Comprehensive Electromechanical Construction Technology of Super High-rise Buildings

(Take Shenzhen Ping An Project as an Example)

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2016年10月

October 2016
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平安金融中心工程由中国平安人寿保险股份有限公司投资建设，结构高度近600米，是目前深圳在建的第一高楼。工程总建筑面积约46万平方米，地上118层，其中裙楼11层，地下5层。

Ping An financial center project is the highest building with a height of nearly 600 meters under construction in Shenzhen at present, which is invested and constructed by Ping An Life Insurance Company of China. The total building area of the project is about 460,000 square meters, and the project has 118 aboveground floors (including a 11-floor podium building) and 5 underground floors.

其功能集甲A级办公、高端商业于一体，建成后将成为中国华南地区又一智能型标志性建筑。

Its function integrates Grade A and high-end business, and it will become another intelligent landmark building in Southern China after completion.
一、项目工程概况介绍

I. Project Overview

本项目机电总承包工程创新国内记录:

The electromechanical general contracting project of the project creates new domestic records:

合同金额：12.83亿元。

Contract amount: RMB 1.283 billion.

系统齐全，容量大：含20多个机电专业系统，空调系统总冷负荷为12910冷吨，设计总蓄冰容量为40000冷吨时；变配电总容量58330kVA，发电机总负荷20000kVA。

Complete systems, large capacity: including more than 20 electromechanical professional systems; the total cooling load of air conditioning system is 12,910 RT, and the designed total ice storage capacity is 40,000 RTH; the total capacity of power transformation and distribution is 58,330kVA, and the total generator load is 20,000kVA.

设备材料垂直运输：机电设备层13个，设备机房近400个，总体机电设备材料垂直吊运次数多达6000次。

Vertical transportation of equipment and materials: 13 electromechanical equipment floors, nearly 400 equipment rooms, and 6000 times of vertical hoisting transportation of electromechanical equipment and materials. 三级板换输系统：制冷机房位于B3层，通过26层、50层、65层换热机房三级转输将冷量传输至整个大楼。

Three-level plate heat exchange and transmission system: The refrigerating station located in B3F transmits the refrigeration capacity to the whole building through the three-level transmission of the heat exchanger rooms in 26F, 50F and 65F.
一、项目工程概况介绍

I. Project Overview

国内最大的室内冷却塔机房：塔楼6-9挑空层，高22米，13台超大体积闭式逆流冷却塔（单台尺寸11036mm×2991mm×4888mm）。

The largest indoor cooling tower room in China: The 6F-9F of the tower is the open floor with a height of 22 meters, and there are 13 closed countercurrent cooling towers with an extra large volume (dimensions of each tower: 11036mm×2991mm×4888mm).

施工精度：施工精细化管理，精装修净高严格控制3.0米，办公区域噪音NC40，局部区域NC35，舒适度要求高。

Construction precision: delicacy management of construction, refined decoration clear height strictly controlled in 3.0 meters, office area noise NC40, local area noise NC35, high comfort level requirements.

工期：机电系统现场实际施工时间约28个月，施工组织难度大。

Construction period: The on-site actual construction time of electromechanical system is about 28 months, and the construction organization difficulty is large.

质量标准：确保鲁班奖（国家优质工程）。

Quality standards: Ensure Luban Prize (National High-quality Project).
## 二、超高层机电总承包管理

### Electromechanical General Contracting Management of Super High-rise Buildings

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### “靶心”理念

- 核心价值理念：项目全生命周期效益高于一切；坚持最终用户导向建设；
- 核心建设理念：安全、环保、使用、效益
- 战略策划 | Strategic planning |
- 战术策划 | Tactical planning |
- 目标制定 | Goal formulation |
- 资源保障 | Resource guarantee |
- 实施策划 | Implementation planning |
- 施工要素分解 | Decomposition of construction factors |
- 分解组织 | Decomposition of construction factors |
- 策划服务 | Coordination Service |
- 机电总承包管理理念及策划 | Electromechanical general contracting management idea and planning

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二、超高层机电总承包管理
II. Electromechanical General Contracting Management of Super High-rise Buildings

作为建筑行业第一个双总包（施工总包+机电总包）模式，机电项目部大胆创新与探索，形成项目独有的机电总承包“靶心”理念—统筹组织、集成管理、协调服务。从计划管理到深化设计，从工厂预制成全息验收，从物资采购到调试运维，项目部将BIM技术始终贯穿项目全生命周期管理，实现由“只重现场”向“虚拟、施工、运维”为一体的模式转变。项目深度应用BIM技术，真正全面实现机电施工的数字化建造和工业化施工，探索出一条超高层机电总承包施工管理的全新之路。

For the first double general contracting (construction general contracting + electromechanical general contracting) mode in the construction industry, the electromechanical project department has carried out the bold innovation and exploration to form the unique electromechanical general contracting “bull’s eye” idea of the project—overall planning organization, integrated management and coordination service. From plan management to deepening design, from factory prefabrication to holographic acceptance, and from material purchasing to commissioning, operation and maintenance, the project department makes the BIM technology always run through the full life cycle management of the project so as to realize the mode transformation from “only paying attention to the construction site” to “integrating virtualization, construction, operation and maintenance”.

