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## 1 Purpose

This Procedure outlines controls to protect personnel working on metallic pipelines from potentially hazardous touch voltages.

This Procedure is applicable to all work activity on metallic pipelines identified as being affected by voltages induced by the presence of nearby overhead or underground power distribution and transmission lines. For electrical hazards that may exist when constructing new metallic pipelines, refer to the [Electrical Safety in Metallic Pipeline Construction](#) guideline.

## Content

<b>1 Purpose</b> .....	<b>1</b>
<b>2 Scope</b> .....	<b>1</b>
<b>3 Roles and Responsibilities</b> .....	<b>2</b>
<b>4 Training</b> .....	<b>2</b>
<b>5 Procedure – Pipeline Voltage Mitigation</b> .....	<b>3</b>
<b>5.1 Work Procedures Applicable to All Tasks</b> .....	<b>3</b>
<b>5.1.1 Site Inspection, Pre-Work Risk Assessment and Briefings</b> .....	<b>3</b>
<b>5.1.2 Working Procedure</b> .....	<b>4</b>
<b>5.1.3 Post Work Procedure</b> .....	<b>4</b>
<b>6 Work Procedures Applicable to Specific Tasks</b> .....	<b>4</b>
<b>7 Records</b> .....	<b>5</b>
<b>8 Definitions</b> .....	<b>5</b>
<b>9 Compliance Mapping</b> .....	<b>6</b>
<b>10 References</b> .....	<b>6</b>
<b>Appendix A1 Pipeline maintenance involving painting on pipelines or fittings</b> .....	<b>7</b>
<b>Appendix A2 Operating valves on pipelines, and pipeline maintenance involving water quality inspections and sampling on pipelines and their fittings</b> .....	<b>8</b>
<b>Appendix A3 Cathodic protection inspections and testing on underground pipelines or underground sections of aboveground pipelines with cathodic protection installed</b> .....	<b>9</b>
<b>Appendix A4 Equipment Installation activities (including pipe banding), but not limited to hydrant installation and replacement on pipelines</b> .....	<b>10</b>
<b>Appendix A5 Hot Tapping Activities on Pipelines</b> .....	<b>11</b>
<b>Appendix A6 Maintenance of air and section valves on pipelines</b> .....	<b>13</b>
<b>Appendix B Affected Pipelines</b> .....	<b>15</b>
<b>Appendix C Voltage Mitigation Standard</b> .....	<b>16</b>
<b>Appendix D Equipment</b> .....	<b>17</b>
<b>Appendix E Extract from AS2225 – 1994 (Appendix C)</b> .....	<b>20</b>

## 2 Scope

This procedure applies to all workers (including employees and contractors performing works under contract) undertaking the following specific operational and maintenance activities on 'Affected Pipelines' (as identified in Appendix B):

- Pipeline maintenance involving painting of pipelines or fittings
- Pipeline activity involving water quality inspections and sampling on pipelines and their fittings.

- Cathodic protection inspections and testing on underground pipelines or underground sections of aboveground pipelines with cathodic protection installed.
- Equipment installation activities including but not limited to hydrant installation and replacement on pipelines.
- Hot tapping activities on pipelines.
- Operating valves on pipelines.
- Air and section valve maintenance on pipelines.

**Note:** The process for identifying metallic pipelines affected by induced voltages from nearby overhead or underground power lines requires calculations involving up to sixteen variables, and therefore is complex and time consuming. The procedure in this document ONLY applies to the affected metallic pipelines listed in Appendix B, where the above calculations have shown may be affected by induced voltages.

Where an affected metallic pipeline has had permanent mitigation (that is, protection) fitted at appurtenances, this Procedure will still apply for the relatively infrequent need for work on the service *between* appurtenances (e.g. where pipeline protective coating is exposed for access).

### 3 Roles and Responsibilities

Role	Responsibilities
Asset Owner representative	<ul style="list-style-type: none"> <li>• Ensure that all necessary inspections, pre-work risk assessments and briefings are conducted prior to the commencement of works.</li> <li>• Communicate to the crew supervisor all identified risks, control measures and site specific warnings including the work scope.</li> <li>• Where the Asset Owner representative is also the crew supervisor and competent person conducting the work, it must be their responsibility to communicate and instruct all other competent persons that may be present of all identified risks, control measures and site specific warnings, prior to commencing work. This includes the identified work scope.</li> </ul>
Supervisor	<ul style="list-style-type: none"> <li>• Prior to starting, and during work, the crew supervisor must communicate and instruct all competent persons of all identified risks, control measures and site specific warnings including work scope for the job to be completed.</li> </ul>

### 4 Training

Water Corporation employee training records must be maintained in accordance with Section 7.

Contractors must be responsible for maintaining employee training records.

