

# **A Case Study on Management Process of Building Commissioning for a New Building in Hong Kong**

## **屋宇调试管理 — 香港的一个物业发展个案**

Ir Leo C. F. Wong 黄镇晖, Ir Dr. Leonard K. H. Chow 周冠雄

中国建设部建筑智能化技术专家委员会专家

中国勘察设计协会工程智能设计分会技术专家

Founding Members, Hong Kong Building Commissioning Centre

### **Abstract**

Buildings are essential as they are places where people accommodate their living and business. Financially, buildings are real estates and their values are usually reflected directly on business and personal accounting statements. For health and safety issues, building provides a hygienic and safe living environment. Therefore, quality buildings are very important in modern world.

The term, “commissioning” (Cx) is derived from ship-building industry. It is conventionally viewed as a stage to make building services installations to function as intended. The interpretation on commissioning from US and Britain are quite different. The former model demands commissioning as a quality control process throughout planning, design, construction, acceptance and post-acceptance phases; the latter demands a validation process that makes the installations work to design intent.

In this paper, management process on commissioning of a new building in Hong Kong was examined. The management and documentation on the commissioning process are also compared with those guidelines recommended by professional institutions.

### **Key Words**

buildings, commissioning process, quality, management

### **提要**

屋宇对人类相当重要，既提供了居所地亦是业务上的根据地。在财务上，楼宇的价值一般都在业务及个人的财政状况上反映出来。楼宇并提供了一个卫生和安全的家居和活动环境，故此，楼宇在现代社会中是重要的。屋宇调试一词是源于造船业的术语，传统上在楼宇建成后，屋内的各个系统按设计要求作出测试。在英、美两个国家，屋宇调试在不同程度上有分别。美国侧重于文件查核的整理及质量监测，务

楼宇于计划、设计、施工，验收和营运各环节上都有详尽的记录。英国则较注重于楼宇建成时的验收步骤。但两者都有一个共通点，以设计要求为蓝本。本文以香港一幢新盖楼宇为个案，考查其楼宇调试管理和文件的记录过程，并与专业团体的指引为对照。

## 关键词

楼宇，调试过程，质量，管理

## 1. Introduction

Building is classified as real estate and its value is always reflected directly on business financial statements. For health and safety issues, building provides a safe shelter and a hygienic living environment. Therefore, quality buildings are very important in modern world.

The term “commissioning” (in short as Cx) has two definitions according to US and Britain model. In US, ASHRAE Guideline 1-1996 defined that “commissioning is the process of ensuring that systems are designed, installed, functionally tested, and capable of being operated and maintained to perform conformity with the design intent” [1]. Conventional testing, adjusting and balancing (TAB) on systems are executed by a separate contractor and is not considered as building commissioning process (BCx). In Britain, the CIBSE Cx Code W-2003 defined that “commissioning is the advancement of an installation from the state of static completion to the full working order to specified requirements” [2]. These two models had also been preliminarily reviewed at international perspective by Schiess in 1988 [6].

In view of these two definitions, the US model is more focusing on management and documentation throughout the whole building development process while the Britain is more functional orientated in the acceptance stage. Nevertheless, ASHRAE published the ANSI/ASHRAE 111-1988 “Practices for Measurement, Testing, Adjusting and Balancing of Building HVACR Systems” which outlined the TAB process and requirements. Another important document ASHRAE/NIBS Guideline 0-2005 has been published recently to provide the guidelines on total building commissioning process. This new document will greatly advance the implementation of the quality delivery process for all types of constructed projects, including new buildings, facilities, campuses, utilities, public projects, rehabilitations, additions, re-commissioning and retro-commissioning.

In Britain, in order to meet the newly introduced Building Regulation Part L and to foster the management of system regulation works, CIBSE has also published its Commissioning Code M in 2003 to deal with commissioning management issues.

## **2. Commissioning Process**

Commissioning is always complicated due to massive documentations and validation on performance of equipment, sub-systems and systems in building. Because all components and sub-systems are integrated, a deficiency in one component will cause a less optimal operation and performance among other components. Remedying these deficiencies can result the following benefits <sup>[5]</sup>:

- i) Improve occupants' comfort level.
- ii) Save in energy through system tuning.
- iii) Improve environmental conditions.
- iv) Ensure system and equipment function.
- v) Facilitate building operation and maintenance.
- vi) Enhance building productivity.

Therefore, a proper commissioning process, the performance of building services installations could be achieved, validated and documented that meet the design needs and requirements specified by the owner.

