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1. Introduction

As part of our ongoing commitment to exceptional customer support, we present to you the ETAP 7.0.0 Demo. We acknowledge you for taking the first step in viewing the most popular and powerful electrical engineering analysis and management tools established as a world leader in power system design, analysis, and monitoring.

ETAP is a true 32-bit program developed for the Microsoft® Windows® 2003/2008, XP, and Vista operating systems. This demo is fully interactive and allows you to make changes to the one-line diagram, run system studies, and graphically review study results - just like the full, commercial release of the program. It gives you the opportunity to explore the many features and capabilities of ETAP including Load Flow, Short-Circuit, and Underground Raceway Systems analysis. Other analysis modules such as Motor Acceleration, Harmonics, Transient Stability, Device Coordination, Optimal Power Flow, Reliability Assessment, DC Load Flow, DC Short-Circuit, Battery Sizing and Discharge, Ground Grid Systems, Transformer MVA Sizing, Transformer Tap Optimization, Parameter Estimation, and Cable Pulling Systems can be made functional upon request.

Operation Technology, Inc. values the support and dedication from our highly satisfied group of users. As part of our assurance to achieve excellence, thousands of hours of design and engineering experience have gone into the overall development of this software. We have combined state-of-the-art software development experience with real-life, practical engineering know-how to create intelligent and user-friendly engineering software. A novice engineer can use it easily, and yet it has sophisticated capabilities that professional engineers require. Enjoy your tour through our software and experience for yourself why ETAP is the leader in power system analysis and management tools worldwide.
2. Product Description

ETAP is a fully graphical electrical power system analysis program that runs on Microsoft® Windows® 2003/2008, XP, and Vista operating systems. In addition to the standard offline simulation modules, ETAP can utilize real-time operating data for advanced monitoring, real-time simulation, optimization, and high-speed intelligent load shedding. However, only offline simulation modules are included in the ETAP 7.0 Demo.

ETAP has been designed and developed by engineers for engineers to handle the diverse discipline of power systems in one integrated package with multiple interface views such as AC and DC networks, cable raceways, ground grid, GIS, panels, protective device coordination/selectivity, and AC and DC control system diagrams.

ETAP allows you to work directly with graphical one-line diagrams, underground cable raceway systems, three-dimensional cable systems, advanced time-current coordination and selectivity plots, geographic information system schematics (GIS), as well as three-dimensional ground grid systems. The program has been designed according to three key concepts:
Virtual Reality Operation
The program operation resembles real electrical system operation as closely as possible. For example, when you open or close a circuit breaker, place an element out of service, or change the operating status of motors, the de-energized elements and subsystems are indicated on the one-line diagram in gray. ETAP incorporates new concepts for determining protective device coordination directly from the one-line diagram.

Total Integration of Data
ETAP combines the electrical, logical, mechanical, and physical attributes of system elements in the same database. For example, a cable not only contains data representing its electrical properties and physical dimensions, but also information indicating the raceways through which it is routed. Thus, the data for a single cable can be used for load flow or short-circuit analyses (which require electrical parameters and connections) as well as cable ampacity derating calculations (which require physical routing data). This integration of the data provides consistency throughout the system and eliminates multiple data entry for the same element.

Simplicity in Data Entry
ETAP keeps track of the detailed data for each electrical apparatus. Data editors can speed up the data entry process by requiring the minimum data for a particular study. To achieve this, we have structured the property editors in the most logical manner for entering data for different types of analysis or design.

ETAP’s one-line diagram supports a number of features to assist you in constructing networks of varying complexities. For example, each element can individually have varying orientations, sizes, and display symbols (IEC or ANSI). The one-line diagram also allows you to place multiple protective devices between a circuit branch and a bus.

ETAP provides you with a variety of options for presenting or viewing your electrical system. These views are called presentations. The location, size, orientation, and symbol of each element can be different.
in each presentation. Additionally, protective devices and relays can be displayed (visible) or hidden (invisible) for any particular presentation. For example, one presentation can be a relay view where all protective devices are displayed. Another presentation may show a one-line diagram with some circuit breakers shown and the rest hidden (a layout best suited for load flow results).

Among ETAP’s most powerful features are the composite network and motor elements. Composite elements allow you to graphically nest network elements within themselves to an arbitrary depth. For example, a composite network can contain other composite networks, providing the capability to construct complex electrical networks while still maintaining a clean, uncluttered diagram that displays what you want to emphasize - yet the next level of system detail is within easy reach of your mouse. 

*Power is at your fingertips.*

We consider ETAP to be the foremost-integrated database for electrical systems, allowing you to have multiple presentations of a system for different analysis or design purposes.

### 2.1 Modeling

- Virtual reality operation
- Total integration of data (electrical, logical, mechanical, and physical attributes)
- Looped and radial systems
- Unlimited isolated subsystems
- No system connection limitations
- Multiple loading conditions
- Multi-level nesting of subsystems
- Advanced sparse matrix techniques
- User access control and data validation
- Asynchronous calculations, allow multiple modules to calculate simultaneously
- Database transitioning reduces the risk of database loss during a power outage
- True 32-bit programming designed for Windows 2003/2008/XP/Vista
- 3-phase and single-phase modeling including panels and subpanels
An Example of Simultaneous Cable Derating, Short Circuit, and Load Flow Studies
2.2 Program Features

- Five levels of automatic error checking
- Dynamic help line and error messaging
- Message logger to track program usage and access
- Multiple user access levels
- ODBC (open database connectivity) - use Microsoft Access, SQL, Oracle, etc.
- Manages maintenance data via info, remarks, and comment pages
- Merge independent ETAP project files
- Convert project files between databases such as Microsoft Access, SQL, and Oracle
- Integrated 1-phase, 3-phase, and DC systems
- Integrated one-line diagram and underground raceway systems
- Integrated one-line diagram and device coordination/selectivity module
- Common database for all studies
- Simplicity in data entry
- Multiple subsystems and swing machines
- User-controlled auto save and transaction
- User-controlled default settings for all components
- Typical data for motors, generators, transformers, reactors, governors, and exciters
- Individual LTC time delays (initial and operating)
- No voltage limitations
- Unlimited protective and metering device connections to branches and loads
- Unlimited load connections to a single bus
- Any system frequency
- English and metric unit systems
- 25 character component IDs
- Raw manufacturer data entry
- Individual and global load demand and diversity factors
- Temperature sensitive cable resistance for all studies
- Element navigator
- Lumped loading
- Equipment cables for loads, eliminating requirement for terminal buses
- Edited by and checked by data stamping
- Date stamping of all data changes
- Intelligent editors with user-defined data fields
- Analysis-dependent data entry requirements
- Multiple user network support
- Compatible database with the ETAP Real-Time module’s real-time monitoring, simulation, and supervisory control (Real-Time module is not active in the 7.0 Demo)
2.3 One-Line Diagrams

ETAP provides a fully graphical editor to construct your one-line diagram. From the One-Line Diagram Edit toolbar, you can graphically add, delete, undo, redo, move, or connect elements; zoom in or out; display grid on or off; change element size, orientation, alignment, symbol, or visibility; enter properties; set operating status; etc.

You can use composite networks and motors with unlimited nesting capabilities to create uncluttered and easy to follow one-line diagrams. Composite networks allow up to 20 connections from outside the network, making them very flexible so they can be used in a variety of configurations.

Note that the nesting capabilities of a one-line diagram do not affect the calculation results in any way. Calculation programs consider all one-line diagram components nested to any level.
2.4 One-Line Diagram Features

- Unlimited one-line diagram presentations
- Single-phase system (2 and 3 wires)
- Panel systems
- Unlimited status configurations/scenarios (switching devices, motors, loads, etc.)
- Multiple engineering properties (base and revision data)
- Three-dimensional (3-D) database
- Ground grid systems
- Multiple loading categories (conditions) with individual percent loading
- Unlimited one-line diagram nesting for subsystems, MCCs, etc.
- Simultaneous view of one-line diagram presentations
- Simultaneous view of system configurations
- Simultaneous view of different study results
- One-Line Diagram Templates
  - Auto-Select
  - Symbols Quick Pick
  - Phase adapters
  - Automatic bus insertion
  - Find elements from editors or the project window
  - Grouping/ungrouping of elements
  - Change size, symbol, orientation, and alignment of elements, individually and globally
  - ActiveX (programmable objects)
  - Graphically fault/clear fault from buses
  - Selectable zoom-to-fit
  - State-of-the-art built-in graphic user interface
  - Drag-and-drop, cut and paste, undo and redo, zooming, etc.
  - Built-in ETAP CAD system
  - XML data exchange
  - Export one-line diagrams to third party CAD systems via DXF and metafile formats
  - Import OLE objects (text, pictures, spreadsheets, GIS maps, etc.)
  - Import ETAP DOS project files
  - Import ASCII project files
  - Execute external programs
  - Customizable graphical display of results annotations
  - Customizable graphical display of nameplate data annotations
  - Interchangeable ANSI and IEC element symbols
  - Multiple sizing and rotation of element symbols
  - Multi-color symbols and annotations
  - Supports True Type fonts
  - Hide and show protective devices per presentation
  - Remote connectors
  - Graphical operation (open/close) of switching devices in edit or study modes
  - Display of fixed tap and load tap changer (LTC) positions on the one-line diagram
  - Direct device coordination from the one-line diagram
  - Comprehensive printing/plotting capabilities
  - Individual and global section of elements, objects, and composites
• Schedule manager for system components
• Customizable output reports (Crystal Reports)
• ASCII output reports
• Output report manager for both ASCII files and Crystal Reports
• Access database output reports
• Crystal Reports for all library data
• Comprehensive summary reports
• Customizable output plots
• Report status of loads and protective devices for all configurations
• System dumpster with unlimited cells for storage and retrieval of deleted components
• Resizable, floating/attachable toolbars for each study

2.5 3-D Database
ETAP uses a 3-D database concept to implement presentations, configurations, and revision data. The use of this multi-dimensional database concept allows you to independently select a particular presentation, status configuration, or revision data within the same project database.

• Presentations
  Unlimited, independent graphical presentations of the one-line diagram to represent the one-line diagrams for any purpose such as impedance diagram, study results, relay diagrams, plot plan, etc.

• Configurations (Status)
  Unlimited, independent system configurations to keep track of the status of switching devices (open and closed), motors and loads (continuous, intermittent, and spare), MOVs (open, closed, throttling, and spare).

• Revision Data (Engineering Properties)
  Base data and unlimited Revision data to keep track of changes and modifications of the engineering properties (nameplate, settings, etc.) of elements.

These three system components are organized in an orthogonal fashion to provide you with great power and flexibility in constructing and manipulating your ETAP project. Using the concept of Presentation, Status Configuration, and Revision Data, you can create numerous combinations of networks of diverse configurations and varying engineering properties that allow you to fully investigate and study the behavior and characteristics of the electrical networks using one database. This means that there is no need to copy your database for different system configurations, ‘what if’ studies, etc.
These dimensions can be used in conjunction with multiple loading categories and multiple study cases to quickly and efficiently perform system design and analysis without the possibility of data discrepancies caused by multiple copies of a single project file being used to account for various system changes.  

This powerful new concept is unique to ETAP. A 3-D database vs. a flat database means:

- No need to keep multiple copies of the database
- Eliminate data discrepancies & errors
- Higher capability & flexibility
- Higher productivity
- Less man-hours
2.6 Presentations

Two Graphical Presentations of the System
with Different Annotations, Symbols, Locations, and Visibility of Elements
2.7 Configurations (Status)

One-Line Diagram with Status Configuration “Emergency1” Active
(Note that transformer T2 is out of service)
2.8 Revision Data (Engineering Properties)

Base Data Indicating Engineering Properties of the Existing System

Revision Data Indicating Modifications of Transformer Ratings
2.9 ETAP Wizards
ETAP includes time-saving project management tools called the ETAP Wizards, which allow you to record and run any study at any time. The ETAP Wizards include the Scenario Wizard, Study Wizard, and Project Wizard. All three are described below.

Through the ETAP Wizards, you will be able to combine the orthogonal tools (Presentations, Configurations, and Revision Data), study types, output reports, and study cases (the loading and generation system operation factors together with solution parameters) to perform a complete system study with the click of a button.

