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IOGP S-701, Supplementary Specification to IEC 62040-3 for AC Uninterruptible Power Systems (UPS), Second Edition, January 2024

ADDENDUM 1

This addendum (Version 2.01) replaces Edition 2.0 published in January 2024.

NOTE: In addition to the updates listed below, minor editorial/typographical amendments may have been made.

List of updates

Clause/subclause	Update
2	Reference IEC 60364-4-44 added
3.0	Abbreviated terms IP and TCP added
5.1.2	First addition to subclause amended
7.1	New subclauses 7.1.6 and 7.1.7 added
7.3	New subclause 7.3.6 added
7.4	New subclause 7.4.11 added
7.5	New subclauses 7.5.4 and 7.5.5 added
7.7	New subclause 7.7.5 added
8.2	New subclause 8.2.7 added
8.3	New subclause 8.3.6 added
8.4	Subclauses 8.4.1.5 and 8.4.1.8 amended New subclause 8.4.1.10 added Subclause 8.4.2 amended
Bibliography	References ATEX Directive (2014/34/EU), Ecodesign Directive (2009/125/EC), Electromagnetic Compatibility Directive (EMCD) (2014/30/EU), IEC 62402, Low Voltage Directive (LVD) (2014/35/EU) and PIP ELSAP04 added

SPECIFICATION
IOGP S-701J

October 2025
Version 2.01

ADDENDUM 1 TO SECOND EDITION (JANUARY 2024)

Supplementary Specification to IEC 62040-3 for AC Uninterruptible Power Systems (UPS)

NOTE This version (S-701J) of the specification document provides the justification statements for each technical requirement, but is otherwise identical in content to S-701.

Revision history

VERSION	DATE	PURPOSE
2.01	October 2025	Addendum 1
2.0	January 2024	Second Edition
1.0	August 2020	First Edition

Acknowledgements

This IOGP Specification was prepared by a Joint Industry Programme 33 Standardization of Equipment Specifications for Procurement organized by IOGP with support by the World Economic Forum (WEF).

Foreword

This specification was prepared under Joint Industry Programme 33 (JIP33) "Standardization of Equipment Specifications for Procurement" organized by the International Oil & Gas Producers Association (IOGP) with the support from the World Economic Forum (WEF). Companies from the IOGP membership participated in developing this specification to leverage and improve industry level standardization globally in the oil and gas sector. The work has developed a minimized set of supplementary requirements for procurement, with life cycle cost in mind, resulting in a common and jointly agreed specification, building on recognized industry and international standards.

Recent trends in oil and gas projects have demonstrated substantial budget and schedule overruns. The Oil and Gas Community within the World Economic Forum (WEF) has implemented a Capital Project Complexity (CPC) initiative which seeks to drive a structural reduction in upstream project costs with a focus on industry-wide, non-competitive collaboration and standardization. The CPC vision is to standardize specifications for global procurement for equipment and packages. JIP33 provides the oil and gas sector with the opportunity to move from internally to externally focused standardization initiatives and provide step change benefits in the sector's capital projects performance.

This specification has been developed in consultation with a broad user and supplier base to realize benefits from standardization and achieve significant project and schedule cost reductions.

The JIP33 work groups performed their activities in accordance with IOGP's Competition Law Guidelines (November 2020).

This second edition cancels and replaces the first edition published in August 2020. Due to technical writing requirements leading to extensive changes, this second edition should be treated as a new document.

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Introduction

The purpose of the IOGP S-701 specification documents is to define a minimum common set of requirements for the procurement of AC uninterruptible power systems (UPSs) in accordance with IEC 62040-3, Edition 3.0, 2021-04, uninterruptible power systems (UPS) – Part 3: Method of specifying the performance and test requirements, for application in the petroleum and natural gas industries.

The IOGP S-701 specification documents follow a common structure (as shown below) comprising a specification, also known as a technical requirements specification (TRS), a procurement data sheet (PDS), an information requirements specification (IRS) and a quality requirements specification (QRS). These four specification documents, together with the purchase order, define the overall technical specification for procurement.

JIP33 Specification for Procurement Documents
Supplementary Technical Requirements Specification (TRS)

This specification is to be applied in conjunction with the supporting PDS, IRS and QRS as follows.

IOGP S-701: Supplementary Specification to IEC 62040-3 for AC Uninterruptible Power Systems (UPS)

This specification defines technical requirements for the supply of the equipment and is written as an overlay to IEC 62040-3, following the IEC 62040-3 clause structure. Clauses from IEC 62040-3 not amended by this specification apply as written. Modifications to IEC 62040-3 defined in this specification are introduced by a description that includes the type of modification (i.e. *Add*, *Replace* or *Delete*) and the position of the modification within the clause.

NOTE Lists, notes, tables, figures, equations, examples and warnings are not counted as paragraphs.

IOGP S-701D: Procurement Data Sheet for AC Uninterruptible Power Systems (UPS) (IEC)

The PDS defines application-specific requirements. The PDS is applied during the procurement cycle only and does not replace the equipment data sheet. The PDS may also include fields for supplier-provided information required as part of the purchaser's technical evaluation. Additional purchaser-supplied documents may also be incorporated or referenced in the PDS to define scope and technical requirements for enquiry and purchase of the equipment.

IOGP S-701L: Information Requirements for AC Uninterruptible Power Systems (UPS) (IEC)

The IRS defines information requirements for the scope of supply. The IRS includes information content, format, timing and purpose to be provided by the supplier, and may also define specific conditions that invoke the information requirements.

IOGP S-701Q: Quality Requirements for AC Uninterruptible Power Systems (UPS) (IEC)

The QRS defines quality management system requirements and the proposed extent of purchaser conformity assessment activities for the scope of supply. Purchaser conformity assessment activities are defined through the selection of one of four generic conformity assessment system (CAS) levels on the basis of evaluation of the associated service and supply chain risks. The applicable CAS level is specified by the purchaser in the PDS or in the purchase order.

The specification documents follow the editorial format of IEC 62040-3 and, where appropriate, the drafting principles and rules of ISO/IEC Directives Part 2.

The PDS and IRS are published as editable documents for the purchaser to specify application-specific requirements. The TRS and QRS are fixed documents.

The order of precedence of documents applicable to the supply of the equipment, with the highest authority listed first, shall be as follows:

a) regulatory requirements;

b) contract documentation (e.g. purchase order);

c) purchaser-defined requirements (e.g. PDS, IRS and QRS);

d) this specification;

e) IEC 62040-3.

1 Scope

Add to second paragraph

This specification additionally covers the AC UPS design and performance requirements for rectifiers, inverters, static switches, static and maintenance bypasses, battery isolator box, and functional requirements related to measurement, protection and alarms. Packing, handling, preservation and storage requirements are specified.

Justification

IEC 62040-3 deals only with the performance and test requirements of the AC UPS. Additional design, performance and functional requirements are specified in this specification. Packing, handling, preservation and storage requirements are included.

2 Normative references

Add to first paragraph

The following publications are referred to in this document, the PDS (IOGP S-701D) or the IRS (IOGP S-701L) in such a way that some or all of their content constitutes requirements of this specification.

Add to clause

IEC 60076-1, *Power transformers – Part 1: General*

IEC 60076-11, *Power transformers – Part 11: Dry-type transformers*

IEC 60076-12, *Power transformers – Part 12: Loading guide for dry-type power transformers*

IEC 60085, *Electrical insulation – Thermal evaluation and designation*

IEC 60092 (all parts), *Electrical installations in ships*

IEC 60364-4-44, *Low-voltage electrical installations - Part 4-44: Protection for safety - Protection against voltage disturbances and electromagnetic disturbances*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60721-2-6, *Classification of environmental conditions – Part 2-6: Environmental conditions appearing in nature – Earthquake vibration and shock*

IEC 60947-2, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*

IEC 60947-3, *Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*

IEC 60947-4-1, *Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters*

IEC 61000-2-4:2002, *Electromagnetic compatibility (EMC) – Part 2-4: Environment – Compatibility levels in industrial plants for low-frequency conducted disturbances*

IEC 61892 (all parts), *Mobile and fixed offshore units – Electrical installations*

IEC 62040 (all parts), *Uninterruptible power systems (UPS)*

IOGP S-740, *Specification for Batteries (IEC)*

Replace Clause 3 title with

3 Terms, definitions and abbreviated terms

Add new subclause 3.0 to start of clause

3.0 Abbreviated terms

AC	alternating current
BMS	battery management system
CAS	conformity assessment system
DC	direct current
ECMS	electrical control and management system
ESD	emergency shutdown
FGS	fire and gas system
HMI	human machine interface
IP	internet protocol
IRS	information requirements specification
LED	light emitting diode
MCB	miniature circuit breaker
MCCB	moulded case circuit breaker
MCT	multi-cable transit
PCS	process control system
PDS	procurement data sheet
QRS	quality requirements specification
SIS	safety instrumented system
TCP	transmission control protocol
TRS	technical requirements specification
VRLA	valve-regulated lead-acid

3.2 Systems and components

Add new term 3.2.39

3.2.39
electrical control and management system
ECMS
system that automatically controls the electrical power and distribution system through instrumentation and control devices

Add new term 3.2.40

3.2.40
process control system
PCS
system that includes overall site-integrated process automation, control and/or monitoring

3.3 Performance of systems and components

Add new term 3.3.20

3.3.20
soft start
function that controls the gradual increase of AC input current within a specified time when the UPS starts or restarts

4 Environmental conditions

4.2 Normal conditions

4.2.2 Operation

4.2.2.1 Ambient temperature and relative humidity

Add to start of first paragraph

For industrial applications,

Justification

The ambient temperature and humidity range specified in IEC 62040-3 is considered to be more supportive to commercial sector UPSs, hence the requirements for industrial applications are specified.

