Addressable Emergency Lighting with Central Battery System

A. Description:

1. The Central Battery system (CBS) shall consist of a rectifier/battery charger, batteries, inverter, automatic local transfer switch, protective devices, surges suppression device, battery circuit breaker, external mechanical bypass switch and accessories as specified in this Specification that will automatically effect continuity of electrical power, upon failure or deterioration of the power supply. Continuity of electric power to the load shall be maintained for an emergency period of ‘fire’ and/or ‘normal mains failure’ with the inverter supplied by the batteries, up to the specified maximum time or until restoration of the normal power supply.

2. The CBS shall be designed in a modular configuration so as to enable the power of the CBS installed to be easily increased on the site by paralleling more than one module to meet the new operating requirements and the desired reliability. In this connection, transformation of a unitary module into a multi-module configuration shall be able to be carried out directly on site without returning to equipment to the factory for modification and with a minimum installation down time.

3. Single module system shall have the rectifier/charger, inverter, automatic load transfer switch and all the necessary monitoring and control functions contained in a single cabinet. Multi-module system shall have separate cabinet containing the rectifier/charger, inverter and the necessary monitoring and control functions for each module, and with a separate dedicated cabinet to house the system control and monitoring functions and automatic load transfer switch.

4. The battery of CBS shall be sealed lead acid battery, heavy duty, re-chargeable, comply with BS6290 part 4, no separate battery rooms shall be required for the CBS.

B. Particular Requirements on Quality Assurance:

1. The Central Battery system (CBS) shall be designed for continuous reliable operation such that the ‘Mean-Time-Between-Failure’ (MTBF) for individual modules of the CBS rectifier/charger unit, inverter unit and static switch etc. shall be more than 8760 hours.

2. The CBS shall be designed and constructed in accordance with the latest revision of the following standards.
   - EN50091-1 General and Safety
   - EN50091-2 EMC
   - EN50091-3 Design
   - IEC62040-1 General and Safety
   - IEC62040-2 EMC
   - IEC62040-3 Design
   - BS7430 Code of Practice for Earthing
   - BS6290 part 4 Sealed lead acid battery
C. System Operation

The CBS shall be designed to operate in the following modes:

1. Normal
   The CBS shall feed the load directly in the rectifier/charger section and convert the mains supply to direct current to float charge the battery system as well as to feed the inverter.
2. Upon failure of mains supply, the CBS battery system shall supply sufficient power to maintain the specified CBS output for not less than 2 hours (NO generator back-up) support time.
3. When mains power is restored, the rectifier/charger shall automatically adjust the output voltage to float charge the battery system.
4. Central Battery System can also be activated while Fire happens. If normal mains supply is not failure, maintained type emergency lights and non-maintained type emergency lights activate and to be back up by normal mains supply is required.
5. The CBS shall provide with an external mechanical bypass switch to manually bypass the entire CBS for major maintenance and services purposes.
6. For maintenance purpose, it shall be possible to isolate the battery system from the rectifier/charger and the inverter by means of a circuit breaker.
7. Emergency Stop completed with a cover should be provided to break the CBS input, output and battery by just pressing one control button.

D. Specification:-

1.1 The Contractor shall design, supply, install, test and commission addressable emergency lighting installation with central battery system (CBS) and all necessary accessories for all emergency lighting including EXIT and all maintained type and/or non-maintained type luminaries.

1.2 The contractor shall design, supply and install central testing system or facility with a central battery system to comply with FSD’s requirements on the testing of emergency lighting and exit sign installation. The testing of emergency lighting installation shall be made by addressable emergency lighting system with central battery system at prescribed intervals with no disruption to any other electrical services. Notification of failures or reductions of performance shall be given at the earliest opportunity to enable the system to be restored to full operation.

1.3 The system shall be used for the emergency lighting installation with information to check whether the installed luminaries are under their normal function or not.

1.4 The system shall be a computerized maintenance management system to test all emergency lighting luminaries and exit signs automatically in accordance with the FSD’s requirement including circular letter No. 1/2006. The system shall also be able to operate and carry out testing when the control computer is failure.

