Industry Guidelines
For Electrical Geophysics

Ground Geophysical Surveys Safety Association

1 February 2015

PREFACE

This document has been created with the intention of providing guidelines for ground electrical geophysical surveys. The objective of these guidelines is to provide GGSSA members with uniform requirements and procedures to facilitate safe electrical geophysical surveys.

These guidelines recommend minimum hardware and procedural requirements. GGSSA is a non-regulatory body and as such does not have any authority to compel members to follow its recommended practices. However members have agreed under the terms of membership to follow GGSSA Guidelines and recommended practices including incident reporting. This manual is not a replacement for the regulatory requirements of the country of registration and or operation. Each member must fully comply with all regulatory requirements and undertakes to follow the practices in this manual when they are more stringent or not covered by regulations.

The use of the information and advice provided by GGSSA is at member's risk. GGSSA believe that advice provided by it is appropriate and accurate; however no warranty of accuracy is given. The GGSSA does not accept responsibility or liability arising from any representation, act or omission and does not accept responsibility or liability for any harm or injury caused directly or indirectly by the use of advice provided by GGSSA. GGSSA recommends that members undertake a risk assessment for all survey work.

FORWARD

Ground based geophysical surveys require careful planning and design to mitigate risk to the contractor, client, community and the environment.

There are a range of generic issues to be addressed with all survey types but the use of hazardous voltages in any ground geophysical survey introduces the potential of specific high risk activities. The aim of this document is to address those issues. Although contractors may not always be operating under the definition of high voltage, these procedures apply to all electrical ground geophysical operations.

High Voltage is defined in AS/NZS3000 as any voltage exceeding 1000V AC. or 1500V DC. The following, based on AS/NZ3000, provides guidance on the voltage classifications.

> ***Extra Low Voltage***: not exceeding 50V AC or 120V ripple-free DC.
>
> ***Low Voltage***: exceeding Extra Low Voltage, but not exceeding 1000V AC or 1500V DC.
>
> ***High Voltage***: exceeding Low Voltage

Primary Risks associated with Electrical Geophysical Surveys:

- Electric shock, as detailed in AS/NZS 60479, including lightning strikes
- Fire

The SEVERITY of CONSEQUENCE for both these risks is likely to be in the very highest category so it is vitally important that careful Planning and Design of the survey mitigate the LIKELIHOOD of OCCURRENCE to a level where the risk assessment is as low as reasonably practicable.

Contents

Revision History

Rev #	Date	Approved by	Summary of Amendments
0	28/11/2012	GGSSA Committee	Draft released to industry for review
0.1	19/04/2013	GGSSA Committee	Revision of Document
0.1a	16/05/2013	GGSSA Committee	Revision of Document
0.2	02/07/2013	GGSSA Committee	Revision of Document
0.3	03/07/2013	GGSSA Committee	Revision of Document
0.4	26/08/2013	GGSSA Committee	Reorganisation of document sections
1.0	29/05/2014	GGSSA Committee	Version 1.0 released
1.1	14/11/2014	GGSSA Committee	Revision of Document
2.0	01/02/2015	GGSSA Committee	Revision of Document

Referenced Documents

The following documents are referred to in these guidelines:

Standard	***Title***
AS/NZS 3000:2007	Electrical installations (wiring rules)
AS/NZS 60479.1:2010	Effects of current on human beings and livestock – general aspects
AS 1940-2004	The storage and handling of flammable and combustible liquids
AS/NZS 2906:2001	Fuel containers – portable – plastic and metal
AS/NZS 1269 Set:2005	Occupational Noise Management Set
AS/NZS 1768-2007	Lightning Protection
	GGSSA Guidance Note – Working with Lightning

Definitions

For the purpose of these Guidelines, the definitions below apply:

