

Uninterrupted Power Supply Introduction for Technical Grade Staff

HUI CHI KONG EnI/QMH/1

SHUM Chi Yin AEnI/QMH/1/5 Part A

LI CHIU KEUNG AEnI/QMH/1/1 Part B

20-May 2022

PART B

- 1. Preventive Maintenance Guide, PM Schedule arrangement**
 - PM form**
- 2. Department Guideline for Acceptance Test**
- 3. Equipment and Tools**
 - Annual calibration**
- 4. Sharing the 15 kVA & 60kVA UPS system at QMH**
- 5. Battery Disposal**
- 6. Engineering Guideline on Uninterruptible Power Supply (UPS) System (ESG15)**

Preventive Maintenance Guide

- ▶ Four Time One Year
- ▶ Data Measurement
- ✓ Input
- ✓ Output
- ✓ Battery
- ✓ Load
- ▶ Transfer Test
- ▶ Battery Discharging test (Dummy or Actual load) Every year
- ▶ Assessment
- ▶ Battery Management/Monitoring system

Health Sector Services  **EMSD**

UPS Preventive Maintenance Report (>3KVA)

Venue: _____ Date: _____

Last PM Date: _____ Start Time: _____

End Time: _____

A. Equipment Detail

UPS Make and Model: _____ UPS No.: _____

UPS Rating: _____ AMS/REG No.: _____

Battery Make and Model: _____ Serial No.: _____

Battery Voltage & Capacity: _____ No. of Cells: _____

Year of installation (if known): _____

B. Data Measurement

Rectifier Input Voltage	V _{in}	V _{in}	UPS Output Voltage	V _{out}	V _{out}
Battery Floating Voltage	V _{bat}	V _{bat}	Neutral to Earth Voltage	V _{ne}	V _{ne}
Rectifier Input Current	I _{in}	A _{in}	UPS Output Current	I _{out}	A _{out}
Input Frequency	f _{in}	Hz	Output Frequency	f _{out}	Hz
Voltage difference between Inverter Output and Bypass Input			V _{di}	V _{di}	V _{di}
Rectifier Output Current	I _{out}	A _{out}	Battery Discharge Current	I _{bc}	A _{bc}
UPS Temp.	°C	°C	Load Power	VA	VA
Battery Hotspot Temp.*	°C	°C	Load Power	W	W
AC Capacitor Temp.	°C	°C	Power Factor		
DC Capacitor Temp.	°C	°C			
Duty Cycle	%	%			

Note: Current (A) and voltage (V) are measured in rms.

C. Operation Condition

[] Satisfactory (✓); Unsatisfactory (x); Not Completed (NC); Not Applicable (NA)

[] UPS Room Temperature: _____ °C	[] Clock Setting
[] UPS Room Relative Humidity: _____ %	[] Alarm History Checking
[] UPS Cooling Fan, Air Filter and Harmonic Filter (if available)	[] UPS Synchronization
[] AC and DC Capacitor Banks	[] Inverter / Inverter Transfer
[] Tidiness and Cleanliness of UPS	[] External Bypass Key Interlock / Transfer (optional)
[] Correct Status of Display LEDs / Indicators & Readings	[] UPS Remote Alarm Panel/Workstation/CCMS Interface
[] Correct Status of PCB LEDs	[] No Abnormal Heat and Noise on Major System Components
[] Emergency Hotline Label	[] Isolation Transformer (if available)

D. Battery Discharge Test on Actual Load ☐ Permitted ☐ Not Permitted by Client

Discharge Time (Min): (Depends on Output Loading)																			
Battery Voltage (V _{bat})																			
Battery Current (I _{bc})																			

Note: Supplementary sheet for individual battery measurement data (battery bank number, terminal voltage, battery impedance, battery temperature, etc.) can be attached.

E. Measurement Data from Battery Management/Monitoring System (BMS)**: To be provided in separate sheet.

F. Assessment

UPS Condition:	[] Normal	[] Abnormal	
Battery Condition:	[] Normal	[] Abnormal	[] Discharge test not conducted
OB Condition:	[] Normal	[] Abnormal	

G. Test Equipment

Description: _____

Make and Model: _____

Serial Number: _____

Calibration Date: _____

H. Remark:

Service Performed By: _____ Acknowledged by Client: _____

Name: _____ Post: _____

Name: _____ Post: _____

* Applicable if a hot spot is found using Thermal Imager

** Applicable if a BMS is installed

* To be filled in as appropriate

* To be filled in if available. If otherwise, enter "N/A"

mm-pm-01 [Rev.05/20]



F2 OT UPS PM
loading test report



F5 OT DL May
2019

Socomec Masters IP+ (2 x 15KVA , parallel) UPS system at QMH

- ▶ 15KVA UPS PM Dummy load test 15 minutes (Annual)
- ▶ Make a appointment with client and UPS contractor
- ▶ To work with EMA colleague to change UPS power source
- ▶ Inform EMA duty colleague UPS alarm will appear during the UPS PM
- ▶ To ensure all the preparation is corrected before start dummy load test
(check room temperature ,humidity, battery temperature and UPS system value)
- ▶ Start Dummy load test
- ▶ Test and record UPS system value every 5 Minutes
- ▶ Finished Dummy load test and resume UPS to normal
- ▶ Check OT room power socket is normal or not on pendant
- ▶ Inform OT Nurse in charge and EMA duty colleague

PM Schedule arrangement

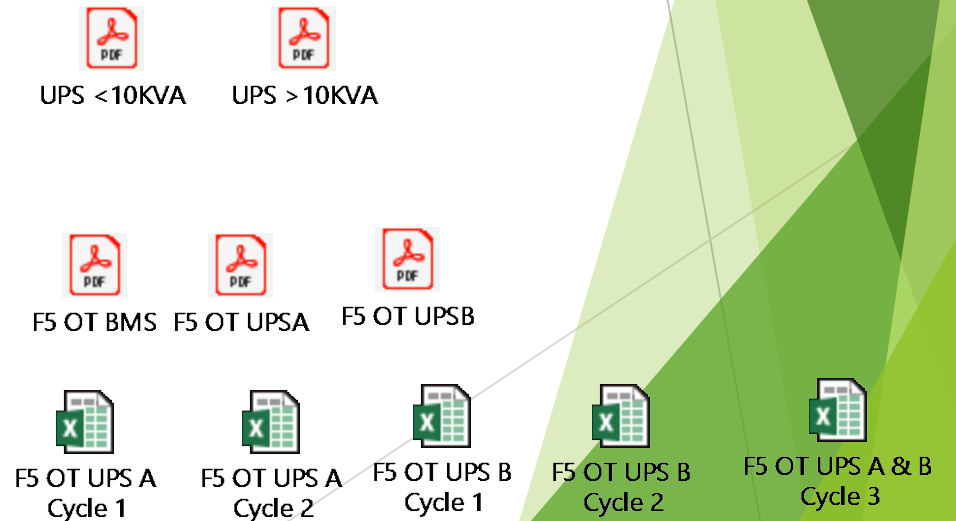
According to the schedule of Operating theater overhaul, we will Plan UPS PM schedule next year

[illegible]

Department Guideline for Acceptance Test

To ensure the UPS system is installed correctly and operating normally, we will make acceptance test before the operation used

- ▶ Visual Inspection Check of Equipment
- ▶ Dummy / Actual Load Testing
- ▶ Mechanical Check of Equipment
- ▶ Electrical Check of Equipment
- ▶ Verification of Proper Installation & Operation
- ▶ Benchmarking Important Test Values