In first list item, replace "+15 °C to +30 °C" with

0 °C to +40 °C

Justification

The 0 °C to +40 °C ambient temperature range is considered a minimum requirement for industrial AC UPSs. The +15 °C to +30 °C range specified in IEC 62040-3 is considered to be more supportive to commercial sector UPSs.

In second list item, replace "10 % to 75 %" with

20 % to 80 %

Justification

The 20 % to 80 % (non-condensing) relative humidity range is considered a minimum requirement for industrial AC UPSs. The 10 % to 75 % (non-condensing) range specified in IEC 62040-3 is considered to be more supportive to commercial sector UPSs.

5 Electrical conditions, performance and declared values

5.1 General

5.1.2 Markings and instructions

Add to subclause

The nameplate shall include the following information:

- item serial number;
- purchase order reference;
- month and year of manufacture;
- manufacturer's address;
- battery type;
- battery capacity (Ah).

Justification

This information is helpful to identify a specific AC UPS purchased for the project.

Add to subclause

Caution, danger and warning labels shall display information in English and, if applicable, in an additional specified language.

Justification

Identifying warnings in the local language is important for the safety of personnel working around the equipment.

Add new subclause

5.1.3 Electromagnetic compatibility

The AC UPS shall conform to the electromagnetic emission and immunity levels of IEC 62040-2 for the specified category level.

Justification

EMC (emission and immunity) levels are important. This requirement specifies the EMC levels necessary to prevent UPS electromagnetic interference with other equipment (emission) and UPS immunity to external electromagnetic interference.

Add new subclause

5.1.4 Noise

The sound pressure level, measured at a distance of 1 m from the AC UPS in any direction, shall not exceed the specified value at load conditions ranging from no load to the rated load.

Justification

This occupational and environmental safety requirement is followed in the industry to prevent noise pollution.

Add new subclause

5.1.5 UPS design basis

The operational life of the AC UPS components at the rated load shall be in accordance with Table 7.

Justification

Reliable performance is key to the UPS and this requirement ensures that serviceable parts and components supplied for the AC UPS have a defined life expectancy.

Add new Table 7

Table 7 – UPS operational life

Components	Minimum operation life (years)
Rectifier unit, inverter unit and static switch unit	20
Cooling fan	5
AC capacitor and DC capacitor	7
Input isolation transformer and output isolation transformer	20
Bypass transformer	20

Justification

Reliable performance is key to UPS and this table ensures that serviceable parts or components supplied for the AC UPS have a defined life expectancy.

Add new subclause

5.1.6 Overload capacity

5.1.6.1

The AC UPS shall have an overload capacity of at least 125 % of the rated output current for 10 min.

Justification

The UPS is capable of supplying power continuously to prevent power loss at output as long as any of the input power sources (AC mains, stored energy) are available. This requirement ensures that the UPS is capable of sustaining short-time overloads and peak demand of currents (short circuits) in case of an electrical fault at the output side (load side).

5.1.6.2

The AC UPS shall have an overload capacity of at least 150 % of the rated output current for 1 min.

Justification

The UPS is capable of supplying power continuously to prevent power loss at output as long as any of the input power sources (AC mains, stored energy) are available. This requirement ensures that the UPS is capable of sustaining short-time overloads and peak demand of currents (short circuits) in case of an electrical fault at the output side (load side).

5.1.6.3

If no value is specified, the design value for the inverter short circuit shall be 200 % of the rated current for 0.1 s.

Justification

The UPS is capable of supplying power continuously to prevent power loss at output as long as any of the input power sources (AC mains, stored energy) are available. This requirement ensures that the UPS is capable of sustaining short-time overloads and peak demand of currents (short circuits) in case of an electrical fault at the output side (load side).

NOTE Battery sizing is independent of the output overload capacity of the AC UPS.

Justification

Batteries are not included in this specification. This note is only a caution statement to consider the correct data for battery sizing calculation.

5.2 UPS input specification

5.2.1 Conditions for normal mode operation

In second list item of list item d), replace second paragraph (< 12 % with…) with

> ≤ 8 % in accordance with IEC 61000-2-4:2002, Table 5 with maximum level of individual harmonic distortion of voltages in accordance with IEC 61000-2-4:2002, Table 2, Table 3 and Table 4 for class 2 compatibility levels.

NOTE This requirement is applicable to onshore and offshore installations.

Justification

A THD of ≤ 12 % and class 3 compatibility level for individual harmonics specified in IEC 62040-3 is on the higher side and most supplier standard products are associated with ≤ 8 % THD and class 2 compatibility level for individual harmonics. Higher input voltage harmonics could potentially increase the equipment cost. The standard industry practice for maintaining the THD at low voltage networks is ≤ 8 % or better, hence ≤ 8 % THD and class 2 compatibility levels for individual harmonics are specified. IEC 61892-1 for offshore installations refers back to IEC 61000-2-4 for harmonic compatibility levels, hence it is specified as a common requirement for both onshore and offshore installations.

5.6 Signal, control and communication ports

Add to subclause

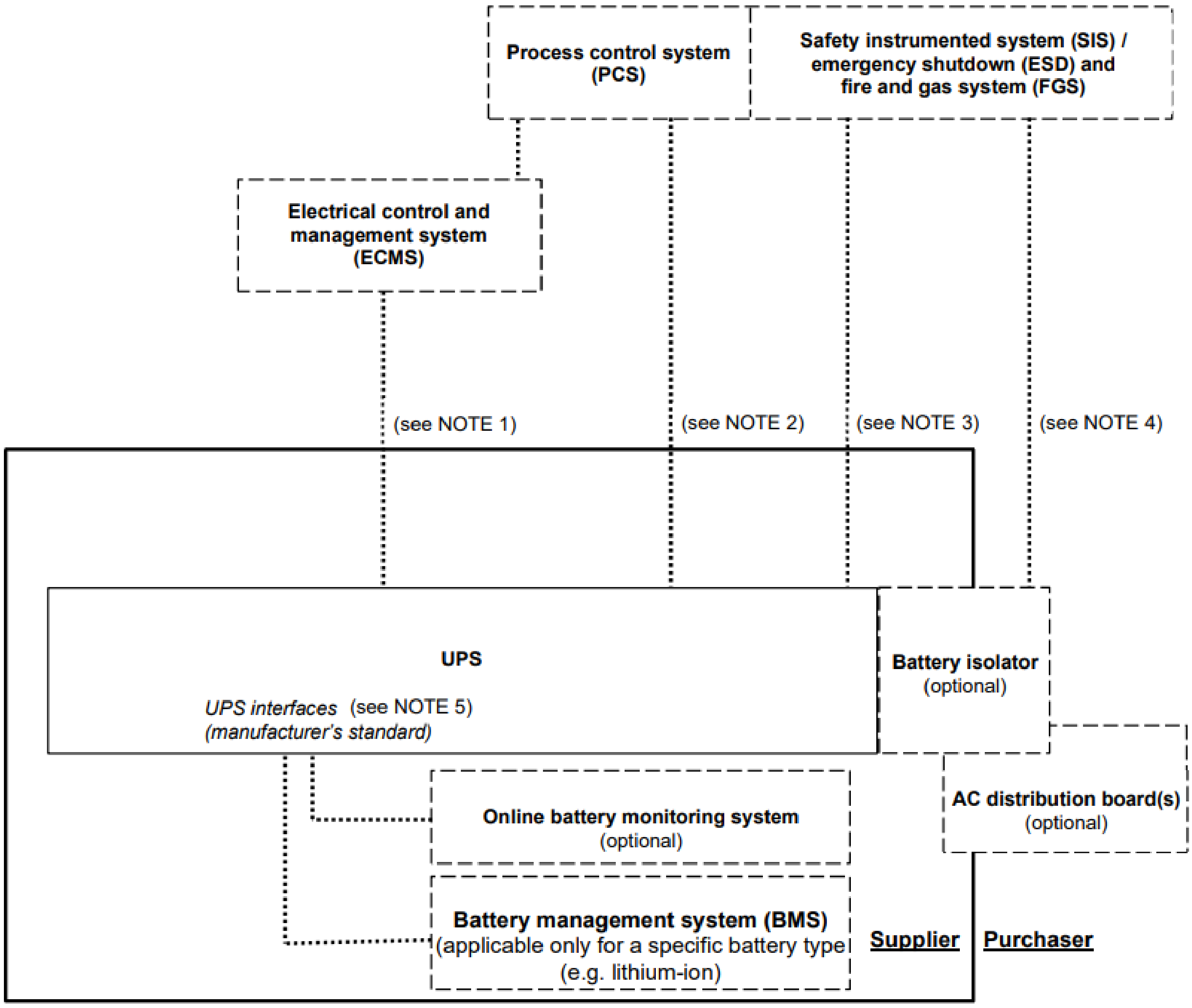
The AC UPS shall be provided with communication hardware compliant with the specified interface media and protocol.

Justification

The industry has a wide choice of communication media and protocol. The choice of required media and protocol can be exercised through the PDS. This requirement ensures the hardware compatibility of the AC UPS for the selected media and protocol.

NOTE See Figure 6 for a typical communication interface block diagram detailing data communication and signalling circuits intended to be exchanged between the AC UPS and other equipment.

Add new Figure 6



NOTE 1 Network connectivity interface for time synchronization, remote access and configuration.

NOTE 2 Direct interface for critical / safety critical status and alarms to PCS where the ECMS is not present, independent of the ESD system trip.

NOTE 3 Direct interface for the ESD trip and the FGS function (e.g. boost charge inhibit) / trip.

NOTE 4 Direct interface for ESD and FGS trips.

NOTE 5 Supplier standard interface for synchronization and load sharing between the UPSs (applicable for parallel systems), UPS battery monitoring system and BMS where applicable.