Category	Term	Acronym	Definition
Association	Ground Geophysical Surveys Safety Association	GGSSA	Association formed to advance safety in ground geophysics
	National Professional Engineers Register	NPER	A register of Electrical Engineers who meet minimum requirements for training and experience from which competent electrical engineers can be selected to assess a contractor's SOP and compliance with this guideline , or appropriate international equivalent. See: www.engineersaustralia.com.au
Procedure/Plan/ Equipment	Dry Chemical Powder/ ABE High Performance	DCP	Fire extinguisher suitable for use on Class A (ordinary combustible solids), Class B (flammable and combustible liquids) and Class E (electrical) fires.
	Emergency Position Indicating Radio Beacon	EPIRB	Emergency beacons used to alert rescue authorities of your distress situation, indicating your approximate location anywhere.
	Emergency Response Plan	ERP	Systematic procedures that detail what needs to be done, how, when, and by whom in the event of an emergency.
	Isolation		In a general sense, to isolate an area means to remove all **hazardous energy** [electrical, pneumatic, hydraulic, stored (e.g. springs and batteries), kinetic (by virtue of position) heat and radiation] and **hazardous substances** [gases, vapours, liquids, dust with the potential to cause injury or lines].

Category	Term	Acronym	Definition
Procedure/Plan/ Equipment (cont.)	Job Safety Analysis	JSA	A systematic review of a job, task, process or procedure used to identify the risks or hazards associated with that activity in the workplace to determine appropriate measures to eliminate or control those hazards.
	Job Hazard Analysis	JHA	
	Material Safety Data Sheet	MSDS	Intended to provide workers and emergency personnel with procedures for handling or working with that substance in a safe manner, and includes information such as physical data (melting point, boiling point, flash point, etc.), toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment, and spill-handling procedures. MSDS formats can vary from source to source within a country depending on national requirements.
	Personal Locator Beacons	PLB	Small, personal emergency beacons used to notify search and rescue agencies of distress, indicating your location anywhere in the world.
	Personal Protective Equipment	PPE	Safety clothing and equipment required for specified circumstances or areas to provide personal protection and minimise risk for employees.
	Safe Operating Procedure	SOP	A set of written instructions that identifies the risks that may arise from the jobs or tasks that make up a system of work and documents how these risks will be mitigated and or controlled. Written method statements outlining how to perform a task with minimum risk to people, equipment, materials, environment, and processes.
	Safe Work Practices	SWP	
	Safe Work Instructions	SWI	

Category	Term	Acronym	Definition
Electrical	AC/DC		GGSSA advises there does not look to be any regulatory definition for AC or DC. All medical research done on electric shock seems to assume <=1 Hz is equivalent to DC. 1 Hz would include 500 mS ON/500 mS OFF or 250 mS ON/250 mS OFF. DC - An electric current that flows in just ONE direction through a circuit. A current (conventional) from a DC power supply is considered to flow from the positive terminal of the power supply, around the circuit to arrive back at the negative terminal of the DC power supply. Note that we now know it is electrons which flow in currents. AC - An electric current where the charge moves back and forth in a wave pattern (the charges oscillate or alternate their motion in the conductors). The charges flow first in one direction and then reverse and move back in the opposite direction. The terminals of an AC power supply change their polarity, swapping from being positive to negative and back again at a certain frequency, usually 50 Hz in Australia (i.e. 50 times per second).
	De-Energised		De-energised means separated from all sources of supply but not necessarily isolated, earthed, discharged or out of commission, e.g. Generator/Transmitter is shut down and the output circuit is disconnected.

Category	Term	Acronym	Definition
Electrical (cont.)	Generator		A machine that converts mechanical energy into electrical energy that is used to supply power to Transmitter equipment.
	Isolated (specific to electrical geophysics)		Isolated means disconnected from all possible sources of electrical supply and rendered incapable of being made energised without premeditated and deliberate action.
	Power Cable		A power cable is an assembly of one or more electrical conductors, usually held together with an overall sheath. The assembly is used for transmission of electrical power. A power cable is different to a transmitter wire (see below).
	Receiver Cable		An insulated conductor used to connect voltage sensors to a receiving/recording device. For example, a multicore cable connecting pots to a receiver.
	Transmitter Wire		An insulated, single conductor electrical cable which may be used to carry potentially significant voltage or current. For example, wires carry current to where the transmitter electrodes contact the earth for IP surveying and carry current around a loop for EM surveying.
	Transmitter	Tx	An electro-mechanical device that generates a voltage potential and the resultant currents that are used in time and frequency domain electrical geophysics.