Equipment and Tools



Digital multimeter



AC/DC Clamp Meter



Thermometer



Temperature and Humidity Meter

Equipment and Tools



Battery Tester



Power Quality Analyzer



Thermal Imaging Camera

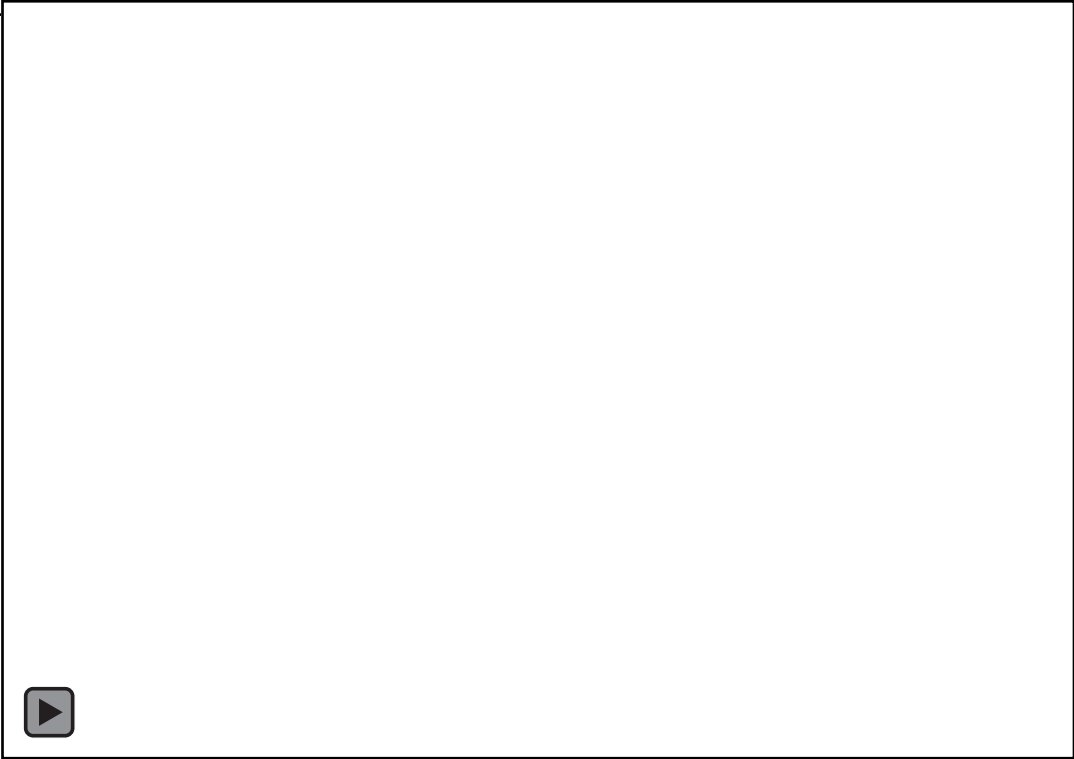
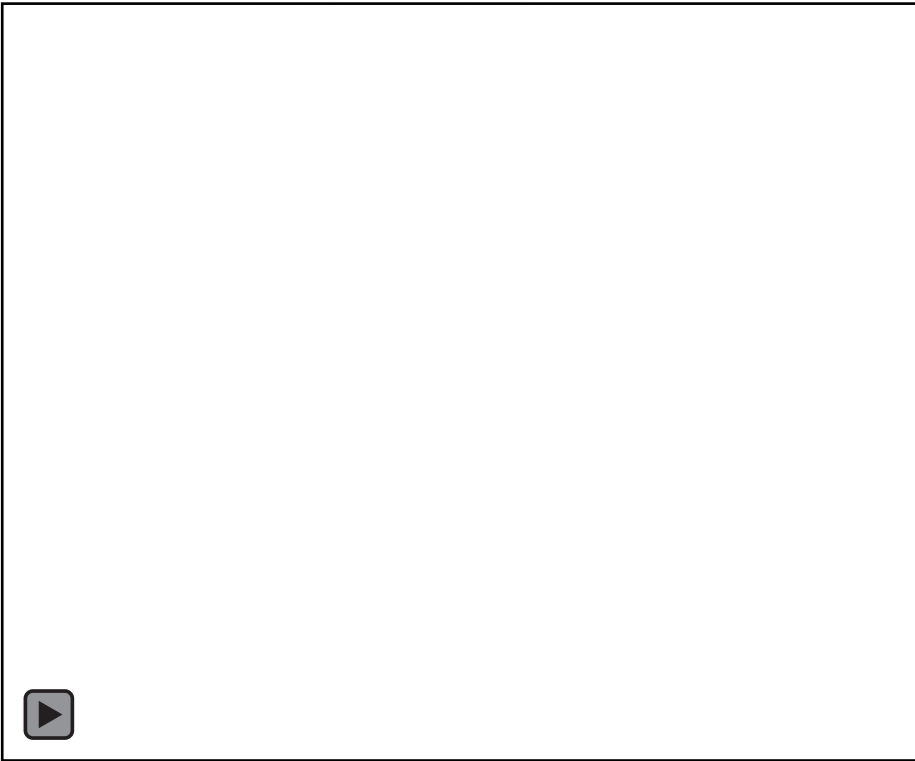
Annual calibration



輝創工程有限公司
Sun Creation Engineering Limited
Calibration & Testing Laboratory



輝創工程有限公司
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Calibration & Testing Laboratory



Engineer

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輝創工程有限公司 - 校正及檢測實驗室
c/o 香港新界屯門新安里一號四樓
Tel/電話: (852) 2927 2606 Fax/傳真: (852) 2744 8986 E-mail/電郵: callab@suncreation.com Website/網址: www.suncreation.com

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Tel/電話: (852) 2927 2606 Fax/傳真: (852) 2744 8986 E-mail/電郵: callab@suncreation.com Website/網址: www.suncreation.com

