



# Network Analysis

**Short Circuit - ANSI**

**Short Circuit - IEC**

**Load Flow**

**Motor Acceleration**



# Power System Enterprise Solution

ETAP is the most comprehensive analysis platform for the design, simulation, operation, control, optimization, and automation of generation, transmission, distribution, and industrial power systems.

# Customize ETAP to fit your needs, from small to large power systems

ETAP Enterprise Suite provides one solution to your power system design, analysis, and operation needs. ETAP offers a comprehensive suite of analysis modules that can be configured to suit your specific needs. This modular approach allows you to purchase only the modules you need.

◆ Featured in this brochure



## Intelligent Load Shedding

- Adaptive Load Shedding
- Automatic Islanding
- Load Preservation & Management
- System Restoration & Control
- Load Shedding Validation

## Star Protective Devices

- Protection Coordination & Selectivity
- Sequence-of-Operation
- Relay Test Set Interface

## Distribution

- Unbalanced Load Flow
- Optimal Power Flow
- Transformer Tap Optimization
- Switching Sequence Mgmt.
- Reliability Assessment
- Optimal Capacitor Placement
- GIS View

## Base Package

- Cable Ampacity & Sizing
- Transmission Line Constants
- Report Manager
- Project Management Wizards
- Output Report Comparator
- Multi-Dimensional Database
- Libraries

## Cable Systems

- Cable Sizing - Phase
- Cable Sizing - Grounding/PE
- Cable Ampacity
- Electric Shock Calculation
- Underground Thermal Analysis
- Cable Pulling

## Data Exchange

- DataX
- MS Access® & Excel®
- CAD Interface
- e-DPP® Interface
- SmartPlant® Interface
- Third-Party Software

## Transmission Line

- Line Constants
- Line Ampacity
- Mutual Coupling
- Sag & Tension
- HV DC Transmission Link

## Arc Flash

- AC Arc Flash
- DC Arc Flash
- Result Analyzer
- Sequence Viewer

## Monitoring & Simulation

- Real-Time Monitoring
- State Estimation
- Energy Accounting
- Predictive Simulation
- Event Playback
- Load Forecasting

## Ground Grid Systems

- Finite Element Method
- IEEE 80 Method
- IEEE 665 Method

## Dynamics & Transients

- Transient Stability
- Generator Start-Up
- Wind Turbine Generator
- User-Defined Dynamic Model
- Parameter Estimation

## Network Analysis

- Short-Circuit – ANSI
- Short-Circuit – IEC
- Load Flow
- Motor Acceleration

## Energy Management System

- Automatic Generation Control
- Economic Dispatch
- Supervisory Control
- Interchange Scheduling
- Reserve Management

## User-Defined Dynamic Modeling

- Graphical Logic Editor
- Transfer Function Blocks
- Import/Export to Simulink®
- Excitor/Governor/Stabalizer
- Generic Load

## Panel Systems

- ANSI Panel
- IEC Panel
- Code Factors
- Schedule Reports

## Renewable Energy

- Wind Turbine Generator
- Wind Farm
- Photovoltaic Array

## Intelligent Substation

- Substation Automation
- Switching Management
- Load Management
- Smart Grid
- Micro Grid

## Power Quality

- Harmonic Load Flow
- Frequency Scan
- Harmonic Filters

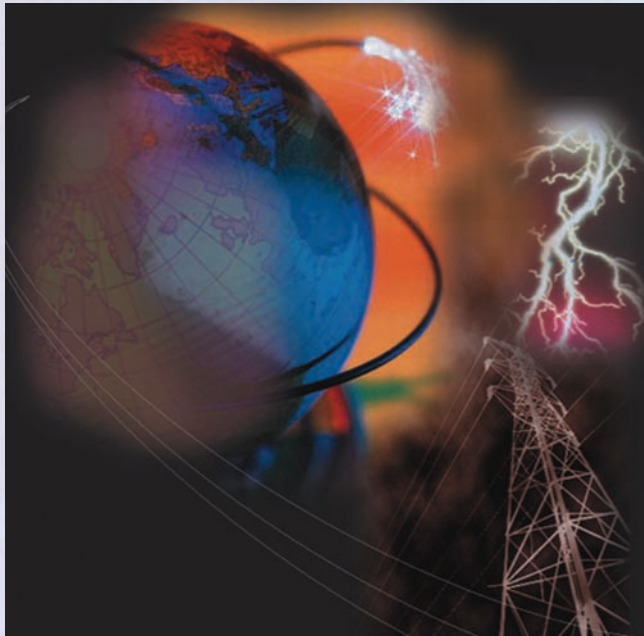
## DC Systems

- Load Flow
- Short-Circuit
- Control System Diagram
- Battery Discharge
- Battery Sizing



