TITLE:- SAFETY HANDBOOK

LECTURER:-

DATE:-

EQUIPMENT:- Safety Handbook

The Electrical Safety Handbook is compiled by the Electrical Engineering staff in Whyalla for issue to all new starters in the Electrical field.
The main purpose of the book is to outline potential hazards associated with electrical equipment, and to help protect electricians and others from coming into contact with LIVE conductors.
The main rules which the book covers are:-

1. Switches must be opened and/or fuses must be withdrawn before working on any equipment.
2. A switch must be locked out wherever provisions for doing so are made.
3. Danger tags must be employed.
4. All equipment must be earthed.

IF IN DOUBT - ASK !

The book also supplies a number of useful diagrams, tables, etc. which the electrician will need almost daily.

Special provisions have been set out dealing with the work of apprentices, and these regulations must be observed.

1. Apprentice electrical fitters and mechanics, during first and second years of their apprenticeship, must work under direct instruction of a foreman, leading hand, or journeyman.
2. During this period, they shall not be permitted to connect or disconnect circuits which have previously been "alive".
3. In the third year of apprenticeship, a boy may be permitted to operate fuses and switches, but he shall work under direct supervision.
4. In the fourth year of apprenticeship, a boy may work at all classes of work under general instructions and directions of his foreman, leading hand, or journeyman.

TITLE:- EFFECTS OF ELECTRIC SHOCK

LECTURER:-

DATE:-

EQUIPMENT:-

The effects of electric shock on a human being, is rather unpredictable and may manifest itself in a number of ways.

(a) Asphyxia:- Electric shock may cause a cessation of respiration (asphyxia). Current passing through the body may temporarily paralyse either the nerves, or the area of the brain which controls respiration.

(b) Burns (contact & flash):- Contact burns are a common result of electric current passing through the body; they vary in severity, the same as thermal burns. The burns can normally be seen at the points where the current entered and left the body; however, internal tissues along the path of the current are also damaged. Therefore, the seriousness of electric burns may not be immediately evident, because the appearance does not indicate the depth, or extent, of the internal injury.
In some accidents there is a flash, or electric arc, the rays and heat from which may damage the eyes, or result in thermal burns, to exposed parts of the body.

(c) Heart stoppage & fibrillation:- Electric shock may disturb the natural rhythm of the heart-beat. When this happens, the heart muscles may stop completely, or they may be thrown into a twitching, or trembling state known as "Ventricular fibrillation", in which the action of the individual muscle fibres are no longer co-ordinated. In either case (complete stoppage or ventricular fibrillation), the pulse disappears and circulation ceases.

(d) Muscle spasm:- A series of erratic movements of a limb or limbs may occur, owing to alternating contraction and relaxation of the muscles. This muscle spasm action on the muscles of respiration may be a factor in the stoppage of breathing.

Action of electric current:- In electric shock, the current may pass through the breathing centre at the base of the brain, and cause the centre to stop sending out the nerve impulses which act upon the muscles responsible for breathing. As a consequence, breathing stops abruptly. In such cases, starting artificial respiration immediately substitutes for the natural breathing of the victim. If the shock has not been severe, the breathing centre recovers after a time, and resumes its vital function; but the current may so paralyse the breathing centre, as to require several hours for recovery, and artificial respiration must be continued unceasingly, until there is recovery, or positive evidence of death. Under these conditions, victims of electric shock are unconscious, but heart action and blood circulation continue. Recovery depends on prompt and effective lung ventilation, until normal respiration is restored.

Current tolerance of the human body:- Alternating currents of high frequency produce little sensation, compared with alternating currents of low frequency and equal strength. Tests have been made to determine the "tolerance current" of typical individuals at several frequencies. The tolerance current was arbitrarily assumed, as the limiting current strength, which the subject could take through the arms and body, without marked discomfort or distress.
A man can tolerate only about 30 mA at 11,000 c/s, but can tolerate nearly .5 amps at 100,000 c/s. Although the tolerance current was found to increase very rapidly above 11,000 c/s, the increase between 60 and 11,000 c/s, was much less rapid, ranging from about 5mA at 60 c/s, to 30 mA at 11,000 c/s.

