TECHNICAL SPECIFICATION

STATIC DC UNINTERRUPTIBLE POWER SUPPLY UNIT (STATIC DC UPS UNIT)

DEP 33.65.50.31-Gen.

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DESIGN AND ENGINEERING PRACTICE

USED BY

COMPANIES OF THE ROYAL DUTCH/SHELL GROUP

PREFACE

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The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual operating companies to adapt the information set forth in DEPs to their own environment and requirements.

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1. INTRODUCTION

1.1 SCOPE

This DEP is a revision of an earlier DEP of the same number entitled "DC Supply Unit", dated July 1983. It gives minimum requirements for a static (semi-conductor) rectifier and battery unit, hereafter referred to as a DC UPS unit. The DC UPS unit is required to serve as a secure (uninterruptible) direct current source of power to vital instrumentation and safeguarding systems that perform a controlling or monitoring function in continuously operating process units, utility installations, and production facilities.

The DC UPS unit shall comply with this DEP and IEC 146, 478, 623 and 896. In the event of contradiction, the requirements of this DEP shall take precedence.

Additional information relating to a specific installation is given in the requisition sheet DEP 33.65.50.93-Gen.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIPM, the distribution of this DEP is confined to companies forming part of the Royal Dutch/Shell Group or managed by a Group company, and to Contractors and Manufacturers nominated by them, (i.e. the distribution code is "F", as defined in DEP 00.00.05.05-Gen.).

This DEP is intended for use in oil refineries, chemical plants, gas plants and in exploration/production and supply/marketing installations.

If national and/or local regulations exist in which some of the requirements may be more stringent than in this DEP the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable as regards safety, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

For the purpose of this DEP, the following definitions shall hold:

1.3.1 General definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The **Purchaser** is the party which buys the DC UPS Unit. The Purchaser may be either the Contractor or the Principal.

The word **Shall** indicates a requirement.

The word **Should** indicates a recommendation.

1.3.2 Technical definitions

Crest factor is the ratio of the peak value to the rms value of the total periodic waveform.

Final (or end-of-discharge) voltage is the voltage at which battery discharge is

terminated.

Float charging is the passing of an electric current through a battery by applying a constant voltage from a charger such as to maintain the battery in a state of charge.

Mean time between failure (MTBF) represents the predicted duration of trouble-free operation and is calculated as follows:

$$MTBF = \frac{\text{operating time}}{\text{number of faults resulting in outage}} \quad \text{(hours)}$$

Nominal Capacity of a battery is a battery cell rated capacity, selected and declared as such by its Manufacturer, based on a specific discharge time, final voltage and reference temperature.

Non-flame propagating material is one which, without any further admixture, will not, when ignited, continue to burn nor cause other material, in contact with or adjacent to it, to ignite.

Non-toxic substance is one which causes no harm to the environment nor to a person exposed to it or ingesting it, except only if exposed to or ingested in an overwhelming dose or unusual conditions.

Partially discharged condition of a battery is the condition reached when the battery has been discharged at the rate specified on the requisition to the final voltage.

Power factor is the power factor of the fundamental wave, cos ϕ, (sometimes referred to as the displacement factor)

$$\cos\phi = \frac{\text{active power of the fundamental wave}}{\text{apparent power of the fundamental wave}}$$

Rapid charging is the passing of an electric current through a battery by applying a controlled voltage from a charger, such as to restore the battery to a predetermined state of charge in a limited timespan.

Rated output is the power, expressed in kW, which can be continuously delivered by the DC UPS unit over the range of conditions of service and electrical loading specified in this document, without exceeding component ratings or going outside any of the specified output tolerances.

Relative harmonic content is the ratio of the rms value of the harmonic content to the rms value of the total non-sinusoidal periodic waveform,

$$\text{relative harmonic content} = \sqrt{1-(g_1/g)^2} * 100\%$$

where g_1 = rms value of the fundamental component of current or voltage

and g = rms value of the total waveform of current or voltage.

Reliability is defined as: $e^{-(\frac{8760}{MTBF})} * 100\%$

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Starting voltage is the voltage present at the battery terminals when it starts to discharge.

Switched Mode Power Supply (SMPS) is a power supply where the output D.C. voltage and current are pulse-width controlled by means of switching, at high frequency, an unregulated DC voltage converted from the AC mains.

Valve Regulated (or Sealed) Cell is a cell or battery in which the venting of electrolysis gas is controlled by a re-closing valve. Provision is not made for water additions. The electrolyte may be immobilized, absorbed, or limited in volume.

Vital service is a service which, when failing in operation or when failing if called upon, can cause an unsafe condition of the process and/or electrical installation, jeopardize life, or cause major damage to the installation.

1.4 CROSS REFERENCES

Where cross references to other parts of this DEP are made, the referenced section/paragraph number is shown in brackets. Other standards referenced in this DEP are listed in (8).

2. GENERAL REQUIREMENTS

2.1 BASIS OF DESIGN

The DC UPS unit shall comply with IEC 146 and IEC 478. The DC UPS rectifier shall be of either the thyristor controlled type or of the switched mode power supply (SMPS) type. The selection shall be Manufacturer's choice unless specified otherwise in the requisition.

The design of the DC UPS unit shall be such as to minimize the risk of short circuits and shall ensure personnel and operational safety at all times.

The design and selection of equipment and components shall be based on achieving the following minimum lifetimes when operating under the specified service conditions (2.4).

- 20 years for the rectifier;
- 20 years for vented battery cells;
- 10 years for valve regulated battery cells and capacitors of the electrolytic type.