Category	Term	Acronym	Definition
Personnel	Active Member		A person or company that is a member of GGSSA and performs geophysical surveys
	Associate Member		A person or company that is a member of GGSSA and is not actively engaged in performing geophysical surveys.
	Crew Chief/Leader		Person who is responsible for the field supervision of a geophysical survey
	Member Endorsed Personnel		Person who has been trained and assessed as competent in the Safe Operating Procedures and this Guideline for Electrical Geophysical Surveys.
	Authorised Operational Personnel		
	Transmitter Operator		Person who has been trained and assessed as competent in the Safe Operating Procedures and these Guidelines for Electrical Geophysical Surveys, and holds the necessary permits to operate the electrical Transmitter.

1 SAFE OPERATING PROCEDURES

1.1 Survey Design and Risk Analysis for Electrical Geophysics

a) As stated on the forward page, the main risks associated with Electrical Geophysical Surveys are:

- Electric shock
- Fire

b) Electric shock and fire may impact on:

- Active and Associate Members
- Landowners, general public, community assets
- Livestock
- Native fauna

1.1.1 Electric Shock

GGSSA recommends the minimum requirements to reduce the risk of electric shock, including lightning strike, as follows:

a) It is the responsibility of the client contracting the Active Member to provide, in consultation with the Active Member, communication and warnings to landholders, stakeholders and the general public in advance of the survey, notifying all concerned parties that the use of hazardous voltages for a geophysical survey is planned for their area.

b) In Western Australia it is mandated that a NPER registered Electrical Engineer is required to certify Safe Operating Procedures. GGSSA recommends the use of a NPER registered Electrical Engineer to certify Safe Operating Procedures regardless of location in Australia. Outside Australia GGSSA members should consult with local professional engineering bodies to have their procedures certified.

c) Hardware maintained in a serviceable state.

d) Operation of all Transmitter equipment should only be undertaken by Member Endorsed Personnel who hold all necessary licences.

e) All Active Member employees and subcontractors should be suitably trained in the safe operation of ground geophysical equipment and communication procedures.

f) Constant surveillance and vigilance by all operating staff.

g) Suitable positioning of Transmitter electrodes and a method of connecting the Transmitter Wires to electrodes that ensures no one can touch bare wires or metal when the equipment is energized.

h) Appropriate signage is to be used, where people (i.e. survey crew, clients and members of the public) can access the survey site, electrode sites and at the transmitter.

i) Ground electrodes are to be suitably demarcated by signage, fencing, bunting, taping, and monitored as deemed appropriate (Also refer to sections 1.2.1 c) and 1.2.4).

j) All wiring/cabling should have suitable insulation and sufficient current carrying capability for the equipment being used, (see Section 4.1.4).

k) Transmitter Wires should not be draped over, or be in contact with, any fencing.

l) All energised work should cease during severe rain or when there is the threat of or lightning or fire activity. It is left to the discretion of the Crew Chief when rain becomes a safety factor for their crew. Consideration needs to be given to the increased likelihood of slips and falls as well as electrical safety. GGSSA recommends all work should cease at the first sign of lightning and shelter should be sought when there is 30 seconds or less between visible lightning and audible thunder, and to wait 30 minutes after hearing the last thunder clamp before resuming activities (see GGSSA Guidance Note – Working with Lightning).

m) The Active Member should develop SOPs for Electrical Surveys which addresses all sections of these guidelines. These SOPs are to be reviewed by the Active Member and stakeholders at the start of each survey utilising Transmitters and noted in the safety meeting minutes.

1.1.2 Fire

a) On days of Total Fire Ban, GGSSA recommends no survey work involving Transmitters and vehicles, which is classified as hot-work under many state and territory's legislation, be carried out.

b) GGSSA recommends that Active Members undertake a JSA to determine if it is safe to proceed with surveying on HIGH FIRE DANGER days.

c) GGSSA recommends reducing the fire risk when using electrical ground geophysical equipment through:

- Adherence to NPER (or appropriate international equivalent) Certified SOP
- Training is provided to all survey personnel in:
    - the use of fire extinguishers
    - the location and type of firefighting equipment deployed on survey
    - the safe operation of ground geophysical equipment and the Active Members' SOP
    - communication procedures
    - emergency equipment shutdown procedures
- Smoking only in designated smoking areas as defined in the JSA.
- The provision of suitable, compliant and clearly visible fire extinguishers in appropriate areas: Dry Chemical Powder (DCP) for electrical fires and water for grass/scrub fires.

