

## 1. SCOPE

This section of the Live Working Manual details the procedures to be followed when working on alkaline or acid substation batteries of any type or voltage. It also covers work on or near to battery charging **Apparatus** that is **Live**.

All work on substation batteries shall be considered **Live** work.

The procedures apply the principles established by the ScottishPower Safety Rules (Electrical and Mechanical) to achieve **Safety from the System** and in particular OPSAF-10-012 (PSSI 12) - Low Voltage Apparatus.

This document does not cover any work carried out on batteries supplying overhead pole mounted **Apparatus**, or telecommunication and tele-control equipment eg. RTU batteries.

## 2. ISSUE RECORD

This is a **Reference** document. The current version is held on the EN Document Library.

**It is your responsibility to ensure you work to the current version.**

Issue Date	Issue No	Author	Amendment Details
March 2018	3	Dave Naylor Mark Brookman	Major update. Now includes dry cells and work on chargers.

## 3. ISSUE AUTHORITY

Author	Owner	Issue Authority
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## 4. REVIEW

This is a **Reference** document which has a 5 year retention period after which a reminder will be issued to review and extend retention or archive.

## 5. DISTRIBUTION

This document is part of the Live Working Manual but does not have a maintained distribution list.

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## 7. REFERENCE OR RELATED DOCUMENTS

Health, Safety & Environmental Handbook  
OPSAF-10-012 (PSSI 12) **LV** Apparatus  
BATT-12-001 Ancillary Plant: Batteries and Chargers

## 8. DEFINITIONS

Terms printed in bold type are as defined in the Scottish Power Safety Rules (Electrical and Mechanical).

## 9. ASSESSMENT

All work on or so near **Live** exposed **LV** conductors that **Danger** may arise requires assessment before the commencement of work to ensure that **Danger** is managed during the course of the work. This assessment will be carried out by a suitably **Authorised Person** who holds the appropriate authorisation to undertake the work. Note that battery systems are unique in that it is not possible for them to be **Isolated** in order to remove electrical **Danger**.

In all cases, as part of the assessment, **Apparatus** shall be subjected to a visual inspection prior to the start of any work to ensure that **Danger** will not arise due to the condition of the **Apparatus**. Refer to document BATT-12-001 for guidance on inspection of batteries. Attention shall be paid to any abnormal smell for example hydrogen sulphide gas given off by lead acid cells may indicate low electrolyte or cells which are overcharging or degraded.

Should this initial inspection reveal any significant deficiency in the **Apparatus** which could give rise to **Danger**, no attempt shall be made to work on the **Apparatus** until a supervisor with appropriate knowledge has been consulted and assessed the situation.

## 10. DANGERS

The main **Dangers** to **Persons** carrying out work or testing on batteries and chargers are electric shock, explosion, or burns arising from:

1. The ignition of hydrogen which is given off by cells during the process of charging. The gas may be ignited by naked flames and cigarettes or by sparks if cell terminals are accidentally earthed or shorted together (i.e. positive and negative terminals directly connected).
2. Contact with electrolyte contained within the cells. Burns can result from contact with either alkaline or acid electrolyte.
3. Fire, overheating and the expulsion of electrolyte from cells. This may occur if cells are short-circuited.
4. Arc energy, heat and light released from cells if they are short-circuited. The arc energy released may cause burns from conductors being heated rapidly or from the material causing the short-circuit.
5. Work being carried out on or in proximity to **Live** AC or DC conductors and battery cells.

## 11. ADDITIONAL HAZARDS

Whilst not directly introducing **Danger**, the following hazards may arise as a result of undertaking work on batteries or chargers with the potential to harm to **Persons** working on or near the **System**, or to the general public and other people at work. These procedures have been written including steps to mitigate the hazards.

1. Loss of protection supplies to a circuit being worked upon or to adjacent circuits.
2. Inadvertent operation of protection systems on a circuit being worked upon or adjacent circuits.

## 12. TRANSPORTATION, STORAGE AND DISPOSAL

Note that the **Dangers** identified in section 10 exist while cells are transported, stored and disposed of. Suitable care shall be taken to avoid those **Dangers**.