Sharing UPS SYSTEM at QMH

- ▶ 2 x 15KVA , parallel UPS System

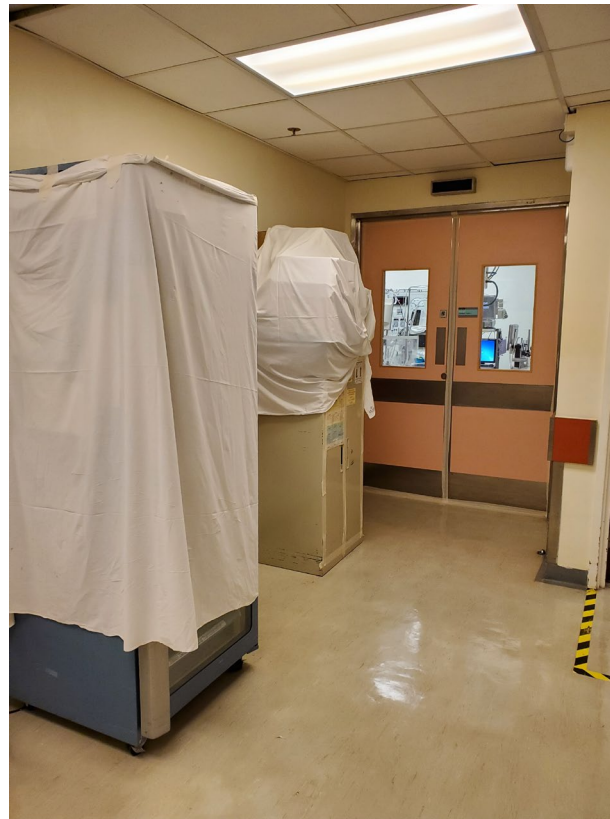


- ▶ 60KVA UPS System module base - centralized

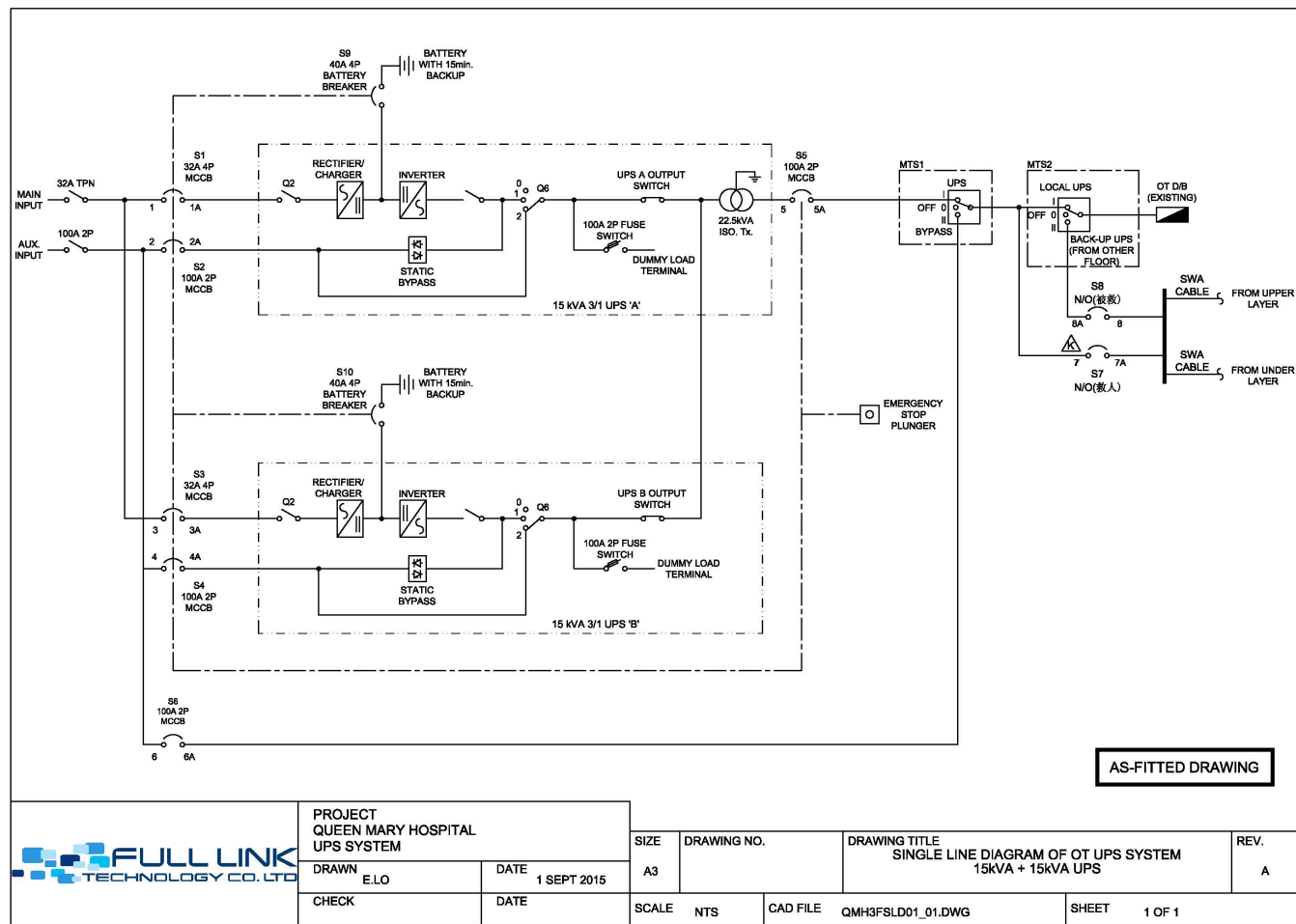


Operating Theater

Barrier control will be arranged against contamination to OT before dummy load testing



UPS Socomec Masterys IP+ (2 x 15KVA , In parallel)



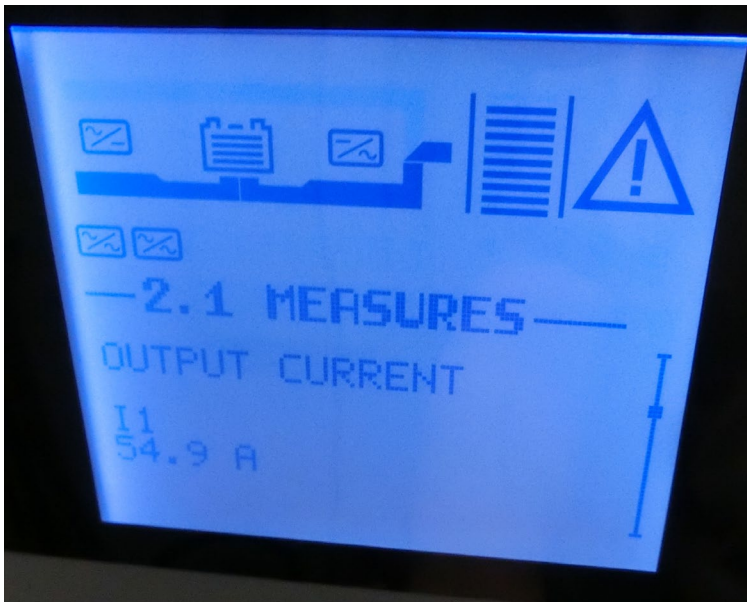
UPS
own_start up proc

15KVA UPS

Socomec Masterys IP+ (2 x 15KVA , parallel) UPS system at QMH (OT F2 TO T7)



Socomec Masterys IP+ (2 x 15KVA , parallel) UPS system at QMH



$15\text{KVA} \times 0.8 / 220\text{V} = 54\text{A}$
PowerFactor 0.8

Full load 54A in 15mins



Actual load A?
Discharge A?



Socomec Masterys IP+ (2 x 15KVA , parallel) UPS system at QMH

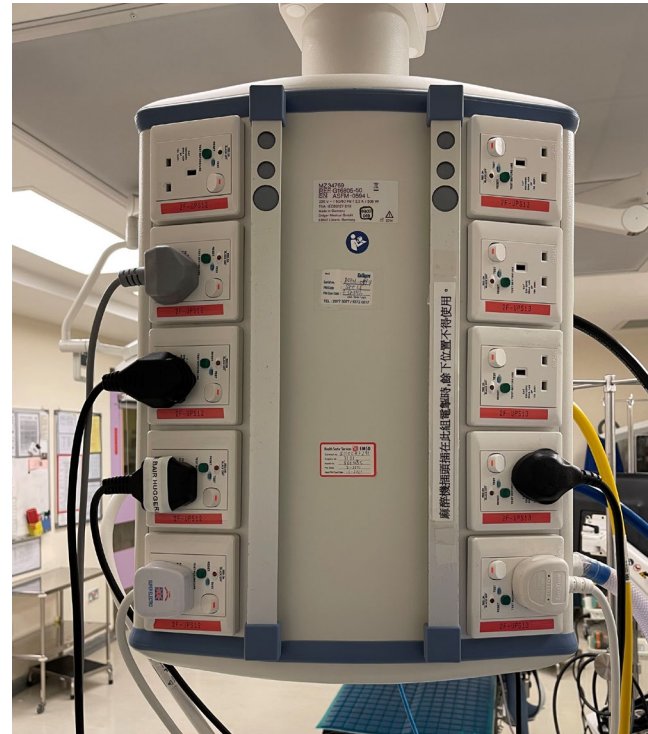
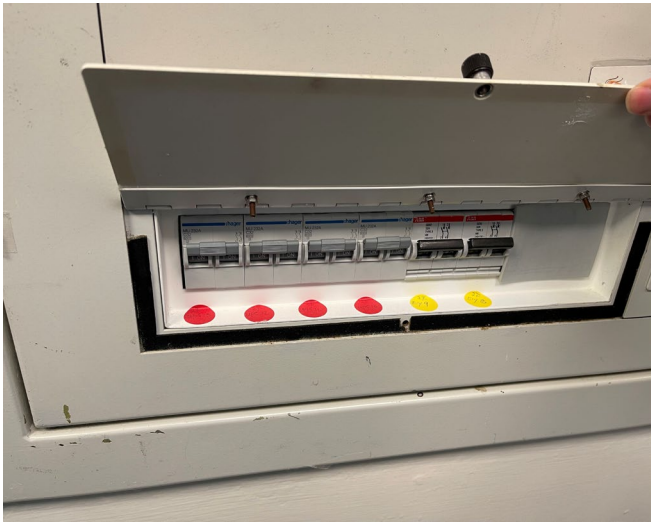


