

International Background and Domestic Activities on Commissioning Process

Nobuo Nakahara

Professor Emeritus, Nagoya University
Nakahara Laboratory, Environmental Syst.-Tech.

Introduction

It was in 1986 that the author introduced HVAC commissioning concept to Japan at a certain committee meeting promoting proper maintenance system of building and building services systems, which later resulted in establishment of Building and Equipment Life Cycle Association, BELCA, of Japan. As the chairman of BEMS (Building and Environmental Management System) committee of SHASE (Society of Heating, Air-conditioning and Sanitary Engineers of Japan), I was so afraid of being late in recognizing the importance of commissioning process in order to promote keeping quality assurance of energy and environmental performance in production stage as well as in O&M stage that I set up commissioning WG to hasten to establish HVAC commissioning guideline as soon as possible. After finishing first draft in 1998, formal commissioning committee was set up and began to review the first draft to finalize for SHASE standard.

During the SHASE commissioning committee activity, I personally experienced the CA for a first initial commissioning process in 2000~2001 asked by Yamatake Co., visited the 9th NCBC (National Conference on Building Commissioning) in May 2001 on a mission, having participated in IEA ECBCS Annex 40 project called “Commissioning of Building HVAC Systems for Improved Energy Performance” as the chairman of Japan shadow committee, chaired organized sessions on commissioning in 2002 SHASE academic meeting and other activities to proliferate recognition on commissioning among designers, owners, control makers and O&Ms through lectures and written documents, and ASHRAE new draft guideline 0P-200x. was issued in summer 2002. On March 3 in 2003, just one month before the present international workshop, a symposium on building HVAC commissioning based on the completed new draft was held to discuss among SHASE members to finalize the draft in early 2004 as a new SHASE Guideline. This time length required to develop the manuscript after the first introduction looks too long but is a necessary step to give birth a new concept into new formalized documents.

1. What is commissioning (process) ?

1.1 Commissioning (Process) and “Seinou Kensho (Katei)”

We can not find the word “commissioning” in English dictionary, so that it is considered as the gerund of “commission” in which we find the meaning “put a warship on duty” likely

as an origin of commissioning concept, as popularly said. In this sense commissioning focuses on the inspection at hand over/acceptance of the building and systems. Building and/or HVAC commissioning in nowadays sense, however, is understood as the process to realize the real owner’s project requirements through building construction stage and continuing to operation and maintenance stage as the life-cycle process in an ideal sense, by defining OPR on performance, reviewing, inspecting, verifying and testing a total functional performance. That is, commissioning just at the acceptance step is too late and remains quite insufficient, if not initiated at the program phase, and continuous commissioning after acceptance is also necessary to optimize system operation and detect faults and diagnose them. Thus, the commissioning should have the view for lifecycle of the building and systems and this kind of commissioning as a system will be well imagined by using the term “commissioning process” and well discriminated from the terms inspection, receiving, acceptance, verification, etc. as the incident of a certain point.

How to translate commissioning into Japanese was a problem to me, because the naming will contribute how correct impression the term gives people to become popular with the real meaning recognized. The “seino kensho”, or performance verification/inspection, was the result. However, in order to get rid of misunderstanding real meaning of it, it is better to call it “seino kenshou katei”, meaning to use commissioning process instead of commissioning. The term has an impression somehow it relates to performance verification/ inspection/testing and also it is a systematical process.

1.2 What is commissioning process

Definition of commissioning process in SHASE Commissioning Guideline is almost the same as discussed in the Annex 40 as follows. In the main text of the guideline the definition sentence is shortened.

Commissioning, Cx

Commissioning is to diagnose and verify building system performance, and to propose ways to improve the performance in compliance with owner’s or occupants’ requests, necessarily accompanied with fully developed documentation. Commissioning is performed in order to keep the system in optimal condition through the life of the building from viewpoints of environment, energy and facility usage. These viewpoints include energy conservation, indoor air quality, urban and global environment and

maintainability and preventive maintenance of building systems.

The commissioning is carried out under the instruction of a qualified commissioning authority, to ensure that building system is designed, installed, functionally tested, and capable of being operated and maintained to perform in conformity with design intent or users requests. Commissioning begins with pre-design phase and can be applied through life of building including all phases, which are pre-design, design, elaboration, construction and operation and occupancy phases.

Commissioning Process, CxP :

Commissioning Process is defined as a process from production stage to operation and maintenance stage for the purpose of accomplishing the commissioning aim. The two stages are divided into five phases: 1) pre-design, 2) design, 3) elaboration 4) construction, and 5) operation and occupancy. The phases are subdivided into eight steps: 1) program, 2) planning, 3) preliminary design, 4) working design, 5) elaboration 6) construction, 7) acceptance, 8) post-acceptance, and 8) ordinary operation steps. At the milestones between these steps, there are contracts between owner and commissioning authority, design professional and contractor, the acceptance of the building system, and submission of the final commissioning report, etc. The range of the commissioning process implemented depends on the wishes of the building owners and can be defined in a contract between the owner and a commissioning authority. The commissioning process is classified into four types: 1) initial commissioning, 2) re-

missioning, 3) retro-commissioning and 4) on-going commissioning (continuous commissioning) according to whether the building system targeted are new or not, whether commissioning is continuously implemented or not, etc. as following definitions.

