## Data from the PRIS IAEA to verify or modify

Table: Design Characteristics, Bushehr-1 (according to the PRIS/IAEA).

Please kindly check, modify or provide correct values if relevant.

Please kindly check/confirm especially information in yellow lines.

| Systems | Response from the End-User |
| --- | --- |
| Primary Systems |  |
| 1 | Reactor pressure vessel |   |  |
| 2 | Reactor vessel shape  | Cylindrical, Hemispherical End | OK |
|   | Reactor vessel centreline orientation | Vertical | OK |
|   | Reactor vessel material | Alloyed Steel | основной металл- сталь 15Х2НМФА |
|   | Reactor vessel material specification | 15Ch2MFA; 2,5%Cr0.6°Mo0,25%V | 15Х2НМФА(Содержание:% от масса,не более:Меди-0.08%,Серы-0.012%,Фосфора-0.010%,Мышьяка-0.010%, Олова-0.005%,Сурмы-0.005%,сумарное содержание Фосфора, Сурмы, Олова<0.015% масс )15Х2НМФА класс 1-для обечаек активной зоны(Содержание:% от масса,не более:Меди-0.080%,Серы-0.015%,Фосфора-0.012%, Кобальта-0.020%)15Х2НМФА-А(для крышки) (Содержание Кобальта<0.03% ) |
|   | Vessel cladding material | Stainless Steel | Внутренняя поверхность корпуса плакирована аустенитной наплавкой. |
|   | Vessel cladding material specification | 08%Cr18%Ni10%Ti | сталь 08Х18Н10Т |
|   | Reactor vessel overall length/height [m] | 11.18 | 11.185m |
|   | Inside shell diameter [m] | 4.13 | 4.15 mDiameter of the vessel cylindrical part in the core area |
|   | Shell thickness [mm] | 199.5 | 192.5 mm |
|   | Reactor Core  |   |  |
|   | Fuel assembly geometry  | Hexagonal |  |
|   | Fuel Form | Pellets |  |
|   | Fuel material | UO2 |  |
|   | Refuelling type  | OFF-line |  |
|   | Moderator material | H2O |  |
|   | Fuel clad material  | Zirconium Alloy |  |
|   | Fuel clad material specification |   |  |
|   | Average fuel enrichment [% of U235] | 2.45 |  |
|   | Refuelling frequency [month] | 10 |  |
|   | Part of the core refuelled [%] | 33 |  |
|   | Average discharge burnup [MWd/t] | 43000 |  |
|   | Active core diameter [m] | 3.16 |  |
|   | Active core height/length [m] | 3.53 |  |
|   | Number of fissile fuel assemblies/bundles  | 163 |  |
|   | Fuel weight [t] | 79.840 |  |
|   | Moderator weight [t]  | 391 |  |
|   | Number of fuel elements per assembly/bundle | 311 |  |
|   | Fuel clad thickness [mm] | 0.685 |  |
|   | Average core power density [kW/dm3] |   |  |
|   | Average fuel power density [kW/kgU] |   |  |
|   | Fuel linear heat generation rate [kW/m] | 16.67 |  |
|   | Reactivity control  |   |  |
|   | Control rod material  | Boron Carbide |  |
|   | Burnable neutron absorber material | Other - CrB2+Al |  |
|   | Burnable neutron absorber material specification |   |  |
|   | Soluble neutron absorber material | Boric Acid H3BO3 |  |
|   | Secondary shutdown system |   |  |
|   | Number of control rod assemblies | 103 |  |
|   | Reactor coolant system  |   |  |
|   | Number of external reactor coolant loops  | 4 |  |
|   | Coolant type | H2O |  |
|   | Coolant weight [t] | 391.6 |  |
|   | Operating coolant pressure [MPa] | 15.7 |  |
|   | Reactor outlet temperature [°C] | 321 |  |
|   | Reactor inlet temperature [°C] | 291 |  |
|   | Coolant mass flow at the rated power [t/h] | 84800 |  |
|   | Steam generators (SG)/drum separators |   |  |
|   | Type of SG  | Horizontal | OK |
|   | SG output | Saturated Steam | OK |
|   | Number of SG | 4 | OK |
|   | Tube shape  | U-tube | OK |
|   | Tube material | 08CH18N10T SS | OK |
|   | SG shell material | 10GN2MFA alloyed carbon steel | OK |
|   | Design thermal capacity per SG [MW] | 753 | OK |
|   | Design heat transfer surface [m2] | 6115 | OK |
|   | Main coolant pumps/circulators |   |  |
|   | Total number of pumps/circulators | 4 | OK |
|   | Number of pumps per RCS loop | 1 | OK |
|   | Pump motor rating [MW]  | 5 | OK |
|   | Design pressure difference [MPa] | 0.588 | OK |
|   | Pressurizer  |   |  |
|   | Total volume [m3] | 79 | OK |
|   | Number of safety valves | 3 | OK |
|   | Number of relief valves | 3 | OK |
|   | Installed heater power [kW] | 2520 | OK |
|   | Containment systems |   |  |
|   | Containment type  | Double | OK |
|   | Containment Shape | Spherical | OK |
|   | Containment structure | Reinforced Concrete+Steelstrained steel containment | СЗО представляет собой герметичную конструкцию сферической формы диаметром –56м., сваренную из листовых заготовок (штампованных сегментов). Сегменты изготовлены из теплоустойчивой, высокопрочной стали BH51WS. |
