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Power, Elevator and Customer-Oriented Sustainability Strategies

以电力，电梯与客户为导向的可持续策略

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Being a world-class skyscraper with international corporate tenants, reliable power supply, expedient elevating service and customer-oriented sustainability pose formidable challenges on a building like PAFC. Some of the engineering solutions to bring these about include N+1 power supply, high speed double-deck lifts with predictive control, strategically planned chilled water hydraulic zoning, etc. This chapter outlines the solutions from the perspectives of engineering design strategies, which are driven towards satisfying occupants' needs for years to come.

作为一个有国际租户的世界级摩天大楼，可靠的电力供应，便捷的电梯，以及以客户为主导对可持续性的要求，给工程师们带来了严峻的挑战。有效的工程解决方案，包含如N+1模式供电，有预测控制功能的高速双层电梯，冷冻水水力分区规划等等。本文从工程设计策略的角度出发，概述了为满足未来多年这些客户们的需求所作出的解决方案。

Introduction

After PAFC's completion, there will be a total of 49 0.8MVA -2.0MVA cast-resin dry-type transformers installed on plantroom floors to meet an overall demand of 55 MVA. A total of 77 elevators, including 45 double-deck elevators will be installed to provide vertical transportation for a total population of over 17,000 people. A secure and reliable power supply and a flexible and expedient elevator service, along with customer-oriented sustainable design, play an important role in sustaining the operation of the skyscraper in good condition and meeting the needs of Class A tenancy at all times.

Main Power System

Service Strategy

Reliability, resiliency and redundancy of the power supply system are of paramount importance to keeping a world-class skyscraper operating in good condition all year round. The following strategies have been adopted for PAFC facilitate this:

- Multiple high-voltage (HV) Infeed – The power company will provide power to the PAFC from different sub-stations with 10kV feeders running in diversified routes to secure the availability of HV supply at all times.
- Duty-standby feeders – A total of nine of 10kV feeders will be provided by the power company. Three will be dedicated standby feeders to back up the duty feeders whenever required.
- Dual HV risers – The 10kV feeders will be running in two independent HV risers rising through the core of the building, to eliminate the risk of total blackout in case of fire or accident in one of the risers.
- Dual tenant risers – Each tenant floor will be served by dual low-voltage (LV) busduct risers feeding from different transformer sources. In case of power failure, it will be possible to change over the tenant loads the functioning busduct riser.

介绍

建成后整个项目共装载49台0.8MVA-2.0MVA的干式变压器，以满足55MVA的设计容量。垂直运输方面，共设有77部电梯，其中包括45部双层轿厢电梯，载客总量超过17,000人。随着以客户为主导的可持续设计，一个安全、可靠的电力供应和灵活便捷的电梯服务，对于超高层摩天大厦在维持良好的运营状态，满足各种租赁客户的需求方面，发挥了重大作用。

主电源系统

服务策略

对一个全年经营状况良好的世界级摩天大楼而言，提供可靠的，灵活的和有富余的供电方案是必不可少的。下面是平安金融中心所采用的策略：

- 多路高压进线 - 电力公司从不同的电力变电所引来多路10kV的供电线路供给大厦用电，确保平安金融中心运行。
- 适当的备用 - 电力公司共提供9条10kV的电源进线，其中3条作为备用线路在必要时使用。
- 双高压电缆井 - 在大厦的核心区域设两处独立的高压电缆井敷设

- Segregation of Services – Within the building core, dry and wet trades will be segregated from each other, thus minimizing the risk of flooding impact.

Above-Ground Transformer Substation

Due to the sheer height of PAFC, siting the transformer substations on above-ground mechanical floors where the major M&E plant is located, is the best way to contain voltage drops and distribute electricity to the plant and tenants.

To facilitate transportation of power transformers for future maintenance, a 4500kg service elevator, tailor-made for vertical transportation of the transformers and their associated switchgear within PAFC will be provided. In addition to transportation of transformers for future expansion, the service elevator could also be utilized to transport large furniture for fitting-out of Class A offices for international corporate tenants.

N+1 Power Supply

An N+1 power supply arrangement is an effective way to enhance the resilience of a power supply, in which standby reserves could be available at all times to back up the power supply whenever required.

In PAFC, there will be nine dedicated 10kV electricity feeders to be supplied from different substations in the Shenzhen region (see Figure 5.1). Out of the nine feeders, six of them will be duty feeders, while the other three will be standby feeders. In case a duty feeder fails, its supported loads could be easily transferred to a standby feeder by means of change-over switchgear specifically designed for PAFC, thus ensuring a continual normal power supply to all tenants.

Emergency Power Supply

In China, emergency generators are generally located at the ground or basement floors due to site constraints. As a result, the major load centers will be far away from the generators and voltage drop will be an issue, especially for megatall buildings.

