Queensland Government
Workplace Health and Safety

Workplace Health and Safety Guide

The Safe Use In Industry of

Radio Frequency Generating Plant

October 2000

Contents

1. Introduction

1.1 What is this Guide about ?

The Workplace Health and Safety Guide for the Safe Use in Industry of Radio Frequency Generating Plant gives guidance on how the hazards associated with the use of radio frequency (RF) generating plant can be controlled.

This Guide applies to radio frequency induction heaters, dielectric heaters and microwave ovens operating at frequencies between 3 kHz and 3 GHz. This Guide does NOT apply to deliberate transmitters of radiofrequency fields such as are used in the communications and broadcast industries.

1.2 Workplace health and safety obligations and the *Workplace Health and Safety Act 1995*

The *Workplace Health and Safety Act 1995* imposes obligations on people at workplaces to ensure workplace health and safety. Workplace health and safety is ensured when persons are free from the risk of death, injury or illness created by workplaces, workplace activities or specified high risk plant. Ensuring workplace health and safety involves identifying and managing exposure to the risks at your workplace.

How can I meet my obligations?

Under the Act, there are three types of instruments made to help you meet your workplace health and safety obligations – regulations, advisory standards and industry codes of practice.

If there is a regulation about a risk – you must do what the regulation says.

If there is an advisory standard OR industry code of practice about a risk – you must either

- do what the standard or code says; or
- adopt and follow another way that gives the same level of protection against the risk.

If there is no regulation, advisory standard or industry code of practice about a risk – you must choose any appropriate way and take reasonable precautions and exercise proper diligence to ensure you meet the obligation.

1.3 Workplace health and safety obligations in relation to radio frequency generating plant

Obligations of employers and self-employed persons

An *employer* has an obligation to ensure:

- the workplace health and safety of each of the employer's workers at work;
- his or her own workplace health and safety and the workplace health and safety of others is not affected by the way the employer conducts the employer's undertaking.

A *self-employed person* has an obligation to ensure his or her own

workplace health and safety and the workplace health and safety of others is not affected by the way the person conducts the person's undertaking.

These obligations include protecting workers, themselves and others from exposure to levels of radio frequency fields (RFF) that:

- may cause adverse health effects; or
- exceed the Exposure Limits[1].

Obligations of workers

A *Worker* has an obligation:

- to comply with instructions given for workplace health and safety at the workplace by the employer at the workplace;
- to use personal protective equipment if the equipment is provided by the worker's employer and the worker is properly instructed in its use;
- not to wilfully or recklessly interfere with or misuse anything provided for workplace health and safety at the workplace;
- not to wilfully or recklessly interfere with or misuse anything provided for workplace health and safety at the workplace;
- not to wilfully place at risk the workplace health and safety of any person at the workplace; and
- not to wilfully injure himself or herself.

These obligations include:

- following safe RF working procedures established by the employer;
- not intentionally exposing themselves or others to levels of Radio Frequency Radiation (RFR) that may exceed the Exposure Limits; and
- not operating plant with any shielding removed.

[1] Exposure Limits refer to exposure limits for non-ionising radiation declared in Schedule 1 of the Australian Radiation Protection and Nuclear Safety Regulation 1999. Refer also to Standards Australia (1998) AS/NZS 2772.1 (Int):1998 *Radio frequency fields Part 1: Maximum exposure levels – 3 kHz to 300 GHz.*

2. Radio Frequency Radiation - Background Information

RFR is a form of non-ionising radiation that is emitted naturally from the sun, galaxies and the earth. Non-ionising radiation does not have enough energy to form ions in the body to damage DNA. RFR is also generated by humans for a variety of uses such as cooking, communications, welding, medicine, and heating wood, metal and plastics.

RFR is electromagnetic energy (waves) that is transmitted at frequencies between 3 kHz (3 thousand Hz) and 300 GHz (300 thousand million Hz) is one complete cycle per second. Electromagnetic waves are waves of electric and magnetic forces. Each wave has both an electric and magnetic field. The strength of the electric field is expressed in amperes per metre (A/m) and the magnetic field strength is expressed as volts per metre (V/m). At distances greater than half a wavelength from the radio frequency source, the electric and magnetic field strengths can be multiplied to get the power density, which is expressed in watts per square metre (W/m^2). (See figure 1 overleaf.)

To ensure that there is minimal interference with communications and broadcast applications, the nominal frequency of industrial heating applications should be controlled. These heating applications should be at frequencies within the Industrial, Scientific and Medical bands approved by the Australian Communications Authority.

2.1 Exposure limits

Schedule 1 of the Australian Radiation Protection and Nuclear Safety Regulation 1999 documents exposure limits for non-ionising radiation. The occupational and non-occupational exposure limits for RFR are expressed in terms of specific absorption ratio (SAR), a measure of the rate at which RF energy is absorbed in the body. The units of the SAR are watts per kilogram of bodyweight (W/kg). A SAR of 4 W/kg can raise the core body temperature by 1^0C.

The **occupational exposure limit** for whole body exposure is **0.4 W/kg** and the non-occupational limit is **0.08W/kg**.

Occupationally exposed workers are assumed to be:

- informed about the sources and risks of RFR;
- aware that the exposure is occurring;
- aware of the potential risk; and
- able to take appropriate precautions.

By comparison, in non-occupational exposure:

- people may not be aware that the exposure is occurring;
- those exposed may include particularly susceptible groups or individuals; and
- the people exposed are often unable to take precautions to prevent or minimise the exposure.

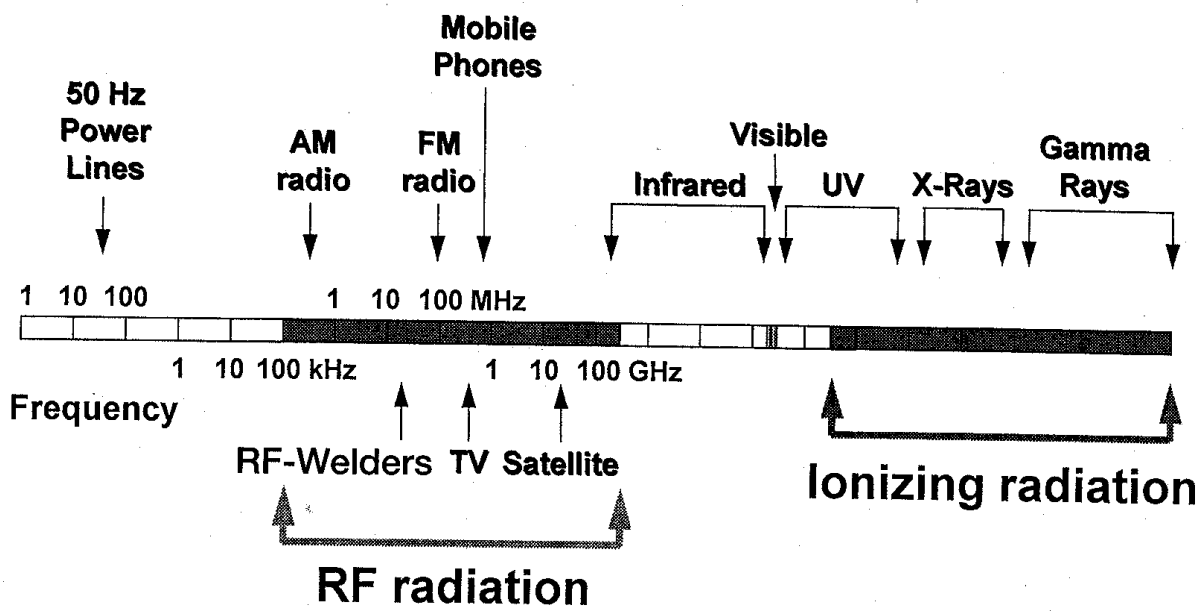


Figure 1: Use of Parts of the Electromagnetic Spectrum: Each band of frequencies is used for multiple applications.

If only part of the body is exposed, a SAR of 8 W/kg applies to all body tissue except for that of the hands, wrists, feet and ankles. For part body exposure to hands, wrists, feet and/or ankles, a SAR of 20W/kg applies. Even if the SAR averaged over the whole body is below the Exposure Limit, localised exposures to body parts should not exceed the part body limits.

SAR is difficult to measure directly and so tables of derived exposure levels express Exposure Limits in units that can be measured more easily.

Exposure to lower levels than the maximum electric and magnetic fields, maximum power densities and maximum induced body currents will ensure the SAR remains below the Exposure Limits.

