PART 1 - GENERAL

1.1 UPS DEFINITIONS

A. **Purpose:** The purpose of this specification is to define the design, manufacture and testing characteristics required in view of supplying, putting into operation and maintaining an Uninterruptible Power Supply system (referred to as a UPS in the rest of this document). The UPS system shall be designed to supply dependable electric power to:

B. **Brief description:**
1. The UPS system shall be made up of ...[2 / 3 / 4 / 5 / 6 / 7 / 8]... identical, parallel-connected modular UPS units, all having the same power rating. Each modular UPS unit shall operate in double-conversion mode and shall be of the VFI-type as per standard IEC 62040-2. The system shall ...[not provide redundancy]...[include 1 / 2 / 3 redundant modular UPS units among the total].
2. Each modular UPS unit shall have a rating of ...[250 / 300 / 400 / 500]... kVA and shall be made up of the following components, described in detail in this specification:
   a. Rectifier
   b. Battery charger
   c. Inverter
   d. Battery
   e. Automatic bypass (via a static switch)
   f. User and communications interface
   g. Battery management system
3. What is more, the UPS system shall include:
   a. A common external bypass for all the modular UPS units, that shall be installed in a cabinet
   b. Any and all other devices required for safe operation and maintenance, including circuit breakers, switches, etc.

1.2 WARRANTY

A. The components making up each modular UPS unit (rectifier, charger and inverter subassemblies) shall be guaranteed (parts and labour on site) for one year following the start-up date.
PART 2 - PRODUCTS

2.1 OPERATING PRINCIPLES

A. The UPS system shall operate in double-conversion mode, described in detail in this specification.

B. **Normal operation** (normal AC source available): The rectifier of each modular UPS unit shall supply its inverter and charger. Each modular UPS unit shall continuously contribute, in parallel with the other modular UPS units via a common bus, to supplying the load with backed up electrical energy and the charger shall float charge the battery.

C. **Operation on battery power** (normal AC source not available or outside tolerances): Upon failure or excessive deterioration of the normal AC source, the inverter of each modular UPS shall continue to supply the load from battery power without interruption or disturbance, within the limits imposed by the specified battery backup time.

D. **Battery recharge** (normal AC source restored): When the normal AC source is restored, the rectifier of each modular UPS shall again power its inverter, without interruption or disturbance to the load, while the charger automatically recharges the battery.

E. **Transfer to bypass AC source:**

   1. **(system without redundancy modules)**
      a. The system does not provide redundancy. The inverters of the \([2 / 3 / 4 / 5 / 6 / 7 / 8]\) modular UPS units shall operate in parallel to supply the load. The automatic bypasses of each modular UPS unit shall be connected to the same bypass AC source.
      b. Voluntary shutdown or a major fault on a modular UPS unit shall result in automatic transfer, without interruption, of the load to the bypass AC source via the bypass of each modular UPS unit, including the unit shut down, if the AC bypass is within tolerances and synchronised with the inverter outputs.
      c. On request, the UPS system may automatically transfer the load with a micro-interruption (adjustable from 15 to 1000 ms) if synchronisation with the bypass source has not been established, to enable operation in downgraded mode and enhance supply of power to the load.
      d. In all cases, to ensure load transfer in complete safety, the system shall simultaneously control all the static switches.

   2. **(system with redundancy)**
      a. The modular UPS units shall operate in parallel, providing redundancy and sharing the load.
      b. Redundancy shall be of the \([n+1] \ [n+2] \ [n+3] \ldots \) type, i.e. \([1] \ [2] \ [3] \ldots \) modular UPS units will be redundant out of the total of \([2 / 3 / 4 / 5 / 6 / 7 / 8]\) modular UPS units. The automatic bypasses of each modular UPS unit shall be connected to the same bypass AC source.
         1) If a major fault occurs on a modular UPS unit, it shall automatically disconnect and its inverter shall no longer supply the load. Given that the system is redundant, the remaining modular UPS units shall continue to supply the load.
      c. However the initial level of redundancy shall be reduced by one unit, falling from \([n+1] \ [n+2] \ [n+3] \ldots \) non-redundant operation to \([n+2] \ [n+1] \ [n+3] \ [n+2] \ldots \) modular UPS units.
         1) If another modular UPS unit shuts down, the resulting level of redundancy shall determine whether inverter operation is still possible.
         2) Loss of redundancy is in all cases signalled by an alarm.
         3) If redundancy has been lost, shutdown of another modular UPS unit shall result in automatic transfer, without interruption, of the load to the bypass AC source via the bypass of each modular UPS unit, including the units shut down, if the AC bypass is within tolerances and synchronised with the inverter outputs.
      d. On request, the UPS system may automatically transfer the load with a micro-interruption (adjustable from 15 to 1000 ms) if synchronisation with the bypass source has not been established, to enable operation in downgraded mode and enhance supply of power to
the load.
e. In all cases, to ensure load transfer in complete safety, the system shall simultaneously control all the static switches.