Figure 6 – Typical communication interface block diagram

Justification

This diagram shows the typical communication interface between the AC UPS and other equipment. The communication media, protocol and hard wiring requirements could be project specific and should be communicated to the supplier for compliance.

6 UPS tests

6.5 Type tests – Environmental

6.5.3 Operation in dry heat, damp heat and cold environments

Replace list item c) 2) with

2) Damp heat at +30° C ±2° C at a humidity between 82 % and 88 % for a duration of 96 h using test method Cab of IEC 60068-2-78.

Justification

82 % to 88 % humidity for damp heat testing is specified to support the requirement of 20 % to 80 % (non-condensing) relative humidity specified for industrial UPSs in 4.2.2.1, second list item of first paragraph. 72 % to 78 % humidity specified in IEC 62040-3 for damp heat testing is aligned with the requirement of the 10 % to 75 % (non-condensing) relative humidity range for the UPS operation, which is considered to be more supportive to commercial sector UPSs.

Add new clause

7 Design requirements

7.1 General

7.1.1

Components, printed circuit boards, connectors and terminals, including their locations, shall be identified with labels in accordance with IEC 62040-1.

Justification

Identification of components, printed circuit boards, connectors and terminals help to minimize troubleshooting time. Labelling these items individually and referencing them in schematics, troubleshooting manual and technical manual expedite the fault-finding process. Labelling prevents component mounting at a wrong location and incorrect plugging of connectors or terminals. Labelling helps to maintain the spare parts inventory.

7.1.2

Components requiring periodic replacement shall be listed in the spare parts list with the recommended replacement frequency.

Justification

A spare part list helps maintenance personnel to ensure availability of spare parts with the right specification and required quantity prior to the end of life. Scheduled outages prevent exigencies due to failure of components and this improves continued availability of the UPS for operation.

7.1.3

An obsolescence management plan in accordance with an industry recognized system (e.g. IEC 62402) shall be provided for all AC UPS assembly components.

Justification

An obsolescence management plan helps ensure the availability of components or spares in the market for main equipment during its service life. Unforeseen obsolescence could involve higher costs by means of engaging alternate resources to resolve the crisis. This situation could place reliability and operation of critical systems at risk. Hence, having an obsolescence management plan in place reduces the risk of obsolescence issues and/or reduces the impact when an item becomes obsolete.

7.1.4

Components weighing more than 25 kg shall have provisions for mechanical handling.

Justification

Considering ergonomic issues while handling heavy items, any component weighing more than 25 kg needs appropriate provisions (e.g. lifting/pulling lugs, eye bolts) for mechanical handling as per common industry practice.

7.1.5

If supplied, the battery bank shall comply with the requirements of IOGP S-740.

Justification

The IOGP S-740 set of specification documents which includes IOGP S-740 (TRS), IOGP S-740D (PDS), IOGP S-740Q (QRS) and IOGP S-740L (IRS) specifies the requirements for compliance when a battery bank is supplied as part of a UPS package. IOGP S-740 is included as a normative reference to this specification.

7.1.6

Cabling between components shall consist of one continuous length without splicing.

Justification

Splicing or joining of cables can lead to heating of the joint and increase the likelihood of a short circuit or failure.

7.1.7

Nameplates on compartment doors and panels shall be mounted with stainless steel screws.

Justification

The use of non-stainless steel hardware for these important identifiers may result in illegibility due to corrosion or loss of the nameplate altogether.

7.2 Enclosure

7.2.1

The AC UPS shall be installed in steel cabinet enclosures.

Justification

The UPS is considered critical equipment. This requirement ensures that the UPS is securely installed within steel cabinet enclosures on the floor or on the wall with the required supports and fixtures. Smaller units are mounted on a wall or on a pedestal frame where appropriate. Otherwise, floor mounting is considered the most appropriate option for units with steel cabinet enclosures.

7.2.2

The enclosure shall have an external degree of protection of at least IP31 with doors closed in accordance with IEC 60529.

Justification

The degree of protection specifies the extent of protection to be provided by the enclosure against access to hazardous parts by personnel, against ingress of solid objects and of water. The first characteristic digit "3" specifies that the enclosure should have protection against ingress of any object having a size ≥ 2.5 mm to prevent contact with hazardous live parts. The second characteristic digit "1" specifies that the enclosure should have protection against ingress of vertically dripping water. The UPS is generally installed in a climatically controlled atmosphere maintained by a HVAC system with restricted access (only qualified electrical personnel can enter). Water (condensate) dripping from the HVAC duct is a likely scenario and an enclosure installed under the duct requires protection against vertically dripping water.

7.2.3

Undrilled removable gland plates or multi-cable transits (MCTs) shall be used for cable entry.

Justification

Gland plates or MCTs are used for sealing and termination of cables at their end locations. Undrilled removable gland plates are drilled to fit the cable gland of the cable size selected. Sometimes, cable sizing is done at a later stage of the project. Gland plates pre-drilled based on preliminary cable sizes may call for a replacement of the gland plate or re-work at site, hence undrilled gland plates are preferred.

7.2.4

Gland plates for single-core cable entries shall be made of non-magnetic material.

Justification

The net flux surrounding the single-core cable induces eddy current in gland plates made of magnetic material such as steel. The induced eddy current results in the heating of glands and subsequent failure of cable insulation due to heat. A non-magnetic material gland plate for single-core entry prevents eddy current heating.

7.3 Accessibility and maintenance safety

7.3.1

Access for operation and maintenance shall be from the AC UPS cabinet front only.

Justification

The layout of UPS components and modules is done with the objective to facilitate service, maintenance and repair of items from the front of the enclosure. This requirement is more relevant in a location where there is space constraint, and no additional space around the enclosure is used for service, maintenance and repairs. This requirement ensures minimum dismantling, faster restoration and increased availability of the equipment.

7.3.2

AC UPS assemblies shall provide a minimum internal degree of protection in accordance with Table 8.

Justification

This requirement ensures that personnel are protected against accidental contact with hazardous parts or live components that are accessible with the compartment door open. The ingress requirement of IP2X ensures the protection against openings ≥ 12,5 mm for objects and tools and against access by finger during internal maintenance. IPXXB is stipulated (as distinct to IP2X) as once the door is open, the compartment is no longer an enclosure. The degree of protection IPXXB is chosen when the danger addresses access to hazardous parts only (direct contact) rather than protection of an enclosure against ingress of solid foreign objects combined with protection against access to hazardous parts. IPXXB is the equivalent of "touch-safe".

Add new Table 8

Table 8 – Internal degree of protection

Location	Minimum degree of protection
Between panels or cabinet enclosures	IP 2X
Between compartments of each functional unit and other compartments	IP XXB
Fuse-links and associated fuse carriers	IP XXB
Air-insulated live parts inside enclosures or on the inside face of compartment doors that are accessible with the compartment door open	IP XXB
NOTE IPXXB is stipulated in accordance with IEC 60529 as distinct to the use of designation IP2X when the door is open and the danger is access to hazardous parts within. IPXXB provides finger "touch-safe" protection against contact with live parts and electric shock equivalent to IP2X.	

Justification

This requirement ensures that personnel are protected against accidental contact with hazardous parts or live components that are accessible with the compartment door open.

The ingress requirement of IP2X ensures the protection against openings ≥ 12,5 mm for objects and tools or protected against access by finger while performing internal maintenance.

IPXXB is stipulated (as distinct to IP2X) as once the door is open, the compartment is no longer an enclosure. The degree of protection IPXXB is chosen when the danger is addressing access to hazardous parts only (direct contact) rather than protection of an enclosure against ingress of solid foreign objects combined with protection against access to hazardous parts. IPXXB is the equivalent of "touch-safe".

7.3.3

The maintenance bypass switch and bypass transformer shall be located in a separate compartment in accordance with the arrangement shown in Figure C.3 for servicing purposes.

Justification

Locating the maintenance bypass switch and transformer in a separate compartment ensures safety for maintenance personnel during maintenance of the AC UPS.

7.3.4

Isolating switches that enable the maintenance bypass mode of operation shall have a facility for padlocking in the open position.

Justification

Isolation switches with a padlocking facility improve maintenance personnel safety by locking the switches and thereby preventing accidental switching.

7.3.5

Terminals shall be provided in the external maintenance bypass compartment for wiring to and from the AC UPS rectifier/inverter/static bypass compartments to enable complete isolation during maintenance of the AC UPS.

Justification

Housing terminals of incoming and outgoing connections at the external bypass compartment provide additional safety and enable complete supply isolation.

7.3.6

Warning labels shall be provided on access doors of compartments containing external AC and DC voltage sources.

Justification

Warning labels warn operators that compartments contain potentially live equipment.

7.4 Components

7.4.1

Main circuit breakers and isolation switches shall have a facility for padlocking in the open position.

Justification

Switches and circuit breakers used in the power circuits provide electrical protection and supply isolation when required. For implementing the "lock out, tag out" (LOTO) procedure, maintenance personnel padlock the isolation device in the open position to ensure safety.

7.4.2

Mechanical-type main circuit switches shall be in accordance with IEC 60947-3.

Justification

IEC 60947-3 specifies the requirements for classification, characteristics, construction, performance and testing of switches, which ensures uniformity and quality of the switches supplied by the manufacturer as part of the UPS.

7.4.3

Main circuit switches shall comply with utilization category AC-22A and DC-22A for AC and DC switches respectively in accordance with IEC 60947-3.

Justification

IEC 60947-3 specifies the utilization category of switches operating under various load conditions. AC-22A and DC-22A category switches are meant to be applicable for frequent switching of mixed resistive and inductive loads, including moderate overloads. The loads to be connected to the UPS output are of categories AC-22A and DC-22A. Considering the life expectancy of 20 years for the UPS, the frequent switching category (suffix A) has been specified.