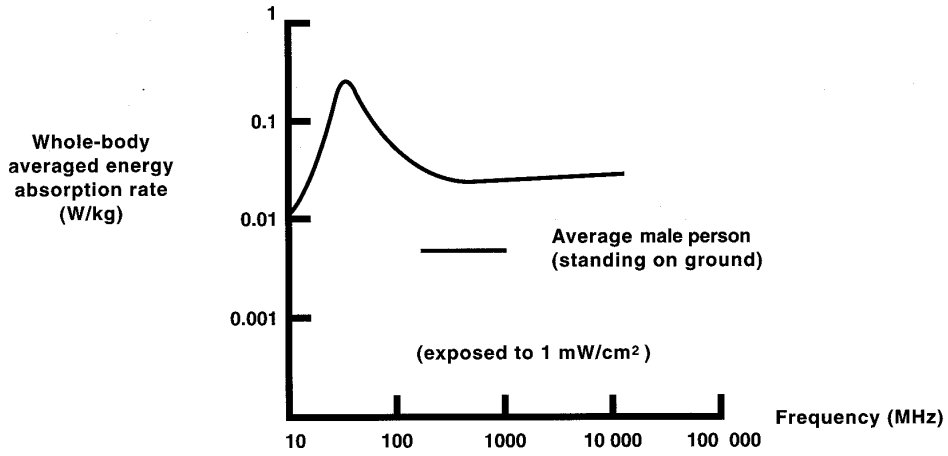


Figure 2: Variation of Whole-body Averaged energy Absorption Rate with Frequency. These SAR values vary with the frequency of the RF fields.

Tables 1 and 2 of Appendix 1 provide the derived exposure levels for the frequencies of RF generating plant covered in this Guide.

2.2 Those at risk of exposure

RF generating plant may be used in workplaces that undertake the following activities:

- forging
- annealing
- tempering
- brazing
- soldering
- sealing of plastics
- glue drying
- curing particle boards and panels
- heating fabrics and paper
- cooking, using a microwave oven.

RF generating plant uses high frequency alternating electromagnetic energy (EME) to perform the work (heating). With the exception of microwave ovens, this high frequency EME is usually produced by a generator that is connected to the induction heater, welding press or other device. If the documentation for a piece of plant is insufficient to decide if it is RF generating plant, advice should be sought from the manufacturer of the plant.

Workers in industrial workplaces that use RF generating plant are at risk of exposure to levels of RFR that can have adverse health effects. Usually those workers operating the plant are most likely to be exposed.

However, workers who do not operate RF generating plant but are situated within its vicinity, and people coming into the workplace, can also be at risk.

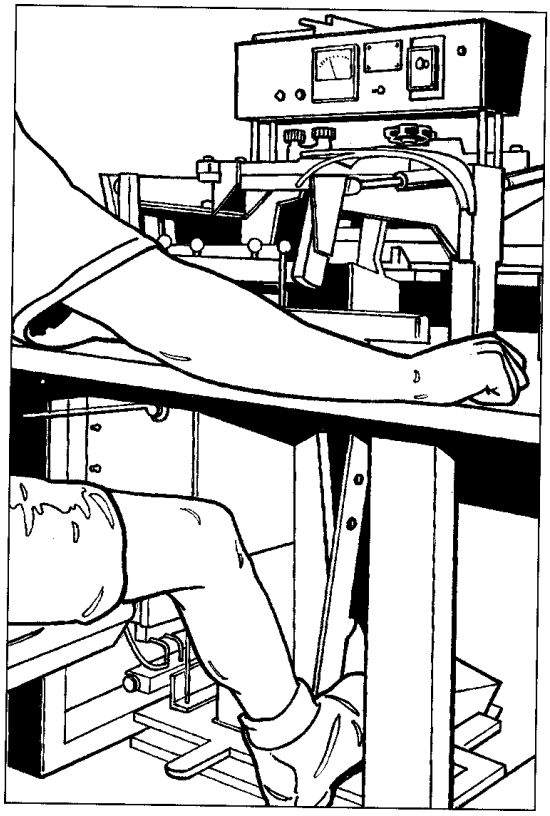


Figure 3: Even though the power output of single operator sewing machines is low, exposure levels to the operator can exceed Exposure Limits.

2.3 Health effects

The likelihood of a health effect resulting from exposure to RFR is related to the frequency of the RF fields produced as well as the duration and intensity of the exposure. The potential hazards of exposure to RFR can be classified as:

- direct effects on people;
- indirect effects on people; and
- effects on flammable vapours and electro-explosive devices.

Direct effects on people

Whole Body Effects

RFR greater than 10 MHz interacts with the human body predominantly by heating tissue. As the frequency of the RFR increases, the depth of

penetration of the radiation into the body alters. At the frequencies covered by this Guide, whole body heating can occur.

Particularly during summer in Queensland, excessive RFR exposure where the core body temperature rises by 1^0 C or more, can contribute to the onset of heat-stress caused illness. This core body temperature rise is accompanied by cardiovascular changes including increased heart rate and increased cardiac output. An increased feeling of tiredness has been reported by operators of dielectric heaters. A rise in the core body temperature of 1^0 C has also been:

- shown to impair concentration. This loss of concentration may lead to injury caused by another agent; and
- found to increase the risk of foetal damage in pregnant women.

Localised Effects

The male testes are sensitive to heating from RFR. Testicular temperatures are normally several degrees below body temperatures. Exposure to high intensity RF fields has been shown to cause changes in the number of normal, motile sperm. This effect occurred across the frequency range covered by this document.

The lens of the eye is potentially sensitive to heating. Its lack of a direct blood supply means that it cannot disperse heat quickly enough to prevent a temperature rise in the tissue. Although the mechanism exists for cataracts to be formed in response to over-exposure to RFR from induction furnaces and dielectric heaters, neither animal nor epidemiology studies have so far found that this occurs. The microwave frequency range is the range at which most RF energy is absorbed by the lens of the eye and over-exposure to high levels of microwave RFR has been shown to induce cataracts. Plastic welder operators have also reported conjunctivitis. This is probably related to decomposition products from the plastic.

Operator hand numbness and neurological disturbance have been shown to occur in operators of dielectric heaters whose hands and wrists are consistently over-exposed to high levels of RF fields. This effect has not been found so far in workers using induction heaters or microwave ovens.

Contact with large, ungrounded metallic objects situated in the RF field can result in currents flowing through the part of the body in contact. In addition to a startle reaction, these currents can cause RF shock and burns. Contact with the energised weld head of a dielectric welder will also deliver RF shocks and burns. RF burns are typically deep, painful and heal slowly. In some cases, where the damage to nerves, muscles and blood supply is severe, surgical intervention may be necessary.

Heating of the fluids in the ear can lead to the exposed person hearing clicking, buzzing or hissing sounds. These sounds have not been found to have adverse health effects, other than interfering with concentration.

To date there is no conclusive, scientific evidence that exposure to RFR can initiate cancer.

Indirect effects on people

RF fields can interfere with the normal operation of implanted devices such as cardiac pacemakers. Implanted metal plates, rods and fixings may act as conductors when exposed to RFR and

can concentrate heating in the tissue around the implant.

Effects on flammable vapours and electro-explosive devices

When liquids that produce flammable vapours are stored within an RF field, these vapours can be ignited if a spark occurs between the conductive structures eg metal pipes or tanks that act as antennae. Flammable liquids can also be heated by the RF fields, increasing the rate of release of vapour. This can increase the flammability hazard and also increase the inhalation risk from the substance.

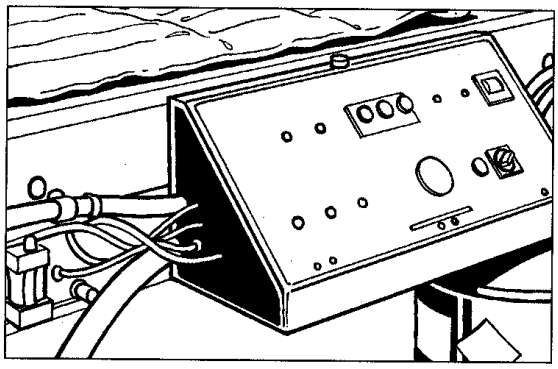


Figure 4: The drum containing glue in this figure is stored within the RF field and can cause a fire hazard.

Commercial detonators can also be fired by exposure to sufficiently strong RF fields.

3. How to manage workplace health and safety

Under the Act, exposure to health and safety risks that arise from workplace hazards must be managed. This includes the health and safety risks arising from the use of RF generating plant at the workplace.

3.1 The risk management process

Section 22 of the Act describes a five-step process for managing workplace health and safety, known as the workplace health and safety risk management process[2].

The five basic steps of this process are:

1. **Identify** hazards
2. **Assess** risks that may result because of the hazards
3. **Decide** on control measures to prevent or minimise the level of the risks
4. **Implement** control measures
5. **Monitor** and review the effectiveness of the measures.

3.2 Consultation

Consultation should occur at each stage of the workplace health and safety risk management process. This will help to achieve better health and safety outcomes from the process.

The Act provides for consultation through workplace health and safety representatives (WHSR) and workplace health and safety committees.

3.3 Record keeping[3]

Adequate recording of the workplace health and safety risk management process will help you to demonstrate that you have been actively working to ensure workplace health and safety, should you need to prove this[4]. Keeping records should also maximise the effectiveness of the process and provide a reference point for review and follow up.