### 12.1 Transportation of wet cells

All wet cells shall be transported in a sturdy non-conductive, corrosion-resistant container with a lid to cover cell terminals. See figure 1 for an example. The casing shall retain each cell in an upright position and secure during transit, to prevent spillage of electrolyte causing damage to surroundings. All cells shall be electrically separate i.e. shall have no electrical connection to adjacent cells. All straps and connections between cells/battery blocks shall be removed and associated cells/battery blocks shall have their terminals covered prior to any transportation.

Battery cells are heavy: refer to manual handling guidance contained within the Health, Safety & Environment handbook.



Figure 1. Example of wet cells storage and transportation container

### 12.2 Transportation of dry cells

All dry cells shall be transported in a non-conductive, corrosion resistant container. All electrical terminal leads shall be insulated from each other or leads of defective cells cut close to the cell body to avoid electrical contact.

### 12.3 Storage of wet cells

Wet cells shall be stored in a cool dry place, where reasonably practicable banded, and cells shall not be connected via any electrical means. The cells shall be held in an upright position in a non-conductive, corrosion resistant container with a means of covering the cell terminals to prevent electrical shorting.

## 12.4 Storage of dry cells

All dry cells shall be stored in a cool dry place in a non-conductive container with all electrical terminal leads insulated from each other. New cells shall be retained in the manufacturer's packaging until ready for use. Electrical terminal leads of used or defective cells shall be cut close to the cell body or insulated from all surroundings.

## 12.5 Disposal of cells

Cells shall only be removed from the storage area for disposal by a licensed waste specialist. Any electrolyte spillage shall be contained or mopped using appropriate absorbent materials which shall be disposed of in an **Approved** manner, as Active Waste.

Details of the licensed contractor will be available from the local Depot Manager.

## 13. PROCEDURE WL1.06 WORK ON SUBSTATION BATTERY CELLS

Where it may introduce **Danger**, the AC supply to a battery charger shall where reasonably practicable be **Isolated** before commencement of work. If it is not reasonably practicable then the site specific risk assessment shall consider if work may proceed safely with appropriate control measures in place. Consideration shall be given to the proximity of **Live** AC terminals within the charger unit/battery cabinet. Control measures to control the **Danger** from adjacent **Live** AC terminals may include:

- isolating the AC supply,
- use of **Approved** shrouding
- wearing **Approved** rubber gloves
- using an **Approved** insulated mat.

**Approved** PPE including flame retardant coveralls (fastened up to neck and wrists) and a minimum of light eye protection shall be worn. Appropriate gloves shall be selected to protect the skin. Certain tasks in this procedure may require face protection to be augmented by the use of a full face visor.

The risk assessment shall consider the effect of any sudden movements inside a panel or cabinet caused by involuntary reaction to arcing or flashover that may result in secondary injuries e.g. cuts, abrasions and impact injuries.

Before any work takes place on batteries or cells where there may be **Danger**, **Approved** shrouding shall be placed over any exposed terminals of adjacent cells.

Selected tasks within this procedure may be undertaken by an **Authorised Person** working unaccompanied.

Task	Accompaniment required?
Changing Wet Cells	Yes
Replacing complete sets of wet cells	Yes
Refilling or topping-up wet cells of any voltage	May be completed unaccompanied*
Converting 30V wet cells to dry cells	Yes
Replacing packs of 30V dry cells	May be completed unaccompanied*
Replacing dry cells other than 30V packs	May be completed unaccompanied*
Batteries with voltage tapping(s)	Yes
Replacing Translay Batteries	May be completed unaccompanied*
Work on Battery Chargers	Yes