The figure 1 shows definition of phases with stages and steps, typical topics at phase interface, important procedures in each step and definition of various commissioning process.

1.3 How commissioning differs from similar processes?

There has never been the similar process as initial commissioning process in the past. It must have been the role of architect in the old days and either the construction supervisor, CM (construction manager) or PM (project manager) nowadays may take the similar role but it is different from what commissioning authority takes in its technical importance. Especially CM and PM's roles are stressed on cost and schedule controls, and as far as quality control is concerned, it rather depends on construction relating parties' in-house QC.

The TAB (testing, adjusting and balancing), a point incident in initial commissioning is similar to the acceptance commissioning but quite different from the viewpoint of functional performance testing. In case for existing building and systems, retro-commissioning is a similar process as the ESCO and system diagnosis for energy conservation, however, there is a decisive difference between them in which commissioning is executed by commissioning professionals often called as CA

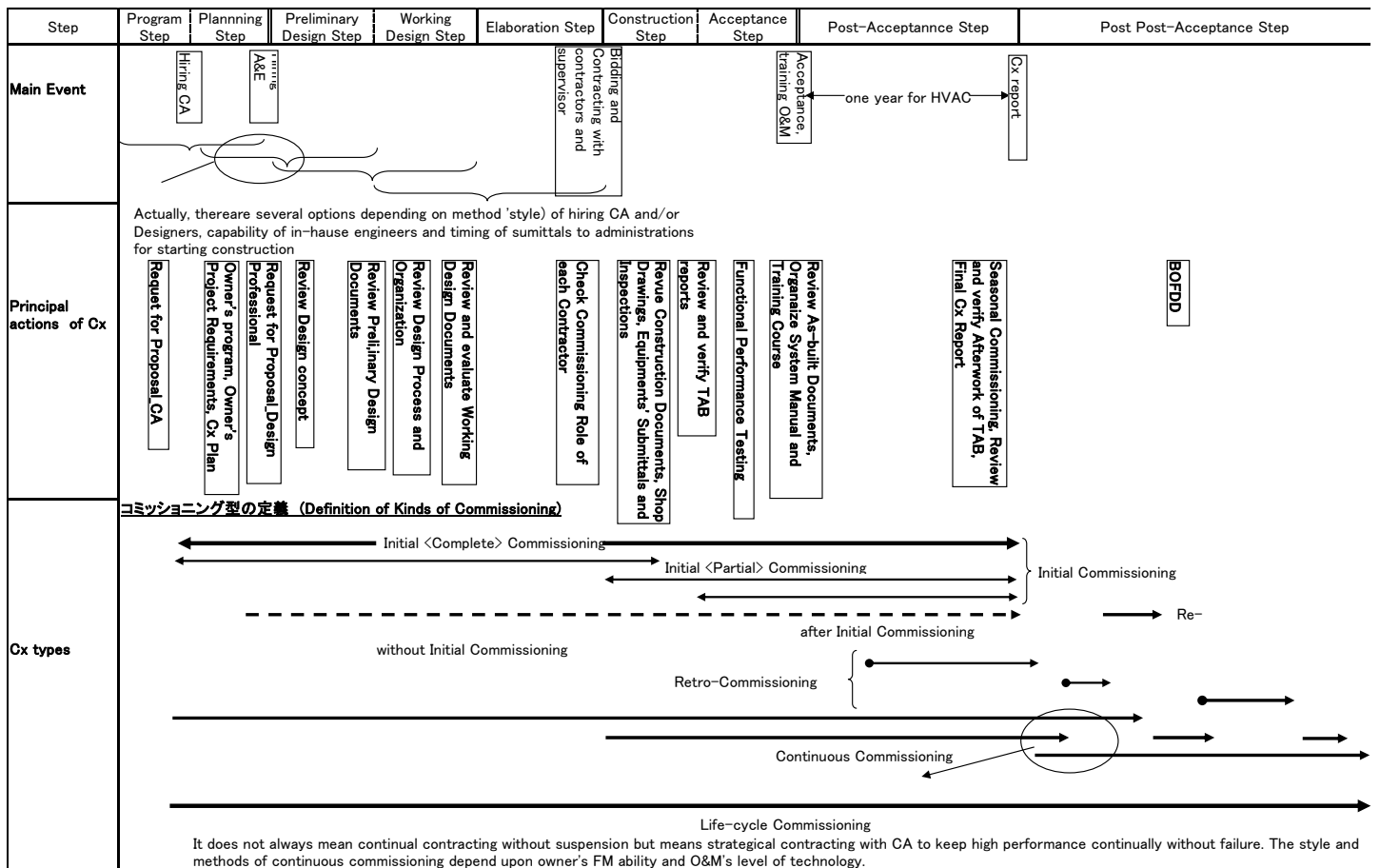


Fig.1 Phase and step definition, typical topics at phase interface, important procedures in each step and various commissioning definitions

(Commissioning authority, commissioning agent) who are directly paid commissioning fee by the owner and therefore the result of diagnosis must be judged in fair manner and with lifecycle view using high-tech tools.