3.4 Training and instructing workers

Workers must know how to work safely. They must be trained and instructed in safe work practices and procedures and supervised by experienced people before carrying out work unsupervised.

Training and instruction should include:

- workplace health and safety induction
- hazards and risks associated with RF generating plant and with other work activities and the control measures in place

[2] For a detailed explanation of the workplace health and safety risk management process, refer to the *Workplace Health and Safety Risk Management Advisory Standard 2000*.

[3] The *Workplace Health and Safety Risk Management Advisory Standard 2000* provides sample forms to help with record keeping.

[4] It is important to note that there are specific record keeping requirements for certain workplace hazards. If you have identified such hazards, you must refer to the relevant regulations and advisory standards for details of the recording requirements.

- safe work practices and procedures for tasks involving the use of RF generating plant
- the safe use of plant and associated equipment, electrical safety and other training required under hazard-specific regulations
- the correct use, fitting, care and storage of PPE, tools and equipment and why the equipment is needed
- emergency and first aid procedures

This training should be refreshed from time to time. Documentation of the training should include details of:

- what was covered
- who conducted the training
- who attended the training
- the duration of the training
- how competency was assessed
- the date on which the training was conducted.

4. Using the Risk Management Process

This section describes how to use the workplace health and safety risk management process to manage exposure to radio frequency radiation.

4.1 Step1: Identify hazard

The first step in the risk management process is to identify workplace hazards. A hazard is defined as *something with the potential to cause harm.* This section of this document deals with the hazard – radio frequency radiation. (Section 5 of this document examines other hazards associated with the use of RF generating plant, including the plant itself, heat stress, lighting, electrical hazards, manual tasks, and fire and explosion.)

4.2 Step 2: Assess risk

The second step in the process is to assess the risk associated with the hazard. The risk is the likelihood that death, injury or illness might result because of RFR. To assess risk, you need to consider both likelihood and consequences.

Measuring field strengths

You should measure the field strengths around the RF generating plant under typical conditions of use[5] in order to determine the likely exposure of workers and others in the workplace. If typical conditions vary substantially either during the day or from day to day, as is the case where power to the RF source, or the antenna size, varies substantially, the measurements of field strengths should reflect the conditions likely to result in the highest exposure or "worst case scenarios".

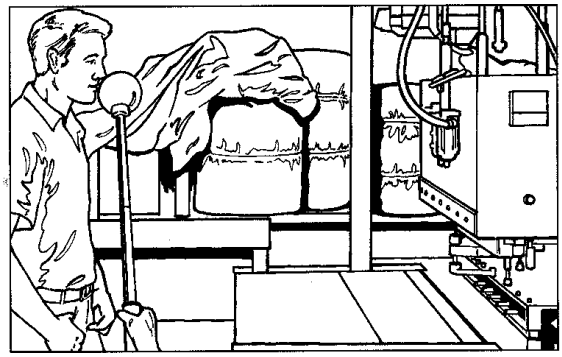


Figure 5: Monitoring should be conducted during usual work.

For plant with a nominal frequency of less than 200 MHz, both electric and magnetic fields need to be measured. For plant above this nominal frequency, only the power density needs to be measured or calculated from either the electric or magnetic field strength.

Measurements should be taken at the locations in the workplace where people may be exposed. Initial spot measurements over the body height and width should be taken to establish the position of highest exposure and a six minute average measurement should be taken at this site.

In addition, where people other than the operators may be exposed, the boundary where the field falls away to non-occupational exposure levels must be ascertained under worst-case conditions, if applicable.

Measurement of induced body currents will give information on individual exposure but should not be used to predict the exposure of other persons

[5] Measurement of field strengths around the RF plant may also help to identify areas where shielding is inadequate or where re-radiation of RF fields occurs.

for whom measurements have not been taken. This is because the amount of body current induced varies with the person's height and weight, their position and orientation in the RF field.

If the manufacturer does not specify time intervals for measurement, these should be conducted yearly and after any repair, process change or modification of the plant where this repair, process change or modification has the capacity to alter the RF field strengths significantly. Measurements should be conducted by a person who has the appropriate training and experience both to take measurements that realistically represent exposure and to interpret the results of these measurements.

Assessing the Risk

The field strength measurements should be compared with the exposure limits for RFR prescribed in the Australian Radiation Protection and Nuclear Safety Regulation 1999 to determine whether the exposure is acceptable. A copy of these limits for both *occupational* and *non-occupational exposure* is given in Appendix 1 of this Guide. The occupational exposure limits should apply for RF workers who are actually using the RF generating plant and would therefore be aware of when it was radiating. The occupational exposure limits should also be applied to other people in the workplace if their exposure is controlled. The non-occupational limits should apply to all other people in the vicinity.

Exposure Limits have been set at levels that will protect against thermal effects of exposure to RF fields. There is currently scientific research being conducted into the incidence and causation of non-thermal effects that may occur at lower exposure levels than thermal effects. While in every case keeping the exposure below the Exposure Limits, the risk of non-thermal effects should be managed using the Precautionary Principle.

The Precautionary Principle is a risk management policy applied in circumstances with a high degree of scientific uncertainty reflecting the need to take action for a potentially serious risk without awaiting the results of scientific research.[6] In view of the uncertainty about safe levels of exposure to RF fields, consideration should be given to reducing the levels as far as possible, taking into account both costs and benefits.

4.3 tep 3: Controls for RFR

Step 3 in the risk management process involves deciding on control measures to manage exposure to identified risks.

Like all workplace risks, the best control options for managing exposure to RFR should be chosen by following the Control Priorities, listed below.

[6] World Health Organisation (March 2000) Electromagnetic Fields and Public Health Cautionary Policies

Control Priorities
Start at the top of the list and work your way down. Firstly, try to **eliminate the hazard** If this is not possible, prevent or minimise exposure to the risk by one or a combination of: • ***Substituting*** a less hazardous material, process or equipment • ***Redesigning*** equipment or work processes • ***Isolating*** the hazard (Note: These measures may include engineering methods.) As a last resort, when exposure to the risk is not (or can not be) minimised by other means: • Introduce *administrative controls* • Use appropriate *personal protective equipment*

Eliminate the hazard

The ideal solution is to get rid of a hazard completely. This is the most effective control and should always be attempted in the first instance. If a hazard is removed from the workplace, the associated risk is completely eliminated. If the RF generating plant in the workplace is very rarely used, consider selling it and out-sourcing any jobs that would normally use the plant. Specialist firms may be more likely to implement control measures specific to this hazard.

Prevent or minimise exposure to the risk

If a hazard cannot be eliminated, there are a number of control options that can be used alone, or in combination, to prevent or minimise exposure to the risk.

Substitution

- involves replacing the hazard with one that presents a lower (and more manageable) risk. That is, replacing the plant, product or processes that represent a hazard with something that does the same job but has less potential to cause harm. For example, rather than welding synthetic fibre products such as canopies and awnings, consider using sewing machines.

Redesign

- involves changing the design of the workplace, equipment or work process. It involves thinking about ways the work could be done differently to make the workplace safer.

Plant

RF sources should be supplied with documentation from the manufacturer that enables the plant to be used safely.

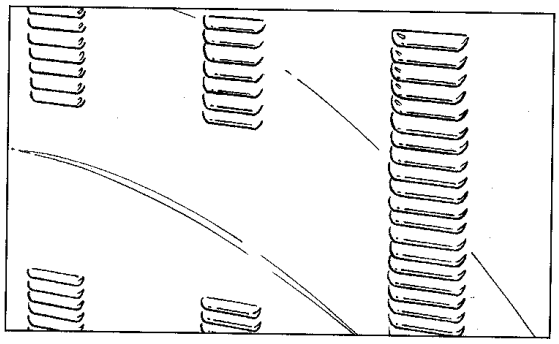
RF sources should be designed with:

- wiring that complies with SAA Wiring Rules published as AS 3000-2000 by Standards Australia. If the wiring does not comply (for instance in some cases when plant is imported), the plant must be modified so that it is wired according to the Wiring Rules;
- an interlock system that automatically cuts off power or

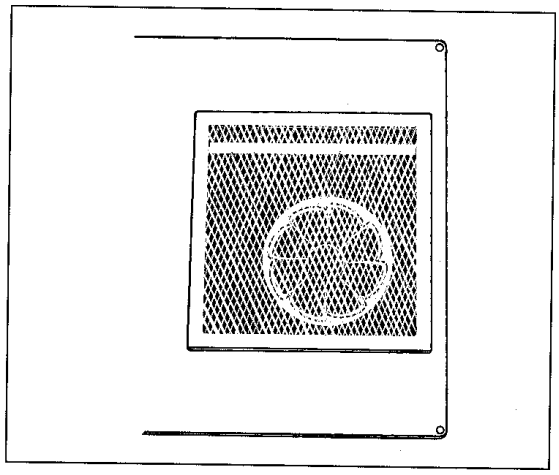
closes a shutter mechanism to prevent exposure when access panels are removed;

- visual and/or audible 'power-on' indicators;
- a shield or shielded enclosure of appropriate material with joints welded, overlapped or fastened with rivets or bolts no greater than 7.5cm apart to ensure good electrical contact. Materials commonly used for shields are aluminium, brass, copper and phosphor bronze. The effectiveness of the shield to reduce RFR should be assessed by measuring RF field strengths;
- all material feed openings in the shield (such as those over conveyors) fitted with a waveguide-below-cut-off[7];
- all ventilation or viewing points fitted with a perforated metal sheet of the appropriate dimensions and gauge[8]; and

shuttle trays or conveyor belts installed instead of a manual material feed, to increase the distance between the operator and the RF source.



