

Weld Australia  
Technical Guidance Note

# **Welding Electrical Safety: Electric Shock Injury and Electrocution Reporting**

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## Foreword

This Technical Guidance Note contains the pop-out guide and form *Welding electric shock injury and electrocution report form* referenced within Weld Australia's Technical Note 22 *Welding electrical safety*.

It is designed to be read in conjunction with the Technical Note, and, to assist users in its application when investigating welding current related electric shocks or electrocutions.

## Edition

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## Acknowledgements

This Technical Guidance Note has been prepared under the direction of an expert working group consisting of:

|                              |                                 |
|------------------------------|---------------------------------|
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## Future Revisions

This Technical Guidance Note will be revised from time to time and comments aimed at improving its value to industry will be welcome. This publication is copyright and extracts shall not be reprinted or published without the Publisher's express consent.

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## About Weld Australia

### Who We Are

Weld Australia represents the welding profession in Australia. Our members are made up of individual welding professionals and companies of all sizes. Weld Australia members are involved in almost every facet of Australian industry and make a significant contribution to the nation's economy.

Our primary goal is to ensure that the Australian welding industry remains both locally and globally competitive, both now and into the future.

A not-for-profit, membership-based organisation, Weld Australia is dedicated to providing our members with a competitive advantage through access to industry, research, education, certification, government, and the wider industrial community. Weld Australia is the Australian representative member of the International Institute of Welding (IIW).

### Our Mission

Weld Australia is the leader in facilitating growth of world class welding in Australia.

### Our Vision

Weld Australia seeks to enable industry to access leading edge technologies for all types of joining processes through technology transfer, education and certification opportunities.

### Our Value Proposition

Weld Australia generates revenue through its commercial activities which is then reinvested back into the welding community for the benefit of members.

Weld Australia brings individual and company members together to deliver:

- A forum for the exchange of ideas and the sharing of resources
- A voice to promote the interests of the welding community and shape the market for welding services
- Specialist technical problem solving and a conduit between industry and research organisations
- A pathway for learning and career development and the opportunity to benchmark against world's best practice

### Our Services

Weld Australia provides:

- Events and Seminars
- Technical Publications
- Technical Support and Advisory Services
- Project Management
- Professional Development
- Qualification and Certification

### Real Solutions to Real Problems...

Weld Australia has a team of highly qualified welding engineers and technologists available to provide expert advisory services on all welding related matters. With expertise in a wide range of industries, ranging from biotechnology to heavy engineering we have a unique capability to solve your welding problems.

Our advice can help you substantially increase the operational life of your plant and equipment and thereby reduce your maintenance and repair overheads.

### Further Information

For further information about Weld Australia and how we can help your business, visit: [www.weldaustralia.com.au](http://www.weldaustralia.com.au).

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## Introduction

The *Welding electric shock injury and electrocution report form* from Weld Australia's Technical Note 22 has been reproduced in this Technical Guidance Note, and includes modifications based on user experience and feedback to Weld Australia.

This document is a stand-alone document and users may copy the document for use in their workplace where welding and allied processes are used, to assist investigators in the investigation of welding current electric shock injuries and incidents, and electrocutions.

Reference should be made to IEC 60479-1:2018 particularly when estimating current flow through the victim's body. In the absence of definitive clothing and body impedance information, a value of 500 ohms may be used (see also Weld Australia's Technical Note 22).

Of particular note, users should be aware of the effects of even small levels of dampness and sweat on conductivity, including the welder's gloves, clothing and personal protective equipment. Further information is available in Weld Australia's Technical Notes 7 and 22.

[illegible]

## Welding Current Electric Shock Injury / Fatality Report

### Section 1: Victim Information (Continued)

**PPE Worn by Victim at Time of Incident – list:**

**1. Respiratory protection – type**

**2. Boots/shoes – type and condition**

**3. Eye/Face protection worn**

**4. Other**

**Victim's Gloves**

**Type and Condition**

(Damaged, holes, damp, wet, dry, etc.)

Was victim wearing gloves at time of incident?