7.4.4

Main circuit breakers and isolation switches shall be manually operated.

Justification

The main circuit breakers and isolation switches provided in the UPS circuit are used for supply isolation and are operated manually but in a sequence as per the procedure described in the operating manual.

7.4.5

Main circuit breakers and isolation switches shall be of air-break type for continuous duty.

Justification

The main circuit breakers and isolation switches provided in the UPS circuit are used for supply isolation and are operated manually but in a sequence as per the procedure described in the operating manual. Air-break type is the most commonly used circuit breaker and isolation switch, and is widely available in the market for low-voltage applications.

7.4.6

Miniature circuit breakers (MCBs) and moulded case circuit breakers (MCCBs) shall comply with the requirements of IEC 60947-2.

Justification

IEC 60947-2 specifies the characteristics of circuit-breakers and their operating behaviour under normal and fault conditions, which ensures uniformity and quality of the MCBs and MCCBs supplied by manufacturers as part of the UPS.

7.4.7

Contactors shall be rated for continuous duty in accordance with IEC 60947-4-1.

Justification

IEC 60947-4-1 specifies the construction, dielectric properties, characteristics of contactors and operating behaviour under normal and fault conditions, which ensures uniformity and quality of contactors supplied by manufacturers as part of the UPS.

7.4.8

Contactors shall comply with utilization categories AC-1 and DC-1 for AC and DC contactors in accordance with IEC 60947-4-1.

Justification

IEC 60947-4-1 specifies the utilization category of contactors operating under various load conditions. AC-1 and DC-1 category contactors are meant to be applicable for switching of slightly inductive loads. The loads to be connected to the UPS output are of this category.

7.4.9

Transformers and reactors shall be of air-cooled type in accordance with IEC 60076-1, IEC 60076-11 and IEC 60076-12.

Justification

IEC 60076 specifies the requirements for dry-type power transformers. IEC 60076 ensures uniformity and quality of power transformers supplied by manufacturers as part of the UPS. Air-cooled type transformers are suitable for indoor installation, which helps the transformer installation within the UPS as part of the main UPS enclosure. Air cooling is considered to be more effective when the UPS is installed in a climatically controlled environment.

7.4.10

The transformer insulation material shall have a minimum rating of thermal class 180 (H) in accordance with IEC 60085.

Justification

The insulation material used in electrical equipment is classified based on the temperature that it can withstand without self-destruction and losing its insulation properties. The most widely used insulation thermal class for transformer windings in the industry is class H which allows a temperature rise of 125 °C over an ambient temperature of 40 °C and an additional hotspot temperature band of 15 °C. This temperature withstand capability ensures less insulation deterioration and longer life.

7.4.11

If anti-condensation heaters are specified, the external power supply to the heating resistor shall be accessible during transportation and storage without removal of packaging.

Justification

This requirement ensures access to operate the anti-condensation heaters during transportation and storage without compromising packaging and preservation.

7.5 Internal wiring and terminals

7.5.1

Wiring shall be labelled with alphanumeric characters located adjacent to the terminals.

Justification

Labelling of wiring helps to identify the path between the connections, which is key for any troubleshooting. Labelling also helps to identify the interface for connections external to the equipment. Proper identification of wires, connectors and terminals helps to restore the wiring after repair or replacement of components without human error.

7.5.2

Wiring for external connections shall be routed to individual terminals on an accessible terminal block.

Justification

It is good engineering practice to assign terminals at an accessible location close to the cable entry point for external connection interfaces. This helps to make a segregation between internal equipment wiring and external wiring, and prevents routing interferences.

7.5.3

The separation distance between the cable entry and the associated connection terminals within the cabinet shall permit the required cable core bending radius.

Justification

This requirement ensures adequate space for the cable termination between the gland plate and the terminals for spreading out cable cores, and allows stress-free terminal connections. Cable core bending due to inadequate space can pose mechanical stress at the connection point and cause damage to terminals, hence this requirement provides adequate space for allowing the bending radius. Also, it provides adequate space for proper cable installation and termination as loose connections can cause failures.

7.5.4

Wiring penetrations through compartment or cubicle sections shall be fitted with protective strips or alternative means to prevent insulation damage.

Justification

This requirement prevents tripping or short circuits resulting from damage to wiring insulation from contact with penetrations between panels.

7.5.5

Wiring identification shall be on ferrules made of insulated material.

Justification

This requirement improves safety and maintainability, reducing risk of conducting ferrules causing interference and short circuits at terminations.

7.6 Earthing

7.6.1

A main protective earthing arrangement shall be provided inside the enclosure in close proximity to the cable entry location.

NOTE The main protective earthing arrangement can be a copper bar, conductor or terminal, as appropriate.

Justification

A protective earthing conductor/terminal strip or rail is usually installed right across the rear end of the series of cabinets at the bottom, near the gland plate. This protective earthing conductor/terminal strip or rail is connected to the main earthing grid of the electrical system. All earth connections from the internal components, gland plates and cabinet structural assembly are connected to this conductor/terminal strip or rail to maintain equipotential and equipment earthing. This arrangement protects maintenance personnel against electric shock due to leakage currents.

7.6.2

The AC UPS enclosure shall be bonded to the main protective earthing arrangement in accordance with IEC 62040-1.

Justification

A protective earthing conductor/terminal strip or rail is usually installed right across the rear end of the series of cabinets at the bottom, near the gland plate. This protective earthing conductor/terminal strip or rail is connected to the main earthing grid of the electrical system. All earth connections from the internal components, gland plates and cabinet structural assembly are connected to this conductor/terminal strip or rail to maintain equipotential and equipment earthing. This arrangement protects maintenance personnel against electric shock due to leakage currents.

7.6.3

Exposed, non-current carrying parts of the AC UPS inclusive of the enclosure, frame, components, gland plates (or MCTs) and doors shall be bonded to main protective earth.

Justification

A protective earthing conductor/terminal strip or rail is usually installed right across the rear end of the series of cabinets at the bottom, near the gland plate. This protective earthing conductor/terminal strip or rail is connected to the main earthing grid of the electrical system. All earth connections from the internal components, gland plates and cabinet structural assembly are connected to this conductor/terminal strip or rail to maintain equipotential and equipment earthing. This arrangement protects maintenance personnel against electric shock due to leakage currents.

7.6.4

If neutral is required for the AC output distribution system, the inverter output and bypass transformer neutrals shall be connected to the main protective earthing arrangement by a removable link within the enclosure.

Justification

The inverter output transformer or bypass transformer acts as an isolation between the input side (UPS or bypass input) and the load side. To provide a common reference to the output circuit (load side), the star point of the secondary winding of the transformer is connected to the common earth by a removable link.

7.7 Ventilation

7.7.1

Cooling fans shall be installed with a redundant "n+1" configuration where "n" is the number of fans required to support the AC UPS.

Justification

The number of cooling fans required to extract the heat generated from the system is decided based on the amount of heat generated within the system and on the capacity (flow rate) of the fan considered. The UPS installed with one additional fan of similar capacity provides "n+1" redundancy. The failure of any fan does not impact the cooling requirement of the UPS and allows the equipment to continue working. This increases the availability of the equipment for use.

7.7.2

Fans shall be equipped with monitoring facilities to provide an alarm in the event of fan failure.

Justification

The UPS performance is not impacted due to one cooling fan failure because of "n+1" redundancy. A second fan failure can impair the performance because of reduced cooling. Hence, the early replacement of a failed fan ensures continued availability of the UPS for use. An alarm in the event of fan failure helps maintenance personnel to take appropriate action for the immediate replacement of the failed unit.

7.7.3

Cooling air filters shall be replaceable while the AC UPS remains in service.

Justification

The cooling system remains effective as long as the rated capacity of air flow is ensured through the system. Hence, regular cleaning of the filters has to be ensured. The UPS is intended to feed process critical loads and its interruption for filter replacement is not desirable.

7.7.4

If a cooling fan is out of service, the AC UPS shall continue to deliver the rated load without switching to bypass mode.

Justification

The UPS feeds process critical loads and its continued operation is essential. UPS performance is not impacted due to the failure of one cooling fan because of "n+1" redundancy. This requirement ensures that the AC UPS is able to deliver the rated load without transferring it to the bypass.

7.7.5

When the cooling system design incorporates standby fans, the standby fans shall start automatically in the event of main fan failure.

Justification

This requirement prevents overheating of the UPS in designs where standby fans are used.

7.8 Additional requirements for offshore (fixed and floating) installations

For offshore installations, the AC UPS and associated equipment and components shall be in accordance with the general requirements of IEC 62040 (all parts) and the following:

– requirements of IEC 61892 (all parts) for mobile and fixed units; or

– requirements of IEC 60092 (all parts except 301, 305, 306, 501, 502 and 503) for electrical installations in ships.

Justification

The UPS equipment design needs specific attention to handle shakes and vibrations due to wave turbulences for offshore installations (vessel or platform). Hence, compliance with the listed standards is required in addition to the requirements of IEC 62040-3.

7.9 External battery isolator box (if specified)

7.9.1

The battery isolator shall be lockable in the open position using a padlock.

Justification

The battery isolator is used for isolating the supply between the battery bank and the UPS. This requirement allows for padlocking to implement proper lock-out during maintenance.

7.9.2

The battery isolator box shall provide an external degree of protection of at least IP31 with the enclosure closed in accordance with IEC 60529.

Justification

The degree of protection specifies the extent of protection provided by the enclosure against access to hazardous parts by personnel, against solid objects ingress and against water ingress. The first characteristic digit "3" specifies that the enclosure has protection against ingress of any object having a size ≥2.5 mm to prevent contact with hazardous energized parts. The second characteristic digit "1" specifies that the enclosure has protection against the ingress of vertically dripping water.

