

SKM vs ETAP vs EasyPower

An Engineer's View to Engineering Analysis Software

IEEE IAS Atlanta

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How calculations were done before software:

Ex(2): ^(1.2) The primary and secondary sides of a single phase ^(1.5) 1MVA, 4KV/2KV transformer have a leakage reactance of 2Ω each. Find pu X of the transformer referred to primary and secondary side.

Agenda

- ▶ Criteria for Choosing Software
- ▶ IEEE Standards
- ▶ Software Packages:
 - ▶ SKM
 - ▶ ETAP
 - ▶ EasyPower

Criteria for Choosing Software:

- ▶ **COST**
 - ▶ Product Cost?
 - ▶ Maintenance Fee?
- ▶ Training or Consulting Costs?
- ▶ Learning curve?
- ▶ Number of users?

Additional Criteria for Choosing Engineering Software:

- ▶ **Component library**
 - ▶ Does it include the latest protection components from all the major industry players?
- ▶ **Technical Support**
- ▶ **Features vs Price**

Features:

- ▶ Load Flow
- ▶ Short-Circuit
- ▶ Arc Flash
- ▶ Harmonics
- ▶ Motor Starting
- ▶ Duct Bank Heating
- ▶ Step & Touch Potential
- ▶ Device Protection and Coordination

IEEE Standards

- ▶ **IEEE Standard 80-2013** - IEEE Guide for Safety in AC Substation Grounding
- ▶ **IEEE Standard 141-1993** - Recommended Practice for Electric Power Distribution for Industrial Plants
- ▶ **IEEE Standard 241-1990** - Recommended Practice for Electric Power Systems in Commercial Buildings
- ▶ **IEEE Standard 242-2001** - IEEE Recommended Practice for Protection and Coordination of Industrial Power Systems
- ▶ **IEEE 551-2006** - Recommended Practice for Calculating AC Short-Circuit Currents in Industrial and Commercial Power Systems
- ▶ **IEEE 1584-2018** - IEEE Guide for Performing Arc-Flash Hazard Calculations

Equation Slide:

$$V = I(R \cos \phi + X \sin \phi)$$

Approximate Voltage Drop Formula:

V = voltage drop, line to neutral

I = current flowing in conductor

R = line resistance for one conductor, in ohms (Ω)

X = line reactance for one conductor, in ohms (Ω)

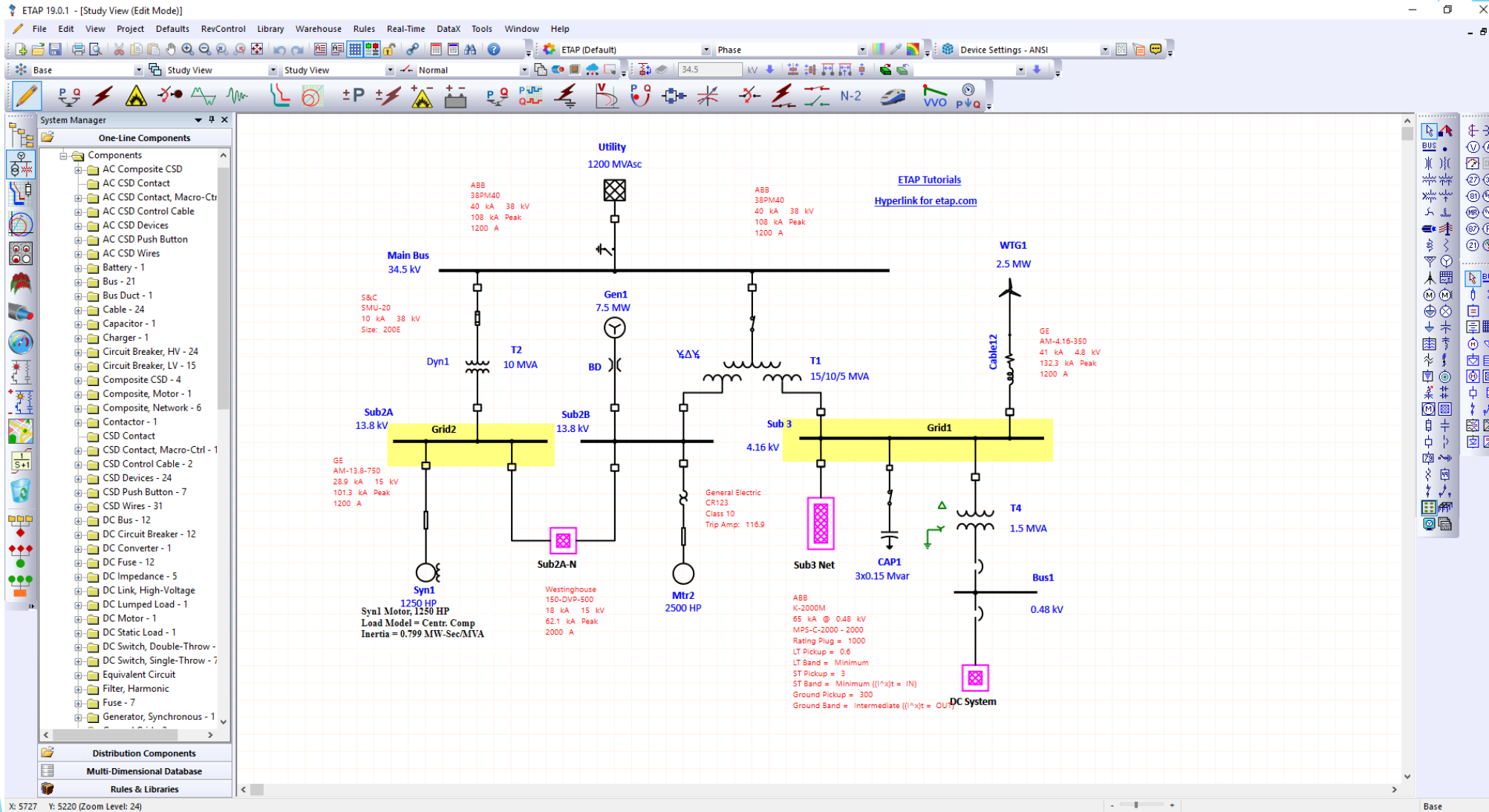
ϕ = angle whose cosine is the load power factor