(1) TAB vs. FPT (functional performance test)

It is difficult to define differences between the two. Functional performance testing is the focus of acceptance commissioning, which is the process of determining if the system is completed to be satisfied with owner's project requirements, to meet with final design intent and to show the performance requested. It should be extended another year after completion in order to clarify HVAC. It verifies that the equipment, subsystem and total system work with their harmonization (including the stability and durability) to show the final function of building air-conditioning, and the objective environment written in design documents can be realized within energy consumption predicted. The dynamic performance, partial load performance and seasonal performance for HVAC equipments are very important in this sense.

Thus, the functional performance testing of equipment lays emphasis on the harmonization in the system, and is differentiated with testing, adjusting and balancing on the performance of equipment itself.

(2) ESCO vs. Retro-commissioning (RCx)

Retro-Commissioning means the first time commissioning being implemented in existing building in which a documented commissioning was not implemented before. In many cases, design documents of the existing building have been lost or unmatched with the current situation. Therefore, the retro-commissioning process would include verification matters on the design as shown in parts of initial commissioning. Basic difference from ESCO originates in the form of payment for expenses. As described before, RCx expense is paid as professional fee irrelevant to actual pay back expected, while, as well known, ESCO pursues maximum profit and pays expenses by actual, but estimated on a baseline energy model, fruits due to energy saving. Also, the environmental quality is put aside in case of ESCO, if not worsen it, while RCx targets improvement of environmental quality as well, which certainly effects the difference of results.

Most people may believe that ESCO is better than RCx, because the owner will never lose money as ESCO pay money for retrofitting and owner enjoy energy cost reduction, however RCx should pay money regardless of degree of energy cost reduction. It should not be forgotten that there is a pit fall here that ESCO necessarily targets realizing maximum performance/cost items in a short range, that critical items that may largely effect the environmental performance as well as energy performance only could be judged in a long range and that there are risks in estimating energy cost reduction due

to lack of data and precise but complicated tools which are available in a limited time and cost for bidding. This often results in familiar items such as changing lamps, adding pump inverters and exchanging low-efficient machines with high efficient ones. However, diagnosing technology becomes substantially similar, if the cost for diagnosing could be neglected.

(3) Diagnosis for energy saving vs. RCx

Diagnosing procedure for energy saving may exist just between ESCO and RCx, because actual diagnosis for energy saving for a certain building and systems are either one day free diagnosis service by Energy Conservation Center of Japan or detailed but currently free diagnosis by potential contractors of the retrofit works following later. Putting the former style aside due to its preliminary character, the latter procedure will be taken when the system is clearly degraded and needs renewal and ask potential contractors to diagnose the system performance with a bargain that the company will be asked to do retrofit works. In this case tools applied depend on the scale of retrofit and diagnose may be more detailed than RCx business based on commissioning fee, when the research fund is to be invested from the owner.

2. How Commissioning Developed?

2.1 Japan and world

The table 1 compares rough history of development of commissioning process system in Japan and in the world. It is said that discussions on HVAC commissioning had come on the table during 1970s in UK and USA but actual activities to establish commissioning guidelines began after mid 1980s. In UK, the guideline having been prepared by CIBSE/BSRIA (CIBSE: Chartered Institute of Building Services Engineers, BSRIA: The Building Services Research and Information Association) are rather close to TAB technical guidelines but the first issue was "Division of Responsibilities" in 1988. ASHRAE issued the first guideline in 1989 as "The HVAC

Table1 Development of Commissioning Process , World and Japan

World	Japan Com-
<ul style="list-style-type: none"> • 197? Cx Activ. Began in USA • 197? CIBSE Code on Cx(TAB) • 198? HK Cx Activ. began • 1989 First AHRAE Cx Guide • 1991 Annex25, BOFD • 1995 Annex34, BOFD Demo • 1996 ASHRAE New Guide on Cx Process • 2000 Annex40, Commissioning • 2002 AHHRAE/NIBS Cx Process 200X-0 (Public review draft) • 2002-3 HK Cx Center Established • 2003~2004 Asia INCBC? (proposed by Hong Kong) 	<ul style="list-style-type: none"> • 1991 Annex25 • 1995 Annex34 • 1997 Cx Activ. began, BEMS Committee, SHASE • 1998 First Cx Guide Draft • 1999 Cx Committee, SHASE • 2000 Annex40 • 2002.9 Organized Sessions on Cx, SHASE Academic Meeting • 2003.4 Annex40 Kyoto Mtg. with International Symp. (planned) • 2003,4 Cx Process Guide • 2003~2004 Asia INCBC? (proposed by Hong Kong)

missioning Process”. In Asia, Hong Kong experience in an early stage due to under the British reign.