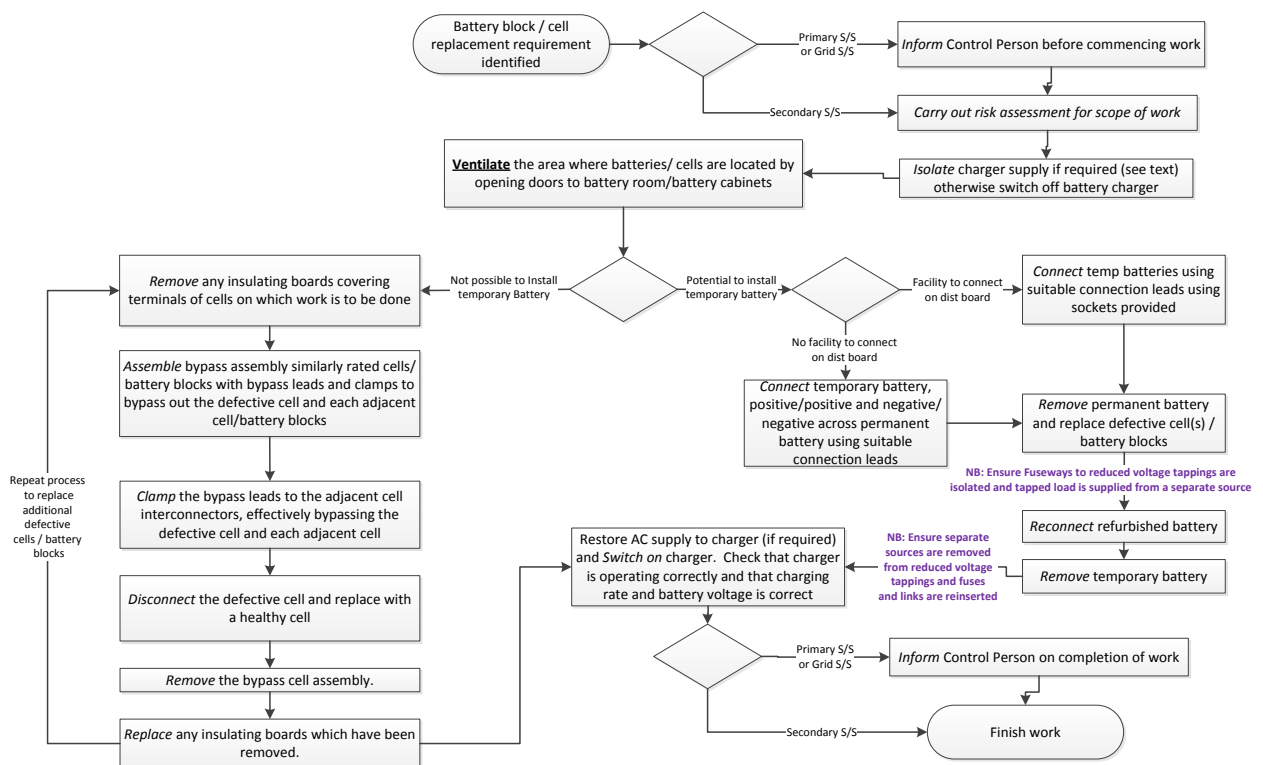
\*The risk assessment shall consider if being accompanied by another **Authorised Person** will substantially contribute towards the implementation of a safe system of work and if so, a second **Authorised Person** shall be present.

Where reasonably practicable, when working on any battery supplying protection or tripping systems where a disconnection is to take place, then a slave temporary battery of equal or greater electrical capability shall be connected in parallel before work commences. Refer to appendix 1 for examples of temporary chargers and battery sets.

Under some circumstances – depending on battery supervision or protection, switching off a battery charger may result in operation of circuit breakers in the substation. Particular attention shall be paid to this hazard.

### 13.1 Battery replacement work flow chart.

This flow chart describes the generic approach for replacement of either wet or dry cells. Refer to the specific task below for full detail.



### 13.2 Changing Wet Cells

This section is for the replacement of one or a number of individual wet cells in a battery, or where or cells are to be removed for cleaning/maintenance.

While working on wet cells, in addition to the basic PPE specified above, a full face visor and PVC gloves shall be worn when risk assessment does not require the use of **Approved** rubber gloves for electrical protection. Only **Approved** insulated tools shall be used and tools used on lead acid cells shall not be used for working on alkaline cells and vice versa.

This task shall only be undertaken with the accompaniment of a second **Authorised Person**.