1.5 Spare capacity of 20% for power supply rating and 15% minimum for battery rating is required.
2.1 Central Battery system together with addressable emergency lighting system shall be designed, supplied and installed by the Contractor for emergency lighting, including Exit sign. To ease and secure the future maintenance work on emergency lighting installation by centralized control and monitoring minimum two (2) separate sets of central battery system shall be provided for the premises inside the respective sub-main switch rooms for the essential back-up supply to the emergency lighting installation of the building concerned. The system shall be so designed that in event of normal power supply suspension, situation of completely black-out for the whole floor due to the equipment failure can be eliminated since each of the battery system supports only half of the floor lighting. The system and battery selection shall be designed in strict accordance with Fire Services Department as well as meeting the environmental concern. Ventilation or air-conditioning provision for the location of batteries installed shall be duly considered so as to assure the battery system is to be continuously operated in an efficient manner and long operating life of not less than five (5) years.

2.2 The Contractor shall provide EXIT signs in accordance with FSD’s requirements and the essential power supply shall be fed from the Central Battery System. The external frame of the EXIT signs shall be included in the Electrical Contract and subject to Architect’s approval.

2.3 When mains supply failure occurs, the lighting fittings shall be switched instantaneously to the battery operated mode. Upon restoration of mains supply or back up by standby generator set, the lighting fittings shall be switched back automatically to the mains supply or generator set supply operating condition. Then, the battery shall be re-charged again.

2.4 The power supply cable to emergency lighting fittings shall be at least Category CWZ cable to BS6387 and be installed in steel conduit or metal trunking of Government approved standard. All related switchgears, sub-main and final circuit distribution boards and cables for power supply to emergency luminaries shall be located inside fire rated switch rooms or cable ducts.

2.5 The contractor shall supply and install a concealed/surface G. I. Conduit system with watertight accessories e.g. cable change box for the perimeter lighting.

2.6 The Identity Number of the emergency lighting fitting shall be clearly labeled on a proper surface of the luminaries for easy future maintenance. The type of label and positioning of the label is subject to Architect’s/Engineer’s approval.

2.7 Emergency lighting system shall be independent of any lighting control scheme.

2.8 Both Maintained Type Output and Non-maintained Type Output from the Central Battery System are required.

2.9 The system software shall be suitable to run under Windows XP platform or higher. The installed software in the control computer shall carry out the following functions:-
(a) Program scheduled testing of emergency lighting to relevant standard and user requirements
(b) Ability to activate manual testing of emergency lighting to user specification.
(c) Provide status reports on system and emergency luminaries.
(d) Allow for group testing to prevent adjacent luminaries being subjected to full duration testing at the same time.
(e) Provide database management
(f) Produce test reports as required.
(g) Monitor the power supply unit in terms of:
   (i) Input Power phase, current and voltage
   (ii) Output Power phase, current and voltage
   (iii) percentage of output capacity
   (iv) Battery Voltage
   (v) Battery Discharge Duration
   (vi) Battery Low Alert
   (vii) General Fault Visual and Audible Alarm
(h) Monitor the Emergency Lighting Status in terms of ‘LIVE’ graphic display for:
   (i) Addressable in terms of showing the Identity Number
   (ii) Normal condition: E. Light ‘On’, E. Light ‘Off’
   (iii) Fault condition: E. Light ‘Communication Error’ or E. Light ‘Fault’
(i) Monitor the Central Battery System in terms of:
   (i) ‘Maintained Type Emergency Lights On’
   (ii) ‘Non-maintained Type Emergency Lights On’
   (iii) ‘Battery Normal’
   (iv) ‘Battery Discharge’
   (v) ‘CBS Main Unit Normal’
   (vi) ‘CBS Main Unit Fault’
   (vii) ‘CBS Input Power Failure’
   (vii) ‘CBS Receiving Signals’

2.10 FTP or Cat.5/Cat.5e cable for the monitoring network.

2.11 Central Battery System can be activated while Fire happens and/or Normal Mains Supply fails. If normal mains supply is not failure, maintained type emergency lights and non-maintained type emergency lights activate and to be back up by normal mains supply is required.