An investigation was made of the amount of 60 c/s current, which will produce mild shock, disclosed that the average current at which 42 persons first observed the sensation of shock, upon sudden contact, was 1.2 mA, and that the average of the maximum currents, which the persons could withstand without serious discomfort, was 8 mA.
Voltages as low as 12V - 25 to 60 c/s alternating current, have been shown by test, to be all that some individuals could withstand under conditions of good contact with the circuit. Other tests have shown that, when dry electrodes were held in both hands, a.c. voltages, ranging from 20 to 40, were all that were required to produce to maximum current, that individuals could withstand for a short time, and still have voluntary control of their muscles. In these tests, the currents ranged from 6, to 10 mA. Tests with direct current indicated that slightly higher current values could be withstood for a short time, until a hot spot occurred at the point of contact. The comparative immunity to injury, in handling circuits up to 120V with bare hands, is due to the high resistance of the dry, uninjured human skin. This resistance is greatly lowered by any thorough wetting of the skin, especially by perspiration and many chemicals, also by cuts and blisters. Under such conditions, 110 to 120V alternating current can produce a change in heart action, which may prove fatal. Furthermore, it requires only a few seconds contact, with a 50V standard frequency a.c. circuit, to produce blisters at the point of contact, thus destroying the dry-skin high resistance protection.

Factors determining seriousness of electric shock:-

(1) Body electrical resistance
(2) Path of current flow through the body
(3) Amount of current and duration of time.

(1) Body electrical resistance:-

a. Average body resistance approx. 5000 ohm (dry)
b. Average body resistance approx. 1000 ohm (damp)

Amount of current to cause death - approx. 0.1 amp

Voltage to produce fatal shock:-

a. E = 0.1 x 5000 = 500 volts
b. E = 0.1 x 1000 = 100 volts

(2) Path of current through body:-

Most electrocutions are due to "earth-fault" currents, i.e. current flowing from a "live" conductor or apparatus to earth, the current path being mainly between one hand and the feet. Most dangerous paths are those effecting the heart and brain, i.e. -

Current	path	from	Head	to	Leg
"	"	"	Arm	"	Arm
"	"	"	Arm	"	Leg
"	"	"	Arm	"	Chest

(3) Amount of current and duration of flow:-

Low current for a long time could be as dangerous as high current for a short time.
Current passing through the body is (ohms law) equal to applied voltage, divided by the resistance of the path taken by the current.

Effect of current passing through the body

1 Milliamp:- threshold of perception

10 - 15 Milliamps:- Tightening of muscles, and difficulty in releasing any object gripped - acute discomfort.

25 - 30 Milliamps:- Extension of muscular tightening to the Thoracic muscles, dangerous if not quickly stopped.

Over 50 Milliamps:- Fibrillation of the heart, which is generally fatal.

TITLE:- TESTING HAZARDS

LECTURER:-

DATE:-

EQUIPMENT:-

All work on an installation, or item of equipment, should be done with the circuit or equipment "dead". It is only necessary in theory to open a switch and/or remove a fuse to ensure safety. But even with such a simple operation, things can go wrong, i.e. labels may be incorrect or indistinct, a switch may be in the neutral wire, or, with a three phase bank or row of fuses, there may be a cross connection with an adjacent circuit, so that a "live" wire exists at a point of work. All too often the wrong circuit is isolated.

The safe working habit of TEST BEFORE TOUCH with a suitable testing instrument is essential. The series test lamp is NOT a suitable testing medium, and its use is forbidden, due to several serious accidents which have occurred to electricians while using them.

In many cases, particularly when investigating faults on such things as motor starters, complicated control circuits, and electronic apparatus, it is necessary to work with apparatus "live". Never work with, on or near live electrical equipment unless a second person is present. Such second person must know how to switch off the electricity supply and they should be conversant with resuscitation procedure.

Special care must be taken, by the use of correct test instruments and leads, insulated tools, and particularly strips of insulating material for the operation of contacts.

A further precaution often neglected, is to remove and replace apparatus covers, only whilst the apparatus is switched OFF. Serious accidents have happened when a cover (often heavier than expected) has dropped on "live" metal. Care must be taken, to check all equipment in a compartment, because control circuits often remain "live" when the main control switch is isolated.

Many commercial and industrial installations include very complicated control and safety circuits, e.g., air conditioning, lifts, process plant conveyors, diesel generating plant etc.

In many cases, trouble will occur in the control equipment, and to diagnose the fault it is common procedure, to operate or simulate operation of control circuits with drives isolated. As the systems vary so much, it is not possible to detail safety methods here, the following points should be noticed:-

(1) Make certain that you know what you are doing.
(2) Get a full circuit and sequence diagram, and study it.
(3) Depending on the layout, isolate circuit breaker, or withdraw fuses as necessary.
(4) TEST BEFORE TOUCH.
(5) Use insulated tools and devices as necessary.
(6) Remember that when a circuit breaker is isolated, control circuits may still be "alive".
(7) Never cut out an interlock if the device is faulty, replace or repair it.