Battery charging current
after dummy load test



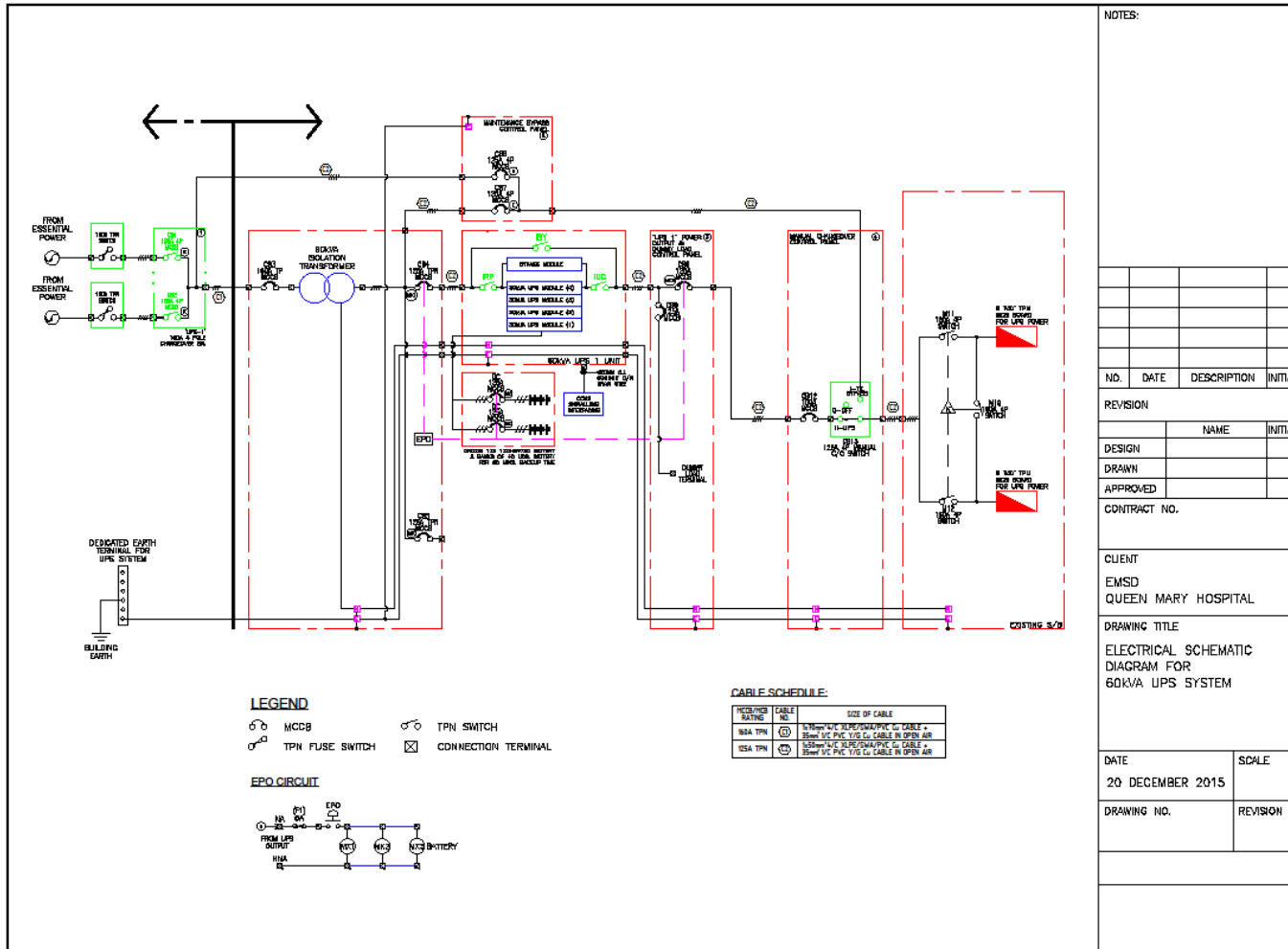
Charging time about 10 hours or
discharging time X 10

Operating Theater Power Socket



Ensure power socket back to normal after dummy load test

60KVA UPS System module base - centralized



K12 UPS UAT

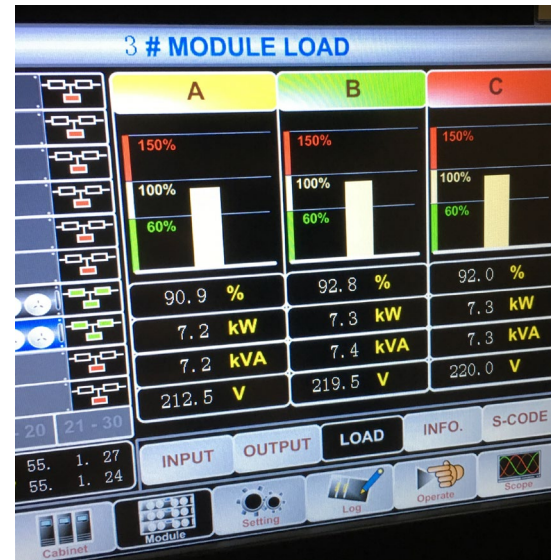
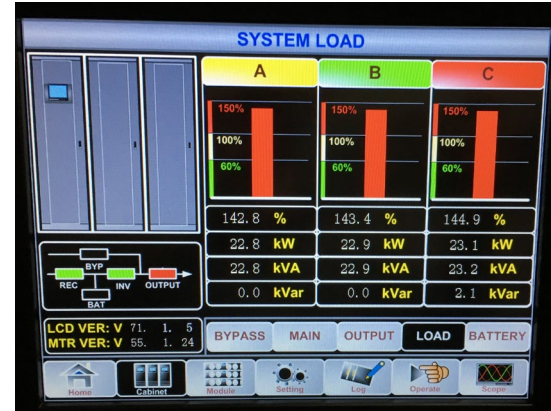
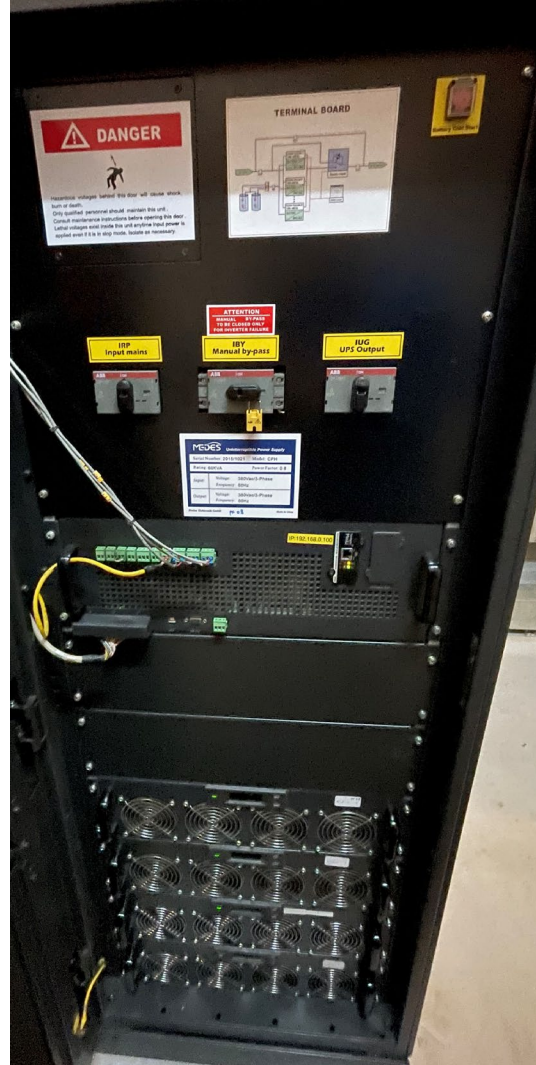