Figures 6 Examples of shieldings over ventilation points.



Figures 7 Examples of shieldings over ventilation points.

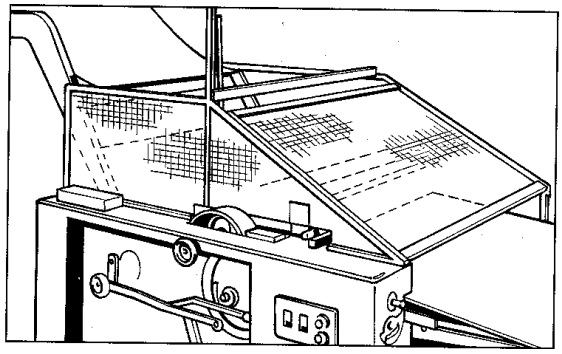


Figure 8: Potential points of RF leakage should be shielded.

Installation

The RF generating plant should be installed, operated and maintained in accordance with the manufacturer's instructions. If the installation or maintenance is not performed by the plant manufacturer, installation and maintenance should be undertaken by

[7] A waveguide is a hollow pipe, tube or duct made of electrically conducting material, that is sufficiently large for a RF field to exist in and pass through readily. Waveguides are a form of shielding that prevent objects such as metal pipes, light fittings and other metal objects from coupling with the RF fields and becoming unintended antennas. They minimise RF energy leakage.

[8] The appropriate dimensions and gauge are related to the wavelength of the RF field.

a person competent to perform the tasks. In this context, a competent person is one who has undertaken a RF Equipment Safety Course conducted by a manufacturer of the type of RF generating plant on which the installation or maintenance is performed, or who has equivalent experience.

As part of the installation, RFR measurements should be taken to determine the field strengths. The accuracy of tuning to the nominal frequency and the minimization of harmonics should also be measured.

The positioning of the RF source should take into account the potential for reflection or re-radiation from large metallic objects. Objects such as a metallic wall can reflect the RF fields back onto the operator and increase exposure. Metallic shelving and frames should not be positioned near to a high frequency source. Electrical cables and wiring in the vicinity should be as short as possible, not hung in long, high, runs and enclosed in plastic ducting.

In addition, the RF source should NOT be positioned close to metal pipes, as these can:

- couple to energy leaking from a dielectric heater and give rise to excessive radiation in unexpected places within the workplace where the pipe runs; and
- depending on their length, resonate (couple maximum RF energy) at the fundamental operating frequency or one of its harmonics.

Grounding

The installation of dielectric heaters below 50 MHz should include effective grounding[9]. Grounding should be undertaken by a person who is competent to do the installation or maintenance.

Grounding may be by means of:

- a capacitative ground plate to which both the generator and the RF unit are connected on two sides; or
- both the generator and the dielectric heater connected to a capacitative coil that is connected by a spike to the ground plane of the area.

All connections should be with aluminium, brass or copper straps of an appropriate width. Wire or braided metal is not a suitable connecting material.

The top of the generator should be coupled to the top of the dielectric heater to prevent a potential difference arising between the two. The bar holder should also be connected back to the metal body of the heater. The bonding should not give rise to an induced circulating current. If large metallic objects within the RF field, such as metal shelving or pallet racking cannot be re-located, they should also be bonded to the case of the RF generator.

Shielding

If in spite of installation according to the manufacturer's instructions and effective grounding the exposure of the operators is still excessive, retro-fitted shielding of the radiating source should be used to reduce operator exposure.

The shielding should be designed and fitted by a competent person.

For work processes where a fixed shield would interfere with the work, a movable shield may be used. To be

[9] Effective grounding can reduce the RFR by up to seventy percent.

effective the shield must enclose the RF source once the work is prepared and before the source is energised. The shield should be constructed of a suitable conductive material, such as mesh rather than solid, and not create other hazards, such as shock or burns.

The exposure of operators should be tested across the whole body to ensure the shield is efficacious in reducing the exposure to below the Exposure Limits.

If RF sources are placed adjacent to each other in the workplace and are used at the same time, the area where the RF fields overlap may be higher than for either source alone. If workers normally work in this area of overlap, their exposure will be higher than would be the case from just one RF source. The manufacturer's advice should be sought on the placement of the plant in the workplace and confirmed by measurement of field strengths.

Isolation

- involves isolating or separating the hazard from the person, or the person from the hazard.

During power-on, the levels of RFR may exceed those produced during normal operation. The boundary where the occupational exposure limits cease to be exceeded should be found by measurement. RF workers should remain outside of these boundaries during power-on.

RF sources should be situated :

- as far as possible from workers not directly involved in the RF process; and
- so that non RF workers are not exposed to field strengths that exceed the non-occupational exposure limits.

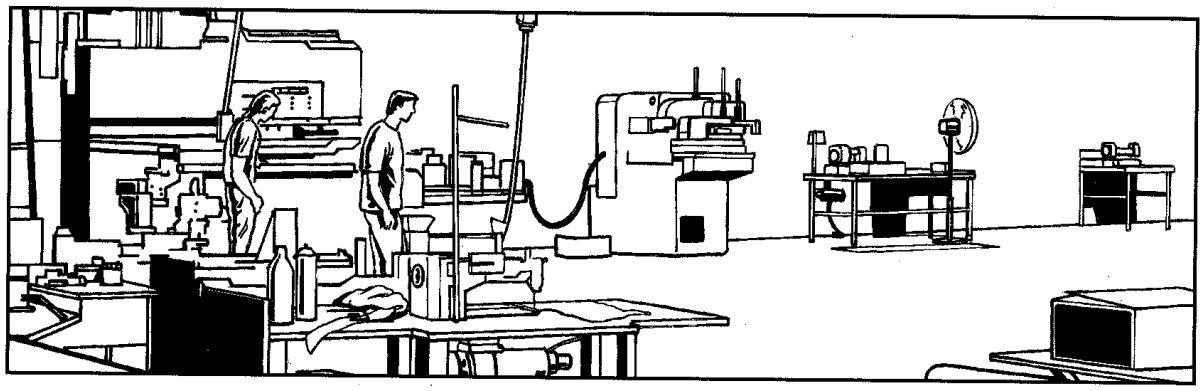


Figure 9: In this figure, the sewing machine in the background is located too close (approximately 1 metre) to the RF welder. The sewing machine in the foreground is located an adequate distance (approximately 10 metres) from the welder.

If the RF source is used in areas where people other than RF operators can be exposed, the boundary where the field strengths do not exceed non-occupational limits (identified by measurement) should be marked and access inside that boundary restricted to RF operators, by barriers and signs.

This is particularly important when portable RF sources are used in multiple locations.

Alternately, the RF source may be placed in a shielded enclosure such as a metal screen room to confine the RFR. This is not a suitable control for any situation in which the RF operator

and the source are within the metal enclosure as the operator's exposure will be increased many times.

Large metallic objects such as motor vehicles, metal structures, fences and large tools should be situated outside of the RF field.

When exposure to the risk is not (or can not be) minimised by other means

When exposure to the risk is not (or can not be) minimised by other means, administrative controls and personal protective equipment can be used. These controls are lowest on the list of control priorities. In general, these measures should only be used:

- when there are no other practical control measures available (that is, as a last resort);
- as temporary measures while a more permanent solution is found; or
- to supplement other controls (that is, as back-up controls).

Administrative controls

- involve minimising exposure to a risk through the use of procedures or instruction. It is often necessary to use these controls in conjunction with other measures.

Human Resources. A person knowledgeable about the risks of RFR and their management should assist the employer or self-employed person to manage those risks in the workplace. This person can also be the person who conducts field strength measurements in the workplace.

Policies. The Workplace Health and Safety Policy for the workplace should address the risks associated with the RF generating plant. This policy should be written and communicated to all workers likely to be using this plant or exposed to RFR. It should include provision for:

- reducing exposure of pregnant workers to the non-occupational exposure limits; and
- people with cardiac pacemakers or metallic implants to seek medical advice about any possible adverse effect from RFR exposure.