$\cos \phi$ = load power factor, in decimals

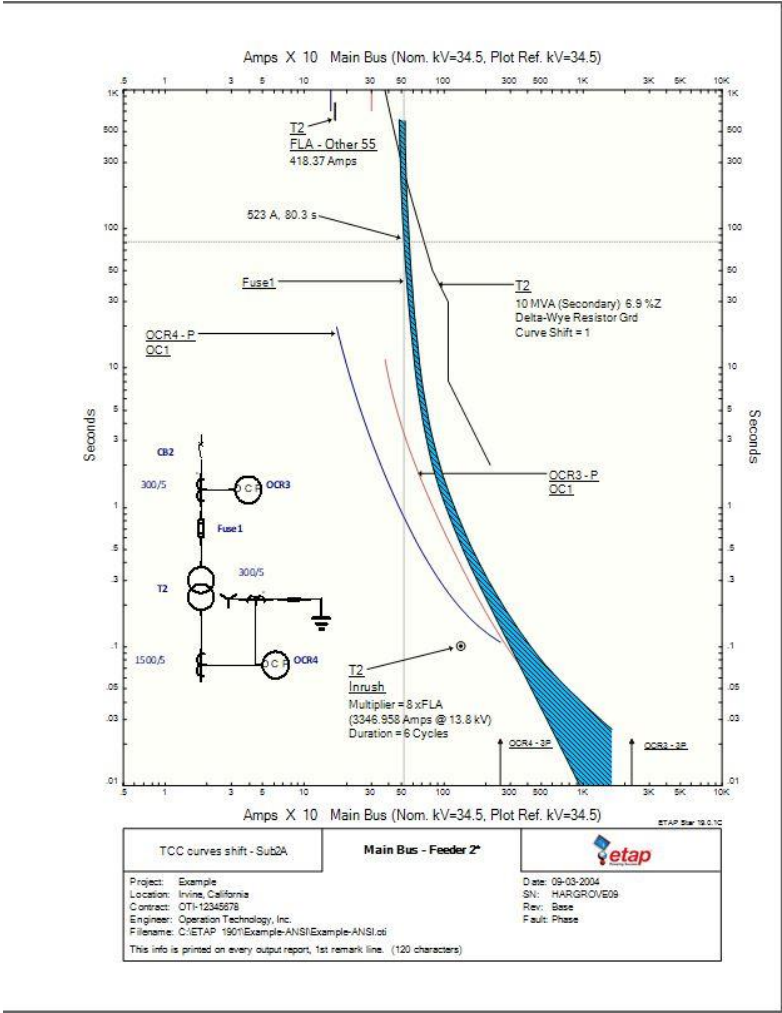
$\sin \phi$ = load reactive factor, in decimals