Avoid working on conductors and/or apparatus from any position, from which a shock or slip will tend to bring your body towards exposed "live" parts.

When closing a switch or circuit breaker, keep your head turned. Do not look directly at the equipment if you can avoid it. Never work on electrical apparatus until you have been fully instructed of the hazard possibilities and how to obviate them. Radiation and induction heating cannot be seen and can be dangerous.

Micro-wave ovens, ultra-violet lamps, and X-ray equipment should be treated with respect. Learn what is required before you service and test.
Do not attempt to commence repairs on apparatus, until you are certain all safety procedures for isolating, tagging and locking off have been followed.

(1) SWITCH-OFF and ISOLATE before you start work or remove covers.

(2) Place a DANGER TAG on the source of supply to warn others that you are working on the circuit.

(3) TEST BEFORE YOU TOUCH, if in doubt ask.

TITLE:- SAFE PRACTICE

LECTURER:-

DATE:-

EQUIPMENT:- Nil

Accidents occur daily throughout the plant. Some are serious, but most are of a minor nature. Avoid becoming a statistic or causing someone else to become a statistic by remembering four basic causes of accidents.

1. LACK OF KNOWLEDGE
2. LACK OF FORETHOUGHT
3. CARELESSNESS
4. NEGLECT

Before carrying out ANY task think carefully about these four accident causing topics.

1. LACK OF KNOWLEDGE

Do not attempt any task unless you know EXACTLY what you are doing, and how your actions will affect others.
If you are unsure - ASK.
Don't allow your personal pride to prevent you asking questions - it is better to be safe at first than sorry later.
Read all notices displayed around the plant - get to know what they mean, why they are there, and most of all, you must REACT to notices, i.e. if the notice says "Wear safety glasses", then wear safety glasses.

2. LACK OF FORETHOUGHT

A person whose mind is pre-occupied with thoughts other than the job he is doing will be more susceptible to accidents than someone who CONCENTRATES on his job and THINKS about what he is doing.
Think before you act. Try to visualise what will, or could happen by your actions before you begin ANY task no matter how simple.
Everyone is equipped with a marvellour piece of equipment which when used properly, can make your life and work much easier and enjoyable - it is a thing called a BRAIN - USE IT TO THINK WITH. It will tell you what to do and how to do it by a simple thing called COMMON SENSE, which is again something which can prevent accidents when used.

3. CARELESSNESS

A number of factors can cause a person to be careless at what he or she is doing.

a. Anger
b. Haste
c. Pressure of time
d. Pressure of supervision
e. Fatigue
f. Lack of interest
g. Preoccupation.

A person who has no sense of responsibility towards himself, to others, or to equipment tends to be careless at most things he or she does. This type of person is dangerous in almost all situations and is one who frequently is the cause of accidents.
Study yourself; would you place yourself in this category, or would you judge yourself to be the CAREFUL type. If you are the latter, the chances are that you won't be the cause of accidents or the injured party provided that you don't allow the above factors to effect you.

4. NEGLECT

When you know that something should be done, and it is not done, then it is called NEGLECT. When injury or death is caused by another person's neglect, then the consequences can be extremely serious for the person who has been neglectful.
Safety is the responsibility of everyone, and anyone who sees anything which is unsafe and does not take the necessary steps to correct it is guilty of neglect. Obviously it is difficult to prove whether or not a person has seen something unsafe, but should an injury occur that you could have prevented by reporting what you had seen, then your neglect will disturb your conscience for a very long time especially if that injury was fatal.
A person who is lazy is more likely to neglect his duties and cause accidents than any other so if you see anything that you consider unsafe or dangerous, take steps to correct it. Either correct it yourself or inform your leading hand.

Safe Practice

The four topics described are the basis of what each person can contribute towards a successful safety programme regardless of what that person's job is. The electrician, however, has a much greater responsibility in his work as the results of what he or she does can endanger the lives of anyone handling electrical equipment. It is of extreme importance, then, that the electrician in particular must overcome the four factors described.
All safe practice is based upon these four important factors. Without them, no amount of effort on the part of the company in providing safety rules, equipment, or procedures will prevent accidents from occurring.
However, the company does make these safety rules, it does provide safety equipment, and it does lay down rules for certain dangerous procedures.
Most of the subjects are covered in lectures received in the Electrical ATS, other subjects will be covered by various departments during your training on the plant. These subjects may be summed up under the one heading of SAFE PRACTICE.

1. Listen carefully to instruction.
2. Don't exceed your instructions.
3. Obey all rules, regulations and notices.
4. Don't abuse tools and equipment.
5. Use tools and equipment in the proper manner.
6. Wear protective clothing and equipment.
7. Don't fool around on the plant.
8. Keep your workplace clean and tidy.
9. Don't interfere with electrical or other equipment unless you know exactly what you are doing.
10. Ask, if you are unsure or don't know.