K12 UPS PM

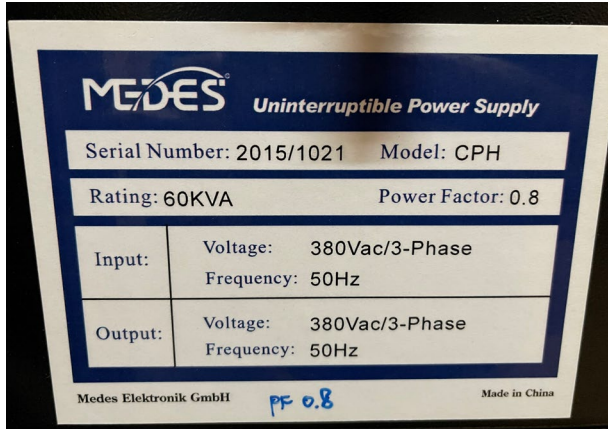


Schematic
am for 60kVA UP

60KVA UPS System module base - centralized

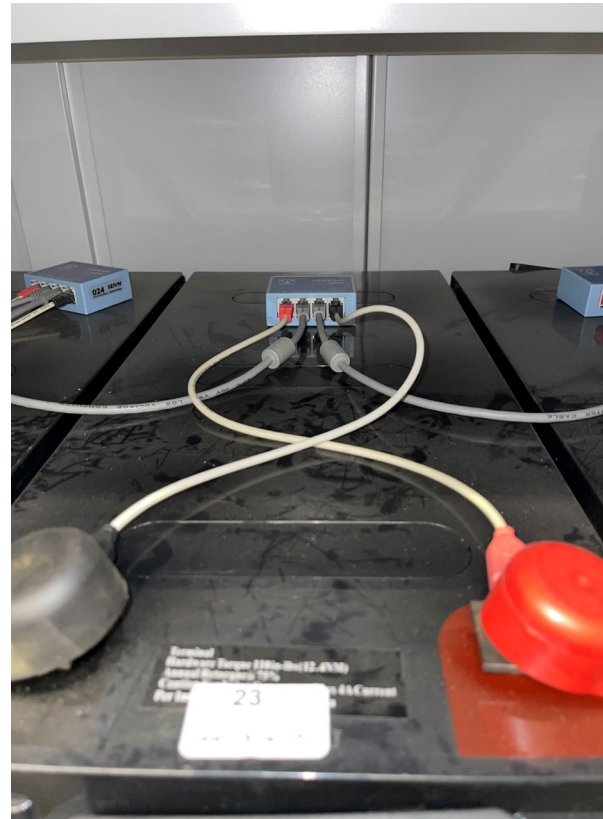
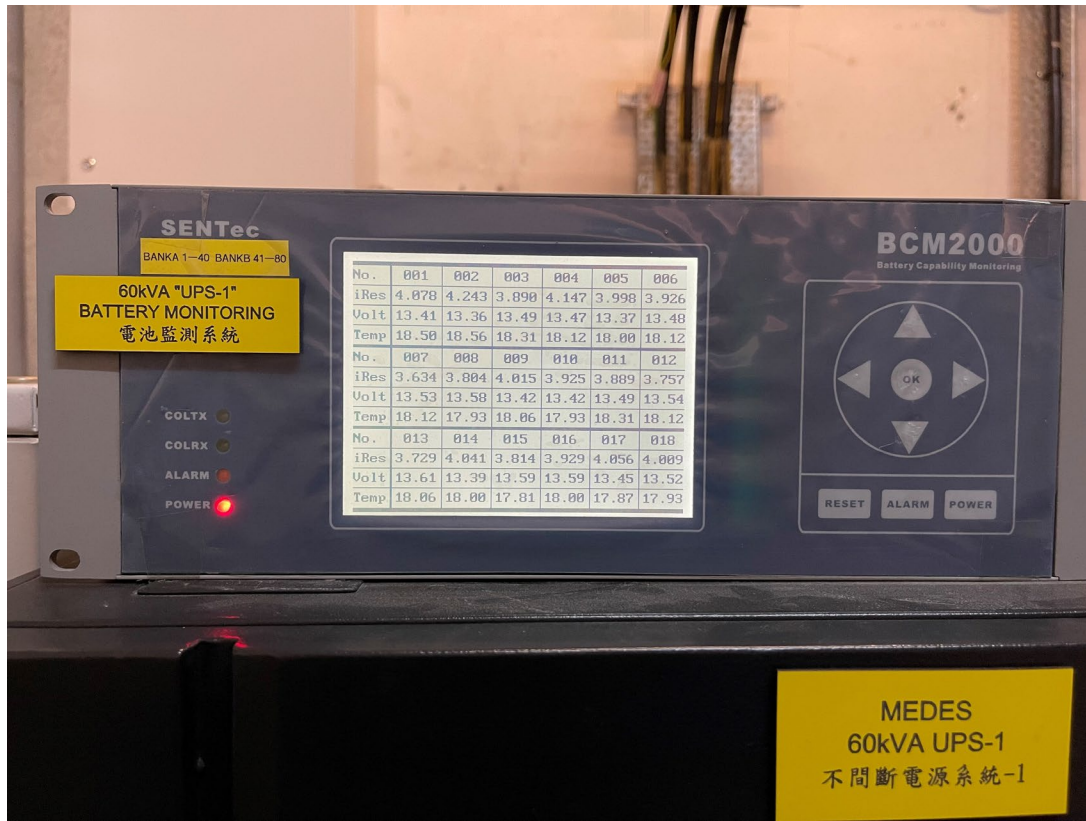


60KVA UPS System module base - centralized



Battery Management System (BMS)

Wireless VS Wired connection

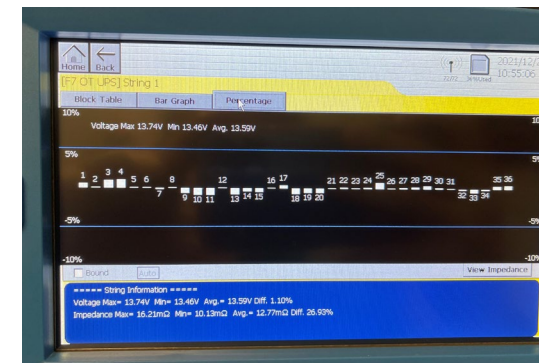
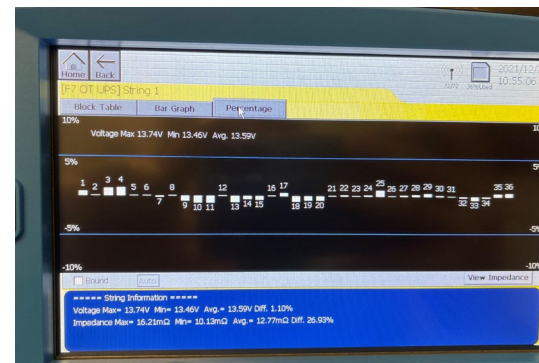
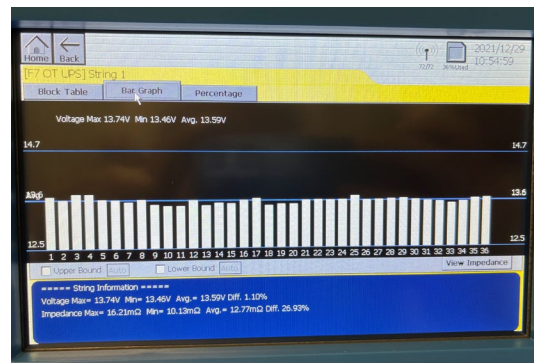
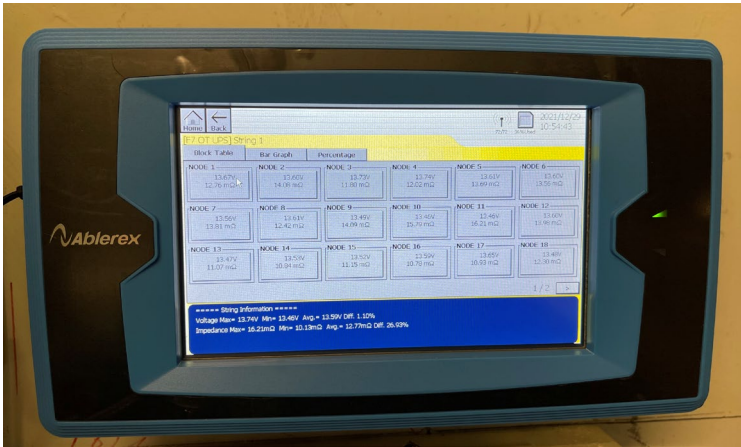