Voltage System	Multiply By
Single Phase	2
Three Phase	$\sqrt{3}$


ETAP 19.0.1 - Edit Mode



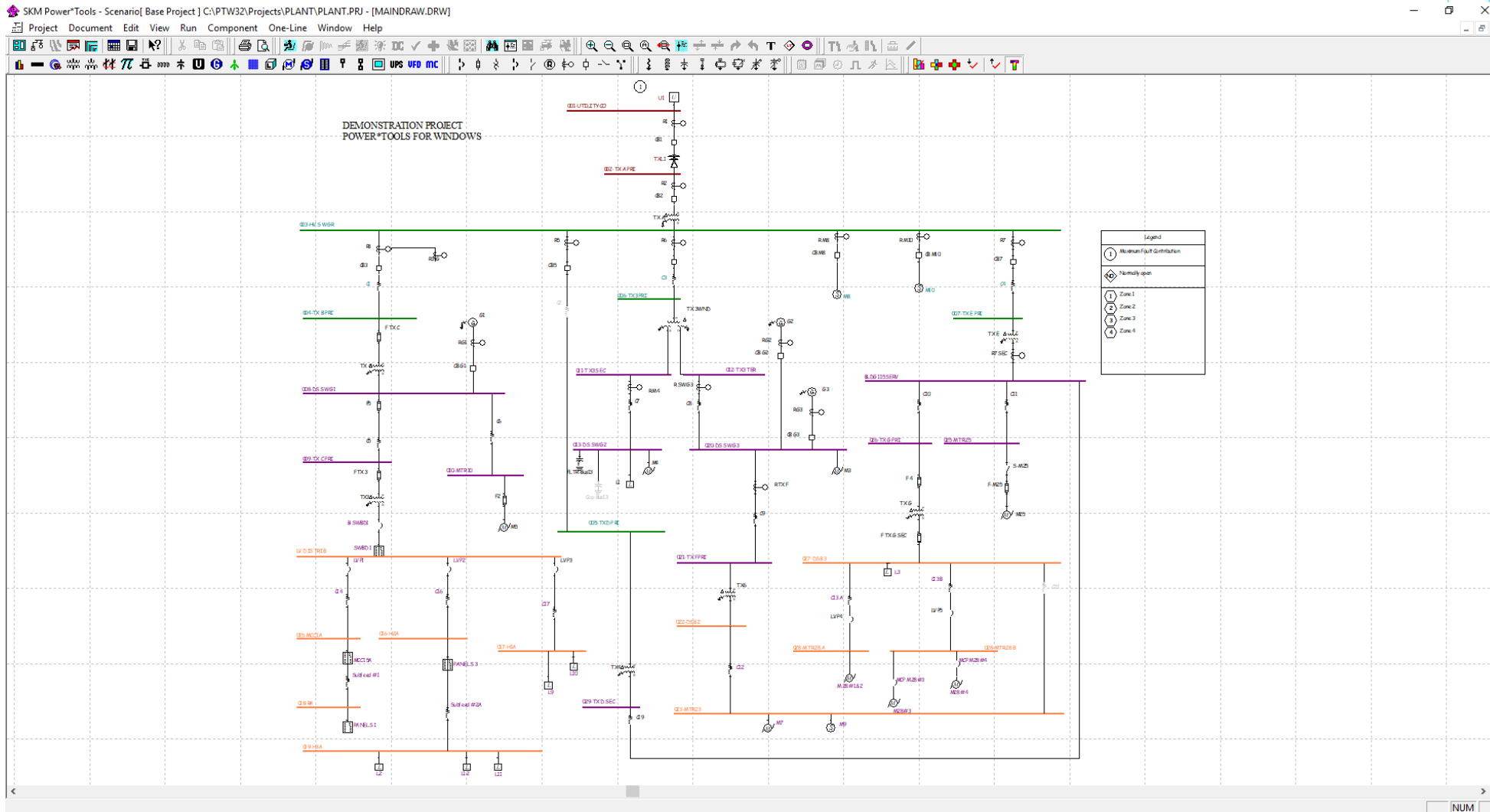
ETAP 19.0.1 - Time Current Curve (TCC)