Yes \_\_\_\_\_ No \_\_\_\_\_

**Victim's Clothing**

**Type**

(Fire resistant, cotton, woollen, leathers, hood, etc.)

**Condition**

(torn, holes, soiled, damp, wet, dry, etc.)

### Other Information

**Take photographs of incident setting, condition of gloves, clothing.**

**Take photographs of the 3 Ps: Parts, People and Positions.**

Report if Safety person/Observer present, their proximity and access to power switch, and if CPR trained. Include photographs of the welding machine & settings, cables, electrode holder, work return clamp(s) etc. (Attach all to this report.)

## Welding Current Electric Shock Injury / Fatality Report

### Section 2: Environmental Conditions

|          |                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>a</b> | <b>Season</b><br>(Spring, Summer, Autumn, Winter, wet, dry, etc)                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>b</b> | <b>Weather Forecast</b><br>Note if a significant weather change is forecast, especially a cool change. A sudden (large) increase in humidity can occur during a cool change without warning. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>c</b> | <b>Ambient Temperature at Time of Incident</b><br>In confined space or work area, or if preheat is in use, measure at work location as it will be considerably above normal ambient.         | _____ °C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>d</b> | <b>Weld Preheat and Interpass Temperatures</b>                                                                                                                                               | Pre-heat in use                      Yes _____ No _____<br>Pre-heat temperature specified    _____<br>Interpass temperature specified    _____                                                                                                                                                                                                                                                                                                                                                    |
| <b>e</b> | <b>Work Area</b><br>(Australia: see AS 1674.2)                                                                                                                                               | CAT. A _____ (Low risk of contact with the workpiece or circuit)<br>CAT. B _____ (Some risk of contact with the workpiece or circuit, dry work area, low humidity, ambient temperature <32°C, clean & dry clothing/PPE)<br>CAT. C _____ (High risk of contact with the workpiece or circuit, hot or high humidity, wet or damp, low body impedance due to sweat, moisture etc.)<br>Environment with increased risk of electric shock _____<br>Other (describe work area): _____<br>_____<br>_____ |
| <b>f</b> | <b>Insulating Material between the Welder and Welding Circuit</b>                                                                                                                            | _____<br>(Example: Wooden boards, insulating blanket, mats, etc)<br>Wet _____ Dry _____                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>g</b> | <b>Humidity Level</b><br>(Measured, or from daily weather report)<br>Note: if outdoors and raining at time of incident indicate humidity at 100%                                             | Rain _____ Mist _____ Fog _____ Snow _____<br>Sleet _____ Dry _____<br>Humidity level measured _____ (at time of incident)<br>Humidity level weather report _____                                                                                                                                                                                                                                                                                                                                 |

## Welding Current Electric Shock Injury / Fatality Report

## Section 2: Environmental Conditions (Continued)

[illegible][illegible]

## Welding Current Electric Shock Injury / Fatality Report

### Section 3: Injury / Fatality Information

**Injury** ☐ or

**Fatality** ☐

(Describe contact points, include skin colouration, blistering etc.)

**Electrode/electrode holder:** \_\_\_\_\_

(Also mark on drawing)

**Return lead/work piece contact:** \_\_\_\_\_

(Also mark on drawing)

**Workpiece/workbench/machinery/structure:** \_\_\_\_\_

**Other Injuries**

For example, skin burns, eye burn, bone break from fall etc.

**Contact Area and Current Path Through Body**

Describe and mark on drawing (g) below. Indicate if large or small contact area e.g. full palm of hand v/s fingers.

**Estimated Body Resistance**

Consult expert for assistance.

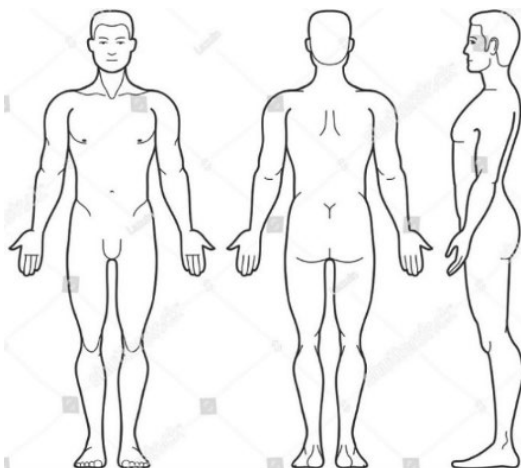
**Current Flow Duration**

Actual duration if known. For example, long contact duration >0.2 sec, short contact duration etc.