The project deeply applies the BIM technology to really and comprehensively realize the electromechanical digital construction and industrialized construction so as to explore a new road to the electromechanical general contracting construction management of super high-rise buildings.
作为机电总承包单位，项目部编制了《机电总承包管理手册》，从深化设计、计划管理、商务合同、施工协调、公共资源、垂直运输管理、接口管理、会议管理、档案管理、质量管理、安全管理等方面对专业分包实施全方位全过程标准化流程管理。

As the general electromechanical contractor, the project department prepares Management Manual for General Electromechanical Contracting to carry out all-around, overall-process and standardized flow management over professional subcontractor from deep design, plan management, commercial contract, construction coordination, public resources, vertical transportation management, interface management, conference management, file management, quality management, safety management and other aspects.

下面着重就深化设计管理和计划管理两方面来做简单地交流和汇报。
Simple exchange and report are performed from deep design management and plan management as below.
二、超高层机电总承包管理
II. Electromechanical General Contracting Management of Super High-rise Buildings

——深化设计管理
——Deepening design management

作为机电总承包方，图纸的深化设计质量至关重要，依托《机电总承包管理手册》，项目部制定了《深化设计策划及指导书》，从组织架构到管理制度及流程、标准、进度控制、质量控制、审查、报批、发放等方面全方位管理。

For the electromechanical general contractor, the deepening design quality of drawings is crucial. Relying on the Project Electromechanical General Contracting Management Manual, the project department has formulated the Deepening Design Planning and Guidance Instructions to carry out the comprehensive management from organizational structure to management system and process, standards, progress control, quality control, review, submission for approval, issuance and other aspects.
二、超高层机电总承包管理
II. Electromechanical General Contracting Management of Super High-rise Buildings

--- 深化设计管理
--- Deepening design management

- 深化设计进度
  Deepening design progress
- 工期要求
  Construction period requirements
- 成果下发
  Achievement issuing
- 要求指导
  Requirement guidance
- 深化设计内容
  Deepening design content
- 深化设计质量
  Deepening design quality
- 深化设计计划
  Deepening design plan

- 设计
  Design
- 施工
  Construction

- 深化反馈
  Deepening feedback
- 深化设计
  Deepening design
- 做什么
  What to do
- 做成什么样
  How to do
- 什么时候做
  When to do
二、超高层机电总承包管理
II. Electromechanical General Contracting Management of Super High-rise Buildings

——深化设计管理
——Deepening design management
二、超高层机电总承包管理
II. Electromechanical General Contracting Management of Super High-rise Buildings

——深化设计管理
——Deepening design management

专业类图纸深化设计流程
Professional drawing deepening design process

机电分包
Electromechanical subcontracting

专业图
Professional drawing

专业专项技术方案
Professional special technical scheme

专业参数复核
Professional parameter review

设计院审核
Design institute review

顾问审核
Consultant review

监理审核
Supervisor review

业主审核
Employer review

告知机电分包机电总包存档
Inform electromechanical subcontractor and electromechanical general contractor of archiving

提资综合
Comprehensive information provision

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二、超高层机电总承包管理
II. Electromechanical General Contracting Management of Super High-rise Buildings

——深化设计管理
——Deepening design management
(1) 空间的合理排布及优化

(1) Reasonable arrangement and optimization of space

项目部统筹各专业，按照施工阶段LOD400的标准建立全专业BIM模型，进行机电管线综合排布。

The project department carries out the overall planning of various specialties to establish BIM models of all specialties according to in LOD400 standards the construction phase so as to implement the comprehensive configuration of electromechanical pipelines.

