization window. The latest optimized design will replace the previous non-optimized design in the Design view. The user can check to make sure all of the violations have been cleared by clicking the Detailed Results tab. This is shown in Figure 6-9.

![Figure 6-9 Optimized Results with Violations Cleared](image)

Since the new optimization engine relies on equipment costs to perform the optimization, transformers, nodes, and cables now have an associated cost that must be entered into the SEDS database. In addition, each transformer now has a summer and winter cold load pickup criteria. A review of the SEDS database is recommended to determine which data need to be added.
Section 7  Inputting Three Phase Data
This section of the SEDS Application Guide provides step-by-step instructions for inputting data for an example Three Phase system. SEDS is a very easy to use program, and following through this example will provide you with sufficient familiarity to set up and run your own cases.

SEDS: Three Phase is limited to radial, three-phase secondary distribution systems. SEDS can accommodate up to one hundred loads and up to twenty-five tiers. Figure 1-5 illustrated the definition of a load tier.

Opening the Program

SEDS Three Phase opens to the Design Tab window shown below in Figure 7.1. The Design Tab is a drawing tablet where all the system components are graphically added and their parameters (properties) are set. The other tabs (Voltage Drop, Flicker, and Short-Circuit) are selected to reveal calculation results, after the circuit design has been entered.

![Figure 7-1 SEDS Three Phase Design Tab Window](image)

Entering the Circuit Configuration

The first step of inputting case data in SEDS is to draw the secondary system configuration. On the Design Tab is the object toolbar, shown on the top right side of Figure 7-1, which has buttons for each circuit element plus a button for copying properties (parameters) of the elements. Only one of these buttons can be selected at a time.
Placing the Transformer and Primary Source Objects

Circuit configuration input begins by placing the distribution transformer on the drawing tablet. Select either UG Trans, OH Trans, or OH Bank by clicking the appropriate button. Now, using the mouse, click on the location on the drawing tablet where the symbol (object) for the transformer is desired to be placed. Hold down the left mouse button and drag the mouse slightly, then release. Symbolic objects representing the transformer and its primary source will appear on the tablet as illustrated in Figure 7-2.

![Figure 7-2 Overhead transformer bank and primary source object placed on the tablet.](image)

The primary source and the transformer objects can be moved together to a new location on the tablet by clicking on the source symbolic object (three parallel lines) once, and then pressing the mouse button again and holding the button down while dragging the source and transformer to the new location. Clicking and dragging the transformer object in a similar manner can move the transformer object alone.

Neither the primary source nor the transformer objects can be deleted once placed on the design tablet. The transformer type can be changed at any point in the design process by right clicking on the transformer object and then selecting the appropriate change in type.

Note that the transformer object is initially red in color. This indicates that transformer parameters have not yet been input. Later when the parameters have been input, the red color disappears.
Inserting Nodes

Connection points where two or more secondary cables come together (other than at the transformer) are called nodes. Nodes can represent a secondary panel or a pole where several secondary service cables connect to the secondary main. Nodes can also be used for transition points where the secondary cable size or type changes, or for transition between overhead and underground secondaries.

The next step to laying out the secondary configuration is placing nodes (if any) on the tablet. In the object toolbar, select the button for Node. Now place the node object onto the drawing tablet by holding down the mouse button and dragging at the desired location. Repeat click and drag for any other nodes. Figure 7-3 illustrates two nodes added to the example circuit layout.

![Figure 7-3 Two nodes added to the circuit.](image)

Adding Loads

The secondary circuit needs to have at least one load. Load objects are placed on the tablet by first selecting Load in the object toolbar. Click and drag on the tablet in the desired location for each load. Note that the secondary conductor interconnections between the transformer, nodes, and loads are added in the next step. The load object color is initially red, indicating that the parameters of the load have not yet been entered. Once the parameters have been entered, the object will change colors. Figure 7-4 shows five loads added to the example circuit.
Figure 7-4  Example circuit with five loads placed.

**Adding Secondary Conductors**

Secondary conductors (overhead or underground) are added to the circuit in a different way than the transformer, nodes, and loads are placed. First, select Conductor from the object toolbar. Next select the beginning point (upstream end) of the first cable by clicking the object to which it is connected (e.g., the distribution transformer object). Now click the end point object of the same cable. If, after clicking the beginning point object, a different beginning point object is desired, select a different object on the toolbar and then re-select Conductor. The next object selected will be a conductor beginning point, instead of an end point.

In our example, conductors have been placed connecting the transformer to the two secondary pedestals (nodes) and to the loads. Conductors have also been placed from the pedestals to two loads each. The configuration of the example is illustrated in Figure 7-5. Note that the conductor objects appear as broken lines, indicating that their parameters have not yet been specified.
There are limitations to the placement of secondary conductors:

- Only one conductor can have its end point on a given object. This prohibits closing a secondary loop, and also prohibits parallel conductors. Secondary circuits with parallel conductors can be analyzed by representing the parallel cables as one equivalent cable, with an impedance equal to the parallel combination.
- Only the beginning end of conductors can be connected to the distribution transformer object.
- Only the downstream ends of conductors can connect to a load. You cannot connect a conductor from one load to another. If the actual circuit has the secondary conductor connecting to one load and then continuing on to another, then terminate the incoming cable before the first load at a fictitious node, and insert a very short conductor between that load and the first load. The conductor from the first to second load in the actual system is represented in SEDS by a conductor between the fictitious node and the second load.

**Order of Object Placement**

In the example shown above, the objects were placed in the order of transformer, nodes, loads, and conductor. It is necessary to begin with placing the transformer, and conductors must connect existing objects. Otherwise, the order of object placement is arbitrary. For example, the configuration shown in Figure 7-5 could be fully assembled and then a new node and load added, connected by new conductor sections.
Drawing Over a Graphic Image

A useful feature of SEDS is that it allows the secondary circuit to be drawn on top of another graphic image, such as a floor layout showing load and transformer locations. Figure 7-6 illustrates this capability.

![Figure 7-6 Floor layout loaded as a SEDS background.](image)

To insert the background image, click the **View → Insert Back Picture** menu item, and select the desired image file. The background image must be in bitmap, Windows metafile, or enhanced metafile formats. The background image can also be removed by clicking **View → Remove Back Picture**.

Specifying Object Parameters

To enter parameters in an object, double-click on the object to open its data window. It is also possible to copy properties from one object to another similar object (e.g., from a load to a load or a conductor to a conductor). This will be described later. Note that nodes do not have any properties to specify.

Parameters in SEDS are set by selecting from a pre-existing list, or by directly inputting parameters. Your company’s SEDS Program Administrator, based on materials and practices used by your company, set up the pre-existing lists in SEDS. These lists are maintained in a separate password-protected area of SEDS.
Source Parameters

Optionally, the primary source voltage and/or impedance can be included in SEDS calculations. Source voltage will only be used in steady-state voltage drop calculations. Source impedance will only be used for calculating flicker and short-circuit currents.

The SEDS default is to ignore primary-side impedance in flicker and short-circuit calculations, which is the same as assuming that the primary side of the distribution transformer is connected to an infinite bus. The default source voltage is the primary rating of the transformer bank, also defined as 1.0 PU.