To manage the commissioning process properly, the fundamental objectives of commissioning should be first defined. No matter what Cx model is adopted, the following objectives must be set:

- i) To create methodology and procedures to verify then document the performance of the facilities and their systems that meeting with owner's requirements.
- ii) To enhance communication between varies parties by documenting data and decisions throughout all phases of a project.
- iii) To validate and report that system performance meets the design intent.

### **2.1 Commissioning Model in United States**

In US, commissioning process can be implemented in five different phases <sup>[1]</sup>:

- i) Facility program phase - the functional, operational and occupant requirements of the facility are defined. An initial statement of design intent and a preliminary commissioning plan are prepared.
- ii) Design phase - the complete design of the facility including all systems is completed including the tender document and construction drawings and project specifications. The commissioning plan and commissioning specifications are prepared.
- iii) Construction phase - the facility is constructed, installation with utility and services installed, functionally tested and operated. The commissioning plan is modified to

reflect changes on systems and equipment.

- iv) Acceptance phase - performance testing is executed to verify that performance of the systems meet the design intent. O&M documentation is reviewed and approved and maintenance staff is trained.
- v) Post-acceptance or occupancy phase - performance testing is continued to account for dynamic changes that occur in a facility over time including seasonal variation.

As shown, US commissioning is a quality control process that facility and its sub-systems are planned, designed, installed, tested and capable of being operated and maintained to perform according to design intent. The commissioning services provider, known as commissioning authority (CxA) should be directly employed by owner.

## **2.2 Model in Britain**

In Britain, CIBSE Code M demands a proper management on commissioning in the following ways <sup>[2]</sup>:

- i) Issues and duties at the design stage (as per Tables 2 and 3 in section 6.1 <sup>[3]</sup>).
- ii) Duties at the installation stage (as per Table 4 in section 6.1 <sup>[3]</sup>).
- iii) Duties at commissioning and testing stage (as per Table 5 in section 6.1 <sup>[3]</sup>).
- iv) Duties at completion and post-handover stage (as per Table 6 in section 6.1 <sup>[3]</sup>).
- v) A commissioning report that proves compliance with Part L of Building Regulations.

Apart from this, CIBSE published Cx codes on air, boiler, automatic controls, lighting, refrigeration and water for procedural system testing and commissioning.

Apparently, this commissioning model puts more focus on the post-construction and acceptance stages, the research conducted by BSRIA revealed that involvement of a commissioning manager employed by owners in early stage benefits the handover process. The study also recognized that with an appropriate commissioning manager involved even at a later stage, the situation could still be improved as compared to no commissioning manager employed<sup>[3, 4]</sup>. There is specific requirement on the employment of commissioning services provider, known as commissioning management organization (CMO),

## **3. Implementation of an Effective Commissioning Process**

### **3.1 Commissioning Documentations**

In order to have an effective commissioning process, the following two documents should be

prepared in ensuring an effective commissioning process.

- i) The commissioning plan – a document that describes all aspects from beginning to end of the commissioning.
- ii) The commissioning specifications – a document provides a clear description of the context and extent of the verification testing required including documentation, reporting and scheduling requirements.

Normally, the commissioning specifications shall also detail the operation and maintenance training and documentation requirements.

### **3.2 Responsibility amongst Parties**

To succeed in commissioning process, each of the following parties has specific responsibilities to ensure that the commissioning process is completed according to the commissioning plan and commissioning specifications <sup>[5]</sup>.

- i) Owner - the owner shall show the dedication in procurement of quality building and systems by defining the overall vision and establish operational goals and requirements.
- ii) Commissioning Services Provider (CxA or CMO) - the commissioning service provider is a person or organization who is experienced in commissioning process and capable of organizing and leading the commissioning team. The commissioning team shall prepare the commissioning plan and specifications, monitors the commissioning process and prepares the final commissioning report.
- iii) Design Team - the design team consists of architects and engineers shall prepare the design documents which explicitly transforming the owner's design intent into realistic function of the building systems.
- iv) Project or Construction Manager - the project or construction manager is responsible for managing the construction process and assuring respective commissioning process completed on time. The specific commissioning responsibilities could include coordinating interactions between the commissioning team and other project team members.
- v) Main Contractor - the main contractor is responsible for overall construction and coordination. The specific commissioning responsibilities could include, but not limited to site coordination, schedule performance tests and provision of facilities for commissioning.
- vi) Building Services Contractors - the building services contractors are responsible for performing work and supplying equipment as stated in their respective contracts. Specific commissioning responsibilities could include performing performance tests

and providing training and documentation for O&M staff.