# Short-Circuit ANSI & IEC

Instant Results, Comprehensive, Graphical Summary



**ANSI / IEEE Standards C37 & UL 489**

**IEC Standards 60909 & 61363**

**Automatic Device Evaluation for  
3-Phase, 1-Phase, & Panel Systems**

**Load Terminal Short Circuit Calculation**

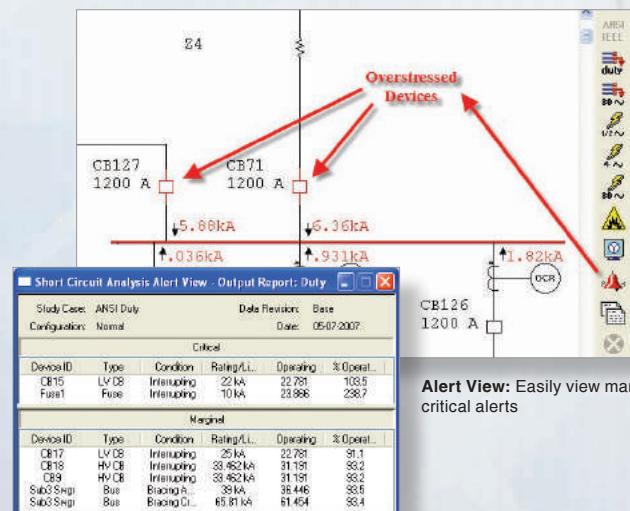
**Display Critical & Marginal Alerts**

## As Easy as **1, 2, 3**

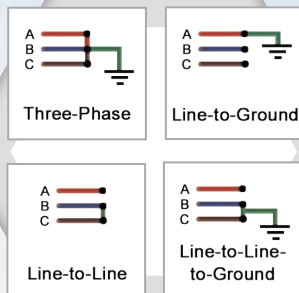
Save hours of tedious hand calculations and take the guesswork out of short circuit studies by automating the process with multiple calculation and result analysis tools within ETAP.

The Short-Circuit module makes it easy to go from selecting elements from the comprehensive libraries of short circuit current ratings to performing dozens of different types of short circuit analysis with the purpose of finding the worst-case device duty. Built-in intelligence allows it to automatically apply all ANSI / IEEE or IEC factors and ratios required for high- and low-voltage device duty evaluation. Determine fault currents and automatically compare these values against manufacturer short circuit current ratings. Overstressed device alarms are automatically displayed on the one-line diagram and reports.

The Short-Circuit module seamlessly integrates with device coordination and performs arc flash hazard calculations.



**Alert View:** Easily view marginal and critical alerts

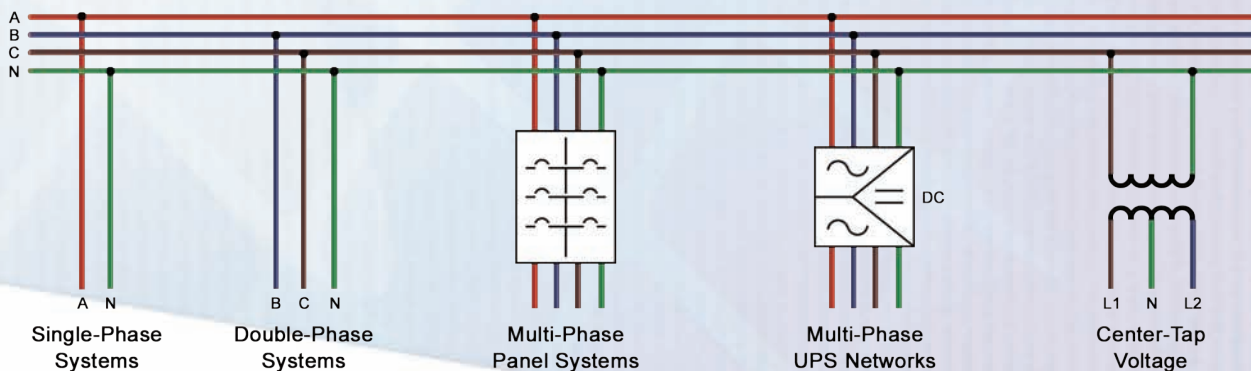
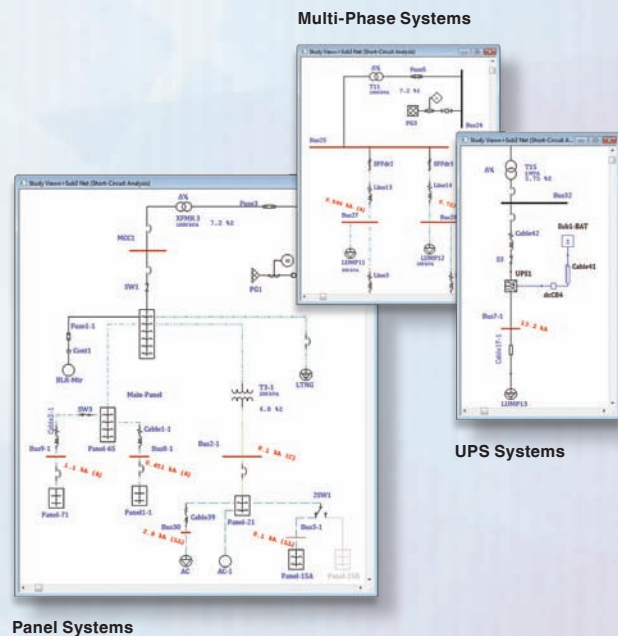


## Device Duty Calculation & Evaluation for Single & Multiple-Phase Systems, Panel, & UPS

ANSI and IEC standards are used for calculating short circuit current for parts of the network below main panels, subpanels, UPS, and phase adapters. Device duty calculation compares the calculated fault current from these networks for evaluation of protective devices and automatically generates critical and marginal alerts based on user-defined alarm limits.