Defective cells may only be changed either one at a time or in groups of adjacent defective cells. While the cell(s) are being changed, it is important that the battery can still perform its duty (e.g. CB tripping). To ensure this, cell connections shall not be broken before a bypass, comprising a minimum of three

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cells of equal capacity, is put in to replace the defective cell(s) and one cell on either side of it/them (see drawing Figure 2). The current rating of the bypass leads required is dependent on the battery size:

For 30V or 50V batteries, **Approved** 10 sq.mm. copper double insulated bypass leads are required;  
For 110V batteries, **Approved** 25 sq.mm. copper double insulated bypass leads are required.

Step 1 Inform appropriate **Persons** before commencing work. This will include advising the **Control Person** when working in Primary/Grid substations.

Step 2 Isolate AC supply if required.

Step 3 Switch off battery charger.

Step 4 Ensure any gases are dissipated by opening doors and thoroughly ventilating the area in which the cells are placed.

Step 5 Remove any insulating boards covering terminals of cells on which work is to be done. Apply **Approved** temporary shrouding to any remaining exposed terminals of adjacent cells.

Step 6 Assemble three (or more) similarly rated cells with bypass leads and clamps to bypass the defective cell(s) and one adjacent cell on each side. (See Figure 2).

Step 7 Clamp the bypass leads to the adjacent cell interconnectors, effectively bypassing the defective cell(s) and one adjacent cell on each side.

Step 8 Disconnect the defective cell(s) and replace with healthy cell(s).

Step 9 Remove the bypass cell assembly.

Step 10 Remove temporary shrouding and replace any insulating boards which have been removed.

Step 11 Restore AC supply if required and switch on the battery charger unit. Check that charger is operating correctly and that the charging rate and battery voltage is correct.

Step 12 Inform the **Control Person** that work is complete, so that any remote alarms can be cleared and depletions removed from the **System** diagram.