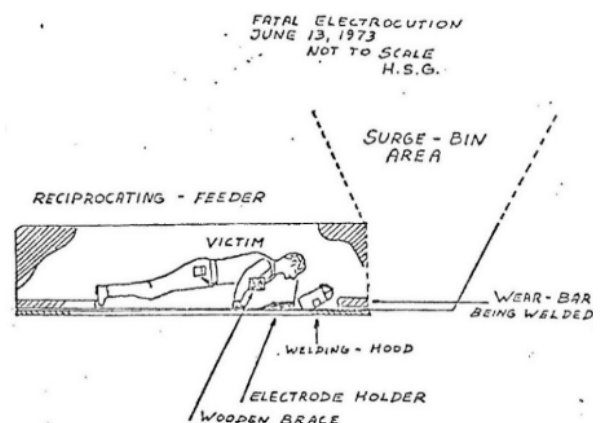
**Estimated Current Flow Through Body**

Consult expert for assistance. See next page for calculation information.

**Body Contact Drawing**



Indicate standing seated lying – draw in contact areas, if prone draw a line indicating front/back contact surface of body with base metal or earth (see reverse).



Example drawing (picture) if water flowing or damp clothing/PPE or wet contaminated surfaces, show that information and describe. Print and attach pictures to report. If possible, have person simulate position of victim, ensuring safety first. See example above.

### Section 3: Injury / Fatality Information (Continued)

1. Use 5% of the population values for estimation of impedance.
2. Skin impedance values may not apply if contact with the electrode/workpiece was via a puncture wound or mouth.
3. Clothing impedance values will be very low if:
  - a. Welders gloves or clothing is damp; or,
  - b. Welder is kneeling, sitting or lying on the workpiece.
4. Clause 5.8 of IEC 60479 1:2018 provides an estimate of current density based on contact point skin colourisation changes.  
**NOTE:** *With large contact areas, current densities may be low enough not to cause any alterations of the skin in spite of fatal current magnitudes.*
5. Typical total impedances for welder's damp with sweat or moisture, especially when kneeling, sitting or lying on the workpiece are known to vary from <300 ohms to 650 ohms. This may vary with the power source's open circuit voltage and polarity.
6. For general calculation purposes, a value of 500 Ohms is often used in the absence of specific data required to estimate current flow.
7. If the HRD/VRD had not activated at the time of the incident, use the open circuit voltage (OCV) of the power source for the calculations.

*A welder using the MMAW process, was fatally electrocuted whilst welding was being performed on a raised perforated metal floor. The awkwardness of the job meant that the welder had to be either kneeling with his face close to the floor or lying on his back to afford any view of the job. The electrode had to be bent so it could properly access the parts to be welded. An insulating mat was not used. The welder's gloves and clothing was dirty and soaked with sweat. The welding power source was a portable AC transformer type with an open-circuit voltage of 49 Volts AC. The welding equipment was found to be in good order. From the position adopted it is probable that electrical contact points were either hand and back or face and back.*

The investigation determined that 3 days after the incident, there was the equivalent of 10% moisture by weight remnant in the clothing and that the AC impedance of the clothing at the time of test to have been around 350 Ohms. From IEC 60479 1 the total body impedance (hand to hand) at 50VAC is assumed to be 1450 Ohms for the worst case 5% of the population, and 4375 Ohms for the best-case 5% of the population. The deceased was sweating heavily, and this could lower total body impedance by up to 50%.