Components shall be capable of withstanding the thermal and dynamic stresses resulting from internal and external short circuits and circuit switching operations, etc. Damage arising from component failure should be confined to the component concerned.

The DC UPS unit components shall be suitably protected for operation in the environmental conditions specified in (2.4). Component materials shall be non-flame propagating, wherever practicable.

The DC UPS unit including all individual components forming part of the system shall have a reliability of at least 90%, and an overall efficiency of at least 80% at nominal load. The Manufacturer shall submit data to the Purchaser to demonstrate that the design satisfies these criteria.

Capacitor electrolytes shall be non-toxic and free from polychlorinated biphenyls (PCB's).

2.2 OPERATING PRINCIPLE

The performance requirements as specified in (3) shall be based on the following basic operating principle of the DC UPS unit :

The output of the rectifier shall, during normal operation, continuously supply the power requirements of the load while simultaneously maintaining the battery charge in the float charge mode. In the event of an interruption or depression in the AC mains voltage to the rectifier, the battery shall supply the load requirements for not less than the specified time (3.4) whilst maintaining the output voltage within the permissible limits (3.5). The battery capacity selected by the Manufacturer in order to achieve this will henceforth be referred to as its 100% nominal capacity.

Upon restoration of the AC mains voltage, the rectifier shall automatically resume supply of the load requirements while simultaneously recharging the battery. The rate of recharging shall, depending on type of battery, be such as to restore it within the specified time to a capacity which is either its 100% nominal capacity or a percentage thereof (3.1). Where rapid charging is necessary to fulfil this requirement, then this shall only be possible by manual initiation, providing the interlocking provisions of (3.3) are met.

The DC UPS unit shall be suitable for operation in parallel with one or more identical units, that may have unsynchronized AC supplies.

2.3 UNIT RATING

The rated output of the DC UPS unit rectifier shall be based on standard duty class I of IEC 146.

Unless otherwise specified on the requisition, DC UPS units having rated outputs up to and including 1.8 kW shall have single-phase and neutral inputs and units having rated outputs in excess of 1.8 kW shall have 3-phase and neutral inputs.

The nominal DC output voltage shall be as indicated on the requisition as one of the following standard DC voltages 24 V, 48 V, 110 V and 220 V.

2.4 SERVICE CONDITIONS

Unless otherwise specified, the DC UPS unit shall be located inside a freely ventilated room or module in which the following conditions apply:

- maximum ambient air temperature : 40°C
- minimum ambient air temperature : 5°C
- relative humidity not exceeding : 90%
- altitude not exceeding : 1000 m

Where a specific room environment is provided for the battery (e.g. a battery room) then the applicable battery cell temperatures shall be as indicated on the requisition.

2.5 MAINS ELECTRICITY SUPPLY

The AC power supply to the DC UPS unit shall be single-phase or symmetrical three-phase with earthed neutral, and of nominal voltage and frequency as indicated on the requisition. The waveform of the input voltage, with the DC UPS unit disconnected, will be sinusoidal (as defined by IEC 146). The input supply variations shall be limited under steady-state conditions :

- nominal system voltage : plus 10% and minus 10%
- nominal system frequency : plus 5% and minus 5%.

In addition to the above variations the input voltage may be subject to transients comprising voltage depressions up to 20% of nominal voltage, during motor starting, and to voltage interruptions during system short circuits. Transient high frequency voltages of up to 2 kV may also be superimposed on the input voltage as a consequence of system switching operations.

2.6 CONFIGURATION AND TIE-IN

The DC UPS system shall consist of a number of DC UPS units, each comprising a rectifier and its pertaining battery, connected in parallel. The number of DC UPS units to be installed shall be as indicated on the requisition and is based on "n+1" where "n" is the number of units required to fulfil the load requirements. Appendix 1 shows a typical arrangement of interconnections between two 100% DC UPS units, the AC mains and DC distribution board.

The Manufacturer shall specify the current rating of general purpose fuselinks (type gG, in accordance with IEC 269) or of a moulded-case circuit breaker (category B, in accordance with IEC 947-2) which the Purchaser shall provide in the mains supply switchboard energizing the DC UPS unit.

Unless specified otherwise in the requisition, blocking diodes will be provided by the Purchaser on the DC distribution board.

The Purchaser shall provide the cables connecting the DC UPS unit to the external equipment, including those to the battery when the latter is not installed in an enclosure adjoining the DC UPS unit. The Manufacturer shall specify the size of conductor required for the battery cables, based on a cable length not exceeding 20 m, or as otherwise specified in the requisition.

The Manufacturer shall provide suitably sized fuses or a moulded-case circuit breaker on the battery circuit, to isolate the battery in the event of short circuits on the output of the DC UPS unit. The protection device shall be of the wall mounted type, installed adjacent to the battery.

2.7 INFORMATION TO BE SUBMITTED WITH THE TENDER

The Manufacturer shall submit a technical specification of the DC UPS unit which shall include a description of the design, operation, construction, performance and maintenance aspects of the equipment.

The information shall include relevant calculations of the nominal battery capacity and the number of battery cells that are needed to meet the specified performance requirements of

the DC UPS unit (2.3).

The Manufacturer shall also submit the information requested on the requisition by completing the document and returning it with the tender.

The Manufacturer shall verify in writing that the DC UPS unit fully complies with this specification, or shall list all specific points of non-compliance.

The Manufacturer shall state in the requisition the country of origin of the main parts of the DC UPS unit and, for site maintenance back-up, shall indicate the nearest service organisation recommended for the location at which the DC UPS unit will be installed.

