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Cost Control of EPC Project of Water Conservancy Project under FIDIC Framework

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Abstract: ***With the deep integration and development of the international engineering contracting market, the number of EPC projects of water conservancy projects using FIDIC 'design-procurement-construction (EPC) / turn-key project contract conditions' (silver book) is increasing. The design-procurement-construction (EPC) general contracting model has been widely used in large-scale water conservancy projects because of its advantages of effectively integrating resources, clarifying the main body of responsibility, and shortening the construction period. The International Federation of Consulting Engineers (FIDIC) issued the "Design Procurement Construction (EPC)/ Turnkey Project Contract Conditions" (commonly known as the "Silver Book") [1], which is a model contract for international EPC projects. Because the silver book stipulates the principle of risk allocation, the contractor needs to have high cost control ability. The purpose of this paper is to deeply study the dynamic and systematic cost control strategy covering the whole process of bidding quotation, design, procurement, construction and contract management under the framework of FIDIC silver book, so as to improve the international project management level and profitability of Chinese contractors.***

Keywords: Water conservancy project, ePC general contracting, flDIC Silver Book, Cost control**.**

1. Introduction

As a major infrastructure construction related to people's livelihood, water conservancy projects have the characteristics of large investment scale, long construction period, complex technology [2], and uncertainty of geological conditions. They play an irreplaceable role in promoting economic development and ensuring the well-being of people's livelihood [3]. The traditional design-bidding-construction (DBB) model can easily lead to the disconnection between design, procurement and construction, resulting in many changes and claims, resulting in investment overruns and delays in construction period. The EPC general contracting mode integrates the design, procurement and construction of the project by a general contractor [4], which realizes the seamless connection of each link and is conducive to the owner's control of the total investment and construction period. Its efficient and integrated characteristics have brought significant advantages for project implementation [5].

FIDIC Silver Book is a contract model tailored for EPC projects, and its core feature is the principle of risk allocation. For water conservancy projects, complex geological and hydrological conditions, harsh natural environment, strict environmental protection requirements and long construction period further increase the cost risk under EPC mode. Therefore, it is of great theoretical and practical significance for Chinese enterprises to "go out" to successfully implement international water conservancy EPC projects by systematically studying how to carry out effective and whole-process cost control under the FIDIC silver book contract conditions.

2. The Core Characteristics of FIDIC Silver Book and Its Influence on Cost Control

2.1 Risk Allocation Principle: the Risk Borne by the Contractor

Compared with the FIDIC Red Book (Conditions of Contract for Construction) and the Yellow Book (Conditions of Contract for Production Equipment and Design-Build), the Silver Book specifies in detail the rights and risks of the contractor's claims. This characteristic determines that cost control must be shifted from 'post-account' to 'pre-account', otherwise any 'unforeseen' in the later period will directly erode profits.

2.2 Contract Price Nature: Fixed Total Price is Given Priority to.

The silver book usually adopts a fixed total price contract, and the price is generally adjusted in the event of a specific risk event (such as legal change, force majeure, etc.) or the owner's change order. This means that the quotation in the bidding stage may already be a fixed price, and the space for later increase is limited. The cost overrun is generally borne by the contractor itself. Therefore, the contractor must 'calculate the risk enough' in the bidding stage, 'squeeze the cost dry' in the design stage, and 'minimize the waste' in the construction stage.

2.3 Impact on Cost Control, the Characteristics of the Contract Determines the Contractor's Cost Control Must be Comprehensive.

Forward-looking and preventive: All risks must be identified and quantified as accurately as possible in the bidding and design stages and included in the quotation.

Whole process and systematicness: cost control must run through the whole process of feasibility study, design, procurement, construction and trial operation, and the loss of control in any link may lead to overall loss.

Dynamic and refined: it is necessary to establish a dynamic cost monitoring and early warning system, respond to new situations in the process in a timely manner, and carry out refined management.