Course Name	Mandatory for Roles	Description	Period of Validity
<b>Pipeline Voltage Mitigation</b> SAP #Q00006326	<ul style="list-style-type: none"> <li>• Personnel who are required to complete work on any metallic pipeline listed in Appendix B of the Pipeline Voltage Mitigation procedure, including:             <ul style="list-style-type: none"> <li>○ The onsite crew Supervisor</li> <li>○ A minimum of 50% of the work crew, inclusive of the crew supervisor (e.g. for a crew supervisor plus two crew, the supervisor and at least one of the crew must be trained).</li> </ul> </li> <li>• Civil and Trades Team Leaders of crews that operate or maintain affected mains listed in Appendix B of the Pipeline Voltage Mitigation procedure.</li> </ul>	Provides participants with knowledge of the dangers of induced voltages from high voltage overhead power lines when in the near vicinity of underground or above ground metallic pipelines.  Provides participants training in the safeguards to be adopted.  4 hour course.	4 years.

NOTE: Personnel intending to undertake work on affected metallic pipelines listed in Appendix B must attend a 4hr training package TC0514 (Pipeline Voltage Mitigation) prior to commencing any work. Please contact the Training Coordinator or the Technical Consultant Electrical at Aroona (93714064 or 93714187) for details of available training sessions.

## 5 Procedure – Pipeline Voltage Mitigation

Water Corporation and Contractor staff, performing maintenance activities on certain metallic pipelines, located near or within electric power transmission line easements, are subject to various prospective electrical hazards, even though the pipeline is physically separated from any electrical energisation sources. Inductive, conductive and capacitive coupling between the nearby energized power lines and metallic pipelines can result in personnel being exposed to hazardous touch voltages. (See Appendix C)

The pipeline, or section of pipeline, having undergone a hazardous voltage investigation, and, irrespective of its size, function or location must be identified and classified as either mitigated or unmitigated. This will determine whether a Safe Work Procedure must be employed for the work to be performed.

### 5.1 Work Procedures Applicable to All Tasks

#### 5.1.1 Site Inspection, Pre-Work Risk Assessment and Briefings

- With reference to this procedure, the Asset Owner representative must ensure that all necessary inspections, pre work risk assessments and briefings are conducted prior to the commencement of works.
- The Asset Owner representative must communicate to the crew supervisor all identified risks, control measures and site specific warnings including the work scope.
- Prior to starting, and during work, the crew supervisor must communicate and instruct all competent persons of all identified risks, control measures and site specific warnings including work scope for the job to be completed.
- Where the Asset Owner representative is also the crew supervisor and competent person conducting the work, it must be their responsibility to communicate and instruct all other competent persons that may be present of all identified risks, control measures and site specific warnings, prior to commencing work. This includes the identified work scope.

The briefing should include but is not limited to:

- Determine the need for a Job Rescue Plan, with the involvement of all crew.
- The crew supervisor must identify themselves and provide all of their contact details to the work party. Adequate communication must be provided so the crew supervisor or emergency services can be easily contacted.
- If any changes in working conditions or work scope arise during the normal work process, the work party must cease work. The crew supervisor must be notified. Risk assessments and briefings must be reviewed prior to the recommencement of works
- Equipment safety inspections must be made prior to use, to ensure that all equipment is fit for service. The issue, use and inspection of electrical insulating gloves must be made in accordance with AS2225 in Appendix E.
- Location of First Aid and Fire Fighting equipment.
- Location of nearest Emergency facility.
- All adequate warning signs, safety barriers, personal protective equipment and access to emergency procedures must be provided and maintained throughout the duration of the works.
- A review of locally observed and predicted weather conditions must be made with respect to adverse weather warnings. Under no circumstances must works begin or be conducted when lightning is present or likely to occur.

- Observations must be made with regard to the proximity of overhead or underground distribution or transmission lines. Where a work crew assembly area is located adjacent to or in close proximity of overhead or underground power or transmission lines then it must be located as far away from the lines as possible, to reduce the likelihood of EPR or induction.
- Assessment of buried services and objects.
- The origin of any groundwater must be found and dammed to prevent further groundwater ingress. The work site must be secured to ensure that the work area is as dry as practicable during the works.
- Soil that is suitable to provide a stable base must be installed in the work area prior to the installation of any equipotential working mats to avoid any submergence. (Coarse sand or gravel may need to be brought on site to prevent equipotential mats from sinking into soggy or wet earth).

## 5.1.2 Working Procedure

The work procedures that must be adhered to for specific tasks are listed in Appendices A1 to A6. Careful observation of the common requirements of Section 5 apply to all tasks in Appendices A1 to A6, together with the specific work procedures outlined for each task.

- Where possible, the operator should avoid making direct contact with exposed metallic pipe or fittings.
- Under no circumstances must contact occur with persons not wearing the appropriate personal protective equipment, including suitably rated electrical insulating gloves, when passing equipment.

Prior to installing, cutting or removing any section of operational metallic pipework or fitting, where the electrical continuity is likely to be broken, a bridging cable must be fitted to maintain electrical continuity.

**Note:** This does not apply to the cutting of inspection holes/hatches.

The operator must wear suitably rated PPE boots (see Appendix D) if:

- any groundwater is found to be present upon inspection; or
- the natural soil conditions are found to be such that the normal standing position required to complete the work cannot be maintained without the risk of submergence, both during work area establishment and during the normal course of works.