|   | Pressure suppresion system | Spray | OK |
|   | Total containment volume [m3] | 91654 | Геометрический объём СЗО, за вычетом объема, занимаемого железобетонными конструкциями и оборудованием реакторной установки, составляет– 71040 м3 . |
|   | Number of containment spray pumps | 4 | OK |
|   | Containment design pressure [MPa] | 0.46 |  |
|   | Design leakage rate [% per day] | 0.25 |  |
|   | Type of H2 recombiner  | Passive | OK |
|   | Emergency core cooling systems |   |  |
|   | Number of HPSI systems  | 4 | OK |
|   | Number of LPSI systems | 4 | OK |
|   | Number of hydroaccumulators | 12 | OK |
|   | HPSI systems pressure [MPa] | 5 | OK |
|   | LPSI system pressure [MPa] | 0.9 | OK |
|   | HPSI system flowrate [t/h] | 200 | OK |
|   | LPSI system flowrate [t/h] | 1102 | OK |
|   | Reactor protection system |   |  |
|   | Control equipment technology  | Digital/Analog | OK |
|   | Number of independent system divisions | 2 | OK |
|   | Engineered Safeguard Feature Actuation System |   |  |
|   | Control equipment technology  | Digital/Analog | OK |
|   | Number of independent system divisions | 4 | OK |
| Secondary systems |  |
|   | Turbine |   |  |
|   | Turbine type | Saturated steam |  |
|   | Number of turbine-generators per unit/reactor | 1 | OK |
|   | Turbine speed [rpm] | 3000 | OK |
|   | Number of HP cylinders per turbine  | 1 | OK |
|   | Number of IP cylinders per turbine |  no | OK |
|   | Number of LP cylinders per turbine | 3 | OK |
|   | HP cylinder inlet steam pressure [MPa] | 5.88 | OK |
|   | HP cylinder Inlet steam moisture [%]  | 0.5 | OK |
|   | HP cylinder inlet steam temperature [°C] | 274.3 | OK |
|   | HP cylinder Inlet steam flow rate [t/h] | 5980 | OK |
|   | Main generator  |   |  |
|   | Rated active power [MWe] | 1000 | OK |
|   | Rated apparent power [MVA]  | 1176.47 |  |
|   | Output voltage [kV]  | 27 | OK |
|   | Output frequency [Hz] | 50 | OK |
|   | Main condenser |   |  |
|   | Primary means of condenser cooling | Sea (once-through) | OK |
|   | Number of condensers per turbine-generator | 2 | OK |
|   | Condenser tube material  | Titanium | OK |
|   | Number of main condensate pumps  | 3 | OK |
|   | Number of main condensate pumps required for full power | 2 | OK |
|   | Condenser vacuum at the full power (absolute pressure) [kPa] | 7.55 | OK |
|   | Feedwater system |   |  |
|   | Number of motor-driven main feedwater pumps | 3 | OK |
|   | Number of feedwater pumps required for full power operation | 2 | OK |
|   | Feedwater discharge pressure [MPa] | Максимальное давление на выходе из насоса с учетом плюсового допуска, МПа, не более 9,8 | OK |
|   | Steam generator feedwater inlet temperature [°C] | 220 | OK |
|   | Auxiliary / Emergency feedwater |   |  |
|   | Number of electrical motor-driven pumps | Auxiliary= 2(RR12,22D001)Emergency =4(11RS12D001,12RS22D001,13RS32D001,14RS42D001) | OK |
|   | Number of diesel driven pumps | no | OK |
|   | Number of turbine driven pumps | no | OK |
|   | Fire protection system |   |  |
|   | On-site fire suppression/extinguishing system | Water+Supplementary chemical systems |  more explanation, please |
|   | Fire retardant cable coating used for |  more explanation, please |  |
|   | Cable segregation within the unit used for  |  more explanation, please |  |
|   | On-site fire brigade  |  more explanation, please |  |
|   | Off-site fire brigade response time |  more explanation, please |  |
|   | Emergency power supply systems |   |  |
|   | Number of alternate power sources from the transmission grid (standby transformers available per unit)  | 2 | OK |
|   | Number of on-site safety related diesel generators (available per unit) | 8 | OK |
|  |  |  |  |
|   | Number of on site non-safety related diesel generator | 1 | OK |
|  |  |  |  |
|   | Other on-site emergency AC power sources |  2 |  |
|   | Estimated time reserve of the batteries at full load [h] | 1 | 2 |
|   | Total installed capacity of the on-site emergency power sources per unit [MW] | 24.9 | 24.8 |
|   | Total battery capacity [Ah]  | 1500 | OK |
| Spent fuel storage |  |
|   | Reactor building spent fuel pool capacity (number of spent fuel assemblies) | 639 |  |