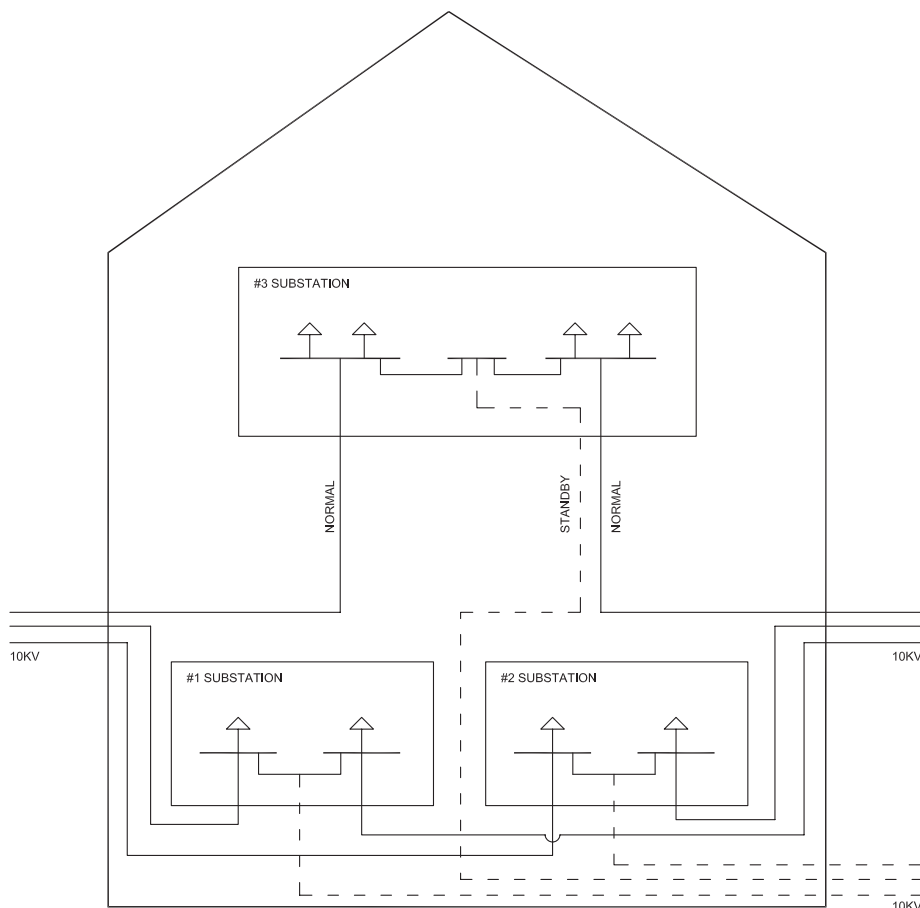


Figure 5.1. Simplified HV supply schematic (Source: J. Roger Preston Limited)

图5.1. 高压电源示意图 (来源: 澧信工程顾问有限公司)

10KV高压电缆, 当发生火灾或意外事故时, 可保证其中一个可继续运行, 以消除停电带来的风险。

- 双租客用电竖井-在每个租户区, 敷设两条低压供电线槽, 并由不同的变压器的出线回路引来, 当一路断电时, 可进行切换, 由另一路进行供电。
- 管井隔离 – 在建筑物的核心筒, 干、湿工作管井相隔开, 以减低水浸的风险。

楼层变电站

由于平安金融中心相当高, 需要在机电层设楼层变电站。这是降低低压配电的电压降, 优化供电的最好方式。

为了便于变压器的运输及日后的维护, 在平安金融中心内专设了一部4500KG的服务电梯, 这台电梯不仅考虑到日后变压器增容运输的需要, 还可以用来为甲级办公的国际公司租户装修时运送大型的家具等。

N+1供电

N+1的供电模式, 提高了供电的恢复能力, 从而在任何需要的时候都有备用电源。

平安金融中心共有9条专门的10KV线路从深圳不同地区的供电变电站提供 (见图5.1)。9条电力馈线当中, 6条馈线作日常运行, 其余3条则作为备用。若运行中的馈线出现故障, 则可由平安金融中心专设的切换装置, 很方便的将其负载切换至备用馈线, 从而保证了所有租户持续正常的供电

应急供电

在中国内地, 由于场地限制应急发电机一般都设于地面层或地下层。这就造成主要的负载中心远离发电机, 导致电压下降, 尤其对于超高层建筑更明显。

平安金融中心有6台 2,000kW的柴油发电机, 为租户提供必备/生命安全保证的负荷 (如安全疏散电梯, 消防设备等), 以及租户的重要负荷 (如电信和数据设备)。6台发电机被分成3组2x 2,000kW的发电机, 每组分别服务于建筑物的低区, 中区和南区。为了避免电压下降的问题, 中区和南区采用10KV的高压发电机组作为应急电源。每个区的两台高压

In PAFC, six 2000kW diesel generators will be provided to back up the landlord essential/ life safety loads (e.g. security, evacuation elevators, fire services installation, etc.) and tenants' mission-critical loads (e.g. telecom and data equipment). The generators will be divided into three groups of two 2000kW generators, with each group serving the loads at low, middle and high-zones of the building. In order to overcome the problem of voltage drop, 10kV HV generators will be adopted to supply emergency power to the essential loads at middle and high zones. The two HV generators for each of the zones will be paralleled in order to further enhance the resilience of the emergency power supply. The emergency power supplied at 10kV will be transmitted via HV riser inside the building core (see Figure 5.2). A number of step-down transformers will be provided on high-level mechanical floors to step down the voltage to 400V and distribute the emergency power to LV switchboards via automatic changeover switches.

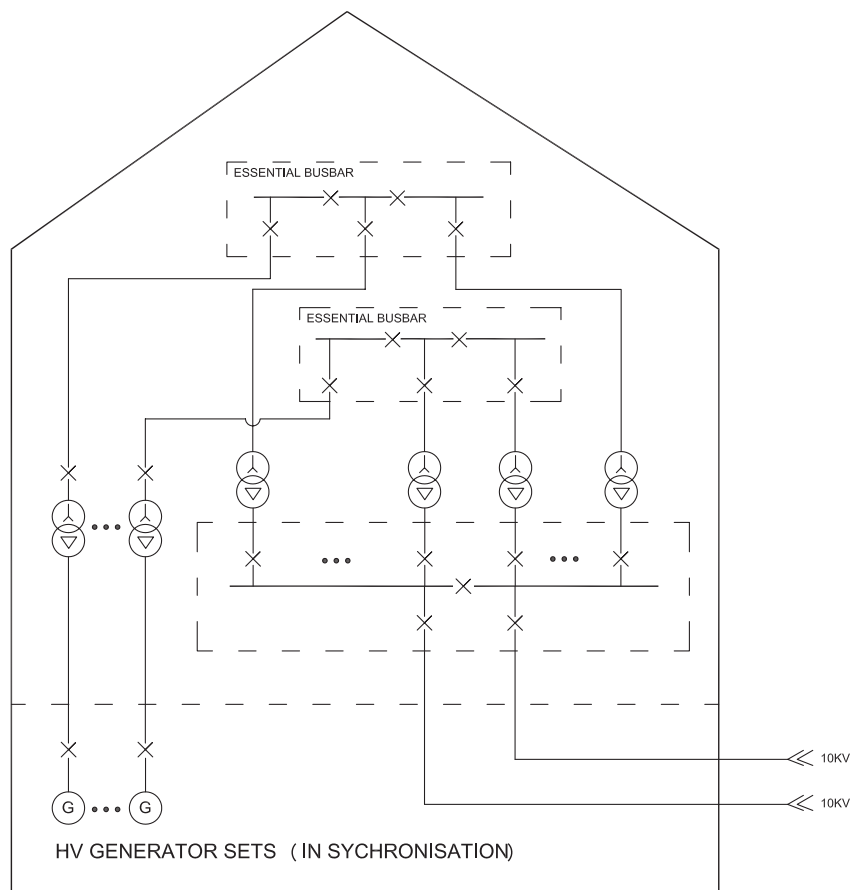


Figure 5.2. Simplified HV generator supply schematic (Source: J. Roger Preston Limited)
图5.2. 高压发电机电源示意图 (来源: 澧信工程顾问有限公司)

Vertical Transportation System

Overview

Designing a vertical transportation system for a megatall building is a challenging task for all engineers. In order to come up with an optimal and holistic design, due consideration should be paid to striking a balance between core efficiency and elevator shaft spaces. Collaboration among design team members at the onset of a project is crucial to achieving the goal.