If it is desired to specify a primary feeder voltage and/or impedance, double click on the primary source object to open the properties window shown in Figure 7-7.

![Figure 7-7 Primary source data window.](image)

To enter primary source impedance, click the button marked Consider primary source impedance. Next, input the available short-circuit (fault) current at the transformer primary terminals, in Amperes. This short-circuit current should be the available current if the transformer primary winding were a short circuit. Thus, the appropriate short-circuit current for a phase-neutral (wye) connected transformer is the phase-ground fault current, and the short-circuit current for a phase-to-phase (delta) connected transformer is the available phase-to-phase fault current. Enter the ratio of inductive reactance to resistance (X/R ratio) for the primary system. For a phase-to-neutral connected transformer, the X/R should be that of the phase-to-neutral current path impedance (one-third of the sum of the positive, negative, and zero-sequence source impedances). Typical overhead primary systems have an X/R ratio in the range of 0.5 to 10, and total underground primary systems range from 0.3 to 3.
To enter a primary source voltage, click the button marked Actual Feeder Voltage. Next, enter the primary line-to-line voltage applied to the transformer. This should be slightly more or less than the primary line-to-line voltage rating of the transformer bank.

After entering and selecting the source object parameters, click OK. Clicking Cancel closes the primary source data window without executing the inputs provided.

**Transformer Parameters**

With one of the transformer buttons selected on the object toolbar, double-click on the transformer object to open one of the windows shown in Figure 7-8. If the object is a transformer bank the input window on the left will appear. If the object is an OH (overhead) or UG (underground) transformer then the input window on the right will appear.

![Transformer Bank Data](image)

For OH or UG transformers, under the label marked transformer list, there is a selection of all padmount transformers (if the transformer object placed on the tablet is a padmount transformer), or all polemount transformers (if that type was placed), for which your company’s SEDS Program Administrator has provided data. One of these transformers may be selected. If so, that transformer’s parameters will show next to the selection list.

The list of transformers can be filtered by using the selection boxes at the top of the Transformer Data window. The default filtering selection is an asterisk (*), meaning “wild card,” or unrestricted by that category. There are four categories of filtering: kVA rating, primary winding voltage, connection type, transformer type, and transformer
Inputting Three Phase Data

Selection of a parameter in a category will limit shown transformers to those having the same parameter for that category. The transformer type category can be used for various purposes, depending how the company SEDS Program Administrator sets it up. It can be used to indicate special transformer features such as CSP or fusing options. The filtering selection for each category can be reset to the wild card value by clicking the appropriate Reset button. All categories can be reset using the Reset All button.

If the transformer to be studied is not available on the list, then the user can optionally provide the transformer data directly by clicking on the check box marked User Specified Transformer Parameters. The transformer impedance (%Z) and resistance (%R) are in percent of the impedance base for the selected nameplate kVA rating. Resistance may not exceed the total transformer impedance. Enter the maximum summer and winter loading capability of the transformer, based on your company's loading practices. Typically, these maximum loadings exceed the nameplate kVA. The tap setting selected will be used to adjust the secondary transformer voltage during steady state voltage calculations.

For transformer banks there are six configurations to select from. Floating-Wye Delta, Open-Wye Open-Delta, Open-Delta Open-Delta, Wye Wye, Delta Wye, and Delta Delta. The configuration is selected by clicking on the appropriate tab at the top of the form shown on the left of Figure 7-8. Once the bank configuration is selected the parameters of the individual transformers making up the bank can be specified by clicking the button labeled Transformer 1, 2, or 3. The individual transformer property input screens are very similar to the three phase transformer input screen described above. The properties of transformer 1 can be copied to either of the other two transformers by selecting the Copy Data from T1 button.

After all entries are complete, click OK to assign the parameters to the transformer object.

Conductor Parameters

Double-click on any conductor object to open the window shown in Figure 7-9 for specifying the parameters of that conductor. A selection list of conductors is shown in this window. This list is maintained by your company SEDS Program Administrator, and should contain the service cable types and sizes that your company uses. Clicking the Overhead or Underground buttons at the top of the window causes the conductor list to show only that category of conductors.

Selection of a conductor causes the resistance and reactance per 1000' of that conductor to be shown, as well as the summer and winter conductor ampacity (see
Figure 7-9). After selecting the desired conductor type, enter the length of the particular conductor section in feet and click OK. The parameters of each conductor object need to be set in this manner, or by using the Properties button described later.

![Conductor data input window](image)

**Figure 7-9** Conductor data input window.

**Load Parameters**

Double-click on any load object to open the window shown in Figure 7-10. This window will set the parameters for the selected load. The parameters of each load object need to be set using the procedure described below, or load parameters can be copied from one load to another using the Copy Properties function.

A load ID box appears near the top of the load data input window. SEDS assigns a default name for the load, depending on which node the load is connected to. For example, N2L1 indicates the first load (in order of entry) connected to the second node (in order of entry). If the load is supplied directly from the transformer secondary without an intervening node, the default name will begin with S instead of N#. Optionally, the user can provide a descriptive name for the load, such as the house number or meter number. The user-supplied name is entered by overwriting the default name in the data input window. The load name appears on the circuit.
configuration drawing, and in results output reports. A longer text description of each load can also be stored in the description field.

![Load data input window.](image)

Figure 7-10  Load data input window.

One of the changes in SEDS V4.2 is that users can define parameters for three-phase loads and save them in the equipment database for retrieval. Loads can be defined as a combination of balanced and unbalanced phase-to-neutral (wye connected) and phase-to-phase (delta connected) loads. Summer and Winter KVA and PF can be specified. If the winter check boxes are left blank the summer values will be used for winter calculations. If a certain kVA category (such as Unbalanced P-P) is not being used the check box by the label can be left unchecked so the input fields are not displayed. The list box at the top of the window in Figure 7-10 allows the user to select
load parameters from the database to apply to a load in SEDS. Once the load parameters are chosen, they can be customized by the user.

Flicker calculations require the largest transient current to be specified for each load. Usually, this transient current is the starting current for a relatively large motor, such as a pump.

1. The first option is to click HP, RC, & PF. Motor horsepower and starting power factor is input and the NEMA rotor code for the motor is selected.
2. The second option is to click Starting Amps & PF and input the motor starting current and starting power factor directly. This option can be particularly useful for a non-motor load which cause flicker, such as a welder.

Note that the starting currents specified are used only for flicker calculations. The running motor load should be included in the Total Running Motor Load section. Transient current (i.e., motor starting current) data are not mandatory. If there is no transient current data provided for a load, the voltage flicker calculated will be the worst flicker caused by transient currents drawn by another load fed from the same transformer. However, if no transient loads are specified for the secondary system, the calculated self-induced flicker will be zero.

The total running motor load is used to capture additional motor load that is not represented in the Wye Load Data or Delta Load Data sections of the form.

At the bottom of the input form, three-phase Equipment load can be chosen from the database to be added. This equipment can be added via the Edit Custom Parameters → Equipment menu item in either single phase SEDS. This enables users to setup customized loads that can be directly selected while building up either a single-phase or three-phase load. Users may click the Add Equipment button to add a new line item to the grid and then choose the specific equipment from the drop-down box. Likewise, a line item may be deleted by selecting row of interest and clicking the Delete Equipment button.

