***Joint Comprehensive Plan of Action***

***Vienna, 14 July 2015***

**B. ARAK, HEAVY WATER, REPROCESSING**

8. Iran will redesign and rebuild a modernised heavy water research reactor in Arak, based on an agreed conceptual design, using fuel enriched up to 3.67 %, in a form of an international partnership which will certify the final design. The reactor will support peaceful nuclear research and radioisotope production for medical and industrial purposes. The redesigned and rebuilt Arak reactor will not produce weapons grade plutonium. Except for the first core load, all of the activities for redesigning and manufacturing of the fuel assemblies for the redesigned reactor will be carried out in Iran. All spent fuel from Arak will be shipped out of Iran for the lifetime of the reactor. This international partnership will include participating E3/EU+3 parties, Iran and such other countries as may be mutually determined. Iran will take the leadership role as the owner and as the project manager and the E3/EU+3 and Iran will, before Implementation Day, conclude an official document which would define the responsibilities assumed by the E3/EU+3 participants.

10. There will be no additional heavy water reactors or accumulation of heavy water in Iran for 15 years. All excess heavy water will be made available for export to the international market.

**B. ARAK HEAVY WATER RESEARCH REACTOR**

2. Iran will modernise the Arak heavy water research reactor to support peaceful nuclear research and radioisotopes production for medical and industrial purposes. Iran will redesign and rebuild the reactor, based on the agreed conceptual design (as attached to this Annex) to support its peaceful nuclear research and production needs and purposes, including testing of fuel pins and assembly prototypes and structural materials. The design will be such as to minimise the production of plutonium and not to produce weapon-grade plutonium in normal operation. The power of the redesigned reactor will not exceed 20 MWth. The E3/EU+3 and Iran share the understanding that the parameters in the conceptual design are subject to possible and necessary adjustments in developing the final design while fully preserving the above- mentioned purposes and principles of modernization.

**C. HEAVY WATER PRODUCTION PLANT**

14. All excess heavy water which is beyond Iran's needs for the modernised Arak research reactor, the Zero power heavy water reactor, quantities needed for medical research and production of deuterate solutions and chemical compounds including, where appropriate, contingency stocks, will be made available for export to the international market based on international prices and delivered to the international buyer for 15 years. Iran's needs, consistent with the parameters above, are estimated to be 130 metric tonnes of nuclear grade heavy water or its equivalent in different enrichments prior to commissioning of the modernised Arak research reactor, and 90 metric tonnes after the commissioning, including the amount contained in the reactor.

15. Iran will inform the IAEA about the inventory and the production of the HWPP and will allow the IAEA to monitor the quantities of the heavy water stocks and the amount of heavy water produced, including through IAEA visits, as requested, to the HWPP.

**Attachment: Arak conceptual design**

**Fundamental Principles:**

Maximize use of the current infrastructure of original design of Arak research reactor, designated by the IAEA as IR-40, according to their respective ratings.

Modernizing of the original design in order to be a multi-purpose research reactor comprising radio-isotope production, structural materials and fuel (pins and assembly prototypes) testing and able to conduct other neutronic experiments which demand high neutron fluxes (more than 1014).

Using heavy water as coolant, moderator and reflector. Light water would be utilized as an annular ring around the compact new core for safety reasons if necessary.

Around 78 fuel assemblies in a tight hexagonal grid spacing with the following preliminary characteristics will be loaded.

Up to 3.67 percent enriched UO2, in the improved assembly design, will be used as fuel.

Power will not exceed to 20 MWth.