Signage. Access to areas where RFR exposure may occur in excess of the Exposure Limits should be restricted by:

- painting colour-coded lines on the floor;
- displaying signs to indicate areas of restricted entry; and
- placing signs warning at-risk people, such as pregnant women and anyone with a medical device such as a cardiac pace-maker or a metallic implant, that RF generating equipment is in use.

Job rotation. Workers should be rotated between RF and non RF tasks so that each worker is exposed for a minimum amount of time. In any case, the exposure of all workers must be kept below the Exposure Limits.

Monitor exposure levels. Keep records of the duration of exposure to the RFR so that estimations of total exposure can be made. Report any overexposure or suspected overexposure on the approved Incident Report Form to Workplace Health and Safety as a Dangerous Event. (Section 52 of the Workplace Health and Safety Regulation 1997 requires this action.) Records of exposure should be retained for thirty years and must be kept at the workplace. Note, the most likely time for employers to become

aware of overexposure is after measurements have been conducted.

Medical Surveillance. Medical examination of RF workers should be conducted following substantial exposure in excess of the maximum Exposure Limits. The employer should arrange and pay for medical examination in the event of a substantial over-exposure. The medical examination should be conducted by a registered specialist in occupational medicine and records of the medical surveillance should be kept at the workplace. Such records should be retained for thirty years. Medical information is confidential. Therefore *:*

- an employer may only obtain a worker's medical record with the worker's written consent; and
- an employer must not disclose the content of the worker's medical record to anyone other than the worker (unless the worker has given written consent).

The employer or self-employed person may also choose to have themselves or their workers undergo health surveillance:

- at commencement of employment;
- once every five years during employment; and
- on employment termination.

Health surveillance should be done in any case if there has been a history of over-exposure to RFR over an extended period in the workplace.

Maintenance. Maintenance of the Radio Frequency generating plant should be performed according to the manufacturer's instructions and at the intervals specified. It should include ensuring the grounding is still operating effectively.

Records should be kept of maintenance undertaken.

To prevent accidental RFR exposure during maintenance, the power should be isolated or a lock out procedure should be used.

When maintenance is complete, checks should be made to ensure that:

- all areas of potential leakage such as access panels have been secured;
- all shields have been replaced and are fastened in place;
- all fasteners have been replaced correctly and there is good metal to metal contact. (Note, these checks should also be made whenever access panels or shields are removed to resolve any temporary problems during operation of the plant.); and
- RF generating plant is tuned correctly to the nominal frequency and that any harmonics are minimised.

Measurement of field strengths should be conducted to ensure that these have not increased as a result of the maintenance.

Shields should be inspected weekly for any visible damage or in the case of microwave ovens, rust.

Personal Protective Equipment (PPE)

- is worn by people as a final barrier between themselves and the hazard. This measure does not control the hazard at the source.

There is NO PPE readily available that effectively controls RFR. Therefore, this is not a feasible control option. However, if the RF process produces Infra-red radiation (indicated by a glow in the material being heated), and

workers view the hot materials, protective goggles with lenses made of a suitable filtering material should be worn.

4.4 Step 4: Implement control measures

Step 4 involves putting selected control measures in place at your workplace. This means undertaking those activities necessary to allow the measures to function or operate effectively.

Implementing control measures involves:

- **Developing work procedures**

Develop work procedures in relation to the new control measures to make sure they are effective. Management, supervision and worker responsibilities may need to be clearly defined in the work procedures.

For example, a work procedure is developed to clean out dust that is drawn into the cavity of an RF generator. This is performed once a week.

The procedure would specify the responsibility of the worker to:

- electrically isolate the plant;
- discharge residual capacitance;
- remove the covers;
- vacuum out the cavity and inside of covers;
- replace the covers;
- check that all fasteners have been replaced;
- note on a checklist the steps completed and
- power on the plant.

The procedure would specify the responsibility of the supervisor to:

- develop the work procedure in consultation with the workers;
- develop a checklist to note down the completion of each step of the procedure;
- supervise the worker to ensure that the procedure is being implemented;
- sign off on checklist and keep records.

The procedure would specify the responsibility of the employer to:

- identify and provide training in the task;
- provide resources to implement the procedure;
- include the carrying out of the procedure in the workload of the worker; and
- require the supervisor to report back on the new control measures.

- **Communication**

You should inform workers and others about the control measures to be implemented. It is important to clearly communicate the reasons for the changes.

- **Providing specific training and instruction**

You should provide specific training and instruction for the workers, supervisors and others in relation to the new control measures.

- **Supervision**

You should provide adequate supervision to verify that the new

control measures are being used correctly.

- **Maintenance**

Maintenance relating to control measures is an important part of the implementation process. Work procedures should spell out maintenance requirements to ensure the ongoing effectiveness of the new control measures.

4.5 Step 5: Monitor and review

The final step in the risk management process is to monitor and review the effectiveness of measures.

For this step, it can be useful to ask questions to determine whether:

- **chosen control measures have been implemented, as planned**
  - Are chosen control measures in place?
  - Are these measures being used?
  - Are these measures being used correctly?
- **chosen control measures are working**
  - Have the changes made to control exposure to the assessed risks resulted in what was intended?
  - Has exposure to the assessed risks been eliminated or adequately reduced?
- **there are any new problems**
  - Have implemented control measures resulted in the introduction of any new problems?
  - Have implemented control measures resulted in the worsening of any existing problems?

To answer these questions, you can:

- consult with workers, supervisors and health and safety representatives;
- measure people's exposure and around the RF plant to identify the parts of the plant where the field strengths are highest; and
- monitor incident reports.

In addition, a checklist of the key features of the control measures could be developed and used weekly by workers. This, combined with a annual self-audit using the "Control Checklist For Industrial RF-Generating Plant" (refer Appendix 2), should enable the ongoing effectiveness of the new control measures to be monitored. Measurement of exposure of RF operators should be conducted as part of this process.

You should also set a date to review the entire workplace health and safety risk management process.

5. Other Hazards Associated With the Use of the RF Generating Plant

5.1 Heat Stress

Since exposure to excessive levels of RFR can raise the core body temperature, simultaneous exposure to excessive heat can lead to heat-stress caused illness.

The following controls should be considered when deciding on measures to manage exposure to this risk.

- Hot processes should be located away from the RFR source, if possible or heat shields can be used.
- If the air temperature is less than 35^0 C, dressing lightly and having a fan blow on RF operators will cool them down. A fan will also reduce the effect of high humidity. If the temperature is higher than 35^0 C, the operator should ensure the skin is covered and a fan is not used..
- Hard physical work will generate metabolic heat. In excessively hot environments, reduce the physical demands of the work if possible. One method of doing this is by introducing mechanical assistance for tasks.
- A source of clean cool drinking water should be sited close to the work area.
- There should be a cooler area where workers can take rest breaks.

5.2 Plant-related

For dielectric welders, crush or other injuries may result from:

- the high closure speed of the weld bar;
- the closure force of the weld bar;
- a weld starting while a hand or other body part is in contact with it[10]; or
- nip or pinch points associated with other moving parts of the plant.

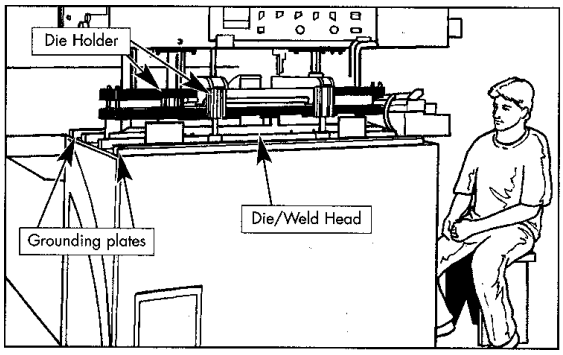


Figure 10: Contact with other metal parts of RF plant that can be 'live' during a weld can cause burns or shock.

The *Plant Advisory Standard 2000* gives practical advice on ways to manage exposure to risks related to the use of plant, including safe design, manufacture and installation. It outlines the obligations of persons involved with plant and provides information on risks and their control.

[10] When the machine is welding, the grounding plates are energised as well as the weld head. Metal components adjacent to the weld head may have significant currents induced in them by the RF fields. Contact with an energised part of the plant may result in RF burns or shock. Metal jewellery (including jewellery in body piercings) should not be worn while welding as an arc between the welder and the jewellery may result..

5.3 ighting

The level of lighting for the work activities involving RF generating plant should be adequate to illuminate the work. If lighting is inadequate, the distance between the work and the eyes is commonly decreased. This can increase exposure to the eyes and chest.