After selecting or specifying load parameters, click OK to assign the parameters to the selected load. Repeat for all of the loads, or use the Copy Properties function described below.

**Copying Properties**

The Properties button can be used to copy parameters from one conductor to another, or from one load to another. To use this function, select Properties on the object toolbar. Select the object from which the parameters are to be copied from. Next, select the object (which must be of the same type; conductor or load) to which the parameters are to be copied.
If conductor parameters are being copied, SEDS will prompt the user for the length of the conductor section to which parameters are being copied. (In essence, SEDS allows the type of conductor to be transferred, but not the section length).

The “copy to” process can be repeated multiple times without performing another “copy from.” If another object is desired to be the “copy from” object, click a different button on the object toolbar to reset the copy function and then click the Properties box.

**Deleting Objects**

Selecting the object, and then pressing Delete on the computer keyboard can delete load, node, and conductor objects. Be sure not to leave any “stranded” loads or nodes.

**Saving and Loading SEDS Data**

SEDS allows saving of case data, and loading of saved case data using standard Windows commands such as Save, Save As, and Open on the File menu. SEDS cases are saved with the file extension *.flw. Note that the parameters for cables, transformers (other than user-defined), and standard loads are contained in a separate SEDS database maintained by your company’s SEDS Program Administrator. An individual saved case contains references to this database. Any changes to parameters stored in the database can cause calculation results in a retrieved saved case to differ from the results obtained before database modification. To get reliable results from a saved case, the appropriate equipment database must be associated with SEDS when the case is loaded. SEDS will give a warning if they are not consistent. Use the **Database Utilities** button on the Main Menu to change the equipment database (see the Database Utilities subsection in Section 3, Launching SEDS).
Section 8  Obtaining Three Phase Results
Mouse-over Feature

Information about each of the objects on the design pallet can be seen in the information box located at the bottom of the application window by moving the mouse pointer over the desired object. An example of the mouse-over feature when hovering over a cable while on the Voltage Drop tab is shown in Figure 8-1.

![Mouse-over Feature Example](image1)

Figure 8-1  Example of Information Box using the mouse-over feature

After completing input of the secondary system configuration and parameters, SEDS performs calculations automatically when any of the output tabs (Voltage Drop, Flicker, or Short Circuit) are selected. Results are shown directly on the circuit diagram for each of these tabs.

Voltage Drop Tab

Clicking the Voltage Drop tab displays steady-state loading results for the system. An example is shown in Figure 8-2. Summer peak conditions are shown when SEDS is switched to the Voltage Drop tab. Winter peak conditions can be displayed by clicking the button marked Show Winter. Summer conditions can again be displayed by clicking Show Summer. Using the dropdown box below the Show Winter button can also change the voltage base displayed.

![Voltage Drop Tab Example](image2)

Figure 8-2  Example voltage drop tab display
Secondary Conductor Currents

The current flow is shown in the lower information boxes for each conductor for the selected season by using the mouse-over feature. SEDS compares the secondary conductor load with the conductor rating, for the chosen season. If the conductor current exceeds the ampacity limit, the conductor will be displayed as a thick red line on the diagram.

Service Entrance Voltages

Voltages at peak demand for the selected season are shown on the graphic circuit diagram. The user has the option of displaying voltage results on four different bases: a L-N (line-to-neutral) nominal base, a L-L (line-to-line) nominal base, and both of these bases in Per Unit. To change the voltage display mode, choose the appropriate base in the voltage selection box located to the right of the Short-Circuit tab.

If the voltage drop at a load exceeds a warning threshold, the voltage is displayed in red text. The warning threshold can be set via the Edit Custom Parameters → Warning Criteria menu.

Flicker Tab

Switching to the Flicker tab will display voltage change caused by the transient loads, such as motor starting. An example is shown in Figure 8.3.

![Flicker Tab Example](image)

**Figure 8-3** Example flicker calculation results.

Note that the total transient voltage regulation is the sum of the transient voltage change (flicker) and any steady-state voltage drop present at that time. Customer
irritation from transient load changes is a function of the relative change in light output, and not the minimum absolute voltage during the event. Thus, the Flicker tab displays only the transient voltage change.

When SEDS is switched to the Flicker tab, the display shows percent voltage change at service entrances due to transient loads at that service only. This is termed self-induced flicker. The effects of a transient load at one service on flicker voltages at another can also be displayed by clicking the button on the upper right of the window marked Show Mutual. There are two options for the mutual flicker display. The option marked Include Self (the default option), displays shows the worst-case flicker from loads anywhere on the system, including flicker caused by loads at the same service. The second option, Exclude Self, shows only the greatest mutual flicker at each service as a result of transient loads at another service. The Exclude Self option allows both types of flicker to be viewed. All of the mutual flicker output includes an indication of the load responsible for the worst-case flicker that is shown.

If any load is subject to a voltage flicker magnitude greater than a specified threshold, the flicker magnitude is displayed in red text. The warning threshold can be set via the Edit Custom Parameters → Warning Criteria menu.

**Short Circuit Tab**

Switching to the Short Circuit tab will cause SEDS to calculate and display the available short-circuit currents at each load and the transformer secondary terminals. Figure 8-4 shows an example.
Any short-circuit current greater than a specified threshold is displayed in red text. The warning threshold can be set via Edit Custom Parameters → Warning Criteria.

Printed Output

Results Summary Report

A summary of SEDS results can be previewed on-screen or sent to a selected printer. Figure 8-5 shows an example SEDS report. Click on File → Print Preview.

![Figure 8-5](Example SEDS printed summary report.)

Printing and Copying Circuit Image

Clicking on the File → Print Screen menu item can print the secondary circuit image, with the result showing on that tab. The secondary circuit configuration can be copied to other documents by two different methods. By clicking File → Save Graphics, the circuit configuration is saved as an enhanced metafile. This file can then be inserted into another document, such as a report. The other approach is to click Edit → Copy to Clipboard. Then, switch to the other application, such as a word processor, and paste the image into the document.
Section 9  SEDS Single Phase Calculations
Coincidence Factors

All transformer loading, cable current, and steady-state voltage drop calculations in SEDS are based on coincident peak loading. The usual utility practice is to apply coincidence factors to the sum of individual loads to estimate the coincident load. The coincidence factor decreases as the total number of loads increases. Also, utilities often use different coincidence factors for different load classifications, such as homes with electric heat versus homes with non-electric heat.

Conventional Coincidence Factor

Where loads of unequal size or type are combined, however, the conventional coincidence factor method can give unreasonable results. The coincidence factor for n loads, Kn, is conventionally defined as:

\[ S_{Total(n)} = K_n \sum_{m=1}^{n} S_m \]

This type of coincidence factor does not always give reasonable answers if the loads are different in size or nature. Consider the following example:

A distribution transformer serves one large, all-electric residence of 12 kVA peak load and a small residence without electric heat or A/C with a peak load of 5 kVA. If the coincidence factor for two loads (K2) is 0.7, the conventional approach would say that the peak coincident load is 11.9 kVA. This is less than the large house’s load. The coincident peak, however, should never be less than the largest load. Thus, the conventional method fails in this situation.