The three ETAP Wizards are located on the System toolbar.

2.10 Scenario Wizard
A scenario allows you to group all study options into one place. For this reason, scenarios are useful anytime you want to record a study to be executed. Every project file contains a Scenario Wizard. Scenarios are created and recorded in the Scenario Wizard and can be run individually at any time. A project can have an unlimited number of scenarios. Scenarios are composed of the following parameters:

- System (Network Analysis or CSD Analysis)
- Presentation (e.g., one-line diagram, UGS, or CSD)
- Revision Data (Base or Revision Data)
- Configuration Status (e.g., Normal, Stage 1, or TSEvents)
- Study Mode (e.g., Load Flow or Short-Circuit)
- Study Case (loading and generation system operation factors and solution parameters)
• Study Type (vary depending on Study Mode)
• Output Report (vary depending on Study Mode)

When you run a scenario in a project, it will automatically create an output report or overwrite an existing report with the same name.

2.11 Study Wizard

Macros reduce the time it takes to run several scenarios. Every project file contains a Study Wizard. The Study Wizard enables you to sequentially group existing scenarios into study macros. You must have created the scenarios you want to include in your study macro before you can create the macro. You create the scenarios using the Scenario Wizard. (See the Scenario Wizard section above for more information.)

A project may have an unlimited number of study macros. When you run a study macro, all of the scenarios included in it are run, creating or overwriting the output reports just as they would if they were run individually. For example, you could group scenarios related to load flow or a specific type of load flow into one study macro.
2.12 Project Wizard

The Project Wizard is project independent and is saved within the ETAP folder. It enables the user to group existing study macros into project macros. You should use a project macro when you have several projects from which you want to run multiple study macros and their scenarios simultaneously. This feature automates opening and closing project files and individually executing study macros and their scenarios.
2.13 Output Database Comparison Program

The Output Database Comparison Program (DB Compare Program) is a console designed to compare two Microsoft Access Database (MDB) files as instructed by a third MDB file (instruction database). This console has been designed to interface with the scenarios in ETAP to allow the comparison of current ETAP output database results against results from a benchmark Output Report database. The benchmark results could have been generated using a previous version or the same version of ETAP.

![Compare Output Editor (DB Compare Console)](image)

2.14 Editors

ETAP editors are called “intelligent editors” because they have the following capabilities:

- Minimum data entry required
- Automatic substitution of typical data
- Multiple-page layout for various data
- Check all possible electrical interdependencies of parameters
- Automatic error & range checking of every data field
- Optimization & sizing capabilities
- User-defined data fields
- Navigator, undo, & find commands
- Keep track of changes for every data field
2.15 Libraries
ETAP provides extensive user-controlled libraries based on actual manufacturer published data.

- Cable (NEC, ICEA, and manufacturer published data)
- Cable fire coating (manufacturer published data)
- Cable fire stop (manufacturer published data)
- Cable fire wrap (manufacturer published data)
- Motor nameplate
- Motor circuit model (single and double cage motors)
- Motor characteristic model
- Motor load model
- Relay (manufacturer published data)
- Recloser (manufacturer published data)
- Electronic Controller (manufacturer published data)
- LV circuit breaker (manufacturer published data)
- HV circuit breaker (manufacturer published data)
- Fuse (manufacturer published data)
- Overload Heater (manufacturer published data)
- Harmonic (IEEE and manufacturer published data)
- Motor overload heater (manufacturer published data)
- Battery
- Reliability index library
- Interruption cost library
- 50,000+ device time-current characteristic curves
- Merge data from different libraries
- Export library data to Microsoft Access file with report manager and Crystal Reports
2.16 ODBC (Open Database Connectivity)

ETAP organizes and accesses its database using the latest industry standard, Microsoft® ODBC® (Open Database Connectivity), allowing ETAP to use any database for which an ODBC driver is available.

- Set ETAP database in Microsoft Access, Oracle, SQL server, etc.
- Access the database from third party database managers
- Integrate other project data into the same database

ETAP

ODBC

Access SQL Oracle

ODBC enables you to access your ETAP databases via third party software such as Microsoft Access. This helps you to manage your data and provides a simple method of transferring the data from ETAP into other media. You may also insert additional fields (along with values provided by ETAP) into the ETAP database tables.

2.17 OLE Client

OLE is a program-integration technology used to share information between programs. Many Windows programs, including Microsoft Office, are OLE capable. Within ETAP, you can dynamically embed OLE objects such as bitmaps, text, spreadsheets, tables, and metafiles into your one-line diagrams.
2.18 Convert to EMF, WMF and DXF files

Export ETAP one-line diagrams to Enhanced MetaFiles (EMF), Windows MetaFiles (WMF), and AutoCAD DXF files. These files can be imported into AutoCAD®, Microsoft Word®, etc.

An EMF File Generated by ETAP & Inserted here as a Picture

2.19 Printing / Plotting of One-Line Diagrams

The following options are available for each presentation, including composite motors and networks:

- Print Options
- Printer Setup
- Zoom Level for Print Size
- Print Coordinates & Scrolling
- Customizable Print Preview
- Batch Printing
Print Preview of a One-Line Diagram with Load Flow Results & OLE Objects
2.20 **Active Error Viewer**

ETAP provides five levels of error checking. The active error viewer appears when you attempt to run a study with missing or inappropriate data. Double-click each individual error message to locate and open the component editor associated with the cause of the error message.

![Active Error Viewer](image)

**Run Time Error Viewer with Direct Link with the Reported Errors**

A Transformer Editor Activated after Double-Clicking on the Error

2.21 **Application Message Logging**

Track ETAP usage and access using the application message logger. It keeps track of who opens a project, which level of access they have, and how long they were in the project.

![Message Logger](image)
2.22 Output Report Manager
Provides more than 250 reports in Crystal Reports formats for different studies including the following subsections:

- Complete report
- Input data
- Results
- Summary reports
- Customizable subsections

2.23 Crystal Reports®
ETAP uses the Crystal Reports program to generate output reports. Crystal Reports is a reporting tool with customizable report formats with full-color presentation-quality. ETAP provides a number of different report formats for various analyses, library data, and schedules.
Getting Started

Product Description

The Crystal Reports browser/printer is available within ETAP. Users can create report formats and modify the existing ones using the Crystal Reports program. Crystal Reports is a Business Objects product. To obtain more information about this software, go to the following Web site: http://www.businessobjects.com

2.24 Schedule Report Manager

Using Crystal Reports, ETAP provides different schedules for elements in the database, such as bus, branch, load, and cable with the following options:

- Base & Revision Data
- Energized / De-Energized Elements
- Elements in the Dumpster

A Sample of Cable Schedule
3. Demo Restrictions

The active ETAP demonstration program contains limitations not present in the commercial version. These limitations are listed below:

- The trial period for the demo is 60 days (extendable by contacting OTI with your Return Code).
- The Example project may be modified, but cannot be saved. You can open a new project and edit it just like in the regular commercial version, but you cannot save the changes.
- The one-line diagram may have a maximum of twelve AC buses and ten DC buses. See Ten Bus Limitation to learn how to remove existing buses to add new ones.
- New components may be inserted into the one-line diagram except for panels and phase adapters.
- Existing panels have some limitations such as disabled Summary page, Report Manager Printing, Library Quick Pick Window, and fixed number of circuits.
- The Underground Raceway System (UGS) can have a maximum of two raceways, each with a maximum of two conduits/locations. There can be a maximum of two external heat sources.
- The Ground Grid Systems, Cable Pulling Systems, and Underground Raceway Systems can be viewed, but no calculations can be performed in these presentations.
- Printing output reports (Crystal Reports) and plots are restricted to the original example reports included on the Demo CD. However, the displayed results on the one-line diagram are based on the modifications made.
- The Alert View function is disabled.
- Importing and exporting functions are disabled.
- Adding and copying in the Library is disabled.
- Library selection is limited to a few sample models from different manufacturers.
- Access to Revision Data is disabled. You can only access Base Data.

- The following modules are functional in the demo:
  - Load Flow
  - Short-Circuit (ANSI and IEC)
  - Star Device Coordination
  - Arc Flash

- The following modules are not functional in the demo:
  - Star Sequence of Operation
  - Motor Acceleration (Dynamic and Static)
  - Harmonic Analysis (Load Flow and Frequency Scan)
- Transient Stability
- Optimal Power Flow
- DC Load Flow
- DC Short-Circuit
- Battery Sizing & Discharge
- Optimal Capacitor Placement
- Parameter Estimation
- Transmission Line Sag & Tension
- Transmission Line Ampacity
- Cable Pulling
- Cable Ampacity
- Reliability Assessment
- Transformer Sizing
- Transformer Tap Optimization
- Ground Grid Systems
- User-Defined Dynamic Models

You can enable most of the disabled analysis modules by contacting OTI with your Return Code. Your Return Code is specified within all of the Demo Limitation dialog boxes. Return Codes are different for every computer on which the demo is installed.
4. Demo Setup

This quick setup document is designed to guide you through a typical installation of the ETAP 7.0 Demo.

System Requirements

Minimum Hardware Requirements
- Intel Pentium 4 or better
- 256 MB RAM
- 5 GB available hard disk space
- CD/DVD drive
- 1024x768 screen resolution

Operating System (32-bit or 64-bit)
- Microsoft® Windows XP (Service Pack 3) Professional or Home Edition
- Microsoft® Server Windows 2003 (Service Pack 2 or Higher)
- Microsoft® Vista (Home Premium, Business, Enterprise)
- Microsoft® Server Windows 2008

Other Software Requirements
- Internet Explorer 5.0.1 or Higher (or minimum version level as specified by the Operating System in use)
- Microsoft® .NET Framework v1.1, Service pack 1
- Microsoft® .NET Framework v2.0, Service pack 1

ETAP 7.0 Demo Installation

If you are installing the ETAP Demo, you need to have administrative access to your computer.

1. Close all applications and insert the ETAP Demo CD into your CD-ROM drive.

2. Click the ETAP 7.0.0 Demo link to begin installation.
3. Click Next on the Welcome screen to continue.

4. Enter the code which is sent to you by OTI to continue. If you did not receive the code or misplaced it, you may contact sales at 949-462-0100.

5. The installation and use of the demo is governed by the terms and conditions of the ETAP License Grant and Agreement. These terms must be accepted before the installation can continue. To accept, click on the Yes button.
6. The Information window displays hardware and software requirements as well as other useful information. Click on Next to continue with the installation.

7. Setup requires the name of a destination folder on your hard drive where you would like the ETAP Demo to be installed. The default destination folder is C:\ETAP 700 Demo. To install the program in a different location, click on the Browse button and select or type a new destination folder.
8. The Start Copying Files dialog box provides the opportunity to verify the set up information. If the set up information is correct, click on Next to continue the installation.

9. Select Next to begin the installation of ETAP 7.0 Demo.

10. Click on Finish and check the Launch ETAP 7.0.0 Demo if you would like to run the demo as soon as you finish the setup.
The ETAP 7.0 Demo icon is placed on the desktop when the installation is complete.

**Running the ETAP Demo**

To start the ETAP Demo, double-click on the shortcut that was created on your desktop during the installation.

The ETAP 7.0 Demo Getting Started PDF files are located on the Demo CD in the folder named: WinRoot\ETAP70Demo\User Guide.

For more information, please contact sales@etap.com or visit our web site at www.etap.com.
5. Demo Structure

This section describes the structure of the ETAP 7.0.0 Demo package. The demo has been designed to allow sampling of most of the editing and analysis tools in ETAP.

Select Demo Project Editor
This window is immediately displayed as soon as you run the ETAP 7.0 Demo program. It gives you the following options:

New Project
The New Project option allows you to open a new ETAP project where you can build a one-line diagram from scratch. The system that you build can have as many as twelve AC buses and ten DC buses. You can perform all enabled analysis on this newly created project, but you cannot save the changes you make. Please refer to Section 2 for a list of all the studies that you can perform or need to enable using your Return Key Code.

Example Project (ANSI)
If you select this option, an example project will open which has been setup to run all the available ETAP modules. The example project contains several links to allow you to view the getting started documents for ETAP. It also contains valuable information regarding one-line diagrams editing features. In this project, all symbols and studies are based on ANSI standard.