通过BIM技术进行三维出图是设计行业发展的大趋势，。项目严格按照BIM模型转CAD图纸出图的方式执行，将现场施工碰撞点提前在深化阶段消除，减少现场施工拆改浪费，降本增效。针对机电核心机房部位，项目部实施BIM三维演练，组织参建各方对排布观感效果进行评定，提升机电总承包深化设计管理水平，为现场施工指导打下坚实基础。

It is a general development trend of design industry to make a 3D drawing through BIM technology. The project is implemented strictly according to the mode from BIM model to CAD drawing to eliminate the on-site construction impact points in advance in the deepening phase so as to reduce the dismantling and alteration waste of the on-site construction, reduce costs and increase benefits. For the electromechanical core machine room, the project department implements the BIM 3D drilling and organizes all participants to evaluate the configuration perception effects so as to improve the deepening design management level of electromechanical general contracting and lay a solid foundation for the on-site construction guidance.

项目部完成综合图563张，空调专业图939张，综合留洞图118张，二次砌体配合图274张，完成分包单位各类图纸审批约4000余张。

The project department has completed 563 comprehensive drawings, 939 air conditioning professional drawings, 118 comprehensive hole reservation drawings and 274 secondary masonry cooperation drawings, and has completed the approval of more than 4000 various drawings of subcontractors.
BIM出图
BIM drawing
(2) 系统功能优化校核
(2) Optimized check of system function

在深化设计过程中对管路系统进行优化后，进行专业系统的核算，如对水泵、风机等设备的参数校核，验证系统最不利环路情况下设备参数是否满足原设计要求。

After optimizing the pipeline system during the deepening design, calculate professional systems, such as the parameter checking of water pumps, fans and other equipment. Under the conditions of index circuit of the verification system, check whether the equipment parameters meet the original design requirements.

项目部完成了机电所有系统的校核优化。

The project department has completed the checking and optimization of all electromechanical systems.
(3) 噪声和振动设计管理
(3) Noise and vibration design management

超高层建筑的噪声和振动控制是相当关键的，而目前各系统设计专业集成度不高，未考虑彼此之间的影响，甚至各设备之间产生共振想象。

It is significantly important to carry out noise and vibration control for super high-rise buildings. However, owing to low professional integration level in design of various systems, mutual effect is not considered or even devices may generate resonance.

项目部在深化设计阶段即统筹考虑建筑结构及机电各专业，分析噪声（振动）源及传播途径，进行严格的消声、隔振、吸音计算，并采取相应措施。

In the deep design stage, the project department considers building structure and various electromechanical majors as a whole, analyzes noise (vibration) source and transmission route, carries out strict noise elimination, vibration isolation and sound absorption calculation, adopts corresponding measures.
本项目中主要从以下方面进行降噪减振深化设计：

The project carries out deep design about noise reduction and vibration attenuation from following aspects:

(1) 主机房及设备层浮筑地台设计；
(1) Floating platform design of primary station and equipment level;

(2) 设备选型；如空调机组样机进行专门的噪声测试，运用全频降噪阵列消声设计、集成声源控制设计方法，降低设备噪声；
(2) Equipment type selection; carry out special noise test for sample of air conditioner unit, adopt full-frequency noise reduction array for noise elimination design, integrate sound source control design method and reduce equipment noise;

(3) 核心机房吸音墙的深化设计；
(3) Deep design of sound absorption wall for key station;

(4) 减振基础、支架的综合优化；
(4) Comprehensive optimization of vibration attenuation foundation and support;

(5) 管道式消声器的选型计算；
(5) Selection and calculation of pipeline silencer;

(6) 末端选用加长静音型VAV BOX。
(6) Adopt long silent VAV BOX at the end.

通过一系列的措施，确保实现NC40的控制标准。
Realize NC40 control standard through a series of measures.
从收集业主进度要求和外部环境条件为前期条件，通过机电总包总控计划（包括施工进度节点、深化设计出图计划、物资报审计划、物资招投标计划、物资进场计划、甲指乙供设备进场计划，专业分包招投标计划及进场计划等各方面）分解成年度计划、月度施工计划和周计划。

Take the collection of employer’s progress requirements and external environmental conditions as the preconditions to decompose the electromechanical general contracting general control plan (including construction progress node, deepening design drawing plan, plan of material submission for approval, material tendering and bidding plan, material entry plan, entry plan of equipment specified by Party A and supplied by Party B, professional subcontracting tendering and bidding plan, entry plan and other aspects) into the annual plan, monthly construction plan and weekly plan.