3.1 Signals of ‘Fire Alarm’, ‘Normal Mains Failure’ and ‘Local normal mains (normal power distribution board) failure’ signals to activate CBS is required.

3.2 CBS signals in terms of ‘volt free dry contact’ including ‘System normal’, ‘System Fault’, ‘Battery Fault’ and ‘Battery Discharge’ transmitted to Fire Services Control Panel is required.

3.3 Control Cable and/or signal cable for the system monitoring, signals transmitting and emergency
lighting status is required.

4.1 Computerized managed battery weekly/monthly testing and event logging to meet the Fire Service Installation and Government Building General Specification requirement

4.2 Microprocessor control unit for data entries, renewal in the monitoring system is required.

4.3 For automatic central monitoring, testing and logging system, all the emergency luminaries shall be connected to a computer unit completed with RS232/422 communication.

4.4 Monitoring data transmitted via power line is not accepted.

E. Equipment Functional Requirements:

1. Materials, Parts and Components
   All materials and parts comprising the CBS shall be new, of current manufacturer, of a high grade and free from all defects and imperfections.

2. All active electronic devices shall be solid state. All semiconductor devices shall be hermetically sealed. All relays shall be dust tight.

3. The maximum working voltage, current and \( \frac{di}{dt} \) of all solid state power components and electronic devices shall not exceed 75% of the ratings established by their manufacturer. The operating temperature of solid-state component cases shall not be greater than 75% of their ratings. Electrolytic capacitors shall be computer grade and be operated at no more than 75% of their voltage rating.

4. The CBS solid-state power switching circuits and control system shall be modular in construction for ease of maintenance and to minimize down time. It is preferred that all solid-state power switch modules are of the draw-out type removable from the front of the CBS. The CBS shall be designed to permit ready access to modules and assemblies. The placement of parts, test points and terminals shall be such that they are accessible for circuit checking, adjustment and maintenance without the removal of any adjacent module or assembly.

5. Self-diagnostic Aids
   The CBS shall be provided with sufficient built-in diagnostic aids to facilitate trouble-shooting, maintenance and circuit calibration. Each circuit module of the CBS shall be accompanied by suitable indicators and test points allowing the current status of each module to be monitored as required. The CBS shall be equipped with an event recorder so that hard copy of critical data or status can be made available for analyzing when necessary.

6. The CBS shall be constructed in heavy-duty metal enclosures, designed for floor mounting. The CBS shall be structurally adequate and have provisions for hoisting, jacking and forklift
The individual cabinets shall be capable of being arranged side-by-side. Wire runs shall be protected in a manner to separate power and control wiring. Provisions shall be made in the cabinet to permit installation of input, output and inter-cabinet cabling using raceway or conduit. The CBS cabinets shall be cleaned, primed and painted.

7. Ventilation – Adequate forced air-cooling by suitably rated blowers shall be installed to ensure that all components are operated within their environment ratings. The power supply of blowers shall be from the CBS. All blowers shall be equipped with wind vanes sensor connected to an alarm and the control panels.

8.1 The rectifier/charger unit shall be provided with an input circuit breaker. The circuit breaker shall be of the frame size and trip rating to supply full rated current to the critical load and recharge the drained battery at the same time. The sub-cycle in-rush current of the rectifier/charger unit shall be less than 8 times the normal full load input current.

8.2 The rectifier/charger unit shall provide for input current limiting whereby the CBS module shall draw only sufficient power to drive the critical load. In addition, this facility shall also provide a preset maximum power level to limit the charging current for the battery. Preferably, the current limit can be adjustable from 100% to 125% of the full input current rating.

8.3 The rectifier/charger unit shall provide features whereby when the AC power is returned to the AC input bus after the CBS has been operating on battery power or has been de-energized, the total initial current requirement at the input terminals will not exceed 20% of rated load current, and the current will gradually increase to 100% of full rating over a 15-second time interval.