2.2 Flow into commissioning

We can see several upstream which flow into commissioning process.

(1) TAB flow

In the US where HVAC engineering has acquired a certain level of civil right and the society is strictly based on contracts discussions on TAB was hard since 1970s. At ASHRAE meeting in 1979 a symposium on “dos and don’ts in TAB” was held from which I would like to excerpt some sentences as follows.

Don't expect a perfectly operating turn key building at acceptance, but Do get involved early in the project. The earlier, the better for you. For this paper, we will assume you were involved in the design concept stage. Should you not be that fortune, you will need to play “catch up” as you identify and attempt to correct potential problems.¹⁾

Do advise the Engineer that you need design and equipment selection data, operating limits, system and operating curves, equipment submittal data, recommended maintenance and manuals. Assure that contract documents identify these requirements.¹⁾

Don't neglect complete and thorough TAB planning with the assumption that it will somehow get worked out in the field. It won't! TAB requires lots of effort which costs some amount of money. Although the amount of money involved is small compared to the total system cost, and although this cost requires a good investment for the owner, if arrangements are not made to do testing and balancing work via good specifications, no one is about to assume this responsibility out of the goodness of his heart.²⁾

(2) Commissioning flow, from dawn to popularized

ASHRAE symposium on Commissioning was held in 1986 from which I would like to excerpt the following.

Commissioning goes beyond testing and balancing. While it may spot checks of balancing reports, or even extensive airflow measurements on a job where balancing has been particularly troublesome, commissioning is aimed at assessing system performance from functional standpoint.³⁾

Like anything else, mechanical systems are not exempt from occasional design errors. Those errors might not be discovered, or

their impact might not be realized, until the system is put in service. The commissioning process involves identifying any aspects of a system design that may be responsible for unsatisfactory performance.³⁾

The independent consultants would act as a liaison between all participants – owner, AE, contractor, manufacturer's representative, and O&M personnel – as the construction phase comes to a close, and be responsible for inspections and testing of fully integrated building systems prior to final owner acceptance of systems installed.⁴⁾

ASHRAE Guideline for commissioning process was issued in 1989 just after these discussions at the dawn, and then revised in 1996 supposedly involving feedbacks for and/or against the previous version. There have lots of movements after the issue of these guidelines as follows, one of which was the “Rebuild America”⁵⁾ project in mid 1990s and studied estimated contribution for energy saving through applying commissioning process to existing buildings as well as new buildings. Based on that policy GSA (General Services Administration) promoted to apply commissioning to Federal buildings and asked researches and developments of commissioning tools to universities and national laboratories. Some states such as Texas promoted its own project for energy saving called as Texas LoneStar program, and Texas A&M university has been actively involved in it.

PECI (Portland Energy Conservation Inc.) has managed NCBC (National Conference on Building Commissioning) since 1993 and gathering several hundreds people now. It also prepared Model Commissioning Plan and Guide Specifications with DOE in a public domain in order to propagate commissioning business in a standard manner. Researches in LBNL (Lawrence Barkley National Laboratory) is also remarkable in developing commissioning tools and their demonstration for actual building commissioning process. Another remarkable movement is to facilitate the training course for CA (Commissioning Authority) as are worked in Wisconsin University and Iowa Energy Center.

In Japan we are at the dawn stage now but efforts to establish commissioning guideline has been accelerated and catching up with these developed countries such as UK and US from the viewpoint of building commissioning.

(3) BOFD flow

As shown in Table1, commissioning activities concerning HVAC began at IEA/ECBCS/Annex25 in 1991, whose subject was not exactly the commissioning but BOFD (Building Optimization and Fault Diagnosis). Japan has participated in Annex activities since 1988 for Annex16 (Users guidance for

BEMS) and Annex 17(BEMS emulation and dynamic simulation) which comes connecting to HVAC commissioning later. The subject of Annex 25, BOFD, was quite timely to me who had experienced design and construction jobs and has thought that design faults should be eliminated at first, then operation faults may be minimized. At the same time I introduced a life-cycle BOFD that may be synonymous with life-cycle commissioning. In this Annex25 Japan team, for which the author took a role of leader, contributed a lot with many research reports^(6,7) and directivity towards BEMS and BOFD

became popular in Japan, when broken bubbles of Japanese economy largely resulted in loss of energy for BOFD demonstration research project in Annex34 except for a few companies who participated in the Annex.. The present Annex40 started in April 2000 after two workshops to decide the goal of the study. I thought desperate situations in construction industry, if any, such that social unfairness, irresponsibility, loss of professional mind of engineers and the-cheaper-the-worth attitude forgetting about maximization of performance/cost