## 5.1.3 Post Work Procedure

- Remove all plant and equipment from the work area. This can include, as the first action, disconnecting the insulated equipotential bonding conductor from equipotential working mats.
- Remove equipotential working mats from the work area.
- Remove all barriers and warning signs from around the work area.
- Ensure that all personal protective equipment is correctly stored.
- Reinstate pipeline and or valve as required.

## 6 Work Procedures Applicable to Specific Tasks

Appendix	Task
A1	Pipeline maintenance involving painting on pipelines or fittings
A2	Operating valves on pipelines, and pipeline maintenance involving water quality inspections and sampling on pipelines and their fittings.
A3	Cathodic protection inspections and testing on underground pipelines or underground sections of aboveground pipelines with cathodic protection installed.
A4	Equipment installation activities including but not limited to hydrant installation and replacement on pipelines.
A5	Hot tapping activities on pipelines.
A6	Maintenance of air and section valves on pipelines.

## 7 Records

Water Corporation records associated with the pipeline voltage mitigation must be filed in accordance with the [Water Corporation Records Retention and Disposal Schedule](#), with the filing convention, retention period and disposition type outlined below:

Record	To be retained by	Filing convention	Retained for (time period)	Disposition Type
Training and Competency records	SAP	n/a	Retained in accordance with the General Disposal Authority for Human Resource Management Records (GDAHRM).	
	Branch Manager	<b>STAFF DEVELOPMENT - Training</b>	2 years after last action	Destroy 7 years after last action

Contractor records associated with work on affected pipelines must be available for the duration of the task and then stored in an easily retrievable manner.

## 8 Definitions

Term	Description
<b>Affected Pipeline</b>	Metallic pipelines, running parallel to overhead high voltage power transmission lines, where hazardous induced voltages may be present.
<b>Appurtenance</b>	Valves, fittings, or physical items added to, or part of, the pipeline, and accessible at ground level.
<b>Asset Owners Representative</b>	An Operations person from the Branch, Region or Alliance (e.g. Civil Team leader) responsible for the overall management of work crews carrying out tasks on affected metallic pipelines.
<b>Competent Person</b>	A person who has, through a combination of training, education and experience, acquired the knowledge and skills enabling that person to perform correctly, a specified task.
<b>Crew Supervisor</b>	The site supervisor of a work crew assigned to carry out tasks on affected metallic pipelines (listed in Appendix B). For example this could be a leading hand mechanical fitter. For in-house work this could be the same person as the Asset Owners representative.
<b>Earth Potential Rise (EPR)</b>	Earth potential rise is a measure of the difference in voltage level that can occur in the ground, at varying locations, following a discharge of current to ground when an electrical fault, or lightning strike, occurs (i.e. step or touch voltage).
<b>Equipotential Working Mat</b>	A mat that has been designed to place an operator at the same potential as the equipment being operated, thus minimising a voltage potential between the operators feet and hands.
<b>Fittings</b>	Valve handles, tapping's, section valves and other appurtenances physically attached to the metallic pipeline, and generally above ground, accessible to maintenance and operations personnel, or the public.
<b>Mitigated Pipeline</b>	A metallic pipeline that is affected by hazardous induced voltages, where modifications and protective devices have been fitted to neutralise the voltages that may be present on the pipeline or its appurtenances. <b>Note:</b> For above ground pipelines, the whole pipeline is mitigated to safe touch voltage levels. For below ground pipelines, only the appurtenances are mitigated to safe touch voltage levels, and therefore all other below ground pipe sections, hazardous induced voltages may be present.
<b>Non Conductive Barrier</b>	A barrier of non-conductive material, that prevents the flow of electricity and the effects of induced voltages from being transmitted across an intervening space.
<b>Rescue Plan</b>	A document that details how to conduct an initial rescue of personnel who have been subjected to an unplanned event with undesirable consequences, relating to a specific work situation.
<b>Step Voltage</b>	Step voltage is that voltage (EPR) that may be received by a person or livestock through two contact points, when walking on a surface such as soil through which a current, usually a fault current from an earth electrode, is flowing. A lightning strike can also produce similar step voltages.
<b>Suitably Rated Boots</b>	Insulating boots for electrical purposes are rated for use according to nominal working voltage. Unless otherwise specified insulating boot rating must be taken to be for a nominal working voltage of 1000V in accordance with AS 2225.
<b>Suitably Rated Gloves</b>	Insulating gloves for electrical purposes are rated for use according to nominal working voltage. Unless otherwise specified insulating glove rating must be taken to be for a nominal working voltage of 1000V in accordance with AS 2225. (Higher voltages may be present on some pipelines). This definition must include the use of both glove liners and outer protective gloves to also give the maximum possible mechanical protection.

Term	Description
<b>Touch Voltage</b>	Touch voltage is that voltage that may be received by a person (or livestock) when in contact with the ground and a conductive part of an electrical installation that has become live, possibly due to an earth fault. Touch voltages may, in some circumstances, be hazardous.
<b>Unmitigated Pipeline</b>	A metallic pipeline, affected by induced voltages, where <b>NO</b> modifications or protective devices have been fitted to neutralise the voltages that may be present on the pipeline or its appurtenances.
<b>Work Site</b>	The working area in the immediate vicinity of an affected metallic pipeline

## 9 Compliance Mapping

Task	Legislation
Pipeline Voltage Mitigation	AS2225 Insulating Gloves for Electrical Purposes
	AS1319 Safety Signs for the Occupational Environment
	AS/NZS 4853 Electrical Hazards on Metallic Pipelines
	The Electricity Authority of NSW – Earthing Handbook 1975.