After exhaustive co-ordination among design team members, PAFC was designed with seven elevator zones for the office floors and a dedicated elevator zone for the observation deck/F&B levels at the top of the skyscraper (see Figure 5.3). There are altogether 77 elevators providing vertical transportation for working population of more than 17,000 people. The capacities and speeds of the elevators range from 900kg to 4500kg and 1.75m/s to 10m/s.

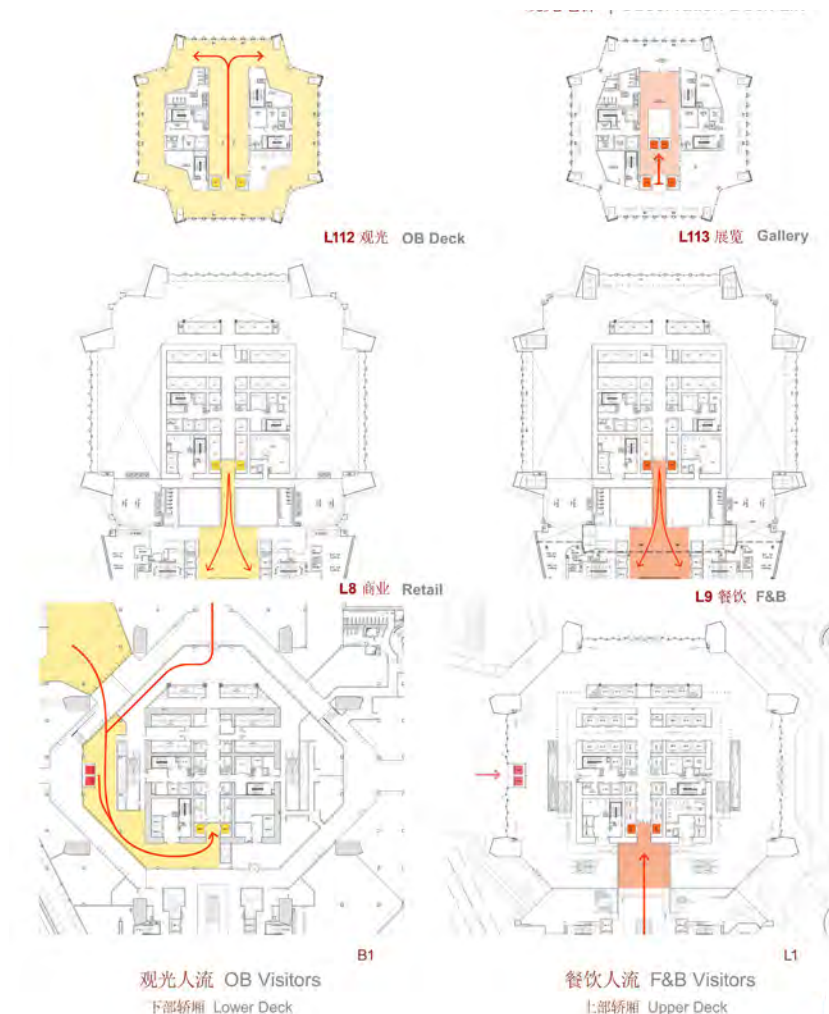


Figure 5.3. Floor plans and traffic circulation of the elevator zones (Source: Ping An)
图5.3. 楼层平面图和电梯间的交通流线 (来源: 平安)

A good elevator design plays an important role in achieving a flexible and expedient elevator service. The key features adopted for PAFC are outlined in the following section.

Sky Lobby Approach for Office

With a floor area of 300,000m² and 91 office floors, direct transportation between the main elevator lobbies and all the local elevator zones will waste a lot of elevator shaft spaces and reduce the efficiency of the building core drastically. The sky lobby approach is the best way to overcome such inefficiency.

The office floors of PAFC are divided into seven elevator zones with two sky lobbies:

L10-L24 Zone 1	L53-L64 Zone 4
L25-L34 Zone 2	L65-L80 Zone 5
L35-L48 Zone 3	Sky-lobby 2
Sky lobby 1	L85-L96 Zone 6
L53-L64 Zone 4	L97-L112 Zone 7

The first sky lobby and second sky lobby will both be served by six 1800kg-capacity high-speed double-deck shuttle elevators (see Figure 5.4). Both of the shuttle elevators will terminate at B1/L1 as terminal floors for transportation of passengers directly to/from sky lobbies.

In order to tackle the difference in floor-to-floor height of the terminal floors and the sky lobbies, the shuttle elevators will use super double-deck elevators, whereby the distance between the lower car deck and the upper car deck could be adjusted automatically during trips, thus ensuring both car decks land on the upper/lower sky lobbies or the L1/B1 floors at the same time.

With the introduction of sky lobbies, elevator shaft spaces are saved in the low zones, the size of the building core is substantially reduced, and more usable floor area is available for the low-zone floors.

Crowd Sensor Control

Crowd sensor control function, which prevents passengers from crowding into sky lobby areas that have elevators of different capacities arriving and departing, is essential to elevator installations that use the with sky-lobby approach.

Under the crowd sensor control, passengers arriving and leaving the sky lobbies can be closely monitored by the call destination control system and crowd detectors. If there are more people arriving than people leaving, the departure trips will be prioritized over trips that bring people to sky lobbies. Thus the transportation of passengers to the sky lobbies will be reduced until the lobbies are no longer overcrowded.

