### WI58 ARC FLASH HAZARD ASSESSMENT & PPE SELECTION

<table>
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<tr>
<th>PURPOSE</th>
<th>SCOPE</th>
<th>RESPONSIBILITIES</th>
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<tbody>
<tr>
<td>The purpose of this work instruction is to provide detailed direction to workers approaching and accessing all LV and HV electrical equipment for either operational or maintenance activities to ensure adequate steps for personal protection from possible electrical arc flash and touch voltages are taken into account.</td>
<td>This work instruction applies to all employees and contractors of QUU undertaking activities on or near live LV or HV electrical equipment. This document excludes work on ELV equipment as ELV is not considered a hazardous voltage level to personal safety.</td>
<td>It is the responsibility of the person/s coordinating and performing the tasks to ensure the directions outlined in this work instruction are followed, all pre start checks are carried out prior to commencing works.</td>
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<table>
<thead>
<tr>
<th>TRAINING/COMPETENCY</th>
<th>DEFINITIONS/ ACRONYMS</th>
<th>DEFINITIONS</th>
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</table>
| QUU authorised staff with training and competencies for task being completed and as identified in the WRAP process. | AC – Alternating Current  
cal – Calorie  
cm – centimetre  
CB- Circuit Breaker  
DC – Direct Current  
ESR – Electrical Safety Regulations  
mA – milliamp  
mm – millimetre  
O&M – Operations and Maintenance  
PSA – Power System Analysis  
SWMS – Safe Work Method Statement | ELV – Extra Low Voltage: Not exceeding 50 volts AC or 120 volts ripple free DC  
LV – Exceeding ELV but not exceeding 1,000 volts AC or 1,500 volts DC.  
HV – Exceeding low voltage  
Switchboard – An electrical enclosure containing circuit breakers, and other switchgear components and an example is a distribution board.  
Control Panel – electrical enclosure with a single phase 240 volt AC, 30mA RCD protected main incoming supply rated at 32A or less.  
Electrical Equipment: Generally includes switchboards, control panels, |
Generators – refer to permanently installed or mobile LV diesel generators typically used for emergency power supply when the utility supply to the site is unavailable.

Standard PPE includes:

- Hard hat
- Safety boots
- Long sleeve shirt and trousers
- High visibility shirt or vest

All PPE shall comply with PRO424 PPE Standard Operating Procedure.

WRAP – QUU worksite risk assessment process

RELATED DOCUMENTS

<table>
<thead>
<tr>
<th>NFPA 70E 2015</th>
<th>PRO4 – QUU Event Escalation Guidelines</th>
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<tr>
<td>IEEE 1584</td>
<td>PRO424 - Personal Protective Standard Operating Procedure</td>
</tr>
<tr>
<td>MP71 - Electrical Safety Management System</td>
<td>WI55 Mobile Generator Connection and Disconnection</td>
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<tr>
<td>SWMS 27 - Electrical Testing SWMS</td>
<td>RE025800-RPT-001 – Arc Flash Risk Assessment Workshop 1&amp;2 Report</td>
</tr>
<tr>
<td>PRO379 – Energy Lock Out Tag Out</td>
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<tr>
<td>PRO450 - Electrical Safety Standard Operating Procedure</td>
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</table>

FOR553 Worksite Risk Assessment Process WRAP
1. PERSONAL PROTECTIVE EQUIPMENT

As identified in this work instruction and the QUU WRAP process
2. FLOWCHART

Figure 1 ARC FLASH HAZARD ASSESSMENT & PPE SELECTION

If an issue occurs during the course of this work please refer to QUU PRO4 – Escalation Guidelines for details on how to escalate events.
### 3. INSTRUCTION

