Construction Strategy of SMART Nuclear Power Plants in Saudi Arabia

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1. Introduction

The SMART reactor has been developing by KAERI since 1997 and it had received the world's first standard design approval (SDA) in 2012. In order to commercialize and export the SMART nuclear power plants (NPPs), SMART Power Company was founded in December 2014. In 2015, the Republic of Korea and Saudi Arabia signed a MOU on SMART partnership for construction of at least two (2) SMART NPPs in Saudi Arabia after the completion of SMART pre-project engineering (PPE). By end of 2018, SMART PPE has been carried out to accommodate enhancement of safety reflecting fully passive safety system and to finish the design of SMART NPP so that it can be ready for construction. Contrary to the completion of SMART PPE, the business structure of SMART NPP has not been determined yet. Nevertheless, the right direction to accelerate the FOAK (First-of-a-Kind) construction should be presented.

2. Pre-emptive Preparations for Construction

In order to construct a nuclear power plant, its owner must be identified first and the bid invitation specifications (BIS) also be prepared by the owner. According to this BIS, the construction contractor may prepare a construction proposal and submit it to the owner. The construction work can only be started after a construction contract is signed through ~~the~~ evaluation and negotiation of construction proposal.

The main purposes of the BIS are ~~is~~ to clearly represent the followings:

- Owner's requirements - technical, commercial and financial - expectations and plans;
- Conditions and circumstances under which the contractor has to perform its responsibilities
- Forms and contents of bids
- Criteria on which the bids are evaluated

During the bid evaluation process, all aspects of the technical, economic, financial and contractual approaches must be considered. The technical evaluation of bids mainly verifies the compliance with and the properties of:

- Scopes of supply and services:
- Technical design features;
- Project implementation;
- Warranties;
- National participation and technology transfer;
- Nuclear fuel;
- Options and alternatives

The objective of the economic evaluation of bids is to rank according to costs. The different types of costs which will be incurred during plant construction, lifetime and decommissioning may be classified as follows:

- Total capital investment costs (TCIC);
- Nuclear fuel cycle costs;
- Options and alternatives.

The main activities and documents of a bidding process are shown schematically in Fig. 1

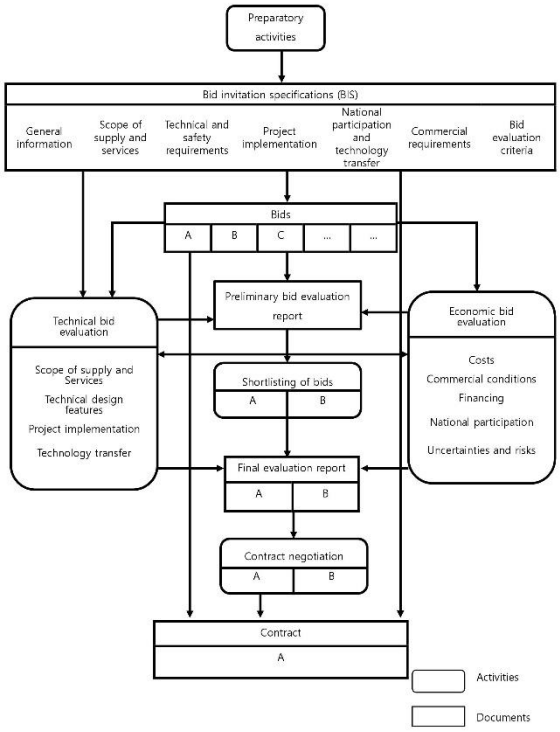

FIG. 1 Overall scheme of a bidding process in case of bids A, B, C

In case of FOAK, it is essential to comply with the requirements of Saudi Arabia as the FOAK will be a project of not-competition one. As shown in Fig. 1, the results of the technical and the economic evaluation of the contents of the proposal should satisfy the requirements of the owner. In particular, since SMART NPP has never been constructed, it is impossible to reflect the concepts of the referenced plant which can be regarded as a design-proven NPP. ~~I~~t is important to prove licensability and performance and to secure economics. The information to be provided by the owner such as site characteristics and infrastructure facilities, as well as the owner's requirements at BIS, will be the headstones of successful construction contracts and the onset of construction.

3. Considerations of Construction at Completion of SMART PPE

The reason why SMART PPE did not lead to construction can be estimated as follows:

The owner of SMART NPP in Saudi Arabia has not been determined yet, and there is no independent regulatory authority to permit construction of nuclear power plant. As a result, there is no owner's requirements as a prerequisite for construction of NPP and there is no organization to submit PSAR even if a PSAR was prepared for construction permit. In addition, even though three candidate sites had been selected near Yanbu in Saudi Arabia, a site location has not been determined yet, i.e. there is no information related to the site. Accordingly, the PSAR prepared and submitted by KAERI to Saudi Arabia is not enough for construction.