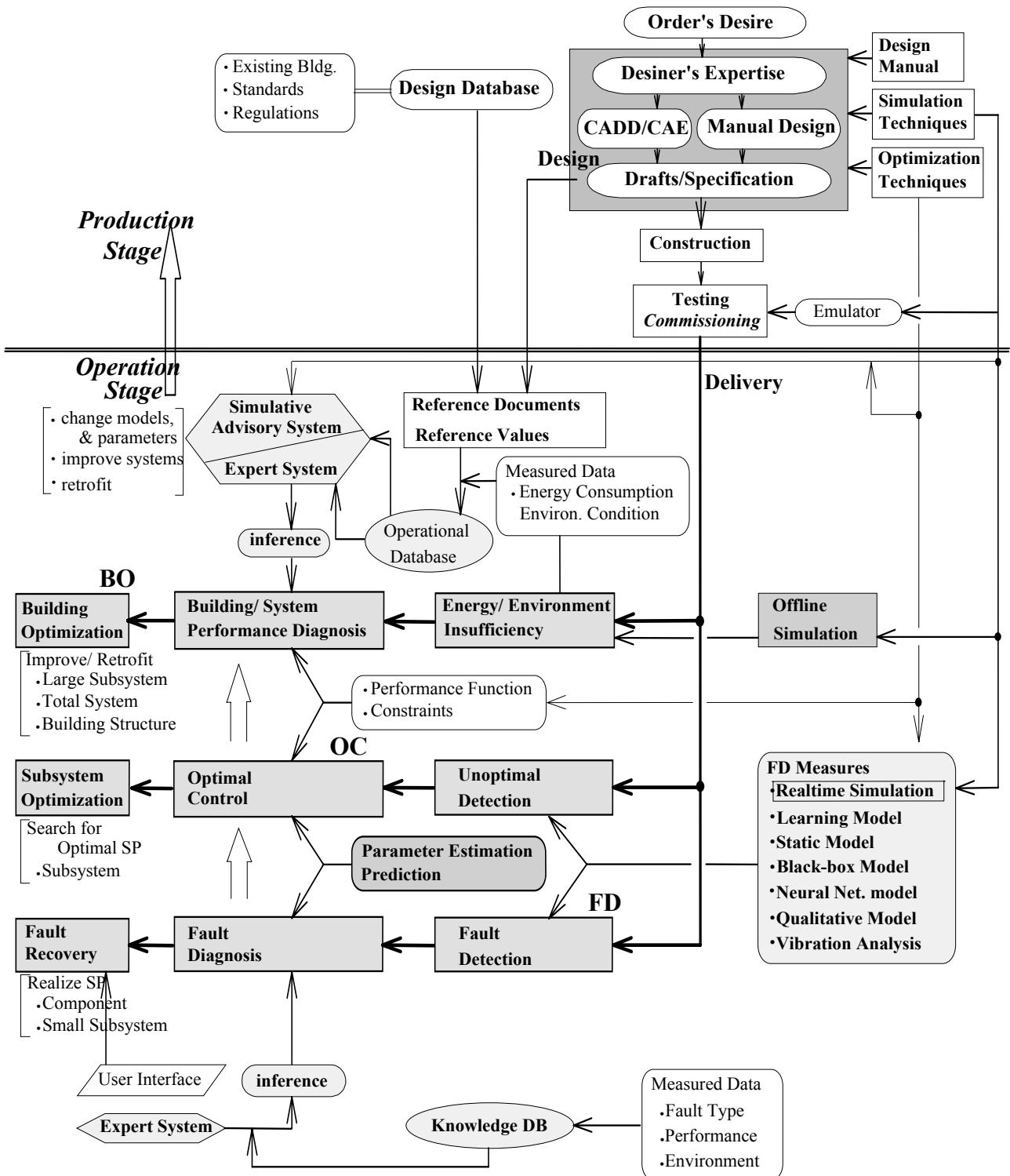


Fig.2 Total structure of BOFDD and life-cycle commissioning

at the limited investment could have an trigger for improvement with commissioning process. As many as twenty-two companies agreed with my calling to join the present Annex, which gave me a profound expectation for realizing better society.

It is remarkable that, in this BOFD/commissioning flow, such institutions as KTH (Sweden), VTT (Finland), Oxford U. (UK), Liege U. (Belgium), CSTB (France), Stuttgart U. (Germany), NIST (USA), Johnson Controls and some others continually joined several Annexes from the early stage of Annex 10 to Annex 40 and that researchers are come from many field of science and engineering, which was quite different from Japanese way. I am happy to see, however, that participants to Annex40 domestic team look belonging to wide range of professional background, because I believe the subject has a considerable width and depth in its characteristics.