3. PERFORMANCE REQUIREMENTS

3.1 RECTIFIER

The rectifier shall operate according to the constant voltage, current limiting principle and shall incorporate a soft-start feature to gradually accept load on initial energizing. The rectifier shall restart automatically upon restoration of the mains power supply following a mains supply interruption.

3.1.1 For DC UPS units equipped with valve regulated lead acid batteries, the rectifier shall be rated to:

- fulfil the load requirements as stated in the requisition, and simultaneously;
- recharge the battery within a period of 15 hours, from the partially discharged condition to 95% nominal capacity.

NOTE: Where valve regulated battery cells are specified, the rectifier shall perform battery charging only at the single-rate corresponding to the battery float charge mode of operation. Rapid-charge facilities shall not be provided.

3.1.2 For DC UPS units equipped with vented batteries, the rectifier shall be rated to:

- fulfil the load requirements as stated in the requisition, and simultaneously recharge the battery, with the output voltage within the accepted tolerances specified in (3.5) from the partially discharged condition to 80% nominal capacity in 15 hours;

  and,

- rapid charge the battery to restore it within a period of 8 hours from the partially discharged condition to 100% nominal capacity, with the external DC load disconnected.

3.2 BATTERY FLOAT-CHARGE OPERATION

The rectifier steady state DC output voltage variations shall be controlled to within plus 1% and minus 1% of the set value (corresponding to the battery float-charge voltage) during load variations between zero and the rated output of the rectifier, and during steady-state input voltage and frequency variations referred to in (2.5).

Transient mains supply voltage depressions of not more than 20%, which may be the result of motor starting activities, shall not result in a trip of the rectifier or the initiation of battery discharge.

On-line adjustment of the set value of float-charge voltage shall be possible by means of either a potentiometer on the relevant control circuit card or, where applicable, by an appropriate menu-driven software change.

The DC output current of the rectifier, when operating under current-limiting conditions, shall be controlled to within plus 2% and minus 2% of the set value.

3.3 BATTERY RAPID-CHARGE OPERATION

Facilities shall be provided to initiate battery rapid-charge operation only by manual means.

To ensure that the external DC load is disconnected from the unit throughout rapid-charging operations, a manually operated mechanical interlock shall be provided between the rectifier float/rapid-charge selector switch and the main outgoing circuit switch of the DC UPS unit, such that the selector switch is only operable if the main outgoing circuit switch is "off".

Operation of the selector switch to the rapid-charge position shall initiate an automatically controlled rapid-charge cycle according to constant current/constant voltage characteristics.

The duration of battery rapid-charge operation shall be controlled by an adjustable timing relay. The relay shall be activated on detection of battery voltage and current conditions which indicate the restoration of the battery to an appropriate state of charge. After the elapsed time, the timing relay will re-instate the rectifier output voltage to that corresponding to continuous float charge operation.

When operating under constant current limiting conditions, the DC output current of the rectifier shall be controlled to within plus 2% and minus 2% of the set value.

When operating under constant output voltage conditions, the voltage shall be controlled to within plus 1% and minus 1% of the set value.

On-line adjustment of the set value of the final voltage applied to the battery shall be possible by means of either a potentiometer on the relevant control circuit card or, where applicable, by an appropriate menu-driven software change.

3.4 BATTERY AND DC CIRCUIT

The battery voltage and capacity shall be such as to fulfil the load requirements for a period as specified in the requisition while maintaining an output voltage within the permissible tolerances (3.5).

The battery discharge performance shall be fulfilled :

- throughout the range of service conditions specified in (2.4);
- repeatedly, each discharge performance being preceded by restoration of the battery to the required capacity by means of a recharge operation not exceeding the specified periods in (3.1);
- following a prolonged period (i.e. not less than one year) of battery float-charge operation;
- at the end of its service life specified in (2.1).

The battery capacity shall also be such that fuses protecting the connected loads, (type gG to IEC 269) and rated one quarter of the rated output of the DC UPS unit, will melt within three milliseconds after the occurrence of a short circuit.

The nominal ampere-hour capacity of the new battery shall not be less than 110% of the nominal ampere-hour capacity required to fulfil the performance criteria stated above.

The battery Manufacturer shall specify the rms value of the actual, and the maximum permissible, ripple current through the battery, as a percentage of the battery nominal ampere-hour capacity, when the DC UPS unit is operating under battery float-charge conditions. These limits, applicable for the battery supplied with the DC UPS unit, shall not be exceeded, and as a minimum shall fulfil the following two requirements :

- The maximum allowed rms ripple current shall not exceed 5% of the battery nominal ampere-hour capacity, under float-charge conditions;
- The maximum allowed rms ripple voltage, with the battery disconnected, shall be equal to or smaller than 2% of nominal output voltage.

The DC circuit shall be unearthed unless otherwise specified in the requisition.

3.5 OUTPUT VOLTAGE REQUIREMENTS

The output voltage shall be limited to within plus 10% and minus 10% of the nominal value. This limitation applies during battery recharge operations, float-charge operations and during battery discharge operations corresponding to the maximum load current and for the specified discharge period.

NOTE: Switched diodes or supplementary battery cells as a means of limiting DC voltage variations are not acceptable.

The output voltage dynamic response of the DC UPS unit, with battery connected, shall not vary more than plus 20% and minus 10% of nominal output voltage in the event of instantaneous load changes of up to 50% rated output. The output voltage shall be restored to within the steady-state limits within 100 millisecs.