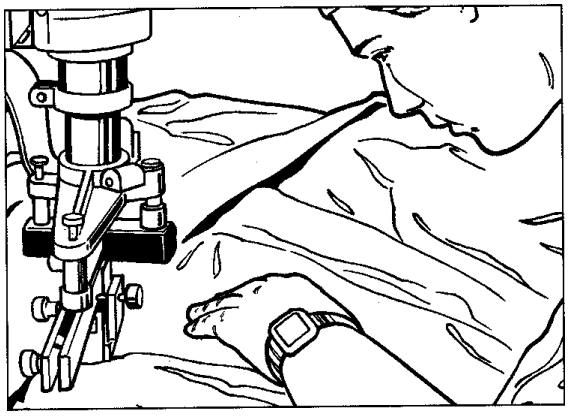


Figure 11: In inadequate light conditions, the operator needs to get closer to the work.

Appropriate light levels for work activities involving Radio Frequency generating plant are:

- 400 lux for large, continuous welding work and processes not involving small, detailed work; and
- 600 lux for work requiring resolution of detail.

5.4 Electrical hazards

As part of their general workplace health and safety obligations, employers and self-employed persons must ensure that electrical equipment is maintained in a safe condition. This involves regular visual inspection of such equipment to check that:

- the item of equipment, including the connecting lead and plug, has no obvious external damage or inadequate temporary repairs;
- the inner cores of connecting leads are not exposed and that outer coverings are not cut, frayed, worn or otherwise damaged;
- sockets are not cracked or broken; and
- the connection of the lead to the item of equipment is secure.

In addition, the *Workplace Health and Safety Regulation 1997* (the 1997 Regulation) sets out specific requirements about electrical equipment and installations at a workplace. Under the 1997 Regulation, all employers and self-employed persons must:

- locate and protect extension leads and flexible cables so they are not damaged by anything (including liquid); and
- consult the local electricity authority if any person or equipment are likely to come within 2 metres of an overhead electric line.

The 1997 Regulation identifies different requirements for different classes of work. In general, work involving RF generating plant would be classified as 'class 2 work'[11] under the 1997 Regulation and certain items of RF generating plant, such as dielectric welders that are not hard-wired, would be classified as 'specified electrical equipment'[12] under schedule 9 of the 1997 Regulation.

[11] Class 2 work refers to assembly, fabrication, installation, maintenance, manufacturing, refurbishment or repair work.

[12] Specified electrical equipment is equipment that meets any of the following criteria:

- It is designed to be connected by a flexible cord and plug to low voltage supply and is used by a person to perform class 1 or 2 work.
- It is designed to be connected by a flexible cord and plug to low voltage supply and is capable of being moved during its normal use for the purpose of its use.
- It is an extension lead or power board.

Following are the requirements for class 2 work. Employers and self-employed persons must make sure:

- double adaptors and piggyback plugs are not used;
- specified electrical equipment is inspected, tested and tagged by a competent person at prescribed intervals;
- specified electrical equipment is immediately withdrawn from use if it is not safe to use;
- specified electrical equipment is connected to a type 1 or 2 residual current device or portable device (unless the electrical supply is provided by an unearthed output from a single phase portable generator);
- residual current devices and portable devices are tested at prescribed intervals; and
- residual current devices are withdrawn from use if they are not working properly.

For specified electrical equipment used for office work or in the amenities area of workplaces[13], such as an electric jug, the test period is at least every five years.

Residual current devices are available for three phase circuits and devices.

5.5 Manual tasks

Factors associated with the design of the work area and the handling of process materials can contribute to musculoskeletal disorders. Particular issues to be considered include:

- lifting or carrying heavy or bulky loads;
- lifting loads while the back is bent and/or twisted;
- transferring loads around or over plant or parts of plant; and
- working for extended periods with arms and shoulders elevated.

[13] This refers to equipment that is designed to be connected by a flexible cord and plug to a low voltage supply and is capable of being moved during its normal use for the purpose of its use.

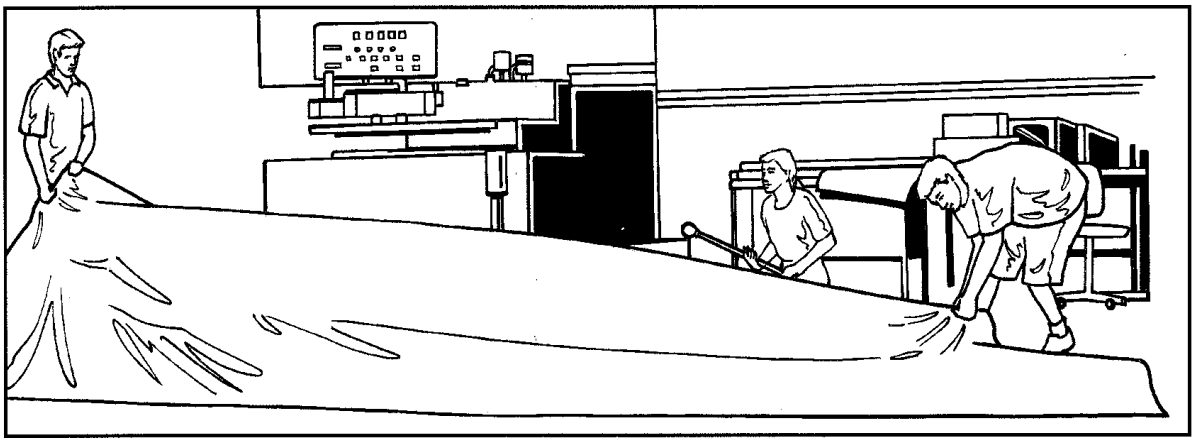


Figure 12: Examples of inadequate work practices are demonstrated in figures 12 and 13 (overleaf).

Control measures include providing mechanical aids for moving process materials where possible, arrange for regular maintenance, and make sure workers are trained in how to use them. Where processed materials are likely to interfere with the mechanical aid, eg. when glue can stop rollers from running freely in the timber handling part of a timber laminating process, set up a procedure for having the aid checked at appropriate intervals.

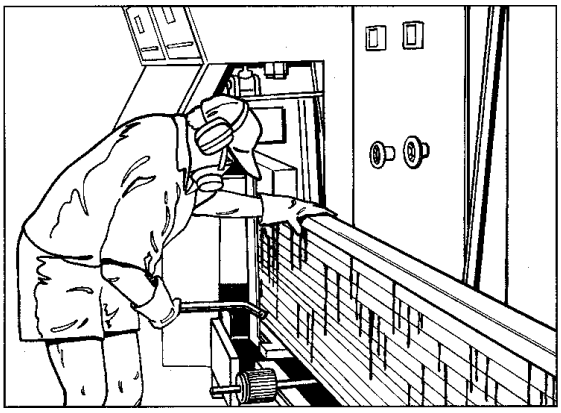


Figure 13: A procedure should be set up for regularly checking the rollers in the timber handling part of a timber laminating process as glue can stop the mechanical aid from running freely.

Store materials close to where they are to be used, where possible, to minimise double handling. For lifting ease, store materials at waist level.

The *Manual Tasks Advisory Standard 2000* states ways to prevent or minimise exposure to risk factors that can contribute to or aggravate work related musculoskeletal disorders.

5.6 Fire or explosion

Flammable gases, solvents, fuels or electro-explosive devices should not be stored or used within strong RF fields. Empty containers that have contained flammable or explosive materials but have not been flushed and cleaned can also cause a fire or explosion hazard if stored within the RF field.

Appendix 1: RF Fields - Maximum Exposure Levels

Table 1: Derived occupational exposure levels to time varying electric and magnetic fields (unperturbed r.m.s values) (whole body exposure)

Frequency Range (MHz)	Electric field Strength E (V/m)	Magnetic Field Strength H (A/m)	Power Flux Density S (W/m^2)
0.003 to 0.065	614	24.6	+
0.065 to 1	614	1.6/f	+
1 to10	614/f	1.6/f	+
10 to 400	61	0.16	10
400 to 300 000	61	0.16	10

Table 2: Derived non-occupational exposure levels to time varying electric and magnetic fields (unperturbed r.m.s values)

Frequency Range (MHz)	Electric field Strength E (V/m)	Magnetic Field Strength H (A/m)	Power Flux Density S (W/m^2)
0.003 to 0.1	87	0.73	+
0.1 to 1	87	$0.23/\sqrt{f}$	+
1 to10	$87/\sqrt{f}$	$0.23/\sqrt{f}$	+
10 to 400	27.5	0.073	2
400 to 300 000	27.5	0.073	2

+ In this frequency range it is not appropriate to measure the field strength in these units

f = the frequency in MHz

Averaging time for E^2, H^2 or S measurements is 6 minutes

Source:

Standards Australia (1998) AS/NZS 2772.1 (Int):1998 *Radio frequency fields Part 1: Maximum exposure levels – 3 kHz to 300 GHz.*

Appendix 2 : Control Checklist for Industrial RF Generating Plant

This checklist has been designed to assist workplaces to assess how they are controlling the risks associated with the use of RF generating equipment. The checklist asks a series of questions about:

- Management of Radiation Hazards by: Assessment of radiofrequency radiation (RFR); RF-generating plant design, installation and maintenance; workplace design, work practices and training; and responsibility; and
- Plant-related factors; lighting; electrical safety; manual tasks; and factors that may result in fire or explosion.