### Capabilities

- Automatic 3-phase device evaluation
- Device evaluation based on total or maximum through fault current
- Automatically adjust conductor resistance & length (both lines & cables)
- Global or individual device impedance tolerance adjustments for maximum & minimum fault currents
- Include / exclude fault impedance modeling for unbalanced faults
- Include / exclude shunt admittance for branches & capacitive loads (unbalanced faults)
- Graphical or tabular bus fault selections
- Automatically determine fault currents at motor terminals without the need to add additional buses
- Phase-shifting transformers
- Grounding models for generators, transformers, motors, & other loads
- Motor contribution based on loading category, demand factor, or both
- Extract manufacturer published data from the libraries for thousands of devices



# ANSI / IEEE Standards



## Features

- 1-phase & panel systems device evaluation
- Determine maximum & minimum short circuit fault currents
- Calculate ½ cycle, 1.5–4, & 30 cycle balanced & unbalanced faults (3-phase, L-G, L-L, L-L-G)
- Check momentary & interrupting device capabilities
- Check closing & latching capabilities
- Evaluate symmetrical or total rated circuit breakers
- Special handling of generator circuit breakers for system & generator faults
- Interrupting duty as a function breaker contact parting time
- Standard & user-definable contact parting time
- Automatically includes No AC Decay (NACD) ratio
- User options for automatic adjustment of HVCB rating

## Standards

- IEEE C37.04 Standard Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current including Supplements: IEEE C37.04f, IEEE C37.04g, IEEE C37.04h, IEEE C37.04i
- IEEE C37.010 Standard Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current
- IEEE C37.010b Standard and Emergency Load Current-Carrying Capability
- IEEE C37.010e Supplement to IEEE C37.010
- IEEE C37.13 Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures
- IEEE C37.013 Standard for AC High-Voltage Generator Circuit Breakers Rated on a Symmetrical Current Basis
- IEEE C37.20.1 Standard for Metal Enclosed Low-Voltage Power Circuit Breaker Switchgear
- IEEE 399 Power System Analysis – the Brown Book
- IEEE 141 Electric Power Distribution for Industrial Plants – the Red Book
- IEEE 242 IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems – the Buff Book
- UL 489\_9 Standard for Safety for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures

## Reporting (ANSI & IEC)

- Load terminal fault current reporting
- Automatically flag marginal & critical overstressed devices
- Individual fault current contributions for  $I_{sym}$ ,  $I_a$ , &  $3I_0$
- Phase & sequence voltage profiles ( $V_a$ ,  $V_b$ ,  $V_c$ ,  $V_1$ ,  $V_2$ , &  $V_0$ )
- Phase & sequence current profiles ( $I_a$ ,  $I_b$ ,  $I_c$ ,  $I_1$ ,  $I_2$ , &  $I_0$ )
- Phase & sequence impedances
- Alert view to display critical & marginal limit violations
- Export one-lines with short circuit results to third party CAD applications
- Input data, detailed individual & total short circuit contributions, & summaries
- Enhanced state-of-the-art graphic display of results for balanced & unbalanced faults
- Export output reports to your favorite word processor or spreadsheet
- Full color customizable Crystal Report® viewers

Bus ID	ID	Load Type	KV	HP&KW	KVA	Feeder Z (ohm)		1/2 Cycle Short-Circuit Current		
						Heater & Cable R	Cable X	Sytem	Load	Total
Bus23A	Mtr1	Ind. Motor	0.380	100.00	118.05	0.01658	0.00987	7.88	0.957	8.701
LVBUS	Syn2	Syn. Motor	0.460	150.00	134.22	0.00944	0.00336	11.44	0.892	12.286
LVBUS	Load1	Static Load	0.480	280.41	280.41	0.00261	0.00335	13.10	0.000	13.097
LVBUS	CAP2	Capacitor	0.480	20.00	20.00	0.00102	0.00041	15.33	0.000	15.327
LVBUS	MOV1	MOV	0.460	15.00	14.74	0.15087	0.02270	1.80	0.000	1.797
MCC1	Mtr6	Ind. Motor	0.460	120.00	53.74	0.00000	0.00000	17.49	0.354	17.843
MCC1	Mtr4	Ind. Motor	0.460	125.00	110.12	0.00000	0.00000	17.11	0.731	17.843
MCC1	Mtr3	Ind. Motor	0.460	75.00	66.20	0.00000	0.00000	17.41	0.437	17.843