7.9.3

If the battery isolator box has an indirect cable entry via an "ex e" enclosure, the enclosure shall have an undrilled, removable gland plate for the cable entry.

Justification

The undrilled removable gland plate requires drilling to suit the cable gland of the cable size selected. Sometimes, cable sizing is done at a later stage of the project, so gland plates pre-drilled based on preliminary cable sizes may not suit the actual requirement and may call for replacement of the gland plate or re-work. Hence, undrilled gland plates are specified.

7.9.4

The battery isolator shall be selected for the rated DC voltage and DC current.

Justification

The battery isolator selection for the rated DC voltage and DC current is essential to perform the intended operation properly and safely.

7.9.5

The auxiliary supply voltage for the MCCB control element (under voltage coil and/or shunt trip coil) shall be derived from the MCCB terminals connected to the AC UPS.

Justification

Deriving supply for the MCCB control element from the terminal connected to the AC UPS side ensures all time supply availability. When the MCCB is tripped due to battery under voltage, the supply at the battery side may not have adequate voltage to energize the coil after under voltage reset. Hence, deriving supply from the AC UPS side is proposed.

7.9.6

If specified, potential free status contacts of the battery isolator shall be wired to the terminals.

Justification

The potential free contacts are used for notifying the on/off status of the battery isolator (MCCB or switch fuse) to the UPS.

Add new clause

8 Functional requirements

8.1 Rectifier

8.1.1 Rectifier components

8.1.1.1

The rectifier unit and components on the input side of the AC UPS shall be sized to supply the rated output and simultaneously boost charge the battery at the highest permissible current rating.

Justification

The rectifier is the source of supply for feeding power to the inverter and charging the battery. In accordance with the state of charge of the battery, the charging requirement is determined by the rectifier. When the battery supplies the load for a considerable duration following a power interruption, boost charging is used to restore the capacity and this requires high current charging at an elevated DC voltage. Hence, the rectifier is adequately sized to feed the inverter and boost charge the battery simultaneously.

8.1.1.2

If an AC UPS with a bi-directional rectifier is specified, the rectifier shall be provided with an on-line battery capacity discharge test feature by feeding the power back to the mains supply.

Justification

The healthiness of batteries is checked periodically by performing a discharge test as the batteries feed the critical loads during a power outage for a stipulated duration of time. Batteries are discharged either by feeding the load for short durations, which is the most common methodology, or by feeding the power back to the mains using a bi-directional rectifier (active front end). Bi-directional rectifier (active front end) functionality eliminates the risk of the actual load being affected for unknown battery performance issues when it is directly fed from the battery for discharge testing.

8.1.1.3

When an on-line battery monitoring system is specified, the AC UPS shall generate an alarm if the battery parameters exceed the tolerance limit specified by the battery manufacturer.

Justification

The on-line battery monitoring feature immediately generates alerts in the event of an issue with the battery system. These alerts provide an advance notification to maintenance personnel for early corrective action to restore the healthiness of the system and thereby improve its availability for use.

8.1.1.4

The total AC ripple at the battery terminals, including that generated by the inverter and load, shall not exceed the tolerance limits specified by the battery manufacturer.

Justification

The battery manufacturer specifies the tolerable limits of the AC ripple that is present in the charging current. Higher ripple current adversely impacts the guaranteed service life of the battery. Hence, this requirement ensures that the ripple current is maintained within tolerable limits. The adverse impact of a higher ripple current on batteries is internal heat generation, gassing or dry-out depending on the battery type.

8.1.1.5

The AC UPS shall interface with the BMS to continuously monitor, control and protect the battery bank for the functional safety of the specific battery type (e.g. lithium-ion).

Justification

The battery bank is a key functional unit of the UPS, hence proactive testing and maintenance are essential for ensuring a long life cycle. The BMS ensures that all key parameters of the battery such as voltage, current and temperature are maintained within their operational limits for proper performance and safety of the battery.

8.1.2 Operation

8.1.2.1

The rectifier unit shall be provided with constant voltage, current limiting and soft start functionality.

Justification

The rectifier serves the dual purpose of feeding the inverter and simultaneously charging the battery. The rectifier provides a constant voltage to charge the battery connected to the DC bus (after the rectifier). DC voltage variations from the rectifier adversely impact the service life and charging. The current limiting feature of the rectifier ensures that the battery remains protected and the rectifier prevents current beyond the maximum recommended by the manufacturer to prevent any damage to the battery. When the rectifier is started, it develops the output voltage gradually and reaches the set value within a predetermined time. This feature is known as walk-in, ramp-up or soft start. This feature ensures that the batteries are not stressed due to voltage surge on the rectifier start-up.

8.1.2.2

The rectifier unit shall restart automatically upon restoration of the input power supply following a power interruption.

Justification

Any interruption to the mains supply requires that the battery provides the required power to keep the critical loads operational. When the mains power is resumed, it is important to ensure that the battery starts charging or storing energy for the next interruption. Automatic restart is required to prevent any possible delay due to manual intervention.

8.1.2.3

The rectifier unit shall be rated to recharge the battery to the nominal value of Ah capacity following a discharge at rated load for the specified autonomy time, simultaneously meeting the inverter input requirements while the inverter is delivering the rated output.

Justification

The rectifier serves the dual purpose of feeding the inverter and charging the battery. This requirement ensures that the rectifier has adequate capacity to meet the rated input current of the inverter and maximum (controlled) current that is demanded by the battery after a discharge. If the rectifier capacity is inadequate, the battery does not get enough current to restore its full energy within the stipulated time. This leads to lesser availability of the battery (stored energy) in case of a mains power interruption eventuality.

8.1.2.4

Depending on the type of battery selected for energy storage, the rectifier shall perform battery charging at float, boost and equalization charge, or float and equalization charge, in manual and auto modes.

Justification

The requirement of boost, float or equalizing charge depends on the state of charge of the battery. This requirement ensures that the rectifier provides adequate power for the battery to attain a required state of charge. This requirement also ensures that the rectifier control circuit provides the functionality to operate in boost, float or equalizing charge mode as required in both manual and auto modes.

8.1.2.5

Manual initiation of float and boost modes of operation on the rectifier shall be provided.

Justification

This requirement ensures that the rectifier includes a provision to manually initiate the boost and float charging of the battery when required. Manual intervention is needed to keep the battery fully charged followed by a periodic battery discharge test or cell replacement as part of routine maintenance.

8.1.2.6

Upon restoration of the input power supply following a power interruption, if the rectifier is in automatic mode, the rectifier unit shall initiate the boost charge cycle.

NOTE Boost charge initiation depends on the state of charge or type of battery selected for energy storage.

Justification

This requirement ensures that the rectifier has provision for initiating a boost or float charging depending on the state of charge of the battery following an interruption of power in automatic mode. This is considered a default feature as the duration of interruption is unpredictable. As stated, some battery types do not require boost charging.

8.1.2.7

The duration of the boost charging shall be controlled by one of the following options:

– automatic timer; or

– feedback of the battery current and voltage indicating that the required adequate battery charge has been achieved.

Justification

This requirement ensures that the rectifier has a facility to control the duration of boost charging by an adjustable pre-set timer. The rectifier is switched to float mode eventually after the set time for boost charging. If the battery has sufficient charge and does not require boost charging at the start of the charging cycle, the rectifier overrides the timer and places the battery on float mode. This feature ensures that batteries are not overcharged, thereby impacting the battery service life.

8.1.2.8

The rectifier unit shall revert automatically to float charging upon completion of the boost charging or equalization charging.

Justification

When the battery has attained a sufficient state of charge, the rectifier overrides the pre-set timer and switches over the rectifier to float mode. This feature ensures that batteries are not overcharged, thereby not impacting the battery service life.

8.1.2.9

The rectifier unit shall have provision to inhibit boost charging using an external signal (e.g. ventilation failure or H2 detection within the battery room).

Justification

Boost charging involves high current charging at an elevated constant DC voltage. Batteries produce more heat and hydrogen during boost charging because of the high current. The battery room ventilation system is meant for maintaining room temperature and hydrogen concentration within limits by making the required number of air changes. High room temperature adversely impacts the battery service life and high hydrogen concentration creates an explosive atmosphere. Hence, this requirement prevents boost charging during a ventilation system failure or high concentration of hydrogen detection.

8.1.2.10

The rectifier unit shall have provision for accepting temperature compensation input for batteries to control the battery charging voltage with an accuracy of ±1 %.

Justification

This requirement ensures that the rectifier has a facility to accept the temperature input from the battery and adjust the charging voltage so that the battery current is controlled and the rise in temperature is restricted within the battery manufacturer's recommended limit.

8.1.2.11

If specified, the AC UPS shall permit a black start delivering power to the load from the batteries at the rated output without mains supply.

Justification

This requirement allows the UPS to restart in the absence of the main power supply with a fully charged battery connected when required.

8.1.2.12

The rectifier shall restrict the battery charging current to a safe value specified by the battery manufacturer, depending on the mode of operation.

Justification

Limiting the charging current within the recommended limit ensures that the battery remains protected against overcharging. This requirement ensures that the rectifier does not allow the charging current to exceed the maximum recommended by the manufacturer to prevent battery damage.

8.2 Inverter

8.2.1

The inverter shall be short-circuit-proof with a current limiting design.

Justification

The current limiting feature in an electrical circuit imposes an upper limit on the current that may be delivered to a load during a short circuit or overload. This feature protects the UPS from detrimental effects due to high currents and the inverter limits the current to protect itself from such scenarios.

8.2.2

The output voltage regulation shall be maintained within ±1 % of the rated output voltage while operating in non-synchronous conditions.