**Preliminary Characteristics:**

|  |  |
| --- | --- |
| **Core Parameters** | **Values** |
| Power (MW) | 20 |
| Number of fuel assemblies | ~ 78 |
| Active length (cm) | ~ 110 |
| Lattice configuration | Hexagonal |
| Fuel pellets Material | UO2 |
| Fuel enrichment level | Up to 3.67 % |
| Clad material | Zr Alloys |
| Burnable poison | Yes, if necessary |
| Lattice pitch (cm) | ~ 11 |
| Coolant medium | D2O |
| Moderator medium | D2O |
| Reflector medium | D2O |
| Reflector thickness (cm) | ~ 50 |
| Purity of D2O | ~ 99.8% |
| Mass of D2O (mtons) | ~ 60-70 |
| Yearly makeup | Yes |
| Keff | < 1.25 |
| Core Excess reactivity (pcm) | < 20000 |
| Cycle length (days) approximatly | ~ 250 |
| 239Pu at EoC (g) | ~ 850 |
| 239Pu purity at EoC | ~ 78% |
| 235U consumption | ~ 60% |
| Maximum Thermal Flux , E<0.625ev | ~ 3•1014 |
| Maximum Fast Flux, E>0.625ev | ~ 1•1014 |
| Minimum Thermal Flux , E<0.625ev | ~ 1•1014 |
| Minimum Fast Flux, E>0.625ev | ~ 1•1014 |
| Fluid velocity in channels (m/s) | ~ 3.8 |
| Channel mass flow rate (kg/s) | ~ 2.4 |
| Working pressure (MPa) | 0.33 |
| Fluid inlet temperature (oC) | ~ 47 |
| Fluid outlet temperature (oC) | ~ 78 |
| Core material | Mainly S.S. 304 |
| Core wall Thichness (mm) | ~ 30 |
| Fuel Pellet Diameter (cm) | ~ 0.65 |
| Inner Clad Diameter (cm) | ~ 0.67 |
| Outer Clad Diameter (cm) | ~ 0.8 |
| Number of pins per assembly | 12 |
| Mass of UO2 in full core load (Kg) | ~ 350 |
| Core diameter (cm) | ~ 240 |

**5. Arak Modernisation Project**

5.1. As described in Section B of Annex I, an international partnership composed of E3/EU+3 parties and Iran, which may subsequently be enlarged to include mutually determined third countries will be established, to support and facilitate the redesign and rebuilding of the IR-40 reactor at Arak into a modernised, not exceeding 20MWth, heavy-water moderated and cooled research reactor, based on the agreed conceptual design (as attached to Annex I).

**6. Nuclear Fuel**

6.2. E3/EU+3 parties will seek to cooperate regarding the supply of modern fuels, including, as appropriate, joint design and fabrication, the relevant licenses and fabrication technologies and equipment and related infrastructure, for current and future nuclear research and power reactors, including technical assistance on purification processes, forming and metallurgical activities for different types of nuclear fuel clads and cladding for the modernised Arak heavy water research reactor.

**Annex IV – Joint Commission**

**2. Functions**

2.1. The Joint Commission will perform the following functions:

2.1.1. Review and approve the final design for the modernized heavy water research reactor and the design of the subsidiary laboratories prior to the commencement of construction, and review and approve the fuel design for the modernized heavy water research reactor as provided for in Section B of Annex I;

**Annex V - Implementation Plan1**

**A. Finalisation Day**

**B. Adoption Day**

12. E3/EU+3 participants and Iran will begin discussions on an official document to be concluded in advance of Implementation Day which will express strong commitments of the E3/EU+3 participants to the Arak Heavy Water Reactor modernisation project and define the responsibilities assumed by the E3/EU+3 participants.

**C. Implementation Day**

14. Implementation Day will occur upon the IAEA-verified implementation by Iran of the nuclear-related measures described in paragraph 15 below, and, simultaneously, the E3/EU+3 taking the actions described in paragraphs 16 and

17 below, and with the actions described in paragraph 18 below taking place at

the UN level in accordance with the UN Security Council resolution.

15. **Iran will implement the nuclear-related measures as specified in Annex I**:

15.1. Paragraphs 3 and 10 from Section B on "Arak Heavy Water Research Reactor";

15.2. Paragraphs 14 and 15 from Section C on "Heavy Water Production Plant";