BMS is very stable to collection battery value through the wired



BMS UAT K12
UPS

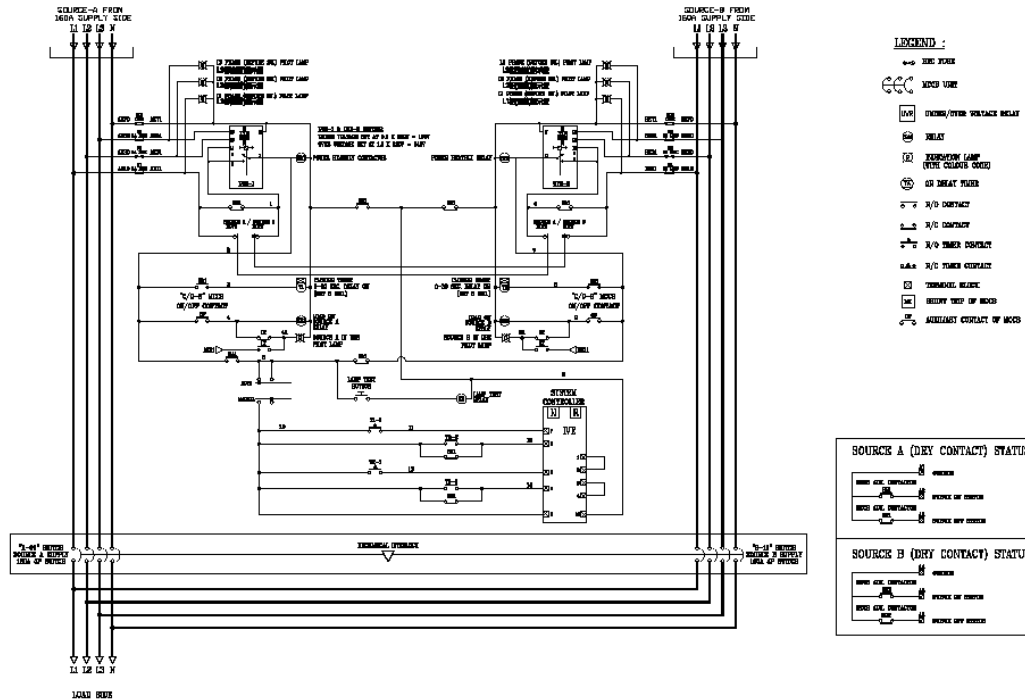
Battery Management System (BMS) Wireless VS Wired connection



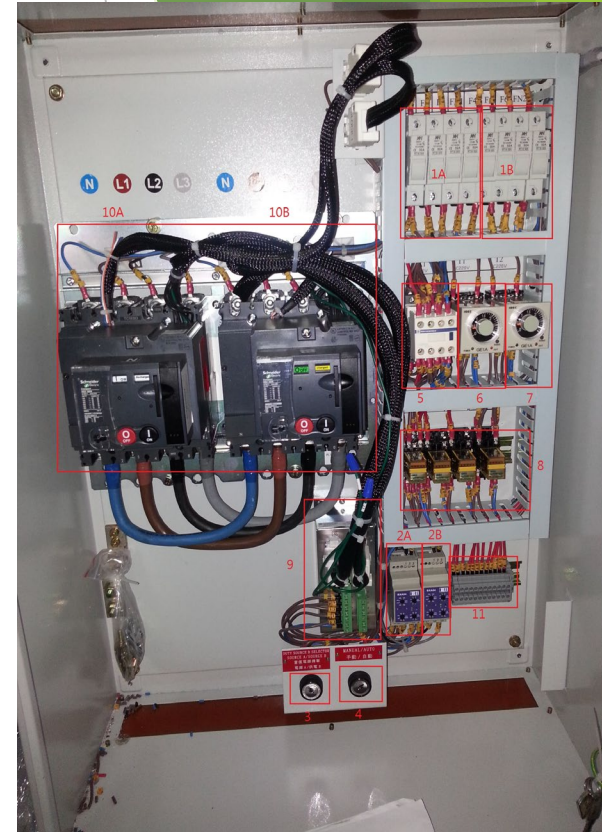
BMS is unstable to collection battery value through the wireless receiver
The wireless receiver is easy to damage



Automatic Transfer Switch (ATS)

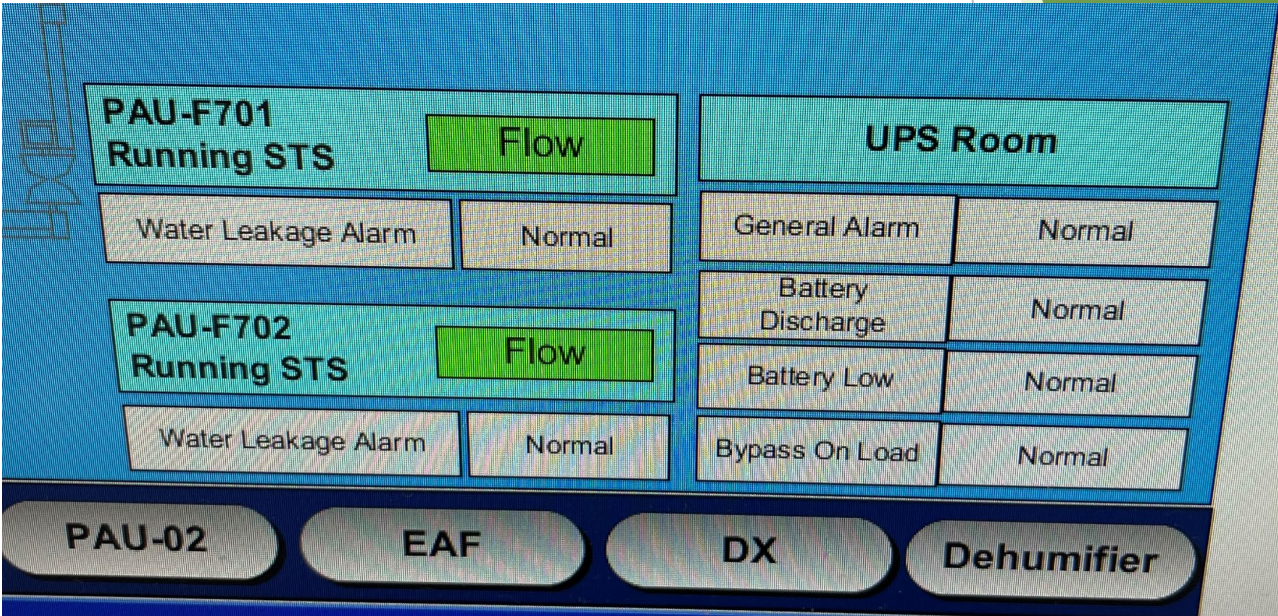
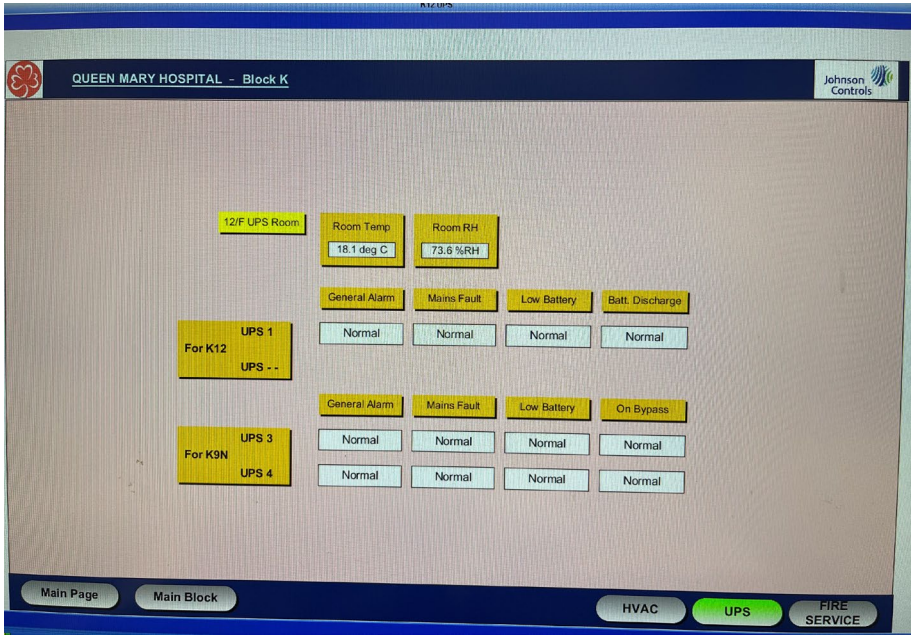