## 10 References

Doc #	Title
	Electrical Safety in Metallic Pipeline Construction
WC-OSH 024	<a href="#">Selection and Management of Contractors</a>

Document Revision History	
28 Mar 2013	Original version
22 Apr 2014	Added guidance around underground power lines, pipe banding and metallic pipeline construction. Refer to MOC #10680268.
29 March 2017	Low level review with no changes in the body of the document.
23 Jan 2019	Low level review.
12 Jul 2019	Low level review – replaced 'shall', added Nexus document number.
11 Dec 2019	Low Level Review.

### Appendix A1 Pipeline maintenance involving painting on pipelines or fittings

#### Safety Equipment Required (Appendix D)

Gloves and Liners  
Boots (damp ground only)  
Equipotential Working mats  
Non Conductive barrier

#### Specific Safety Requirements

The following mandatory requirements apply:

- Should, upon inspection, any groundwater is found to be present, or the natural soil conditions found to be such that the normal stance position required to complete the work cannot be maintained without the risk of submergence, both during work area establishment and during the normal course of works, the operator must then be required to wear additional personal protective equipment in the form of suitably rated boots.
- Under no circumstances must any work be performed whilst standing in water or partially submerged in soil (either natural or fill) without this additional protection.
- All painting tasks require the operator to wear suitably rated electrical insulating gloves
- The operator should avoid where possible making direct contact with exposed metallic pipe or appurtenances.
- No contact must occur by way of passing tools or the like by persons not wearing the appropriate personal protective equipment including suitably rated electrical insulating gloves. This must be considered imperative and under no circumstance must this be compromised.

### Appendix A2 Operating valves on pipelines, and pipeline maintenance involving water quality inspections and sampling on pipelines and their fittings

#### Safety Equipment Required (Appendix D)

Gloves and Liners  
Boots (damp ground only)

#### Specific Safety Requirements

The following mandatory requirements apply:

- Should, upon inspection, any groundwater be present, or the natural soil conditions found to be such that the normal stance position required to complete the work cannot be maintained without the risk of submergence, both during work area establishment, and during the normal course of works, the operator must then be required to wear suitably rated boots.
- It must be understood by all work party members that under no circumstances must any work be performed whilst standing in water or partially submerged in soil either natural or fill without this additional protection.
- All inspection and sampling tasks require the operator to wear suitably rated electrical insulating gloves (see Appendix E)
- All valve operation requires the operator to wear suitably rated electrical insulating gloves, underneath leather outers, that provide suitable mechanical protection. Where groundwater is present, or natural soil is found to not be stable, suitably rated insulating 'Gumboot' type work boots must also be worn.
- The operator should avoid where possible making direct contact with exposed metallic pipe or appurtenances.
- No contact must occur by way of passing tools, samples or the like by persons not wearing the appropriate personal protective equipment including suitably rated electrical insulating gloves. This must be considered imperative and under no circumstance must this be compromised.



### Appendix A3 Cathodic protection inspections and testing on underground pipelines or underground sections of aboveground pipelines with cathodic protection installed

#### Safety Equipment Required (Appendix D)

Gloves and Liners  
Boots (damp ground only)

#### Specific Safety Requirements

The following mandatory requirements apply:

- Excavation will generally not be required for this maintenance task. If surface groundwater is found to be present, or the natural soil conditions found to be such that the normal stance position required to complete the work cannot be maintained without the risk of submergence during the normal course of works, the operator must then be required to wear suitably rated boots.
- It must be understood by all work party members that under no circumstances must any work be performed whilst standing in water or partially submerged in soil either natural or fill without this additional protection.
- All cathodic protection inspections and testing requires the operator to wear suitably rated electrical insulating gloves (see Appendix E). Where groundwater is present or natural soil is found to not be stable, suitably rated insulating 'Gumboot' type work boots must also be worn.
- No contact must occur by way of passing tools or the like by persons not wearing the appropriate personal protective equipment including suitably rated electrical insulating gloves, to those in contact with the test point or equipment. This must be considered imperative and under no circumstance must this be compromised.
- AC voltage tests, with the test meter set on 1000V must be conducted to earth from the test point within test posts, where cables are directly connected to the water mains, as a precaution prior to measuring cathodic voltages.