3.6 MAINS VOLTAGE DISTORTION

Based on short circuit capacity of the supply system of 40 times the kVA rating of the DC UPS unit, the current harmonic consumption shall be such that the total voltage distortion caused by the unit on the mains shall be less than 5%. The relative harmonic content and crest factor of the input current shall not exceed 50% and 2.5 respectively.

3.7 NOISE LIMITS

EEMUA 140 shall apply with regard to definitions, notations, measuring equipment, procedures, reporting and calculation methods.

The sound pressure level measured at one metre distance from the DC UPS unit, at any position, shall not exceed 70 dB(A) at any load between zero and rated output of the unit. If narrow band or impulsive components are present, the noise limit shall be 5 dB(A) less.

3.8 RADIO FREQUENCY INTERFERENCE LIMITS

The production of radio frequency interference voltages shall not exceed the values of suppression grade "N", as defined in EN 55014/55015, for thyristor controlled type rectifiers and suppression grade "B", as defined in EN 55022, for SMPS type rectifiers.

The performance of the DC UPS unit shall not be affected, or in any way degraded, by the use of equipment (e.g. portable radio transmitters/receivers) operating in the frequency range 27-170 MHz, at 460 MHz, and at 800 MHz when the severity of the electromagnetic radiation environment corresponds to class 2, in accordance with IEC 801-3.

4. CONSTRUCTIONAL REQUIREMENTS

4.1 UNIT ENCLOSURE AND ACCESSIBILITY

4.1.1 Unit Enclosure

The rectifier shall be installed in a freestanding, self-supporting steel cabinet forming an enclosure. The cabinet shall be suitable for operation and maintenance with its rear panel against a wall and with similar units located immediately on both sides.

NOTE: No more that one rectifier shall be installed in any one cabinet.

The enclosure shall provide a degree of protection of not less than IP 31 in accordance with IEC 529. The floor shall not be considered as forming part of the enclosure.

4.1.2 Cooling

Internal cooling of the rectifier unit should be by natural ventilation. If forced air cooling is necessary, then the rectifier shall be capable of continuously delivering its rated output with any one forced air ventilation fan out of service. Under the latter condition, the maximum continuous temperature of components shall not be exceeded.

4.1.3 Accessibility

Equipment and components located within the enclosure shall not be mounted directly on the walls of the enclosure. The location and grouping of components and auxiliary equipment shall permit easy identification and access for operational, maintenance and repair purposes. Suitable partitioning between individual items shall be provided where necessary to allow adjustment and inspection to be carried out safely.

All live terminals of door-mounted equipment having a maximum (peak) voltage of greater than 24 Volts shall be shrouded or otherwise protected by barriers to a degree of protection of at least IP 30. Barriers shall be of rigid transparent insulating material to enable the screened components to be identified. Protection relays which can cause tripping of the unit shall not be mounted on the door.

All bare busbars and all live terminals of equipment and components located within the enclosure shall be similarly protected by barriers or shrouds to a degree of protection of at least IP 20, unless adequately recessed within the enclosure to prevent inadvertent contact or short circuit by personnel when performing control circuit adjustments or when resetting/replacing protective devices, etc.

4.1.4 Battery Enclosure

The battery may be installed in a separate cabinet adjoining that of the rectifier or on separate, unenclosed, free-standing support racks. Specific requirements shall be indicated on the requisition.

Battery enclosures shall be naturally ventilated to ensure that temperatures inside the enclosures do not exceed the maximum limit allowed (2.4) and to prevent the accumulation of a flammable gaseous atmosphere. The battery shall be positioned such that possible leakage of electrolyte or emission of gaseous products shall not cause damage to other equipment components, or adjacent cells.

When installed in cabinets, the battery shall be readily accessible to allow inspection and maintenance.

Separate, free-standing support racks for batteries having plastic cell containers may be steel or solid wood. Nickel-cadmium batteries having steel cell containers shall be supplied in wooden crates. Support racks for the latter shall be solid wood. All wood should be treated to render it non-hygroscopic and acid resistant. Steel racks shall have a plastic or epoxy coating to provide suitable protection against the effects of electrolyte spillage.

For inspection and maintenance purposes the support racks shall be such that the top of the upper battery row shall not exceed 1600 mm and total rack depth shall not exceed 1000 mm.

4.2 RECTIFIER COMPONENTS

Printed circuit boards (PCBs) shall be installed in standardized electronic equipment frames and be fitted with handgrips for easy removal. The frames shall incorporate card guides to facilitate the correct insertion of PCBs, and allow access to the wiring side of connectors. PCBs shall include visual light emitting diode (LED) status indications and test connections on the front to facilitate fault diagnosis.

Main circuit switches (mechanical) shall comply with IEC 947-3 and be of the independent manually operated air-break type for continuous duty. They shall comply with utilization category AC23 and DC23 for AC and DC switches respectively.

Contactors shall comply with IEC 947-4-1 and be rated for uninterrupted duty and intermittent duty of at least class 0.1. The utilization category for DC contactors shall be not less than DC-5 and for AC contractors not less than AC-3.

Transformers and reactors shall be of the air-cooled type and comply with IEC 146.

4.3 WIRING AND TERMINATIONS

Internal wiring shall be single core, insulated, and have stranded copper conductors. Wiring between terminals shall be continuous and without joints. Wires shall be held in position by means of insulating tubes, channels, cleats or plastic strips, and be routed such as to avoid mechanical damage. Wiring between fixed portions and hinged doors shall be mechanically protected against abrasion or entrapment and not be routed around sharp edges.

Individual wires or cables terminating in fixed (non-plug-in) components which require to be disconnected for the purpose of component testing or replacement, shall be identified by means of colour or by ferrules of insulating material marked in accordance with the Manufacturer's drawings.