3. What change are expected due to Commissioning?

Expectance for improvement through commissioning is, in other words, what are not sufficed in the present manner.

3.1 Meaning to owner

Owner's intent on the project and performance requirements become clear and he obtains exactly what he wants matching with his request for quality. Sufficient amount of documentation contributes facility management and efficient and economical management of the building and optimal operation of systems. It also gives occupants comfortable environments and then the building will be evaluated as high grade to earn higher rents. It also gives the building owner satisfaction due to conviction of contributing for energy conservation and global environment

3.2 Meaning to design professional

As owner's project requirements are given as the OPR document, the role and responsibility requested to design professionals become clear which result in better design quality. Then he will be highly evaluated for his good design and can insist fair amount of design fee matching the contents of his works. Design faults will be minimized with fame maximized. He has also the chance to extend his business to commissioning authority (CA) by himself. Actually he stands at the nearest point from the way to CA.

3.3 Meaning to contractor

The scope and contents of TAB works, which are even contracted by dedicated TAB contractors in US, become clear and could be more correctly estimate than before. It reduces trou-

bles during construction and after completion and, in addition, responsibility becomes clear. Especially, many vague relationships with design professionals such as tasks for design development and design change by contractors become clear in relation to requested performance and cost fairness. He has also the chance to extend his business to commissioning authority (CA) by himself.

3.4 Meaning to O&M

It is officially recommended for O&M personnel to participate in construction process as early as possible, so that maintainability and controllability could be checked. This condition will give a chance to evaluate O&M's status higher and well characterized engineers will be called for with better working conditions. Training and education on system maintenance at the acceptance step and sufficient amount of system manual with full of maintenance, operation and control documentation will open his eye for better understanding on controls and maintenance. The system that he accept for operation is well TABed and claims from occupants decrease. He can also receive consulting chance on BOFDD based on the personal and occupational acquaintance with CA.

4. Outline of SHASE Commissioning Guideline

4.1 Intent of proposal

In the beginning intent of proposal is described as follows.

The reasons to propose commissioning, especially in the meaning of life-cycle commissioning, are listed as follows.

- 1. Well maintenance of building stocks are socially called for and people come to recognize the importance of thorough quality controls through construction and maintenance process for better environmental quality and energy conservation.*
- 2. The problems on energy and environmental conservation, especially global environmental matters, have come to critical status that life cycle management of energy and CO2 generation are requested to reduce to minimum.*
- 3. As keywords such as environment, energy and quality control become popular due to spread of ISO-9000 and -12000 series to many construction companies, performance maintenance concept has now become daily matters, as far as the terminology is concerned.*
- 4. Energy consumption in the home and building sector is still increasing at a steady rate, so that introduction of energy saving design, precise verification of its effectiveness, operational optimization after acceptance, and life cycle commissioning are considered as the solution to reduce realize energy saving.*
- 5. International as well as domestic trends for deregulation directs to performance contracts request commissioning process*

as a necessary social system.

6. Facts that faults in operation and controls of building HVAC systems are clearly causing more energy consumption, better environment and weakening of managing constitution of enterprises have been disclosed, which may be one of the principal reasons of economical stagnation.
7. Establishing building and HVAC commissioning process is an international trend not only in the western countries but also in Asian countries, so that it is necessary to have international agreeable recognition with options due to local cultural differences. Especially Japanese traditional process is to be well evaluated if it is substantially well enough based on humanity.
8. A new professional called as Commissioning Authority is to be recognized and established who are directly hired by the owner and independent from design professional and contractors when he works on a certain project. It will also contribute to clearly define the status of HVAC design professional engineer of Japan.
9. The prevalent custom of unreasonable cost-reducing and competition beyond allowable limit of social fairness that naturally results in lowered quality control, unfair evaluation of technologies, losing engineers mind of conscience could only be gotten rid of through application of correct commissioning process.
10. Two kinds of urges exist in construction site, they are, one is positive urge for optimization to pursue engineering conscience and the other is a negative urge for degrading to pursue profit. Reasonable commissioning process will assist making use of the first urge and restraining the second urge to pursue maximum performance/cost concept.

4.2 Object and scope

Object and scope sections are cited as follows from the guideline.

1. Object of the guideline

This guideline describes fundamental items common to commissioning process for various building services systems, to diagnose and verify building system performance, and to propose ways to improve the performance in compliance with owner's or occupants' requests, necessarily accompanied with fully developed documentation. Commissioning is performed in order to keep the system in optimal condition through the life of the building from viewpoints of environment, energy and facility usage. These viewpoints include energy conservation, indoor air quality, urban and global environment and maintainability and preventive maintenance of building systems. In order to satisfy these objects, commissioning is required to do through the building life, where the process is called life cycle commissioning.

