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【土木建筑工程】

Bidding management of the ETFE cladding project of the National Aquatic Center for Beijing Olympics

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Abstract: The National Aquatic Center, which is one of the three main buildings for the Beijing 2008 Olympic Games, uses ethylene-tetra-fluoro-ethylene (EFTF) structure as the cladding system. By comparing bidding type with non-bidding procurement types, the international competitive negotiation was selected for bidding the EFTF cladding project. This study discusses the bidding management mainly by means of a weighted average evaluation model. The bidding documents were evaluated by the project developers and experts in two rounds. According to the second round evaluation results, the negotiation group put forth the name list of the candidates to the project developers who would determine the contractor. The practice shows the bidding management is successful.

Key words: Beijing Olympic Games; National Aquatic Center; ETFE structure; international competitive negotiation; weighted average evaluation model; bidding

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The Beijing Olympic National Aquatic Center (NAC) with a land area of approximately 62 828 m² is located within the central area of the Olympic Green precinct in northern Beijing. The floor area of the NAC during the Olympic Games is appropriately 80 000 m² in 6 000 permanent seats and 11 000 temporary seats which will be removed after the 2008 Olympic Games. The overall cost of the NAC is USD 100 million. The NAC is designed as a multi-functional aquatic sports center, which will stage swimming, diving, synchronized swimming and final polo events. After the games, the NAC will host aquatic competition for national and international events, providing a range of recreational, leisure and fitness facilities for public use. The swimming center includes an Olympic swimming pool, diving pool, warm-up pool, leisure pool, catering, recreation facilities, entertainment and club. The construction of the NAC started on December 24, 2004, and the main structures were completed in the autumn of 2007^[1]. The whole project is completed in early 2008.

The ETFE (ethylene-tetra-fluoro-ethylene) is a fluorocarbon-based polymer (a fluoropolymer), a kind of plastic. It is designed to be a material with high corrosion resistance and strength over a wide temperature range. The ETFE has been applied in the film structure field in Europe for over 20 years. The famous archi-

tecture is the Allianz Areen Stadium in Munich, German. The ETFE structure of the stadium can be changed into blue and red colors by the lights^[2]. In consideration of the transparent performance of the ETFE being able to meet the green and technological requirements of the Beijing Olympic Games, the EFTF structure is used as the cladding system of the NAC. The color variation of the EFTF structure has over ten kinds, much more than the two colors of Allianz Areen Stadium. So far, the application of the ETFE cladding in the NAC is the largest in size, most complex in construction and comprehensive in technological integrity in the world. The ETFE structure makes the NAC resemble a water cube and allow sunshine into the internal space.

The tendering and bidding management in China began in 1990s and has used the experience of western countries for reference. In Europe and the United States of America, the contractors are chosen by bidding except military projects, it is similar to the situation in China. The selections of the contractors for the Chinese public projects are carried out in accordance with the Government Procurement Law and the Tendering and Bidding Law of the People's Republic of China^[3-4]. In western countries, the evaluation methods such as lowest price and comprehensive evaluation are usually determined by the developers. The evaluation

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methods presented by western countries are generally employed for the projects in China.

In order to control the construction schedule and quality of the NAC, the project developer, the National Stadium Co., Ltd., invited China Three Gorges Project Corporation (CTGPC) to be the project manager. This paper addresses the bidding management process and experience of the ETFE structure project in accordance with the CTGPC practice in the NAC project site.

1 Procurement procedures of international competitive negotiation

The Construction Law, the Government Procurement Law and the Tendering and Bidding Law of the People's Republic of China stipulate that the contractor of large and middle size public projects should be determined by bidding. For small projects and sub-projects of large and middle size public projects, the contractors may be chosen in non-bidding way by the project developer^[3-4]. The NAC is classified as a large public project in China, therefore the contractor was chosen by bidding. The contractor of the ETFE structure as a part of the NAC can be selected by non-bidding procurement or the bidding way. Article 26 of the Government Procurement Law of the People's Republic of China stipulates that the government procurement can utilize public bidding that should be given priority, invitation tender, competitive negotiation, single supply procurement, inquiry and way worked out by the State Council^[4]. The competitive negotiation can be used for the following cases in accordance with the article 30 of the Government Procurement Law.