**Table 1 Arc Flash Hazard Assessment and PPE Selection**

<table>
<thead>
<tr>
<th>STEP</th>
<th>INSTRUCTION</th>
<th>SAFETY/ENVIRONMENT/KEY MESSAGES</th>
</tr>
</thead>
</table>
| Step 1  
Determine activity to be undertaken | • From the job planning process determine the type of activities that need to be undertaken to complete the tasks  
• Select the activities to be undertaken, the highest risk consequence and applicable PPE from Appendix A. | **Incident Energy**: The amount of (arc) energy at the working distance from a potential arc flash. It is calculated using a set of formulae from IEEE 1584. The incident energy is expressed as cal/cm².  
**Working Distance**: The distance between the arc source and the workers body (face and torso). The arc flash incident energy is calculated at the specified Working Distance and for an LV switchboard is typically 455mm and for a HV switchboard is typically 910mm.  
**Arc Flash Boundary**: The distance from the switchboard or generator enclosure containing live voltage components, greater than Extra Low Voltage at which a person could receive a curable burn (2nd degree burn). |
| Step 2  
Undertake WRAP | • Complete WRAP process | • Identify risks, controls and standard operating procedures. |
<table>
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</tr>
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<tr>
<td>Step 3 Identify arc flash incident energy level at the equipment</td>
<td>• Upon arrival at site locate any Arc Flash labels. Refer to Appendix B for arc flash labels and locations at the equipment.</td>
<td>• Arc Flash labels are being introduced across all QUU sites. Not all sites may have arc flash labels installed yet. • Refer to the PSA Report for the site if further information is required on the arc flash PPE category ratings of individual switchboards if more than one switchboard is at the site. • Reconfirm WRAP and update as required • Ensure all switchboard and control panel access door locks and latches on escutcheons are in the closed and locked positions if not required to be open for the work task.</td>
</tr>
<tr>
<td>STEP</td>
<td>INSTRUCTION</td>
<td>SAFETY/ENVIRONMENT/KEY MESSAGES</td>
</tr>
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</table>
| Step 4. Determine PPE required from site labels and WRAP process | • The arc flash label at the equipment nominates the arc flash PPE categories required for specific tasks.  
• The arc flash label nominates the minimum PPE items required for each PPE Category 0, 2 and 4  
• Should there be no arc flash labels installed at the equipment, then use minimum level Category 2 PPE for all tasks that require access to the inside of the equipment while energised. This is applicable with the escutcheon panel open or other access doors open and when within 1.5m of the enclosure.  
• Standard QUU PPE is accepted for undertaking tasks with all equipment doors locked closed and all removable covers fixed in place while energised.  
• When an emergency generator is connected to a switchboard and is running the PPE Category required to access the switchboard may be different to when the switchboard is fed from Energex normal supply.  
• When the generator is operating refer to the arc flash label at the generator main control compartment for PPE required for each task to be performed on the generator and the switchboards connected to the generator.  
• A portable hired generator may not have arc flash labels provide and in this case refer to Appendix D of this work instruction when accessing the generator and live switchboards fed from the generator. | • Record PPE decision on WRAP  
• The safety observer must wear an equivalent level of PPE should a rescue need to be carried out in proximity to the equipment being accessed  
• From Appendix A of this work instruction select the QUU approved PPE.  
• For LV switchboards and generators that are properly installed and maintained by qualified persons there is minimal risk to persons external to the equipment during operation i.e. with the switchboard escutcheon panel securely closed (escutcheon front access door open) and all other access doors locked closed and removable covers secured in place.  
• A person may wear standard QUU PPE to operate pushbuttons or access meters on an LV switchboard with the escutcheon panel securely closed and all other doors locked close. This will be indicated on the Type 3 arc flash label with doors closed for control/monitoring task.  
• A person need only wear standard QUU PPE to enter a switchroom containing only LV switchboards that have all the energised switchboards with access doors locked closed and all removable covers fixed in place.  
• To operate equipment such as pushbuttons or other equipment on a HV switchboard arc rated PPE shall be worn as per the Category specified for the task on the arc flash label fixed to the HV switchboard.  
• To access a switchroom containing HV equipment including HV switchboards and transformers a person shall wear PPE as indicated on the Type 1 label fixed to the exterior of the switchroom access doors. |
### Step 5: Undertake Job

- This completes the Arc Fault Hazard Assessment and PPE Selection; continue with standard work instructions and procedures to complete the job safely.