The checklist provides a range of control options that can be used to control RFR and related risks in your workplace.

Who should use this checklist?

The checklist is primarily designed to be used by employers, managers and people with health and safety responsibilities. It may also assist employers to involve workers in the risk management process.

How should this checklist be used?

1. Answer the questions in the left-hand column by ticking either the 'yes' or 'no column that corresponds to each question. To get the right information you may need to talk to the plant operators, the person who maintains the plant, the Workplace Health and Safety Officer or the operations manager.
2. If you have responded 'no' to any of the questions, you may need to take some action to better control the risk of RFR exposure. Look in the right hand column next to questions where you have responded 'no' for some options for what you can do.
3. Using a risk management approach to controlling hazards will enable you to identify and assess the risk and choose the ways to control risk that suit your business. It is unlikely that you would need to use all the control suggestions in this checklist, although you will probably need to choose a combination of several controls to ensure that the risk is managed effectively.
4. Decide on the control options that will be most suitable and effective in your workplace and develop a plan of action to implement them.
5. Use this checklist to assess control annually or whenever modifications are made to RF plant or work processes.

1	IDENTIFICATION AND ASSESSMENT OF RFR	YES	NO	SOME SUITABLE CONTROL OPTIONS
1.1	Is the RF-generating plant used in a single workplace?		GO TO 1.5	
1.2	Have RF levels in the workplace: • ever been measured? • been measured within the last 12 months?		GO TO 1.11	❑ Arrange for a competent person to measure RFR exposure levels in the workplace and assess compliance with the Exposure Limits for RFR in Schedule 1 of the Australian Radiation Protection and Nuclear Safety (ARPANS) Regulation 1999.
1.3	Were the field strengths in 1.2 measured under typical conditions of use?			❑ Measurements should be conducted under conditions that are typical of use so that a realistic picture of operator exposure is obtained. ❑ If typical conditions vary substantially either during the day or from day to day, the measurements should reflect the 'worst case scenario'.
1.4	Were the exposures of other workers in the vicinity measured?			❑ Measurements should be conducted to determine if other workers in the vicinity of the RFR source are also exposed at greater than the non-occupational Exposure Limits.
1.5	Is the RF-generating plant taken out and used in multiple locations?		GO TO 1.9	
1.6	Have RF levels associated with the portable RF-generating plant use: • ever been measured? • been measured within the last 12 months?		GO TO 1.11	❑ Contract a competent person to measure RF exposure levels in the workplace and assess compliance with the Exposure Limits for RFR in Schedule 1 of the Australian Radiation Protection and Nuclear Safety Regulation 1999.
1.7	Do the field strength measurements from 1.6 reflect 'worse case' exposure conditions?			❑ Arrange for a competent person to measure RF field strengths under the worst case exposure conditions and assess likely personal exposure. This assessment may include augmentation of the field strengths by reflective or re-radiating objects.

1	IDENTIFICATION AND ASSESSMENT OF RFR	YES	NO	SOME SUITABLE CONTROL OPTIONS
1.8	Were the measured levels less than the maximum Exposure Levels?			❑ Occupational Exposure Limits should be used only for workers who are actually operating the RF-generating plant. The exposure should be assumed to be to the whole body unless it is known that only a small part of the body (eg the hands and wrists) is exposed. Non-occupational Exposure Limits should be applied to every other person exposed. The exposure of pregnant women, even if they are operating RF- generating plant should always be below the non-occupational Exposure Limits. ❑ Use this checklist to identify where improvements in RF control can be made. ❑ Consult a competent person about how RF risks in the workplace could be reduced to less than the maximum exposure level.
1.9	Even if the field strengths were below the Exposure Limits, were the measured levels as low as is reasonably achievable?			❑ Use this checklist to identify where improvements in RF control can be made. ❑ Consult a competent person about how RF risks in the workplace could be reduced to the lowest possible levels.
1.10	Were the occupational and non-occupational field level boundaries* of RF sources defined? *the boundaries of areas where exposure may occur in excess of the maximum occupational and non-occupational exposure levels.			❑ Ask the person who did the measurements to define the occupational and non-occupational field level boundaries and use this information to target control measures such as access restrictions.
1.11	Are RF hazards in the workplace assessed regularly for compliance with Exposure Limits and to ensure they are in control?			❑ Use this checklist to assess control of RF in the workplace annually and when modifications are made to RF plant or work processes. ❑ Contract a competent person to measure RF levels and assess compliance with Exposure Limits once a year and when modifications are made to RF plant or work processes.

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2	ISOLATION OF RFR SOURCES	YES	NO	SOME SUITABLE CONTROL OPTIONS
2.1	Is the RF source located away from workers who are not operating RF plant?			❑ Move workers not directly involved in RF tasks to another area of the workplace. ❑ Relocate the RF source to an area of the workplace where workers other than the operators are not present.
2.2	Can the RF source be placed in a shielded enclosure?			❑ Place the RF source in a shielded enclosure such as a metal screen room to confine the RF radiation. This is not a suitable control for any situation in which the RF operator and the source are within the metal enclosure as the operator exposure will be increased many times.
2.3	Where RF sources are taken to other workplaces to be used, is access to the area of excessive field strengths restricted?			❑ Identify by measurement, the boundary where the field strengths do not exceed non-occupational limits and mark these by barriers and signs. ❑ Restrict access inside that boundary to RF operators.

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3	DESIGN, INSTALLATION AND GROUNDING	YES	NO	SOME SUITABLE CONTROL OPTIONS
3.1	Is the plant wired in compliance with SAA Wiring Rules, published as Australian Standard 3000:2000			❑ If you are unsure about this, refer to the plant documentation or contact the equipment manufacturer. ❑ If the wiring does not comply (for example when the plant is imported), the plant must be modified so that it is wired according to the Code.
3.2	Does the RF source have an interlock system*? *a system which automatically cuts off power or closes a shutter mechanism to prevent RFR exposure when access panels are removed eg during maintenance.			❑ Ask your RF plant supplier or another competent person about the possibility of retrofitting an interlock system. ❑ Develop and implement a procedure that ensures that any new RF plant purchased has an interlock system.
3.3	Does the RF source have visual and/or audible 'power-on' indicators?			❑ Ask your RF plant supplier or another competent person about the possibility of effectively retrofitting visual and/or audible 'power-on' indicators. ❑ Develop and implement a procedure that ensures that any new RF plant purchased has visual and/or audible 'power-on' indicators.
3.4	Is the RF source fitted with a shield or shielded enclosure?			❑ Ask your RF equipment supplier or another competent person about the possibility of effectively retrofitting a shield or shielded enclosure to the plant. ❑ Develop and implement a procedure that ensures that any new RF plant purchased has an adequate shield or shielded enclosure
3.5	Has the effectiveness of the shield in reducing RFR been tested by a competent person?			❑ Contract a competent person to measure RF levels and assess the effectiveness of the shield in maintaining exposure levels below the maximum.
3.6	Are all material feed openings in the shield (such as those over conveyors) fitted with a waveguide below cut off*? *a hollow metal tube over the opening.			❑ Contract a competent person to measure RF levels and assess whether a waveguide below cut off is necessary to prevent RF leakage. ❑ Ask your RF plant supplier or another competent person about the possibility of retrofitting a waveguide below cut off over material feed openings.

3	DESIGN, INSTALLATION AND GROUNDING	YES	NO	SOME SUITABLE CONTROL OPTIONS
3.7	Is the shield made from an appropriate material*? *a material which is proven to effectively shield from RF radiation at the frequency present.			❑ Ask your RF equipment supplier or another competent person about modifying the current shield to make it more effective. ❑ Have a new shield made from an appropriate material fitted to the plant.
3.8	Are all joints on the shield: • welded or • overlapped or • fastened with rivets or bolts no greater than 7.5 cm apart?			❑ Install extra bolts or rivets in the shield joints so that the fasteners are no more than 7.5cm apart thereby reducing the opportunity for RF leakage to occur. ❑ Weld shield joints together.
3.9	Are all ventilation or viewing ports fitted with a perforated metal sheet of the appropriate dimensions*? *the dimensions which effectively shield RF radiation are dependant on the wavelength.			❑ Ask your plant RF plant supplier or another competent person about the possibility of retrofitting a perforated metal sheet over ventilation and viewing ports. ❑ Develop and implement a procedure that ensures that any new RF plant purchased has perforated metal shields on ventilation and viewing ports.
3.10	Is good electrical contact maintained between doors/removable panels and the shield cabinet?			❑ Install a springy metallic material (such as beryllium copper stripping) around the contact edges of the doors and panels.
3.11	Are the generator, press and electrode connected with appropriate connectors?			❑ Have strap connectors made of aluminium, copper or phospor bronze fitted so that press, generator and weld head are effectively connected.
3.12	Has grounding for the RF plant been designed, installed and tested by a competent person?			❑ Have a competent person design, install and test effective grounding for the RF plant.
3.13	Are large metallic objects eg motor vehicles, structures, fences, tools situated outside of the RF field?			❑ Remove these objects from within the RF field. ❑ Develop and implement a policy that restricts the placing of such objects in RF fields. ❑ Communicate this policy to workers by displaying notices and through a basic induction program.

