

INSTITUTION OF MECHANICAL ENGINEERS HONG KONG BRANCH
TECHNICAL VISIT TO GALAXY MACAU PHASES 1 AND 2 ON 28/3/2015



General

Colane and Taipa were two distinctive island of Macau for decades. However, their landscape changed beyond recognition after the Macau government decided to reclaim the area of water between them in order to make land, precious to the famous city of “Oriental Monticello”, for the new players of casinos and resorts. Suddenly, the water disappeared and a large area of flat land linking the islands arose. Taking the name of the parent islands, the land was named “Cotai Strip” and as soon as the land was formed, gigantic building structures broke the ground and swiftly transformed into glamorous resort complexes. One of them is the nowadays Galaxy Macau, the compound with close to 4,000 hotel rooms, suits and villas, as well as over 80 food and beverage (F&B) outlets, an over 200 shop shopping malls and the largest indoor wave generator in the world under its roof.

To support the massive operations of the above facilities, the electrical and mechanical infrastructure (E&M) is equally in breath-taking size, state-of-the-art and rare of its kind. With the generosity of the host, in the morning of 28 March, 2015, 24 members of Institution of Mechanical Engineers (IMechE) were privileged to Galaxy Macau and appreciate the E&M in its possible gigantic scale.

Mechanical Facilities



Galaxy Macau is a multi-phase development with plans in place for future extension. Currently Phase 1 is in operation and Phase 2 will become function in May 2015.

Phase 1

Phase 1 comprises hotels, casino, F&B outlets, wave pool, ballroom, cinemas and shopping malls in the following parameters:-

Description	Parameter
Gross floor area	550,000 m ²
Galaxy Hotel	1,449 rooms
Okura Hotel	488 rooms
Banyan Tree Hotel	256 rooms
Gaming Table	over 500 tables
Slot Machine	over 1,000 machines

Macau is a sub-tropical city which both temperature and relative humidity are high in summer. It is vital to provide a controlled ambient for the entire floor area in order to keep people and facilities indoor comfortable, and the demand on air-conditioning is greater than ever. In this connection, the Chiller Plant of Galaxy Macau Phase 1 has equipped with multiple Chillers providing installed capacity of 72,400 kW, or 20,600 RT, at 6 °C and 12.5 °C supply and return temperature respectively (6 °C/12.5 °C), contributed by the following units:-



Unit capacity	Type	Quantity	Capacity
2,800 RT	11 kV centrifugal	5 units	14,000 RT
1,000 RT	400 V centrifugal	3 units	3,000 RT
1,200 RT	400 V centrifugal (East Square)	3 units	3,600 RT
		Total	20,600 RT

In summer, three (3) York Maxe-made 11 kV units operate full load with few 400 V units (LV Chillers) at variable load to meet the demand, which is about 60 % of the installed capacity, or 12,360 RT. The variable frequency driven (VFD) 400 V units provide quick start-up, warranting swift response to demand and top robustness and reliability of the Chiller Plant.

Phase 1 also equips with 20 Heat Pumps, which chilled water produced is sufficient to meet the air-conditioning demand and turn-off all Chillers in winter times. In parallel, five (5) diesel-fired Boilers, fuelled by a 50,000 litre fuel tank, supply 78 °C hot water for consumption in hotel rooms and F&B outlets, while two (2) dual-fuel (diesel and natural gas) enabled Boilers are dedicated to generate steam at 160 °C at 7.5 bars, principally for restaurants. The diesel fuel required to generate hot water and steam costs Galaxy Macau about HK\$1 million per month.

Phase 2

The Phase 2 Chiller Plant is installed with Trane-made Chillers in the following number and capacity:-

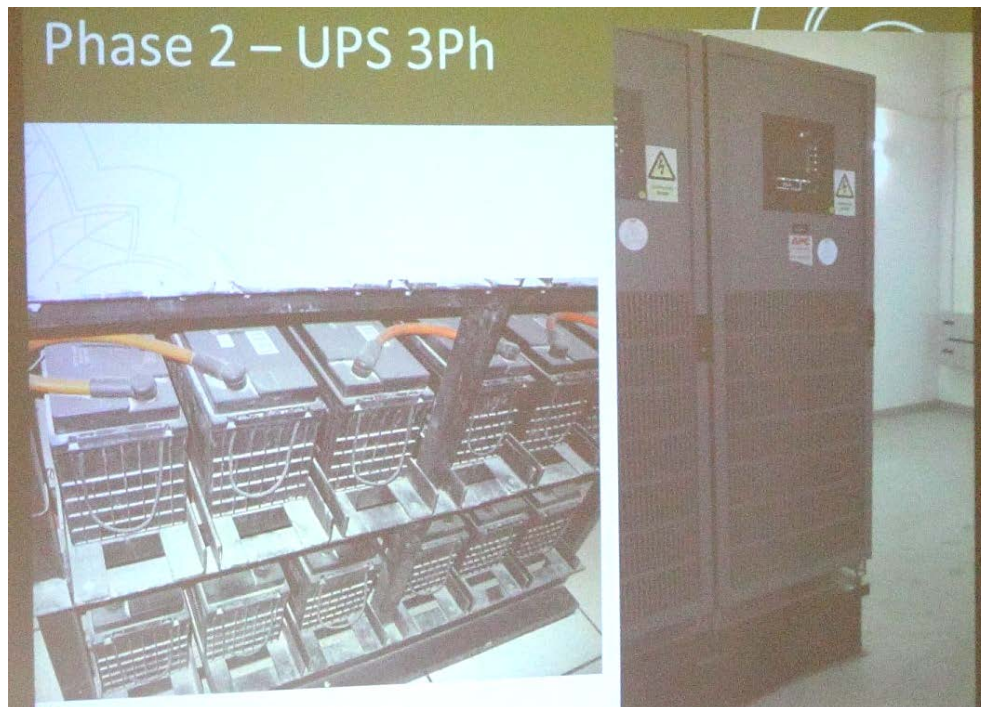
Unit capacity	Type	Quantity	Capacity
2,500 RT	11 kV centrifugal	6 units	15,000 RT
1,200 RT	400 V VFD centrifugal	4 units	4,800 RT
		Total	19,800 RT

