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| C:\Users\tarykin\Desktop\LOGO-Full Wording-P301.jpg | **MOSCOW CENTRE**  **WANO-MC**  25 FERGANSKAYA, MOSCOW, 109507, RUSSIA  PHONE: +7 495 376 15 87  FAX: +7 495 376 08 97  INFO@WANOMC.RU |

**Appendix 2**

**Advanced Information Package**

# WANO-МC, Technical Support Mission:

*" Procedure for justification of application of TVS-2M in WWER-1000 nuclear power plant "*

*Bushehr NPP, 01-05 July 2017.*

# Part 1. GENERAL INFORMATION

# Site Address And Contacts

**Address**

Site Address : Bushehr NPP, Bushehr, Iran

Phone: +98 77 3 111 2585

Fax**:** +98 77 3 111 2710

**Contact Person** (Logistic Issues Coordinator) *(responsible of the NPP / organizations for accommodation, transport, meals, entry permission, interpreters and organizational matters)*

Name, Surname: Rasoul Mahmoudi

Position: Manager of Managing Director Office, Public Relations & International Affairs

Phone: + 987731112585

Fax: + 987731112586

Mobile phone: +989171733734

e-mail: bnpp@nppd.co.ir

**Host Interface Representative** *(for technical issues TSM – customer mission)*

Name Surname: Hedayat Abbaspour

Position: Deputy for Safety

Phone: + 987731112592

e-mail: Abbaspour@nppd.co.ir

**Site Representative of WANO Moscow Centre** (TSM Coordinator)

Name Surname: Hamid Azarbad

Position: Site representative

Phone: + 987731117535

Mobile phone: + 989173516368

e-mail: [azarbad@nppd.co.ir](mailto:azarbad@nppd.co.ir); azarbad@wanomc.ru

# Logistics

*experts name, date and time of arrival/departure, flight number (train) and the name of the airline (will be provided by TSM Team Leader)*

*experts team transference from the airport (name of airport) to the hotel (name of hotel) on the first day and from the hotel to the airport on the last day*

*place at the airport where the experts team will be met by waiting person at the airport with identification nameplate "WANO Technical Support Mission"*

*phone number of waiting person*

*Other information needed and/or important for the experts during arrival/departure travelling*

*transportation of experts and meals during TSM carrying out*

**In Tehran**

Name: Mehdi

Surname: Tafti

Phone Number: +989123205781

Date and time of arrival/departure: 30 July from Moscow – 01 June Tehran to Bushehr / 05 June Bushehr to Tehran – 06 June to Moscow

Flight number: SU512 – SU513

Name of the airline: Aeroflot

Specify the place of the team experts meeting at the airport: Somebody (Mr. Tafti) holding a placard written “WANO” in Imam Khomeini Airport.

After arriving, team members will be transferred from Imam Khomeini international airport to Mehrabad Airport (Domestic flights). The distance between two airports is 45 minutes

**In Bushehr**

Name: Drayush

Surname: Gorgin

Phone Number: +989172682503

Date and time of arrival/departure:

Flight number: IR407

Name of the airline: IranAir Airlines

Specify the place of the team experts meeting at the airport: Somebody holding a placard written “WANO” in Bushehr Airport

Working hours for the plant personnel identified with 07:30 to 16:30.

# Accommodation

*Hotel address:*

***Tehran:*** *Grand Hotel, Vali-asr Street, Tehran, Iran*

***Bushehr:*** *Hotel Plus, Delvar Square, Bushehr, Iran*

*Information related to the*

1. *hotel rooms (desk with light, an electrical socket, internet connection, etc.)*
2. *meeting room*

* *desks or tables for the team members*
* *computer with USB connections*
* *local printer connected to the computer*
* *video projector and a screen*
* *flip chart*
* *white board*
* *power socket to connect lap-top computers*
* *plug adaptors, if necessary*

TSM meetings will be held in the administrative buildings of BNPP during the TSM. The main building is the BTC building (Training Center).