① No supplier sent the tendering documents; no suitable supplier was chosen as the contractor; and re-bidding was also not successful; ② The specifications or requirements can not be determined because of technical complexity or special functions; ③ The time is not enough for urgent developer; ④ The total price can not be determined prior to the selection of the contractor.

The competitive negotiation includes domestic competitive negotiation and international competitive negotiation (ICN). Because technical complexity of the ETFE structure and lack of experience of the ETFE structure installation in China, the project developer decided to adopt the ICN to choose the contractor for the ETFE structure project after the approval of the Beijing Municipal Government is obtained.

The general procurement procedures of the INC are as follows: ① Set up the negotiation team. The negotiation team consists of the officers from the project developer and more than three experts from other companies, among which the experts account for more than two third of the total members. ② Write the negotiation documents. The negotiation documents clearly describe the items such as the negotiation procedures, negotiation contents,

draft clauses of the contract and the evaluation standards. ③ Determine the name list of the bidders to attend the negotiations. The negotiation team selects and determines at least three qualified bidders to attend the negotiation from the name list, and provide the negotiation documents to the qualified bidders. ④ Negotiate with the selected bidders. All of the members in the negotiation team secretly negotiate with the selected bidders one by one. ⑤ Determine the final bidder. After the negotiation, the negotiation team requires the bidders who have attended the negotiations to give their final quoted prices in the specified time. The project developer determines the winner from the candidates provided by the negotiation team in accordance with the demands, quality, service and the quoted price. The project developer also informs the bidding result to all of the bidders who have attended the negotiations.

2 Work process of the ETFE procurement

The work process of the ETFE procurement was worked out in accordance with the above-mentioned procedures of the ICN and the actual characters of the NAC. The phases are classified as preparation, initial evaluation by experts, clarification, negotiation and decision-making. The work contents of each phase are shown in Table 1.

Table 1 Work process of the ETFE procurement
表 1 ETFE 采购工作流程

Phase	Work contents
preparation	procurement approved by government
	write procurement documents and make out work plan
	sell procurement documents;
	work out evaluation standards
initial evaluation	accept quoted documents.
	perform initial evaluation by experts
clarification	give the comments for the bidding documents.
	prepare further questions
negotiation	explain and answer the questions of the bidders.
	first round negotiation
	selection of the suitable bidders
decision-making	second round negotiation
	perform second evaluation by the negotiation team;
	give scores in consideration of the initial evaluation;
	provide a recommendation list
	final decision-making by the project developer;
send the bidding results to each bidder.	

3 Evaluation system

The kernels in the whole procurement process are the initial evaluation by experts and the second evaluation by the negotiation team. A weighted average evaluation model is employed to calculate the score for each bidder during the two phases. A recommendation name list is drawn by the calculated results by the evaluation model.

3.1 Weighted average evaluation model

The evaluation of the bidding documents involves in many influential factors. Assumed that influential factors have m items and each factor is divided into n_i items, the score of a bidder can be expressed as

$$Score = \sum_{i=1}^m \omega_i \left(\frac{1}{p} \sum_{j=1}^{n_i} \sum_{k=1}^{p_i} x_{jk} \right). \quad (1)$$

where, ω_i is the weight of i influential factor; $\sum_{i=1}^m \omega_i = 100$; p_i is the people number of evaluating i factor; n_i is the amount of the items in i factor, and x_{jk} is the score of j item given by the k people.

3.2 Key evaluation factors and evaluation standard

For the ETFE structure project, the key evaluation factors are company's competence, technical capacity and economical capacity. The weight distributions to the three factors are the same during the periods of the initial and second evaluations, but the weights of the items of the company's competence are little different from the ones of the technical and economical capacities to avoid each kind of technical and economical risks as possible. The total score of the three factors is set to be equal to 100, in which the company's competence, technical capacity and economical capacity are 10, 50 and 40, respectively.

The company's competence includes ① construction experience of similar projects such as scale, features, and structure form; ② financial status; ③ staff standing; ④ whether the certifications required by the procurement documents are complete or not; ⑤ qualification and capacity of the consortium; and ⑥ rationality of the consortium agreement. The standard scores for the six items are stipulated as 3, 1, 1, 3, 1 and 1.