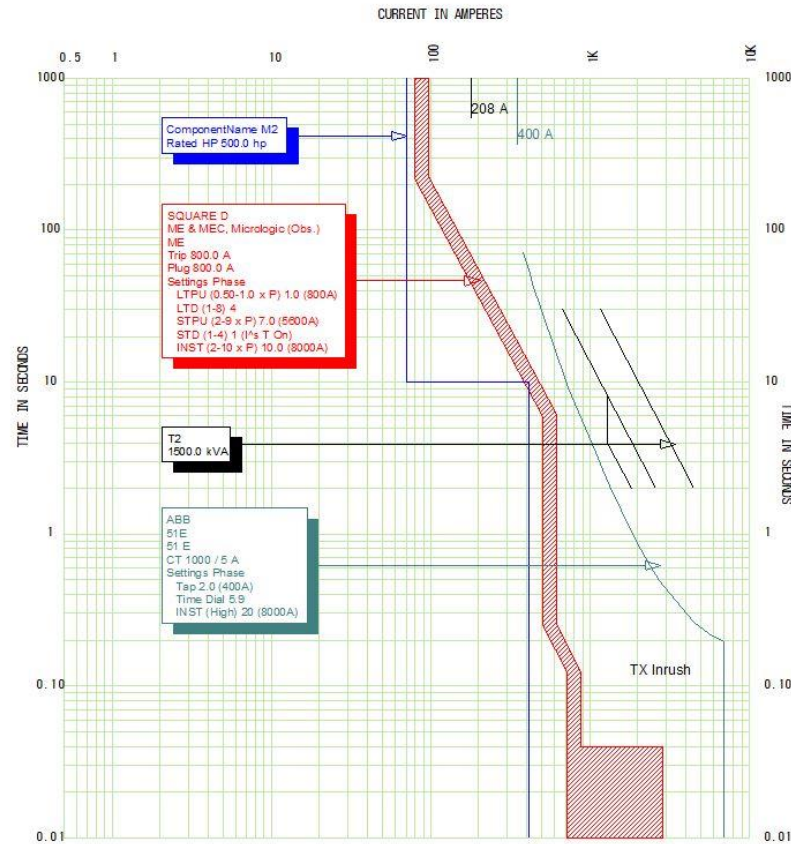
ETAP 19.0.1 - Arc Flash Label

 WARNING		
Arc Flash and Shock Hazard Present		
Appropriate PPE Required		
Arc Flash Boundary (Dc)	1.7 ft	Level A Min. PPE Requirements
Incident Energy (Ed) 0.9 cal/cm ²		
Working Distance	24.0 in	Non-melting or untreated natural fiber long-sleeve shirt and long pants
Shock Hazard Exposure 480 VAC		
Shock Hazard when covers removed		
Class 00 Insulating Gloves		
V-rating 500 VAC		
Limited Approach Boundary	3.5 ft	
Restricted Approach Boundary	1.0 ft	
Source protective Device: CB31		
Bus2		
		03-11-2020

SKM Power Tools 8.0.2.5



SKM Power Tools 8.0.2.5 - TCC



TCC Name: MTRAND XFMR COORDINATI Current Scale x 10 Reference Voltage: 480
Oneline: DRAW2
March 11, 2020 10:02 PM SKM Systems Analysis, Inc.

SKM Power Tools 8.0.2.5 - Arc Flash Label



WARNING

Arc Flash and Shock Risk

ARC FLASH PROTECTION

Working Distance: 18 in
Incident Energy: 2.1 cal/cm²
Arc Flash Boundary: 26 in
Refer to CSA Z462 for requirements

SHOCK PROTECTION

Shock Hazard when cover is removed: 480 VAC
Limited Approach: 42 in
Restricted Approach: 12 in
Glove Class: 00

Equipment Name: 028-MTR 28 B

Arc Flash Analysis by:

File:

March 11, 2020

Std. IEEE 1584

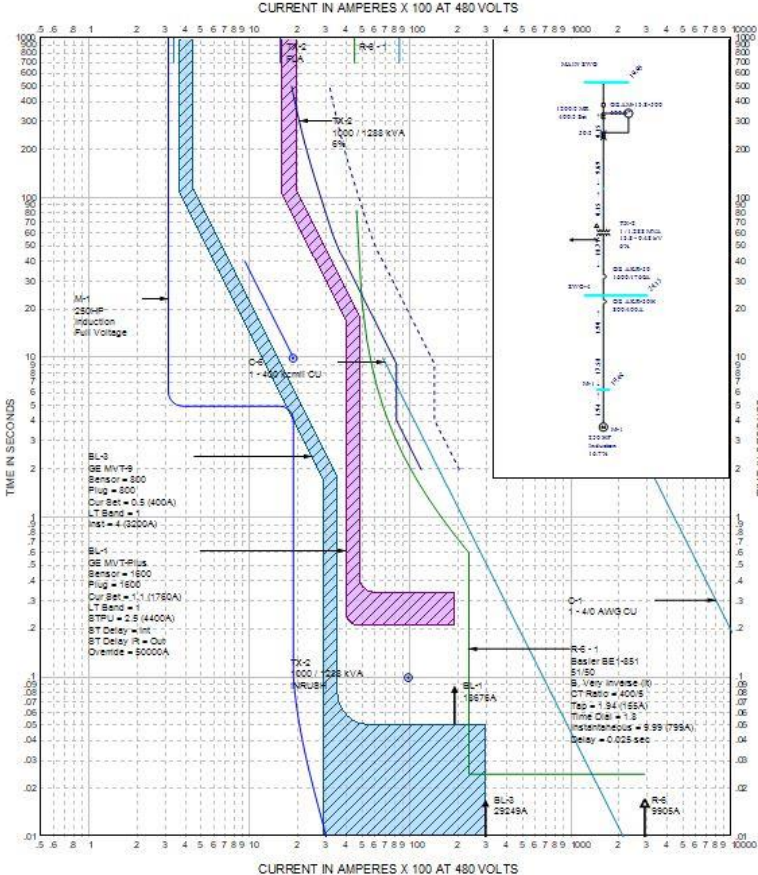
EasyPower 10.2 - Database Edit

The screenshot displays the EasyPower 10.2 software interface in the 'Database Edit' mode. The window title is 'EasyPower - [Protection-1.dex (Base Case)]'. The interface includes a ribbon menu with tabs for FILE, HOME, INSERT, and TOOLS. The ribbon contains various icons for clipboard operations (Paste, Copy), editing (Delete, Activate, De-Activate, Change, Color, Text Visibility, Find-Select), actions (Auto Design, Scenario Mgr), view (Zoom, Window), and analysis (Database Edit, Short Circuit, Coord, Power Flow, Harm, Motor Starting).

On the left side, there is an 'Equipment Pal...' panel with sections for 'AC Equipment' and 'DC Equipment', each containing various electrical symbols. Below the ribbon, the main workspace shows a detailed power system diagram. The diagram features a 'MAIN SW' bus at the top, which branches into three feeders. The left feeder includes a transformer 'TX-3' (3 MVA, 13.8-2.4 kV, 6%) and a bus 'REFINER'. The middle feeder includes a transformer 'TX-4' (0.33 MVA, 13.8-0.48 kV, 4%) and a bus 'STG-4'. The right feeder includes a transformer 'TX-2' (1.288 MVA, 13.8-0.48 kV, 6%) and a bus 'STG-4'. Each feeder contains several circuit breakers (e.g., GE AM-13.8-500, GE VB-4.16-220B) and busbars. At the bottom, there are three motor units (MCO-1, MCO-2) with their respective ratings and induction percentages. The diagram is annotated with various electrical parameters and labels.

The status bar at the bottom of the window shows the following information: www.easypower.com, SNAP, System Base MVA: 10, Default, Sys Freq: 60 Hz, and a zoom level of 58%.


EasyPower 10.2 - TCC



	EasyPower® TIME-CURRENT CURVES	TCC-1
	PROJECT: Large Industrial LOCATION: Unit Substation - Large Motor	FAULT: 3-Phase DATE: May 30, 2002 BY: CED REVISION: 1

PROJECTION:

EasyPower 10.2 - Arc Flash Label

 WARNING	
Arc Flash and Shock Hazard Appropriate PPE Required	
2' - 8" 1.7	Flash Hazard Boundary cal/cm2 Flash Hazard at 26.0 Inches PPE Description Refer to NFPA 70E-2018 Table 130.5(G)
13.8 5' - 0" 2' - 2" **	kV Shock Hazard when cover is removed Limited Approach Restricted Approach - Class 2 Voltage Gloves Prohibited Approach - Class 2 Voltage Gloves
Equipment Name: BUS-3 (Fed by: R-6)	

Reports - Typical File Formats

- ▶ SKM
 - ▶ Filetype: *.rpt
- ▶ ETAP
 - ▶ Filetype: *.dosx, *.xlsx, *.pdf
- ▶ Easypower
 - ▶ Filetype: *.xlsx, *.csv

Sample Reports - SKM, ETAP, EASYPower

SKM

SC_AFLT - Notepad
 File Edit Format View Help
 DEMONSTRATION STUDY FOR POWER*TOOLS FOR WINDOWS

Apr 05, 2007 13:19:40

ALL INFORMATION PRESENTED IS FOR REVIEW, APPROVAL INTERPRETATION AND APPLICATION BY A REGISTERED ENGINEER ONLY SKM DISCLAIMS ANY RESPONSIBILITY AND LIABILITY RESULTING FROM THE USE AND INTERPRETATION OF THIS SOFTWARE.