F. **UPS maintenance:**
   1. All power and control electronics of the modular UPS units making up the UPS system shall be accessible from the front of the UPS.
   2. For maintenance purposes, the UPS system shall include an external, mechanical, manual bypass system with one-button operation, common to all modular UPS units.
   3. For personnel safety during servicing or testing, this system shall be designed to isolate the UPS system while continuing to supply power to the load from the bypass AC source. The UPS shall also include a device making it possible to isolate the rectifier and the charger of each modular UPS unit from the normal AC source.
   4. **(system with redundancy):** In a redundant system, with the above device, it shall be possible to shut down a modular UPS unit and isolate its charger and inverter for maintenance, with the other inverters in the UPS system continuing to supply the load.

G. **Battery maintenance:** For safe maintenance, the battery of each modular UPS unit shall include a circuit breaker to isolate the battery from the rectifier, the charger and the inverter. When the battery is isolated from the system, the UPS shall continue to supply the load without interruption or disturbance, except in the event of a normal AC source outage.

H. **Cold start (normal AC source absent):** The battery of each modular UPS unit shall be capable of starting the UPS if the normal AC source is absent and continue supplying power to the load within the specified backup time. Cold start on battery power shall be possible on the condition that the system shall have started at least once on normal AC power.

2.2 **SIZING AND GENERAL CHARACTERISTICS**

A. **Technology:** The battery of each modular UPS unit shall be capable of starting the UPS if the normal AC source is absent and continue supplying power to the load within the specified backup time. Cold start on battery power shall be possible on the condition that the system shall have started at least once on normal AC power.

B. **Rating:**
   1. The UPS system shall be sized to continuously supply a load of ____ kVA, at a power factor (pf) of 0.9.
   2. The UPS system shall be made up of ...[2 / 3 / 4 / 5 / 6 / 7 / 8]... identical, parallel-connected modular UPS units, each having a power rating of ...[250 / 300 / 400 / 500]... kVA.
   3. The total installed power rating shall be ____ kVA. It shall be possible to use ...[1] [2] [3]... modular UPS units for redundancy.

C. **Battery backup time:**
   1. The battery backup time in the event of a normal AC source outage shall be ______ minutes, for a load power factor of 0.9.
   2. The battery of each modular UPS unit shall be designed for a service life of ...[10 / 12]... years. It shall be selected and sized correspondingly, for a load power factor of 0.9.

D. **Types of loads accepted:**
   1. The UPS system shall accept high crest factors (3:1) without derating (kW) to ensure correct operation with computer loads and loads where the leading power factor can reach 0.9.
   2. The total harmonic voltage distortion at UPS output (THDU downstream) shall respect the following limits:
      a. THDU downstream ph/ph ≤ 2% for non-linear loads.

E. **PFC sinusoidal-current input rectifiers:**
   1. The UPS system shall not draw a level of harmonic currents that could disturb the upstream AC system, i.e. it shall comply with the stipulations of guide IEC 61000-3-4.
   2. The PFC input rectifiers of the modular UPS units, using sinusoidal-current IGBTs, shall have the following performance levels:
a. Total harmonic current distortion (THDI) upstream of the rectifier not exceeding 5%

b. Input power factor (PF) greater than 0.99 from 50% load upwards.

F. Outputs without a transformer: To reduce losses, dimensions and weight, the output of each UPS unit shall be of the transformerless type and the neutral shall be recreated electronically.

G. Efficiency: Overall efficiency (between the rectifier inputs and the UPS output) shall be greater than or equal to:
1. 94.5% from 50% load to full rated load (In);

H. Noise level: The noise level, measured as per standard ISO3746, shall be less than …[75 dBA (for 250, 300, 400, 500 kVA)].

2.3 AC SOURCES

A. Normal AC source (rectifier input): The normal AC source supplying the UPS system shall, under normal operating conditions, have the following characteristics:
1. Rated voltage: 380, 400 or 415 V at full rated load Pn.
2. Input voltage range: 250 V (at 30% load) to 470 V.
3. Number of phases: 3, a neutral is not necessary.
4. Frequency: ______ Hz ± 10%.

B. Bypass AC source (automatic-bypass input):
1. The characteristics of the bypass AC source supplying the UPS system in the event of an inverter shutdown (maintenance, failure) or an overload (short-circuit, very high inrush current) shall be the following:
   a. Voltage: ______ / ______ volts, ± 10%
   b. Number of phases: 3 ph + N + earth (a non-distributed neutral is possible)
   c. Frequency: ______ Hz ± 8% (adjustable up to ± 2 Hz)
2. Outside these tolerances, it shall be possible to supply the load, but in downgraded mode.