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4	WORK PRACTICES AND PROCEDURES	YES	NO	SOME SUITABLE CONTROL OPTIONS
4.1	Does the workplace have a written RF protection policy?			❑ Outline in writing the organisation's commitment to worker protection from RF hazards and the strategies that will be used to achieve protection. This may form part of the general company policy or the Workplace Health and Safety Policy. ❑ Display the policy in a location where it can be read by all workers eg in the lunch room or on a notice board.
4.2	Have RF workers been informed of the potential health effects of exposure to RF radiation sources in the workplace?			❑ Hold a training session for workers about RF hazards and risks. ❑ Distribute written information to workers about the potential health effects of exposure to RF radiation. ❑ Include this type of information in a basic worker induction program.
4.3	Have RF workers been trained in safe operating procedures for RF equipment?		GO TO 5.5	❑ Run step by step through the procedure for the safe operation of RF plant with each worker or as a group. ❑ Include the instructions for safe RF plant operating procedures in a basic worker induction program.
4.4	Is the training regularly updated/refreshed?			❑ Run 'refresher' training courses in RF safety yearly or when any modifications are made to the RF plant or work process.
4.5	Are female RF workers advised that in the event of pregnancy, the employer must be informed and must reduce RF exposure to non-occupational levels.			❑ Display in a conspicuous place a notice that outlines the importance of reducing the RF exposure of female workers to below the non-occupational levels (a conspicuous place may be the female toilets or the lunch room). ❑ Include this advice for females in a basic worker induction program.
4.6	Are workers with cardiac pacemakers or other metallic implants advised that the employer must be informed of this to allow specific control measures to be adopted.			❑ Display in a conspicuous place a notice that outlines the importance of reducing RF radiation exposure of workers with metallic implants. ❑ Include this advice in a basic worker induction program

4	WORK PRACTICES AND PROCEDURES	YES	NO	SOME SUITABLE CONTROL OPTIONS
4.7	Is RF plant in the workplace regularly maintained in accordance with the manufacturer's instructions or yearly?			❑ Maintenance should be performed according to the manufacturer's instructions and at the intervals specified. ❑ It should include ensuring the grounding is still operating effectively and that RF-generating plant is tuned correctly to the nominal frequency and that any harmonics are minimised. ❑ Measurement of field strengths should be conducted after the maintenance to ensure that these have not increased as a result of the maintenance.
4.8	Is the person who performs the maintenance a competent person?			❑ A competent person in this context is one who is an electrical worker under the Electrical Act 1994 and who has undergone an RF Equipment Safety Course by a manufacturer of the type of RF-generating plant on which the installation or maintenance is performed.
4.9	Are records kept of RF plant maintenance?			❑ Ask the person who does the maintenance to document what is done and when and keep these records in a central file.
4.10	When maintenance is being conducted on RF plant is: • the power isolated or • a lock-out procedure used?			❑ Develop and implement a maintenance protocol of which the first step is to isolate power to the plant being maintained. ❑ Develop and implement a lockout procedure to ensure that power is not switched on or plant operated during maintenance.
4.11	Following maintenance activities, are checks made to ensure that all fasteners have been replaced and all areas of potential leakage eg access panels secured?			❑ Develop and implement a maintenance procedure to be followed and documented at each maintenance check that includes checks to ensure all plant is in a safe condition before returning to normal operation. ❑ Nominate a person in the workplace to be responsible for post maintenance checks to ensure all safety sub-systems are in place prior to returning the plant to normal operation.
4.12	Are the shields regularly inspected for visible damage?			❑ Inspect the shields weekly for any sign of visible damage, or in the case of microwave ovens, rust.

4	WORK PRACTICES AND PROCEDURES	YES	NO	SOME SUITABLE CONTROL OPTIONS
4.13	Is access restricted to areas where RF exposure may occur in excess of the maximum limits?			❑ Place physical barriers around RF sources to prevent access to unnecessary persons. ❑ Display signs advising of restricted entry at access to areas where RF exposure may occur in excess of the maximum limits. ❑ Paint colour coded lines on the floor to indicate restricted areas and walkways.
4.14	Is duration of worker exposure to RF limited? * *For this control to be effective, the field strengths must be known.			❑ Rotate workers between RF and non-RF tasks so that each worker is exposed to RF radiation for a minimum amount of time. ❑ Place restrictions on the amount of time a worker may operate RF plant in any one day.
4.15	Are medical examinations of RF workers conducted following a period of exposure in excess of the maximum exposure levels?			❑ Develop and implement a procedure whereby occupationally exposed workers are medically examined by a registered specialist in occupational medicine before employment, every five years, on termination and following exposure in excess of the maximum exposure levels.
4.16	Is there a system in place for the recording of an overexposure to RF radiation?			❑ Develop and implement a system whereby a record of an over exposure to radiation is made by the employer in the approved form as per s.53 of the Workplace Health and Safety Act 1995.
4.17	Is there a system in place for notifying Workplace Health and Safety in the event of an overexposure to RF radiation?			❑ Develop and implement a system whereby Workplace Health and Safety is notified of an over exposure to RF radiation as per s.52 of the Workplace Health and Safety Act 1995.

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5	RELATED NON-RADIATION HAZARDS	YES	NO	SOME SUITABLE CONTROL OPTIONS
5.1	Are RF operators exposed to excessive heat?		GO TO 5.3	
5.2	Is the risk of heat-caused illness managed in the workplace?			❑ Locate hot processes away from the RFR source if possible or use heat shields; ❑ Use fans and encourage workers to dress lightly if the air temperature is less than 35^0 C. For the temperature is higher than this, encourage workers to cover up and turn fans off; ❑ In excessively hot environments, reduce the physical demands of the work. • Introduce mechanical assistance for tasks; • Schedule hard physical work for cooler periods. ❑ Locate a source of clean cool drinking water close to the work area; ❑ Provide a cooler area where workers can take rest breaks.
5.3	Is the RF-generating plant guarded appropriately?* *The Advisory Standard for Plant gives guidance on appropriate guarding.			❑ The design and operation of the plant may create the risk of burns or crush injuries. ❑ Use guarding, reduction of press pressure, or reduction of press closure speed to minimise the risk of burns or injuries from moving or energised parts of the RF plant.
5.4	Do the lighting levels in the workplace give adequate illumination for the type of RF-related work being done?			❑ 400 lux is adequate for ordinary work; ❑ 600 lux is adequate for detailed or close work.

5	RELATED NON-RADIATION HAZARDS	YES	NO	SOME SUITABLE CONTROL OPTIONS
5.5	Is all specified electrical equipment* used in the manufacturing or repair process electrically safe as specified in Section 159 of the Workplace Health and Safety Regulation 1997? * Specified electrical equipment for class 2 work (assembly, fabrication, installation, maintenance, manufacturing, refurbishment or repair work) means: Either a cord extension set, a portable outlet device or electrical equipment that is designed to be connected by a flexible cord and plug to a low voltage supply.			❑ Ensure the equipment is inspected, tested and tagged by a competent person: At least every year for double insulated equipment; or At least every six months for equipment that is not double insulated. ❑ Ensure that the electrical equipment is connected to: a type 1 or 2 residual current device at a switchboard where a final subcircuit of electrical wiring at the workplace originates; or a type 1 or 2 portable residual current device. Residual current devices are available for three phase circuits and devices.
5.6	Are the risk factors for manual tasks associated with the RF-related manufacturing or repair process controlled?			❑ The risk factors for manual handling are: Lifting of excessive weights; Applying excessive force to move loads; Lifting weight while the torso is twisted or bent; Lifting or carrying weight around or over plant or parts of plant; and Working for extended periods with arms and shoulders elevated. ❑ For significant risks: re-design the workstation to eliminate or minimise the risk; and/or provide manual handling aids to minimise lifting of excessive weight.
5.7	Are manual handling aids checked regularly to ensure they are working properly?			❑ Devices such as rollers may have glue build up on them and may cease to roll. ❑ Check that such devices are operating effectively on a weekly basis. ❑ Try to eliminate or minimise the use of substances that interfere with the effective working of manual handling aids.

5	RELATED NON-RADIATION HAZARDS	YES	NO	SOME SUITABLE CONTROL OPTIONS
5.8	Are all flammable gases, solvents, fuels or electro-explosive devices stored or used away from where RF field may be present?			❑ Remove all flammable gases, solvents, fuels or electro-explosive devices from the vicinity of RF sources. ❑ Develop and implement a policy which restricts the use or storage of such materials where RF fields may be present. ❑ Communicate this policy to workers by displaying notices and through a basic induction program.

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