Double-deck Elevators

There will be a total of 45 double-deck elevators provided for office floors:

Local Passenger Elevators – 33 elevators of 1600kg/1600kg, 3.5-7m/s

Shuttle Passenger Elevators – 12 elevators of 1800kg/1800kg, 7-9m/s

In order to get the maximum efficiency from the double-deck elevators, the following considerations have been taken during the design phase of the project.

- For upward travel from main lobbies or sky lobbies, the lower car deck will serve even floors and the upper car deck will serve odd floors. Adequate signage shall be provided to guide tenants/visitors to the correct lobbies.

发电机并列运行，以进一步提高应急电源的恢复力。10kV应急电源线路在管井内进行敷设。(见图5.2)。设在高层机电层的多个10/0.4kV降压变压器将供电电压变到400V，并通过低压配电盘的自动转换开关器进行应急配电。

垂直运输系统

概述

对所有工程师而言，超高层建筑的垂直运输系统设计是一个富有挑战性的工作。为

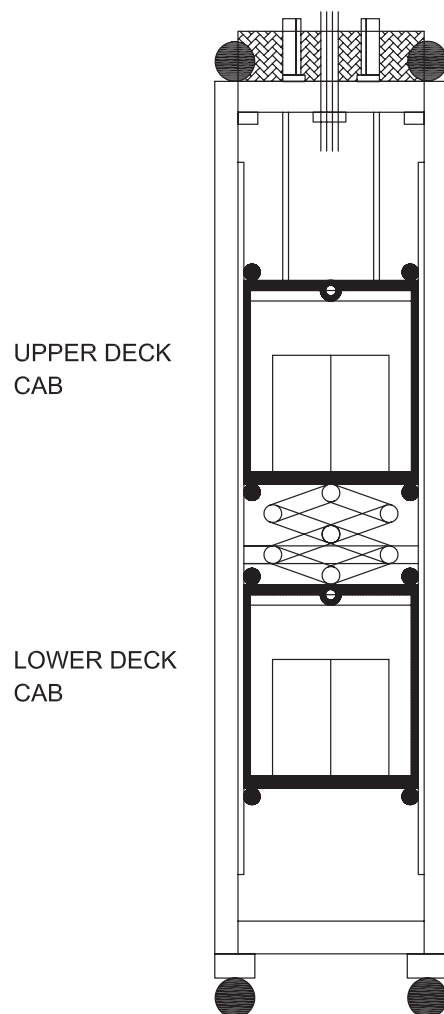


Figure 5.4. Super double-deck elevator (Source: J. Roger Preston Limited)

图5.4. 超级双层电梯 (来源: 澧信工程顾问有限公司)

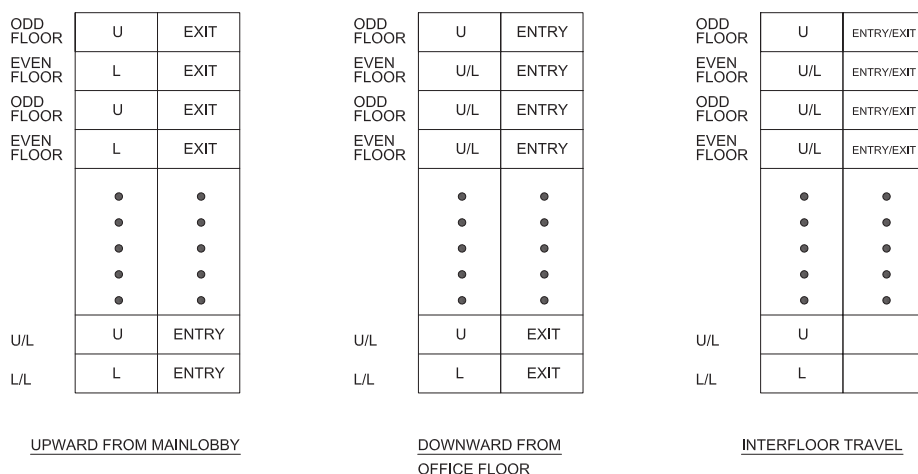


Figure 5.5. Double-deck lift traffic concept (Source: J. Roger Preston Limited)
图5.5. 双层电梯的交通运行概念 (来源: 澧信工程顾问有限公司)

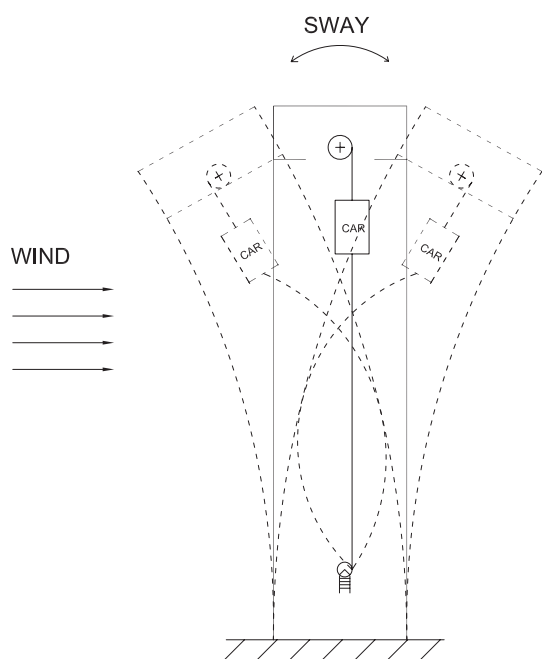


Figure 5.6. Building sway effect (Source: J. Roger Preston Limited)
图5.6. 建筑物摇摆的影响 (来源: 澧信工程顾问有限公司)

- Selection of elevator control system should best suit the operation of double-deck elevators.

The double-deck elevator traffic concept is explained as follows (see Figure 5.5):

The compact size of the building core of PAFC is attributed to the adoption of double deck local passenger elevators and shuttle elevators.

Building Sway

PAFC will be subject to strong wind effects during typhoon seasons, which create a complex oscillation and torsional movement of the building i.e., building sway. The sway might be barely perceptible to occupants, but its profound impact on the safe operation of the vertical transportation system must not be underestimated. The roping systems inside elevator shafts could be excited to oscillate under the influence of building sway, and in extreme circumstances match the resonance of the sway, resulting in severe damages to the installations inside elevator shafts (see Figure 5.6).