二、超高层机电总承包管理
II. Electromechanical General Contracting Management of Super High-rise Buildings

——计划管理
——Plan management

机电施工节点目标
深化设计等资源保障计划
甲指乙供设备、分包招投标
专业分包进场计划
土建配合条件计划
深化设计出图计划
物资进场计划
劳动力投入计划
资金保障计划
针对本项目特点，以空间和时间两条主线，按照分段流水作业，制定如下计划管理手段：

Based on characteristics of the project, take two major lines (space and time) to prepare following plan and management means in accordance with flow process in different sections:

1) 两条主线贯穿全程：空调施工+消防验收，其他机电施工内容依附这两条关键线路进行编排，达到各专业分阶段分区域完成功能调试。
1) The two main lines run through the whole process: air-conditioning construction + fire control acceptance; other electromechanical construction contents are arranged according to these two key lines so as to realize the staged and regional completion of function debugging of each specialty.

2) 两大区域并行施工：塔楼低区和地下室施工为一区，塔楼高区和裙楼施工为一区。
2) Parallel construction of two major areas: The tower low area and basement construction is taken as an area, and the tower high area and podium building construction is taken as an area.

3) 六大控制原则：深化设计先行原则、机电优先原则、主机房优先原则、样板先行原则、均衡施工及流水作业原则、调试优先原则。
3) Six major control principles: deepening design beforehand principle, electromechanical priority principle, main machine room priority principle, template beforehand principle, balanced construction and flow process principle, commissioning priority principle.
项目实施“1+5”计划管控模式（即一个主控节点进度计划加五大资源保证计划：深化设计计划、工作面条件移交计划、物资计划、劳动力计划、资金计划），按照以上资源保证计划次序，将计划管理作为各项工作之首，深化设计计划和工作面条件计划为先决条件，物料报审、进场计划，劳动力投入计划和资金保障计划为实施保障，开展各项施工工作。

The project implements the “1+5” plan management and control mode (namely one master node progress plan and five resource guarantee plans: deepening design plan, working face condition transfer plan, material plan, labor force plan and fund plan). According to the sequence of the above resource guarantee plans, take the plan management as the first of all the work, take the deepening design plan and working face condition plan as the preconditions and take the material submission for approval, entry plan, labor force input plan and fund guarantee plan as the implementation guarantee so as to carry out each construction work.

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<td>图纸方案</td>
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<tr>
<td>配合条件</td>
<td>末端点位确定12.30，天花管线完成：1.18标高复核调整1.30，点位确定完成，管线完成，末端配合在进行</td>
<td></td>
<td>与装饰末端配合</td>
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<td>设备材料</td>
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<td>已完成，风口配合装饰面选型</td>
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<td>劳动力</td>
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## II. Electromechanical General Contracting Management of Super High-rise Buildings

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### Plan management

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#### Horizontal Construction Monitoring Table

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Electromechanical comprehensive construction technology in the big data era

2015年8月31日，国务院发布文件《促进大数据发展行动纲要》，标志着大数据时代的到来。

The State Council released the document “Action Outline for Promoting Big Data Development” on August 31, 2015, which symbolized the advent of the big data era.

公司及项目部紧跟大数据时代的背景，依托云平台、物联网、移动互联网等技术，探索新型的机电施工技术，提高施工效率，引领行业改革。打造建筑业从设计、施工准备、施工、调试验收至运维管理的全生命周期管理模式。

Under the background of big data, and relying on technologies such as cloud platform, Internet of Things, and mobile Internet, our company and project department explores new-type electromechanical construction technologies, enhances the construction efficiency, guides industrial reforms, and creates the life-cycle management mode of the architecture industry from design, construction preparation, construction, commissioning and acceptance to operation and maintenance management.
三、超高层新技术应用
III. Application of New Technology of Super High-rise Buildings

1. 私有云平台在超高层建筑施工管理中的综合应用技术
BIM私有云平台的搭建，为项目机电总承包深化设计工作、BIM技术开发应用以及信息化集成管理工作提供了强有力的硬件支持和保障，大大提高了项目机电总承包技术工作管理效率；同时也为项目大数据库的形成创造了条件，更为基于BIM大数据库的深度应用（运维管理平台）奠定了基础。

The establishment of BIM private cloud platform offers the strong hardware support and guarantee for the electromechanical general contractor in design deepening, BIM technology development and application, and information integration and management, thus greatly improving the technical management efficiency of the electromechanical overall contractor; meanwhile, this also creates conditions for the formation of big database and lays the foundation for the detailed application (operation and maintenance management platform) of BIM big database.
三、超高层新技术应用
III. Application of New Technology of Super High-rise Buildings

2. 气流组织CFD数值模拟研究
2. Air distribution CFD numerical simulation research

针对本工程特难点，项目团队联合国内知名院校，开展课题研究。利用CFD软件（Computational Fluid Dynamics，即计算流体动力学），在BIM模型的基础上，建立相应的物理模型和数学模型，设定边界条件，并借助工作站级的计算机，应用离散化的数学方法，对流体力学的各类问题进行数值实验、计算机模拟和分析研究。

Based on characteristics and difficult of the project, the project team joined hands with domestic famous institutes to carry out subject study. Via CFD (Computational Fluid Dynamics) software, and on the basis of BIM model, we established the corresponding physical model and mathematical model, defined boundary conditions, and conducted numerical experiment, computer simulation, and analytical study of various problems of fluid dynamics by resorting to workstation-level computers and applying discrete mathematical methods.