Reporting: Load terminal fault current reporting



# IEC Standards

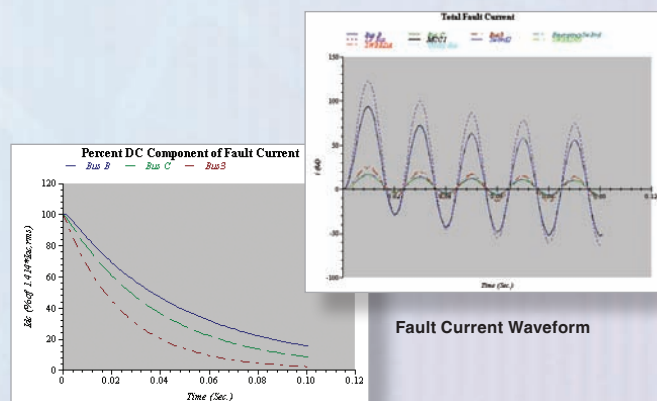


## Features

- 1-pole / 2-pole short circuit device duty for 1-phase panel / UPS systems
- Unbalanced L-G, L-L, & L-L-G faults analysis
- Transient IEC 61363 short circuit calculations
- Compares device ratings with calculated short circuit values
- User-definable voltage C factor
- Service or ultimate short circuit current ratings for LVCB breaking capability
- User-definable R/X adjustment methods for  $I_p$  (method A, B, or C)
- Phase-shifting transformers
- Negative or positive impedance adjustments for max/min  $I''_k$  &  $I_k$
- Automatic application of K correction factors (i.e., KT, KG, KSO)
- Automatically determines meshed & non-meshed networks for calculating  $I_b$ ,  $I_k$ , &  $I_{dc}$
- $I_b$  for meshed network is adjusted by individual machine contributions for improved accuracy
- Considers both near & far from generator short circuits
- Generates relay test set compatible plots for transient short circuits
- Detailed IEC device duty reports & complete contributions for unbalanced faults

## Standards

- IEC 62271-100 High-Voltage Switchgear and Controlgear, Part 100: High-Voltage Alternating-Current Circuit Breakers
- IEC 62271-200 High-Voltage Switchgear and Controlgear, Part 200: AC Metal-Enclosed Switchgear and Controlgear for Rated Voltages Above 1 kV and up to and including 52 kV
- IEC 62271-203 High-Voltage Switchgear and Controlgear, Part 203: Gas-Insulated Metal-Enclosed Switchgear for Rated Voltages Above 52 kV
- IEC 60282-2 High-Voltage Fuses, Part 2: Expulsion Fuses
- IEC 60909-0 Short Circuit Currents in Three-Phase AC Systems, Part 0: Calculation of Currents (including 2002 Corrigendum 1)
- IEC 60909-1 Short Circuit Currents in Three-Phase AC Systems, Part 1: Factors for the Calculation of Short Circuit Currents According to IEC 60909-0
- IEC 60909-2 Electrical Equipment – Data for Short Circuit Current Calculations in Accordance with IEC 909 (1988)
- IEC 60909-4 Short Circuit Currents in Three-Phase AC Systems, Part 4: Examples for the Calculation of Short Circuit Currents
- IEC 60947-1 Low Voltage Switchgear and Controlgear, Part 1: General Rules
- IEC 60947-2 Low Voltage Switchgear and Controlgear, Part 2: Circuit Breakers
- IEC 61363-1 Electrical Installations of Ships and Mobile and Fixed Offshore Units, Part 1: Procedures for Calculating Short Circuit Currents in Three-Phase AC



Fault Current Waveform

# Load Flow Analysis

One Program, One Database, One Solution



## Create & Validate System Models with Ease & Accuracy

With ETAP's advanced Load Flow module, you can create and validate your system model with ease and obtain accurate and reliable results. Built-in features like automatic device evaluation, summary alarms / warnings, result analyzer, and intelligent graphics make it the most efficient Load Flow program available today.

ETAP calculates bus voltages, branch power factors, currents, and power flows throughout the electrical system. ETAP allows for swing, voltage regulated, and unregulated power sources with multiple power grids and generator connections. It is capable of performing analysis on both radial and loop systems. ETAP allows you to select from several different methods in order to achieve the best calculation efficiency and accuracy.

**Voltage Drop**

**Power Factor Correction**

**Automatic Device Evaluation**

**Automatic Temperature Correction**

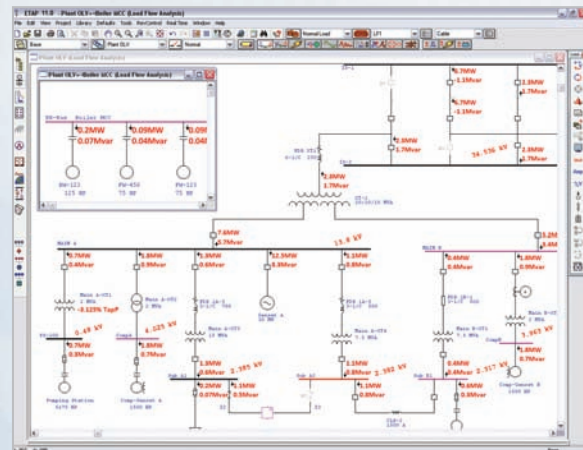
**2W & 3W Transformer LTC / Regulator Actions**