Example Project (IEC)
If you select this option, an example project will open which has been setup to run all the available ETAP modules. The example project contains several links to allow you to view the getting started documents for ETAP. It also contains valuable information regarding one-line diagrams editing features. In this project, all symbols and studies are based on IEC standard.

Star Project
This project opens a small one line example to show the approach to time-overcurrent analysis with precise protective device modeling. Create a Star curve or view the star curves already created in this project to view this intuitive and logical approach to coordination studies. Star’s sequence-of-operation feature evaluates, verifies, and confirms the operation and selectivity of the protective devices for various types of faults for any location right from the system one-line diagram.

T&D Project
If you select this option, a large project file opens which can only be browsed. This project is provided as an example of larger systems and how they can be divided into subsystems or “composite networks” to
simplify and organize one-line diagrams. This project is a bigger version of the example project. It is very important to know that ETAP does not have any system size limitations; this means that you can have an unlimited number of buses.

**ETAP Real-Time Video**

ETAP Real-Time is an intelligent power management system that runs as an operator workstation to monitor, control, simulate, optimize, and automate the operation of your power system. It simultaneously serves as an engineering workstation capable of utilizing real-time data to perform design, simulation, and analysis of power systems. Please contact sales at sales@etap.com or call 949-462-0100 for more information.

**ETAP GIS Video**

The ETAP GIS Video option shows the process of building and synchronizing an ETAP project with a GIS project.
6. Interface Maps

The following maps are provided to describe the general structure and user interface of ETAP.

6.1 Edit Mode

Here you can graphically add, delete, relocate, and connect elements, zoom in or out, display grid off or on, change element size, change element orientation, change symbols, hide or show protective devices, enter properties, set operating status, and more.

Select Status Configuration

Unlimited Number of Configurations to Save Status of Switching Devices/Loads

Select Mode

Edit Mode: Drag/Drop & Connect Elements
Study Mode: Load Flow, Short-Circuit, … etc.

Project View

Edit Toolbar
AC Elements
DC Elements
Instrument Devices

Help Line
Displays the description for every entry field.

Message Logger
View the latest messages related to ETAP Projects.
It can be expanded or reduced.

One-Line Diagram
In Edit Mode
Menu Bar

The Menu bar contains a comprehensive list of menu options. Each option activates a drop-down list of commands such as, File operations, Printing, Database Conversions, Data Exchange, OLE objects, Project Standards, Project Settings and Project Options, Libraries, Defaults, Annotation Fonts, Base and Revision Data, and more.

Project Toolbar

The Project toolbar contains buttons that provide shortcuts for many commonly used functions. Those functions are: Create Projects, Open Projects, Save Projects, Print, Print Preview, Cut, Copy, Paste, Pan, Zoom, Undo, Redo, Text Box, Grid Display, Continuity Check, Themes, Get Template, Add to OLV Template, Hyperlink, Power Calculator, Find, and Help.

Project View

The Project View is a graphical tree representation that includes Presentations, Configurations, Study Cases, Libraries, and Components associated with your project. Here you can create and manipulate the following presentations, configurations, and study cases:

- One-Line Diagram Presentations
- U/G Cable Raceway Systems
- Ground Grid Systems
- Cable Pulling Systems
- Dumpster
- Status Configurations
- Study Cases

You also have full access to all libraries and elements that exist in your project.

Edit Toolbars

The Edit toolbars are active when you are in Edit Mode. You can click or double-click to select, drag and drop AC, DC, and instrument elements on the one-line diagrams. Additionally, you can perform the following functions:

- View & Print Customizable Output Reports (Text & Crystal Reports)
- Change Display Options
- Access Schedule Report Manager
- Add New Ground Grid Systems
- Add Composite Networks & Composite Motors
ETAP provides the following study modes directly from the one-line diagram:

1. Load Flow Analysis
2. Unbalanced Load Flow Analysis
3. Short-Circuit Analysis
4. Arc Flash Analysis
5. Motor Acceleration Analysis
6. Harmonic Analysis
7. Transient Stability Analysis
8. Star – Protective Device Coordination
9. Optimal Power Flow Analysis
10. Reliability Assessment Analysis
11. Optimal Capacitor Placement
12. DC Load Flow Analysis
13. DC Short-Circuit Analysis
14. Battery Sizing and Discharge Calculations
15. Underground Cable Raceway Systems
16. Ground Grid Systems Studies
17. Cable Pulling Systems
Cable and ground grid analysis, and cable pulling calculations are available from the Underground Cable Raceway Systems, Ground Grid Systems, and Cable Pulling Systems studies, respectively.

6.3 Example - Motor Acceleration Mode

The Motor Acceleration Study Case editor contains solution control variables, pre-start loading conditions, motor starting events, and a variety of options for output reports. The study case is used for both dynamic motor acceleration and static motor starting studies. The Motor Acceleration Study Case toolbar changes according to the selected Study Mode. The results are displayed directly on the one-line diagram.
7. Tutorial

This chapter is intended to give you a brief overview of some of the features of ETAP. After going through this series of tutorials, you will be familiar with many of the key concepts and capabilities of ETAP. Each section is available in an interactive format, allowing you to visualize each step as it is explained in this chapter.

The tutorials are all independent of each other, so you do not need to worry about being introduced to everything at once. Simply choose any number of sections that you are interested in learning. The breakdown of the sections is described below.

Section 1: How to build and manipulate a one-line diagram
Section 2: How to set up and run a load flow study
Section 3: How to set up and run an unbalanced load flow study
Section 4: An introduction to ANSI and IEC short circuit studies
Section 5: How to set up an run arc flash analysis
Section 6: How to set up and run both static and dynamic motor acceleration studies
Section 7: A brief overview of a harmonic analysis of a system
Section 8: How to simulate and analyze system transients
Section 9: An overview of the basic operation of the Protective Device Coordination (Star) module
Section 10: An introduction to Optimal Power Flow analysis
Section 11: How to setup and run a reliability analysis
Section 12: An overview of the DC Load Flow module
Section 13: How to run a DC Short-Circuit study and make multiple study cases
Section 14: An introduction to Battery Sizing and Battery Discharge
Section 15: A brief overview of the Underground Raceway Systems module
Section 16: How to build and run studies on a Ground Grid Systems
Section 17: How to set up and build a Cable Pulling System
Section 18: How to set up and connect Panel Systems to existing networks
Section 19: A detailed explanation of the output report formats
Section 20: An overview of the libraries of ETAP

To begin, start ETAP by double-clicking the icon on your desktop.

The first tutorial shows you how to create a small system. For this section you can use the “New Project” option when the Select Demo Project window appears. For the rest of the tutorials (with the exception of Star), you should use the “Example Project” option instead.
7.1 Building a One-Line Diagram

The purpose of this tutorial is to show the fundamentals of building and manipulating a one-line diagram (OLD) in ETAP. Various elements will be added to the one-line view (OLV), and an introduction to equipment editors will be made. Open the ETAP 5.0.0 Demo and select the option “New Project” for this tutorial section.

To build or edit a one-line diagram in ETAP, you must be in Edit Mode. Click the Edit button on the Mode toolbar.

On the AC Edit toolbar, select a Power Grid (Utility) element by clicking on the Power Grid button. Click anywhere in the OLV to place a Utility on your one-line diagram.

By following the same procedure, insert the following elements until your OLD appears as follows:

You can stretch buses to appear as Bus2 does by placing the mouse pointer over either end of the bus, until a double arrow appears. Then click and drag to the desired length.

Now connect the elements in the OLD. Place the mouse pointer over the connection pin of an element, and it will turn red. Then click and drag to the connection pin of another element. In the case of buses, the entire element graphic functions as a connection point. The continuity button in
the Project toolbar is useful for showing when elements are energized. Notice that a node is automatically inserted when connecting the cable to the transformer.

The OLD can be navigated by using the scrollbar arrows located at the right side and bottom of the window.

The data contained in any element on the OLD can be accessed by opening its editor. Double-click Cable1 to open the Cable Editor. You can click any tab in the editor to open its respective page. Data can be entered manually into fields with a white background only.

Click the Library button on the Info page to select a cable. Then click OK to exit both the Quick Pick window and the editor window. The engineering properties of the selected cable are now entered in the editor.
You can also manipulate the orientation and appearance of elements in the OLD. A list of options will appear if you right-click an element graphic. For example, you can rotate a power grid or load by right-clicking on it, select Orientation, and then select a rotation angle.

There is a variety of options that can be chosen by simply right-clicking on an element graphic.

Populating a composite network is very similar to populating the first OLD. To open the composite network, double-click its graphic. The title of this window will be OLV1=>Network1. You may change its name by double-clicking anywhere inside or by right-clicking on its graphic and selecting Properties. Connect elements to create a one-line diagram as was done previously. Now, to make this OLD look cleaner, you can right-click to hide the unused connection pins as shown.

Creating a one-line diagram in ETAP is fast and easy. Once complete, you can take full advantage of all the powerful tools that ETAP has to offer.
7.2 **Load Flow Analysis**

The purpose of this tutorial is to give you an introduction to the use of the Load Flow Analysis module. It will also provide an example of how to regulate bus voltage using transformer LTCs and how ETAP flags overload conditions. For this section of the tutorial you should use the “Example Project” option.

Click the Load Flow Analysis button on the Mode toolbar to switch to Load Flow Analysis mode. Now you can run a study by clicking on the Run Load Flow button on the Load Flow toolbar. You will be prompted to enter a name for your output report if Prompt is selected. Later, you will learn how to customize your study by changing options in the Load Flow Study Case editor.

The results of the study can be seen on the OLD. The information shown on the OLD can be changed in the Display Options. For even more detailed results, output reports can be viewed.

To view any overload problems, simply click the Alert View button on the Load Flow toolbar. This will open a window containing a list of undersized equipment. Please note that the alert view button is disabled in the ETAP 5.0 Demo.
Note that the operating voltage of Bus1 is 97.94%. This caused the bus to be flagged as marginally under voltage in the Alert View window. The criteria for which a condition is flagged can be changed in the Load Flow Study Case editor, which will be discussed in the next lesson. We will now use the bus voltage regulation feature of the Transformer Editor to change our Load Flow results.

ETAP allows Auto LTC settings to be applied to regulate buses that are directly or indirectly connected to a transformer. For example, we can use transformer T4 to regulate Bus1 at 100% of nominal voltage. Open the editor of T4 by double clicking on its graphic. On the Tap tab, enable (check) the Auto LTC box on the primary winding.

Open the LTC settings window by clicking on the LTC box and change the Regulated Bus ID to Bus1. Click OK for both the LTC window and the Transformer Editor window.

Now you can run a Load Flow study again, with attention paid to the operating voltage of Bus1. Click the Run Load Flow button on the Load Flow toolbar to do so.

Notice that the operating voltage of Bus1 is now within a tap step of the desired 100% regulation value. This is just one example of the many features of the ETAP Load Flow module.
The Load Flow Result Analyzer allows you to view the results of various load flow studies in one screen so you can analyze and compare the different results. You can compare the results of general information about the project or more specific information such as the results contained from buses, branches, loads or sources in a load flow study. The Load Flow Result Analyzer is a time saving tool that allows you to compare and analyze different reports coming from different projects, within the same directory, in a single display.
7.3 Unbalanced Load Flow Analysis

The purpose of this tutorial is to give you an introduction to the use of the Unbalanced Load Flow Analysis module. It will also provide an example on how a large single-phase load impacts a balanced three-phase system. You will need to contact OTI with your Return Key Code so that you can activate this module. For this section of the tutorial you should use the “Example Project” option.

Click the Unbalanced Load Flow Analysis button on the Mode toolbar to switch to Unbalanced Load Flow Analysis mode. Now you can run a study by clicking on the Run Unbalanced Load Flow button on the Unbalanced Load Flow toolbar. You will be prompted to enter a name for your output report if Prompt is selected. Later, you will learn how to customize your study by changing options in the Load Flow Study Case editor.

The results of the study can be seen on the OLD. The information shown on the OLD can be changed in the Display Options. For even more detailed results, output reports can be viewed. Select the following options from the display options:
To view any overload or unbalance problems, simply click the Alert View button on the Load Flow toolbar. This will open a window containing a list of undersized equipment, as well as equipment with unbalanced conditions. Please note that the alert view button is disabled in the ETAP Demo.