Coincident Incremental Contribution

A new technique has been developed and implemented in SEDS, which provides more reasonable estimates of coincident peak demand in the case where unequal size or dissimilar type loads are on the same secondary system. To allow for loads of mixed size or mixed type, a coincident incremental contribution (CIC) factor k for each load will be used to determine the net coincidence factor K’n for n loads. The net coincidence factor K’n is determined as follows:

1. First, rank all loads supplied in order of largest to smallest nominal kVA. (S1, S2, … Sn). Scalar values of load are used \( S_n = |\bar{S}_n| = \sqrt{P_n^2 + Q_n^2} \)
2. Next, calculate the net coincidence factor:
\[ K'_n = \frac{S_1 + \sum_{k=1}^{n} (k \cdot S_k)}{\sum_{k=1}^{n} S_k} \]

Where \( k_2, k_3, \text{etc.} \) are the CIC factors for the second, third, etc. loads in order of size.

When loads are of mixed type, the CIC factor for the respective load type and load-size order are used for each \( k_n \).

The method shown above is equivalent to the conventional method if all loads are equal in size and the same coincidence factors apply to all loads. Otherwise, the method provides a weighted average.

**Determining Coincident Incremental Contribution Factors**

The CIC factors can be easily determined from the conventional coincidence factors. The CIC factor for the \( n \)th largest load \( (k_n) \) is:

\[ k_n = n \cdot K'_n - K_{n-1} \cdot (n-1) \]

**Example Calculation: Mixed Load**

A utility uses the following coincidence factors (conventional definition) for general residential and all-electric residential loads:

<table>
<thead>
<tr>
<th>Number of Loads</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Electric Residential</td>
<td>1.00</td>
<td>0.90</td>
<td>0.84</td>
<td>0.80</td>
</tr>
<tr>
<td>General Residential</td>
<td>1.00</td>
<td>0.65</td>
<td>0.53</td>
<td>0.47</td>
</tr>
</tbody>
</table>

Coincident peak loading is to be estimated for the following four loads to be served from the same distribution transformer:

- #1. 14kVA peak, 0.85 pf all-electric residence
- #2. 10 kVA peak, 0.85 pf all-electric residence
- #3. 7 kVA peak, 0.95 pf residence (general class)
- #4. 5 kVA peak, 0.95 pf residence (general class)
First, the CIC factors need to be determined from the given coincidence factors:

<table>
<thead>
<tr>
<th>Size Order of Load</th>
<th>k2</th>
<th>k3</th>
<th>k4</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Electric Residential</td>
<td>0.80</td>
<td>0.72</td>
<td>0.68</td>
</tr>
<tr>
<td>General Residential</td>
<td>0.30</td>
<td>0.29</td>
<td>0.29</td>
</tr>
</tbody>
</table>

The net coincidence factor is:

\[ K'_n = \frac{14 + 0.8 \times 10 + 0.29 \times 7 + 0.29 \times 5}{14 + 10 + 7 + 5} = 0.708 \]

Because the power factors of the loads are not the same, the total coincident kVA loading must be based on adding loads as phasors. The total coincident load is:

\[
\tilde{S}_{\text{coincident, peak}} = 0.708 \cdot \left[ (14 + 10) \cdot (0.85 + j \cdot \sqrt{1 - 0.85^2}) + (7 + 5) \cdot (0.95 + j \cdot \sqrt{1 - 0.95^2}) \right]
\]

\[ \tilde{S}_{\text{coincident, peak}} = 22.5kW + j \cdot 11.6kVAR \]

\[ S_{\text{coincident, peak}} = |\tilde{S}_{\text{coincident, peak}}| = 25.3kVA \]

**Coincident Current Calculations**

All load currents in SEDS are the coincident peak currents for that branch (cable or transformer). SEDS determines the current for each branch using the CIC method based on the loads downstream of that branch.

Individual load currents are calculated using the following:

\[
\tilde{I}_n = \frac{P_n \left( 1 + j \cdot \frac{\sqrt{1 - p^2}}{p} \right)}{240} \quad \text{(P in Watts)}
\]

Note that these calculations assume the current to be invariant with voltage (i.e., constant-current loads). This is a common distribution engineering approximation, and is the approximate net composite characteristic of combined constant impedance (e.g., incandescent lighting) and constant power (thermostatically-controlled loads) in a home.
Voltage Drop Calculation Assumptions

SEDS steady-state voltage drop calculations assume that the primary voltage is fixed at the nominal primary winding voltage rating. Thus, the no-load voltage at the secondary of the transformer is assumed to be the nominal 120/240 Volt value. Primary voltages at a given feeder location depend on many factors other than the loading of the secondary system under study. Primary voltages are affected by load tap changing substation transformers, voltage regulators, and feeder capacitor banks. Primary system modeling, however, is beyond the scope of SEDS. Primary voltage behavior, however, does not significantly affect the relative voltage regulation. For example, if SEDS calculates 117 Volts at a load (assuming a 120 V source), the voltage drop is three volts. If the effective source voltage (no-load transformer voltage for the given primary voltage condition) is 118 Volts, then the actual service voltage will be three volts less or 115 Volts.

Voltage drop calculations along the secondary system use the coincident peak current for each section. Because the currents into a node serving more than one load does not necessarily equal the sum of the currents out, the circuit analysis does not strictly obey Thevenin’s laws. In essence, SEDS voltage calculations are an approximation worst-case voltage drop at each load service, but do not provide the simultaneous voltage profile over the whole system at any given instant in time.

Because constant current loads are assumed, voltage drop calculations need to be iterative only to account for the relatively small phase shift in voltage over the system. The iterative technique used in SEDS is very robust, and should converge without notice by the user for any reasonable distribution system case.
Flicker Calculations

Flicker calculations assume that the transient load is a constant impedance defined by:

$$
\tilde{Z}_{\text{flicker}} = \frac{240}{I_{\text{start}} \cdot (pf_{\text{start}} + j \cdot \sqrt{1-pf_{\text{start}}^2})}
$$

Voltage flicker is calculated using simple impedance division. Figure 9.1 shows a simple secondary system. Self-flicker at load N1L1, due to a transient load at the same service having an impedance $Z_{\text{flicker}(N1L1)}$, is calculated by the following:

$$
\Delta V_{\text{self}(N1L1)} = \left(1 - \left| \frac{\tilde{Z}_{\text{flicker}(N1L1)}}{\tilde{Z}_{\text{source}} + \tilde{Z}_{1} + \tilde{Z}_{m} + \tilde{Z}_{\text{xfmr}} + \tilde{Z}_{\text{source}}} \right| \right) \cdot 100\%
$$

If the user selects the Infinite Bus option for the primary source impedance, $Z_{\text{source}}$ is zero by definition. Otherwise, the primary feeder impedance, reflected to the secondary side ($Z_{\text{source}}$) is defined as:

$$
\tilde{Z}_{\text{source}} = \frac{240^2}{I_{sc} \cdot V_{pri} \cdot 10^6} \cdot \left(\cos(Tan^{-1}(X/R)) + j \cdot \sin(Tan^{-1}(X/R))\right)
$$

where $(X/R)$ is the ratio of reactive impedance to resistance of the primary short-circuit path, $I_{sc}$ is the primary current in kA, available if the transformer primary terminals are shorted together, and $V_{pri}$ is the primary winding voltage rating in kV.