### Safety/Environment/Key Messages

- When performing switching and other tasks on energised LV or HV equipment all other persons shall remain outside the arc flash boundary of the equipment.
- Plant operators are permitted to perform process isolations on LV equipment and shall comply with this work instruction.
- Monitor activities. Should the activities increase or be modified, review WRAP and modify risks accordingly.
- Consider if the new risk profile changes existing risk profile from the activities change the hazard category.
- Report any hazards or incidents following QUU hazard and reporting process.
- Ensure all equipment access doors are locked closed and all removable covers are fixed in position on completion of the works.
- This completes the assessment.
### Appendix A – PPE for Arc Flash Hazard Category

<table>
<thead>
<tr>
<th>Hazard Category</th>
<th>Rating</th>
<th>PPE</th>
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</table>
| 0               | <=1.2 cal/cm² | • Untreated natural fibre long sleeve shirt and long pants or coveralls  
|                 |        | • Hard Hat  
|                 |        | • Arc rated face shield with chin cup  
|                 |        | • Safety glasses or safety goggles  
|                 |        | • Hearing protection (ear canal inserts)  
|                 |        | • Work wear gloves heavy duty leather*  
|                 |        | • Heavy duty leather work shoes or safety boots  
|                 |        | *Rated to the highest voltage level in proximity to worker |
| 2               | <= 8 cal / cm² | • Arc rated long sleeve shirt and pants or arc rated coveralls with minimum arc rating of 8 cal/cm² OR overcoat with a minimum arc flash rating of 8 cal/cm²  
|                 |        | • Hard hat  
|                 |        | • Safety glasses or safety goggles  
|                 |        | • Hearing protection (ear canal inserts)  
|                 |        | • Rubber insulated work wear gloves* with leather protectors  
|                 |        | • Arc rated face shield with chin cup  
|                 |        | • Arc rated balaclava  
|                 |        | • Heavy duty leather work shoes or safety boots  
|                 |        | *Rated to the highest voltage level in proximity to worker |
| 4               | <= 40 cal / cm² | • Arc flash suit with minimum arc rating of 40 cal/cm² consisting of:  
|                 |        | • Arc flash suit, hood/face shield  
|                 |        | • Arc flash shirt/coat  
|                 |        | • Arc flash pants/coveralls  
|                 |        | • Hard hat  
|                 |        | • Safety glasses or safety goggles  
|                 |        | • Hearing protection (ear canal inserts)  
|                 |        | • Rubber insulated work wear gloves* with leather protectors  
|                 |        | • Heavy duty leather work shoes or safety boots  
|                 |        | *Rated to the highest voltage level in proximity to worker |
| DANGEROUS       | > 40 cal / cm² | Strictly no live access to generators and switchboards while energised. There is no PPE available that can offer adequate protection to an arc flash incident energy exceeding 40 cal/ cm². |
### Appendix B Arc Flash Signage Labels

<table>
<thead>
<tr>
<th>Label</th>
<th>Location</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arc Flash Label - Type 1</td>
<td>The arc flash label Type 1 shall be fixed to the switchroom building access doors at QUU facilities where the equipment contained in the switchroom is operated at high voltage.</td>
<td><img src="attachment" alt="Image" /></td>
</tr>
<tr>
<td></td>
<td>A Type 1 label shall be installed on access gates of security fences around outdoor electrical equipment where the equipment contained within the fence is operated at high voltage.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A Type 1 label will NOT be displayed where the switchroom or fenced area only contains LV switchboards and/or control panels.</td>
<td></td>
</tr>
</tbody>
</table>
### Arc Flash Label - Type 2

A Type 2 label shall be fixed to the exterior of the front access door of the common control compartment on all indoor LV switchboards. The same applies for outdoor switchboards not accessible by general public i.e. site has security fence and locked access gates.

The Type 2 label shall be fixed to the outdoor switchboard escutcheon at the common control compartment where switchboard can be accessed by the general public.

Note the label will not be visible without opening the front door to access the escutcheon panel.

### Arc Flash Label - Type 3

Same fixing rules and location applies as for Type 2 labels. Type 3 label is fixed adjacent and nearby the Type 2 label.

A Type 3 label shall generally be fixed to electrical equipment including switchboards, distribution boards, generators and control panels.