Note that the system is well balanced, as can be seen from the voltage and current values per phase.

A system unbalance will be introduced by changing the connection of motor Syn1 (1250 Hp) from three-phase to single-phase. Open the Syn1 motor editor and make the changes indicated below:
Run the unbalanced load flow again and check the results.

Notice that there is current and voltage unbalance in different areas of the system, which did not exist in the original (balanced) load flow case. This is just one example of the many features of the ETAP Unbalanced Load Flow module.
7.4 Short-Circuit Analysis
The purpose of this tutorial is to introduce the Short-Circuit Analysis module of ETAP, and provide instructions on how to run ANSI and IEC short-circuit calculations. In addition, there will be a brief look at study case editors and the Alert View function.

From the Mode toolbar, select the short circuit mode by clicking on the Short-Circuit Analysis button.

From the Study Case toolbar, click the Edit Study Case button. This will open the Short Circuit Study Case editor, allowing you to change calculation criteria and options. From the Info page, choose a bus or multiple buses to be faulted. Click all buses except Sub 3 and select ~Fault>> to place them in the Don’t Fault category. Sub 3 should now appear alone in the Fault category. Click OK when finished.

This task can also be done graphically by right-clicking on a bus and selecting Fault or Don’t Fault.

Note: The faulted bus, Sub 3, will be shown in dark red color on the OLD, indicating that it will be faulted.

You can now run a short circuit (duty) study by clicking on the Run 3-Phase Device Duty button on the ANSI Short Circuit toolbar. Since Prompt is selected in the Study Case toolbar, you will be prompted to enter a name for your output report.
There are four other types of studies besides the 3-Phase ANSI that can be performed under the ANSI standard setting. In addition, three studies according to the IEC set of standards can be performed. The ANSI methods are the default for short circuit studies, but this can be changed in the Standard page of the Short Circuit Study Case editor.

The OLV will show the results of the Device Duty Short Circuit calculation. Changing the settings in the short circuit Display Options can modify the results displayed on the OLD.

Note that breaker CB9 is now colored magenta. This flag means that the device capabilities have been exceeded in some way. If the Alert View window has not already appeared, click the Alert View button on the ANSI Short Circuit toolbar to view the flagged devices (please note that the alert function is disabled in the Demo). Note that the default position for the Short Circuit toolbar is vertically along the right edge of the ETAP window.

All devices that have been flagged will appear in this window.

To view or modify the Alert settings, open the Short Circuit Study Case editor to the Alert page. Check the Marginal box and change the limit to 70%. Also, click the Auto Display button and...
then click OK. When the Marginal box is checked, all devices that have been exceeded by this limit, but remain under 100% rating will appear in the Alert View in the Marginal category. Devices that have been exceeded by 100% of rating will always be flagged, and will appear in the Critical category of the Alert View.

Now run the same short circuit study again by following the procedure used above. Note that once the calculation has been completed, the Alert View window will automatically open, as per the change made to the Alert page in the Short Circuit Study Case editor. Notice that other protective devices appear in the Marginal Alert View, and will be flagged in magenta in the OLD. Note that the short circuit results do not change.

The Alert function of the Short Circuit and Load Flow modules of ETAP is a convenient way to size protective devices at your facility.
7.5 Arc Flash Analysis

The purpose of this tutorial is to introduce the Arc Flash Analysis module of ETAP, and provide instructions on how to perform Arc Flash calculations.

ETAP Arc Flash has typical equipment gap and X-factors included in the project settings menu on the menu toolbar. You can take advantage of these typical values or used user-defined values to perform a quick User-Defined Arc Flash calculation.

Go to the rating page of the bus and select the type of equipment that is represented by the bus. This can be enclosed equipment like MCC or Switchgears or open-air equipment (not enclosed in a box). Once you have selected the equipment type, select typical values by clicking on the “Typical Data” button. This will bring all required gap information as well as approach boundaries as defined by NFPA 70E.
Go to the Arc Flash page to view or change the working distance. This is defined as the distance from the person’s torso and face to the energized equipment. This distance is set by the voltage and device type specified for the bus. The typical values are defined under the Project pull down menu from the menu toolbar. Go to Project - Settings - Arc Flash - Arc Flash Hazard Analysis table to view the typical values or set user defined values.

After running Arc Flash, the Bolted Fault Current is calculated and displayed on the Arc Flash tab of the bus editor. The Arc Fault Clearing Time (FCT) along with the source PD is also displayed.
After running an arc flash analysis, the incident energy, flash protection boundary and the hazard/risk level, according to NFPA 70E 2009, will also be displayed.

Once you see the calculated results, all you have to do is to select the arc flash label template that you want and click on the print button.
A Crystal Reports viewer window will open with a label that is ready for printing. The bus Arc Flash page allows you to get Arc Flash results instantly.

**DANGER**

**Arc Flash and Shock Hazard**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash Protection Boundary</td>
<td>4.0 ft</td>
</tr>
<tr>
<td>Incident Energy</td>
<td>5.1 Cal/cm²</td>
</tr>
<tr>
<td>Working Distance</td>
<td>18 in</td>
</tr>
<tr>
<td>Required PPE Level</td>
<td>2</td>
</tr>
<tr>
<td>Shock Hazard Voltage</td>
<td>480 VAC</td>
</tr>
<tr>
<td>Limited Approach</td>
<td>10.0 ft</td>
</tr>
<tr>
<td>Restricted Approach</td>
<td>1.0 ft</td>
</tr>
<tr>
<td>Prohibited Approach</td>
<td>0.1 ft</td>
</tr>
<tr>
<td>Equipment ID</td>
<td>Bus1</td>
</tr>
</tbody>
</table>

ETAP gives you the ability to perform a quick calculation using user-defined values or it also calculates all the required parameters for you automatically. The first option is only used if you want to perform quick “what if” scenarios or you only have one or two buses to analyze and you do not want to perform a system wide short-circuit calculation.

The global calculation can be performed based on User-Defined values or System calculated results. This gives you complete flexibility for parts of the system for which you may be missing required parameters.

The global arc flash calculation requires the same information that is needed to run a 3-phase short-circuit calculation. It also requires you to select the equipment type, gap, working distance, and system grounding according just like in the user-defined case.

You need to select the buses that you want to fault. You can do this through the Info page of the Short-Circuit (SC) study case.
Next you must select the analysis method from the SC study case Arc Flash page. This can be either NFPA 70E or IEEE 1584. The IEEE method is a more accurate model and is set to default.
The next step requires the selection of the arc fault clearing time (FCT). The default is set to the automatic determination of the FCT from the Star protective device Time current characteristics (TCC) of the protective devices. In most cases, the most conservative solution is reached by selecting a TCC only for the main feeder PD since they take the longer time to operate. If you do not select a TCC for the bus, ETAP will use the user-defined FCT from the bus Arc Flash page. ETAP will consider all the PDs directly connected to the bus and will pick the longest clearing time in case there are several feeder paths to the bus.

The remaining options to be selected can be left as default. You can choose to update the global calculation results back to the Arc Flash page of the bus. You can select to let ETAP automatically determine the system grounding or use the user-defined one. You have the flexibility of determining the method to use in order to determine the hazard/risk category. You can select the NFPA 70E 2000, 2004, 2009 or select the user-defined categories.

Once this information has been selected from the bus and SC arc flash pages, all you need to do is to click on the Arc Flash Icon on the SC toolbar to launch the calculation. The program will provide a full set of reports for all the faulted buses as well as all the labels for every PD (cubicle) location and for the faulted buses.
7.6 Motor Acceleration Analysis

The purpose of this tutorial is to introduce the Motor Acceleration module of ETAP. It will show the static and dynamic models that can be used to simulate real motor characteristics. The minimum amount of data necessary to run each type of study will be entered. An example of a motor starting output plot will be shown. You will need to contact OTI with your Return Key Code so that you can activate this module.

Switch to Motor Acceleration Analysis mode by clicking on the Motor Acceleration Analysis button on the Mode toolbar.

From the Study Case toolbar, open the Motor Starting Study Case editor. From here you can add and modify conditions for your study.

On the Event page, change the Total Simulation Time to 10 seconds. The output plots will now graph the results of the study from time 0 to 10 seconds.
Now you can add an unlimited number of events to simulate switching actions in a single Motor Starting simulation. You can start or switch off individual loads or categorized motor groups with the Action by Load and Action by Starting Category features, respectively. You can also change the operating load by clicking the Load Transitioning option to change from one loading category to another.

You can add an event by selecting the Event page and clicking on the Add button under the Events heading. Actions occurring at each event time can be added, modified, or deleted by selecting the event and modifying the respective Action heading (by Element, by Starting Category, by Load Transitioning). Click OK to save any changes you make.

Open Syn1’s editor by double-clicking on the element graphic in the OLV. Click the Load Model tab. In the Acceleration Time (Static Starting) fields, enter 1 second as the no load acceleration time, and 3 seconds as the full load acceleration time. Click OK to save and exit.
The data you have just seen and changed is the minimum necessary to run a simple Static Motor Starting study. Run the study by clicking on the Run Static Motor Starting button on the Motor Starting toolbar.

Note: Once the calculation has completed, plots and output reports are accessible. An example of the plots will be shown for a Dynamic study.

Now a Dynamic Motor Starting study will be performed using the same Study Case conditions and events as the Static study. However, additional data is necessary for a Dynamic Study. Double-click the Syn1 element graphic to open its editor, and go to the Model tab. Under the Dynamic Model heading, a category other than “None” must be selected. Clicking on the Typical Data button will fill the necessary fields based on the ratings specified under the Nameplate tab.
Now click the Load tab to view the load model. Ensure that a Load Model is entered for this motor.

If a Load Model needs to be entered, click the Load Model Lib button, and accept a Motor Load by clicking OK in the window that appears.

Also, go to the Inertia tab and enter 0.2 into the motor inertia (H) field, and click OK. The motor WR² will automatically be updated. Exit the Syn1 Synchronous Motor editor by clicking OK.
Now you can run a Dynamic Motor Starting study. Click the Run Dynamic Motor Starting button on the Motor Starting toolbar to perform the study.

To view the plots that are generated as a result of a study, click the Motor Starting Plots button on the Motor Starting toolbar. The Motor Starting Plot Selection window will appear to allow you to choose which plots will be displayed. Select the plots you wish to view, or click OK to show all plots.

The Motor Acceleration Analysis module of ETAP is an excellent tool to simulate and investigate motor acceleration scenarios.
7.7 Harmonic Analysis
The purpose of this tutorial is to introduce the Harmonic Analysis module of ETAP. It will be shown how to discover resonant frequencies within a system, and also how to determine the magnitude of the harmonic disturbance. You will need to contact OTI with your Return Key Code so that you can activate this module.

Switch to Harmonic Analysis mode by clicking on the Harmonic Analysis button on the Mode toolbar. ETAP has two analytical methods contained within the Harmonic Analysis mode.

Open the Harmonic Analysis Study Case editor to change the calculation options for the study. On the Plot page, you can choose the elements that you wish to appear on the output plots and OLD.

Click on the Run Frequency Scan button on the Harmonic Analysis toolbar. If Prompt is selected, you will be prompted to enter a name for your output reports. Make sure that you run Harmonic Frequency Scan.
The impedance values calculated in the frequency scan are shown on the OLD. You can adjust the Frequency Slider to show the impedance value at different frequency intervals. For complete results, view the Output Reports or Plots. Note that the results shown on the OLD are for the buses selected for plotting in the Harmonic Analysis Study Case editor only.

You can see the graphical results of the frequency scan by clicking on the Harmonic Analysis Plots button on the Harmonic Analysis toolbar, then selecting all of the previously chosen buses. One or all of the buses can be selected to appear on the plot(s).

The plots make it easy to determine if there are any resonant conditions in your system. As can be seen, there appears to be a resonance point at the 21st harmonic at the Sub 3 bus.
To determine the severity of this resonance, you can run a Harmonic Load Flow study. Click the Run Harmonic Load Flow button on the Harmonic Analysis toolbar.