SKM POWER*TOOLS FOR WINDOWS
 A FAULT SHORT CIRCUIT ANALYSIS REPORT
 COPYRIGHT SKM SYSTEMS ANALYSIS, INC. 1996-2007

Apr 05, 2007 13:19:40 THREE PHASE LOW VOLTAGE DUTY PAGE 1
 DEMONSTRATION STUDY FOR POWER*TOOLS FOR WINDOWS

THREE PHASE FAULT REPORT
 (FOR APPLICATION OF LOW VOLTAGE BREAKERS)
 PRE FAULT VOLTAGE: 1.0000
 MODEL TRANSFORMER TAPS: NO

015-MCC 1A FAULT: 8.853 KA AT -76.78 DEG (7.36 MVA) X/R: 4.89
 VOLTAGE: 480. EQUIV. IMPEDANCE= 0.0072 + j 0.0305 OHMS
 LOW VOLTAGE POWER CIRCUIT BREAKER 8.853 KA
 MOLDED CASE CIRCUIT BREAKER < 20KA 9.842 KA
 MOLDED CASE CIRCUIT BREAKER > 20KA 8.853 KA
 CONTRIBUTIONS: M6-A 0.168 KA ANG: -86.19
 M6-B 0.219 KA ANG: -73.09
 M6-C 0.168 KA ANG: -86.19
 M6-D 0.168 KA ANG: -86.19
 C14 LV DISTRIB 8.137 KA ANG: -76.30

016-H2A FAULT: 7.197 KA AT -61.69 DEG (5.98 MVA) X/R: 1.92
 VOLTAGE: 480. EQUIV. IMPEDANCE= 0.0183 + j 0.0339 OHMS
 LOW VOLTAGE POWER CIRCUIT BREAKER 7.197 KA
 MOLDED CASE CIRCUIT BREAKER < 10KA 7.392 KA
 MOLDED CASE CIRCUIT BREAKER < 20KA 7.197 KA
 MOLDED CASE CIRCUIT BREAKER > 20KA 7.197 KA
 C16 LV DISTRIB 7.197 KA ANG: -61.69

017-H1A FAULT: 4.601 KA AT -40.26 DEG (3.83 MVA) X/R: 0.86
 VOLTAGE: 480. EQUIV. IMPEDANCE= 0.0460 + j 0.0389 OHMS
 LOW VOLTAGE POWER CIRCUIT BREAKER 4.601 KA
 MOLDED CASE CIRCUIT BREAKER < 10KA 4.601 KA
 MOLDED CASE CIRCUIT BREAKER < 20KA 4.601 KA
 MOLDED CASE CIRCUIT BREAKER > 20KA 4.601 KA

ETAP

Project: Example ETAP Page: 1
 Location: Irvine, California 19.0.1C Date: 05-17-2020
 Contract: SN:
 Engineer: Study Case: ANSI Duty Revision: Base
 Filename: Example-ANSI Config: Normal

This info is printed on every output report. 1st remark line. (120 characters)
 Second line of remarks for "ANSI Duty" study case.

Electrical Transient Analyzer Program

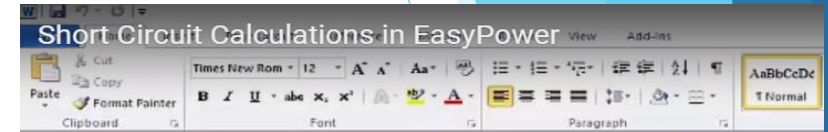
Short-Circuit Analysis

ANSI Standard

3-Phase Fault Currents

	Swing	V-Control	Load	Total			
Number of Buses:	3	1	16	20			
	NFMR2	NFMR3	Reactor	Line/Cable/ Burway	Impedance	Tie PD	Total
Number of Branches:	7	1	0	6	0	0	14
	Synchronous Generator	Power Grid	Synchronous Motor	Induction Machines	Lumped Load	Total	
Number of Machines:	1	1	1	9	5	17	
System Frequency:	60.00						
Unit System:	English						
Project Filename:	Example-ANSI						
Output Filename:	C:\ETAP 1901\Example-ANSI\ANSI-Duty.SA15						