Justification

The UPS tracks the bypass supply and remains in synchronization with the bypass at all times. This synchronization ensures that the transfer of load from the UPS to the bypass is seamless without any supply interruption. However, there is a defined tolerance value for the UPS output voltage and frequency. If the bypass supply varies beyond a pre-set limit, the UPS disables the bypass tracking and continues operation as free running until the bypass supply returns to within the tolerable limit. This requirement ensures that the UPS output voltage regulation is maintained within ±1 % of the rated output voltage during this non-synchronized operation. The UPS output voltage and frequency regulations are considered to be important as they can be detrimental to the loads connected to the system if not maintained within the limits required.

8.2.3

The waveform of the AC UPS output voltage shall be sinusoidal with a THD not exceeding 4 % for linear and 5 % for non-linear loads unless another value is specified.

Justification

Semiconductor devices used in the UPS create output voltage waveform distortions known as harmonics. Non-linear loads connected to the UPS output also contribute to waveform distortions. This requirement ensures that the UPS includes all necessary filtering and smoothening devices to maintain voltage waveform distortion to a level not exceeding 4 % for linear and 5 % for non-linear loads unless another value is specified in the PDS.

8.2.4

The inverter output frequency shall be maintained within ±0,1 % of the rated output frequency while operating in non-synchronous conditions.

Justification

The UPS tracks the bypass supply and remains in synchronization with the bypass at all times. This synchronization ensures that the transfer of load from the UPS to the bypass is seamless without any supply interruption. However, there is a defined tolerance value for the UPS output voltage and frequency. If the bypass supply varies beyond a pre-set limit, the UPS disables the bypass tracking and continues operation as free running until the bypass supply returns within the tolerable limit. This requirement ensures that the UPS output frequency is maintained within ±0,1 % of the rated frequency during this non-synchronized operation. The UPS output voltage and frequency regulations are considered to be important as they can be detrimental to the loads connected to the system if not maintained within the limits required.

8.2.5

The inverter unit shall control the output of the AC UPS to maintain synchronism with the bypass voltage during variations in bypass supply frequency, within the specified tolerance limits.

Justification

The UPS tracks the bypass supply and remains in synchronization with the bypass at all times. This synchronization ensures that the transfer of load from the UPS to the bypass is seamless without any supply interruption. However, there is a defined tolerance value for the UPS output voltage and frequency. If the bypass supply frequency varies beyond a pre-set limit, the UPS disables the bypass tracking and continues operation as free running until the bypass supply frequency returns to within the tolerable limit.

8.2.6

If the bypass supply frequency variation exceeds the defined synchronization limits, the inverter shall revert to free-running operation, i.e. non-synchronous operation.

Justification

The UPS tracks the bypass supply and remains in synchronization with the bypass at all times. This synchronization ensures that the transfer of load from the UPS to the bypass is seamless without any supply interruption. However, there is a defined tolerance value for the UPS output voltage and frequency. If the bypass supply frequency varies beyond a pre-set limit, the UPS disables the bypass tracking and continues operation as free running until the bypass supply frequency returns to within the tolerable limit.

8.2.7

The UPS system shall withstand a minimum load crest factor of 3:1 (Ipeak/Irms).

Justification

The crest factor is the ratio of the peak current to the mean current of the circuit. A crest factor of 3:1 is typical for most UPSs and inverter units, and aligns with PIP ELSAP04 which defines a crest factor of 3.0.

8.3 Static and maintenance bypass

8.3.1

The switching devices of the static bypass unit at the inverter output and at the bypass path shall be sized for a continuous current rating equivalent to the rated output of the AC UPS.

Justification

Switching devices are rated for the continuous current of the circuit path where it is installed in order to perform its intended operation safely and reliably. Underrated devices can pose a danger in terms of over-heating and electric fire. The UPS is intended for feeding process critical loads, hence its reliability is very essential in terms of continued equipment availability for use. This requirement ensures that switching devices used in the UPS are properly rated for ensuring safety and equipment reliability.

8.3.2

The static bypass circuit shall have a short-time current rating of:

– 1 000 % of the AC UPS current rating for 50 ms; and

– 150 % of the AC UPS current rating for 60 s.

Justification

The short-time rated high current is used to operate the protective device in case of a fault at the downstream power distribution. The system allows such a high current to flow until the protective device operates, hence the circuit and switching devices are rated to withstand this current for the duration specified. The specified short-time current ratings and duration are the industrywide used norms for the selection of static bypass circuit devices.

8.3.3

The protection device used in the static bypass circuit shall permit the short-time rated current required to clear the fault at downstream of the output protective device.

Justification

This requirement ensures that any fault at the load side is cleared by an immediate upstream protective device connected to the load side distribution circuit and not cleared by the protective device of the static bypass circuit. This is in accordance with protective device coordination and selectivity. Clearing a load side fault by a static bypass protective device instead of a load side protective device means a loss of supply to all loads connected to the UPS. Another aspect of this requirement is that the system allows for a sufficient short-time rated current for the protective device at the load end to pick up and clear the fault.

8.3.4

The protection device used in the static bypass circuit shall prevent damage to the static switch when the overcurrent persists for longer than the specified time.

Justification

This requirement ensures that the static switch in the bypass circuit is protected if the fault current persists for more time than specified. It also ensures that the fault current is cleared before the device withstand time, otherwise it could pose a danger by damaging the device.

8.3.5

The AC UPS shall be provided with the facility to initiate a manual transfer from the inverter supply to the bypass supply and vice-versa, even in case of HMI failure.

Justification

This requirement ensures that a manual transfer facility is provided for performing routine/planned maintenance activities on the UPS and restoring the UPS supply back after maintenance.

8.3.6

Manual transfer shall be inhibited under inverter fault conditions.

Justification

This requirement improves safety and availability by reducing the risk of maloperation by transferring the UPS output to the inverter with a fault.

8.4 Measurement, protection and control

8.4.1 Indication and display

8.4.1.1

The AC UPS shall have a real time interactive operator interface using a microprocessor-based HMI mounted on the front door.

Justification

The AC UPS functionality is complex in nature and involves a lot of discrete circuits for various measurements, computation and controls. Troubleshooting a fault in the system by checking and verifying data from each of these circuits can be a challenging task. The latest technology enables all required real time data and information on an operator interface display screen using microprocessor hardware with a menu-driven keypad for HMI. Hence, the complete information about the UPS operation status from HMI is useful for service personnel to troubleshoot the system easily. It also enables performance data to be retrieved by an operator, maintains data history and processes operator commands.

8.4.1.2

The HMI shall indicate the AC UPS operation status.

Justification

The AC UPS functionality is complex in nature and involves a lot of discrete circuits for various measurements, computation and controls. Troubleshooting a fault in the system by checking and verifying data from each of these circuits can be a challenging task. The latest technology enables all required real time data and information on an operator interface display screen using microprocessor hardware with a menu-driven keypad for HMI. Hence, the complete information about the UPS operation status from HMI is useful for service personnel to troubleshoot the system easily.

8.4.1.3

The HMI shall accept operational input commands.

Justification

The AC UPS functionality is complex in nature and involves a lot of discrete circuits for various measurements, computation and controls. Troubleshooting a fault in the system by checking and verifying data from each of these circuits can be a challenging task. The latest technology enables all required real time data and information on an operator interface display screen using microprocessor hardware with a menu-driven keypad for HMI. Hence, the complete information about the UPS operation status from HMI is useful for service personnel to troubleshoot the system easily. It also enables performance data to be retrieved by an operator, maintains data history and processes operator commands.

8.4.1.4

The HMI shall monitor operating parameters and display alarms, events and fault diagnostics.

Justification

The AC UPS functionality is complex in nature and involves a lot of discrete circuits for various measurements, computation and controls. Troubleshooting a fault in the system by checking and verifying data from each of these circuits can be a challenging task. The latest technology enables all required real time data and information on an operator interface display screen using microprocessor hardware with a menu-driven keypad for HMI. Hence, the complete information about the UPS operation status from HMI is useful for service personnel to troubleshoot the system easily. It also enables performance data to be retrieved by an operator, maintains data history and processes operator commands.

8.4.1.5

The following status shall be displayed on the HMI or by discrete light emitting diode (LED) indication lights located on the AC UPS front panel:

- AC input power supply healthy;
- bypass power supply healthy;
- rectifier ON;
- inverter ON;
- battery breaker ON;
- boost/float/equalize mode;
- load on inverter;
- load on bypass;
- inverter/static bypass synchronized;
- battery discharging;
- fan failure (where applicable);
- over-temperature;
- common AC UPS alarm (LED signalling light);
- discharged battery.

Justification

The status indications convey the operational status of major sections of the UPS to the operator. Alarms help to alert the operator for system abnormality.

8.4.1.6

Failure of the HMI display or indicating device on the AC UPS shall not compromise the autonomous operation of the AC UPS.

Justification

The HMI display or any other indicating device is not directly linked to the UPS functioning manual commands that are communicated from the HMI keypad. This requirement ensures that any abnormality in the HMI display unit or complete unit failure does not impact the functioning of the UPS as it is intended for feeding process critical loads.

8.4.1.7

The HMI shall have password-protected multiple levels of access as follows:

– for viewing, by the operator;

– for settings, by trained operating personnel;

– for service, by the manufacturer's personnel.

Justification

The password protected access provides protection against unauthorized access to the equipment. The level of protection is set based on the purpose of the access to the equipment. Access for viewing parameters does not affect equipment operation, hence it can be made available to an operator who is not necessarily trained for operating the equipment. Access for making changes to equipment settings is made available only to trained operating personnel as improper settings could affect equipment functioning. Service level access is meant for someone who fully knows about the equipment operation, and who is qualified and properly trained for performing any troubleshooting, maintenance or replacement activity within the equipment.