Overall, the results on the OLD show very little total harmonic distortion at bus Sub 3. You can open a plot to see further details by clicking on the Harmonic Analysis Plots button as was done previously.

The Harmonic Analysis module of ETAP allows you to determine the severity of any harmonics in your system, and from there you can decide how to correct a problem, if necessary.
7.8 Transient Stability Analysis

The purpose of this tutorial is to introduce the Transient Stability Analysis module of ETAP. It will demonstrate how to simulate events and actions that are the cause of system transients. You will need to contact OTI with your Return Key Code so that you can activate this module.

Switch to Transient Stability mode by clicking on the Transient Stability Analysis button on the Mode toolbar.

Open the Transient Stability Study Case editor by clicking on the Edit Study Case button on the Study Case toolbar. From the Transient Stability Study Case editor you can add, modify, and delete transient-causing events.

Open the Events page by clicking on the Events tab. There are two events that have been entered: Event 1, a fault occurring at time $t=0.5$ seconds, and Event 2, the fault being cleared, occurring at time $t=0.7$ seconds. You can add, modify, or delete both events and actions within these events here in this editor page.
Every event needs at least one action. You can modify an event action by clicking on the Edit (Action) button. You can choose any number of options from the Action editor. Click OK to save data and exit the Action editor, and click again on OK to save and exit the Transient Stability Study Case editor.

In the Transient Stability Study Case editor, you can select the method by which induction and synchronous machines are modeled on the Dyn Model tab. You can also select the devices for plotting and displaying in the OLD on the Plot page.
Now run a Transient Stability Analysis on this system by clicking on the Run Transient Stability button on the Transient Stability toolbar. You will be prompted to enter a name for your output reports, if Prompt is selected.

The results of the study can be seen for selected elements on the OLD. The Transient Stability Time Slider tool can be used to view the results at any time over the selected study period.
Graphical results can be viewed by using the Transient Stability Plots. Click this button on the Transient Stability toolbar. Choose the type(s) of plot that you would like to display by checking the appropriate boxes on the right side of the window that appears.

With the Transient Analysis module of ETAP, you can easily create multiple transient scenarios, so that you can better evaluate the response that your system will have.
7.9 Protective Device Coordination (Star)

This tutorial provides a brief overview of the basic operation of the Star module, focusing on how to create a Star view and how to manipulate TCC curves from an existing one-line diagram.

To create a new Star TCC follow the steps indicated below:

1. Start the ETAP 7.0 Demo. From the Select Demo Project Screen (second screen), select New Project.

2. From the Select Access Level Screen (fourth screen), select Project Editor.
By default, one-line diagram view OLV1 will open in the ETAP Demo. The toolbars and menus you will be using for this section of the tutorial are illustrated below.

3. Click the Edit button on the Mode toolbar.
4. Click the Overcurrent Relay button from Edit toolbar and drop it on the OLV1 presentation.

5. Double-click the overcurrent relay element to open the Relay editor.
6. Click the OCR page, and then click the Library button. This will display the Library Quickpick - Relay dialog box as shown below.
7. Select manufacturer GE Multilin and model 735/737 and click OK. GE Multilin 735/737 relay data is populated in the OCR page. To learn more about relay settings, refer to the Relay Section in Instrumentation Elements chapter of the User Guide or click the Help button.

8. Click the Input page.
9. Enter primary and secondary ratings for Phase CT (800:5) and Ground CT (50:5) as shown below. CT ratios can be entered directly in the Relay Editor where no CT is connected to the relay. To learn more about Input page of Relay editor, see the Relay section in the Instrumentation Elements chapter of the User Guide or click the Help button.

10. From the Mode toolbar, click the Star – Protective Device Coordination button to switch to the Star mode.

11. To generate the Star View, select the relay, and then click the Create Star View button from the right-hand side Star Mode toolbar.
You have created a Star TCC View. Star Views for other protective devices can be generated in a similar manner.
If you want to add a device curve to the Star view, follow the steps indicated below:

1. Switch to Edit mode, and then drop a fuse in the one-line diagram view OLV1.

2. Double-click the fuse symbol to open Fuse editor.
3. Go to the Rating page and click the Library button to display the Library Quick Pick – Fuse dialog box.
4. Select manufacturer S&C, and model SMU-20, at 27 Max. kV, with standard speed and size 13E.
5. Switch to Star mode using the Mode toolbar. Hold the Shift key down, and then select the fuse and drag it to the active Star View.

A fuse curve is added to the existing Star TCC View (Star1) as shown below.

This concludes the tutorial on creating a Star view.
Now you will learn how to access a Star View for an existing ETAP one-line diagram.

1. Exit the ETAP 7.0 Demo and restart it again. From the Select Demo Project Screen (second screen), select Example Project (ANSI).

2. From the Select Access Level Screen (fourth screen), select Project editor.

3. When the one-line diagram opens, switch to the Relay View presentation using the Presentation drop-down list.
4. Switch to Protective Device Coordination (Star) mode using the Mode toolbar.

5. Click on the Run / Update Short-Circuit Clipping kA from the Star (PD Coordination) toolbar. This will perform a ½ cycle 3 phase and line-to-ground short-circuit study for the faulted buses and update the clipping current for the connected protective devices accordingly.

6. Open the Low Voltage Circuit Breaker editor for CB22 and go to the TCC kA tab.
7. The short circuit current and base kV values are updated in the Low Voltage Circuit Breaker editor as shown above.

8. Click on Star Systems from the System toolbar.

9. Select Bus 1 – TCC from the Presentation toolbar.
The following TCC curve will appear:

You can create TCC curves from an existing one-line diagram, just as the one shown above by simply following the steps shown below:

**Creating TCC curves from an existing one-line diagram.**

1. Highlight or rubber-band the path for which the Star view has to be created.
2. Click on the ‘Create Star View’ button from the Star (PD Coordination) toolbar.

![Create Star View](image)

The following TCC curve will appear:

![TCC Curve](image)

By clicking on the ‘TCC Plot Options’ tool or double-clicking on the Star View background, the display options can be opened in order to customize colors, line styles, axis settings, legend, device labels, etc.

Keep the Relay View presentation open in Star mode for the next section of this tutorial.

**Star Sequence-of-Operation**

With ETAP Star, not only can you work with the time-current curves, you can also determine the operating time of protective devices simply by placing a fault on the one-line diagram. The sequence of
operations are automatically calculated and listed in an Event Viewer, which is dynamically linked with the one-line diagram. This one-step concept utilizes the intelligent one-line diagram and performs a complete set of actions to determine the operation of all protective devices. This includes internal shifting (normalizing) of each time-current characteristic curve based on the individual fault contribution level.

1. Click on the Fault Insertion (PD Sequence-of-Operation) from the Star (PD Coordination) toolbar and drop it on Bus1.
2. Click on the Sequence Viewer from the Star (PD Coordination) toolbar. The Viewer displays a tabulated sequence summary list of actions for the applicable protective devices.
7.10 Optimal Power Flow Analysis

The purpose of this tutorial is to introduce the Optimal Power Flow Analysis module of ETAP. As an example, it will be shown how to determine the optimal settings of system transformers. You will need to contact OTI with your Return Key Code so that you can activate this module.

1. Switch to Optimal Power Flow Analysis mode by clicking on this button on the Mode toolbar.

2. Open the Optimal Power Flow Study Case editor by clicking on the Edit Study Case button on the Study Case toolbar.

3. Open the Objective page to enter the purpose of your study by clicking on the Objective tab of the editor.

To enter the constraints and controls of the study, use the remaining pages of the Optimal Power Flow Study Case editor. Eligible system elements can be selected or deselected.

4. Run an Optimal Power Flow study by clicking on the Run Optimal Power Flow button on the OPF toolbar. You will be prompted to enter a name for your output reports, if Prompt is selected.
The results of the OPF study will appear in the OLD. For complete results, view the Output Reports. The amount of information that is displayed on the OLD can be changed in the Display Options. Note a new tap setting for transformer T2 is recommended.

Optimizing your system to fit a set of specified constraints is now possible with ETAP. The Optimal Power Flow Analysis module allows you to find the most advantageous way to configure your system.
7.11 Reliability Analysis

The purpose of this tutorial is to introduce the Reliability Analysis module of ETAP. It will be shown how to run a study, enter equipment reliability data, and view the results of your study. You will need to contact OTI with your Return Key Code so that you can activate this module.

Switch to the Reliability Analysis mode by clicking on the Reliability Assessment button on the Mode toolbar.

Select the study case named RA from the Study Case toolbar. To view or modify the conditions for the study, open the Reliability Analysis Study Case editor by clicking on the Edit Study Case button.

The reliability data for each element in your system can be viewed or modified within each element’s editor. This data can be picked from a library or entered manually.
Run a reliability study by clicking on the Run Reliability Assessment button on the Reliability Analysis toolbar. If Prompt is selected, you will need to enter a name for your output reports.

The results of the reliability study are shown on the OLD. The amount of data shown can be changed using the Display Options.

To view the resultant data and indexes for your system, you can open the Output Reports by clicking on the Report Manager button on the Study Case toolbar.

Determining the possibility of failure for different points in a system can accurately be accomplished with the Reliability Assessment module of ETAP. This can lead to conclusions on how to increase the overall reliability of your system.
7.12 DC Load Flow Analysis

The purpose of this tutorial is to introduce the DC Load Flow Analysis module of ETAP. Modifications to the DC Load Flow Study Case editor will be made, and the benefits of creating different loading scenarios will be investigated. You will need to contact OTI with your Return Key Code so that you can activate this module.

Switch to DC Load Flow Analysis mode by clicking on the DC Load Flow Analysis button.

Open the DC Load Flow Study Case editor by clicking on the Edit Study Case button on the Study Case toolbar.

The study parameters and limitations are specified in the Study Case editor. Click the Charger/UPS Operating Load box to update the Charger and UPS editors. Now, when a DC Load Flow study is performed, the Charger and UPS editors will reflect the calculated operating load. Also, check the Report Critical and Marginal Voltage boxes.
Run a DC Load Flow study by clicking on the Run DC Load Flow button on the DC Load Flow toolbar.

The results of the Load Flow calculation will appear in the OLD. Note that only flows to and from DC elements are shown. The amount of data displayed in the OLD can be changed using the Display Options. For complete result data, use the Output Reports. As with the AC Load Flow Analysis mode, a magenta colored bus represents a marginally under- or over-voltage condition, and a red colored bus represents a critical voltage condition.

Open the editor of Charger1 by double-clicking on the element graphic in the OLD. Click the Loading tab to open the Loading page. Note that the calculated Charger loading that appears in the OLD is also present here, as a result of the change made in the DC Load Flow Study Case editor. Click the Info tab to return to the Info page. Disconnect the Charger by clicking on the Out of Service box. Click OK to save and exit the editor.
Open the editor of UPS-1 by double-clicking on the element graphic. On the Info page of the UPS Editor, click the Out of Service box to disconnect the UPS. Now the only power source in the DC system is a battery.

If you run the DC Load Flow calculation again, you will be able to see the loading that will be placed on the battery under these conditions. Click the Run DC Load Flow Analysis button to run the study again. Note that this situation results in critically under-voltage buses. Conclusions may be drawn from creating scenarios such as this.

This is an example of a simple way to simulate a loss-of-power scenario in your facility. ETAP allows you to creatively customize scenarios to suit your needs.
7.13 DC Short-Circuit Analysis

The purpose of this tutorial is to introduce the DC Short-Circuit Analysis module of ETAP. It will also be shown how to create and save multiple study cases in the same project file. You will need to contact OTI with your Return Key Code so that you can activate this module.

Switch to DC Short-Circuit mode by clicking on the DC Short-Circuit Analysis button on the Mode toolbar.

Buses can be selected to be faulted or not by simply right-clicking on them and selecting Fault or Don’t Fault. Buses can also be selected for faulting from the Info page of the DC Short-Circuit Study Case editor. Deselect DeBus1 as a bus to be faulted.

Run a DC Short-Circuit study by clicking on the Run DC Short-Circuit button on the DC Short-Circuit toolbar. If Prompt is selected, you will be prompted to enter a name for the output reports.