Terminals shall be provided for all external connections. External connections shall not be made directly to component terminals. Terminals shall be of the rail-mounted type and have screw connectors suitable for a minimum of 2.5 mm^2 conductors. Only one conductor shall be terminated in each terminal. Insulating shields shall be used to separate terminals belonging to different circuits.

Additional load circuit terminals shall be provided to facilitate connection of a temporary load to test the DC UPS unit while the permanent load is energized via the duplicate DC UPS unit.

The rectifier enclosure shall have facilities for the entry of cables from above or below, as specified on the requisition. Cable entries, cable glands and terminals shall be suitable for the type and size of cables specified on the requisition. Cable glands shall be of the compression-type and mounted on a removable gland plate.

The proximity of terminals and gland plates shall be such that ample space is available for terminating the cores of external cables.

4.4 EARTHING

An earth rail, with a suitable number of earthing bolts or screws, shall be provided in a position close to the external cable glands to facilitate termination of cable earth braids or armouring. Individual connections of all earth wires shall be provided.

A threaded brass earth stud of not less than 6 mm diameter, with nuts and spring washers, shall be provided within the enclosure to facilitate termination of a separate, single-core, earth cable.

Electrical conductivity between the exposed, non-current carrying conductive parts of the DC UPS unit components and the enclosure, and between the enclosure and the earth rail/earth stud, shall be such as to maintain effective continuity of protective circuits. Earth bonding conductors shall be utilized between enclosures and doors, and where required to achieve effective protection.

4.5 BATTERY CELLS AND CONTAINERS

4.5.1 Design

The battery shall be of the nickel-cadmium or lead-acid type, in accordance with the data given on the requisition. Batteries are required to achieve the lifetimes specified in (2.1).

Nickel-cadmium battery cells shall be of the pocket-plate, sintered-plate or fibre-plate types in accordance with IEC 623. Lead-acid battery cells may be of the Planté type or of the valve regulated type in accordance with IEC 896. Valve regulated cells shall be of the flat-plate construction incorporating electrolyte absorbed in the plate separators.
Terminal pillar seals shall be of a design that prevents the initiation of pillar corrosion.

Cell containers should be plastic, provided they are non-flame propagating and mechanically shock resistant. Steel cell containers should be used if they are necessary to avoid the need for parallel operation of battery cells. Plastic containers of vented, flooded cells shall permit the electrolyte level to be viewed through the container material. Vented, flooded cells shall be fitted with flame-arresting vent plugs.

Inter-cell connectors and terminals shall be insulated or otherwise provided with protective covering to prevent inadvertent short circuiting.

4.5.2 Supply conditions

4.5.2.1 Vented, flooded batteries

Vented, flooded batteries shall be supplied complete with ready-mixed liquid electrolyte which shall be appropriate for the cell temperatures referred to in (2.4).

Vented, flooded battery cells shall be supplied as follows:

(i) Delivery by land transport:

Nickel-cadmium cells shall be supplied filled and charged.

NOTE: If nickel-cadmium cells cannot receive a commissioning charge within 6 months (3 months in tropical climates) of leaving the factory, then alternative delivery forms shall be specified, i.e. filled and discharged or dry and discharged.

Lead-acid cells shall be supplied dry and charged. Liquid electrolyte shall be delivered with the battery in suitable sealed containers.

NOTE: If lead-acid cells can receive a commissioning charge within 3 months of leaving the factory (2 months in tropical climates), then the cells may be supplied filled and charged.

(ii) Delivery by ship:

Nickel-cadmium cells shall be supplied dry and discharged.

Lead-acid cells shall be supplied dry and charged.

Liquid electrolyte shall be supplied with the battery in suitable sealed containers.

4.5.2.2 Valve regulated lead-acid batteries

Valve regulated lead-acid battery cells shall be supplied filled and charged. These cells must receive a commissioning charge within 6 months of leaving the factory (3 months in tropical climates). Air-freighting of cells shall be considered as an alternative to sea-freight if these commissioning requirements cannot otherwise be met.

4.6 MARKING

All external operating, measuring and indicating components shall be clearly identified with permanent descriptive labels that allow easy recognition by the operator. All components shall be identifiable by labels inscribed in accordance with the system of identification used on the Manufacturer's reference drawings and documents.

Rail-mounted terminals of equipment and components shall be identifiable by numerical, alphabetical, or alpha-numerical markings in accordance with the Manufacturer's drawings. Terminals of input and output supply cables shall be clearly and individually marked to indicate the nominal system voltage and the phase/polarity of the supply.

The identification of terminals shall be in accordance with IEC 445.

The following information shall be inscribed on a non-destructive, corrosion-resistant, indelible name/rating plate attached to the rectifier unit enclosure :

- purchaser's order number;
- year of manufacture;
- name of Manufacturer;
- type and serial number of unit;
- nominal input current and voltage;
- nominal output current and voltage.

A similar name/rating plate, inscribed with the following information, shall be attached to the battery rack or cabinet:

- purchase order number;
- year of manufacture;
- name of Manufacturer;
- type of battery;
- number of cells;
- nominal capacity of cells.

All other labels/nameplates shall be of corrosion-resistant material with indelible inscriptions in the language specified in the requisition.

4.7 FINISH

The treatment and protection of metalwork shall include cleaning, degreasing, rust resisting primers and paint finishes that provide effective protection against corrosion under the functional and climatic conditions described in (2.4).