8.4 The rectifier/charger shall have an output filter to minimize the ripple current into the battery. Under no condition shall the RMS supply current into battery exceed 3% of the average charging current. Filtering shall be adequate to ensure that the DC output of the rectifier/charger will meet the input requirements of the inverter. When the battery is disconnected, normal operation shall be maintained with the DC voltage derived from the rectifier.

8.5 In addition to supplying power to the inverter, the rectifier/charger shall be capable of recharging the battery as specified herein. Charging current shall be voltage regulated and with current limiting. The charging rate shall be sufficient to restore the battery from discharge to 95% charge within ten (10) times the discharge time at full load. After the battery is recharged, the rectifier/charger shall maintain the battery at full charge until the next emergency operation.

9.1 The inverter unit shall be a solid-state device capable of accepting the output of the rectifier/charger or battery and providing an AC output with the operating characteristics as specified hereafter. The output of the inverter unit shall be connected to a transformer network and a 3-phase filter (for 3-phase output only) to the output terminals. The transformer shall be a
dry type transformer. When operating under the full load condition and at the maximum ambient temperature, the temperature of the transformer’s hottest sport winding shall not exceed the limit of the transformer insulation class of material. The CBS inverter unit shall have a low output impedance to high harmonics to keep the harmonic voltages caused by the load to a minimum.

9.2 The output frequency of the inverter shall be maintained in a phase-locked condition with the frequency of the bypass source as long as it is within the specified limited. In the event the bypass line frequency goes out of tolerance, the inverter shall phase lock to a built-in temperature compensated oscillator. In such a case, the total frequency deviation including short time fluctuations and long-term drift, shall not exceed + 0.25% from the nominal frequency.

9.3 The inverter shall have fault sensing, a static interrupter and output circuit breaker for the removal of the inverter output from the critical load, without exceeding the limits stated in this specification.

10. The CBS shall be provided with Battery Circuit Breaker. When open, the battery shall be completely isolated from the rectifier/charger and from the inverter. The CBS shall automatically by disconnected from the battery by opening the circuit breaker when the discharge limit of volts per cell is reached, or when signaled by other control functions. The circuit breaker may also be manually operated during servicing of the batteries.

11. The CBS shall be fitted with an integral control and indication panel. In case of a separate system control cabinet being provided, it shall match the construction and appearance of the CBS modules and shall contain bus bar connections for the output and bypass switch. The control and indication panel or the system control cabinet shall include all the necessary instrumentation, alarms and indicators showing the operation of the CBS.

12. The CBS shall be provided with, as a minimum, the meters either hardware or software indicated as below:- input voltage and current with phase selection
   DC battery discharge current
   DC battery voltage
   CBS output voltage and current with phase selection
   Frequency of CBS output

13. The CBS shall be provided with, as a minimum, the following alarms and indications:-
   CBS Common Fault
   Over-temperature shutdown
   Battery open or Battery Low
   Battery Discharge
   Inverter Overload
14. Local Emergency Shutdown provisions shall be provided. Activation of the local emergency shutdown switch shall cause the module input, output and battery circuit breakers to open, completely isolating the CBS from all sources of power. The critical load shall be automatically transferred to bypass when the emergency shutdown is activated.

15. System Bypass Switches:-
   (a) System Mechanical Bypass Switch
       The CBS shall be provided with an external mechanical bypass switch to manually bypass the entire CBS for maintenance and service purposes.
   
   (b) Automatic load transfer switch
       A four-pole automatic load transfer switch shall be provided to control the path of power supply to the load. It shall be of break-before-make type.

       The load shall be connected to the CBS inverter. In the event of inverter failure, the CBS shall be switched automatically to the bypass supply by the automatic load transfer switch after an adjustable delay from 0 to 10 seconds. The initial setting shall be at 0.5 second. If the bypass supply is not healthy, the transfer shall be inhibited. Upon the recovery of the inverter output, the load shall be switched back to the inverter with an adjustable time delay of 0 to 10 seconds. Manual selection facilities shall be provided such that the load can be switched to the inverter output or the bypass supply.