**Real & Reactive Power Losses**

**Auto-Run Based on System Changes**

**Extensive Violation Alerts**

**Multi-Report Result Analyzer**



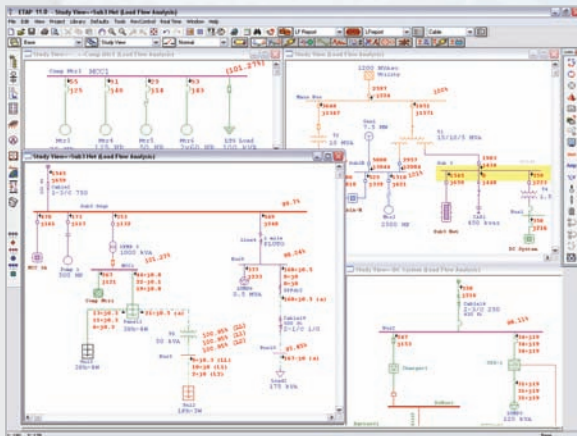
**Intelligent Graphics:** State-of-the-art graphical display of results including voltage drop, load terminal voltage, branch losses, and transformer LTC settings



# Most Efficient Load Flow Program Available

## Study Options

- Option to update initial conditions
- Phase-shifting transformers
- Auto-adjust LTC / regulator settings
- Power factor correction
- Saves solution control parameters for each scenario
- Make changes to your system & re-run studies instantly
- Conduct unlimited "what if" studies within one database
- Calculate bus voltages, currents, & power factors
- Bus / transformer / cable reactor overload warnings
- Calculate power flows
- Update loading for DC load flow
- Voltage drop calculations
- Five levels of automatic error checking



**3-Phase and 1-Phase Power Flow:** Calculate power flow for 3-phase, 1-phase, panel, and UPS systems simultaneously

## Capabilities

- Simulate multiple loading & generation conditions
- Automatically adjust transformer tap & LTC / regulator settings
- User-controlled convergence parameters
- Compare & analyze multiple reports using result analyzer
- Include effect of phase-shifting transformers
- View results graphically
- Evaluate critical & marginal limit violations
- Solve 3-phase & 1-phase system load flow simultaneously
- Isolated 1-phase source modeling

## Flexible Operation

- Diverse operating conditions
- Multiple loading categories
- Multiple demand factors
- Different model of lumped loading
- Unlimited configurations
- Different nameplate data
- Global & individual bus diversity factors

Critical Report							
Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Fuse3	Fuse	Overload	300.000	Amp	442.932	113.6	3-Phase
Sub3 Segr	Bus	Overload	225.000	Amp	233.625	103.8	3-Phase

Marginal Report							
Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus10	Bus	Under Voltage	2.402	kV	2.345	97.6	A
Bus2	Bus	Under Voltage	0.480	kV	0.461	96.1	3-Phase
MCC1	Bus	Over Voltage	0.480	kV	0.486	101.3	3-Phase
Sub22	Bus	Under Voltage	3.450	kV	3.324	96.4	3-Phase

Load Flow Analysis Alert View - Output Report: LFReport							
Device ID	Type	Condition	Rating/Limit	Operating	% Operating	Phase Type	
Bus1	Bus	Under Voltage	0.48 kV	0.451	93.9	3-Phase	
Bus10	Bus	Under Voltage	2.402 kV	2.231	92.9	A	
Bus2	Bus	Under Voltage	0.48 kV	0.437	91.1	3-Phase	
		Under Voltage	4.16 kV	3.98	95.3	3-Phase	
		Overload	200 Amp	203.192	101.6	3-Phase	
		Overload	300 Amp	456.519	117.1	3-Phase	
		Over Exceeded	5.627 Mvar	5.827	100	3-Phase	
		Under Voltage	0.48 kV	0.448	93.6	3-Phase	
		Under Voltage	4.16 kV	3.943	94.8	3-Phase	
		Overload	225 Amp	226.195	105	3-Phase	
		Overload	12 MVA	12.5	104.2	3-Phase	

Marginal							
Condition	Rating/Limit	Operating	% Operating	Phase Type			
Under Voltage	0.48 kV	0.462	96.5	3-Phase			
Under Voltage	0.24 kV	0.22	96	L1			
Under Voltage	13.8 kV	13.471	97.6	3-Phase			
Over Voltage	13.8 kV	14.055	101.9	3-Phase			
Overload	175 Amp	184.14	105.1	3-Phase			
Under Voltage	0.48 kV	0.462	96.3	3-Phase			

**Automatic Device Evaluation:** Automatically generate critical and marginal alerts for overstressed 3-phase and 1-phase systems

# Simultaneous Analysis of Different Scenarios

## Load Flow Result Analyzer

ETAP Load Flow Result Analyzer is a time-saving tool that compares and analyzes multiple reports in a single view. You can compare the results of general information about a project or more specific information such as the load flow results for buses, branches, loads, or sources.