The PSAR, which is one of the products of SMART PPE, does not contain enough information which should have been incorporated in Chapter 2 (Site Characteristics) of the PSAR.

Besides, there is a lack of communication between a potential project owner and Korean counter-part.

The technical information and technologies acquired through SMART PPE, which was carried out by the KAERI-led R&D, should have been transferred to industrial circles and the follow-up project should have been led by the industrial circles centered on SMART Power Company which is in charge of export and construction of the SMART NPP. But there is a new movement toward SMART business structure centering on KHNP ignoring Smart Power Company which is supposed to be the EPC contractor based on the SMART PPE agreement between KAERI and K.A. CARE.

However, it is considered that the proposal for construction prepared by KHNP does not meet the qualifications because the requirements of the plant owner had not been reflected to this proposal. It is understood that their proposal has been unofficially submitted to Saudi Arabia because construction cost to be reflected in the proposal could not be determined.

From the beginning on, Saudi Arabia has been worrying about the risks of licensing and performance assurance for the SMART FOAK and the scale of its construction cost directly linked to economic efficiency. The construction cost estimated by Smart Power Company during and at the end of SMART PPE has increased compared to the initial estimate of 1 trillion Korean won of KAERI. As shown in Fig. 2, the construction schedule has been analyzed to exceed the target period of 36 months because the period required to manufacture and install an integrated reactor is absolutely necessary.

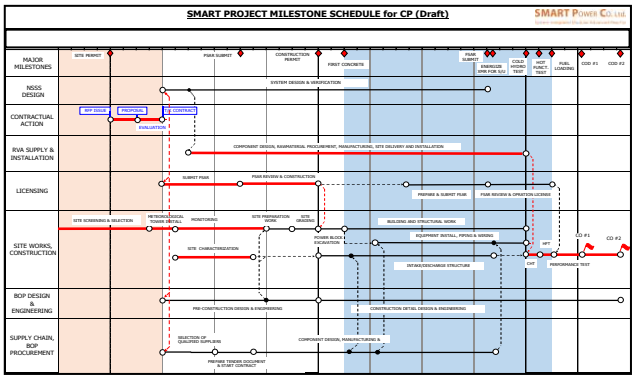

FIG. 2 SMART project milestone schedule (Draft)

Fortunately, there is an opportunity to reduce the risk by pursuing the design certification of regulatory body for change to design at the time of Standard Design Approval (SDA), and consequently, to secure licensability of SMART NPPs abroad although such design certification is done in Korea.

The SMART NPP Task Force was launched in January of 2018 to support the export of SMART NPPs and to establish a business structure accordingly, but no further follow-up was done until today.

Considering the current trends and activities of SMR competitors such as U.S.A and China, it is urgently required to reorganize the SMART NPP TF structure for the SMART NPP export promotion and to establish industry-oriented strategies.

4. FOAK Strategy in Saudi Arabia

The Korean government should keep continuing close relationship with Saudi Arabia, and supporting Saudi Arabia to implement the recommendations in the Integrated Nuclear Infrastructure Review (INIR) report (IAEA Delivers Report on Nuclear Power Infrastructure Development to Saudi Arabia (IAEA, '19.1.25)) submitted by the IAEA to Saudi Arabia in a timely manner. In addition, it is necessary to create various conditions for construction permit by giving technical support for the establishment of the independent regulatory body in Saudi Arabia.

In order to encourage the construction of SMART NPPs in Saudi Arabia, followings are recommended:

First, it is recommended to release the concerns of Saudi Arabia from the risk of FOAK construction through the verification of SMART PPE design by third party.

Second, it is recommended to make efforts to construct SMART NPP as economically as possible. The cost savings should be maximized in terms of design, construction and procurement of equipment by operating, so-called "SMART Economy Enhancement Council".

Third, it is recommended that KINS evaluate the SSAR or SDCA on the basis of European regulatory requirements. By doing so, it will be possible to secure the licensability.

Last but not least, it is recommended that SMART NPP TF monitor international trends in SMR and the needs of SMR in Saudi Arabia.

5. Conclusions

SMART PPE was carried out by joint financing–of $100 million from K.A. CARE and $30 million from Korean industries and government, but ended with half a success and half a failure. It was believed that SMART NPP has prevailed in building SMR in Saudi Arabia, but Saudi Arabia will turn their eyes to other SMRs at any time if they are not satisfied with SMART NPP in every respect.

It is strongly recommended:

To encourage the owner of SMART NPPs to issue BIS including their requirements.

To cope with the essential requirements for construction requested by the owner of SMART NPPs.

To be ready to revise the construction proposal and negotiate the contract.

REFERENCES

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