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THE APPLICATION OF PROJECT MANAGEMENT IN OPERATIONS PREPARATION OF NUCLEAR POWER STATION

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摘　要

生产准备在核电站设计、建造、调试、运行等过程中十分重要，但很容易被忽视。该文研究了如何采用项目管理的方法，系统、有效地实施生产准备工作。首先简要介绍项目管理的基本概念，发展历史和特点，然后分析核电站生产准备工作采用项目管理方法的可行性和必要性，最后详细探讨了岭澳核电站采用项目管理方法实施生产准备工作的研究与实践。理论研究和实际经验表明，项目管理方法是核电站等能源企业生产准备管理的有效工具。

The Application of Project Management in Operations Preparation of Nuclear Power Station

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ABSTRACT

Concept, history, characteristics of the project management is introduced. Analysis is performed on the suitability of application of project management approach in nuclear power station operations preparation. Then the application of project management is detailed in order to present the readers our study and practice. Theory and practice indicate that the project management is a useful management tool for operations preparation of nuclear power station to achieve a good performance.

1 CHARACTERISTICS AND MAIN APPLICATION OF PROJECT MANAGEMENT

Project management includes the application of simple, but not always obvious, rules of common sense to uncommon and complex situations, with deadlines and tight budgets.

In order to understand more clearly what project management means, a definition by Cleland and King [1] is very often cited as follows: project management is the application of the systems approach to the management of technologically complex tasks or projects whose objectives are explicitly stated in terms of the time, cost and performance parameters.

The project management approach is characterized by four principal components as defined goal, designated resources, specific organization and prescribed methodology. And it usually concerns the terms as objectives, goals, resources, planning, costs, monitoring, performance, systems, organization, schedule and controlling, etc.

The project management approach of bringing a group of people together on a temporary basis to achieve specific goals has been used for centuries, even millennia. During the classical periods of Chinese, Egyptian, Greek and Roman history, very impressive results were achieved and many of the fundamentals of this approach were employed. Of course, it was not called project management at that time. Only since the second half of the twentieth century have many of the tools of modern project management come into use. The sophisticated methods of planning, scheduling, budgeting, forecasting and reporting have been developed only recently. The use of project management has been increasing rapidly with the advent of relevant computer software.

Diverse areas using project management in recent years, most of which were suggested by Brunies (1989) [2], include aerospace, defense industries, engineering and construction, manufacturing, electrical generation and distribution, process plants, crude oil and natural gas exploration, developing and production, etc. The application also includes infrastructure for the various levels of government, research and development, data/information processing, health care and biomedicine, computer hardware and software, educational institutions, and of course management undertakings.

2 BRIEF INTRODUCTION OF LING AO NUCLEAR POWER STATION

Situated to the east of Shenzhen and one kilometer away from the operating Guangdong Daya Bay Nuclear Power Station (GNPS), Ling Ao Nuclear Power Station (LNPS) comprises four PWRs of the 1000 MWe class under the established project program. Two of which are under construction in the first phase development involving an investment of four billion US Dollars. The Ling Ao project preparations got off the ground in mid 1994. With the main structural works being commenced on May 15, 1997, the two units are scheduled to be put into commercial service respectively due July 15, 2002 and March 15, 2003. At present time，the work load emphases have been transferred from civil engineering and installation to commissioning and taking over to operations.

Another important background to Ling Ao is the Daya Bay Nuclear Power Station, which not only is the technical reference, but also provides technical personnel, training services, maintenance and experience, etc. Generally speaking, the operation management of both stations is under the same policies and same administration except that they have independent financial systems.

3 THE APPLICATION OF PROJECT MANAGEMENT IN LING AO OPERATIONS PREPARATION

3. 1 Definitions of the work scope of the operations preparation and the suitability of project management application

Operations preparation, *travaux de pré-exploitation* in French, briefly refers to all the preparation work for the commercial operation, which is performed by operations personnel[3]. It normally concerns the establishment of operations organization, recruitment and training, establishment of administrative and technical procedures, obtaining permit and authorization from government, equipment and systems taking over, etc. Also operations preparation concerns all the relevant work which should be done before the commercial operation while not included in the work scope of the Project Department which undertake the designing and procurement, civil engineering, construction, commissioning, etc. In some nuclear power stations, for example, Civaux, even the unit commissioning is included in operations preparation. From the work demarcation point of view, the operations preparation involves nearly all the functions of an operations team including

operations, maintenance, nuclear surveillance, industrial safety & health physics, planning and reporting, quality assurance, budget and cost control, etc.