# Practical Advice

* 1. ***Weather conditions***

*(to specify the expected temperature for the period of the TSM, to give recommendations on clothing).*

When this technical support mission is held, Bushehr weather will be warm and humid. Temperature difference in day and night will not be tangible and the temperature range will be from 35 to 40 Celsius and humidity will exceed %70.

* 1. ***Financial Issues***

*(Availability of using the bank cards in the hotel, town, etc.)*

The currencies: used in Iran are dollars, euro, Rls

The exchange rate: At the present time; 1 dollar equals to 36000 Rls and 1 euro equals to 40000 Rls.

No credit or bank card can be used in Iran.

* 1. ***Food***

*(Recommendations for food, eating place, time)*

Please promptly report their dietary requirements and restrictions.

Main information on using the food in Iran: no pork, no alcohol

* 1. ***Medical issues***

*(Availability of medical aid, etc).*

* 1. ***Circuit voltage***

*(voltage of network, etc.)*

For KS devices: 220 V

* 1. ***Other information***

It is forbidden to bring or drink any alcoholic beverages throughout the station.

Smoking is permitted only in designated areas. Smoke elsewhere prohibited.

# SITE ACCESS.

* 1. ***Access to the plant***

*Information related to the organization formalities.*

After obtaining permits for members of the TSM team will be given instruction on compliance with radiation, fire and industrial safety.

Details on the physical protection of nuclear power plants, radioactive, toxic, reactive, flammable liquid substances and incendiary devices, drugs and alcohol are the same as the other NPPs and other details will be reminded at the time of entering the NPP.

Using video - equipment, mobile phones with built-in cameras), recording equipment is forbidden in the controlled area.

* 1. ***Team workplace***

*Information related to the team location at the plant during the TSM:*

* *desks or tables for the team members*
* *computer with USB connections*
* *local printer connected to the computer*
* *video projector and a screen*
* *flip chart*
* *white board*
* *power socket to connect lap-top computers*
* *plug adaptors, if necessary*
* *internet*
  1. ***Dress code***

Information related to the preferable clothing during the WANO TSM Mission.

Formal shirts and pants during TSM- (due to weather may be without the customary coat)- (in Bushehr shorts not common)

* 1. ***Safety Rules And Emergency Response***

*Information related to the:*

* *summary of rules related to the general safety*

Being on the territory of the NPP team members may only be accompanied by a specially assigned plant personnel.

Movement on plant area is permitted in accordance with the established safe routes.

* *summary of behavior in emergency situations*

In case of any emergency conditions in NPP, experts should observe the rules based on the briefing made at the time entering NPP.

* *other important information*

Through briefing, they will be provided with the required rules.

*.*

# General NPP Information

Construction of Bushehr NPP in IRI started in 1975 by the German company «KWU» (subsidiary of the company "Siemens"). After the February Islamic revolution in 1979 the contract was terminated and the construction of the plant was ceased.

On August 24, 1992 the governments of Iran and Russia signed the contract on cooperation in the field of the peaceful use of atomic energy and construction of nuclear power plant on the territory of IRI.

In January 1995 VPO «Zarubezhatomenergostroy» and Atomic Energy Organization of Iran (AEOI) signed the contract on construction completion of unit 1 of Bushehr nuclear power plant.

Unit №4 of Balakovo NPP (В-320) is the reference unit for Bushehr NPP unit № 1.