Self flicker at load N1L2, due to a transient load at the same service having an impedance $Z_{\text{flicker}(N1L2)}$, is calculated similarly:
\[
\Delta V_{\text{self}}(N1L2) = \left(1 - \frac{\tilde{Z}_{\text{flic ker}(N1L2)}}{\tilde{Z}_{\text{flic ker}(N1L2)} + \tilde{Z}_2 + \tilde{Z}_m + \tilde{Z}_{\text{sfmr}} + \tilde{Z}_{\text{source}}} \right) \cdot 100\%
\]

The mutual flicker at load N1L1 is:

\[
\Delta V_{\text{mutual}}(N1L1) = \left(1 - \frac{\tilde{Z}_{\text{flic ker}(N1L1)} + \tilde{Z}_1}{\tilde{Z}_{\text{flic ker}(N1L1)} + \tilde{Z}_1 + \tilde{Z}_m + \tilde{Z}_{\text{sfmr}} + \tilde{Z}_{\text{source}}} \right) \cdot 100\%
\]

The mutual flicker at load N1L2 is:

\[
\Delta V_{\text{mutual}}(N1L2) = \left(1 - \frac{\tilde{Z}_{\text{flic ker}(N1L2)} + \tilde{Z}_2}{\tilde{Z}_{\text{flic ker}(N1L2)} + \tilde{Z}_2 + \tilde{Z}_m + \tilde{Z}_{\text{sfmr}} + \tilde{Z}_{\text{source}}} \right) \cdot 100\%
\]

If there are more than two loads, the mutual flicker at any given load is the most severe of the flicker caused by the other loads.

The flicker at the transformer secondary is:

\[
\Delta V_{\text{mutual}}(N1L1) = \text{Max}\left[\left(1 - \frac{\tilde{Z}_{\text{flic ker}(N1L2)} + \tilde{Z}_2 + \tilde{Z}_m}{\tilde{Z}_{\text{flic ker}(N1L2)} + \tilde{Z}_2 + \tilde{Z}_m + \tilde{Z}_{\text{sfmr}} + \tilde{Z}_{\text{source}}} \right), \left(1 - \frac{\tilde{Z}_{\text{flic ker}(N1L1)} + \tilde{Z}_1}{\tilde{Z}_{\text{flic ker}(N1L1)} + \tilde{Z}_1 + \tilde{Z}_m + \tilde{Z}_{\text{sfmr}} + \tilde{Z}_{\text{source}}} \right)\right] \cdot 100\%
\]

**Short-Circuit Current Calculations**

Available short-circuit currents at the load service entrances and at the transformer secondary terminals are calculated by SEDS. The fault path is assumed to be from ungrounded leg to ungrounded leg (i.e., across the 240V). The system is represented as an ideal nominal (240 V) voltage source behind the primary source impedance, as reflected through the transformer turns ratio. If the user selects the Infinite Bus option for the primary source impedance, the reflected primary source impedance (Zsource) is zero. Otherwise, the impedance is as determined from the user-input primary winding voltage, short-circuit current available, and primary system (X/R) ratio by the same calculation as used for flicker calculations.

For the load service N1L1 in Figure 9-1, the available short-circuit current is:

\[
I_{sc} = \frac{240}{\tilde{Z}_{\text{source}} + \tilde{Z}_{\text{sfmr}} + \tilde{Z}_m + \tilde{Z}_1}
\]
Section 10  Program Administrator Information
Custom Parameters

A very useful feature of SEDS is that the user can select transformers, cables, and loads by name or description from lists. These lists can be customized to conform to the materials and practices of the utility using the program. Maintenance of the custom parameters is assumed to be performed by a Program Administrator, who has access to the more detailed information needed to create the standardized models.

Custom parameters are added, modified, and deleted using the Edit Custom Parameters menu item in SEDS. To avoid inadvertent changes to the custom parameters, access to this menu is protected by a password. The password, at program installation, is “power.” Once this password is entered, the Administrator can change the password.

Database Security

The Database Security menu option is used to unlock the current database and access the user input forms for both single phase and three phase data. To get to this option, select **Edit Custom Parameters → Enter Password**. When the database is locked, the data editing items are disabled in the menu as shown on the left side of Figure 10-1. The password window in on the right side of Figure 10-1 will appear when the menu item is selected. The default password, at program installation, is “power.” Once this password is entered, the Administrator can change the password.

![Figure 10-1 Locked database utilities menu and password window for database access](image)

When the correct password is provided, the database will be unlocked and data editing menu items will be enabled on the Database Utilities menu bar as shown in Figure 10-2.
Custom parameters can now be added, modified, and deleted using the user input forms available under **Edit Custom Parameters**. A detailed description of this data as well as the user forms can be seen in the Section 10 Program Administration Information.

**SEDS Data Structure**

All of the customized selection list data used in SEDS, such as standard transformers, conductors, and loads, are stored in an Access database file, which is originally loaded into the same file folder as the program executable (secondary.exe). The database name is SEDS_database.mdb. Note that all changes made to the custom parameters using the Edit Custom Parameters menu are immediate and irreversible as soon as Update or Close is clicked on the data forms accessed by Edit Custom Parameters. No explicit “save” is necessary to execute the changes. Care should be exercised in making changes to the custom data in the database, and this master database file should periodically be backed up.

The program installs with a database having only one or a few example entries in each category. The Administrator should build the database with data specific to their company. The updated SEDS_database.mdb should be distributed to end users, who should replace the stripped-down version placed into the folder where SEDS is installed by the installation routine, with the customized version. Note that the database file can reside anywhere on the hard drive and can be pointed to SEDS using the Database Utilities function found on the main menu.

Do not delete all data from a given category. The user should first install their customized data, and then delete the examples if desired. If another data entry references the example to be deleted, then the record cannot be deleted unless the link is changed. For example, an example load may reference the example coincidence

![Figure 10-2](image-url)
class. The example coincidence class record cannot be deleted without first changing
the coincidence class reference in the example load record to a coincidence record
which is to be retained. Alternatively, the example load can be deleted first, then the
example coincidence class.

Deleting data from the database may cause problems when recalculating results using
previously saved SEDS case files. Subsequent runs of that case will cause SEDS to
replace the deleted item with the next item in the database. This next item may not be
a suitable replacement (e.g., a 100 kVA transformer might be replaced with a 10 kVA
transformer if the former is deleted from the database). Therefore, any SEDS runs
referencing custom data items that have been deleted should have an appropriate
replacement item selected by the user.

Modification to the parameters of a custom data item will change calculation results of
any saved files that reference the changed data item.

Initial Data Setup

Note that all custom data present in SEDS on program installation are for illustration
only. This data should not be assumed to be correct, or to even be representative of
typical parameters.

A company’s SEDS program administrator should delete all data from the custom
parameters, and enter data relevant to their material and design practices. The only
exception is the motor type called “no motor” which should be retained for associating
with loads for which there is no assumed transient load. The modified copy of
SEDS_database.mdb should be provided to users installing SEDS.