The operations preparation of Daya Bay Nuclear Power Station was carried out mainly under EDF responsibilities. As the first cooperation in this domain, due to lack of experience of GNPS and insufficient anticipation of EDF to conditions and situations of Daya Bay, the operations preparation of GNPS was not fully satisfactory. As it was said, if it had not been for the 14-month delay of the construction, the insufficient preparedness would have had difficulty to meet the demand of the units' operations commencement.

Experiences and lessons drawn from GNPS and other NPPs investigated direct us to seek solutions from project management for Ling Ao operations preparation.

After conscious studying, it was found that all the characteristics of operations preparation accord with the ideal situations for project management in which the following conditions are presented.

(1) A high-priority undertaking;

(2) Requirement for a multidisciplinary effort;

(3) A non-repetitive situation;

(4) A limitation on some of the required resources.

With this cognition, since the first day the project management approach has been employing in Ling Ao operations preparation. Officially started in mid August 1996, 5 members were selected from GNPS to form a prophase project management team for implementing the operations preparation project.

3. 2 Establishment of a systematic planning and indicators management

Symbolized by its powerful planning and scheduling, the project management primarily requires the personnel to draw out a comparatively integrated planning system[5]. An engineer of the prophase team was appointed to pilot making out the plan. After researching the experience feedback from Daya Bay, Diablo and Civaux Project, and in accordance with its own characteristics, the whole duration of Ling Ao operations preparation was defined in three subsequent stages as:

(1) The Conceptual Stage;

(2) The Independent Implementation Stage;

(3) The Taking-over Stage.

The Conceptual Stage, or the Prophase Strategy Making Stage called by the station, refers to the period from mid August 1996 to June 1, 1998. During this period, the general policy of operations preparation is conceived[6]. Based on the

experience feedback drawn from other projects, a work scope was identified, a potential solution was developed, and very rough economic data were examined to justify pursuing the project. Not only the prophase team was with the management hierarchy of GNPS, but also the GNPS functional branches undertook all the relative operations preparation work of this period, as GNPS is considered the cradle of Ling Ao operations team.

During this stage, systematic documents were produced as:

(1) The Operations Preparation Guideline, which is a top document managed by the General Management of the company. It defines the main work scope, the demarcation and responsibilities of concerned company departments, the main solutions or policies, the rough budget and cost, the future relationship with GNPS as well as the milestones of the whole cycle of about six years, etc.

(2) The General Implementation Plan and Schedule of Operations Preparation[7], a station management level plan for implementing work in all aspects, such as organization establishment, recruitment and training, procedures writing, governmental permit and authorization, taking-over from installation, maintenance after TOM (taking-over for maintenance), technical support, logistic support and administration, etc.

(3) The Operations Preparation Performance Indicators System, which defines the index and indicators covering all the facets of operations preparation, for measuring the achievements realized in every aspect and for every stage.

(4) The Branch Level Execution Schedule[8], which was detailedly made out and strictly implemented by all the functional branches in the Operations Department. It also covers the whole cycle from September 1996 to March 2003.

(5) The Annual Management Plan, which was annually made out in detail by all the branches and followed up by the Planning Branch.

(6) The Personnel Training Guideline, highlighting policies, solutions, plans and schedules, approaching the training and authorization target for Ling Ao.

(7) The Technical Procedure Writing Guideline, which defines policies, solutions, plans and schedules as well as software development, for the establishment of technical procedures.

(8) The Management Procedure Writing Guideline, which defines the writing of the Plant Quality Organization Manuals (PQOM) and other administrative procedures.

(9) The General Budget for Ling Ao Operations Preparation, detailing the

allocations of costs for each and every potential work.

All the above mentioned materials were successively drawn out, forming a systematic and instructional documents that manage the following years of operations preparation project.

The Independent Implementation Stage began with the foundation of Ling Ao Operations Department on June 1, 1998. During this period the Operations Department undertakes all-side preparation task.

The Taking-over Stage is scheduled to come on April 30, 2001 with the beginning of the Cold Test, from then on the taking-over workload of both units will be multiplied to a peak, the major force of the Operations Department will be located in system acceptance and commissioning.