- vii) Suppliers and Manufacturers - the suppliers and manufacturers provide specified systems, equipment and components to owner, main contractor and subcontractors. The specific commissioning responsibilities could include conducting factory and site performance tests, if specified and providing O&M documentation for specific equipment.
- viii) Operation and Maintenance Staff - the O&M staff should provide continual feedback to the owner about the system performance hence the deficiency in design, installation, even poor commissioning could be upgraded or fine-tuned in the development. The specific commissioning responsibilities could include O&M requirements in the design intent; training requirements and attendance on performance testing.

#### **4. A Case Study on a New Building in Hong Kong**

(Some information have been deliberately omitted in order to maintain privacy)

A prestigious building owned by a developer is newly built in the commercial and business district in Hong Kong. This building had been opened in 2005 and the construction period was commenced since 2003. The building is a leisure and commercial development and was fully looked after by the developer in project management and construction with aids from famous local architectural and engineering firms. The building is managed by an international chain management operator.

Only the outline design and site progress documents could be made available from developer for this study.

##### **4.1 Program Phase (Planning stage)**

According to the available documents <sup>[7]</sup>, an independent commissioning services provider has not been employed in this phase to look after the following Cx tasks:

- i) The preliminary commissioning plan.
- ii) Commissioning budget and cost estimation.
- iii) Commissioning guides, drawing and quality standards.
- iv) Management operators' specific requirements.

##### **4.2 Design Phase (Design Stage)**

In view of the Design Outline Documents and Specifications<sup>[7]</sup>, the following findings have been observed.

- i) Detailed commissioning plan and specification are not included.
- ii) Both general and particular technical specifications are prepared by the design team (architectural and engineering) without any inputs from a commissioning service provider; consequently the design has not been reviewed on commissionability and functionality.
- iii) Only some general clauses specified the requirements on system commissioning without a detailed implementation scheme.
- iv) Commissioning budget and cost are included in tender sum without a detailed breakdown and analysis.
- v) Commissioning schedule and program are not specified.

#### **4.3 Construction Phase (Installation Stage)**

Apart from traditional site progress and coordination meetings, site inspection etc., there is no sign that commissioning review meeting has been conducted. The building services contractors did not submit any commissioning method statements and program at the commencement of construction.

By the fall of 2004, when the owner observed there was a possible delay caused to hand over the building to management operator for partial opening in mid-2005, the project management team has assigned a representative (here-in-after called the commissioning manager) to take care the whole commissioning task on site. It was found that this Cx manager has extensive practical experience and received prior training in commissioning process.

The Cx manager has immediately conducted the following tasks:

- i) Review the design documents and site progress.
- ii) Require all services sub-contractors to submit the Cx method statement with a presentation.
- iii) Issue a work plan with consolidated and comprehensive Cx task list to all contractors and demanded respective Cx document submissions to comply with this umbrella document.
- iv) Conduct numerous site inspections and Cx coordination meetings and prioritized central plants and critical systems for complete installation and preliminary commissioning purposes.
- v) Monitor the actual installation progress and ensure the installations are substantially

completed before commissioning process.

#### **4.4 Acceptance Phase (Testing Stage)**

In the acceptance phase, the Cx manager has made the following arrangements.

- i) Schedule the testing and commissioning activities sequence according to contractors' program and the developed work plan.
- ii) Comment on the commissioning submissions.
- iii) Arrange site staff to attend and witness the site tests.
- iv) Conduct commissioning meetings amongst all building services contractors.
- v) Initiate preliminary training on operation and maintenance.

#### **4.5 Post-acceptance Stage (Occupation Stage)**

In this stage, the commissioning manager has compiled the documents and prepared the commissioning report, operation and maintenance manual then handed over to management operator, and continued the staff training.

### **5. Discussion**

Although neither US nor Britain commissioning model has been adopted in this building development, the commissioning process has been drastically improved in about six months from the late construction to acceptance phases by the engagement of a commissioning manager.