5. MEASUREMENT, PROTECTIONS AND CONTROL EQUIPMENT

5.1 GENERAL

The DC UPS unit shall incorporate all the necessary equipment to enable operation, protection and control of the unit in accordance with this specification, and to safeguard it and its components from the consequences of internal and external short circuits, overvoltages and any main or control circuit malfunctions, howsoever caused.

Operating, status and diagnostic indications by means of light-emitting diodes (LED's) or liquid crystal displays (LCD's) are acceptable. Each LED/alarm circuit shall have in-built test facilities. Failure of an LED/LCD shall not cause DC UPS unit maloperation or affect the correct functioning of the remote common alarm signal. Indication by means of filament lamps is not acceptable.

5.2 STATUS INDICATIONS

At least the following indications, in the form of LED/LCD's and/or measuring instruments, shall be provided on the front outside panel of the unit to enable verification of the operational status of the DC UPS unit.

- AC input supply available;
- rectifier on;
- battery on rapid charge.*

*not applicable for valve regulated batteries.

5.3 MEASUREMENT

Measuring instruments may have digital or analogue display. The following measuring instruments shall be provided on the front outside panel of the unit:

- DC voltmeter measuring DC circuit voltage;
- DC ammeter measuring battery charge and discharge current;
- DC ammeter measuring rectifier output current.

All measuring instruments shall be at least as accurate as that corresponding to class 1.5 of IEC 51-2.

5.4 ALARMS, TRIPS AND FUSE PROTECTION

5.4.1 Alarms and trips

The status of the alarm and trip functions shall be visually verifiable by appropriate indicators. Alarms associated with trip functions shall be able to be reset by hand.

The following alarm and trip functions shall be provided as a minimum:

(1 = alarm; 2 = alarm and trip rectifier)

- AC input phase undervoltage	2
- Rectifier failure	2
- DC overvoltage	1
- DC undervoltage	1
- Charge failure/battery discharging	1
- Cubicle fan failure*	1
- Cubicle temperature high*	2

* For rectifiers with forced air cooling only.

The above alarm contacts shall be wired to a terminal block such as to provide one normally open and one normally closed, potential-free, contacts for remote cabling to a common alarm. The operation of the common alarm contacts shall have an adjustable time delay with a range of not less than 4 seconds.

5.4.2 Rectifier DC output and battery circuit fuse links

Rectifier output and battery circuit fuse links shall be general-purpose type "gG" in accordance with IEC 269. The rating of rectifier output and battery circuit fuse links shall be coordinated such that the battery supply to the load is maintained in the event of rectifier short circuits. If a moulded-case circuit breaker is selected for battery circuit protection then it shall be category B in accordance with IEC 947-2.

5.5 CONTROLS

The following adjustment and control facilities shall be provided:

- DC UPS unit input isolation switch;
- Rectifier on/off control switch;
- Rapid charge initiation switch*;
- Rapid charge duration timer*;
- DC output voltage adjustment;
- DC current limit adjustment;
- Float charge control on battery temperature**;
- DC UPS unit output isolation switch.

* not applicable for valve regulated batteries.

** applicable for valve regulated lead-acid batteries, to be provided if battery cell temperature is expected to be less than 10°C or more than 30°C.

NOTE: As an alternative to the input and/or the output isolating switches, contactors with front mounted control switches are acceptable.

5.6 BATTERY DIAGNOSTIC FACILITIES

If indicated on the requisition, the DC UPS unit shall be provided with an on-line battery cell monitoring and/or battery discharge test facility to determine battery condition without having to disconnect the DC UPS unit from the load.

The monitoring facility shall measure voltage levels of blocks of cells within a battery, either by means of a permanently installed monitoring device or alternatively by means of a portable device which can be plugged into a battery control panel which is prewired to the battery cells. The monitoring device shall have an alarm at a preset voltage level (high and low) indicating under-performance of a particular block of cells.

The on-line discharge test facility shall be such that a short duration battery discharge into the load can be effected manually. Battery terminal voltage and load current shall be measured during such a discharge and, by comparing these measurements with the pre-programmed discharge characteristics of the particular battery, shall be able to predict time left until end of discharge down to the final discharge voltage (3.5) at that particular load current. It shall also indicate whether the battery capacity deviates by more than a certain, adjustable, value from its nominal capacity.

The above test facilities shall be mounted on the front of the rectifier cabinet.

6. INSPECTION AND TESTS

6.1 GENERAL

Prior to despatch, the Manufacturer shall verify by test that the operation of the assembled DC UPS unit complies with the requirements specified on the purchase order documents, and shall submit to the Purchaser a report incorporating measurements and results of all tests performed (6.3).

If specified on the requisition, a representative of the Purchaser shall witness the functional tests (6.3) and shall carry out an inspection of the assembled unit and related documents to verify compliance with the requirements of the purchase order and this specification.

Unless otherwise specified, testing of the assembled DC UPS unit at the Manufacturer's works need not include the battery that forms part of the purchase order. Tests shall be confined to verifying the performance of the rectifier, assembly and related auxiliaries. Battery discharge tests to verify the capacity of the battery shall be performed by the Purchaser as part of the commissioning procedure after site erection.

Prior to the commencement of tests, the Manufacturer shall make all relevant adjustments to the protection and control circuit components of the rectifier, as necessary to fulfil the requirements of the purchase order and this specification. The rectifier output voltage and current limits shall be set to the appropriate values for the type and number of battery cells and to the relevant cell temperatures referred to in (2.4).

6.2 QUALITY CONTROL

The Manufacturer shall make available for review by the Principal a quality control programme, based on ISO 9002, regarding inspection and testing of the DC UPS components. This programme shall include heat-soak/burn-in tests.