## Appendix A4 Equipment Installation activities (including pipe banding), but not limited to hydrant installation and replacement on pipelines

### Safety Equipment Required (Appendix D)

Gloves and Liners  
Equipotential Working mats  
Non Conductive barrier

### Specific Safety Requirements

The following mandatory requirements apply:

- The work site should be excavated and exposed as required. Sufficient room must be left to safely place equipotential bonding equipment and working mats around the work site. This must be enough area to perform all anticipated works without the risk of any of the work party coming within 1m (one metre) of the edge of the equipotential working mats whilst working.
- The work site must be inspected for any groundwater and natural soil condition upon completion of the excavation and exposure. Should groundwater be found, or the natural soil conditions are such that the placement of equipotential working mats cannot be completed without the risk of submergence, both during work area establishment and during the normal course of works, procedures must be developed to ensure submergence does not occur.
- The placement of the equipotential working mats must be such that they are near as practicable but without touching any part of the pipeline.
- Mats should already have all insulated bonding conductors fitted where possible between mat sections. Equipotential working mats must be configured and be of sufficient size and or number such that all facets of the work can be performed without any part of plant, equipment work party coming within 1m (one metre) of the edge of the equipotential working mats whilst performing their required task.
- It must be ensured that an electrically continuous, mechanically durable, flexible, insulated bonding conductor of minimum cross sectional area 70 mm<sup>2</sup>, is connected between the equipotential working mats and the hot tapping device.
- No work, whether it be actual equipment installation or assisting, can be conducted without standing on the equipotential working mats, and or with an equipotential bonding conductor as described connected to the hot tapping tool. This must include, but not be limited to, any contact by way of passing tools, or the like, by persons not standing on the equipotential working mats, and not wearing suitably rated electrical insulating gloves, to persons standing on the equipotential working mats not wearing suitably rated electrical insulating gloves. This must be considered imperative and under no circumstance must this be compromised.
- The suitably rated electrical insulating gloves maybe removed to perform intricate tasks whilst ever an electrically continuous, mechanically durable, flexible, insulated bonding conductor of minimum cross sectional area 70 mm<sup>2</sup>, is connected between the equipotential working mats and the pipeline or it's fitting.
- The competent person can only expose the pipeline metallic area when all persons are wearing and using PPE, and all work party members have been informed that work is about to commence.
- To prevent persons not standing on the equipotential working mats coming in contact with persons performing the hot tapping operation, a nonconductive barrier should be placed a minimum of 2.4m from the outermost edge of the equipotential working mats/work area, with one defined means of entry/egress.
- All plant and equipment required to perform the task must be placed on the equipotential working mats prior to the connection of the hot tapping tool to the pipeline.
- No leads, cables, hoses (whether electrical, hydraulic, pneumatic) or similar are to be connected to plant or equipment not located on the equipotential working mats.

## Appendix A5 Hot Tapping Activities on Pipelines

### Safety Equipment Required (Appendix D)

Gloves and Liners  
Boots (damp ground only)  
Equipotential Working mats  
Non Conductive barrier

### Specific Safety Requirements

The following mandatory requirements apply:

- The suitably rated electrical insulating gloves may be removed to perform intricate tasks whilst an electrically continuous, mechanically durable, flexible, insulated bonding conductor, of minimum cross sectional area 70 mm<sup>2</sup>, is connected between the equipotential working mats and the pipeline. It is acceptable that this be via the hot tapping device. Should this connection need to be broken or removed, all persons standing on the equipotential working mats must be wearing the suitably rated electrical insulating gloves before this can be effected. It must be considered that all persons will wear suitably rated electrical insulating gloves whilst normal works are being conducted.
- The work site should be excavated and exposed as required. Sufficient room must be left to safely place equipotential bonding equipment and working mats around the work site. This must be enough area to perform all anticipated works without the risk of any of the work party coming within 1m (one metre) of the edge of the equipotential working mats whilst working.
- The work site must be inspected for any groundwater and natural soil condition upon completion of the excavation and exposure. Should groundwater be found, or the natural soil conditions are such that the placement of equipotential working mats cannot be completed without the risk of submergence, both during work area establishment and during the normal course of works procedures must be developed to ensure submergence does not occur.
- The placement of the equipotential working mats must be such that they are near as practicable, but without touching any part of the pipeline.
- Mats should already have all insulated bonding conductors fitted, where possible, between mat sections. Equipotential working mats must be configured, and be of sufficient size and or number, such that all facets of the work can be performed without any part of plant, equipment or work party coming within 1m (one metre) of the edge of the equipotential working mats whilst performing their required task.
- When hot tapping, it must be ensured that an electrically continuous, mechanically durable, flexible, insulated bonding conductor, of minimum cross sectional area 70 mm<sup>2</sup>, is connected between the equipotential working mats and the hot tapping device.
- No work whether it be actual equipment installation, or assisting, can be conducted without standing on the equipotential working mats and/or with an equipotential bonding conductor, connected to the hot tapping tool. This must include, but not be limited to, any contact by way of passing tools or the like by persons not standing on the equipotential working mats, and not wearing suitably rated electrical insulating gloves, to persons standing on the equipotential working mats not wearing suitably rated electrical insulating gloves. This must be considered imperative and under no circumstance must this be compromised.
- The suitably rated electrical insulating gloves maybe removed to perform intricate tasks whilst an electrically continuous, mechanically durable, flexible, insulated bonding conductor, of minimum cross sectional area 70 mm<sup>2</sup>, is connected between the equipotential working mats and the pipeline or it's fitting.
- Hot tapping to the pipeline can only commence once all persons are aware of the hazard controls and work scope.