F. A storage battery bank shall be furnished for the CBS with sufficient ampere-hour rating to maintain the CBS output at the rated output capacity and for a period of duration of two (2) hours (or as specified). It shall be of heavy-duty, rechargeable industrial type design for power back-up services. Battery cells shall be rechargeable, extra low maintenance, high performance sealed lead acid battery, valve regulated, comply to BS6290 part 4. Battery capacity Calculation and Battery Discharge Table should be submitted for approval. Battery shall be supplied with either racks or cubicles protected.
with electrolyte resistant paint; inter-cells and interior connectors protected with anti-corrosive plastic covers.

G. Electrical Characteristics and Performance

1. Electrical Performance:-
   (a) The CBS shall have built-in self-protection against:-
       (i) Over and under voltage power line surges.
       (ii) Load switching and circuit breaker operation in the distribution system.
       (iii) Sudden changes in output load exceeding the rating limit
       (iv) Short circuits at the output terminals.
       (v) Power semiconductors in the CBS shall be fused with fast acting fuses so that the loss of any one power semiconductor will not cause cascading failures.
       (vi) Thermostats shall be fitted to monitor the temperature of the power semiconductors, such that when over-temperature is sensed, the CBS shall automatically be shut down and the critical load transferred to the bypass source via the automatic load transfer switch.

   (b) The CBS shall have built-in protection against permanent damage to itself and the connected load for all predictable types of failures within the CBS. Fast acting current-limiting devices shall be used to protect against failure of solid-state devices. Internal failure of the CBS shall cause the CBS to trip off-line and switch to bypass automatically. All failure shall generate visual and audible indications.

   (c) Information shall be generated within the CBS to maintenance personnel regarding the reasons for tripping.

   (d) Noise generated by the CBS under any normal operating condition shall not exceed the allowable sound pressure level of 75 dB(A) measured at 2 metre from the nearest surface of the CBS cabinet.

2. Electrical Characteristics:
   (a) (i) The Input
       - voltage 380VAC +/- 10%
       - frequency 50Hz +/- 2%
       - Power walk-in 20% to 100% of rated load in 15 seconds
       - Power factor Unity to 0.7 lagging
   (ii) Output
       - voltage 380VAC +/- 10%
       - frequency 50Hz +/- 2%
       - Power rating to suit the system: Minimum
       - Power rating 110% for 60 minutes
       - Overload 125% for 10 minutes
       - Overload 150% for 10 seconds
- Nature of Load: Emergency Lighting
  
  (iii) Phase 120 deg. + deg. For displacement, balance load, 120 deg. + deg. For 30% unbalanced load
  
  (iv) Harmonic distortion: 3% maximum for any single harmonics, 5% maximum for total value

(b) Efficiency: The CBS efficiency shall be 80% minimum under the following condition:-
  
  (i) The CBS is operating at rated load,
  
  (ii) The battery is fully charged and floating on the system
  
  (iii) The input voltage is within the specified limits.
  
  (iv) The load power factor is between unity and 0.80 lagging
  
  (v) Efficiency shall be defined as the ratio of output KW to the input KW

(c). Radio Suppression:
  
  The equipment shall incorporate radio suppression comply with BS EN 50015 and shall include screening as necessary for the suppression of radiated interference.

H. Installation Equipment:-

1. All equipment, cabling, etc. shall be installed in the LV switch room.

2. All equipment except portable equipment shall be firmly held in place. Fastenings and supports shall be adequate to support their loads with a safety factor of at least three.

3. Provision of cables, cable trays, conduit and trunking etc. shall be in accordance with the requirements of the specifications.

4. All cabinet(s) shall be solidly bonded to a good earth in accordance with BS7430 using adequate section of cable or bus bar. The earth connection at the cabinet(s) shall be made to the frame earth terminal provided or alternatively to a substantial part of the base frame rather than to bolted-on panel.

5. The central battery power supply system shall be designed and manufactured by a reputable manufacturer which has continuously manufactured the system for at least five (5) years and their manufacturing facility shall have a local agent to provide full technical support which includes adequate spare holding and technical expertise in testing, commissioning and trouble shooting.

6. The major equipment, parts and component can be purchased in Hong Kong in any cases of maintenance purposes.