- A dry powder fire extinguisher, should be located adjacent the Transmitter Equipment, and clearly visible.
- Constant surveillance and vigilance by all survey staff.
- Correctly maintained ground electrode installation on cables and wires.
- Appropriate clearance of combustible materials from the area around the Transmitter electrodes.
- The use of suitable Transmitter Wire with applicable insulation and methods of maintaining that level of insulation and mechanical strength on all joins.
- Constant monitoring of the current weather and combustible material i.e. grass of the survey area.
- All engines must be fitted with an efficient spark arrester (e.g. muffler) device to reduce the risk of fire.

d) Other factors to be considered in the survey design are where the ground electrodes and Transmitter Wires are sited in relation to areas accessible to the general public and utility infrastructure.

e) Care should be taken when operating around active mines when there is a risk of blasting being carried out. Before undertaking any survey approval should be granted by the appropriate mine manager.

f) Adherence with any other site specific safety procedures or restrictions.

1.2 Electrical Geophysics Safe Operating Procedures

1.2.1 Loop and Electrode Safety

GGSSA recommends the following, at a minimum, for Loop and Electrode Safety:

a) Five (5) metre safe distance is observed by all persons whilst near live grounded Transmitter electrodes during transmission. A safe as practicable distance should be maintained away from energised Transmitter Wires.

b) Unattended electrode locations will be appropriately fenced off (with non-conductive material) and signposted. No survey personnel shall enter the fenced area unless positive communication is made with all survey personnel to ensure that the electrode and connecting wires are not live. The Generator/Transmitter system must be de-energised and isolated at all times when personnel are working on Transmitter electrodes.

c) High visibility road cones, signage and road matting should also be used if wires cannot be safely buried across access roads. Consideration should be given to manning the road if local conditions warrant such action, e.g. near populated areas, heavy traffic, and possibility of theft of wire whilst transmitting.

d) Non active wires, including receiver cables will be deployed in such a way as to guarantee they cannot make inadvertent contact with a live electrode, or Transmitter Wire. Whilst not transmitting, both Transmitter Wires must be disconnected from the Transmitter terminals so that dangerous voltages cannot inadvertently be transmitted at any time.

e) All loop or electrode equipment is to be considered “LIVE” unless otherwise advised by the Transmitter Operator.

1.2.2 Transmitter Safety

1.2.2.1 Roles and Responsibilities

a) The Transmitter Operator is directly responsible for the electrical safety of all personnel and members of the public within the survey area Transmitter and Generator Location and Setup.

1.2.2.2 Transmitter and Generator Location and Setup

GGSSA recommends:

a) Whenever possible the Generator should be set-up on flat open ground with clear field of vision on all sides so that anyone can be seen approaching the site.

b) Care must be taken in selection of the Transmitter location to minimize the risk of combustible materials catching fire.

c) Where the Transmitter location is fixed (e.g. gradient IP, fixed loop EM, etc.) the Transmitter equipment is fenced off, using an appropriate barrier to a distance as determined from the JSA. Where the Transmitter equipment is positioned adjacent to the power generation equipment, it is acceptable to position the fence such that it encloses both.

d) Engines are fitted with an efficient spark arrester (e.g. muffler) device to reduce the risk of bushfire.

e) Appropriate warning signs are located immediately adjacent to the fenced off area, clearly visible in all directions to approaching personnel and public.

1.2.2.3 Transmitter Operation

GGSSA recommends:

a) The Transmitter Operator remains vigilant at all times while the Transmitter is operating, observing and listening for any abnormal occurrence.

b) If anything abnormal is noticed in the survey area the Transmitter should be immediately shutdown.

c) A method to establish a valid circuit exists prior to the transmitter being energised should be implemented. This is to avoid having any voltage potential on the transmitter output whilst crew members are attempting to establish a circuit.

d) Whenever the Transmitter is being moved, it should be de-energised.

e) Loops or electrodes will not be connected to the Transmitter unless the Transmitter is "**safe**" (i.e. "Reset", turned "**off**" and "**isolated**").

f) Where radio communications is lost, faulty, misheard, unintelligible or confused, the system must be de-energised and isolated until radio communications have been restored.

g) The Transmitter equipment is not left unmonitored by personnel at any time when:

- operational
- the power cable is connected
- left in an unisolated state when it can accidentally or inadvertently be made operational

1.2.2.4 Connection to Other Equipment

GGSSA recommends:

a) Only a Member Endorsed Person plug cables into the Transmitter.

b) Power Cables are run between the Transmitter and the power supply in as direct a path as possible without coiling.

c) Power cables are only handled when the power supply is de-energised and isolated.

d) Power cables are not walked over or stepped upon during normal survey activities.