NOTE: Prior to final assembly and conducting the load duration tests (6.3), individual electronic components shall be submitted to 24-hour heat-soak test, at temperatures not less that 70°C, but otherwise in accordance with the Manufacturer's standards.

6.3 PERFORMANCE TESTS

6.3.1 Insulation Tests

The voltages specified in the following table shall be applied for one minute to the circuits indicated:

Withstand voltages	Control electronics < 60 V	Power electronics Un1	Auxiliary circuits Un2
To earth	700 V DC	(2 x Un1) + 1000 V	(2 x Un2) + 1000 V
To control electronics	-	(2 x Un1) + 1000 V	(2 x Un2) + 1000 V
To power electronics	(2 x Un1) + 1000 V	-	(2 x Un1) + 1000 V
To auxiliary circuits	(2 x Un2) + 1000 V	(2 x Un1) + 1000 V	-

DC test voltages may be applied instead of AC. The magnitude of DC test voltages to be applied shall be √2 times the above-mentioned AC (rms) values.

6.3.2 Load-duration test

All rectifiers shall be subjected to a load-duration test performed at rated voltage for a period of not less than 48 hours prior to the execution of functional tests.

At least one rectifier of each group of identical rectifiers shall be loaded to its rated output, throughout the 48-hour test period.

All other rectifiers shall be energized as above or under partial load or zero load current conditions throughout the test period.

Manufacturer's test reports shall state the dates and times on which the load-duration test was performed and shall record details of load currents and any circuit or component malfunction identified during the test period.

6.3.3 Functional tests

Functional tests shall be performed on all rectifiers. If, during the execution of functional tests, an electronic component of the rectifier is required to be replaced, e.g. due to rectifier malfunction or failure of the unit to fulfil the performance requirements of the specification, then the rectifier load-duration test shall be repeated at rated current following which the functional tests shall be carried out.

The Manufacturer's standard test protocol will be acceptable provided it is no less stringent than that specified below.

6.3.3.1 Rectifier load test at constant output voltage:

Measurements shall be carried out in the rectifier float-charge operating mode and in the rapid-charge operating mode. In each mode, measurements shall be carried out at nominal AC supply voltage and at zero, 50% and 100% of rectifier full load direct current. Measurements at 100% full load current shall be repeated at 90% and 110% of nominal AC supply voltage.

Measurements shall comprise:

- input phase voltage and frequency;
- input phase current;
- input power;
- DC output voltage;
- DC output current;
- output voltage ripple (this test may be omitted subject to the Manufacturer submitting test records for approval by the Purchaser which identify the dates and location of tests, and demonstrate compliance with the specified performance values.).

6.3.3.2 Rectifier load test at constant output current limit:

Measurements shall be carried out both in the rectifier float-charge operating mode and in the rectifier rapid-charge operating mode. In each mode, measurements shall be carried out when the rectifier is operating under DC output current-limiting conditions with the DC output voltage between zero and the set value corresponding to constant voltage operation.

Measurements shall comprise:

- DC output voltage;
- DC output current.

6.3.3.3 Auxiliary equipment and control circuit tests:

The correct functioning of all measuring instruments, alarms and indications, protection and controls referred to in (3) and (5) shall be verified.

6.3.3.4 Battery discharge test (6.1):

A battery discharge test shall be performed at the rated current of the DC UPS unit.

The following measurements shall be recorded:

- battery voltage after the specified discharge time (3.4);
- battery discharge duration at the instant of initiation of the DC circuit low-voltage monitor.

NOTE: Although the battery discharge test need not be performed by the Manufacturer prior to shipment (6.1), all battery cells shall be tested individually by the battery Manufacturer, prior to despatch, to ensure correct cell performance.

7. DOCUMENTS

The Manufacturer shall submit at least the following documents to the Purchaser:

- general arrangement drawings;
- main and control circuit schematic diagrams;
- equipment lists;
- recommended spare parts lists;
- test reports and performance curves;
- operating manuals incorporating installation, commissioning, operating and maintenance instructions, and fault-finding procedures.

8. REFERENCES

In this DEP, reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest issue of each publication shall be used (together with any amendments/supplements/revisions thereof)

SHELL STANDARDS

Index to DEP publications and Standard Specifications	DEP 00.00.05.05-Gen.
Requisition data sheet for DC Supply Unit	DEP 33.65.50.93-Gen.

BRITISH STANDARDS

Noise Procedure Specification	EEMUA 140

Issued by:
The Engineering Equipment and Materials Association,
14, Belgrave Square
London SW1X 8 PS

EUROPEAN STANDARDS

Limits and methods of measurement of radio interference characteristics of household electrical appliances, portable tools and similar electrical apparatus	EN 55014
Limits and methods of measurement of radio interference characteristics of fluorescent lamps and luminaires	EN 55015
Limits and methods of measurement of radio interference characteristics of information technology equipment	EN 55022

INTERNATIONAL STANDARDS

Recommendations for direct acting indicating analogue electrical measuring instruments and their accessories: Part 2: Special requirements for amperemeters and voltmeters	IEC 51-2
Semiconductor converters	IEC 146
Low-voltage fuses	IEC 269
Identification of equipment terminals and of terminations of certain designated conductors, including general rules for an alphanumeric system	IEC 445
Stabilized power supplies, d.c. output	IEC 478
Classification of degrees of protection provided by enclosures (IP Code)	IEC 529
Vented Nickel-Cadmium prismatic rechargeable single cells	IEC 623