（1）室内冷却塔群及风冷热泵机组群数值模拟研究。
（1）Indoor cooling tower group and air-cooled heat pump unit group numerical simulation research

平安金融中心项目冷却塔群及风冷热泵机组设于塔楼内，进/出风量、散热量能否达到设计效果、返流现象是否存在等问题是设备选型和空间布置等深化设计的重点，如何确保在施工前消除这些疑难技术，确定一个合理的方案，从而指导施工至关重要。

Cooling tower group and air-cooled heat pump unit group of Ping An International Finance Center are arranged in the tower. Whether air supply/discharge volume and heat dissipating capacity can reach design effects, and whether there is the backflow phenomenon are the key and difficult points for detailed designs such as equipment model selection, spatial arrangement, etc. Therefore, it is vital to eliminate the difficulties and determine a reasonable scheme before the start of construction.
III. Application of New Technology of Super High-rise Buildings

通过对设计满负荷工况下冷却塔群气流组织的模拟，得到如设计优化：
(1) 设计工况下，冷却塔塔外余压不低于150Pa，因此根据此参数重新选型以达到设计要求。
(2) 通过强排风形式，使静压箱气流分布良好，避免倒灌回流现象。
(3) 东北角与西北角有轻微返混现象，但对进风温度几乎没有影响。
三、超高层新技术应用

III. Application of New Technology of Super High-rise Buildings

（2）室内大开间办公区气流组织模拟研究。

（2）Air distribution simulation research of indoor large bay office area

对塔楼办公区标准层13F空调送风系统的送风管道和末端进行数值模拟，分析两种送回风方式对办公建筑气流组织的影响，为该类建筑的空调设计提供指导依据。两种送回风方式分别采用中间送风两侧回风（送回风方式A）与两侧送风中间回风（送回风方式B）。

Carry out numerical simulation of air duct and end of 13F air-conditioner air supply system of the tower office area, and analyze the impacts of the two air supply and return ways on air distribution of the office building so as to offer basis for air-conditioner design of such buildings. The two air supply and return ways are the air supply in the middle and air return at two sides (air supply and return way A) and air supply at two sides and air return in the middle (air supply and return way B).

通过送回风口布置数值模拟得出以下结论与优化：

The following conclusions and suggestions can be obtained through the numerical simulation of air supply and return opening arrangement:

①送回风方式B下玻璃幕墙办公建筑内气流混合较为均匀，产生的涡流比方式A的少；
①Under air supply and return way B, air flow in office buildings of glass curtain wall is relatively even, and the swirl rate generated is smaller than that in Way A;
②送回风方式B比方式A的室内温度分布均匀，整体热舒适性高，因而方式B要优于方式A；
②Under air supply and return way B, indoor temperature is evener than that under Way B, and the overall thermal comfort is higher than that under Way A;
③建议采用送回风方式B。
③It is advisable to adopt air supply and return way B.
III. Application of New Technology of Super High-rise Buildings

（3）. Optimization of air pipe connection mode

对塔楼办公区标准层13F空调送风系统的送风管道和末端进行数值模拟，分析系统管道内风速及风压，优化系统连接方式—德国法兰。

Carry out numerical simulation of air duct and end of 13F air-conditioner air supply system of the tower office area, analyze air speed and air pressure in the duct, and optimize the system connection way—German flanges.