As the concept of commissioning is not popular, this guideline includes explanations in addition to instructions and attached with Annexes in order to help implementing actual commissioning process, such as formats and model documents, for this guideline to be practically useful.

2. Scope of application

This guideline consists of Fundamental Guideline commonly to be applied to various building services systems and Implementing Guideline for each building services system. The Implementing Guidelines are to be issued sequentially starting from HVAC Implementing Guideline. The present document describes the Fundamental Guideline.

In the Fundamental Guideline describes basic guideline on the concept and application kind of commissioning and commissioning process, sequence of commissioning process beginning at program phase and arriving at ordinary operation phase, contents of commissioning items in each phase and step and work sharing and responsibility of commissioning relating parties.

Commissioning process is considered to be executed through life cycle as an ideal, which is called life cycle commissioning and on which this guideline basically stand, but actual scope of application is due to contracts between the owner and commissioning authority. It is considered that a commissioning process might begin at construction phase in which case particular procedure shall be taken different from the case where commissioning begins at program phase. This guideline has considered applicable in that case.

Principal player of the commissioning process is the Commissioning Authority who works as a new kind of professional and who shall be defined and licensed with a certain criteria. Engineering licensing of the Commissioning Authority shall be properly defined among various architectural and engineering licensing system in Japan which are now under rearrangement. Details of actual operation among the existing license system will be discussed in the following section.

Details of tools to be used by commissioning authority and commissioning managing team members are not included in this guideline. References are listed for readers' convenience.

4.3 Composition (table of contents)

Fundamental Guideline of Commissioning Process for Building Services Systems (draft)

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1. Object of this Guideline
2. Scope of Application
3. Definition of Terminology

4. *Implementing life cycle commissioning*
 - 4.1 *Application of Commissioning Process*
 - 4.2 *Application of Partial Commissioning Process*
5. *Implementing System and Task Sharing*
 - 5.1 *Commissioning Agent, Commissioning Authority*
 - 5.2 *Implementing System*
 - 5.3 *Commissioning Authority and Task Sharing*
 - 5.4 *Management of Commissioning Conference*
 - 5.5 *Commissioning Plan*
6. *Essential Items of Commissioning at Program and Design Phases*
7. *Essential Items of Commissioning at Construction phase*
 - 7.1 *Construction Commissioning Process*
 - 7.2 *Acceptance Commissioning Process*
8. *Post-acceptance Commissioning Process*
9. *Essential Items of Commissioning in Re- and Retro Commissioning*
 - 9.1 *Re-commissioning Process (Operation Phase Commissioning)*
 - 9.2 *Retro-commissioning Process (Performance Diagnosis of Existing Systems)*
10. *references*

Appendices

Appendix-1 Commissioning Process, overview

Appendix-2 Definition and Explanation of Terminology relating Commissioning Process

Appendix -3 Standard Task Sharing and Responsibility of Commissioning Relating Parties

Appendix-4 Guideline Description of Request for Proposal to Commissioning Authority

Appendix -5 Guideline Description of Commissioning Plan

Appendix-6 Commissioning Organization

Implementing Guideline for HVAC Commissioning Process (draft)

Preface

1 Implementing Guideline for Commissioning Process at Program Phase

1.1 Program Step

1.2 Planning Step

2 Implementing Guideline for Commissioning Process at Design Phase

2.1 Preliminary Design Step

2.2 Working Design Step

3 Implementing Guideline for Commissioning Process at Elaboration Phase

3.1 Elaboration Phase

3.2 Preparation Procedures for Construction Commissioning

4 Implementing Guideline for Commissioning Process at Con-

struction Phase

4.1 Construction Commissioning

4.2 Acceptance Commissioning

5 Implementing Guideline for Commissioning Process at Operation Phase

5.1 Post-acceptance Commissioning

5.2 Post Post-acceptance (Ordinary operation) Commissioning

Annex documents

1. Definition and Explanation of Terminology relating Commissioning Process

2. Commissioning Phases and Steps

3. Detailed Flowchart of Initial Commissioning Process

4. Standard Task Sharing and Responsibility of Commissioning Relating Parties

5. Items of Owner's Program

6. Model Example Document of Owner's Program

7. Documentation Matrix of Commissioning Process

8. Guideline Description of Request for Proposal to Commissioning Authority

9. Detailed Guideline Description of Request for Proposal to Commissioning Authority

10. Guideline Description of Request for Proposal to Design Professional

11. Guideline Description of Commissioning Plan

12. Detailed Guideline Description of Commissioning Plan

13. Model Example Document of Commissioning Plan (Planning Step)

14. Guideline Description of Owner's Project Requirements

15. Model Example Document of Owner's Project Requirements

16. Issue Log Sheet Form

17. Sheet Form of Commissioning Process Progress Report (Simplified version)

18. Issue Log Sheet List

19. Issue Log and Discussion Table with Example Description

20. Checking Items of Maintainability

21. Guideline Description of Basis of Design

22. Guideline Description of Design Intent Document

23. Guideline Description of Operation and Control Manual

24. Model Example Document of Operation and Control Manual

25. Information Flow Diagram in Construction Commissioning

26. Maintainability Check List

27. Guideline Description of TAB Plan

28. Guideline Description of TAB report

29. List of As-Built Record

30. Example Document of Training and Education Plan for O&M

31. *Model Example Document of Commissioning Plan (Post-acceptance Step)*
32. *Model Example Document of Commissioning Report (Post-acceptance Step)*
33. *Discussion on Estimating Method of Commissioning Fee*
34. *Actual Example of Commissioning Fee*