As elevators with long roping systems are more susceptible to building sway effects, those elevators in PAFC with long roping systems, such as shuttle elevators, will be under the control

了做出一个最佳、最全面的设计，平衡电梯核心筒效率和电梯井道空间应适当地考虑。在项目开始时，设计团队成员之间的合作对于完成整个项目目标是非常重要的的一环。

经过设计团队成员之间尽心尽力的协调，平安金融中心办公楼层被规划出7个电梯服务区域，以及直达顶楼观景台或餐厅食肆使用之专用电梯 (见图5.3)。电梯数量共有77部，为超过17,000人提供垂直运输服务。电梯的容量和速度范围从900kg到4,500kg和1.75米/秒至10米/秒。

一个好的电梯设计在实现灵活及便利的电梯服务方面是重要的一环。以下部分概述平安金融中心主要采用特点。

通向办公楼层的空中大堂

对于办公用房91层，建筑面积30万平方米的建筑来说，主要电梯大堂至各区域之间采用直达电梯将浪费很多电梯井空间，并降低建筑物核心筒使用效率。应用空中大堂的方式是弥补此种低效率的最佳方法。

平安金融中心的办公楼层划分为7个电梯分区，设置两个空中大堂：

L10 – L24 1区

L25 – L34 2区

L35 – L48 3区

空中大堂1

L53 – L64 4区

L65 – L80 5区

空中大堂2

L85 – L96 6区

L97 – L112 7区

第一、第二空中大堂均有六台1,800kg/1,800kg高速双层穿梭电梯 (见图

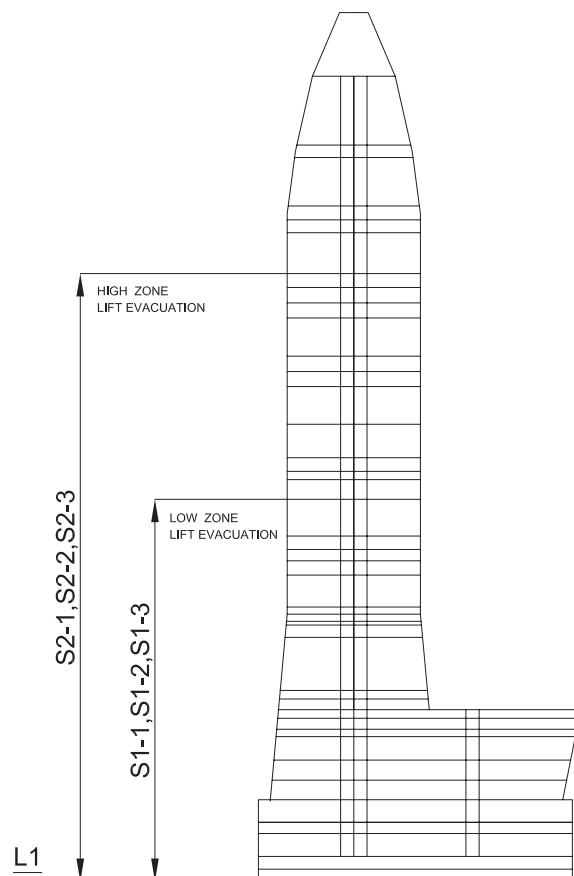


Figure 5.7. Conceptual illustration of elevation evacuation (Source: J. Roger Preston Limited)
图5.7. 电梯疏散概念说明 (来源: 澄信工程顾问有限公司)

of a building sway sensor. When building sway is detected, the speed of the elevators will slow down progressively and ultimately stop and park at “non-resonance” floors if the sway is severe.

Evacuation Mode Operation

For a skyscraper of 115 stories with an envisaged population of over 17,000 people, safely and orderly evacuating occupants under emergency situations is no easy task. With the two sky lobbies located near to the refuge floors, three shuttle passenger elevators for each of the sky lobbies are assigned as evacuation elevators to assist evacuation of the occupants when required (see Figure 5.7). During emergencies, the assigned shuttle elevators will be switched to evacuation mode and manually controlled by fire wardens. The lower deck of the shuttle elevators could then be parked on the refuge floors and transport the occupants from refuge floors to the ground floor directly.

To provide continuous and safe operation of the evacuation elevators under emergencies, a highly secured electricity backup for the elevators and a dedicated environmental control for the elevator machine rooms are essential. Those elevators are therefore designed to standards on a par with the stringent requirements of a fireman’s elevator, and the elevator machine rooms are provided with dedicated VRV cooling systems to ensure that the elevator machine will not be overheated during emergencies.

Customer-Oriented Sustainability Strategies

Customer-oriented sustainability strategies aim at providing comfortable, safe, trouble free and reliable operation to all occupants for years to come.

Hydraulic Zoning

Given the PAFC’s height, a single chilled water hydraulic zone is adopted, the pressure rating of low-zone equipment and chillers will be higher than 600 meters head working pressure, which is beyond the common commercially available product range. The addition of heat exchanges can provide hydraulic breaks, but the overall system pumping pressure and the chilled water supply temperature (viz. the pump power and the chiller power) will be increased.

5.4)。两组电梯均以B1/L1层为地面层，直达空中大堂。

为了解决在地面层及空中大堂层高之间的差别，该项目将采用超级双层电梯，电梯的上层轿厢和下层轿厢之间的距离可以自动调节，从而两个轿厢可同时在地面层及上/下区空中大堂位置停靠。

空中大堂的使用，可以节省低区电梯井空间，减少建筑物核心筒尺寸，为低区楼层提供更多有效使用建筑面积。

人群感应器控制

为了避免因各电梯到达或离开空中大堂时间不一情况下引致人群拥挤，在采用空中大堂的电梯系统中设置人群感应器控制功能是必要的。

在人群感应器控制协助下，空中大堂内进入和离开的乘客可通过目的层控制系统和人群探测器紧密监测。如果进入大堂的乘客比离开的乘客多，各电梯控制会根据穿梭空中大堂之需求制定电梯出发优先次序。这样的话，可降低到达空中大堂之乘客交通量，直到空中大堂不再过分拥挤。