- The competent person can only expose the pipeline metallic area when all persons are wearing and using PPE, and all work party members have been informed that work is about to commence.
- To prevent persons not standing on the equipotential working mats coming in contact with persons performing the hot tapping operation, a non-conductive barrier should be placed a minimum of 2.4m from the outermost edge of the equipotential working mats/work area, with one defined means of entry/egress.
- No persons must step on or off the mats while the hot tapping device is in contact with the pipeline.
- All plant and equipment required to perform the task must be placed on the equipotential working mats prior to the connection of the hot tapping tool to the pipeline.
- No leads, cables, hoses (whether electrical, hydraulic, pneumatic) or similar are to be connected to plant or equipment not located on the equipotential working mats.

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## Appendix A6 Maintenance of air and section valves on pipelines

### Safety Equipment Required (Appendix D)

Gloves and Liners  
Boots (damp ground only)

**Note:** Most valve maintenance is simply to test that the operation of the valve is satisfactory (See Appendix 2). It is only if a problem is found with the valve operation, that maintenance or valve replacement is done.

### Specific Safety Requirements

The following mandatory requirements apply:

- Where possible, the fitting must be surrounded by equipotential working mats. In all cases, equipotential working mats must be placed as near as practicable, but without touching any part of the pipeline or valve arrangement.
- No works can be conducted without standing on the equipotential working mats, and/or with an equipotential bonding conductor connected to the hot tapping tool.
- Work can only commence when all persons are informed, and fully understand, the pre work risk assessment, hazards, importance of control measures, work scope and all previously mentioned conditions.
- The work site should be excavated and exposed as required. Sufficient room must be left to safely place equipotential bonding equipment, and working mats, around the work site. This must be enough area to perform all anticipated works without the risk of any of the work party coming within 1m (one metre) of the edge of the equipotential working mats whilst working.
- The work site must be inspected for any groundwater and natural soil condition upon completion of the excavation and exposure. Should groundwater be found, or the natural soil conditions are such that the placement of equipotential working mats cannot be completed without the risk of submergence, both during work area establishment and during the normal course of works, procedures must be developed to ensure submergence does not occur.
- The placement of the equipotential working mats must be such that they are near as practicable, but without touching, any part of the pipeline.
- Mats should already have all insulated bonding conductors fitted where possible between mat sections. Equipotential working mats must be configured and be of sufficient size, and or number, such that all facets of the work can be performed without any part of plant, equipment, or work party coming within 1m (one metre) of the edge of the equipotential working mats whilst performing their required task.
- It must be ensured that an electrically continuous, mechanically durable, flexible, insulated bonding conductor, of minimum cross sectional area 70 mm<sup>2</sup>, is connected between the equipotential working mats and the hot tapping device.
- No work, whether it be actual equipment installation or assisting, can be conducted without standing on the equipotential working mats. This must include, but not be limited to, any contact by way of passing tools or the like, by persons not standing on the equipotential working mats, and not wearing suitably rated electrical insulating gloves, to persons standing on the equipotential working mats not wearing suitably rated electrical insulating gloves. This must be considered imperative and under no circumstance must this be compromised.
- The suitably rated electrical insulating gloves maybe removed to perform intricate tasks whilst an electrically continuous, mechanically durable, flexible, insulated bonding conductor, of minimum cross sectional area 70 mm<sup>2</sup>, is connected between the equipotential working mats and the pipeline or it's fitting.
- The competent person can only expose the pipeline metallic area when all persons are wearing and using PPE, and all work party members have been informed that work is about to commence.

- To prevent persons not standing on the equipotential working mats coming in contact with persons performing the hot tapping operation, a non-conductive barrier should be placed a minimum of 2.4m from the outermost edge of the equipotential working mats/work area, with one defined means of entry/egress.
- All plant and equipment required to perform the task must be placed on the equipotential working mats prior to the connection of the mats to the pipeline.
- No leads, cables, hoses (whether electrical, hydraulic, pneumatic) or similar are to be connected to plant or equipment not located on the equipotential working mats.

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## Appendix B Affected Pipelines

Listed are pipelines that have been analysed (i.e. affected) and mitigated, and analysed and not mitigated, for which this procedure is applicable. It should be noted that this list is current at time of writing but should be reviewed and updated as required.

Region	Pipeline	Affected & Mitigated	Affected & Not Mitigated	Pipeline Route
Metro	Stirling to Tamworth TM		Yes	
Metro	Stirling TM Duplication		Yes	
Metro	Harris Dam to Stirling catchment		Yes	
Metro	Wungong	Yes		
Metro	Aubin Grove (Lyon Rd) DM	Yes		
Metro	Banksia–Pinjar Rd (Wann Res to Clarkson Av)	Yes		
Metro	Benara Rd DM	Yes		
Metro	Gnangara Rd TM & Bore Main	Yes		
Metro	Hammond Rd DM, Success	Yes		
Metro	Henderson Rd DM	Yes		
Metro	Samson TM		Yes	
Metro	Serpentine Canning Link Main		Yes	
Metro	Kwinana to Thompson Res (Perth Desal)	Yes		
Metro	Southern Seawater Desal Plant	Yes		
Metro	Toodyay BH Extension	Yes		
MWR	Walkaway	Yes		
SWR	Harris Dam to Williams (CollieRd "T" only)	Yes		
GAR	Kalgoorlie Inlet Main, Bindulli	Yes		
NWR	Karratha Tanks 1&2 pipe duplication		Yes	
NWR	Pt Hedland to Sth Hedland DN380 Lot 954 to Lot 2519		Yes	