EASYPower



LV Momentary Report

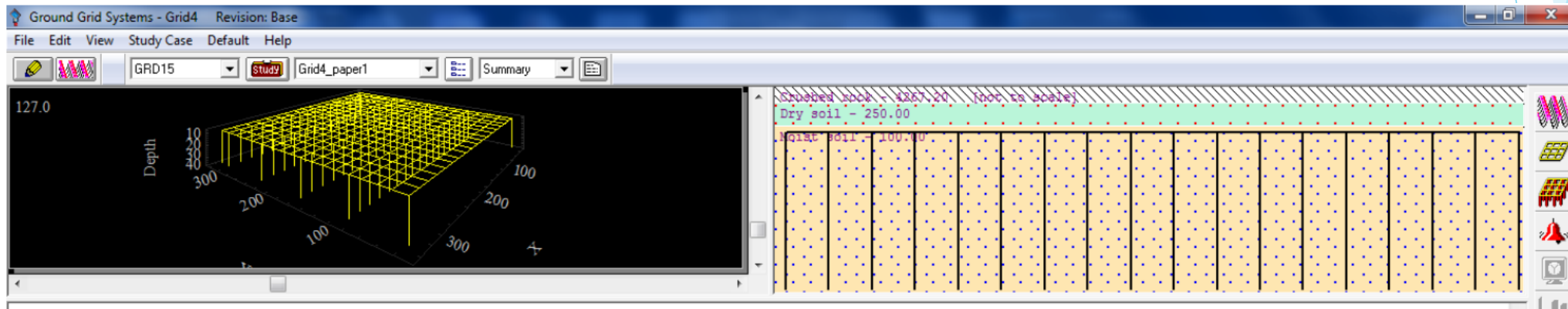
V_{pu} = 1.00

Bus Name	Bus kV	Total Fault Currents				Equipment Duties	
		Sym Amps	X/R Ratio	Mult Factor	Asym Amps	Equip Type	Duty Amps
BUS-4	0.480	23625.6	4.76	1.26	29686.7	LVPCB	23625.6
						MCCB 10-20 kA	25831.2
BUS-4_A0	0.480	23625.6	4.76	1.26	29686.7	MCCB > 20 kA	23625.6
						LVPCB	23625.6
BUS-4_A0	0.480	23625.6	4.76	1.26	29686.7	MCCB 10-20 kA	25831.2
						MCCB > 20 kA	23625.6
BUS-5	0.480	21015.4	2.84	1.13	23701.6	LVPCB	21015.4
						MCCB 10-20 kA	21015.4
BUS-5_A0	0.480	15553.6	1.56	1.03	16030.8	MCCB > 20 kA	21015.4
						LVPCB	15553.6
BUS-5_A0	0.480	15553.6	1.56	1.03	16030.8	MCCB 10-20 kA	15553.6
						MCCB > 20 kA	15553.6
BUS-5_A1	0.480	12048.4	1.18	1.01	12182.4	LVPCB	12048.4
						MCCB 10-20 kA	12048.4
BUS-5_A1	0.480	12048.4	1.18	1.01	12182.4	MCCB > 20 kA	12048.4
						LVPCB	12048.4
BUS-5_A2	0.480	21015.4	2.84	1.13	23701.6	MCCB 10-20 kA	21015.4
						MCCB > 20 kA	21015.4
BUS-5_A6	0.480	15553.6	1.56	1.03	16030.8	LVPCB	15553.6
						MCCB 10-20 kA	15553.6
BUS-5_A6	0.480	15553.6	1.56	1.03	16030.8	MCCB > 20 kA	15553.6
						LVPCB	12048.4
BUS-5_A9	0.480	12048.4	1.18	1.01	12182.4	MCCB 10-20 kA	12048.4
						MCCB > 20 kA	12048.4
BUS-6	0.480	11570.1	0.72	1.00	11579.2	LVPCB	11570.1
						MCCB 10-20 kA	11570.1
BUS-6	0.480	11570.1	0.72	1.00	11579.2	MCCB > 20 kA	11570.1
						LVPCB	13081.3
BUS-6_A0	0.480	13081.3	0.99	1.00	13145.4	MCCB 10-20 kA	13081.3
						MCCB > 20 kA	13081.3
BUS-6_A1	0.480	12485.9	1.25	1.01	12662.1	LVPCB	12485.9
						MCCB 10-20 kA	12485.9
BUS-6_A1	0.480	12485.9	1.25	1.01	12662.1	MCCB > 20 kA	12485.9
						LVPCB	10963.3
BUS-6_A2	0.480	10963.3	1.10	1.01	11054.1	MCCB 10-20 kA	10963.3
						MCCB > 20 kA	10963.3
BUS-6_A3	0.480	11570.1	0.72	1.00	11579.2	LVPCB	11570.1
						MCCB 10-20 kA	11570.1
BUS-6_A3	0.480	11570.1	0.72	1.00	11579.2	MCCB > 20 kA	11570.1