13F空调风系统速度场
Velocity field of 13F air-conditioner air system

13F空调风系统压力场
Pressure field of 13F air-conditioner air system
III. Application of New Technology of Super High-rise Buildings

3. Super high-rise virtual simulation and large-scale equipment hoisting and transportation technology

The project department combines super high-rise virtual simulation construction technology and BIM technology for virtual construction of important construction techniques and hoisting schemes of the project, and instructs site construction through the simulation drilling demonstration. The combination of virtual simulation and site situation makes the owners, supervisor, and construction party intuitively learn about the implementation process of schemes, easily discover risk factors, and argue the feasibility of schemes. So far, the project department has accumulated a huge amount of virtual simulation construction achievements for important electromechanical construction schemes and equipment hoisting schemes (especially super high-rise equipment hoisting). The most representative achievements include “B2 diesel generator set transportation route”, “tower plate heat exchanger unit hoisting”, “tower cooling equipment hoisting”, and “air-conditioner water pipe upside-down installation method”.
III. Application of New Technology of Super High-rise Buildings

Tower Plate Heat Exchanger Hoisting Scheme

Plate heat exchanger entering hoisting cage

Plate heat exchanger entering floor

First direction adjustment in floor

Second direction adjustment in floor
III. Application of New Technology of Super High-rise Buildings

Virtual simulation
Site implementation
三、超高层新技术应用
III. Application of New Technology of Super High-rise Buildings

4、基于BIM平台测量机器人在机电管线施工中的应用
4. Application of BIM platform-based measuring robots in electromechanical pipeline construction

BIM技术与测量机器人的结合，拓展了BIM技术在机电施工行业上应用，打破传统机电施工的壁垒。两者之结合，在技术上展现出其在行业内的先进性，并显著提高了工作效率及施工精准度（节约人工成本约30%）。

The combination of BIM technology and measuring robots expands the application of BIM technology in the electromechanical construction and breaks through the barriers of traditional electromechanical construction. Their combination reveals the advance of the technology in the industry, and remarkably increases the working efficiency and construction precision (saving labor cost by 30%).

就平安项目塔楼标准层现场放样过程中为例，完成一个标准层主风管放样及支吊架固定过程，利用传统方法需要3名工人工作7个工作日，在全站仪的配合下完成相同量的该工作，只需要两名工人工作3个工作日即可完成，每一个标准层节省了15个标准工作日。

Taking site setting out of a standard floor of the tower as the example, completing the main air duct setting out and support fixing process of a standard floor requires three workers and seven working days through the traditional method. However, finishing the work of the same load under the support of a total station just requires two workers and three working days. 15 working days are saved at each standard floor.
利用全站仪实现深化设计与现场施工的无缝连接
Realizing the seamless connection of detailed design and site construction via total stations
5. 基于BIM的薄钢板风管工厂预制加工技术
5. Sheet steel air duct factory prefabrication technology based on BIM

由于施工现场场地受限，项目部专程在深圳郊区建立场外加工中心。在图纸深化阶段，深化设计中心结合BIM工作站，将风管划分为不同标准节和异形件并提供料单，场外加工中心根据料单将镀锌板加工成L型半成品后，分类标记，打包运输至施工现场，而后进行流水化拼装作业。

Due to the restriction of the construction site, the project department especially established the off-site processing center. In the drawing deepening stage, the detailed design center worked with BIM workstation to divide air ducts into different standard sections and special-shaped parts, and offered the material list. According to the material list, the off-site processing center processed galvanized sheets into L-shaped semi-finished products, labeled them according to different categories, and packaged and transported them to the site for streamlined assembly.

“L”型风管运输至现场后，使用手持式电动合缝机将其两两拼接，风管节与节之间连接引进高标准、自动化生产的德国法兰（TDC组合式法兰），结合碰焊机代替半机械化或纯手工加工的法兰。

After L-shaped air ducts are transported to the site, handheld electric linking machines are used to link every two ducts. With the support of butt welders, the high-standard, automatic German flanges (TDC combined flanges) are introduced for the connection of air duct section and section. Such flanges substitute for semi-mechanically or pure-manually processed flanges.

使用自动化物料提升设备，完成风管的最终安装。

Automatic material hoisting equipment is employed for the final installation of air ducts.
三、超高层新技术应用
III. Application of New Technology of Super High-rise Buildings

BIM模型图纸处理
BIM model drawing processing

分类标注
Categorized label

根据预制图出下料单
Issuing the laying-off list according to the prefabricating drawing
III. Application of New Technology of Super High-rise Buildings

场外加工
Off-site processing

打包运输
Package and transportation

全自动风管合缝机
Fully automatic air duct linking machine

法兰碰焊机
Flange butt welder
III. Application of New Technology of Super High-rise Buildings

6. Construction technology of combining large-diameter pipeline automatic welding and “upside-down installation method”

Develop the technology of “large-diameter automatic welding for electromechanical installation of super high-rise buildings”, thus making welding operation shift from traditional manual operation to robot operation, and further enhancing the working efficiency. In the project, the technology is mainly applied to the welding of large-diameter pipelines (DN300-1200).