**Note:** The above pipeline list is interim until a permanent list is developed and published on the Corporation Waternet. The spreadsheet will include all pipelines that have been analysed and mitigated, and analysed and not mitigated. Links to Reports, Drawings and Maintenance requirements and other relevant data will be available. Until so published, all queries are to be directed to the Principal Electrical Engineer (Power), IDB, before maintenance or modification work is commenced on any affected pipeline.

## Appendix C Voltage Mitigation Standard

### AS/NZS 4853:2012 Electrical Hazards on Metallic Pipelines

The pipeline irrespective of its size, function or location must be identified and classified as either mitigated or unmitigated. This will determine which Procedure must be used for the work to be performed.

Pipelines investigated for hazardous voltages to AS/NZS 4853:2000 apply Category "A" touch voltage limits for safety.

Pipelines investigated for hazardous voltages to the updated Standard AS/NZS 4853:2012 (released March 2012) apply an approach to derive touch voltage limits based on the data in AS/NZS 60479.1 relating to the effects on human beings. Safe touch voltage limits will vary from project to project.

During pipeline construction and maintenance, Clause 5.6 of AS/NZS 4853:2000 states that Category A voltage limits are to apply. So, at sites where the pipeline is exposed for maintenance, touch voltages are to be limited to Category A during both normal load and single phase to earth fault conditions.

#### Inductive Coupling

Pipelines located in transmission line easements are subject to induced potentials due to the large magnetic and electric fields associated with high-voltage energy transmission. During normal load conditions, magnetically induced pipe potentials are relatively small compared to those present during earth fault conditions. This low pipe potential can be explained by considering the magnetic fields surrounding transmissions lines feeding balanced three-phase loads.

During normal load, line currents are much less than during fault conditions. Since magnetic flux density is proportional to current, the amount of magnetic coupling and hence the induced pipeline potential is lower. Also during normal load conditions, line currents are more or less balanced with a relative phase difference of 120°. The magnetic fields surrounding each line therefore have similar phase differences. These balanced magnetic fields tend to cancel and the resultant magnetic field induces significantly lower pipeline potentials.

Any small residual pipeline potential is due to the incomplete cancellation of the magnetic fields because of slightly unbalanced line currents and the unequal distance between each transmission line phase conductor and the pipeline.

During single phase to earth faults, one of the three phases carries a large fault current while the other two phases carry zero current. Due to the large magnitude fault current and the associated large current imbalance, single phase to earth faults represent the worst-case fault scenario. That is, the induced pipeline potential is a maximum for single phase to earth faults.

#### Conductive Coupling

When phase to earth faults occur at transmission line towers, large currents are injected into the soil through the tower's earthing systems thus raising the potential of the surrounding soil. Any well-insulated and remotely earthed pipeline that is located near the faulted tower will remain at a relatively low potential. If the pipeline fitting is unearthed at this location, large touch voltages are possible due to the potential difference between the soil and the pipeline metal.

#### Capacitive Coupling

Pipelines suspended above the earth underneath high voltage transmission lines are subject to capacitive coupling. Capacitive coupling is the result of the suspended pipe section intercepting a small portion of the current that usually flows to earth via the phase conductor shunt capacitance. If the pipeline sections are suspended via high impedance structures, such as vehicles with insulating tyres or dry wood or concrete skids, the suspended pipeline will re-transmit this current to earth via its own shunt capacitance. Since this shunt capacitance appears as a very high shunt impedance, the voltage on the pipeline section can be very high. A person touching the suspended pipeline section provides a much lower resistance path to earth and is therefore subject to hazardous voltages and currents.



## Appendix D Equipment

### Electrical Insulating Gloves:

Gloves to be rated for appropriate working voltage in compliance with AS2225. (Note: The working voltage will vary with pipeline affected – See pipeline database for details)

(a) Voltage Rated Gloves



(b) Voltage Rated Gloves



(c) Glove Liners



(d) Protective Gloves



### Electrical Insulating Boots:

Boots to be 1,000 volts rated working voltage in compliance with DIN 4843.



## Equipotential Working Mats

All mats are to be constructed of cross meshed galvanised mild steel or aluminium. The mat is to have fixed to it a 2 metre x 35sq.mm earthing lead with a heavy duty spring clamp for clipping onto the metallic surface of the pipe (which will have an attachment point welded to the pipe material).



See below for guidance on the use of interconnected, or multiple mats.