Maintaining Custom Data

Transformer Data

After entering the password, custom transformer data can be accessed via the Edit
Custom Parameters → Transformer menu item. The administrator is given the choice
of the following:

Data

This item is the basic list of transformers and their parameters. Some of the parameters,
such as size (kVA rating), type, and primary winding voltage are selected from lists rather than typed
in.

Size

This item is the list of standard transformer sizes. All transformers
listed in the Data list must have a kVA rating selected from this
Size list. If a size is deleted from the size table, then all transformers associated with that size would be eliminated from the transformer Data list.

**Type**

This item is the list of transformer “types.” It can be used flexibly, depending on a company’s needs. All transformers must reference a type on this list. For example, a company may stock padmount transformers with and without bayonet fusing. Type can then be used as a field to allow the user to filter transformers “with bayonet” and “without bayonet.” If there are transformers with no special attributes, a type entry such as “none” should be created. If a Type is deleted from the Type table, then all transformers associated with that Type will be eliminated from the transformer Data list.

**Primary Voltage**

This item is the list of primary winding voltages (line-to-ground voltage for transformers connected phase-to-neutral, and line-to-line voltage for transformers connected phase-to-phase). All transformers in the Data list must have a primary winding voltage selected from this list. If a voltage is deleted from the list, then all transformers associated with that voltage will also be deleted.

**Secondary Voltage**

Only used in Three Phase SEDS - This item is the list of secondary winding voltages (line-to-ground voltage for transformers connected phase-to-neutral, and line-to-line voltage for transformers connected phase-to-phase). All transformers in the Data list must have a secondary winding voltage selected from this list. If a voltage is deleted from the list, then all transformers associated with that voltage will also be deleted.

**Conductor Data**

The list of standard conductor types, and their parameters, can be accessed via the Edit Custom Parameters → Cable menu item. Resistance and inductive reactance are entered in units of ohms per 1000’. Note that conductor impedances are specified on a circuit basis, that is the impedance down one leg and back the other. This is twice the per-conductor impedance. Summer and winter ratings are in Amperes.
Custom Load Data (Single Phase SEDS Only)

The list of standard load types, and their parameters, can be accessed via the Edit Custom Parameters → Load menu item in Single Phase SEDS. The fields for Coincidence Class and Motor Load must be selected from the lists provided. Coincidence Class indicates the table of coincidence factors associated with the load type.

To modify the tables of coincidence factors, select the Edit Custom Parameters → Coincidence menu item. A window such as shown in Figure 10-3 is displayed. For each coincidence class, enter the conventional coincidence factors to be used for 2 to 25 loads. The coincidence factors to be entered here are simply the ratio of the coincident peak load for a transformer or cable serving n identical loads, divided by n times the peak demand of one load. The coincidence factors should never increase as the number of loads increase. All calculations of the coincident incremental contribution (CIC) method are performed internal to Single Phase SEDS.

Note that, if a coincidence class is deleted, all load types referencing that coincidence class will also be deleted.

All defined single phase loads must reference a motor load, representing the transient load associated with that load type. To modify the tables of motor types, select the Edit Custom Parameters → Motor menu item in Single Phase SEDS. A window such as shown in Figure 10-4 is displayed. There are two options for data input:

1. The motor starting current can be defined directly by the Amperes and starting power factor.
2. Motor horsepower can be specified along with the NEMA locked-rotor current code. These codes are listed in Table 10.1. The power factor of the starting current must also be specified. SEDS calculates the starting current based on the following formula:

   \[ I_{Start} = \frac{\text{HP} \times 1000 \times \text{StartMultiplier}}{\text{MotorVoltage} \sqrt{3}} \]

The SEDS database delivered with the program has a motor type called “No Motor.” This type should not be deleted, as it cannot be recreated.
Table 10.1  Locker Rotor Current Codes

<table>
<thead>
<tr>
<th>Code</th>
<th>kVA/hp*</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.00 - 3.14</td>
</tr>
<tr>
<td>B</td>
<td>3.15 - 3.54</td>
</tr>
<tr>
<td>C</td>
<td>3.55 - 3.99</td>
</tr>
<tr>
<td>D</td>
<td>4.00 - 4.49</td>
</tr>
<tr>
<td>E</td>
<td>4.50 - 4.99</td>
</tr>
<tr>
<td>F</td>
<td>5.00 - 5.59</td>
</tr>
<tr>
<td>G</td>
<td>5.60 - 6.29</td>
</tr>
<tr>
<td>H</td>
<td>6.30 - 7.09</td>
</tr>
<tr>
<td>J</td>
<td>7.10 - 7.99</td>
</tr>
<tr>
<td>K</td>
<td>8.00 - 8.99</td>
</tr>
<tr>
<td>L</td>
<td>9.00 - 9.99</td>
</tr>
<tr>
<td>M</td>
<td>10.0 - 11.19</td>
</tr>
<tr>
<td>N</td>
<td>11.2 - 12.49</td>
</tr>
<tr>
<td>P</td>
<td>12.5 - 13.99</td>
</tr>
<tr>
<td>R</td>
<td>14.0 - 15.99</td>
</tr>
<tr>
<td>S</td>
<td>16.0 - 17.99</td>
</tr>
<tr>
<td>T</td>
<td>18.0 - 19.99</td>
</tr>
<tr>
<td>U</td>
<td>20.0 - 23.39</td>
</tr>
<tr>
<td>V</td>
<td>22.4 and up</td>
</tr>
</tbody>
</table>

* SEDS uses the upper limit of each range

Figure 10-3  Coincidence data window.
Custom Images and Equipment

The administrator can customize the images used for each component represented in SEDS. This enables administrators to use images that may be consistent with your utility practices. To access the image customization window, the user must select Main Menu and click on Database Utilities. After opening the Database Utilities window, click on the Database Security → Unlock Database menu item and enter the Program Administrator password. The menu item list will be expanded as shown below in Figure 10-5.

![Database Utilities Menu](image)

**Figure 10-5** *Database Utilities Menu*

To customize the Images, simply click the Images → Customize Images menu item. Figure 10-6 shows the Custom Image window. To assign your own custom image, click on the desired image to change and choose a *.bmp file. Typical image pixel sizes are in the range of 60 pixels x 30 pixels. Users will need to experiment with image sizes to make layouts look reasonable. The default images are located in the SEDS installation directory and have filenames consistent with the image type.
Figure 10-6  Customize Image Window

To customize the Equipment, simply click the Equipment → Edit Equipment menu item. Figure 10-7 shows the Equipment edit window. From this window, users can create custom single-phase and three-phase loads. These loads will then be exposed to users who choose to build up a load based upon equipment.
Figure 10-7  Equipment Edit Window
Section 11  SEDS Command Reference
Drop Down Menu Bar

SEDS has a standard Windows menu bar, shown in Figure 11-1 that can be used to access various program commands and functions. Table 11.1 shows all of the menu items and their associated functions.

![Drop Down Menu Bar](image)

Figure 11-1 Instructions for Opening An Existing Input Data File

1. From the main window select the Open menu item under File.
2. A window will be displayed for selecting the folder/directory and filename of the data file. The default file type is .flw for all SEDS input files.
3. Select the desired filename, click OK, and SEDS will load the input file. All of the inputs should change to reflect the new input file. Also, the top of the main window should display the complete filename and path of the currently opened file.