“Upside-down installation method” means that materials are fed and welded at the bottom fixed floor, and then hoisted to the final floor as a whole. This changes the low efficiency in traditional construction caused by the fact that operators and welding equipment are moved with operating floors.

The combination of automatic welding technology and “upside-down installation method” can lift the working efficiency and improve the welding quality.
III. Application of New Technology of Super High-rise Buildings

- 自动焊接技术研发中
  Research and development of automatic welding technology

- 作业过程
  Operating process
III. Application of New Technology of Super High-rise Buildings

7. Noise reduction and vibration attenuation construction technology

Carry out on-site noise reduction and vibration attenuation construction in strict accordance with deep design achievement.

浮筑地台施工
Construction of floating platform

惯性基础及出口管道减振
Vibration attenuation for inertia foundation and outlet conduit
III. Application of New Technology of Super High-rise Buildings

机房吸音墙
Acoustic absorption wall of station

设备运行后，使用八倍频程噪声仪进行噪声测试，并绘制NC曲线。
Use noise meter with eight times of sound interval for noise test and then draw NC curve.

落地式减振支架
Vibration attenuation support on floor
III. Application of New Technology of Super High-rise Buildings

8. Remote holographic scanning acceptance system

Remote video acceptance system combines mobile microwave communication technology, WiFi technology, chip positioning technology, holographic scanner, and BIM technology, reflecting laborer distribution through real-time chip positioning; reflecting construction situation and appearance quality through real-time transmission of pictures and videos; directly forming 3D images of the site through holographic scanner so as to supervise physical installation quality, and transmitting the data above to each display at real times. Firstly, the system realizes the remote monitoring and management of the project site, and achieves the purpose of operating informatization; and secondly, it feeds model data acquired through scanning to in-depth designers at real times, directly measures the positioning of physical objects, and compares it with BIM model so as to precisely control site construction.
三、超高层新技术应用
III. Application of New Technology of Super High-rise Buildings

保持信息同步传送
Synchronous transmission of information

- 激光技术
  - 相位激光
  - 976,000 点/秒
- 测程
  - 最高 120m
- 精度
  - 可达0.3mm 标准差

现场拍专人对验收部位进行实时摄像
Special persons are designated to pick up images of the accepted parts at real times.

数据接收与处理
Data receiving and processing

验收人员通过实时影像对需要查看的部位验收
Acceptance personnel check and accept the parts to be accepted through real time images.
9、基于BIM的项目全生命周期数字化运维管理系统
9. Life-cycle digital operation & maintenance management system based on BIM

（1）、应用二维码管理物资调配。
（1). Managing material allocation via 2D bar codes

项目部联合软件公司联合开发物资二维码管理系统，从物资生产、运输、入库、出库及安装全过程信息进行可追溯性仓储式管理；采用装配式货架，对重要、零散材料进行分类管理，标示清楚，方便出入库管理；结合二维码物流配送和调拨管理，通过移动终端设备PDA对条码的扫描，从而实现提高施工阶段材料进出库、分类、限额领料等的管理效率，清楚知道该物资库位信息（一级库、二级库）入库、出库、盘点等信息。二维码管理系统的成功使用，将之与BIM技术相结合，为基于BIM的项目全生命周期数字化运维管理系统的研发创造了良好的基础。

The project department cooperates with a software company to jointly develop the 2D bar code material management system, carrying out traceable warehouse management of materials from production, transportation, warehousing, delivery, and installation; making categorized management of important and scattered materials with fabricated racks, and clearly marking them for the convenience of warehousing management; improving the management efficiency of material warehousing and delivery, categorization, and quota material requisition in the construction stage through scanning bar codes via PDA on the basis of 2D bar code logistics and allocation, and being clear about warehousing, delivery, and inventory information of materials (including warehouse information such as primary warehouse, secondary warehouse). The successful research and development of 2D bar code management system, together with BIM technology, creates the favorable foundation for the research and development of BIM-based project life cycle digital operation and maintenance management system.
III. Application of New Technology of Super High-rise Buildings

1. Supplier receives purchase orders.
2. Print 2D barcode labels.
3. Attach labels before shipment.
4. Load the goods.
5. Feedback delivery information (quantity, delivery date, etc.).
三、超高层新技术应用
III. Application of New Technology of Super High-rise Buildings
III. Application of New Technology of Super High-rise Buildings

（2）. Building the fully digital operation & maintenance management system

Operation & maintenance management is the focus of the owners’ concern after the delivery of Ping An International Finance Center. Only a simple, user-friendly, comfortable, efficient, and low-cost operation & management system can bring true values for the owners.

