

1. Module details**Module name****High Voltage Principles****Module duration**

It is expected that students with the appropriate entry knowledge and skills will successfully complete this module in 18 - 20 hours.

Module code

NUE224

Discipline code

0703130

2. Module purpose

This module is to provide theory that underpins safe practice and effective skill in the application of live line operations at high voltages.

3. Prerequisites

NE162 Electrical Principles 3 or equivalent new NUE module in Applied Electricity.

4. Relationship to competency standards

This module partially addresses Unit 4.4 of the E.S.I. National Competency Standards for Overhead Line Work and Cable Jointing.

5. Content**Electrical principles relating to EHV lines**

conductor skin resistance and its effect
inductance
phase and line voltages
corona

Electrostatics

the electric field
models
measurement of the field
effect of distance in the field
potential of an object in a field
effect of distance on that potential
graph of distance vs potential
fields in transmission lines
effect of the earth plane
graphical representation
effect of earth plane on object in field
effect of various towers on electric field
behaviour of insulators in a field
number of discs in a string
effect of failed discs
detection of a failed disc
string testing
data and result recording

Electrostatic induction

resistance of the human body
human body in the electric field
effect of current levels on the body
alleviation of electrostatic field
the Faraday cage

Access to loaded conductors

safe clearances
approaching the conductor
hot end shunt
purpose
effect on strings

Lightning and switching surges

characteristic of surges
origins
effect on electric field
possible effect on bare-hand lineworker
methods to alleviate surges
ferroresonance

Magnetic field monitoring

magnetic and electrostatic fields (similarities / differences)
source of magnetic fields
measuring magnetic fields
requirements of field measurements
limitations of field monitors

6. Assessment strategy

Assessment methods

Short answer questions (written, oral or graphic or computer based).
Suitable practical exercises which assess the skills required of each learning outcome.

Conditions of assessment

Theory room for written tests together with practical field observation.

7. Learning outcome details

Learning outcome 1

Explain electrical and electrostatic theory necessary for bare-hand lineworkers.

Assessment criteria

- 1.1 Explain the relationship of changes to Ohm's Law components as they relate to transmission lines.
- 1.2 Correlate phase voltage with its respective line voltage for each system level.
- 1.3 State how an electric field is produced, draw a simple model of an electric field and define the units of measurement.
- 1.4 State the effect distance has on an electric field.
- 1.5 Determine the potential of an object placed in an electric field and explain how distance affects the potential of an object placed in an electric field.
- 1.6 Plot a graph of distance versus potential for an object placed in an electric field.
- 1.7 Modify the model of a simple electric field to show the effect of an earth plane and plot the effect.
- 1.8 Explain how an object placed in an electric field is affected by the earth plane.
- 1.9 Explain how an object placed in an electric field is affected by the earth plane.
- 1.10 Describe how each type behaves in an electric field and list the factors which affect the performance of each type.
- 1.11 Identify the component parts of a disc insulator and determine how a disc insulator behaves in an electric field.
- 1.12 List the number of sound discs needed for each line voltage used in the system.
- 1.13 Predict how a string will perform with failed discs in a string.
- 1.14 List the minimum allowable number of sound discs per string for each line voltage in the system, which will enable bare-hand work to proceed.

- 1.15 Describe the consequences of having too many failed discs in a string.
- 1.16 Identify a way of detecting a failed disc in a string and use appropriate tools and equipment to test a string.
- 1.17 Record test data and plot results using appropriate scientific symbols and interpret and evaluate recorded data and distinguish between sound and failed discs.

Learning outcome 2

Describe Electrostatic induction and the concept of the Faraday Cage.

Assessment criteria

- 2.1 Measure the resistance of a human body.
- 2.2 Use Ohm's Law to predict how a human body behaves in an electric field.
- 2.3 List different levels of current and their effect on a human body.
- 2.4 Detail how a bare-hand worker will be affected by being placed in an electric field.
- 2.5 Explain how electrostatic induction problems are alleviated in bare-hand live line work.
- 2.6 Identify how an object in a Faraday cage is affected by an electric field.
- 2.7 List the advantages of bare-hand workers using a Faraday cage.
- 2.8 Describe the Faraday cage used by bare-hand live line workers.

Learning outcome 3

Define the problems associated with gaining access to a live, loaded high voltage conductor.

Assessment criteria

- 3.1 List the minimum safe clearances allowed for each line voltage in the system.
- 3.2 State what is required of a bare-hand live line worker as they approach a conductor.
- 3.3 Describe the importance of safety with regard to bare-hand tools.
- 3.4 State the purpose of the bare-hand Hot end shunt.
- 3.5 Determine the effect of the hot end shunt on the performance of a string.

Learning outcome 4

Explain how lightning and switching surges may affect the performance of string insulators.

Assessment criteria

- 4.1 Define the characteristics of surges on transmission lines.
- 4.2 Describe their origin.
- 4.3 Relate the model of an electric field to surges.
- 4.4 Describe their effect on a defective string.
- 4.5 State the effect a surge could have on a bare-hand live line worker.
- 4.6 List the methods used to alleviate surges on transmission lines.

Learning outcome 5

Describe the techniques necessary for the monitoring of a magnetic field.

Assessment criteria

- 5.1 List the similarities between magnetic fields and electrostatic fields.
- 5.2 List the differences between magnetic fields and Electrostatic fields.
- 5.3 Identify the source of magnetic fields.
- 5.4 Identify the measuring device used in the bare-hand live line training and course and demonstrate its correct use.
- 5.5 Locate and measure known sources of magnetic fields.
- 5.6 Transfer measured data from the measuring device to a data storage device and analyse and interpret stored magnetic field exposure data.
- 5.7 Identify workers who **must** monitor magnetic field exposure.
- 5.8 Identify where bare-hand workers will carry the magnetic field monitoring device.
- 5.9 Describe the limitations of the magnetic field monitoring device.

8. Delivery of the module

Delivery strategy

Delivery of this module will be both of the job (in a classroom type situation) and on the job. Theory and knowledge components of the module will be delivered in conjunction with practical demonstrations using both simulated and live work condition.

Resource requirements

As well as classroom based facilities this module requires the following equipment:
Separate AC 50 Hz High voltage source to 300 kV
Live Line Hotstick kit (including ladder)
Mock model of transmission tower wing
Appropriate test and measuring equipment.
Appropriate equipment to enable trainees and instructor to gain access to the mock wing
30 sound disc insulators
Suitable low voltage supply to suit separate high voltage source

Further special tools and equipment will include:
Minimum of 3 Emdex Lite Magnetic field monitoring devices or equivalent.
Emdex Lite (or equivalent) software
Computer
Separate low voltage high current source capable of 400 amps.
Relevant Australian Standards
Enterprise work manuals and standing instruction

Occupational health and safety requirements

Students should be made aware of Occupational Health and Safety issues in all situations and be expected to demonstrate safe working practices at all times. Electrical safety must be emphasised.