2.4 ELECTRICAL CHARACTERISTICS

A. Rectifier and charger
1. Supply: The PFC rectifier of each modular UPS unit, drawing sinusoidal current, shall be supplied by the normal AC source, without a neutral. It shall provide power for the load as well as charge or float charge the battery. The battery charger shall be supplied by the rectifier to avoid transmitting any AC fluctuations to the battery. Each unit is independent in terms of its input module, i.e. one unit can operate on battery power, the others on AC power.
2. Inrush current: A device shall be provided to limit the inrush currents of each charger. When AC power fails and during genset start, the rectifier shall limit the power drawn by implementing a walk-in for ten seconds.
3. Sequential start: An adjustable device shall make it possible to stagger start-up of the PFC rectifiers when the normal AC source returns to within tolerances (transfer from battery power to normal AC power). By ensuring sequential start, this device shall avoid overloading a genset picking up the supply to all the rectifiers.
4. Phase sequence: A device shall check that the phase sequence is correct to protect the power system from the effects of incorrect connections.
5. Operating mode: The standard charger of each modular UPS unit shall be sufficient to charge the battery rapidly. For a backup time of …[5 / 10 / 15 / 20 / 30] … minutes, battery recharging shall take less than …[4 / 6 / 7 / 8 / 9 hours]… (values after discharge to Pn/2 and recovery of 90% of total battery charge for a recent battery).
6. Input power factor: > 0.99 @ 100% load.
7. Charger regulation and monitoring:
   a. The battery recharge system shall include independent regulation and monitoring devices to ensure conformity with standard NFC 58311.
   b. The battery recharge voltage shall be a function of the ambient temperature in the battery room.
B. **Batteries:** Each modular UPS unit shall be equipped with its own battery of the:

1. Each modular UPS unit shall be equipped with its own battery of the [sealed lead-acid type, mounted and wired in a cabinet identical in aspect to that of the UPS] [sealed lead-acid type, mounted on shelves] [vented lead-acid type mounted on racks] ... and shall have a service life of ... [10 / 12] ... years.

2. The battery shall be sized to ensure a continuous supply to the inverter for at least ... [5 / 10 / 15 / 20 / 30 ...] ... minutes, in the event the normal AC source fails, given that the inverter is at full rated load, i.e. _______ kVA for a power factor PF = 0.9.

3. Sizing calculations shall assume an ambient temperature between 0°C and 35°C.

C. **Inverter:** Each inverter shall be sized to supply a rated load of ... [250 / 300 / 400 / 500 ...] kVA at 0.9 PF and shall satisfy the specifications listed below.

1. **Output voltage**
   a. **Rated voltage:** ... [380 / 400 / 415] ... volts rms, adjustable via the user interface, within tolerances of +/- 3% in order to take into account voltage drops in the cables.
   b. **Number of phases:** 3 phases + neutral + earth.
   c. **Steady-state conditions:** Variations in the rated voltage shall be limited to ± 2% for a balanced load between 0 and 100% of the rated load, whatever the voltage level on the normal AC source and the DC voltage level, within the defined limits.
   d. **Voltage variations for load step changes:** Output voltage transients shall not exceed ± 1% of rated voltage for 0 to 100% or 100 to 0% step loads. In all cases, the voltage shall return to within steady-state tolerances in less than 100 milliseconds.
   e. **Unbalanced conditions:** For a load unbalance between phases, the variation in the output voltage shall be less than 1%.

2. **Output frequency**
   a. **Rated frequency:** - 50 or 60 Hz.
   b. **Variations in the free-running frequency:** - ± 0.5 Hz,

3. **Synchronisation with bypass power**
   a. **When bypass power is within tolerances:** To enable transfer to bypass power, the inverter output voltage shall be synchronised with the bypass source voltage whenever possible. To that end, during normal operation, a synchronisation system shall automatically limit the phase deviation between the voltages to 3 degrees, if the bypass source frequency is sufficiently stable (within adjustable tolerances of 0.5% to 8% with respect to the rated frequency).
   b. **Synchronisation with an external source:** It shall be possible to synchronise with all types of external source.
   c. **Autonomous operation following loss of synchronisation with bypass power:** When the bypass source frequency deviates beyond these limits, the inverter shall switch over to free-running mode with internal synchronisation, regulating its own frequency to within ± 0.02 Hz. When bypass power returns to within tolerances, the inverter shall automatically resynchronise.
   d. **Variation in frequency per unit time:** To avoid transmitting to the inverter any excessive frequency variations on the bypass AC source when it is within tolerances, inverter frequency variations per unit time (dF/dt) shall be limited to 1 Hz/s or 2 Hz/s (user defined).

4. **Overload and short-circuit capacity:** The UPS shall be capable of supplying for at least:
   a. 10 minutes a load representing 125% of the rated load
   b. 30 second a load representing 150% of the rated load.
   c. For the specified power rating of ... [250 / 300 / 400 / 500 ...] kVA, the inverter shall be capable of current limiting to a peak capacity of ... [277% / 230% / 234% / 245%] ... for 150 ms to allow highly disturbed transient operating states without transferring the load to the bypass.
   d. The overload capacity shall be capable of taking into account temperature conditions for more than ten minutes, by allowing a continuous, 10% overload when the temperature is less than or equal to 20°C.