TITLE:- WORKING ON LIVE CIRCUITS

LECTURER:-

DATE:-

EQUIPMENT:-

All employees are forbidden to work on live circuits, except the following:-

(a) Those employees authorized in writing by the Chief Electrical Engineer, to carry out running repairs, tests and adjustments, to control gear associated with continuous processes. Good quality, insulated tools, and approved rubber floor mats, must be used for such work.
The authorization to carry out such work will cease when the authorized employee is transferred away from the section of the plant specifically mentioned in the authorization, or if cancelled by the employee's foreman.

(b) Where permission is given by the Chief Electrical Engineer in writing, for other than work covered by (a).
Such permission shall apply only for the one occasion specified in the written order.
The written order shall specify the safety precautions to be taken, and will include the general precautions, besides any special ones necessary, to safely carry out the work mentioned in the order.
The person to whom the written order is given, must read the instructions contained in it, and sign a declaration at the end of the order, thereby indicating that he has read the instructions, is willing to carry out the work, and will observe the safety instructions embodied in the order.

Never work on a live circuit, unless absolutely unavoidable.
Never work alone on a live circuit - have at least one person standing by in case of accidents.
The standby man should be ready to deaden the circuit immediately a case of electric shock occurs, or if this is not possible, he should have suitable material handy to remove the victim from a live conductor.
He should advise you on the position of all parts of the material you are moving, particularly if it is a long length.
Be sure that you are insulated to withstand the full circuit voltage (maximum value).
Carry all your tools on your person; do not receive tools or material from persons at a different potential than yourself.
Be careful of removing leads from "negative", or "earth" bus-bars, unless they are disconnected at the higher potential end of the circuit, (e.g., meter leads). This precaution must be taken on <u>all</u> circuits, whose negative leads are held by the same bolt or clamp.
Do not use engineer's measuring tapes near live conductors, because they have a metallic thread, interwoven with the linen threads.
Fatal accidents have occurred, through lack of this precaution.

<u>General electrical maintenance</u>:-

(1) Treat <u>all</u> electrical circuits and apparatus as ALIVE and DANGEROUS, until <u>you</u> are <u>sure</u> they are <u>isolated</u> and <u>earthed</u>.

(2) Switches, fuses and isolators, must be wired in the higher potential conductor.

(3) Rope off any temporary dangerous situation, and hang suitable warning notices from the rope.

(4) If working close to live conductors, place dry wooden barrier boards between the unsafe area and yourself.

<u>Isolating</u>:- (1) Before isolating a circuit for maintenance, notify all persons concerned with the circuit, and place danger tag at the isolating switch.
(2) Do not interrupt a conductor carrying current, except at apparatus designed for this duty.

TITLE:- S.A.A. RULES (EXTRA LOW VOLTAGE CIRCUITS)

LECTURER:-

DATE:-

EQUIPMENT:- S.A.A. Wiring Rules

S.A.A. 7.3.1. Source of supply - installations and portions of installations operating at extra-low voltage, shall be supplied from suitable generating, transforming, or converting equipment, or from batteries, having an output voltage not exceeding extra-low voltage at rated output, and not exceeding 40 volts A.C., or 145 volts D.C. at no-load.

S.A.A. 7.3.2. Isolation of transformer windings.

S.A.A. 7.3.4. Accessibility of any generator, transformer, converter or battery.

S.A.A. 7.4. Enclosure of live parts when used in a damp situation.

S.A.A. 7.5 & 7.6 Voltage rating of equipment and voltage drop in conductors.

S.A.A. 7.7 & 7.8 This section deals with main switches and general switches.

S.A.A. 7.9 Over-current protection of extra-low voltage circuits. Protection required - Protection not required and Fault level.

S.A.A. 7.10 Location of switchboards - distance from transformer.

S.A.A. 7.11 Determination of maximum demand - final sub-circuits - mains and sub-mains.

S.A.A. 7.12 Number of points per final sub-circuit - circuits protected by fuses - circuits protected by circuit-breakers.

S.A.A. 7.13 Final sub-circuits - reduction in current-carrying capacity.

S.A.A. 7.14 Plugs and Plug sockets - current rating - marking of voltage - preventing the insertion of an extra-low voltage plug, into a plug socket, connected to a circuit of higher than extra-low voltage.

S.A.A. 17.15 Conductors for extra-low voltage installations - Use of bare conductors - Use of bare busbars - Aerial conductors - Underground wiring - Earthing and where required.