Therefore, the project department, in the construction stage, brought into full play the advantages of the electromechanical general contractor, sorted out logical relationship and operating tactics of all electromechanical systems, collected setting parameters and maintenance measures of equipment, concluded important information of equipment and materials and established the background database with 2D bar codes as the medium.

As for the development of the operation & maintenance platform, our company and the project department actively mobilizes internal and external resources, sets up the basic framework, and expects to join hands with the owners to build the fully digital operation & maintenance management system together.
三、超高层新技术应用
III. Application of New Technology of Super High-rise Buildings

该体系主要包含以下几个板块内容:
The system mainly includes contents of the following sections:

- 建筑空间与设备运维管理
  - Building space and equipment management
- 公共安全运维管理
  - Public security maintenance management
- 建筑资产运维管理
  - Building asset operation & maintenance management
- 建筑能耗监测与分析
  - Building energy consumption monitoring and analysis

数据管理工具
Data management tool

数据交换
Data exchange

信息数据
BIM

Information data BIM

全数字化运维管理系统
Fully digital operation & maintenance management system
III. Application of New Technology of Super High-rise Buildings
The system is mainly composed of the following sections:

(1) Building space and equipment management

Monitor and analyze each floor’s lease and usage, each day’s visitor flow and function distribution, and optimize the resource allocation of each functional space and the start and stop of equipment.

(2) Public security maintenance management

Link BIM operation & maintenance platform with fire alarm and security system, and push information to related personnel via mobile phones. Once discovering emergencies, quickly start the safety management plan to minimize the loss.

(3) Building asset operation & maintenance management

Establish equipment & material life-cycle files through the BIM big database so as to control the purchase, maintenance, replacement, and disuse of equipment and materials; and connect with the property charging system and integrate all charging channels so as to offer the one-stop intimate service to lessees.
（4）建筑能效管理

(4) Building energy efficiency management

能效管理可为物业的运行成本控制提供强有力的保障。它主要是建立一整套的运行数据收集及分析体系，通过专业人员对整个大楼系统运行状态的研究，比对各个能耗点的不同状态下的运行数据，结合电价、管控策略等外部条件综合分析后，设定大楼整体运行最优的管控方案。构建能效管理模块，主要有两个目的：一是通过不同状态下运行数据的收集与分析，不断修正大楼的整体运行策略，达到更节能的目标；二是同比和环比数据的积累，可对运行状况做出预判，便于业主对大楼运行成本的把控。

Energy efficiency management can offer the strong guarantee for the operating cost control of property. It is mainly to establish a whole set of operating data collection and analysis system. Through the research of the whole building’s system operation, professionals compare operating data of each energy consuming point under different statuses, and set up the optimum management and control scheme of the whole building in the light of external conditions such as electricity price and control strategies. The energy-efficiency management module is established mainly for two purposes: 1. continuously correct the overall operating strategy of the building through the collection and analysis of operating data under different statuses; 2. prejudge the operating status through the accumulation of year-on-year data and month-on-month data so as to make it convenient for the owners to control operating cost of the building.

全数字化运维管理系统是以BIM为基础的，依托于BIM的大数据库，实现传统低效的管理方式将得到根本性转变。

Fully digital operation & maintenance management system realizes the fundamental change of the traditional low-efficiency management way on the basis of BIM and relying on the big database of BIM.
三、超高层新技术应用

III. Application of New Technology of Super High-rise Buildings

BIM导航

BIM navigation
三、超高层新技术应用

III. Application of New Technology of Super High-rise Buildings

基于BIM模型的运维信息
Operation & maintenance information based on BIM model
平安金融中心机电总承包在国内超高层建筑机电安装方面做了大胆探索，也取得一些成绩，但我们明白，这仅仅只是一个开始，未来还有很长的路要走，我们愿与在座各位同仁一道，为中国建筑施工行业的建造发展一起努力。

The electromechanical general contractor of Ping An International Finance Center has made the bold exploration in electromechanical installation of super high-rise buildings at home, and made the great achievements. However, we understand that this is only a beginning, and there is still a long way to go. We are willing to work with all of you to make efforts for the development of the Chinese architecture construction industry.

在此向听取本次汇报的各位领导、同仁表示诚挚感谢，祝愿大家身体健康、工作顺利、阖家幸福。

I would like to extend my sincere thanks to the leaders and colleagues listening to the report here. Wish you and your family good health and happy life.

谢谢大家！

Thanks!
汇报完毕！
The end of the report!
谢谢聆听
Thanks for listening