The results of the study will be displayed on the OLD. The amount of data displayed can be changed in the Display Options. Full results can be viewed in the Output Reports.
You can create a new study case, based on the same OLD. Make the Project Editor the active window. Then, right-click the DC Short-Circuit study case folder, and select Create New. A new number will appear beside the folder, indicating the total number of study cases.

Select the new study case from the drop-down menu on the Study Case toolbar. Click the Study Case Editor button to open the new study case editor.
Give the new study case a name in the Study Case ID field on the Info page. Next, set up the study case conditions by selecting the desired criteria. Click OK to save the setup and exit the editor.

Now you can run a DC Short-Circuit Analysis with the new study case, by clicking on the Run DC Short-Circuit button on the DC Short Circuit toolbar as it was done previously. Note the change in fault current contribution from the charger.

With ETAP, you can easily create and save many different study case conditions, all within a single project file. By means of a simple drop-down menu, changing from one case to another is fast, and makes the comparison of results effortless.
7.14 Battery Sizing and Discharge

The purpose of this tutorial is to introduce the Battery Sizing and Discharge module of ETAP. Two functions can be performed within this module: You can determine the cell size necessary for your system with the Battery Sizing calculation, or analyze the performance of the existing battery with the Battery Discharge calculation. You will need to contact OTI with your Return Key Code so that you can activate this module.

Switch to Battery Sizing and Discharge Analysis mode by clicking on the Battery Sizing Discharge button on the Mode toolbar.

Open the Battery Sizing Study Case editor by clicking on the Edit Study Case button. This will allow you to choose the battery that is to be sized and to establish your sizing criteria. Choose Battery1 and click OK to accept the criteria defaults.

Run a Battery Sizing study by clicking on the Run Battery Sizing button on the Battery Sizing toolbar. You will be prompted to enter a name for your output reports, if Prompt is selected.
Once the calculation has completed, the recommended sizing data will be displayed in the OLD. Complete results are shown in the Output Reports. Note that this calculation used loading data from an internal load flow calculation. For convenience, the Battery Discharge Time-Slider allows you to view the power flows at any time interval.

You can also run a study based on a load summation method. You can change the method on the Info page of the study case editor. To modify the duty cycle of a piece of equipment, open the Element editor and click the Duty Cycle page. The duty cycle is a user-defined field that can be entered to reflect manufacturer or design specifications. A graphical summary of the each duty cycle is automatically shown.
Run a Battery Discharge study based on the existing battery characteristics by clicking on the Run Battery Discharge button on the Battery Sizing toolbar. The Battery Discharge Time-Slider may again be used to view the flow from the battery at any time interval.

The discharge plots can be viewed by clicking on the Battery Discharge Plots button on the Battery Sizing toolbar. The plots are an excellent way to analyze your results.

The Battery Sizing and Discharge module of ETAP allows you to analyze your most reliable source of backup power effectively. Showing results in both numerical and graphical form, the results from ETAP are easily interpreted.
7.15 Underground Raceway Systems
The purpose of this tutorial is to introduce the Underground Raceway Systems component of ETAP. It will be shown how to build a basic system, as well as perform calculations using an existing system. This module is disabled in the demo version.

Switch to the Project View window by clicking the Window button at the top of the screen, and selecting the appropriate choice.

Right-click the U/G Raceway Systems folder to begin a new Underground Raceway System. Select Create New by clicking on this. A new UGS window will appear, entitled “UGS3.”

Add a raceway by clicking on one of the four types of raceway buttons on the Edit toolbar.
Add a new conduit to this raceway by clicking on the New Conduit button on the Edit toolbar. Your UGS view should now look like this:

You can continue to add elements in this manner until your system is complete.

Switch to the existing “UGS1” by clicking on Window and selecting UGS1.

To perform cable derating calculations based on the active underground raceway system, click the U/G Cable Raceways button on the Mode toolbar.
Double-click the “soil” (the background of the UGS window) to open the Underground System editor. Here you can enter the temperatures that your calculations will be based on.

Run a Cable Derating calculation (Steady State Temp.) by clicking on one of the five calculation buttons on the Cable Derating toolbar.

To show the results, click Summary from the drop-down menu of the Study Case editor. Then click the Report Manager button. The calculated optimal cable sizes appear here.

### Summary (RW1)

<table>
<thead>
<tr>
<th>No.</th>
<th>Cable ID</th>
<th>Conduit/Location ID</th>
<th>Size</th>
<th>Current Amp</th>
<th>Temp. C</th>
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<tbody>
<tr>
<td>1</td>
<td>Cable 1-LH</td>
<td>Con 1</td>
<td>4.0</td>
<td>50.00</td>
<td>74.42</td>
</tr>
<tr>
<td>2</td>
<td>Cable 1-LB</td>
<td>Con 1</td>
<td>4.0</td>
<td>50.00</td>
<td>74.42</td>
</tr>
<tr>
<td>3</td>
<td>Cable 1-TC</td>
<td>Con 1</td>
<td>4.0</td>
<td>50.00</td>
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</tr>
<tr>
<td>4</td>
<td>Cable 2</td>
<td>Con 1</td>
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<td>206.00</td>
<td>91.92</td>
</tr>
<tr>
<td>5</td>
<td>Cable 3-LH</td>
<td>Con 1</td>
<td>2</td>
<td>47.00</td>
<td>121.78</td>
</tr>
<tr>
<td>6</td>
<td>Cable 3-LB</td>
<td>Con 1</td>
<td>2</td>
<td>47.00</td>
<td>121.78</td>
</tr>
<tr>
<td>7</td>
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<td>2</td>
<td>47.00</td>
<td>121.78</td>
</tr>
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<td>8</td>
<td>Cable 4-LH</td>
<td>Con 1</td>
<td>3.30</td>
<td>0.00</td>
<td>72.27</td>
</tr>
<tr>
<td>9</td>
<td>Cable 4-LB</td>
<td>Con 1</td>
<td>3.30</td>
<td>0.00</td>
<td>72.27</td>
</tr>
<tr>
<td>10</td>
<td>Cable 4-TC</td>
<td>Con 1</td>
<td>3.30</td>
<td>0.00</td>
<td>72.27</td>
</tr>
<tr>
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<td>Con 1</td>
<td>4.0</td>
<td>70.00</td>
<td>72.72</td>
</tr>
<tr>
<td>12</td>
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<td>Con 1</td>
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</tr>
<tr>
<td>13</td>
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<td>Con 1</td>
<td>4.0</td>
<td>70.00</td>
<td>72.72</td>
</tr>
<tr>
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<td>134.00</td>
<td>124.34</td>
</tr>
<tr>
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<td>Con 2</td>
<td>3.0</td>
<td>134.00</td>
<td>124.34</td>
</tr>
<tr>
<td>16</td>
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<td>Con 2</td>
<td>3.0</td>
<td>134.00</td>
<td>124.34</td>
</tr>
<tr>
<td>17</td>
<td>Cable 6-LA</td>
<td>Con 1</td>
<td>3.00</td>
<td>230.00</td>
<td>340.11</td>
</tr>
</tbody>
</table>
7.16 Ground Grid Systems

The purpose of this tutorial is to introduce the Ground Grid System component of ETAP. An overview of how to build a new ground grid system will be given. This module is disabled in the demo version.

The Ground Grid Systems Presentation is a separate application within ETAP. You can create new grid systems by clicking on the Ground Grid element button on the AC Edit toolbar and then clicking in your OLV to place the element. Double-click the grid graphic in the OLV to open the Ground Grid Presentation window. Choose a default calculation method to begin.

The Ground Grid Presentation will appear in a new window. Select a pre-defined grid by clicking on a choice from the IEEE toolbar. Click anywhere on the bottom blank section of the window to place the grid.
The Ground Grid Presentation window will now appear as below.

To add or remove rods or conductors from the grid, double-click within the T-Shape. On the Conductor page, you can change the number of conductors lying uniformly in the horizontal or vertical direction. On the Rods page, you can select a grounding rod configuration.

To view a three-dimensional display of the grid, use the scroll bars in the upper left corner of the Ground Grid Presentation window. For an automatic rotation around the vertical axis, double-click on the 3-D display.
You can also modify the resistivity and thickness of the layers of soil underneath your grid. Double-click anywhere in the soil portion, in the upper right corner of the Ground Grid Presentation. The Soil editor will appear.

Switch to calculation mode by clicking on the Ground Grid Study button on the Mode toolbar. Run a ground grid calculation by clicking this button on the Ground Grid toolbar.

The Summary and Alert window appears after the calculation has completed, notifying you of any exceeded conditions.
7.17 Cable Pulling Systems
The purpose of this tutorial is to introduce the Cable Pulling module of ETAP. It will be shown how to model a pull path, and how to run a calculation to determine the sidewall pressure and total tensions. This module is disabled in the demo version.

To begin a Cable Pulling study, activate the Project Editor view. Double-click the Cable Pulling Systems folder and select any existing study presentation. To create a new system, right-click on the Cable Pulling Systems folder and select Create New.

The characteristics of the pull can be outlined in the Study Case editor. To open this, click the Edit Study Case button on the Study Case toolbar. Set up the study conditions then click OK to save data and exit the editor.
To open the Conduit editor, double-click the conduit in the upper right portion of the Cable Pulling Presentation window. Set up the physical characteristics of the conduit, or leave defaults and click OK to save data and exit.

To add a cable to the conduit, click either the New Cable or Existing Cable button, and then click your mouse inside the conduit. The added cable will appear inside the conduit. To set up cable characteristics, double-click the cable. The Cable editor will be shown. To delete a cable from the conduit, simply click to select the cable, and press the delete key.

To add another segment of conduit to your pull path, click the New Segment button.

The physical characteristics of the routing itself can be entered using the fields in the bottom half of the Cable Pulling Presentations window. As the data is entered, the 3-D display in the upper left portion of the window will show the modifications.
Now that a pull path is laid out, you can run a calculation to determine the maximum tensions for your system. Click the Calc Cable Pull button to begin the calculation. You may be prompted to enter a name for your output reports.

If any specified condition on the study is exceeded, the Summary and Alert window will appear and the Alarm or Warning message will be shown.

The more detailed results of the calculation can be found below the input routing data. Note that exceeded conditions will be displayed in red.

The Cable Pulling Systems Presentation of ETAP makes planning or designing a new cable routing easy. Detailed data entry allows complex pull path geometry to be outlined, and therefore an accurate solution is obtained.
7.18 Panel Systems
The purpose of this tutorial is to introduce the Panel Systems module of ETAP. It will be shown how to connect panels to buses and to other panels, as well as how to enter loading data into the Panel Schedule page. Note that you cannot add new panels in this demo, but you can browse the existing panels in the example project.

Ensure that you are in Edit mode. Open the composite network Sub3 Net by double-clicking on it.

Connecting a panel to a bus is the same as with any other OLD element. The default connection pin of each panel is the top connector. Note how Panel11 is connected.

Double-click Panel11 to open the Panel editor. On the Info page, notice the panel is a three-phase element. On the Rating page, you will see that the rated voltage is 0.48kV to match the connected bus voltage.
On the Schedule page, the individual panel slots can be filled by clicking on the corresponding Link box, and selecting an option from the drop-down menu. If you want to connect a slot to an external element, choose one of the four Ext-X slots. Note connections #2 and #8 are designated external. The Summary page of the Panel Schedule editor details the total loading on the panel.

If you have a 3-phase panel and would like to attach a 3-phase load to it, you need to change the number of poles. As a result, three slots are used in the panel.
Add another panel to the OLD by following the steps above. You can connect this panel to an existing one by moving your mouse over the new panel’s connection pin and dragging it to the pin specified in the Panel Schedule of the existing panel (Ext-2).

Using the Load Flow Analysis Study Case editor, you can perform load flow calculations on your panel system. Click the Load Flow Analysis button on the Mode toolbar. Then click the Edit Study Case button on the Study Case toolbar. Check the box entitled Calc Panel Systems.

From here you can run a Load Flow study on your panel system in ETAP as outlined in the Load Flow Analysis tutorial. Note the power flows to and from the panels.
7.19 Output Reports

The purpose of this tutorial is to introduce the functions of the Output Reports in ETAP. The basic functions of displaying and printing the Crystal Reports will be shown, as well as more advanced features such as exporting report data to other programs and using the Text Report function.