- Understand results of multiple studies in one glance
- Compare & view multiple load flow results in a single view
- Analyze & compare reports from multiple projects
- Create a base line report & quickly identify deviations for all cases
- View multiple bus, branch, load, & source results
- Advanced alert & warning feature identifies & highlights overstressed components
- Easily find components on one-line diagrams from the analyzer view
- Export summary view into Microsoft® Excel for maximum data flexibility & visualization

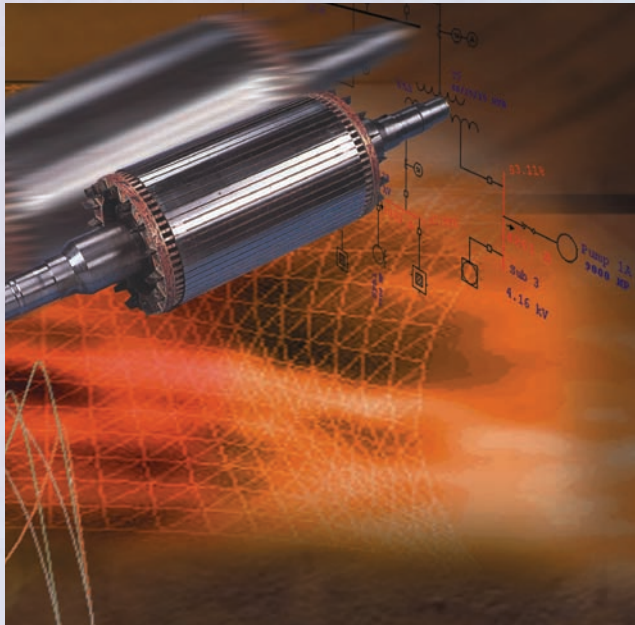






# Motor Acceleration

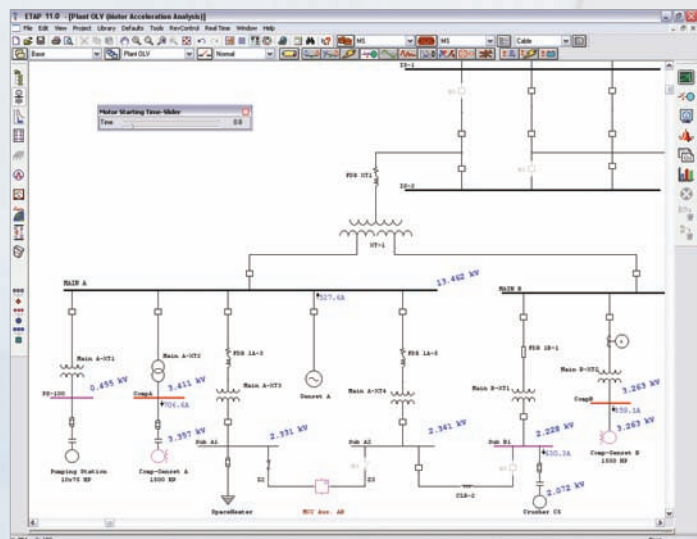
Intuitive, Intelligent, Incomparable



## Advanced Technology in Motor Evaluation & Simulation

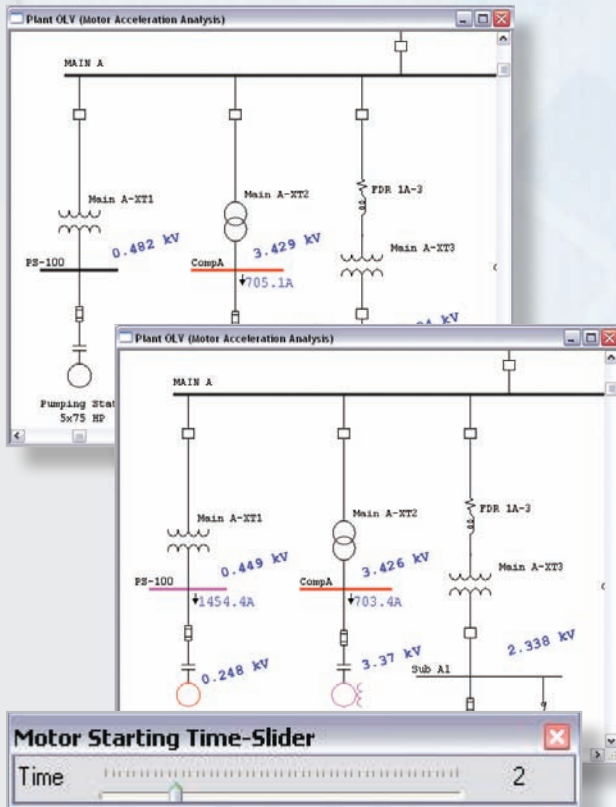
The Motor Acceleration module enables engineers to thoroughly evaluate the impact of load changes to electric power systems. Motor Acceleration is fully capable of starting one motor or transitioning an entire power system to another state. Sequence-start a series of machines using static or dynamic models, operate Motor Operated Valves (MOVs), and simulate the switching actions of Load Tap Changers. Advanced plotting and time varying graphical display enable engineers to quickly evaluate results and make decisions.