- i) The Cx manager has prior practical experience and training on Cx process. This is essential as the commissioning process is commenced in the late construction phase. Both US and Britain models demanded that commissioning services provider should be competent in the Cx process.
- ii) Despite lacking of the commissioning plan prepared in the program and design phases, the commissioning tasks have been centrally consolidated by the work plan with comprehensive Cx tasks prepared and issued by the Cx manager. This document could be considered as "pseudo-Cx plan and specification" that supplemented part of the original Cx documents ought to be prepared in program and design phases.
- iii) As there is no commissioning plan available so all building services contractors would prepare their own plans to suit respective installation progress. The Cx manager has adopted a contingent approach to organize commissioning meeting with presentations



conducted by respective building services contractors. This is very unusual but has enlightened the significance on the commissioning process amongst all building services contractors and led to a better view on the whole Cx process resulting in less conflict between different contractors. The Cx manager's role in coordination has been significantly reduced.

- iv) The Cx manager has successfully scheduled those systems and plants are most critical to partial occupation and operation with priority in the commissioning process. System commissioning on remaining systems are scheduled in sequential order with respect to actual site progress.
- v) The building services contractors have submitted the Cx documents according to the work plan, this saved time in document preparation before testing. Consequently, all building services contractors could spend more time in site works and commissioning tasks. The documents (proforma test record and check sheet) submitted would be the bases for commissioning report, and the O&M manual.
- vi) Respective contractor's site installation progress was found improving autonomously due to the imminent commissioning process. Those outstanding site installations have been accelerated internally by own Cx tasks and activities, and externally the testing on interfacing nodes demanded by other contractors.
- vii) As a need to cope with the sudden increase in Cx process, the Cx manager has recruited several students from local technical colleges to aid the process. These students have received adequate technical education in commissioning and maintenance and performed satisfactorily in this period. Indeed training on management staff in operation and maintenance has been aided by those students.
- viii) With the participation of the commissioning manager, the staff training for management operator has been moved forward in the acceptance phase and this facilitated the taking over process for occupation.

## **6. Conclusion**

The Cx manager has played a key role in this building development though he was being involved just before the acceptance phase. It is found that the requirements on typical Cx tasks in program and design phases have been partially adopted. The commissioning process adopted has definite contribution leading to a better building quality control thus benefits the owner and management operator in long run.

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(For privacy reasons, information of owner, designers and contractors have been deliberately omitted)

### About the Authors

黄镇晖工程师 Ir Leo CF Wong，毕业于英国布来顿理工学院机械工程系。黄先生为英国皇家特许工程师和环境保护师，英国多个专业学会会员；香港工程师学会会员和注册专业工程师。黄先生有十多年管理、设计、承造和调试经验。参与本地项目有地铁、汇丰银行新厦及发电厂；并曾参与国内如北京国际俱乐部、首都时代广场及国贸中心等多个大型楼宇项目。黄先生现时担任职业训练局讲师，专注于楼宇调试和维护领域，在港与多个团体创立了香港楼宇调试中心 (Hong Kong Building Commissioning Centre) 改善楼宇建造质量。黄先生乃美国 Building Commissioning Association 的首位国际会员，多次到美国参与及深造楼宇调试事务研讨工作。近年黄先生对于环保工作十分投入，现正修读英国之可持续和环境管理、香港浸会大学当代中国研究硕士课程，并于 2005 年 6 月成为世界自然基金(香港)会 (WWF-HK) 之永久会员。 ([cfwong@vtc.edu.hk](mailto:cfwong@vtc.edu.hk))

周冠雄博士工程师 Ir Dr. Leonard KH Chow 于 1984 年在英国伦敦大学帝国学院机械工程系考取一级荣誉学士学位。后在 1988 年于香港大学机械工程系考取硕士学位，继后于 2000 年在澳洲西澳洲大学获得工程系博士学位。周冠雄工程师是香港，英国及澳洲认可专业工程师。他亦是香港工程师学会会员，英国机械工程师及屋宇设备工程师学会会员，澳洲工程师学会会员，美国能源工程师学会会员，美国供暖及空调工程师学会会员。在过去 20 年，周工程师在科联顾问工程师有限公司工作了 14 年，曾出任至副合颖人。现在周博士是 1995 年自己创办的工业安全公正行的董事，业务包括能源环保，安全，结构及机械的顾问服务。在学会公职方面，周工程师自 2000 年开始便在香港工程师学会，亚洲智能建筑学会(2003 年担任主席)，美国供暖制冷及空调工程师学会，香港能源工程师学会担任委员会主席等职务。整体上，在社会及学会公职方面周工程师是非常活跃的。 ([leonardchow@ispl.com.hk](mailto:leonardchow@ispl.com.hk))