Control panels with single phase 240VAC supply not exceeding 32A do not require a Type 3 label installed.
| Arc Flash Label - Type 4 | Switchboards that can be accessed by the general public shall have a Type 4 label installed on the front door of the main control compartment. This mainly applies to outdoor switchboards not contained within security fenced sites.  
Indoor switchboards are generally located in locked switchroom building and are not accessible to the public and do not require a Type 4 label.  
The Type 2 and 3 arc flash labels will generally be installed on the escutcheon behind the front door with the Type 4 label. |
|---|---|
| Arc Flash Label - Type 5 | LV Switchboards and control panels fed from a 240 volt AC single phase main supply rated at 32A or less are considered to have negligible risk to arc flash hazard. These enclosures have a Type 5 label fixed to the exterior surface of the front access door. Persons can access the energised enclosure with standard PPE and safety glasses and must follow SWMS27 for testing works.  
A face shield is accepted in lieu of wearing safety glasses. |
| Arc Flash Label - Type 6 | Switchboards and generators that have arc flash incident energy exceeding 40 cal/cm² are declared Dangerous and no access to live components is permitted. This means access doors must not be opened and covers not removed while the switchboard is energised.

Switching and isolations must be performed upstream at a location that does not have a Dangerous incident energy level. If switching and isolations are required at a Dangerous switchboard then a site specific risk assessment for the works approved by QUU is required.

Note: Access to the Dangerous switchboard escutcheon is permitted while the switchboard is energised with standard PPE. All other tasks required while the switchboard is live require a site specific risk assessment for the tasks proposed and must be approved by QUU. |
Appendix C – Arc Flash PPE Risk Assessment

For work activities on LV electrical equipment which stipulate PPE Category 0 it is accepted to undertake a risk assessment to relax the requirement for some items of PPE. The following items can only be omitted from PPE Category 0 where supported by risk assessment and where it is considered not practical to perform the tasks effectively while wearing the items:-

- Arc rated face shield with chin cup
- Hearing protection (ear canal inserts)
- Work wear gloves heavy duty leather can be substituted with rubber arc rated gloves for specific tasks

For work activities on equipment classified as PPE Category 2 or 4 a risk assessment is NOT accepted to relax the PPE requirements stated on the arc flash labels for the specific equipment. A risk assessment is also NOT accepted to relax the PPE required to perform all tasks on HV switchboards.
Appendix D - Generators

When a generator is connected and operating at the site the arc rated PPE category and arc flash boundary in Table 1 is applicable to access the generator and ALL switchboards fed from the generator at the site. This includes sub boards fed from the main switchboard.

The Type 3 label at the generator shall take precedence over all other Type 3 labels installed on other equipment when the generator is connected and operating.

Where a Type 3 label is not provided on a generator the PPE category and arc flash boundary shall be determined using Table 1.

Table 1 Generator PPE Category

<table>
<thead>
<tr>
<th>Generator Rating</th>
<th>PPE Category</th>
<th>Arc Flash Boundary (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;=30kVA</td>
<td>0</td>
<td>0.3</td>
</tr>
<tr>
<td>&gt;30kVA and &lt;=320kVA</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>&gt;320kVA and &lt;=500kVA</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>&gt;500kVA and &lt;=800kVA</td>
<td>4</td>
<td>2.5</td>
</tr>
<tr>
<td>&gt;800kVA and &lt;=1250kVA</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>1500kVA</td>
<td>4</td>
<td>3.5</td>
</tr>
</tbody>
</table>

The information in Table 1 is applicable for all tasks performed at the generator and switchboards fed from the generator.

Standard PPE is accepted for control/monitoring tasks at an operating generator and energised switchboards when all access doors are locked closed and enclosure covers are securely fixed in place.

For generators exceeding 1500KVA refer to the site specific PSA report for PPE category and arc flash boundary distances.
Appendix E - Application Examples of Work Instruction WI58

Example 1 An electrician approaches an LV switchboard located outdoors at a pump station to attend to a fault. The electrician has a task to perform fault finding on the switchboard panel. A Type 1 label is not displayed on the site access front gate and the electrician enters the site only wearing standard QUU PPE. The electrician opens the front door to the main control panel and identifies the Type 2 and 3 arc flash labels fixed to the escutcheon. The Type 3 label indicates Category 2 PPE is required for opening doors and performing electrical works. The electrician wears Cat 2 PPE for the duration of the work while accessing the switchboard while it is live with doors open. Note the electrician can avoid wearing arc rated PPE and only required to use standard QUU PPE if isolation of the switchboard can be done by removing the Energex fuses feeding the switchboard.