CONTROL WIRING DIAGRAM OF 4 POLE AUTO CHANGEOVER SYSTEM



K12 ATS

CCMS For K12 UPS and F2 to F7 UPS



Fire Drill



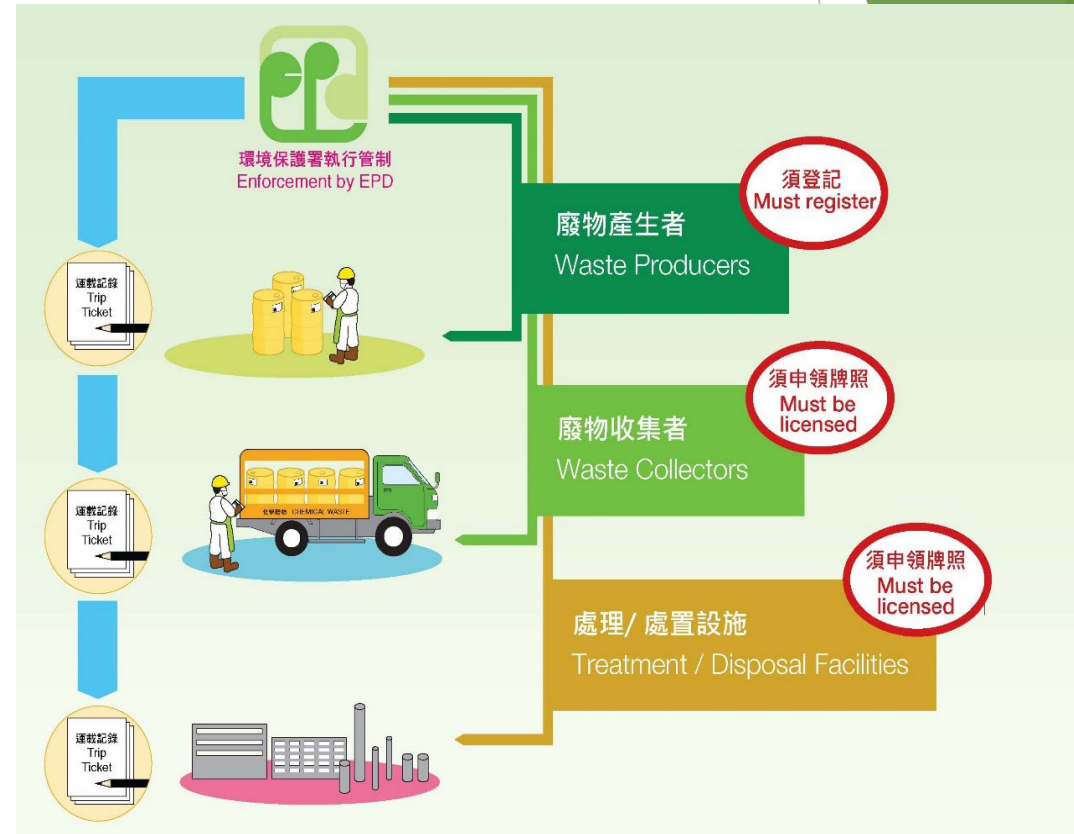
Battery Disposal

Disposal Procedure

The disposal of WLAB in Hong Kong is governed by Waste Disposal (Chemical Waste) (General) Regulation (Cap. 354, section 33):

Waste Lead-Acid Batteries (WLABs)

Waste lead-acid batteries (WLABs) are used lead-acid batteries that need to be disposed of. Lead-acid batteries are commonly used in motor vehicles. They are also used in certain mobile machineries, generators, uninterruptible power supply (UPS) of computer servers and systems as well as emergency lighting and burglar/fire alarm systems in buildings.



Battery Disposal

- ▶ Rechargeable Battery Recycling Programme
- ▶ Launched in April 2005, the Rechargeable Battery Recycling Programme (RBRP) is the first voluntary Producer Responsibility Scheme in Hong Kong. It has been set up and funded by the industry to collect and recover three common types of rechargeable batteries from household, which are Li-ion, Ni-MH and Ni-Cd
- ▶ EPD has launched a Helpdesk with Hotline (2838-3111). Service Hours: 8:30 am - 6:30 pm, Monday to Friday. We operate the Hotline and help the public if they would like to recycle rechargeable batteries.



環境保護署

- 廢物收集/再造

https://www.epd.gov.hk/epd/tc_chi/environmentinhk/waste/guide_ref/guide_ref_dwc.html

化學廢物 - 持牌的化學廢物收集者名單

1. 廢電池

<https://cd.epic.epd.gov.hk/EPICDI/chemicalwaste/download/search/>

2. 廢鉛酸電池

<https://cd.epic.epd.gov.hk/EPICDI/chemicalwaste/download/search/>

環境保護署

申請牌照的指引說明

https://www.epd.gov.hk/epd/tc_chi/application_for_licences/guidance/guidance_licence.html



354 Application
Form

Battery Disposal Ticket Number

Please carefully read the instructions overleaf before completing this form. 請細閱背頁所載指示以正確地填寫此表格。

Waste Producer's Copy
廢物產生者存根

WASTE DECLARATION (廢物聲明): Import 入口 ☐ Part A 甲類 ☐ Export 出口 ☐ Part B 乙類 ☒

Environmental Protection Department
環境保護署
Waste Disposal Ordinance (Chapter 354)
香港法例第354章廢物處置條例

Part A Waste Notification Reference No. (甲類化學廢物通知書編號):
Waste Disposal (Chemical Waste) (General) Regulation 4200414980
廢物處置(化學廢物)(一般)條例
登記紀錄

Ticket Number (票號): **1308514**

A. WASTE PRODUCER (廢物產生者)
Full Name 全名: EMSD - Queen Mary Hospital
Address 地址: EMS - 瑪麗醫院, 102 Pokfulam Road, KLO5, Lower Ground 5, Bld K, Hong Kong
Waste Producer Number 廢物產生者編號: 0019-171-E2099-21
Contact Person 聯絡人姓名: Wong Tse Chiu
Capacity 職位: Supervisor
Tel. No. 電話: 28553134
Signature 簽名: [Signature]
Name 姓名: [Name]
Date 日期: [Date]
Time 時間: [Time]

B. WASTE COLLECTOR (廢物收集者)
Company Name 公司名稱: C & M Logistics Company Ltd
Address 地址: 8 Wang Lee Street, Yuen Long Industrial Estate, Yuen Long, N.T.
Waste Collection Licence Number 廢物收集執照編號: 7111-797-C0024-WC
Intended Disposal Site 擬送往的處置設施: Dunwell Ind. (Holdings) Ltd.
Operator 運載者姓名: [Signature]
Tel. No. 電話: 24423018
Vehicle Registration or Vessel Licence No. 車輛登記編號或船隻牌照編號: W-12650
Signature 簽名: [Signature]
Name 姓名: [Name]
Date 日期: [Date]
Time 時間: [Time]