3. 3 The process control in the project implementation

A complete plan is just only a good start for a project. Whether or not the plans are practically feasible and strictly respected, it still needs to be proved through substantial practice.

By forecasting future performance and by use of trending techniques, potential variances are identified. Actual and potential performance variances are analyzed. Corrective action plans are implemented to bring performances back to the planed status.

In order to effectively manage the project plan, responsible persons or pilots were appointed respectively to the specific fields, and the Operations Planning Branch is in charge of the overall following-up. Also two important periodic meetings were organized. One is the Operations Preparation Committee, which is convened bimonthly for high level decision making, high priority work coordination as well as deviation analysis and correction. The other meeting is the bimonthly Coordination Meeting between Project Department and Operations Department, dealing with the important issues concerning the design, construction, commissioning, taking-over, etc. All the measures for planning and scheduling management were documented into a procedure named the Operations Preparation Planning and Reporting Management.

At the end of every month two Top Ten Work Sheets are issued to all the concerned Branches, one for the past month work summary, the other for the planning of the next month. At the end of every quarter, a summary report is raised on the implementing progress of the General Implementation Plan and Schedule of Operations Preparation. Also at every milestone, a summary report is raised on the

comparison between the preset indicators/ requirements and the practical implementation.

No plan is so ideal as to avoid any variances between the original plan and the implementation. Due to the ineluctability of variances existing through the whole project process, the more important work we need is the variance analysis and schedule adjustment. A Schedule Adjustment Application and Validation Sheet was designed to handle the adjustment, in which variances analysis and corrective actions are explicated and different approvals are required to different work schedule adjustment, so as to make all the scheduled work controllable.

3. 4 Establishment of the operations department organization

The human resources of Ling Ao Operations Department mainly come from three quarters: the cadres promoted from GNPS relevant functional positions, the technical positions recruited mainly from universities or colleges and trained in GNPS relevant functional positions, and a few experienced technicians or engineers from the public human resources market.

There's a saying in China, the more guys, the easier to fulfill the work; while the fewer guys, the easier to distribute the breads. The organization chart design and staff recruitment plan is considered one of the most crucial issues to be faced within the project duration.

Taking the GNPS organization as a reference and based on the Resources-Sharing-Optimization of the Multi-reactor Management Principle, an organization chart for LNPS was made out in which there are six functional branches and two temporary offices. The six branches are LPO (the Operations Branches), LPE (the Equipment Management Branch), LSL (the Nuclear Safety and Licensing Branch), LPH (the Health Physics Branch), LPP (the Planning Branch), LPA (the Logistic Support and Administration Branch), and the two temporary offices are the Procedure Writing Coordination Office and the Construction-Operations Liaison Office. The maintenance, technical support, environment protection and emergency preparedness, personnel training as well as documentation, etc, are undertaken by the GNPS with appropriate number of human resources supplement.

3. 5 Training and authorization

Training and authorization is the critical path for operations preparation project. According to the Regulation HAF0301 [4], duration of around six years training is imperative for a college or university graduates to be a licensed reactor operators. GNPS is strategically taken for the base of operators training and other technical

positions training.

As mentioned above, a Personnel Training Guideline was drawn out, and a Five Year Individual Training Plan was also developed, as well as STA (Systematic Training Approach) with KSA (Knowledge-Skill-Attitude) Analysis for every position, etc. A training Committee was organized to steer the training work.

College and university graduates were recruited according to the personnel plan every year. Almost all of them were sent to GNPS relevant positions for site training and practice. As a whole, 78 university graduates were arranged for reactor operators and senior operator training, while 86 technical school graduates for site operators. Reshuffled with the GNPS experienced operators, from June 1998 to April 30, 2001, they are scheduled to be appointed to LNPS Operations Department to participate the procedure writing or system commissioning.

Other technical positions' training goes in the similar route, with the characteristic of Tutor-Apprentice Approach. A tutor is appointed for every recruit ——the apprentice. A training program is made out specifically for the apprentice and strict biweekly report and assessment rules are undertaken in order to make sure the training effect.

3. 6 Procedure writing and licensing document preparation

Procedure writing is an arduous and essential task for nuclear power station, which concerns with PQOM, operations procedures, safety procedures, water treatment procedures, maintenance procedures, industrial safety and radio-protection procedures, etc. The licensing document preparation is mainly undertaken by the Project Department, while a certain part concerning the licenses of the acceptance of the fuels and first loading by the operations team.