3. Based on the Characteristics of FIDIC Silver Paper Framework, the Key Risk Points of

Cost Control of EPC Project of Water Conservancy Project

3.1 Technical Risks

3.1.1 Geological and hydrological risks, which are the core risks of water conservancy projects

Although there are survey data provided by the owners, but the underground karst caves, faults, fracture zones, leakage, unexpected water gushing, deep anti-sliding stability of the dam foundation, the huge fault fracture zone that the tunnel passes through, the landslide and bank collapse of the reservoir bank, the leakage channel of the reservoir, the super-standard flood during the construction period and other 'unforeseen' geological conditions, the difficulty and cost of the treatment are far more than the conventional survey can foresee. Under the terms of the contract, it may be borne by the contractor, resulting in a surge in the cost of foundation treatment, support, drainage and other measures. For example, an overseas dam project exposed a large-scale karst channel, and the curtain grouting alone increased the cost by about tens of millions, which directly led to the loss of the project.

3.1.2 Design risk. Design is the key point in EPC mode. The advantage of EPC is the integration of design and construction.

If the design team lacks EPC experience, the scheme is conservative, the design redundancy is high, or it is out of touch with the construction process, it will lead to high 'congenital' cost. The design interface conflicts between various professions (hydraulic, mechanical and electrical, metal structure) may not be exposed until the construction stage, resulting in huge rework costs. The technical feasibility and economic rationality of the design scheme directly determine the project cost. Insufficient design optimization, design errors, missing items, and insufficient integration with procurement / construction will lead to a large number of subsequent changes and rework.

3.1.3 Technical standard risk

International projects often involve technical specifications of different countries. Understanding deviations or adopting improper standards may lead to design not being approved or construction acceptance difficulties.

3.2 Management Risk

3.2.1 Interface Management Risks

There are many participants in EPC project, and the organizational interface between design, procurement, construction and subcontractors is complex. Poor interface management will lead to low work efficiency, responsibility prevarication and delay of construction period, which will lead to high indirect costs. Poor coordination of information flow, logistics and capital flow will lead to slow decision-making, low efficiency, waste of resources, and increase management fees. For example, due to the design of a project did not provide timely embedded parts drawings, resulting in sluice installation team workers for about 1 month, the loss of labor costs alone amounted to millions.

3.2.2 Procurement risk

The price fluctuation of main materials such as large electromechanical equipment, steel and cement, the delay of supply cycle, the quality defects of equipment, and the problems in logistics transportation (especially international transportation) will have a huge impact on the project cost and schedule.

3.2.3 Subcontracting risk

The selection and management of professional subcontractors (such as tunnel TBM construction and dam roller compacted concrete construction) are directly related to the success or failure of the project. There are loopholes in the subcontract, which may lead to the subcontractor’s claim or low work efficiency and encroach on the total contract profit.

3.3 External Environmental Risks

3.3.1 Political and social risks

Unstable policies, wars, unrest, strikes, community disturbances, environmental protests, etc.in the countries where the project is located may cause engineering disruptions and generate huge stoppage costs.

3.3.2 Natural climate risk

Natural disasters such as floods, earthquakes, and extreme climates far exceed historical records, which may lead to damage to completed projects and delays in construction. Although some belong to 'force majeure', the cost sharing of subsequent processing and resumption of work still needs to be specifically defined according to the contract.

3.3.3 Exchange rate and inflation risk

International project income and expenditure often use different currencies, local currency inflation and exchange rate volatility will seriously erode project profits. Labor costs and local material prices in high-inflation countries are rising rapidly. If there is no price adjustment clause in the contract, the contractor will bear all inflation costs alone.

4. The Whole Process Cost Control Strategy of EPC Project of Water Conservancy Project based on FIDIC Silver Book

4.1 Bidding Stage: Risk Pre-control and Quotation Strategy. This Stage is the Source of Cost Control, which is Very Important.