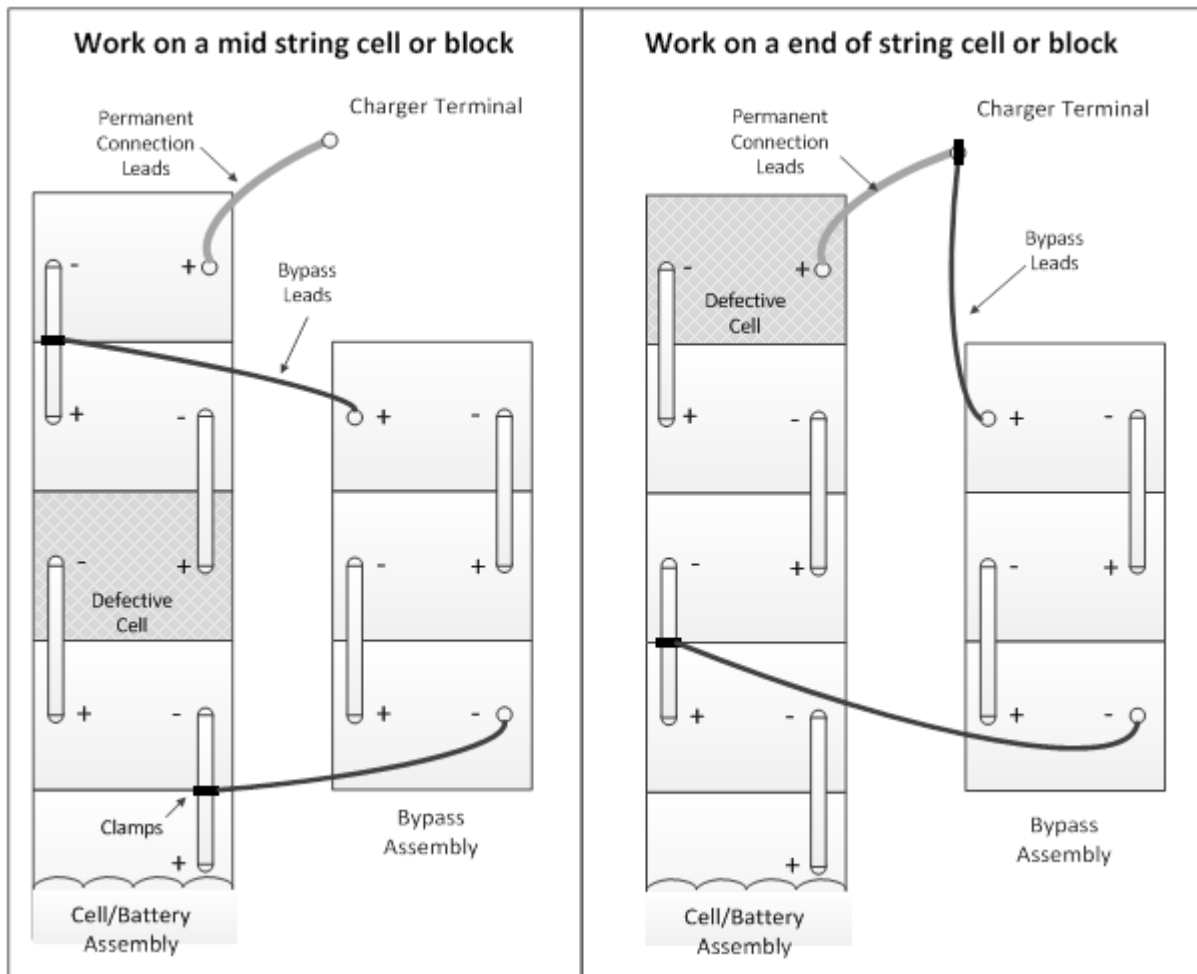


Figure 2. Standard arrangement for replacing individual cell(s). Capacity of cells shall be greater than or equal to the cells being replaced.

### 13.3 Replacing complete sets of wet cells:-

This section is for the replacement of all of the wet cells in a battery of any voltage.

While working on wet cells, in addition to the basic PPE specified in section 13, a full face visor and PVC gloves shall be worn when risk assessment does not require the use of **Approved** rubber gloves for electrical protection. Only **Approved** insulated tools shall be used and tools used on lead acid cells shall not be used for working on alkaline cells and vice versa.

This task shall only be undertaken with the accompaniment of a second **Authorised Person**.

Where chargers or distribution boards are fitted with an auxiliary socket a temporary battery may be plugged into the charger before work commences to change the existing battery. Otherwise a temporary battery of appropriate electrical capability shall be connected in parallel to the existing battery (i.e. with outgoing terminals of batteries connected positive/positive and negative/negative) before the existing battery is disconnected from the charger. Note the important requirements of section 13.8 if there are multiple voltage tappings taken from the battery being worked on.

Step 1 Inform appropriate **Persons** before commencing work. This will include advising the **Control Person** when working in Primary/Grid substations.

Step 2 Isolate AC supply if required and switch off battery charger.



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- Step 3 Allow any gases to dissipate by opening doors and thoroughly ventilating the area where the cells are kept.
- Step 4 Assemble temporary slave cells adjacent to cells to be replaced. These may be battery blocks linked or preferably pre-packaged temporary sets.
- Step 5 **Approved** temporary shrouding, insulating mat and the use of **Approved** rubber gloves or other protective gloves shall be considered subject to site specific risk assessment.
- Step 6 Connect the slave cells in parallel using **Approved** bypass leads.
- Step 7 Remove and replace defective cell with healthy cells using **Approved** insulated tools.
- Step 8 Remove bypass leads and slave cells from work area.
- Step 9 Ensure voltage levels are correct for system protection needs.
- Step 10 Restore AC supply if required and switch on the battery charger unit. Check that charger is operating correctly and that the charging rate and battery voltage is correct.
- Step 11 Remove **Approved** shrouding (if applied earlier).
- Step 12 Inform the **Control Person** that work is complete, so that any remote alarms can be cleared and depletions removed from the **System** diagram.

#### 13.4 Refilling or topping-up wet cells of any voltage.

**Persons** undertaking this task need not be accompanied, however if, as part of the risk assessment carried out prior to work commencing, it is concluded that being accompanied by another **Authorised Person** will substantially contribute towards the implementation of a safe system of work, a second **Authorised Person** shall be present.