- Dynamic Motor Acceleration
- Static Motor Starting
- Voltage Flicker
- Motor & Load Dynamic Models
- Conventional & Soft Starting Devices
- VFD Frequency Control Motor Starting
- Multi-Sequence Starting
- Load & Generation Transitioning
- Comprehensive Alarm & Warning
- Motor Operated Valve (MOV) Simulation



Accelerate Multiple Motors: Start multiple motors using unlimited sequence of events

# Quickly Evaluate Results & Make Decisions



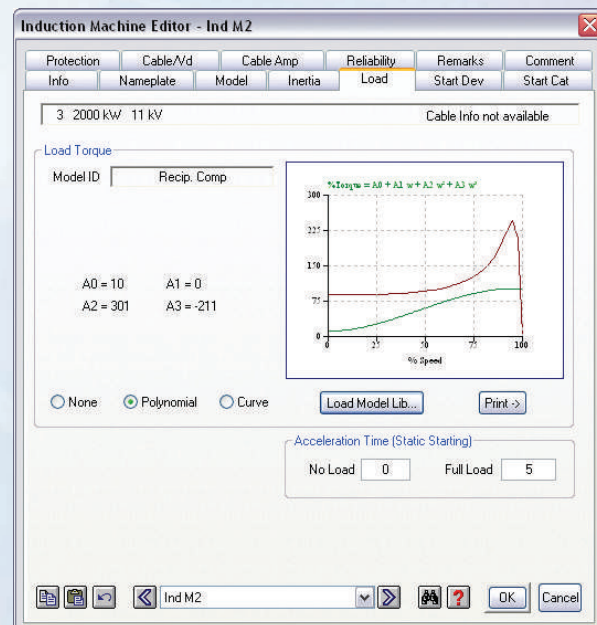
**Motor Starting Time Slider:** View time domain results graphically

## Capabilities

- Accelerate / stop multiple motors
- Dynamically model motors & loads
- Create unlimited sequence of events
- Compare the response from various motor starters
- Simulate load ramping of starting motor
- Transition loading of entire system
- Vary generator / grid operating parameters
- Visualize results with extensive alerts & warnings
- Simulate transformer LTCs / voltage regulators
- Simulate MOVs with five operating stages

## Comprehensive Modeling

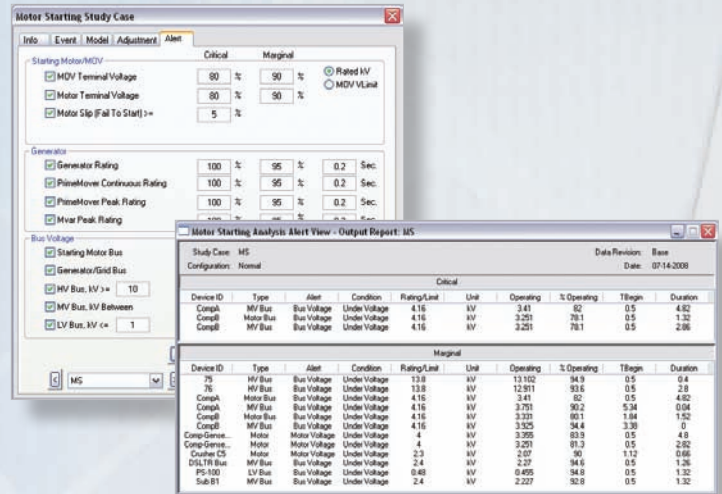
- No voltage or system connection limitations
- Induction / synchronous motor dynamic models
- Typical & user-defined load models
- Global or individual LTC time delays
- Transformer phase shift
- Motor acceleration with VFD & soft starters
- Starting devices: auto-transformer, capacitor, rotor / stator R or X, Y/ $\Delta$ , partial winding, etc.
- Voltage, current, or torque controlled soft starters
- Five levels of automatic error checking



**Dynamic Modeling:** Complete modeling of machines and connected load

## Reporting

- Graphical display of time-varying results
- Auto-alert abnormal conditions with marginal or critical levels
- Graphically display buses with marginal or critical voltage levels
- Comprehensive plots with operation details
- Export one-line diagrams including results to third party CAD systems
- Export to your favorite word processing program



User-Defined Alerts: Automatically flag marginal and overstressed devices

## Automatic Result Validation / Alert

- Motor start failure
- Under-voltage for starting motor / MOV
- Under-voltage buses per bus type & voltage level
- Overloaded generator & prime mover
- User-defined marginal & critical alert limits

## Libraries & Models

- Double-cage (dependent circuit)
- Double-cage (independent circuit)
- Single-cage (without deep-bar)
- Single-cage (deep-bar)
- Characteristic motor model
- Polynomial & characteristic load models

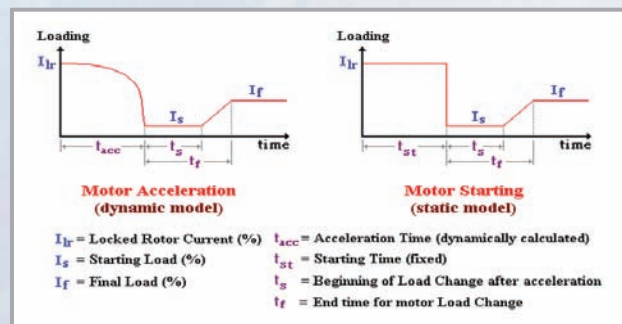
Project: ETAP PowerStation Example 3	ETAP	Page: 1
Location: Lake Forest, California	6.0 DC	Date: 07.14.2008
Contract: OTT1234567890		SN: ETAP-OTT
Engineer: Operation Technology, Inc.	Study Case: MS	Revision: Base
Filename: Example3		Config: Normal

This info is printed on top of every output report, 1st remark line. (120 characters)