Instructions for Saving Data and Using the Save As Function

At any time during the data input process, the input data can be saved. Saving the input data can be accomplished in a number of ways:

1. Select Save from the main menu. This is under the File menu item. If this is the first save then a standard looking save window will appear. Enter the descriptive filename in the folder/directory of choice and click OK. If the data has already been saved to a file, then clicking the Save icon will overwrite the old data with the new data. No save window will appear.
2. If the input data has already been saved, and it is desired to save the data to another filename, then the Save As menu item under File should be selected. This will display the same window that was described above in 1.

In all cases, the suggested file extension for the input data files is .flw (default extension). This will assist the users in identifying the data files associated with SEDS.

Command Reference
### Table 11.1  Menu Items and Functions

<table>
<thead>
<tr>
<th>Menu Item Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>File</td>
<td></td>
</tr>
<tr>
<td>New</td>
<td>Erases existing data and opens a new SEDS case.</td>
</tr>
<tr>
<td>Open</td>
<td>Select and open an existing input data file.</td>
</tr>
<tr>
<td>Save</td>
<td>Save the current data file.</td>
</tr>
<tr>
<td>Save As</td>
<td>Save the current data file under a different filename</td>
</tr>
<tr>
<td>Save Graphics (*.EMF)</td>
<td>Saves the circuit image to an enhanced metafile (.emf) file</td>
</tr>
<tr>
<td>Balanced Calculations</td>
<td>Switches SEDS into Balanced Calculation Mode</td>
</tr>
<tr>
<td>Unbalanced Calculations</td>
<td>Switches SEDS into Unbalanced Calculation Mode</td>
</tr>
<tr>
<td>Print Report</td>
<td>Displays a preview of the summary report showing all results of analysis. This report can then be sent to a printer for a hard copy.</td>
</tr>
<tr>
<td>Print Design Main Menu</td>
<td>Prints current screen Returns SEDS to the main menu where</td>
</tr>
<tr>
<td>Exit</td>
<td>Exits SEDS</td>
</tr>
<tr>
<td>Edit</td>
<td></td>
</tr>
<tr>
<td>Properties</td>
<td>Edits the properties of the selected object. This can also be accomplished by double clicking on the object</td>
</tr>
<tr>
<td>Copy to Clipboard</td>
<td>Copies the circuit image to the Windows clipboard</td>
</tr>
<tr>
<td>View</td>
<td></td>
</tr>
<tr>
<td>Scrollbars</td>
<td>Turns on the tablet scrollbars, effectively allowing the user to draw larger designs</td>
</tr>
<tr>
<td>Grid</td>
<td>Places a grid in the background of the window. Objects can be snapped to the grid</td>
</tr>
<tr>
<td>Zoom</td>
<td>Zooms window by 75%, 100%, and 150% of Normal window</td>
</tr>
<tr>
<td>Insert Back Picture</td>
<td>Inserts a graphic image in the background of the window. The image must be a bitmap (<em>.bmp), Windows metafile (</em>.wmf), or enhanced metafile (*.emf).</td>
</tr>
<tr>
<td>Remove Back Picture</td>
<td>Removes the graphic image from the background of the window</td>
</tr>
<tr>
<td>Edit Parameters Custom</td>
<td></td>
</tr>
<tr>
<td>Warning Criteria</td>
<td>Displays the warning criteria window to allow adjustments of warning criteria for out-of-limits voltage regulation, flicker, or short-circuit current.</td>
</tr>
<tr>
<td>Node and Load Prefixes</td>
<td>Allows the user to edit the templates that are used by default to name the nodes and loads as they are placed</td>
</tr>
<tr>
<td>Password</td>
<td>Displays the password window for input of password to obtain access to the SEDS database (for use by the SEDS</td>
</tr>
<tr>
<td>Menu Item Name</td>
<td>Function</td>
</tr>
<tr>
<td>---------------</td>
<td>----------</td>
</tr>
<tr>
<td>Transformer</td>
<td>Displays transformer data window to allow adjustments of transformer data</td>
</tr>
<tr>
<td>Load **</td>
<td>Displays load data window to allow adjustments of load data</td>
</tr>
<tr>
<td>Cable</td>
<td>Displays cable data window to allow adjustments of cable data</td>
</tr>
<tr>
<td>Motor **</td>
<td>Displays motor data window to allow adjustments of motor data</td>
</tr>
<tr>
<td>Coincidence **</td>
<td>Displays coincidence factor data window to allow adjustments of coincidence factors.</td>
</tr>
<tr>
<td>Help</td>
<td>Displays a help box for SEDS</td>
</tr>
<tr>
<td>Help Contents</td>
<td>Displays the program information window</td>
</tr>
<tr>
<td>About</td>
<td></td>
</tr>
</tbody>
</table>

** Available in Single Phase SEDS Only

** Tabs

Tabs provide access to the data input (Design) and results (Voltage Drop, Flicker, Short-Circuit, and Detailed Results) screens. Figure 11-2 shows the tabs that appear just below the SEDS menu bar.

![Figure 11-2 Mode Tabs.](image)

** Design Tab

The Design Tab is where all the system components are graphically added and their properties are set. It consists of a drawing tablet and an object toolbar shown below in Figure 11-3. Selecting a graphic circuit element button on the object toolbar and then dragging the mouse around the place desired on the drawing tablet will create that object in that place on the board. The process for adding each object is described in Table 11.2.