When topping-up of wet cell(s) is required, particular care shall be taken to avoid **Danger** from electrolyte which is present in the cells to be topped-up. Great care shall be taken to minimise the disruption to the electrolyte within the cells. Any electrolyte displacement may cause injury or damage to **Persons** nearby or surrounding surfaces / materials. Any spillage must be contained or mopped using appropriate absorbent materials which shall be disposed of in an **Approved** manner, as Active Waste.

While working on wet cells, in addition to the basic PPE specified in section 13 above, a full face visor and PVC gloves shall be worn when risk assessment does not require the use of **Approved** rubber gloves for electrical protection.

All cells in the battery shall be inspected before any are topped-up. Refer to document BATT-12-001 for guidance on inspection of batteries.

Only de-ionised or distilled water shall be used for topping-up and **Approved** means of refilling the cells shall be used (ie. non-conductive funnels or water pump dispensers).

The electrolyte level of a cell must not exceed the mark displayed on the cell casing, making allowance for expansion due to changes in ambient temperature -any electrolyte escaping from the cell will cause accelerated corrosion to the positive cell terminal.

#### 13.5 Converting 30V wet cells to dry cells :-

This task shall only be undertaken with the accompaniment of a second **Authorised Person**.

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In addition to the basic PPE identified in section 12, when working with wet cells a full face visor and PVC gloves shall be worn when risk assessment does not require the use of **Approved** rubber gloves for electrical protection.

In addition to changing the cells, the charger shall be re-configured to prevent overcharging the dry cells which will lead to their early failure.

- Step 1 If required, inform appropriate persons before commencing work.
- Step 2 Allow any gases to dissipate by opening doors and thoroughly ventilating the area in which the cells are placed.
- Step 3 Isolate the 230V supply to the battery charging unit.
- Step 4 Connect slave cells to retain 30V dc supply for protection system functionality
- Step 5 Remove DC supply from charging unit to wet cells.
- Step 6 Remove the wet cells from the charger cabinet and install new dry cell pack.
- Step 7 Carry out charger conversion to the manufacturer's instructions, restoring the DC supply from charging unit to dry battery cells.
- Step 8 Disconnect slave cells.
- Step 9 Ensure DC output voltage will be correct for protection systems and reconnect 230V supply to newly converted charger unit.
- Step 10 Inform appropriate persons that work is complete – this may include advising the **Control Person** if there is a depletion to remove from the **System** diagram.

### 13.6 Replacing packs of 30V dry cells

This task is for like-for-like replacement of 30V dry cell packs. **Persons** undertaking this task need not be accompanied, however if, as part of the risk assessment carried out prior to work commencing, it is concluded that being accompanied by another **Authorised Person** will substantially contribute towards the implementation of a safe system of work, a second **Authorised Person** shall be present.

30V dry cell packs consist of fifteen 2V cells connected in series. These cells are held on a rigid plastic base and covered in a plastic insulated wrapping. Three electrical leads: positive, negative and a 22/15V tapping for different protection systems are available for connection on certain makes of cells – see figure 3.

- Step 1 If required, inform appropriate persons before commencing work.
- Step 2 Isolate the 230V supply to the charger
- Step 3 When replacing defective cells, this shall be completed without delay as the protection systems are without their 30V DC supply.
- Step 4 Identify 30V cell leads to be disconnected, and disconnect them one at a time and cover bared conductor with insulation tape/material. Never allow the positive and negative leads to touch each other. Remove the old dry pack cells from charger.
- Step 5 Install and connect new dry pack cells leads, only baring and connecting one lead at a time.
- Step 6 When the connection of new cells is complete, check the voltage of cells is near 30V as the cells may need a short amount of time to charge and attain the optimum voltage required.

Step 7 The old dry cell leads shall be cut one at a time as close to the cells and insulated from each other as some residual charge may still be present.

Step 8 Inform appropriate persons that work is complete – this may include advising the **Control Person** if there is a depletion to remove from the **System** diagram.