8.4.1.8

The AC UPS shall have non-volatile memory for retaining the following:

– event/alarm/trip logging with time and date stamping;

– historical trending for assisting troubleshooting and failure analysis;

– UPS configuration parameters.

Justification

The HMI unit displays the alarms and events captured by the system. Operator or service personnel use this information (alarms, events and historical data) for performing failure analysis and troubleshooting. The chronological sequence of events with date and time stamping are key for understanding the origin of the event and its cascading effect in order to perform the failure analysis and further troubleshooting. Hence, this requirement ensures that the AC UPS has adequate storage capacity to store all this data.

8.4.1.9

The AC UPS shall have communication facilities as specified for remote monitoring and interface including real time clock synchronization.

Justification

Most commonly, the plant operation requires all equipment data to be presented at a centralized location for remote monitoring and control (e.g. ECMS/PCS). This requirement ensures that the UPS hardware has communication functionality for such remote connectivity to transfer data and enable control where required.

8.4.1.10

The HMI display shall be backlit.

Justification

This requirement ensures the UPS HMI or synoptic visualisation remains legible in normal and emergency lighting levels.

8.4.2 Measurements

As a minimum, the following measurement data shall be displayed on the HMI by discrete measuring or display instruments located on the front panel of the AC UPS:

- AC UPS input voltage per phase;
- AC UPS input current per phase;
- DC voltage;
- battery charging current;
- battery discharging current;
- AC UPS output voltage per phase;
- AC UPS output current per phase;
- AC UPS output frequency;
- remaining autonomy time of the battery in percentage or minutes.

Justification

The display conveys important operational parameters of major sections within the UPS to the operator. This helps the operator to assess the AC UPS performance and initiate actions when required.

8.4.3 Alarms and protection

8.4.3.1

Alarm and trip functions shall be provided in accordance with Table 9.

Justification

Main alarm and trip functions are indicated in Table 9 as a minimum to be provided for the UPS. These alarms and trip functions with fault descriptions alert the operator or maintenance personnel for appropriate action.

Add new Table 9

Table 9 – Minimum alarm and trip functions

Trouble description	Alarm	Rectifier trip	Inverter trip
AC input power supply – undervoltage	x	Off [a, b]	
Input isolation transformer overtemperature	x [c]		
Rectifier failure	x	x	
DC link overvoltage	x	x	
DC link undervoltage	x		x
Battery discharging	x		
Battery breaker off / battery disconnected	x		
Battery temperature high – valve-regulated lead-acid (VRLA) batteries only	x		
Cooling fan failure	x		
Inverter failure	x		x
Inverter overcurrent	x		
Inverter output voltage deviation	x		x
Inverter/bypass unsynchronized	x		
Power module overtemperature	x		x
Output isolation transformer overtemperature	x [c]		

[a] When the AC input power supply falls below allowable limits, the rectifier shuts down.

[b] When the AC input power supply resumes and remains within allowable limits, the rectifier starts automatically and no reset is required.

[c] Applicable only when a transformer is supplied.

Justification

This table indicates main alarm and trip functions as a minimum to be provided for the UPS. These alarms and trip functions with fault descriptions alert the operator or maintenance personnel for appropriate action.

8.4.3.2

Alarms and trip functions shall be reset manually, locally or remotely, except for the rectifier shutdown due to AC input power supply undervoltage (see Table 9).

Justification

Alarms and trip functions have manual reset for safety reasons. Alarms and trips are acknowledged, investigated and cleared before reset by the operator or maintenance personnel. Any attempt to restart the system without clearing the fault can pose a danger to equipment and personnel.

8.4.4 Controls

8.4.4.1

The settings and threshold limits of parameters shall be adjustable on-line without requiring an outage of the AC UPS.

Justification

The settings and parameters sometimes require fine adjustments to improve equipment performance and its continued availability for use. The UPS has a critical functionality and equipment outage is not desirable, hence the adjustments are done on-line by a qualified service engineer.

8.4.4.2

The internal control supply of the AC UPS shall be available provided that at least one of the input supply sources to the AC UPS is present.

Justification

The UPS receives three sources of input power, namely mains supply, bypass supply and DC supply from the battery. The internal control supply of the UPS is derived from these three input supply sources and this requirement ensures that failure of one or two of these supplies does not interrupt the control supply availability. The UPS requires continued availability of the internal control supply for its uninterrupted operation.

Add new clause

9 Packing, handling, preservation and storage

The AC UPS and associated equipment and components shall be packed to ensure protection against damage during transportation.

Justification

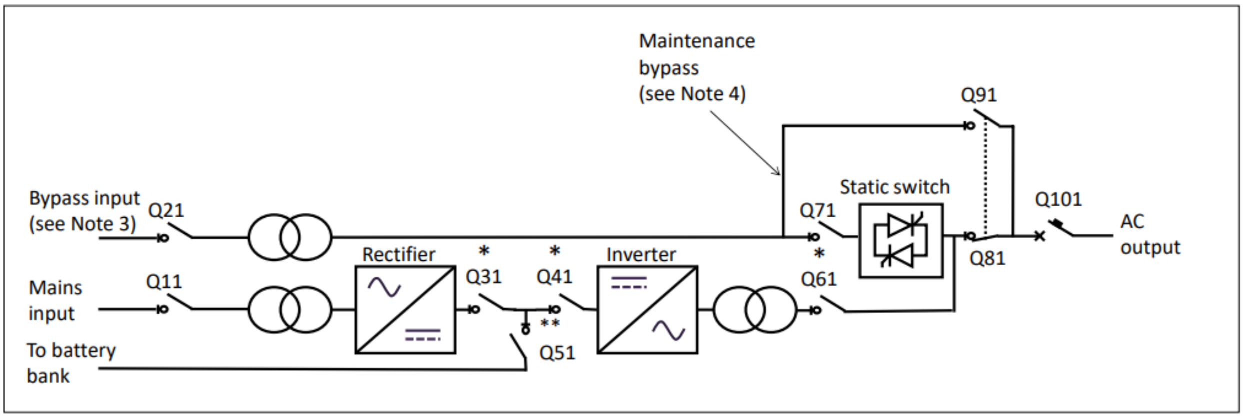
This requirement ensures that the equipment is transported to the site without any mechanical and environmental damages and can be stored at the installation site under the prevailing environmental conditions.

Annex A
(informative)
Configurations – Uninterruptible power system (UPS)

A.2 Single output bus UPS

A.2.3 Single UPS with bypass

In Figure A.2, replace drawing with



Add new notes to Figure A.2

* Switches should be installed where rectifier, inverter and static switch sections have physical separation for complete supply isolation and to prevent access to live parts.

** The switch is installed inside the AC UPS, while the battery isolator (see 7.9) is external to (i.e. outside) the AC UPS.

Add key to Figure A.2

Key

Q11	mains input breaker or switch
Q21	bypass input breaker or switch
Q31, Q41, Q61, Q71	internal isolator switch
Q51	internal battery circuit isolator switch
Q81 and Q91	interlocked maintenance bypass breaker or switch
Q101	AC output circuit breaker or switch

Figure A.2 – Simplified single UPS with bypass

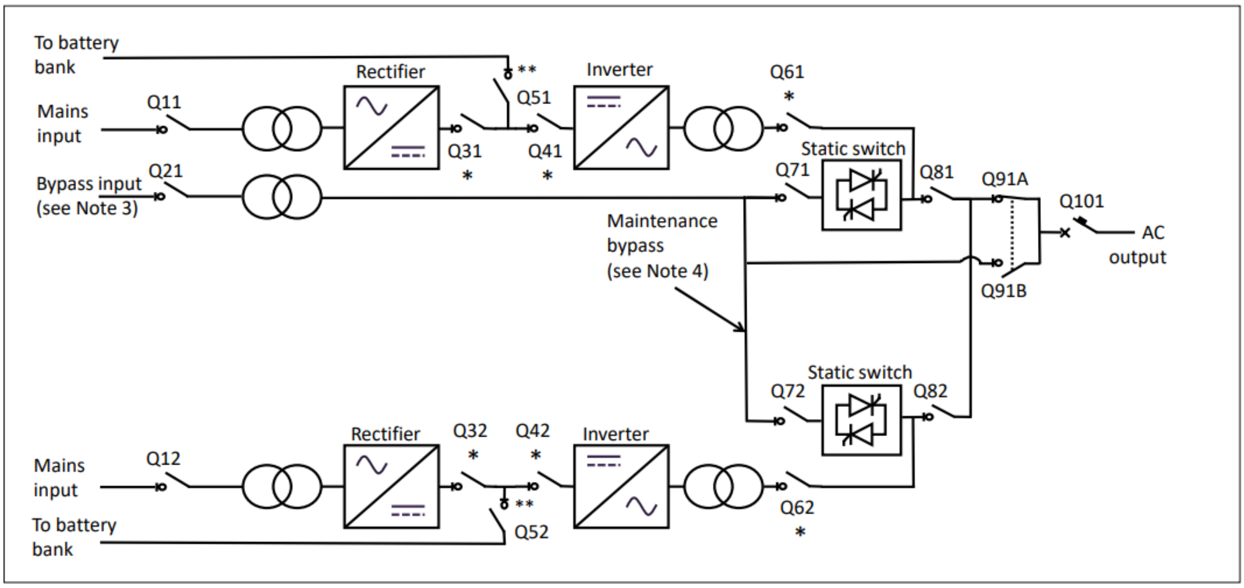
Justification

This diagram is a detailed representation of the UPS configuration that identifies all major components required to be part of the main equipment.

A.3 Parallel UPS

A.3.2 Parallel UPS with common bypass

<u>Replace Figure A.3 with Figure A.3 a) and Figure A.3 b)</u>



NOTE Figure A.2, notes 1 to 5 apply.

