



ARC FLASH STUDIES

INTRODUCTION

MiPower is highly interactive, user-friendly windows based Power System Analysis Software Package. It includes a set of modules for performing various studies like Load Flow, Short Circuit, Stability and Relay co-ordination studies, etc. Numerous elements of the power systems can be modeled in it.

In recent power system studies Arc flash hazard analysis has drawn attention towards the human safety. In addition to protection of equipment, it is essential to provide safety assurance for working persons. The arc flash hazard analysis can be done in MiPower.

This analysis can be performed to find Arcing current, Incident energy, Hazard Risk Category (HRC) and Personal Protective Equipment (PPE) requirements in an electrical system as per the IEEE 1584-2002a and NFPA 70E standards.

EMPERICALLY DERIVED MODELS

An empirically derived model is provided to enable calculations. The ranges of model are given in Table below.

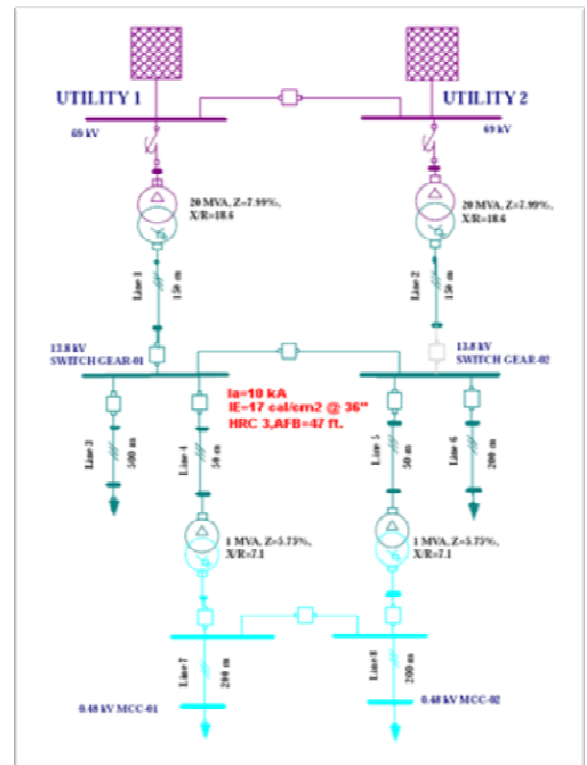
Parameter	Applicable Range
System voltage in kV	0.208 kV -15 kV
Frequency in Hz	50 or 60 Hz
Bolted fault current in kA	0.7 kA-106 kA
Gap between electrodes in mm	13 -152 mm
Equipment enclosure type	Open air, Switch gear, MCC, panel, box, cables
Grounding type	Ungrounded, grounded and high resistance ground
Phases	3 phase faults

THEORETICALLY DERIVED MODELS

- A theoretically derived model, based upon Lee's paper, is applicable for three-phase systems in open air substations, and open air transmission and distribution systems.
- For cases where voltage is more than 15 kV or gap is outside the range of the model as shown in the above Table or for asymmetrical fault types, the theoretically derived Lee method can be applied.
- This model is intended for applications where faults will escalate to three-phase faults. Situations where this is not likely possible, this model will give a conservative result. In case of Single-phase systems this model will provide conservative results.

NFPA 70E STANDARDS

- Protective clothing and personal protective equipment (PPE) are followed as per the NFPA 70E standards.
- Arc flash protection boundaries are considered as per the NFPA 70E standards for the analysis.
- Hazard Risk Category is the minimum acceptable arc rating, as designated by NFPA 70E, for a given flame resistant (FR) fabric or other personal protective equipment (PPE). The Hazard Risk Category (HRC) is often referred to as merely the "Category" (e.g., Category 2). The minimum arc ratings for HRC 1 (Category 1) through HRC 4 (Category 4) are as follows:
 - ✓ HRC 1: Minimum arc rating of 4 cal/cm²
 - ✓ HRC 2: Minimum arc rating of 8 cal/cm²
 - ✓ HRC 3: Minimum arc rating of 25 cal/cm²
 - ✓ HRC 4: Minimum arc rating of 40 cal/cm²



Typical Network modeled in MiPower

ARC FLASH STUDIES

Bus Data

Bus Number: 1 [Fetch Bus]

Bus Name: Bus1

Description: Bus1

Nominal Voltage: 11.000 kV

Area Number: 1 [Select: 1 Area1]

Zone Number: 1 [Select: 1 Zone1]

Owner Number: 1 [Select: 1 Owner1]

Contingency Weightage: 1

Voltage Limits in kV: Min 10.45, Max 11.55

Cost Per Unit in: 0 [Cost library]

Relay: Bus Bar Differential

Global Change Load Details Costlib >> GPS

Arc Flash [Bus details]

Bus Data

BusGap in mm	config	k	k1	Grounding	k2	cf
25.0	0	-0.153	-0.792	0	0.000	1.5

configuration:
0--open air
1--box

grounding:
0-ungrounded
1-grounded
2-highly resistive

Arc current in KA	distance in mm	En in J/cm2	X	incident energy E in cal/cm2	AFB feet
9.0340	455.00	1.857	1.641	1.054	1.38

Incident Energy E=4.412004 J/cm2
 AFPB =421.600407 mm
 Working Distance in inches=18.000000
 HRC=0.0 PPE Requirement:Untreated Cotton

A typical result of Arc Flash studies

Bus details

Bus No. [] Equipment Type: Open Air

User Defined

If checked, the user has to enter the details. Otherwise default values will be taken from standards.

Equipment Type:
 0 ----- Open air
 1 ----- Switch Gear
 2 ----- MCC and Panels
 3 ----- Cabets
 4 ----- Others

Gap in mm: 104

X-Factor: 0.973

Working Distance in mm: 910

OK Cancel

Bus Library for Arc Flash

ARC FLASH LABELS

The following labels can be printed based on the arc flash study results.

WARNING

**Arc Flash and Shock Hazard
Appropriate PPE Required**

3' - 4" 4.9 #2	Flash Hazard Boundary cal/cm2 Flash Hazard at 18 Inches PPE Level Cotton underwear plus FR shirt and FR pants
0.48 3' - 6" 1' - 0" 0' - 1"	kV Shock Hazard when cover is removed Limited Approach Restricted Approach - Class 00 Voltage Gloves Prohibited Approach - Class 00 VoltageGloves

Equipment Name SWG-2A
 IEEE 1584 Hazards; Project 1289A -- Safety Procedure #A6D24 --
 EasyPower File: "Plant-A6.dez" -- Date: September 9, 2003

Warning label based on Arc Flash Studies

Arc Flash Studies

Type:
 IEEE 1584-2002 a
 NFPA 70E 2012

Fault Type:
 Three Phase Faults
 Single line to Ground fault

User Defined Fault Clearing Time
 Calculated Fault Clearing Time

Transient Reactance Xd' p.u.
 Sub-transient reactance Xd'' in p.u.

Pie - Fault Voltages: []
 Flat start Volt. Value: []

Multiplication Factor Number: []

Consider:
 Motor contribution
 Cable/Shunt capacitance

Ok Cancel

Arc Flash studies window in MiPower

DANGER

**NO PPE AVAILABLE
ENERGIZED WORK PROHIBITED**

134 inch	Flash Hazard Boundary
144 cal/cm^2	Flash Hazard at 18 inches
Dangerous!!!	No FR Class Found
180 VAC	Shock Hazard when cover is removed
10	Glove Class
12 inch	Limited Approach (Fixed Circuit)
12 inch	Restricted Approach
1 inch	Prohibited Approach

Caution label based on Arc Flash Studies