Basic distinguishing features of Bushehr NPP compared to the reference unit are:

* Integration of the Russian design to the civil part constructed under KWU design ,
* RP with reactor containing 121 CPS drives, reactor vessel with enlarged height, upgraded SG and RCPS and new elements of earthquake-proof fastening of equipment and pipelines,
* Additional hydraulic accumulators of emergency core cooling system when BDBA,
* Four safety channels,
* New APCS on the basis of soft and hardware.
* Big amount of earthquake-proof measures for the NPP (Bushehr NPP is designed to withstand the intensity of 9 magnitude)

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| **Commissioning stages** | **Date** |
| **Preparatory works (stage 0);** | **06.2006** |
| **Pre-operational tests (stage А);** | **25.10.2010** |
| **Fuel loading, initial criticality and low power test (stage В);** | **20.05.2011** |
| **Power test, achievement of rated power (stage С).** | **09.09.2013** |
| **Stage «Power unit trial operation»** | **22.09.2013** |
| **Signing of report Н-9 «Preliminary acceptance of the power unit by the Principal»** | **23.09.2013** |

# NPP Structure

* The structure of nuclear power plant is sent attached.
* Macro-Organization of the Operating Company of Bushehr NPP in Appendix A.1 in Russian and English languages

# NPP Organization

NPPD

# List Of Counterparts

|  |  |
| --- | --- |
| Name | **Position** |
| Hedayat Abbaspour | **Deputy of Safety** |
| Reza Banazade | **Deputy of Chief Engineer for Maintenance** |
| Mohsen Moazzen | **Substitute of Safety Deputy** |
| Saeed Gol | **Manager of Fuel and Nuclear Safety** |
| NPP experts |  |
|  |  |

# WANO Performance Indicators NPP

It is less than 0.037 Bq/gr (It is calculated -0.16)

# The Events at the NPP on the subject of TSM

# Info on the Internet

# Part 2 PROBLEM AREA / PROCESS

# Description of problem

Based on Fuel Supplier Proposal, the operating organization of BNPP-1 (Nuclear power Production and Development Company of Iran) has decided to modify its fuel type and use the new type fuel (TVS-2M) instead of current fuel (AFA). To assure the BNPP-1 safety and reliability during the transition to new type fuel, WANO was requested to hold a technical support meeting with the subject of “Exchange of experiences on migration to new nuclear fuel assemblies (TVS-2M) in WWER 1000 reactors, with emphasis on Tianwan NPP experience”. The following outcomes are foreseen to be achieved:

1-The management process in decision making during transition to new type fuel including strategy/roadmap selection and technical and commercial issues;

2-The other NPPs (specifically Tianwan NPP) experiences in the transition of NPP core to new type fuel;

3-The completeness of documentation, submitted by the Contractor, necessary for the Licensing and operation

4-Introducing and comparing other western and Russian fuels of the new generation (third generation) with the Fuel TVS-2M;

5-Criteria for choosing important parameters (particularly the length of the cycle) considering the conditions of hybrid technology of BNPP Unit-1 (German-Russian);

6-How to unify the energy released in the core volume when using the hybrid uranium-gadolinium fuel rods (as the poison used) instead of СВП rods, as well as comparing the performance of these two type of poisons;

7-How to choose the layout of fuel assemblies for the transition period from UTVS to TVS-2M (transition period is from the time of starting to use the fuel TVS-2M until all of fuels in the core will be TVS-2M type)

8-Comparing the parameters of neutron physics such as Ql, Kv, Kq ,…( and also coefficients and effects of coolant and fuel temperature as well as the pressure and density on the reactivity) of two WWER-1000 plants with 4-year cycle (10 month of operation and length of approximately 300 effective days) that one of them uses the UTVS fuel and the other one uses TVS-2M fuel; as well as a review of their changes within the cycle;

9-Considering the fact that the diameter of fuel pellets increases by 0.03 (the energy generated by every rod increases due to increase of richness of rod), the space between the cladding and pellet decreases. The status of heat transfer and the manner of temperature distribution and its effect on the parameter DNBR should be explained;

10-The effect of using the blanket on the core parameters specially on the offset, within the transition period from UTVS to TVS-2M (transition period is from the time of starting to use the fuel TVS-2M until all of fuels in the core will be TVS-2M type);