4.1.1 Depth due diligence, in-depth study of the information provided by the owners

Conduct independent and in-depth supplementary geological surveys (such as increasing drilling holes and geophysical prospecting points) or hire professional institutions to conduct in-depth field surveys and market surveys, review risk assessment reports, and quantify risk probabilities and losses. Through in-depth research on local building material prices,

labor skills and efficiency, subcontracting resources, water and electricity supply, transportation networks, tax policies, customs processes, legal environment, political and social environment, etc., the uncertainty is transformed into quantifiable risk costs. Communicate with local Chinese enterprises to obtain first-hand information. The risk breakdown structure (RBS) and the work breakdown structure (WBS) are used to estimate the emergency cost (Contingency) for each identified risk. The water conservancy projects with high geological prospecting uncertainty are calculated separately and included in the basic quotation.

4.1.2 A thorough understanding of 'owner's requirements'

Organize the expert team to study the owner's requirements one by one, identify the vague, contradictory or even wrong places, and require the owner to clarify the terms that cannot be verified or the risk is too high through the bidding clarification mechanism, or include sufficient risk reserve fees in the quotation. Such as clear owners of off-site roads, power supply, etc.to provide responsibility.

4.1.3 Establish risk weighted bidding model

The risk-based quotation model is adopted. The quotation should not be a simple cost plus profit, but a risk-weighted quotation model should be established. Use WBS (work breakdown structure) and RBS (risk breakdown structure) to allocate emergency costs for each potential risk, and clarify the use conditions and approval process of each cost.

4.1.4 Carefully examine the terms of the contract, review and negotiation

In the review and negotiation of contract terms, legal and contract experts must carefully review the unreasonable and risky terms of special contract terms (such as too strict liability for compensation and vague acceptance criteria) and try their best to negotiate with the owners to strive for a more equitable distribution of risks.

4.2 Design Phase: Design is the Key to Cost Optimization, which is Reflected in the EPC Project.

4.2.1 Implementation of quota design and value engineering (VE)

Based on the approved target cost, a quota design is implemented for the design team. At the same time, the design, procurement, construction and cost management personnel are regularly organized to carry out value engineering analysis, and seek design schemes and material selections with lower cost and easier construction under the premise of meeting the requirements of function and use.

4.2.2 Strengthen the integration of design, procurement and construction (D-B synergy)

Establish a collaborative work platform to allow procurement and construction experts to intervene in the design process in advance. Their experience can help to avoid 'good-looking design, difficult construction' solutions, choose easy to purchase, convenient installation of equipment and materials, from the source to save costs and time.

4.2.3 Collision inspection and optimization using BIM technology

Application of building information model (BIM) technology for three-dimensional design, found in advance between different professional design.

4.3 Purchasing Stage: The Core Link of Cost Control is the Focus of Control

4.3.1 Formulating strategic procurement plan

According to the overall schedule of the project, a detailed procurement plan is formulated to clarify the procurement window period of key equipment and materials. Through global procurement, we can find the best balance between quality, price, delivery time and service.

4.3.2 Skillfully use the form of contract price

When signing contracts with subcontractors and suppliers, different contract forms such as fixed price, adjustable price, cost plus remuneration can be flexibly adopted according to the type of risk. For bulk materials with large price fluctuations, it can be considered to sign a long-term lock-in agreement or use financial instruments for hedging.

4.3.3 Strict compliance management

Establish a strict joint system of supervision, delivery, inspection and transportation to ensure that the equipment and materials are delivered to the site on time, according to quality and quantity, so as to avoid the loss of on-site shutdown due to supply problems.

4.4 Construction Stage: Dynamic Monitoring and Fine Management. This Stage is the Implementation Stage of Actual Cost Occurrence and Control.

4.4.1 The introduction of earned value management method, strengthen the progress and cost linkage control

By comparing the budgeted cost of the planned work (BCWS), the budgeted cost of the completed work (BCWP) and the actual cost of the completed work (ACWP), the performance of the project cost and schedule is accurately evaluated, and the deviation is found in time and corrective measures are taken.