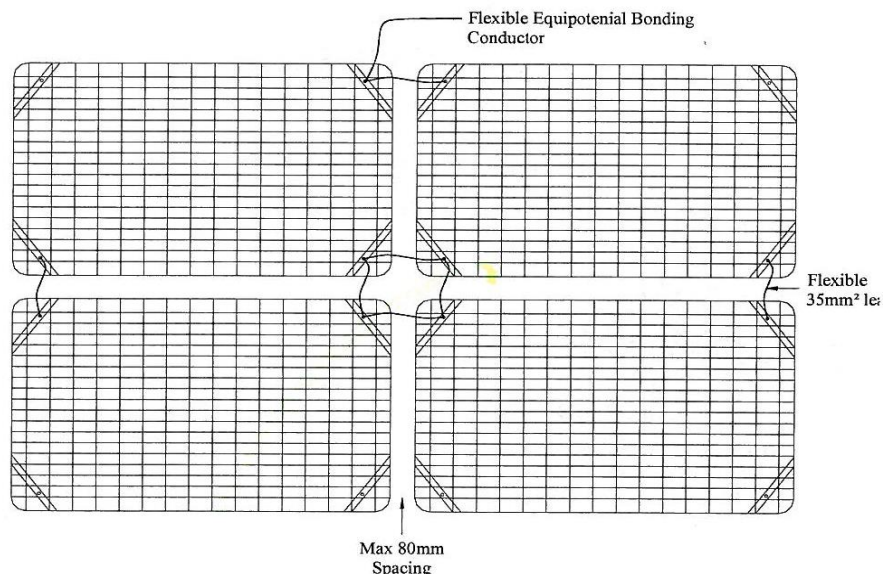
Equipotential working mats are available in Western Australia (manufactured to order) from Unitest Instruments, U4/9 Vale Street, Malaga WA. Website is [www.unitest.com.au](http://www.unitest.com.au). Ph: 9248 8601. The approximate price for a standard 800mm x 600mm mat is \$400. An MMR has been organised, so quoting number MMR 21107 at either the Canning Vale or Balcatta Stores (5 mats will be held at each store) will be required to acquire mats for any project.

**Note:** Personnel using equipotential working mats are advised that work is not to proceed where groundwater is present and/or natural soil conditions result in the mat being submerged.

If any groundwater is found to be present, its origin must be determined and dammed to prevent further groundwater ingress. In addition any existing and by chance future unplanned water ingress must be able to be removed by means of pumping or the like to ensure that the work area is as dry as practicable. Soil materials suitable to provide a stable base must be installed in the work area or trench prior to installation of any equipotential working mats to avoid such submergence. It must be understood by all work party members that under no circumstances must any work be performed whilst standing in water or with equipotential working mats submerged in natural soil or fill.

### Use of Multiple Mats

Where multiple mats are used, they are to be spaced no more than 80mm apart (maximum) and connected to each other via a 35mm green and yellow PVC flexible insulated conductor.



## Non-Conductive Barriers

### Non Conductive Barrier



## Warning Signage

Warning signage must be selected and sized so as to warn all persons that a work area has been established and that authorisation to access the work area is required.



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**Appendix E Extract from AS2225 – 1994 (Appendix C)****RECOMMENDATIONS CONCERNING THE STORAGE, ISSUE, EXAMINATION BEFORE USE AND PRECAUTIONS IN THE USE OF GLOVES****C1 STORAGE**

Gloves should be stored unfolded, right side out, not distorted and not stored directly above, or in the proximity to, steam pipes, radiators and other sources of artificial heat. Gloves should not be exposed to direct sunlight or other sources of ozone. It is desirable that the ambient storage temperature should not exceed 35°C. Gloves that have been issued for service but which are not in use, should be dusted with talc and kept in containers used solely for that purpose or in a place where they will not be subject to mechanical and chemical damage.

**C2 ISSUE**

Gloves intended for electrical line workers and other outdoor workers should be issued in a protective container, free from grease and oil, and suited to the class of work for which they will be used. Canvas or leather bags that can be attached to a linesman's belt are suitable for overhead line work. Fibre boxes are appropriate when gloves need to be kept in tool boxes. Gloves issued for emergency use only should be kept in waterproof containers.

**C3 EXAMINATION BEFORE USE**

Before use, gloves should be visually inspected for cuts, tears, perishing and distortion. Gloves should be pressure tested for pinholes by sealing the entry to the glove and compressing the air trapped within by rolling the glove on itself. Loss of air indicates that the glove is defective. Gloves found to be defective should not be used.

**C4 PRECAUTIONS IN USE**

Care should be taken to avoid mechanical damage caused by abrasion or sharp edges. Gloves should not be exposed unnecessarily to heat or light or allowed to come into contact with solvents, oils or other chemical agents. If other protective gloves are used at the same time as insulating gloves for electrical purposes, they should be shorter than, and worn over, the insulating gloves. If the outer protective gloves become damp, oily or greasy, they should be removed. They should also be removed from the insulating gloves when the latter are not in use. Care should be taken in the selection of other protective gloves, when used in conjunction with insulating gloves for electrical purposes, to ensure that they do not negate the insulation properties of the electrical insulating gloves.

When insulating gloves become soiled, they should be cleaned in accordance with the recommendations of the glove manufacturer.