11-Considering the effective length change of the fuel assemblies, the manner of using Control Rods within the transition period from the UTVS to the TVS-2M (transition period is from the time of starting to use the fuel TVS-2M until all of fuels in the core will be TVS-2M type) should be reviewed;

12-Introducing and reviewing the changes in the systems, equipment and software which are used in other plants during the transition from the UTVS to the TVS-2M; as well as providing recommendation for making the minimal changes and the most economical condition possible in the BNPP-1;

13-In regard to the fact that it is said that there is no need for making changes in the secondary circuit and with taking into the account the possibility of increase of power (up to %107 for 18 month cycle), the method for creating thermal balance between the primary circuit (with changes) and the secondary circuit (without change) should be explained;( discussion on the required conditions for power uprating to 104% or more, considering need to modernize systems and equipment especially turbo generator of the Unit should be done) ;

14-Considering the possibility of creating a 18-month cycle and also to achieve higher power, the equipment service life (in terms of effect of radiation on material) should be reviewed and compared (specially the reactor and related equipment);

15-Comparing the remaining heat of the spent fuel in the Pool containing the UTVS fuel and the pool containing a mixture of UTVS and TVS-2M fuel for a specified time period;

16-Required changes and recommendations for the transition period from the 10-month cycle of the fuel TVS-2M to the 12-month cycle of the fuel TVS-2M and then transition from that to the 15-month and 18-month cycles of the fuel TVS-2M

17-Comparative review of two WWER-1000 Plants with 4-year cycle (10 month of operation and length of approximately 300 effective days) that one of them uses the UTVS fuel and the other one uses TVS-2M fuel in terms of nuclear safety and radiation safety;

18-Discuss about Experiences to achieve 18 months fuel campaign on the following items:

-Prerequisites to achieve 18 months fuel campaign;

-Systems and equipment needed to be modernized;

-Probable changes on fuel enrichment and number of fuel assemblies for each fuel cycle;

- An overall cost estimation for the required activities and documents;

-The possible advantages and disadvantages of migrating to 18 months fuel cycle.

# Description of areas for improvement (if the problem is related to this area)

# The cause of the problem

# *The transition to new type fuel is the first design change of BNPP-1. The lack of knowledge in transition from old fuel assemblies with new type fuel assemblies in BNPP-1 (TVS-2M) may cause some risks in BNPP-1 indexes of safety, reliability and economy.*

# Organization of process related to the problem

# Additional information important for understanding the problem

# NPPD strategy in transition to new type fuel:

# The implementation of four-year fuel cycle with annual loading of 42 fresh TVS- 2Ms into the core that is 6 pieces less than the today makeup.

# The implementation of 18-month or 5-year fuel cycles considering the necessity of work performance on the modernization of the Unit equipment and systems, after the implementation of four-year fuel cycle based on TVS-2M.

# The list of documents of the NPP associated with the topic of the TSM

# Feasibility study report on TVS-2M implementation at BNPP-I (446-PR-176);

# List and description of procedures for justification of TVS-2M introduction in

# Bushehr NPP;

# Detailed description of reports on TVS-2M implementation project;

# Calculation of thermal-mechanical behavior of UTVS in the core of BNPP-1, Selection of the optimal strategy of introduction of rigid skeleton FA (446-PR- 186).

# Expected Result Of TSM

# WANO recommendations about:

# How to justify the safe transition from the AFA to TVS-2M, with emphasis to

# the safety justification of the fuel of standard height (UTVS) to the fuel of

# increased height (TVS-2M);

# Sufficiently of the prepared list of the necessary activities, description and content of documents and services on justification of TVS-2M implementation and related applications;

# Sufficiently of the predicted modification in BNPP-1 systems and equipment:

# The WANO experts point of view about NPPD strategy in transition to new type fuel;

# Planning a comprehensive roadmap to receive WANO assistance during transition to new type fuel;

# Additional comments