### Questions to the End-User

1) In the Table 18.4 please kindly check/confirm information in yellow lines. This information will be used for inventory of the reactor core initial calculation.

2) Please kindly provide information what is the state of the SFP which should be assumed by ESTE Bushehr for inventory of the SFP calculation.

If it is possible, please let us know what is the number of spent fuel assemblies discharged to the pool?

How old are groups of these assemblies?/fuel from how many refueling periods has been placed into the pool?

This information will be used for initial calculation of the SFP inventory.

3) Please kindly confirm information on the design leakage rate of the containment (0,25% per day). This value or other value provided by End-User will be applied in the process of calculation of source terms database.

Is there any free space between inner and outer containment (of double containment structure)? Yes, there is.

Is/can be the free space between inner and double containment ventilated to the stack? Yes,it can be ventilated to the stack .

If yes, are there in the pathway to the stack any aerosol and iodine filters, which would be applied in case of emergency conditions? Yes, there are aerosol and iodine filters in the pathway to the stack.

4) Please kindly provide information on possible pathways for release in case of “interfacing system LOCA”. Вытяжная система TL09 предназначена для создания разрежения в герметичной оболочке с целью предотвращения выхода загрязненного радиоактивными веществами воздуха за пределы гермообъема через неплотности в строительных конструкциях.

Воздух из помещений герметичной оболочки перед выбросом в атмосферу через высотную венттрубу проходит двухступенчатую очистку в фильтровальной установке от радиоактивных аэрозолей и йода.

Предусмотренная проектом система TL10 обеспечивает ограничение выхода протечек радиоактивных веществ в окружающую среду за счет поддержания разрежения в межоболочном пространстве. Поступающие в межоболочное пространство радиоактивные вещества перед выбросом их в атмосферу через венттрубу проходят очистку от аэрозолей и йодов на фильтровальной установке.

При течах в пределах гермообъема, сопровождающихся неэффективной работой спринклерной системы и повышением давления более 0,46 МПа, для исключения повреждения гермооболочки, сопровождающегося большими выбросами радиоактивных материалов, штабом по управлению запроектной аварией может быть принято решение о снижении давления под гермооболочкой путем частичного сброса давления через систему вентиляции. Для этих целей могут быть использованы линии вытяжной системы вентиляции TL09 с арматурой TL09S001,002,003,004,020,021 в случае наличия электропитания для управления указанной арматурой. При этом выброс радиоактивных продуктов осуществляется через фильтры в венттрубу.

Are some pipes and tanks of ECCS placed outside containment? Yes , Some pipes and tanks of ECCS placed in the ZB building.

Can be the structures and parts (pipes, tanks) of ECCS assumed as potential pathway for by-pass of containment in case of leak from primary circuit to the ECCS ?

Can the system of essential service water (pipes, tanks) be assumed as potential pathway for bypass of containment in case of leak from primary circuit to the ESW system?

This information provided by End-User will be applied in the process of calculation of source terms database for ESTE Bushehr.