5. **Higher power ratings for lower temperatures:** It shall be possible to increase the power rating when the temperature is less than 35°C. The rating can be raised by +3% for 30°C, +5% for 25°C and +8% for 20°C.
D. **Automatic bypass**

1. **Load transfer to the static bypass:**
   a. Each modular UPS unit in the UPS system shall be equipped with an automatic bypass comprising a static switch. The automatic bypasses of each modular UPS unit shall be connected to the same bypass AC source.
   b. Instantaneous transfer of the load from the inverter to bypass power and back shall take place without a break or disturbance in the supply of power to the load, on the condition that the bypass source voltage and frequency are within the specified tolerances and that the inverter is synchronised.
   c. Transfer shall take place automatically in the event of a major overload or an internal inverter fault. Manually initiated transfer shall also be possible.
   d. If the bypass power is outside the specified tolerances or is not synchronised with the inverter, automatic transfer of the load from the inverter to bypass power shall take place after a calibrated interruption adjustable from 15 to 1,000 milliseconds.

2. **Static-switch protection:** The static switch shall be equipped with an RC filter for protection against switching overvoltages and lightning strikes.

3. **Automatic-bypass withstand:** For the specified power rating of ...[ 500 / 400 / 300 / 250 ]... kVA for each modular UPS units, each static switch shall be capable of handling an overcurrent of ...[ 16 / 16 / 21 / 25 ]... times the rated current of the modular UPS unit to facilitate discrimination within the electrical installation.

E. **External maintenance bypass:** The UPS system shall include an external, mechanical, manual bypass system with one-button operation, common to all modular UPS units. This system shall be designed to isolate the UPS system while continuing to supply power to the load from the bypass AC source and shall be sized to supply the full load.

F. **Discrimination and short-circuit capacity**

1. If the bypass power is within the specified tolerances, the static switches shall make it possible to use the short-circuit power of the bypass source to trip the downstream protection devices of the inverter.
2. Each static switch shall be sized to handle the overcurrent corresponding to the short-circuit power divided by the number of modular UPS units in parallel and any redundant units.
3. To ensure tripping in a selective manner, the total available power shall be sufficient to trip protection devices with high ratings (circuit breaker rated In/2 or UR fuses rated In/4, where In is the rated inverter current).
4. If the bypass source is outside the specified tolerances, all the inverters in operation shall, for the same discrimination requirements, be capable of tripping circuit breakers rated In/2 or UR fuses rated In/4, irrespective of the type of short-circuit.

F. **System earthing (grounding) arrangement (SEA):** The UPS system shall be compatible with the following system earthing arrangements (SEA):

1. **Upstream source SEA:** ...[ TT/ IT / TNS / TNC ]...
2. **Downstream installation SEA:** ...[ TT/ IT / TNS / TNC ]...
3. If the upstream and downstream SEAs are different, galvanic isolation shall be provided on the normal and bypass lines.

2.5 **MECHANICAL CHARACTERISTICS**

A. **Mechanical structure:** The inverter and batteries of each modular UPS unit shall be installed in cabinet(s) with an [ IP 20 / IP 32 ] degree of protection (standard IEC 60529). Access to the subassemblies making up the system shall be exclusively through the front.

B. **Modular design:** The UPS system shall be designed to allow the installed power to be easily increased on site by connection of additional modular UPS units, either to meet new load requirements or to enhance system availability by introducing or increasing redundancy. This transformation shall be possible directly on site, without returning the equipment to the factory and without causing excessive system downtime.

C. **Dimensions:** The UPS system shall require as little floor space as possible. To gain space, it
shall be possible to install the modular UPS units with the back to the wall or back to back.

D. Connection:
1. To facilitate connections, all terminal blocks must be easily accessible from the front when the modular UPS units are installed with the back to the wall. Entry of upstream and downstream power cables, as well as any auxiliary cables, shall be possible through the bottom without requiring a false floor.
2. The UPS shall be equipped with an earth-circuit connector, in compliance with the listed standards. The cables shall comply with the listed standards and be mounted in compliance with the safety stipulations.

E. Ventilation:
1. Cooling of each modular UPS unit shall be by forced-air ventilation. To facilitate layout of the modular UPS units (particularly when installed back to the wall), air input shall be through the front and bottom, exit through the top.
2. All power electronics shall be equipped with a redundant ventilation system including fault detection.

2.6 ENVIRONMENT CONDITIONS

A. UPS (not including battery)
1. Operation: The UPS, not including the batteries, shall be capable of operating under the following environmental conditions without loss of performance:
   a. Ambient temperature range: 0° C to +35° C.
   b. Maximum temperature: 40°C for eight hours
   c. Recommended temperature range: +20° C to + 25° C;
   d. Maximum relative humidity: 95% at 25° C;
   e. Maximum altitude without derating: 1000 meters.
2. Storage
   a. The UPS, not including the battery, shall be designed for storage under the following conditions: ambient temperature range: -25° C to +45° C.