In order to fulfill the procedure writing task and undertake the training and operations taking-over work, a well-balanced task force is required. Task analysis was previously made during the Conceptual Stage, then was the task forces. According to the respective characteristics, we adopted two types of project task forces. This first type is a grouped task force for maintenance procedure writing group and operations procedure wring group, where the majority of the members are located together in a geographical sense or in a common area. The second type is a dispersed task force for other procedures, where the members remain in their own departmental area. A temporary office, the Procedure Coordination Office, is in charge of the procedure policy drawing, Procedure Management Database development, planning and scheduling control for procedure writing, upstream

documents tracing, etc.

Under the common management and coordination, the procedure writing is in very good progress. Up to now, more than 40% of the task has been finished. Due December 15th, 2001, the first fueling date, 85% of the maintenance procedures is expected to be finished as well as all the operations procedures and safety procedures.

3. 7 Budget and cost control

In June 1998, a section of three people was set to make the budget and undertake the cost control for the operations preparation project. Before that a person had already been appointed to collect and analyze the budget and expenses for the operations preparation of GNPS. With the experience drawn from GNPS and analysis to the present project, the General Budget for Ling Ao Operations Preparation was made out, and subsequently the detail budget itemization and yearly budget plan. Along with these, as set of budget and cost control procedures were soon made out to define the responsibilities, interface and work process for the concerned work.

3. 8 Taking-over management

For any large size project, the taking-over stage plays an important role in the whole project process. It not only deals with the coordination between Operations Department and Project Department for smooth taking-over, but also acts as a pass for project acceptance. In order to improve the work efficiency, a great deal of measures has been taken in the Operations Department. The Taking-over Liaison Office was set up early in June 1998, and a set of management procedures were established. In January 2000, a web-based Taking-over Management Information System was put into service, in which all the EESR (End of Erection Status Report), TOB (Take-Over for Blocking), TOM (Take-Over for Maintenance), TOTO (Take-Over for Temporary Operation) and BHO (Building Hand-Over) inspections/ acceptances are recorded and traced in detail. So, results are fed back to the Project Department and they try to solve them during the construction and commissioning stage. It's normal that the workload accumulates in the Taking-over Liaison Office due to it's bottleneck characteristic. To lower down this accumulation, a Taking-over Liaison meeting is organized weekly.

3. 9 Quality assurance for the operations preparation project

A hard nut for the project management is the complaint that a change from the norm is 'gong to require us to do something differently'. It is a certain that no plan is

as ideal as to be totally identical to its realization. But it is also true that productivity on the job will suffer if this feeling is allowed to prevail. The method to obtain the balance point is that we need to make changes prudently. And further more, when changes are introduced, it is necessary to make sure that everyone understands why the changes are being made.

The QA branches of LNPS and GNPS undertake the quality assurance respectively on their own responsible fields. They perform periodic or random surveillance and audit. After the surveillance or audit, an Observation Request or Corrective Action Request is issued to make sure of the schedules and qualities of the project.

Further more, the self-assessment and independent assessment are planned. The self-assessment was performed in the autumn of 1999. Before the assessment, a Self-Assessment Guideline was made out with the references of WANO, INPO and IAEA relevant standards. During the assessment, the SWOTA (Strength, Weakness, Opportunity, Threat, and Action) method was adopted to an all-sided and thorough retrospection and review. Consequently 5 severe deficiencies, 72 important interior weaknesses as well as 18 exterior threatens were found out along with the relevant corrective actions. After cautious study, most of the actions were put into the General Implementation Plan and Schedule of Operations Preparation.

In October 2000, a group of experts from EDF came to Ling Ao to perform an independent review for the operations preparation project as a rehearsal for the coming Pre-OSART scheduled in August 2001, three month before the first fueling of unit one.

4 CONCLUSION

In a nuclear power project, normally the design, construction, commissioning and operations have been very often studied, however the operations preparation is still waiting for our further exploitation. In Ling Ao Nuclear Power Station, with the application of Project Management, systematic measures were made out during the prophase stage, the operations preparation are well organized and performed with precise anticipations. However, the final result is still waiting for confirming and proving in the future commercial operation. We hope our study and practice will draw the interest from other NPPs, and we are looking forward to the their experiences in this domain to improve our own work.

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