![Figure 11-3 Object Toolbar for Single Phase](image)
<table>
<thead>
<tr>
<th>Process</th>
<th>Process Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adding a transformer</td>
<td>Only one transformer can be added to the design layout. To add a transformer you must first select either transformer type button on the object toolbar. Next click and drag on the location you want to place the transformer. When you release the mouse button the transformer is added.</td>
</tr>
<tr>
<td>Adding a node</td>
<td>To add a node to the design layout first select the node button on the object toolbar. Next click and drag on the location you want to place the node. When you release the mouse button the node is added.</td>
</tr>
<tr>
<td>Adding a load</td>
<td>To add a load to the design layout first select the load button on the object toolbar. Next click and drag on the location you want to place the load. When you release the Mouse button the load is added.</td>
</tr>
<tr>
<td>Adding a cable</td>
<td>To add a cable to the design layout first select the cable button on the right side of the screen. Next select the origin of the cable followed by the destination of the cable. The text box, at the top of the screen, will prompt you for the selections.</td>
</tr>
<tr>
<td>Adding a primary source</td>
<td>The primary source is automatically created when a transformer is created. Primary source impedance is used for flicker and short-circuit calculations, but not steady-state voltage drop calculations. The default value for the primary source impedance is zero (an infinite bus)</td>
</tr>
<tr>
<td>Setting Properties</td>
<td>Once an item has been created on the design layout double-clicking on that item can set its properties. This will bring up a menu box that will allow you to edit or set the item's properties.</td>
</tr>
<tr>
<td>Copying Properties</td>
<td>Properties of one item can be copied to another item by selecting the copy properties button on the object toolbar. The text box at the top of the screen then prompts you to select the item to be copied. Then you are prompted for the item to copy properties to.</td>
</tr>
<tr>
<td>Adding a Custom Comment</td>
<td>To add a custom comment, or freeform text, to the design layout, select the Caption button from. Click and drag to draw a box in the approximate area where you want the caption. When you let go of the mouse, a dialog will appear for entering the caption. The font and background color can be selected from this dialog.</td>
</tr>
<tr>
<td>Size Transformer Button</td>
<td>By clicking the Size Transformer Button the program will evaluate the loading on the transformer and suggest a different size if the existing transformer is under or over</td>
</tr>
<tr>
<td>Process</td>
<td>Process Details</td>
</tr>
<tr>
<td>------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Process Details</td>
<td>Transformer loading limits are set in the Edit Custom Parameters, Transformer, and Data.</td>
</tr>
<tr>
<td>Design Menu Button **</td>
<td>When the Size Transformer button is selected it toggles to Design Menu. This allows the user to edit the secondary design.</td>
</tr>
<tr>
<td>Deleting a Component</td>
<td>To delete a component, select the node (left click) and hit the keyboard delete key. When a node is deleted it will also delete any associated cable links. Do not leave any stranded loads. Execution of calculations with stranded loads may cause a program crash.</td>
</tr>
<tr>
<td>Adding a transformer</td>
<td>Only one transformer can be added to the design layout. To add a transformer you must first select either transformer type button on the object toolbar. Next click and drag on the location you want to place the transformer. When you release the mouse button the transformer is added.</td>
</tr>
<tr>
<td>Adding a node</td>
<td>To add a node to the design layout first select the node button on the object toolbar. Next click and drag on the location you want to place the node. When you release the mouse button the node is added.</td>
</tr>
<tr>
<td>Adding a load</td>
<td>To add a load to the design layout first select the load button on the object toolbar. Next click and drag on the location you want to place the load. When you release the mouse button the load is added.</td>
</tr>
<tr>
<td>Adding a cable</td>
<td>To add a cable to the design layout first select the cable button on the right side of the screen. Next select the origin of the cable followed by the destination of the cable. The text box, at the top of the screen, will prompt you for the selections.</td>
</tr>
<tr>
<td>Adding a primary source</td>
<td>The primary source is automatically created when a transformer is created. Primary source impedance is used for flicker and short-circuit calculations, but not steady-state voltage drop calculations. The default value for the primary source impedance is zero (an infinite bus)</td>
</tr>
<tr>
<td>Setting Properties</td>
<td>Once an item has been created on the design layout double-clicking on that item can set its properties. This will bring up a menu box that will allow you to edit or set the item's properties.</td>
</tr>
<tr>
<td>Copying Properties</td>
<td>Properties of one item can be copied to another item by selecting the copy properties button on the object toolbar. The text box at the top of the screen then prompts you to select the item to be copied. Then you are prompted for the</td>
</tr>
<tr>
<td>Process</td>
<td>Process Details</td>
</tr>
<tr>
<td>-------------------------</td>
<td>---------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Adding a Custom Comment</td>
<td>To add a custom comment, or freeform text, to the design layout, select the Caption button from. Click and drag to draw a box in the approximate area where you want the caption. When you let go of the mouse, a dialog will appear for entering the caption. The font and background color can be selected from this dialog.</td>
</tr>
<tr>
<td>Size Transformer Button **</td>
<td>By clicking the Size Transformer Button the program will evaluate the loading on the transformer and suggest a different size if the existing transformer is under or over loaded. Transformer loading limits are set in the Edit Custom Parameters, Transformer, and Data.</td>
</tr>
<tr>
<td>Design Menu Button **</td>
<td>When the Size Transformer button is selected it toggles to Design Menu. This allows the user to edit the secondary design.</td>
</tr>
<tr>
<td>Deleting a Component</td>
<td>To delete a component, select the node (left click) and hit the keyboard delete key. When a node is deleted it will also delete any associated cable links. Do not leave any stranded loads. Execution of calculations with stranded loads may cause a program crash.</td>
</tr>
</tbody>
</table>

** Available in Single Phase SEDS Only

**Voltage Drop Tab**

The Voltage Drop Tab is used to calculate the voltage drop between the source and each load. SEDS shows the results of the Voltage Drop calculations underneath each load along with the secondary conductor currents. To select the basis for voltage drop results display, click the drop-down box on the top middle of the screen. The options for this screen are shown in Table 11.3.
Table 11.3  Options available on the Voltage Drop Tab

<table>
<thead>
<tr>
<th>Options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select Volt Display</td>
<td>There are three different voltage bases to choose from: 120V, 240V, and %. Selecting one of these options will change each load's displayed voltage according to the base chosen. The default base is 120 V. However, once the program is opened and another base is selected the results will stay on the new base until changed again.</td>
</tr>
<tr>
<td>Transformer Results Box **</td>
<td>The transformer results box lists the actual loading on the transformer, and the loading limits for the transformer selected. The net coincidence factor used to calculate transformer loading is also shown in this box.</td>
</tr>
<tr>
<td>Line Current Results **</td>
<td>The line currents shown on the Voltage Drop Tab represent the coincidental current for each line segment. When overloaded the line changes to red.</td>
</tr>
<tr>
<td>Winter or Summer Results</td>
<td>By clicking on the Show Winter or Show Summer button the voltage drop values shown for each load, will change to the appropriate seasonal results.</td>
</tr>
</tbody>
</table>

** Available in Single Phase SEDS Only

** Flicker Tab

The Flicker Tab is where each load's motor starting current (or other transient current) is evaluated for its flicker effects at that service and at other services on the system, and at the transformer secondary terminals. Flicker calculation results are shown under each of the modeled loads. If the flicker warning limit is exceeded the results turn red. The worst-case flicker at the transformer secondary terminal is shown in a text box located on the upper right hand part of the screen. The options for the flicker tab are shown in Table 11.4.
Table 11.4  Options Available on the Flicker Tab

<table>
<thead>
<tr>
<th>Options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flicker Button</td>
<td>Select whether self-induced flicker results or worst-case mutual flicker results are show on the window.</td>
</tr>
<tr>
<td>Show Self Flicker</td>
<td>Flicker induced at each service by a motor at the same service. If there is no motor then the self-induced flicker will be 0.</td>
</tr>
<tr>
<td>Show Mutual Flicker</td>
<td>Worst-case flicker induced at each load by a motor at another load or by the motor at the load. The format is percent flicker and load name (motor) that caused the flicker i.e. .78% N2L1 (Node 2, Load 1) Mutual flicker can will consider self-induced flicker if “Include Self” is selected. If “Exclude Self” is selected mutual flicker will only consider the impact of motors at other services.</td>
</tr>
</tbody>
</table>

Short Circuit Tab

The Short-Circuit Tab is used to calculate the available fault current values at each of the Loads (service entrances) and at the Transformer Secondary. All calculated short-circuit values for the loads are shown under their respective loads. Note that the primary source impedance is only included in the short-circuit calculations if the user specified the impedance value on the Design Tab for the source is selected.

Detailed Results Tab

The Detailed Results Tab is a composite of data entered on the Design Tab, and calculations done on the Voltage Drop Tab and the Flicker Tab. It is covered in more detail in the section Detailed Results Tab.