5. Discussions and Future Overview

Lastly the author would like to discuss how commissioning process could be promoted together with obstruction which caused the process necessary.

(1) Observe actual phenomena during operation

It is regrettable that designers and owners do not well observe the actual operation, energy consumption and environmental satisfaction in order to feedback for their building management and any following design as well as fault diagnosis. Designers are thus losing the best chance to heighten their skill, and owners cannot recognize how much energy their buildings consume energy and money in vain by only looking at reduction of initial cost and maintenance cost to be ordered outside. Commissioning let them remind the importance of observing actual phenomena during operation.

(2) Designers' attitude pursuing essentiality

It seems quite often that A&E lack reality on world view and optimality of their design, so that energy and environmental performance of their design are poor enough. They have to pursue to perform the best quality design, which means maximizing performance/cost. Therefore, defining performance is the most important thing and commissioning process can clarify it by picking up essential owner's project requirements at the planning step of program phase. to establish performance function and constraints for design and by managing design process commissioning.

(3) Social fairness based on humanism

Simply speaking, nothing good can be obtained with unreasonable price. Unfairness necessarily return back onto his head in a worth figure. We must believe that sincerity is paid by sincerity and fairness is rewarded by fairness some day after. When vicious circle dominates there will be nothing believable. Commissioning process relies on this philosophy and it shall serve as turning key of the circle.

(4) Correcting inflexibility in education and administration

In Japan there is a strong stiffness of social system, especially in the administrative system and educational system in which little change can take place even if deregulation is loudly

spoken and old leather bags are dropping wine on the ground. This must be because of the national character and vertically divided administration system brought up since Meiji revolution, which must be broken through by consistent humanism and environmental education as well as by acquiring real international sense. Commissioning of HVAC system may have a role of correcting the educational and administrative system, if it may be small enough, with its interdisciplinary character of HVAC engineering and life cycle viewpoint through all phases of building production and operation.

In the same kind of sense, SHASE stands at the nearest way for taking this role and for promoting propagation of commissioning process. Also international as well as domestic networks through Annex40 tasks may well contribute to this object.

(5) Maintenance engineer's standpoint

In spite of the fact that environmental quality and energy performance largely depend on Maintenance engineers owners as well as operators have incredibly low recognition of the fact. It is necessary to change our mind who always thinks upstream is more valuable than downstream, by which status of maintenance engineer shall be graded up. The quality of building services system is surely dominated by produced system for which initial commissioning process is concerned, but revealing of actual performance is largely dependent of maintenance engineer's skill and provided tools for BOFDD. Actual practice of retro-commissioning and continuous commissioning in the US clearly shows the importance of BEMS assisted commissioning at the maintenance stage.

(6) Reflect commissioning to assessment of real-estate

Commissioning will lead to a normal society where a good building with well-facilitated, well-maintained, better IAQ and sustainability is evaluated better and earn more money as a better real-estate. This should be followed by accurate evaluation on the quality of building services systems, especially of HVAC and energy utilization systems. Facility management and re-commissioning will continually maintain the quality of the real-estate. Then, the cost to earn much more money from energy cost saving and rent through lifecycle shall be properly appreciated and "cost too much" myth why should I pay 'extra' for commissioning⁵⁾ will quickly disappear. The BEMS and BOFD are powerful tools for better maintenance and continuous commissioning is a powerful system for retaining highest value of the facility.

(7) Training CA and licensing policy

Required quality for Commissioning Authority is ideally the

ability of highly and practically trained technical knowledge as well as a superior management capability on the total commissioning process. Such talented persons are not always acquired easily, so that, depending on the scale of a project, an individual can not do a whole roles of commissioning but works as a team in which sub-chief commissioning authority with high technical expertise would relay his or her role from phase to phase. Therefore, the least condition for authorized commissioning authority is to have general level of wide knowledge and deep expert knowledge on design, construction, TAB, O&M, CM, construction supervisor or quality control together with highly management capability. The licensing system of CA should consider these points of view and it will seemingly comprise some degree of hierarchy such as first class, second class and so on.

The most important thing is that we should never create another closed and right-and interest-retaining new qualification and that education system to bring up this kind of professional engineer in education facilities including university graduate course, and continuous professional training system of CA should be established.

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