1.2.3 Communications

GGSSA recommends:

a) All survey personnel have access to two way communications in the form of radio or mobile phone if working out of speaking distance from another crew member. Mobile phone communication should only be considered when radio is not available.

b) Survey personnel are equipped with Satellite Phone and Emergency Distress Beacons (EPIRB) or Personal Location Beacons (PLB), as determined by the JSA.

c) The Emergency Response Plan incorporates a regular communication schedule.

d) During surveys, a clear set of radio calls are established every time the system is electrically energised to ensure that the entire survey crew knows when the system is live.

e) The Transmitter Operator does not energise the Transmitter Wires until they have positive communication from every crew member that they are clear of all Transmitter Wire and electrodes.

f) All loop or electrode equipment is to be considered "**live**" unless otherwise advised by the Transmitter Operator.

g) When crew members or members of the public that may be within the work area speak different languages, a means of effective communication needs to be established.

1.2.4 Signage

GGSSA recommends that:

a) Appropriate warning signs are erected at Generator/Transmitter sites, remote electrode sites, road crossings and along public access routes where transmission wires are in use.

b) At Generator/Transmitter sites, signs be erected that warn against access to the site without first making contact with the survey crew via UHF or Mobile/Satellite Phone.

c) An instructional first aid sign for the treatment of electric shock be provided near the Transmitter and within vehicles and portable first aid kits.

1.2.5 General Safety

GGSSA recommends the following general safety practices be observed:

a) Use safe manual handling techniques at all times.

b) Appropriate PPE as outlined in the Safe Operating Procedure and JSA must be worn at all times.

c) All personnel within five (5) metres of operational generators wear appropriate hearing protection in accordance with AS/NZS 1269.

d) Equipment is not operated in confined spaces or restrictive areas that do not allow clear access to controls and equipment.

e) When star pickets, earth stakes, or other similar sharp objects are used, safety caps are fitted to the ends of objects to prevent injury from inadvertent contact.

f) All visitors to the geophysical survey site should receive a short induction to make them aware of the hazards associated with the survey operations.

ALL CREW MEMBERS MUST CONTINUALLY REMIND THEMSELVES TO BE AWARE AND NOT ACT WITHOUT THINKING.

1.2.6 Fuel Storage, Handling and Decanting

Active Members should have and implement a Fuel Storage, Handling and Decanting procedure which complies with AS1940 and AS/NZ2906.

2 DOCUMENTATION

When planning for an electrical ground geophysical survey, the Active Member should consider, as a minimum, the following list of documentation requirements:

- Safe Operating Procedures (SOP) and Risk Assessment

- Location map(s) with survey boundaries, co-ordinates, no-go areas Emergency Response Plans, both general & project specific
- Material Safety Data Sheets as required
- Electric shock protocol and lightning management procedure (refer to the GGSSA Lightning Guidance Note)

3 TRAINING

The Active Member has overall responsibility to ensure that all its employees are trained and competent. They will retain records of all training and assessments completed.

GGSSA recommends information, training and instruction provided to a worker is to be suitable and adequate, having regard to:

- the nature of the work being carried out,
- the nature of the risks associated with the work at the time, the information, training or instruction is provided, and
- the control measures implemented.

Active Members should ensure so far as reasonably practicable that the information, training and instruction is provided in a way that is readily understandable by any person to whom it is provided.

Examples of training could include but are not limited to:

- Induction
- Supervisor and management training
- Work specific
- Emergency procedures
- First aid
- Electric shock protocol
- Fire management
- Vehicle operation

3.1 Electrical Safe Operating Procedures Training

It is recommended training is undertaken when:

a) a person has been absent for the industry for a period of 6 months or more or a person has not used electrical geophysical equipment within the industry for 6 months or more,

b) new equipment is introduced that is sufficiently different or existing equipment is altered sufficiently that re-training is required and

c) when the Safe Operating Procedures are modified.

3.2 Training Records

Records should be kept as per legislative requirements.