In addition to two (2) new hotels, Phase 2 features an outdoor pool with an exotic stream named “Lazy River”, made of six (6) metre in diameter glass channels. The outdoor pool has two (2) fresh water fill points and filtration system using perlite as filter media, providing filtration fineness to less than one (1) micrometre. After filtration, the pool water is treated by liquid chlorine, acid and ultra-violet as supplementary disinfection.



The indoor wave-generator of the outdoor pool is the largest in the world. Inside the wave-generating plant room, five (5) fan-driven Blowers create continuous air jets and Dampers downstream of the Blowers control the release of the air jets blowing to the pool water surface. The air jets impulse on the water and generate a water peak propagating the pool, becoming wave.

Electrical Facilities



Abundant and reliable power supply is essential and paramount to Galaxy Macau. To eliminate the impact of power loss, Phase 1 and 2 is backed-up by Uninterrupted Power Supply (UPS) comprising over 1,000 Schindler-made lead-acid batteries giving both single and three (3) phase power (3Ph), together with 19 diesel-powered generation sets (Gen-sets) which connect to the low voltage system. Supported by FM200 fire service system, the UPS system is arranged to have two (2) units on duty and one (1) stand-by in guaranteeing top reliability, in conjunction with HK\$2 million is budgeted for replacing malfunctioned batteries every year.

The city mains at 110 kV is connected to the Galaxy Macau-owned Sub-Station, where electricity is stepped-down to 11 kV and then distributed to the respective electrical system of Phase 1 and Phase 2 for further step-down to 400 V. The Sub-Station has been designed to cater the developments of the future Phase 3 and 4.

The gaming facilities are given top priority in power supply so that their normal function is maintained in any foreseeable circumstance. The facilities backed-up by UPS in warranting continuous power supply include the following ones:-

- gaming table lighting
- closed-circuit television (CCTV)
- network server
- radio communication
- security
- fire services
- air-conditioning

Moreover, other than Firemen Lifts, 50 Lifts in Phase 1 and Phase 2 have connected to Gen-sets to provide sufficient people movement capacity in the event of power loss.

Building Management System

Phase 1 and Phase 2 have total eight (8) Building Management Systems (BMS) controlling the following facilities, which inter-connection is minimum in order to avoid chain system failure in the event of power-cut:-

Phase 1	Make	System Capacity
Podium BMS/Access Control System (ACS)/ Chiller Plant control	Johnson Controls	13,000 signal points
Bayan Tree and Okura Hotel BMS/ACS	Johnson Controls	5,000 signal points
Galaxy Hotel BMS/Boiler Plant	Siemens	2,000 signal points (high level integrate to BMS)
Phase 2	Make	System Capacity
Podium BMS/ACS	Honeywell	15,000 signal points
Marriott and Ritz Carlton Hotel BMS/ACS	Honeywell	5,000 signal points
Chiller Plant control	Johnson Controls	2,000 signal points (high level integrate to BMS)
110 kV Sub-Station	Chubb and Delta	1,000 signal points (high level integrate to BMS)
	Total	43,000 signal points

Testing and Commissioning

The operations of Galaxy Macau are unique in its simultaneous function of gaming and hospitality business. In this connection, the testing and commissioning (T&C) regime was tailored to satisfy the high demand on system reliability. To achieve it, the systems were tested to simulate the real operating conditions as well as the peak consumption scenario.

These installations in Plant Rooms are individually T&C:-

- 110 kV Chiller
- 400 V Chiller and Heat Pump
- Pump of other services
- Pool and Filtration
- Steam and Hot Water Boiler
- Air Handling Unit (AHU), Primary Air Unit (PAU), Fan, etc.