双层电梯

以下是提供办公楼层共45台双层电梯：

本区载客电梯 - 33部3.5-7米/秒，
1,600kg/1,600kg的电梯

往返直达穿梭电梯 - 12部7-9米/秒，
1,800kg/1,800kg的电梯

为了使双层电梯使用达到最大效率，在项目设计阶段中需考虑如下事项：

- 在主大堂与空中大堂上行行程中，下层轿厢将服务双数楼层，上层轿厢将服务单数楼层。充足的指示牌将会提供给租户/访客引导到正确大堂。
- 选择最适合双层电梯的运行之电梯控制系统。

双层电梯的交通运行概念解释如下图 (见图5.5)

通过采用双层本区电梯及穿梭电梯，平安金融中心的建筑核心筒尺寸得以紧凑。

建筑物摇晃

600米高的平安金融中心在台风季节的强风影响下将会出现振荡和扭动，即建筑物摇晃。这种摇晃可能几乎无人察觉，但对

To minimize the pump power requirement, large chilled water delta-T as 7 °C to 8 °C is adopted for office-zone terminal units. The chilled water supply temperature of the chiller is 5.6 °C with 7 °C delta-T, further reducing the energy consumption compared to the 5.6 °C with 5.9 °C delta-T chillers. Utilizing heat exchangers with less than 1 °C temperature rise, the top office zone chilled water supply temperature is limited to 8.5 °C in order to provide supply air at appropriate temperature in summer. The large delta-T design can achieve an estimated annual energy saving of around 5% comparing all the airside and waterside equipment to the 5 °C delta-T system.

Through such optimization exercises, minimal heat exchangers are placed at respective mechanical floors to form the three hydraulic zones (see Figure 5.8).

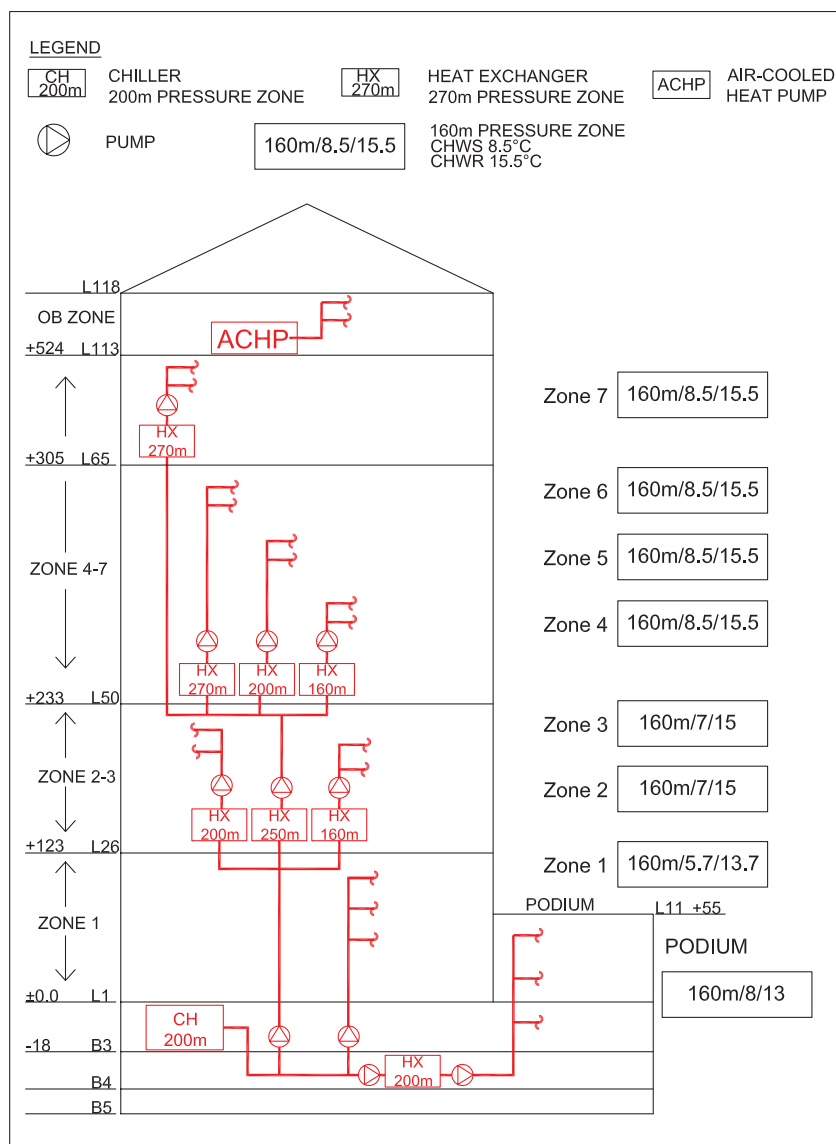


Figure 5.8. Simplified chilled water schematic (Source: J. Roger Preston Limited)
图5.8. 简化的冷冻水示意图 (来源: 澧信工程顾问有限公司)

垂直运输系统的安全运行所产生深远的影响是不可低估的。建筑物电梯井内的绳索系统可能在猛烈摇晃影响下振荡, 在极端的情况下对电梯井的安装设备造成严重损害 (见图5.6)。

由于电梯长绳索系统更易受到建筑物晃动影响, 这些设在平安金融中心电梯内长绳索系统, 如穿梭电梯, 均安装建筑物摇摆传感器来监控。当检测到建筑物摇晃, 电梯速度会逐渐减慢。在更严重晃动情况下, 电梯最终停止并停泊在“非共振”楼层内。

疏散模式操作

对于115层高及预计容纳超过17,000人的摩天大厦来说, 在紧急情况下能安全有序地疏散所有人并非容易的任务。靠近避难层的两个空中大堂均指定三台穿梭电梯为疏散模式电梯, 有需要时可协助人们进行疏散 (见图5.7)。在紧急情况下, 被指定的穿梭电梯将被切换到疏散模式, 由消防纠察手动方式操作。下层轿厢将停泊在避难层上, 直接从避难层运送人员到地面。