2.7 BATTERY MANAGEMENT

A. Batteries are components whose service life is sensitive to operating conditions, i.e. particular care is required for their management. In addition to the indicated protective systems, battery management shall include the systems listed below.
B. Measurement of actual backup time: The battery function of each modular UPS unit shall be equipped with the means to know at all times the real backup time available (AC power available) or remaining (AC power not available) for the battery of the unit, taking into account the true load on the inverter, the battery temperature and battery ageing.
C. Digital battery monitoring
   1. Each modular UPS shall be equipped with a system for battery digital management.
   2. Based on a number of parameters (percent load, temperature, battery type and age), the system shall control the battery charge voltage and continuously calculate:
      a. The true available backup time
      b. The remaining service life.
D. Block by block monitoring
   1. To further optimise battery availability and service life, it shall be possible to equip the UPS system with an optional system to continuously monitor all battery strings and display a block by block failure prediction.
   2. The system shall include the functions listed below.
      a. Continuous measurement of the voltage of each block.
      b. Continuous measurement of the internal resistance.
      c. Identification of faulty blocks (trend curves).
      d. Possibility of replacing individual blocks.
      e. Remoting of all information via Ethernet, dry contacts or JBus.
2.8 DISPLAY

A. **User interface:** UPS system operation shall be facilitated by a user interface, on each of the modular UPS units, comprising:
   1. A graphic display (at least quarter VGA and high resolution are preferable);
   2. ON and OFF control buttons (independent of the display);
   3. Status indications with mimic panel.

B. **Graphic display:** The mimic diagram shall enable display of installation parameters, configuration, operating status and alarms and indication of operator instructions for switching operations (e.g. bypass). It shall be capable of supervising a given modular UPS unit or a parallel system (up to eight UPS units with the external bypass).
   1. **Display of measurements:** It shall be possible to display the following measurements for any one of the modular UPS units or for the entire system:
      a. Inverter output phase-to-phase voltages
      b. Inverter output currents
      c. Inverter output frequency
      d. Voltage across battery terminals
      e. Battery charge or discharge current
      f. Rectifier/charger input phase-to-phase voltages
      g. Rectifier/charger input currents
      h. Crest factor
      i. Active and apparent power
      j. Power factor of the load
      k. Battery temperature
      l. Battery percent charge
      m. Available backup time
      n. The remaining battery service life

   5. **Display of status conditions and events:** It shall be possible to display the following indications:
      a. Load on battery power
      b. Load on UPS
      c. Load on automatic bypass
      d. General alarm
      e. Battery fault
      f. Remaining battery backup time
      g. Low battery warning
      h. Bypass AC source outside tolerances
      i. Battery temperature
      j. Additional information shall be provided in view of accelerating servicing of the system.

   6. **Display of operating graphs:** It shall be possible to graphically display the measurements mentioned above on the screen over significant periods.

   7. **Statistics:** Number of overloads, number of transfers to battery power, cumulative time on battery power, maximum power levels, demand power levels.

   8. **Log of time-stamped events:** This function shall store in memory and make available, for automatic or manually initiated recall, time-stamped logs of all important status changes, faults and malfunctions, complete with an analysis and display of troubleshooting procedures. It shall be possible to time stamp and store at least 2,500 events.

C. **Controls:** Each modular UPS unit shall comprise the following controls:
   1. **Two ON and OFF buttons:** Located on the front panel of the UPS, they shall control UPS-unit ON/OFF status. It shall be possible to turn OFF the UPS externally via an isolated dry contact.

   2. **EPO terminal block:** The UPS shall be equipped with an emergency power off (EPO) terminal block for complete system shutdown following reception of an external control signal. The EPO command shall result in:
      a. Shutdown of UPS units;
      b. Opening of the static switches on the bypass line and of the battery circuit breaker;
      c. Opening of an isolated dry contact on the programmable card.

   3. **Alarm reset button:** This button shall turn off audio alarms (buzzer). If a new alarm is de-
D. **Status indications with mimic panel:** Indication of status conditions shall be distinct of the graphic display.
   1. Three LEDs on the control panel on each modular UPS unit indicate the following status conditions:
      a. Load protected by the modular UPS unit;
      b. Minor fault;
      c. Major fault.
   2. The mimic panel shall represent the modular UPS and indicate the status of the load supply using five two-colour (red and green) LEDs:
      a. Load supplied (LED at UPS output on mimic panel),
      b. Inverter on (inverter LED on mimic panel),
      c. Operation on battery power (LED between battery and inverter on mimic panel),
      d. Bypass activated (bypass LED on mimic panel),
      e. PFC rectifier on (rectifier LED on mimic panel).
   3. A buzzer shall warn the user of faults, malfunctions or operation on battery power.

2.9 ACCESSORIES

A. **StruxureWare Data Center Expert:** A centralized infrastructure management platform hereafter referred to as Data Center Expert shall be available for purposes of complete system monitoring and management of all components outlined in this specification used as a single solution for small IT or part of the StruxureWare software stack providing data to systems such as Data Center Operation.
   1. **Monitoring** - Data Center Expert shall be capable of monitoring a PDU through a network of Cat 5 cable and a switch supplied by the user. This switch shall relay information to Data Center Expert, which in turn shall allow access to this information via the user's public network via a single IP address.
   2. **Monitored Values:** Data Center Expert shall be capable of monitoring alarms, general status parameters, voltage and current of the PDU.
   3. **Thresholds:** For individualized customer needs, Data Center Expert shall allow for user configurable thresholds for alarm notification. With this feature, Data Center Expert can notify clients of reaching thresholds for PDU capacity, or branch circuit breaker capacity. Other custom programmable alarm points for non-APC products shall also be available via dry contact input signal.
   4. **Public Network Monitoring:** Data Center Expert shall also be capable of monitoring other APC devices that are connected to the client's public network.