Open your project file in ETAP and run a study. For the purposes of this tutorial, a Load Flow Analysis has been used. After the calculation has completed, choose a report from the drop-down list in the Study Case toolbar, and click the Report Manager button to display the selected report.

Alternatively, to display single or multiple reports at once, click the Report Manager button on the current Analysis toolbar. (In this case, it is the Load Flow toolbar.)

Note: As many as one report from each of the tabs in the Report Manager can be displayed.
The selected report will automatically display in a new window. To navigate through the report, use the arrows at the top of the window. To print a Crystal Report, click the Print button at the top of the window, and select your options from the resulting window.

Another useful function of the Output Reports is the option to export the result data to another program. Adobe Acrobat Reader, Microsoft Excel, and Microsoft Word are just a few of the programs to which output data can be exported. Click the Export button in the Crystal Report window, and select an application to receive the data. Then click OK.

The Output Reports and associated tools of ETAP are a fast and effective way to organize your analysis results. They make it easy to prepare presentations and summary documents by which to display your findings.
7.20 Libraries

The purpose of this tutorial is to introduce the library functions of ETAP. How to access, modify, export, and add to library data will be explained. The library provided with this demo version is a condensed form of the one available with the commercial version.

Open an ETAP project file. At the top of the screen, click the Library button. Depending on whether or not the project file has previously been connected to a library, a warning message may appear. This is simply to state that a library needs to be connected. Click OK on each message.

Connect to your project library by browsing to find the location and clicking the Open button. Once you have a library associated with your project file, you can use the data contained within this library file. There are a number of ways in which the active library can be accessed.
One way that the library can be accessed is from various element editors. Double-click an element such as a cable in the OLD to open the element editor. Click the Library button on the Info page to open the Cable Library Quick Pick window. Choose the desired voltage, type, and size of cable, and then click OK. The library data for the selected cable is automatically transferred to the editor of that cable.

To open a library with editing capabilities (providing that your user profile has editing authorizations), click the Library menu at the top of the screen and select the library you wish to view or edit. The selected library editor will appear.
You can edit, add, delete, or copy library elements by using the respective button from the library editor.

Another way in which library data can be accessed is through the Crystal Report format. Click the Library button at the top of the screen and select Export. Select the library you wish to view by clicking on the respective button and click OK. Note that more than one library may be selected at once. Finally, select the report you wish to view from the Library Report Manager, and click OK. The selected library will be displayed in Crystal Report format. See the Output Report tutorial for details. This feature is disabled in the demo version.
8. System Elements

**AC Elements, One-Line Diagram**
- Bus / Node
- Transformer, 2-Winding
- Transformer, 3-Winding
- Cable
- Transmission Line
- Reactor, Current-Limiting
- Impedance
- Power Grid (Utility System)
- Synchronous Generator
- Induction Motor / Generator
- Synchronous Motor
- Motor Operated Valve (MOV)
- Static Load
- Lumped Load
- Capacitor
- Harmonic Filter
- Panel Schedule
- Remote Connector
- Phase Adapter
- Static Var Compensator
- High Voltage DC Link
- Fuse
- Circuit Breaker, High Voltage
- Circuit Breaker, Low Voltage
- Contactor
- Switch, Single-Throw
- Switch, Double-Throw
- Current Transformer (CT)
- Potential (Voltage) Transformer (PT)
- Ground Grid System
- Voltmeter
- Ammeter
- Multi-meter
- Overcurrent Relay
- Voltage Relay
- Frequency Relay
- Motor Relay
- Solid State Trip Relay
- Reverse Power Relay
- Overload Heater
- Multi-Function Relay

**Elements, Ground Grid System**
- Grids
- Rods
- Conductors

**Nested Subsystems, One-Line Diagram**
- AC Composite Motor
- DC Composite Motor
- Composite Network

**DC Elements, One-Line Diagram**
- Bus / Node
- Cable
- Impedance
- DC-DC Converter
- Battery
- Motor
- Lumped Load
- Static Load
- Elementary Diagram
- Circuit Breaker
- Fuse
- Switch, Single-Throw
- Switch, Double-Throw

**AC-DC Elements, One-Line Diagram**
- Charger
- Inverter
- UPS
- VFD

**Elements, Underground Raceway Systems**
- Cable, One-Line
- Cable, Equipment
- Cable, UGS
- External Heat Source
- Duct Bank Raceway
- Direct Buried Raceway
- Conduit (Duct Bank)
- Location (Direct Buried)

**Elements, Cable Pulling Systems**
- Cable, One-Line
- Cable, Cable Pulling System
- Segment (Bend)
9. Online Help

The complete contents of the ETAP User Guide are included in the online Help file. There are several methods for displaying Help contents in the ETAP program.

- Help search
- Help for all editors
- Help line
- Function key <F1> Help
- Help from the project toolbar

Help Search
Click Help on the ETAP menu bar to conduct your Help search by using the index or by doing a word search. The Help window contains Contents, Index, and Search pages. The Contents page allows you to browse the help files chapter-by-chapter similar to the ETAP User Guide.

From the Index page you can view the Help index and display the contents of any item listed. To facilitate your search, type in the first few letters of the word or subject you are looking for. The index listing highlights the index item closest to what you have entered.
10. Analysis Capabilities

10.1 Load Flow

- Newton-Raphson, fast decoupled, and accelerated gauss seidel
- New double-precision Newton-Raphson method with current injection
- Advanced solution techniques for fast convergence
- Voltage drop calculations
- Load forecasting
- New alert view to display critical and marginal limit violations
- Bus/transformer/cable overload warning
- Single phase load flow display
- Option to select any loading category
- Global and individual bus diversity factors
- Individual demand factors for continuous, intermittent, and spare operating conditions
- Option to update the database from load flow solutions
- Lumped loads
- Phase-shifting transformer
- Power factor correction
- Automatically adjust transformer tap and LTC/regulator settings
- Generator governor/exciter control settings
- New summary output report on bus loadings and overload conditions
10.2 Short-Circuit

- Complete compliance with ANSI/IEEE C37 series
- Complete compliance with IEC 60056, 60282, 61363, 60781, 60909, 60947
- IEEE Standard 141 and 399, UL 489
- New Arc Flash Analysis module (NFPA 70e-2000) for determining incident energy and flash protective boundary (ANSI and IEC)
- Extensive manufacturer data for fuses, LV and HV breakers
- Automatic crest and interrupting duty comparison
- Automatic peak and breaking duty comparison
- New alert view to display critical and marginal limit violations
- 3-phase, line-line, line-ground, and line-line-ground faults
- ½ cycle to 30 cycle faults including 2, 3, 5, and 8 cycle breakers
- Breaking duty as a function of breaker time delay
- Interrupting duty as a function of breaker cycle time
- Fault impedance (Z1 and Z0)
- User-definable voltage c factor for IEC analysis
- Complete grounding modeling for motors, generators and transformers
- CB duty calculation based on the maximum-through fault current (ANSI)
- Phase-shifting transformer for ANSI unbalanced faults
- Check making and breaking capabilities of protective devices against fault currents
- Cable temperature adjustment
- User-selected bus faulting
- Report fault current contributions (IA and 3 I0) and voltage profiles (va, vb, and vc)
- User-selected fault current contribution level reporting
- Option to include motor delays
- Option to include feeder and overload heater elements
- Option to set pre-fault voltages (fixed values or load flow results)
- Option to use different X/R methods and c factors
- Option to consider motor contributions based on loading categories
- Updates directly to device coordination
10.3 Time-Current Device Coordination/Selectivity (ETAP Star)

- Sequence-of-operation
- Graphically adjustable device settings
- Extensive device library (verified and validated)
- Auto-update short circuit current
- Time-current device coordination
- Auto-coordinate devices
- Integrated with one-line diagrams
- Drag or calculate time differences
- Multi-function (universal) relays
- Built-in ARTTS hardware interface
- Display of actual transient response
10.4 Motor Acceleration
Note: Contact OTI with your Return Key Code to activate this module.
- Dynamic motor acceleration
- Static motor starting
- Multi-motor starting, stopping, and restarting in a single run
- Group starting/acceleration of motors and loads using starting categories
- Option to select any loading category for pre-start condition
- Option to accelerate motors and loads by load transition (loading categories)
- Option to use global or individual LTC time delays
- Dynamic simulation of LTCs and regulators
- Phase-shifting transformer
- Induction/synchronous motor/generator dynamic models
- Single-cage, single-cage with deep-bars, double-cage, and double-cage with independent circuits
- Start motors, loads, capacitors, MOV, etc.
- Comprehensive MOV closing and opening operation
- Motor load modeling
- Consider various starting devices including autotransformer, resistor, reactor, and capacitor
- Time-slider toolbar for continuous display of results on the one-line diagram
- User-customizable plots with option to overlay

Results Displayed on the One-Line Diagram Using Time-Slider

Motor Starting Plot Selector
Motor Current Plot of Accelerated Motors vs. Time
10.5 Transient Stability

Note: Contact OTI with your Return Key Code to activate this module.

- Simulate any combination of system disturbances and operations
- Induction/synchronous motor/generator dynamic models
- Frequency dependent machine models
- Frequency dependent network models
- Extensive dynamic machine models
- Phase-shifting transformer
- IEEE and selected manufacturer exciter, governor, and power system stabilizer models for generator
- Remote voltage control bus for all exciters
- Synchronous motor exciter/avr system
- User-defined dynamic models (UDM) interface for the following:
  - Exciter/AVR
  - Governor - turbine
  - Power system stabilizer
- Complete integration with User-Defined Dynamic Models for the Generator Start-Up Analysis
- Unlimited time events and actions
- Segment (fractional) faults for cables and transmission lines
- Time-slider toolbar for continuous display of results on the one-line diagram
- Automatic CB operation based on the following instantaneous relay settings:
  - Overcurrent (50)
  - Voltage (59/27)
  - Frequency (81)
  - Directional overcurrent (67)
  - Reverse power (32)
  - Motor overcurrent (50M)
  - Solid state trip (SST)
- User-customizable plots with option to overlay
- New plots for machine terminal impedance (for out-of-step relay setting)
- New plots for branch flows (MW, Mvar, MVA, and Amps)
- MOV starting
- Motor acceleration
- Motor load modeling
- Loss of excitation action
- Critical fault clearing time and system islanding time
- Fast bus transfer studies
- Impact loading and generator rejection
Action Editor for Faulting Buses, Closing Circuit Breakers, Accelerating Motors, etc.

An Example of Frequency Relay Settings for Automatic Load Shedding

10.6 Harmonic Analysis

Note: Contact OTI with your Return Key Code to activate this module.

- IEEE 519a Standard
- Harmonic load flow
- Harmonic resonance and frequency scan
- Model harmonic sources
- Filter overloading
- Filter design
- User-definable frequency range (0 to 6000 Hz)
- Generator and transformer saturation
- Phase-shifting transformer
- Harmonic distortion limits
- Total Root Mean Square Value (RMS)
- Total Arithmetic Summation Value (ASUM)
- Total Harmonic Distortion (THD)
Getting Started

- Telephone Influence Factor (TIF)
- I*T Index (I*T)
- User-customizable plots with option to overlay
- Customizable output reports using Crystal Reports format
- Graphical display of harmonic characteristics for components
- Harmonic-slider toolbar for display of harmonics on the one-line diagram
- Frequency-slider toolbar for display of frequency scan results on the one-line diagram

Plots of Voltage Waveforms, Current Spectrum, & Bus Impedance (Frequency Scan)
10.7 **Optimal Power Flow**

Note: Contact OTI with your Return Key Code to activate this module.

- Comprehensive objectives and constraints
- Determine all control settings
- Ensure all controls are within limits
- Ensure all bus and branch constraints are met
- Ensure all objectives are met
- Minimize system operating cost
- Maximize system performance
- Minimize real and reactive power losses and circulating reactive power
- Minimize real power exchange with other systems (utilities or power grids)
- Maximize voltage security index
- Maximize branch loading security index
- Minimize series and shunt compensation
- Minimize load shedding
- Minimize control movements/actions
- Minimize generation fuel cost
- Generator fuel cost minimization
- Utility electricity cost minimization
- Advanced load forecasting

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**Optimal Power Flow Study Case Editor**
10.8 Reliability Analysis

Note: Contact OTI with your Return Key Code to activate this module.