	% Alert Settings		
	Critical	Marginal	
<b>Starting Motors/MOV</b>			
MOV Terminal Voltage	≤ 80.00	90.00 (Vntr. rate)	
Motor Terminal Voltage	≤ 80.00	90.00 (Vntr. rate)	
Failed to Start, Slip Rept	≥ 5.00		
<b>Generator/Engine/Exciter Rating</b>			
Generator Rating	100.00	95.00	Min. Span (Sec.)
Engine Continuous Rating	100.00	95.00	
Engine Peak Rating	100.00	95.00	
Exciter Peak Rating	100.00	95.00	
<b>Bus Voltage Group</b>			
Starting Motor Bus	VBus ≤ 80.00	90.00	Min. Dip Width (Sec.)
Grid/Generator Bus	VBus ≤ 92.00	95.00	
MV Bus, kV ≤ 10.00	VBus ≤ 90.00	95.00	
MV Bus, 10.00 > kV > 1.00	VBus ≤ 90.00	95.00	
LV Bus, kV ≤ 1.00	VBus ≤ 90.00	95.00	

Critical Report									
DeviceID	Type	Alert	Condition	Rating/Limit	Unit	Operating	% Operating	T Begin	Duration
CompA	MV Bus	Bus Voltage	Under Voltage	4.16	kV	3.40	82.0	0.500	4.820
CompB	Motor Bus	Bus Voltage	Under Voltage	4.16	kV	3.251	78.1	0.500	1.320
CompB	MV Bus	Bus Voltage	Under Voltage	4.16	kV	3.251	78.1	0.500	2.660

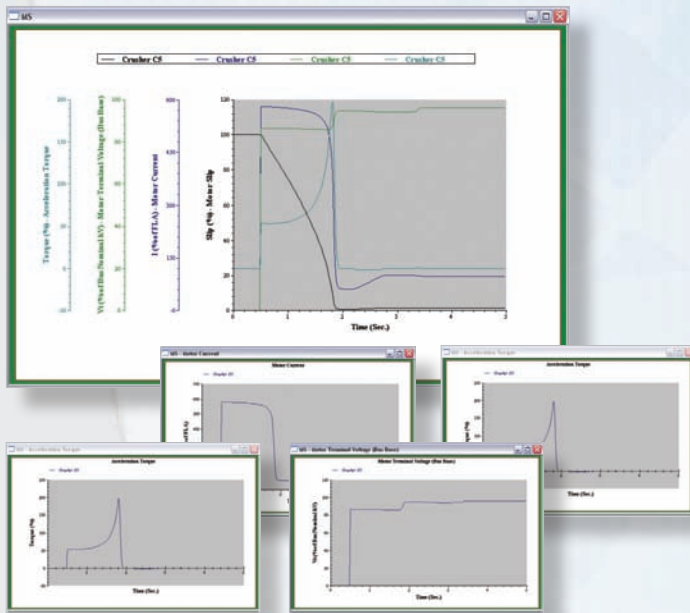
Comprehensive Reporting: Customizable output reports using Crystal Reports®



Realistic Operation: Simulate load and generation transitioning



# Comprehensive & Reliable Tools for System Analysis



**Flexible Plots:** View results as individual or combined plots

## Plots

- Motor
- MOV
- Static Load
- Capacitor
- Generator
- Bus
- Slip / Speed
- Terminal / bus voltage
- Torque
- Electrical power
- Mechanical power
- Terminal / Line Current
- Generator / grid current, power, & power factor
- Frequency
- Volts per Hertz

## Customized Results

- Include multiple axes
- Display multiple motors simultaneously
- Zoom to any detail
- Export data to Microsoft® Excel
- Change text & axes
- Line, bar, 3-D, & scatter plots

## Features

- Multiple motor / load acceleration / stop & sequencing
- Switch on / off static loads & capacitors
- Open / close MOVs with five operating stages
- Include transformer LTC / voltage regulator action
- Generator / grid operating parameters & load profiles
- Multiple loading conditions & generation levels
- Different loading categories for pre-start conditions
- Motor load ramping
- Group actions
- Individual actions
- Start / stop by group
- Group start globally or by individual bus
- Start, stop, & restart in a single run
- Fast bus transfer using load transitioning
- Unlimited actions in each event
- Unlimited events in one simulation
- Unlimited simulations stored in study cases
- Change & rerun studies instantly
- Motor nameplate library
- Motor circuit model library
- Motor characteristic model library
- Polynomial based load model library
- Curve based load model library
- Integrated with motor parameter estimation
- Automatic alert & warnings
- Simulate motor starters including soft-starters
- VFD for starting & running operation
- Comprehensive & flexible plots & reporting
- Execute multiple preset simulations at one-click with Study Wizard

***etap.com***

**Quality Assurance Commitment**

ETAP is Verified and Validated (V&V) against field results, real system measurements, established programs, and hand calculations to ensure its technical accuracy. Each release of ETAP undergoes a complete V&V process using thousands of test cases for each and every calculation module. ETAP Quality Assurance program is specifically dedicated to meeting the requirements of:



ISO 9001:2009

10 CFR 50 Appendix B

10 CFR 21

ANSI/ASME N45.2

ASME NQA-1

ANSI/IEEE 730.1

CAN/CSA-Q396.1.2

ANSI N45.22