4.4.2 Refined on-site management

Implement lean construction to reduce waste. New technologies and new processes are used to improve work efficiency (such as large formwork trolley, roller compacted concrete technology, long tunnel TBM tunneling). Identify and reduce waste of overproduction, waiting, handling, processing, inventory, actions, and defects through lean tools (such as 5S, Kanban management, and last planner system LPS). Strengthen the optimization of construction organization design, improve mechanical and manual efficiency, strictly control on-site visas and sporadic

employment, and establish a strict change approval process. For changes caused by non-contractor reasons, it is necessary to obtain the written instructions of the owner / engineer in time, record the same period, and submit the change price application in time according to the contract procedure, so as to ensure that any additional cost expenditure is well-founded and under control.

4.4.3 Do a good job in claim and counter-claim management

Although there are few claims under the framework of the silver book, it is important to pay close attention to claims caused by owner reasons or force majeure events [6]. Once it occurs, it is necessary to collect and collate complete evidence (records, letters, photos, videos, etc.) in strict accordance with the procedures and time limits stipulated in the contract, and timely make reasonable claims to make up for losses. At the same time, it is necessary to strictly manage subcontracts, prevent and respond to unreasonable claims made by subcontractors.

4.5 Contract and Financial Management Strategy

4.5.1 Establish contract consciousness

All project personnel, especially project managers and engineers, must have a deep understanding of the terms of the silver book, establish the working principle of "all based on contract," develop the habit of keeping written records of everything, and provide evidence for possible dispute resolution.

4.5.2 Strengthen cash flow management

According to the schedule plan, make detailed cash flow forecast, actively collect the owner's progress, reasonably arrange the payment to subcontractors and suppliers, maintain healthy cash flow and reduce financial costs.

4.5.3 Using financial instruments to hedge risks

For exchange rate risk, it can be locked by financial instruments such as forward settlement and sale of foreign exchange and currency swap. For the inflation risk, the price adjustment formula can be sought in the contract, or through the procurement strategy to avoid.

5. Case Analysis and Application Suggestions

Taking the EPC project of a large hydropower station in Central Asia as an example. A contractor in China conducted independent geological drilling in the bidding stage and found that the geological data provided by the owner was too optimistic. The contractor included an additional high geological risk reserve fee in the quotation. During the implementation of the project, a large-scale landslide was encountered. Due to sufficient reserve funds and proper treatment plan, the project cost was not seriously impacted. At the same time, the project optimizes the design of the underground powerhouse cavern group through BIM technology, reduces the amount of excavation and concrete, and saves a lot of costs. The experience of this case in all aspects confirms the effectiveness of the above cost control strategy, and further expounds that Chinese contractors should try to avoid accepting pure silver book contracts on projects with complex geological conditions in large-scale water conservancy EPC projects for international projects. Strive to adopt the EPC model based on the yellow book, or transfer some extreme geological risks through special clauses, make good use of insurance tools, and transfer some accidental risks by purchasing all risks of the project, third-party liability insurance, transportation insurance, etc. Moreover, it is necessary to cultivate its own core technical capabilities and project management capabilities, especially the front-end design optimization capabilities and the overall project integration management capabilities.

6. Conclusion

Under the framework of FIDIC silver book, the cost control of EPC project of water conservancy project is a complex and difficult system engineering. The traditional cost management method limited to the construction stage has been completely unable to meet its requirements. The contractor must achieve a fundamental change, from phased control to integrated control of the whole process, move the threshold of cost control to the bidding and design stage, and realize the dynamic linkage of design, procurement and construction costs through information means. Actively apply BIM, big data, EVM and other advanced technologies and management tools to improve the accuracy of cost prediction and control. Cultivate compound talents who know both technology and cost and are proficient in international contracts and FIDIC terms, and improve the compliance and profitability of the project. For China's international engineering contractors, only by in-depth study and compliance with the FIDIC silver book contract rules, in-depth study, to build a set of scientific, efficient, throughout the whole process of the project active cost control system, in order to achieve sustainable development in the international water conservancy project market full of opportunities and challenges.

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