Assuming that the reduced value of impedance was 1500 Ohms and an impedance face to back was in the order of 20% of the hand to foot impedance, the total body impedance is estimated to be 300 Ohms (20% of 1500). The total impedance of body and clothing is therefore estimated to be 650 Ohms. The resulting current at 50V AC is 77 mA. This is well above the average let-go threshold of 10mA for AC. If the heart-current factor F is taken to be 0.7 – the value for current flow from left hand to back. This results in an equivalent current of 54 mA for the path left hand to both feet. With reference to IEC 60479-1 and assuming a contact time of 1.0 second, under these conditions there is a probability of ventricular fibrillation for around 5% of the population. If the deceased was a member of this percentile band, then a fatal situation can certainly be shown to exist using the known information.

If the moisture content of the clothing at the time of the incident was 15% then the clothing impedance drops to 100 Ohms. If the welder was sweating heavily and had low body impedance, then total body impedance (hand to hand) could be of the order of 800 Ohms, resulting in a face to back impedance of 160 Ohms. The total impedance of body and clothing would then be 260 Ohms; the resultant current 192 mA, equivalent to a left hand to both feet current of 135 mA. From IEC 60479-1: with a contact time of 1 second this implies a probability of ventricular fibrillation for almost 50% of the population.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

## Welding Current Electric Shock Injury / Fatality Report

### Section 4: Welding Machine (Power Source) Data

|          |                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>a</b> | <b>Make of Welding Machine</b>                                                                                                                                                                                                                                                                                                                                  | <div style="border-bottom: 1px solid black; height: 15px; margin-bottom: 2px;"></div> <div style="border-bottom: 1px solid black; height: 15px; margin-bottom: 2px;"></div> <div style="border-bottom: 1px solid black; height: 15px; margin-bottom: 2px;"></div> <div style="border-bottom: 1px solid black; height: 15px;"></div>                                                                                                                                                                                                                                                                                                                                                                     |
| <b>b</b> | <b>Model, Name, Type and Designation of Welding Machine</b><br><small>Include welding process details e.g. MMAW, GMAW (MIG), FCAW, GTAW (TIG), Air-carbon arc etc. If DC machine, indicated if "inverter" or "transformer-rectifier" type.</small>                                                                                                              | <div style="border-bottom: 1px solid black; height: 15px; margin-bottom: 2px;"></div> <div style="border-bottom: 1px solid black; height: 15px; margin-bottom: 2px;"></div> <div style="border-bottom: 1px solid black; height: 15px; margin-bottom: 2px;"></div> <div style="border-bottom: 1px solid black; height: 15px;"></div>                                                                                                                                                                                                                                                                                                                                                                     |
| <b>c</b> | <b>Nameplate No Load / OCV Voltage(s) AC/DC</b><br><small>Record actual set voltage and type indicated (report "RMS" if AC).</small>                                                                                                                                                                                                                            | <div style="border-bottom: 1px solid black; height: 15px; margin-bottom: 2px;"></div> <div style="border-bottom: 1px solid black; height: 15px; margin-bottom: 2px;"></div> <div style="border-bottom: 1px solid black; height: 15px; margin-bottom: 2px;"></div> <div style="border-bottom: 1px solid black; height: 15px;"></div>                                                                                                                                                                                                                                                                                                                                                                     |
| <b>d</b> | <b>Settings at Time of Incident</b><br><small>Record all voltage, current, frequency settings – take photo for history. If GTAW (TIG) being used, indicate the start method e.g. scratch, lift, high frequency (HF), etc.</small>                                                                                                                               | <div style="border-bottom: 1px solid black; height: 15px; margin-bottom: 2px;"></div> <div style="border-bottom: 1px solid black; height: 15px; margin-bottom: 2px;"></div> <div style="border-bottom: 1px solid black; height: 15px; margin-bottom: 2px;"></div> <div style="border-bottom: 1px solid black; height: 15px;"></div>                                                                                                                                                                                                                                                                                                                                                                     |
| <b>e</b> | <b>Actual measured output voltage (OCV/no load) at incident setting and type of voltage AC/DC</b><br><small>Actual duration if known. For example, long contact duration &gt;0.2 sec, short contact duration, etc.</small>                                                                                                                                      | <p>As nameplate and measured output voltage can differ:</p> <ol style="list-style-type: none"> <li>1. Record the measured voltage and polarity at the settings at time of incident.</li> <li>2. If DC, record and verify the voltage output waveform using an oscilloscope or similar (minimum 15kHz capability).</li> <li>3. Record details of the equipment used to make the measurement.</li> </ol> <div style="border-bottom: 1px solid black; height: 15px; margin-bottom: 2px;"></div> <div style="border-bottom: 1px solid black; height: 15px; margin-bottom: 2px;"></div> <div style="border-bottom: 1px solid black; height: 15px;"></div>                                                    |
| <b>f</b> | <b>Voltage Reducing Device and/or Hazard Reducing Device</b><br><small>Consult expert for assistance. See next page for calculation information.</small><br><br><small>Note: VRD may be add-on device, or integral to machine, if integral, option must be selected to "On" position via internal machine settings. Consult operating manual to verify.</small> | <div style="display: flex; justify-content: space-between;"> <div>HRD/VRD installed</div> <div>Yes _____</div> <div>No _____</div> </div> <div style="display: flex; justify-content: space-between;"> <div>HRD/VRD installed and in use</div> <div>Yes _____</div> <div>No _____</div> </div> <div style="display: flex; justify-content: space-between;"> <div>HRD/VRD functionality verified after event</div> <div>Yes _____</div> <div>No _____</div> </div> <div style="display: flex; justify-content: space-between;"> <div>Type/Make/Model</div> <div>_____</div> </div> <div style="display: flex; justify-content: space-between;"> <div>HRD/VRD response time</div> <div>_____</div> </div> |
| <b>g</b> | <b>Circuit Contact</b><br><small>Was contact made whilst VRD was active, while welding or VRD disengaged?</small>                                                                                                                                                                                                                                               | <div style="display: flex; justify-content: space-between;"> <div>Yes _____</div> <div>No _____</div> </div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