Example 2 An operator approaches an LV switchboard located indoors at a pump station to reset a fault. There is no Type 1 label on the pump station access door so operator can enter the building with only standard QUU PPE. The operator approaches the switchboard and identifies the arc flash labels Type 2 and 3 on the exterior of the front door of the main control compartment. The Type 3 label indicates the switchboard requires PPE Category 0 for all tasks with doors open and for the control/monitor tasks with doors closed the Type 3 label indicates standard QUU PPE. The operator is only wearing standard PPE and so can reset the fault using the pushbutton on front of the switchboard. The operator can perform any control/monitoring task from the main control escutcheon while wearing standard PPE as long as all other switchboard access doors are locked closed and covers fixed in place.

Example 3 A control systems engineer requires access to an LV enclosure containing PLC processor, I/O cards and other control equipment. The enclosure is outdoors and the site is not fenced to restrict access by the public. The engineer identifies a Type 5 arc flash label on the external front door of the enclosure. The Type 5 label allows access to the energised enclosure by opening the front doors and requires the engineer to wear QUU standard PPE and safety glasses. Enclosures fed from a single phase 240VAC supply rated at 32Amps and less will be provide with an Arc Flash Type 5 labels and this is applicable at all QUU facilities.

Example 4 An electrician approaches an LV switchboard located outdoors at a sewerage pump station that is being fed from an emergency temporary installed generator. The electrician has a task to perform fault finding on the switchboard panel and/or generator. The electrician locates the Type 4 arc flash label on the front of the switchboard main control compartment. The electrician opens the front door to the switchboard main control panel compartment and identifies the Type 2 and 3 arc flash labels fixed to the escutcheon. The Type 3 label indicates Category 0 PPE is required for opening doors and performing electrical works. The switchboard is currently fed from a generator and the electrician must check the Type 3 label on the exterior of the generator’s main control compartment door. This generator Type 3 label calls for Category 2 PPE for all tasks with generator access doors open and when switchboards are fed from the generator. This label has precedence over the other Type 3 label at the switchboard main control compartment only when switchboard is fed from a generator. The electrician wears Cat 2 PPE for the duration of the work when accessing the switchboard with doors open and while it is energised by the generator.
Note the electrician can avoid wearing arc rated PPE items and can use standard PPE if isolation of the switchboard can be done by removing the Energex fuses and isolating at the generator on board CB.
If the electrician requires to access the generator while energised then he must wear Category 2 PPE. If all doors are locked closed on the generator then the electrician is only required to wear standard PPE to perform control/monitoring tasks at the generator.

**Example 5** An electrician approaches a HV switchboard located in a switchroom to check status of the HV switchgear and read the digital displays on the power meter and the protection relays. There is a Type 1 label on the switchroom access door so electrician must comply with the PPE stated on the label to enter the switchroom. The electrician approaches the energised switchboard and identifies the arc flash labels Type 2 and 3 on the front door of the main control compartment. The Type 3 label indicates the switchboard requires PPE Category 0 for all tasks for the control/monitor tasks with doors closed. The electrician strictly complies with all PPE items required for touching and inspecting the switchgear, protection relay and power meter.

**Example 6** A control systems engineer requires access to an indoor LV switchboard containing PLC processor, I/O cards and other control equipment for fault finding. The switchboard is located in a switchroom with a Type 1 label on the switchroom access door. The engineer complies with the Type 1 PPE and enters the switchroom and then identifies a Type 2 and 3 arc flash labels on the external front door of the switchboard. The Type 3 label calls for PPE Category 2 for all activities with doors open and this includes access to the PLC control compartment. The engineer must wear Category 2 PPE items for all tasks while the switchboard is energised and doors are open. If all doors and escutcheon panels are locked closed the Type 3 arc flash label will indicate that the engineer can control/monitor the switchboard pushbuttons and displays with standard PPE.

**Example 7** An electrician approaches an LV switchboard with a Type 6 Dangerous Arc Flash Label to perform some site isolations. The electrician is permitted to control/monitor equipment from the switchboard escutcheon with the main control compartment door open to access the escutcheon. For this task standard PPE is required. No other tasks are permitted including opening doors or removing covers while the switchboard is energised. The switchboard must be isolated upstream before any switching is performed at the Dangerous switchboard or if any access doors are to be opened or covers to be removed. If isolations are required to be performed or if access is required to components contained within the energised Dangerous switchboard then a site specific risk assessment for the tasks is required to be approved by QUU.