DEVELOPMENT OF A MATHEMATICAL MODEL TO ASSESS THE ARC FLASH SEVERITY OF LOW VOLTAGE DISTRIBUTION PANELS

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Degree of Master of Science

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Dissertation submitted in partial fulfillment of the requirements for the degree Master of Science in Electrical Installations

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DECLARATION

I declare that this is my own work and this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. I retain the right to use this content in whole or part in future works (such as articles or books).

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K. D. R. Prasad

The above candidate has carried out research for the Masters dissertation under my supervision. I confirm that the declaration made above by the student is true and correct.

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ABSTRACT

Arc flash occurs when an electric arc forms unexpectedly within electrical equipment, releasing a massive amount of energy. An arc fault happens when the insulation between live conductors breaks down, typically due to factors like aging, pollution, moisture, vermin, overvoltage, or human error during maintenance when electrical equipment is still energized. On average, each day in the United States, there are typically between 5 to 10 arc flash incidents, which lead to over 30,000 injuries and around 400 deaths every year. The report further reveals that the arc flash does not only occur in high and medium voltage environments, but actually more common in low voltage distribution systems. In Sri Lanka, 150 electrocution deaths per year are reported but no arc flash incidents being reported – perhaps due to the reason all the arc flash incidents are being recorded as burn incidents.

NFPA 70E: 2021 and IEEE 1584: 2018 are the latest standards for arc flash analysis. NFPA 70E provides the guidelines for work involving electrical hazards, arc fault calculations and the selection of arc flash personal protective equipment (PPE). IEEE 1584 states the method for calculating the arc incident energy levels at different points in the electrical power system. However, a common approach is required for performing arc fault calculations and arc flash PPE selection in order to maintain a safe working environment. The IEEE 1584:2018 standard utilizes an empirical model that calculates intermediate values for average arc current, incident energy, and arc-flash boundary. These values are then adjusted by various factors to determine the final results. This research aims to gain a deeper understanding of arc flash phenomena by individually examining key parameters that influence it, including arc-fault current, arc flash characteristics in both open air and enclosed spaces, electrode gap, and enclosure size. The proposed approach seeks to develop a simplified method for calculating arc-fault currents, incident energy, and arc-flash boundaries. The validity of this method will be confirmed by comparing its results with data obtained from tests conducted according to the IEEE 1584 standard.

Keywords: Arc flash, incident energy, arc fault, IEEE 1584, NFPA 70E

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LIST OF ABBREVIATIONS

Abbreviation	Description
AFB	Arc Flash Boundary
ANSI	American National Standards Institute
HOA	Horizontal conductors in open air
HCB	Horizontal conductors inside a metal box
IEEE	Institute of Electrical and Electronic Engineers
MDB	Main Distribution Board
N/A	Not Applicable
NFPA	National Fire Protection Association
PPE	Personal Protective Equipment
RH	Relative Humidity
SDB	Sub Distribution Board
T/F	Transformer
VOA	Vertical conductors in open air
VCB	Vertical conductors inside a metal box
VCBB	Vertical conductors terminated in an insulating barrier inside a metal box

LIST OF APPENDICES