Due to the strategic importance of Server Room in operations, the integration of systems in Server Room was specifically tested in various situations, as below:-

- Normal power failure
- Essential power failure and 3Ph UPS intervention
- Mode switch of Computer Room Air-Conditioning Unit from “Duty” to “Emergency”
- 3Ph USD discharge, alarm, control

- Security access control
- BMS
- Automatic Fire Alarm (AFA)
- Water Leakage Detection
- Lighting
- FM200

Stress Test was conducted T&C the systems to the design conditions. Staffs were dispatched to occupy all hotel rooms to perform tests on demand. In some cases, all rooms would consume the utilities simultaneously so that the full functionality of the Plant Room was verified.

The Gen-sets were also T&C at 100 % room occupancy to test their capability in powering the following facilities:-

- Essential power supply system
- Casino and gaming systems
- UPS: single phase and 3Ph
- Information and communication technologies: radio, mobile and fixed telecommunication, network, work-station, Server Room
- CCTV
- BMS and chilled water distribution control
- ACS
- LV Chillers
- Computer room air-conditioning
- Water supply
- Sewage sump pump
- Lift operation
- Fire service and AFA

Environmental Friendliness

Galaxy Macau has strived to maximise the efficiency of its operations in order to minimise utility consumption and hence better protect the environment.

Carbon dioxide monitoring

AHU is sized to the fresh air demand in full-house condition, while carbon dioxide monitoring adjusts the fresh air supply flow rate according to the number of occupant. Power consumption on AHU is effectively reduced as a result.

Carbon monoxide monitoring

Comparing with other compartments in a building, car park is relatively easier to accumulate carbon monoxide (CO). CO sensors control the variable speed drives on fans for the exchange of fresh and exhaust air in car park so that the fan speed varies with CO concentration, rather than is fixed at all times.

VFD speed setting

The speed of the VFD-fans in PAU is reduced by 10 %, resulting reduction of air flow by 10 % and measured electricity consumption by 27 % to 30 %.

Lighting

The LED-lit outdoor lighting is adjusted to follow the sun-rise and sun-set pattern, delivering 5 % reduction in electricity consumption.

Cooling Tower and Cooling Tower fan control

Chiller performance is improved by operating additional Cooling Towers to increase the overall heat rejection and lower the condenser water return temperature, which in turn increases the Coefficient of Performance of Chillers and decreases the electricity consumption of Cooling Tower Fan Motors. The Cooling Tower Fan Motors are installed with VFD with soft-starting function enabled; thus lengthening the motor life.

LEED certification

Phase 2 is designed to excel in energy efficiency and has been pre-certified Gold Level in the U.S.-based LEED (Leadership in Energy & Environmental Design) in the following categories:-

- (i) Stainable sites
- (ii) Water efficiency
- (iii) Energy and atmosphere
- (iv) Material and resources
- (v) Indoor and environmental quality

The preparation of Phase 1 in the obtainment of LEED certification is underway

Remark

The tourism industry of Macau is thriving, of which Galaxy Macau has become a pillar. The gigantic and glamorous gaming and F&B facilities of Galaxy Macau are supported by the E&M in equally breath-taking size, in terms of physical dimension, capacity and advanced technology. Not only is Galaxy Macau a paradise for leisure seekers, but for E&M engineering.



IMechE Hong Kong Branch thanks Mr. Antonio Chan, Assistant Vice President of Engineering, and his Galaxy Macau colleagues for their generous support to the technical visit.

- END -

Encl.
WHT

Photographs were taken by Mr. Benny C.Y. Sit with permission to use. Copyright reserved.



Courtesy of Galaxy Macau

IMechE Hong Kong Branch
Activity Sub-Committee
Local Technical Visit Group

TECHNICAL VISIT GALAXY MACAU PHASES 1 AND 2

**Institution of
MECHANICAL
ENGINEERS**

Improving the world through engineering

Free of charge for IMechE members. Number of participants is limited to 25 with priority given to IMechE members.

Date: 28 March, 2015

Time: 0900 hrs. to 1230 hrs.

"Mega" may be the only right word to describe the sheer size of the electrical and mechanical (E&M) facilities required in supporting the complex with close to 4,000 hotel rooms, suits and villas, as well as more than 80 food and beverage outlets, a shopping mall with over 200 shops and the largest indoor wave-generator in the world found in Galaxy Macau. The mega resort is unique and magnificent on its own.

For the first time ever, IMechE Hong Kong Branch is privileged and honoured to organise a technical visit to Galaxy Macau and members who are interested in building E&M and installations in mega-size are strongly encouraged to enrol early to avoid disappointment.

Attending members should arrange their own transport to join the visit.

Registration and Enquiries

For registration, please visit IMechE webpage:
<http://nearyou.imeche.org/near-you/north-east-asia/hong-kong/events>

For more information please contact:
Mr. Jimmy Lee [leefookwan@hotmail.com]
Mr. Benny Sit [sitcheuk@gmail.com]