4 EQUIPMENT

When planning for an Electrical Ground Geophysical Survey the Active Member should consider, as a minimum, the following list of equipment requirements:

- Appropriate survey equipment and spares
- Appropriate vehicles, safety equipment and spares
- Appropriate first aid kits
- Appropriate fire extinguishers
- Appropriate signage
- Appropriate spill kit(s)
- Appropriate bunding
- Appropriate communications systems, both local and long distance

4.1 Equipment Safety Features

4.1.1 Transmitters

GGSSA recommends that transmitters used for Electrical Ground Geophysics include, at the minimum, the following safety features:

a) Open circuit load detection with automatic shutdown upon detection of an open load condition.

b) Suitable earthing mechanisms to detect/eliminate voltage potentials between the operator(s) and equipment/ground.

4.1.2 Generator

It is recommended that Generators used for Electrical Ground Geophysics include, at the minimum, the following features:

a) Isolating device(s) or mechanism(s) to prevent starting of the Generator during inspection, repair and maintenance events

b) An easily accessible Emergency stop feature

c) Over current protection that is appropriate for the rated voltage and current of the circuit on which it is installed

d) Electrical bonding of engine frame, Generator frame, Transmitter and any metal enclosing electrical wiring and equipment

e) Fuel supply system that complies with AS/NZS 2906 and AS 1940

f) Guards fitted over all moving parts

g) Sensitive earth leakage protection

h) Engine noise reduction systems

4.1.3 Wire and Cables

GGSSA recommends:

a) The Active Member document in their Safe Operating Procedure what mechanisms they have engaged to distinguish between wire types, such as Transmitter Wires, receiver Cables and Power Cable on survey and included in their training program

b) The Active Member only installs Transmitter Wires of suitable gauge and insulation rating appropriate for the maximum voltage/current capability of the equipment in use

c) The cable(s) used to earth/ground the Transmitter and Generator equipment are of sufficient current rating and the insulation of sufficient voltage rating to suit each system. The minimum requirement is that it is not less than 4mm² - 5.3.3.2 AS NZS 3000:2007 Electrical Installations

4.1.4 Insulation for Electrical Ground Geophysical Surveys

The areas of concern with regards to insulation are:

a) at the Transmitter output connectors and in the close vicinity of the Transmitter and

b) where the Transmitter Wires connect to the electrodes.

4.1.4.1 Safe Insulation Practices

In light of these areas of concern GGSSA recommends that:

a) At the Transmitter:

- No Transmitter output wiring is allowed to rest against any metal surface. The method of connecting the wires to the Transmitter output connectors should include insulators, double insulation, flexible conduits or other mechanical protection to ensure that the transmitter conductors' insulation cannot be damaged and energise adjacent metal work. Such an insulation failure could pose an electric shock hazard to the Transmitter Operator.

b) Along the Transmitter wires:

- Wire joins are to be made such that the integrity, mechanical strength and insulation properties of the original wire are maintained.
- The Transmitter Wire jointing method is to be documented by the Active Member.
- If the wire insulation becomes degraded over time due to mechanical damage or environmental exposure (UV/chemical), the wire should be replaced.

c) At connections to the ground electrodes:

- The method used to connect the Transmitter Wires to the ground electrodes should be suitable for the voltages that are to be used and mechanically robust as an aid to prevent accidental disconnection of the Transmitter Wire by wandering animals or humans.
- An insulated female socket on the Transmitter Wire and a male plug on the earthing electrode connection are preferred as this prevents an operator touching the bare cable during this potentially hazardous activity. Note: The act of connecting the Transmitter Wire to the earthing electrode is particularly hazardous if the isolation equipment/process has failed, or during lightning or should stray voltages are being induced onto the Transmitter Wire whilst it is unearthed.
- GGSSA recommends the method of connection be documented in the Active Member's SOP.