为了保障疏散电梯在紧急情况下连续及安全运行, 高度可靠的备用电力供给电梯和其专用电梯机房内环境控系统用电非常重要。在设计这些电梯时, 其设计标准严格上与消防电梯要求看齐。电梯机房设有专用VRV冷却系统, 以确保电梯机器在紧急情况下不会过热运行。

以客户为主导的可持续策略

以客户需求为主导的可持续设计方案, 在长远的将来, 为租户提供一个舒适、安全、稳定和可靠的工作环境。

水压分区

由于平安金融中心的特殊高度, 如果采用单一水压分区, 低区设备和冷水机组的额定压力将超过600米压头, 超出了通常设备限定 (或者设计) 范围。若增设热交换器提供水压分区, 则整个系统的输送扬程和冷冻水供水温度 (即水泵的能耗和制冷机能耗) 也将会相对地增加。

为减少水泵能耗, 办公区末端设备冷冻水温采用7°C至8°C的大温差设计。冷水机组出水温度为5.6°C, 并采用7°C大温差设计, 相对于5.9°C温差设计, 能进一步降

With the above-mentioned hydraulic breaks, the following benefits can be realized:

- The maximum working pressure of the tenant airside terminal unit is limited to a 60-meter head, a commercially common equipment pressure rating that facilitates procurement for tenant fit-out work.
- The maximum working pressure of the heat exchanger is limited to a 250-meter head for most of the office zones, except zones 6 and 7.
- Further adding hydraulic zones and lowering the chilled water supply temperature in chiller can be avoided as the heat exchanger for top office zones 6 and 7 is designed at a 270-meter head.

Air-Cooled Chiller System & Tenant Gen-Set System

Emergency cooling for mission critical equipment is regarded as a minimum requirement from the commercial tenant point of view. In addition to the chilled water supply from the central main chiller plant, an air-cooled chiller with generator back-up is designated at the intermediate mechanical floors to serve each office-zone tenant.

Likewise, plant room space is reserved at Basement 2 for anchor tenants to install their dedicated generators to back up critical facilities such as data centers.

Three-Pipe Reverse Return

In view of the demand to provide cooling-load-intensive floors, such as trading floors or IT server floors for large financial office tenants, tapping of additional chilled water from the existing and operating chilled water riser system with minimal interruption of chilled water supply to tenants always poses a challenge to the property management team.

A three-pipe reverse return with standby chilled water riser is therefore introduced to allow pipework tee-off from the main riser while maintaining 100% chilled water supply to other floors. Each tee-off is achieved by shutting down one of the three main risers at

低能耗。采用温升小于1°C的换热板换，顶部办公区冷冻水供水温度能保持最高8.5°C，以保证炎夏时均能提供适当的送风温度。考虑到所有空气末端设备及水设备的总用电量，相较于5°C温差系统，冷水机组的大温差以及所有空气侧和水侧设备电源设计预计可每年节约5%用电量。

通过设计优化，在各个机电层设置最少量的换热板换，以形成三个水压分区（见图5.8）上述水压分区可达到：

- 租户区末端设备的最大工作压力限制于160米，，有利于租户装修工程时设备采购。
- 除了第6及第7区外，其它办公区的热交换器的最大工作压力限制于250米。
- 因办公6区及7区采取270米压力（相当于400psi）热交换器，可减少所需水压分区及因而降低制冷机冷冻水出水温度。

风冷式冷水机系统与租客发电机组系统

为核心的营运设备提供后备紧急冷源是商业租户的基本要求。除中央主冷水机组所提供的平时冷冻水外，设在多个机电楼层中的风冷式冷水机组通过备用发电机电源供电，服务各办公区租户。

同样地，地下2层预留机房空间，供租户安装专用的备用发电机，支持他们的核心设施，如数据中心。

三管同程系统

应租户要求而增设某些冷负荷需求密集的楼层，如大型金融租户的交易层或IT服务器层。在现有运行中的冷冻水主管上增加分支水管，同时减少影响其它租户，这对物业管理团队来说总是一个挑战。

因此，冷冻水立管采用三管同程兼备用设计，使增加管道分支期间也能保持100%冷冻水供应到其它楼层。每增加一个分支时需要暂停三根立管中的一根立管供水（见图5.9）。由于每层分支管上设两对隔离阀及一个动态流量平衡阀，当系统由同程供水改为异程供水时，水泵能保持持续运行，提供冷冻水至各层。其后分支同样需要物业营运商配合系统转换，以减少对其他租户之影响。

全空气变风量系统

本项目采用全空气变风量系统，适应不同设计的吊顶和写字楼灵活布局的需要。在租户装修期间，送风口可按新的布局和分区很容易地重新布置，全空气变风量系统可达到更好的室内空气质量品质和能源优化控制。

鉴于交易层所需要空调24小时运行，其送风设备的可靠性十分必要。安装在每个办公楼层的两个空调机组，可以通过共享一条环形主送风管设计，以达到送风设备互补备用效果。如果其中一台调机组停止运作，整个办公楼层中的部分制冷仍可维持。

建筑能源和能源成本

深圳低谷时电价为峰时段电价60%，因而本项目利用这一优点采用冰蓄冷系统。这样冰蓄冷系统估计每年节省的能源比不设蓄冰系统高达15%。

以下措施能进一步降低建筑总耗能：-

- 高效率冷水机组，COP>=5.6，
- 变速驱动器，
- CO₂传感器优化新风控制，
- 高效率马达，

a time (see Figure 5.9). Two pairs of isolation valves are to be installed with a dynamic flow balance valve at each floor. In operation, the reverse-return system will be changed to a direct return system with the chilled water pump in continuous operation. Subsequent changeover of isolation valves at individual floors will be conducted by the building operators to minimize the interruption during pipework modification.

All-Air VAV System

An all-air VAV system is proposed to support the flexibility of different ceiling designs and internal layout amongst office tenants. During tenant fitting-out, the supply air plenum can be relocated easily to suit the new layout. Better indoor air quality and energy optimization control can be achieved by the VAV system.

In view of the 24-hour air-conditioning requirement for trading office, reliability of the airside system is essential. The two air-handling units installed at each office floor can enhance resilience by providing cross-backup through the main supply air duct, which is purposely connected in a ring duct design. If one of the AHUs is out of service, partial cooling to the whole office floor can still be maintained.