2.10 COMMUNICATION

A. **Standard communication:** It shall be possible to remote the following controls, indications and measurements. To that end, each modular UPS unit shall have as standard equipment:
   1. A programmable card with four inputs and six outputs.

B. **Communications options:** The UPS system shall be designed to enable the extension of communications, without system shutdown, to the following types of cards that may be installed on each modular UPS unit:
   1. Multi-standard communications card with two outputs:
      a. An RS485 serial-link implementing the JBus/ModBus protocol for connection to a building management system (BMS)
      b. Ethernet 10/100 Mbps using one of the protocols below:
   2. XML-Web for direct UPS connection to an intranet network, without connection to a server, capable of supplying information via a standard web browser SNMP for connection to a computer-network management system
      a. Multi-standard communications card with three outputs:
         1) The two outputs listed above
2) Plus a modem output for communication with a tele-maintenance system.
   b. The UPS shall be detectable by supervision software for large UPS systems.
   c. Shutdown and administration software shall be available in addition to the communication cards.

PART 3 – EXECUTION

3.1 PROTECTION

A. UPS: Each modular UPS unit in the UPS system shall include protection against AC-source overvoltages (as per standard IEC 60146), excessive external or internal temperature rise and vibrations and impacts during transport.

B. Rectifier and charger:
   1. Each rectifier and the corresponding battery charger shall accept external orders provoking automatic shutdown in the following cases:
      a. EPO (emergency power off), in which the battery circuit breaker also opens
      b. If the temperature exceeds the specified limits.
   2. The rectifier shall automatically shut down if the DC voltage reaches the maximum value specified by the battery manufacturer or if the temperature exceeds the specified limits.

C. Inverter:
   1. The load shall be protected against overvoltages resulting from a loss of voltage regulation at the output of the inverters.
   2. Each inverter (and the corresponding rectifier and charger) shall shut down automatically when the DC voltage reaches the minimum voltage specified by the battery manufacturer.
   3. In the event of an overload exceeding system capacity (AC bypass absent), each inverter shall be equipped with an automatic shutdown system to protect its power circuits. A load short-circuit shall provoke the static shutdown of each inverter without fuse destruction.

D. Batteries:
   1. Protection against deep discharge: The UPS shall comprise a device designed to protect each battery against deep discharges, taking into account the characteristics of the discharge cycles, with isolation of the batteries by a circuit breaker.
   2. Independent regulation and monitoring systems:
      a. A regulation system shall regulate the battery voltage and the charge current of each modular UPS unit.
      b. A second system, independent of the regulation, shall monitor the battery voltage and the charge current. Consequently, if the regulation system fails, the monitoring system steps in to shut down the charger and avoid overcharging.
   3. Regulation of the battery voltage depending on the ambient temperature:
      a. A temperature sensor adapts the charge voltage of each charger to the ambient temperature.
      b. This regulation system takes into account the chemical reaction and prolongs the battery service life.
      c. The permissible temperature range is set in the personalisation parameters.
      d. An alarm shall be issued for temperatures outside the permissible range.
   4. Self-test:
      a. The battery shall be equipped with a self-test that can be run:
         1) On request via a manual control
         2) automatically according to user-set time intervals.
      b. The self-test shall enable updating of battery parameters and detection of all abnormal conditions in view of preventive maintenance.

3.2 MAINTAINABILITY

A common external bypass shall be available to completely isolate the UPS.
A. **Local and remote diagnostics and monitoring - E. Services:** The UPS shall be equipped with a self-test system to check operation of the system as a whole each time it is started. To that end, the supply control/monitoring electronics shall offer:
   1. Auto-compensation of component drift;
   2. Acquisition of information vital for computer-aided diagnostics or monitoring (local or remote);
   3. Overall readiness for remote supervision services provided by the manufacturer.

### 3.3 STANDARD AND TESTS

#### A. Standards

1. All equipment shall be designed and built in accordance with accepted engineering practice and applicable international standards, in particular the standards listed below.
   a. IEC 60140-4: UPS - Performance.
   b. IEC 62040-1 and EN 62040-1: UPS - Safety.
   c. IEC 62040-2 and EN 62040-2: UPS - Electromagnetic compatibility (EMC), level B.
   d. IEC 62040-3 and EN 62040-3: UPS - Performance.
   e. IEC 60950 / EN 60950: Safety of IT equipment, including electrical business equipment.
   f. IEC 61000-2-2: EMC, levels of compatibility.
   g. IEC 61000-3-4: Limits for harmonic current emissions (equipment input current > 16 A/ph).
   h. IEC 61000-4: EMC – Immunity tests.
   i. IEC 439: Low-voltage switchgear and controlgear assemblies.
   j. IEC 60529: Degrees of protection provided by enclosures (IP Code).
   k. ISO 3746: Sound power levels.
   l. CE marking.