- Analysis includes protective device effects on fault isolation and load restoration such as replacement and alternative supply
- Analysis also includes single and double contingency effects.
- Radial, looped, and multiple isolated system configurations
- Model each component with its own reliability characteristics
- Implements the user-defined parameters and settings
- Calculate load point and bus reliability indices:
  - Average Failure Rate [$\lambda$]
  - Average Outage Duration [$r$]
  - Annual Outage Duration [$\mu$]
- Calculate system reliability indices:
  - System Average Interruption Frequency Index [SAIFI]
  - System Average Interruption Duration Index [SAIDI]
  - Customer Average Interruption Duration Index [CAIDI]
  - Average Service Availability Index [ASAI]
  - Average Service Unavailability Index [ASUI]
- Calculate reliability cost/worth indices for load points, buses, and system:
  - Expected Energy Not Supplied [EENS]
  - Expected Interruption Cost [ECOST]
  - Interrupted Energy Assessment Rate [IEAR]
- Rank element contributions to the cost/worth indices
- Sensitivity analyses for EENS and ECOST:
  - Element contributions to the EENS and their rankings
  - Element contributions to the ECOST and their rankings
- Customizable output reports using Crystal Reports format
10.9 DC Systems

Note: Contact OTI with your Return Key Code to activate this module.

The DC system is an integral part of electric power systems, interconnecting AC systems or providing power to control circuits, critical equipment, and backup systems during normal and emergency conditions. DC systems may include power sources (batteries, chargers, and generators), buses, motors, static loads, inverters, distribution networks, protective devices, and other vital support equipment.

The ETAP DC Systems module is an ideal tool to perform DC system studies. It provides a diverse array of DC components and calculation methods for conducting DC power system design and validation studies. It can handle any system configuration including radial, looped, and AC-DC interconnected systems. This module is based on the IEEE 308, 446, 485, and 946 Standards.

The ETAP DC Systems module allows you to model the DC power system as an integral part of the whole electric power system through AC-DC power conversion components, such as rectifiers, chargers, inverters, and UPSs. You can perform calculations on both the AC and DC system or on the DC system separately. The ETAP DC Systems module handles the interface between the AC and DC systems for calculations to imitate real operating conditions. ETAP provides numerous study types to perform DC power system studies, ranging from initial system design to final system validation.

DC Load Flow Calculation

The DC Load Flow Analysis module evaluates system voltage profiles and component loading conditions for a given loading category. DC batteries will take effect automatically whenever their terminal bus voltages are below the battery rated voltage.

- IEEE 308, 446, 485, 946 Standards
- DC load flow
- Voltage drop
- DC-DC converter elements
- Battery charger, inverter, and UPS elements
DC Load Flow Results Displayed on the One-Line Diagram
DC Short-Circuit Calculation
The DC Short-Circuit Analysis module is in compliance with the IEEE Std. 946. It determines and evaluates the ratings of system protective devices. It calculates the total fault current, contributions from different sources, and the time constant for fault current rise.

- IEEE 308, 446, 485, 946 Standards
- DC short-circuit
- Voltage drop
- DC-DC converter elements
- Battery charger, inverter, and UPS elements

Battery Sizing and Discharge Calculations
The Battery Sizing and Discharge calculations are in compliance with the IEEE Std. 485 and 308. They determine the appropriate size of the battery for a selected load duty cycle. The program considers constant current, constant power, and constant impedance loads. Voltage drops of system components are taken into account in the battery sizing calculation.

- Calculate battery discharge using an existing battery or using a battery that is automatically sized by ETAP
- Battery discharge using DC Load Flow method or load summation method
- Generate plots and reports using Crystal Reports
- Use different diversity and correction factors such as, temperature, aging, initial capacity, and initial conditions
- Plots for battery duty cycle, voltage, capacity, current, power and characteristics
- Plots for branch flow, bus voltage, and bus loading
10.10 **Underground Raceway Systems**

Note: Contact OTI with your Return Key Code to activate this module.

- Graphical user interface
- Multiple duct banks, direct buried, and external heat sources
- Non-uniform placement of ducts and direct buried conduits
- Transient cable temperature plotting
- External heat sources
- Grounded/ungrounded shielding
- One-line diagram database integration
10.11 **Ground Grid Systems**

Note: Contact OTI with your Return Key Code to activate this module.

The safety of people who work and live around electric power installations is of great concern. The proper design of a grounding system is a key element to improve safety conditions and to protect the lives of all individuals who are in close proximity to the electrical power systems. During unbalanced faults, the ground potential rise of a grounded structure presents a risk of electrocution to anyone who comes in contact with the grounded structure. ETAP provides a three-dimensional, fully graphical tool that allows for the design of a proper ground grid system, which adheres to IEEE or Finite Element Method (FEM) standards.
To begin working with the Ground Grid Systems, insert a ground grid on the one-line diagram by doing the following:

3. Click the Ground Grid button on the AC Edit toolbar.
4. Access the Ground Grid editor screen by double-clicking the ground grid itself from the one-line diagram and choosing the standard (IEEE or FEM) that you will use for the design.

- Analysis includes four different methods:
  - IEEE 80 - 1986
  - IEEE 80 – 2000
  - IEEE 665 – 1995
  - Finite Element
- Graphic user interface for conductors and rods
- Graphic soil view
- Handles irregular configurations of any shape
- Allows a two-layer soil model in addition to the surface material
- Unlimited conductors and rods
- Conductor segments can be oriented in any possible 3-D direction
- Complete integration with one-line diagram for elements placed on the grid and short-circuit values
- Calculates tolerable step and touch potentials
- Compares calculated step and touch potentials with tolerable limits
- Optimizes number of conductors with fixed rods
- Optimizes number of conductors and rods based on cost
- Calculate the maximum allowable current for conductors
- Compares allowable currents against fault currents
- Calculates ground system resistance
- Calculates ground potential rise (GPR)
- User-expandable conductor library
- Tabulates absolute, step, and touch potentials throughout the grid
- 3-D plot of grid configuration showing conductors and rods
- 3-D plots of absolute, step, and touch potentials
- Customizable output reports using Crystal Reports format
10.12 **Cable Pulling Systems**

Note: Contact OTI with your Return Key Code to activate this module.

The accurate prediction of cable pulling force is essential for the design of cable conduit systems. This knowledge makes it possible to avoid over-conservative design practices and achieve substantial capital savings during construction. The Cable Pulling Presentation of ETAP is used to determine the tensions and the sidewall pressures a cable is subjected to when pulled into a conduit. A point-by-point calculation method is performed at every conduit bend and pull point.

- 3-D isometric view
- Pull multiple cables
- Pull different size cables
- Vertical and horizontal levels
- Checks for NEC requirements
- Forward and reverse tension
- Sidewall pressure

![Cable Pulling Systems Presentation](image)
10.13 Panel Systems

Note: Contact OTI with your Return Key Code to activate this module.

ETAP allows for the modeling of electrical panels used in electrical power systems, directly on the one-line diagram. The number of panels that can be represented is unlimited since ETAP supports the nesting of panels. Therefore, a panel can be connected to a subpanel, and in turn, a subpanel can be connected to another downstream panel elsewhere in the circuit. Each panel can be modeled as a 3-phase or a single-phase panel. The 3-phase panels can be 3-wire or 4-wire configurations, while single-phase panels can be 2-wire or 3-wire configurations. Internally, each panel is comprised of protective devices and a collection of circuits that supply system loads.

Panels are added to the one-line diagram by clicking on the Panel Systems button located in the AC Edit toolbar and dropping the panel anywhere on the one-line diagram. Once added to the diagram, double-clicking on the panel will open the Panel editor for editing panel and circuit information. The user can customize useful information such as Panel ID, Phase Connections, Panel Rating, Number of Circuits, Circuit Schedule, and Load Summary.

- 3-phase 3-wire and 4-wire panels
- 1-phase 2-wire and 3-wire panels
- Graphic user interface
- Unlimited circuits with or without external connections
- Unlimited subpanel connections
- External (graphical) load and branch connections
- Load flow display
- Spreadsheet load modeling
- Column and standard layouts
- ANSI and IEC standard panels
- Extensive switching device libraries
- Comprehensive circuit feeder/cable libraries
- User-configurable defaults and layouts
- Dynamic subpanel and main-panel systems updates
- User selectable load types (LCL, NCL, warehouse, receptacle, hospitals, etc.)
- User modifiable demand and diversity factors (NEC and others)
- Ten loading categories per circuit
- Customizable panel system reports using Crystal Reports format
- Intelligent panel calculations
- Detailed panel loading summary
10.14 Transformer Sizing
Note: Contact OTI with your Return Key Code to activate this module.

The Transformer Sizing module of ETAP is accessible through the 2-Winding Transformer editor. From this editor, there are two sizing calculations: Transformer MVA Sizing and Transformer Tap Optimization.

Transformer MVA Sizing
The 2-Winding Transformer MVA Sizing calculation sizes the transformer rated MVA, maximum MVA, and %Z based on the transformer loading, installation, insulation level, and short-circuit duties. Load variation factors can also be included in the sizing calculation.

- Sizing Based on the Actual Connected or Operating Load
- Includes ANSI & IEC Standard Types, Classes & Ratings
- Considers Ambient Temperature, Altitude, Growth, & Loading Factors, etc.
Transformer Tap Optimization
This calculation is to optimize a generator unit transformer tap ratio based on ANSI standards. The first calculation is hereafter referred to as Transformer MVA Sizing, whereas the second calculation is referred to hereafter as Transformer Tap Optimization.

- IEEE CSF.116 Standard
- Optimize Transformer Tap Setting or Turns Ratio
- Considers Cables Connected to Primary & Secondary Side of Transformer
- Considers System Voltage Variation
- Plot Generator Mvar Output vs. System Voltage
10.15 Parameter Estimation

Note: Contact OTI with your Return Key Code to activate this module.

The ETAP Parameter Estimation module calculates equivalent circuit model parameters for induction machines and synchronous motors at starting condition. The calculation is based on an advanced mathematical estimation and curve fitting technique, which requires only the machine performance characteristic data. This data is readily available from machine manufactures or obtainable from field tests. The estimated model parameters include the resistances and reactances representing the machine stator, rotor, and magnetizing branches characteristics. The estimated model together with its parameters can be used to represent the machine dynamics during motor starting and transient stability studies.

- Estimate dynamic parameters of induction machines
- Include parameter variations due to speed and/or deep-bar effects
- Requires most readily-available characteristics published by MFRs
- Calculate input parameters using estimated results and report deviations

Induction Machine Editor & Parameter Estimation Page
10.16 Transmission Line Sag, Tension, and Ampacity

Note: Contact OTI with your Return Key Code to activate this module.

- Overhead line parameters and coupling
- Sag/tension vs. temperature
- Conductor ampacity vs. temperature
- Physical parameter to impedance calculator
- Multiple spans between dead-end structures
- Level spans of unequal length
- Include effects of wind, temperature, and k factor
10.17 **Arc Flash**

Note: Contact OTI with your Return Key Code to activate this module.

- IEEE 1584-2002 Standard
- Integrates with Short-Circuit
- Integrates with Star
- Use with both ANSI and IEC
- Cubic box and open air
10.18 User-Defined Dynamic Modeling

Note: Contact OTI with your Return Key Code to activate this module.

- Build your own governor/turbine, exciter/AVR, and power system stabilizer control block diagrams for Transient Stability analysis
- Large selection of control blocks and elementary functions
- Stand-alone test model performance including isolated step response
- Complete integration with Generator Start-Up analysis
- Run-time compile within ETAP
- Utilize models within the Transient Stability analysis
- Select user-built models within generator editors
- Utilizes block diagrams generated by Simulink®
- Implement system-wide operations such as load shedding, fast bus transfer, islanding, etc.
- Requires Transient Stability analysis
10.19 **Optimal Capacitor Placement**

Note: Contact OTI with your Return Key Code to activate this module.

- Optimal location and bank size
- Minimize installation and operation cost
- Voltage support and power factor correction
- Capacitor control method
- Branch capacity release and cost saving
- Review capacitor impact on the system