* Switches should be installed where rectifier, inverter and static switch sections have physical separation for complete supply isolation and prevent access to live parts.

** The switch is installed inside the AC UPS, while the battery isolator (see 7.9) is external to (i.e. outside) the AC UPS.

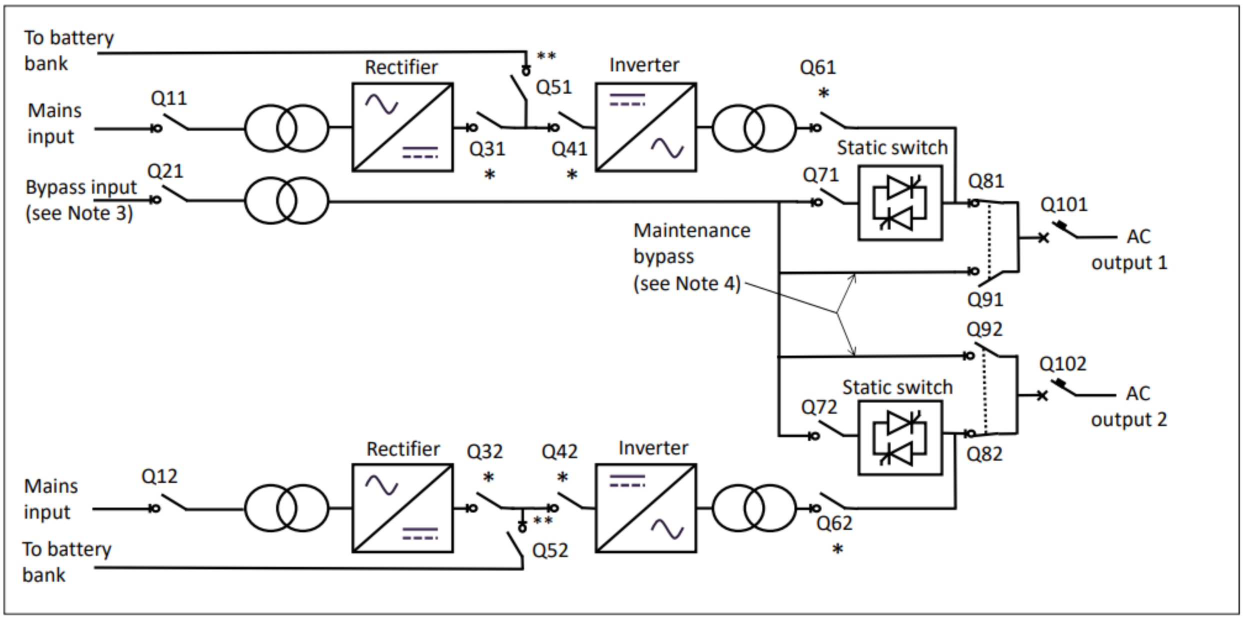
Key

Q11, Q12	mains input breaker or switch
Q21	common bypass input breaker or switch
Q31, Q32, Q41, Q42, Q61, Q62, Q71, Q72	internal isolator switch
Q51, Q52	internal battery circuit isolator switch
Q81, Q82	individual module output isolator switch
Q91A and Q91B	interlocked maintenance bypass breaker or switch
Q101	AC output circuit breaker or switch

Figure A.3 a) – Simplified parallel UPS with common bypass and common output

Justification

This diagram is a detailed representation of the UPS configuration that identifies all major components required to be part of the main equipment.



NOTE Figure A.2, notes 1 to 5 apply.

* Switches should be installed where rectifier, inverter and static switch sections have physical separation for complete supply isolation and prevent access to live parts.

** The switch is installed inside the AC UPS, while the battery isolator (see 7.9) is external to (i.e. outside) the AC UPS.

Key

Q11, Q12	mains input breaker or switch
Q21	common bypass input breaker or switch
Q31, Q32, Q41, Q42, Q61, Q62, Q71, Q72	internal isolator switch
Q51, Q52	internal battery circuit isolator switch
Q81 and Q91, Q82 and Q92	interlocked maintenance bypass breaker or switch
Q101, Q102	AC output circuit breaker or switch

Figure A.3 b) – Simplified parallel UPS with common bypass and separate output

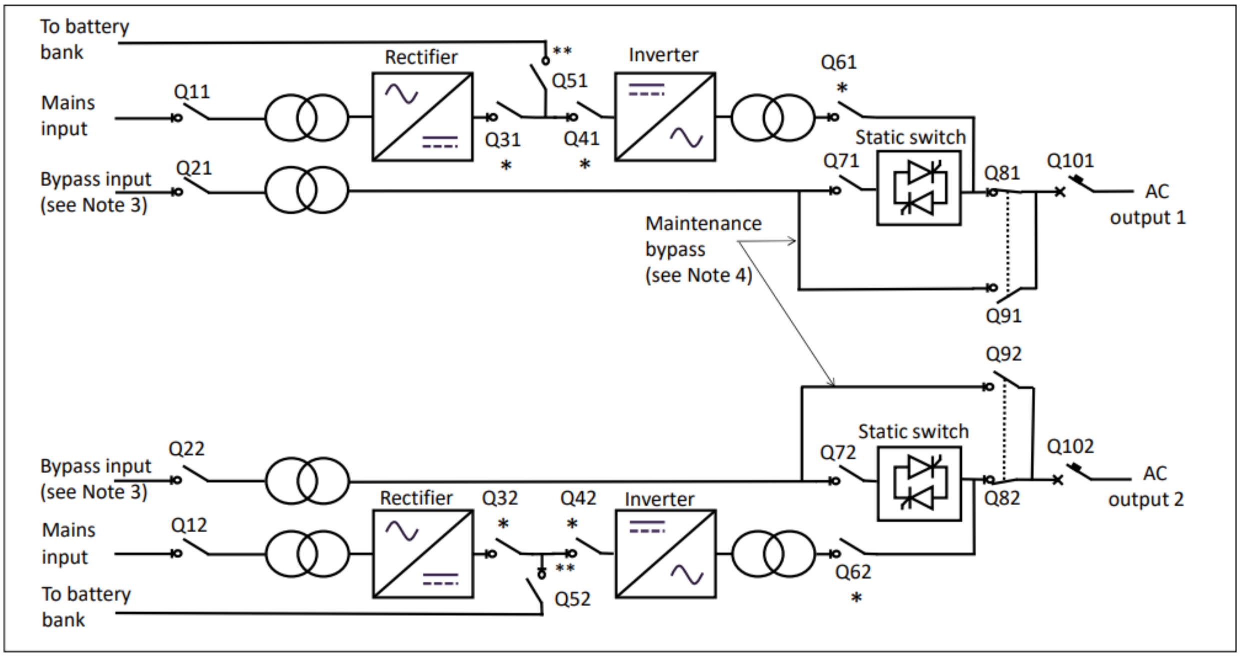
Justification

This diagram is a detailed representation of the UPS configuration that identifies all major components required to be part of the main equipment.

A.4 Dual bus UPS

A.4.1 Basic dual bus UPS

Replace Figure A.6 with



NOTE Figure A.2, notes 1 to 5 apply.

* Switches should be installed where rectifier, inverter and static switch sections have physical separation for complete supply isolation and prevent access to live parts.

** The switch is installed inside the AC UPS, while the battery isolator (see 7.9) is external to (i.e. outside) the AC UPS.

Key

Q11, Q12	mains input breaker or switch
Q21, Q22	bypass input breaker or switch
Q31, Q32, Q41, Q42, Q61, Q62, Q71, Q72	internal isolator switch
Q51, Q52	internal battery circuit isolator switch
Q81 and Q91, Q82 and Q92	interlocked maintenance bypass breaker or switch
Q101, Q102	AC output circuit breaker or switch

Figure A.6 – Simplified dual bus UPS with bypass

Justification

This diagram is a detailed representation of the UPS configuration that identifies all major components required to be part of the main equipment.

Annex D
(informative)
Purchaser specification guidelines

D.5 UPS technical data sheet – Manufacturer's declaration

Replace second sentence with

The manufacturer's equipment data sheet submitted post order shall contain the AC UPS technical data in accordance with Table D.1.

Justification

IOGP S-701D version 1.0 has been modified to address procurement-only requirements during the maintenance update. This means that IOGP S-701D focuses on data sheet elements required for bid evaluation and order placement. The manufacturer's data sheet to be submitted post order as part of IOGP S-701L requirements should include all detailed technical data of the equipment to be supplied. IEC 62040-3, Table D.1 addresses the data sheet elements to be included in the PDS as part of the manufacturer's declaration. Table D.1 is listed under Annex D which is an informative section. Hence, this requirement has been added to make Table D.1 normative.

Bibliography

Add to start of Bibliography

The following documents are informatively cited in the text of this document, IEC 62040-3, the PDS (IOGP S-701D) or the IRS (IOGP S-701L).

Add to Bibliography

ATEX Directive (2014/34/EU), *Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres*

Ecodesign Directive (2009/125/EC), *Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products*

Electromagnetic Compatibility Directive (EMCD) (2014/30/EU), *Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility*

IEC 61439-2:2020, *Low-voltage switchgear and controlgear assemblies – Part 2: Power switchgear and controlgear assemblies*

IEC 62402, *Obsolescence management*

IEEE 802.3, *IEEE Standard for Ethernet*

ISO/IEC Directives, Part 2, *Principles and rules for the structure and drafting of ISO and IEC documents*

Low Voltage Directive (LVD) (2014/35/EU), *Directive 2014/35/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits*

PIP ELSAP04 *, *Uninterruptible Power Supply (UPS) System Specification*

* Cited in IOGP S-701J only.

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