2. What is more, the equipment shall comply with eco-design and eco-manufacturing criteria in view of sustainable development and to that end, the manufacturer shall be able to demonstrate:
   a. R&D and production on an ISO 14001 certified site
   b. Manufacture with over 90% recyclable materials
   c. Capacity to recover products at the end of their service life and provide proof of destruction by a certified organisation
   d. The environmental profile of the product, which shall be supplied with the sales offer.

#### B. Certification of conformity:

The manufacturer shall provide, on request, a complete qualification file demonstrating compliance with the above standards. What is more, the indicated levels of performance shall be confirmed by certification from independent laboratories (e.g. TÜV or Veritas).

### 3.4 QUALITY SYSTEM AND TEST PROCEDURES

#### A. Test procedures:

1. The manufacturer shall provide proof of a quality-assurance system. In particular, the main manufacturing steps must be subject to suitable tests such as:
   a. Inspection of incoming components, tests on discrete subassemblies
   b. Complete functional checks on termination of manufacture.
2. The equipment shall be subject to burn-in under load conditions prior to shipping.
3. Final checks and adjustments shall be recorded in a report drafted by the quality-inspection department of the supplier.
4. Certification of the industrial facilities in compliance with ISO 9001 or 9002 shall be required.

#### B. Quality system:

The UPS must be designed using an ISO 9001 quality system and a dependability study to ensure maximum reliability.

### 3.5 SERVICES

#### A. Maintenance:

The supplier shall propose contracts covering four levels of maintenance.
1. **Level one:** simple checks and settings, procedures accessible without any dismounting and involving no risk.
2. **Level two:** preventive maintenance, checks not inhibiting continuous operation of the system and preparing operators for Manufacturer services.

3. **Level three:** trouble-shooting. Repairs by standard exchange of subassemblies and functional power and control components. Preventive-maintenance operations, both systematic and when indicated by qualified diagnosis.

4. **Level four:** major preventive and corrective maintenance operations or technical upgrades during start-up, operation or renovation of the UPS installation and recycling of equipment or components representing a risk. These operations require the use of devices and means that have been calibrated by certified organisations.

**B. Technical competency:**
1. **Customer operators:** the supplier shall offer a level 2 training program.
2. **Service personnel:** the supplier shall ensure that service personnel are qualified for level 4.

**C. Functional components - organisation of supplier services:**
1. Sufficient geographical proximity of the supplier or an authorised agent shall ensure reasonable access times to the customer site in view of reducing the mean time to repair (MTTR). The supplier shall be in a position to offer a contract limiting the response time to four hours.
2. The supplier's logistics system and the availability 24 hours a day of original replacement parts shall similarly contribute to reducing to the greatest extent possible the mean time to repair (MTTR).

**D. System start-up:** The system and equipment shall be started up on site by the supplier or its authorised agent. The procedure shall include checks on the characteristics of the upstream and downstream protection devices and on the UPS installation parameters.

**E. Replacement parts:** The supplier shall undertake to provide certified original replacement parts for at least ten years following the date of delivery.

**F. Recycling and renovation/substitution:** At the end of the UPS service life, the supplier shall guarantee the continuity of service of the customer’s installations if necessary, including dismantling of equipment and replacement of equipment, in compliance with applicable standards on environmental protection.

### 3.6 INSTALLATION SERVICES

**A. Required services include:**
1. Supply of the UPS and any accessory parts or elements.
2. Carriage-paid UPS transportation and delivery to the site.

**B. Options:**
1. UPS handling and installation on the site.
2. Connections between the battery and the UPS.
3. Connection of the normal AC source to the rectifier/charger.
4. Connection of the bypass AC source to the input transformer or bypass input.
5. Connection of the load circuits to the UPS output.

**END OF SECTION**
**CHECK LIST FOR GUIDE SPECIFICATION**

To meet the requirements of your project, use this checklist to identify the technical specifications available.

