Project name: Completion of the first unit of Bushehr Nuclear Power Plant (BNPP-1)

History and background:

Under a treaty between Iran and West Germany, the turnkey contract for the construction, installation, and delivery of two 1293 MW pressurized water reactors (PWR) was signed between the Atomic Energy Organization of Iran and German Kraftwerk Union (KWU) in 1975. The German company was obliged to supply the bushehr NPP’s fuel for the next 10 years within the framework of a separate contract. Additionally, in order to provide fresh water for the region by using the plant's steam power, two desalination units with a capacity of two hundred thousand (200,000) m3 per day were predicted under a contract with a Japanese company.

Bushehr NPP site is located in the northern part of the Persian Gulf Coast. Till 1978, KWU Company conducted the operations of design, construction, and equipment supply of the project based on the contents of the concluded contract. As the Iran- Iraq war started, although a main part of the construction activities at Bushehr Nuclear Power Plant had been completed, KWU decided to stop continuing the work on the commissioning and delivery of the units and suspended the contract execution. In 1992, a cooperation agreement for the peaceful use of nuclear power was signed between Islamic Republic of Iran and the Russian Federation. Based on the contents of this cooperation agreement, a contract for the completion of the first unit of Bushehr Nuclear Power Plant was concluded in 1994 between Atomic Energy Organization of Iran (represented by Nuclear Power Plants Division) and Zarubejatom company (which changed its name into Atomstroyexport later on) and then was put into force in 1995. A separate contract for the 10-year supply of nuclear fuel was signed between Iran and TENEX Co., a Russian company which was replaced by TVEL later on.

In 1998, the two parties revised the contract conditions and finally addendum No.1 was signed through expert examinations and aiming at use of KWU equipment and handing over the whole responsibility of project for design, construction, installation, and commission of the reactors on turn-key terms to the Russian company. The Russian company also committed itself to train Iranian operators and after that the executive operations started.

Finally, in the late summer of 2011, after passing successfully the commissioning tests, first Unit of Bushehr Nuclear Power Plant was connected to the national grid for the first time.

Project goals and objectives:

* Completion of the first unit of the Bushehr nuclear power plant with 1000 MW electric power
* Maximum use of equipment remaining in the KWU design, such as buildings, structures, installed equipment
* Applying necessary and appropriate changes to comply with laws and standards and day-to-day technology
* Ensure the obtaining of necessary licenses and timely and successful launch of Bushehr Nuclear Power Plant Unit 1
* BNPP-1 operation in safe and reliable manner

Project execution time (start, completion, total project duration):

* The executive operations for completing of BNPP-1 started in September 1998:
* Temporary delivery of BNPP-1 to the Iranian Operator and commercial generation of electricity was in September 2013
* Total project duration is 15 years.

Project peculiarities:

The obvious feature of the BNPP-1 is the completion of a Western-made power plant by Russian technology with the maximum use of buildings, structures and installed equipment.

Bushehr NPP is a VVER-1000 reactor type of which the technical specifications are as below.

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| **No.** | **Technical Specifications** | **Measurement Unit** |
| 1 | Designed lifetime of reactor | 40 years |
| 2 | Reactor’s thermal power | 3000 MWheat |
| 3 | Produced electrical power | 1030 MWeletrical |
| 4 | Number of cooling loops of primary circuit | 4 loops |
| 5 | Operation time between two refueling at full power | 7000 hours |
| 6 | Reactor fuel cycle | 3 years |
| 7 | Number of fuel assemblies inside the core | 163 |
| 8 | Number of high-pressure turbines | 1 |
| 9 | Number of low-pressure turbines | 3 |
| 10 | Number of steam generators | 4 |

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| Parameters of primary circuit | | |
| 1 | Outlet pressure of core | 15.7 MPa |
| 2 | Temperature of inlet water into the core | 2910C |
| 3 | Temperature of outlet water from the core | 3210C |
| 4 | Flow rate of circulated water in core | 84800 m3/h |

Project milestones:

* January 1995: Concluding the Contract for completing the first Unit of Bushehr NPP with 1000 MW with the Russian Party
* September 1998: Starting the executive operations for completing the first Unit of Bushehr NPP
* Up to 2004: Construction activities and manufacturing main equipment in Russian factories
* December 2007: Entering the fuel into the NPP
* June 2009: 35 Bar Test in primary circuit
* November 2009: 250 Bar Test in primary circuit
* December 2009: 110 Bar Test in secondary circuit
* January 2010: Conducting the containment test
* April 2010: Starting hot-run test
* May 2011: reactor criticality (Start of reactor activity)
* August 2011: NPP turbine with 3000 rpm
* September 2011: first connection of generator to the national grid
* August 2012: Reaching 100% reactor power and delivering 1000 MW electricity to the national grid
* September 2013: temporary delivery of the first Unit to the Iranian Operator and commercial generation of electricity
* February 2014: First Bushehr NPP-1 refueling
* September 2015: Second Bushehr NPP-1 refueling
* May 2016: permanent delivery of NPP to the Iranian operator

Project completion results:

Bushehr Nuclear Power Plant, which is in commercial operation at the moment, was delivered by the Contractor to Nuclear Power Production and Development Holding Company of Iran, as the operating organization, in the summer of 2013. Hereinafter, the Nuclear Power Production and Development Holding Company of Iran delegated the responsibility of safe and reliable operation as well as technical support and maintenance and repair activities to the Operating Company of Bushehr Nuclear Power Plant, which enjoys very experienced and trained staff.

Qualified and competence operation personal for safe operation of BNPP-1 is one of the main achievements of this project.

As the operating organization and owner of Bushehr Nuclear Power Plant, the Nuclear Power Production and Development Holding Company of Iran monitors performance of the BNPP Operating Co. to ensure the safe and reliable operation of the plant and meeting the operation requirements. Based on this, in 2016, supervisory programs were developed and executed for monitoring and ensuring the NPP safe performance as per the national and international standards.

The share of nuclear power in Iran's electricity capacity is about 1.3 percent and its contribution to the electric power generation is about 2.2 percent in 2017.

In sum, Bushehr NPP, Unit 1, during the commissioning years from 2011 and commercial operation since September 2013 up to Feb. 2018, produced 28197 million KWh electricity of which 25587 million KWh was delivered to the national grid.

Some of the achievements are as follows:

* Updating national nuclear standards,
* Competency building in National Companies for suitable contribution in the program,
* Engineering experience in Project Management,
* Sufficient training in new generation for Operation,
* Participation of trained operators in commissioning phase which enabled them prepared for proper repair & maintenance activities and refueling,
* Planning for development suitable Technical infrastructure,
* Involvement of universities and research institutes in appropriate subjects,
* Upgrading nuclear safety infrastructure including Regulatory Body, and;
* Public awareness and acceptance

Conformity with criteria of nomination

The first unit of Bushehr's nuclear power plant is a unique nuclear reactor in the world, with Russian technology on the western technology being developed and completed. All technical issues were reviewed and resolved at the time of the implementation of the project. Since there was one of the goals of the contract for the use of German equipment in completing the project, much time was spent on the coordination between the equipment and the new design. The successful construction and operation of this project has had many scientific and technical experiences as the first nuclear reactor for the Islamic Republic of Iran. Based on above mentioned in terms of completing, commissioning, commercial operation, and finally, the delivery of the BNPP-1 to the Iranian operator is an exception in the world.

Safe operation and sustainable power generation with a load factor of 85% in the fourth cycle of the first unit indicate that the above items are properly planned and implemented in the BNPP-1.