#### Other Information

e.g. describe the condition of the electrode holder, work return clamp(s) and cables.

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Intentionally left blank for your use.

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# **Weld Australia Technical Notes**

## **TN 1 – The Weldability of Steels**

Gives guidance on the preheat and heat input conditions (run size, current, voltage) required for acceptable welds and to avoid cold cracking in a wide variety of steels. The Note is applicable to a wide range of welding processes.

## **TN 2 – Successful Welding of Aluminium**

This note covers the major welding processes as they are used for the welding and repair of aluminium and its alloys. Information is given on the processes, equipment, consumables and techniques. It also provides information on the range of alloys available and briefly covers safety, quality assurance, inspection and testing, costing and alternative joining processes.

## **TN 3 – Care and Conditioning of Arc Welding Consumables**

Gives the basis and details for the correct care, storage and conditioning of welding consumables to control hydrogen and to ensure high quality welding.

## **TN 4 – The Industry Guide to Hardfacing for the Control of Wear**

Describes wear mechanisms and gives guidance on the selection of hardfacing consumables and processes for a wide range of applications. Includes Australian Hardfacing Suppliers Compendium 1998.

## **TN 5 – Flame Cutting of Steels**

Gives a wealth of practical guidance on flame cutting including detailed procedures for efficient cutting, selection of equipment and gases, practices for identifying and curing defective cutting, methods of maximising economy and other important guidance on the use of steels with flame cut surfaces.

## **TN 6 – Control of Lamellar Tearing**

Describes the features and mechanisms of this important mode of failure and the means of controlling tearing through suitable design, material selection, fabrication and inspection. Acceptance standards, repair methods, specification requirements and methods of investigation are proposed. Three appendices give details on the mechanism, material factors, tests for susceptibility and the important question of restraint.

## **TN 7 – Health and Safety in Welding**

Provides information on all aspects of health and safety in welding and cutting. Designed to provide this information in such a way that it is readily useable for instruction in the shop and to provide guidance to management. Recommendations are given for safe procedures to be adopted in a wide variety of situations in welding fabrication.