4.2 Equipment Inspection and Maintenance

4.2.1 Equipment Servicing and Inspections

Maintenance schedules and requirements are listed in the relevant equipment manual that accompanies each item of equipment. In addition to following the equipment manual requirements, GGSSA recommends that:

a) All repairs, modifications or electrical work on high voltage equipment must be conducted by a person holding an appropriate Electrical Workers Licence or by persons with extensive knowledge or training in the repair of this type of equipment.

b) Maintenance that requires the use of tools or the removal of covers to gain access to internal components of the Transmitter can only be performed by trained technicians.

c) Electrical ground geophysical survey equipment shall be calibrated, serviced and inspected for any defects or obvious safety hazards by an electronics technician prior to each deployment. Active Member must maintain records of such inspections that include the technician's name, date of inspection, repairs or adjustments required and any relevant comments regarding the status of the equipment. The Electronics Technician must tag the electrical ground geophysical survey equipment as serviceable or out of service, as appropriate. Only serviceable equipment can be deployed on a survey.

d) Daily inspections of all electrical ground geophysical survey equipment are undertaken by a Member Endorsed Person with any defective items tagged as out of service and removed from operations. Active Member should develop and implement a daily checklist to ensure all necessary inspections are conducted and recorded on each production day. The checklist should include, at a minimum, the following inspections:

- Condition of the high voltage connection box and accessory components
- Machine guards are fitted and serviceable on Generators
- Transmitter Wire condition is good, i.e. no exposed conductors or damage to insulation, and contains minimal joins
- Earthing connections between the Transmitter, Generator, earthing points and earthing mats and earthing stake if provided
- Transmitter, Generator and high voltage connection box connections
- Emergency shutoff and system isolation controls are operational
- Positive test of all primary communications equipment to be used during that days' work

e) A Member Endorsed Person conducts an inspection of the Transmitter equipment:

- When the equipment has been unattended after the personnel have left the site and returned
- Following any relocation of the Transmitter
- Following maintenance on equipment
- Any time a Member Endorsed Person believes it necessary

f) At the beginning of each survey day the Active Member should ensure that the open circuit protection system on the Transmitter is functioning by performing an open circuit test.

4.2.2 Scheduled Preventative Maintenance

GGSSA recommends that the Active Member develops and adheres to a scheduled preventative maintenance program for all Electrical Ground Geophysical Survey Transmitters and Generators. This program should include the frequency of maintenance,

details of who is authorised to conduct the maintenance, and the minimum tasks required to be performed during that maintenance.

4.2.3 Equipment Tagging and Isolation

GGSSA recommends that:

a) The Active Member develop and implement a Tagging and Isolation Procedure which includes:

- Danger tags
- Out of Service tags
- Serviceable tags
- Lock out devices
- Who can remove Danger and Out of Service tags

b) All survey crews are supplied with appropriate tags and lock out devices for the equipment deployed.

5 AUDIT STRUCTURE

To validate that Active Members are complying with their obligations of membership to GGSSA, Active Members will be required to undertake periodic internal and external audits. The findings of these audits are to be lodged with an independent third party along with a corrective action plan to rectify any non-conformances.

5.1 Internal Audits

a) The Active Member shall conduct internal audits **bi-annually** to determine whether their Electrical Ground Geophysical operations conforms to:

- their SOP/SWI,
- the requirements of these guidelines

b) An audit programme plan will be documented by the Active Member. This plan will define the audit criteria, scope, frequency and methods to be engaged. The selection of auditors and conduct of audits shall ensure objectivity and impartiality of the audit process.

c) A documented procedure shall be established to define the responsibilities and requirements for planning and conducting audits, establishing records and reporting results. Records of the audits and their results shall be maintained.

5.2 External Audits

a) An external audit shall be conducted upon the first anniversary of compliance to these guidelines then every two years.

b) The external auditor needs to be an electrical engineer on the National Professional Engineers Register (NPER) (or appropriate international equivalent).

c) Failure to rectify a non-conformance within the stipulated timeframe and continuing to operate will be considered a breach of operating to these guidelines for electrical geophysics, excluding lodged non-compliances.

6 Members Compliance Checklist

To demonstrate compliance with their obligations under these Guidelines and their GGSSA membership, the Active Member should maintain the following documentation:

- NPER (or appropriate international equivalent) certified Safe Operating Procedure specific to electrical geophysics
- Training and assessment records
- Pre-start inspection checklists
- Cable joining procedure
- Radio terminology and procedures
- Tagging and isolation procedure
- Scheduled preventative maintenance program
- Maintenance records
- Signage register
- Fuel storage & handling procedure
- Copies of company and individual licences and qualifications
- Health and safety statistics
- Appropriate insurance coverage
- Audit programme
- Audit procedure
- Lightning management procedure