Building Energy Cost

Taking advantage of a 60% tariff policy discount for using off-peak electricity in Shenzhen, an ice storage system has been designed for PAFC. The annual energy cost saving for a chiller plant with an ice storage system is estimated to be up to 15% compared to a chiller plant without an ice storage system.

The following designs are considered with a view to reducing the total building energy consumption:

- High efficiency chillers with COP \geq 5.6,
- Variable-speed drives,
- CO₂ sensor for optimizing fresh air control,

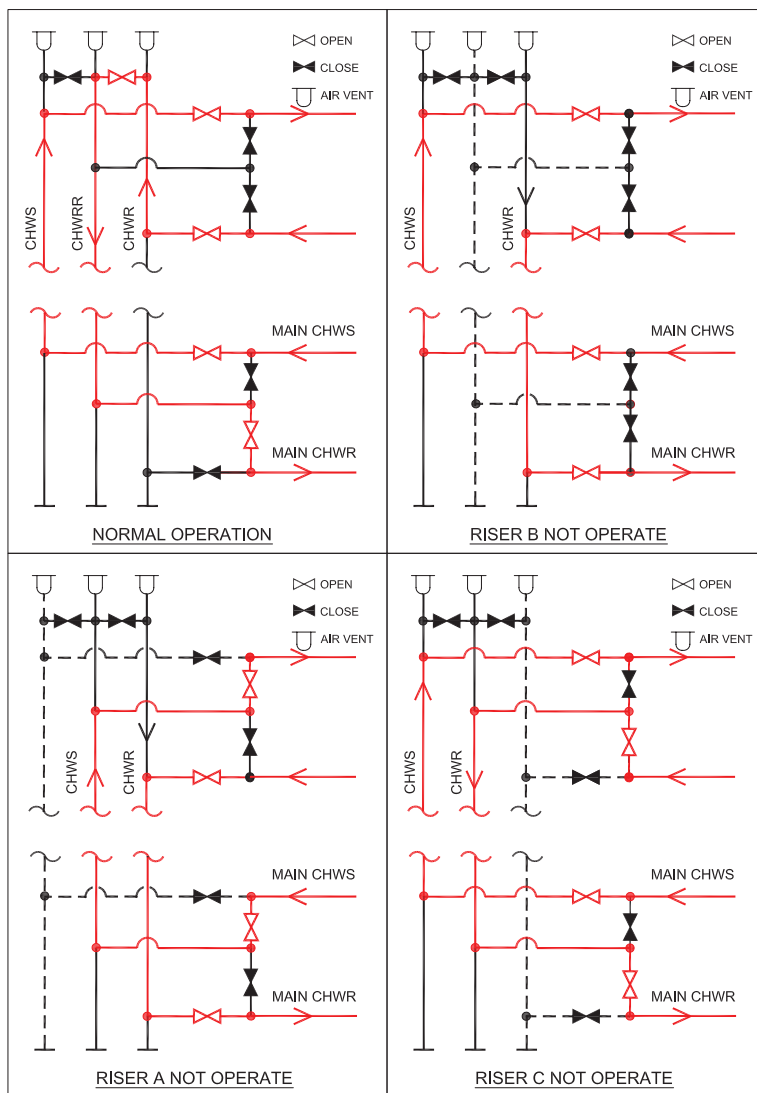


Figure 5.9. Three-pipe reverse return system with standby pipe (Source: J. Roger Preston Limited)

图5.9. 三管同程兼备用系统 (来源: 遭信工程顾问有限公司)

- 高效能灯具,
- 高速电梯再生蓄电系统。

结论

本项目设计目标是为入主平安金融中心的所有客人提供一个舒适, 安全, 无故障及可靠的服务。为满足这些客户的需求, 从工程设计策略的角度出发, 设计所需解决的方案包括:

电力

- 电源供应策略, 以提高供电的可靠性, 并控制电压下降;
- N+1的正常供电, 以最大限度地减少停机时间;
- 提供中央后备发电机供应大厦及租户的关键设备用电, 增强供电有效可用性;
- 发电机组并联, 以提高供应恢复力;

电梯系统

- 空中大堂方法, 以提高建筑核心筒效率。
- 高速双层电梯来优化电梯服务;
- 预测电梯人流控制系统, 最大限度地提高旅客吞吐能力;
- 人群传感器控制, 以避免在空中大堂过度拥挤;
- 建筑摇摆控制, 以保障在台风季节电梯的正常运行;
- 必要时电梯疏散功能, 提供协助人们疏散

- High-efficiency motors,
- High-efficacy luminaires,
- Regenerative power from high-speed elevators.

Conclusion

The design goal is to provide comfortable, safe, trouble-free and reliable services to all occupants of PAFC. The design solutions from the perspective of engineering design strategies, which are driven towards satisfying these customer's needs, include:

Power

- Power supply strategies to enhance supply reliability and contain voltage drop;
- N+1 normal supply to minimize downtime;
- Centralized generator back-up for building and tenant's critical services to enhance supply availability;
- Paralleled gensets to improve supply resilience;

Elevator system

- Sky lobby approach to improve building core efficiency.
- High-speed double-deck elevators to optimize elevator provisions;
- Predictive elevator control system to maximize passenger handling capacity;
- Crowd sensor controls to avoid overcrowding in sky-lobbies during exceptional circumstances;
- Building sway control to safeguard elevator operation during typhoon seasons;
- evacuation elevator provision to assist evacuation of occupants when required

Customer oriented sustainability

- Strategically planned hydraulic zoning to facilitate tenants selection of terminal units ;
- Air-cooled chiller and tenant genset systems to support tenants mission critical equipment;
- 3-pipe reverse return chilled water riser system to minimize interruption of chilled water supply to tenants;
- All air VAV system to facilitate tenants fit-out design;
- Installations such as ice storage system and high efficiency chillers etc to minimize building energy and energy cost.

以客户为主导的可持续性

- 有策略的规划液压分区，方便租户选择；
- 风冷式冷水机和租户发电机组系统，支持租户的关键设备；
- 3管反向恢复冷却水立管系统，最大限度地减少冷冻水供应中断对租户的影响；
- 全空气变风量系统，方便租户装修设计；
- 安装冰蓄冷系统和高效率制冷机等，最大限度地减少建筑能耗和能源成本。