Figure 3. Examples of 30V dry cell packs – note three leads – 30V, 22V and 0V.

### 13.7 Replacing dry cells other than 30V packs

This task is for the replacement either of an individual dry cell or all dry cells in a battery of any voltage other than where packs of 30V cells are used. The approach of installing a temporary (slave) battery is to be adopted whether the work includes replacing a single cell or all of the cells in the battery.



Figure 4 – typical dry cell

**Approved** rubber gloves shall be worn when risk assessment requires electrical protection for the hands. Only **Approved** insulated tools shall be used.

It is expected that the accompaniment of a second **Authorised Person** will be required to assist with this task – partly due to the size and weight of the dry cells – however depending on the work to be undertaken a second **Authorised Person** need not be present if the risk assessment determines that it will not contribute towards the implementation of a safe system of work.

Where chargers or distribution boards are fitted with an auxiliary socket a temporary battery may be plugged into the charger before work commences to change the existing battery. Otherwise temporary batteries of appropriate electrical capability shall be connected in parallel to the existing battery (i.e. with outgoing terminals of batteries connected positive/positive and negative/negative) before the existing battery is disconnected from the charger. Note the important requirements of section 13.8 if there are multiple voltage tapplings taken from the battery being worked on.

Step 1 Inform appropriate **Persons** before commencing work. This will include advising the **Control Person** when working in Primary/Grid substations.

Step 2 Isolate AC supply if required and switch off battery charger.

Step 3 Assemble temporary slave cells adjacent to cells to be replaced. These may be battery blocks linked or preferably pre-packaged temporary sets.

Step 4 **Approved** shrouding, insulating mat and the use of **Approved** rubber gloves or other protective gloves shall be considered subject to site specific risk assessment.

Step 5 Connect the slave cells in parallel with the existing battery and (where necessary) to lower voltage tapplings using **Approved** bypass leads or by the socket provided.

Step 6 Remove and replace defective cell(s) with healthy cell(s) using **Approved** insulated tools.

Step 7 Remove bypass leads and slave cells from work area.

Step 8 Ensure voltage levels are correct for system protection needs.

Step 9 Restore AC supply if required and switch on the battery charger unit. Check that charger is operating correctly and that the charging rate and battery voltage is correct.

Step 10 Remove **Approved** shrouding (if applied earlier).

Step 11 Inform the **Control Person** that work is complete, so that any remote alarms can be cleared and depletions removed from the **System** diagram.

### 13.8 Batteries with voltage tapping(s)

When disconnecting and/or replacing a set of cells that has a lower voltage tapping (ie. 110V/48V/30V set with a lower tapping), consideration shall be given to the voltage tapping.

Each protection system voltage shall have its own slave set for example when replacing a 48V set with a 30V tapping, the tapping for 30V shall be replaced by a power pack or slave set connected to the 30V outgoing connection for the duration of the work.

See figure 5 showing 48V set with 30V tapping, if replacing the 48V set and covering only 48V with slave set the lower voltage tapping will not be present which would allow the 48V protection relays to operate but would render the 30V protection systems and solenoids/trip coils inoperative.

All protection system battery output voltages shall be confirmed present at the end of work.