Regarding the technical capacity, the following items are evaluated:

① Rationality and advanced degree of the design scheme of installation system of the ETFE roof, wall cladding and the associated structures. The main items include construction art effect, thermal resolving measures, structural analyses, waterproof and roofing drainage, optimized design of the aluminum alloyed frame of the ETFE pillow, connection design of main steel structure, open-close system of the elevation ETFE air pillow, the ETFE air

charging system, testing scheme of prototype and other reasonable proposals and schemes.

② Rationality and advanced degree of the technical scheme for construction. The main items include the scheme of supply, manufacture and transportation, scheme of trial installation, installation and maintenance, on-site condition of project management organization, measures of cooperation and adjustment between the bidder and the other contractors, layout of the construction site, and conditions and cooperation needed to be provided by the general contractor.

③ Contents and guarantee of the repair service.

④ Insurance measures of research and developing capacity such as personnel, organization and equipment.

⑤ Scheme and measures to reduce the bidding price in advantage of domestic materials and equipment.

⑥ Rationality and advanced degree of the sound insulation scheme submitted separately.

The standard scores of the above - stated six items are set to equal 20, 16, 5, 5, 2 and 2.

The economical evaluation includes ① quoted price matches in the technical scheme or not; ② quoted price is completed or not; ③ quoted price is reasonable or not; ④ domestic proportion of persons, materials and machines; ⑤ Responsibility to the economical clause; and ⑥ examination to the difference of actual quoted price to the limited maximum price. The standard scores for the six items are 3, 3, 20, 2, 2 and 10.

4 Application of evaluation model

According to the above-mentioned evaluation system, the evaluation factors are classified into company's competence, technical capacity and economical capacity, namely, $m = 3$. The items of company's competence, technical capacity and economical capacity are set as 6, 6 and 6, respectively. There are 7 economical experts and 9 technical experts who took part in the initial evaluation. Seven economical experts and 7 technical experts participated in the second evaluation.

In order to select the suitable contractor with reasonable price and strong technology to endure the deepening design and construction, several rounds of clarification and economical negotiations were performed after the initial evaluation. The final quoted price of each bidder is different from the initial price; therefore, the final quoted price is used during the second evaluation.

There are three qualified bidders who participated in the bidding activity of the ETFE cladding project. The initial evaluation scores of the three bidders are 90, 89 and 60 respectively. The first two bidders were permitted to take part in the second round competition. The second evaluation scores of the two bidders are 92 and 90, the difference is due to the final quoted prices. Ac-

according to the calculated results, the negotiation team gave the recommendation name list to the project developer who would decide the winner by the bidder order in the name list.

Conclusions

By the initial evaluation, technology clarification, economical negotiation and second evaluation in three months, the negotiation team recommended the name list of the contractor candidates for the ETFE cladding project. A weighted average evaluation model is employed to calculate the score for each bidder during the initial and second evaluation periods. The application of the evaluation model heightens the justice of the contractor's selection. The project developer decided the contractor on the basis of the name list. As a result, a joint venture of a German company, Vector Foiltec and a Chinese company, Shenyang Yuanda Co Ltd, was awarded the contract to design and build the ETFE cladding structure of the NAC in January 2005^[5]. The ETFE cladding structure was basically completed in June 2007. During the whole procurement process, the project manager, the CTGPC, had maintained the open, just and honesty principles. The construction practice of the ETFE cladding structure shows the ICN and project management is successful. The bidding evaluation

system is helpful to the contractor's selection for public projects.

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北京奥运国家游泳中心 ETFE 膜结构工程招标管理

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摘要: 北京奥运国家游泳中心是 2008 年北京奥运会三大标志性建筑物之一, 外墙和屋顶采用乙烯四氟乙烯共聚物 (ethylene-tetra-fluoro-ethylene, ETFE) 膜结构作为维护系统。经对招标方式和非招标方式进行研究比较, 选用国际竞争性谈判方式进行采购。借助加权平均评估模型, 讨论 ETFE 膜结构的招标管理过程和经历。对投标文件进行了二次评估。根据第二轮专家评估结果, 专家小组提出了拟中标人名单供业主决定中标人。实践表明该项目的招标管理是成功的。

关键词: 北京奥运会; 国家游泳中心; ETFE 膜结构; 国际竞争性谈判; 加权平均评估模型; 工程招标
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