C. RECEPTION POINT (廢物接收處)
Company Name 公司名稱: Dunwell Ind. (Holdings) Ltd.
Address 地址: 8 Wang Lee St, Yuen Long Ind. Est, Yuen Long, N.T.
Contact Person 聯絡人姓名: Miss Carmen Fan
Capacity 職位: Senior Customer Relations Officer
Tel. No. 電話: 24438120
Signature 簽名: [Signature]
Name 姓名: [Name]
Date 日期: [Date]
Time 時間: [Time]

D. WASTE DESCRIPTION (廢物描述)
(* State the appropriate one 選擇適用者)

Item No. 廢物項目	Waste Type/Chemical Name 廢物種類/化學名稱	Waste Code 廢物代號	Waste Identification 廢物識別		Physical Form 廢物形態	Containers 容器	Quantity 數量		Quantity Collected 收集的數量	Quantity Received 接收的數量
			Dangerous Goods Category (if applicable) 危險貨物類別(如適用)	Solid/Liquid/Sludge/Other 固體/液體/泥漿/其他			Part A Waste and Quantity 甲類廢物及數量	Part B Waste and Quantity 乙類廢物及數量		
1.	Waste Lead-acid Batteries (WLABs)	S66	XXX	Solid	4	Drum	200	kg	400	kg
2.								kg		kg
3.								kg		kg
4.								kg		kg

E. REMARKS (註釋)
(Include any additional information necessary for safe handling of the waste.)
(包括廢物安全處理的必要附加資料。)

Waste Producer 廢物產生者: 歡迎意見提供
Waste Collector 廢物收集者: 諮詢熱線: 2443 8120
Reception Point 廢物接收處: Miss Carmen Fan (范小姐)
Senior Customer Relations Officer

回桶數量 4 個
公司蓋印

WARNING: Any person(s) who knowingly or recklessly provide incorrect or misleading information or omit material particulars or information or knowingly or recklessly certify as correct anything which is incorrect, in relation to any requirement in the Regulation, commits an offence punishable with a maximum fine of \$200,000 and imprisonment for 6 months.

警告: 根據廢物處置(化學廢物)(一般)條例的規定, 任何人士填寫本表格時故意或疏忽地提供不正確或誤導資料或遺漏重要事項, 又或故意或疏忽地證明任何不正確事項為正確, 即屬違法, 最高可被判罰款港幣200,000元及入獄6個月。

CHEMICAL WASTE 化學廢物

HARMFUL 有害

Chemical Name / Common Name 化學名稱或普通名稱
Waste Battery
廢電池

Waste Type and Code 廢物種類及代號
Waste Battery
廢電池 S66

Particular Risks 危險情況
• Harmful by inhalation, in contact with skin and eyes, and if swallowed
吸入, 沾及皮膚或眼睛, 或吞食後都對人體有害

Safety Precautions 安全措施
• Avoid contact with skin and eyes
避免沾及皮膚或眼睛
• Wear suitable protective clothing, gloves and eye protection
穿著適當的防護衣物, 並戴上適當的防護手套及護眼用具

Name, Address and Telephone No. of Waste Producer
廢物產生者姓名/名稱地址及電話
EMS - 瑪麗醫院 EMSD - Queen Mary Hospital
瑪麗醫院 - 機電署
EMS - 瑪麗醫院
102 Pokfulam Road,
Hong Kong Tel: 28553134
薄扶林道102號

Dunwell Environmental Mgmt Co Ltd
正昌環保管理有限公司

Service Hotline 服務熱線
2442 3018



Ticket Number

Engineering Guideline on Uninterruptible Power Supply (UPS) System (ESG15)

- Performance targets

- ▶ (a) To achieve high availability of $\geq 99.9995\%$
- ▶ (b) To achieve high energy efficiency with the following efficiencies at 50% rated load:
 - ▶ i) $\geq 89\%$ (≥ 10 to < 20 kVA UPS)
 - ▶ ii) $\geq 89.5\%$ (≥ 20 to < 40 kVA UPS)
 - ▶ iii) $\geq 90.5\%$ (≥ 40 to < 200 kVA UPS)
 - ▶ iv) $\geq 92\%$ (≥ 200 kVA UPS)
- ▶ (c) To achieve sufficient backup time appropriate to operational need or criticality of the load:
 - ▶ i) 15 to 30 minutes to allow graceful shutdown of computer-based load equipment
 - ▶ ii) 1 hour to support essential lighting in tunnels
 - ▶ iii) 2 hours or as appropriate, taking into account of operational need, to support unattended plants

- **Technologies and standards to be adopted to meet performance targets**
- ▶ (a) Proper UPS configuration should be adopted with respect to the intended load and the required availability according to IEEE 493.
- ▶ (b) Modular architecture with hot-swappable components should be adopted for capacity expansion and concurrent maintainability.
- ▶ (c) Rated load of the UPS, not the actual load, should be used for battery sizing (ref.: IEEE 1184). “Aging factor” (normally 1.25) should be included in the calculation (ref.: IEEE 485).
- ▶ (d) Parallel-battery strings may be used to meet design requirements, including design capacity, redundancy, or maintenance capabilities. When parallel-battery strings are used, they must be correctly sized to support full load UPS operation through the coup de fouet when a string fails. Moreover, each string must be equipped with disconnect capabilities for maintenance and for protection.
- ▶ (e) The rated fault clearing capability of the UPS should be sufficient for the maximum load protective device rating with which the UPS will coordinate under fault conditions (ref.: IEC 62040-3).
- ▶ (f) Proper UPS grounding and neutral arrangement for safety, equipment protection and performance, including the elimination of “floating neutral” conditions. In particular, isolation transformer is required for configuration with multiple input sources (ref: IEEE 1100).

- ▶ (g) For UPS systems requiring a battery string to be installed on multiple racks, or for strings whose dc bus voltage exceeds 250 V, a multipole battery disconnect should be utilized to “split” the string into sections, thereby minimizing the overall voltage on a rack and increasing personnel safety during maintenance (ref.: IEEE 1184).
- ▶ (h) The maximum limits of harmonic levels of the UPS should conform to the relevant requirements in international standards such as IEC 62040-3 or external harmonic suppressing or filtering devices such as active harmonic filters should be considered.
- ▶ (i) External manual bypass switch to bypass the whole UPS system for maintenance, load transfer to and from the bypass source should be of "make-before-break" type.
- ▶ (j) Both the input circuit to the UPS and the associated UPS bypass circuits (including the manual maintenance bypass circuit) should be equipped with surge protection devices (ref.: IEEE 1100).
- ▶ (k) A Battery Monitoring System (BMS) with remote alarm function should be provided to continuously monitor and record voltage (VDC), impedance (Ω) and temperature ($^{\circ}\text{C}$) of each battery unit in a battery bank.
- ▶ (l) For each UPS unit in any configuration (such as parallel redundant or dual bus configurations), interfacing connections (e.g. SNMP, Modbus) should be provided for feeding at least 19 parameters/signals to iBMS (Appendix 2).

- ▶ (iii) Scope of checklist of the projects at venue to meet performance targets
- ▶ (a) Assess space availability in the project site including maintenance access and space for load testing in preventive maintenance or after major repair, desirably with space for future UPS replacement.
- ▶ (b) Assess whether multiple power source paths are available to enhance availability and concurrent maintainability.
- ▶ (c) Assess data connection availability in the project site and implement fixed or wireless data communication network to achieve digitalization.
- ▶ (d) Assess the ambient conditions, in particular the temperature, of the UPS and battery room. The location and arrangement of batteries should result in no greater than a 3 degrees Celsius temperature differential between batteries at a given time (IEEE 1184).
- ▶ (e) Assess the ventilation of the room to prevent accumulation of excessive hydrogen gas released by battery (ref: IEC 62485-2).
- ▶ (f) Incorporate all requirements of iBMS and data communication network specified in this Guideline together with the space requirements of UPS and battery room into the project scope, unless deemed not feasible or approved by EDVC with justifications.

Q & A