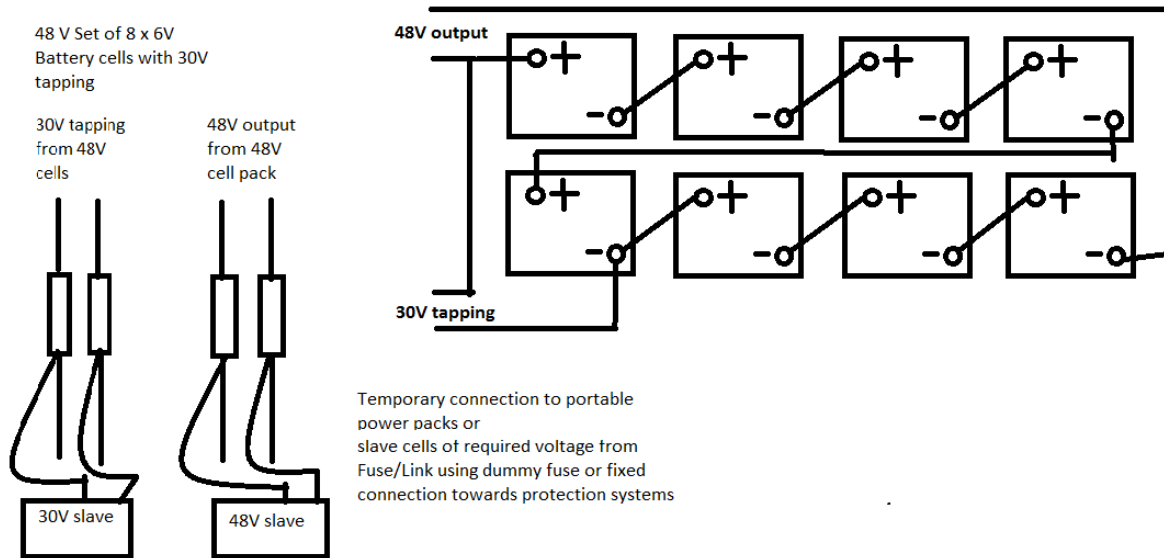


Figure 5 illustration of cells with voltage tapping

### 13.9 Replacing Translay Batteries

This task refers to battery systems associated with overhead Translay protection schemes as deployed on the SPM 33kV distribution network. On these schemes the battery cells are located in a wall-mounted intertripping cabinet and are accessed by means of a drawer arrangement at the base of the cabinet. No charger system is present and the cells are replaced on a periodic basis. Cells shall be replaced as a complete set wherever possible.

It should be noted that with the drawer pulled open the battery terminals are disconnected from the protection panel wiring by means of a contact arrangement at the rear of the drawer. All **Danger** associated with contact with “hot” wiring in the cabinet are therefore removed when the drawer is pulled out of the cabinet housing.

**Persons** undertaking this task need not be accompanied, however if, as part of the risk assessment carried out prior to work commencing, it is concluded that being accompanied by another **Authorised Person** will substantially contribute towards the implementation of a safe system of work, a second **Authorised Person** shall be present.

Step 1 Inform appropriate **Persons** before commencing work. This will include advising the **Control Person** when working in Primary/Grid substations.

Step 2 Open battery drawer and inspect condition of batteries.

Step 3 Unclip the positive and negative outgoing leads

Step 4 Remove the old cells and install the new cells

Step 5 Apply the positive and negative outgoing leads

Step 6 Confirm the correct output voltage is present

Step 7 Insert battery drawer

Step 8 Inform appropriate Control Person as soon as work is complete.



### 13.10 Work on Battery Chargers

Any work undertaken on or within a charger unit shall where reasonably practicable be completed with the AC supply **Isolated** in accordance with OPSAF-10-012 (PSSI 12) section 11. Where it is not reasonably practicable and subject to risk assessment work may proceed with appropriate precautions in place (eg. use of **Approved** shrouding and insulating mat and/or **Approved** rubber gloves and accompaniment from a second **Authorised Person**.

Consideration shall be given to the **Danger** presented by the DC output from the battery cells. Suitable precautions may include disconnecting leads or the application of **Approved** shrouding.

For work on a battery charger in a site other than a secondary substation the **Control Person** shall be informed before work starts. Consideration shall be given to the effect of the work being planned and a method statement and scope of work shall be completed by an appropriately **Authorised Person**. It may be appropriate for a **Senior Authorised Person** to issue a **Limited Work Certificate**.

### 14. APPENDIX 1 – EXAMPLE TEMPORARY CHARGER AND BATTERY SETS

The following photograph shows an example of a temporary chargers and battery sets available for use while work takes place on permanent batteries or chargers. Various combinations of battery are available – e.g. a 60V and a 48V battery may be combined to produce a 110V battery.

Example of temporary charger with 60V and 48V batteries to provide 110V installation.



The unit presents options of the battery packs being used alone without the charger for short duration work. Various output connection can be supported: Anderson socket, lugged connection or bare wire connection for insertion into fuses/links.