Screenshot: <https://youtu.be/QHlvLBOh2ys>

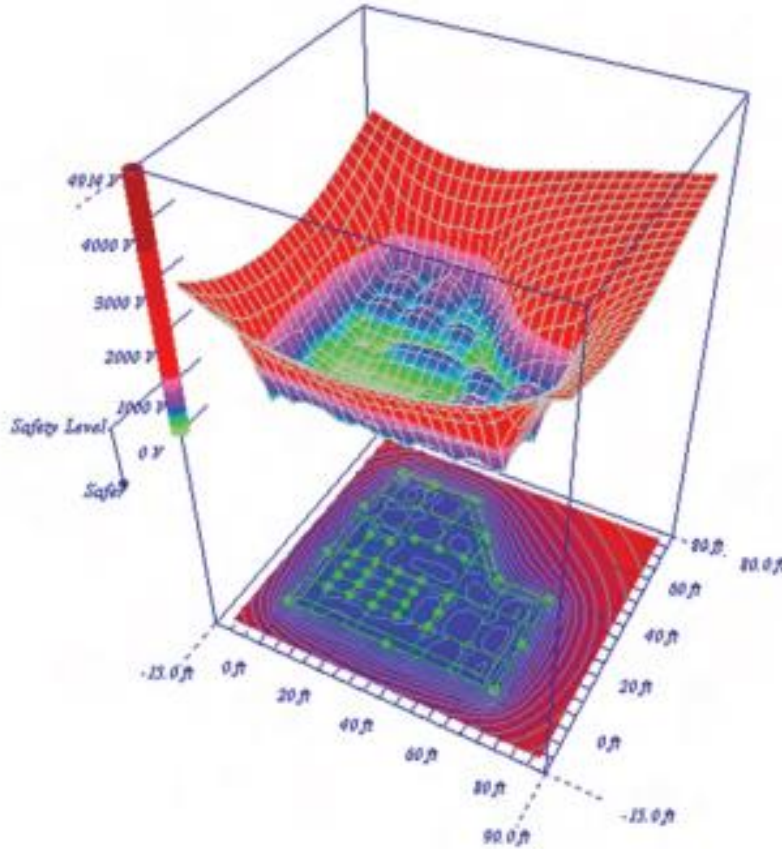
Other Modules Built-in ETAP:

- ▶ ETAP:
 - ▶ Duct bank heating calculation
 - ▶ Cable Ampacity Calculation
 - ▶ Ground Grid / Step & Touch Potential

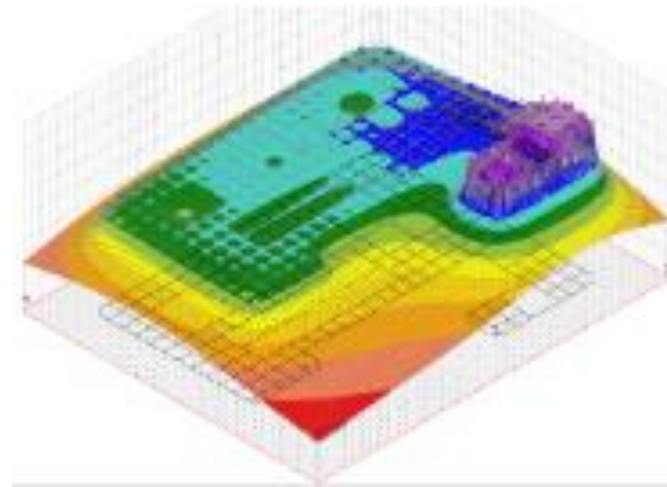


SKM Power*Tools:

- ▶ PTW GroundMAT
 - ▶ IEEE Std 80
 - ▶ Sunde Method
 - ▶ Gradient Method



EasyPower:



▶ Partner firm SINT Ingegneria

▶ Software: XGSLab

▶ Includes several modules:

▶ GSA (GROUNDING SYSTEM ANALYSIS)

▶ GSA_FD (GROUNDING SYSTEM ANALYSIS in the FREQUENCY DOMAIN)

▶ XGSA_FD (OVER AND UNDERGROUND SYSTEM ANALYSIS in the FREQUENCY DOMAIN)

▶ XGSA_TD (OVER AND UNDERGROUND SYSTEM ANALYSIS in the TIME DOMAIN)

▶ NETS (NETWORK SOLVER)

Software Experiences: SKM, ETAP & EasyPower

- ▶ USER Interface
- ▶ Developing the electrical model
 - ▶ Adding equipment:
 - ▶ Buses, Motors, Fuses, VFDs
 - ▶ Relays and current transformers
- ▶ Performing Studies:
 - ▶ Load Flow Analysis, Short-Circuit Analysis, Protection and Coordination Analysis

Q & A