**Type of UPS**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total rated power (kVA) at PF 0.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range of products</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating mode (IEC 62040-3)</td>
<td>double conversion VFI</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Parallel connection of up to 8 modular UPS units</td>
<td>kVA max</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Up to three redundant units (n+3)</td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Alarm signalling loss of redundancy within the UPS system</td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**Rectifier**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input voltage range</td>
<td>250-470 V</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>3-phase input voltage</td>
<td>Without neutral</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Phase sequence</td>
<td>Wrong phase sequence is signaled by alarm</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Sinusoidal input current</td>
<td>THDI upstream ≤ 5% with PFC rectifier</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Input power factor</td>
<td>PF &gt; 0.99 with IGBT rectifier (from 50% load)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>No inrush or start-up current</td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Rapid battery recharging</td>
<td>Typical 10-min. backup time recharged in ≤ 6 hours</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Voltage regulation</td>
<td>± 1%</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Independent regulation/monitoring systems for the charger</td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**Battery**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Standard</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Service life</td>
<td>Years</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Backup time</td>
<td>Minutes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**Battery management and protection**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recharge as a function of the temperature</td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Measurement of actual backup time, depending on: load, temperature, age</td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Cold start on battery power</td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Protection against deep discharge with circuit-breaker opening</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Charge-current limiting</td>
<td>0.05 C10 to 0.1 C10 (depending on battery)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Self-tests</td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Measurement of real backup time</td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Block by block monitoring</td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Prediction on end of service life</td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**Inverter**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three-phase output voltage with neutral</td>
<td>Volts</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Steady-state conditions</td>
<td>± 1%</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Feature</td>
<td>Specification</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>---------------------------------------------------------</td>
<td>-----</td>
<td>----</td>
</tr>
<tr>
<td><strong>Voltage transients</strong></td>
<td>± 2% (load from 0 to 100% or 100 to 0 %)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Output voltage distortion at Pn</strong></td>
<td>THDU &lt; 3%</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Unbalanced conditions</strong></td>
<td>Voltage variation &lt; 1%</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Output frequency</strong></td>
<td>Hz</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Variation in output frequency</strong></td>
<td>± 0.5 Hz</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Adjustable from - 0.25 Hz to + 4 Hz</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Frequency synchronisation with an external source</strong></td>
<td>± 0.5% to ± 8 % of rated frequency</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Overload capacity</strong></td>
<td>125% In for 10 minutes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>150% In for 30 seconds</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Current limiting</strong></td>
<td>300% In for 150 milliseconds</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Crest factor</strong></td>
<td>Up to 3:1</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**Bypass functions**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Automatic bypass of each UPS</strong></td>
<td>With static switch</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Fuseless technology</strong></td>
<td>No fuses in series with static switch</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Short-circuit withstand of static bypass</strong></td>
<td>16 to 25 In for 20 ms, depending on rating (e.g. 25 In at 250 kVA / 16 In at 500 kVA)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Static switch is protected against switching and lightning voltage surges</strong></td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Manual bypass</strong></td>
<td>Via shared external bypass (for maintenance)</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**Efficiency**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall efficiency of UPS system</strong></td>
<td>&gt; 94.5% from 50 % load</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Efficiency Booster mode</strong></td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Rotation strategy</strong></td>
<td>Each UPS in the installation has the same operating time</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Enable or disable the function through the display</strong></td>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**User interface**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Graphic display in 19 languages</strong></td>
<td>selection of operating language</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Customisation menu</strong></td>
<td>with password</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Display</strong></td>
<td>measurements, status, events, graphs</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Event log</strong></td>
<td>2500 time-stamped events</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Bargraphs</strong></td>
<td>Power levels, backup time</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Statistics</strong></td>
<td>% time on battery power, number of transfers to battery power, average percent load, etc.</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Controls</strong></td>
<td>Separated ON/OFF buttons</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Redundant interface with separated mimic panel</strong></td>
<td>Not included on display</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Status indications</strong></td>
<td>Audio alarm, LEDs</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
## Communication

<table>
<thead>
<tr>
<th>Options</th>
<th>Card with two outputs</th>
<th>Card with three outputs</th>
<th>Supervision software</th>
<th>Administration software</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>JBus/ModBus RS485 +</td>
<td>Same as the two-output</td>
<td></td>
<td>With shutdown</td>
</tr>
<tr>
<td></td>
<td>Ethernet 10/100</td>
<td>card + a modem</td>
<td></td>
<td>management</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Certification</th>
<th>See list in section 12.1</th>
<th>LCIE</th>
<th>ISO 9001 / 9002</th>
<th>ISO 14001 site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certified standards and tests</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Performance certification</td>
<td></td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Quality certification</td>
<td></td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Eco-design and manufacturing</td>
<td></td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

## Installation

<table>
<thead>
<tr>
<th>Installation</th>
<th>Cabinet height</th>
<th>UPS cabinet weight (without batteries)</th>
<th>Installation against a wall</th>
<th>Access to cable or bus bar connection through front</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1900 mm maximum</td>
<td>1500 kg maximum</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

## Services

<table>
<thead>
<tr>
<th>Services</th>
<th>Technical competency of supplier</th>
<th>Diagnostics and monitoring</th>
<th>Technical Support</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level 4 NFX 060-010</td>
<td>Remote</td>
<td>International</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

## Operation/Maintainability

<table>
<thead>
<tr>
<th>Operation/Maintainability</th>
<th>Safe maintenance</th>
<th>Access to power components through front</th>
<th>Access to communication through front</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Built-in input, output and bypass switches</td>
<td>hot-swap cards</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

## Availability

<table>
<thead>
<tr>
<th>Availability</th>
<th>Worldwide availability if original replacement parts</th>
<th>Response time of Service teams</th>
<th>Maintenance Programs</th>
<th>Emergency services</th>
<th>Renovation/substitution programs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>t&lt;4h 4&lt;t&lt;8 8&lt;t&lt;24 h t&gt;24 h</td>
<td>Preventive</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Predictive</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>