## **TN 8 – Economic Design of Weldments**

Principles and guidance are given on methods and procedures for optimising design of weldments and welded joints and connections to maximise economy in welding fabrication. Factors influencing the overall cost of weldments which need to be considered at the design stage are discussed.

## **TN 9 – Welding Rate in Arc Welding Processes: Part 1 MMAW**

Gives practical guidance and information on the selection of welding conditions to improve productivity during manual metal arc welding (MMAW). Graphs are provided showing rates as a function of weld size. The graphs enable a direct comparison of different types of welding electrodes when used for butt and fillet welds in various welding positions.

## **TN 10 – Fracture Mechanics**

Provides theory and gives practical guidance for the design and fabrication of structures, planning of maintenance and assessment of the likelihood of brittle or ductile initiation from flaws in ferrous and non-ferrous alloys. Engineering critical assessment case histories are discussed.

## **TN 11 – Commentary on the Structural Steel Welding Standard AS/NZS 1554**

The Note complements AS/NZS 1554 parts 1 to 7, by presenting background information which could not be

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included in the Standard. It discusses the requirements of the Standard with particular emphasis on new or revised clauses. In explaining the application of the Standard to welding in steel construction, the commentary emphasises the need to rely on the provisions of the Standard to achieve satisfactory weld quality.

## **TN 12 – Minimising Corrosion in Welded Steel Structures**

Designed to provide practical guidance and information on corrosion problems associated with the welding of steel structures, together with possible solutions for minimising corrosion.

## **TN 13 – Stainless Steels for Corrosive Environments** (A Joint publication with ACA)

Provides guidance on the selection of stainless steels for different environments. Austenitic, ferritic and martensitic stainless steels are described together with the various types of corrosive attack. Aspects of welding procedure, design, cleaning and maintenance to minimise corrosion are covered.

## **TN 15 – Welding and Fabrication of Quenched and Tempered Steel**

Provides information on quenched and tempered steels generally available in Australia and gives guidance on welding processes, consumables and procedures and on the properties and performance of welded joints. Information is also provided on other fabrication operations such as flame cutting, plasma cutting, shearing and forming.

## **TN 16 – Welding Stainless Steel**

This Technical Note complements Technical Note Number 13 by detailing valuable information on the welding of most types of stainless steels commonly used in industry.

## **TN 18 – Welding of Castings**

Provides basic information on welding procedures for the welding processes used to weld and repair ferrous and non-ferrous castings. It also provides information on the range of alloys available and briefly covers non-destructive inspection, on-site heating methods and safety.

## **TN 19 – Cost Effective Quality Management for Welding**

Provides guidelines on the application of the AS/NZS ISO 9000 series of Quality Standards within the welding and fabrication industries. Guidance on the writing, development and control of Welding Procedures is also given.

## **TN 20 – Repair of Steel Pipelines**

Provides an outline of methods of assessment and repair to a pipeline whilst allowing continuity of supply.

## **TN 21 – Submerged Arc Welding**

Provides an introduction to submerged arc welding equipment, process variables, consumables, procedures and techniques, characteristic weld defects, applications and limitations. Describes exercises to explore the range of procedures and techniques with the use of solid wire (single and multiple arcs) and provides welding practice sheets, which may be used as instruction sheets to supplement demonstrations and class work, or as self-instruction units.

## **TN 22 – Welding Electrical Safety**

Provides information and guidance on welding electrical safety issues (welding equipment, the human body and the workplace), including investigation of welding current related electric shock injuries and electrocution, including investigation of welding current related electric shock injuries and electrocution.

## **TN 23 – Environmental Improvement Guidelines**

Provides information and guidance on how to reduce consumption in the Welding and Fabrication industry, while reducing the impact on the environment at the same time.

## **TN 25 – Welding Specification for the Water Industry**

Published with the Water Services Association of Australia. Applies to all metal fabrication and repair work involving welding, carried out by a Water Agency (WA) and its Contractors/Subcontractors. Prescribes weld preparation, qualification of welding procedures and personnel, workmanship and inspection requirements for welds related to the arc welding by manual metal arc and other processes approved by the WA responsible Welding Coordinator.

[illegible]



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