Electromagnetic compatibility for industrial process measurement and control equipment Part 3: Radiated electromagnetic field requirements	IEC 801-3
Stationary lead-acid batteries; general requirements and methods of test	IEC 896
Low-voltage switchgear and control gear Part 2: Circuit breakers	IEC 947-2
Part 3: Switches, disconnectors, switch disconnectors, and fuse-combination units	IEC 947-3
Part 4: Contactors and motor starters Section 1 - Electromechanical contactors and motor starters	IEC 947-4-1

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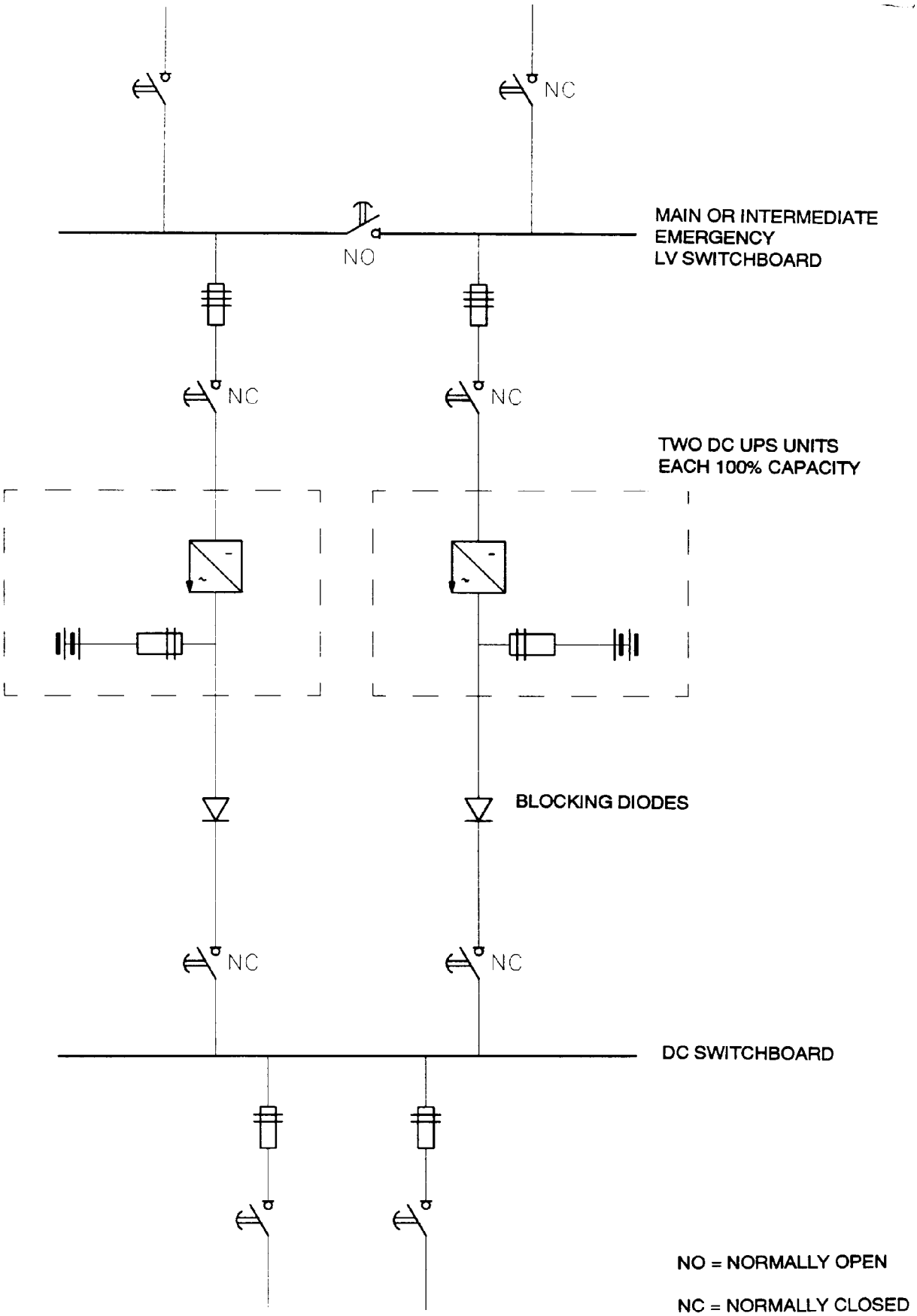
APPENDICES

APPENDIX 1 TYPICAL ARRANGEMENT OF A DC UPS SYSTEM



APPENDIX 2 SPECIAL REQUIREMENTS FOR TELECOMMUNICATION APPLICATIONS

The technical requirements of this DEP may be applied also to DC UPS units feeding telecommunication equipment, except for the following amendments:

(3.1) Rectifier

The rectifier shall be rated to:
- fulfil the load requirements as stated in the requisition, and simultaneously;
- recharge the battery within a period not exceeding 72 hours, from the partially discharged condition to 95% nominal capacity.

(3.3) Battery Rapid-Charge Operation

The rectifier shall not have facilities to rapid charge the battery.

(3.4) Battery and DC Circuit

The battery positive terminal should be earthed.

(3.5) Output Voltage Requirements

To avoid unacceptable levels of electrical noise in the connected equipment smoothing of the DC output is required to achieve:
- less than 50 mV rms over the range 10 Hz to 10 Mhz;
- less than 1 mV rms psophometrically weighted (800 Hz centre of frequency).

(4.1.1) Unit Enclosure

The rectifier should be provided in rack mount configuration (19 or 23 inches wide).